A Study of the Waterfowl Populations on Lough Carra, County Mayo, 1967-2006

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I hereby declare that this thesis is my own work

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Abstract

This study examined the population fluctuations of nine waterfowl species on Lough Carra in County Mayo by comparing count data from two waterfowl counting programmes conducted from 1967 to 1980 and 1995 to 2006. It also examined the population fluctuations of a further six waterfowl species from 1995 to 2006. To add to existing population data, a total of 36 waterfowl counts were conducted as part of the study over 22 months from November 2004 to August 2006. Comparative breeding surveys on ten islands on the lake were undertaken during 2005 and 2006 to compare current breeding populations to those from 1968 to 1973. To develop hypotheses in relation to the decline in the populations of certain species, predation and negative habitat changes were investigated. The research for this element of the study included island vegetation mapping, reedbed analysis and the investigation into habitat changes in two of the lake's sub-catchments. This study found that seven duck species have severely declined on Lough Carra since the 1960s/70s with Teal (*Anas crecca*), Pochard (*Aythya ferina*) and Mallard (*Anas platyrhynchos p*) populations down by 91%, 89% and 88% respectively. The once nationally recognised Mallard breeding population has crashed largely due to high levels of predation and the loss of breeding and feeding habitat. The American Mink (*Mustela vison*) has predated the nests of Mallard and Tufted Duck (*Aythya fuligula*) but evidence also shows that it preys upon adult and juveniles of those species as well as Moorhen (*Gallinula chloropus*) and Teal. Using recognised scientific methods, this study has highlighted the large-scale declines in the populations of waterfowl on Lough Carra, it has provided important data which will contribute to future management and in addition to building upon previous studies, lays a new foundation for further research at the lake.

Chapter 1: Introduction

1.1 The Study Area

Lough Carra lies in the north west of Ireland and in the southern half of County Mayo, it forms part of a chain of five great lakes which cover the two counties of Mayo and Galway (see Map 1). This chain (known as 'The Great Western Lakes') starts with Loughs Conn and Cullin in North Mayo near Killala Bay and extends south in the order of Loughs Carra, Mask and Corrib respectively, the tip of the latter ending in the River Corrib which flows into Galway Bay in the south of that county. The lake and region have a colourful past with evidence of a rich and varied history which tells the story of human settlement from the Neolithic (Stone Age) up to modern times. On Carra's numerous islands and lakeshore stand the ruins of churches, abbeys, castles, a nunnery and a promontory fort. An ancient dug out canoe measuring 16 feet in length and 3 feet wide was found on one of the islands (Stronach, 1981) and the remains of a crannog or artificial island dating from between the Bronze Age and early Christian period can still be seen in the southern end of the southeast basin. The lakeshore is also the idyllic setting for a number of old estates or demesnes including Partry House, Cloonee (home for a period to the renowned ornithologist Major R.F. Ruttledge) and probably most famously, Moore Hall which today stands in ruins at the northern end of the southeast basin. The well known author and historical figure, George Moore from Moore Hall is buried on Castle Island not far from his old family home.

Covering an area of approximately 4,000 acres and measuring six miles in length and two miles at its widest, Lough Carra is unique in being recognised as the largest marl lake in Ireland. Stronach (1981, p. 8) states, "The lake is situated in a Carboniferous Limestone area of the Caninia zone which extends eastwards to the central basin of Ireland". The marl (a mixture of clay and lime which enters the water as calcium carbonate and precipitates to the lake floor) reflects the geology of the area and gives the lake bottom its white or cream colour which is clearly visible in its shallow waters and encrusting the rocks on the lakeshore where the water levels drop during the summer months. Lough Carra is not fed by any large inflowing river but by naturally occurring springs and small streams such as Annie's River which enters the lake on its eastern shore below Moore Hall (also known as Moorehall or Muckloon).

Map 1. Map showing location of region and the western lakes including Lough Carra.

(Map produced from Microsoft Encarta 2001).

The lake's out-flowing waters drain out at its southern end through the Keel Canal which connects it to its larger neighbour, Lough Mask. The waters of Lough Carra are mostly shallow reaching only five to ten feet in depth but there are areas of the lake known to some locally as 'pike holes' which run to depths of 60 feet (Stronach, 1981).

A diverse range of natural and semi-natural habitats and associated flora and fauna surround Lough Carra. The old estates are encompassed by woodland containing stands of Sessile Oak (*Quercus petraea*), Horse Chestnut (*Aesculus hippocastanum*), Sycamore (*Acer pseudoplatanus*), Hornbeam (*Carpinus betulus*) and a mixture of other deciduous species. However many have also been planted with Sitka Spruce (*Picea sitchensis*) and other members of the pine family for commercial forestry. Lough Carra's areas of Limestone pavement are reminiscent of the karst landscapes of the Burren in County Clare albeit in a smaller scale and in turn similar communities of limestone related species of plants and flowers can be found there. As (Anon, 1978, p. 27) notes,

> Of chief botanical importance in the area is Lough Carra. Its shores form the northern limit of several of the rare limestone plants of western Ireland, such as the Spring Gentian *(Gentiana verna)* and the Close-Flowered Orchid *(Neotinea intacta)*.

The botany of the area continues to be studied but in the late 1970s it was claimed that of the 26 varieties of orchids that are found in Ireland, 19 are to be found around Lough Carra (Anon, 1978). Much of the lake is surrounded by low lying agricultural land (Crowe *et al*. 2005) but the habitats found within the lake catchment are quite diverse and include limestone grassland, fen, peatland and in places woodland scrub where such species such as Hawthorn (*Crataegus monogyna*) and Hazel (*Corylus avellana*) grow in thick clumps right down to the lakeshore. Hazel scrub also grows abundantly across the limestone areas mentioned above. A number of smaller loughs and turloughs can also be found in the two sub-catchments of Annie's River and Ballyglass located to the east of the lake. These small loughs and turloughs such as Cloonboorhy Lough, the Carrownacon Loughs and the Mountpleasant School Turlough are fringed by reedbeds and incorporate wetland and tussock and pool vegetation in their surrounding habitats (Lockhart, 1982). Lough Carra itself is fringed by reedbeds (*Phragmites communis*) while beds of the bulrush (*Scirpus lacustris*) are clearly visible in many places. The 73 islands on the lake vary in size but following the natural progression of ecological succession most are heavily wooded by such species as Buckthorn (*Rhamnus cathartica*), Ash (*Fraxinus excelsior*), Sycamore (*Acer pseudoplatanus*), Elder (*Sambucus nigra*) and Willow (*Salix caprea*) with understories of Ivy (*Hedera helix*), Bramble (*Rubus fruticosus*) and Wild Rose (*Rosa sherardii*).

1.2 Previous Studies

All of these areas do not exist in isolation but overlap and are found side by side creating a mosaic of habitats supporting a plethora of biodiversity which is both nationally and internationally recognised. Therefore it is not surprising that Lough Carra has been the focus of much scientific research from as far back as the mid 19^{th} century right up to modern times. The much valued results of previous studies are a constant point of reference for comparative analysis and as a tool for monitoring the ecological state of the lake and its environs. One of the earliest references to research known, is that of a botanical record which involved the collection of specimens on the shores of Lough Carra in 1837. The geology of the Lough Mask/Lough Carra region was mapped by Kinehan, Symes and Nolan as part of the Geological Survey of Ireland with maps produced in 1869 and 1872 (Anon, 1978). One of Ireland's best known naturalists, Robert Lloyd Praeger, surveyed the flora of Lough Mask and Lough Carra in 1906 and published his findings in *The Botanist in Ireland* in 1934 and in articles such as 'On The Botany of Lough Carra' for the *Irish Naturalists' Journal.*

Chronologically, the next documented research on the lake centered on its birdlife and was carried out by the well known ornithologist Major Robert F. Ruttledge who resided at Cloonee on the shores of Carra for many years. Ruttledge, who founded the Irish Wildbird Conservancy (now BirdWatch Ireland), published the results from his fieldwork and his theories in a series of articles for such publications as *The Irish Naturalists' Journal, The Irish Bird Report* and *British Birds.* These included 'The Birds of Lough Carra' in 1916, 'Black Terns on Lough Carra, Co. Mayo' in 1918, 'The Sandwich Tern on Lough Carra' in 1928, 'The Birds of Loughs Mask and Carra and Surrounding District' in 1929, 'Spotted Redshanks and Greenshanks on Lough Carra' in 1943 and 'Bird Migration By The Overland Route Between Killala Bay and Galway Bay' in 1949 (Anon, 1978). As can be seen from the titles of these papers and from other published papers based on his fieldwork from elsewhere in the country, Ruttledge's studies could focus on a particular family of birds or on an individual species. His pioneering research also developed new theories on migration and species distribution. In later life his energy and enthusiasm never quelled and in his final years he was collecting data on sightings of the Blackcap in Ireland (Ruttledge, *pers. comm.*).

The late 1960s and 1970s were a fertile period for research at Lough Carra. From 1968 to 1972 the Irish Wildbird Conservancy (I.W.C.) and The British Trust for Ornithology (B.T.O.) carried out a breeding birds survey in Britain and Ireland with the results published in the book entitled *The Atlas of Breeding Birds in Britain and Ireland 1968-1972.* In Ireland this involved dividing the country up into 10 km squares and recording all the breeding species found in each. Lough Carra was included in this survey with contributions coming from Ruttledge amongst others on the breeding birds in and around the lake (Anon, 1978). In 1973 Kelly surveyed the scrub and woodland at Castlecarra and Derrinrush and on the islands of Hog and Castle, his studies culminated in an unpublished paper entitled 'The Woods at Lough Carra'. Two years later, in the summer of 1975, Shackleton carried out extensive research on the vegetation of Lough Carra which included taking water and soil samples, mapping the littoral vegetation and he trapped and identified moths in the reedbeds and fens around the lake. The results from this research can be found in the unpublished paper 'A Study of Certain Aspects of the Vegetation of Lough Carra' (Anon, 1978). Also in 1975 the Inland Fisheries carried out studies to assess the trophic status of Loughs Mask and Carra. Throughout the years they have also published reports on trout spawning and nursery facilities and the food of the Brown Trout in both lakes (Anon, 1978). Street of the Game Conservancy of England spent some time around the shores of Lough Carra sampling vegetation in relation to the food of wildfowl (Anon, 1978) and in 1977 Whilde produced a paper for *The Irish Naturalists' Journal* entitled 'The Autumn and Winter Food of Mallard (*Anas Platyrhynchos p.*) and Some Other Irish Wildfowl', in which he examined the stomach contents of Mallard (*Anas Platyrhynchos p*), Teal (*Anas crecca*), Tufted Duck (*Aythya fuligula*), Pochard (*Aythya ferina*), Wigeon (*Anas penelope*), Pintail (*Anas acuta*), White-fronted Goose (*Anser albifrons*) and of two wader species, Snipe (*Gallinago gallinago*) and Golden Plover (*Pluvialis apricaria*). All the birds were shot and supplied by local wildfowlers from various parts of the country including North Mayo and Ballinrobe near Lough Carra (Whilde, 1977).

In the early 1980s Lockhart surveyed and mapped vegetation in the Annie's River and Ballyglass region to the east of Lough Carra as part of a pilot Environmental Impact Assessment (E.I.A.) prior to a proposed drainage scheme for the two catchments and produced a report for the Department of the Environment in 1982. The avifauna of Lough Cara continued to be studied as part of two nationwide surveys during this period also. The first of these was the Winter Wetlands Survey (W.W.S) organised by the Irish Wildbird Conservancy in which volunteers from around the country counted the wildfowl and waders on the lakes, estuaries, bogs and other wetlands including Lough Carra. The data from the Winter Wetlands Survey was collated by Sheppard and published by the Irish Wildbird Conservancy under the title *Ireland's Wetland Wealth-The Report of the Winter Wetlands Survey 1984/85, 1986/87*. Shortly after, fieldwork for a second breeding birds atlas was carried out by the same organisations who co-ordinated the 1968-1972 survey (The I.W.C. and The B.T.O.), and coverage for County Mayo included Lough Carra. *The New Atlas of Breeding Birds in Britain and Ireland 1988 – 1991* was published in 1993.

In more recent times research has been carried out at Lough Carra by the scientist and conservationist, Chris Huxley and his wife Lynda. The Huxleys have been counting the waterfowl at Lough Carra on a monthly basis from September to March since 2000 as part of the Irish Wetland Bird Survey (I-WeBS) which is run by BirdWatch Ireland (formerly The Irish Wildbird Conservancy) and in 2003 Chris Huxley co-ordinated a project funded partly by the Heritage Council which involved carrying out new fieldwork and collecting existing data on the lake and its ecology. As well as the monthly waterfowl counts mentioned, this new research included a survey of the reedbeds using similar methodologies used by Shackleton (1975), vegetation mapping at Partry House estate, moth trapping, a butterfly and dragonfly survey, two breeding birds censuses and a survey of land use and farming practises on 34 farms from the Carra catchment (with John Thornton). Much of this research is on-going but the results from the fieldwork and research carried out in 2003 was published in a report to The Heritage Council entitled *The Ecological Status of Lough Carra and its Surrounding Habitats* (Huxley, 2003). Water quality at Lough Carra has also been the focus of recent studies; research in this area has been carried out by Mayo County Council and also by Dr. Ken Irvine and students of Trinity College Dublin and is on-going. The range and diversity of research projects carried out at Lough Carra and its neighbouring lakes were highlighted at a conference entitled 'The Great Western Lakes: Ecology, Heritage and Management' which was held in the Galway-Mayo Institute of Technology at Castlebar between 25th and 27th June 2004. Illustrated talks were given by a number of individuals and staff representing a number of agencies and organisations concerned with the welfare of the Great Western Lakes. A wealth of knowledge and information was imparted to a large audience covering the mediums of ecology, geology, archaeology, water quality research, fish stock studies, tourism, management issues and more.

All of the above research on Lough Carra has contributed to the overall knowledge of the lake and has built on previous studies. However, the longest and most intensive research project not yet mentioned was carried out for An Foras Taluntais and financed by the Department of Lands (Anon, 1978). This project studied the ecology of the waterfowl on Lough Carra and was co-ordinated by Brian Stronach.

1.3 The Study of Waterfowl on Lough Carra 1967 – 1980

Carried out over twelve years and with fieldwork conducted all year round, the State-backed study of the waterfowl found on Lough Carra was an indication of how important the site was for waterfowl both as a wintering and breeding habitat. The project initially started out as a study focused primarily on the Mallard (*Anas platyrynchos p)* but also included in its scope a further eight species of waterfowl found on the lake. As Lockhart (1982, p.1) notes,

> The major objectives of the project were to determine the value of the Mallard stocks as a renewable resource and to determine the most appropriate means of managing them for production and conservation purposes.

Starting at the latter part of 1967, An Foras Taluntais employed Brian Stronach to head the project with funding for extra manpower and equipment to carry out the different elements of the research. In his final report entitled *An Ecological Study of Waterfowl on Lough Carra* he states that,

> This study investigated the biology of the Mallard *(Anas platyrynchos platyrynchos)* and other waterfowl in the West of Ireland with particular reference to its numbers, population dynamics and breeding biology of Mallard

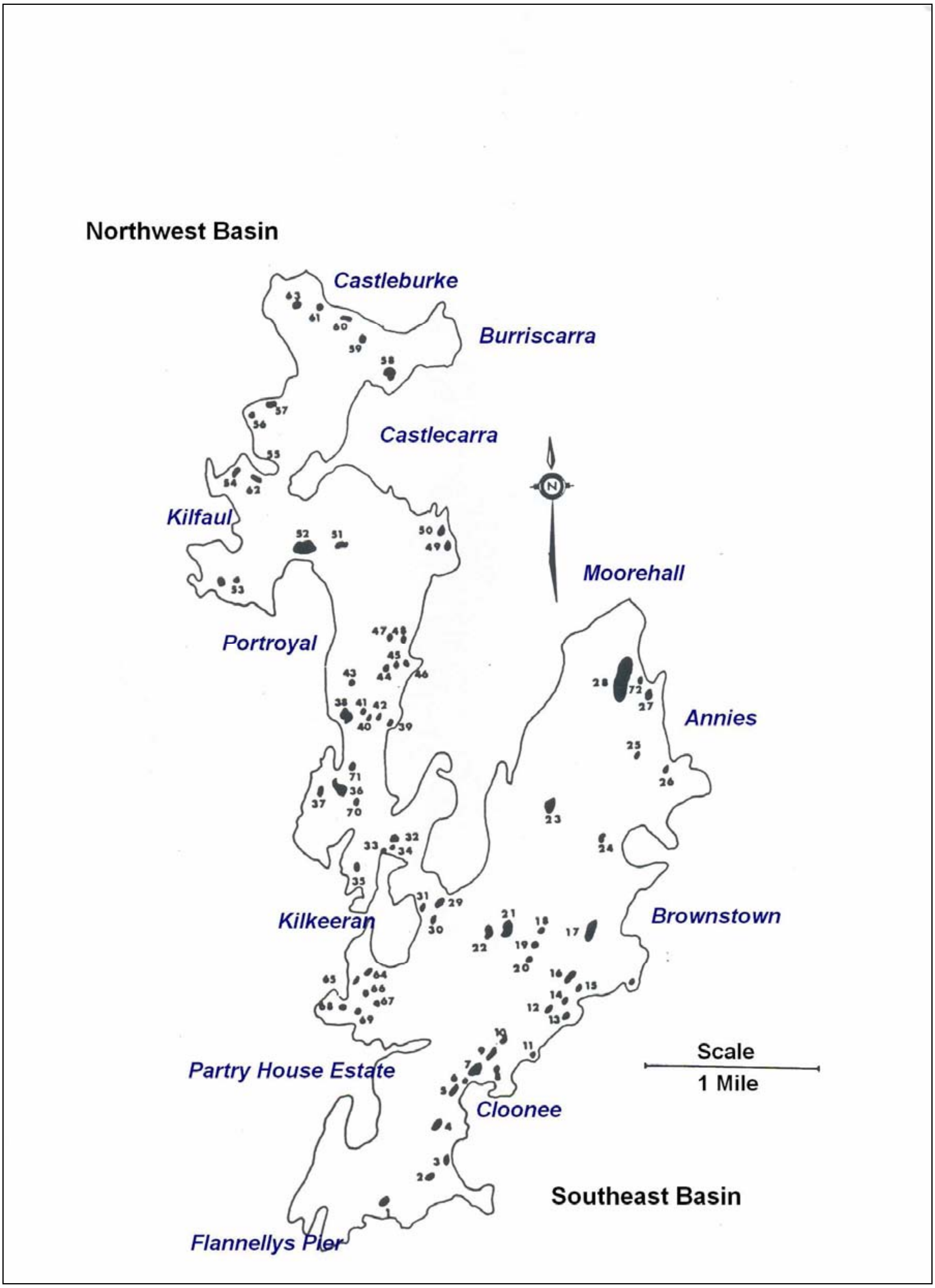
(Stronach, 1981, p. 1).

Stronach embarked on an ambitious programme of fieldwork working with teams of men, many of them from around the local area. Firstly they wanted to gather data on the overall waterfowl populations on the lake all year round. This was achieved by conducting weekly counts during the winter and fortnightly counts during the breeding/summer months. Stronach decided to count the waterfowl by boat following the exact same route each time by using census transects. In addition to these counts, a programme of bird trapping for ringing purposes was also carried out; through the information supplied by the capture/recapture of ringed birds, the data produced also helped in assessing population dynamics, dispersion and survival/mortality rates (Stronach, 1981). To gather information on the breeding populations and more specifically Mallard (*Anas platyrhynchos p*), Stronach and teams of men with Springer Spaniels surveyed the 73 islands (see Map 2) on the lake during the breeding season and those holding nests were continuously visited once a fortnight from 1968 to 1973 (others were visited occasionally to ensure nests did not go unrecorded). Nest numbers, locations, clutch sizes and breeding success were all recorded. Lastly, two experiments were carried out at the site. The first experiment involving predator control was mainly conducted to see if the lowering of Hooded Crow *(Corvus corone cornix)* numbers on the islands would help boost the populations of breeding Mallard but it also examined predator/prey relationships. The second which Stronach described as a 'habitat manipulation experiment' was carried out in 1971 and involved tree cutting on one of the islands to establish a relationship between vegetation, nest success and density (Stronach, 1981).

The waterfowl project involved a lengthy programme of all year round research, this fieldwork gathered data using scientific methods, on the waterfowl populations of Lough Carra. This type of data was especially relevant in Ireland as little or no waterfowl research was taking place at the time. Stronach (1981, p. 17) states,

> At the start of this study a review of the literature showed that little was known about Mallard numbers in Ireland. Estimates had been made in Britain (Boyd, 1963) but no mention was made of numbers in Ireland by Ruttledge (1966), or by Kennedy *et al* (1954). There was no mention of the Lough Carra populations in either of the Irish studies. There was no accurate waterfowl census undertaken in Ireland until the I.W.C (Irish Wildbird Conservancy) took part in the I.W.R.B.'s (International Waterfowl Research Bureau) international counts in the early sixties. Lough Carra was not included in these counts either so there are no comparative data.

Map 2. Lough Carra with main areas and islands numbered by Stronach. Map by Stronach (1981) with annotation by Meehan.



Although it ran from 1967 to 1980, it appears the project did have its 'glory years' and as Lockhart (1982) points out, it was run with varying degrees of intensity over the course of its lifetime. The first six years were the most productive in terms of the rate of fieldwork being carried out; this could reflect the fact that Brian Stronach was most involved during this period. Michael Sweeny who is still with the National Parks & Wildlife Service in Mayo joined the project in 1974 and recalls that Stronach was less involved from that year on. In its latter stages the project was carried out solely by staff from the Forestry and Wildlife Service (Michael Sweeny, *pers. comm.*).

1.4 Aims & Objectives of This Study

The primary aim of this research was to gather modern data on the waterfowl populations on Lough Carra through fieldwork and to collate data from previous studies and in turn use this to assess changes in the numbers of waterfowl on the lake by comparing it to the findings of Stronach *et al*. (1967 – 1980). The objective was then to develop hypotheses for fluctuations in the populations of both wintering and breeding species of waterfowl on the lake over the last 39 years. There were five main research objectives for this study;

- To carry out a programme of all year round counting of the waterfowl on the lake.
- To conduct a breeding survey/nest census on ten islands on the lake.
- To investigate the possible habitat changes in the two Carra sub-catchments of Annie's River and Ballyglass.
- To analyse and investigate changes in habitat for dabbling duck species on Lough Carra.
- To survey and map the vegetation on Doonbeg Island (Island 12) to assess the changes in the breeding habitat for duck since the late 1960s.

The first two objectives were very much fieldwork orientated and were vital components in establishing current population figures. The third objective involved fieldwork but also the examination of reports on land use changes and maps and aerial photographs of the two sub-catchments, while the fourth looked at the fieldwork of Huxley (2003) and Shackleton (1975) for the development of habitat change hypotheses. The fifth objective was to develop the hypothesis that ecological succession has brought about changes in the breeding habitat for duck on the islands of Lough Carra since Stronach's time. This included mapping the vegetation on Doonbeg Island in the southeast basin and comparing it to a map of the same island made by Stronach in the late 1960s. In addition, general notes on vegetation were made on the nine other islands visited during the two breeding surveys in 2005 and 2006.

To succeed in obtaining accurate comparative data, similar methodologies to those used by Stronach were employed and new ones were developed to meet the criteria of the current research. However, where new methods were used it was important to calibrate both old and new methodologies and give a balance to findings. With this aim in mind, two experiments were conducted involving the counting of waterfowl on the lake and the finding of nests on the islands during the breeding season. The objectives of these two experiments were to,

- Complete six waterfowl counts by boat during the counting programme.
- Visit two of the ten islands included in the breeding survey with a Springer Spaniel to look for nests.

Each of the following chapters covering the various elements of this study will contain the methodologies used in the fieldwork relating to them as well as those used by Stronach during his research. The experiment involving the waterfowl counts made by boat is dealt with in Chapter 4, while the findings from the second experiment relating to the island searches with a gun dog are dealt with in the chapter covering breeding populations (Chapter 5).

1.5 Literature Review

To fully appreciate and understand the literature associated with the scientific study of birds in Ireland, one must look at the evolvement of ornithological studies over the last few decades (as touched on in Chapter 2). During the late 1960s, Stronach *et al.* were pioneers in the fledgling world of Irish conservation. Their work at Lough Carra highlighted the importance of population data in the future management of the lake and unbeknownst to them, the Carra project heralded a new era of bird conservation and study in Ireland. Since the formation of the Irish Wildbird Conservancy in 1969, the whole area of waterfowl monitoring has undergone somewhat of a metamorphosis which began with the Winter Wetlands Enquiry in the early-mid 1970s, through to the Winter Wetlands Survey of the mid-late 1980s and right up to the Irish Wetland Bird Survey which began in 1994 and is on-going. In the early years, Irish scientists and ornithologists were probably influenced by the longer strides of their counterparts in Britain and Europe working in the field of bird conservation. It is not surprising that many of the counting programmes in Ireland are partly based on other models and are run in conjunction with other international conservation agencies. However, in more recent times, waterfowl conservation and bird conservation in general has evolved due to a new found awareness and appreciation of our natural heritage. This evolution can be seen with the increase in sites being counted under the latest scheme (I-WeBS) and also with the sheer number of separate or species specific surveys for example, the Brent Goose (*Branta bernicla hrota*) and Whooper Swan (*Cygnus cygnus*) surveys of recent years. In relation to other bird species, conservation strategies have helped to highlight and stem the plight of certain species such as the Corncrake (*Crex crex*) and with an effort to instil a more environmentally friendly ethos amongst the farming community, other species may benefit such as the Barn Owl (*Tyto alba*) and Yellowhammer (*Emberiza citrinella*).

In addition to changing attitudes, the conservation of Irish habitats and fauna and flora has been inadvertently brought about by Ireland's membership to the European Union. This has led to a network of designated sites and to an increase in funding for conservation projects. With an increase in studies, there occurred a surge in scientific papers, books and reports; many of which are referred to in the following review of the literature used in this study.

Since the main aim of this study was to gather new data on the waterfowl populations on Lough Carra for the purpose of direct comparisons to the findings from the waterfowl project 1967 – 1980, the primary source of literature was the internal report compiled by Brian Stronach for the Department of Lands and An Foras Taluntais entitled *An Ecological Study of Waterfowl on Lough Carra.* This report was the foundation of this study as it contains all of the findings from the waterfowl project on population densities and fluctuations, breeding ecology, predation and habitat experiments, species migration and additional information on the lake and surrounding environment. In addition a paper by Stronach and Harrington (1981) 'Dispersion of a Wild Mallard population in the West of Ireland' (which focused on the results from the trapping and ringing programme at the lake), was used to develop hypotheses on the causes for population fluctuations. A number of other reports and papers relating directly to the ecology of the lake were also used. An internal report entitled *An Interim Report On The State Of The Knowledge Of The Natural History Of An Area In South Mayo* (Anon, 1978) provided information on previous studies and a synopsis of some of their findings including species accounts for the birds found in the Carra/Mask region based on records from Ruttledge and on the Irish Wildbird Conservancy publication *The Birds of Mayo and Galway* (Whilde, 1976). Ruttledge's (1916) paper 'The Birds of Lough Carra' by Ruttledge from the *Irish Naturalists' Journal* gave a short account of the birds and more importantly, the waterfowl found on and around the lake from that era.

For the purposes of the study of vegetation changes in the two sub-catchments of Lough Carra, the report by Lockhart (1982) *A Pilot Environmental Impact Assessment – Drainage Scheme in the West of Ireland, Field Study: Lough Carra East* was referred to as were his colour vegetation maps drawn up as part of the assessment. Fossitt's (2000) *A Guide to Habitats in Ireland* helped in the description of habitats. Notes and maps from the recent study of reedbeds *(Phragmites communis)* and lake vegetation carried out by Chris Huxley (from a forthcoming paper) were supplied by him, as were copies of fieldnotes and maps from the 1975 paper by Shackleton – 'A Study of Certain Aspects of the Vegetation of Lough Carra'. Information and data from more recent fieldwork carried at Lough Carra by Huxley *et al*. (2003) were found in *The Ecological Status of Lough Carra and its Surrounding Habitats*. Also used in connection with vegetation and habitats was Whilde's paper 'The autumn and winter food of Mallard *Anas platyrhynchos p* and some other Irish wildfowl' (1977), which includes his findings from duck shot near Lough Carra.

Additional data on the waterfowl populations on Lough Carra and on populations in Ireland as a whole over the last four and a half decades were obtained from *The Atlas of Breeding Birds in Britain and Ireland 1968-1972* (Sharrock, 1980), *Ireland's Wetland Wealth – The Report of the Winter Wetlands Survey 1984/85 to 1986/87* (Sheppard, 1993), *The New Atlas of Breeding Birds in Britain and Ireland 1988-1991* (Gibbons, 1993) and a series of reports published by BirdWatch Ireland from their Irish Wetland Bird Survey (I-WeBS) entitled the *I-WeBS Reports* covering the years 1994/95 to 1998/99 (Delany 1994-1996, Colhoun 1996-2001). Since 1999, the reports from the I-WeBS programme have been published in the journal of BirdWatch Ireland *Irish Birds* and in I-WeBS newsletters and articles. All I-WeBS literature since the initial report of 1994/95 was used in the research for this study and in addition raw data in the form of counts made at Loughs Carra, Conn and Mask were requested and received from BirdWatch Ireland headquarters and Chris and Lynda Huxley. In 2005 BirdWatch Ireland published *Ireland's Wetlands and their Waterbirds: Status and Distribution* (Crowe *et al.* 2005). This large tome provided information on the history of waterfowl counting in Ireland since the sixties, British and European populations plus site and species accounts. Up to date data on the breeding and wintering populations of waterfowl in Europe and their threat status was found in the European Union's 'Birdlife International' publication *Birds in the E.U. – A Status Assessment* (Papazoglou *et al.* 2004).

A number of scientific journals were used for literature relating to the different aspects of the research. In addition to publishing the results from the I-WeBS scheme, *Irish Birds* provided papers on breeding and wintering waterfowl in Ireland such as 'Long-term trends (1965-1988) in the numbers of waterfowl overwintering on Lough Neagh and Lough Beg, Northern Ireland' (Winfield, Davidson and Winfield, 1989), 'The wintering waterbirds of Lough Swilly, County Donegal' (Sheppard, 2002), 'Lough Neagh diving ducks: recent changes in wintering populations' (Allen, Mellon, Enlander and Watson, 2004), 'Breeding waterfowl at Ballycotton, County Cork 1960-2004' (Smiddy, 2005) and 'Whooper *(Cygnus cygnus)* and Bewick's *(C. columbianus)* Swans in Ireland: results of the International Swan Census, January 2005' (Crowe *et al.* 2005). Further data on the populations of some British waterfowl species from 1966 to 1992 and methodologies for estimating waterfowl populations was found in 'Index numbers for waterfowl populations. III. Long-term trends in the abundance of wintering wildfowl in Great Britain, 1966/67-1991/92' from *The Journal of Applied Ecology* (Kirby *et al.* 1995). *Bird Study*, the journal of The British Trust for Ornithology (B.T.O.) was sourced for papers on the movements and population status of certain species in Britain and Ireland including Gadwall (*Anas strepera*) and Wigeon (*Anas penelope*), such as those by Fox and Salmon (1989) – 'The winter status and distribution of Gadwall in Britain and Ireland' and Owen and Mitchell (1988) – 'Movements and migrations of Wigeon (*Anas penelope*) wintering in Britain and Ireland'. A further two species-specific papers were used in research into diving ducks found on the lake, these were 'The food and feeding-habits of the Pochard *(Aythya ferina)*' (Olney, 1968) and 'The food and feeding-habits of Tufted Duck' (Olney, 1962).

Over the course of this study hypotheses were developed involving the predation of nests and duck on the islands of Lough Carra. A considerable amount of literature relating to the subject of predation and wild birds was consulted, including the following, 'Invasive predators and the conservation of island birds: the case of American Mink *(Mustela vison)* and terns *(Sterna spp.)* in the Western Isles, Scotland' (Clode & Macdonald, 2002), *Seabird Populations of Britain and Ireland* (Mitchell *et al.* 2004), which details the effects of predation on seabird colonies, 'Relationships between the nest predation rates caused by different waterfowl nest predators: an artificial nest experiment' (Reihmanis, 2004), 'Duck nests and predators: interaction, specialisation and possible management' (Opermanis *et al.* 2001), 'Of mice and mallards: positive indirect effects of coexisting prey on waterfowl nest success' (Ackerman, 2002), *Interpreting evidence of Depredation of duck nests in the Prairie Pothole Region – Part III: Interpreting depredation* (Sargeant *et al.* 1998) and 'Control of North American Mink Outside Their Native Range' (Centre of Conservation Science, online, 2005). Also used was the *Irish Times* article 'Killing Machine' by Alan Murdoch (2006), it provided information on the spread of the American Mink (*Mustela vison*) and the fur trade in Ireland. A paper by Poysa entitled 'Dynamics of habitat distribution in breeding mallards: assessing the applicability of current habitat selection models' (Poysa, 2001) helped in interpreting brood observations to breeding success and population estimates and possible management strategies to help boost wildfowl populations were researched in 'Elevated artificial nest sites for Mallard *(Anas platyrynchos)* in Latvia' (Laubergs & Viksne, 2004).

Many lakes and wetlands in Ireland are protected under Irish and European wildlife legislation including Lough Carra. This legislation is translated to different sites around the country under a series of designations, for example Special Protection Areas (S.P.A.s), Special Areas of Conservation (S.A.C.s) and Natural Heritage Areas (N.H.A.s). In order to understand the laws within these designations and their implications for Lough Carra and the management of the lake, the State publications *Special Protection Areas for Birds in Ireland* (MacLochlainn, 2002) and *Evaluation of Environmental Designations in Ireland* (Hickie, 1996) were sourced for information. Further details on designations in Ireland were found in *Ireland's Wetlands and their Waterbirds: Status and Distribution* by Crowe *et al.* (2005) and from the Irish Wetland Bird Survey reports 1994-1999.

While out conducting the fieldwork for this research, a variety of field guides were used in the identification of certain species. These included *Collins Bird Guide* (Mullarney, Svensson, Zetterstrom and Grant, 1999), *Bird Identification* (Harris & Tucker, 1994), *The Observer's Book of Birds Eggs* (Evans, 1977), *Wild Animals* (Hoffman, 2001), *Collins Butterfly Guide* (Chinery, 2004), *Trees of Britain and Europe* (Aas, 1994) and *Irish Wild Flowers* (Ross, 1987). A number of laminated field charts were also brought out during fieldwork such as *A Guide to Commoner Water Plants* (Orton *et al.* 1998), *A Guide to Dragonflies and Damselflies of Britain* (Brooks *et al.* 2004) and *A guide to British Mammal tracks and signs* (Bullion, 1995).

Bird Census Techniques-Second Edition (Bibby *et al.* 2000) was consulted as were the two guides to wildfowl *Wildfowl of the British Isles and North-West Europe* (Martin, 1993) and *Wildfowl* (Ogilvie & Pearson, 1994).

Chapter 2: Waterfowl Counting at Lough Carra & Methodology

2.1 A Brief History of Waterfowl Counting in Ireland

The counting of waterfowl to assess and monitor populations and population fluctuations has long been a method used by conservationists, scientists and both governmental and non-governmental organisations in highlighting the importance of wetlands for waterfowl and in developing protection and management strategies based on census data. One of the first counting schemes began in Europe in the late 1940s while in the U.K the Wildfowl Inquiry Committee began a wildfowl census in 1947 and in 1948 a synchronised series of counts at selected waterbodies took place mainly around London and Birmingham. By 1951 counts were being conducted at a national level and the scheme was named the National Wildfowl Counts (NWC). The Wildfowl & Wetlands Trust (WWT), formerly The Wildfowl Trust co-ordinated the National Wildfowl Counts with help also coming from the Wildfowlers Association of Great Britain and Ireland (WAGBI). Small scale counting programmes also began in Ireland during the late 1940s but the results from these regionally smaller schemes were never published. Later in the 1960s counts of Light-bellied Brent Goose (*Branta bernicla hrota)* were made nationally and Greenland White-fronted Goose (*Anser albifrons flavirostris*) numbers were counted on the Wexford Slobs (Crowe *et al.* 2005).

With the formation of the Irish Wildbird Conservancy (IWC) in 1969 from the Irish Wildfowl Conservancy originally established in 1967, counting in Ireland became more co-ordinated and as well as national schemes, counts here were carried out as part of European programmes organised by the International Waterfowl Research Bureau (IWRB). Between the early 1970s and late 1980s there were two national wildfowl counting schemes in Ireland organised by the Irish Wildbird Conservancy (IWC). The first of these was the ‘Wetlands Enquiry’ (1971/72 – 1974/75) which covered 289 sites in the Republic of Ireland; 2,001 counts were made and the results published in *Ireland’s Wetlands and their Birds* (Hutchinson, 1979). The second was the ‘Winter Wetlands Survey’ (1984/85-1986/87) which covered 1,915 sites with 7,084 counts conducted and the data published in *Ireland’s Wetland Wealth* (Sheppard, 1993). In some ways, these early surveys could be described as partly experimental, providing basic data on the numbers of waterfowl overwintering on some of the country’s wetlands and one might say ‘throwing down a gauntlet' for an even better more co-ordinated programme of counting in the Republic. As Crowe *et al.* (2005, p. 4) note,

> As a result of these earlier surveys, population estimates for the majority of wintering waterbird species were estimated and form a basis for long-term comparisons. Further, a large network of important wetland sites was identified. However, there were several shortfalls resulting from this short-term sporadic approach, largely in that these earlier surveys restricted the ability to assess population changes (trends) across a run of more than three years.

Starting in 1994 a long-term waterfowl and wader counting programme was initiated in Ireland. This new survey involves the counting of waterfowl and waders at wetland sites throughout the entire country by experienced volunteers, staff of BirdWatch Ireland and staff from the National Parks & Wildlife Service (NPWS). The Irish Wetland Bird Survey (I-WeBS) is the sister programme to the U.K. equivalent, the Wetland Bird Survey (WeBS). Both surveys are run in conjunction with each other and are supported by a number of organisations in their respective countries such as BirdWatch Ireland, The British Trust for Ornithology, The National Parks & Wildlife Service and The Royal Society for the Protection of Birds and both share the same objectives:

> The primary objective of these permanent and on-going surveys are to monitor the numbers and distribution of non-breeding waterbird populations wintering in the U.K. and Ireland respectively. They are generally focused on the larger and/or better known waterbird sites, though they also encompass a range of additional related surveys. In the long-term, WeBS and I-WeBS enable the population size and trends of several species to be described. The data are used to provide a basis for site selection and designation, and for the reporting on the long-term monitoring of these wetland sites. Further, the results of this survey form the basis for informed decision making by planners, conservationists and developers on the sustainable use and management of wetland biotopes and their waterbird communities.
>
> (Crowe *et al.* 2005, p. 4).

The Irish Wetland Bird Survey is currently in its eleventh season. The scheme in Ireland is being co-ordinated by Olivia Crowe and Helen Boland at BirdWatch Ireland headquarters but there also a network of voluntary regional co-ordinators whose job it is to gather all I-WeBS counts from their respective counties before sending them on to BirdWatch Ireland head office.

2.2 Waterfowl Counting At Lough Carra 1967 – 2006

The quality and usefulness of data from any bird survey is very much dependent on two factors, namely coverage and methodology. With the initiation of the waterfowl research project at Lough Carra, its co-ordinator, Brian Stronach recognised the need for a counting programme which would provide enough data to accurately assess waterfowl populations on the lake and identify trends between months and years. As a result, the most productive years in terms of the most counts conducted (or coverage) at Lough Carra were between 1967–1980. In turn, within this timeframe there were years when more counts were carried out than in others.

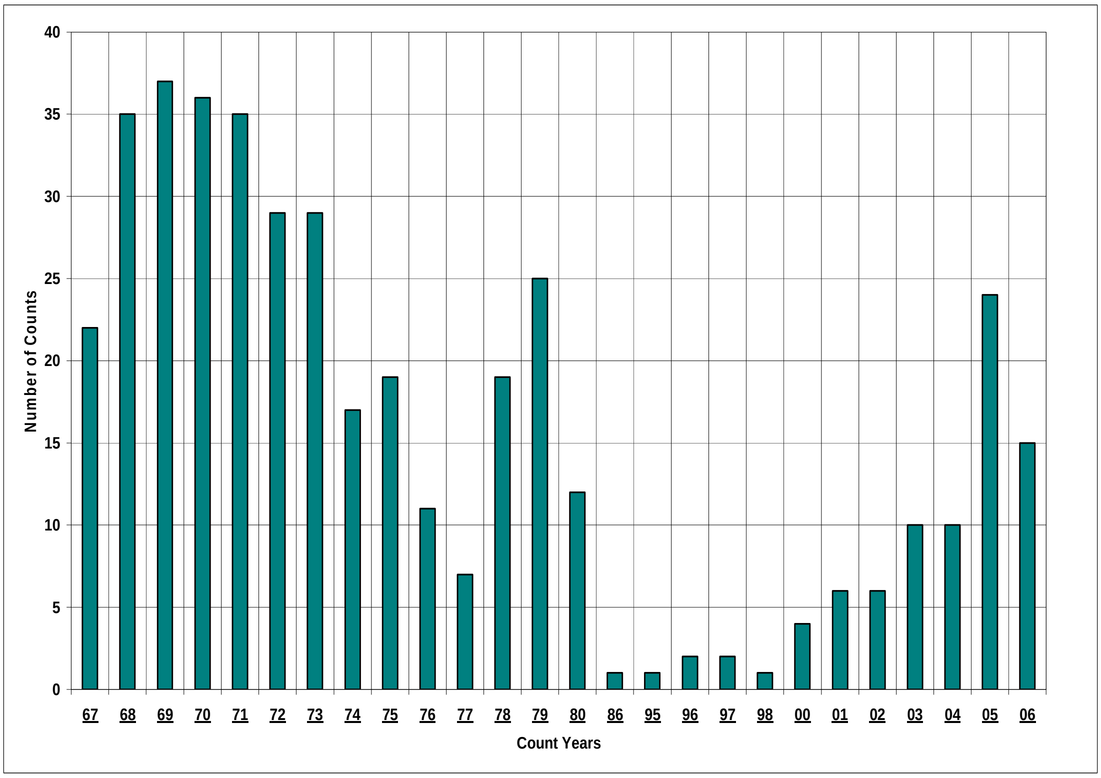
Counting began at the lake in April of 1967 and finished up at the end of October 1980 with a total of 333 counts conducted. Coverage was best for the first six years of the project with peaks in 1969 and 1970 with a total of 37 and 36 counts respectively A slight but steady decline occurred from 1971 (37 counts) to 1977 (7 counts) while an increase occurred in its latter stages from 1978 (19 counts) to 1979 (25 counts).

As Stronach (1981) noted in his final report to the Department of Lands, when research began at Lough Carra in 1967 there was little or no data on waterfowl populations in Ireland. Perhaps ironically, it was during the first few years of the waterfowl project at Lough Carra, that Ireland had its first national wildfowl count namely the 'Wetlands Enquiry'. Fieldwork for this survey was carried out over 1971/72 and 1974/75 when research at Carra had got well underway. In this sense Lough Carra did not benefit from the 'Wetlands Enquiry' in terms of data because Stronach *et al.* had already started fieldwork and were gathering a great deal of data on waterfowl populations on the lake during those years. Of better timing was the next waterfowl count in Ireland, this was the 'Winter Wetlands Survey' (WWS) which covered more sites with fieldwork carried out during the years 1984/85 and 1986/87. In County Mayo 257 sites were visited and counted during the survey, with some of the survey work also being carried out by local gun clubs who helped assess sites in their areas and potential threats to them (Sheppard, 1993). In the publication that followed *Ireland's Wetland Wealth*, Sheppard (1993, p. 5) states, "For the 1984/85 – 1986/87 survey, the objective was to carry out one count per month (October to March inclusive) at each site".

However it appears that only one count was made at Lough Carra, while aerial counts were made at its larger neighbours, Loughs Mask and Corrib. From the results it is unclear what month or year the lake was counted but despite this low coverage, the count still provides valuable data on the state of some of the waterfowl species on Carra since the last counts made in 1980 and also provides the only known data on waterfowl populations on the lake for the entire decade.

The latest year that Lough Carra could have been counted as part of the Winter Wetlands Survey was 1987. It was a further eight years again before it was surveyed as part of the latest scheme, the Irish Wetland Bird Survey (I-WeBS). The aim of the I-WeBS scheme in terms of coverage is to count sites once a month from September to March with an internationally co-ordinated count in January. This is when counting takes place on the same day throughout Europe and it is also when an effort is made to visit sites that are normally undercounted due to man power. The first visit to Lough Carra under the new scheme was made in January of 1995 with one count conducted. Over the following five years coverage remained low with the following counts made, two in 1996, two in 1997, one in 1998 and none in 1999. The coverage for Lough Carra improved dramatically from 2000 onwards, with the most counts made at the lake since the 1970s. This was due to the arrival in the area of Chris and Lynda Huxley who took on the I-WeBS counts from September 2000 to the present time (see Fig. 1). The first count of 2000 was made by Colhoun *et al*. in January followed by three more made by the Huxleys and the number of counts continued to rise in the following years due to their efforts, with six made in 2001, six in 2002 and ten in 2003 which included three extra counts conducted in January, March and April alongside the seven included in the I-WeBS core counts. Since the beginning of November 2004, counting began for this study and so coverage again increased. The number of counts made during the duration of fieldwork (1st November 2004 to 29th August 2006) also includes the core counts made by the Huxleys for the Irish Wetland Bird Survey. The total number of counts made in 2004 was ten while in 2005 and 2006 it was 24 and 15 respectively. With the end of the count programme for this study, the total number of counts made at Lough Carra from April 1967 to 29th of August 2006 is 417 and the I-WeBS core counts are on-going.

Figure 1. Number of waterfowl counts conducted at Lough Carra 1967-2006



(Only years where counts took place are shown)

1967 (April) – 1980 (Oct)

counted by Stronach *et al.*

1986

representative year for the Winter Wetlands Survey 1984/85-1986/87. The actual year the count was conducted is unknown.

1995 (Jan) – 2000 (Jan)

Irish Wetland Bird Survey counts by Delany, Colhoun *et al.*

2000 (Sept) – 2004 (Nov)

counted by Chris & Lynda Huxley for the Irish Wetland Bird Survey.

2004 (Nov) – 2006 (Aug)

counted by Chris & Lynda Huxley for the Irish wetland Bird Survey and the author.

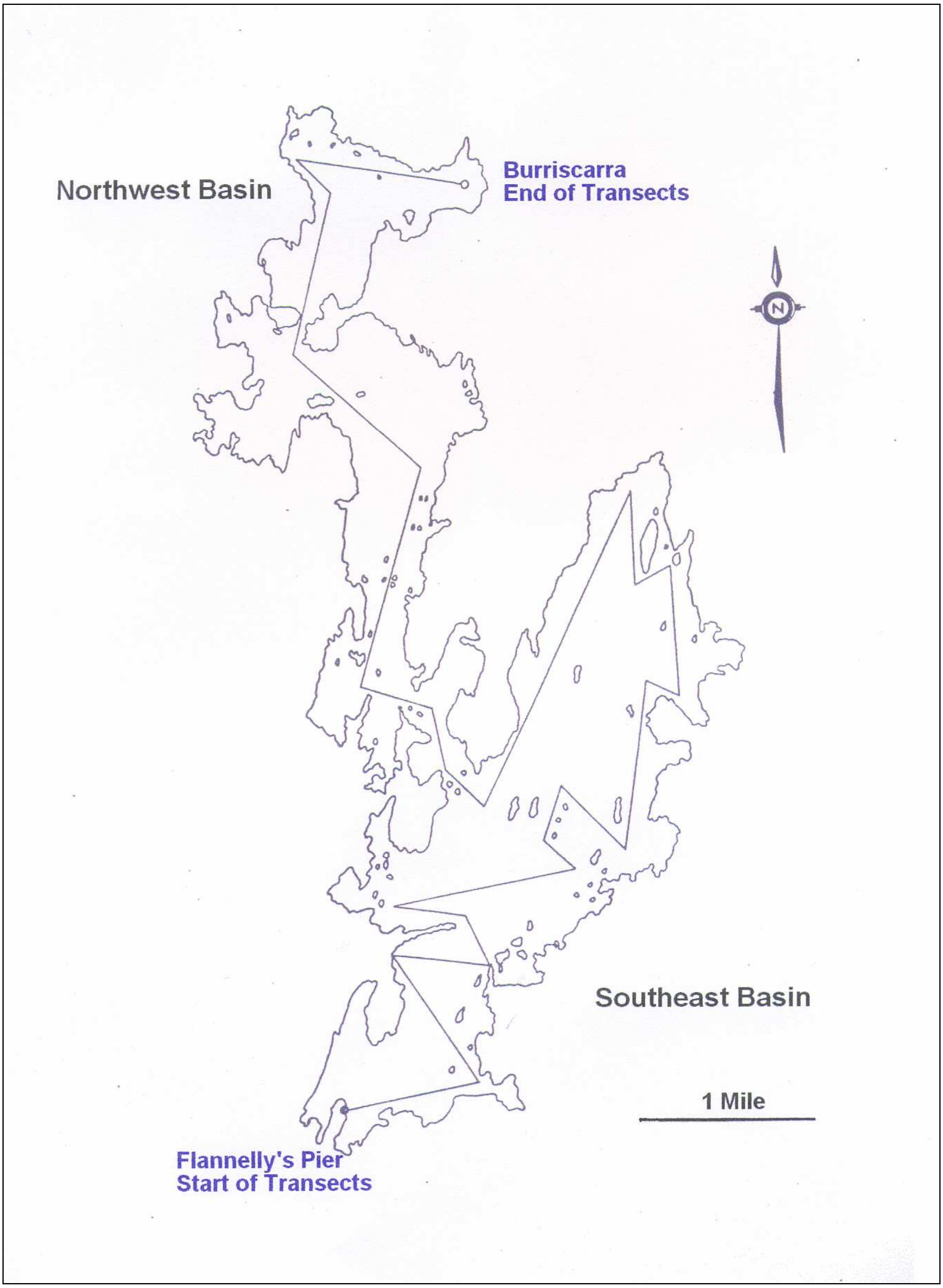
2.3 Count Methodology 1967-1980

On a map of County Mayo the outline of Lough Carra shows two arms or basins which give the lake its distinct shape, these two arms referred to as the northwest basin and the southeast basin meet at the narrows of Kilkeeran and Otter Point. The lake in general is very narrow in many places due to the position of its numerous promontories and points which stick out into the lake and it was this craggy shape that presented Stronach with his first challenge in relation to counting the waterfowl on Lough Carra. He recognised that there were two methodologies he could employ, they were (1) to count the lake from the shore or (2) to count the lake by boat. He choose the latter with the argument that,

> It was impossible to count ducks from the shore because of the large size and the irregular shape of the lake. A transect or series of transects covering all likely loafing areas was selected as the best approach and the route taken was traversed in a boat with an outboard engine.
>
> (Stronach, 1981, p. 19).

Although the number of counts conducted per year varied over the course of the project, the plan was to conduct counts once a week during the winter months and fortnightly in the summer. Stronach had the idea to count the lake more than once a week so as not to miss any winter population fluctuations but found that after a trial run in the autumn of 1973 when three counts were made in one week, the disturbance caused a large percentage of the birds to leave the lake. The route following the series of transects which Stronach refers to always started at a small quay in the western end of the southeast basin, known as Flannellys Pier and counts (weather permitting) were started at 14.00 each time. From here they drove the boat in a northeast direction following the line transects. They then worked their way along the eastern shore as far as Moorehall and then down the western shore as far as Kilkeeran and into the northwest basin. From Kilkeeran, the transects brought them north up the northwest basin and the count ended in a small bay to the east of Castleburke near the ruins of Burriscarra Friary (see Map 3). Due to the shape of the individual basins, the transect lines were laid out in accordance with the geography and dimensions of each one. Subsequently the route taken up through the northwest basin features a series of longer more direct lines while the transects in the southeast basin are purposely laid out to hug the east and west shorelines. This route did not take in the more open areas of water to the northeast and southwest of Hog and Horse Islands but this was probably due to the fact that when the counting programme started in 1967, their main

Map 3. Stronach's waterfowl census line transects on Lough Carra 1967-1980. Map from (Anon, 1978) with annotation by Meehan.



concern was counting Mallard (*Anas platyrhynchos p*) which due to its feeding and roosting habits was more likely to be found in the reedbeds and small bays fringing the lake. However, it would not have been impossible to count birds (such as the diving species) that would have been out on the more open expanses of water as the lake is not of great width. The actual transects varied greatly in length, the larger lines were between a mile and two miles long while the smaller ones were a quarter of a mile or less. The lengths of the two basins are similar measuring close to four miles long. With the first outboard engines Stronach and his team used, it took four hours to complete a count following census transects laid out over ten miles but later on in the programme, four hours were cut to two due to the deployment of bigger and better engines. Stronach does not go into great detail in his report on methodologies employed while on the boat counts but a local man from the area whose father went out in the boat with Stronach recalls up to three men going out on counts (Joe Flannelly *pers. comm.*). This would be appropriate if one imagines one man driving the boat, one (possibly Stronach) man counting the birds through binoculars and a third writing down the data. As they progressed along the transect lines all waterfowl on both sides of the boat would have been counted. There are variations in methodologies that can be employed when counting birds from a boat using transects such as having set zones or distances from the boat and only counting birds within those zones or count blocks (Bibby *et al.* 2000) but these methodologies apply more to boat counts taking place on larger water bodies. As well as counting those birds on the more open areas of the lake, they flushed those that were loafing in the reedbeds, as Stronach (1981, p. 23) states,

> On open water the birds were wary and took flight when the boat approached, the distance varying, but usually between 150-300 yards. In the *Phragmites* reedbeds the flight distance was much less and the birds had to be flushed by whistling handclapping and shouting.

Joe Flannelly also mentions that Stronach used to take photographs of flocks of Mallard while on counts, this method would have also helped in assessing population size, although photographs of the duck on the lake are a notable absence from his final report.

2.4 Count Methodology 1995 – 2004

Since those counts for the waterfowl project 1967-1980, the methodology for counting waterfowl at Lough Carra has changed. From the time of the Winter Wetlands Survey 1984/85 – 1986/87 to the present time, all counting takes place from the shores of the lake. The factors involved in the change to the census methodology include the needs and background to the counting programme, time and resources and to a certain extent developments in optical technology. As mentioned throughout, when the fieldwork by Stronach *et al.* began in 1967, its main focus was the Mallard (*Anas platyrhynchos p*) and then as work progressed it took in other waterfowl species also, namely members of the *Anatidae* (wildfowl family) and this adequately fulfilled and expanded upon the objectives of the research. The overall project was backed by the Department of Lands who it seems made available a lot of funds for paid fieldworkers and equipment (Michael Sweeny *pers. comm.*). This financial backing must have made a huge difference to the success of the project and also to a certain extent, helped Stronach choose his methodology for counting the birds on the lake. He would also have been aware that conducting counts from the shores around the lake would have taken longer than counting by boat and considering the sheer number of counts he intended to complete the methodology he choose seemed appropriate.

Apart from the one off count for the Winter Wetlands Survey in the mid 1980s, all counts at Lough Carra have been conducted as part of the Irish Wetland Bird Survey. The objectives of the I-WeBS scheme are partially similar to those of the waterfowl project, but there are key differences which help determine the reasons for the change in count methodology. The first and most obvious is that the I-WeBS scheme involves the counting of more species and families of birds than the earlier work. So as well as members of the *Anatidae* family, grebes, gulls, herons and members of the *Rallidae* such as the Water Rail (*Rallus aquaticus*) and Coot (*Fulica atra*) are also included in the survey along with all the species of waders that occur in Ireland. While some of those additional species mentioned above still go under-recorded during land counts, there is a far greater chance they will go undetected or under- recorded to a greater extent when counted from a boat (see Chapter 4). In addition, a land count is essential in recording numbers of waders feeding and roosting on the shores of the lake as these birds will not always be visible from a boat. In terms of time and resources unlike the earlier research, the I-WeBS counts are carried out by volunteers or in the case of Lough Carra until September of 2000, visiting paid fieldworkers who were counting a number of other sites in the region because of a lack of coverage in County Mayo. A certain amount of forward planning and a knowledge of the lake would be needed to either lay out new transect lines or use those set out by Stronach to count Lough Carra by boat. The men who worked with Stronach knew the lake and Stronach himself had a knowledge of boats and the money was there to always have the manpower and boat on standby for the counting programme. Aside from these issues such as objectives, time and resources, another factor that has contributed to not just the accuracy of counting waterfowl at Lough Carra but to bird research worldwide, is the development and availability of good quality optics. During the 1960s and 70s binoculars were not as bright or weather resistant as they are today and telescopes were still not commonly used or available. When comparing counts conducted on Lough Neagh in the 1960s to those made later in the 1980s, Winfield *et al*. (1989) cited the improvement in performance and availability of better optical equipment as one of the contributing factors to more accurate counts and species identification in the later surveys. While Lough Carra and Lough Neagh are clearly different in size and structure, the use of good optics during counts has without doubt contributed to accuracy during census work and has made counting from the shore easier and efficient. During the time of Stronach's work he stated one of the reasons he ruled out counting from the shores of the lake was due to its size and shape. Perhaps another factor involved in his choice of methodology was bad quality optics which would have made the task of identifying flocks of duck well off shore more difficult. With the development of better optics, such as those used in the fieldwork for this study, birds further out on the lake and even during days with bad light, can be accurately identified.

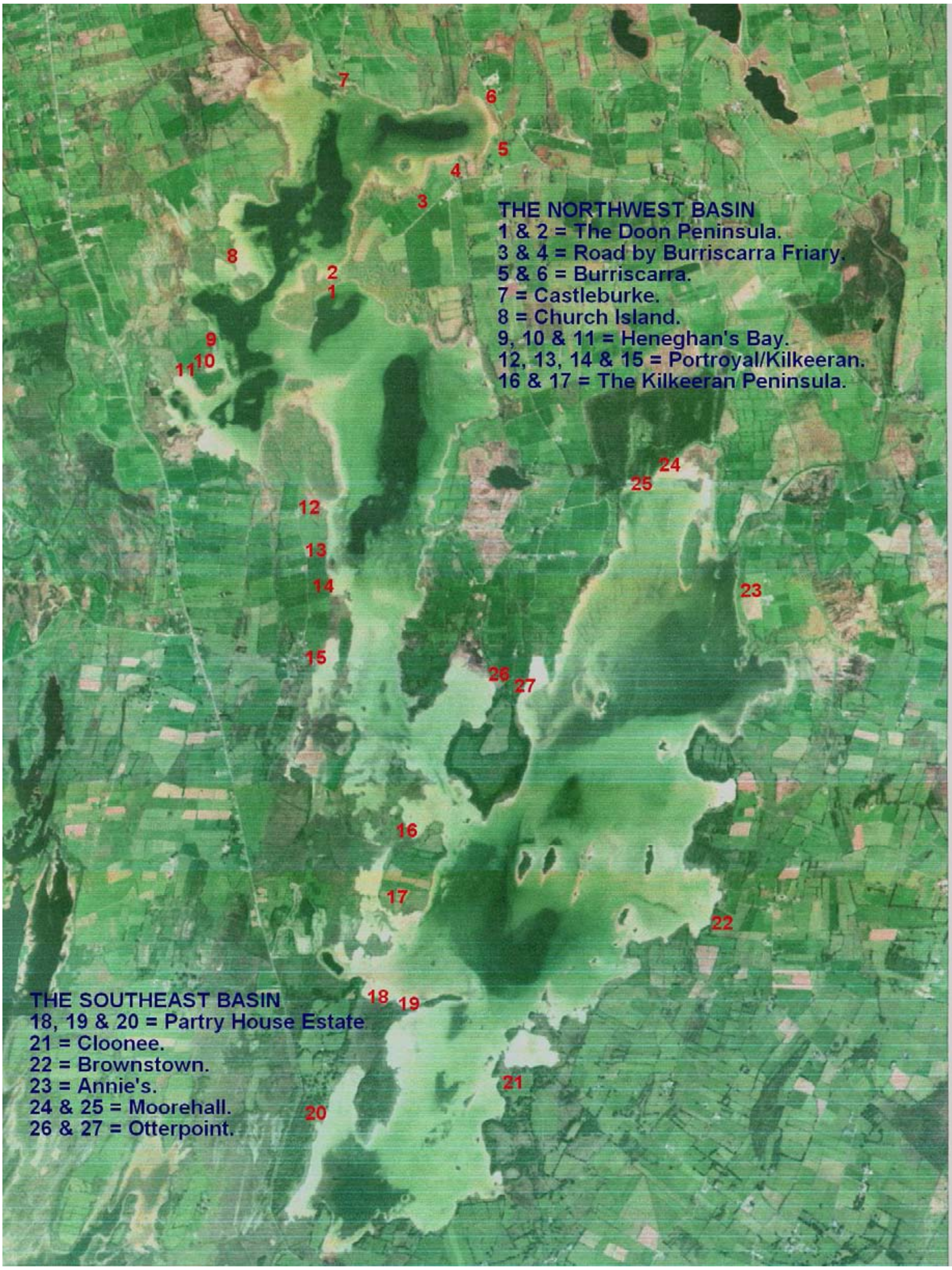
With a new land based methodology, the I-WeBS counts starting in 1995 ushered in a new era of waterfowl monitoring at Lough Carra. From a number of points on the shores of the lake, birds were counted in both the southeast and northwest basins. During at least some of these counts, the lake was counted by a group of counters who split up and counted the two basins simultaneously. When Chris and Lynda Huxley took on the I-WeBS counts in September 2000 they approached a number of land owners and gained access to additional vantage points around the lake. Before starting the counts for this study, the author went on two I-WeBS counts with the Huxleys to get familiar with the route they took around the lake and to confirm that the methodology being used was in keeping the objectives for the waterfowl census element of this research. During these counts both the author and the Huxleys counted waterfowl on the lake and the sections of the lake covered by each count point were identified. In the last week in October 2004, a trial run was carried out by the author to confirm that the route and count points were known.

2.5 Count Methodology for This Study 2004 – 2006

From 1st November 2004 to 29th August 2006 a total of 36 waterfowl counts were made at Lough Carra by the author with an additional eight made by the Huxleys as part of the I-WeBS scheme. The methodology for counting was never changed and was in keeping with that used for the I-WeBS scheme. Each count started on the Doon Peninsula and working in an anti-clockwise direction, birds were counted from 27 vantage points (count points) around the lake (see Map 4). This meant that the northwest basin was counted first (17 count points) then the southeast basin (10 count points) with the count always ending at Otter Point. The schedule proposed was to conduct two to four counts per month over a the total of 22 months, this target was reached for 18 months with one count taking place in the remaining four. The majority of counts started between 9.30 and 11.00 and lasted on average five to five and a half hours but over the course of the count programme eight counts started between 11.30 and 13.00 due to extended daylight during the summer months. This would have made no difference to the data set as the counts still finished well before dusk and so the chance of missing any dabbling duck species due to late evening flights outside the lake to feed was not an issue.

The count points used firstly by the I-WeBS counters and then later added to by the Huxleys, were not laid out at specific intervals or distances from each other as might be employed by someone counting a smaller water body by walking the shoreline (Bibby *et al.* 2000) but they were chosen due to their geographical position looking onto different sections of the lake. Some of these vantage points are slightly elevated such as points 1 and 2 on the Doon Peninsula, point 7 at Castleburke and points 9, 10 and 11 at Heneghan's Bay while others are closer to lake level such as point 8 at Church Island, point 22 at Brownstown and points 24 and 25 at Moorehall. Not all were beside the road but were reached by parking the car and walking through fields, woodland and bog. Where private lands were entered, permission was granted by the owners.

Map 4. Aerial photograph of Lough Carra with the 27 count points from which waterfowl were counted from the shores of lake during this study. These were first used by Colhoun *et al.* (1995) and added to by Huxley (2000).



Map produced using Ordnance Survey of Ireland Trail Master software 2005.

The methodology used for this study and by those counting in Ireland for I-WeBS, is termed the look-see method which is widely used and recognised in the study of individual species of birds and in the regular counting of flocks at a specific site (Crowe *et al.* 2005). Incorporating the look-see method, Bibby *et al.* (2000, p. 203) also provide a brief description of the methodology used to count waterfowl on a lake and which was employed for this study, the only difference being that only parts of the lakeshore were walked where count points were located close together while others had to be driven to,

> For lake and coastal shores the observer can walk along the edge of the area, using binoculars to see where concentrations of waterbirds occur. The observer can then stop and, by using binoculars and a telescope mounted on a tripod, count and identify birds.

A pair of 8x42mm binoculars and an 80mm telescope with a 20-60 zoom eyepiece were used to locate and count waterfowl on the lake. Due to the width of the lake, the power of the scope was more than adequate and in many instances, birds were counted using binoculars. In addition to searching for duck on the open expanses of water, the vantage points provided views for searching the smaller bays, the shoreline of the lake and the shorelines of the islands. This was an important part of the count methodology, as Mallard (*Anas platyrhynchos p*) are often found resting on the shoreline and species such as Wigeon (*Anas penelope*) feed on the grassy areas by the water. Teal (*Anas crecca*) and Gadwall (*Anas strepera*) also prefer the shallower regions and areas with reedbeds (*Phragmites communis).* As birds were counted the figures were written in a waterproof field notebook and entered into a waterfowl census spreadsheet on a computer at the end of each count day. Notes were always made of weather and any other factors which may have affected the count such as the presence of boats on the lake or the sighting of a predator. From the outset of the counting programme, it was decided to count all those species normally covered as part of the I-WeBS scheme so as to add to the data on waterfowl and wader numbers on and around the lake. This did not detract from the counting of waterfowl because while Lough Carra is an important wintering and breeding site for a number of wader species, large flocks (such as those found on estuaries) are not usually seen around the lake with the exception of Lapwing (*Vanellus vanellus*), Golden Plover (*Pluvialis apricaria*) and Curlew (*Numenius arquata*). On the occasions where waterfowl and waders were encountered, the counting of waterfowl was always prioritised.

Chapter 3: Waterfowl Populations on Lough Carra 1967-2006

3.1 The Waterfowl of Lough Carra

The family of birds assembled under the name 'wildfowl' or *Anatidae* comprises ducks, geese and swans. Of this family, ten species regularly occur on Lough Carra and around its lakeshore, while a further eight are scarce or occasional visitors. In Stronach's final report (1981), he provides census histograms for nine species and mentions the remaining nine in less detail. For I-WeBS and subsequently this study the *Podicipedidae* (grebes), members of the *Rallidae* (Moorhen *Gallinula chloropus* and Coot *Fulica atra*) and Cormorant (*Phalacrocorax carbo*) were included in addition to the ten regularly recorded wildfowl species. In summary, 15 species of waterfowl (herein referring to all wildfowl species including Great Crested Grebe, Little Grebe, Cormorant, Moorhen and Coot) were regularly recorded during the counting programme for this study. Of those, the fluctuations for nine species could be directly compared to counts from 1967-1980 while the fluctuations for the remaining six species are presented using counts from 1995 to 2006. Including the waterfowl recorded for I-WeBS and those scarce and occasional visitors, the total number of species recorded on Lough Carra from 1967-2006 is 26 (See Table 1).

Within the 15 common species of waterfowl found on the lake, the largest group represented are the ducks with nine species regularly recorded. This duck group can be divided further into two sub-groups, the dabbling duck and the diving duck. The dabbling duck refers to those species under the genus *Anas* while the diving duck refers to species under a number of different genera *Aythya, Bucephala, Clangula, Melanitta* and *Mergus* (Stronach, 1981, Ogilvie & Pearson 1994).

Charts are not presented for those species that are termed scarce or rare as there is not enough census data on them to analyse fluctuations over a given time-scale, however they are mentioned in the species accounts because although infrequently, they have been recorded on Lough Carra. This study focused on the waterfowl on the lake and so the additional species recorded for I-WeBS (such as the waders, herons etc) since 1995 and over the course of the counting programme are not mentioned in the text or represented in the data tables and charts.

Table 1. A list of all waterfowl species recorded on Lough Carra 1967-2006

	SPECIES	CATEGORY
1	**Mallard *Anas platyrhynchos platyrhynchos***	**Common**
2	**Gadwall *Anas strepera***	**Common**
3	**Shoveler *Anas clypeata***	**Common**
4	**Wigeon *Anas penelope***	**Common**
5	**Teal *Anas crecca***	**Common**
6	**Pochard *Aythya ferina***	**Common**
7	**Tufted Duck *Aythya fuligula***	**Common**
8	**Goldeneye *Bucephala clangula***	**Common**
9	**Red-breasted Merganser *Mergus serrator***	**Common**
10	**Little Grebe *Tachybaptus ruficollis***	**Common**
11	**Great Crested Grebe *Podiceps cristatus***	**Common**
12	**Moorhen *Gallinula chloropus***	**Common**
13	**Coot *Fulica atra***	**Common**
14	**Cormorant *Phalacrocorax carbo***	**Common**
15	**Mute Swan *Cygnus olor***	**Common**
16	**Long-tailed Duck *Clangula hyemalis***	**Scarce**
17	**Scaup *Aythya marila***	**Scarce**
18	**Common Scoter *Melanitta nigra***	**Scarce**
19	**Pintail *Anas acuta***	**Scarce**
20	**Whooper Swan *Cygnus cygnus***	**Scarce**
21	**Bewick's Swan *Cygnus columbianus***	**Scarce**
22	**Greenland White-fronted Goose *Anser albifrons f.***	**Scarce**
23	**Greylag Goose *Anser anser***	**Scarce**
24	**Smew *Mergellus albellus***	**Rare**
25	**Green-winged Teal *Anas crecca carolinensis***	**Rare**
26	**Black-necked Grebe *Podiceps nigricollis***	**Rare**

Notes: Species listed according to category not according to abundance.
Common refers to species that are regularly recorded during counts.
Scarce refers to species that are infrequently recorded during counts.
Rare refers to species that are considered rare on Lough Carra and in Ireland.

3.2 Results of Waterfowl Counting Programmes 1967-2006

In the following section all the results from the counts carried out at Lough Carra will be presented in the form of species accounts and fluctuation charts. The results from counts made from 1967-2006 will be presented and a full discussion on population trends and fluctuation hypotheses will feature in the final chapter (Chapter 7). The individual accounts for each species will give a brief description of that species, including its scientific family and migratory status. Also at the end of the first nine species accounts, minimum and maximum figures will be given for the years the lake was counted by Stronach and for I-WeBS and this study. So this will mean the minimum and maximum counts for those species from 1967-1980 and the minimum and maximum counts from 1995-2006. The dividing of the counts into two separate eras for this purpose is justified by the amount of time that elapsed between Stronach's counts and the counts for I-WeBS and this study. It should be noted that during the Stronach era, the data he presented in his final report does not give counts for all the species of waterfowl starting from or up to the same year, for example the figures for Mallard (*Anas platyrhynchos p*) are from 1967 to 1980 while Tufted Duck (*Aythya fuligula*) figures are from 1967-1976.

The charts included for the first nine species presents the data for annual peak counts from 1967 to 2006 and monthly fluctuations representing all of the counts made in each of the census years while the remaining six species will be represented by charts from 1995 to 2006. All of the data presented are based on figures from the 'Census Histograms' found in Stronach's final report and raw data supplied by BirdWatch Ireland/Chris and Lynda Huxley while the counts made by the author are represented in the count years 2004 to 2006. The only year not to be represented in the annual peak and monthly fluctuation charts is the year from the count made as part of the Winter Wetlands Survey (WWS) 1984/5– 1986/7. Apart from the fact that the actual count year for Lough Carra is unknown, due to the format of the report for the survey, exact figures are not given for each site. Raw data (exact figures) would have been needed to fit in with the format for data presentation in this study. However the value of the count made as part of the WWS is not underestimated and the information and figures from it will be discussed and used in the final chapter.

3.2.1 Species Accounts

Mallard (*Anas platyrhynchos p*)

The Mallard is the biggest in size of the dabbling ducks or genus *Anas* to be regularly present on Lough Carra. The trapping and ringing programme in the 1960s and 70s supported the hypothesis that the Mallard on Lough Carra are mostly sedentary with little movement outside the lake and its environs beyond 20km (Stronach, 1981). Mallard are often seen in small groups roosting on the shorelines of the lake and islands and in or on the fringes of the reedbeds (*Phragmites communis*). The population on Lough Carra has crashed dramatically since the peak counts of 2000 birds and over during the 1960s and 70s.

<u>1967 – 1980</u>

Minimum Annual Peak Count: 1,100 (1980).

Maximum Annual Peak Count: 2,500 (1971).

Mean Annual Peak: 1,636.

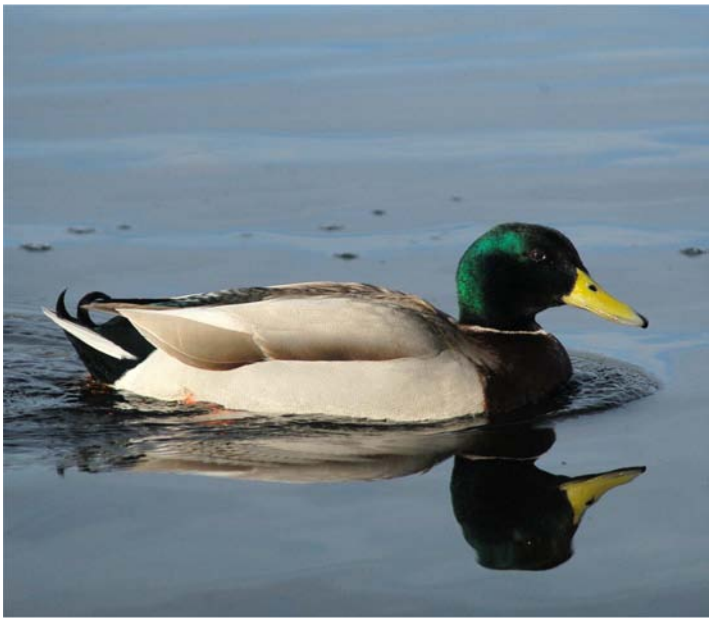
<u>1995-2006</u>

Minimum Annual Peak Count: 95 (1998).

Maximum Annual Peak Count: 409 (1995).

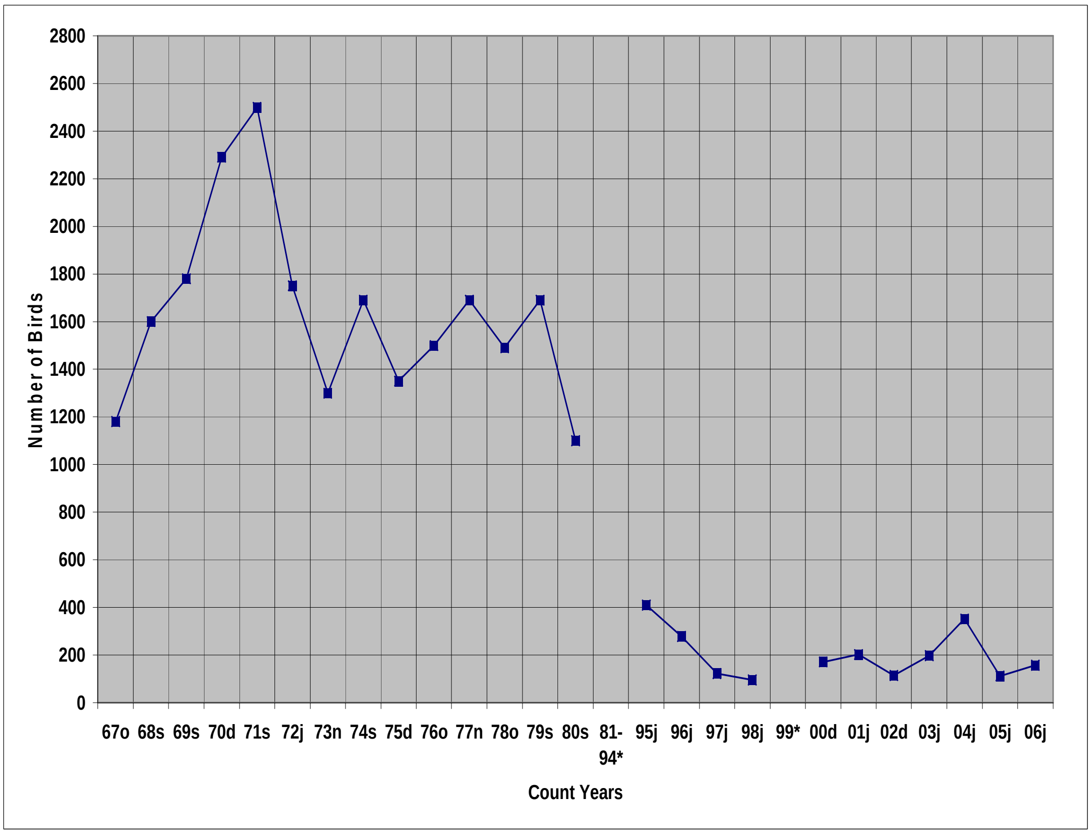
Mean Annual Peak: 200.

Plate 1. Male Mallard (*Anas platyrhynchos p*).



Photograph by John N. Murphy.

Figure 2. Mallard (*Anas platyrhynchos p.*) annual peaks on Lough Carra 1967-2006.



Notes: 1967-1980 = Counts made by Stronach *et al.*

1995-2000 = Counts made by Delany/Colhoun *et al.* for I-WeBS.

2000-2004 = Counts made by Chris & Lynda Huxley for I-WeBS.

2004-2006 = Counts made by Chris & Lynda Huxley for I-WeBS and by the author.

The small letters next to the count years refers to the month in which the peak occurred, **O**=October, **S**=September. **D**=December, **N**=November, **J**=January.

* = No data for the years 1981-1994 & 1999.

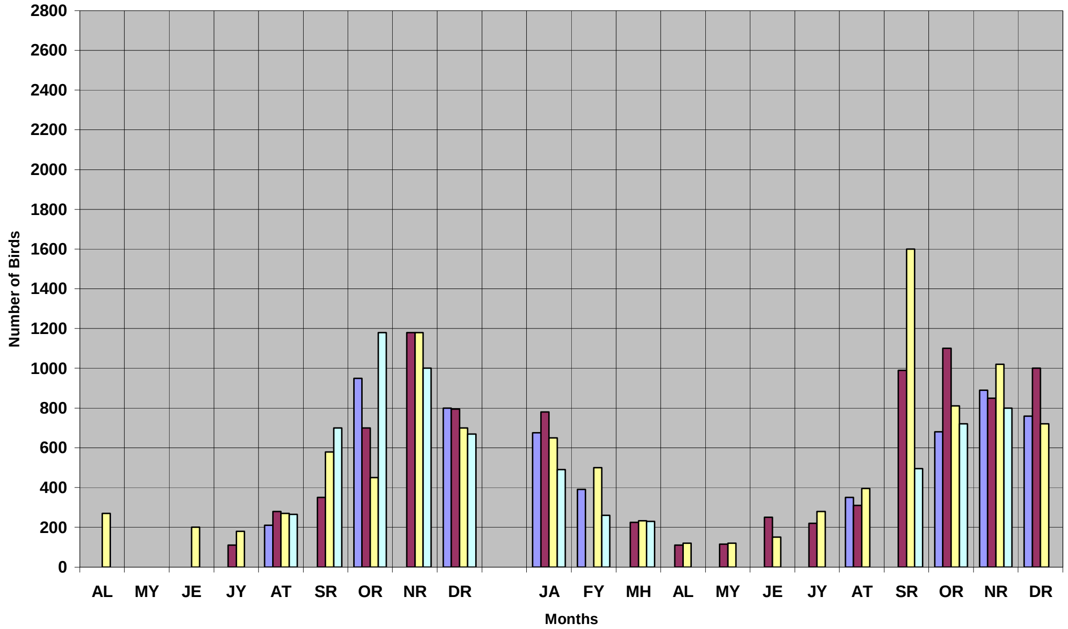
Notes on fluctuation charts presentation

Each chart presents monthly fluctuations for those years displayed below them and incorporates all known counts from 1967 to 2006. Each column or bar within a month represents one count and the number of counts for each month and year depends on coverage. The coverage from 1967-1980 was higher than for 1995-2006 and so fluctuations are more obvious. The scale on the y axis is set at intervals of 200 (major unit) for Mallard (*Anas platyrhynchos p)* with a maximum of 2800 birds but these settings will vary per species.

The months on each chart are denoted by the following keys,
JA = January, **FY** = February, **MH** = March, **AL** = April, **MY** = May, **JE** = June,
JY = July, **AT** = August, **SR** = September, **OR** = October, **NR** = November,
DR = December.
Other keys are as follows,
***** = No count(s) conducted in that month.
= Count conducted but species in question not recorded.

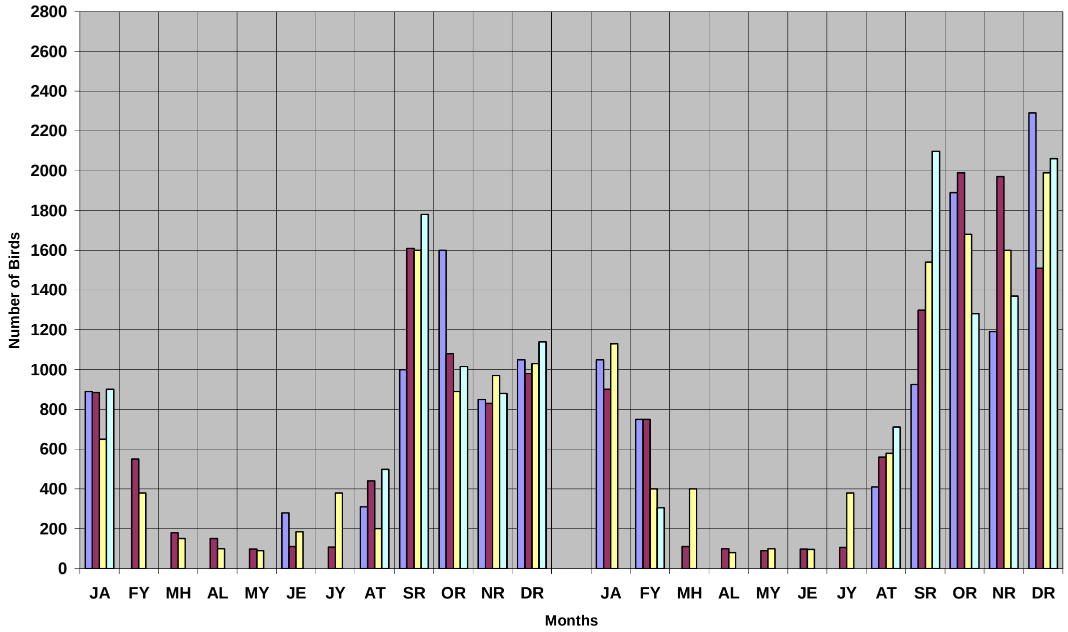
Monthly Fluctuations of Mallard (*Anas platyrhynchos p)* on Lough Carra 1967-2006.

Figure 2a. Mallard (*Anas platyrhynchos p.)* monthly fluctuations 1967-1968.



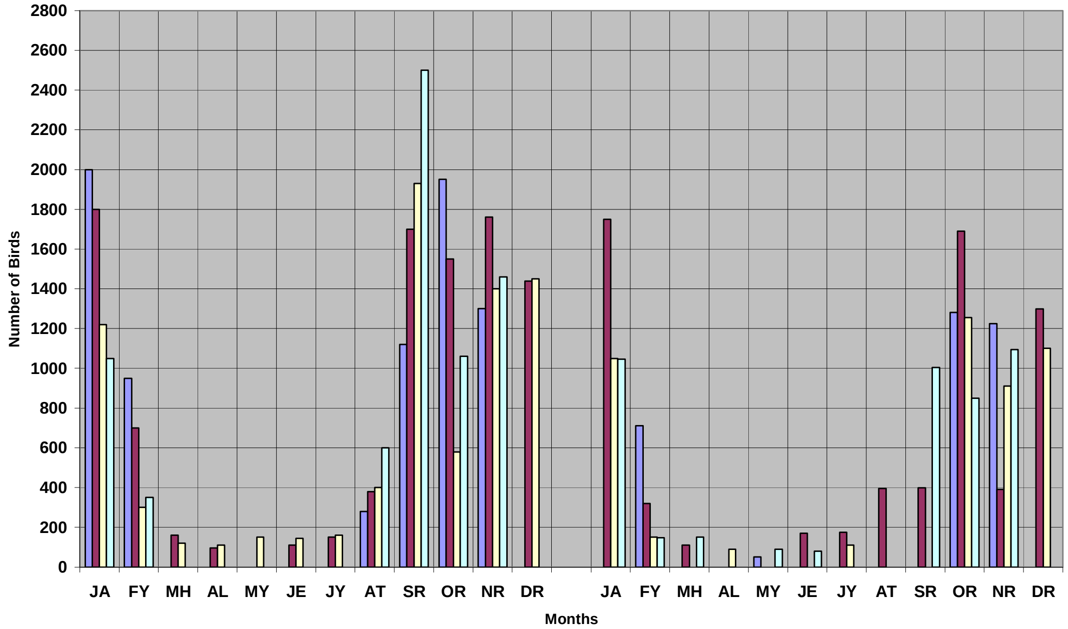
1967 - 1968

Figure 2b. Mallard (*Anas platyrhynchos p.)* monthly fluctuations 1969-1970.



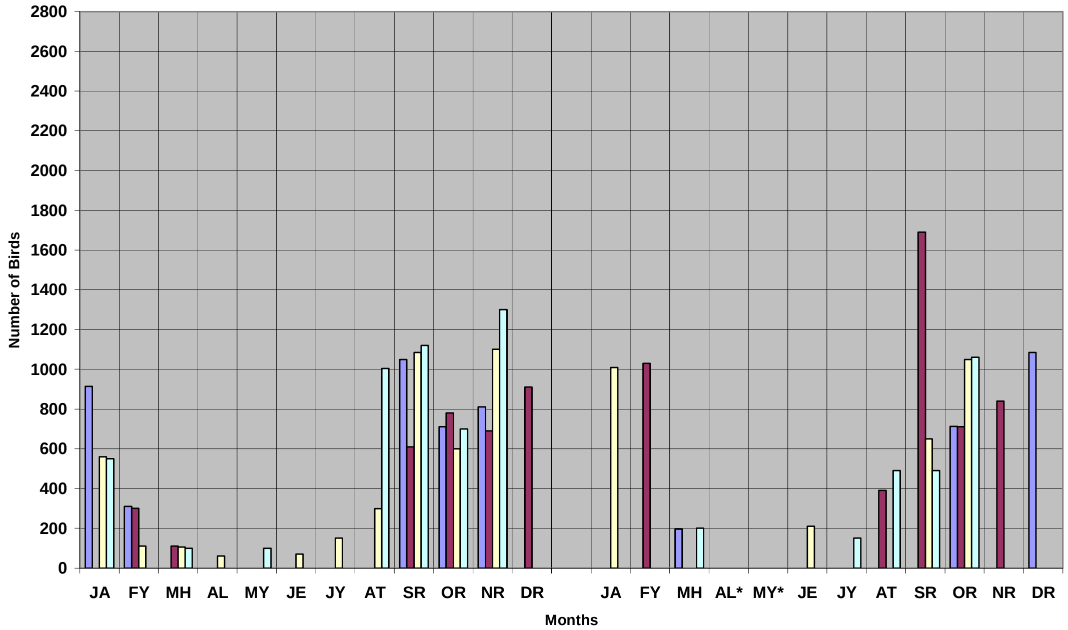
1969 - 1970

Figure 2c. Mallard (*Anas platyrhynchos p.*) monthly fluctuations 1971-1972.



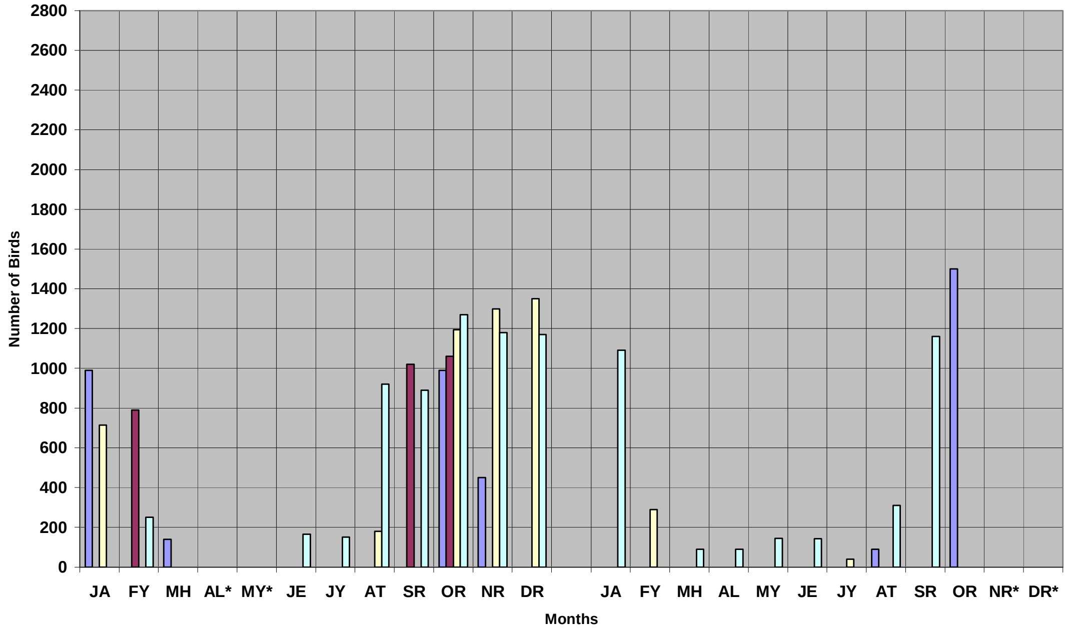
1971 – 1972

Figure 2d. Mallard (*Anas platyrhynchos p.*) monthly fluctuations 1973-1974.



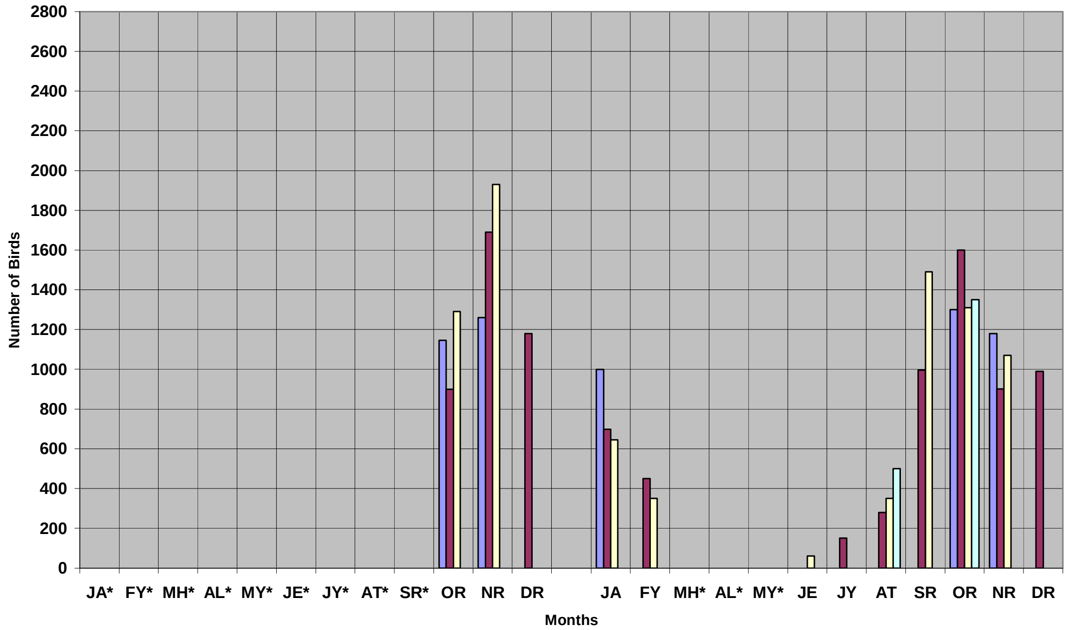
1973 – 1974

Figure 2e. Mallard (*Anas platyrhynchos p.)* monthly fluctuations 1975-1976.



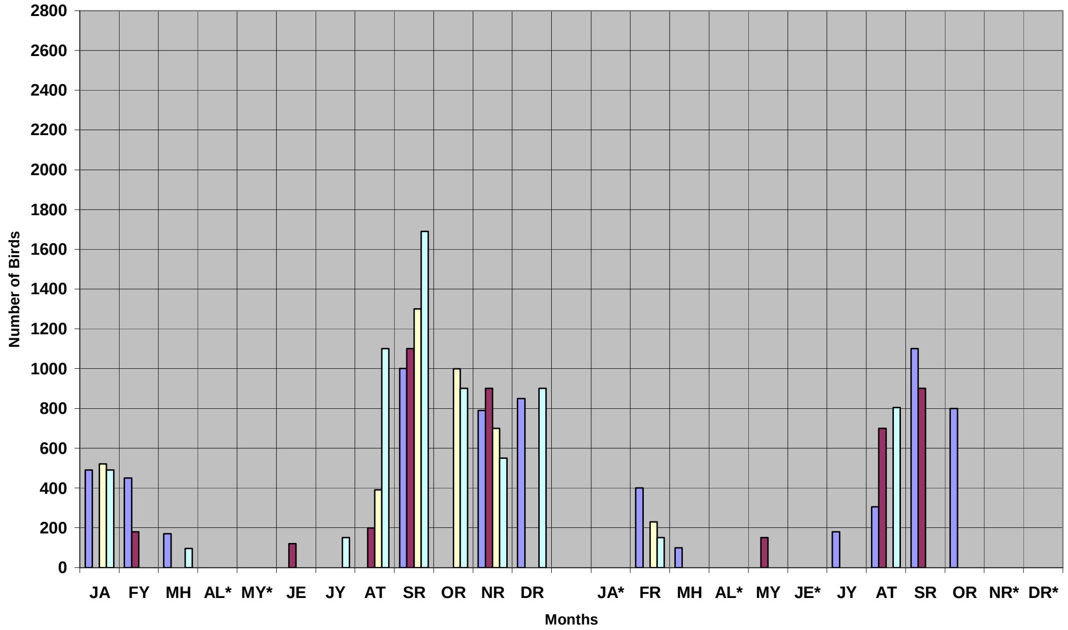
1975 – 1976

Figure 2f. Mallard (*Anas platyrhynchos p.*) monthly fluctuations 1977 – 1978.



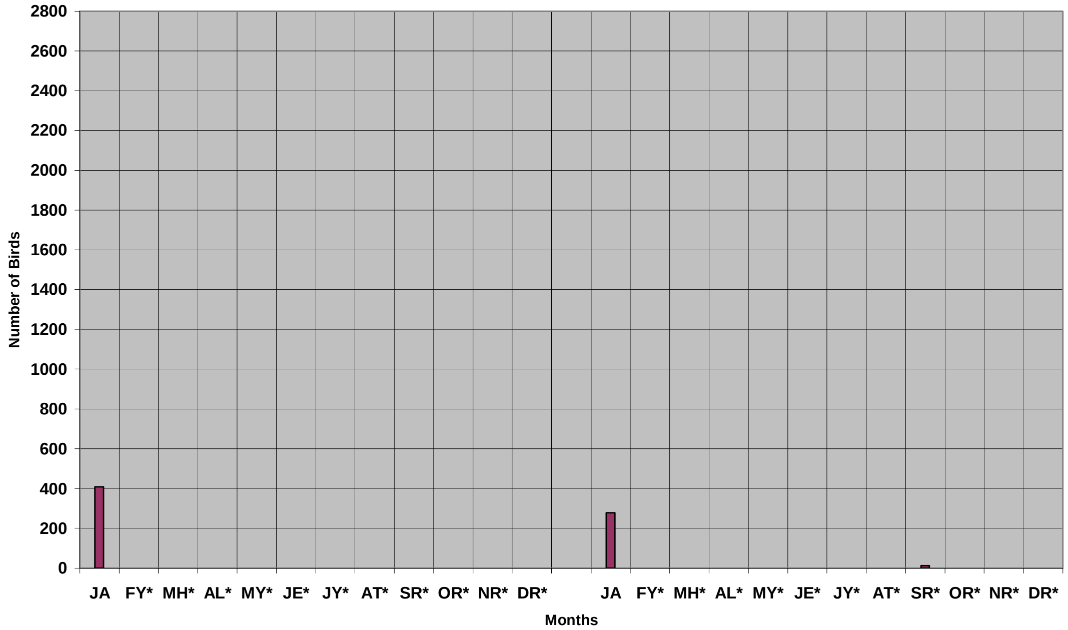
1977 – 1978

Figure 2g. Mallard (*Anas platyrhynchos p.)* monthly fluctuations 1979-1980.



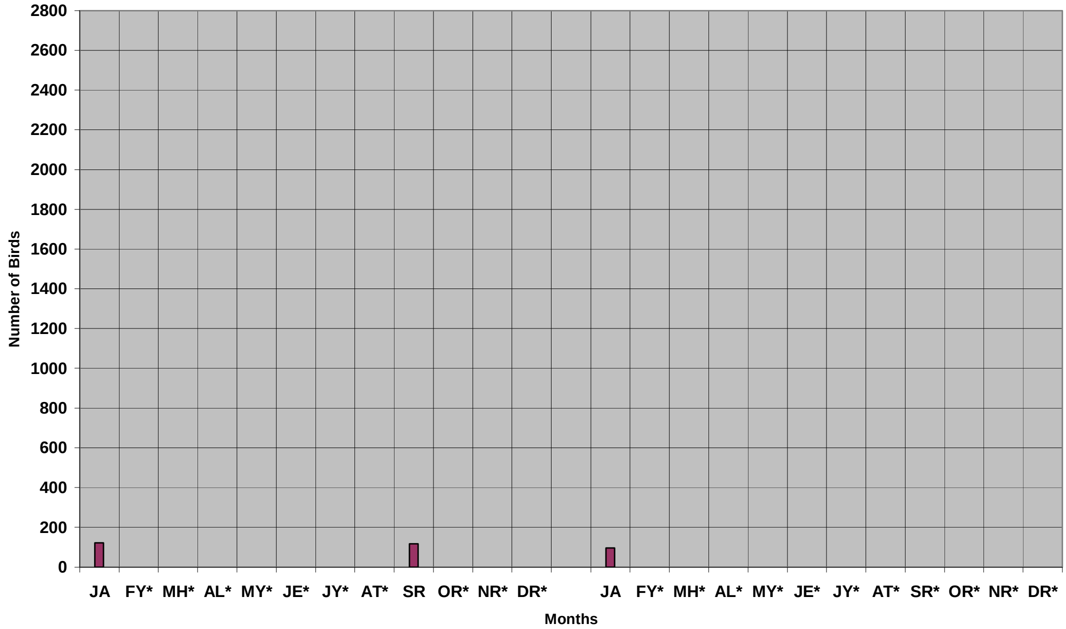
1979 – 1980

Figure 2h. Mallard (*Anas platyrhynchos p.*) monthly fluctuations 1995-1996.



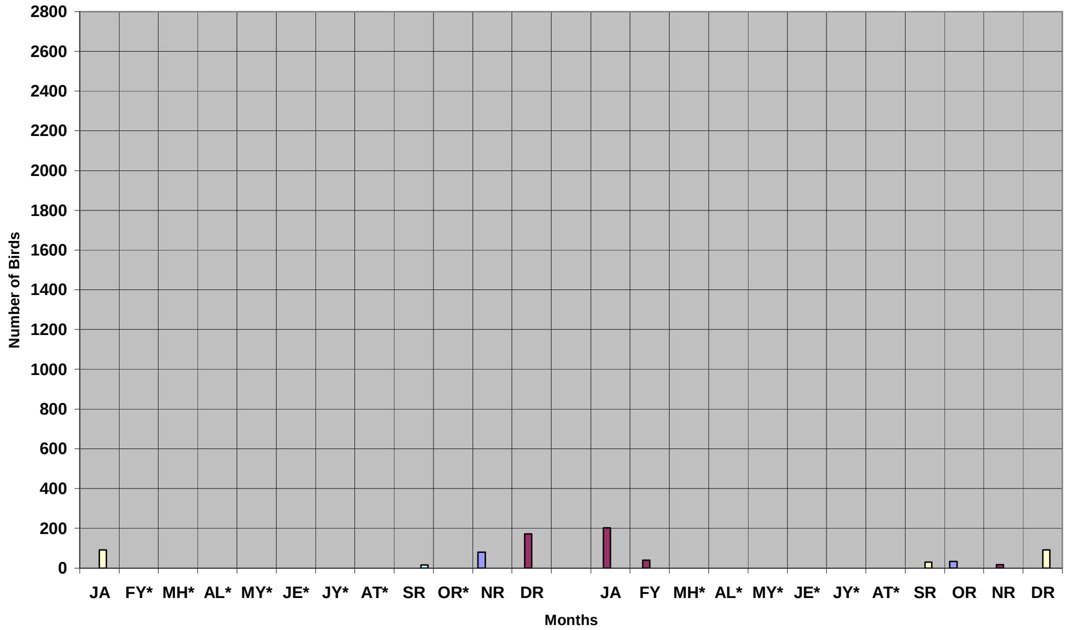
1995 – 1996

Figure 2i. Mallard (*Anas platyrhynchos p.*) monthly fluctuations 1997-1998.



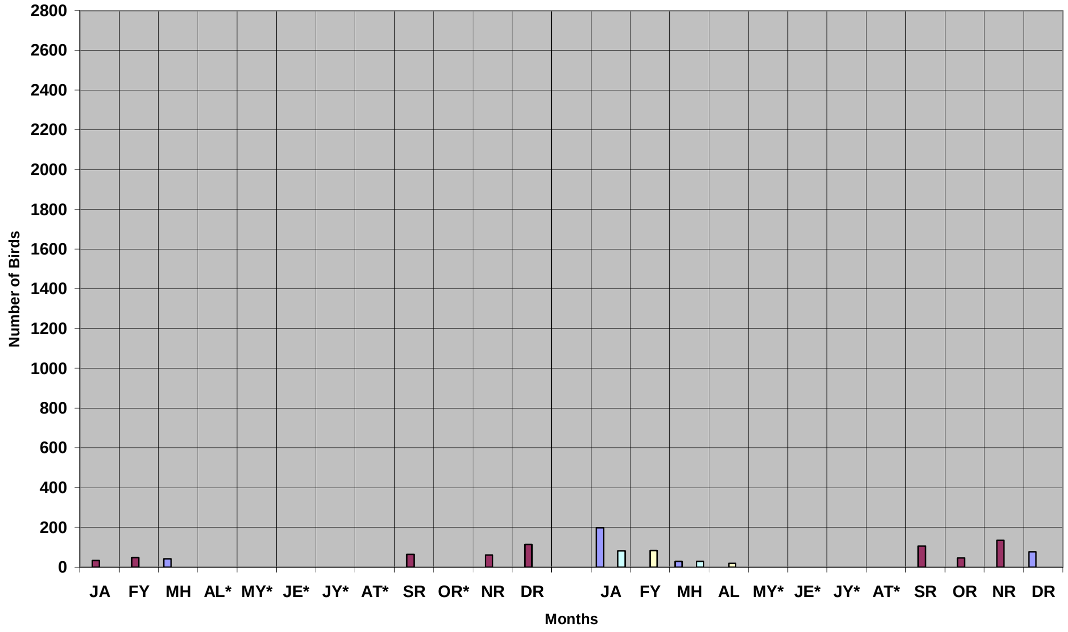
1997 - 1998

Figure 2j. Mallard (*Anas platyrhynchos p.)* monthly fluctuations 2000-2001.



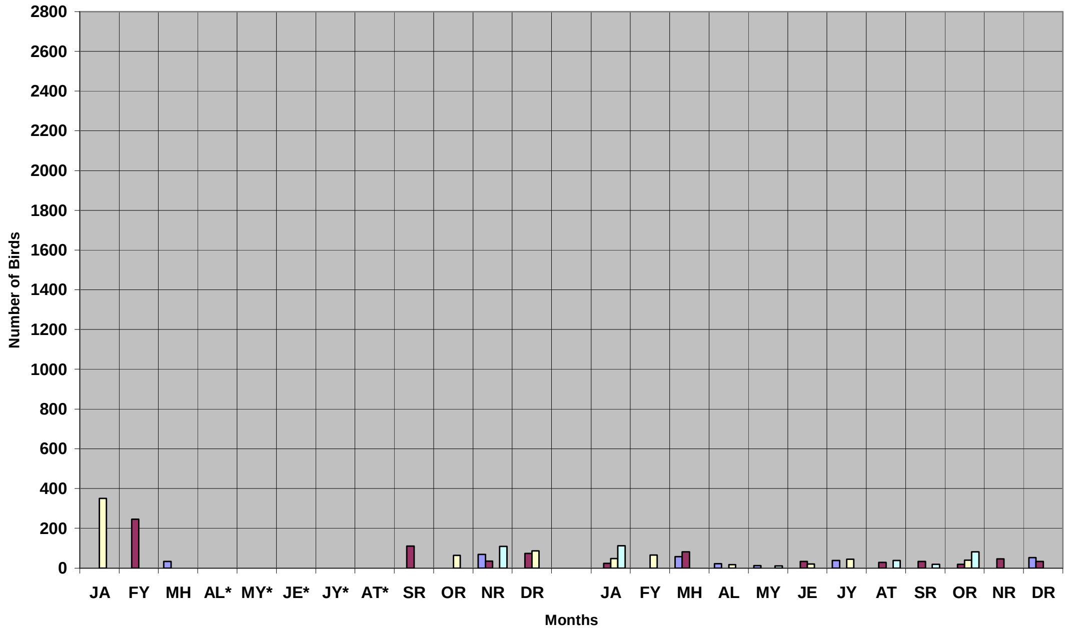
2000 – 2001

Figure 2k. Mallard (*Anas platyrhynchos p.*) monthly fluctuations 2002-2003.



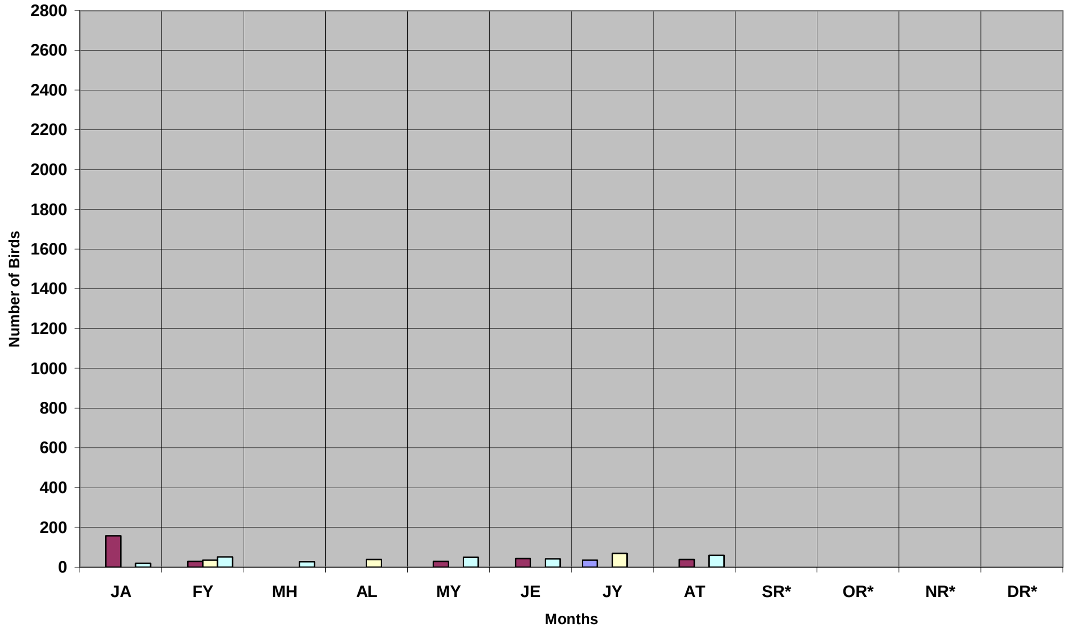
2002 – 2003

Figure 2l. Mallard (*Anas platyrhynchos p.*) monthly fluctuations 2004-2005.



2004 – 2005

Figure 2m. Mallard (*Anas platyrhynchos p.*) monthly fluctuations 2006.



2006

Gadwall (*Anas strepera*)

The Gadwall is a dabbling duck and is similar to the Mallard (*Anas platyrhynchos p*) but is slightly slimmer and smaller in size. It has gained the status of partial migrant since 2006 when the first breeding record for Lough Carra was confirmed (see Chapter 5). The Gadwall on Lough Carra were very site loyal and were often found in the same areas of the lake on each count, such as Moorehall and Kilkeeran. The population on the lake went into a sharp decline during the early 1970s and after a peak of over 80 in 2003, numbers again were on the decrease up to 2006.

<u>1968 - 1976</u>

Minimum Annual Peak Count: 18 (1976).

Maximum Annual Peak Count: 73 (1969).

Mean Annual Peak: 43.

<u>1996 – 2006</u>

Minimum Annual Peak Count: 3 (1997).

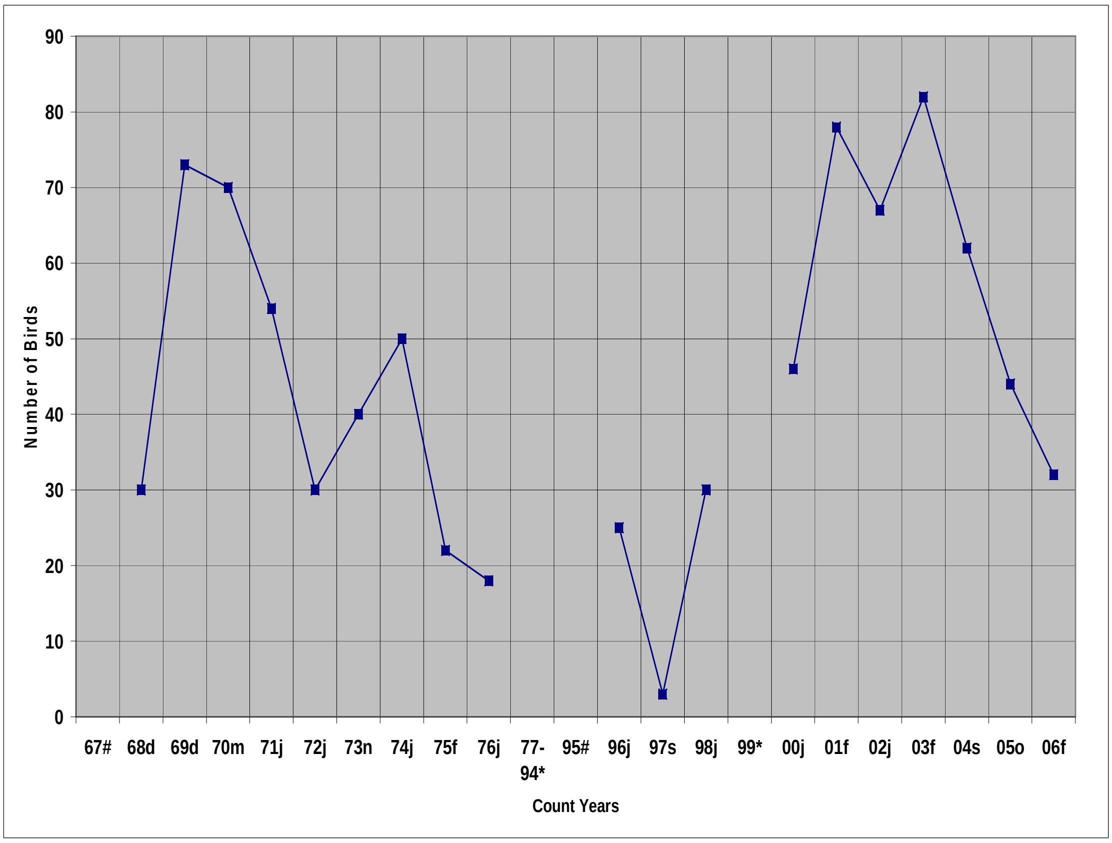
Maximum Annual Peak Count: 82 (2003).

Mean Annual Peak: 46.

Plate 2. Male Gadwall (*Anas strepera*).

Photograph by David Broadbent (R.S.P.B)

Figure 3. Gadwall (*Anas strepera*) annual peaks on Lough Carra 1968-2006.



Notes: 1968-1976 = Counts made by Stronach *et al.*

1996-2000 = Counts made by Delany/Colhoun *et al.* for I-WeBS.

2000-2004 = Counts made by Chris & Lynda Huxley for I-WeBS.

2004-2006 = Counts made by Chris & Lynda Huxley for I-WeBS and by the author.

The small letters next to the count years refers to the month in which the peak occurred, **0**=October, **S**=September. **D**=December, **N**=November, **J**=January, **M**=March, **F**=February.

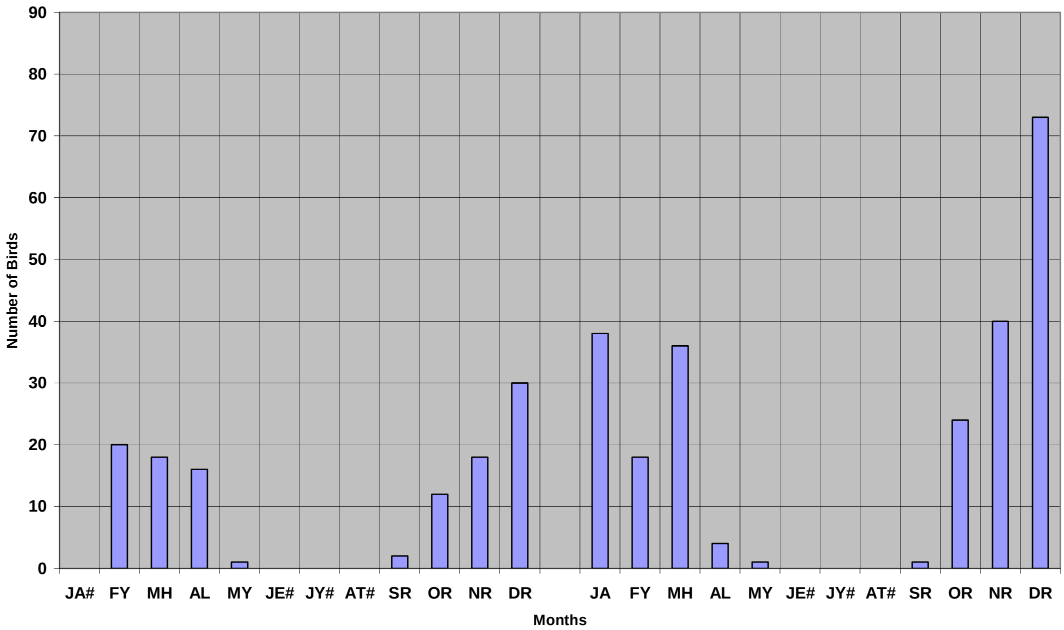
* = No data for the years 1977-1994 & 1999.

= Count conducted but no Gadwall recorded.

Monthly Fluctuations of Gadwall (*Anas strepera*) on Lough Carra 1968-2006

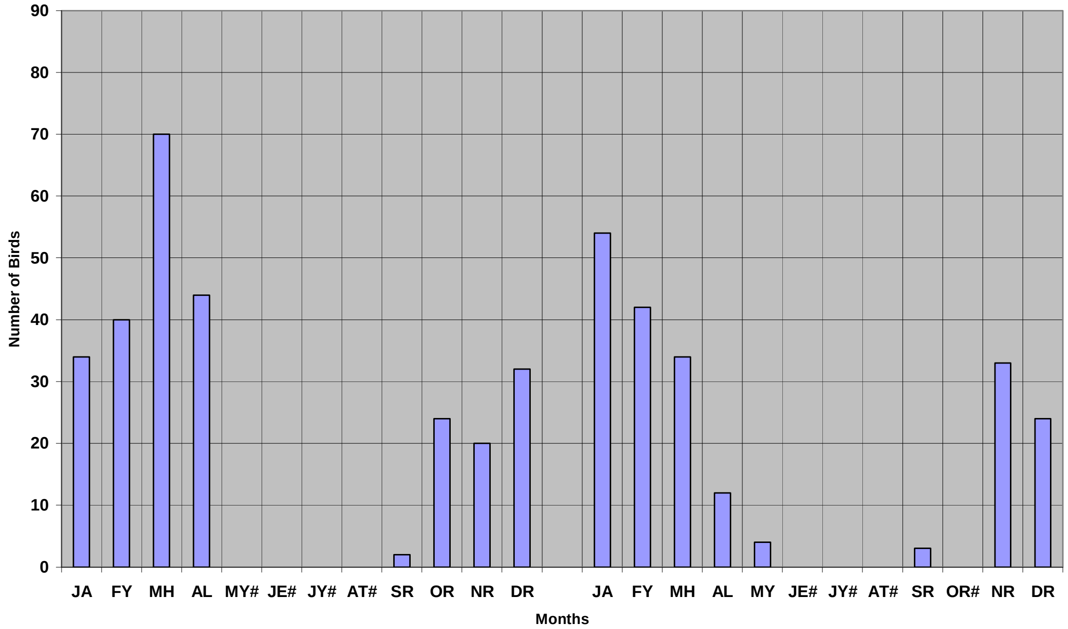
Please note that the figures for Gadwall (*Anas strepera*) presented in the report *An Ecological Study of Waterfowl on Lough Carra* (Stronach, 1981), provide just one count per month for the counting programme from that era. This is due to the presentation of data and is not a reflection of the number of counts actually conducted from 1968 – 1976.

Figure 3a. Gadwall (*Anas strepera*) monthly fluctuations 1968-1969.



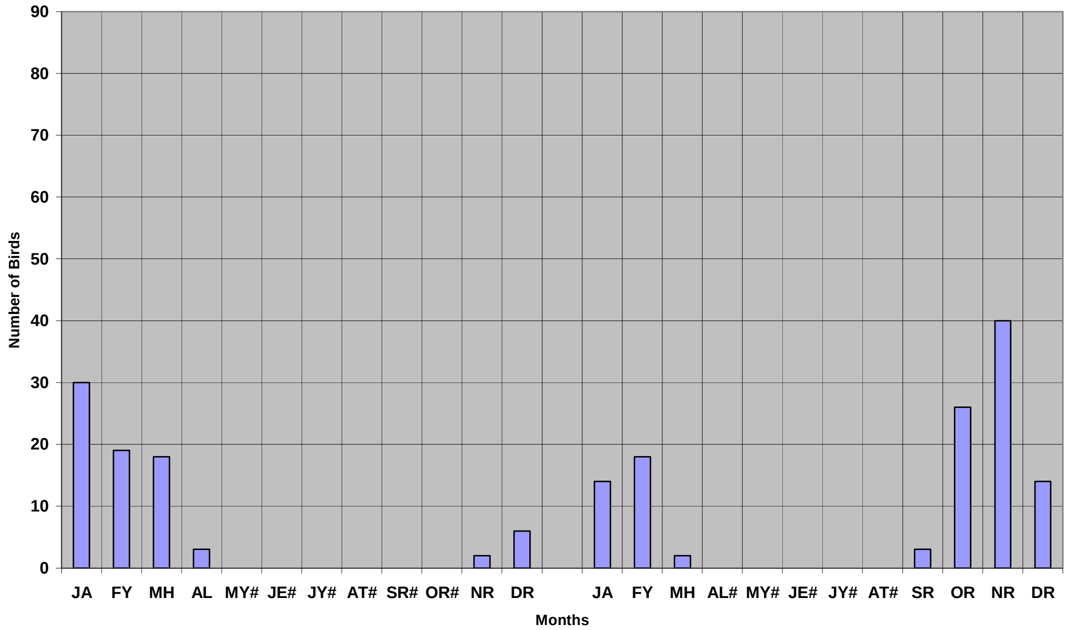
1968 – 1969

Figure 3b. Gadwall (*Anas strepera*) monthly fluctuations 1970-1971.



1970 - 1971

Figure 3c. Gadwall (*Anas strepera*) monthly fluctuations 1972-1973.



1972 – 1973

Figure 3d. Gadwall (*Anas strepera*) monthly fluctuations 1974-1975.

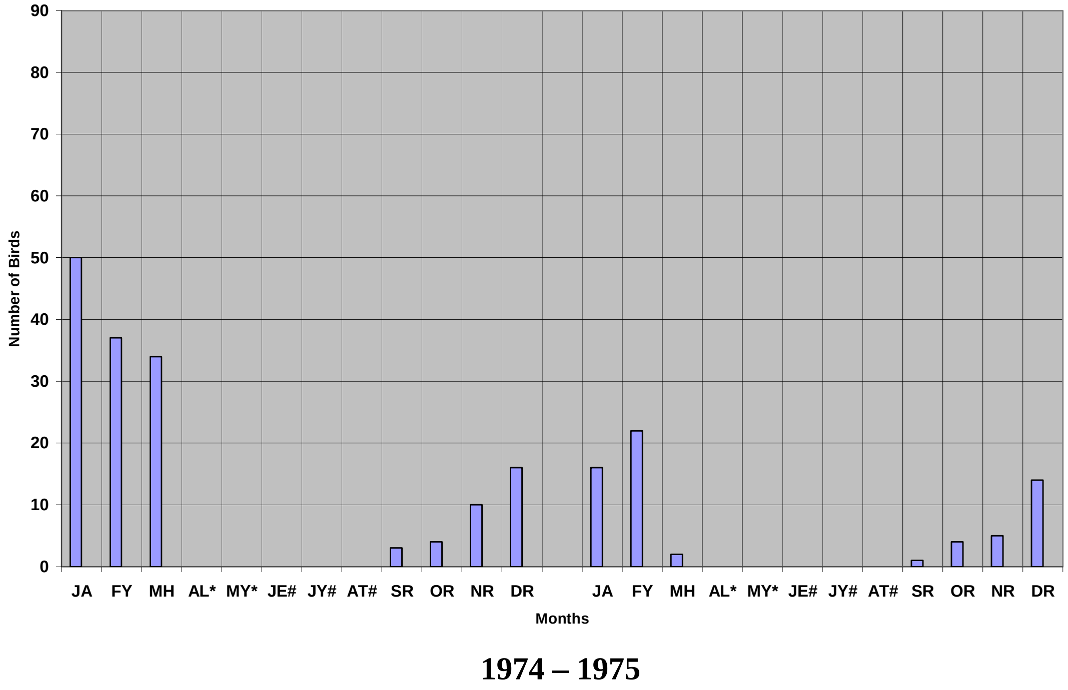


Figure 3e. Gadwall (*Anas strepera*) monthly fluctuations 1976.

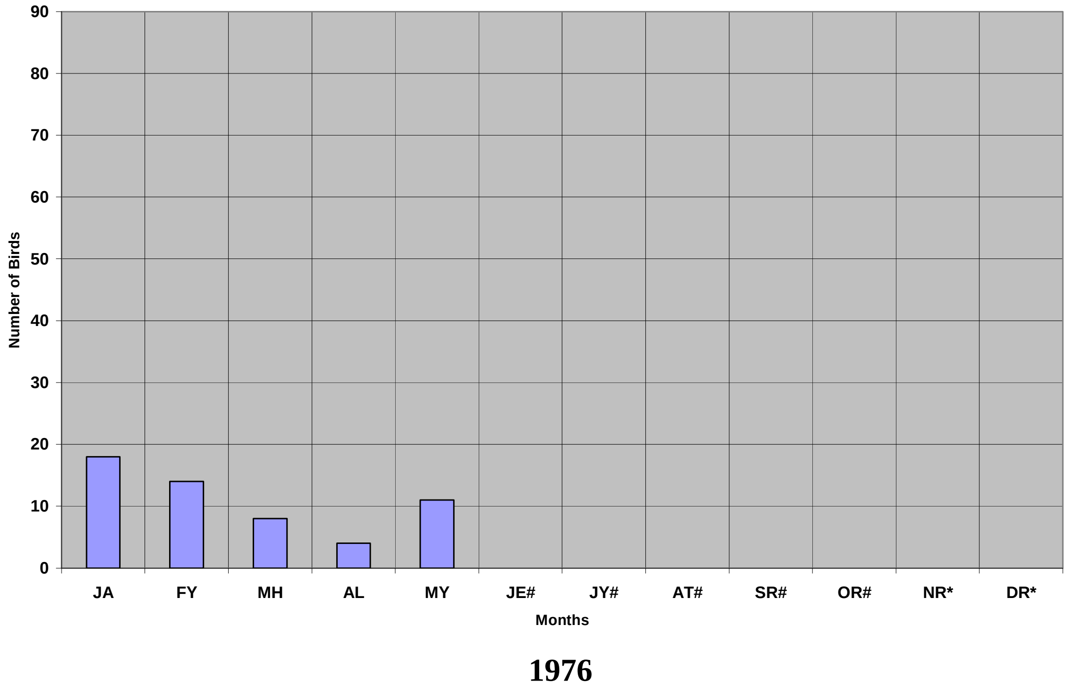
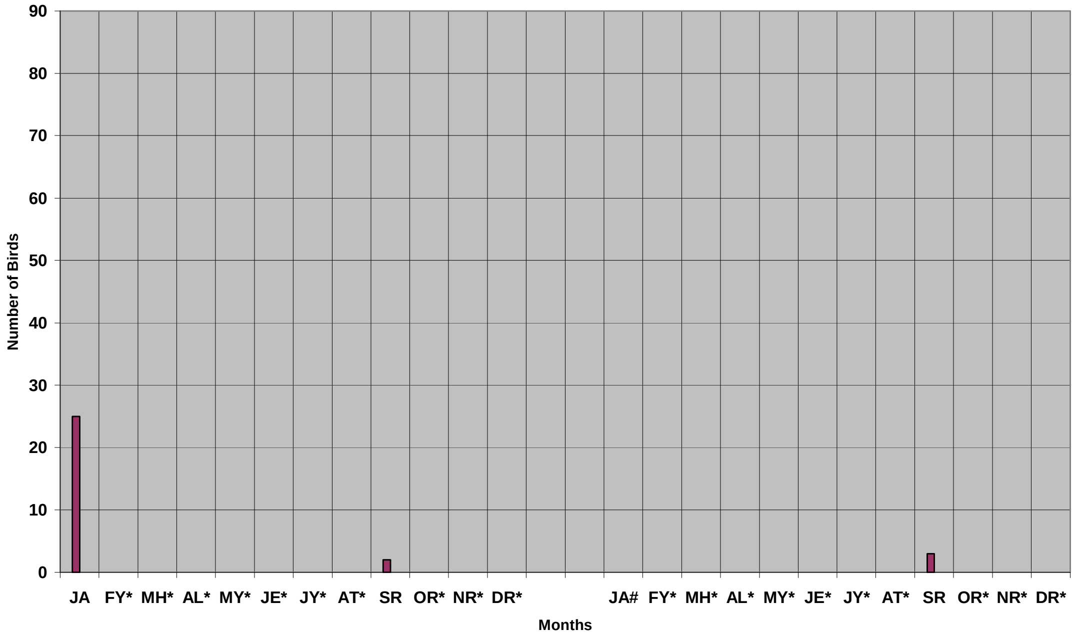
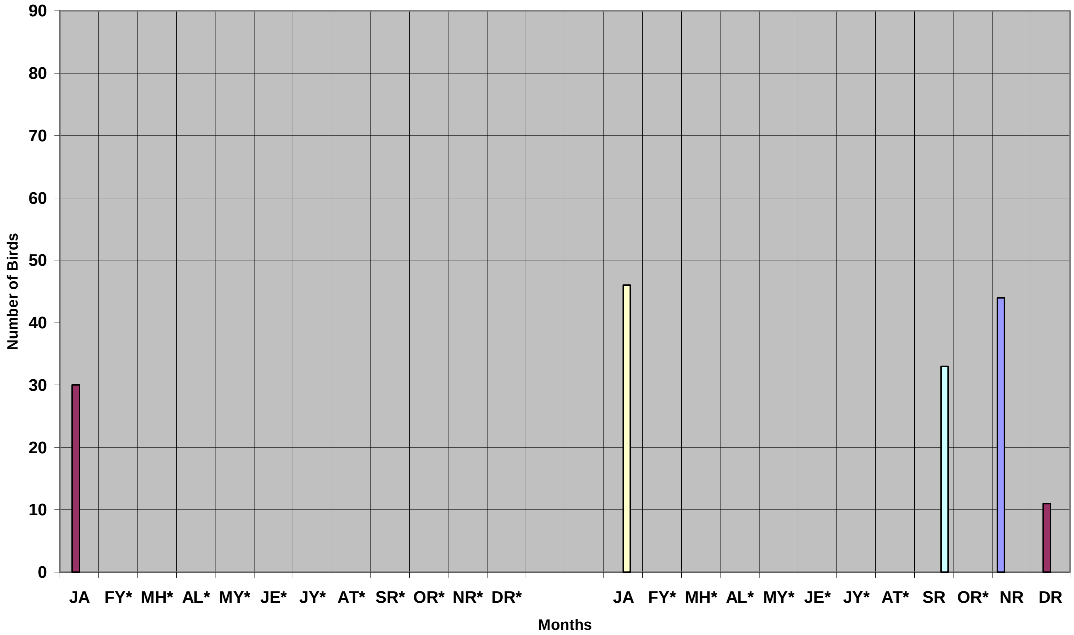


Figure 3f. Gadwall (*Anas strepera*) monthly fluctuations 1996-1997.



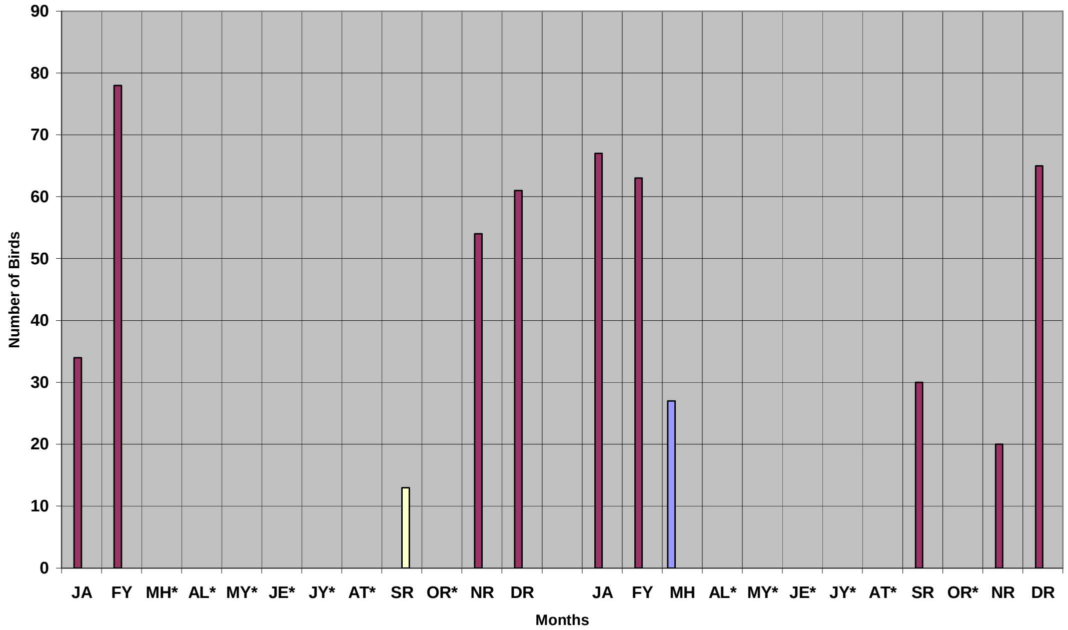
1996 – 1997

Figure 3g. Gadwall (*Anas strepera*) monthly fluctuations 1998-2000.



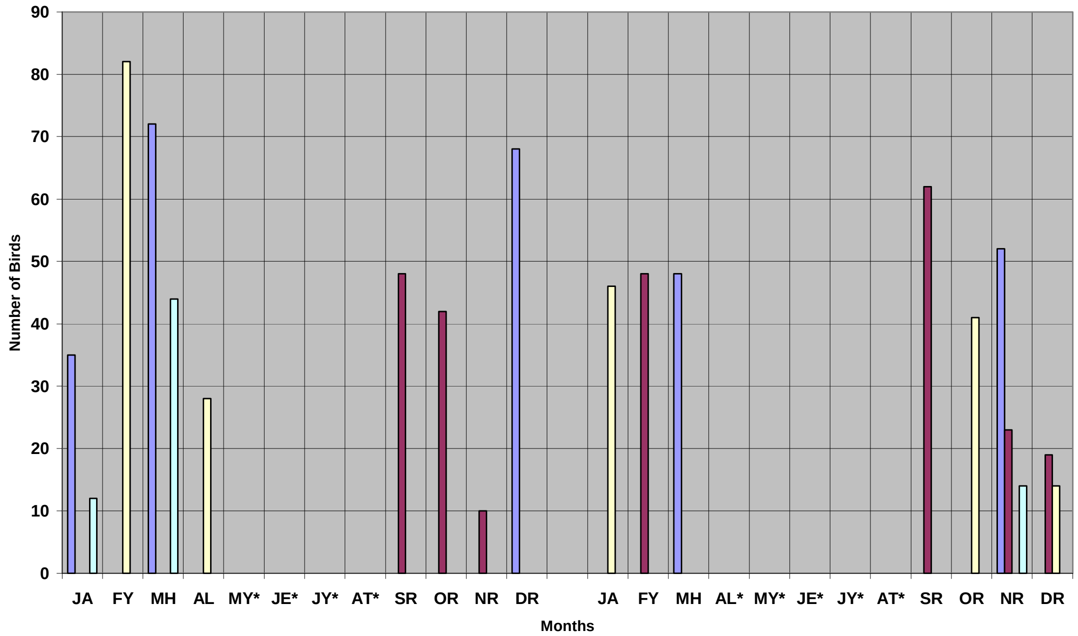
1998 – 2000

Figure 3h. Gadwall (*Anas strepera*) monthly fluctuations 2001-2002.



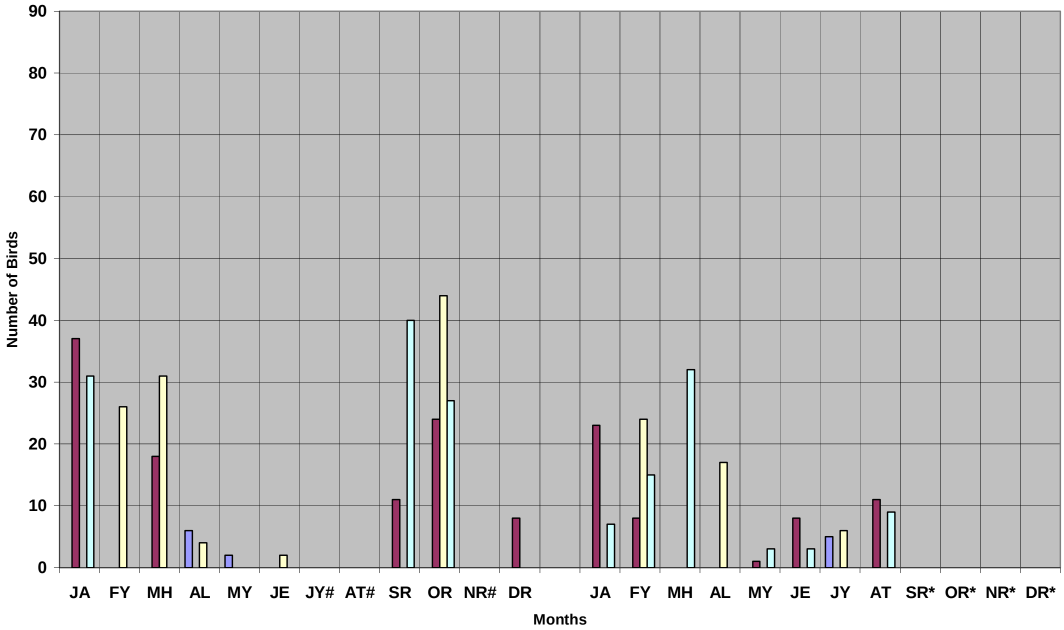
2001 – 2002

Figure 3i. Gadwall (*Anas strepera*) monthly fluctuations 2003-2004.



2003 – 2004

Figure 3j. Gadwall (*Anas strepera*) monthly fluctuations 2005-2006.



2005 – 2006

Shoveler (*Anas clypeata*)

The Shoveler is a dabbling species and a winter migrant on Lough Carra. Its long broad bill and short neck give it a very distinctive shape both in flight and on the water (Mullarney *et al.* 1999). This distinctive stocky shape made the task of picking out and counting Shoveler on the lake easier especially in times of bad light. The Shoveler population on Lough Carra has severely declined since the 1960s and 70s.

<u>1967 – 1976</u>

Minimum Annual Peak Count: 50 (1967).

Maximum Annual Peak Count: 500 (1974).

Mean Annual Peak: 253.

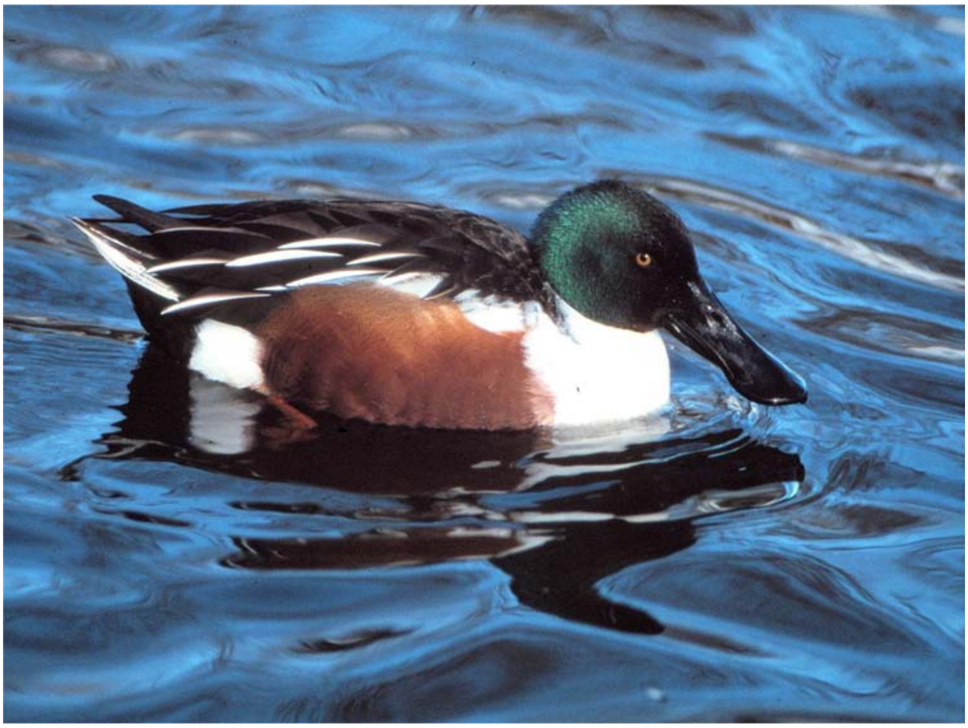
<u>1995 – 2006</u>

Minimum Annual Peak Count: 4 (2000).

Maximum Annual Peak Count: 66 (1996).

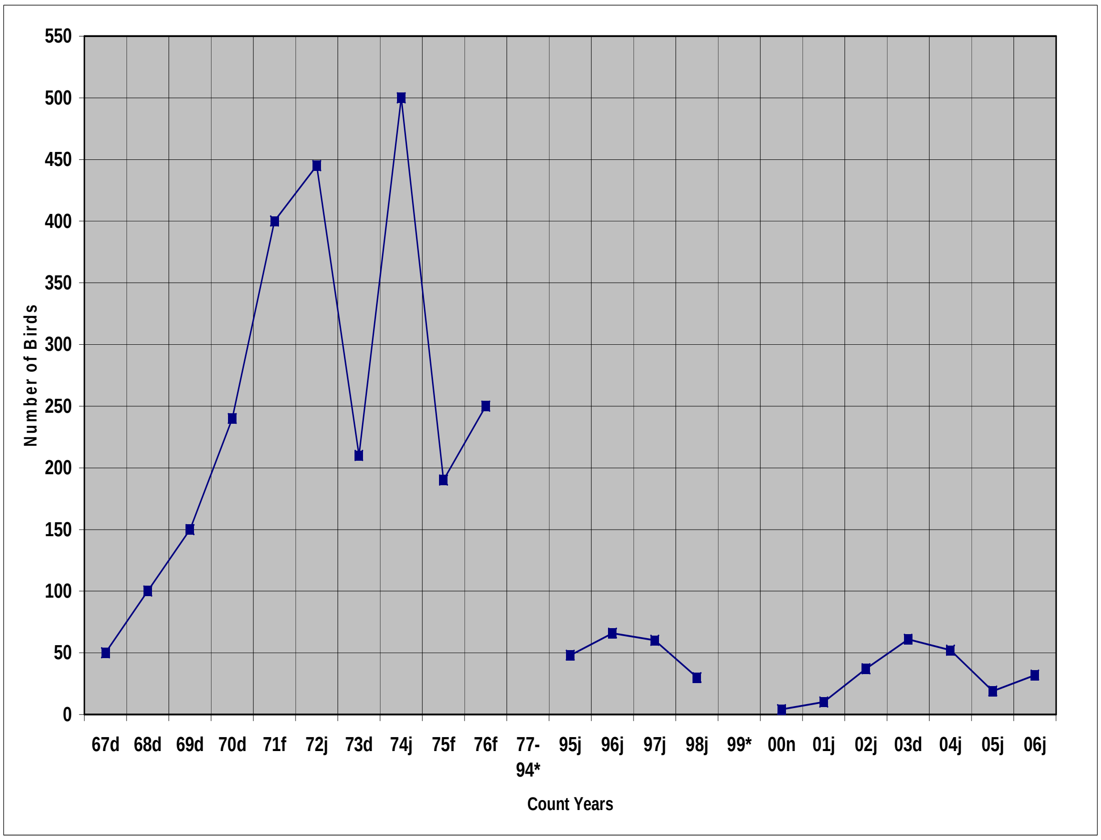
Mean Annual Peak: 38.

Plate 3. Male Shoveler (*Anas clypeata*).



Photograph by John N Murphy.

Figure 4. Shoveler (*Anas clypeata*) annual peaks on Lough Carra 1967-2006.



Notes: 1967-1976 = Counts made by Stronach *et al.*

1995-2000 = Counts made by Delany/Colhoun *et al.* for I-WeBS.

2000-2004 = Counts made by Chris & Lynda Huxley for I-WeBS.

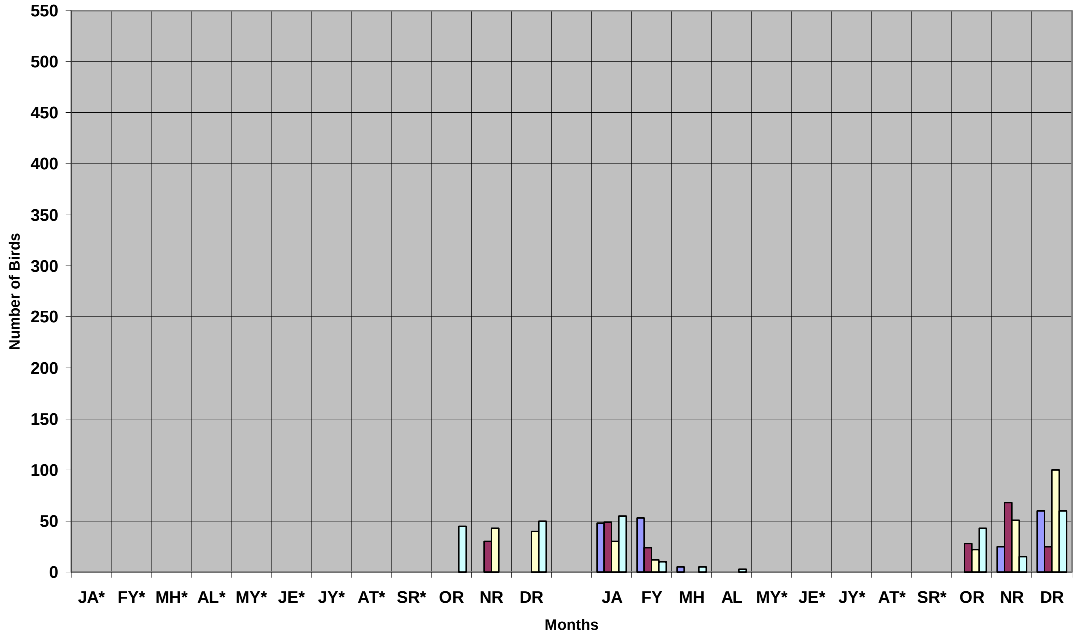
2004-2006 = Counts made by Chris & Lynda Huxley for I-WeBS and by the author.

The small letters next to the count years refers to the month in which the peak occurred, **D**=December, **N**=November, **J**=January, **F**=February.

***** = No data for the years 1977-1994 & 1999.

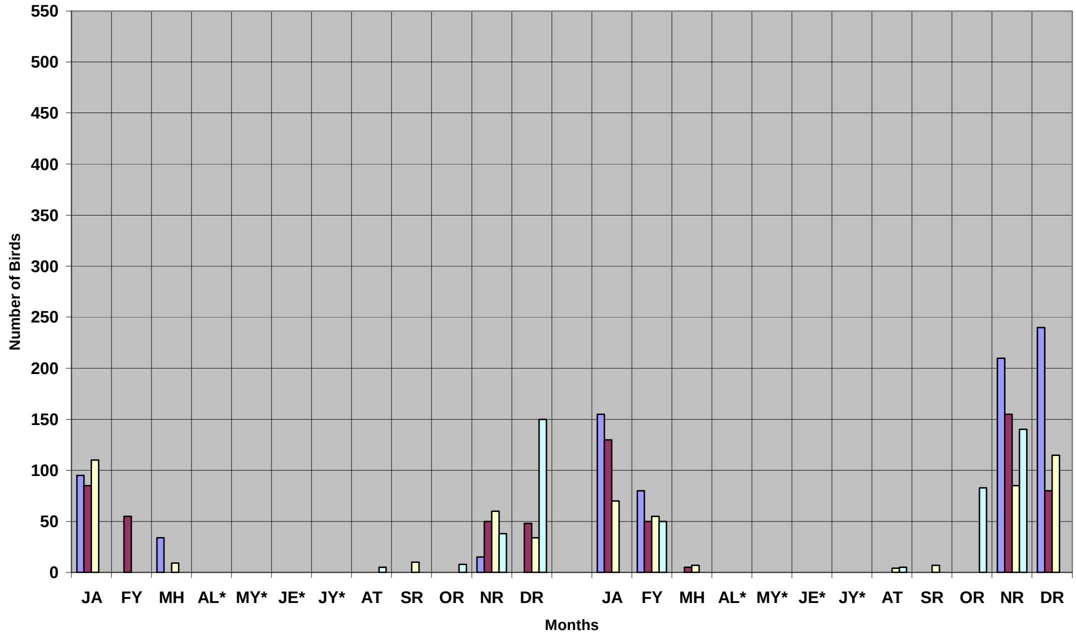
Monthly Fluctuations of Shoveler (*Anas clypeata*) on Lough Carra 1967-2006

Figure 4a. Shoveler (*Anas clypeata*) monthly fluctations 1967-1968.



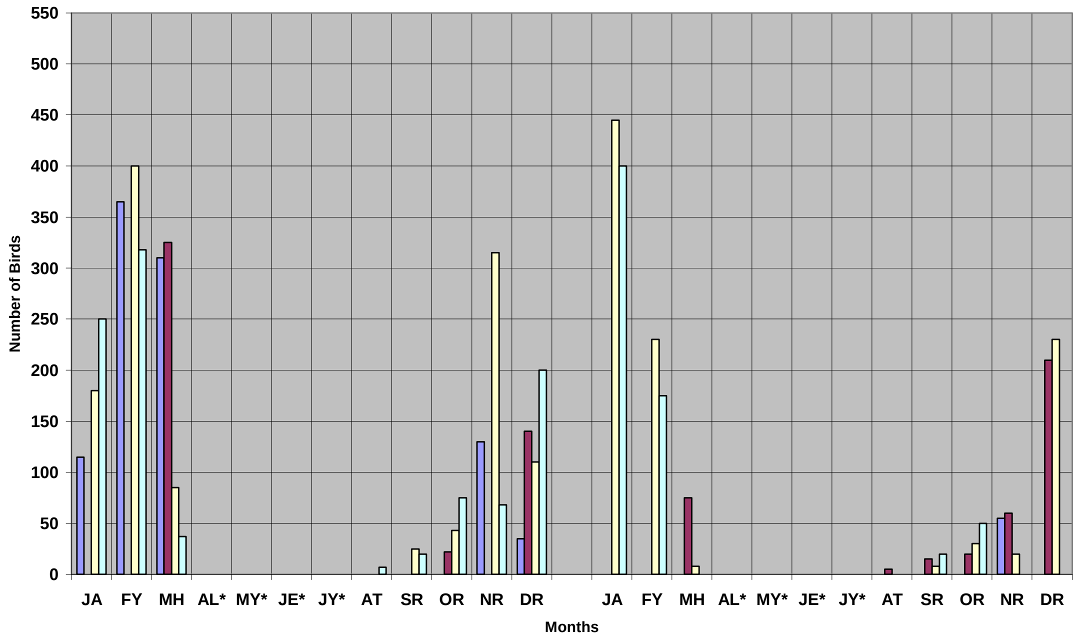
1967 – 1968

Figure 4b. Shoveler (*Anas clypeata*) monthly fluctations 1969-1970.



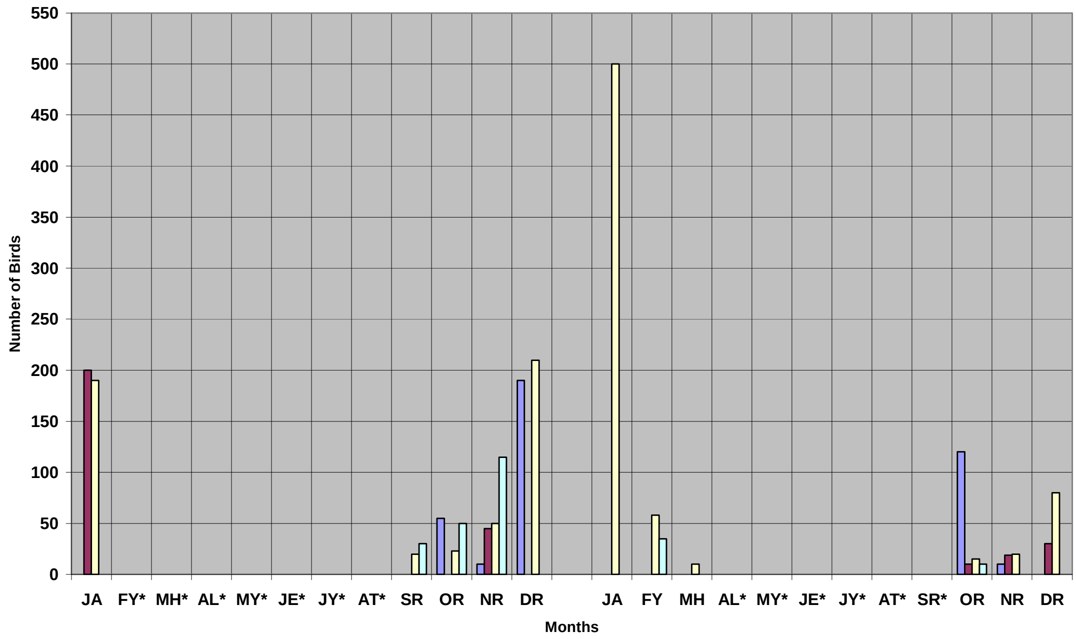
1969 – 1970

Figure 4c. Shoveler (*Anas clypeata*) monthly fluctuations 1971-1972.



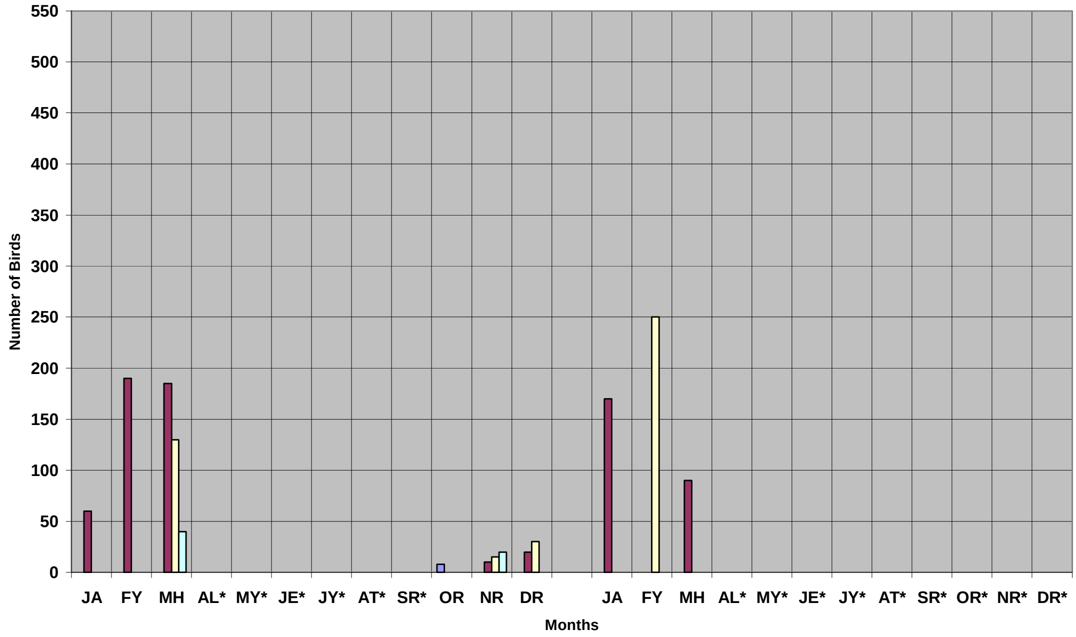
1971 – 1972

Figure 4d. Shoveler (*Anas clypeata*) monthly fluctuations 1973-1974.



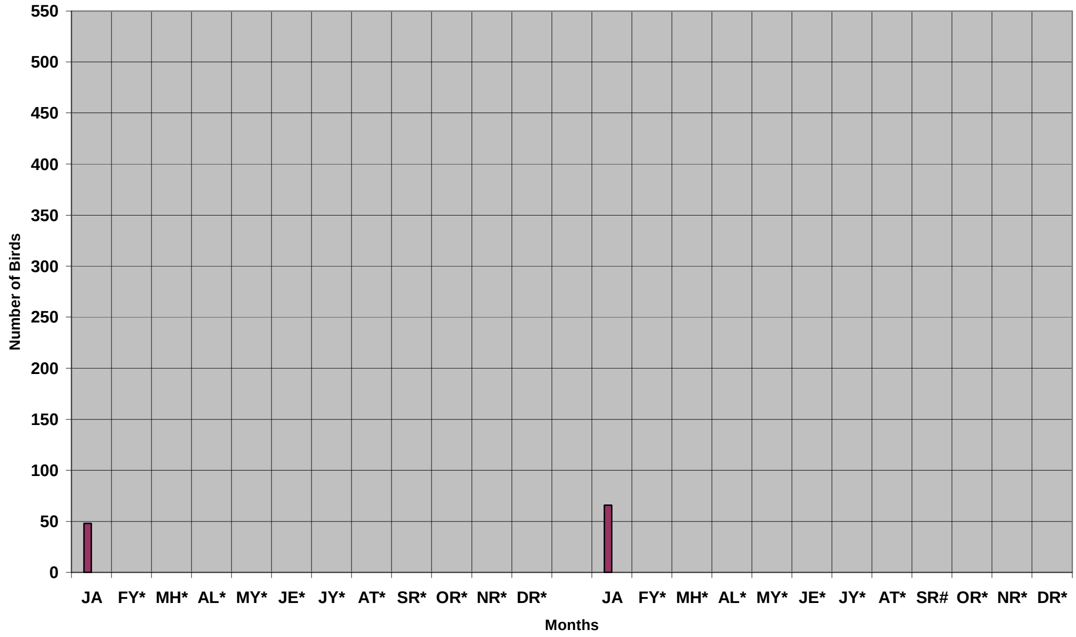
1973 – 1974

Figure 4e. Shoveler (*Anas clypeata*) monthly fluctuations 1975-1976.



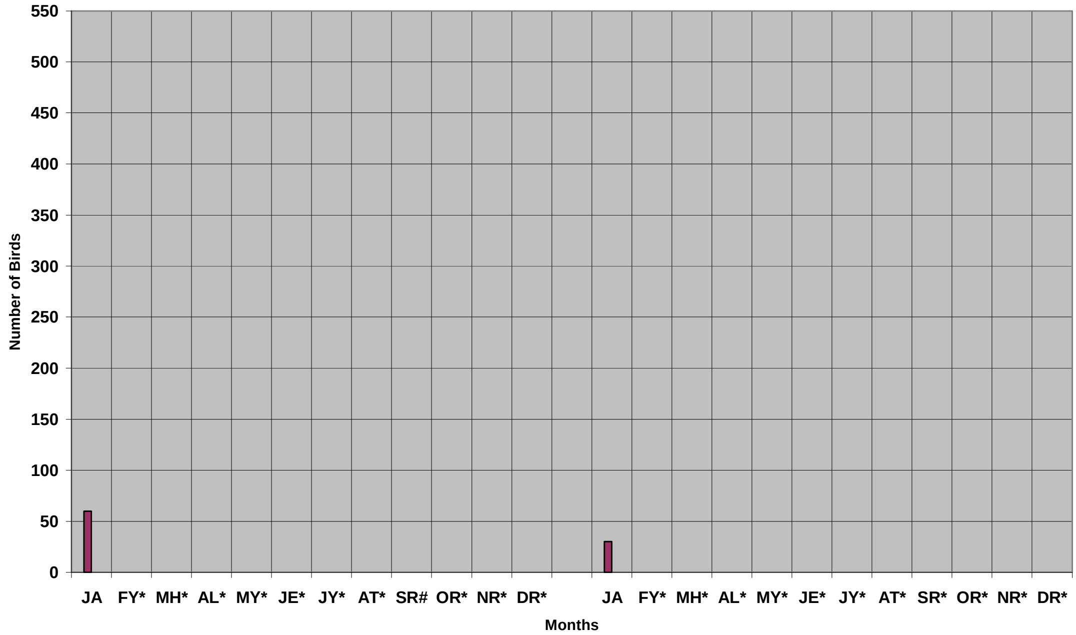
1975 – 1976

Figure 4f. Shoveler (*Anas clypeata*) monthly fluctuations 1995-1996.



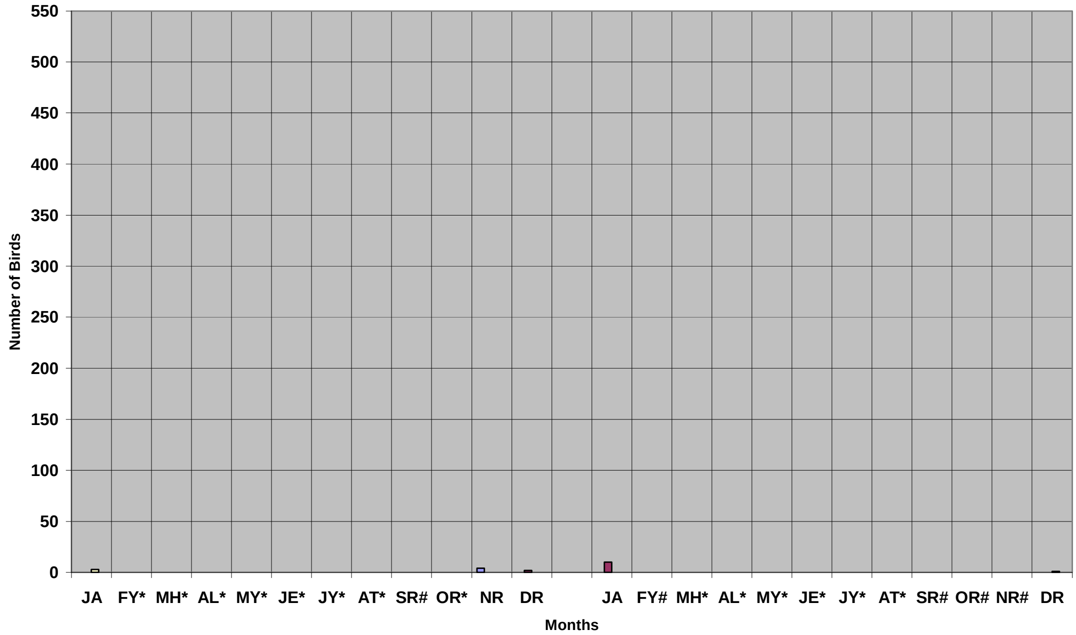
1995 – 1996

Figure 4g. Shoveler (*Anas clypeata*) monthly fluctuations 1997-1998.



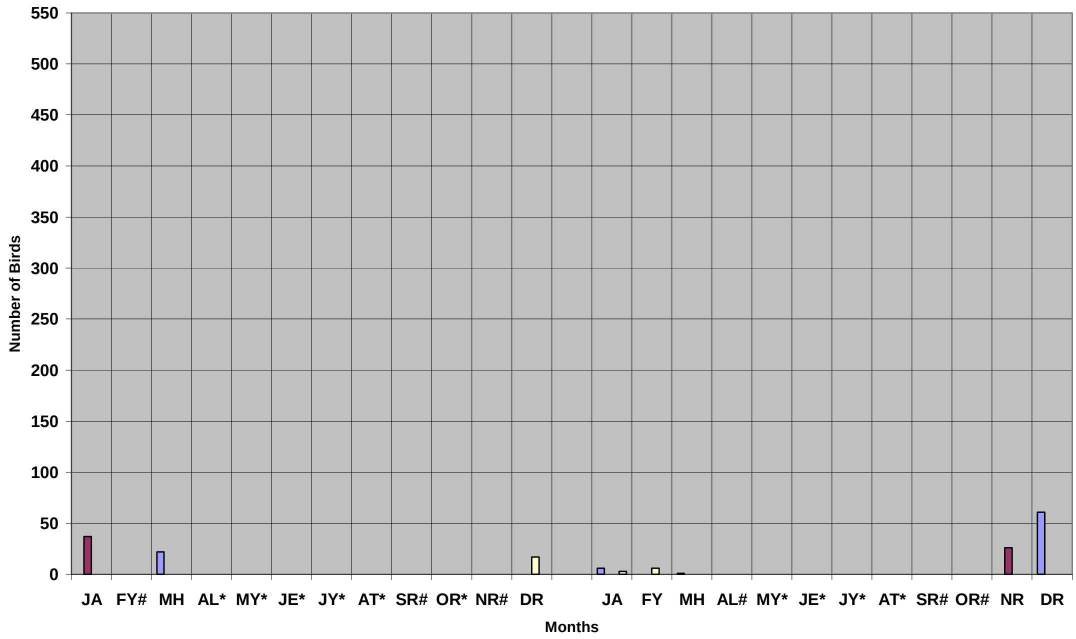
1997 - 1998

Figure 4h. Shoveler (*Anas clypeata*) monthly fluctuations 2000-2001.



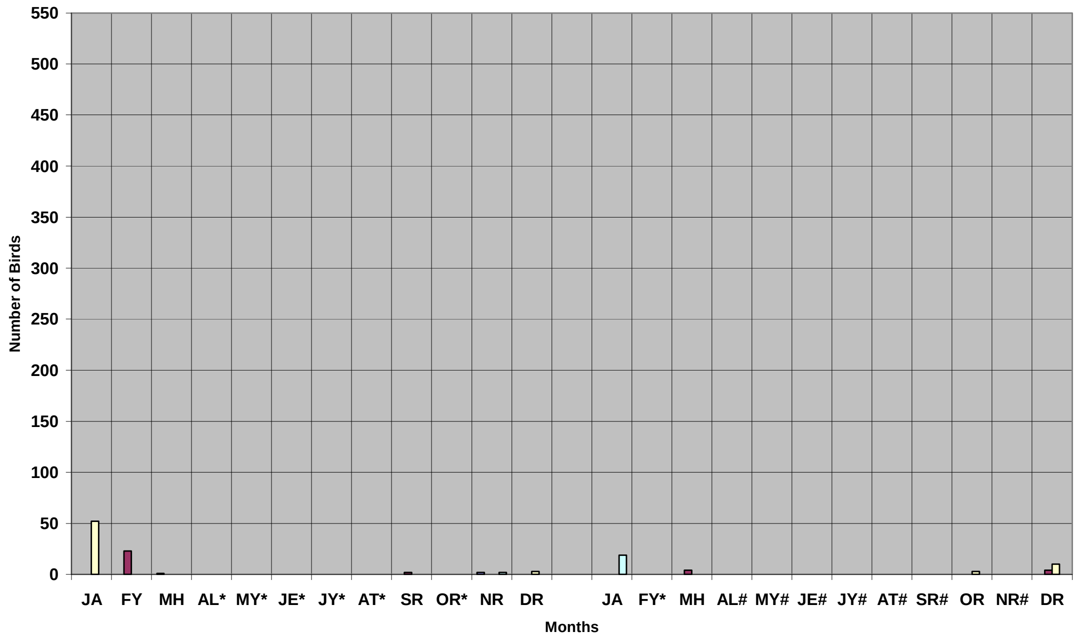
2000 – 2001

Figure 4i. Shoveler (*Anas clypeata*) monthly fluctuations 2002-2003.



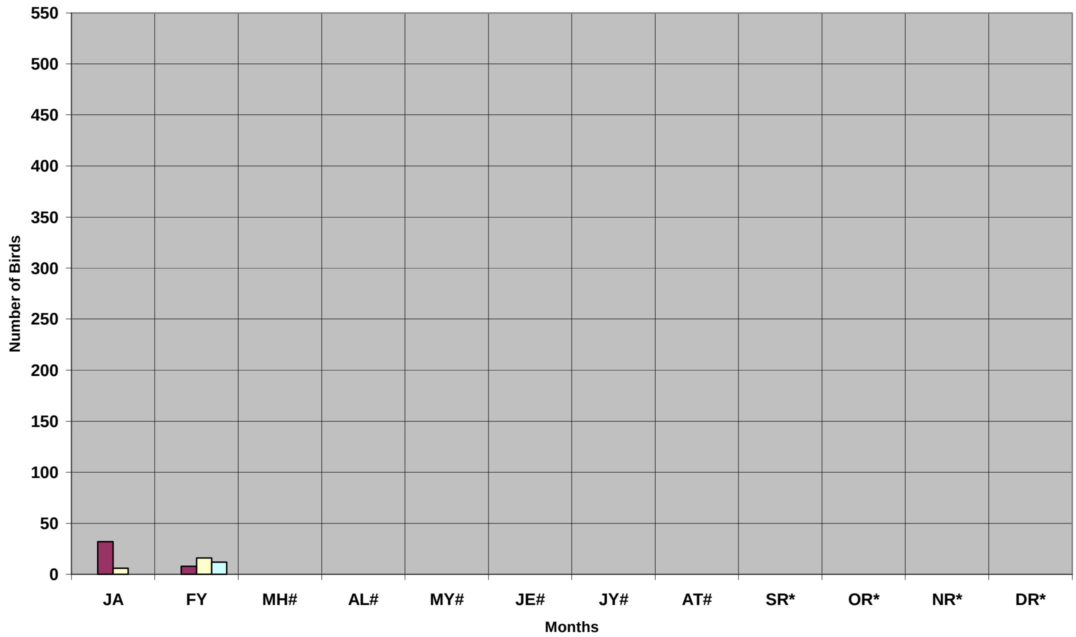
2002 – 2003

Figure 4j. Shoveler (*Anas clypeata*) monthly fluctuations 2004-2005.



2004 – 2005

Figure 4k. Shoveler (*Anas clypeata*) monthly fluctations 2006.



2006

Wigeon (*Anas penelope*)

Wigeon are winter visitors to Lough Carra where they can often be seen on the edges of the lakeshore where they like to graze on short grasses not unlike geese and it is for this reason that they stand out amongst their dabbling counterparts. The male is particularly distinctive with its striking white wing patch and buff coloured forehead while both sexes have rather large and rounded heads. The numbers of Wigeon overwintering on the lake are quite variable but overall numbers are down when compared to the 1960s and 70s.

<u>1968 - 1975</u>

Minimum Annual Peak Count: 45 (1968).

Maximum Annual Peak Count: 590 (1974).

Mean Annual Peak: 241.

<u>1995 – 2006</u>

Minimum Annual Peak Count: 8 (2002).

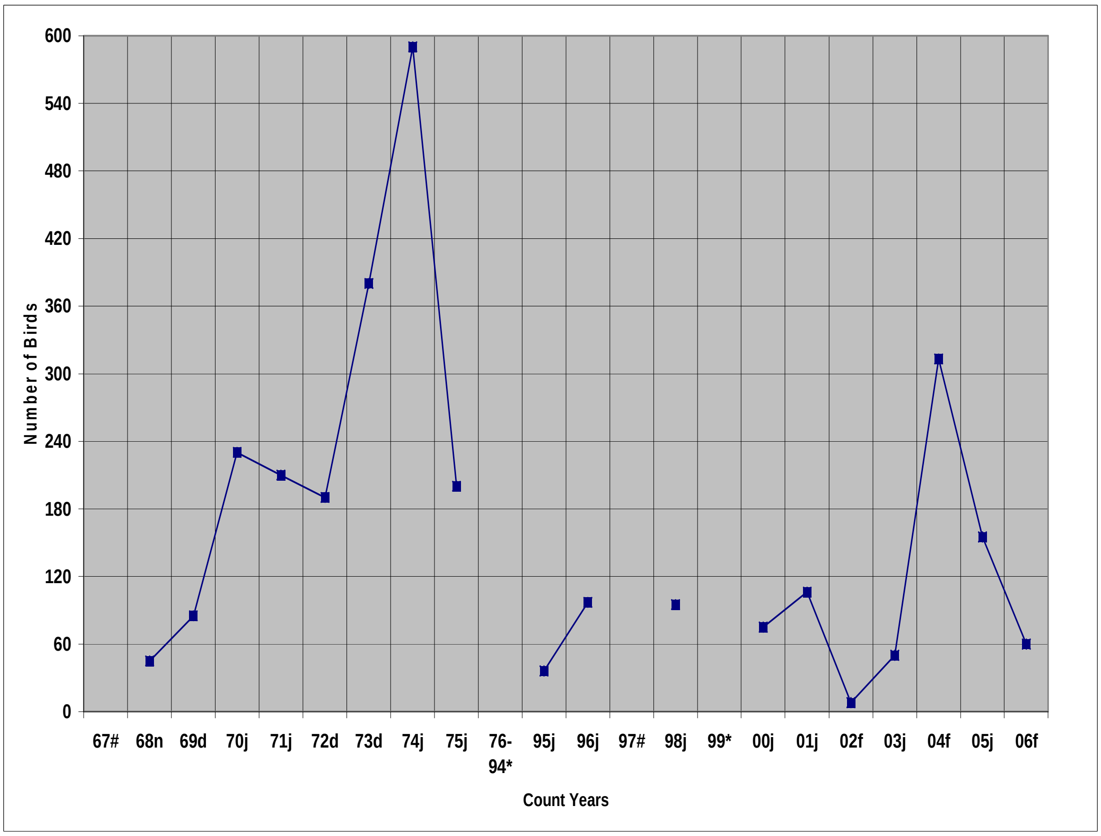
Maximum Annual Peak Count: 313 (2004).

Mean Annual Peak: 99.

Plate 4. Male Wigeon (*Anas penelope*).

Photograph by John N Murphy

Figure 5. Wigeon (*Anas penelope*) annual peaks on Lough Carra 1968-2006.



Notes: 1968-1975 = Counts made by Stronach *et al.*

1995-2000 = Counts made by Delany/Colhoun *et al.* for I-WeBS.

2000-2004 = Counts made by Chris & Lynda Huxley for I-WeBS.

2004-2006 = Counts made by Chris & Lynda Huxley for I-WeBS and by the author.

The small letters next to the count years refers to the month in which the peak occurred, **D**=December, **N**=November, **J**=January, **F**=February.

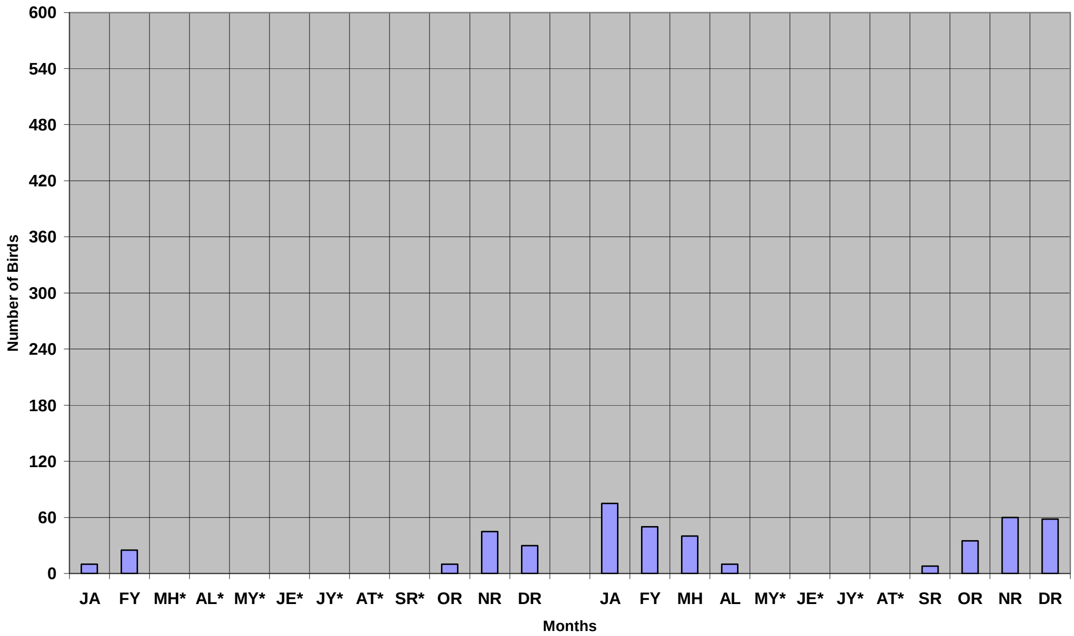
***** = No data for the years 1976-1994 & 1999.

= Count conducted but no Wigeon recorded.

Monthly Fluctuations of Wigeon (*Anas penelope*) on Lough Carra 1968 – 2006

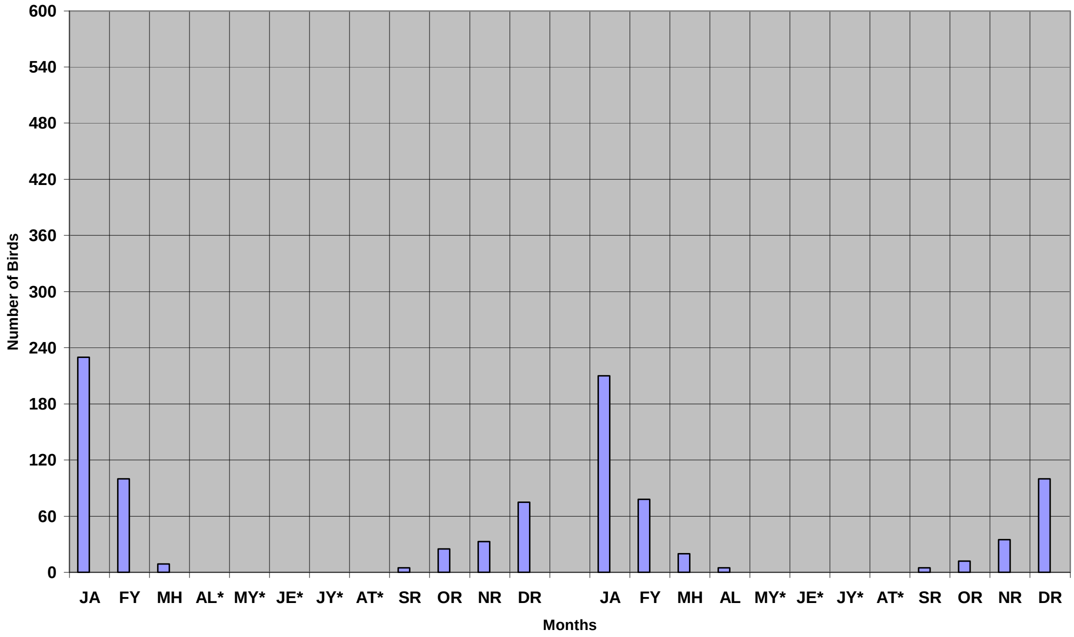
Please note that the figures for Wigeon (*Anas penelope*) presented in the report *An Ecological Study of Waterfowl on Lough Carra* (Stronach, 1981), provide just one count per month for the counting programme from that era. This is due to the presentation of data and is not a reflection of the number of counts actually conducted from 1968 – 1975.

Figure 5a. Wigeon (*Anas penelope*) monthly fluctuations 1968-1969.



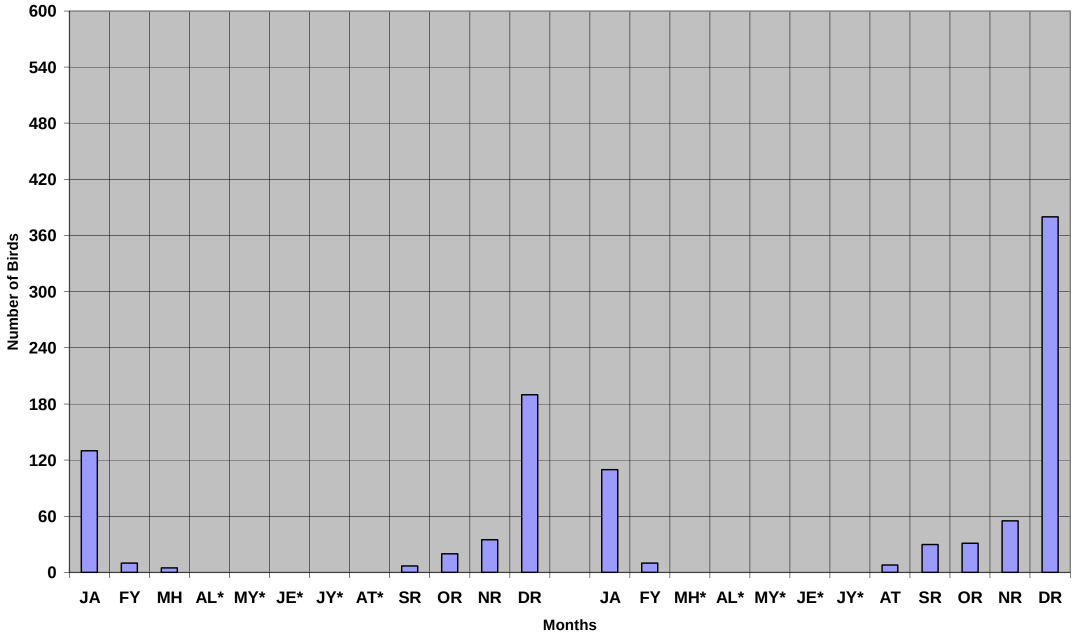
1968 – 1969

Figure 5b. Wigeon (*Anas penelope*) monthly fluctations 1970-1971.



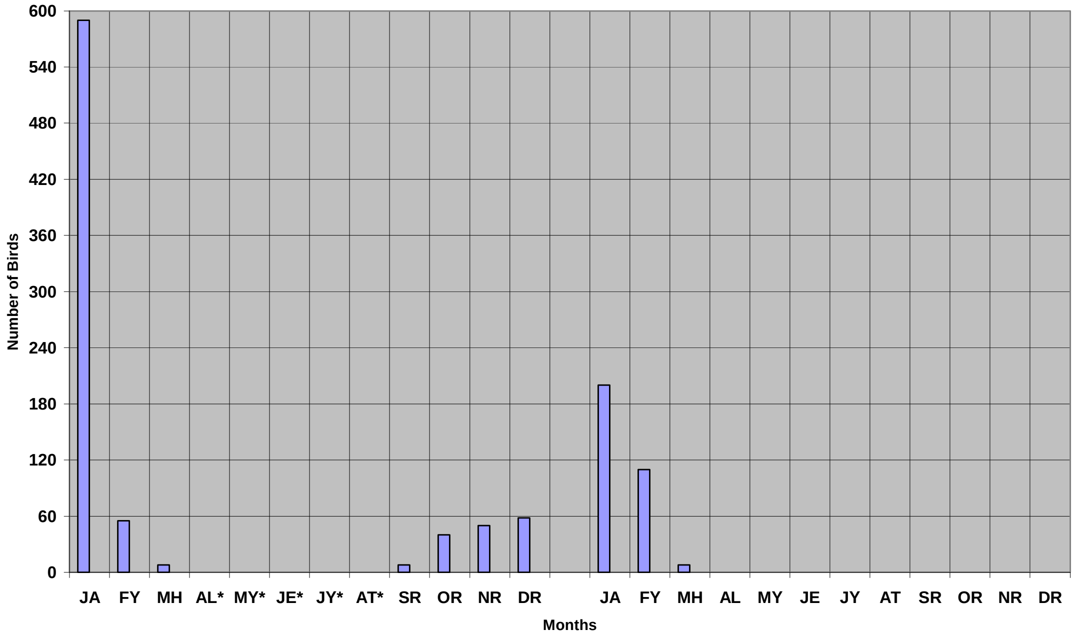
1970 – 1971

Figure 5c. Wigeon (*Anas penelope*) monthly fluctuations 1972-1973.



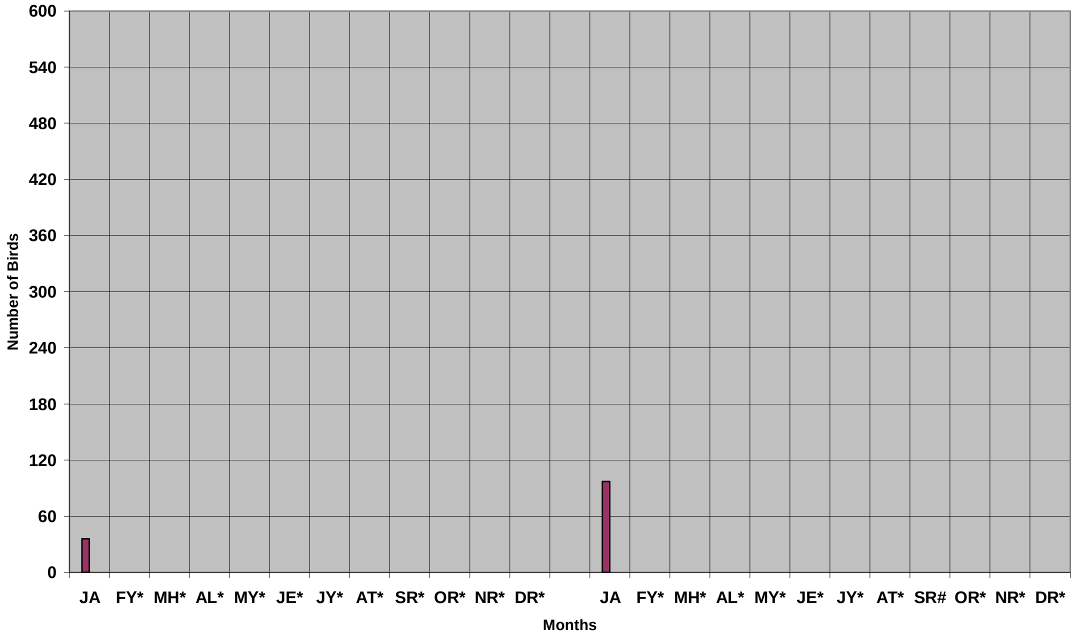
1972 – 1973

Figure 5d. Wigeon (*Anas penelope*) monthly fluctuations 1974-1975.



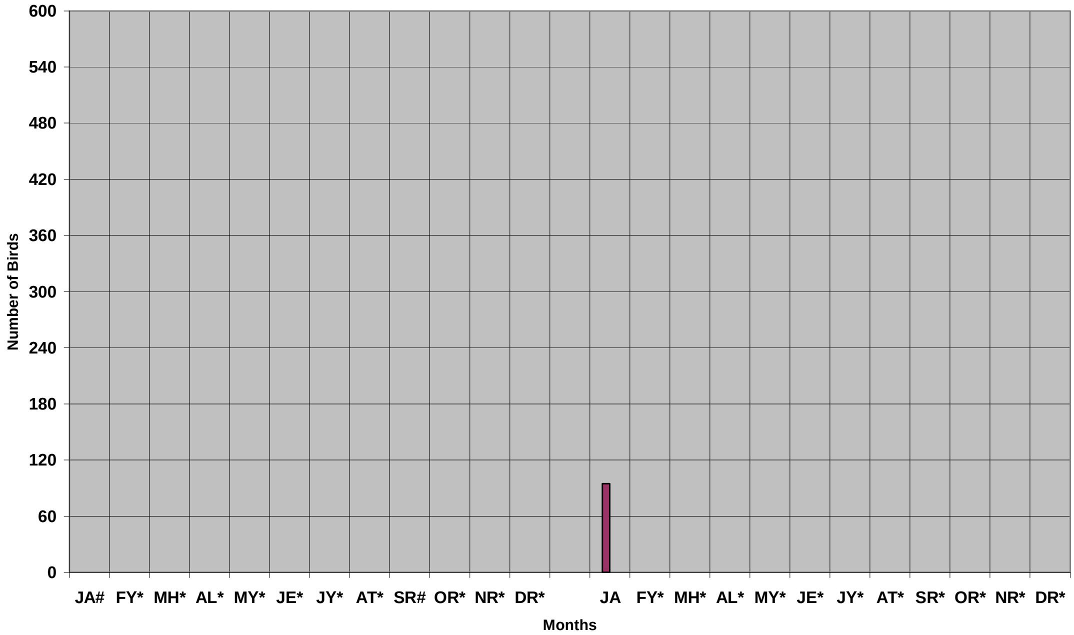
1974 – 1975

Figure 5e. Wigeon (*Anas penelope*) monthly fluctuations 1995-1996.



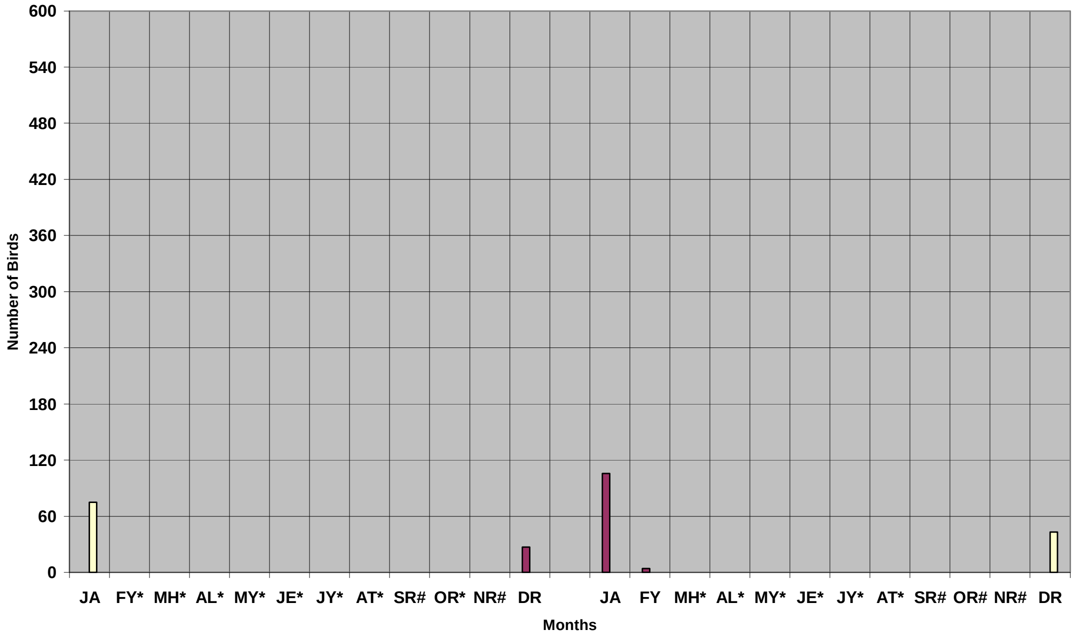
1995 – 1996

Figure 5f. Wigeon (*Anas penelope*) monthly fluctuations 1997-1998.



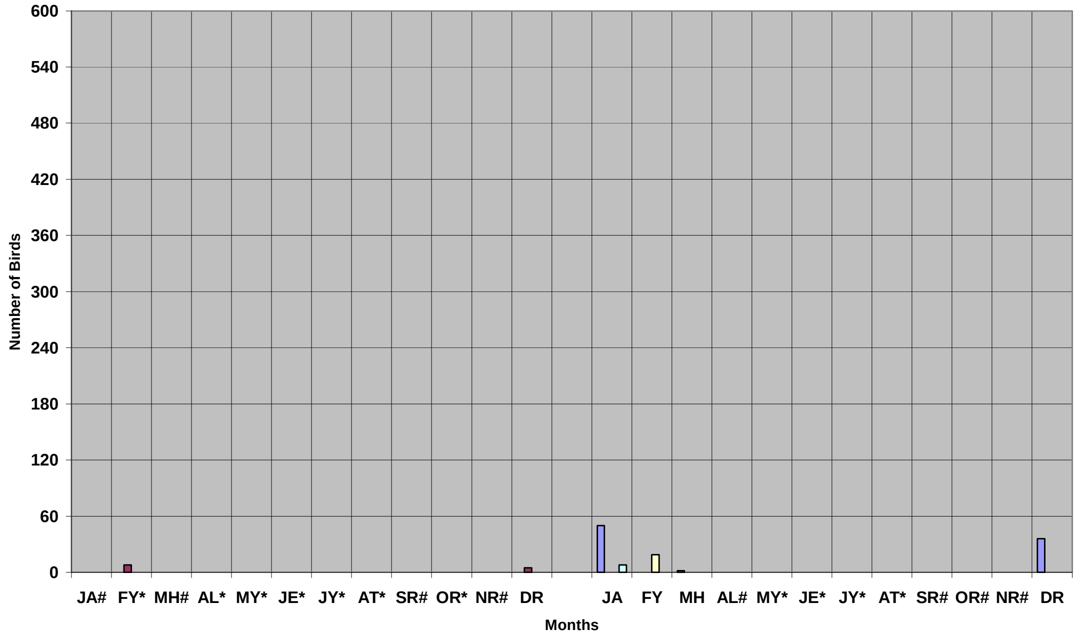
1997 – 1998

Figure 5g. Wigeon (*Anas penelope*) monthly fluctuations 2000-2001.



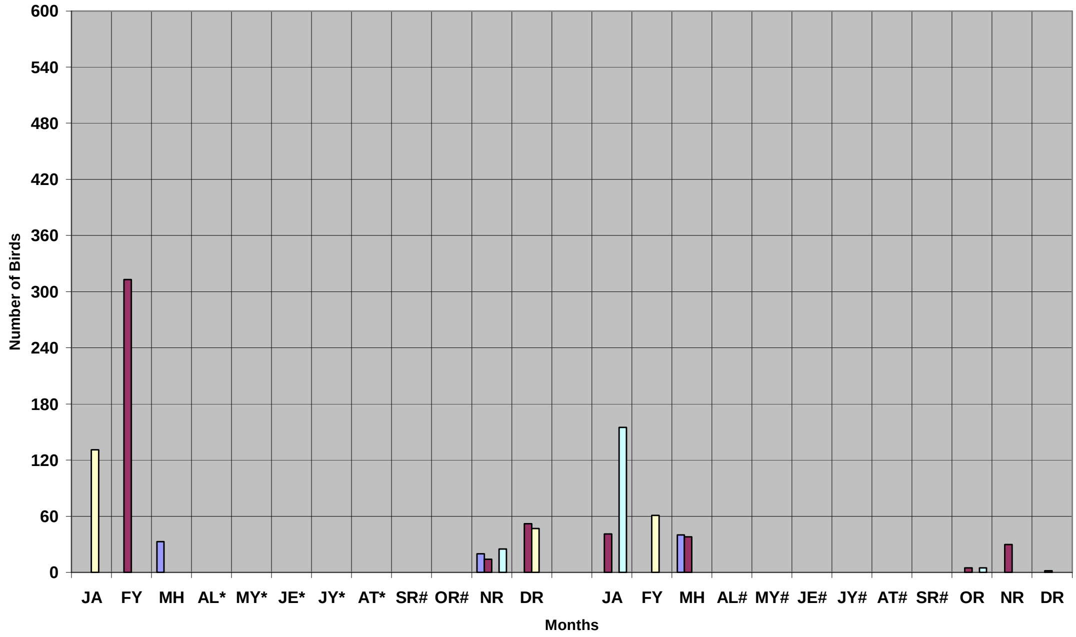
2000 – 2001

Figure 5h. Wigeon (*Anas penelope*) monthly fluctuations 2002-2003.



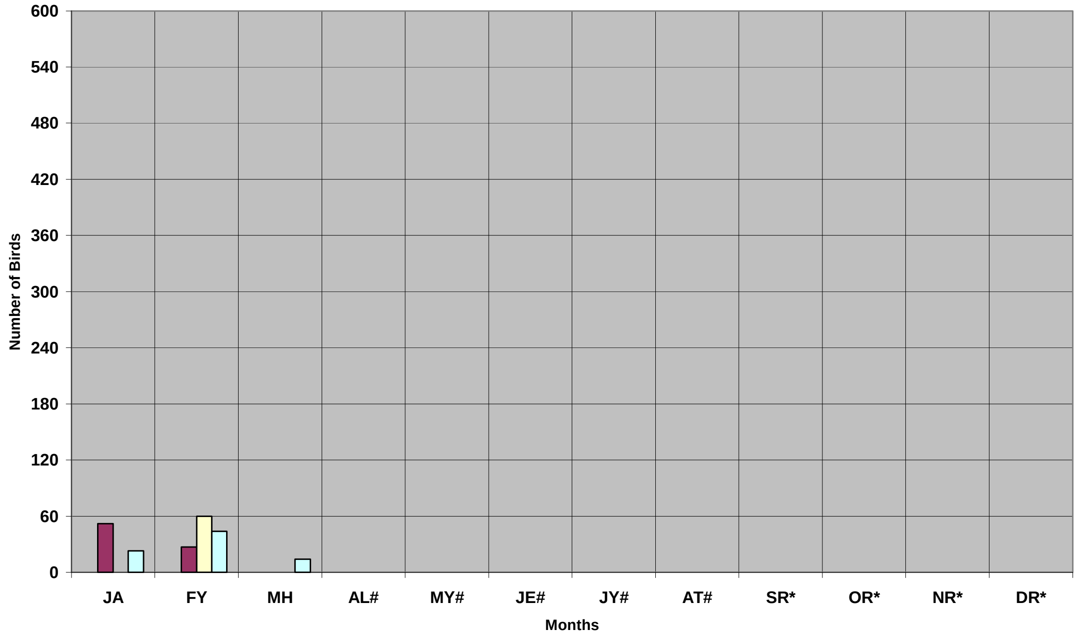
2002 – 2003

Figure 5i. Wigeon (*Anas penelope*) monthly fluctuations 2004-2005.



2004 – 2005

Figure 5j. Wigeon (*Anas penelope*) monthly fluctuations 2006.



2006

Teal (*Anas crecca*)

The Teal is the smallest of the dabbling ducks and due to its size it has been described as wader-like in flight (Mullarney *et al.* 1999). It is often seen swimming in and around the reedbeds (*Phragmites communis*) on Lough Carra and feeding in the shallow margins of the lake. A very small number are sedentary on Lough Carra but the majority migrate north to breed. The wintering population has severely declined since the 1960s and 1970s.

1967 – 1976

Minimum Annual Peak Count: 300 (1976).

Maximum Annual Peak Count: 1,600 (1971).

Mean Annual Peak: 732.

1995 – 2006

Minimum Annual Peak Count: 26 (1997).

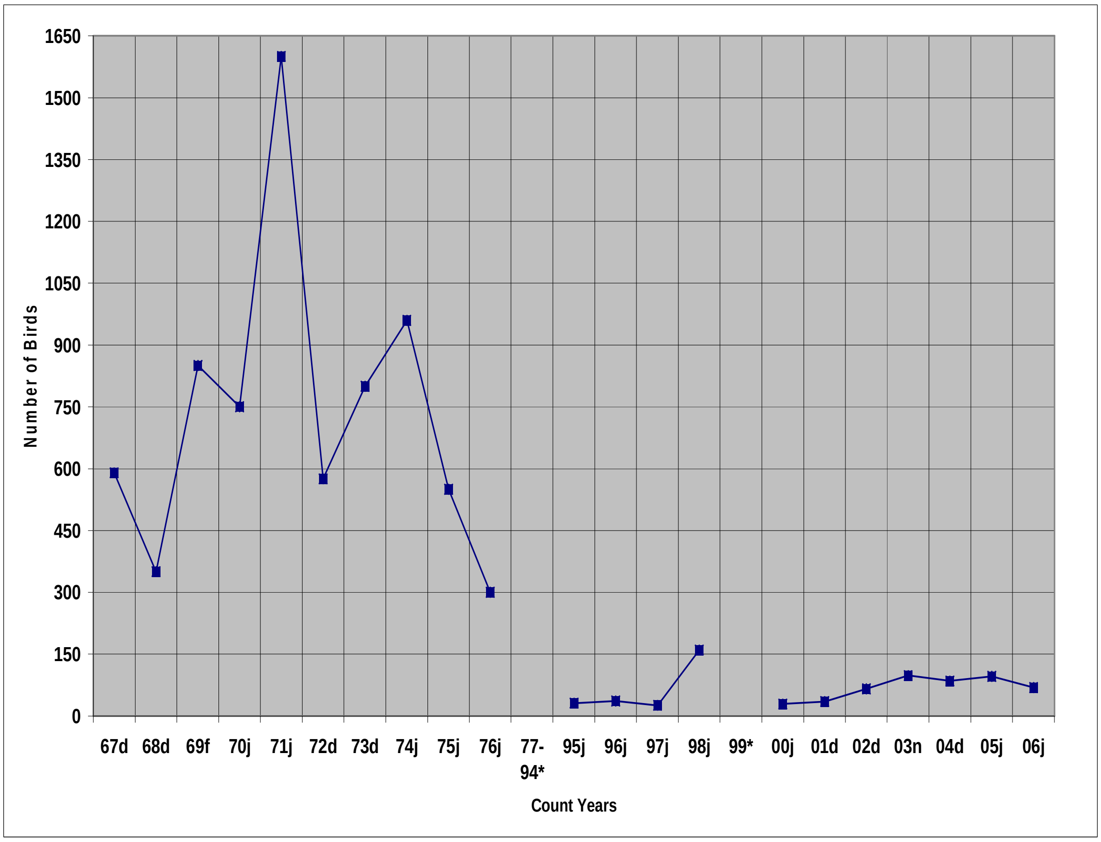
Maximum Annual Peak Count: 160 (1998).

Mean Annual Peak: 66.

Plate 5. Male Teal (*Anas crecca*).

Photograph by John N Murphy

Figure 6. Teal (*Anas crecca*) annual peaks on Lough Carra 1967-2006.



Notes: 1967-1976 = Counts made by Stronach *et al.*

1995-2000 = Counts made by Delany/Colhoun *et al.* for I-WeBS.

2000-2004 = Counts made by Chris & Lynda Huxley for I-WeBS.

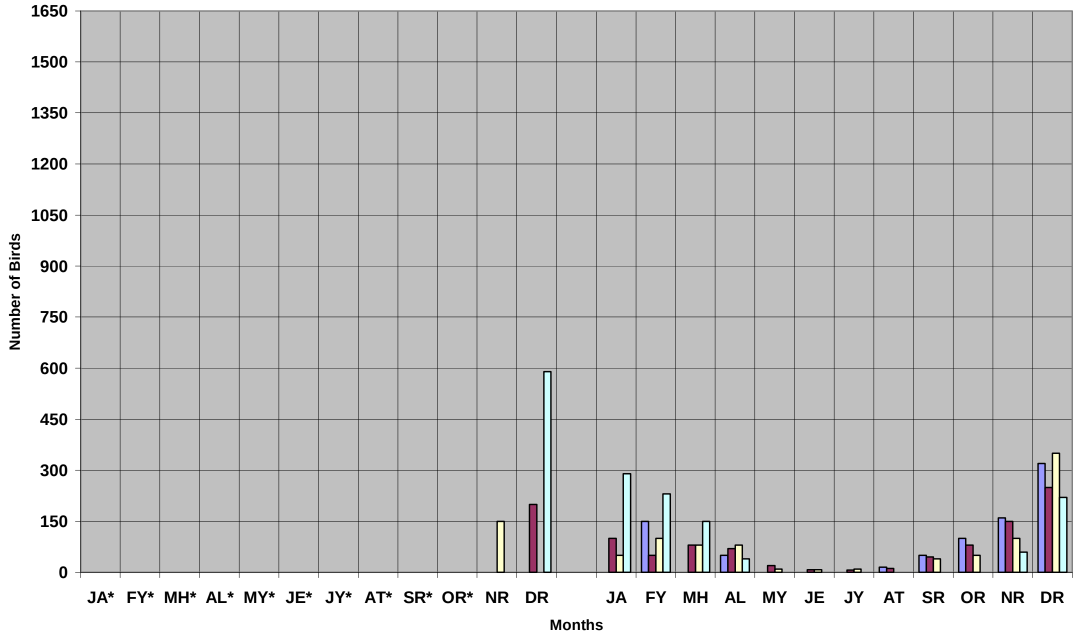
2004-2006 = Counts made by Chris & Lynda Huxley for I-WeBS and by the author.

The small letters next to the count years refers to the month in which the peak occurred, **D**=December, **N**=November, **J**=January, **F**=February.

***** = No data for the years 1977-1994 & 1999.

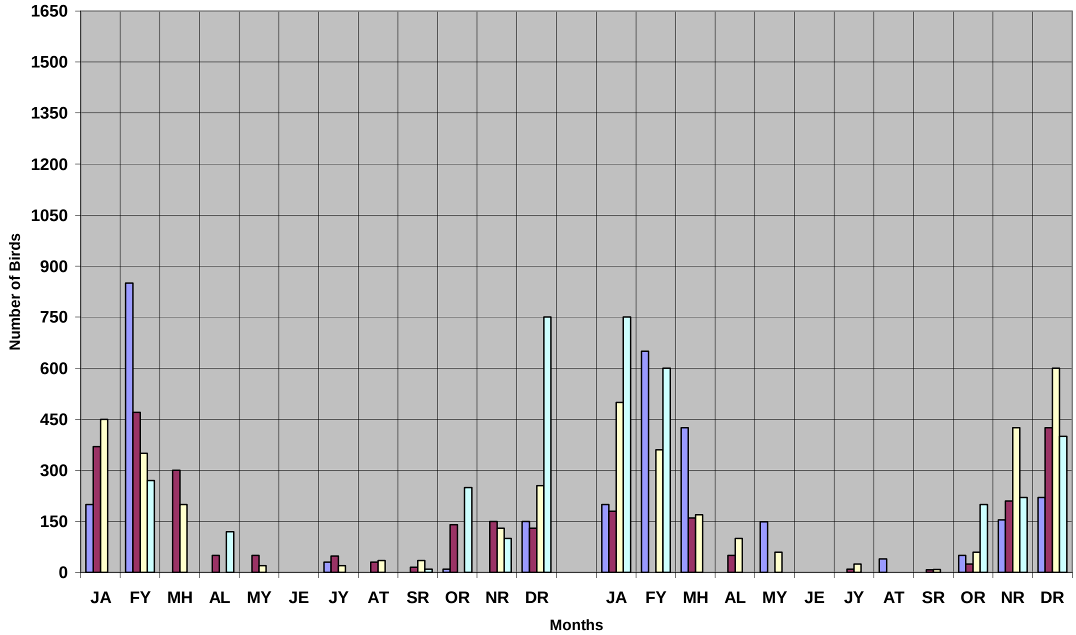
Monthly Fluctuations of Teal (*Anas crecca*) on Lough Carra 1967-2006

Figure 6a. Teal (*Anas crecca*) monthly fluctuations 1967-1968.



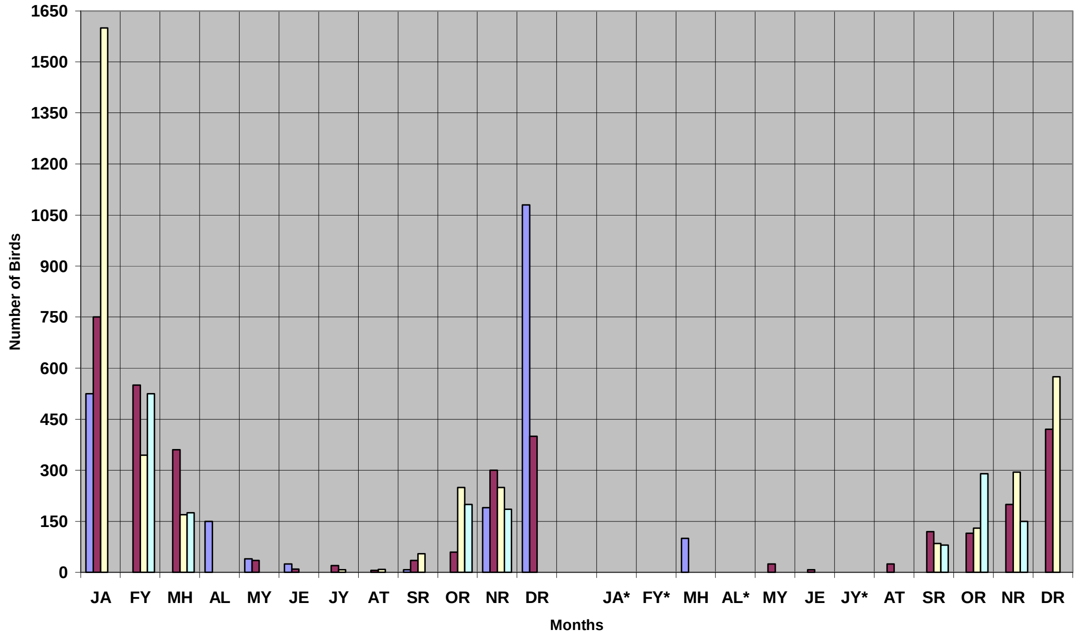
1967 – 1968

Figure 6b. Teal (*Anas crecca*) monthly fluctuations 1969-1970.



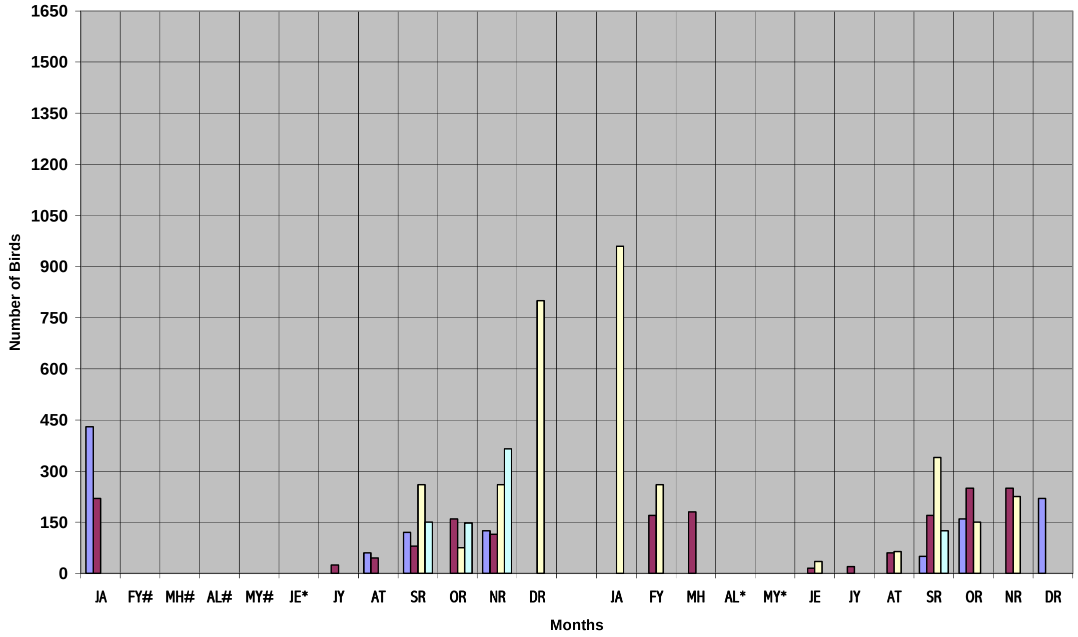
1969 – 1970

Figure 6c. Teal (*Anas crecca*) monthly fluctuations 1971-1972.



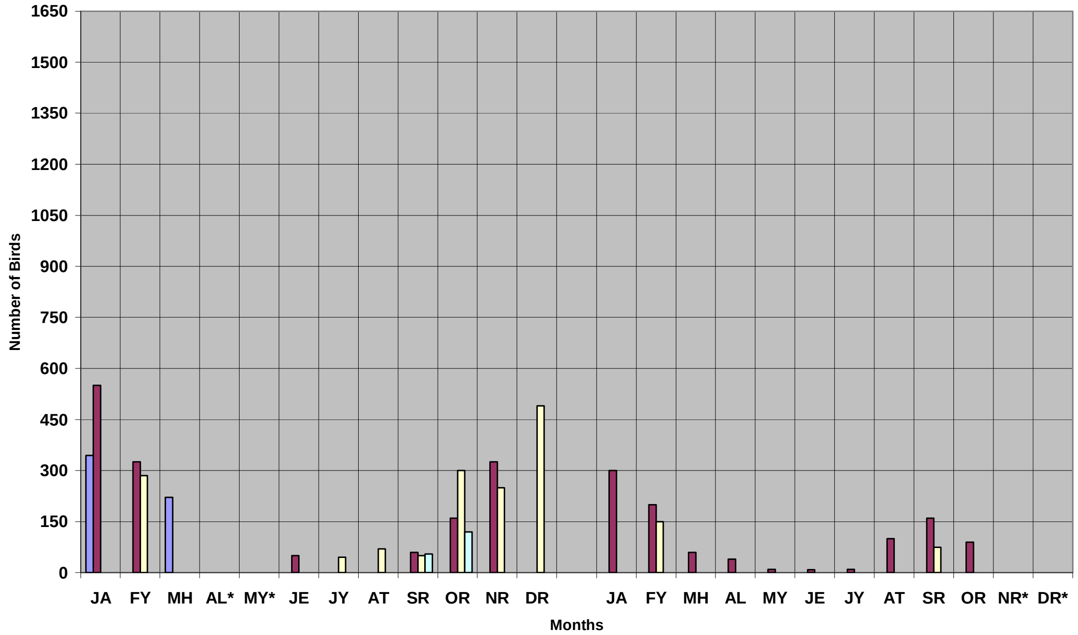
1971 – 1972

Figure 6d. Teal (*Anas crecca*) monthly fluctuations 1973-1974.



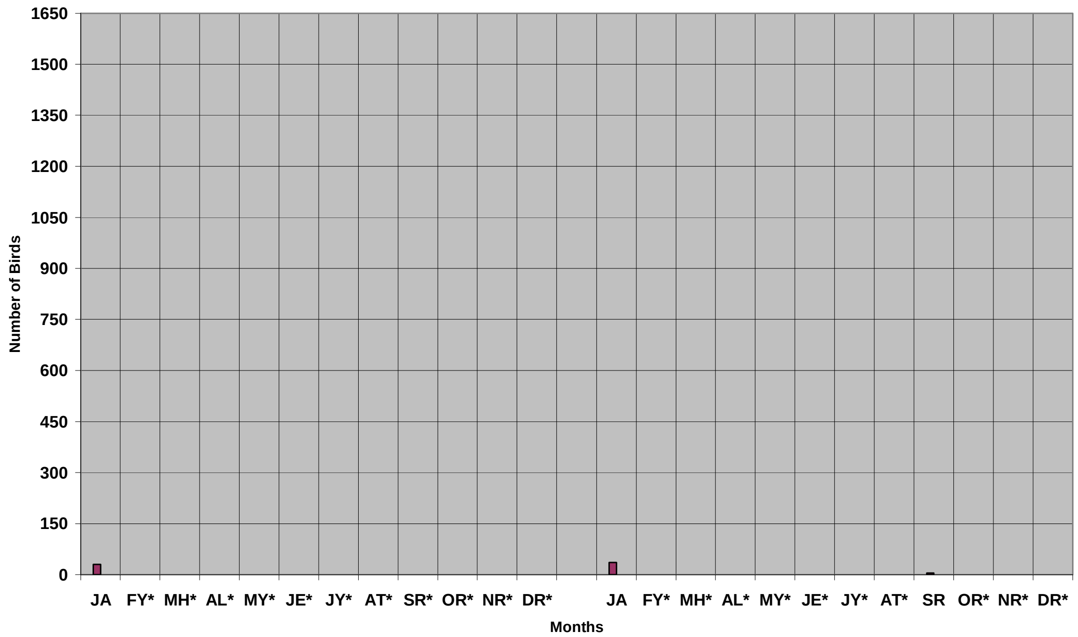
1973 - 1974

Figure 6e. Teal (*Anas crecca*) monthly fluctuations 1975-1976.



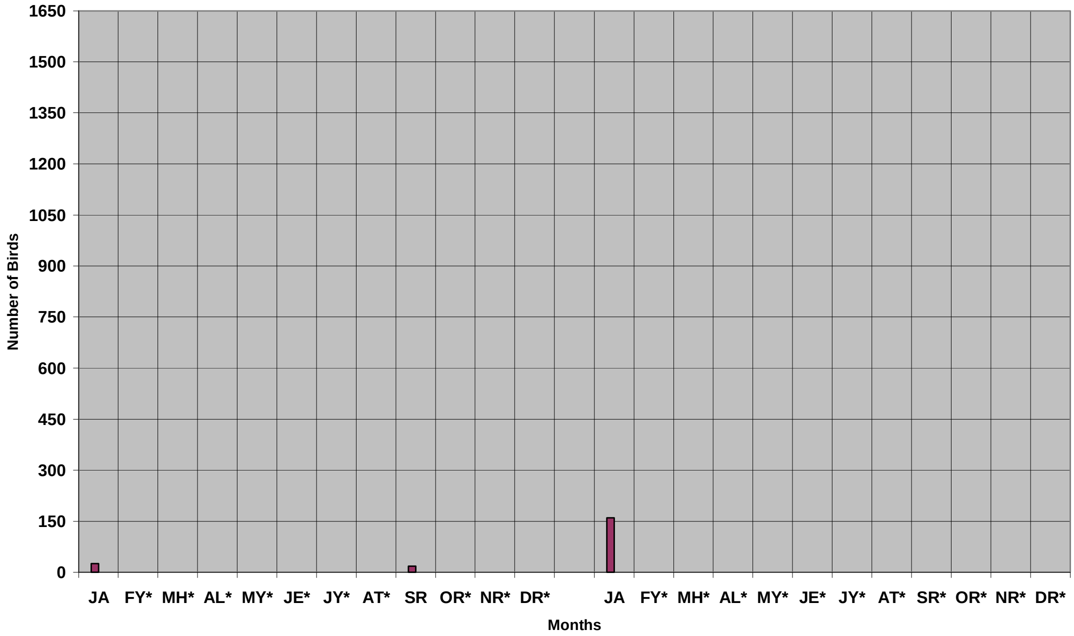
1975 – 1976

Figure 6f. Teal (*Anas crecca*) monthly fluctuations 1995-1996.



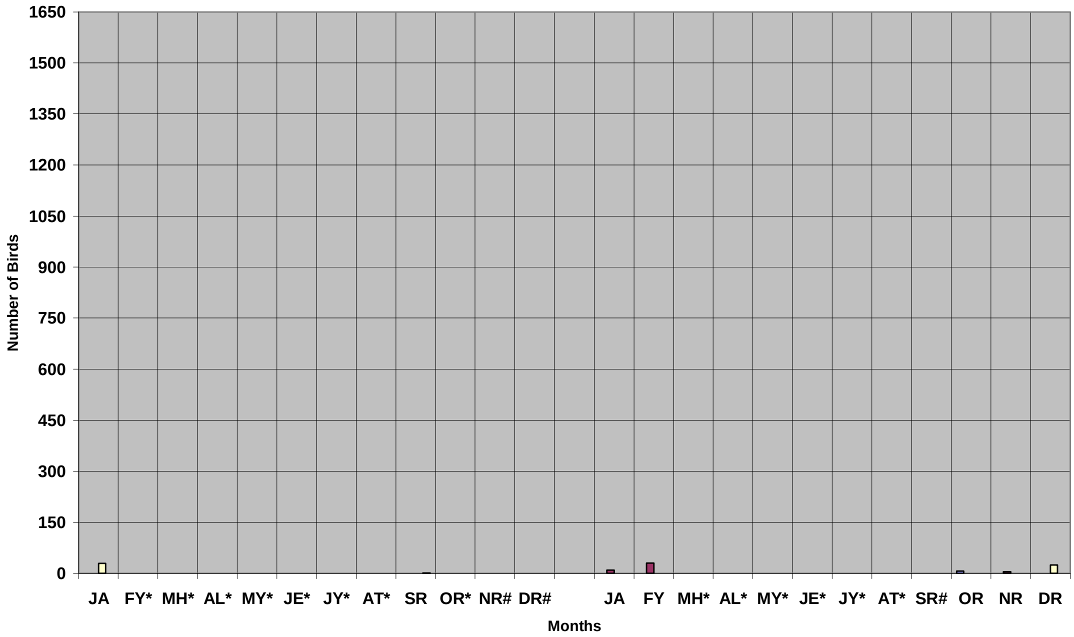
1995 – 1996

Figure 6g. Teal (*Anas crecca*) monthly fluctuations 1997-1998.



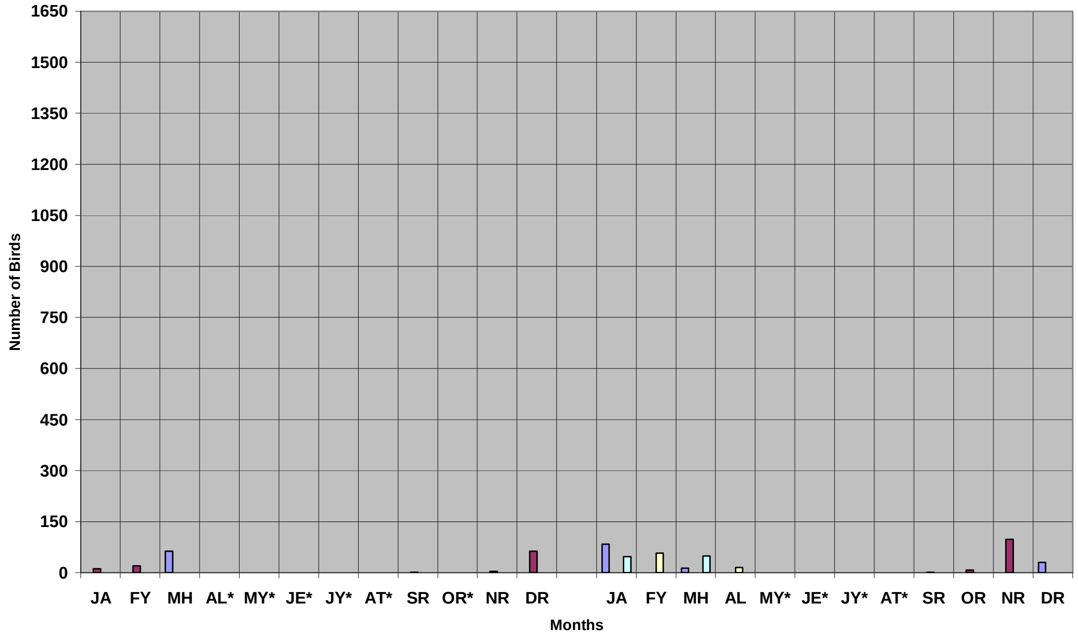
1997 – 1998

Figure 6h. Teal (*Anas crecca*) monthly fluctuations 2000-2001.



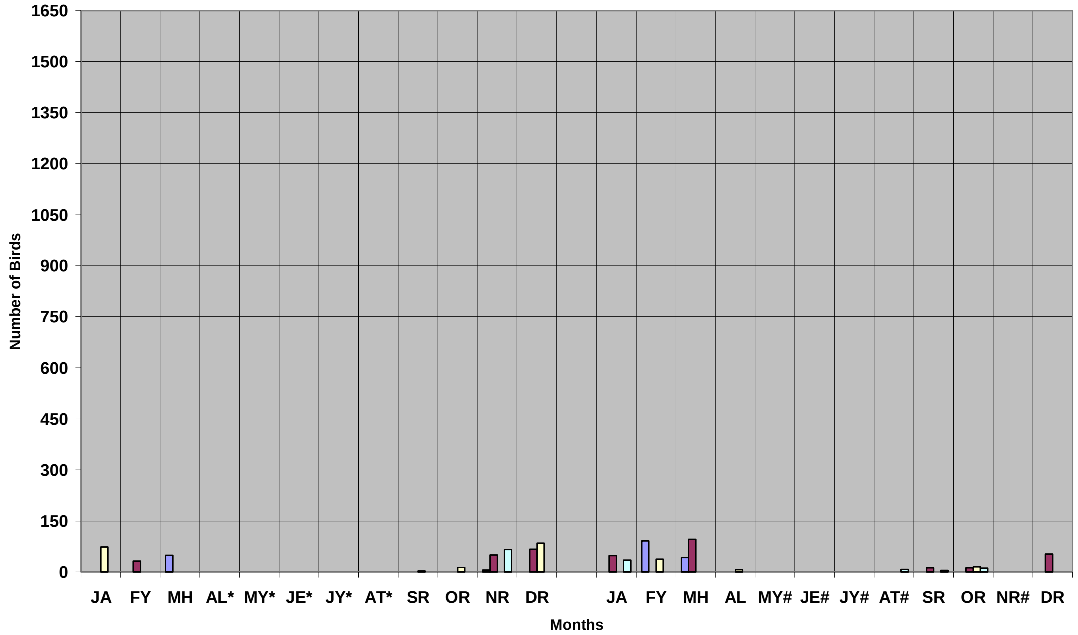
2000 – 2001

Figure 6i. Teal (*Anas crecca*) monthly fluctuations 2002-2003.



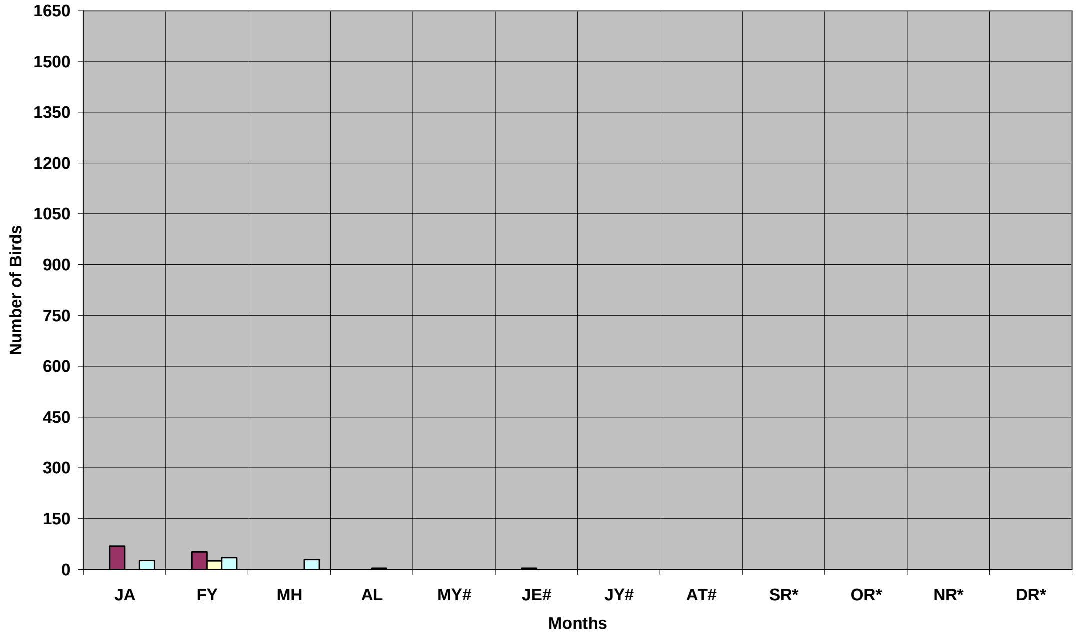
2002 – 2003

Figure 6j. Teal (*Anas crecca*) monthly fluctuations 2004-2005.



2004 – 2005

Figure 6k. Teal (*Anas crecca*) monthly fluctuations 2006.



2006

Pochard (*Aythya ferina*)

The Pochard is a medium sized diving duck and a typical winter migrant on Lough Carra. Stronach (1981) believed that the numbers of Pochard on the lake are supplemented by numbers coming and going from the nearby Lough Corrib. The Pochard on Lough Carra like a number of the other duck species favoured certain parts of the lake, those areas that were suited to their feeding habits and food preferences. There has occurred a large scale decline of Pochard on Lough Carra since the 1960s and 70s.

<u>1967 – 1977</u>

Minimum Annual Peak Count: 250 (1971).

Maximum Annual Peak Count: 890 (1972).

Mean Annual Peak: 469.

<u>1995 – 2006</u>

Minimum Annual Peak Count: 1 (2000).

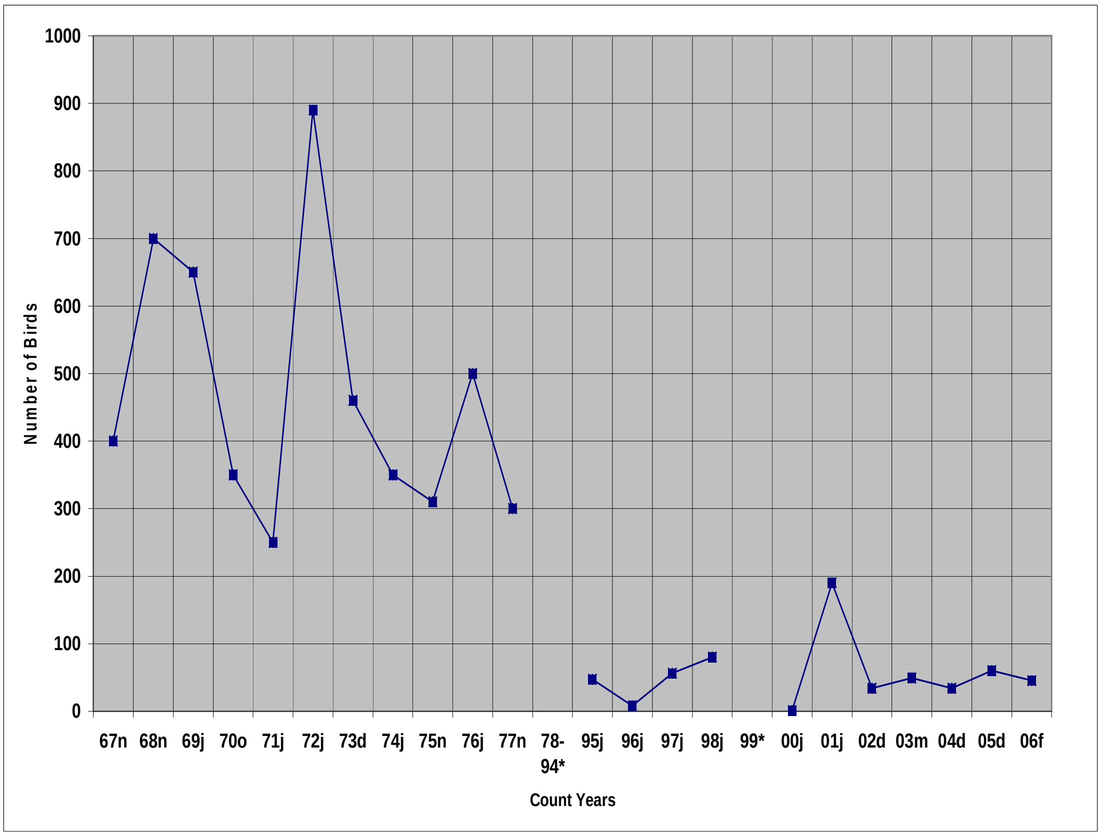
Maximum Annual Peak Count: 190 (2001).

Mean Annual Peak: 54.

Plate 6. Male Pochard (*Aythya ferina*).

Photograph by John N Murphy

Figure 7. Pochard (*Aythya ferina*) annual peaks on Lough Carra 1967-2006.



Notes: 1967-1977 = Counts made by Stronach *et al.*

1995-2000 = Counts made by Delany/Colhoun *et al*. for I-WeBS.

2000-2004 = Counts made by Chris & Lynda Huxley for I-WeBS.

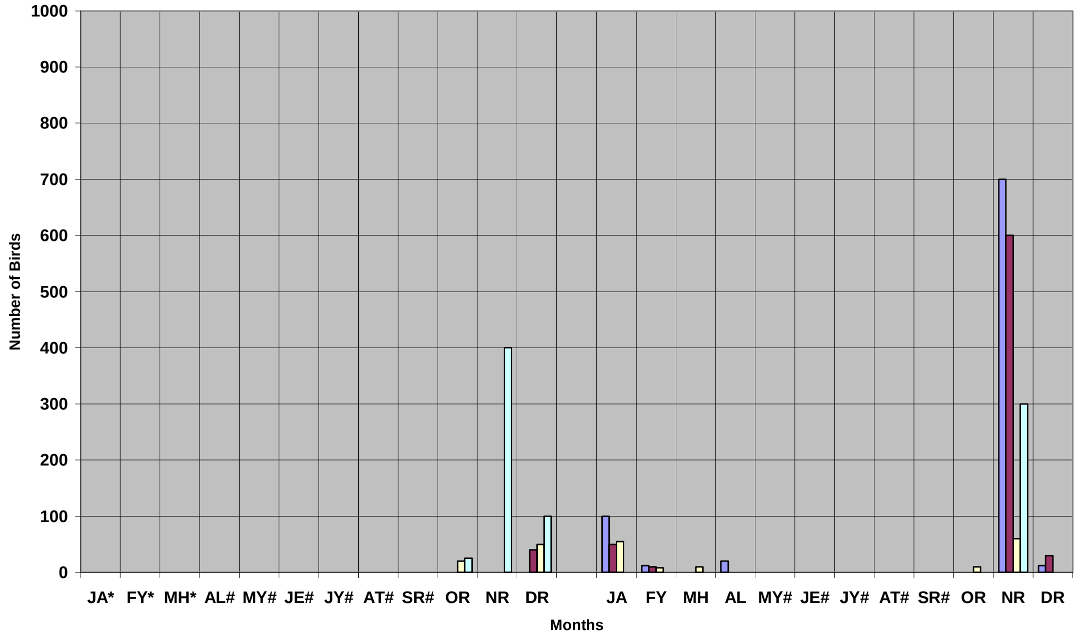
2004-2006 = Counts made by Chris & Lynda Huxley for I-WeBS and by the author.

The small letters next to the count years refers to the month in which the peak occurred, **D**=December, **N**=November, **J**=January, **F**=February, **M** = March, **O** = October.

***** = No data for the years 1978-1994 & 1999.

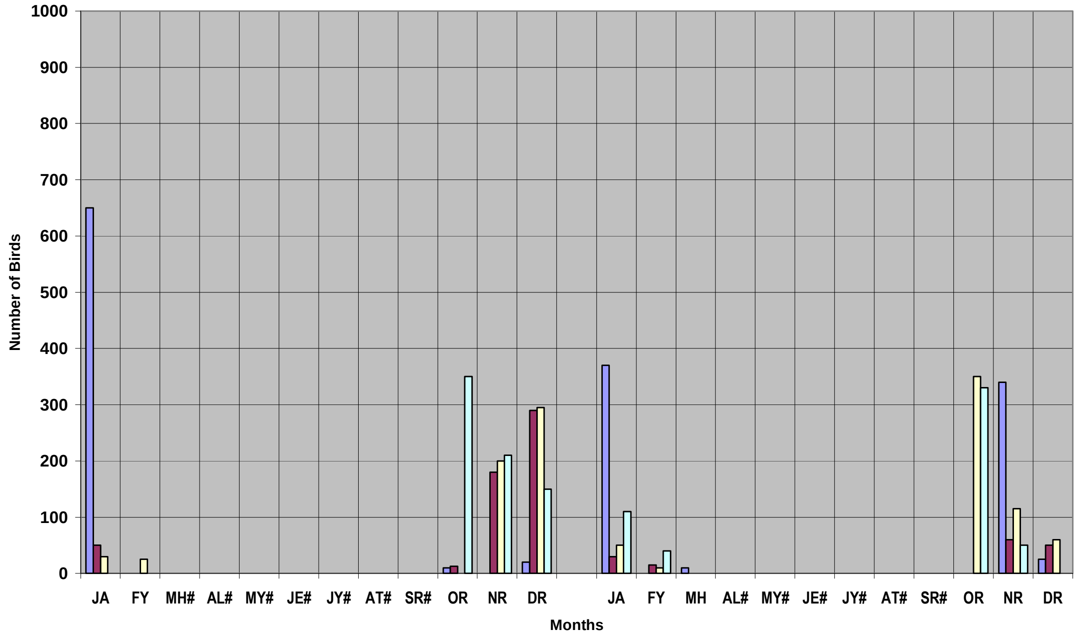
Monthly Fluctuations of Pochard (*Aythya ferina*) on Lough Carra 1967-2006

Figure 7a. Pochard (*Aythya ferina*) monthly fluctuations 1967-1968.



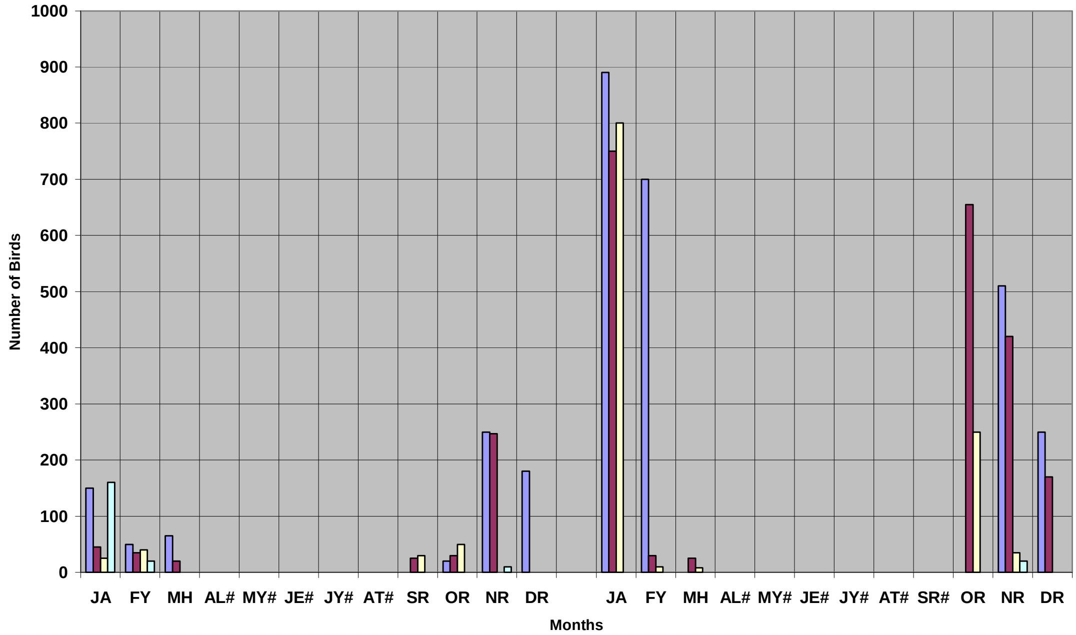
1967 – 1968

Figure 7b. Pochard (*Aythya ferina*) monthly fluctuations 1969-1970.



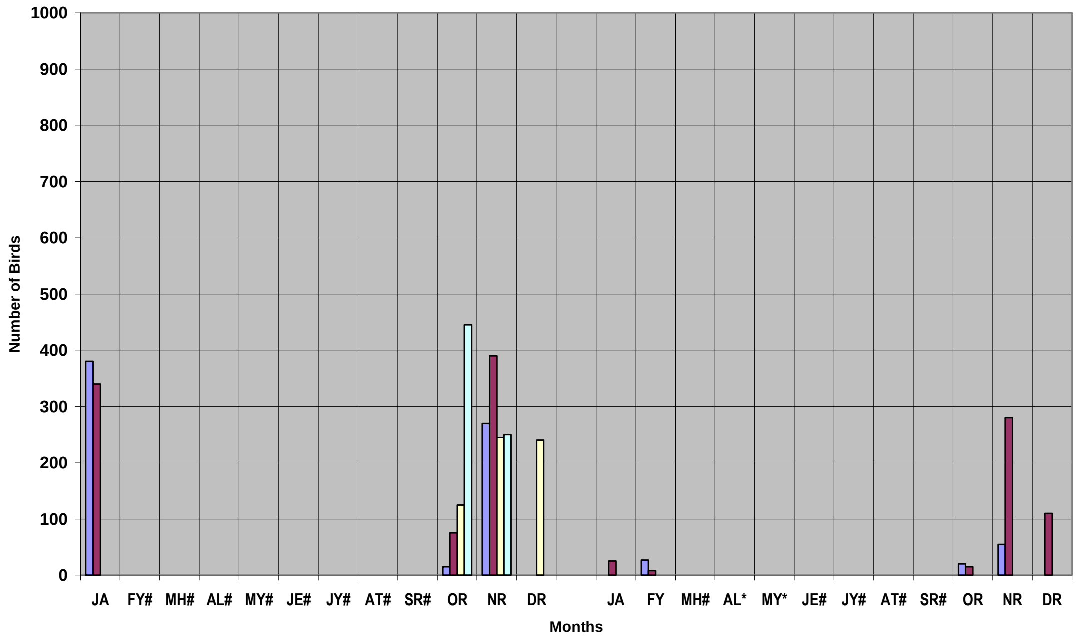
1969 – 1970

Figure 7c. Pochard (*Aythya ferina*) monthly fluctuations 1971-1972.



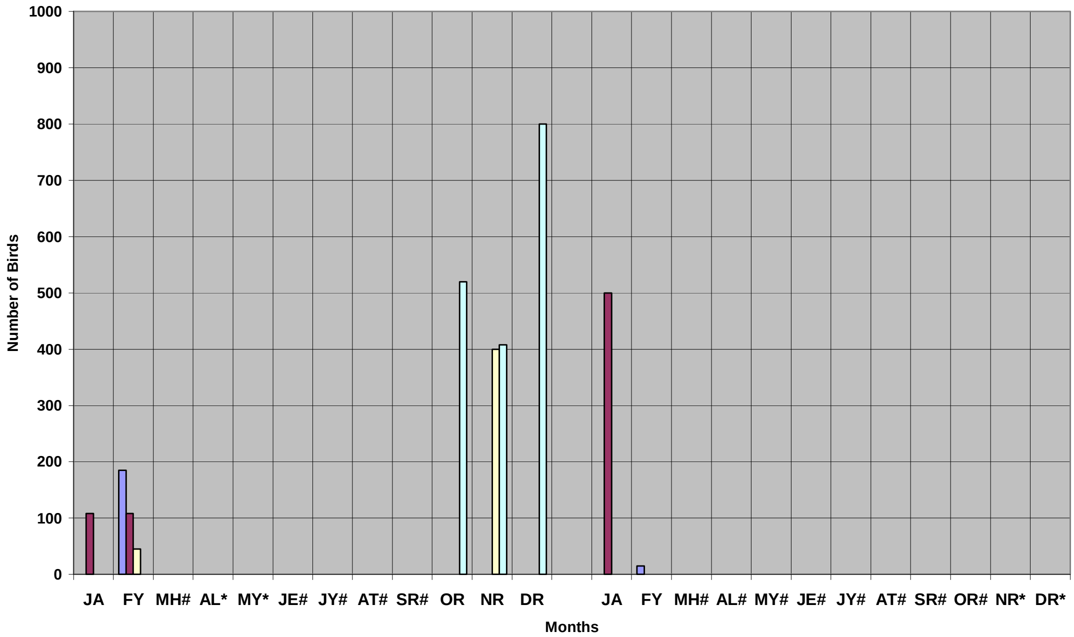
1971 – 1972

Figure 7d. Pochard (*Aythya ferina*) monthly fluctuations 1973-1974.



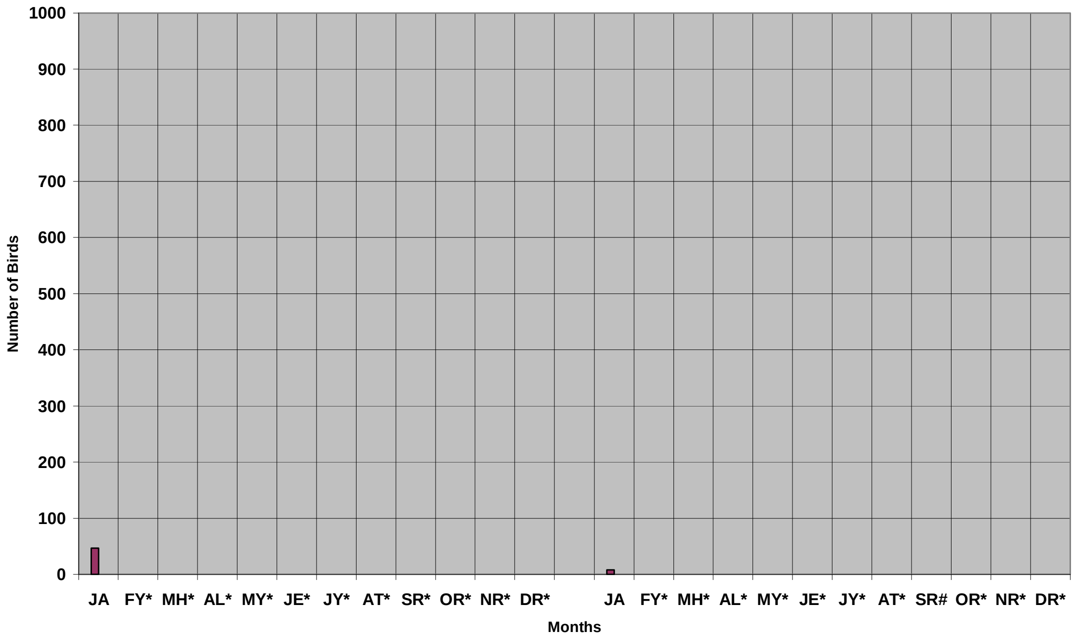
1973 – 1974

Figure 7e. Pochard (*Aythya ferina*) monthly fluctuations 1975-1976.



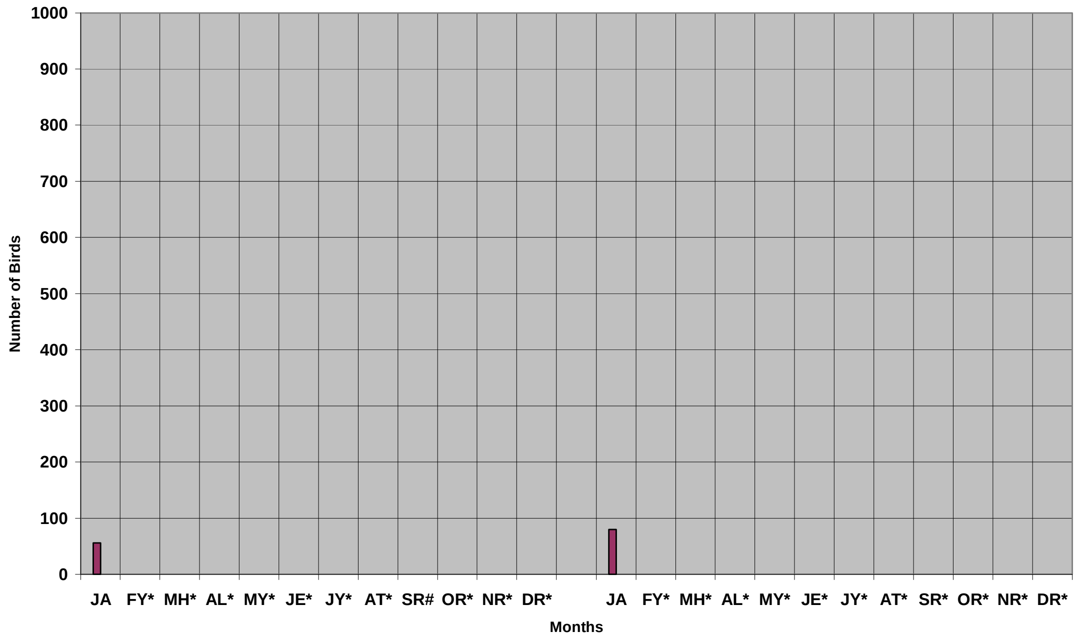
1975 – 1976

Figure 7f. Pochard (*Aythya ferina*) monthly fluctuations 1995-1996.



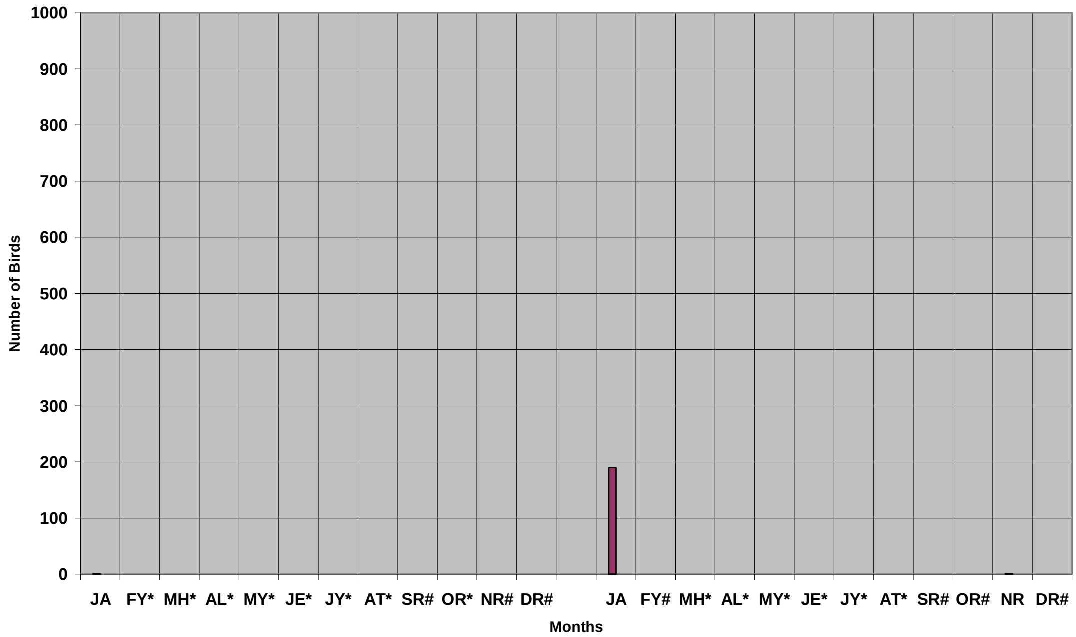
1995 – 1996

Figure 7g. Pochard (*Aythya ferina*) monthly fluctuations 1997-1998.



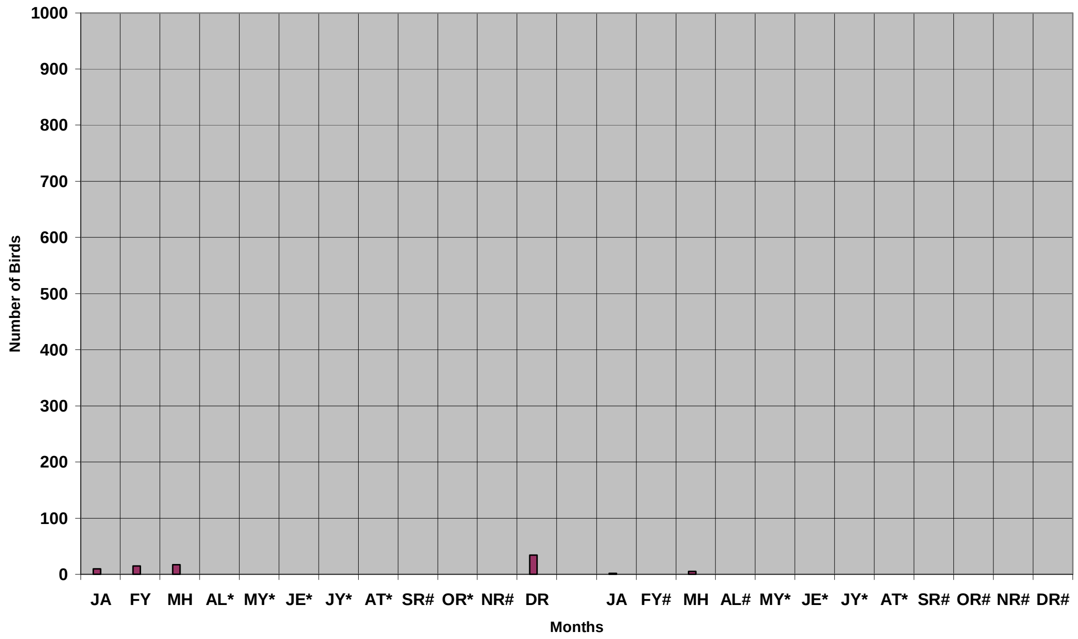
1997 – 1998

Figure 7h. Pochard (*Aythya ferina*) monthly fluctuations 2000-2001.



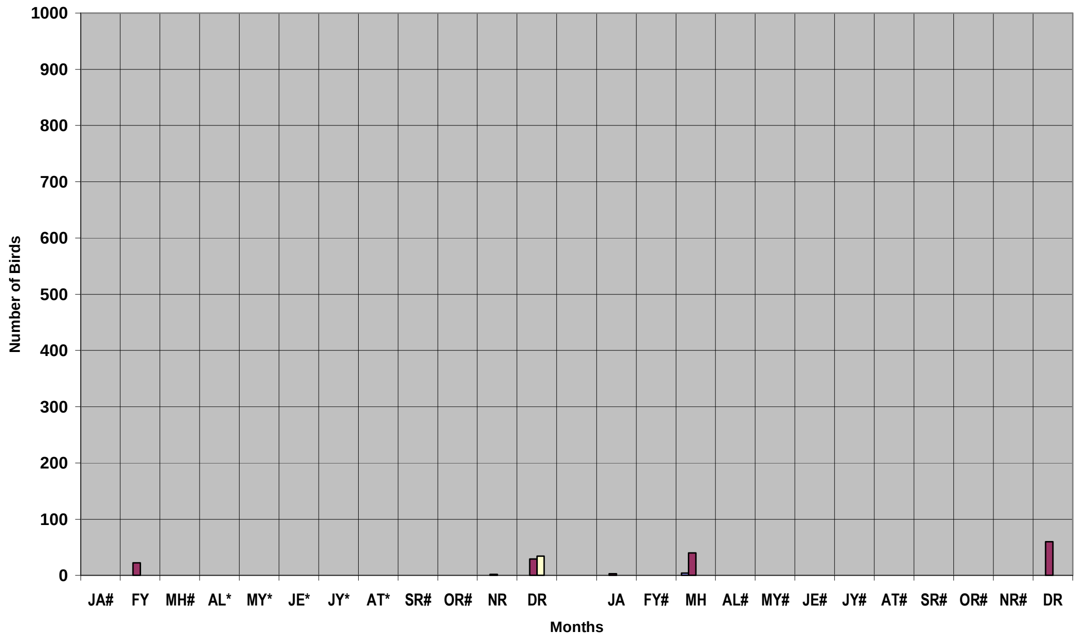
2000 – 2001

Figure 7i. Pochard (*Aythya ferina*) monthly fluctuations 2002-2003.



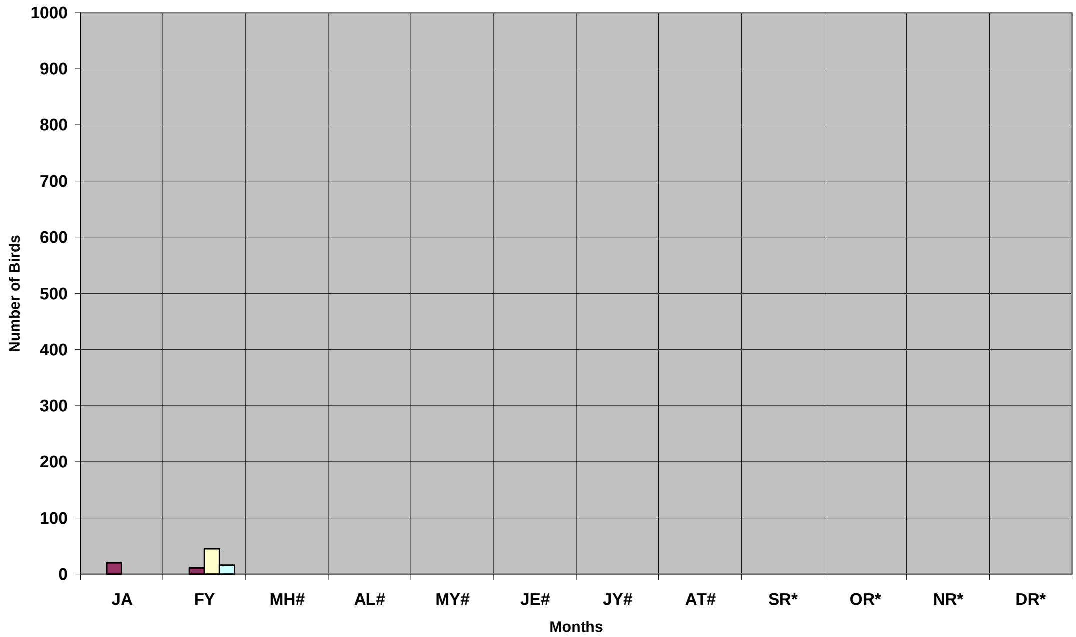
2002 – 2003

Figure 7j. Pochard (*Aythya ferina*) monthly fluctuations 2004-2005.



2004 – 2005

Figure 7k. Pochard (*Aythya ferina*) monthly fluctuations 2006.



2006

Tufted Duck (*Aythya fuligula*)

The Tufted Duck is one of two diving duck species to stay all year round on Lough Carra. The male is particularly distinctive with its black and white plumage and drooping head crest during the breeding season. An influx of winter migrants during the early part of the winter adds to the partially resident breeding population. The overall population of Tufted Duck on the lake underwent two large peaks during the early to mid 1970s and then declined somewhat. Numbers are generally down for 1995-2006 and have never reached the peaks of the 1970s but appear to have stabilised at current levels.

1967 – 1978

Minimum Annual Peak Count: 280 (1974).

Maximum Annual Peak Count: 895 (1971).

Mean Annual Peak: 563.

1995 – 2006

Minimum Annual Peak Count: 119 (1996).

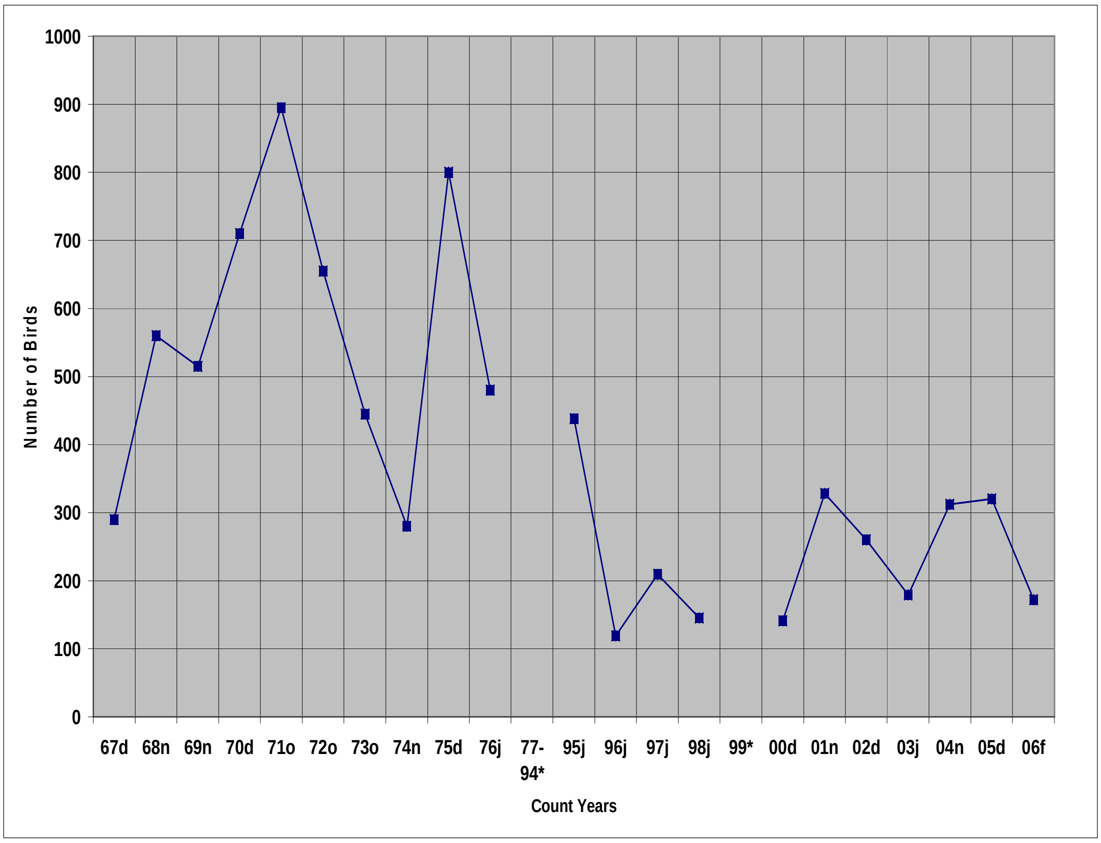
Maximum Annual Peak Count: 438 (1995).

Mean Annual Peak: 238.

Plate 7. Male Tufted Duck (*Aythya fuligula*).

Photograph by John N Murphy

Figure 8. Tufted Duck (*Aythya fuligula*) annual peaks on Lough Carra 1967-2006.



Notes: 1967-1976 = Counts made by Stronach *et al.*

1995-2000 = Counts made by Delany/Colhoun *et al.* for I-WeBS.

2000-2004 = Counts made by Chris & Lynda Huxley for I-WeBS.

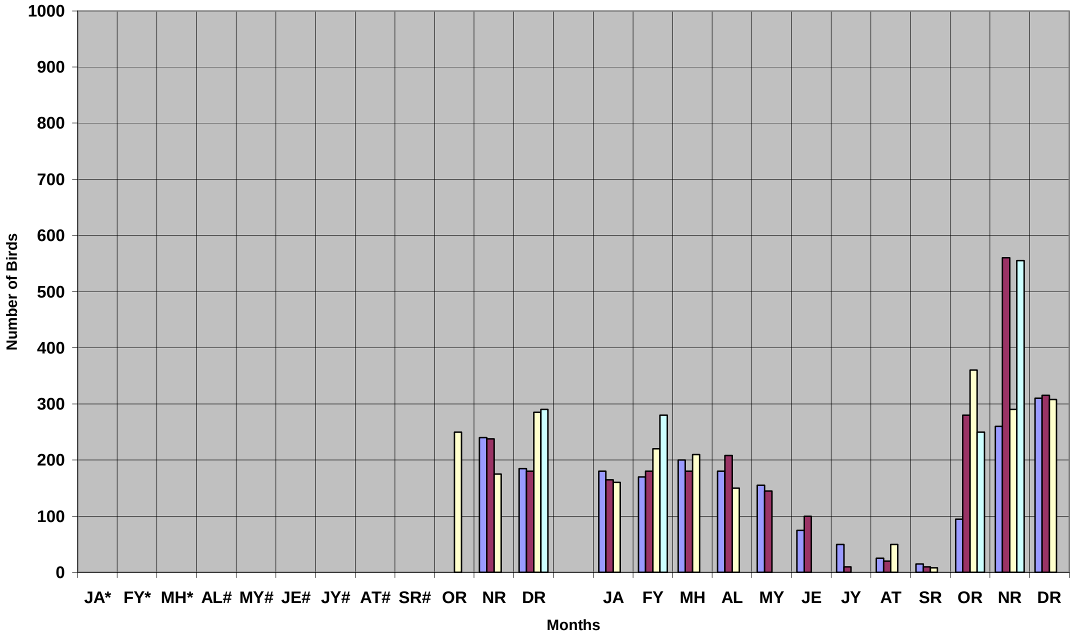
2004-2006 = Counts made by Chris & Lynda Huxley for I-WeBS and by the author.

The small letters next to the count years refers to the month in which the peak occurred, **D**=December, **N**=November, **J**=January, **F**=February, **O** = October.

***** = No data for the years 1977-1994 & 1999.

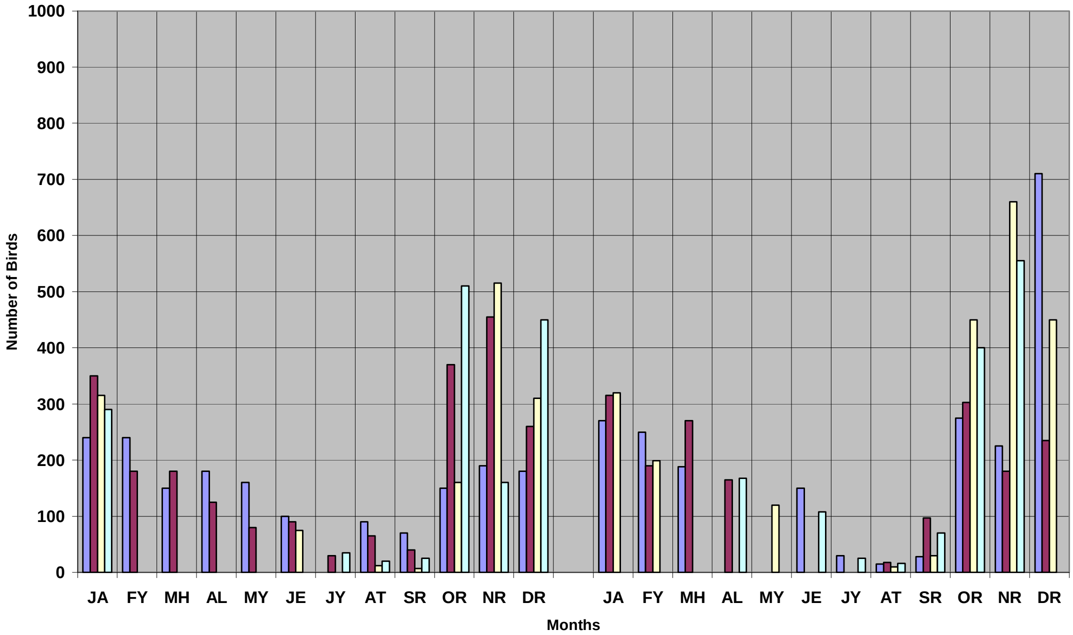
Monthly Fluctuations of Tufted Duck (*Aythya fuligula*) on Lough Carra 1967-2006

Figure 8a. Tufted Duck (*Aythya fuligula*) monthly fluctuations 1967-1968.



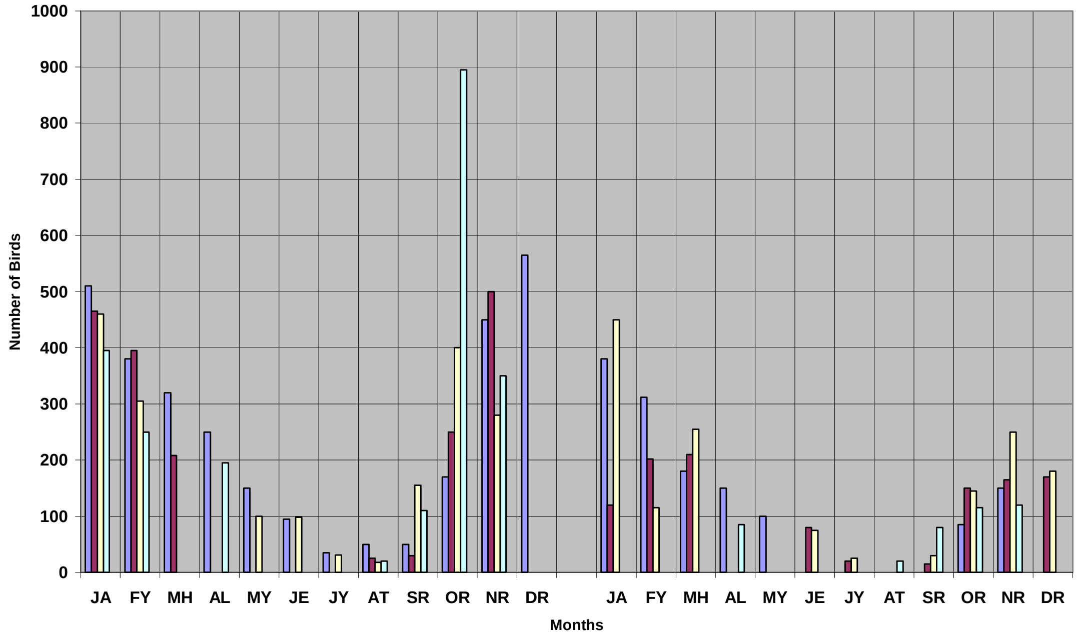
1967 – 1968

Figure 8b. Tufted Duck (*Aythya fuligula*) monthly fluctuations 1969-1970.



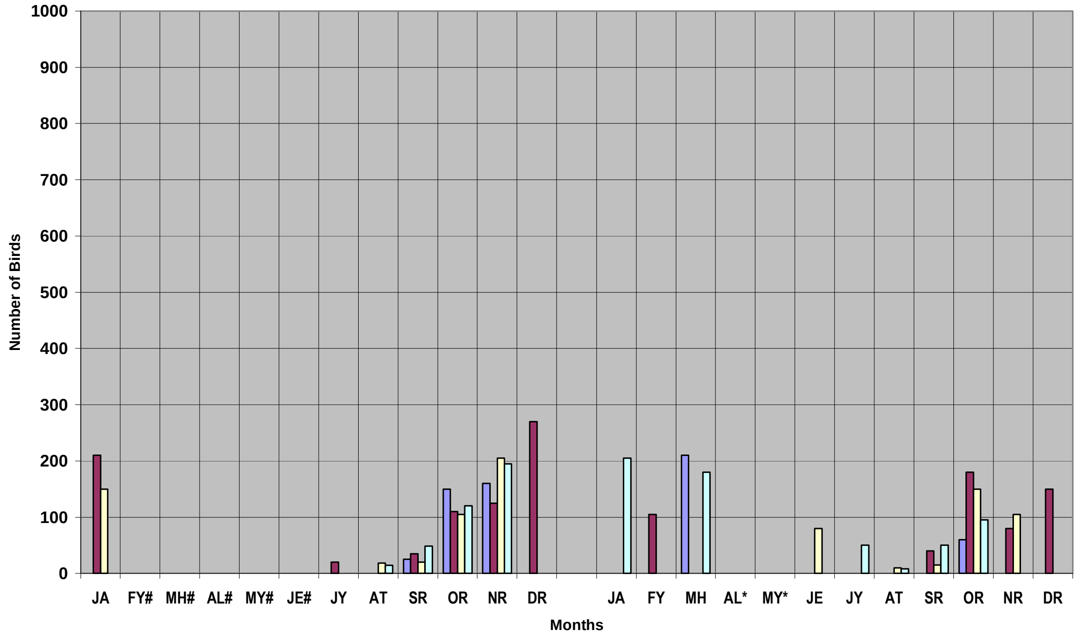
1969 – 1970

Figure 8c. Tufted Duck (*Aythya fuligula*) monthly fluctuations 1971-1972.



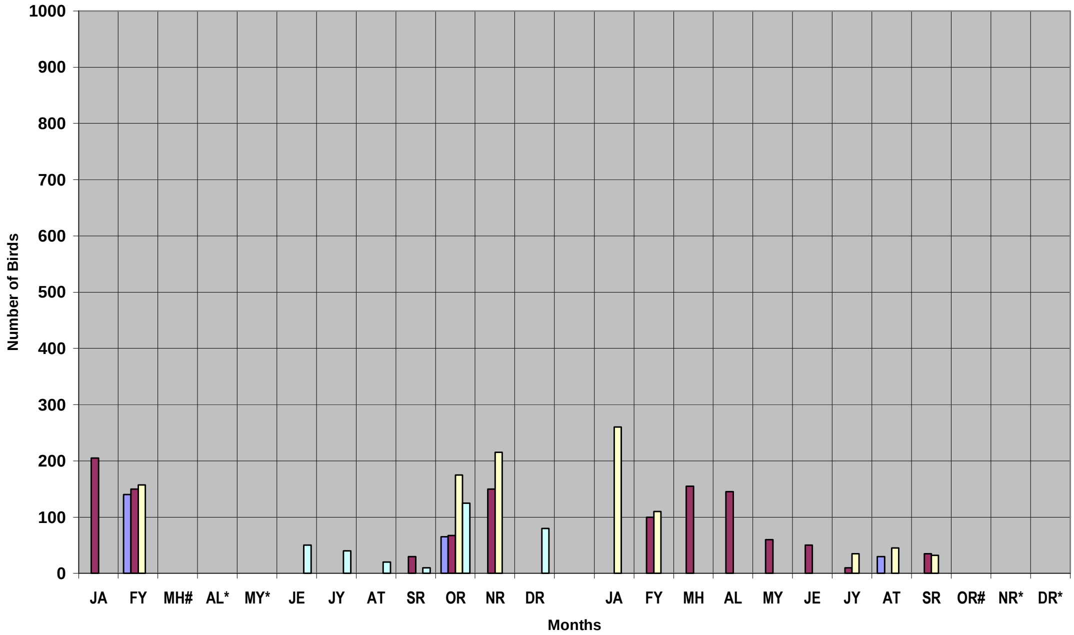
1971 – 1972

Figure 8d. Tufted Duck (*Aythya fuligula*) monthly fluctuations 1973-1974.



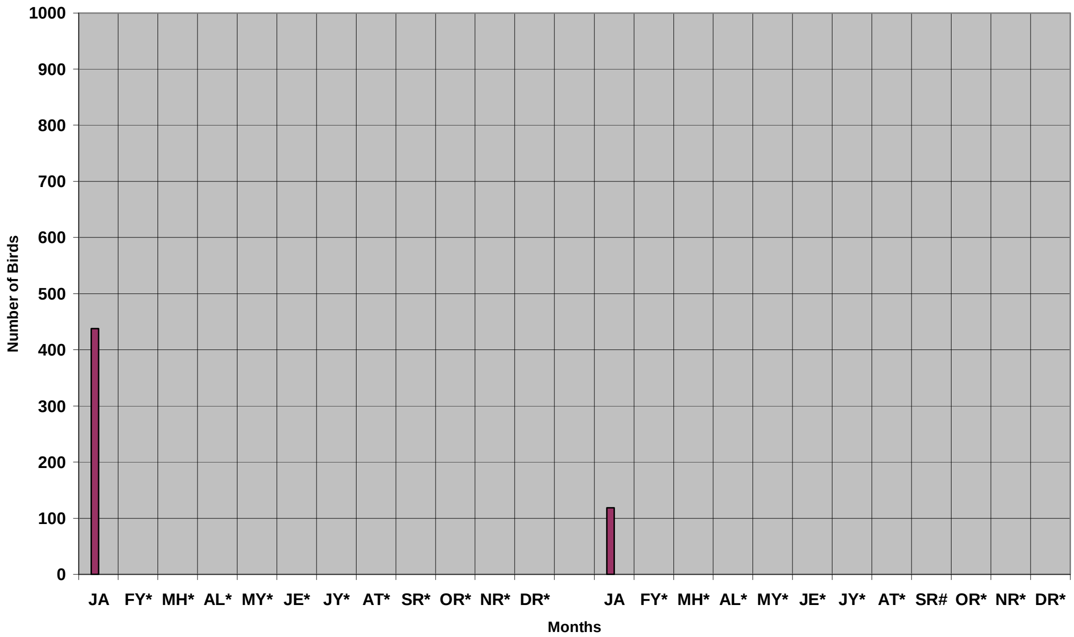
1973 – 1974

Figure 8e. Tufted Duck (*Aythya fuligula*) monthly fluctuations 1975-1976.



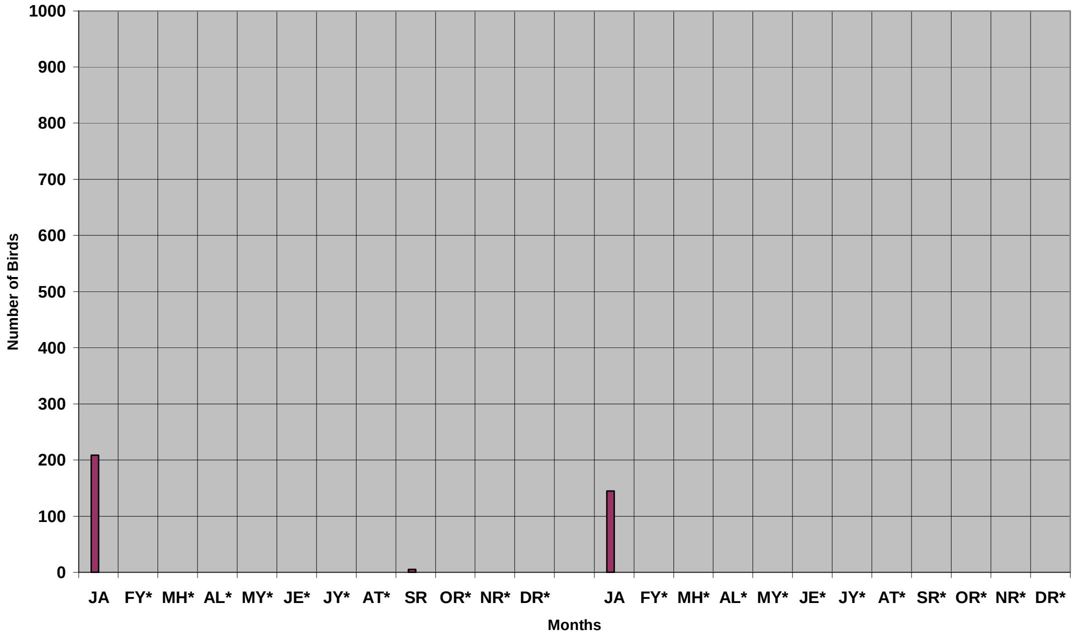
1975 – 1976

Figure 8f. Tufted Duck (*Aythya fuligula*) monthly fluctuations 1995-1996.



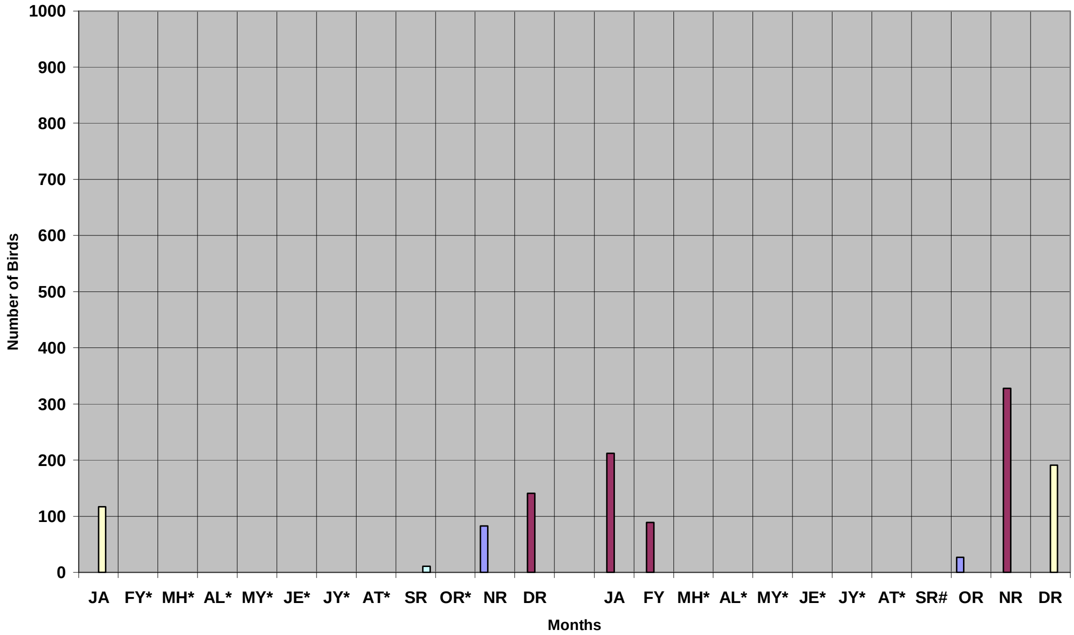
1995 – 1996

Figure 8g. Tufted Duck (*Aythya fuligula*) monthly fluctuations 1997-1998.



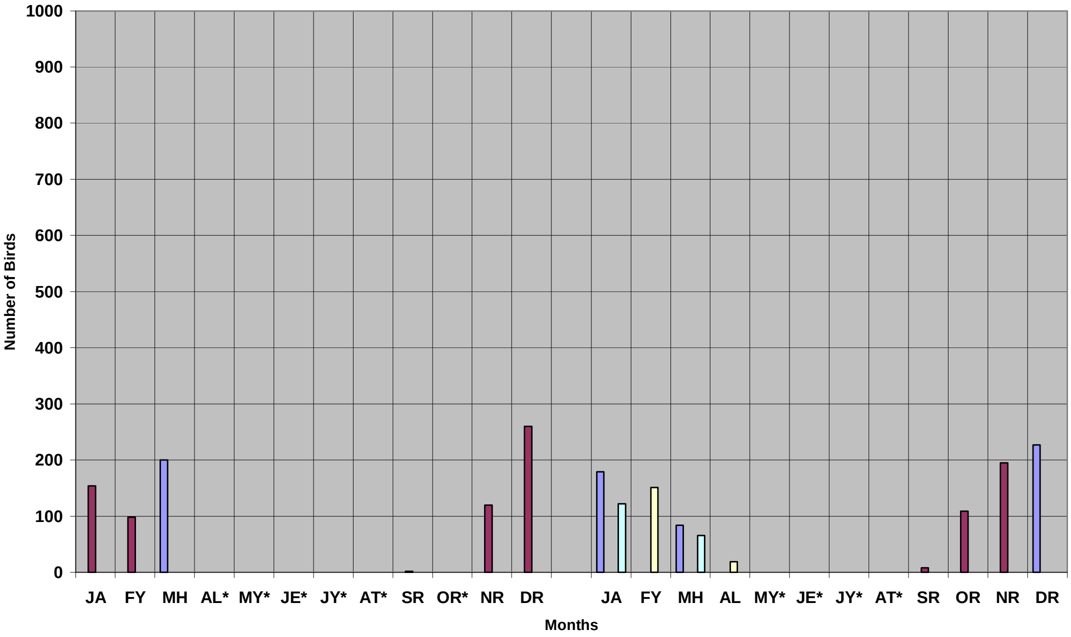
1997 – 1998

Figure 8h. Tufted Duck (*Aythya fuligula*) monthly fluctuations 2000-2001.



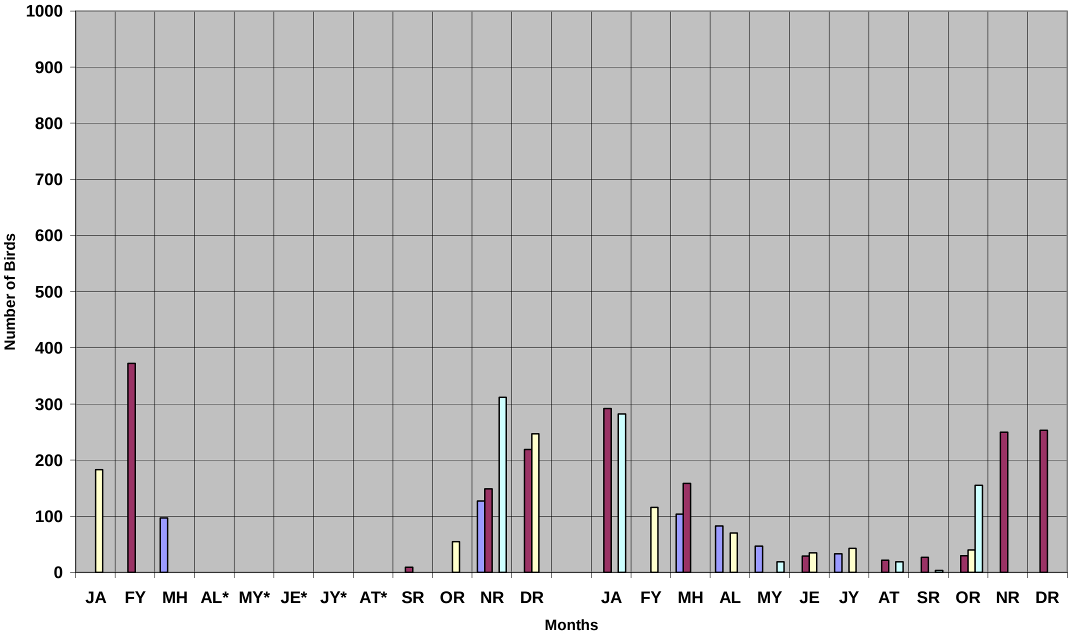
2000 – 2001

Figure 8i. Tufted Duck (*Aythya fuligula*) monthly fluctuations 2002-2003.



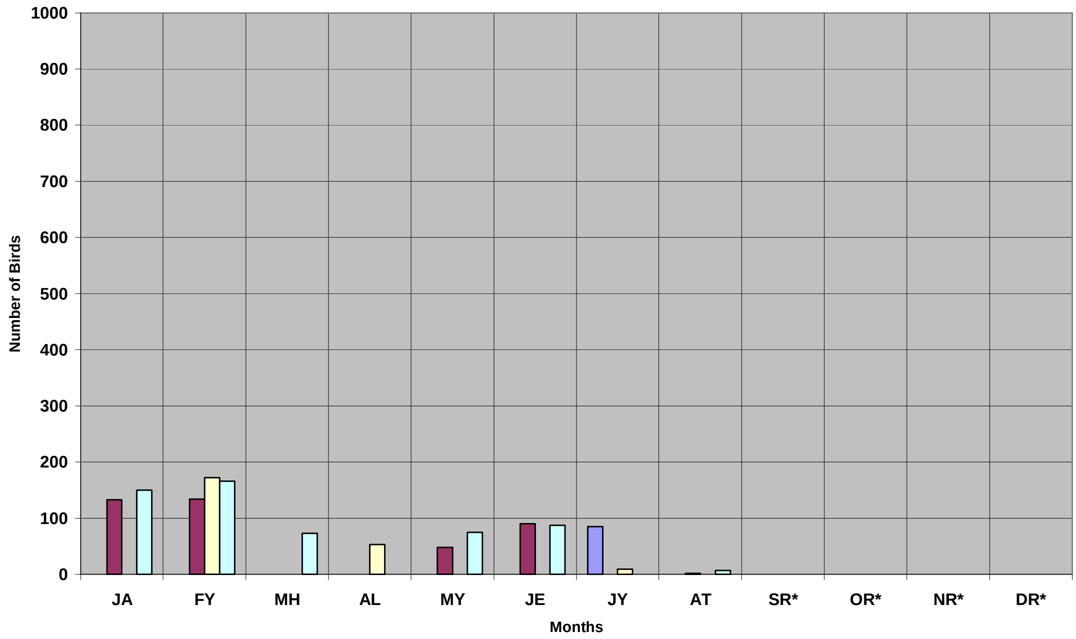
2002 – 2003

Figure 8j. Tufted Duck (*Aythya fuligula*) monthly fluctuations 2004-2005.



2004 – 2005

Figure 8k. Tufted Duck (*Aythya fuligula*) monthly fluctuations 2006.



2006

Goldeneye (*Bucephala clangula*)

Goldeneye are a medium sized diving duck and like the Pochard (*Aythya ferina*) they are only present on Lough Carra during the winter months. As Stronach (1981) noted and as was found throughout the counting programme for this study, Goldeneye were often found in the same locations on the lake where the depth of water suited their feeding habits. During counts in early spring and before they departed for their breeding grounds, the bright males with their green heads and rounded white loral patch were often observed engaging in the head tossing and posturing associated with their courtship display. The populations of Goldeneye on Lough Carra have remained relatively stable since the 1960s and 70s apart from a slight decline in the mid 1990s.

<u>1967 – 1976</u>

Minimum Annual Peak Count: 85 (1974).

Maximum Annual Peak Count: 180 (1972)

Mean Annual Peak: 117.

<u>1995 – 2006</u>

Minimum Annual Peak Count: 42 (1998).

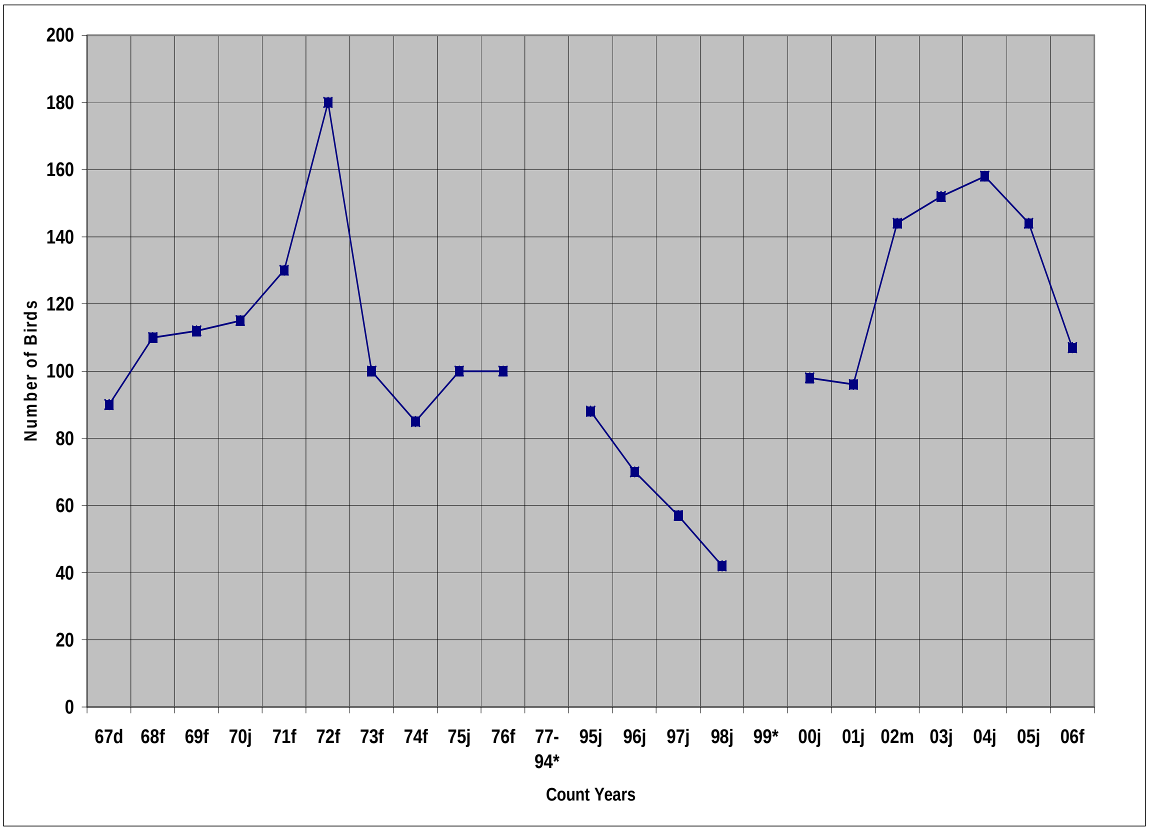
Maximum Annual Peak Count: 158 (2004).

Mean Annual Peak: 103.

Plate 8. Male Goldeneye (*Bucephala clangula*).

Photograph by John N Murphy

Figure 9. Goldeneye (*Bucephala clangula*) annual peaks on Lough Carra 1967-2006.



Notes: 1967-1976 = Counts made by Stronach *et al.*

1995-2000 = Counts made by Delany/Colhoun *et al.* for I-WeBS.

2000-2004 = Counts made by Chris & Lynda Huxley for I-WeBS.

2004-2006 = Counts made by Chris & Lynda Huxley for I-WeBS and by the author.

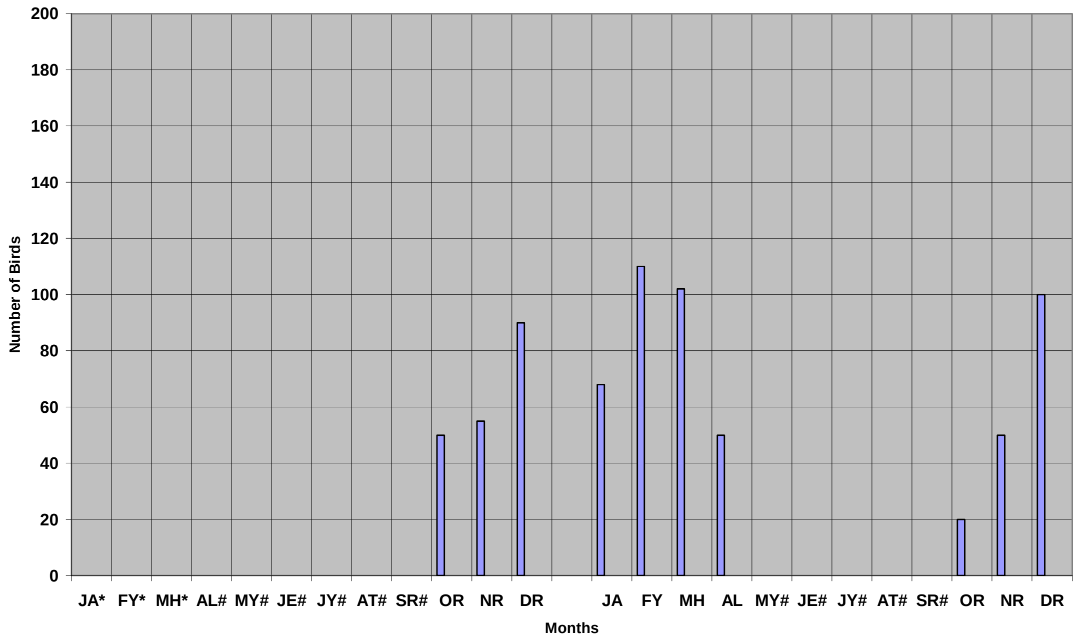
The small letters next to the count years refers to the month in which the peak occurred, **D**=December, **J**=January, **F**=February, **M** = March.

***** = No data for the years 1977-1994 & 1999.

Monthly Fluctuations of Goldeneye (*Bucephala clangula*) on Lough Carra 1967-2006

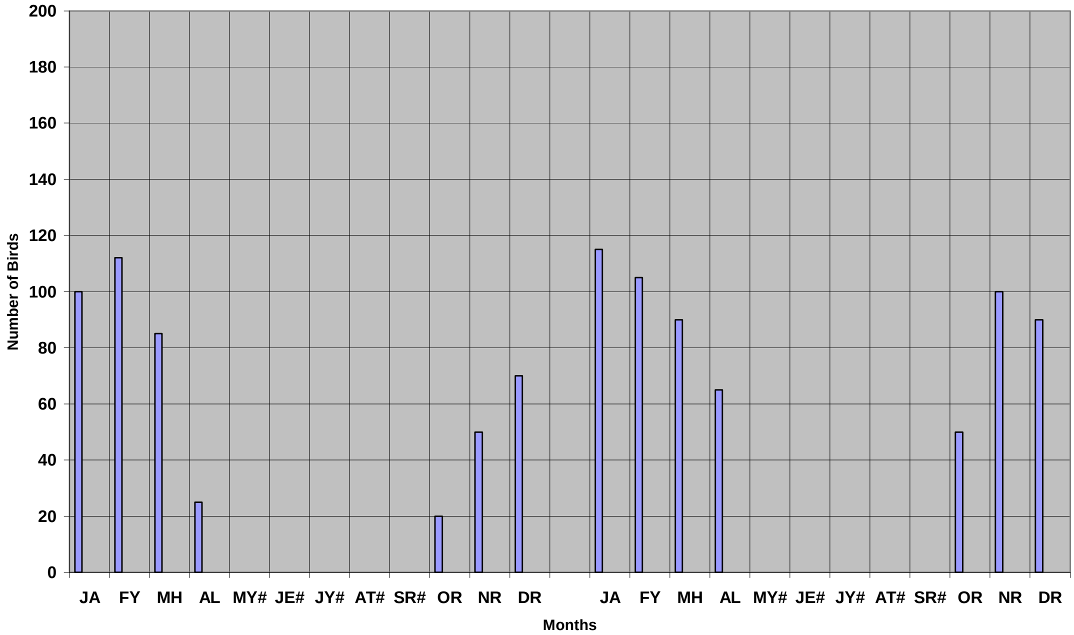
Please note that the figures for Goldeneye (*Bucephala clangula*) presented in the report *An Ecological Study of Waterfowl on Lough Carra* (Stronach, [1981]), provide just one count per month for the counting programme from that era. This is due to the presentation of data and is not a reflection of the number of counts actually conducted from 1968 – 1976.

Figure 9a. Goldeneye (*Bucephala clangula*) monthly fluctuations 1967-1968.



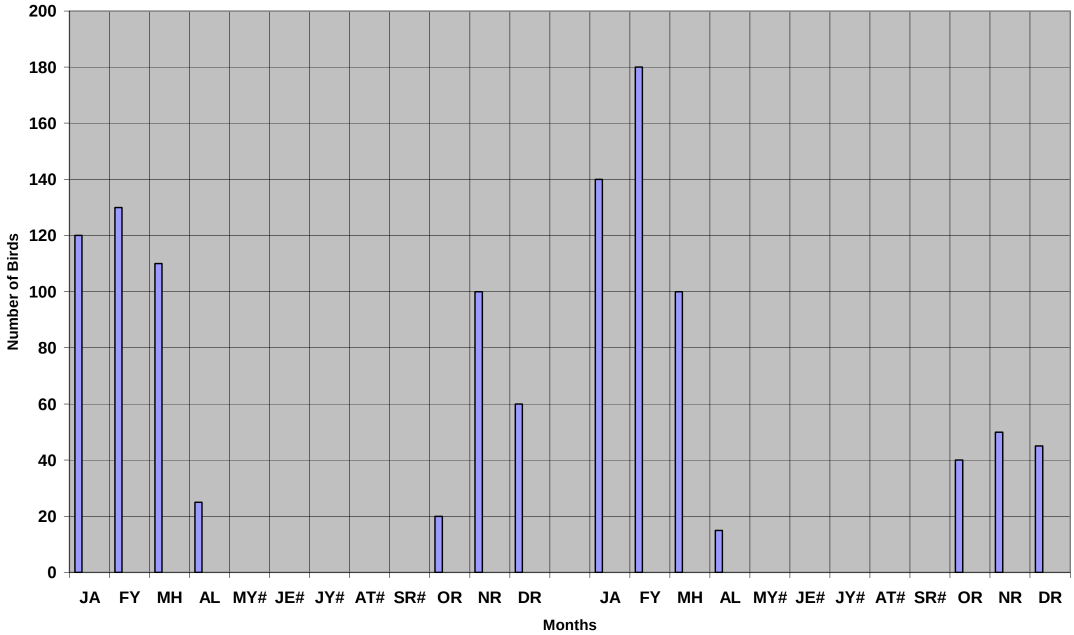
1967 – 1968

Figure 9b. Goldeneye (*Bucephala clangula*) monthly fluctuations 1969-1970.



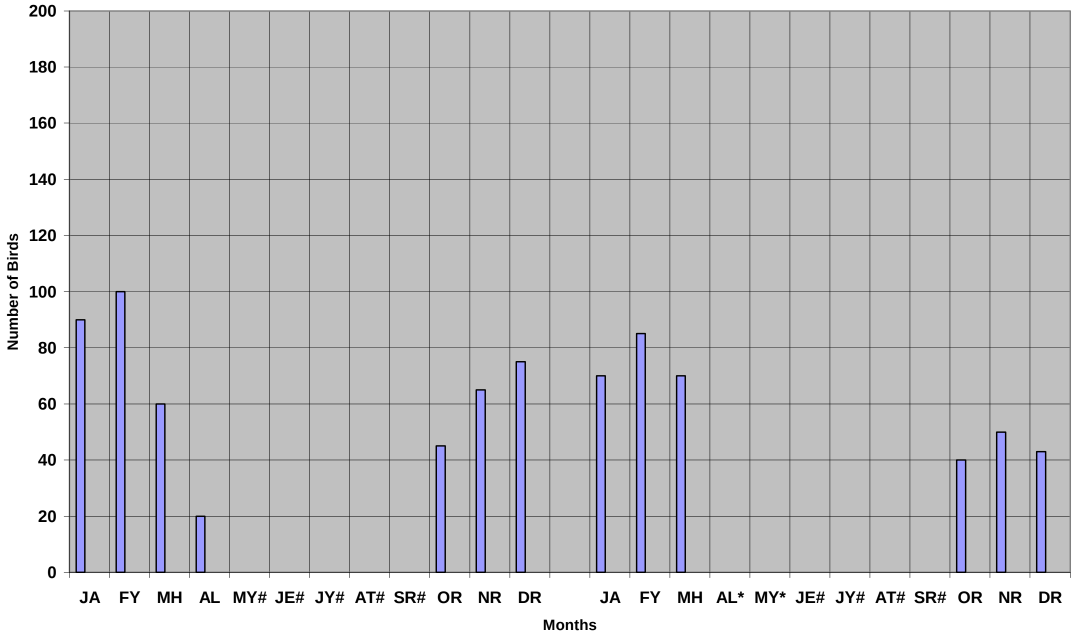
1969 – 1970

Figure 9c. Goldeneye (*Bucephala clangula*) monthly fluctuations 1971-1972.



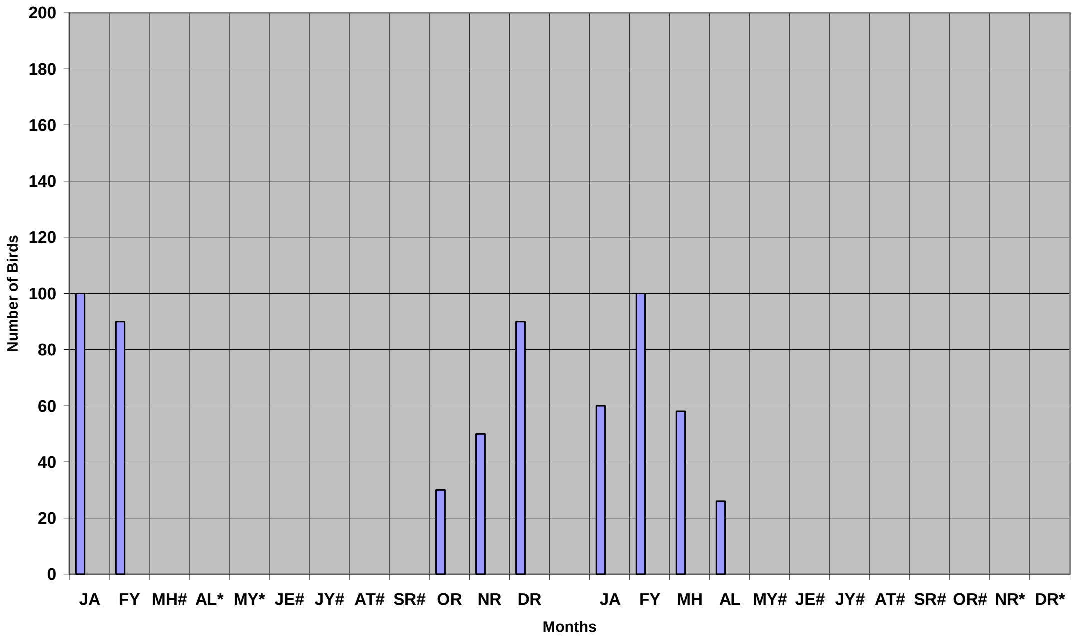
1971 – 1972

Figure 9d. Goldeneye (*Bucephala clangula*) monthly fluctuations 1973-1974.



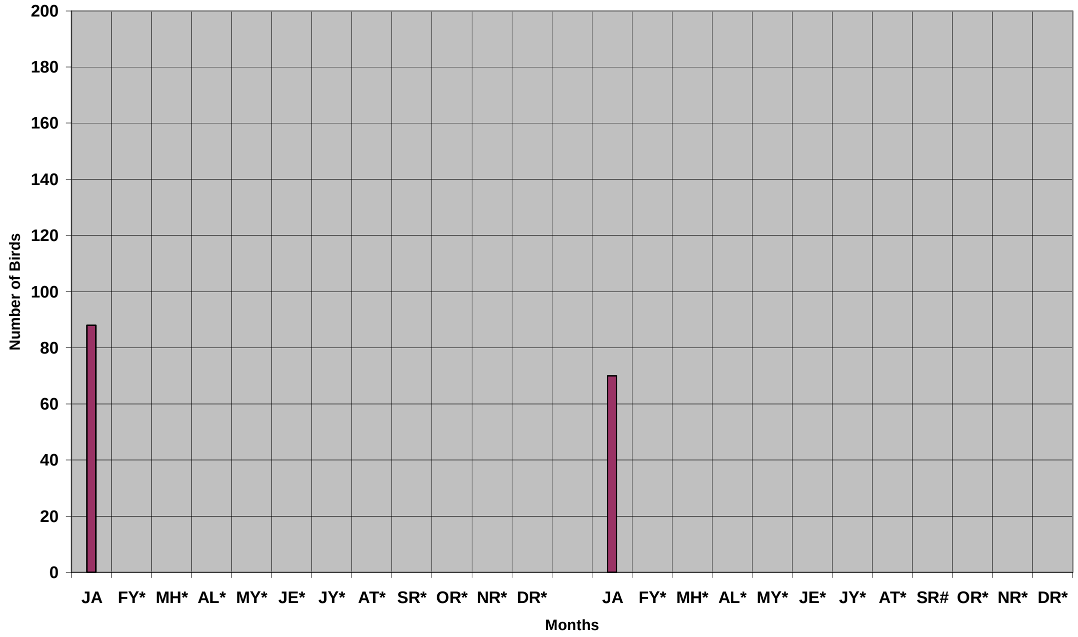
1973 – 1974

Figure 9e. Goldeneye (*Bucephala clangula*) monthly fluctuations 1975-1976.



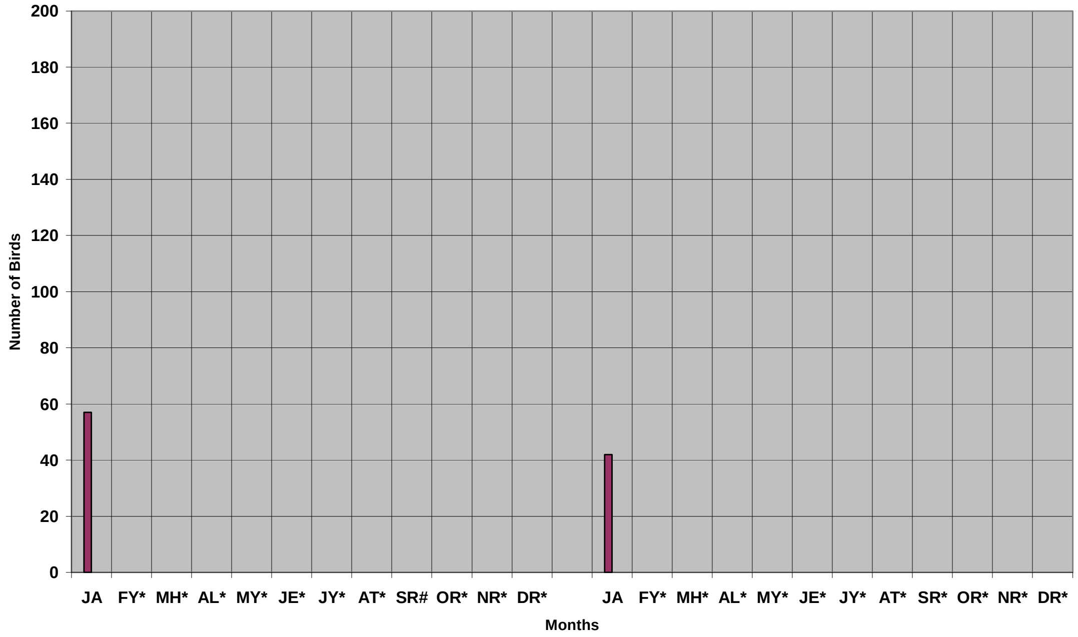
1975 - 1976

Figure 9f. Goldeneye (*Bucephala clangula*) monthly fluctuations 1995-1996.



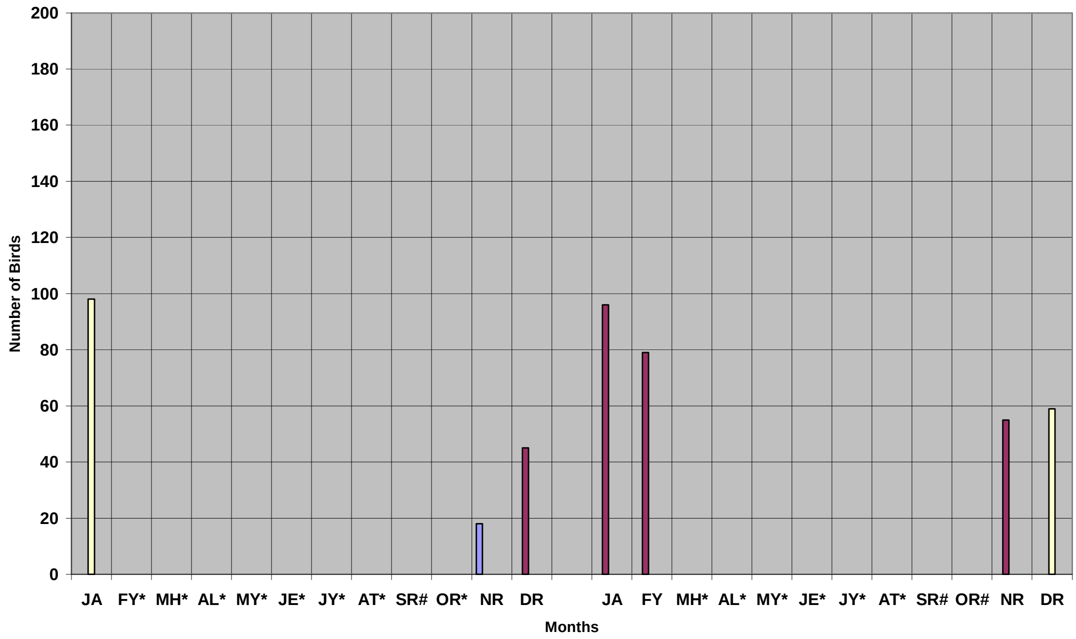
1995 – 1996

Figure 9g. Goldeneye (*Bucephala clangula*) monthly fluctuations 1997-1998.



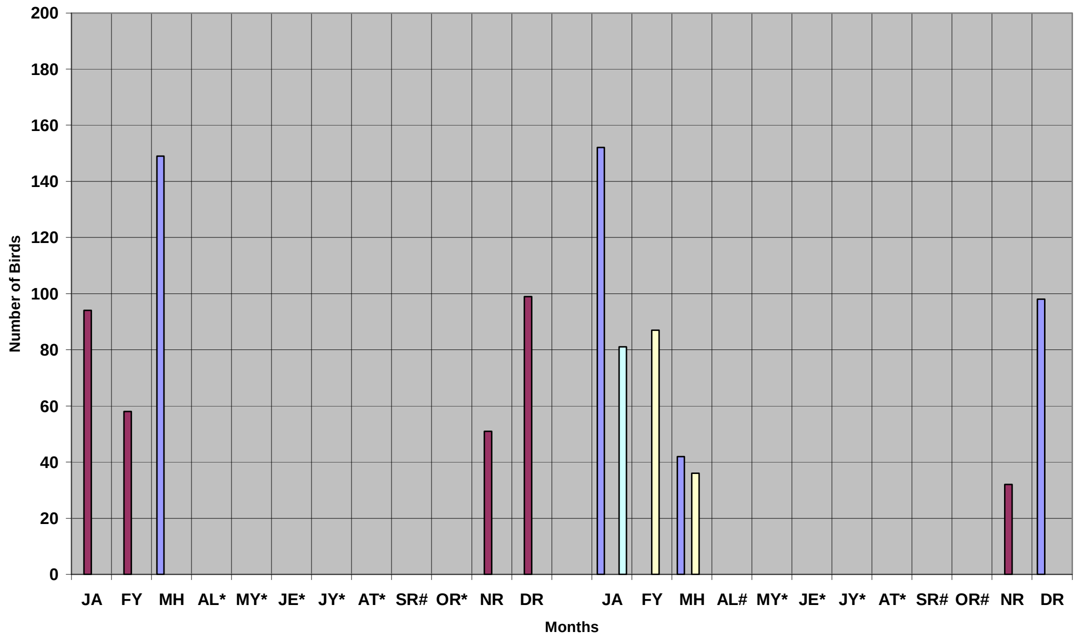
1997 – 1998

Figure 9h. Goldeneye (*Bucephala clangula*) monthly fluctuations 2000-2001.



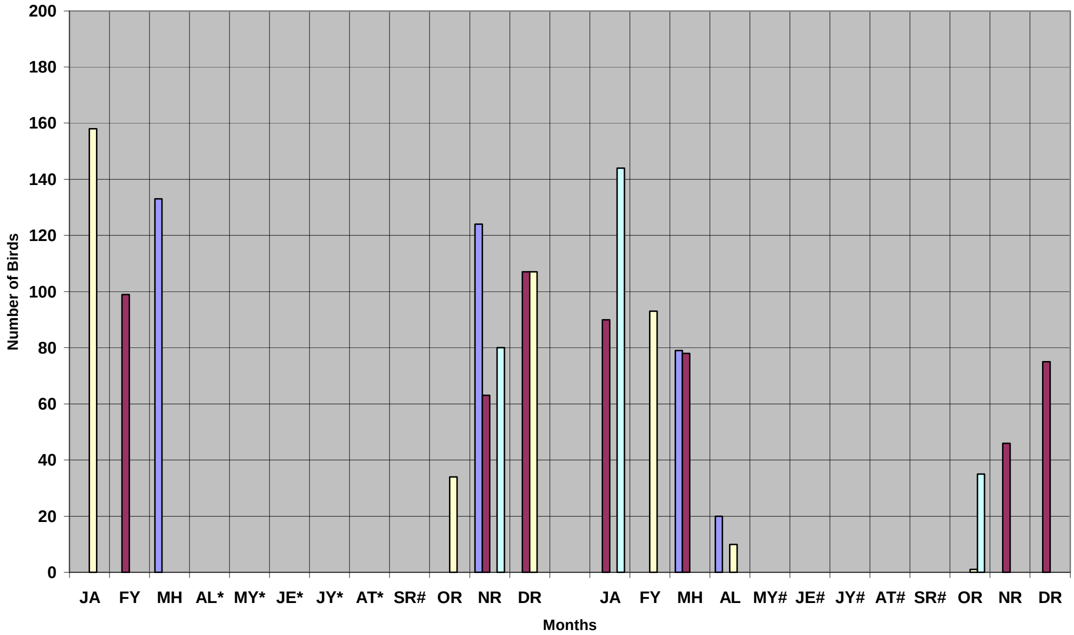
2000 – 2001

Figure 9i. Goldeneye (*Bucephala clangula*) monthly fluctuations 2002-2003.



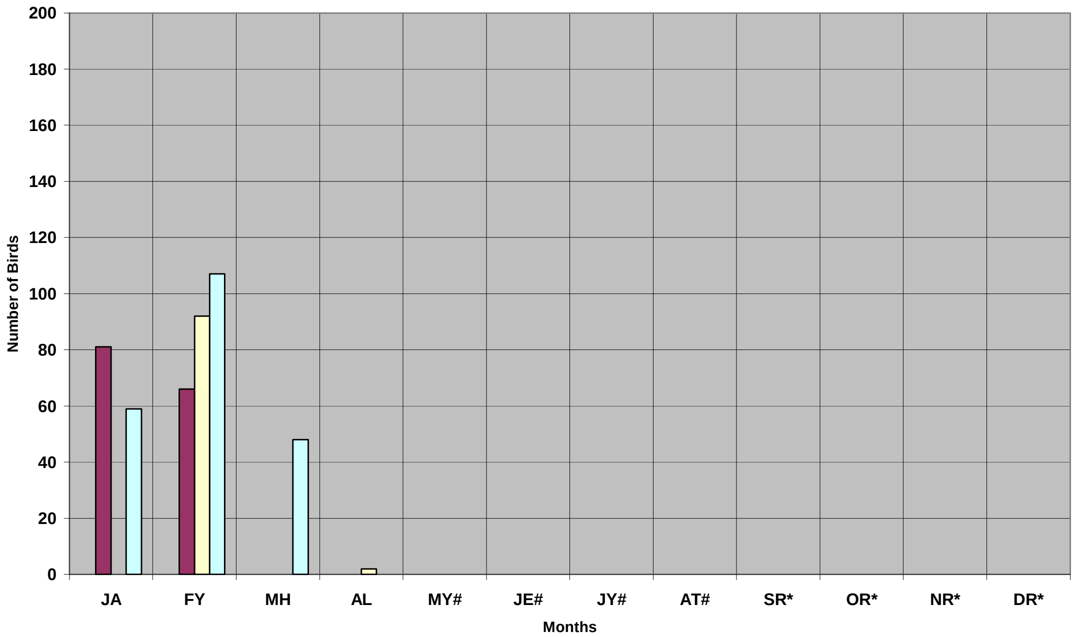
2002 – 2003

Figure 9j. Goldeneye (*Bucephala clangula*) monthly fluctuations 2004-2005.



2004 – 2005

Figure 9k. Goldeneye (*Bucephala clangula*) monthly fluctuations 2006.



2006

Red-breasted Merganser (*Mergus serrator*)

The Red-breasted Merganser is the only other diving duck species besides the Tufted Duck (*Aythya fuligula*) that stays on the lake all year round but differs from the other three species of diving duck found on Lough Carra in that it can be found in both marine and freshwater habitats. Mergansers are a member of the diving duck family known as the sawbills which includes Smew (*Mergellus albellus*) and Goosander (*Mergus merganser*). All sawbills are excellent at catching fish at great depths (greater than 100 feet) and have sharp serrations along their bills for grasping their prey and which gives them their name. The numbers of Red-breasted Mergansers on Lough Carra since the 1960s and 70s have declined.

<u>1967 – 1978</u>

Minimum Annual Peak Count: 20 (1967).

Maximum Annual Peak Count: 50 (1970).

Mean Annual Peak: 42.

<u>1995 – 2006</u>

Minimum Annual Peak Count: 1 (1998).

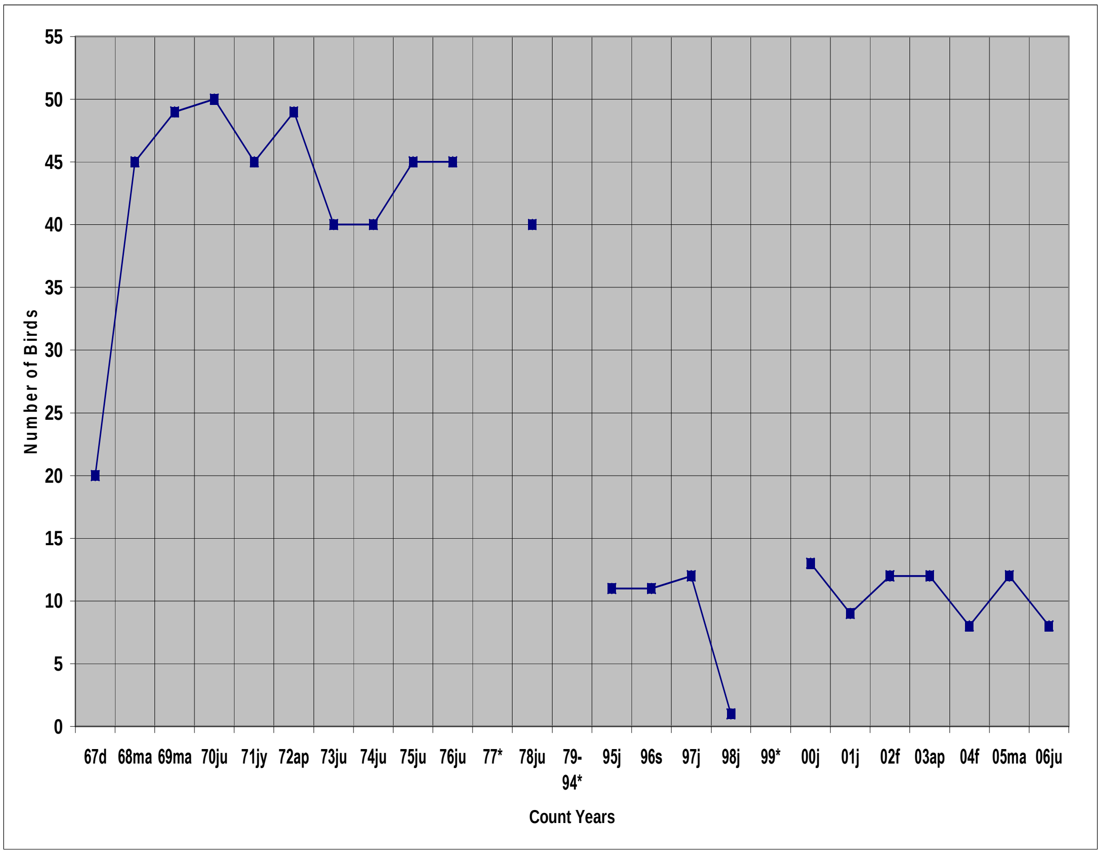
Maximum Annual Peak Count: 13 (2000).

Mean Annual Peak: 9.

Plate 9. Male Red-breasted Merganser (*Mergus serrator*).

Photograph by John N Murphy

Figure 10. Red-breasted Merganser (*Mergus serrator*) annual peaks on Lough Carra 1967-2006.



Notes: 1967-1978 = Counts made by Stronach *et al.*

1995-2000 = Counts made by Delany/Colhoun *et al.* for I-WeBS.

2000-2004 = Counts made by Chris & Lynda Huxley for I-WeBS.

2004-2006 = Counts made by Chris & Lynda Huxley for I-WeBS and by the author.

The small letters next to the count years refers to the month in which the peak occurred,

D=December, **J**=January, **F**=February, **AP** = April, **MA** = May, **JU** = June, **JY** = July,

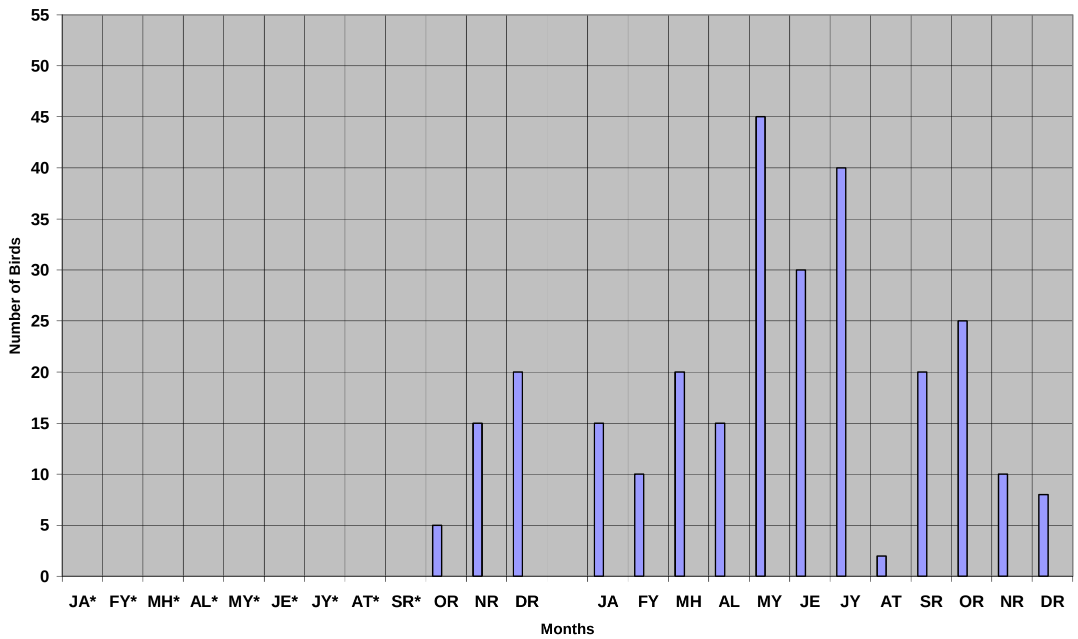
S = September.

***** = No data for the years 1977, 1979-1994 & 1999.

Monthly Fluctuations of Red-breasted Merganser (*Mergus serrator*) on Lough Carra 1967-2006

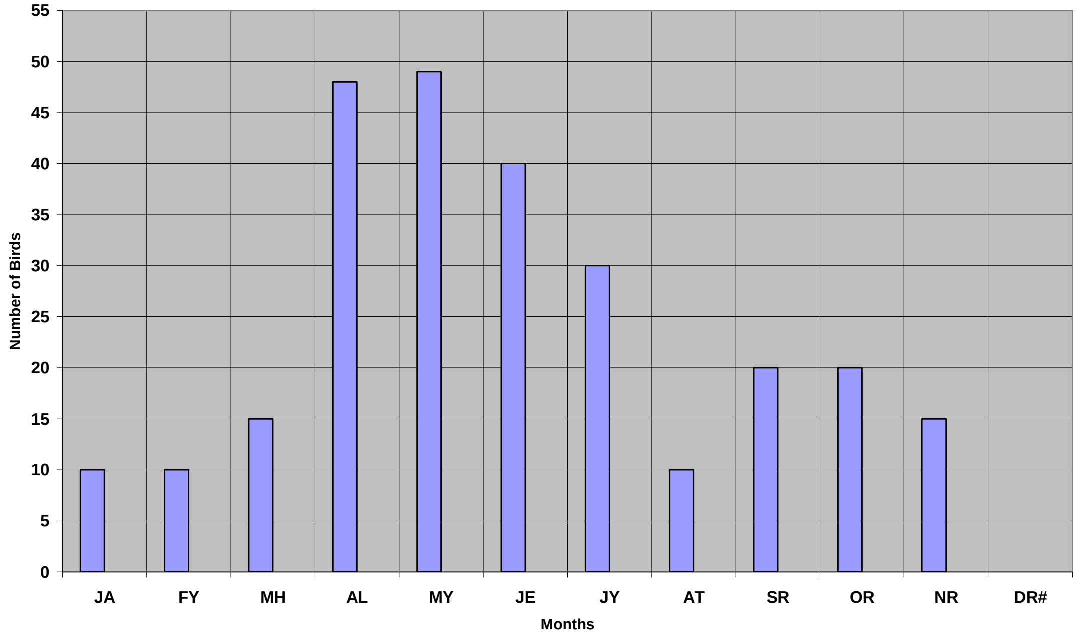
Please note that the figures for Red-breasted Merganser (*Mergus serrator*) presented in the report *An Ecological Study of Waterfowl on Lough Carra* (Stronach, 1981), provide just one count per month and monthly counts are only given for the years 1967 to 1969.

Figure 10a. Red-breasted Merganser (*Mergus serrator*) monthly fluctuations 1967-1968.



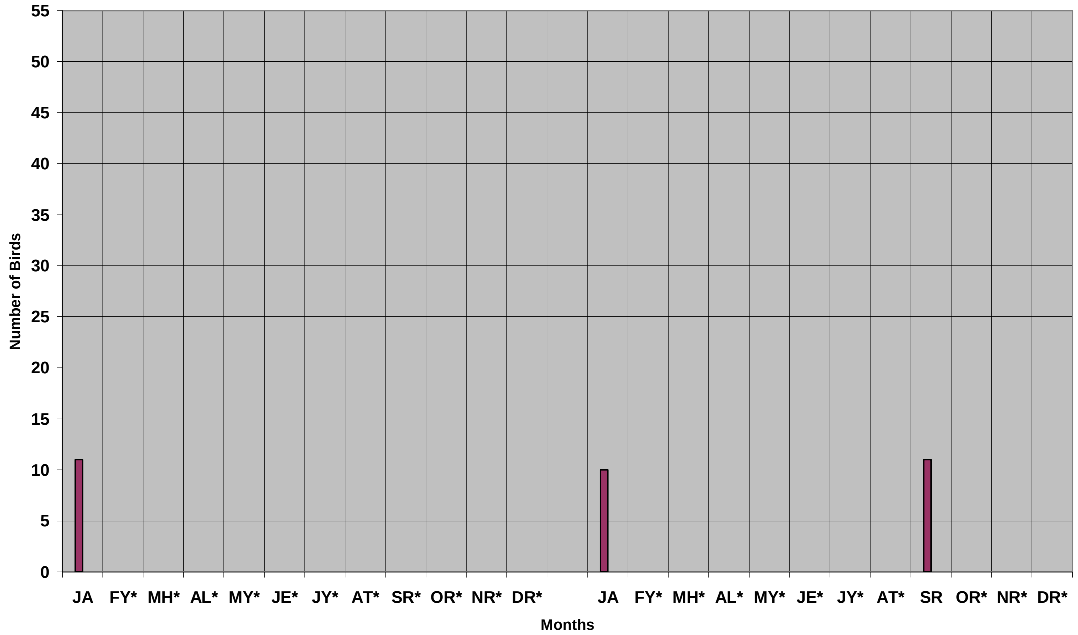
1967 – 1968

Figure 10b. Red-breasted Merganser (*Mergus serrator*) monthly fluctuations 1969.



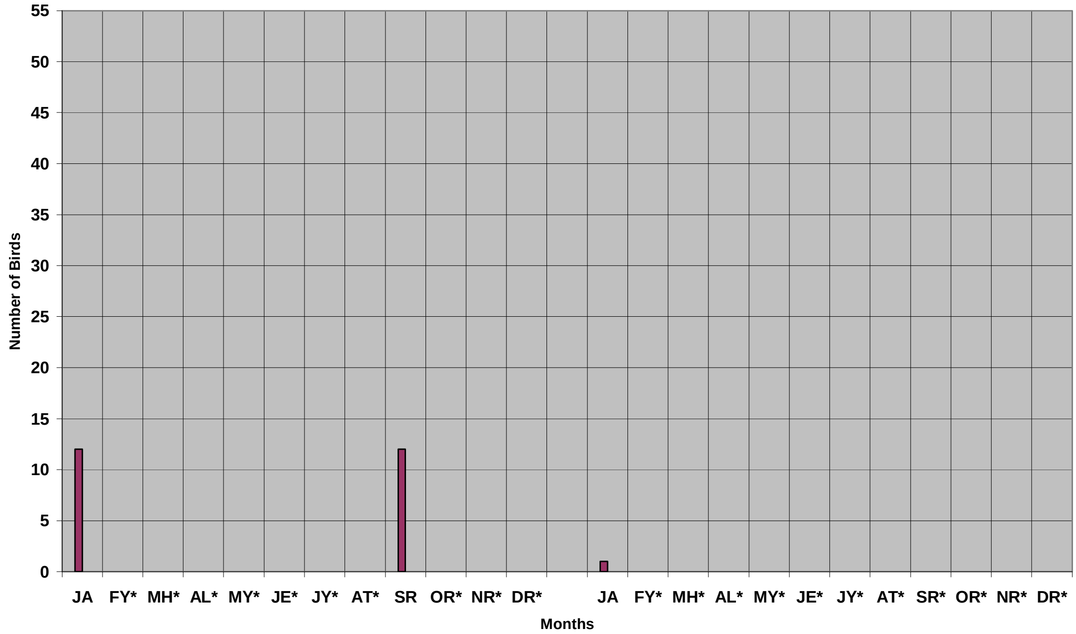
1969

Figure 10c. Red-breasted Merganser (*Mergus serrator*) monthly fluctuations 1995-1996.



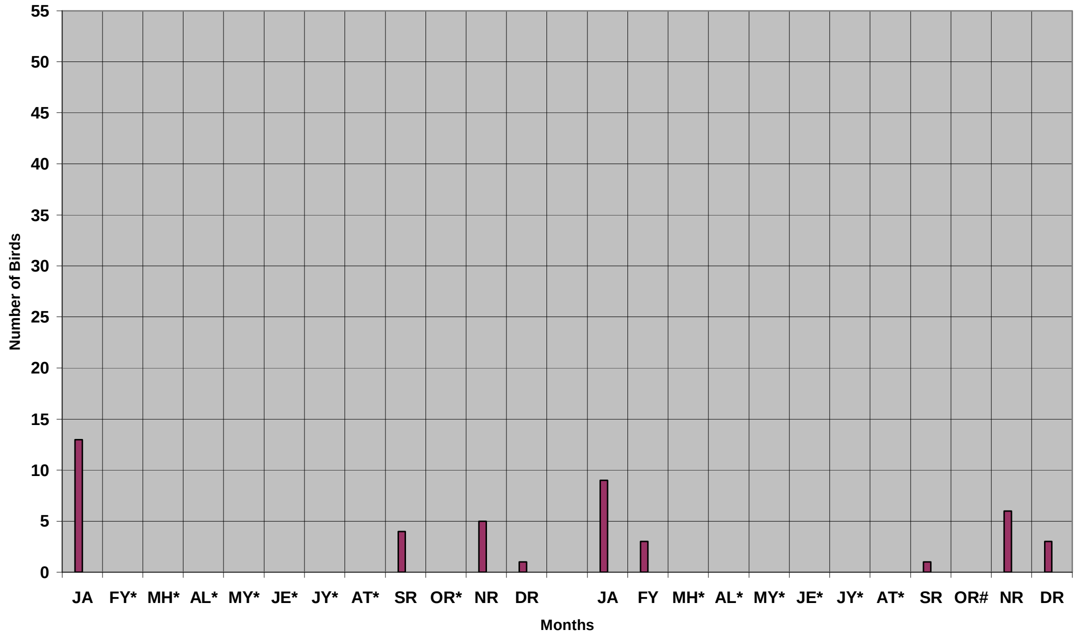
1995 - 1996

Figure 10d. Red-breasted Merganser (*Mergus serrator*) monthly fluctuations 1997-1998.



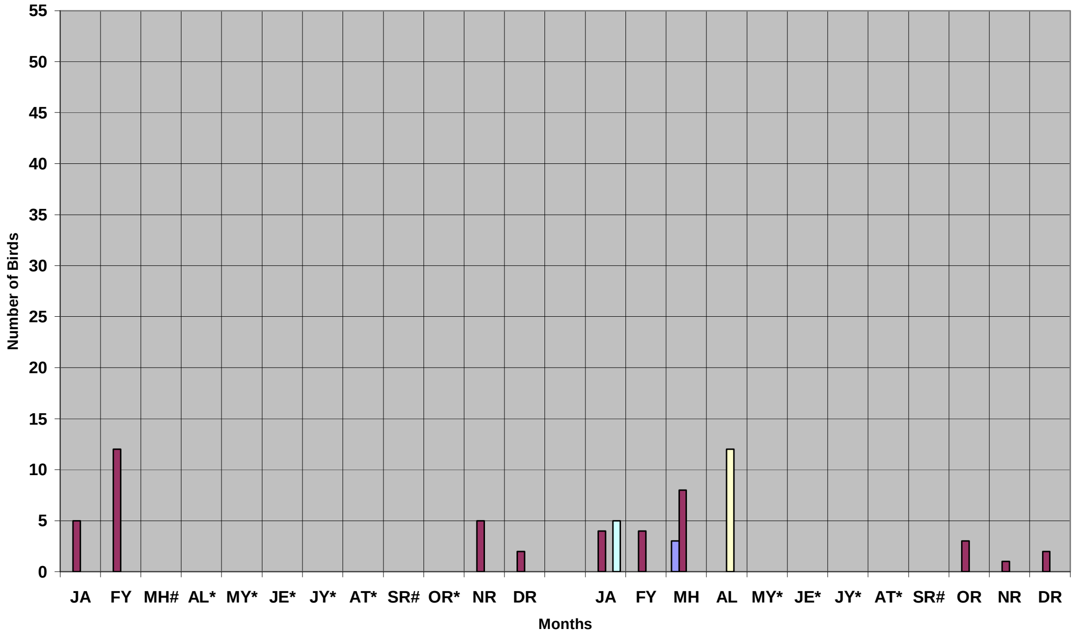
1997 – 1998

Figure 10e. Red-breasted Merganser (*Mergus serrator*) monthly fluctuations 2000-2001.



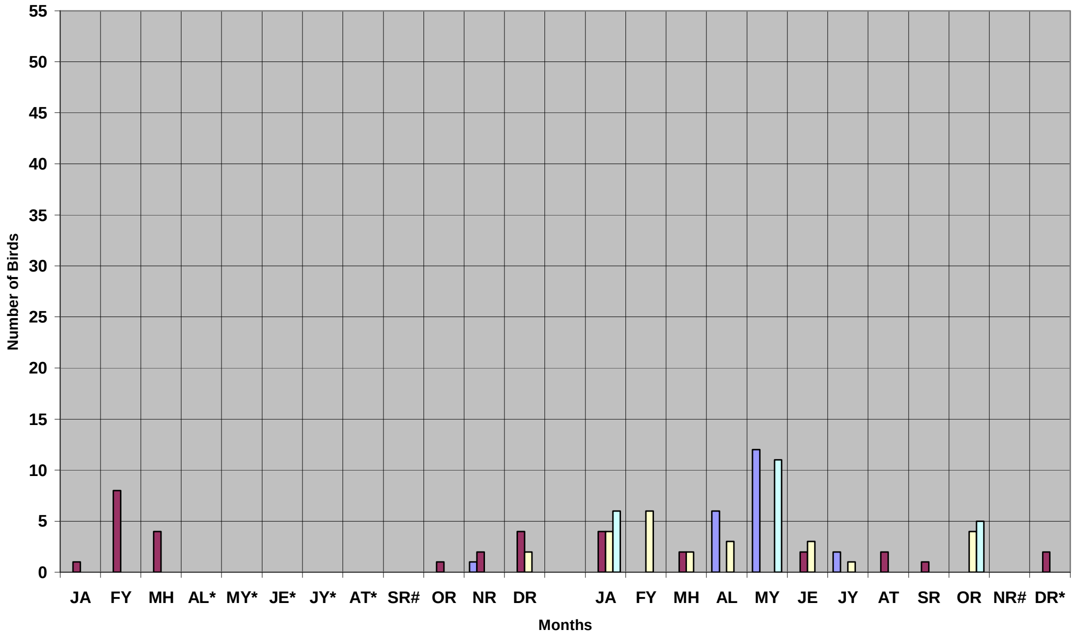
2000 – 2001

Figure 10f. Red-breasted Merganser (*Mergus serrator*) monthly fluctuations 2002-2003.



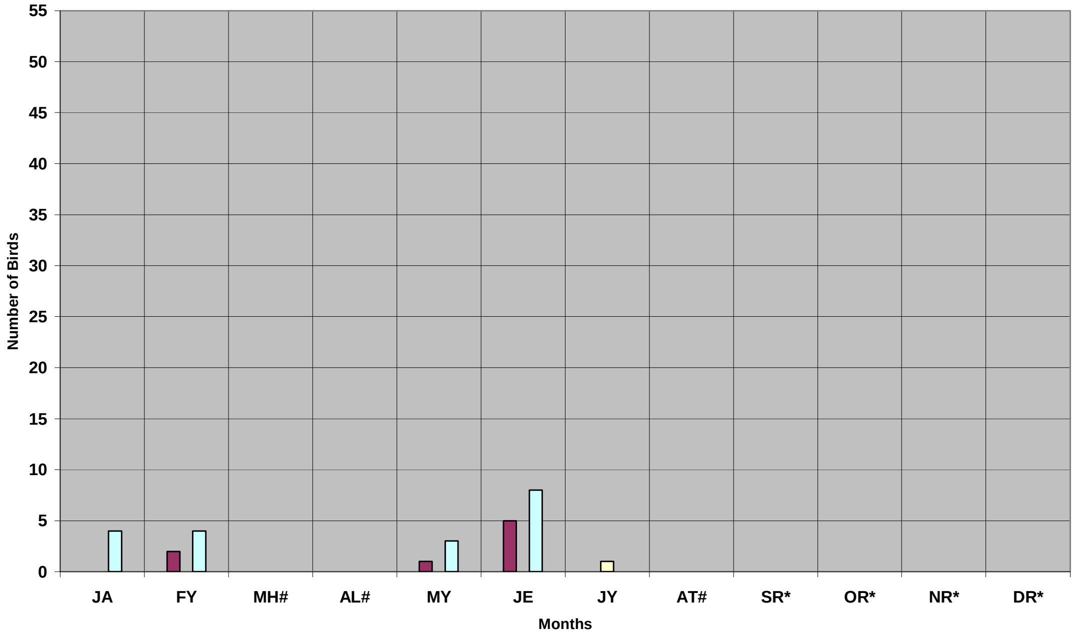
2002 – 2003

Figure 10g. Red-breasted Merganser (*Mergus serrator*) monthly fluctuations 2004-2005.



2004 - 2005

Figure 10h. Red-breasted Merganser (*Mergus serrator*) monthly fluctuations 2006.



2006

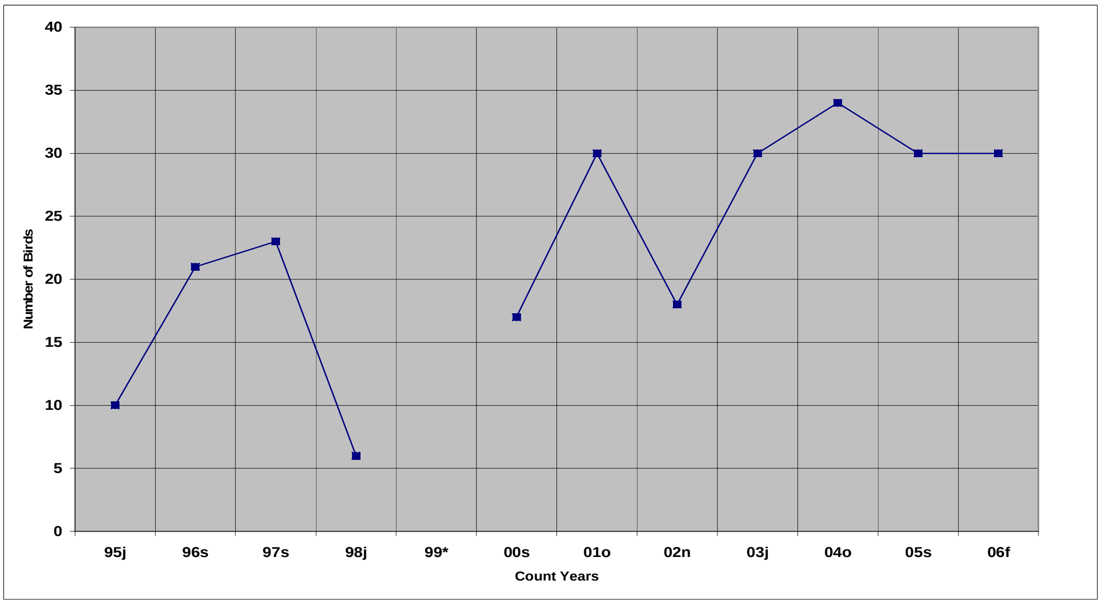
The following six waterfowl species were not counted by Stronach *et al.* (1967-1980) but were counted under the I-WeBS programme and for this study. Subsequently the following annual fluctuation charts and the monthly fluctuation charts for each species are from 1995 to 2006.

Little Grebe (*Tachybaptus ruficollis*)

The Little Grebe is the smallest of the grebes or *Podicipedidae* and as Mullarney et al. (1999) note, due to their size they could be mistaken for a duckling. Although easily missed due to their elusive nature, they can often be heard calling from the reedbeds or seen diving for food in the margins of the lake or near the islands. Little Grebes were often recorded in the same locations around the lake during the count programme. Their numbers since 1995 have displayed an upward trend apart from one low count in 1998.

1995-2006: Mean Annual Peak: 22.

Figure 11. Little Grebe (*Tachybaptus ruficollis*) annual peaks on Lough Carra 1995-2006.



Notes: 1995-2000 = Counts made by Delany/Colhoun *et al.* for I-WeBS.

2000-2004 = Counts made by Chris & Lynda Huxley for I-WeBS.

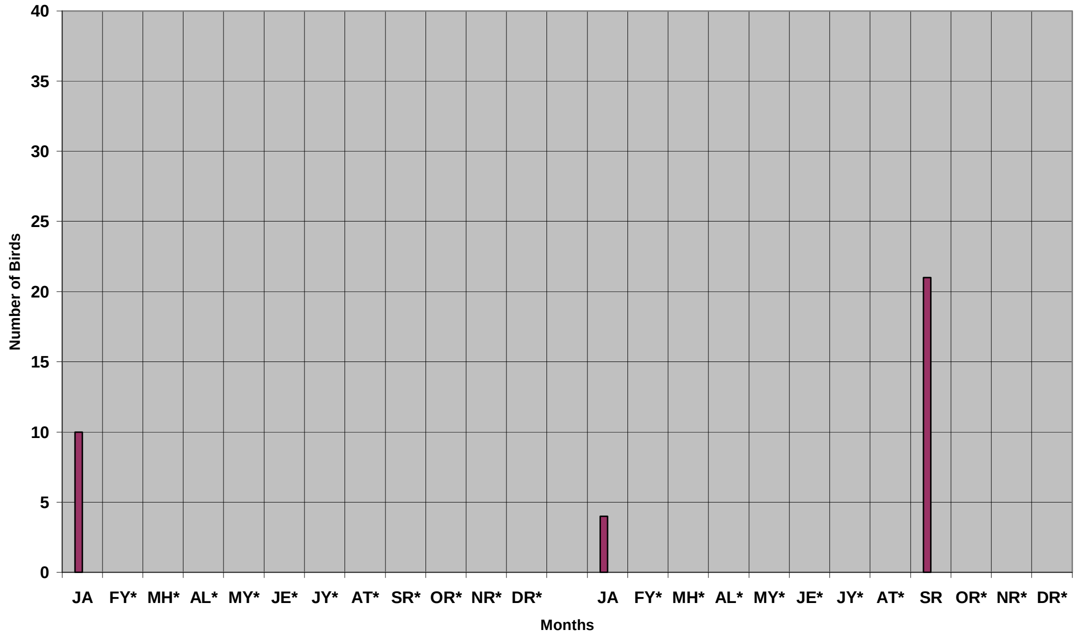
2004-2006 = Counts made by Chris & Lynda Huxley for I-WeBS and by the author.

The small letters next to the count years refers to the month in which the peak occurred, **J** = January, **F** = February, **O** = October, **N** = November, **S** = September.

***** = No data for the year 1999.

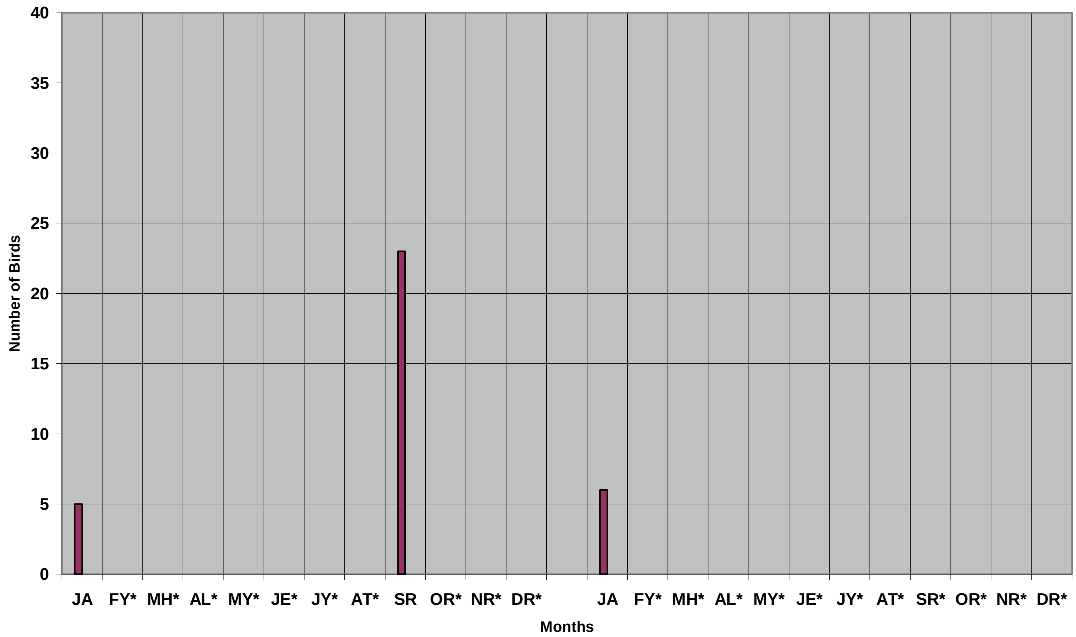
Monthly Fluctuations of Little Grebe (*Tachybaptus ruficollis*) on Lough Carra 1995 – 2006

Figure 11a. Little Grebe (*Tachybaptus ruficollis*) monthly fluctuations 1995-1996.



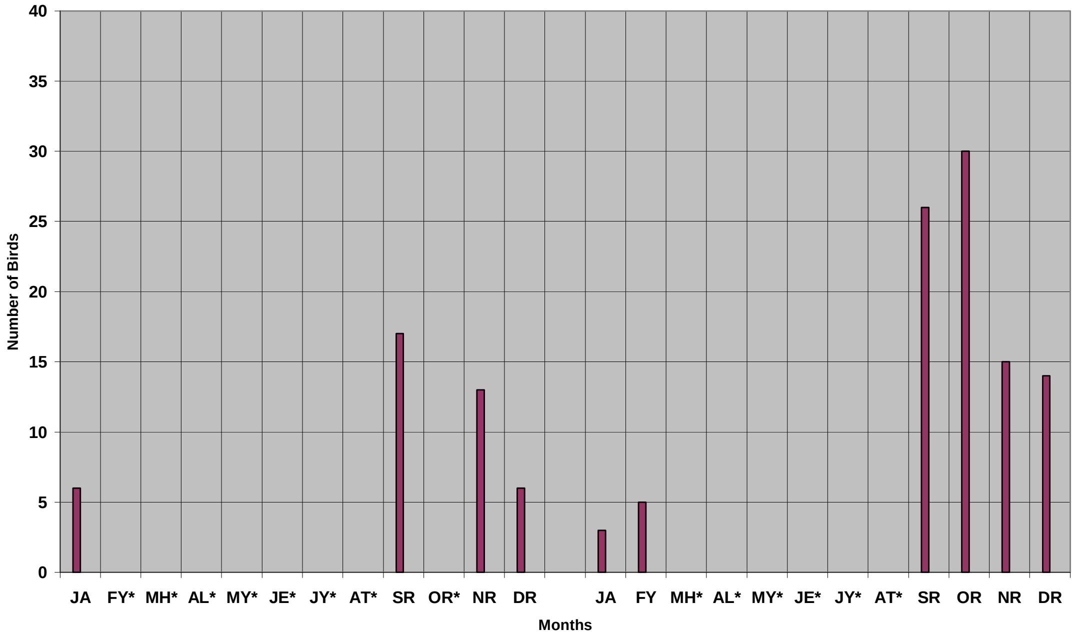
1995 – 1996

Figure 11b. Little Grebe (*Tachybaptus ruficollis*) monthly fluctuations 1997-1998.



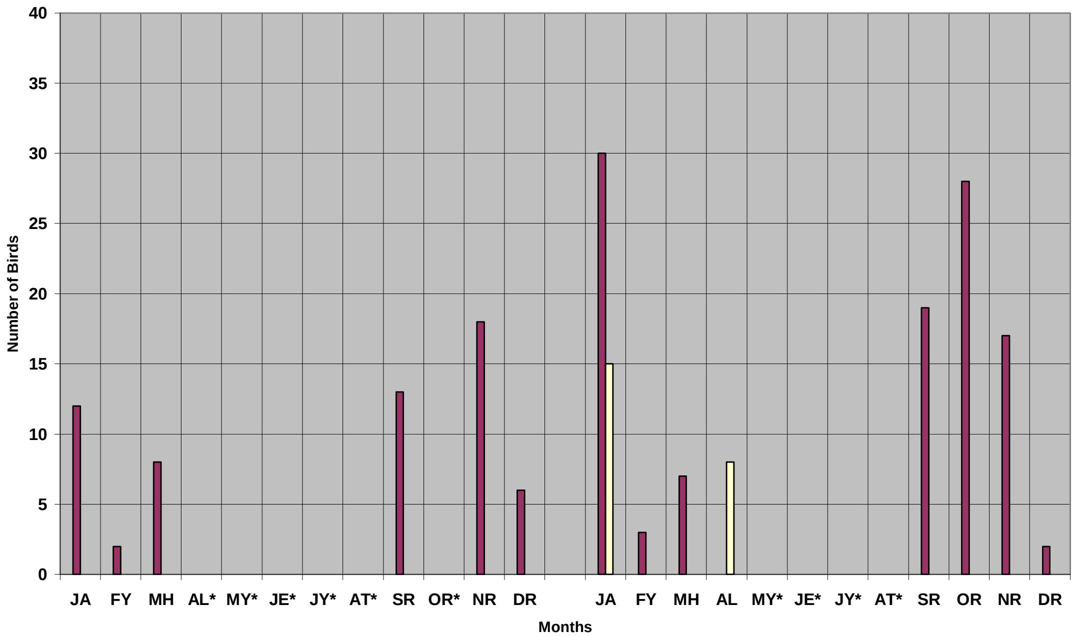
1997 - 1998

Figure 11c. Little Grebe (*Tachybaptus ruficollis*) monthly fluctuations 2000-2001.



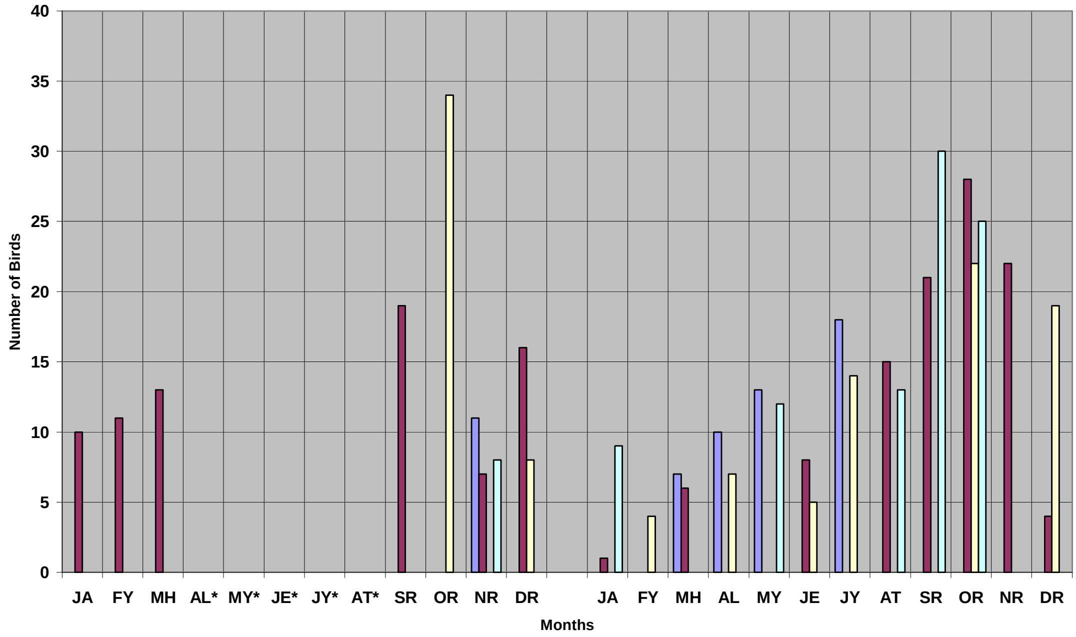
2000 - 2001

Figure 11d. Little Grebe (*Tachybaptus ruficollis*) monthly fluctuations 2002-2003.



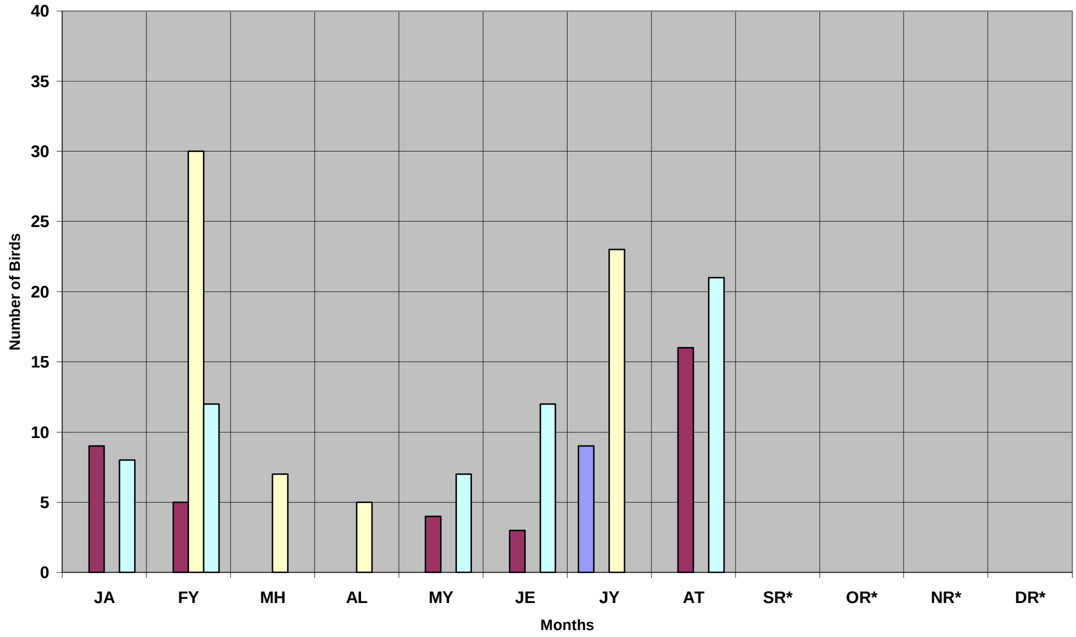
2002 – 2003

Figure 11e. Little Grebe (*Tachybaptus ruficollis*) monthly fluctuations 2004-2005.



2004 - 2005

Figure 11f. Little Grebe (*Tachybaptus ruficollis*) monthly fluctuations 2006.



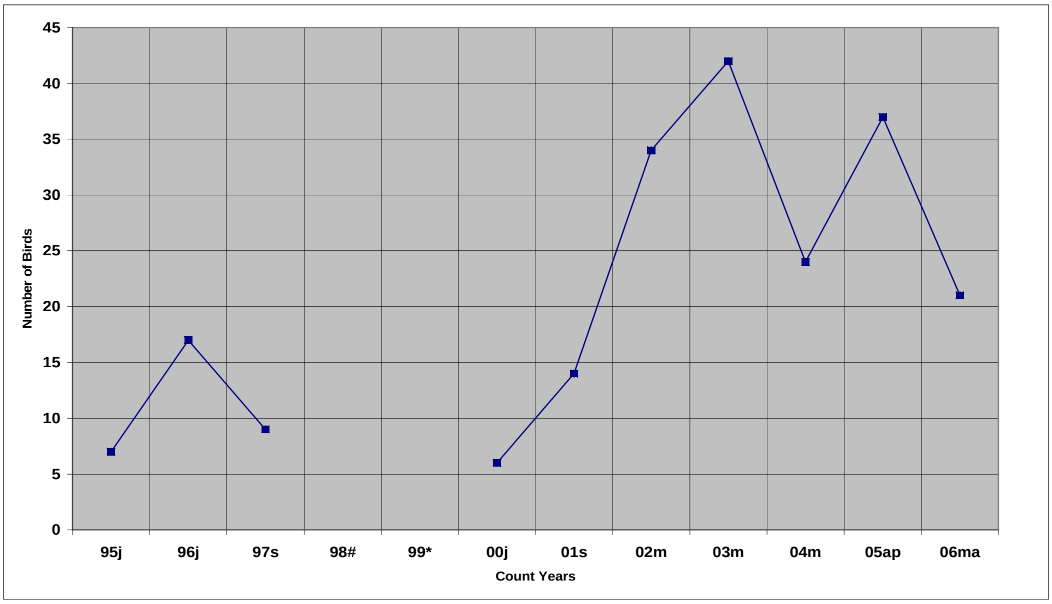
2006

Great Crested Grebe (*Podiceps cristatus*)

The Great Crested Grebe is the largest member of the *Podicipedidae* to be found in Ireland and it is a familiar sight on many lakes and reservoirs. In spring Great Crested Grebes are noted for their complex and unusual courtship display involving dancing and head shaking. From peak counts in years with better coverage, it is becoming clearer that there is a spring passage of Great Crested Grebes through Lough Carra. Their numbers on the lake increased dramatically from 2000 to 2003 but have been variable from then to 2006 with a slight downward trend.

1995 – 2006: Mean Annual Peak: 21.

Figure 12. Great Crested Grebe (*Podiceps cristatus*) annual peaks on Lough Carra 1995-2006.



Notes: 1995-2000 = Counts made by Delany/Colhoun *et al.* for I-WeBS.

2000-2004 = Counts made by Chris & Lynda Huxley for I-WeBS.

2004-2006 = Counts made by Chris & Lynda Huxley for I-WeBS and by the author.

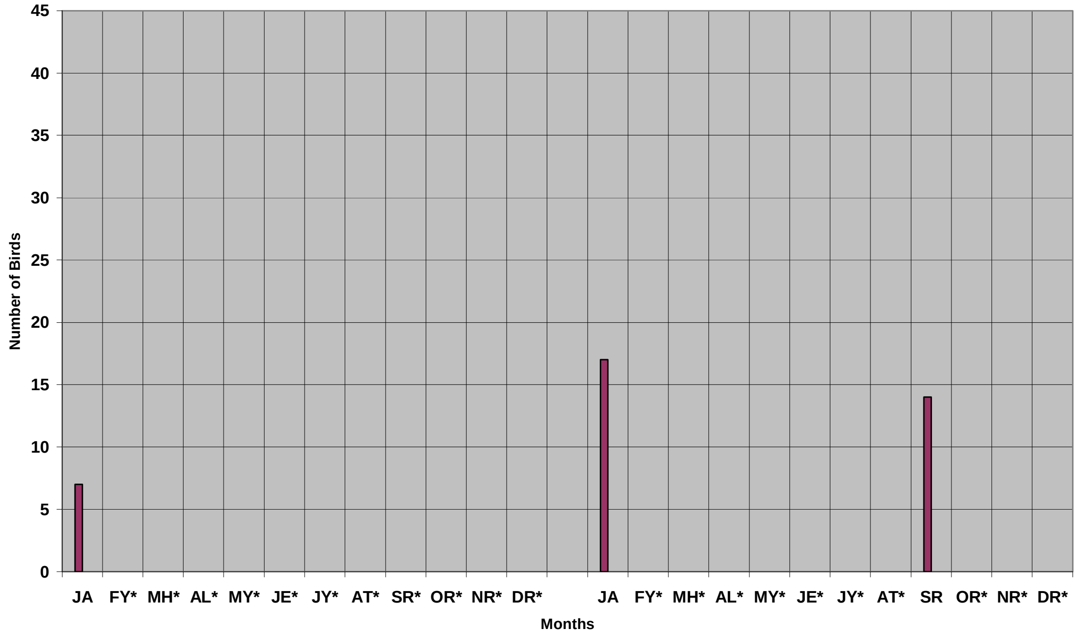
The small letters next to the count years refers to the month in which the peak occurred, **J** = January, S = September, **M** = March, **AP** = April, **MA** = May.

***** = No data for the year 1999.

= Count conducted but Great Crested Grebe not recorded.

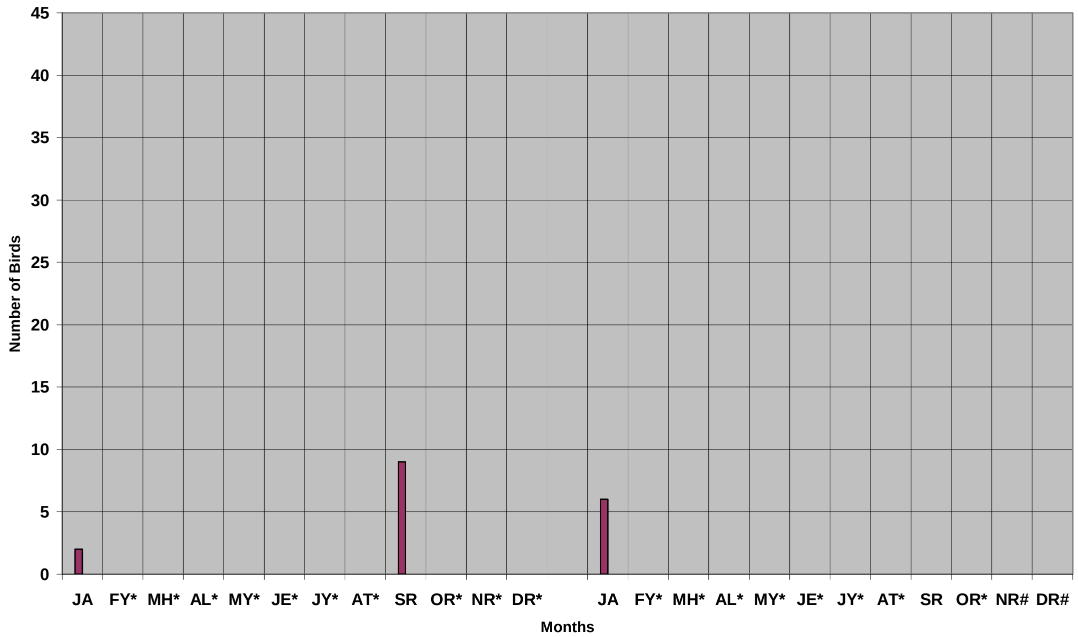
Monthly Fluctuations of Great Crested Grebe (*Podiceps cristatus*) on Lough Carra 1995-2006.

Figure 12a. Great Crested Grebe (*Podiceps cristatus*) monthly fluctuations 1995-1996.



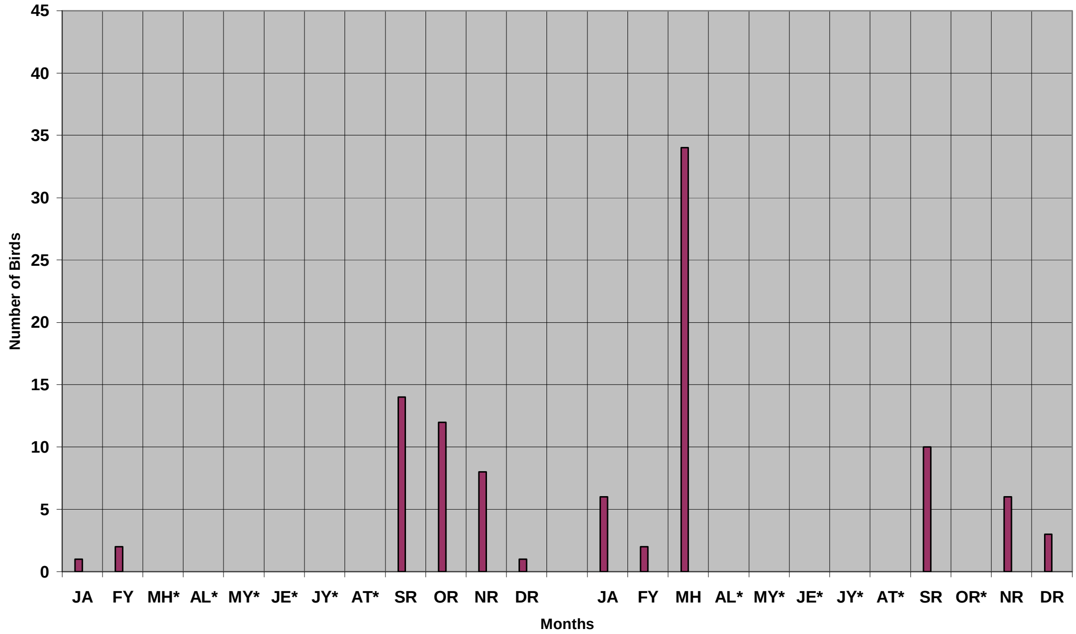
1995 – 1996

Figure 12b. Great Crested Grebe (*Podiceps cristatus*) monthly fluctuations 1997-2000.



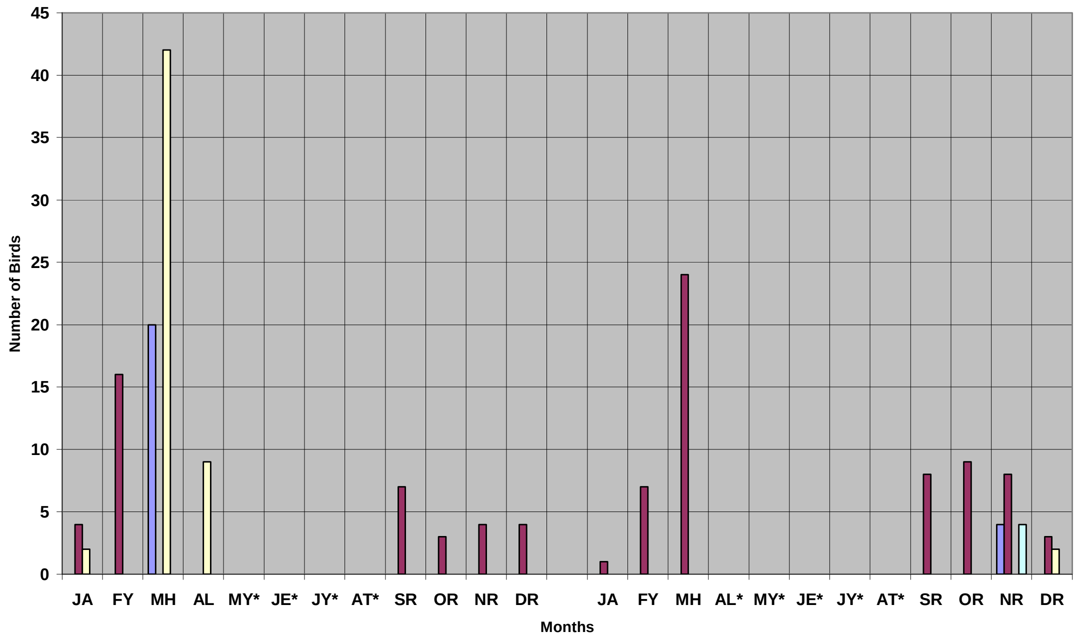
1997 – 2000

Figure 12c. Great Crested Grebe (*Podiceps cristatus*) monthly fluctuations 2001-2002.



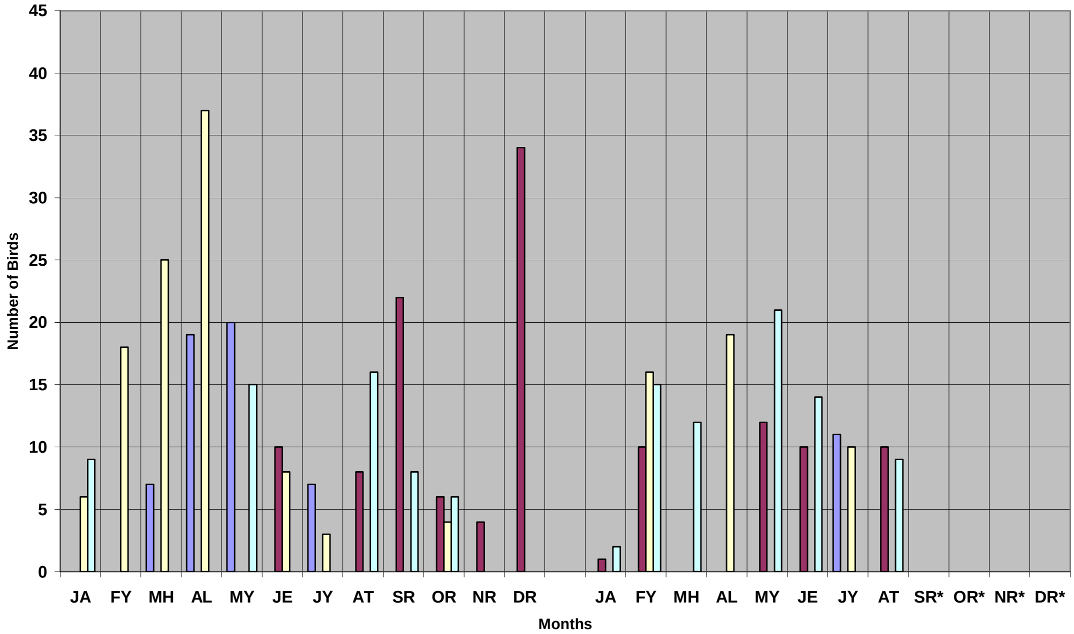
2001 – 2002

Figure 12d. Great Crested Grebe (*Podiceps cristatus*) monthly fluctuations 2003-2004.



2003 – 2004

Figure 12e. Great Crested Grebe (*Podiceps cristatus*) monthly fluctuations 2005-2006.



2005 – 2006

Plate 10. Summer Plumaged Great Crested Grebe (*Podiceps cristatus*)

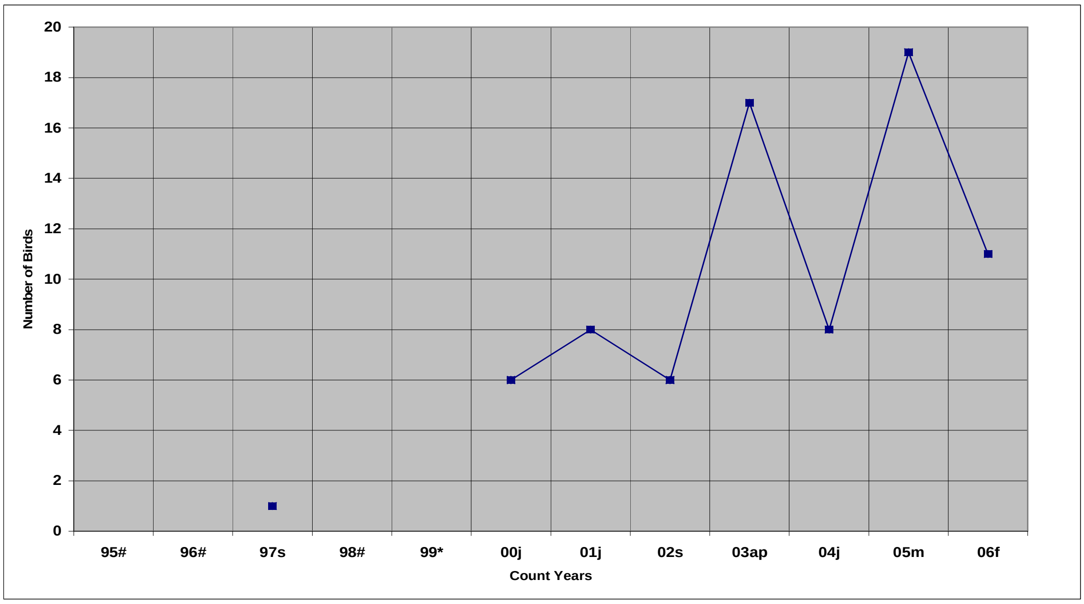
Photograph by John N Murphy

Moorhen (*Gallinula chloropus*)

The Moorhen is a pigeon-sized member of the *Rallidae* with a dark plumage, red bill with yellow tip and distinctive long green legs with large feet. The Moorhen likes dense vegetation and reedbeds although they do feed openly on the grassy verges of lakes and rivers. Despite the abundance of suitable habitat, numbers of Moorhen on Lough Carra were quite low, never exceeding 20 birds. They are present all year round on the lake and breed at locations such as Kilkeeran and Moorehall.

1997 – 2006: Mean Annual Peak: 9.

Figure 13. Moorhen (*Gallinula chloropus*) annual peaks on Lough Carra 1997-2006.



Notes: 1995-2000 = Counts made by Delany/Colhoun *et al.* for I-WeBS.

2000-2004 = Counts made by Chris & Lynda Huxley for I-WeBS.

2004-2006 = Counts made by Chris & Lynda Huxley for I-WeBS and by the author.

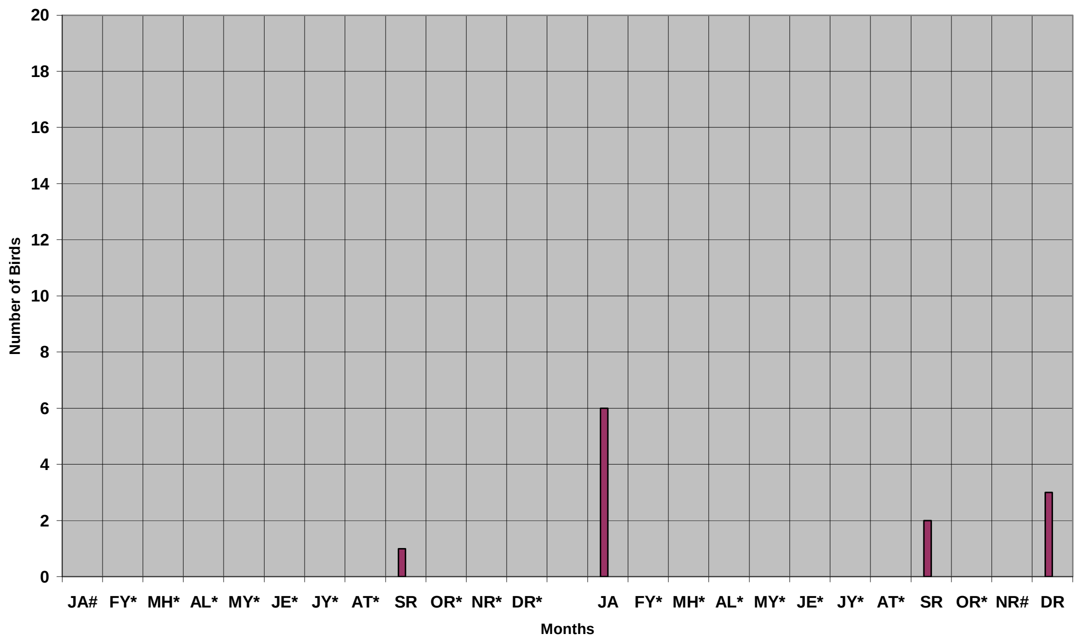
The small letters next to the count years refers to the month in which the peak occurred, **J** = January, **F** = February, **S** = September, **M** = March, **AP** = April.

***** = No data for the year 1999.

= Count conducted but Moorhen not recorded.

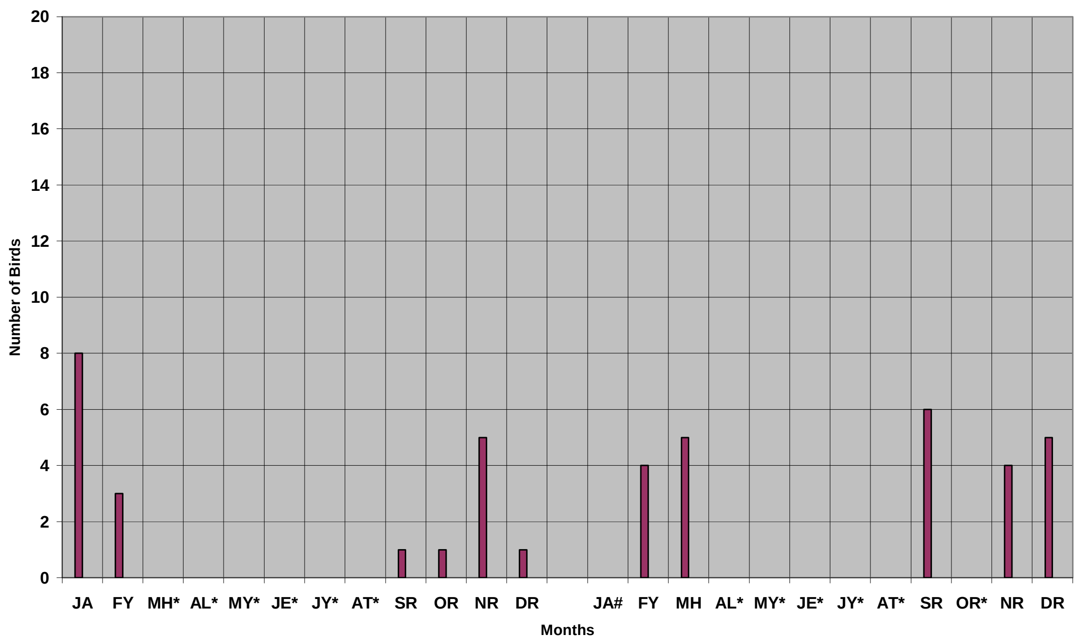
Monthly Fluctuations of Moorhen (*Gallinula chloropus*) on Lough Carra 1997-2006

Figure 13a. Moorhen (*Gallinula chloropus*) monthly fluctuations 1997-2000.



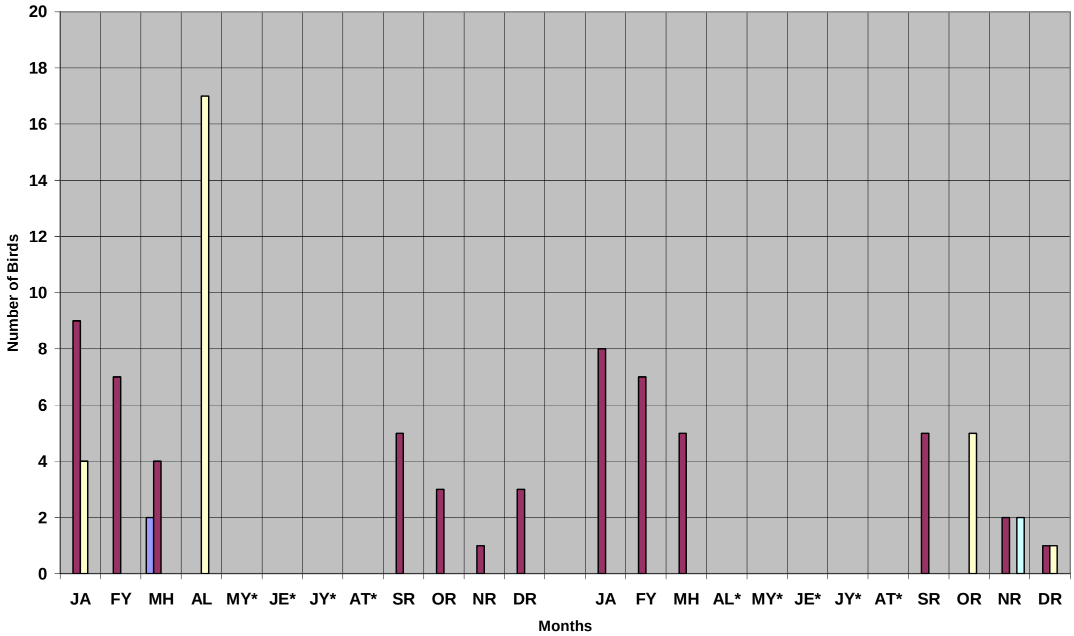
1997 – 2000

Figure 13b. Moorhen (*Gallinula chloropus*) monthly fluctuations 2001-2002.



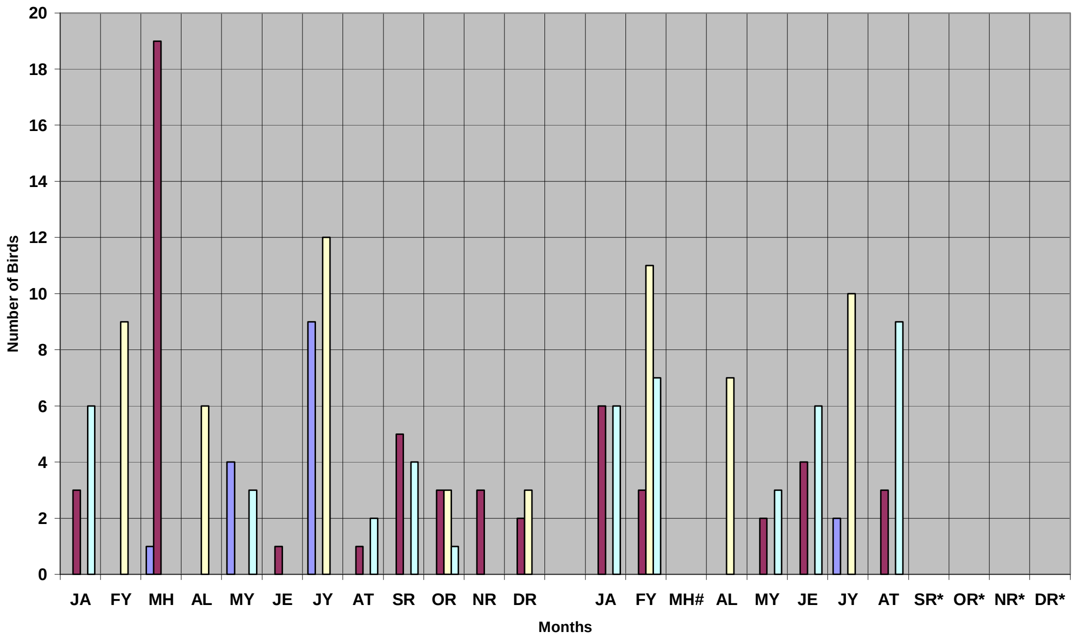
2001 - 2002

Figure 13c. Moorhen (*Gallinula chloropus*) monthly fluctuations 2003-2004.



2003 - 2004

Figure 13d. Moorhen (*Gallinula chloropus*) monthly fluctuations 2005-2006.



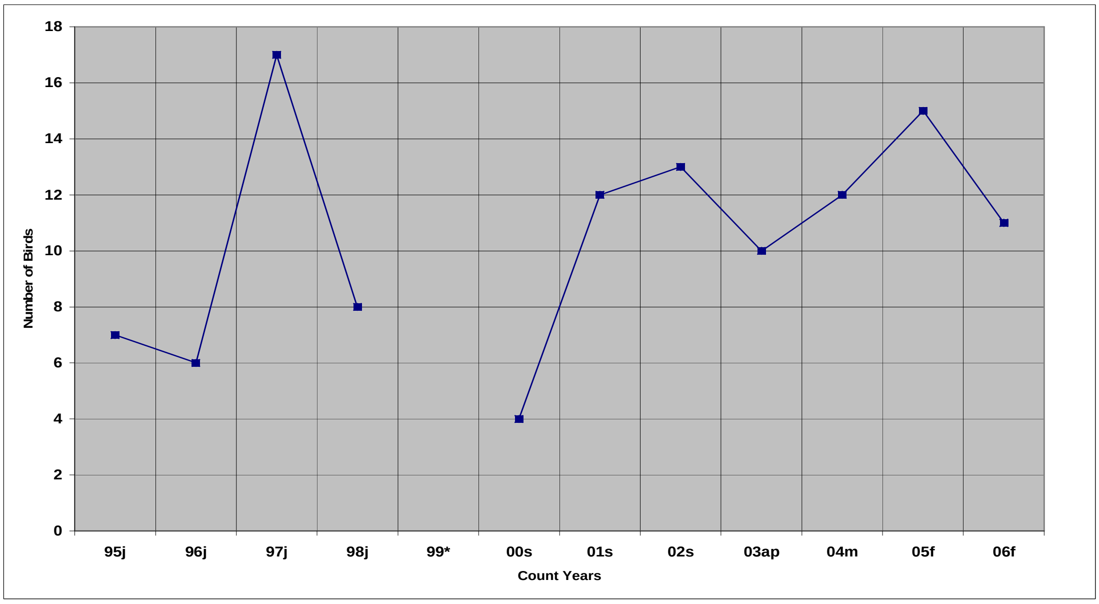
2005 - 2006

Coot (*Fulica atra*)

The Coot is the slightly larger relative of the Moorhen and like it, the Coot is present all year round on Lough Carra. It is dark grey/black in colour with a white forehead and white bill (on the adult the bill has a pink hue) (Mullarney *et al.* 1999). The population of Coot on the lake since 1995 has showed no major fluctuations apart from an increase in 1997 followed by a slight decline in 1998, however numbers since 2000 showed a slight increase.

1995 – 2006: Mean Annual Peak: 10.

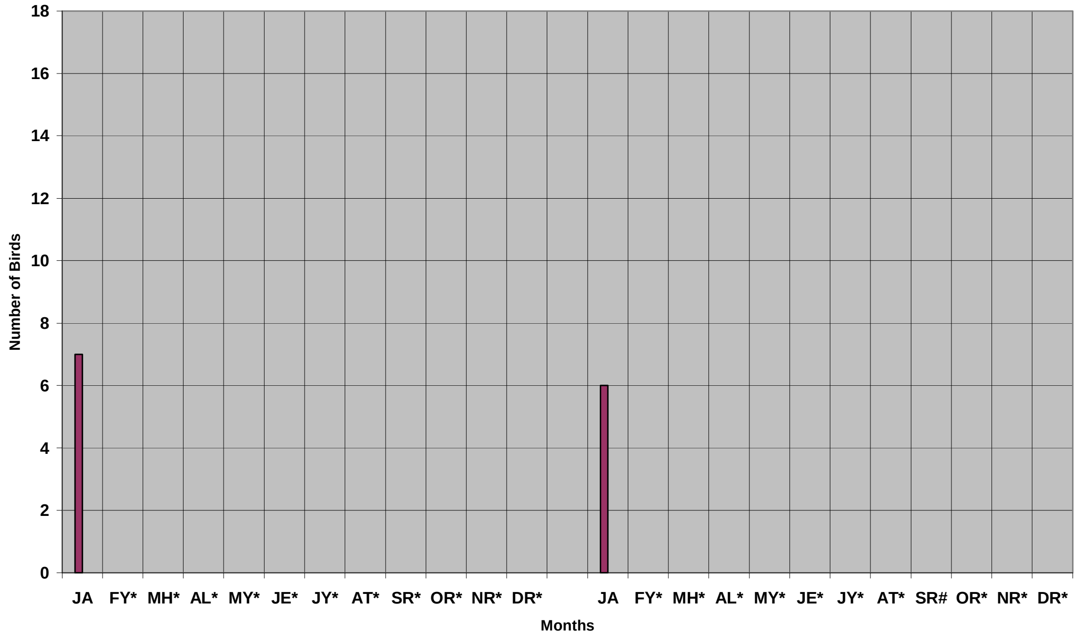
Figure 14. Coot (*Fulica atra*) annual peaks on Lough Carra 1995-2006.



Notes: 1995-2000 = Counts made by Delany/Colhoun *et al.* for I-WeBS.
2000-2004 = Counts made by Chris & Lynda Huxley for I-WeBS.
2004-2006 = Counts made by Chris & Lynda Huxley for I-WeBS and by the author.
The small letters next to the count years refers to the month in which the peak occurred,
J = January, **F** = February, **S** = September, **M** = March, **AP** = April.
***** = No data for the year 1999.

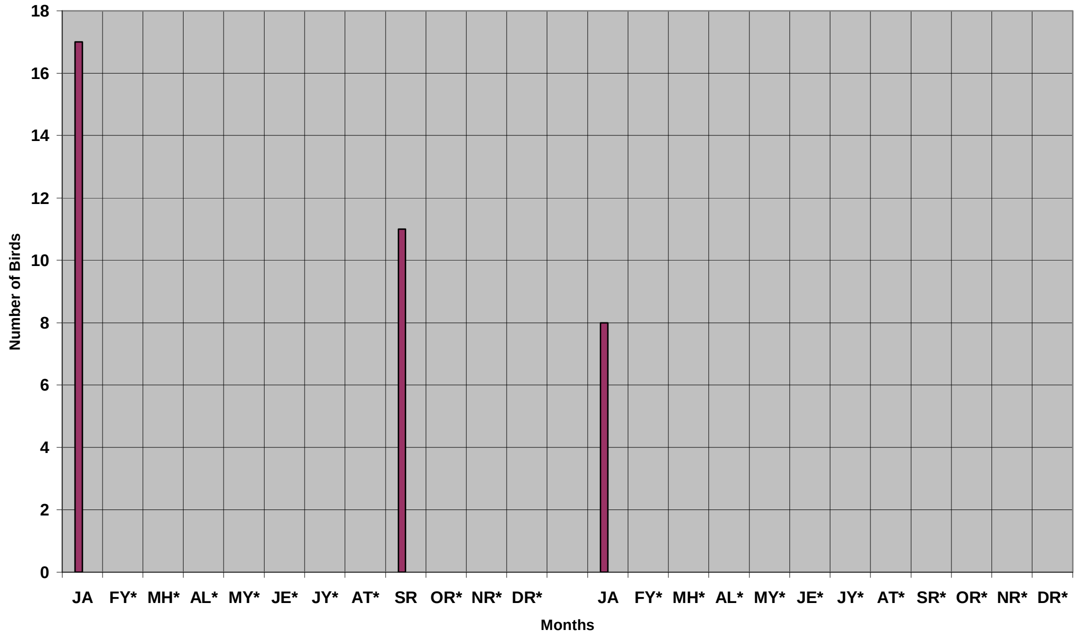
Monthly Fluctuations of Coot (*Fulica atra*) on Lough Carra 1995-2006

Figure 14a. Coot (*Fulica atra*) monthly fluctuations 1995-1996.



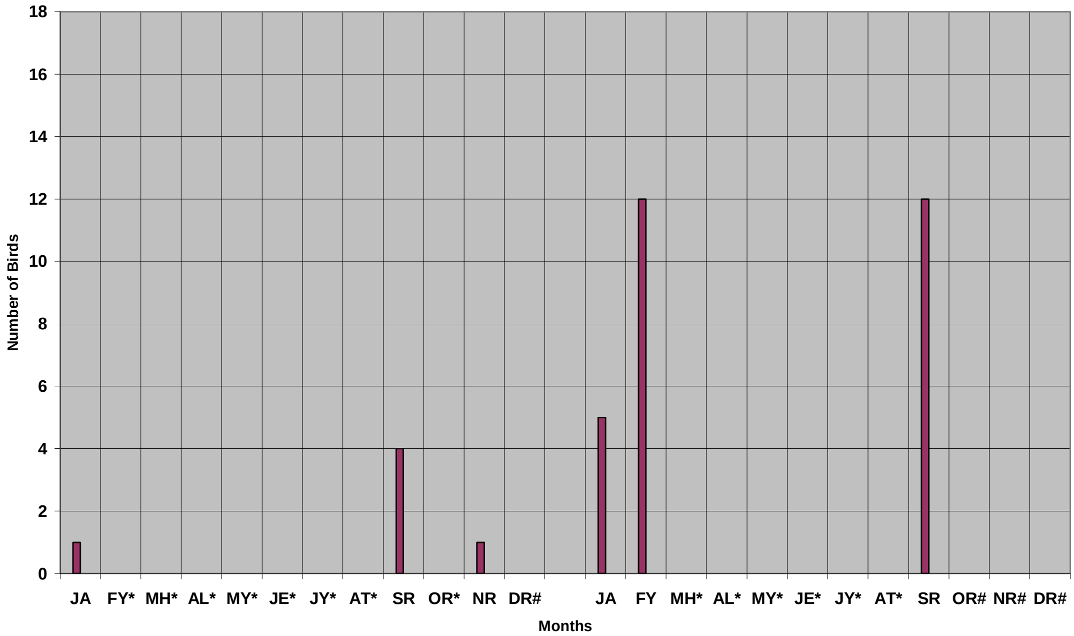
1995 – 1996

Figure 14b. Coot (*Fulica atra*) monthly fluctuations 1997-1998.



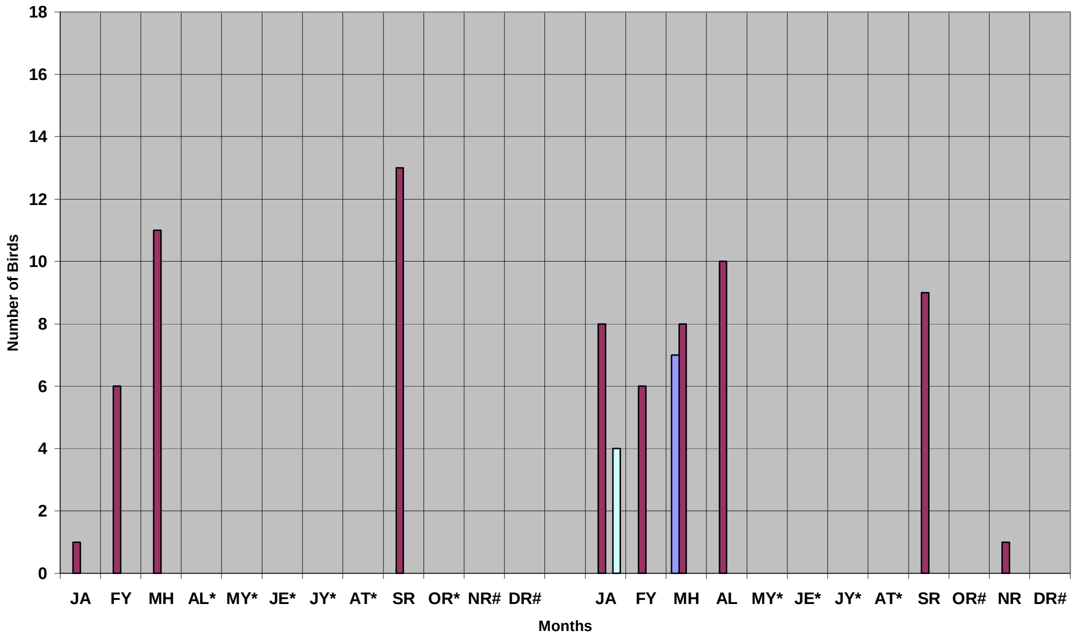
1997 – 1998

Figure 14c. Coot (*Fulica atra*) monthly fluctuations 2000-2001.



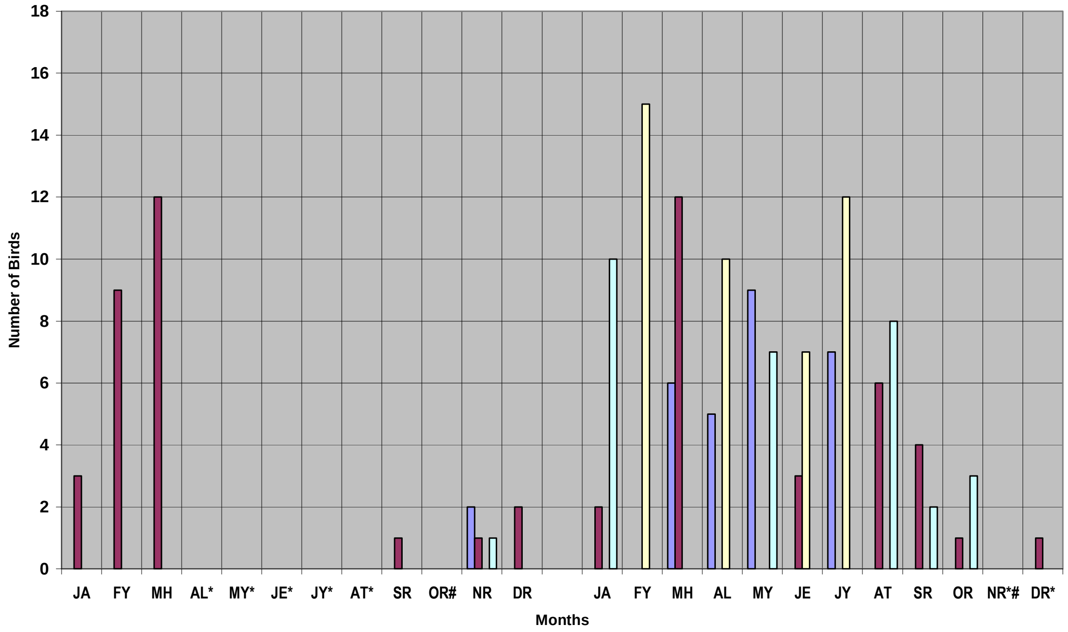
2000 – 2001

Figure 14d. Coot (*Fulica atra*) monthly fluctuations 2002-2003.



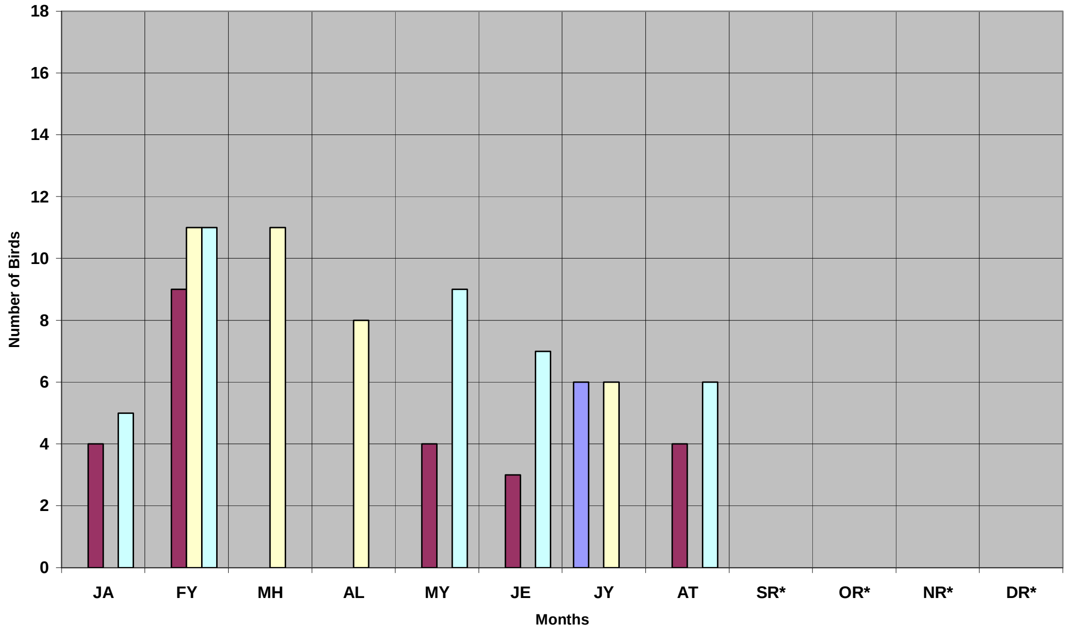
2002 - 2003

Figure 14e. Coot (*Fulica atra*) monthly fluctuations 2004-2005.



2004 – 2005

Figure 14f. Coot (*Fulica atra*) monthly fluctuations 2006.



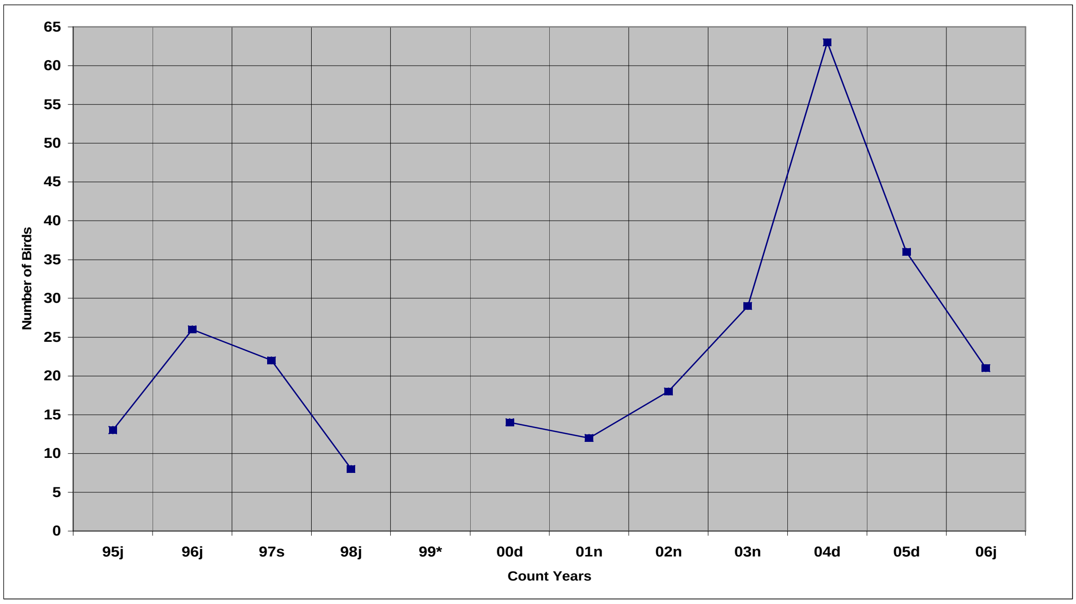
2006

Cormorant (*Phalacrocorax carbo*)

The Cormorant is a large species of *Phalacrocoracidae* which can be found in both marine and freshwater habitats. Cormorants were easily counted on Lough Carra due to their size and habit of gathering on the rocks on the lake in large groups. From the monthly fluctuation charts, it is clear that Cormorant numbers build up on the lake during the winter months and then decline during the spring as the majority of birds migrate out of the lake to breed. A large peak occurred in their population on Lough Carra during December of 2004 when the maximum count numbered 63 individuals.

1995 – 2005: Mean Annual Peak: 23.

Figure 15. Cormorant (*Phalacrocorax carbo*) annual peaks on Lough Carra 1995-2006.



Notes: 1995-2000 = Counts made by Delany/Colhoun *et al.* for I-WeBS.

2000-2004 = Counts made by Chris & Lynda Huxley for I-WeBS.

2004-2006 = Counts made by Chris & Lynda Huxley for I-WeBS and by the author.

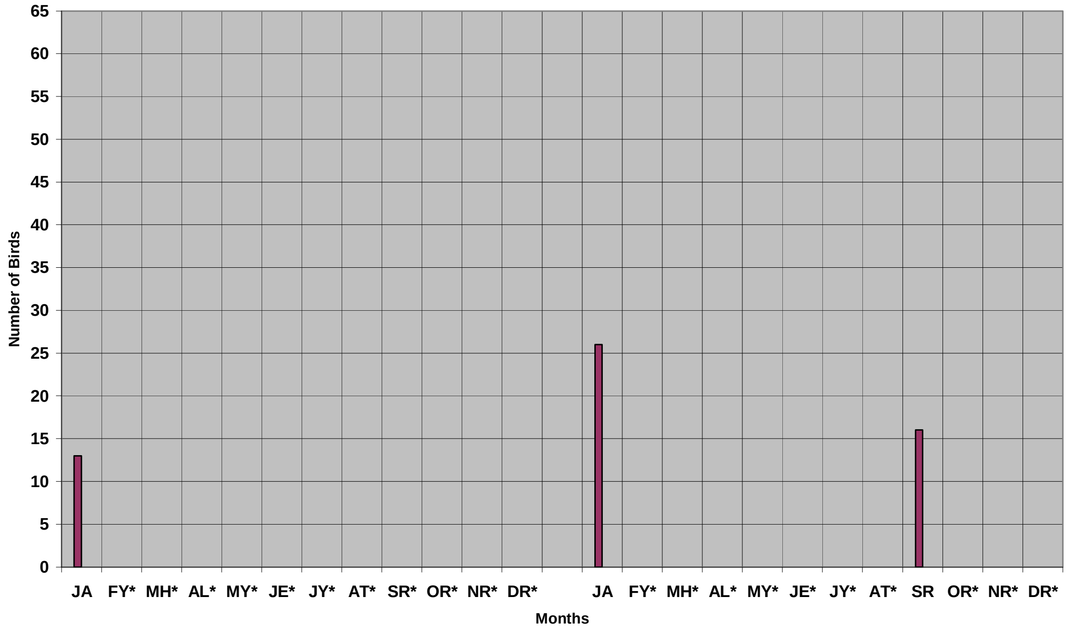
The small letters next to the count years refers to the month in which the peak occurred,

J = January, **D** = December, **S** = September, **N** = November.

***** = No data for the year 1999.

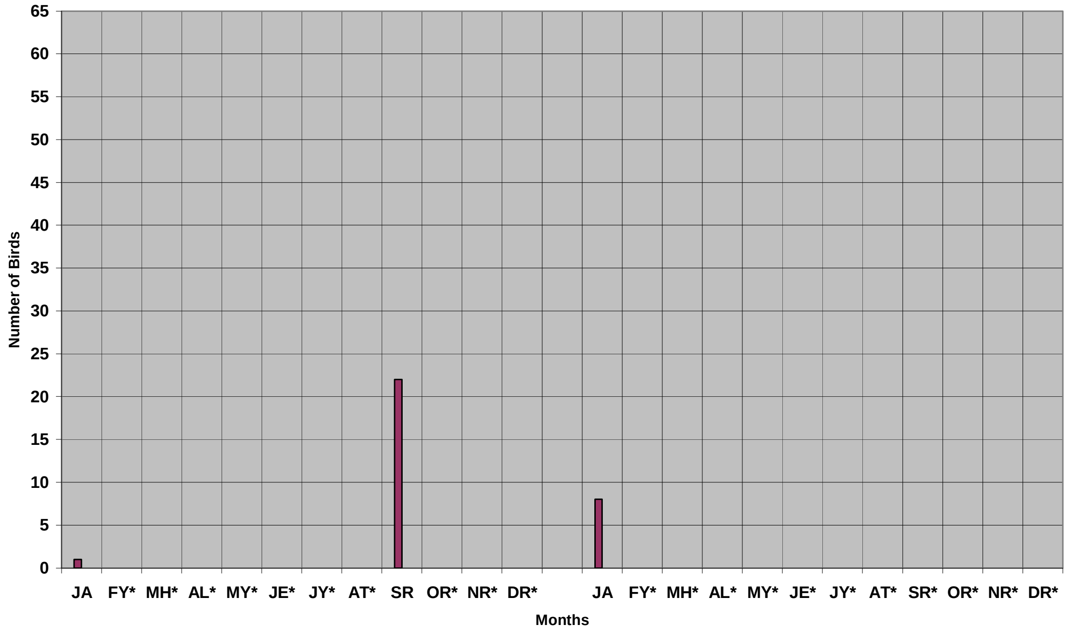
Monthly Fluctuations of Cormorant (*Phalacrocorax carbo*) on Lough Carra 1995-2006

Figure 15a. Cormorant (*Phalacrocorax carbo*) monthly fluctuations 1995-1996.



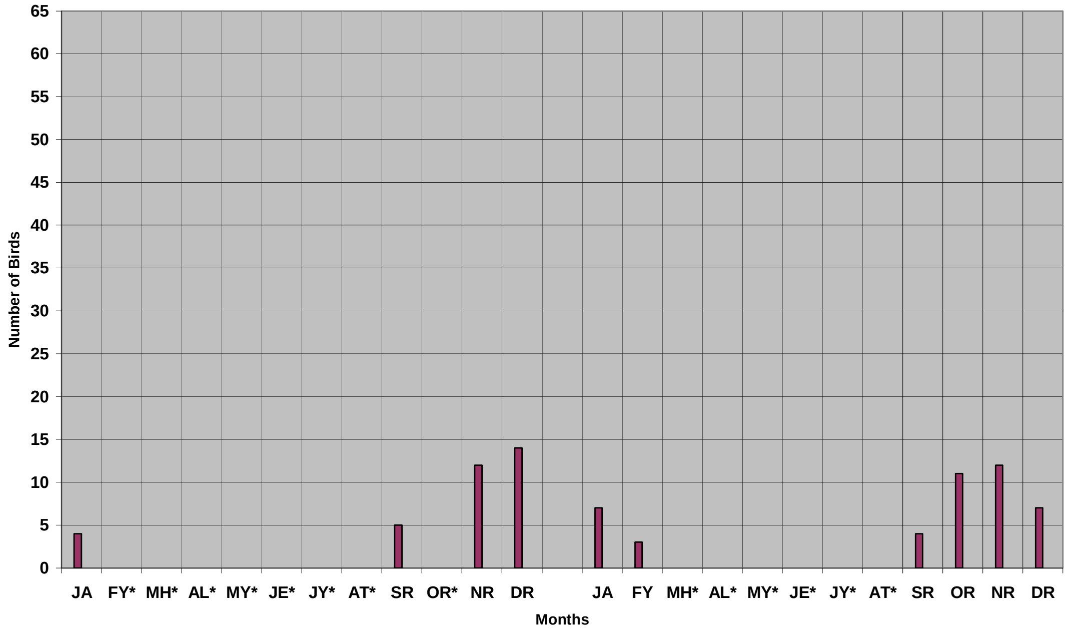
1995 – 1996

Figure 15b. Cormorant (*Phalacrocorax carbo*) monthly fluctuations 1997-1998.



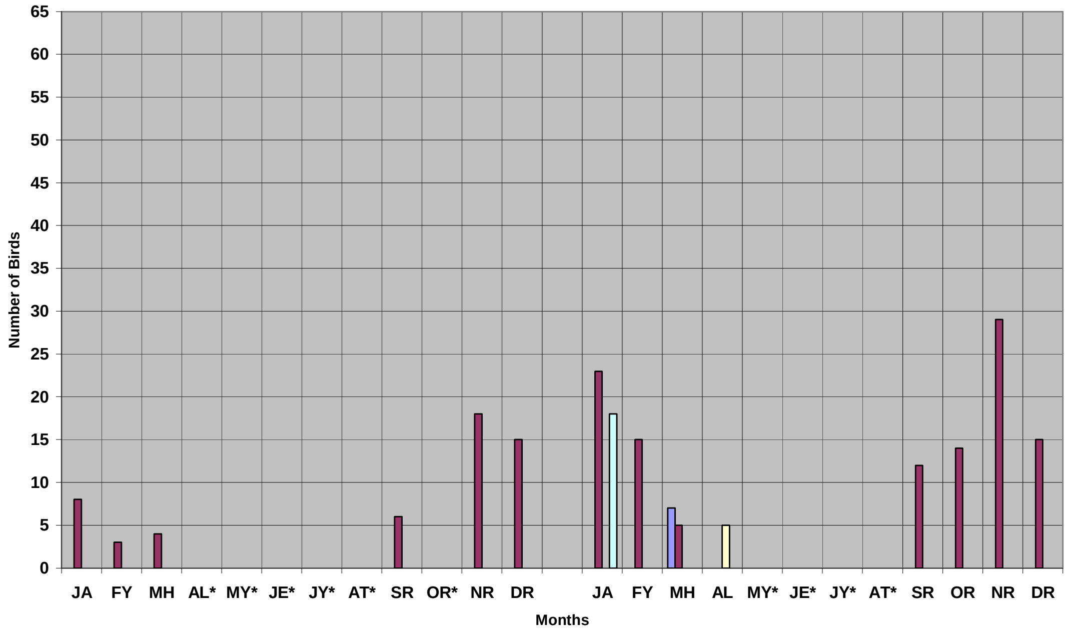
1997 - 1998

Figure 15c. Cormorant (*Phalacrocorax carbo*) monthly fluctuations 2000-2001.



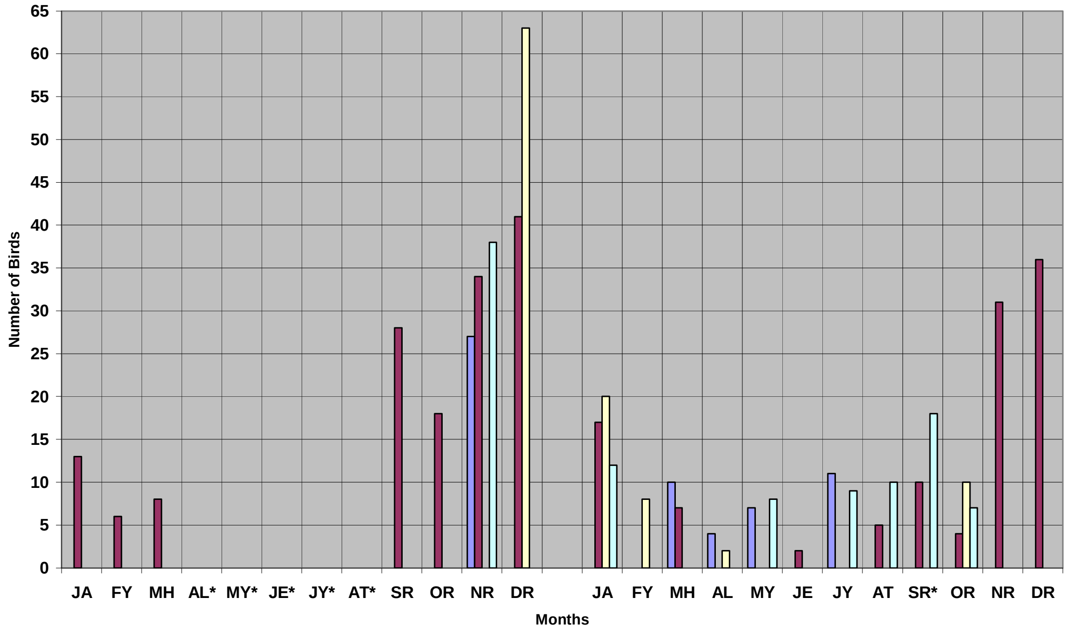
2000 – 2001

Figure 15d. Cormorant (*Phalacrocorax carbo*) monthly fluctuations 2002-2003.



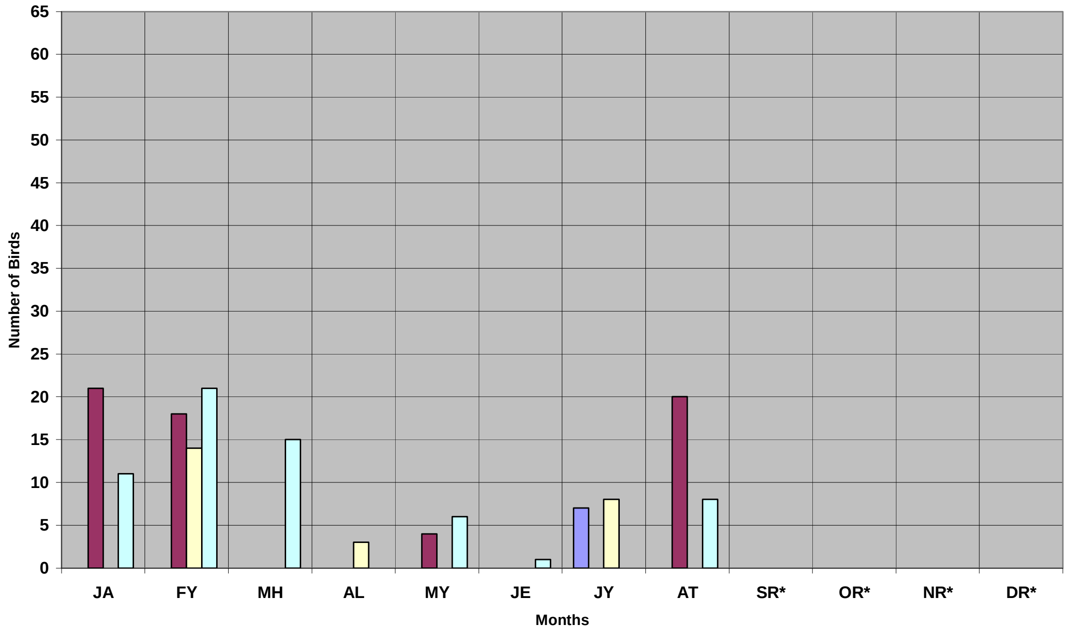
2002 – 2003

Figure 15e. Cormorant (*Phalacrocorax carbo*) monthly fluctuations 2004-2005.



2004 – 2005

Figure 15f. Cormorant (*Phalacrocorax carbo*) monthly fluctuations 2006.



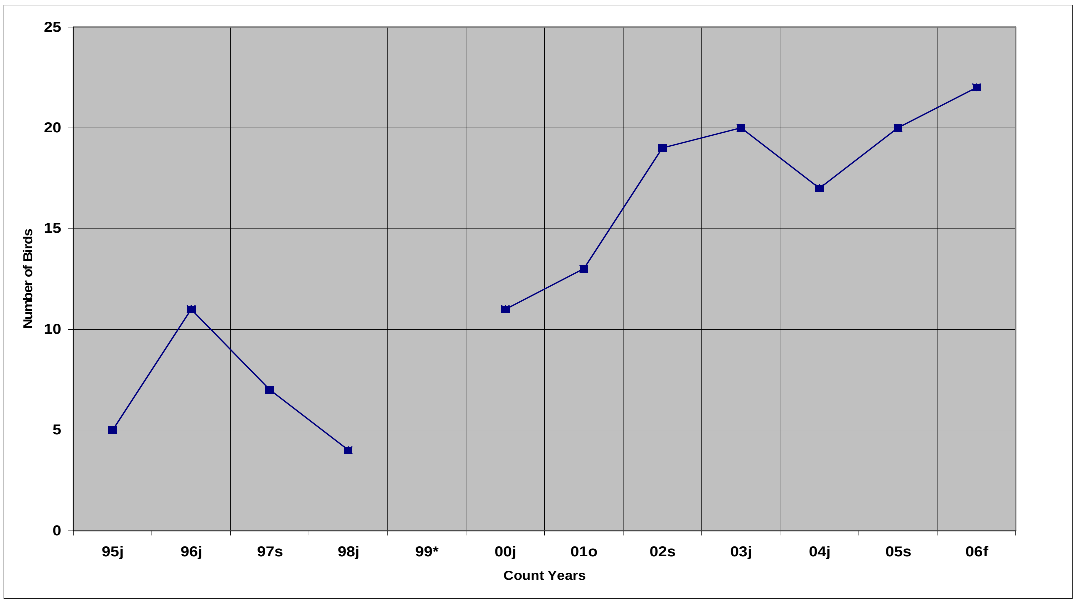
2006

Mute Swan (*Cygnus olor*)

The Mute Swan is probably the most well known and familiar member of the wildfowl family and can be found in most rivers and lakes in Ireland. In urban areas it has become tame due to being fed by the public although Mute Swans are known for their aggressive behaviour when near their nests during the breeding season. Like a number of other species, Mute Swans were often found in the same locations on Lough Carra during counts. The trend in their numbers on the lake has shown a steady increase from 2000 to 2006 when numbers went from 11 to 22 birds.

1996 – 2006: Mean Annual Peak: 13

Figure 16. Mute Swan (*Cygnus olor*) annual peaks on Lough Carra 1995-1996.



Notes: 1995-2000 = Counts made by Delany/Colhoun *et al.* for I-WeBS.

2000-2004 = Counts made by Chris & Lynda Huxley for I-WeBS.

2004-2006 = Counts made by Chris & Lynda Huxley for I-WeBS and by the author.

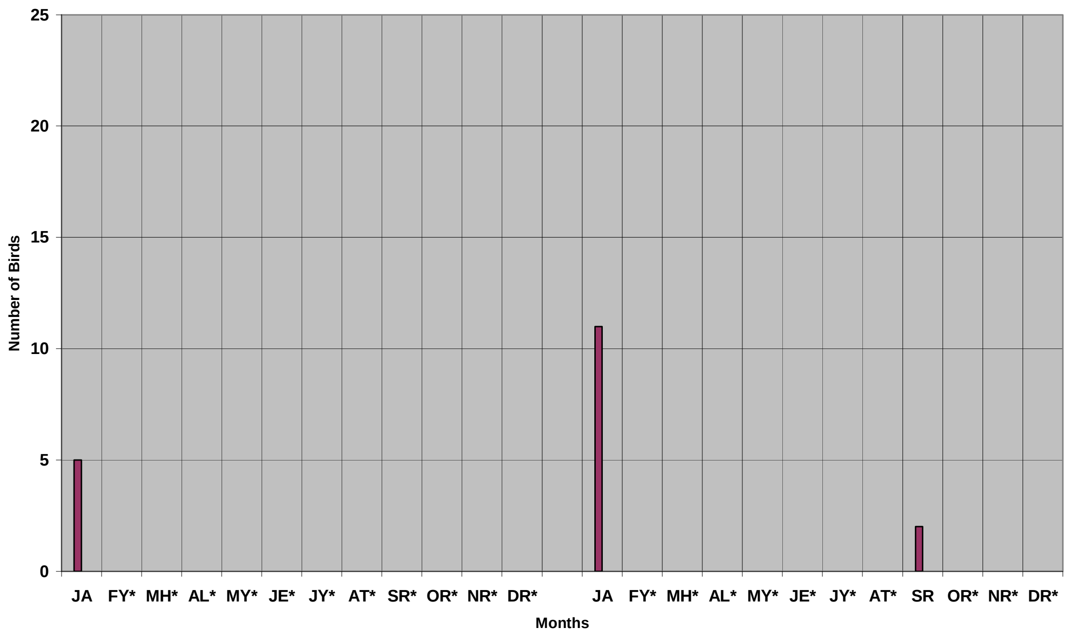
The small letters next to the count years refers to the month in which the peak occurred,

J = January, **S** = September, **O** = October, **F** = February.

***** = No data for the year 1999.

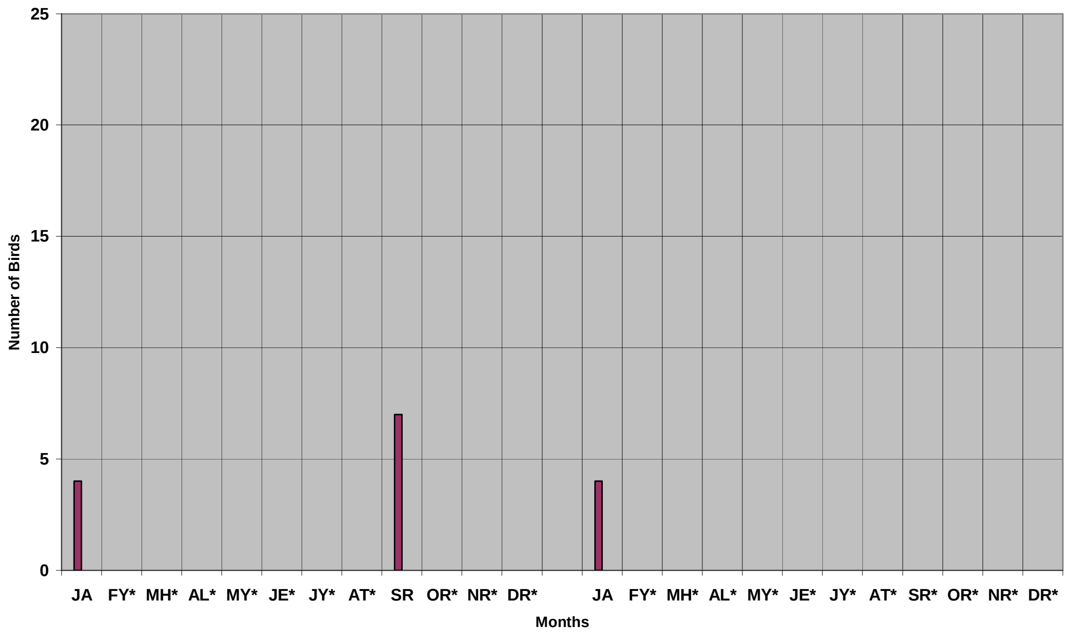
Monthly Fluctuations of Mute Swan (*Cygnus olor*) on Lough Carra 1995-2006

Figure 16a. Mute Swan (*Cygnus olor*) monthly fluctuations 1995-1996.



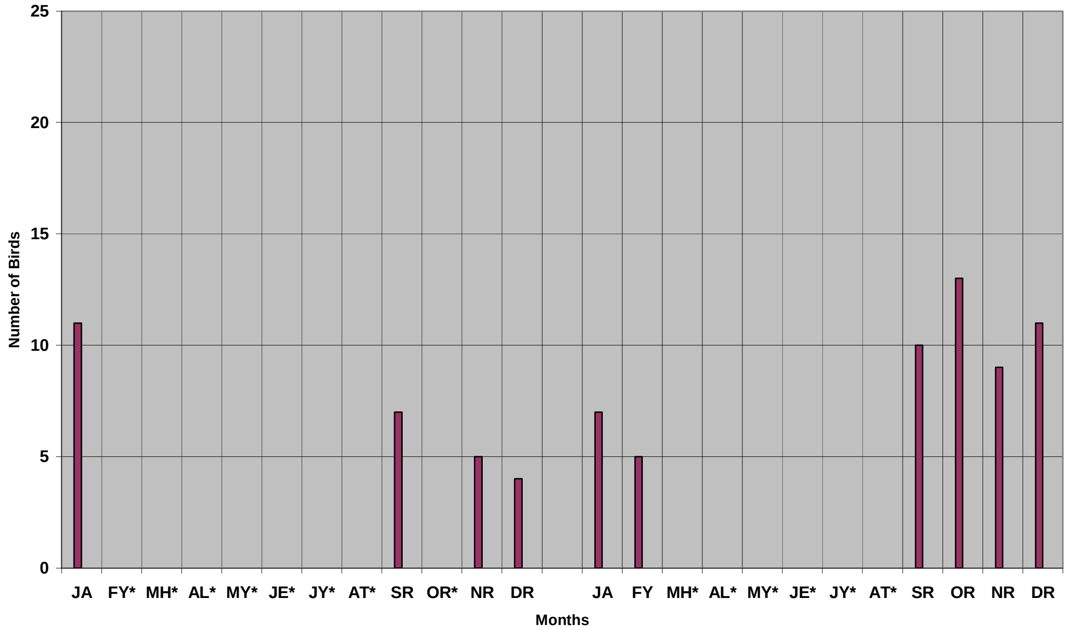
1995 – 1996

Figure 16b. Mute Swan (*Cygnus olor*) monthly fluctuations 1997-1998.



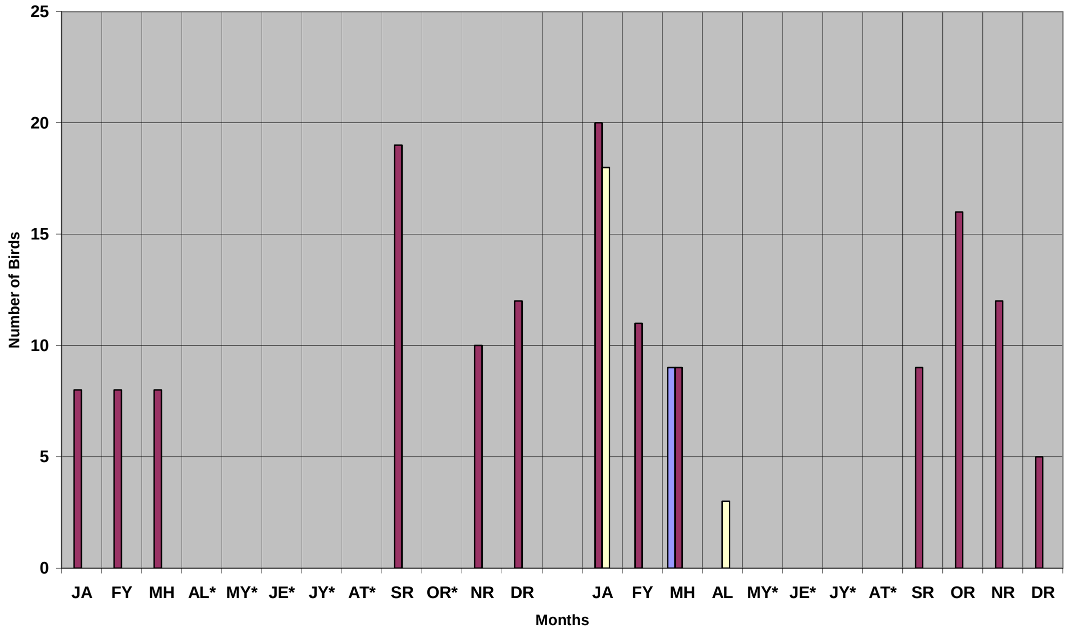
1997 – 1998

Figure 16c. Mute Swan (*Cygnus olor*) monthly fluctuations 2000-2001.



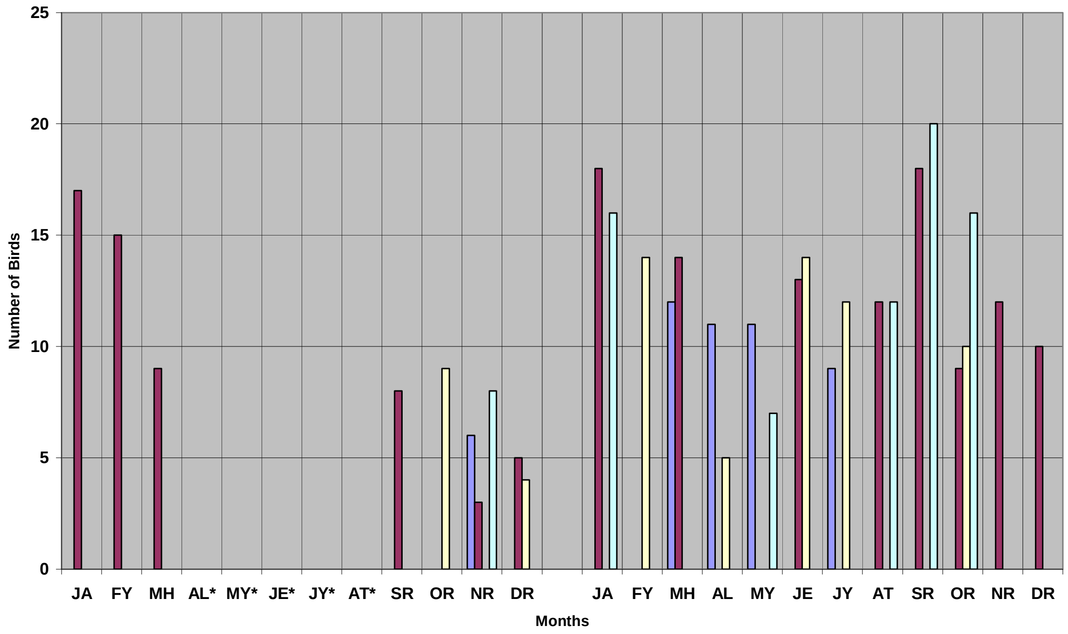
2000 – 2001

Figure 16d. Mute Swan (*Cygnus olor*) monthly fluctuations 2002-2003.



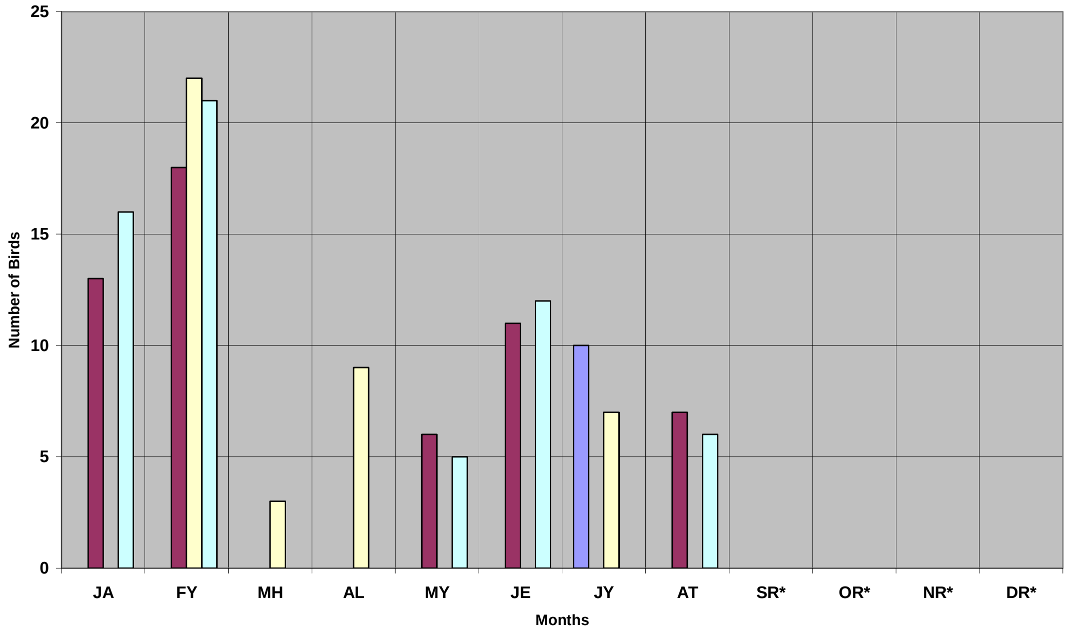
2002 – 2003

Figure 16e. Mute Swan (*Cygnus olor*) monthly fluctuations 2004-2005.



2004 – 2005

Figure 16f. Mute Swan (*Cygnus olor*) monthly fluctuations 2006.



2006

3.2.2 Scarce and Rare Species

From 1967 to 2006 a number of waterfowl species have visited Lough Carra that have been categorised as scarce or rare. These birds are not recorded enough to warrant annual peak or monthly fluctuation charts but are included as they are waterfowl that have been recorded once or more on the lake. They number 11 in all with six duck species, two goose species, two members of the swan family and one grebe making up the group. What follows is a short note on each and where known the date and/or year it was seen.

Long-tailed Duck (*Clangula hyemalis*)

This diving duck has an elegant form with black and white plumage and a long tail on the male reminiscent of the same feature on the male Pintail (*Anas acuta*). Mostly associated with marine habitats, Long-tailed Duck are scarcely seen on Lough Carra. There are no records from 1995-2006 but this was not the case from 1967-1980 as Stronach (1981, p. 123) notes, “Each year these marine diving duck appear on the lake after severe storms. They stay for three weeks to a month and become very tame”. If these birds were staying on the lake after storms for up to a month it is unusual that since 1995 there is not a single record of Long-tailed Duck on Lough Carra.

Scaup (*Aythya marila*)

The Scaup is a diving duck of the *Aythya* genus (Tufted Duck *Aythya fuligula*, Pochard *Aythya ferina* etc) and like the Long-tailed Duck, it is mainly found in coastal/marine habitats. The adult male is particularly reminiscent of male Tufted Duck (*Aythya fuligula*) but the male Scaup features a diagnostic light/grey back. There is only one record of Scaup on the lake from January 1995 and although Stronach (1981) lists it in the wildfowl that has visited Lough Carra from 1967-1980, he does not offer details of sightings, however one could safely presume that such records were infrequent.

Common Scoter (*Melanitta nigra*)

Common Scoter are more associated with our coastline during the winter months where they form large rafts on the open sea in such places as Liscannor Bay, Co. Clare and Brandon Bay in Co. Kerry. They are not uniform in their habitat selection for they breed by rivers and are particularly taken to nesting on lake islands with dense vegetation. With this preference of lake islands, Lough Carra (although not that large) would seem to offer an ideal location for breeding Common Scoter, yet there is only one record of a pair who attempted to breed on one of the islands on the lake in 1969 but were unsuccessful (Sharrock 1980, Stronach 1981). Apart from the one breeding record Stronach mentions that they seldom visit the lake and from 1995-2006, there is only one record of a single bird from 8th December 2002.

Pintail (*Anas acuta*)

Similar in size to the Mallard (*Anas platyrhynchos p*) but slimmer and more elegant (Mullarney *et al.* 1999), the Pintail is a dabbling duck with the male of the species being particularly striking with elongated tail feathers and a chocolate brown head with a white curling stripe on each side. They are not an abundant species in Ireland and flock numbers do not reach the levels of many of our other wildfowl species. There are no records of Pintail on Lough Carra from 1995-2006 and Stronach (1981) comments that they were seldom seen during his counts although he does mention that Pintail were recorded once or twice a year.

Whooper Swan (*Cygnus cygnus*)

The Whooper Swan is a migratory species with the vast majority of birds which migrate into Ireland (usually in October) originating from the Icelandic breeding stock (Crowe *et al.* 2005) It is similar to the resident Mute Swan (*Cygnus olor*) in size but has a yellow bill with a black tip. There are seven records of Whooper Swan on Lough Carra from 1995-2006 of between 2 and 12 birds but more occur in the wetlands and turloughs to the east of the lake. Stronach (1981) notes that they are an infrequent visitor and only use the lake to rest before moving on.

Bewick's Swan (*Cygnus columbianus*)

This species of Swan is very similar to the Whooper Swan (*Cygnus cygnus*) but is smaller and has less yellow on the bill. It too is migratory and usually arrives into Ireland around the same time as the Whooper Swan. Crowe *et al.* (2005) note that wintering numbers have declined in Ireland in recent times and that the Bewick's Swan is limited to a few sites around the country apart from small numbers occasionally appearing amongst flocks of Whooper Swans. On Lough Carra there are no records for Bewick's Swan from 1995-2006 while Stronach (1981) mentions that although they were infrequent visitors, they did turn up on the lake a few times each year.

Greenland White-fronted Goose (*Anser albifrons flavirostris*)

The Greenland White-fronted Goose is a member of what has been termed the 'grey geese' family and the race that migrate almost exclusively to Ireland and southwest Scotland breeds in west Greenland. On Lough Carra Stronach (1981) had a theory that small flocks of White-fronted Geese infrequently stopped off on the larger islands on the lake while moving through on migration and that never more than 36 were recorded. There was one record from 8th November 2004 when the author counted 17 birds flying into Kilkeeran and they have been heard almost annually in the autumn calling on some evenings in this area by local people (Peter Roberts *pers. comm.*).

Greylag Goose (*Anser anser*)

This species of goose is another member of the grey geese family and is similar to the Greenland White-fronted Goose (*Anser albifrons flavirostris*) but is larger and lacks the white 'blaze' on the base of the bill (Mullarney *et al.* 1999). There are no records for Greylag Goose on Lough Carra from 1995-2006 yet Stronach (1981, p. 126) states that, "This goose visits the lake more frequently than the 'White-front' but usually in smaller numbers of 4 to 5". This pattern of infrequent but occasional visits to the lake by 'Greylags' has obviously changed since 1967-1980.

Smew (*Mergellus albellus*)

The Smew is a rare member of the sawbill duck family with the male displaying a striking black and white plumage. Smew are rare in Ireland with only a few records each year. There have been two records from Lough Carra from 1995-2006, one male was seen near Moorehall on 15th February 2003 (Chris and Lynda Huxley) while a female was seen by the author on 29th January in 2005 at Castleburke and later the same day a male was seen at Otter Point. No mention is made of any records from 1967-1980.

Green-winged Teal (*Anas crecca carolinensis*)

This species is the North American equivalent of the European Teal (*Anas crecca*) and is a rarity in Ireland. In January of 1969, Stronach *et al.* trapped and ringed a Green-winged Teal at Kilkeeran (Anon, 1978).

Black-necked Grebe (*Podiceps nigricollis*)

A rare member of the *Podicipedidae* occasionally recorded in Ireland. One was seen from the Doon Peninsula on 25th September 2005 (Chris and Lynda Huxley).

Chapter 4: Count Calibration Experiments

4.1 Introduction to Count Calibration Experiments

As mentioned in the previous chapter, the methodology used for counting waterfowl at Lough Carra since the work of Stronach *et al.* (1967-1980) has changed. Stronach and later the Forestry and Wildlife Service (now the National Parks & Wildlife Service) counted the lake by boat following a series of transect lines (see Map 3, p. 23). The counts under the Irish Wetland Bird Survey (I-WeBS) and counting for this study were land based with birds counted from 27 vantage points around the lake (see Map 4, p. 28). Since the main aim of this research was to gather data on the waterfowl populations on Lough Carra for comparative analysis against the older study (1967-1980), it was recognised that both count methods would need to be tested to ascertain if there were any differences in the resulting data sets from each. If the experiments highlighted a significant difference between the methodologies, then calibration would be needed to give a balance to the overall findings of the counting programme (1967-2006). With this in mind six count calibration experiments were conducted over 2005 and 2006 involving six counts by boat and six by land, to test both methodologies.

4.2 Methodology for Count Calibration Experiments

Due to the nature of these experiments, the principle methodologies governing them were already in place, that is, the counting of waterfowl from land and boat. However the timing of the counts was a key factor in making results comparable. Firstly it was clear that both counting methods could not be employed on the same day as the disturbance to birds on the water from the boat count would make the results from a land based count void. Therefore it was decided that the land based count would take place the day directly after or before the boat count provided that on both count days (land and boat) the weather conditions were the same. The weather played a vital role in the timing of the counts, firstly for either of the count methods, a day with strong wind and/or persistent rain would make counting too difficult. The wind makes the lake choppy and so counting birds on the water can be futile and going out in a boat during the winter in these conditions is unadvisable. The rain wets the lenses of the optics and causes binoculars and telescopes to fog up and reduces visibility. So days with little to no wind and rain were targeted, a little of either element made little difference as long as it was generally calm and dry. In addition it was important that the weather conditions during the day of the land count and the day of the boat count were mainly the same, as the elements can dictate the movements of birds within and in and out of the lake. Hard weather bird movements were noted by Stronach (1981) during his counts (1967-1980) and while large-scale movements are more likely to take place over the course of a few days of very cold weather, an overnight change resulting in a hard frost would certainly influence the movement of birds at dawn the following day. However, both days did not have to mirror each other exactly, for example if on one day the sky was overcast with a little rain and the next day it was more sunny with a light breeze, the difference it would have made to results were negligible, but in the main similar conditions were required. It was decided that if the weather changed dramatically during either count, then that count would be abandoned. The long-term weather forecast bulletins from Met Eireann were listened to and their website was consulted before attempting to set dates for counts.

For the boat based counts it was essential that the same methods used by Stronach *et al.* (1967-1980) were used in repetition. This meant that the exact same census transect lines that he laid out were followed with no deviation. As mentioned in the previous chapter, Stronach *et al.* always started their boat count at Flannelly's pier in the southeast basin and ended it near Castleburke in the northwest basin. Before the first official boat count, a trial run was conducted on 30th January 2005 to view the route and gauge how long it took to complete the transects. For the boat counts as part of the six experiments, the transect route was sometimes reversed with the count starting at Castleburke and ending at Flannelly's pier, this would have had no effect on results as the same route was followed. Also like Stronach *et al.* (1967-1980), in certain areas (namely the *Phragmites* reedbeds) handclapping was employed to flush waterfowl. For the land count, the methodology stayed the same with birds being counted from the 27 vantage points around the lake. All counts as part of the calibration experiment took place during the late autumn and winter months so as to include counts of those species that are only present on Lough Carra as winter migrants and also to avoid the occurrence of other boats on the lake during the experiments.

4.3 Results of the Count Calibration Experiments

From 19th February 2005 to 20th February 2006, a total of six boat counts were conducted on the lake with a land count taking place the day directly after on three occasions and the day before on three. While in the boat the author sat at the bow and counted birds with binoculars, writing the data into a waterproof notebook, while a second person drove the boat. Below are the dates when all six count calibration experiments were conducted.

Table 2. The dates on which boat and land counts were conducted on Lough Carra over 2005 & 2006 as part of six count calibration experiments.

Experiment No.	Date of Boat Counts	Date of Land Counts
1	**19th February 2005.**	**20th February 2005.**
2	**8th October 2005.**	**9th October 2005.**
3	**13th November 2005.**	**14th November 2005.**
4	**14th December 2005.**	**13th December 2005.**
5	**27th January 2006.**	**26th January 2006.**
6	**20th February 2006.**	**19th February 2006.**

During the land and boat counts all 15 species of waterfowl categorised as 'common' on Lough Carra (see Table 1, Chapter 3) were recorded. The data collected over the six experiments show that the calibration or the difference in numbers between the two methodologies for ten species was no greater than a mean of 8 birds. While for the remaining five species the mean difference in numbers counted between the two methods for each was higher, with a difference of 66 in Goldeneye (*Bucephala clangula*), 24 in Tufted Duck (*Aythya fuligula*), 22 in Pochard (*Aythya ferina*), 17 in Little Grebe (*Tachybaptus ruficollis*) and 17 in Cormorant (*Phalacrocorax carbo*). One of the key findings from the experiments was that from the nine duck species that Stronach *et al.* (1967-1980) recorded when counting by boat (see Table 3), there was only a significant difference between the two methods in the mean numbers for three species of diving duck namely Goldeneye, Tufted Duck and Pochard. The numbers for Pochard were based on the data from just two of the experiments as they were not present on the lake for the remaining four counts and so the sample was small and inconclusive for this species. However the singular fact that Pochard were not on the lake during the counts in February, October, November and December 2005, is in itself a reflection on the continued scarcity of this species in the last few years.

The fact that the biggest differences between the two count methods occurred in the numbers of Goldeneye and Tufted Duck, lent considerable weight to the hypothesis that double counting of the diving species while counting by boat is a considerable pitfall when employing this method (see discussion in Chapter 7 for more).

Of the genus *Anas* or the dabbling ducks, there were no significant differences in the numbers counted over the six experiments when comparing the two methodologies. Of the nine duck species recorded by Stronach *et al.* (1967-1980), five were from the dabbling family and these were Mallard (*Anas platyrhynchos p*), Teal (*Anas crecca*), Shoveler (*Anas clypeata*), Wigeon (*Anas penelope*) and Gadwall (*Anas strepera*); of particular concern are the first four species as all have declined to a varying degree since the older survey. To begin with, there was no difference in the mean number of Shoveler recorded with a figure of 5 birds counted using both methods, while for Wigeon the mean difference was just 1 bird, a miniscule statistic. For Teal, the difference was 3 birds and finally for Mallard the mean difference between the two methods was just 7 birds. Considering the scale of decline particularly in Mallard, Teal and Shoveler since the older survey (amounting to 100s of birds), these differences are particularly negligible. In relation to the fifth dabbling species, the Gadwall, there occurred a mean difference of 8 birds when comparing the two methods. However due to their preferred habitat of reedbeds (*Phragmites communis*) and emergent vegetation, some Gadwall may have been missed on the boat counts. This was evident because apart from one count on which none were recorded, on all the other five counts, there were always more Gadwall recorded from the shores of the lake.

In the case of the Little Grebe (*Tachybaptus ruficollis*), it was not surprising that the mean difference between the two methodologies was high (17 birds) and in favour of the land based method. The Little Grebe is particularly elusive and during land counts their numbers more than likely go under-recorded as a certain percentage of them are not easily visible amongst the reeds and emergent vegetation. The chances of under-recording during boat counts was greatly increased as the transects did not cover all the shallow bays and stretches of shoreline where they are often recorded on land counts. The land counts also produced higher numbers of Moorhen (*Gallinula chloropus*) and Coot (*Fulica atra*) partly for the same reason but the mean differences for these two species were far less, with figures of 4 and 5 respectively. In contrast the Cormorant (*Phalacrocorax carbo*), which could be described as a more open water species were recorded in greater numbers from the boat, with a mean difference of 17 birds separating the two methodologies. There was very little numerical difference between the land and boat based counts for the Great Crested Grebe (*Podiceps cristatus*) and as a result the average totals for this species came out equal with a mean of 7 birds.

For further analysis, using the mean number of birds recorded using each method the author applied a standard student's *t-test* (paired two sample for means) to compare the data over the six experiments. The *t-test* incorporates a 5% significance level ($p = 0.05$) meaning that if the difference in numbers counted between the two methods was at or under this level, for example 0.03, it would be significant. This in turn would highlight the need for calibration when comparing the count data from 1967-1980 to the data from 1995-2006. The *t-test* was chosen for the interpretation of results as it does not assume the variances in the data are equal and it is used when there is a natural pairing of observations (as with the boat/land counts). After application, the results from the *t-test* (using the one-tail analysis, see Tables 5-8), show that there was no significant difference in the total number of waterfowl counted using both methods. In both the case of the complete data set (15 waterfowl species) and the nine species recorded by Stronach *et al.* (1967-1980, see Table 3) the probability was calculated at 0.09 or a 9% level of significance. Another notable result was that when the *t-test* was applied to the mean counts for individual species (such as Mallard, Teal, Wigeon, Shoveler and Red-breasted Merganser) that have declined since the older survey, it showed that there was no significant difference in the numbers recorded between the land and boat methods.

	Experiment	**1**	**1**		**2**	**2**		**3**	**3**		**4**	**4**		**5**	**5**		**6**	**6**				
	Count Method	**Boat**	**Land**		**Boat**	**Land**		**Boat**	**Land**		**Boat**	**Land**		**Boat**	**Land**		**Boat**	**Land**		**BM**	**LM**	**MD**
1	**Mallard***	**45**	**65**		**14**	**19**		**54**	**46**		**43**	**32**		**64**	**18**		**39**	**34**		**43**	**36**	**7**
2	**Gadwall***	**17**	**26**		**21**	**24**		**0**	**0**		**0**	**8**		**0**	**7**		**2**	**24**		**6**	**14**	**8**
3	**Shoveler***	**0**	**0**		**3**	**0**		**0**	**0**		**12**	**10**		**2**	**6**		**13**	**16**		**5**	**5**	**0**
4	**Wigeon***	**43**	**61**		**3**	**5**		**40**	**30**		**23**	**52**		**39**	**23**		**86**	**60**		**39**	**38**	**1**
5	**Teal***	**19**	**38**		**0**	**0**		**0**	**0**		**26**	**38**		**40**	**26**		**28**	**25**		**18**	**21**	**3**
6	**Pochard***	**0**	**0**		**0**	**0**		**0**	**0**		**0**	**0**		**0**	**20**		**20**	**45**		**10**	**32**	**22**
7	**Tufted Duck***	**152**	**116**		**26**	**30**		**257**	**250**		**245**	**188**		**198**	**150**		**172**	**172**		**175**	**151**	**24**
8	**Goldeneye***	**140**	**93**		**0**	**0**		**92**	**46**		**157**	**74**		**226**	**59**		**141**	**92**		**126**	**60**	**66**
9	**Red-br Merg.***	**3**	**6**		**0**	**0**		**1**	**0**		**2**	**2**		**10**	**4**		**11**	**0**		**4**	**2**	**2**
10	**Little Grebe**	**0**	**4**		**5**	**28**		**3**	**22**		**0**	**19**		**1**	**8**		**0**	**30**		**1**	**18**	**17**
11	**Gr. C. Grebe**	**12**	**18**		**4**	**6**		**5**	**4**		**0**	**1**		**3**	**2**		**19**	**16**		**7**	**7**	**0**
12	**Moorhen**	**0**	**9**		**0**	**3**		**0**	**3**		**1**	**3**		**2**	**6**		**2**	**11**		**0.8**	**5**	**4.2**
13	**Coot**	**0**	**15**		**2**	**9**		**0**	**0**		**0**	**1**		**4**	**5**		**5**	**11**		**1**	**6**	**5**
14	**Cormorant**	**16**	**8**		**42**	**4**		**43**	**31**		**31**	**18**		**34**	**11**		**24**	**14**		**31**	**14**	**17**
15	**Mute Swan**	**6**	**14**		**7**	**9**		**19**	**12**		**9**	**5**		**21**	**16**		**13**	**22**		**12**	**13**	**1**
	Totals	**453**	**473**		**127**	**137**		**514**	**444**		**549**	**451**		**644**	**361**		**575**	**572**				

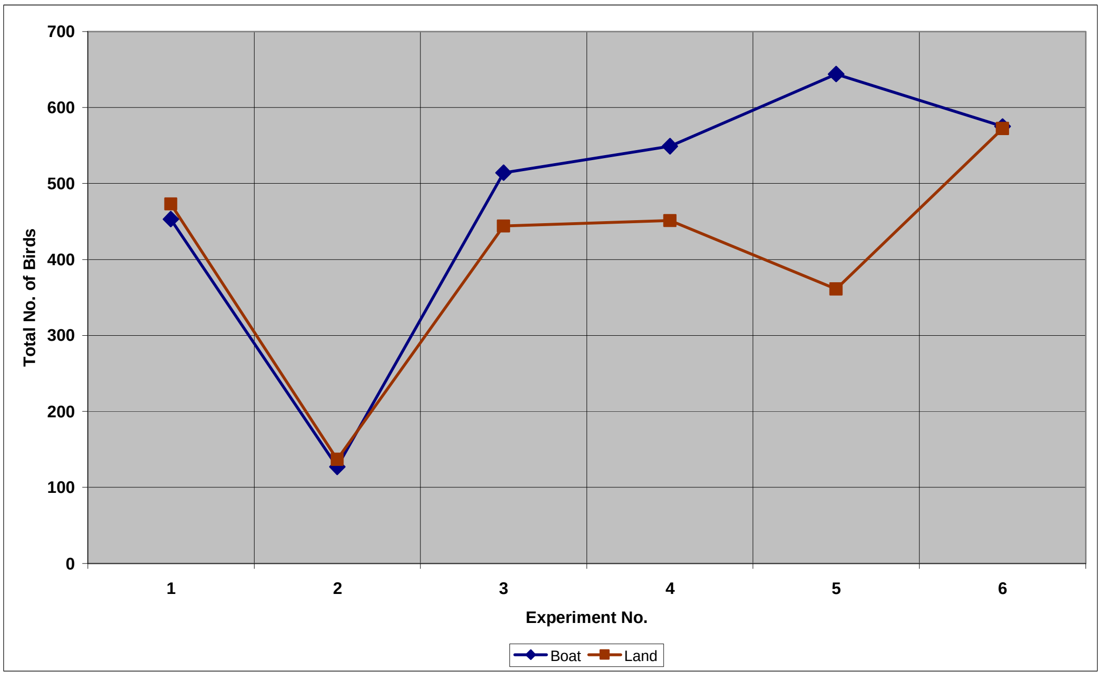
Table 3. The boat and land counts for 15 species of waterfowl recorded on Lough Carra from 19th February 2005 – 20th February 2006.

Notes: *Species recorded by Stronach et al. (1967-1980). **BM** = Boat Mean. **LM =** Land Mean. **MD** = Mean Difference.

Table 4. The land and boat totals for 15 waterfowl species recorded on Lough Carra as part of six count calibration experiments conducted from 19th February 2005 - 20th February 2006.

BOAT	LAND
453	473
127	137
514	444
549	451
644	361
575	572
Total: 2862	Total: 2438
Boat Mean: 477	Land Mean: 406.3

Figure 17. The land and boat totals for 15 waterfowl species recorded on Lough Carra as part of six count calibration experiments conducted from 19th February 2005 - 20th February 2006.



t-Test: Paired Two Sample for Means

Table 5. The overall comparison between boat and land counts for 15 species of waterfowl recorded on Lough Carra as part of six count calibration experiments conducted from 19th February 2005 - 20th February 2006.

	Boat	*Land*
Mean	477	406.33333
Variance	33424.4	21979.86667
Observations	6	6
Pearson Correlation	0.781717306	
Hypothesized Mean Difference	0	
Df	5	
T Stat**	1.516538984	
P(T<=t) one-tail*	0.094913474	
T Critical one-tail**	2.015049176	
P(T<=t) two-tail	0.189826949	
T Critical two-tail	2.570577635	

Note: ***Not significant using a one-tail *t-test* where p=0.05 (5% level of significance).
****For the means between the two methods to be significant, the calculated t-value (or t-stat) would have to exceed the critical t-value (t Critical one-tail).

Table 6. The overall comparison between boat and land counts for 9 species of waterfowl recorded on Lough Carra as part of six count calibration experiments conducted from 19th February 2005 - 20th February 2006.

	Boat	*Land*
Mean	421.5	351.3333
Variance	33332.3	21559.07
Observations	6	6
Pearson Correlation	0.791839	
Hypothesized Mean Difference	0	
Df	5	
T Stat**	1.541116	
P(T<=t) one-tail*	0.091961	
T Critical one-tail**	2.015049	
P(T<=t) two-tail	0.183922	
T Critical two-tail	2.570578	

Note: ***Not significant using a one-tail *t-test* where p=0.05 (5% level of significance).
****For the means between the two methods to be significant, the calculated t-value (or t-stat) would have to exceed the critical t-value (t Critical one-tail).

Table 7. The overall comparison between boat and land counts for Mallard (*Anas platyrhynchos p*) recorded on Lough Carra as part of six count calibration experiments conducted from 19th February 2005 - 20th February 2006.

	Boat	***Land***
Mean	**43.16667**	**35.66666667**
Variance	**284.5667**	**314.6666667**
Observations	**6**	**6**
Pearson Correlation	**0.781717306**	
Hypothesized Mean Difference	**0**	
Df	**5**	
t Stat**	**0.836177**	
P(T<=t) one-tail*	**0.220586**	
t Critical one-tail**	**2.015049**	
P(T<=t) two-tail	**0.441172**	
t Critical two-tail	**2.570578**	

Note: *****Not significant using a one-tail *t-test* where p=0.05 (5% level of significance).
******For the means between the two methods to be significant, the calculated t-value (or t-stat) would have to exceed the critical t-value (t Critical one-tail).

Table 8. The overall comparison between boat and land counts for Wigeon (*Anas penelope*) recorded on Lough Carra as part of six count calibration experiments conducted from 19th February 2005 - 20th February 2006.

	Boat	***Land***
Mean	**39**	**38.5**
Variance	**755.6**	**517.1**
Observations	**6**	**6**
Pearson Correlation	**0.666158352**	
Hypothesized Mean Difference	**0**	
Df	**5**	
T Stat**	**0.058394057**	
P(T<=t) one-tail*	**0.47784833**	
T Critical one-tail**	**2.015049176**	
P(T<=t) two-tail	**0.95569666**	
T Critical two-tail	**2.570577635**	

Note: *****Not significant using a one-tail *t-test* where p=0.05 (5% level of significance)
******For the means between the two methods to be significant, the calculated t-value (or t-stat) would have to exceed the critical t-value (t Critical one-tail).

Chapter 5: Breeding Surveys & Population Estimates

5.1 Introduction to the Island Breeding Surveys 1968 – 1975

An integral part of Stronach's research into Mallard (*Anas platyrhynchos p*) on Lough Carra, was the gathering of data on the local breeding population, as this would help in assessing overall population size, help in future management of stocks and contribute to the field of waterfowl research in Ireland which at the time was in its infancy. As Stronach (1981, p. 26) notes,

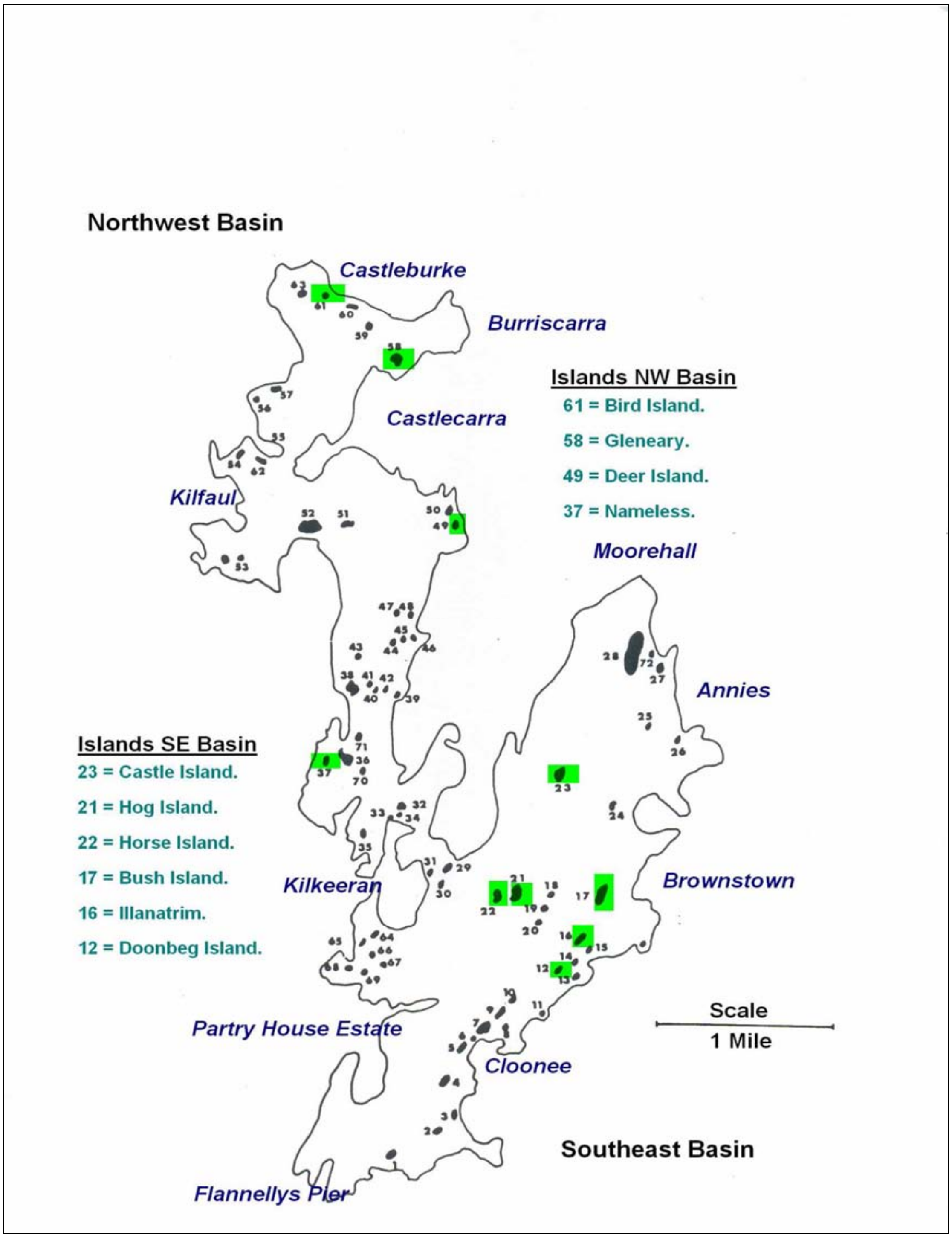
> In Europe the North American research workers have covered virtually all aspects of the breeding biology of the Mallard in considerable depth. In Ireland, however, no work has been done on breeding Mallard, and one might expect some differences due to climate and geographic position, though no quantitative data are available for comparison.

As mentioned in Chapter 2, Stronach *et al*. conducted their waterfowl counts once a week on the lake throughout the winter months and then fortnightly during the spring/summer period. This was done partly to facilitate fieldwork and redistribute manpower and equipment for the breeding survey which got underway from February each year from 1968 to1975.

5.1.1 Methodology 1968–1975

In the initial stages of the breeding survey, Stronach concluded that the nesting densities on the mainland (or areas surrounding Lough Carra) were too low to warrant inclusion in the overall survey and so he and his team of fieldworkers concentrated their efforts on the numerous islands on the lake. These islands number 73 in all and vary in size from 0.1 acres to 2.5 acres (Stronach, 1981). Stronach numbered and marked each one on a map of the lake which can be found in his final report (see Map 5). During the breeding season each island was visited once a fortnight and even those islands that held no nests were re-visited. The main aim of the breeding surveys was to count Mallard nests by flushing the female or hen. Mallard can nest in a number of different habitats depending on the area chosen as a breeding site. For example, the nest can be located on the ground under a bush, in a tree-hole, on a building (they have been recorded at heights of up to 10m, Ogilvie & Pearson, 1994) and they readily take to artificial nest sites such as nest baskets and platforms (Mullarney *et al.* 1999, Laubergs & Viksne 2004). In the case of the islands on Lough Carra, the available habitat was most suited to a ground nesting population and so Stronach used a methodology best suited to locating nests in this environment.

Map 5. The ten islands (highlighted) on Lough Carra surveyed for breeding waterfowl in 2005-2006.



On arrival on an island a team of three or four fieldworkers walked the long axis of the island working one or two dogs ahead of them. The dogs used were mainly Springer Spaniels (English Setters were also used later) which either flushed or caught nesting females in their soft mouths. By flushing the hens in this manner, nests were located and counted and birds caught by the dogs were ringed and case histories of ringed females developed (Stronach, 1981). This methodology is recognised by Bibby *et al*. (2000, p. 172),

> Some types of dogs (especially Pointers) are very good at finding birds nesting in dense (but short) vegetation. Using these dogs can be an efficient way to locate birds in a defined area and hence assess their populations. This method is typically used for gamebirds, but also works well for ducks and other larger ground-nesting species.

As well as counting nests and ringing females, Stronach *et al*. counted (and occasionally weighed and measured) the number of eggs in each nest and noted the nesting materials used. From these fortnightly visits the fate of each nest found could be determined and recorded, that is whether it was successful or unsuccessful. Using these methods Stronach could calculate local breeding numbers, nesting density and distribution, average clutch size, success rate and other biological data. In his final report (*An Ecological Study of Waterfowl on Lough Carra*, 1981), Stronach presents the success rate and nest densities from 1968 to 1973 for eight islands included in the breeding survey. He chose to present data for these islands only as they represented a good variation in habitat and size from the 73 included in the overall survey. It was also from the results of the breeding surveys that he came to his conclusions on the importance of stock management and the relationship between predation and nesting success, which he later tested through his predation experiments.

5.1.2 Methodology 2005 – 2006

From the outset of this study, it was clear that in order to calculate the current numbers of waterfowl and particularly Mallard (*Anas platyrhynchos p*) breeding on Lough Carra, a number of islands included in the 1968-1975 work would need to be re-surveyed. The new data on breeding populations, as with the waterfowl counts, were then used for comparison to the results from the older survey work carried out by Stronach *et al.* It was also recognised that a similar methodology to that used by Stronach *et al.* would have to be employed. The use of an identical methodology (searching for nests using dogs) was not an option as the required manpower and equipment was not at the author's disposal and so a more realistic but similar methodology recommended by Huxley (*pers. comm.*) and recognised by Bibby *et al*. (2000) was employed to carry out the research on current breeding populations.

On arrival on an island, the author carried out a thorough foot-search to flush nesting female ducks (Bibby *et al.* 2000) following a set pattern or route which covered the entire island. The pattern or route followed was laid out in accordance to the size and shape of the island in question so as to cover all likely nesting areas and was always used for that island throughout the surveys of 2005 and 2006. For example, on the larger islands such as Castle Island (2.1 acres), Horse Island (2.6 acres) and Hog Island (2.2 acres), the author firstly walked in a clockwise or anti-clockwise direction around the outskirts of the island and then walked in a zigzag pattern up through its middle or axis. For the smaller islands such as Doonbeg Island (0.15 acres), Bird Island (0.12 acres) and the unnamed island near Kilkeeran (Island 37, 0.15 acres), the author walked in a zigzag pattern up through the island; due to their size, walking the outskirts would have proved fruitless as any birds nesting in and towards the center of the island would have been flushed regardless. The use of the foot-search methodology to flush female Mallard (*Anas platyrhynchos p*) and count nests proved to be successful for this research as the searches took place in defined areas (on islands). On one occasion, a female Mallard was flushed from a nest on Doonbeg Island as the boat approached due to the sound from the engine but no further females were flushed in this manner during this study. In accordance with the older methodology, if a female was flushed from a nest, the nest location was marked, the habitat in which it was situated, clutch size and nest materials used were noted and the nest was re-visited to determine its fate (whether it was successful or unsuccessful). As used by

Reihmanis in his studies on waterfowl nest predators in Latvia, 1.5 meter canes were used to mark and re-locate nests and these were placed at least two meters away from the nests so as to decrease the potential of predators finding the nest using the canes as a marker (Hein 1996, from Reihmanis, 2004). Each nest found was assigned a unique nest code which was written in permanent marker on the side of the nest marker associated with it. For example, **C Is. A 05** was the code assigned to the first nest found on Castle Island during the 2005 breeding season while the second nest was marked **C Is. B O5** and so on. These were then used to build up the histories of each nest over the course of the breeding surveys.

Using the described methodology, the author surveyed ten islands on Lough Carra for nesting waterfowl during the breeding seasons of 2005 and 2006 (see Table 9 and Map 5). The decision of which of the 73 islands to survey were predetermined for eight as these were the only islands for which Stronach (1981) presented data in his final report. The additional two islands were added to the survey as it was felt that ten was the maximum amount that could be covered given the time-scale and resources of this study and they were also chosen for their geographical location on the lake itself. When possible the boat left from a location closest to the islands to be surveyed on that day. For example, for islands such as Castle, Horse and Hog, a boat from Moorehall was favoured while for islands in the northwest basin when available a boat from Castleburke was used. On the occasions when a boat was not available, the author went out on the lake and was dropped to certain islands by local anglers. From the island visits over the two breeding seasons, case histories of each of the ten islands were established and all relevant data associated with each can be found in the island accounts section in this chapter.

It should be noted that while searches were being made, the welfare of nests and nesting birds was always a priority. Searches were always conducted as quickly and efficiently as possible and the author always left islands immediately following a search. Eggs were rarely touched unless they were un-hatched as the objectives of this research did not warrant such an exercise and the down or other nesting materials were rarely disturbed unless the nesting cycle was completed. Local National Parks & Wildlife Service staff were notified of the extent and nature of the research before the fieldwork got underway. With this approach, the author is confident that the minimum amount of disturbance or stress was caused to nesting birds over the course of the breeding survey fieldwork.

In addition to the nest surveys conducted on the ten islands a record was kept of paired birds and brood numbers on the lake by observations made from the boat while travelling to and from the islands during the breeding season and also from the counts made by the author under the waterfowl counting programme because these counts also covered the spring/summer months. A number of field visits were also made to certain areas of the lake such as Moorehall and Kilkeeran during the breeding season to confirm the presence of a species or/and to count nests.

Table 9. Name, size and location of the ten islands on Lough Carra surveyed for nesting waterfowl 2005-2006.

NUMBER* & NAME OF ISLAND	SIZE (Acres)	LOCATION
Is. 12. Doonbeg Island.+	0.15	Southeast Basin.
Is. 16. Illanatrim.+	1.30	Southeast Basin.
Is. 17. Bush Island.+	2.30	Southeast Basin.
Is. 21. Hog Island.+	2.20	Southeast Basin.
Is. 22. Horse Island.+	2.60	Southeast Basin.
Is. 23. Castle Island.+	2.10	Southeast Basin.
Is. 58. Gleneary+.	1.50	Northwest Basin.
Is. 37. (No name on map).+	0.15	Northwest Basin.
Is. 49. Deer Island.++	0.17	Northwest Basin.
Is. 61. Bird Island.++	0.12	Northwest Basin.

Notes: *Numbers assigned to the islands on Lough Carra by Stronach.
+The eight islands from which the data from this study can be directly compared.
++The two additional islands surveyed by the author which Stronach also included in the older survey but for which he presented no data.

5.2 Interpreting Evidence of Nest Fate

Before and during the fieldwork for the breeding surveys of 2005 and 2006, a number of papers were consulted on the issue of how to determine in the field, whether a nest was successful or unsuccessful and the slightly more complex issue of predation. The main aim of the breeding surveys was to count the current number of nests (if any) on each of the ten islands but determining nest fate would ultimately help in developing hypotheses for recruitment levels and fluctuations in the overall populations of nesting waterfowl. Over the two breeding surveys a total of 15 nests were found and for this study and as used by Stronach (1981) and numerous waterfowl breeding studies worldwide (for example Opermanis *et al*. 2001), nest fate was determined by an examination of the nest itself, eggs and/or eggshells at the scene. After this examination a nest could fall within three basic categories, these were (1) Successful, (2) Predated (which Stronach termed 'robbed') and (3) Deserted (see Table 10). While evidence derived from the nest and eggshells to support all these categories can be adequate, there are instances when the evidence at a nest can be misread. For instance, if out of a clutch of ten eggs only eight hatch, the remaining eggs may be predated after the female and her ducklings have departed, resulting in evidence for partial success and partial predation. As used for similar studies in Canada (Sargeant *et al*. 1998), for this study, a nest was considered successful if one or more eggs hatched and this method resolved the issue of a nest that may be found with evidence of both success and predation.

For the category of 'predated', the evidence from an examination of eggshells and the nest itself can reveal much. A predated eggshell looks much different to a successfully hatched one and sometimes the nest itself can be disturbed, so to tell when a nest was predated was not an issue, however what was more complex was the actual identification of the predator. This identification problem did not affect the overall categorisation of a nest as being predated but to further develop hypotheses on population decline, it was an advantage to be able to identify nest predators. Another scenario that the author envisaged was the occurrence of a nest being deserted and then predated, for this study a nest was only categorised as 'deserted' when a nest was re-found intact holding a full clutch of cold eggs and no sign of the female, this was ample evidence to support desertion. When this occurred, the author returned at least twice to the deserted nest to ascertain whether predation of the deserted nest had occurred.

Table 10. Nest fate categories and evidence used to determine categories during the breeding surveys on ten islands on Lough Carra 2005-2006.

Nest Fate Category	Eggs	Other Evidence
Successful	**Eggshell(s) will have neat circular opening at the blunt end where the embryonic duckling has pecked a hole from which to exit the egg.**	**The egg lining or membrane can be found sometimes with bits of eggshell still attached.**
Predated	**Eggshells can have multiple holes or a large hole on one side. They can have chew marks, jagged pieces and be scattered beside and around the nest. If the egg was late into incubation when predated it can have a blood stained interior. Some eggs may be absent from the nest with the remaining ones displaying the evidence described above.**	**The nest may be destroyed or displaced with nesting materials pulled apart. Remains or partial remains (scattered feathers etc) of the female duck may be found beside the nest (mainly in the case of mink predation).**
Deserted	**The eggs will be intact in the nest but cold as the female has deserted the nest due to predator or human disturbance.**	**The nest will be intact and undisturbed.**

(From Sargeant *et al.* 1998 & Opermanis *et al.* 2001)

5.2.1 The Identification of Nest Predators

Even though nest predation has been extensively studied particularly in the United States, Canada and Eastern Europe, the identification of nest predators based on evidence found at nest sites has long been a contentious issue amongst those working in the field of waterfowl research. There are a number of pitfalls associated with identification, as Opermanis *et al.* (2001, p. 3) note,

> The difficulties in predator identification are linked to the high variability of evidence left by individuals of one predator species and close similarity to evidence left by individuals of different predator species.

A number of methods aimed at identifying predators of waterfowl nests have been used with varying degrees of success and despite being hailed as being too expensive and of limited use, many researchers still continue to employ them. These include time-lapse cameras placed at nest sites, hair-catchers and ceramic and wax-filled eggs (Opermanis *et al.* 2001). In an effort to standardise and improve methods of predator identification using the more traditional approach of examining predated eggshells and nest materials, fieldworkers at the Northern Prairie Wildlife Research Center in North America developed a field guide based on a system of recording evidence for later analysis. They state,

> Our examination of literature and our research suggest potential for error in interpreting evidence of depredation. We question the accuracy of identification of offending predators in most literature because of limited information available to investigators attempting to make determinations. Investigators not treating all principal predator species present in their study areas as potential depredators of nests, or investigators unaware of variations within or similarities among depredation patterns of certain predators , were likely to have made identification errors...Investigators interested in identifying predators of duck nests can use information provided herein as a field guide while examining evidence at nests.
>
> (Sargeant *et al.* 1998, p. 1).

For the purposes of this study, the author used methods of predated egg and nest analysis outlined by Sargeant *et al.* (1998) and guidance from Chris Huxley (*pers. comm.*) to determine as accurately as possible, the predators of nests on the islands of Lough Carra surveyed in 2005 and 2006. Implementing these methods involved the careful examination of predated eggshells for the types of damage and the location of openings and other clues for predator identification and other evidence at the scene which would assist in,

> ...ruling out certain predator species because of its uniqueness to 1 or a few species (e.g., cached eggs, dug area, dead hen, conspicuous yolk residue), or to substantiate other evidence (e.g. locations of eggshells, displacement of nest material).
>
> (Sargeant *et al.* 1998, p. 2).

When predated eggshells were found, the author took photographs or brought them away for further analysis. The photographs of predated eggshells found in the guide published by Sargeant *et al.* (1998, see Appendix A) were particularly useful in the identification of predators from damage to eggshells as was the additional information found in the guide.

5.3. Results of Island Breeding Surveys 2005 & 2006

Island Accounts

During the breeding surveys of 2005 and 2006, a detailed record was kept of each of the ten islands surveyed, what follows is an account of each island outlining its size, location on Lough Carra, nest statistics and other relevant information gathered during field visits. A table with nest numbers is presented at the end of each island account for those islands for which Stronach published data.

CASTLE ISLAND – ISLAND 23

SIZE: 2.1 Acres.

LOCATION: Southeast Basin.

NUMBER OF VISITS: 2005 = 5 / 2006 = 4.

DATES OF VISITS: 2005 = March 25th / April 2nd, 10th / May 15th / June 24th.
2006 = March 26th / April 23rd / May 16th / June 15th.

BRIEF HABITAT DESCRIPTION: Castle Island is predominantly covered in mature woodland, with species such as Ash (*Fraxinus excelsior*), Wych Elm (*Ulmus glabra*), Holly (*Ilex aquifolium*), Hawthorn (*Crataegus monogyna*) and Hazel (*Corylus avellana*). As with many of the larger islands on the lake, the bottom story consists of such species as Bramble (*Rubus fruticosus*), Wild Rose (*Rosa sherardii*) and Ivy (*Hedera helix*) which in many places grows in thick carpets on the ground and between the trees with Hogweed (*Heracleum sphondylium*) and Nettle (*Urtica dioica*) also present. Around the fringes of the island close to the waters edge in what Praeger, Neff (Anon, 1978) and Shackleton (1975) class as the *Schoenus* zone, such species as Black Bog Rush (*Schoenus nigricans*), Northern Bedstraw (*Galium boreale*), Butterworth (*Pinguicula vulgaris*) and Grass-of-Parnassus (*Parnassia palustris*) can be found. On the southern end of the island where the Moore monument is located, the mature woodland gives way to a more open area with smaller trees and shrubs and where above the *Schoenus* zone a mixture of grassland species grows including Purple Moor-Grass (*Molina caerulea*) and Quaking Grass (*Briza media*). Towards the north western side of the island stands the remains of the castle and associated rubble.

NUMBER OF NESTS FOUND: 2005 = 2 / 2006 = 1.

NESTING SPECIES: Mallard (*Anas platyrhynchos p).*

NEST DETAILS

NEST: CASTLE ISLAND A 05 – This nest was found on 2/4/05 during the dog search/foot search experiment (see Section 5.4). The dog flushed the female and the nest was then located. It was situated on the southern end of the island in Ivy growing on the ground between trees. The nest was lined with weeds, moss and down and contained a clutch of 15 eggs. Judging by the amount of down surrounding the clutch, it was probable that incubation was in the early stages (the amount of down in the nest increases as incubation advances (Stronach, 1981).

NEST FATE: Nest A was re-found on 10/4/05, the female was flushed and the nest and clutch were intact and the amount of down had increased slightly. On 15/5/05 the author re-found nest A to find it intact but empty. No eggshells were found in or immediately beside the nest but after a further search of the area, five predated eggshells were found on a mammal trail (most likely mink) roughly 20 feet to the southeast of the nest site. All had blood stained interiors supporting the hypothesis that embryo development was at an advanced stage (see Plates 19 & 20). Interpretation of evidence from predated eggshells points to a mink (*Mustela vison*) being the most likely predator. More evidence to support this theory was also found on the mammal trail: a small scattering of feathers lay near to the predated eggs, this could be the remains of the female and clutch from nest A.

NEST: CASTLE ISLAND B 05 – The dog passed by this nest on 2/4/05 and failed to find it but Ben Banes (dog owner/handler) flushed the female and the author located the nest. It was concealed in Black Bog Rush (*Schoenus nigricans*) roughly 10 feet to the southwest of Nest A. The lining consisted of mosses, grasses and down, this nest held a clutch of 12 eggs.

NEST FATE: Nest B was re-found on 10/4/05, it was predated with the nesting material pulled to one side and four out of the clutch of 12 eggs were found scattered near the nest. From interpretation of damage to the eggshells, it appears the predator of at least the four eggs found was avian and most likely Hooded Crow (*Corvus corone cornix*) with multiple holes in the eggshells.

NEST: CASTLE ISLAND A 06 – This nest was found on 26/3/06 after the female was flushed. It was situated near the south eastern tip of the island and in close proximity to the two nests found during the 2005 survey. The nest was concealed in Black Bog Rush (*Schoenus nigricans*) and was lined with rushes and down; it contained a clutch of 12 eggs.

NEST FATE: Nest A 06 was re-found on 23/4/06, the nest had been pulled apart possibly by a small mammal, most likely a mink (*Mustela vison*) or Brown Rat (*Rattus norvegicus*). After a thorough search of the area just two eggs out of the original clutch of 12 were found beside the nest. These two eggshells had puncture holes pointing towards an avian predator, most likely Hooded Crow (*Corvus corone cornix*). From the evidence found at the nest site, it is possible that this nest was predated by both avian and mammalian predators.

Table 11. Nest statistics for Castle Island from 1968-1973 and including 2005 & 2006.

Nest Fate	Successful	Predated	Deserted	Total
1968*	7	8	0	15
1969*	6	0	3	9
1970*	8	4	2	14
1971*	7	2	2	11
1972*	12	7	0	19
1973*	6	2	1	9
2005+	0	2	0	2
2006+	0	1	0	1

Notes: ***** Breeding surveys conducted by Stronach *et al.*

\+ Breeding surveys conducted by Meehan.

<u>HOG ISLAND – ISLAND 21</u>

SIZE: 2.2 Acres.

LOCATION: Southeast Basin.

NUMBER OF VISITS: 2005 = 4 / 2006 = 3.

DATES OF VISITS: 2005 = March 25th / April 10th / May 15th / June 28th.

2006 = March 26th / April 23rd / June 15th.

BRIEF HABITAT DESCRIPTION: Hog Island is heavily wooded with mature woodland, the top canopy consisting of such species as Ash (*Fraxinus excelsior*) and Wych Elm (*Ulmus glabra*) as well as smaller tree species such as Holly (*Ilex aquifolium*), Hazel (*Corylus avellana*) and Hawthorn (*Crataegus monogyna*). There are areas of the island where between the larger mature trees, the smaller species such as the Holly grow in thick clumps along with Bramble (*Rubus fruticous*), Wild Rose (*Rosa sherardii*), Hogweed (*Heracleum sphondylium*) and Nettle (*Urtica dioica*). Like so many of the other islands, where the trees open out, Ivy (*Hedera helix*) grows abundantly over the ground. On the fringes of the island and especially on its west side and its northern end, the *Schoenus* zone is dominated by Black Bog Rush (*Schoenus nigricans*). In places the dilapidated remains of stone walls or other structures can be seen.

NUMBER OF NESTS FOUND: 2005 = 3 / 2006 = 3.

NESTING SPECIES: Mallard (*Anas platyrhynchos p*).

<u>NEST DETAILS</u>

NEST: HOG ISLAND A 05 – This was the first nest to be found on Hog Island on 25/3/05, the female was flushed and the nest was located. It was situated on the northern end of the island at the base of a tree and was concealed very well in Ivy. The nest was lined with reed stalks, dead leaves and down and the clutch consisted of 12 eggs over which the hen defecated on being flushed.

NEST FATE: Nest A 05 was re-found on 10/4/05, it was clear on finding it that the female had deserted this nest as the eggs were intact and cold and there was no sign of any disturbance. This deserted nest remained intact when examined on during two further searches (15/5/05 and 28/6/05).

NEST: HOG ISLAND B 05 - The second nest found on 25/3/05 was situated on the eastern side of the island and was also concealed in Ivy but not as well as Nest A 05, it was not at the base of a tree and was far more visible. The nest lining consisted of grasses, leaves and down and the clutch consisted of 12 eggs.

NEST FATE: Nest B 05 was re-found on 10/4/05; although the nest was not very well concealed it was successful. Hatched eggshells with neat openings were found directly beside the nest and an egg lining or membrane was found in the nest itself (see Plates 15 & 16). Eight of the original clutch of 12 were found, the fate of the remaining four is unknown.

NEST: HOG ISLAND C 05 – The third nest to be found on 25/3/05 was situated more towards the centre of the island. It was well concealed in thick Ivy at the base of a partially up-rooted tree (see Plate 11). Unlike nests A and B, the female did not defecate upon being flushed. The lining was made up of grasses, reed stalks and more down than the other nests found, suggesting more advanced incubation. The clutch consisted of 14 eggs.

NEST FATE: Nest C 05 was re-found on 15/5/05 and was predated. Six of the clutch of 14 eggs were found scattered around and beside the nest. From interpretation of evidence after examination of the eggshells, the predator was most likely a mammal. The nest itself was not disturbed or displaced.

NEST: HOG ISLAND A 06 – The first of two nests found on 26/3/06, this nest was situated towards the middle of the island at the base of a tree and was well concealed in thick Ivy. Nest lining consisted of grasses, leaves and a little down and the clutch was of just eight eggs, suggesting that the hen was still laying.

NEST FATE: On 23/4/06 Nest A 06 was re-found and the clutch was covered with a great deal of down. When originally found on 26/3/06, it was thought that the hen was still laying as the clutch was of just eight eggs, however the clutch was not re-counted as this would have meant removing the down. The next visit to Nest A 06 on 15/6/06 revealed that this nest was successful with a hatched eggshell found beside the nest along with an egg membrane. No further eggshells were found and the nest was undisturbed.

NEST: HOG ISLAND B 06 - The second nest to be found on 26/3/06, it was situated on the east side of the island and was located by flushing the female. It was in a similar location to Nest A 06 at the base of a tree and covered by thick Ivy. Also similar lining as Nest A and with a clutch of nine eggs.

NEST FATE: Nest B 06 was re-found on 23/4/06 and all that remained of the clutch was one un-hatched egg and although a thorough search for more eggshells was carried out, none were found although searching was made difficult due to the height of the surrounding vegetation. However due to the large amount of down and the undisturbed state of the nest, it is believed that this nest was successful despite one egg not hatching, this is not an unknown occurrence in duck nests.

NEST: HOG ISLAND C 06 – With the discovery of this nest on 23/4/06, Hog Island has equalled its tally with last year of three nests. This nest was again concealed in Ivy but not at the base of a tree and was more open. It was lined with moss, grasses and down and the clutch numbered 12 eggs.

NEST FATE: The nest marker for Nest C 06 was re-found on 15/6/06 but the nest itself was not located. Two predated eggshells were found near the nest marker and were mostly likely from Nest C. From the interpretation of damage to these eggshells, the predator appears to have been avian. Although the nest or more eggshells were not located, this nest was recorded as predated.

Table 12. Nest statistics for Hog Island from 1968-1973 and including 2005 & 2006.

Nest Fate	Successful	Predated	Deserted	Total
1968*	6	8	0	14
1969*	6	1	0	7
1970*	2	3	0	5
1971*	9	0	0	9
1972*	14	5	0	19
1973*	13	0	5	18
2005+	1	1	1	3
2006+	2	1	0	3

Notes: * Breeding surveys conducted by Stronach *et al.*
+ Breeding surveys conducted by Meehan.

HORSE ISLAND – ISLAND 22

SIZE: 2.6 Acres.

LOCATION: Southeast Basin.

NUMBER OF VISITS: 2005 = 6 / 2006 = 4.

DATES OF VISITS: 2005 = March 19th, 31st / April 2nd, 10th / May 8th / June 24th.

2006 = March 26th / April 16th / May 5th / June 15th.

BRIEF HABITAT DESCRIPTION: Horse Island is the largest of the ten islands searched as part of the breeding surveys 2005 and 2006, it is also the site where Stronach *et al.* carried out habitat experiments in 1971 in an attempt to increase nest density and nest success (see Chapter 6). Before carrying out tree felling in the centre of the island, Stronach (1981, p. 90) described the habitat as,

> ...typical of other large islands in that it has mature woodland vegetation on the higher better drained soils and *Sesleria* and *Schoenus* zones on the lower less well-drained soils.... the woodland, which dominates the central higher proportion of the island is composed of large trees such as Ash (*Fraxinus excelsior*) and Elm (*Ulmus glabra*) in the centre, and smaller trees (Hazel, Blackthorn, Hawthorn, Holly, Spindle, Elder) present mainly in the ecotone round the woodland edge.

Circling the island there is a strip of mixed grasses and Black Bog Rush (*Schoenus nigricans*) but there is a very large open area dominated by Black Bog Rush with a few small trees on the northern end. Another smaller open area of grassland exists on the south western side of the island and at its edge, the mature woodland gives way to the smaller tree species that Stronach mentions above. Since the tree felling operation 35 years previously, ecological succession has once again taken place leading to the growth of trees in the centre of the island, but signs still remain where there are more open areas in the woodland where smaller trees such as Holly (*Ilex aquifolium*) and low woody species such as Bramble (*Rubus fruticosus*) and Wild Rose (*Rosa sherardii*) grow together to form a dense understory where the light reaches through the open canopy. As with the other larger islands (and particularly reminiscent of Hog Island and Castle Island), Ivy (*Hedera helix*) grows abundantly across the woodland floor between the trees.

NUMBER OF NESTS FOUND: 2005 = 1 / 2006 = 1.

NESTING SPECIES: Mallard (*Anas platyrhynchos p).*

NEST DETAILS

NEST: HORSE ISLAND A 05 – This nest was found on 31/3/05, it was situated towards the centre of the island where the more open areas of woodland are found. The nest itself was in Ivy but not very well concealed and the clutch consisted of 12 eggs (see Plate 13). The nest lining was made up of twigs, leaves and a good deal of down, it was also noted that these eggs were greener in colour than those found in previous nests.

NEST FATE: Nest A 05 was re-found on 10/4/05 when it was noted that there was more down covering it than when last examined on 31/3/05, and so incubation was advancing. The author did not disturb the covering of down to re-count the clutch. Nest A 05 was re-found again on the 8/5/05, the nest itself was intact but no eggshells were found. However it appears the female was taken by a mink (*Mustela vison*): her feathers and one wing were found within three feet of the nest. The eggs in the nest were most likely predated by the Mink and/or Hooded Crows (*Corvus corone cornix*).

NEST: HORSE ISLAND A 06 – Nest A 06 was found on 16/4/06 not far from the location of Nest A 05 from the previous season. The site for this nest differed from the other nests found throughout both the 2005 and 2006 surveys in that it was not directly on the ground but about three feet above ground level in the crook of a tree. Due to this location it took longer than usual to locate the nest after the female was flushed. The nest was lined with twigs, leaves, rushes and was not well concealed in the tree, it contained a clutch of ten eggs, which were covered with a good deal of down, suggesting incubation.

NEST FATE: Nest A 06 was re-found on 16/5/06, it was predated with four of the original clutch of ten eggs found scattered at the base of the tree where it was originally located. Judging from the damage to the eggshells, it appears that both mammalian and avian predators were responsible. It is possible that a mink (*Mustela vison*) first predated the nest and then Hooded Crows (*Corvus corone cornix*) predated the remaining eggs once the Mink had departed or vice versa. After a thorough search around the area, no other eggshells were found and the nest itself was still intact.

Table 13. Nest statistics for Horse Island from 1968-1973 and including 2005 & 2006.

Nest Fate	**Successful**	**Predated**	**Deserted**	**Total**
1968*	**8**	**14**	**2**	**24**
1969*	**9**	**1**	**0**	**10**
1970*	**3**	**0**	**4**	**7**
1971*	**2**	**1**	**1**	**4**
1972*	**4**	**1**	**1**	**6**
1973*	**2**	**0**	**2**	**4**
2005+	**0**	**1**	**0**	**1**
2006+	**0**	**1**	**0**	**1**

Notes: ***** Breeding surveys conducted by Stronach *et al.*

+ Breeding surveys conducted by Meehan.

<u>BUSH ISLAND – ISLAND 17.</u>

SIZE: 2.3 Acres.

LOCATION: Southeast Basin.

NUMBER OF VISITS: 2005 = 5 / 2006 = 3.

DATES OF VISITS: 2005 = March 25th / April 4th / May 24th / June 28th / August 10th.

2006 = April 11th / May 30th / June 28th.

BRIEF HABITAT DESCRIPTION: Bush Island is predominantly covered by mature woodland as found on the other large islands on the lake but also incorporates an open area of mixed grasses on its eastern side. This open area is reached by a grass track and is an indication of the effects of grazing on the islands both in the past and in this case the present. Cows still swim out and graze on Bush Island in the summertime as the fresh droppings and hoof marks along the trackway testify. On its southern end the island narrows before opening out again into a broad point which goes off into an easterly direction, where the island narrows the habitat is wetter and is dominated by Black Bog Rush (*Schoenus nigricans)* while on the point facing east small trees have grown where it is drier with a mixture of grassland species including Purple Moor-Grass (*Molina caerulea*). As with the other large islands, Bramble (*Rubus fruticosus*), Nettle (*Urtica dioica*) and Ivy (*Hedera helix*) grow in the understory of the mature woodland along with smaller tree species such as Holly (*Ilex aquifolium*) and Hazel (*Corylus avellana*).

NUMBER OF NESTS FOUND: 2005 = 3 / 2006 = 0.

NESTING SPECIES: Mallard (*Anas platyrhynchos p).*

<u>NEST DETAILS</u>

NEST: BUSH ISLAND A 05 – This nest was found on 24/5/05 on the eastern side of the island where the mature woodland gives way to smaller tree species. The nest was concealed in grasses between Hazel trees and was lined with reeds, mosses and down (small clutch being incubated), the clutch consisted of eight eggs (see Plate 12).

NEST FATE: Nest A 05 was re-found on 28/6/05 and was predated by an avian species, most likely Hooded Crow (*Corvus corone cornix*). Five eggshells were found beside the nest displaying multiple holes and one had one large hole in the side, the nest itself was undisturbed.

NEST: BUSH ISLAND B 05 – The female was flushed and the nest was located in much the same habitat as nest A 05, in grasses between small trees on 28/6/05. It had a similar lining to nest A and the clutch size was also the same – eight eggs.

NEST FATE: Nest B 05 was re-found on 10/8/05 and like nest A 05, it was predated by corvids, again most likely Hooded Crow (*Corvus corone cornix*). Six predated eggshells were found beside the nest and the nest was undisturbed.

NEST: BUSH ISLAND C 05 – This nest was found on 28/6/05 in the open area of mixed grasses on the eastern side of the island (see habitat description). The nest was not very well concealed and was easy to locate. It was lined with mainly grasses and down and the clutch consisted of nine eggs.

NEST FATE: Nest C 05 was deserted with nine eggs still intact within the nest. The eggs were cold and there was no sign of the female, the nest itself was undisturbed. The author did not get the opportunity to check this nest again to see whether the deserted clutch was later predated as this turned out to be the last visit to the islands as part of the 2005 survey.

Table 14. Nest statistics for Bush Island from 1968-1973 and including 2005 & 2006.

Nest Fate	Successful	Predated	Deserted	Total
1968*	**1**	**13**	**0**	**14**
1969*	**3**	**1**	**0**	**4**
1970*	**10**	**1**	**2**	**13**
1971*	**11**	**6**	**1**	**18**
1972*	**16**	**3**	**0**	**19**
1973*	**8**	**9**	**1**	**18**
2005+	**0**	**2**	**1**	**3**
2006+	**0**	**0**	**0**	**0**

Notes: ***** Breeding surveys conducted by Stronach *et al.*
+ Breeding surveys conducted by Meehan.

<u>ILLANATRIM – ISLAND 16</u>

SIZE: 1.3 Acres.

LOCATION: Southeast Basin.

NUMBER OF VISITS: 2005 = 4 / 2006 = 3.

DATES OF VISITS: 2005 = March 17th / April 29th / May 24th / June 28th.
2006 = April 11th / May 30th / June 28th.

BRIEF HABITAT DESCRIPTION: The northern end of Illanatrim is mainly dominated by larger more mature trees such as Ash (*Fraxinus excelsior*) and Birch (*Betula pubescens*) with Hazel (*Corylus avellana*), Goat Willow (*Salix caprea*) and Holly (*Ilex aquifolium*), much Bramble (*Rubus fruticosus*) and Nettle (*Urtica dioica*) are here also. Interestingly from nearly the middle of the island and on towards the southern end, the habitat becomes more open with smaller trees and one open area of mixed grasses associated with the *Sesleria* zone and reminiscent albeit in a smaller scale of the open area on its neighbour Bush Island. Here Hazel, Holly, and Hawthorn (*Crataegus monogyna*) dominate with low woody species such as Wild Rose (*Rosa sherardii*) and Bramble. Ivy grows on the ground but is less abundant than in the northern half of the island. Black Bog Rush (*Schoenus nigricans*) grows on the fringes of the island which like Bush Island is also strewn with small boulders

NUMBER OF NESTS FOUND: None**.**

Table 15. Nest statistics for Illanatrim from 1968-1973 and including 2005 & 2006.

Nest Fate	Successful	Predated	Deserted	Total
1968*	**5**	**6**	**0**	**11**
1969*	**4**	**0**	**0**	**4**
1970*	**6**	**1**	**0**	**7**
1971*	**4**	**5**	**0**	**9**
1972*	**9**	**0**	**3**	**12**
1973*	**5**	**6**	**2**	**13**
2005+	**0**	**0**	**0**	**0**
2006+	**0**	**0**	**0**	**0**

Notes: ***** Breeding surveys conducted by Stronach *et al.* + Breeding surveys conducted by Meehan.

<u>DOONBEG ISLAND – ISLAND 12</u>

SIZE: 0.15 Acres.

LOCATION: Southeast Basin.

NUMBER OF VISITS: 2005 = 4 / 2006 = 3.

DATES OF VISITS: 2005 = March 17th / April 29th / May 5th / June 28th.

2006 = April 16th / May 30th / June 28th.

BRIEF HABITAT DESCRIPTION: Doonbeg Island is among the smaller islands included in the breeding surveys. Stronach et al. developed a theory that Doonbeg produced the highest number of successful nests due to its habitat. As part of their island habitat experiment they mapped out the vegetation on Doonbeg Island and for comparitive purposes, the author re-mapped the island in 2006 (see Chapter 6). Doonbeg Island today is a mixture of small tree cover with Black Bog Rush (*Schoenus nigricans*) and grasses. There are four distinct clumps of small trees on the island, although there are some more mature species also such as Ash (*Fraxinus excelsior*), and one large Sycamore (*Acer pseudoplatanus*) is present on the northern edge. The smaller species in mixed clumps consist of Hawthorn (*Crataegus monogyna*), Buckthorn (*Rhamnus catharticus*), Goat Willow (*Salix caprea*), Elder (*Sambucus nigra*) and Holly (*Ilex aquifolium*). Guelder Rose (*Viburnum opulas*) is present on the edges of the small trees and Bramble (*Rubus fruticosus*) and Nettle (*Urtica dioica*) grow in some areas, Ivy (*Hedera helix*) grows over the older trees and spreads across the ground in the thickets of small trees. The rest of the island is mainly dominated by Black Bog Rush but includes grass species such as Purple Moor-Grass (*Molinia caerulea*) and *Carex* species such as Common Sedge (*Carex nigra*).

NUMBER OF NESTS FOUND: 2005 = 1 / 2006 = 0.

NESTING SPECIES: Mallard (*Anas platyrhynchos p*).

<u>NEST DETAILS</u>

NEST: DOONBEG ISLAND A 05 – On 17/3/05 while approaching the island by boat from the southern side, a female Mallard (*Anas platyrhynchos p*) flew from the southern end. On landing on the island the author located the nest under a small tree in Black Bog Rush (*Schoenus nigricans*) on the southern end. The nest was lined with grasses, reed stalks and down and the clutch consisted of 13 eggs.

NEST FATE: Nest A 05 was re-found on 29/4/05 and was successful, two hatched eggshells with neat openings were found beside the nest and in the nest were two egg membranes. On a later visit, three predated eggshells were found towards the northern end of the island, these were most likely brought from elsewhere to Doonbeg Island by Crows.

Table 16. Nest statistics for Doonbeg Island from 1968-1973 and including 2005 & 2006.

Nest Fate	Successful	Predated	Deserted	Total
1968*	**7**	**4**	**0**	**11**
1969*	**4**	**1**	**0**	**5**
1970*	**7**	**2**	**0**	**9**
1971*	**3**	**1**	**0**	**4**
1972*	**4**	**2**	**2**	**8**
1973*	**6**	**1**	**0**	**7**
2005+	**1**	**0**	**0**	**1**
2006+	**0**	**0**	**0**	**0**

Notes: * Breeding surveys conducted by Stronach *et al.*
+ Breeding surveys conducted by Meehan.

ISLAND 37 – (No name on map)

SIZE: 0.15 Acres.

LOCATION: Northwest Basin.

NUMBER OF VISITS: 2005 = 2 / 2006 = 2.

DATES OF VISITS: 2005 = March 19th / April 8th.

2006 = May 5th / June 23rd.

BRIEF HABITAT DESCRIPTION: This small island lies very close to the shores of Kilkeeran in the northwest basin. It is very overgrown with small trees and Bramble (*Rubus fruticosus*). The fringes of the island are dominated by Black Bog Rush (*Schoenus nigricans*) and this plant also grows extensively on its southern end where the tree cover gives way to a more open area. On the western side there is a dense stand of Common Reed (*Phragmites communis*); this is an indicator of how shallow the water is around this island. Particularly during the summer months, these shallow waters also made landing on the island difficult on occasion.

NUMBER OF NESTS FOUND: None.

Table 17. Nest statistics for Island 37 from 1968-1973 and including 2005 & 2006.

Nest Fate	Successful	Predated	Deserted	Total
1968*	4	2	0	6
1969*	0	1	0	1
1970*	0	0	0	0
1971*	4	0	0	4
1972*	5	3	1	9
1973*	0	8	1	9
2005+	0	0	0	0
2006+	0	0	0	0

Notes: * Breeding surveys conducted by Stronach *et al.*

\+ Breeding surveys conducted by Meehan.

<u>DEER ISLAND – ISLAND 49.</u>

SIZE: 0.17 Acres.

LOCATION: Northwest Basin.

NUMBER OF VISITS: 2005 = 4 / 2006 = 3.

DATES OF VISITS: 2005 = March 19^{th}, 31^{ST} / May 8^{th} / June 23^{rd}.
2006 = April 16^{th} / May 10^{th} / June 23^{rd}.

BRIEF HABITAT DESCRIPTION: Deer Island is situated close to the eastern shores of the northwest basin and towards the centre of the island are some large and impressive Oak trees (*Quercus spp*). The centre of the island is otherwise open with a mixture of grasses and Black Bog Rush (*Schoenus nigricans*), which also grows abundantly on the fringes of the island where the soils are wetter. At the northern and southern ends the vegetation becomes denser with small trees such as Hazel (*Corylus avellana*), Holly (*Ilex aquifolium*) and Buckthorn (*Rhamnus catharticus*). Ivy (*Hedera helix*) and other low woody species such as Bramble (*Rubus fruticosus*) are present among the small trees and scrub. The island is surrounded by large boulders, particularly on its northern point and western shore. Overall, Deer Island exhibits higher more well drained soils leading to a drier habitat suited to species of the *Sesleria* zone (Purple Moor-Grass, Sedges).

NUMBER OF NESTS FOUND: None.

<u>NOTE</u>

No nests were found on Deer Island during the breeding surveys of 2005 and 2006. Stronach (1981) did not publish nest statistics for this island and so no table with nest statistics is displayed for Deer Island.

<u>GLENEARY – ISLAND 58.</u>

SIZE: 1.5 Acres.

LOCATION: Northwest Basin.

NUMBER OF VISITS: 2005 = 4 / 2006 = 3.

DATES OF VISITS: 2005 = March 17th / April 8th / May 8th / June 23rd.

2006 = April 1st / May 10th / June 23rd.

BRIEF HABITAT DESCRIPTION: Gleneary is located close to the shores of Burriscarra in the northern end of the northwest basin. Mature deciduous species such as Ash (*Fraxinus excelsior*), Wych Elm (*Ulmus glabra*) and Sycamore (*Acer pseudoplatanus*) are present along with smaller species including Buckthorn (*Rhamnus catharticus*), Hawthorn (*Crataegus monogyna*), Holly (*Ilex aquifolium*) and Elder (*Sambucus nigra*). Ivy grows abundantly over the ground and between the trees along with Hogweed (*Heracleum sphondylium*) and Nettle (*Urtica dioica*). Bramble (*Rubus fruticosus*) grows abundantly and is very thick all over the central part of the island making foot-searches difficult. The northern and central parts of the island are particularly overgrown and dense with vegetation and fallen trees; towards the southern end, the cover becomes less dense and easier to walk through.

NUMBER OF NESTS FOUND: None.

Table 18. Nest statistics for Gleneary Island from 1968-1973 and including 2005 & 2006.

Nest Fate	Successful	Predated	Deserted	Total
1968*	1	9	0	10
1969*	2	2	0	4
1970*	4	0	1	5
1971*	3	1	0	4
1972*	5	0	2	7
1973*	8	0	1	9
2005+	0	0	0	0
2006+	0	0	0	0

Notes: ***** Breeding surveys conducted by Stronach *et al.*

+ Breeding surveys conducted by Meehan.

<u>BIRD ISLAND – ISLAND 61</u>

SIZE: 0.12 Acres.

LOCATION: Northwest Basin.

NUMBER OF VISITS: 2005 = 3 / 2006 = 3.

DATES OF VISITS: 2005 = March 17th / April 10th / June 23rd.

2006 = April 1st / May 10th / June 23rd.

BRIEF HABITAT DESCRIPTION: Bird Island lies just off Castleburke in the northern end of the northwest basin. The island is divided in two by a very narrow and shallow channel, these two parts are different in size and habitat. The portion of the island to the southwest is wider and very overgrown with small trees and Bramble (*Rubus fruticosus*) with a very narrow strip of Black Bog Rush (*Schoenus nigricans*) around its fringes. The portion of the island to the northeast is narrow with just a few small trees and Black Bog Rush (*Schoenus nigricans*) growing in the wet soil. This part of the island often gets partially submerged when water levels are high on the lake.

NUMBER OF NESTS FOUND: None.

<u>NOTE</u>

No nests were found on Bird Island during the breeding surveys of 2005 and 2006. Stronach (1981) did not publish nest statistics for this island and so no table with nest statistics is displayed for Bird Island.

Table 19. Nest totals for eight islands on Lough Carra with nest data from 1968-1973 and including 2005 & 2006.

YEAR	**Castle Is.**	**Horse Is.**	**Hog Is.**	**Bush Is.**	**Illanatrim**	**Doonbeg Is.**	**Island 37**	**Gleneary**	**Total**
1968*	**15**	**24**	**14**	**14**	**11**	**11**	**6**	**10**	**105**
1969*	**9**	**10**	**7**	**4**	**4**	**5**	**1**	**4**	**44**
1970*	**14**	**7**	**5**	**13**	**7**	**9**	**0**	**5**	**60**
1971*	**11**	**4**	**9**	**18**	**9**	**4**	**4**	**4**	**63**
1972*	**19**	**6**	**19**	**19**	**12**	**8**	**9**	**7**	**99**
1973*	**9**	**4**	**18**	**18**	**13**	**7**	**9**	**9**	**87**
2005+	**2**	**1**	**3**	**3**	**0**	**1**	**0**	**0**	**10**
2006+	**1**	**1**	**3**	**0**	**0**	**0**	**0**	**0**	**5**

Notes: ***** Breeding surveys conducted by Stronach *et al.*

+ Breeding surveys conducted by Meehan.

No nests were found on the remaining two islands surveyed in 2005 & 2006 (Deer Island and Bird Island) and Stronach (1981) published no nest statistics for these two islands.

Mallard (*Anas platyrhynchos p*) Nests, Nest Marker & Hatched Egg

Plate 11. Nest Hog Island C 05

Plate 12. Nest Bush Island A 05

Plate 13. Nest Horse Island A 05

Plate 14. Cane nest marker.

Plate 15. Egg Membrane from hatched egg.

Plate 16. Hatched egg.

Predated Mallard Eggs & Nest Before and After Predation

Plates 17 & 18. Eggshells after predation by an avian predator (most likely Hooded Crow).

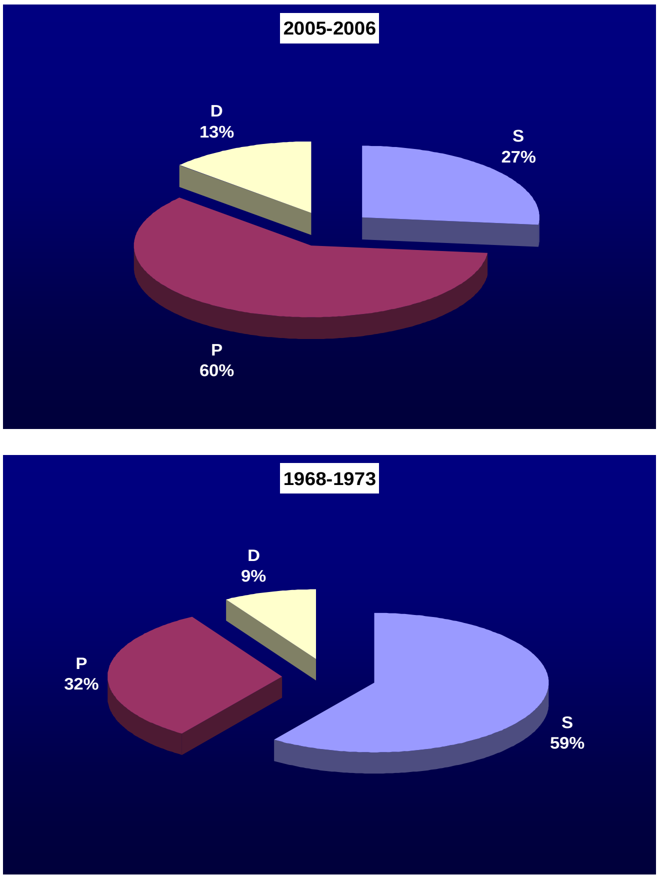
Plates 19 & 20. Eggshells after predation by a mammalian predator (most likely American Mink).

Plate 21 & 22. A nest before and after predation.

Summary of Nest Fate

Despite the fact that Stronach *et al.* found a far greater number of nests over the eight islands that were re-surveyed for this study and that the older survey was conducted over a greater number of years. It is worth highlighting the percentage of successful, predated and deserted nests from 1968-1973 and from 2005-2006. During the former period, Stronach *et al.* initiated a predator control experiment involving the culling of Hooded Crows (*Corvus corone cornix*) on the islands. The lowering of Hooded Crow numbers in turn led to a higher percentage of successful nests (Stronach, 1981). In contrast, the nests found in 2005-2006 were subject to predation from Hooded Crows and a new predator, the American Mink (*Mustela vison*). From the 15 Mallard (*Anas platyrhynchos p*) nests found on five islands out of ten surveyed during the breeding surveys conducted in 2005 and 2006, 9 (60%) nests were predated, 4 (27%) were successful and 2 (13%) were deserted. From 458 nests found on eight out of ten islands surveyed by Stronach *et al*. (1968-1973), 145 (32%) were predated, 273 (59%) were successful and 40 (9%) were deserted.

Figure 18. Percentage of successful, predated and deserted nests at Lough Carra 2005-2006 (100% = 15 nests) & 1968-1973 (100% = 458 nests).



Notes: S = Successful, P = Predated, D = Deserted.

5.4 Dog Search/Foot Search Experiment

As mentioned in Section 5.1.1 (Methodology 1968-1975), Stronach and his team found nests on the islands of Lough Carra by walking the long axis of the islands and flushing nesting females by working one or two Springer Spaniels ahead of them. The methodology used for this research involved searching the islands on foot and flushing the females from the nest, a similar and successful method for the purposes of this study but not identical to the older method. During the preparations for the breeding surveys for this study, a number of questions arose regarding the old and new methods, such as: would there be any difference in the numbers of nests found using both methods? Would there be any difference between the two methods in the time spent conducting the searches? If more nests were found using the dog method, was there a need for calibration to accurately assess current nest numbers? Through a personal contact, Chris Huxley arranged for a man and a Springer Spaniel to take part in an experiment to test both methodologies at the end of March–start of April 2005, this was at the height of the Mallard (*Anas platyrhynchos p*) breeding season.

5.4.1 Methodology

The author chose two large islands in the southeast basin of the lake that were similar in size and habitat and included in the 2005 and 2006 breeding surveys to carry out the experiment. To conduct it on the smaller islands (such as Doonbeg Island or Bird Island) would have been pointless as the area involved was too confined and small as to question the thoroughness of the foot search methodology. On 25th March 2005, the author searched Castle Island (Island 23–2.1 acres) and then on 31st March 2005 searched Horse Island (Island 22–2.6 acres) for nests by foot. On arrival at the island to be searched the author firstly walked the fringes of the island and then walked in a zigzag pattern up through the middle, this methodology was used for both these islands throughout the 2005 and 2006 breeding surveys. On April 2nd 2005, the author, Chris Huxley, Ben Baynes (Dog owner/handler) brought a Springer Spaniel to search firstly Castle Island and then Horse Island. On arrival on the island to be searched, the author and Ben Baynes walked the island working the dog ahead of them in accordance with the older methodology. The Springer Spaniel was a young dog but was well trained as a gun dog by Ben Baynes and she responded well to his commands.

5.4.2 Results

Foot Search of Castle Island

Date: 25/3/05.

Weather: Light easterly wind, overcast but with good spells of sunshine.

Methodology: The author disembarked from the boat on the east side of the island at 16.10 and walked the fringes/outskirts of the island first, in an anti-clockwise direction. Then proceeded to walk through the middle of the island in a zigzag pattern starting at the northern end and finishing at the southern end, the search ended at 17.05.

Duration of Search: 55 minutes.

Number of Nests Found: Nil.

Dog Search of Castle Island

Date: 2/4/05.

Weather: Light southwest wind, overcast with sunny spells.

Methodology: The author, Ben Baynes and the Springer Spaniel disembarked from the boat on the northern end of the island at 11.00. The dog was then worked down the western side of the island from the northern end to the southern end. As the dog worked, it went from side to side sniffing and tail wagging but never ran too far in any direction and obediently obeyed commands from Ben Banes. On reaching the southern end of the island, the author and Ben Baynes turned and worked the dog up the western side of the island from the southern end to the northern end and back to the boat, the search ended at 12.00.

Duration of Search: 1 hour.

Number of Nests Found: Two (One found by dog and one found by Ben Baynes/author).

Foot Search of Horse Island

Date: 31/3/05.

Weather: Light southeast wind but stronger later, overcast.

Methodology: The author disembarked from the boat at the northern end of the island at 11.10 and walked in a clockwise direction around the fringes/outskirts of the island and then walked in a zigzag pattern up through the middle starting at the northern end and finishing at the southern end, the search ended at 13.00.

Duration of Search: 1 hour 50 minutes.

Number of Nests Found: One.

<u>Dog Search of Horse Island</u>

Date: 2/4/05.

Weather: Light southwest wind, overcast with sunny spells.

Methodology: The author, Ben Baynes and the Springer Spaniel disembarked from the boat at the northern end of the island at 12.10 and firstly worked the dog down the eastern side of the island from the northern end to the southern end and then worked her up the western side, from north to south and back to the boat, the search ended at 12.55.

Duration of search: 45 minutes.

Number of Nests Found: Nil.

5.4.3 Discussion

This was a small but interesting experiment involving two similar but not identical methodologies which are still used in waterfowl research today. In terms of the number of nests found using both methods, the results were even. On Castle Island two nests were found but only one of these was located by the dog, the second was considered void as it was found neither by the author on the day of the foot search or by the dog, instead the female was flushed by the author and the dog handler during the dog search and so was not considered a find for either method. The nest that the author missed and the dog located on Castle Island, was situated on the southern end of the island just above the *Schoenus* zone concealed in Ivy (*Hedera helix*). Interestingly the nest that the Spaniel missed was just ten feet from the nest she found, but nevertheless, her skills were remarkable, for she picked up the scent of the female on the first nest from some distance and became more excited as she neared it (this is termed 'drawing'). Also when she flushed the female she nearly caught it and it is not hard to imagine how Stronach also used the dogs to catch the females in this fashion to ring them and build up case histories. On Horse Island, the author found one nest during the foot search on 31/3/05, this was located in Ivy (*Hedera helix*) towards the centre of the island. This meant the author knew where the nest was before the dog search of Horse Island on 2/4/05, it was when the dog was worked down the eastern side of the island in a zigzag pattern that she passed close to the nest and missed it. This meant that the author missed a nest on Castle Island that was found by the dog and the dog missed a nest on Horse Island that the author found. Despite the similarities and the balance in results in terms of nests found using both methods, there was one key difference between the two and that was the time it took to complete a thorough search.

The author found that for foot searches there were three factors that determined the speed in which a search was conducted, these were (1) The size of the island to be searched, (2) The vegetation on the island to be searched and (3) The number of nests found during the search. The first factor is self explanatory as the bigger the island the longer it takes to thoroughly search it. The second factor is in relation to the type and extent of the vegetation encountered during a search, for example, on some of the islands there are areas where the vegetation grows thick and high and so it can impede progress, this is especially relevant in late spring/early summer when the vegetation is at its peak in terms of growth. Getting through dense clumps of Brambles, thick stands of small bushes and shrubs and getting over or around fallen trees and so on, all takes up more time and makes the search less expeditious. The last and third factor concerning the number of nests found during a search also played a part in determining the length of a foot search for when a nest was found, the author took photographs, counted the eggs in the clutch, noted the nest lining and then placed a cane marker. This procedure, on average took between 5-10 minutes per nest and was done as quickly as possible as the author wanted to avoid keeping the female off the nest by staying on the island for too long. In addition, on return visits, the re-finding of nests to determine nest fate was made very difficult by high vegetation as the breeding season progressed, this factor again added time to searches.

The most nests to be found on any one island over the course of the breeding surveys was three and so while it was not always a factor, the recording of nests did add to the time spent searching certain islands. With the dog search methodology and from the results of this experiment it became clear that the first two factors had far less consequence on the time spent conducting a search. On both Horse Island and Castle Island the dog covered ground very quickly and efficiently, it also got through thick and obstructive vegetation quickly and set a fast pace, in this sense, the dog was doing most of the work while the dog handler shouted commands and he and the author followed. This speed and efficiency was the key difference that separated the two methodologies based on the findings of this experiment. On Castle Island, it took the author 55 minutes to conduct a foot search but if one deducts the amount of time spent recording nests (20 minutes) from the dog search, the latter took just 40 minutes. On Horse Island, the difference was even greater, with ten minutes deducted for the recording of the nest found by the author, the foot search here took 1 hour and 40 minutes while with the dog it took 45 minutes, an hour and five minutes faster. It also must be remembered that Stronach *et al.* searched the larger islands (like

Horse and Castle) with two dogs and so he notes that most searches took an average of 10-15 minutes (Stronach, 1981). However, with the sheer number of nests being found on the larger islands of the lake (up to 24) his calculations for the time spent on each island during searches seem underestimated. During their research as well as writing standard field notes, Stronach *et al*. measured and weighed eggs and in many cases when the dogs caught the nesting females, they ringed the hen and took wing measurements (and possibly weighed her in some cases). Although not all nests would have been found in a single day, even the discovery of more than one nest would have added to search times for the larger islands, as was found by the author when recording just the number of eggs and the nest lining.

Ideally, for this research the old methodology of searching the islands using Springer Spaniels would have been used but it was not financially possible to have a dog and handler available for the work. However, while a dog would have made searches easier and faster, foot searches were quite sufficient as the scale of the old research and the research for this study were vastly different. Stronach and his team had to visit 73 islands on the lake once a fortnight and even those that never held nests were always included and so the amount of ground they had to cover meant that the speed and efficiency of dog searches were vital. In contrast, for this study, the author visited ten islands of which four were under an acre. With the decrease in nest numbers from the time of the old survey, the author was not dealing with the same quantities and so less time was spent during searches recording and re-finding nests. From the results of this experiment and from experience gained through spending 24 days searching ten islands on Lough Carra over the 2005 and 2006 breeding seasons, the author believes that an extremely low percentage of nests could have gone unrecorded during survey work. While the foot searches took longer to conduct on the larger islands, it is believed that the use of the dog search methodology, while no doubt, faster would not have yielded a greater number of nests.

A Note on Clutch size and Initiation Dates for Mallard

Due to the longevity and scale of the breeding surveys at Lough Carra (1968-1975), Stronach *et al.* had a large amount of data relating to the breeding biology of the Mallard (*Anas platyrhynchos p*) to analyse and from which to calculate clutch size, nest initiation dates, nesting spread and nest density. The main aim of the breeding surveys for this study was to ascertain the current nest numbers on ten of the islands previously surveyed for comparative purposes. So, it should be remembered that while Stronach *et al.* made their calculations from a sample of 845 Mallard nests to determine clutch size and from 1,050 to calculate nest initiation dates from 73 islands, the same calculations for this study were made from 15 Mallard nests from ten islands surveyed. Nevertheless although 15 nests is a small sample to work with and while diverting from the main aim, the author believes that certain calculations can be made and certain similarities derived from the data published by Stronach (1981) and the data displayed here; this is particularly the case in the areas of clutch size and nest initiation.

5.5 Mallard Clutch Sizes

To determine the clutch size of Mallard (*Anas platyrhynchos p*), Stronach calculated the mean number of eggs found in the nests of 845 incubating females. A clutch could be included only if it was being incubated as otherwise the egg count would be inaccurate as the female would still be in the process of laying. Other nests that were not included were those that Stronach (1981) termed ‘dump’ nests, where two or more females had laid in the same nest but this was a rare occurrence. He noted that there was a decline in clutch sizes over the course of the breeding season, which is common in Mallard (*Anas platyrhynchos p*) and other species,

> There was a significant decline in clutch size over the breeding season. This is characteristic of the *Anatidae* and other families of birds...the mean clutch size for the first fortnight in March is 12.16, in the second fortnight it had decreased to 10.84 to 10.40 in the first fortnight in April, and so on down to 8.0 in the first fortnight in June.
>
> (Stronach, 1981, p. 41)

To determine the mean clutch size for this study, the mean number of eggs found in the nests of 13 incubating females was calculated, two nests were left out of the calculations as these were not deemed to be full clutches i.e. females still laying (see Table 20). The mean clutch size from Stronach's calculations was 9.7, while for this study it was 11.46 with a difference of 1.76. This higher average is not surprising as few nests were found towards the end of the season when clutch sizes would be smaller whereas Stronach *et al.* due to more coverage and a higher breeding population were finding nests towards the end of the breeding season when clutches were on average between six to ten eggs. As with this study, Lack (1968) also found the average was higher in his studies but as Stronach (1981, p. 41) notes,

> The mean clutch size in this study appeared to be in line with other European research findings. Kux (1963) had a mean of 9.45, Lack (1968) gave the average clutch size as 11. This last probably did not take into account the decline in clutch size over the breeding season.

While this study took into account the decline in clutch size over the breeding season, the higher average is a reflection of the proportionately lower number of nests found throughout the study overall and particularly the lower number found between the end of April and the start of June.

Table 20. Dates of discovery and clutch sizes for all Mallard (*Anas platyrhynchos p*) nests found over ten islands surveyed on Lough Carra 2005-2006.

No.	Dates That Nests Were Found	Clutch Size
1	17th March 2005	13
2	25th March 2005	12
3	25th March 2005	12
4	25th March 2005	14
5	26th March 2006	12
6	26th March 2006	8*
7	26th March 2006	9*
8	31st March 2005	12
9	02nd April 2005	15
10	02nd April 2005	12
11	16th April 2006	10
12	23rd April 2006	12
13	24th May 2005	8
14	28th June 2005	8
15	28th June 2005	9

Note: *Not full clutches.

The tables below highlight the decline in clutch sizes of Mallard (*Anas platyrhynchos p*) over the course of the breeding season at Lough Carra (see also Figure 19). Stronach's rate of decline is steadily downwards from a mean of 12.16 from the 1st fortnight in March to a mean of 8 in the 1st fortnight in June. Despite a higher average for the most part, the findings of this research in relation to the decline of clutch sizes over the breeding season are in line with the older study with a mean of 13 in from the 1st fortnight in March to a mean of 8.5 in the 2nd fortnight in June.

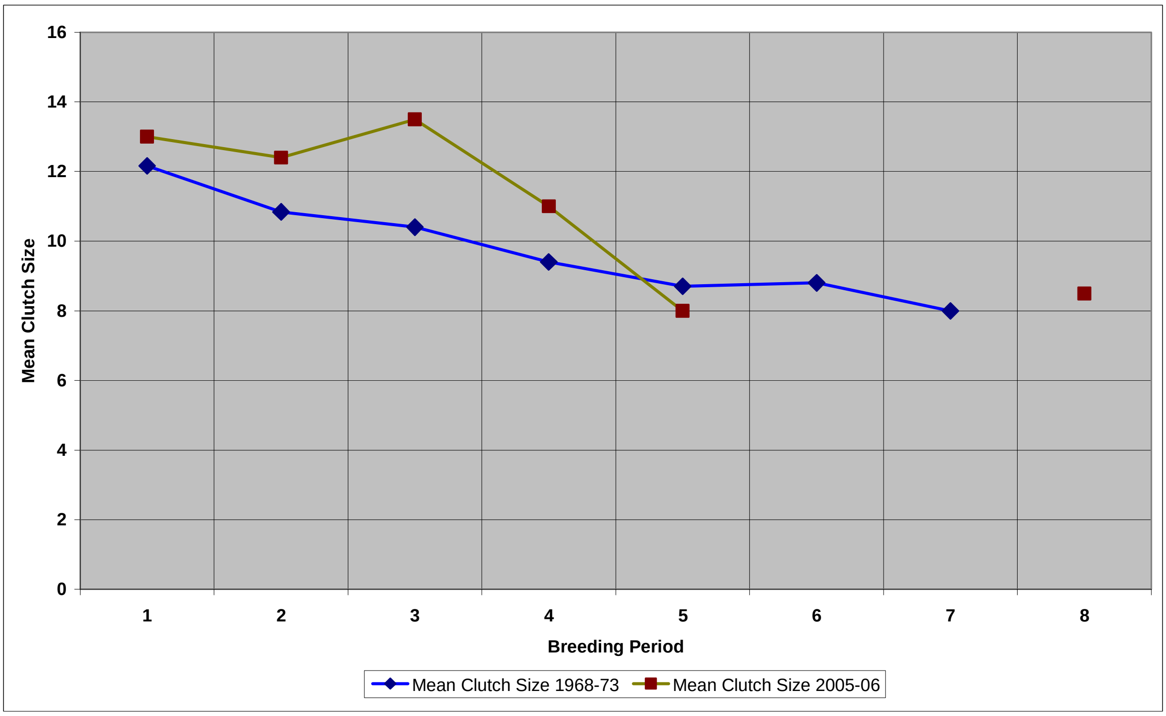
Table 21. The mean clutch size from 845 Mallard nests at Lough Carra 1968-1973 (from Stronach 1981, p .41).

Breeding Period	Mean Clutch Size
1st Fortnight in March	12.16
2nd Fortnight in March	10.84
1st Fortnight in April	10.40
2nd Fortnight in April	9.40
1st Fortnight in May	8.70
2nd Fortnight in May	8.80
1st Fortnight in June	8

Table 22. The mean clutch size from 13 Mallard nests at Lough Carra 2005-2006.

Breeding Period	Mean Clutch Size
1st Fortnight in March	13
2nd Fortnight in March	12.40
1st Fortnight in April	13.50
2nd Fortnight in April	11
1st Fortnight in May	8
2nd Fortnight in May	No Nests Found
1st Fortnight in June	No Nests Found
2nd Fortnight in June	8.5

Figure 19. The decline in the clutch sizes of Mallard (*Anas platyrhynchos p*) at Lough Carra 1968-1973 and 2005-2006.



Notes: The mean clutch sizes for 1968-1973 calculated from the nests of 845 incubating females.

The mean clutch sizes for 2005-2006 calculated from the nests of 13 incubating females.

During the surveys of 2005-2006, there were no nests found during the 2nd fortnight in May or the 1st fortnight in June.

1 = 1st fortnight in March.

2 = 2nd fortnight in March.

3 = 1st fortnight in April.

4 = 2nd fortnight in April.

5 = 1st fortnight in May.

6 = 2nd fortnight in May.

7 = 1st fortnight in June.

8 = 2nd fortnight in June.

5.6 Nest Initiation Dates for Mallard on Lough Carra

From research in the field of wildfowl breeding biology, it has not been confidently established that it is the female who selects the nest site and builds the nest but this is generally thought to be the case. With ground-nesting duck and as with the Mallard (*Anas platyrhynchos p*) nesting on the islands of Lough Carra, after choosing the nest site, the female will smooth out a hollow by pressing her chest on to the ground and slowly rotating, it is then that she will gather available materials by plucking them from around her and build the nest. The down used in the nest lining and to cover the eggs to keep them warm is plucked by the female from her belly, this results in bare patches on the belly which are then placed against the eggs during incubation (Ogilvie & Pearson, 1994).

The term 'nest initiation' does not refer to the start of this process but rather to the date that the first egg of the clutch is laid. If a nest is found when the first egg is laid or early on during the egg-laying process, the initiation date can be reasonably derived with accuracy. Also if a nest is visited regularly and the hatching date can be identified, it is possible to work out when the nest was initiated. For example, if a nest is found containing just one egg, that nest can be identified as being initiated that day while in the case of a nest that is found with for example eight eggs but not containing a full clutch under incubation (i.e. the female is still laying), the initiation date can be identified by deducting eight days from the date the nest was discovered because on average the female lays one egg per day. The average incubation period for Mallard (*Anas platyrhynchos p*) is estimated at 27 days (Ogilvie& Pearson 1994, Martin 1993) and so the initiation date for a hatched nest can be estimated by adding 27 + clutch size and deducting the total from the hatching date.

Stronach and his team of fieldworkers began visiting the 73 islands on Lough Carra from mid February which ensured they detected early nesters and because they then revisited the islands once a fortnight, they also found nests containing incomplete clutches and nests that had just hatched.

Between 1968 and 1973 from 1,251 nests examined, they could determine initiation dates for 1,050. From this considerable dataset, Stronach calculated that,

> Nest initiation in the first four years of this study started in the first week of March. In 1972 and 1973 when the weather in February was mild, nest initiation (first egg) started in the fourth week in February 1972 and the third week in February 1973. There was a steady increase in the number of nests initiated in March reaching a peak in the third week, in all but two years, 1969 and 1973. This was followed by a gradual decline in new nests, followed by a further peak caused by re-nests (birds that lost initial nests to predators) usually in April, though this varied from year to year. The bulk of the birds nest in a three week period, the 3rd and 4th weeks in March and the 1st week in April.
>
> (Stronach, 1981, p. 31).

For this study, the identification of nest initiation by finding nests that had one egg, incomplete clutches or clutches that had just hatched was lessened due to the small number of nests found, the small percentage of successful nests and the fact that due to manpower the islands were not visited once a fortnight. Out of the total of 15 nests found over the 2005-2006 surveys, just two were found where the female was still laying the clutch and so it was possible to calculate initiation dates by the method of deducting the number of eggs from the date of discovery for these nests. The amount of down in the nest and the number of eggs in the clutch were both used to identify clutches under incubation in the field and when found it was clear that the remaining 13 nests were all in the incubation stage of the breeding cycle. The amount of down in the nest increases as incubation progresses and so while it was difficult to determine exactly how many days incubation had progressed when the nest was discovered, it was possible to determine whether it was in the very early stages (very little down) or in the very late stages (a lot of down) (Stronach, 1981). From careful notes made on the amount of down from these 13 nests, it was concluded that the majority were roughly half way through incubation. So to estimate initiation dates for these nests, the author decided to halve the average incubation period, 26-27 days which makes 13 days, this was then added to the clutch size and the total deducted from the date of discovery to calculate the possible initiation date for each nest. From the total of 13 nests for which this method was used, three bore evidence to support its validity, one of these which was found on 25th March 2005, was subsequently found to be successfully hatched on 10th April 2005. This nest held a clutch of 12 eggs and so if this is added to the 13 days and the total (25) deducted from the date of discovery (25th March), it leaves a possible initiation date for this nest of 28th February 2005. To consolidate the theory that this nest was halfway through the incubation period (13 days), when the second half of the period is added (13 days) to the date of discovery (25th March), then the clutch in this nest would have a hatching date of 7th April and it was found hatched on 10th April. Below are two methods used to calculate nest initiation dates, the first is used when a nest is visited regularly and the date of hatching (or at least to within a few days) is known and the second was developed by the author for 13 nests based on the theory that these nests were halfway through incubation on the date of discovery. While not exact to the day, the second method provided initiation dates for those nests found during incubation for comparison to those dates given by Stronach for the older survey.

<u>Method 1</u>

Incubation period = 27 days + clutch size – hatching date = Initiation Date.

<u>Method 2</u>

Half of incubation period = 13 days + clutch size – date of discovery = Initiation Date.

After calculations it was determined that nest initiation for 2005 started in the 3rd week of February and in 2006 in the 1st week of March. In comparison Stronach (1981) found that for the first four years of his study (1968-1971) nest initiation started in the 1st week of March while in 1972 and 1973 when the weather was milder initiation started in the 4th and 3rd week in February respectively. In 2005 numbers of nests initiated reached a peak between the 4th week in February and the 1st week in March while in 2006 a peak occurred between the 3rd and 4th weeks in March. From these figures, it is clear that the birds began nesting earlier in the season in 2005 than in 2006. Taken together over the two breeding surveys nest initiation began in the 3rd week of February and increased reaching a peak in the 1st week of March, this was then followed by a gradual decline into the 4th week in March and a slight increase in the 1st week of June. Stronach found that the bulk of the birds nest in a three week period - the 3rd and 4th weeks in March and the 1st week in April; in 2005 and 2006 the bulk of the birds nested in a four week period over the four weeks of March. Overall, while the dataset was far smaller, the nest initiation dates for 2005-2006 are quite similar to Stronach's estimates with the end of February/beginning of March calculated as the period in which the first nests of the season are initiated. Of course these initiation dates and trends will vary from year to year and are triggered by weather conditions, predation and other natural factors.

The nesting spread or the entire period from the initiation of the first nests to the hatching of the last nests was calculated by Stronach (1981) as extending from the 3rd week in February to the end of July and if the time it takes the ducklings to reach the flying stage is added (eight weeks), the breeding season is from the 3rd week in February to the end of September. This study was in line with his findings with the earliest date for initiation being the 3rd week in February and if one adds the incubation period (27 days) to re-nests found on Bush Island in 2005, had they been successful, these would have hatched at the end of July and the ducklings would have reached flying age two months later.

5.6.1 Re-nesting

Studies have shown that the females of some duck species that have had their nests predated or lost, will re-nest and even nest again if the second nest is lost (Sowls 1955, Keith 1961 from Stronach 1981). To calculate the percentage of re-nesting birds from the overall breeding population on the islands of Lough Carra, Stronach employed two methods developed by Keith in his studies of waterfowl in Alberta, Canada. Stronach notes,

> Keith used the relationship of the number of pairs observed in the study area at the time of breeding with the number of successful nests. In the overall re-nesting he took an arbitrary date and assumed that the birds nesting before were first nests and those nesting after were re-nests.
>
> (Stronach, 1981, p .46).

Stronach mentions that Keith, in order to carry out his calculations of re-nests has to assume several different points that while appropriate for Alberta would not fit the study at Lough Carra. For example, he assumed that immigration and emigration cancelled each other out and he did not take into consideration that some of the birds treated as re-nesters were in fact late nesters. Apart from these points, on the whole, he recognised that Keith's methods would fit the needs of his own at Lough Carra and so to calculate the percentage of Mallards (*Anas platyrhynchos p*) re-nesting he studied (a) the relationship of pairs counted in mid-February to the number of successful nests and (b) overall re-nesting by using an arbitrary date, in this case 15th May. In 1968 using the first method, Stronach et al. recorded 112 successful nests and counted 152 pairs on the lake, this means that there were 1.9 nests per pair counted and from their calculations, 45% of the birds re-nested. In subsequent years, the percentage of re-nests decreased to between 10-35% but this was due to the predation control experiments being carried out at the lake which resulted in fewer nests being predated and henceforth lower re-nesting numbers. Using the second method, Stronach commented that he found it to be more accurate than the first although he notes that even when using the arbitrary date of 15th May (i.e. all nests found thereafter are recorded as re-nests), not all nests found in late May, were in his opinion, re-nests as some of these had clutches of 13 eggs. Therefore these nests that had large clutches but found after 15th May, were thought to be late first nesters. To apply the second method, Stronach calculated the mean data for seven islands included in his studies, these were Doonbeg, Illanatrim, Bush, Hog, Horse, Castle and Gleneary. He found that 58% of first time nesters on these islands were successful and that of the birds that re-nested, 69% of the first time re-nesters were successful and that 63% of the second time re-nesters were successful. In his calculations, he included nests found after the arbitrary date that he considered to be late first time nesters and these came to 13%. Of his findings, one of the most critical points was that 93% of the birds which lost their first nests subsequently re-nested and that re-nests were 12% more successful than first nests.

From the data collected over the course of this study (2006-2006), from 15 nests, just three were found late in the breeding season. These were all located on Bush Island (Island 17) and the dates of discovery and clutch sizes are as follows, 24th May–eight eggs / 28th June–eight eggs and 28th June–nine eggs. To employ the second method (setting 15th May as an arbitrary date) used by Keith (1961) and Stronach (1981), two of these nests were recorded as definite re-nesters as they were found on 28th June and initiated around 6th June, the only question regarding them is, were they first or second re-nests? Given the lateness of the season, it is very possible that they were in fact second re-nests. In the case of the nest found on 24th May, although found late in the month, the initiation date is thought to be 3rd May but while it was initiated before 15th May it was also treated as a re-nest due to the clutch size (eight eggs) which as recognised decreases from first-nesters to second-nesters. From all nests found on the islands throughout the breeding surveys of 2005 and 2006, just 20% were re-nests, this was a surprisingly small statistic considering the amount of predation taking place on the islands surveyed. In addition, all the re-nests found were on Bush Island which previously held no nests, while no re-nests were found on those islands where first nests had been predated. Although re-nesting was not recorded on the islands surveyed in 2006, it did take place on the lake as a whole with the majority of broods appearing throughout July for that year, ten out of a total of 16 broods were recorded in the three week period from the first week to the third week in July. Given the lateness of the season, these birds must have initiated nests in late May or early June.

Through his ringing studies during which he caught and re-caught certain females, Stronach suggested that there was not much movement of birds between islands during the breeding season and that birds usually re-nested on the same islands where their original nest was lost, yet as mentioned, no re-nests were found on those islands where nests were predated even though they were surveyed late into the breeding season. In contrast to Stronach's findings, the author believes that the three birds that re-nested on Bush Island, may have originally nested on another island nearby (possibly Hog) and moved to Bush Island to re-nest.

Note on Initiation Charts

On the following page Figures 20 and 21 display data relating to the initiation periods calculated for this study (Fig.20) and by Stronach (Fig. 21) for the older study. The scales on these two charts differ greatly as the amount of nests is far greater from the older survey and so these charts only represent the trends in nest initiation found from both studies for comparative purposes. The four weeks in every month from February to June are represented F1, F2, F3 etc on the *x* axis.

Figure 20. Initiation periods for 15 Mallard (*Anas platyrhynchos p*) nests from ten islands surveyed on Lough Carra 2005 & 2006.

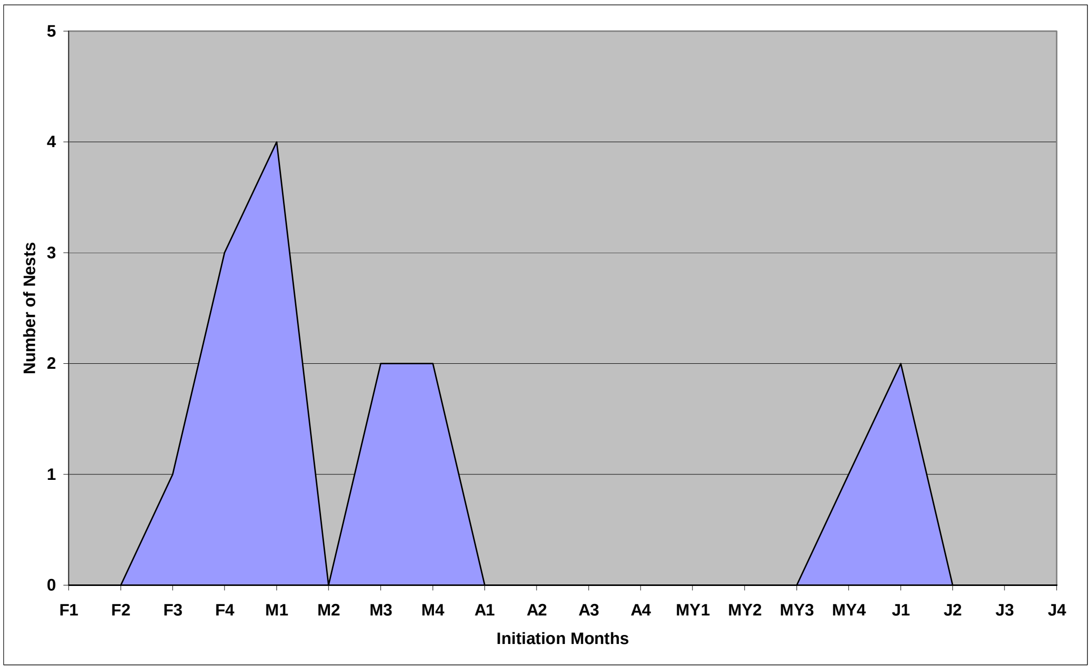
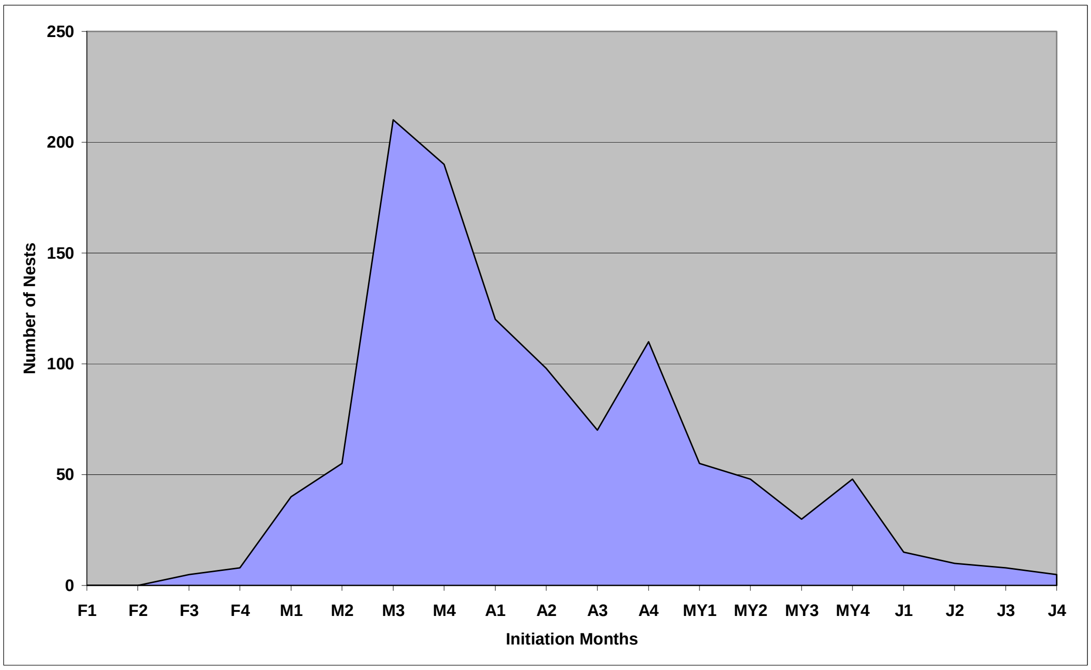


Figure 21. Initiation periods for 1,050 Mallard (*Anas platyrhynchos p*) nests from 73 islands surveyed on Lough Carra 1968-1973.



5.7 Potential Predators of Waterfowl Nests at Lough Carra

As fieldwork was being conducted on the ten islands on Lough Carra during the breeding seasons of 2005 and 2006, certain data were obtained both by chance and investigation on the presence and activities of predators to waterfowl and their nests, this was in addition to the evidence derived from predated Mallard (*Anas platyrhynchos p*) nests. These data were considered valuable in the assessment of the effects of predation on the birds nesting on the islands and on the overall breeding waterfowl population. In relation to the ten islands surveyed, during nest searches, the author came across evidence pointing to the presence of certain predators (droppings, dead birds, tracks) and some predators were seen on and around certain islands. Also, through local anglers and people who live close to the lake and spend time on it, sightings of predators were reported back to the author throughout the study. From this information and evidence gathered in the field, the most regularly recorded predators on the islands were the Hooded Crow (*Corvus corone cornix*) and the American Mink (*Mustela vison*). The Common or Brown Rat (*Rattus norvegicus*) was also present on the islands but evidence supporting its activities was harder to find and interpret. Rooks (*Corvus frugilegus*) nested on and were present on some of the islands while Ravens (*Corvus corax*) were recorded once on Hog Island.

These were not the only predators in and around the lake, but those for which the most evidence was recorded, the Hooded Crow and the American Mink, are individually dealt with in the following sections while a general synopsis of other potential predators follows. The individual accounts do not deal in depth with the habits and biology of the predator in question but rather present evidence for its presence on certain islands and in some areas of the lake. A complete discussion on these predators and their effects on the waterfowl populations on Lough Carra can be found in the final chapter.

5.7.1 American Mink (*Mustela vison*)

This slender semi-aquatic non-native member of the Weasel family (*Mustelidae*) is a carnivore and is regularly seen in and around the lake in both basins. During 2005 and 2006, mink were seen on two islands from the ten surveyed and there was evidence of their presence on all of the islands (see Table 23). Mink droppings which the author and Chris Huxley came across are very distinctive as they have a fish-like smell and often contain the parts of small mammals, fish, birds or other prey. Other evidence of their presence came in the form of the leftovers from their kills, these too are distinctive as the mink rips apart its prey and in the case of birds, will leave behind wings and/or legs and a scattering of feathers. A number of the islands had areas where the remains of birds such as Tufted Duck (*Aythya fuligula*), Mallard (*Anas platyrhynchos p*), Teal (*Anas crecca*) and Moorhen (*Gallinula chloropus*) were found (see Plate 24). The most commonly recorded piece of evidence for mink on all the islands was their trails or 'runs', where the animal has crossed over an island to move from one shore to another or has gone hunting in and around it (see Plate 23). This leaves a narrow but obvious trail of flattened grass and other vegetation which the mink probably re-uses when on the island. These trails were clearly mink runs as they were too small for Otter (*Lutra lutra*) and certainly not man-made due to the fact that most of the islands are unfrequented and their size and erratic route through the vegetation all pointed to mink. The mink trails were particularly easy to find and follow in the areas of the islands where there was Black Bog Rush (*Schoenus nigricans*) and mixed grasses, often the trail would wind in through thick clumps of these plants creating tunnel-like runs which would have been particularly advantageous for the animal when hunting. What follows is a short account outlining evidence of mink activity found on each island surveyed in 2005 and 2006.

<u>Bird Island</u>

On 23/3/05 a kill was found on the northern end of the island; from the remains (wing feathers), the prey was possibly a male Teal (*Anas crecca*). While loading the boat at the quay at Castleburke, a mink was observed swimming about 30 feet from the quay and it proceeded to swim to Bird Island where it left the water and walked in through the thick vegetation. Mink have been recorded at Castleburke at least twice before and two were previously trapped on Bird Island, while another was observed hunting juvenile Moorhens amongst the reedbeds.

Gleneary

Trails were noted on the southwest side of Gleneary on 17/3/05 and a half eaten trout was found on the same day on the northern end. A dead Cormorant (*Phalacrocorax carbo*) was also found on this island but the kill could not be assigned to mink.

Deer Island

Droppings were discovered on Deer Island on 19/3/05 but at the time it was thought they were possibly Otter (*Lutra lutra*). On 31/3/05 more were found and these were belonging to mink due to the distinctive fish-like smell, on dissection, fish scales and small mammal bones were found. Also on the southern end of the island there are a number of trails through the grasses.

Island 37

There are very obvious trails on this island near Kilkeeran and on 19/3/05 the author followed one particular one and came to a flattened area where a number of bird wings and legs were scattered. From the remains there were possibly three birds of which at least two were Tufted Duck (*Aythya fuligula*), also a predated Tufted Duck egg was found floating in the water near the island.

Horse Island

This island had much evidence of mink on it, particularly on its northern end where there is an open area of Black Bog Rush (*Schoenus nigricans*). Here there are numerous trails winding in and around small trees and boulders, here also a number of kills have been found including the remains of two Tufted Duck (*Aythya fuligula*). On the southern end the remains of a Coot (*Fulica atra*) and Common Gull (*Larus canus*) were found and Chris Huxley discovered droppings on the western shore.

Hog Island

Despite being its neighbour, Hog Island did not hold as much evidence for mink activity as Horse Island apart from trails through areas of Black Bog Rush (*Schoenus nigricans*) around its fringes and Northern end.

Castle Island

This is another island with plenty of evidence of mink activity; on 23/4/06 as the island was being approached by boat, a mink was seen standing on rocks on the eastern shore. It showed no fear as the boat neared and slowly made its way along the shore and down towards the north-eastern end of the island. The author examined this end of the island and found the wing of a Tufted Duck (*Aythya fuligula*) in amongst some large boulders, from here there were also trails which ran past the area where the Mallard (*Anas platyrhynchos p*) nested over the two seasons of 2005 and 2006. On 2/4/05 Chris Huxley found droppings on the north-western shore, trails were also found all over the island with the most obvious found through the Black Bog Rush (*Schoenus nigricans*).

Bush Island

Trails were noted in the more open grassy areas on Bush Island and through the Black Bog Rush (*Schoenus nigricans*); one of these trails runs close to where a Mallard (*Anas platyrhynchos p*) nested in 2005.

Illanatrim

Towards the northeast end of Illanatrim there is a narrow strip of Black Bog Rush (*Schoenus nigricans*) and some grasses and through this were very clear mink trails where the animal had gone from one shore to the other (east to west or vice versa).

Doonbeg Island

This small island had trails running across it and these were obvious through the more grassy areas; in the centre of the island a small scattering of primary feathers were found on 16/4/06. From the colouration, the feathers may have been from a female Mallard (*Anas platyrhynchos p*) that was killed by a mink but this was not confirmed.

Table 23. Evidence for the presence of American Mink (*Mustela vison*) on ten islands on Lough Carra surveyed in 2005 & 2006.

Island Name	Seen on Island	Kills Found	Droppings	Trails
Bird Is.	**X**	**X**		**X**
Gleneary Is.		**X**		**X**
Deer Is.			**X**	**X**
Island 37.		**X**		**X**
Horse Is.		**X**	**X**	**X**
Hog Is.				**X**
Castle Is.	**X**	**X**	**X**	**X**
Bush Is.				**X**
Illanatrim.	**X**			**X**
Doonbeg Is.			**X**	**X**

Plates 23 & 24. A mink trail through the *Sesleria* zone and a Mallard wing after mink predation, both from islands on Lough Carra in 2005.

5.7.2 Hooded Crow (*Corvus corone cornix*)

The grey and black plumage of this member of the *Corvidae* has led to it also being named the ‘grey crow’ in many parts of the country. It is not a very popular species in the countryside, especially with farmers who under licence cull a certain number of Hooded Crows every year. As with many places this species is widespread and no less so around Lough Carra and they were encountered in most places during counts. They are opportunistic feeders and scavengers who are responsible for much of the nest predation on the islands on Lough Carra. In terms of the islands, it could not be said that they were exclusive to any particular one or group but they were seen more regularly on certain ones. During the fieldwork over the breeding seasons of 2005 and 2006, they were never seen in large numbers although this was partly due to the fact they had themselves paired off to breed. From the ten islands surveyed, they were found breeding on two – Illanatrim and Castle Island. On Illanatrim there were no nests in 2005 but there were two in 2006 on the east side of the island while on Castle Island, one nest was found. During the older survey (1968-1975) Stronach noted (1981) that the highest count of Hooded Crows in the study area was 37 but after they had carried out a predator control experiment involving the poisoning of the crows using Alpha Chloralose, the average count was 2-4. He also mentions that over the 73 islands they found ten Hooded Crow nests but again the breeding population dropped in numbers after the predation experiment.

It is impossible to say with accuracy what the current numbers of Hooded Crows are on the islands without carrying out a proper survey but they were recorded on or around all the islands surveyed during 2005 and 2006. Even if the same birds were recorded on different islands during different days they are still retaining enough of a presence to predate nests on at least five of the islands in the southeast basin where nests were found. When a predated nest was assigned to an avian species, it was a reasonable assumption to assign predation to Hooded Crows as they were the most frequently recorded and in many cases the only recorded crow species on the ten islands surveyed. Stronach (1981) also identifies Hooded Crows as the predator in the majority of nests predated by another bird species and the increase in successful Mallard (*Anas platyrhynchos p*) nests after the culling of their numbers is proof of their prevalence in the practice of nest predation. Stronach assigned some predation to Magpies (*Pica pica*) but in contrast, not one Magpie was recorded on the islands during the surveys for this study. On occasion, individual predated Mallard eggshells were found in isolation on some of the islands, these individual eggs may have been transported by Hooded Crows/avian predators from the mainland out to the islands to be eaten. Those predated eggs found in isolation and which were identified as being taken by an avian predator are used as additional evidence for the presence of Hooded Crows on the islands in question.

In Table 24, the evidence for the presence of the Hooded Crow on ten islands is presented. The category labelled 'seen' refers to islands where Hooded Crows have been seen in numbers of one or more, 'breeding' refers to those islands that held one or more Hooded Crow nests in 2005-2006 and 'predated eggshell' is assigned to those islands where an individual Mallard (*Anas platyrhynchos p*) eggshell or eggshells have been found in isolation and the predator has been avian.

Table 24. Evidence for the presence of Hooded Crows (*Corvus corone cornix*) on ten islands on Lough Carra surveyed in 2005 & 2006.

Island Name	Seen	Breeding	Predated Eggshell
Bird Is.	X		
Gleneary Is.	X		
Deer Is.	X		X
Island 37.	X		
Horse Is.	X		
Hog Is.	X		X
Castle Is.	X	X	X
Bush Is.	X		
Illanatrim	X	X	X
Doonbeg Is.	X		X

5.7.3 Other Potential Predators

While the Hooded Crow and American Mink were identified as the main predators of ducks and their nests on the islands surveyed based on the evidence presented here, there are other potential predators that should also be mentioned. One of these is the Common/Brown Rat (*Rattus norvegicus*), the presence of this species was noted by Stronach (1981) who observed that over the course of his studies on the islands and as Hooded Crows were being culled, nests were then predated more by rats, this is known as predator substitution,

> ...substitution appeared in the form of an eruption of resident rats on the large islands. In the spring of 1969 a rat poison, Warfarin, was placed in pipes so that the ducks could not get at it. Rats were picked up dead, but the effectiveness of the control was not measured as it was difficult to find the dead rats in the cover...In 1972 and 1973 rats again increased on the large islands. It was difficult to assign nest destruction to rats because rats often eat the shells after the crows have fed on the egg contents.
>
> (Stronach 1981, p. 104).

Like Stronach, the author found it difficult to assign nest predation to rats on the five islands where nests were predated during the 2005 and 2006 surveys, it is possible that when nests were found to be predated by crows that rats ate the shells of those eggs that were unaccounted for. Stronach does mention that when predated nests were found and the predator was not avian, evidence pointed to rats being the culprits as the nest linings were upset and strewn around. There were two cases of this both on Castle Island where the linings in predated nests were disturbed and partially pulled apart, the first was in 2005 and predation was assigned to an avian predator and the second was in 2006 when there was evidence for both avian and mammalian predation. In both cases not all the eggs from the original clutches were found and rats may have been involved in the predation of these nests after the original predator had departed. Some of the local anglers, who regularly land on Castle Island during a day out on the lake, mentioned that they have seen rats on this island. Apart from possible rat activity on Castle Island based on evidence from predated nests and these sightings from anglers, the only other island that held evidence for rat activity was Hog Island, where on 15th May the author saw a rat running through the middle of the island. Another complication in assigning predation to rats during the 2005-2006 surveys, was the possibility that nest linings may have been disturbed or pulled apart by American Mink (*Mustela vison*). Sargeant *et al.* (1998) during their studies of nest predation in Canada, found that from 31 nests predated by American Mink, a certain degree of nest material displacement occurred in 36% of the nests examined. However they do not give the types of material/lining displacement in nests predated by rats and so comparisons of mink and rat destruction could not be made. In addition, from the nests found predated during this study, just two had nest materials displaced and this was too small a sample from which to make assessments pertaining to the assignment of certain types of destruction to a particular predator species. In comparison, Stronach had a considerably larger sample to work with but at the time of his study, the American Mink was not yet a predator at Lough Carra.

In the literature collated on predation and field guides on mammals, the author did not come across any reference connecting the Otter (*Lutra lutra*) to waterfowl nest predation. However they are known to take water birds as part of their diet (Hoffman, 2001) and so while they may not predate nests (or at least certainly not with frequency), they will take adult duck/ducklings in the water, typically attacking them from below. Local opinion suggests that Otters were a common sight on the lake in years gone by and Stronach (1981) also mentions that there were several families in the study area. However, during the many days spent on Lough Carra during the winter conducting boat counts, in the summer visiting the islands and all year round counting from the shores of the lake during this research, none were ever seen. On Deer Island, the habitat would look to be favourable for them and droppings that may have been from an Otter were found there but apart from this and a record of just one sighting in 2006 (by a local man) in the southeast basin, this is the only evidence for Otters found at Lough Carra during this study. The tracks from this mammal are very distinctive and familiar to the author, yet no tracks were found on any of the islands or on the shoreline. Huxley (2003) who recorded mammals at Lough Carra as part of his research into the ecology of the lake, also notes that Otters seemed to have declined in numbers and are only seen infrequently in recent years. Without research, while this evidence based on a lack of sightings can be taken as an indicator of a decline in the local population, the levels of this decline are not known.

In addition to the Hooded Crow (*Corvus corone cornix*), there were two more members of the *Corvidae* recorded on the islands during the breeding surveys, these were the Rook (*Corvus frugilegus*) and the Raven (*Corvus corax*). Rooks were only seen on two of the ten islands surveyed, namely Gleneary (up to five seen) and Hog Island (two seen) but their populations have the potential to grow and become more established on Gleneary as there is a small Rookery on the southern end of the island. Here the author counted five nests in 2005 and this had increased to seven nests in 2006, while on Hog Island a pair were seen on 25th March 2005 obviously holding territory and attempting to breed, a second Rookery may become established here also. If this were the case, there would be Rookeries in both the southeast and northwest basins, not a desirable situation in terms of waterfowl breeding success and recruitment. On 15th May 2005, two Ravens were seen in the canopy of some large trees on Hog Island but this was the only record of this species on the islands during 2005-2006, it is possible that these were from Castleburke where they are known to breed in the old towerhouse near the quay, or possibly from another nest site somewhere on the mainland. Of the other members of the *Corvidae*, the Jackdaw (*Corvus monedula*) and Jay (*Garrulus glandarius*) are all present around the lake but during 2005-2006 were never seen or heard on the islands. Huxley (2006) points out that the damage to eggshells predated by Magpies (*Pica pica*) can be similar to that inflicted by Hooded Crows. Therefore, it would be unwise to completely rule out their involvement in Mallard nest predation on the islands but as mentioned they were not recorded on the islands surveyed for this study. As with the other potential predators, this does not mean that they would not visit the islands to predate nests but if this was a regular occurrence, it would stand to reason that they would have been seen more frequently. Stronach (1981) mentions that during the predator control experiment at Lough Carra, both Rooks and Ravens were found dead after the placing of poisoned eggs on the islands but he believed that the main predator was still the Hooded Crow (*Corvus corone cornix*).

Of the gull family (*Laridae*), there are five species present on the lake and of these the Black-headed Gull (*Larus ridibundus*) and Common Gull (*Larus canus*) have the highest populations. From a census in 2003, Huxley (2003) estimated that around 100 pairs of Black-headed Gulls and 55 pairs of Common Gulls bred on Lough Carra during 2003 along with a few pairs of Lesser Black-backed Gulls (*Larus fuscus*). During waterfowl counts the author made a note of the numbers of breeding Black-headed Gulls and Common Gulls at the colonies on two small islands off the Kilkeeran peninsula. Black-headed Gulls are the most dominant breeding species here with *c*. 230-280 adults counted and *c*. 70-90 adult Common Gulls also present. Numbers for the latter species would increase if the pairs that breed at the disused quarry at Kilkeeran (Huxley, 2003) and those that breed singly around the lake were added. In terms of the larger Gulls, over the counting programme the highest total of Great Black-backed Gulls (*Larus marinus*) was 16, while the maximum count for Lesser Black-backed Gulls was 10, the latter bred in small numbers in 2003 as noted by Huxley (2003) but a greater number may pass through the area on seasonal migration and may be missed by the counts. Stronach (1981) mentions that the larger gulls roosted on some of the islands but does not elaborate on local populations other than to say that the Greater Black-backed Gull, Lesser Black-backed Gull and Herring Gull (*Larus argentatus*) were present on the lake, although records of Herring Gull at Lough Carra are particularly scarce over the last few years.

The main avian threat to duck nests comes from those species, the members of the *Laridae* and *Corvidae*, however the predation of some waterfowl species by birds of prey should be mentioned. During counts by Huxley (2000 onwards) and for this study (2004-2006), five species of raptor were recorded at Lough Carra, these are Kestrel (*Falco tinnunculus*), Merlin (*Falco columbarius*), Peregrine (*Falco peregrinus*), Sparrowhawk (*Accipiter nisus*) and Hen Harrier (*Circus cyaneus*). Of these five the Merlin, Peregrine and Sparrowhawk will prey on small birds but the Peregrine will hunt smaller duck species such as the Teal (*Anas crecca*) and Wigeon (*Anas penelope*) (Orton, 1989).

Another potential predator species at Lough Carra is the freshwater fish species the Pike (*Esox lucius*), adult Pike have been known to prey on young waterbirds and this includes ducklings (Sterry, 2004). The author did not see Pike in the waters of Lough Carra but has seen markers for the lines on which the Western Regional Fisheries Board catch Pike in attempt to cull numbers in the lake and every year and the Lough Carra Trout Angling Association holds a Pike fishing competition partly to achieve the same goal. Previous studies by the Inland Fisheries Trust Organisation (I.F.T.O.) showed that from the stomach content from several hundred Pike taken from Lough Carra, only two had fed on ducklings (Stronach, 1981).

For those birds that nest on the shores of the lake, there are additional predators to contend with such as the Pine Marten (*Martes martes*) which is a member of the Weasel family, its relative the Stoat (*Mustela erminea*) and the Red Fox (*Vulpes vulpes*). All these mammals include birds as part of their diet and will raid nests predating eggs and chicks and all have been recorded around the lake by Huxley (2003). The author has encountered both the Red Fox and the Stoat during waterfowl counts, but not the Pine Marten, which is not surprising due to its secretive nature.

5.8. All Breeding Waterfowl Species on Lough Carra

When conducting breeding surveys over 73 islands on the lake, Stronach *et al*. primarily concentrated on recording the nests of Mallard (*Anas platyrhynchos p*) but while searching the islands they also found the nests of three other species, the Teal (*Anas crecca*), Tufted Duck (*Aythya fuligula*) and Red-breasted Merganser (*Mergus serrator*). These nests were found using the same methods as employed for finding the nests of Mallard,

> During the main nest finding survey which was confined almost entirely to Mallard other species of duck nests and the number of eggs in them was recorded and the position of the nests plotted. The same method was used to find nests i.e. using a team of men and dogs.
>
> (Stronach, 1981, p. 53).

Akin to the older survey, the author searched the ten islands included in the survey with the intention of recording all nesting wildfowl species but only Mallard nests were found. This was despite the fact that during searches, all likely breeding places for other species such as Tufted Duck (*Aythya fuligula*) and Red-breasted Merganser (*Mergus serrator*) were thoroughly searched, such as in the clumps of Black Bog Rush (*Schoenus nigricans*) and between rocks and crevices. Unfortunately while Stronach (1981) mentions that the position of nests were plotted, he presents no figures for the numbers of other duck species nesting on the islands and so although it is now known that no nests were found for these species during this study, it is not known how many nests were on those ten islands during the older survey. Despite this he did make general comments on the overall breeding populations of Tufted Duck on the lake and mentions a record of juvenile Red-breasted Mergansers seen in a group or crèche. Stronach only refers to four species of waterfowl: Mallard (*Anas platyrhynchos p*), Tufted Duck (*Aythya fuligula*), Red-breasted Merganser (*Mergus serrator*) and Teal (*Anas crecca*), in the breeding populations section of his report (*An Ecological Study of Waterfowl on Lough Carra,* 1981, but for this study, the author aimed to identify all those waterfowl species breeding on the lake and calculate estimates of current breeding populations. As the scope of this research did not include nest searches around the shores of Lough Carra, the data to support the current numbers and status of all waterfowl species breeding on the lake was gathered from observations made while out on the lake during the breeding seasons of 2005 and 2006 and while out conducting waterfowl counts during this time. In addition, separate field visits were made to certain areas around the lake which it was thought would hold nesting birds. The author was particularly interested in finding evidence of breeding for Gadwall (*Anas strepera*) which was unrecorded as a breeding species and this led to visits throughout the breeding season to areas such as Kilkeeran and Moorehall. Other records were gathered from Chris Huxley who through the Lough Carra Trout Angling Association received reports of adult female ducks with broods from anglers out on the lake during the breeding season. These were mainly observations of Mallard (*Anas platyrhynchos p*) which were reliable as the anglers are most familiar with this species.

From all data, the status of breeding was confirmed for nine waterfowl species including two members of the genus *Anas* or dabbling duck, two members of diving duck (genera *Aythya* and *Mergus*), two members of the grebe family (*Podicipedidae*), two members of the rails/crakes family (*Rallidae*) and one member of the swan family (*Cygnus*). To confirm breeding a species had to fulfil at least one of two criteria as recommended by Bibby *et al.* (2000) and these were (1) a female with a nest (was recorded) and/or (2) a female with a brood of young (was recorded). Below in Table 25 are the species found breeding at Lough Carra over the two breeding seasons of 2005 and 2006 based on the confirmed breeding criteria.

Table 25. List of species for which breeding was confirmed on Lough Carra 2005/06.

	Species	Nest(s) Found	Brood Appearance
1	**Mallard**	**X**	**X**
2	**Gadwall**		**X**
3	**Tufted Duck**	**X**	**X**
4	**Red-breasted Merganser**		**X**
5	**Little Grebe**		**X**
6	**Great Crested Grebe**	**X**	**X**
7	**Moorhen**	**X**	**X**
8	**Coot**	**X**	**X**
9	**Mute Swan**		**X**

There was one record for a species that was seen in June at Kilkeeran but for which no nest was found or brood seen and this was the Teal (*Anas crecca*). On 13th June 2006, three adult Teal were seen swimming through the reedbeds (*Phragmites communis*) at Kilkeeran, this group comprised two males and a female. The breeding period for this species is between April and June and thus there are two possibilities regarding these birds, (1) they were non-breeders or (2) of the three seen, two were a breeding pair with an extra male invading their territory in pursuit of the female. Regarding the latter, none of these birds showed signs of aggressive or territorial behaviour as one would expect in the case of an unwanted male in a breeding territory. Overall neither of these hypotheses regarding the status of these birds could be confirmed or were satisfactory and so they were not included in the category of breeding species despite being present during the breeding season.

5.8.1 Breeding Species Accounts

For the nine species of waterfowl confirmed as breeding on Lough Carra in 2005 and 2006, estimates of current breeding populations were made based on the data from the counting programme, separate field visits to certain sites and additional information.

A Note on Methodologies used for breeding populations estimates

The main methodologies used to derive estimates are those outlined by Bibby *et al.* (2000) and involved using females with nests and females with broods as count units. The mean number of each species present on the lake during their breeding times was calculated from the counts conducted during the breeding seasons of 2005 and 2006. The data used and methodologies employed in the calculation of breeding numbers are further outlined in the accounts for each species.

<u>**Mallard (*Anas platyrhynchos p*)**</u>

Main Breeding Period: March – May.

Mean Count March - May 2005: 38.2.

Mean Count March - May 2006: 33.6.

Total Brood Count 2005: 6.

Total Brood Count 2006: 16.

Total Nest Count 2005: 10 (on the islands).

Total Nest Count 2006: 5 (on the islands).

Estimated Breeding Population 2005: 16-20 Pairs.

Estimated Breeding Population 2006: 20-30 Pairs.

Mallard bred on Lough Carra in 2005 and 2006 but in miniscule numbers when compared to figures from the 1968-1975 surveys which put the estimated breeding population on the lake at between 100-150 pairs for that period. In the build-up to the breeding season of 2005 during February-March and when numbers drop to their breeding levels (Stronach, 1981) the peak count for Mallard on the lake was 65, this was followed by an unusually sharp increase to 82 on 13th March followed by a steady decline to breeding season levels, reaching 22 birds by 4th April. From May to July there was a steady increase in birds on the lake from 12 to 45 with adult females and broods appearing and increasing numbers. In 2006, the breeding levels dropped to 27 by 23rd March and as with the previous year increased with female and brood appearance from May to July with counts of 49 to 68. From the counts it is clear that in 2006 breeding populations were higher overall, there occurred a steady growth in numbers from March and this was swelled to some extent by a small number of broods appearing in May, a decline in June and then a second peak with brood appearance in July due to re-nesting. In contrast 2005 was a year with very low numbers until May, after which numbers began to grow with the appearance of broods and groups of moulting males.

For comparison, the two breeding seasons of 1971 and 1973 were chosen to highlight the trends and numbers from the earlier surveys of 1968-1975. The trends in both years show a similar pattern with populations dropping to breeding levels in March with counts of 160 and 110 birds in 1971 and 1973 respectively. Following this, numbers increased slightly but steadily from May to July from 150 to 160 in 1971 and from 100 to 150 in 1973. The increase in numbers from May to July shows a trend similar to that of 2005 and 2006 but overall the trends for the two years of this research show more of a variation in numbers while in 1971 and 1973, trends were of large decreases from winter to spring breeding numbers, which stayed level but for slight increases until July and then sharp increases in August and September. Stronach (1981) found that towards the end of each breeding season (late August–early September) numbers on the lake swelled due to the appearance of post-breeding adults and addition of fledged young birds, this led to a sharp rise in populations and this can be seen in the trends for August in 1971 and 1973 when totals came to 600 and 1,005 respectively (see figure 22 & 23). In sharp contrast, in 2005 on 25th August the number of Mallard on the lake was 38 and on 29th August 2006 the total was 59. To put this in context, at the beginning of the breeding season in 1971 the population went from 160 in March to 600 birds in August while in 1973 populations went from 110 to 1,005. In 2005 the population went from 22 birds at the end of March-start of April to 45 in August, while in 2006 populations went from breeding levels of 27 to 68 in August. These end of season totals reflects a massive decline in the breeding numbers of Mallard on Lough Carra as a whole since the 1968-1975 era.

To attain a base figure for the estimated breeding populations for 2005 and 2006, the author used females with nests and females with broods as the count units (Bibby *et al.* 2000, Poysa 2001). From the counts conducted over the whole lake in 2005 covering the main nesting and hatching periods (11 counts from the start of February to the end of July), a total of six broods were recorded and on the islands surveyed there were ten nests found. Additional information and extra field visits to areas suitable for nesting birds and/or females raising ducklings did not yield more broods in 2005 but added four pairs of Mallard in locations around the lake for which no broods appeared. So in 2005, from brood counts (six) and nesting females (ten) the base figure was 16 pairs with four pairs seen but with no nests found or broods seen for the latter, this produced an estimated population of between 16 and 20 pairs. In 2006, during the counting programme (11 counts from the start of February to the end of July), a total of 16 broods was recorded, five nests were found on the islands and from extra information and field visits, nine additional records of broods were obtained. From the total brood count (25) and nest count (5) the estimated breeding population in pairs for 2006 was 30 pairs, this showed a slight increase of between five and ten pairs when compared to the 2005 estimates. Overall when comparing the estimated figures for the current breeding population to those from the

1968-1975 data, there has been a decrease of about 80% in the numbers of breeding pairs of Mallard on the lake.

From the calculations for nest initiation dates for 2005 and 2006 (see Figure 20), it was recognised that overall, very little re-nesting occurred on the islands surveyed that held nests that were predated. In 2006, no late nests were found on the islands but it was recognised that re-nesting did take place elsewhere on the lake and the timing of brood appearance in 2006 bore this hypothesis out. Although the six broods recorded in 2005 is a small sample to work with, it was noted that three appeared in May, two in June and one in July. The evidence for re-nesting could be seen in 2006 with the majority of broods appearing later in the season with four recorded in May, one in June, ten in July and one in August. As mentioned, for both years after July, the number of birds on the lake showed a downward trend, the reverse of what used to occur in the 1960s/70s. A possible hypothesis could be that either migration out of the lake by males occurs in July-August or a certain percentage of ducklings/juveniles are predated each year, thus keeping recruitment levels low. The former hypothesis is an unfavourable one as many males would be in the moulting stage and using the reedbeds for cover (Stronach, 1981). The latter is more likely as evidence from brood counts suggests that some broods lose ducklings as they are particularly vulnerable to predation during the first few weeks after hatching. Predation of nests must also have been a factor for those pairs that bred on the shores of the lake during both years. From many days spent on the lake during the breeding seasons of 2005 and 2006, it is thought that not many pairs now attempt to nest on the smaller islands, possibly due to the presence of the American Mink (*Mustela vison*) (see discussion, Chapter 7).

Figure 22. The peak monthly counts of Mallard (*Anas platyrhynchos p*) on Lough Carra during the main nesting, hatching and post-hatching months 2005 & 2006.

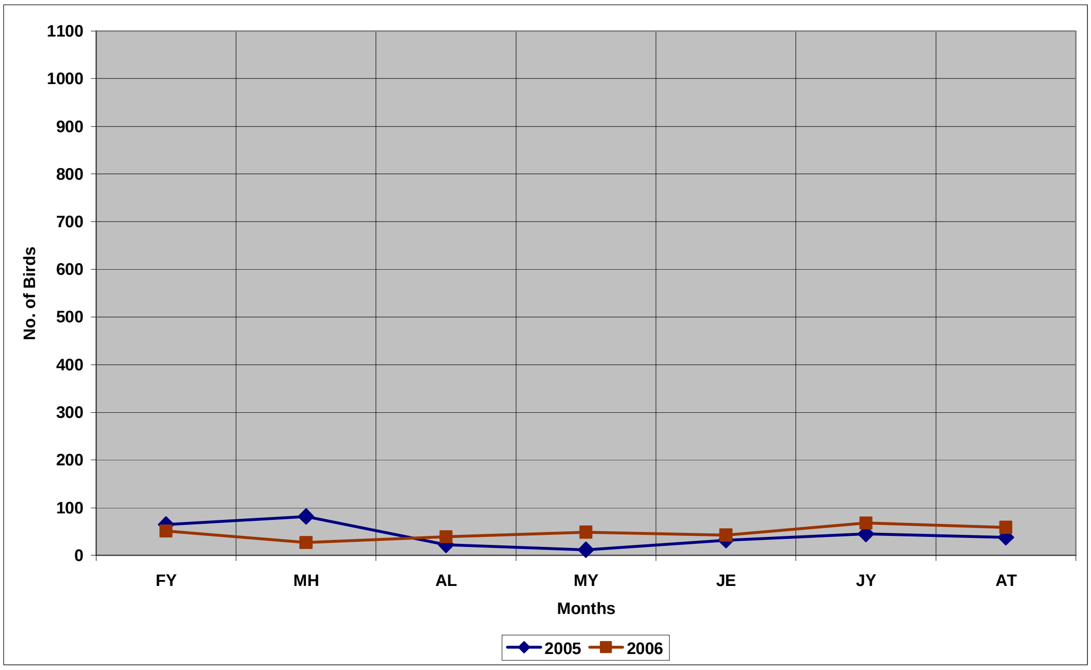
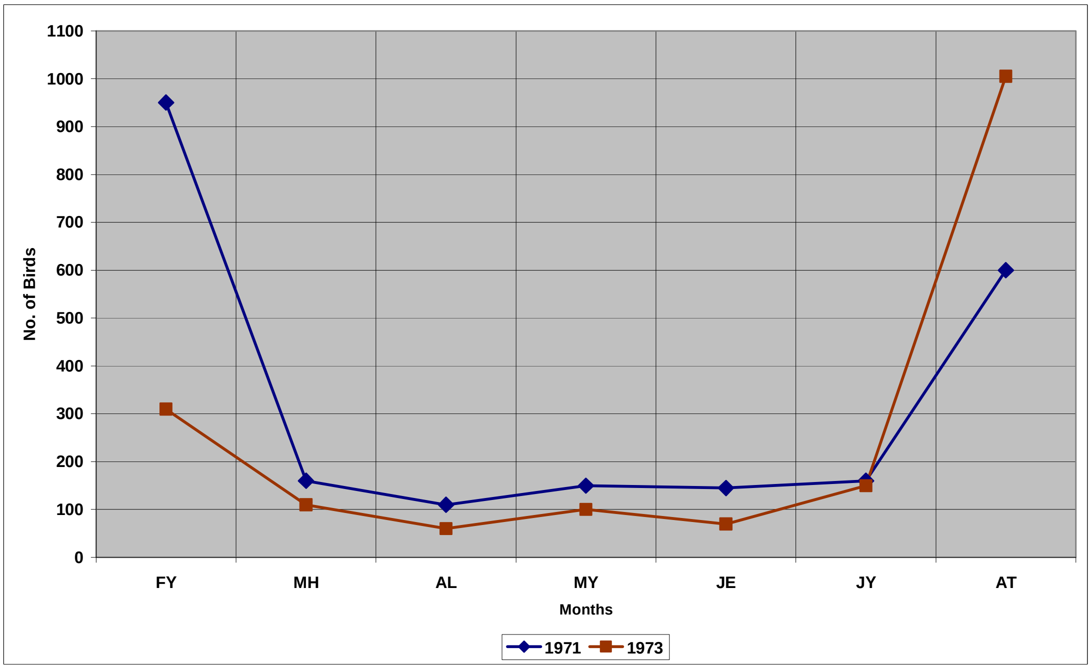


Figure 23. The peak monthly counts of Mallard (*Anas platyrhynchos p*) on Lough Carra during the main nesting, hatching and post-hatching months 1971 & 1973.



Note: FY = February, **MH** = March, **AL** = April, **MY** = May, **JE** = June, **JY** = July, **AT** = August.

<u>Tufted Duck (*Aythya fuligula*)</u>

Main Nesting Period: May - June.

Mean Count May – June 2005: 32.5.

Mean Count May – June 2006: 75.

Total Brood Count 2005: 6.

Total Brood Count: 3.

Estimated Breeding Population 2005: 21 Pairs.

Estimated Breeding Population 2006: 43 Pairs.

Tufted Duck (*Aythya fuligula*) bred on Lough Carra in 2005 and 2006 and in the latter year the estimated breeding population in pairs was just under those levels previously recorded by Stronach (1981) during the older survey. In 2005, there was a total of 82 birds on the lake which dropped to breeding levels of 47 to 36 between 6th May and 16th June. There occurred a slight increase with 43 birds recorded on 21st July, this was due in part to brood appearance from June to July. In 2006 although there was a lower number of 53 birds on the lake in April than in the previous year, there was an increase in breeding populations overall with 53 birds recorded on 21st April followed by an increase by the end of May to 75. These high levels were sustained and increased to 90 birds by 13th June and only dropped slightly to a count of 85 on 3rd July.

For comparative purposes, the breeding seasons of 1970 and 1971 were chosen from the older survey. In 1970, there were 168 birds recorded on the lake in April and this dropped to 120 in May, this was followed by an increase in June to 150 followed by a sharp decline to 30 in July. In the following year of 1971, the figure for April was 250 and this dropped to 150 birds in May, unlike the previous year there was a decrease in June to 98 but reminiscent to 1970 this was followed by a decline to 35 in July. In terms of trends when comparing the two years of this research to 1970 and 1971 from the earlier survey, the three years 2005, 1970 and 1971 all showed declines to breeding levels in April-May with increases in June and July or August due to brood appearance (albeit slight in 2005). The year 1971 with the increase in August may have been a late breeding year with the peak coming in that month due to late brood appearance, Stronach (1981) does not mention Tufted Duck broods in his report but this is most likely the case as numbers normally decline in August.

In 2006, even by casual observation one could tell there were more Tufted Duck on the lake than the previous year and the trend from the 2006 breeding season reflects this. From April there was a steady growth in numbers through June and into July, after July numbers dwindled until they had dropped to seven by the end of August. What is particularly interesting about this year is that there was a steady growth in the numbers of adults and this increase of numbers was not caused by brood appearance, in fact despite the good numbers of birds on the lake there were only three broods recorded during 2006. There may be a number of reasons for this such as high levels of predation on nests/ducklings or the under-recording of broods due to their location in dense vegetation. There is no doubt that had there been more brood appearance during 2006 in correlation with the increases in breeding numbers overall, it would have led to a large peak during the breeding season of 2006.

Unlike the Mallard (*Anas platyrhynchos p*), the methodology using females with nests and females with broods as count units was not wholly suited to the attainment of estimates for Tufted Duck, for two reasons specifically. Firstly, nest finding surveys were confined to ten islands on the lake and this did not include the main areas such as Kilkeeran where the Tufted Ducks nested, thus females with nests were not suitable as count units. Secondly, as mentioned there were very low numbers of broods for this species recorded on the lake during the breeding seasons of 2005 and 2006 and so brood counts would not even roughly reflect breeding populations. So, a different methodology developed by Poysa and outlined in Bibby *et al.* (2000) was applied to derive estimated breeding pairs for Tufted Duck. When calculating estimates for breeding pairs by actually counting pairs, a problem arises when birds are encountered on their own, in flocks with for example five males and three females or even larger groups where the male/female ratio is not balanced. On his work on breeding wildfowl in Finland, Poysa developed and tested a method to resolve this issue. As outlined by Bibby *et al*. (2000, p. 180),

> Breeding pairs are counted for all pairs, single males, males in groups of 2-4 (=2-4 pairs), small male groups chasing a single female (2-4 males and 1 female = 2-4 pairs) and lone females if their number is larger than that of males...Large groups can be included, but care must be taken not to include non-breeding birds or late winter flocks.

As part of his methodology, Poysa, used transects to walk within 100 metres of any point in a study area and then recorded all groups and individuals on a map or in a notebook

(Bibby *et al.* 2000). Transects were not used when counting birds for this study but with the layout of the count points around the lake, his methodology was still applicable as birds were counted within 100m and recorded in a notebook for later interpretation. To calculate the breeding estimates for this study, Poysa's methodology was applied to a count conducted on 16th June 2005 and one conducted on 13th June 2006, both during the height of the breeding season.

<u>Using the Poysa Methodology</u>

On 16th June 2005, the total number of Tufted Duck recorded on the lake was 37 while on 13th June 2006 it was 90. What follows is an example of how breeding pairs were estimated for 2005 using the method developed by Poysa and outlined by Bibby (2000). To make up the total of 37 birds counted on 16th June 2005, the following numbers were recorded at five count points: Count Pt 17 **= 15 birds,** Count Pt 18 = **2 birds,** Count Pt 20 = **2 birds,** Count Pt 23 = **2 birds,** Count Pt 25 = **16 birds.** To apply the Poysa method and derive pairs, these five groups were broken down as follows,

The group of **15 birds** consisted of **4 distinct pairs, 4 males in a small loose group** and **3 males singularly on their own:**

Poysa Method: 4 pairs = 4 pairs / 4 males = 4 pairs / 3 lone males = 3 pairs.

The next birds counted as groups of **2 / 2 / 2** were all in pairs **= 3 pairs.**

The group of **16 birds** consisted of **1 female with a brood of 6, 3 distinct pairs** and **3 males singularly on their own:**

Poysa Method: 1 female (with brood) = 1 pair / 3 pairs = 3 pairs /
3 lone males = 3 pairs.

From the sum total of pairs derived using this method, the estimated number of breeding pairs for 2005 was 21 while for 2006 it was 43. In the older survey, Stronach (1981) noted that the breeding total in pairs was normally around 50 for the years 1968-1975 and so while in 2005 the estimated populations were down by 58%, in 2006 they reached about 43 pairs which was just 14% under the older levels. In 1970 and 1971, numbers were higher during April and May coming into the breeding season and were slightly higher overall. However, Tufted Duck on Lough Carra are now breeding in association with a colony of

Black-headed Gulls (*Larus ridibundus*) at Kilkeeran and due to this association numbers on the lake may increase in the coming years (see Chapter 7 for more). From the monthly counts from 1968-1975, a similar trend existed across most years: this saw a decrease in the numbers of Tufted Duck on the lake from about the middle of July until the middle/end of October. These declines support the hypothesis that a certain percentage of the adults breeding on Lough Carra are summer migrants who arrive to nest and depart in the early autumn as do some of the young birds born on the lake. Then in a reverse trend, from the end of October populations rise with the arrival of returning migrants who bred outside Lough Carra, which leads to a build up in populations until numbers eventually reach winter levels. This was also the case in 2005 when numbers dropped from 43 in July to 22 in August and then steadily climbed to 155 by 31st October.

Figure 24. The peak monthly counts of Tufted Duck (*Aythya fuligula*) on Lough Carra during the main nesting, hatching and post-hatching months 2005 & 2006.

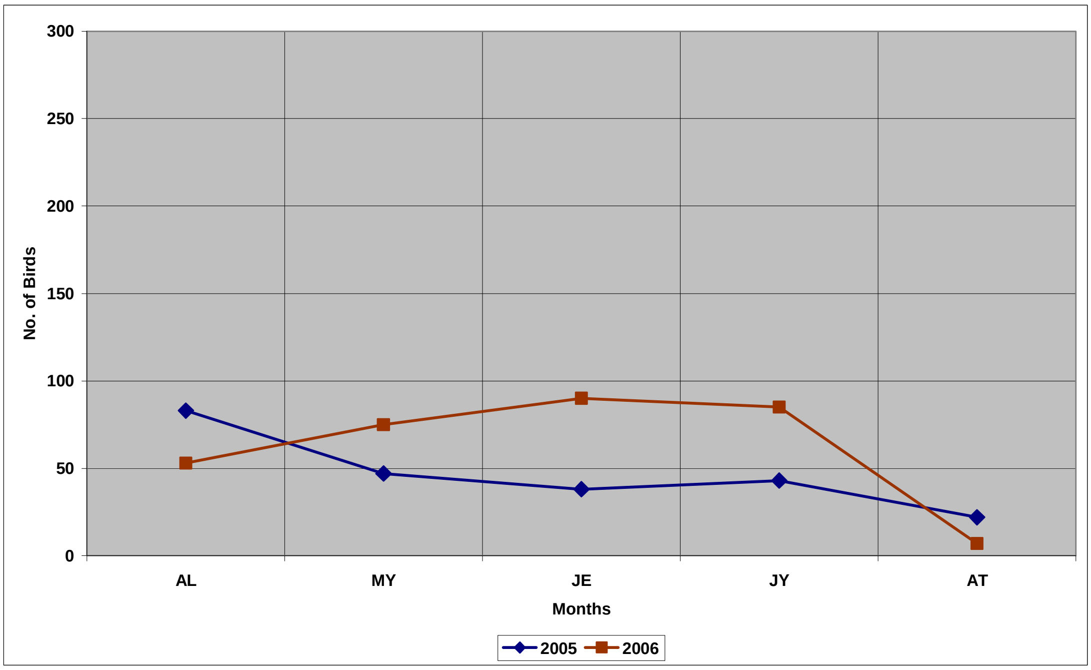
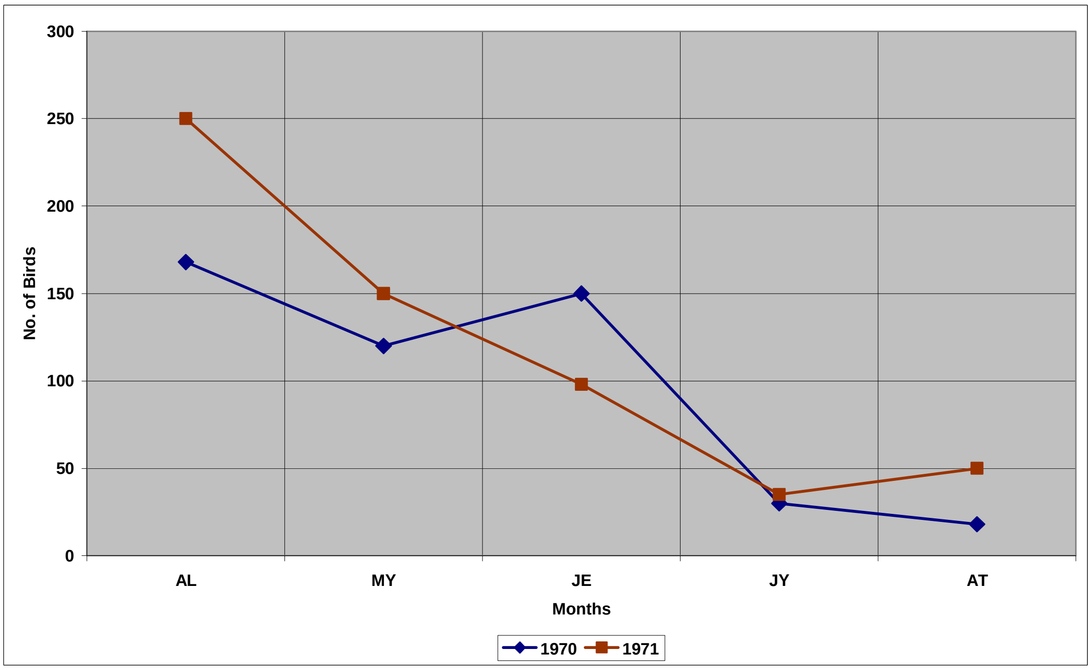


Figure 25. The peak monthly counts of Tufted Duck (*Aythya fuligula*) on Lough Carra during the main nesting, hatching and post-hatching months 1970 & 1971.



Note: AL = April, **MY** = May, **JE** = June, **JY** = July, **AT** = August.

<u>Red – breasted Merganser (*Mergus serrator*)</u>

Main Nesting Period: May – June.

Mean Count May- June 2005: 7.

Mean Count May – June 2006: 2.25.

Total Brood Count 2005: 1.

Total Brood Count 2006: 2 (2 broods in crèche).

Estimated Breeding Population 2005: 7 Pairs.

Estimated Breeding Population 2006: 5 Pairs.

Red-breasted Merganser (*Mergus serrator*) bred on Lough Carra in 2005 and 2006 but their numbers during both those breeding seasons were much lower when compared to the figures from the late 1960s and early 1970s. Unlike most of the other wildfowl species on the lake, rather than dropping from winter levels to breeding levels, the reverse happens and their numbers increase to breeding levels and as a result the numbers of this species peaked for most years during the summer in May-June. However, they are similar to the Tufted Duck (*Aythya fuligula*) in that their numbers always decline in July-August in the latter stages of the season. During the breeding season of 2005, there were six recorded in April followed by a peak in May of 12 birds, then the usual decline was evident from the latter part of June with just three birds recorded and this dropped to two in the first week in July. In 2006, there were slightly lower numbers of Red-breasted Mergansers on the lake than the previous year and not as many records from the counts or from the boat during fieldwork, in fact they were only recorded in May, June and July. In May the total number of birds on the lake was three and this increased to a peak in breeding stock in June of eight birds which was four less when compared to the peak in May of 2005.

From the older survey, Stronach (1981) only provided data on the numbers of Red-breasted Mergansers for the years 1968 and 1969 and so these two years were used for comparison. In 1968, there occurred a surge in populations in June to 45 birds from just 15 in April, a second slight increase from 30 to 40 birds was recorded from June to July and this was followed in the latter part of July by a dramatic decrease to just two birds. In the following year of 1969 the increase to breeding levels occurred earlier in the season when from a total of 15 birds in March the population rose to 48 in April and this was followed by a steady decline from 40 birds in June to 30 in July through to just ten in August. Overall the trends across the four years follow a similar pattern with birds increasing on the lake during the late spring/summer months, usually reaching a peak in May or June followed by a decline in numbers in July-August. Martin (1993) notes that there occurs a build up in the numbers of Red-breasted Mergansers during July-August at some Irish and Scottish coastal sites with the flocking together of moulting birds. This may be the reason for the decline in numbers at Lough Carra around this time as birds may depart from freshwater breeding grounds to their moulting grounds by the coast.

The birds counted during the summer months and from the boat while out on the lake during the breeding season, were nearly always in pairs apart from one record of a group of five birds on 15th May at Castleburke. Despite being in a flock, this group consisted of three males and two females which in turn were interpreted as two pairs and a lone male. This flocking together even at this stage of the breeding season is not uncommon amongst this species who are quite sociable in behaviour and who have been known to often nest in colonies (Martin, 1993). The methodology used to assess current breeding populations for 2005 and 2006 was based on the numbers of pairs counted during April, May and June and from the number of birds counted on the lake overall (see Figure 26). In 2005 there were seven records of pairs seen and in 2006 there were six and from these their geographical distribution was used to deduce distinct pairs and avoid double counting. The details for the two years are as follows:

2005

Northwest Basin

In the northwest basin between 2nd April and 19th May, three pairs were often recorded on the same day at Castleburke in northern end of the basin (on one occasion a male was seen displaying to a female and a pair were seen mating). A pair and a male holding territory were recorded in Heneghan's Bay to the southwest of Castleburke and in the southern end of the basin, a pair were recorded at Kilkeeran.

Southeast Basin

In the southeast basin on 24th May, a pair were recorded off the island of Illanatrim and on 2nd June a pair were present on the shores of Moorehall.

2006

Northwest Basin

In the northwest basin on 10th and 25th May a pair were observed at Castleburke and a pair were recorded at Heneghan's Bay to the southwest on 13th June.

Southeast Basin

On 15th June, three pairs were recorded on the east side of Hog Island.

From these records, it was estimated that in 2005, seven pairs of Red-breasted Mergansers bred on Lough Carra while five pairs bred in 2006. Records of lone males from locations where pairs were regularly recorded were not treated as part of different pairs although in some instances, this may have been the case and the estimates would be slightly higher. Stronach (1981) does not estimate the number of pairs on the lake but judging from the number of birds recorded during the breeding seasons of 1967-69 which came to between 30 and 40, 20-25 pairs would not be an unreasonable estimate. The summer populations have declined by about 33% since the older survey with between eight and 12 birds present on the lake in 2005 and 2006. There were two records of broods from 2005 and 2006 and both were from the southeast basin, one was on 28th June 2005 when a female and two juveniles were seen swimming between Horse and Hog Island but the second was of greater interest. Some weeks after hatching, the broods of more than one pair can amalgamate to form a crèche which can be supervised by one or more adult females, this is also seen in other species of wildfowl such as Shelduck (*Tadorna tadorna*) (Martin 1993, Ogilvie and Pearson, 1994). Stronach does not give an estimated figure for the number of Mergansers breeding on the lake but he does mention that, "Mergansers are inclined to crèche their young and large groups of young ducklings are often seen in August and September, the largest group observed was 27" (1981, p. 54).

This habit of amalgamating young into crèches still occurs on Lough Carra as a record from 24th September 2006 testifies, on this date Chris Huxley counted a group of 15 Mergansers in a group off Brownstown in the southeast basin. In this group were four adults and 11 young which were possibly the broods of two pairs (Huxley *pers. comm.*). Counting young birds gathered in crèches may be a good method of determining breeding numbers and breeding success in the future.

Figure 26. The peak monthly counts of Red-breasted Merganser (*Mergus serrator*) on Lough Carra during the main nesting, hatching and post-hatching months 2005 & 2006.

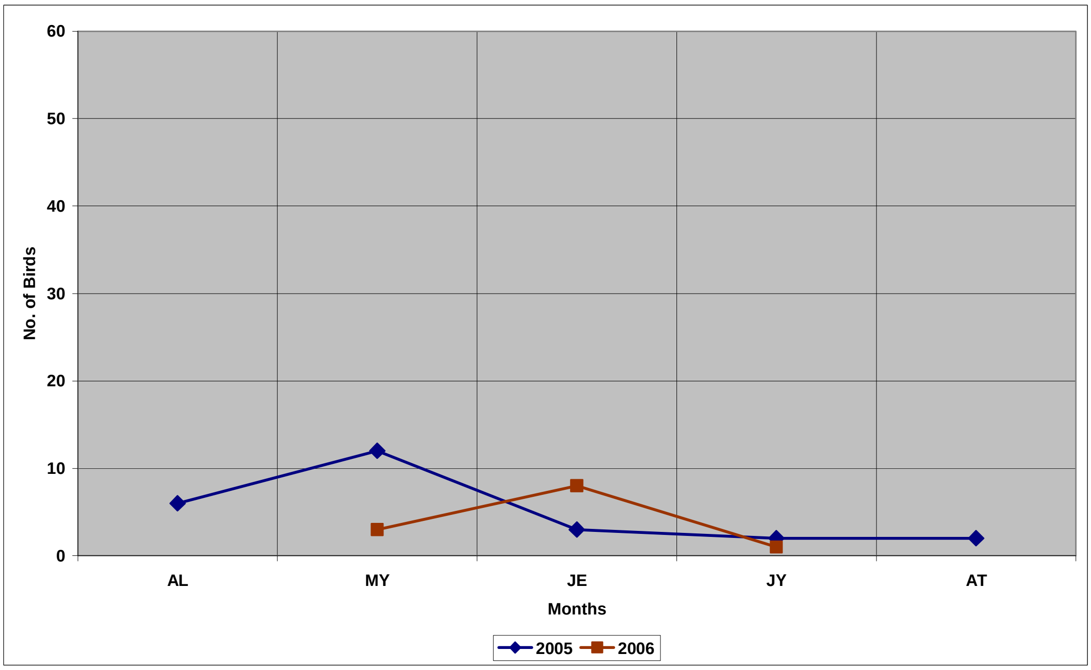
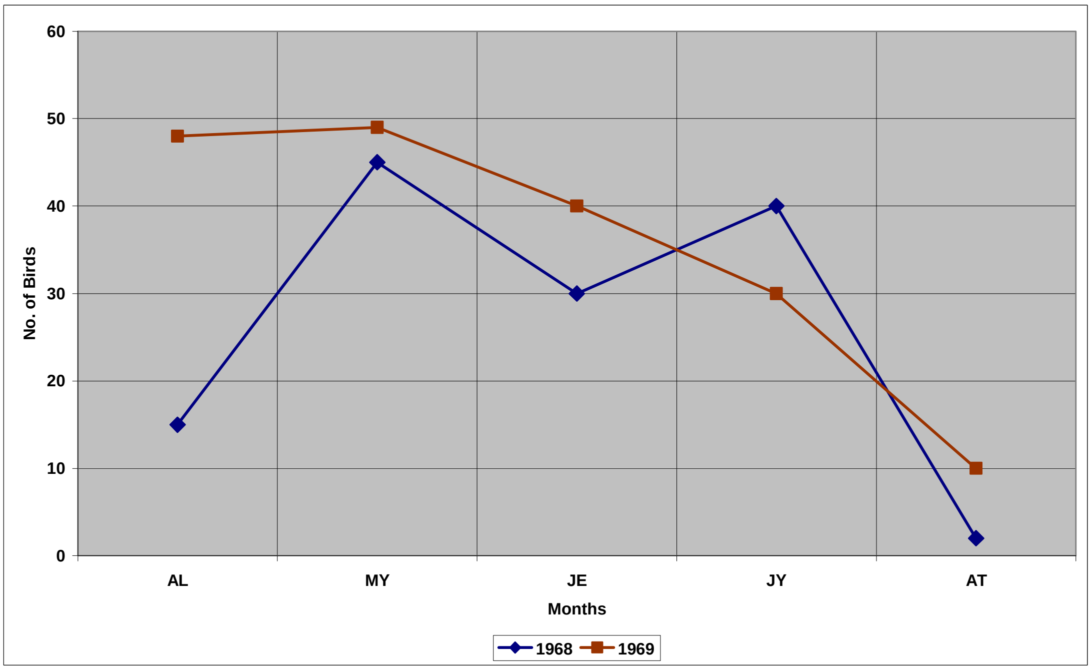


Figure 27. The peak monthly counts of Red-breasted Merganser (*Mergus serrator*) on Lough Carra during the main nesting, hatching and post-hatching months 1968 & 1969.



Note: AL = April, **MY** = May, **JE** = June, **JY** = July, **AT** = August.

<u>Note</u>

The following five waterfowl species were not counted by Stronach *et al.* (1967-1980) but were counted under the I-WeBS programme and for this study. Subsequently the following breeding season monthly peak charts at the end of each breeding account for these five species only cover the years 2005 and 2006.

<u>Great Crested Grebe (*Podiceps cristatus*)</u>

Main Nesting Period: April – July.

Mean Count May- June 2005: 14.5.

Mean Count May – June 2006: 13.7.

Total Brood Count 2005: 2.

Total Brood Count 2006: 1.

Total Nest Count 2005: 1.

Total Nest Count 2006: 6.

Estimated Breeding Population 2005: 7-10 Pairs.

Estimated Breeding Population 2006: 13 Pairs.

The Great Crested Grebe (*Podiceps cristatus*) bred on Lough Carra in 2005 and 2006 and in the latter year, their numbers increased slightly. Huxley (*pers. comm.*) suggests that the numbers of Great Crested Grebes increase on Lough Carra during March-April due to a spring passage of birds moving through the lake to their breeding grounds elsewhere. The data from counts at Lough Carra since 2000, when coverage improved, supports this theory of spring passage as numbers for 2002/03/04 peaked in March with counts of between 24 and 42 birds for those years and in 2005 a peak of 37 birds occurred in April. It is possible that while these figures reflect an increase in the numbers of birds on the lake during the spring, their numbers are under-recorded due to the fact that large flocks can gather in the reedbeds around the lake during the day and so are missed during counts. Also since counts for this study (2005-2006) included the summer months, it was found that large flocks of Grebes were still present as late as mid May in locations such as Moorehall where a flock of 12 was recorded in reedbeds on 19th May in 2006, though it is possible that these were non-breeding birds. Due to this passage of birds through the lake, it could not be said that all birds present on Lough Carra in April were local breeders. A more viable hypothesis was to assume that most of the individuals present on the lake from about the fourth week in May were local breeders and that most of the migrants had moved through at this stage. To work with this theory, numbers on the lake in 2005 went from a count of 20 birds in the first week in May to breeding levels of 15 by the fourth week. This was followed by a decrease to ten in June and seven in July; this decline is possibly due in part to females being on nests and males departing from the lake in July to moulting grounds elsewhere. In 2006, there appeared to be an increase in the local breeding population as the count from the start of May totalled 12 birds and this increased to 21 by the fourth week. In a pattern reminiscent of the previous year, this was followed by a decline to 14 and then 10 birds in June and July respectively.

The trends for both years in terms of increases and decreases were similar (see Fig. 28), but in 2006 there does appear to have been an increase in breeding numbers. In 2005, there was an increase in numbers from seven birds in July to 16 in August and this increased to 22 by 11th September, the number of broods seen on the lake during this year was low with just two recorded in June and August with three and two juveniles respectively (this species lays small clutches of three to four eggs). If the increase recorded in August-September is not due to the recruitment of young birds into the population, then it is possible that a similar migratory pattern to that recorded during the spring also occurs during the autumn with post breeding adult birds passing through the lake after the breeding season. However, the data from more all year counts would be needed to support such a hypothesis as this trend may vary from year to year.

The provision of estimates for the numbers in pairs of Great Crested Grebes on Lough Carra in 2005 and 2006 was made difficult due to the spring passage of birds through the lake and due to the habitat chosen by this species to breed in. The nest is a large floating structure and is usually located in reeds or other dense vegetation, which acts as anchors and keeps it in place (Evans, 1977). More nests were visible in 2006 than in 2005 but nevertheless, using females with nests as count units was not a satisfactory methodology on its own. To derive estimates, the number of distinct pairs on the lake in late May/early June was used and the estimates took into account the mean number of birds on the lake during late May/early June, the number of nests and the number of broods recorded over the two years. Using this approach, it is felt that the estimates projected may still be under the true figures for breeding pairs but taking into account the overall populations on the lake during the breeding period, the calibration needed may be slight. Below are the data from 2005 and 2006 upon which the estimated number of pairs was based:

2005

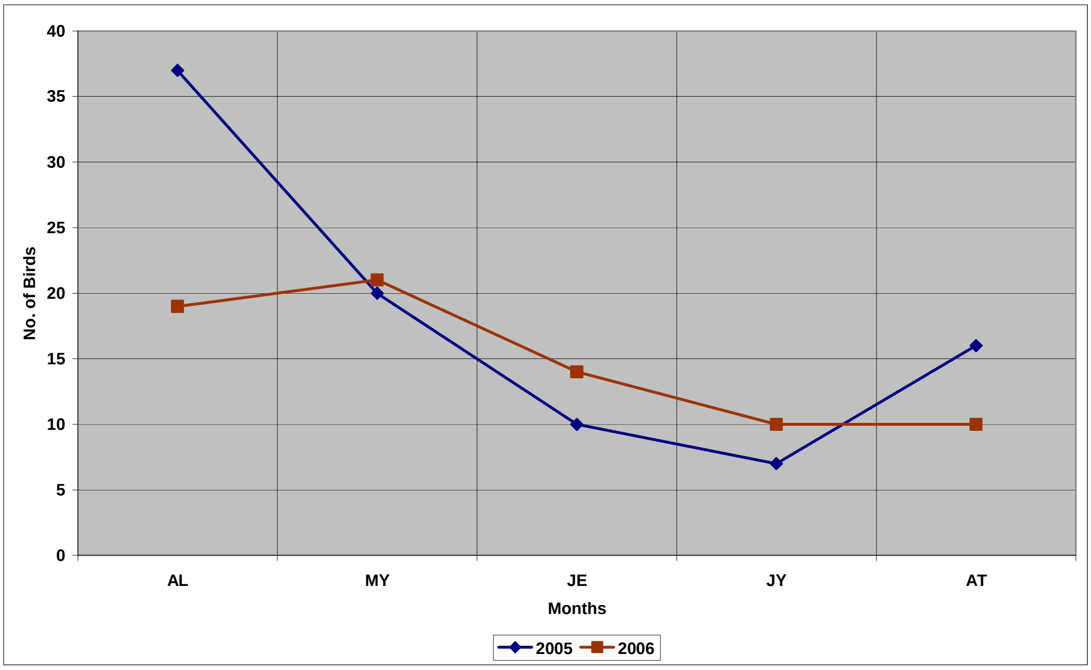
The mean number of birds on the lake from 26th May to 8th June was 12.5. The number of pairs recorded in different locations on the lake between these dates was seven pairs, the number of nests recorded was one (not belonging to any of the pairs counted) and the number of broods recorded was two. This produced an estimate of between seven to ten pairs (7 pairs + 1 pair (from 1 nest) + 2 pairs (from 2 broods)).

2006

The mean number of birds on the lake from 26th May to 13th June was 15.5. The number of pairs recorded in different locations on the lake between these dates was six pairs, the number of females with nests came to seven (one belonged to one of the pairs counted) and the number of broods recorded was one. This produced an estimate of 13 pairs (6 pairs + 6 pairs (from 6 nests) + 1 pair (from 1 brood)). It should be noted that the six pairs recorded were not associated with the six nests included in the calculations and so double counting did not occur.

In 2006, from the total of seven nests recorded on Lough Carra, six were recorded on the Kilkeeran Peninsula where Great Crested Grebes formed a colony in the reeds by a small island which is also home to a colony of Black-headed Gulls (*Larus ridibundus*); in view of its location, like the Tufted Duck, this colony of Grebes may grow over the coming years (see Chapter 7). As was found with the Tufted Duck (*Aythya fuligula*) on the lake, there were very few broods seen during both breeding seasons with just two in 2005 and one in 2006. As was noted by the three broods that were recorded, the adult birds were not hesitant about bringing their young out onto the open water. In some cases, where broods are taken far from shore, the adult birds may be more visible and broods less so.

Figure 28. The peak monthly counts of Great Crested Grebe (*Podiceps cristatus*) on Lough Carra during the main nesting, hatching and post-hatching months 2005 & 2006.



Notes: **AL** = April, **MY** = May, **JE** = June, **JY** = July and **AT** = August.

<u>Little Grebe (*Tachybaptus ruficollis*)</u>

Main Nesting Period: April – June.

Mean Count April - June 2005: 9.1.

Mean Count April - June 2006: 6.4.

Total Brood Count 2005: 1.

Total Brood Count 2006: 1.

Estimated Breeding Population 2005: 5-7 Pairs.

Estimated Breeding Population 2006: 4-6 Pairs.

Little Grebe (*Tachybaptus ruficollis*) bred on Lough Carra in 2005 and 2006 but their populations proved difficult to ascertain, with numbers from counts suggesting that the breeding population increased slightly in the latter year but with roughly the same amount of pairs estimated for both years. This species like its other relative from the *Podicipedidae*, the Great Crested Grebe (*Podiceps cristatus*), usually lays two clutches during the breeding season, in this case one at the end of April and one at the end of June (Evans, 1977). In 2005, breeding levels from 4th April to 6th May went from 10 to 13 birds, this was followed by a decline in the first week of June to eight, possibly due to under recording. On 5th July, the population had increased to 18, although surprisingly all but five of these were juveniles. In the following year 2006, populations on the lake went from five in the third week in April to seven on 26th May and this climbed slightly to 12 by the end of June. From June to July, the numbers were higher than in 2005 but the trend was the same in that numbers increased in July, reaching a total of 23 birds by the third week, almost double the peak count from the end of June. In both years there occurred an increase in numbers from April to May, probably reflecting breeding levels while June was variable with a slight decline in 2005 and vice versa in 2006. Also, in both years there were more significant increases in July and as mentioned this was not due to brood appearance for either year. A hypothesis may be that the appearance of post breeding adults who bred earlier in the season leads to an increase in numbers during this month. The August trend for both years showed a decrease in birds but the populations of Little Grebes typically peak in Ireland during September-October (Crowe *et al.* 2005) and this is also the case at Lough Carra. Thereafter, hard weather movements may occur during some winters leading to lower numbers on the lake as suggested by Huxley (2001). Due to its size and elusive nature and preferred habitat of emergent vegetation in which it conceals itself this species can go under recorded at times. On the lake in 2005 and 2006, just two broods were seen and no nests found but a more true reflection of the breeding populations comes from the count data during the main breeding period. To derive estimates, the number of pairs from four counts (at the end of April, at the start of May, at the end of June and at the start of July) were calculated for both years. The mean was then calculated to give an average pair count for the each period (see Table 26). These two time periods (April/May, June/July) were chosen to coincide with the laying of the two clutches during the breeding season. During these counts, only two broods were recorded and Little Grebes are highly territorial during the breeding season (Crowe *et al*. 2005) so birds were only encountered singly or in pairs and in different locations on the lake. Lone adults were counted as pairs as with the Poysa (Bibby *et al*. 2000) method used for Tufted Duck (*Aythya fuligula*). Considering the amount of suitable breeding habitat at Lough Carra for Little Grebe, the estimates of 5-7 pairs for 2005 and 4-6 for 2006 seem a little low. However, in addition to the possible under-recording of Little Grebes, like so many of the other species, the predation of their broods/nests by predators such as the American Mink (*Mustela vison*) may be keeping numbers down.

Table 26. The mean number of Little Grebe (*Tachtbaptus ruficollis*) pairs on Lough Carra over two time periods from the breeding seasons of 2005 & 2006.

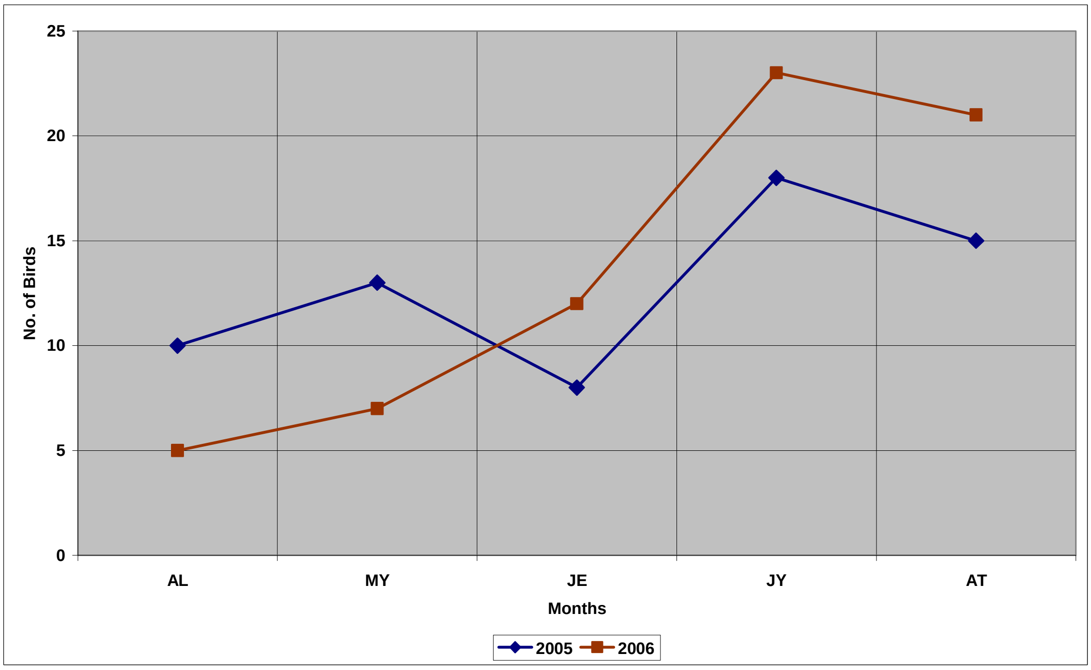
	April/May*	**Mean**	**June/July***	**Mean**
No. of pairs 2005	**5-9**	**7**	**3-7**	**5**
No. of pairs 2006	**4-4**	**4**	**5-7**	**6**

Note: ***** Dates of counts are as follows,

2005 = 20th April / 6th May. 16th June / 5th July.

2006 = 21st April / 11th May. 26th June / 3rd July.

Figure 29. The peak monthly counts of Little Grebe (*Tachybaptus ruficollis*) on Lough Carra during the main nesting, hatching and post-hatching months 2005 & 2006.



Notes: **AL** = April, **MY** = May, **JE** = June, **JY** = July and **AT** = August.

Plate 25. Little Grebe (*Tachybaptus ruficollis*).

Photograph by John N Murphy

<u>Moorhen (*Gallinula chloropus*)</u>

Main Nesting Period: March – July.

Mean Count March - July 2005: 6.5.

Mean Count March - July 2006: 4.1.

Total Brood Count 2005: 2.

Total Brood Count 2006: 3.

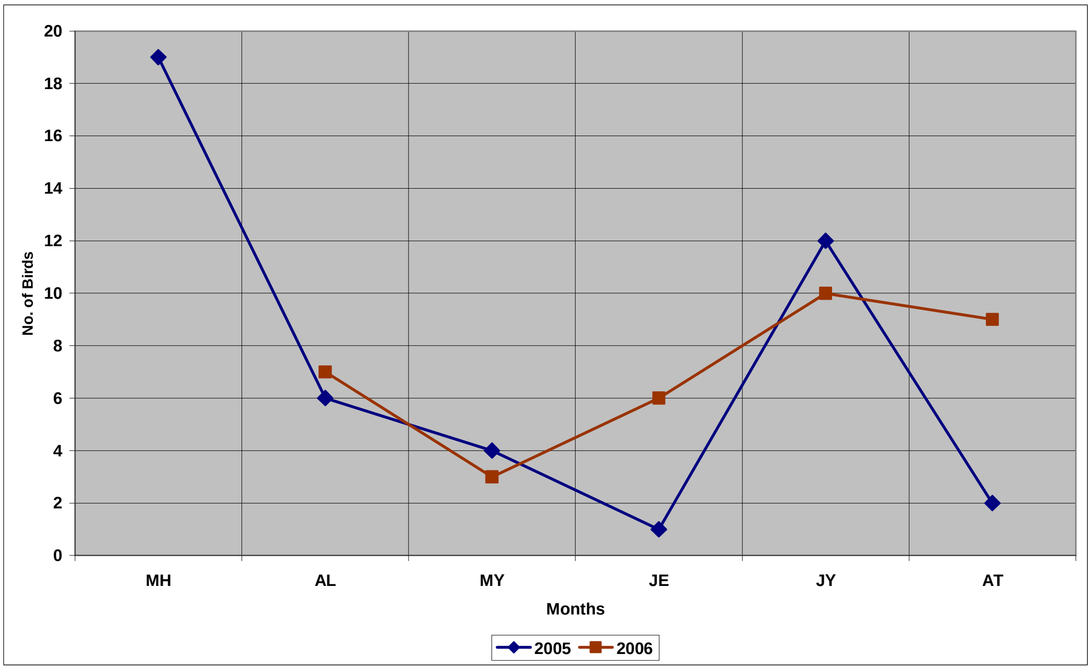
Estimated Breeding Population 2005: 6 Pairs.

Estimated Breeding Population 2006: 8 Pairs.

Moorhen (*Gallinula chloropus*) bred on Lough Carra in 2005 and 2006 but in low numbers considering the suitability of breeding habitat on the lake. Their low populations on Lough Carra have been highlighted in the past by Huxley (2003), who believes that this is partly due to predation by the American Mink (*Mustela vison*). This species is also difficult to count as they are a skulking bird fond of dense vegetation (Crowe *et al*. 2005), they are often heard calling from reedbeds and rushes but not always seen and this has led to the under-recording of their numbers on some counts. They have been known to lay up to three clutches in a single breeding season, the first very often laid in April (Evans, 1977). In 2005, there were 13 birds recorded on 13th March and this dropped to six by 20th April, further declines occurred through May to the start of June when a count of just one bird was recorded. In the third week of July there was an increase to 12 birds and this was due to the appearance of two broods on the lake. In 2006, again due to skulking habits, there were no birds at all recorded in March but there were seven counted in the third week of April and this was followed by a decrease to three on 26th May. Then there occurred increases of six to ten birds from the end of June to the end of July respectively due to brood appearance. Looking at the trends from both years, the numbers of Moorhen on Lough Carra peaked in July due to brood appearance and although low in number (two broods in 2005 and three in 2006) the young from these broods still contributed to increasing populations, this in itself is testament to the low numbers on the lake. The numbers were more variable in 2005 with a count of just one bird in June while in 2006 there was a more steady increase from May to July. Both years showed decreases in August but the decline during this month in 2005 was more extreme (see Fig 30). As with the other waterfowl species that bred on the lake in 2005 and 2006, the fieldwork for this study did not focus on finding the nests of Moorhens, pairs were rarely seen and the numbers of broods recorded in both years were low. Whereas the breeding populations of

Little Grebe (*Tachybaptus ruficollis*) were difficult to assess due to its elusive nature, this was even more the case with Moorhens. The general consensus is that numbers are low during the winter months and from counts, the same can be said for populations during the spring/summer. There still remains the problem and suspicion of under-recording: while perhaps not degrading the numbers to a large degree, it presented a problem when attempting to derive estimates for breeding pairs. To work with the count data, the numbers of pairs were derived from the counts conducted in mid-April for both years and the number of broods added. On the 20th April in 2005 from a total of 6 birds, the number of pairs was calculated as four (lone adults were counted as pairs) and there were two broods seen for this season. On 21st April 2006 from a total of 7 birds, the number of pairs was calculated as five and there were three broods recorded. It was noted however, that early in the season in 2005 there was a count of 19 birds on 13th March, if the lower numbers recorded in both years are due to under-recording, this number may be a truer reflection of actual numbers present during the breeding season.

Figure 30. The peak monthly counts of Moorhen (*Gallinula chloropus*) on Lough Carra during the main nesting, hatching and post-hatching months 2005 & 2006.



Notes: **MH** = March, **AL** = April, **MY** = May, **JE** = June, **JY** = July and **AT** = August.

<u>Coot (*Fulica atra*)</u>

Main Nesting Period: March – July.

Mean Count March - July 2005: 8.

Mean Count March - July 2006: 6.75.

Total Brood Count 2005: 1.

Total Brood Count 2006: 1.

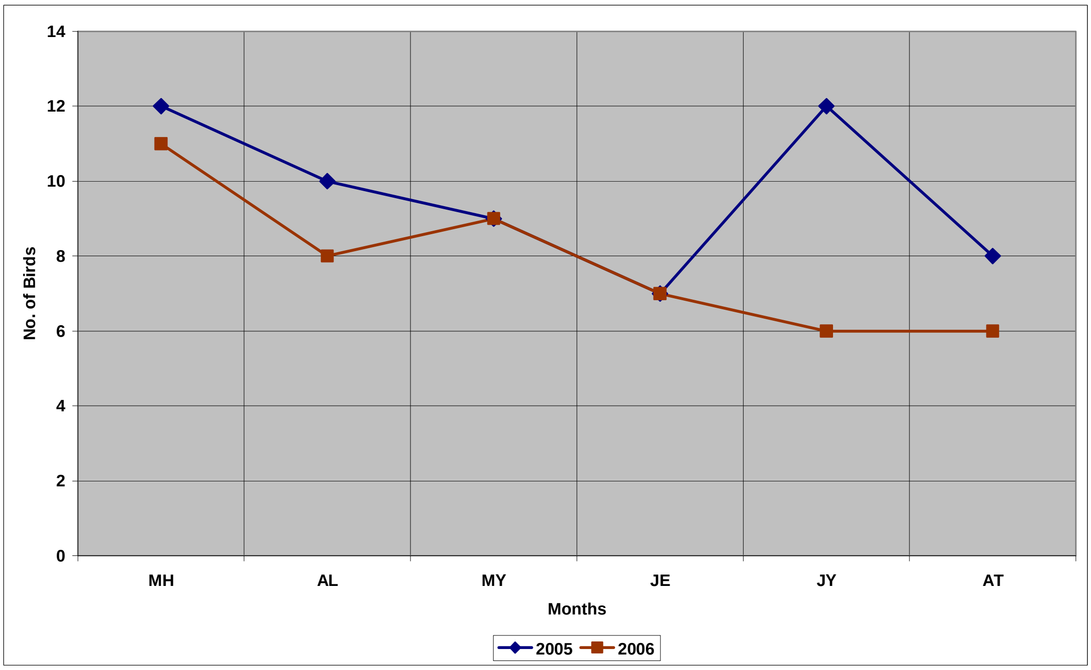
Estimated Breeding Population 2005: 9 Pairs.

Estimated Breeding Population 2006: 8 Pairs.

The Coot (*Fulica atra*) bred on Lough Carra in 2005 and 2006 and during the main nesting period, their numbers were slightly higher overall in the latter year but by very little. Like the Moorhen (*Gallinula chloropus*), they can lay up to three clutches in a single breeding season. Their nests are usually situated by the water's edge and can be added to in the event of a rise in water levels (Evans, 1977). This was seen at Lough Carra in both years when large structures could be seen at Moorehall and on the Kilkeeran peninsula. Numbers in the second week of March in 2005 totalled 12 but through April, May and June they declined to ten, nine and seven, there was a slight peak to 12 birds in July and then a decrease to eight birds in August. In 2006, the trend was much the same with a total of 11 birds on the lake at the end of March; this was followed by eight by the third week of April and minor declines through May, June and July of nine, seven and six birds. Overall the numbers for both years were similar except for a small peak in July of 2005 and populations were low. Coots are described as common breeders on the lowlands of Ireland and who prefer large shallow lakes with emergent vegetation (Crowe *et al.* 2005). Lough Carra is a very suitable habitat for this species yet they are recorded in relatively low numbers during counts conducted during the winter and breeding months.

To calculate estimates for the number of breeding pairs on the lake, the same methodology as that applied to the Moorhen (*Gallinula chloropus*) was used i.e. the number of pairs were derived from the counts conducted in mid-April for both years and the number of broods added. On 20th April 2005 from a total of ten birds, the number of pairs was calculated as eight (as with Moorhen, lone adults were counted as pairs) and there was one brood seen for this season. In 2006, from a total of eight birds, the number of pairs was calculated as seven and there was one brood recorded during the breeding season. This provided estimates of nine pairs for 2005 and eight for 2006; again these were low numbers for the whole lake but they are reflective of the count data from both breeding seasons.

Figure 31. The peak monthly counts of Coot (*fulica atra*) on Lough Carra during the main nesting, hatching and post-hatching months 2005 & 2006.



Notes: **MH** = March, **AL** = April, **MY** = May, **JE** = June, **JY** = July and **AT** = August.

Plate 26. Coot (*Fulica atra*) on nest.

Photograph by John N Murphy

<u>Mute Swan (*Cygnus olor*)</u>

Main Nesting Period: April.

Mean Count April 2005: 8.

Mean Count April 2006: 6.

Total Brood Count 2005: 3.

Total Brood Count 2006: 4.

Estimated Breeding Population 2005: 5 Pairs.

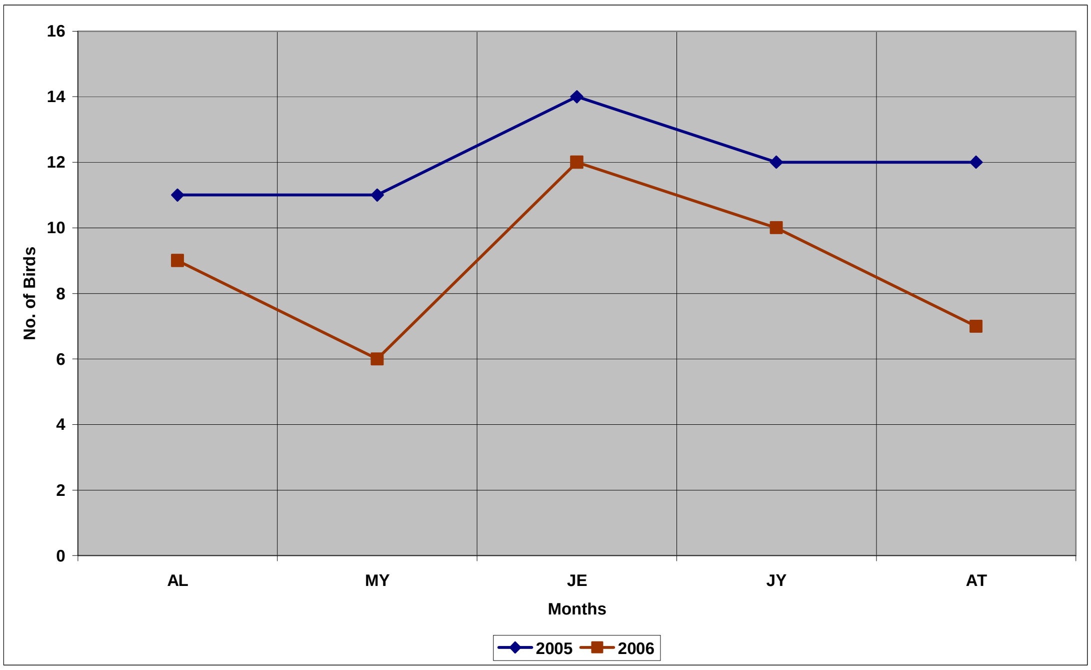
Estimated Breeding Population 2006: 4-6 Pairs.

The Mute Swan (*Cygnus olor*) bred on Lough Carra in 2005 and 2006 and both years were similar in population size. From the older survey (1967-1980), Stronach (1981, p. 127) mentions that,

> There are usually two or three pairs of Mute Swan on Lough Carra throughout the year but occasionally these numbers increase, especially in the autumn when their numbers increase due to the movement of birds which have completed their moult elsewhere.

Since the 1960s and 1970s, the populations of Mute Swans appear to have increased on the lake with an increase in winter numbers and in February of 2006 there occurred a peak of over 20 birds. In terms of numbers during the breeding season of 2005, a steady breeding level population of 11 birds was counted through April and May. In June, there occurred a slight increase to 14 birds with a brood of seven cygnets appearing at Moorehall on 16th of the month and this dropped to 12 in July and remained so into August. The following year in 2006, the number of breeding birds on the lake in April totalled nine on the third week and this dropped to six by 11th May. As with the previous year, there occurred an increase in June to 12 birds with the appearance of family parties on the lake and also a similar decline in July to ten and finally to seven in the second week of August. The trends for both years are broadly similar with the populations of 2005 just above those of 2006 if only by a few birds. It is possible that one or two of those Swans present in April are non-breeders as some do not breed until their second or even third year (Ogilvie & Pearson, 1994), but generally the numbers in April give a good indication of the breeding population size in most years. Mute Swans vigorously defend their territories and there were areas on the lake that held very distinct pairs and for which broods appeared in June-July. From counts conducted in April-May, satisfactory estimates were provided for the number of pairs for both years. From counts conducted on 4th and 20th April and 6th May in 2005, the total numbers on the lake went from 11 to five to 11 birds, during those counts, there were five distinct pairs of Swans recorded in different locations on the lake. Areas such as Burriscarra, Castleburke, Moorehall and Kilkeeran all provided good habitat for breeding Swans and they were recorded in all of those locations in April. Cygnets subsequently appeared at Moorehall, Castleburke and Kilkeeran in 2005 and there were possibly two broods at Moorehall. In 2006, there was just one count conducted in April on 21st due to persistent gales and bad weather at the start of the month. The count on 21st recorded two distinct pairs at Burriscarra and Moorehall but it also included four lone adults at other locations: the question was were these lone birds part of pairs or were they in fact non-breeders? It is believed that at least two were representative of pairs as broods appeared in June at the locations where they were recorded but it is of course possible that they all were part of pairs. From the recording of pairs and broods the estimated number of pairs for 2005 came to five and in 2006 it was estimated as being between four and six pairs.

Figure 32. The peak monthly counts of Mute Swan (*Cygnus olor*) on Lough Carra during the main nesting, hatching and post-hatching months 2005 & 2006.



Notes: **AL** = April, **MY** = May, **JE** = June, **JY** = July, **AT** = August.

<u>Gadwall (*Anas strepera*)</u>

Main Nesting Period: May-June.

Number Recorded in May-June 2005: 2.

Number Recorded in May-June 2006: 3-8.

Total Brood Count 2005: Nil.

Total Brood Count 2006: 1.

Estimated Breeding Population 2005: 2 Pairs (Breeding not confirmed).

Estimated Breeding Population 2006: 1 Pair (Breeding confirmed).

Gadwall (*Anas strepera*) bred on Lough Carra in 2006 and while two pairs were present during the breeding months of May-June in 2005, they were not confirmed as breeding in that year. With the observation of a brood at Moorehall in 2006, the Gadwall became a new breeding species for the lake. Of the Gadwall on Lough Carra, Stronach commented,

> The Gadwall is the least common of our dabbling duck, it arrives in September and leaves later than the other species. It often seemed to me that it would not take much to alter the L. Carra conditions for them to remain behind and breed.
>
> (Stronach, 1981, p. 117).

Gadwall prefer still eutrophic waters with emergent vegetation and with the lakes waters undergoing eutrophication in recent years, the breeding conditions to which Stronach refers now do exist at Lough Carra. From counts conducted over the two breeding seasons of 2005 and 2006, there were a number of records of pairs and other sightings, which for clarity are listed below.

<u>2005</u>

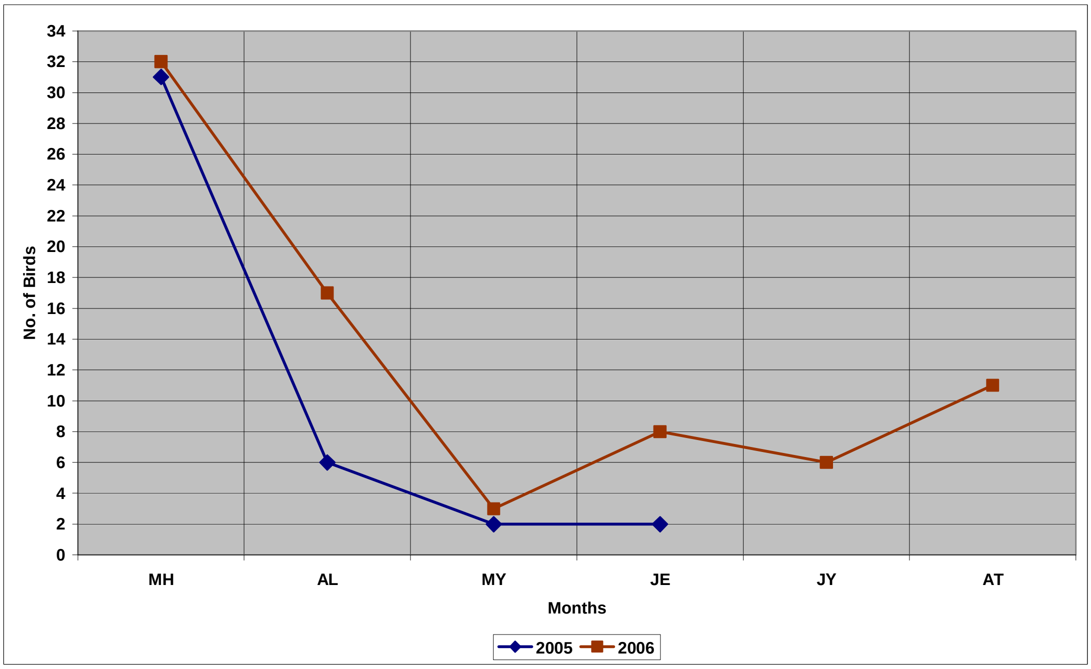
March 13th	31 birds in total.
April 4th	6 birds (at Moorehall).
April 20th	4 birds (at Moorehall).
May 6th	2 birds (pair at Moorehall).
May 26th	2 birds (pair at Moorehall).
June 8th	No Gadwall recorded.
June 16th	2 birds (pair at Moorehall).

2006

March 23rd	32 birds in total.
April 21st	17 birds (including 2 pairs seen at Burriscarra and Kilkeeran).
May 11th	1 bird (a male seen at Kilkeeran).
May 26th	3 birds (1 pair at Kilkeeran and 1 male at Burriscarra).
June 13th	8 birds (2 adults + brood of 4 at Moorehall and 1 pair at Kilkeeran).
June 26th	3 birds (juveniles from brood seen in the reedbeds at Moorehall).
July 3rd	5 birds (1 female and 4 juveniles at Moorehall).
July 20th	6 birds (1 lone male and 1 female + 4 juveniles at Moorehall).
August 14th	11 birds (in a flock at Moorehall).
August 29th	9 birds (in a flock at Moorehall).

Of particular interest from 2005, was the fact that a pair was recorded through May and again in the middle of June at Moorehall, unfortunately despite separate field visits to Moorehall during May and June, no nest was found and no brood recorded, hence breeding could not be confirmed. In 2006, there were pairs seen at Burriscarra and Kilkeeran, a record at the latter site of a lone male in mid June after a pair was recorded on the 13th the month, may suggest that the female was on a nest (Huxley *pers. comm.*) although no brood was recorded thereafter. Breeding was finally confirmed for a pair at Moorehall when on 13th June two adults and a brood of four young were recorded at this location. On 20th July this brood was seen again at Moorehall feeding in a group and a male was present but away from the family party, it is not known whether this was the same bird that was seen with the female and brood on 13th June. In relation to the record of 11 birds at Moorehall on 14th August, the total suggests that there were five (one female and four males) more Gadwall present in addition to the four young and two adults observed on 13th June and 20th July. One hypothesis would be to suggest that these were additional birds that bred on the lake in other locations (possibly where pairs were recorded) and who had joined up with the family party at Moorehall at the end of the breeding season. However, the fact that no additional juveniles were identified in the flock of 11 makes this seem unlikely. Other possibilities suggest that these were birds that bred outside the lake and were returning slightly earlier than normal or they were non-breeders who stayed on at the lake throughout the breeding months but did not nest.

Figure 33. The peak monthly counts of Gadwall (*Anas strepera*) on Lough Carra March-August 2005 & 2006.



Notes: **MH** = March, **AL** = April, **MY** = May, **JE** = June, **JY** = July, **AT** = August.

5.8.2 Site Accounts

While Lough Carra as a complex is an important site for breeding and wintering waterfowl, from those counts conducted over the spring/summer, it became clear that certain areas around the lake played an important role to waterfowl in providing them with both nesting habitats and cover (such as reedbeds) in which to rear their young and even if they did not nest in a given site they could still use it for this purpose. While the breeding numbers of each species inevitably vary from place to place, all the sites around Lough Carra covered by the count points held some evidence for breeding for at least one species of waterfowl. In terms of general areas around the shores of the lake, the 27 count points used for the count programme covered 12 distinct areas in which broods and/or nests were recorded in nine and in the remaining three sites, although broods and/or nests were not recorded, pairs of certain species were seen. What follows is a list of each of the 12 sites and the evidence of breeding recorded in each during 2005 and 2006. It should be noted that where a certain species is not listed as a confirmed breeder for a site, this does not rule out the possibility of it having bred there. This is a particularly relevant point in relation to those 'skulking' species such as Moorhen (*Gallinula chloropus*) and Little Grebe (*Tachybaptus ruficollis*).

<u>**Notes on Site Accounts**</u>

Count Points = The numbered count points that are located within the site.

Number of Species = The number of waterfowl species with evidence for breeding (at least a pair present) at the site.

2005/2006 = The species with evidence for breeding recorded in each year are listed. Where a species has already been listed for the site in 2005, it is denoted with **(*)** in 2006.

Female with brood = One female with brood of young / More than one female with a brood of young is noted as 'female with brood' and the number of broods in that year e.g. x 2.

Pair = If a brood and/or nest was recorded elsewhere on Carra for a certain species but only a pair of this species were recorded at the site in question.

The Northwest Basin

1 – Doon Peninsula (Count Points 1 & 2).

Number of Species: 1.

2005 & 2006

(1) Red – breasted Merganser (*Mergus serrator*) = 1 Pair

2 – Burriscarra (Count Points 3, 4, 5 & 6).

Number of Species: 3.

2005

(1) Mallard (*Anas platyrhynchos p*) = Female with brood.

(2) Great Crested Grebe (*Podiceps cristatus*) = Pair with nest.

2006

(3) Mute Swan (*Cygnus olor*) = Female with brood.

(*) Mallard = 1 pair/Female with brood x 2.

(*) Great Crested Grebe = Pair with nest.

3 – Castleburke (Count Point 7).

Number of Species: 6.

2005

(1) Mallard (*Anas platyrhynchos p*) = Female with brood x3.

(2) Great Crested Grebe (*Podiceps cristatus*) = 2 pairs/Female with brood.

(3) Mute Swan (*Cygnus olor*) = Female with 1 cygnet.

(4) Red–breasted Merganser (*Mergus serrator*) = 1 pair mating.

2006

(5) Moorhen (*Gallinula chloropus*) = Female with brood.

(6) Tufted Duck (*Aythya fuligula*) = Female with brood.

(*) Mallard = Female with brood x3.

(*) Mute Swan = Female with brood.

4 – Church Island (Count Point 8).

Number of Species: 3.

2005

(1) Tufted Duck (*Aythya fuligula*) = 1 pair.

(2) Mallard (*Anas platyrhynchos p*) = Female with brood.

2006

(3) Red-breasted Merganser (*Mergus serrator*) = 1 pair.

(*) Tufted Duck = 5 pairs.

5 – Heneghan's Bay (Count Points 9, 10 & 11).

Number of Species: 2.

2006

(1) Mallard (*Anas platyrhynchos p*) = 1 pair.

(2) Red-breasted Merganser (*Mergus serrator*) = 1 pair.

6 – Kilkeeran (Count Points 12, 13, 14, 15, 16 & 17).

Number of Species: 8.

2005

(1) Mallard (*Anas platyrhynchos p*) = Female with brood.

(2) Tufted Duck (*Aythya fuligula*) = Nests/Female with brood x 4.

(3) Moorhen (*Gallinula chloropus*) = Female with brood.

(4) Coot (*Fulica atra*) = Nests/Female with brood.

(5) Red-breasted Meganser (*Mergus serrator*) = 1 pair.

(6) Mute Swan (*Cygnus olor*) = Female with brood.

(7) Gadwall (*Anas strepera*) = 1 pair.

2006

(8) Great Crested Grebe (*Podiceps cristatus*) = Nests.

(*) Mallard = Female with brood.

(*) Tufted Duck = Nests/Female with brood x 2.

(*) Moorhen = Female with brood.

(*) Mute Swan = Female with brood x 2.

(*) Gadwall = 1 pair.

The Southeast Basin

7 – Partry House Estate (Count Points 18, 19 & 20).

Number of Species: 4.

2006

(1) Mallard (*Anas platyrhynchos p*) = Female with brood.

(2) Little Grebe (*Tachybaptus ruficollis*) = Female with brood.

(3) Tufted Duck (*Aythya fuligula*) = 4 pairs.

(4) Great Crested Grebe (*Podiceps cristatus*) = 1 pair.

8 – Cloonee (Count Point 21).

Number of Species: 2.

2006

(1) Mallard (*Anas platyrhynchos p*) = Female with brood.

(2) Tufted Duck (*Aythya fuligula*) = 2 pairs.

9 – Brownstown (Count Point 22).

Number of Species: 1.

2005

(1) Red-breasted Merganser (*Mergus serrator)* 2 pairs.

2006

(*) Red-breasted Merganser = A group of 15 seen by Chris Huxley (*pers. comm.*) comprising 4 adults and a crèche of 11 young.

10 – Annie's (Count Point 23).

Number of Species: 2.

2006

(1) Mallard (*Anas platyrhynchos p*) = 1 pair.

(2) Great Crested Grebe (*Podiceps cristatus*) = 2 pairs.

11 – Moorehall (Count Points 24 & 25).

Number of Species: 6.

2005

(1) Mallard (*Anas platyrhynchos p*) = 2 pairs.

(2) Tufted Duck (*Aythya fuligula*) = Female with brood x 3.

(3) Coot (*Fulica atra*) = Pair with nest.

(4) Mute Swan (*Cygnus olor*) = Female with brood x 2.

(5) Gadwall (*Anas strepera*) = 2 pairs.

2006

(6) Moorhen (*Gallinula chloropus*) = Female with brood.

(*) Mallard = Female with brood x 7.

(*) Coot = Nest / Female with brood.

(*) Gadwall = Female with brood.

12 – Otterpoint (Count Points 26 & 27).

Number of Species: 2.

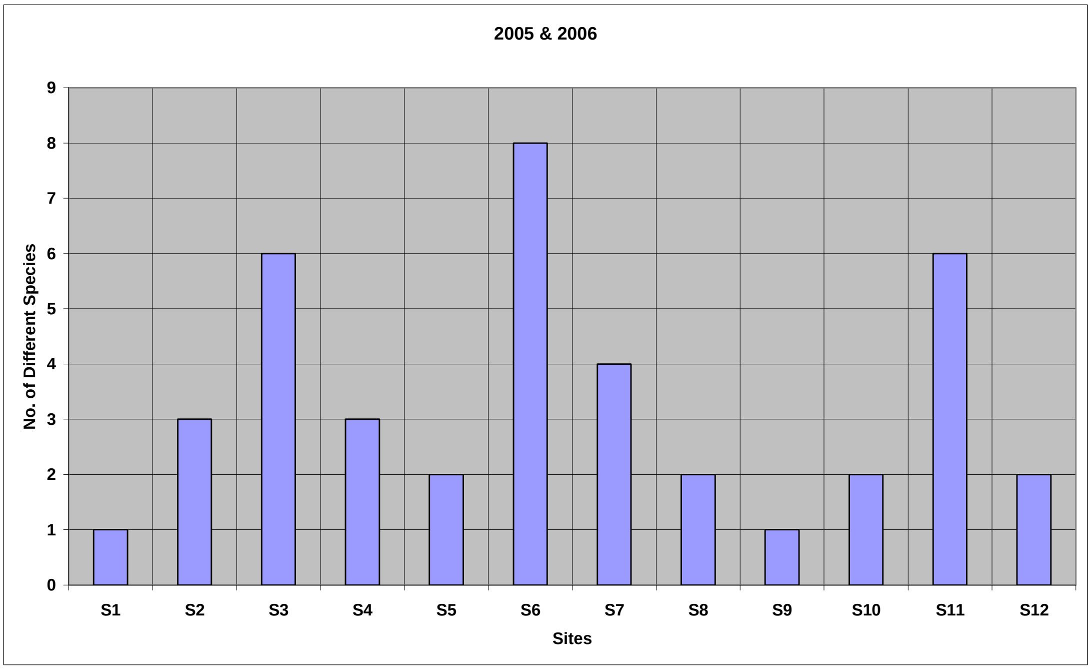
2006

(**1**) Mallard (*Anas platyrhynchos p*) = Female with brood.

(2) Tufted Duck (*Aythya fuligula*) = 2 pairs.

The site with the most diverse species of waterfowl recorded in spring/summer was Kilkeeran which held eight species, followed by Castleburke and Moorehall which each held six species. Next is Partry with four species while both Burriscarra and Church Island held three. Heneghan's Bay, Cloonee, Annie's and Otterpoint held two while at Doon and Brownstown just one species was recorded.

Figure 34. The number of different species recorded at 12 sites at Lough Carra during the breeding seasons of 2005 & 2006.



Notes: **S** = Site.

S1 = Doon / **S2** = Burriscarra / **S3** = Castleburke / **S4** = Church Island /

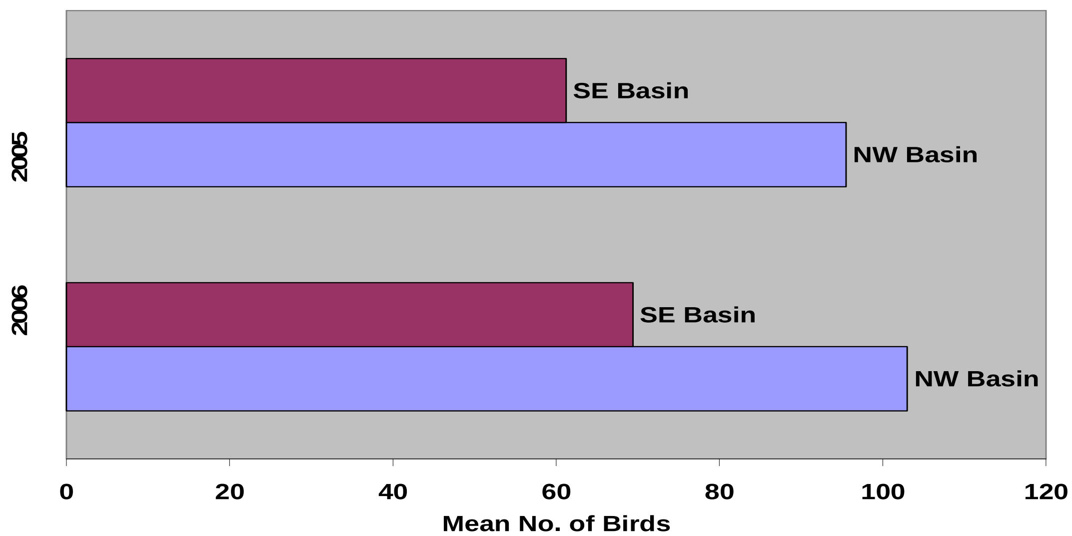
S5 = Heneghan's Bay / **S6** = Kilkeeran / **S7** = Partry House Estate / **S8** = Cloonee /

S9 = Brownstown / **S10** = Annie's / **S11** = Moorehall / **S12** = Otterpoint.

5.8.3 Geographical Spread

As a whole Lough Carra held a total of nine breeding waterfowl species but for the purposes of this study, the two basins were looked at individually to assess if there were any differences in the variety and number of species breeding in each. If one applies the criteria used to confirm breeding for the nine waterfowl species on the lake as a whole (listed in Table 25, p. 202) to the two basins individually, then both the southeast and northwest basins held eight confirmed breeding waterfowl species during 2005 and 2006. This is because Gadwall (*Anas strepera*) was not confirmed as breeding in the northwest basin and the Great Crested Grebe (*Podiceps cristatus*) was not confirmed as breeding in the southeast basin. To calculate the biomass (the total numbers of birds) for each basin over the spring and summer periods of 2005 and 2006, the mean number of each species present in each basin was derived from counts conducted from the start of March to the end of July for both years and then the sum of all birds present in each basin was calculated. The results from these calculations show that there was a higher number of birds present during the spring/summer in the northwest basin during both years than in the southeast basin. The data reveal that in 2005, there were 95.5 (61%) birds present in the northwest basin and 61.2 (39%) in the southeast basin. While in 2006, the totals were 103 (60%) and 69.4 (40%) respectively, showing an increase in both basins but again with higher populations in the northwest.

Figure 35. The mean number of nine waterfowl species present in the northwest and southeast basins of Lough Carra from the start of March to the end of July 2005 & 2006.



Chapter 6: Habitat Analysis

6.1 Introduction

Within the scope of this study, one of the research objectives was to develop hypotheses for the fluctuations of waterfowl populations on Lough Carra by investigating the changes that may have taken place in the habitats used by the birds at and adjacent to the lake. With this objective in mind, three specific areas were looked at and these were (1) Aquatic vegetation, focusing on the distribution of the Common Reed (*Phragmites communis*) on the lake, (2) Island vegetation in relation to the changes to the breeding habitat for Mallard (*Anas platyrhynchos p*) on the islands due to ecological succession and (3) Land use and habitat change in the sub-catchments of Annie's River and Ballyglass to the east of Lough Carra. In terms of the distribution of the Common Reed (*Phragmites communis*) on Lough Carra, the data from two previous studies were obtained for analytical purposes, the first of these studies was carried out by J. Shackleton during July and August of 1975 and the second was a comparative study conducted by Chris Huxley in 2003 (paper pending) who used a methodology similar and in part identical to that used by Shackleton. To investigate island habitat change, Doonbeg Island (Island 12) was re-mapped for comparative analysis and data from Stronach (1981) and found in Shackleton's colour coded maps was also used referred to. To assess possible changes to the habitat in the sub-catchments, the results from a study by Neil Lockhart (1982) were consulted and particularly the colour coded maps he produced identifying the different habitats found within the catchment. After re-mapping the distribution of the reedbeds on the lake, Huxley provided the author with his new map and the colour coded maps given to him by Shackleton. For additional information on his findings, the author conducted an interview with Chris Huxley on 23rd August 2006.

6.2 Reedbed Analysis

Brief Description of the Common Reed (*Phragmites communis*)

The Common Reed *(Phragmites communis*) is found throughout Ireland and is a familiar sight in marshes and freshwater habitats. This perennial is described as Ireland's tallest grass which flowers in late July through October and then turns brown in winter. The sturdy stems can grow up to two metres in height and displays long pointed leaves and clusters of flowers which when young are purple-like in colour but turn light brown and feathery when mature (Sterry, 2004). This species can tolerate and thrive in a range of different habitats including pond margins, ditches and swamps and can tolerate brackish waters as well as freshwater environments. For this reason, it has become a rampant invasive species in countries such as Canada and the United States where it has no natural predator to keep it in check.

6.2.1 Reedbeds and Waterfowl

In Europe where it is a native species, reedbeds are recognised as an invaluable habitat for wildlife and a number of bird species but particularly waterfowl (Orton *et al*. 2000). Their structure provides shelter, breeding habitat and screening from predators and as they are rich in biodiversity, reedbeds are home to a range of species of both plants and animals that in turn are food for waterbirds (for example insect life such as *Chironomids* or midges and invertebrates such as snails). As a result, many wildfowl reserves through reedbed management encourage and sustain wildfowl populations throughout Europe.

The Common Reed (*Phragmites communis*) grows in vast stands on Lough Carra and it has been described as growing extensively in and around the lakes many sheltered bays (Crowe *et al.* 2005). They were noted by Stronach (1981, p. 11) when he wrote,

> Reedbeds of *Phragmites communis* are situated in shallow water round the lake, where the bottom is marl. Some of the beds are extensive and form useful moulting and breeding cover.

All of the nine waterfowl species breeding on the lake use the *Phragmites* beds either as nesting habitat or to rear their young and very often for both purposes. As mentioned in the previous chapter, the Little Grebe (*Tachybaptus ruficollis*) and Great Crested Grebe (*Podiceps cristatus*) both use aquatic vegetation such as reeds to anchor their nests and species such as Moorhen (*Gallinula chloropus*), Mute Swan (*Cygnus olor*), Coot (*Fulica atra*) and Gadwall (*Anas strepera*) site their nests in or on the borders of reedbeds and associated emergent vegetation (Evans 1977, Martin 1993, Ogilvie & Pearson 1994). The stands of *Phragmites communis* and their allies are vital to all those species mentioned as well as to the Mallard (*Anas platyrhynchos p*) and Tufted Duck (*Aythya fuligula*) as cover in which to rear their young. It is in the first few weeks of the brooding period that young birds are at their most vulnerable to predation (Vaananen, 2001) and the reedbeds found in such locations as Castleburke, Moorehall and Kilkeeran, provide the females and broods with cover and increase their chances of survival. During the months outside of the breeding season, the reedbeds are used by the birds as 'loafing' areas and when they are preening or not actively feeding. Species such as the Great Crested Grebe (*Podiceps cristatus*) have been recorded in groups in the reedbeds near Moorehall, where they rest while on spring passage through the lake.

The reedbeds, as Stronach pointed out are equally important to those waterfowl species for moulting cover. The moulting process that all birds must undertake is essential to the survival of all species as feathers have a relatively short lifespan and as they become worn and frayed, must be replaced if a bird is to remain capable of flight. As Ogilvie and Pearson (1994, p. 53) note,

> Throughout the bird kingdom, nearly all species solve this problem by moulting the feathers very slowly, a few at a time and allowing each replacement to grow nearly to full size before moulting some more. This means that the bird never loses the power of flight, but the moult process necessarily lasts many weeks or even months...The wildfowl, and a few other groups of birds (principally the divers, grebes and some of the rails), have evolved a different solution to the problem of wing moult. They shed their main flight feathers simultaneously and the new feathers grow together.

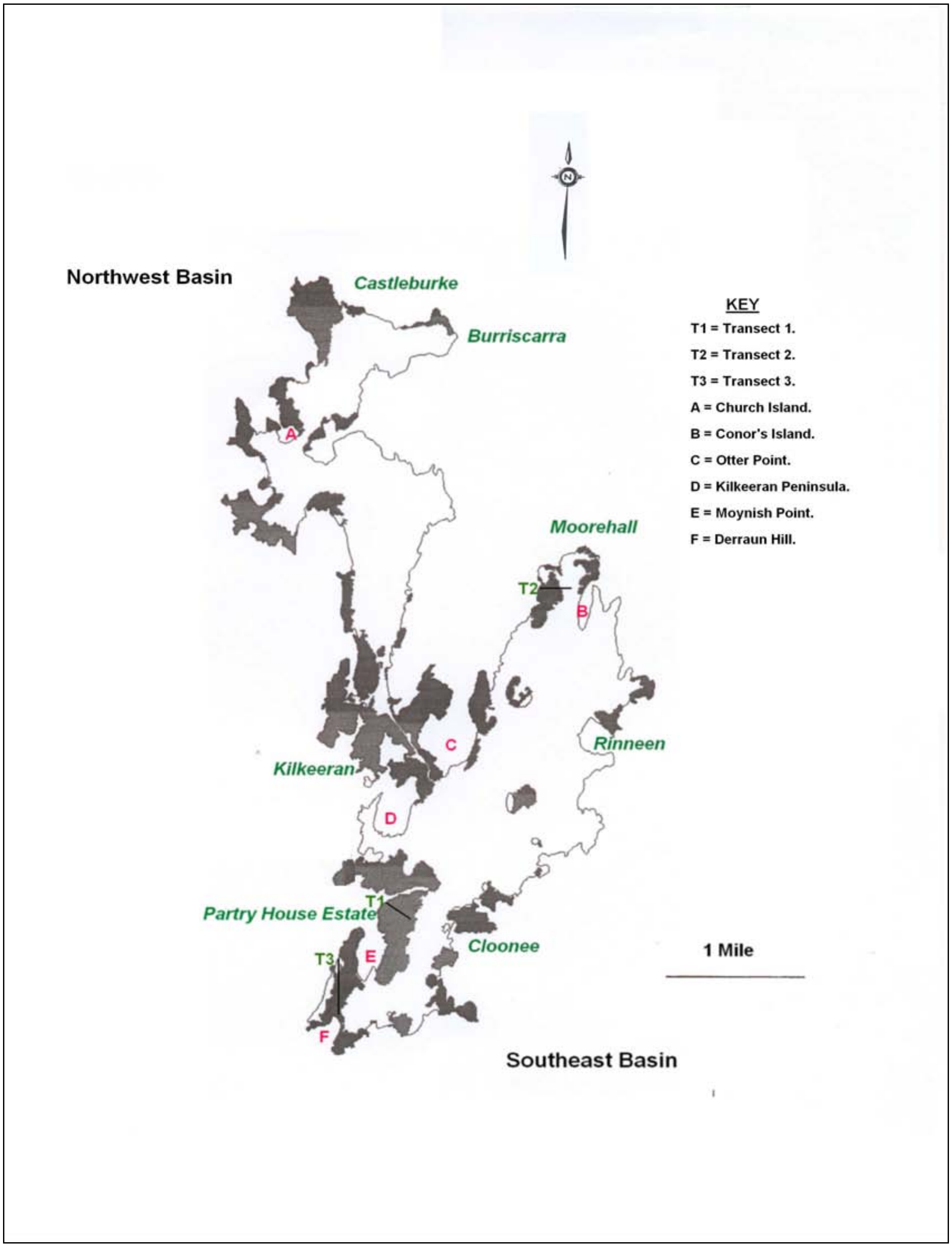
The advantage to moulting and re-growing the wing feathers in one process, is that the moulting period is much shortened and can be completed in about four weeks (bigger species such as the Mute Swan can take up to seven) and this saves energy and rules out long periods of impaired flight (Ogilvie & Pearson, 1994). The disadvantage of losing the main feathers in this fashion, is that it leads to the bird becoming flightless for the duration of the moult (albeit short). This leaves the bird vulnerable to attacks by predators such as the American Mink (*Mustela vison*) and Red Fox (*Vulpes vulpes*) and it is not quite as efficient at obtaining food. Birds such as geese which have been a food source for centuries are often corralled and caught by groups of hunters during their moult as mankind discovered their annual cycle of moulting leading to flightless quarry. While not guaranteeing complete safety, the reedbeds at Lough Carra provide waterfowl with cover and shelter while moulting and incapable of flight. Stronach (1981) observed that around mid June each year, groups of male Mallard were seen flying around the reedbeds on the lake looking for moulting grounds and that after about a week, these exploratory flights ceased as the primary moult had started.

6.2.2 The Study of Reedbed Density & Distribution on Lough Carra

During July and August of 1975, Shackleton carried out extensive research on the vegetation of Lough Carra which included taking water and soil samples, mapping the littoral vegetation and he trapped and identified moths in the reedbeds and fens around the lake (Anon, 1978). The results from this research can be found in the unpublished paper 'A Study of Certain Aspects of the Vegetation of Lough Carra'. As part of his research into the littoral vegetation on the lake, Shackleton investigated the distribution and density of the Common Reed (*Phragmites communis*) by mapping its boundaries and by measuring the number of reeds per square metre along three transect lines in the southeast basin (see Map 7). These transects went through the extensive reedbeds located off Moynish Point (Transect 1), off Creggaun Wood (Transect 2) and by Moorehall (Transect 3). As part of on-going research into the ecology of the lake and its adjacent environment, Chris Huxley obtained colour coded maps and field notes from Shackleton (based on his survey work in 1975) and proceeded to embark on a comparative study to assess the possible changes in the littoral vegetation on Lough Carra since the initial survey.

Starting in 2003, Huxley re-mapped and surveyed the distribution and density of the reedbeds on the lake (see Map 6). To map distribution, he used a boat and starting at the corner of the reedbeds or where they met the shore and he then plotted lines every five metres using a hand-held Global Positioning System (G.P.S.) while working his way around the bed's circumference, a similar methodology to Shackleton's incorporating modern technology. For the attainment of comparative data he also re-surveyed reed density along the same three 1,350 metre transect lines as laid out in the southeast basin by Shackleton. The findings and conclusions of this comparative study are to be published in a forthcoming paper by Huxley (Chris Huxley *pers. comm.*). Of particular interest and importance from the point of view of the waterfowl on Lough Carra, were the two *Phragmites* distribution maps from the two different eras. As the older study by Shackleton was conducted in 1975, the waterfowl populations as can be seen from Stronach's (1981) data, were still far greater for most species at this time. From the new reedbed distribution map, it would be possible to see if there was a correlation in the changes to reedbed distribution and the decline in wildfowl numbers since 1975.

Map 6. The distribution of the Common Reed (*Phragmites communis*) on Lough Carra. after Huxley (2003). Map by Huxley with annotation by Meehan. The dark areas represent the extent of the reedbeds and the three line transects are those used by Shackleton (1975) and by Huxley (2003).



Note: Not all the islands on the lake are shown.

Map 7. The distribution of the Common Reed (*Phragmites communis*) and the Bulrush (*Scirpus lacustris*) on Lough Carra after Shackleton (1975). Map from (Anon, 1978) with annotation by Meehan.

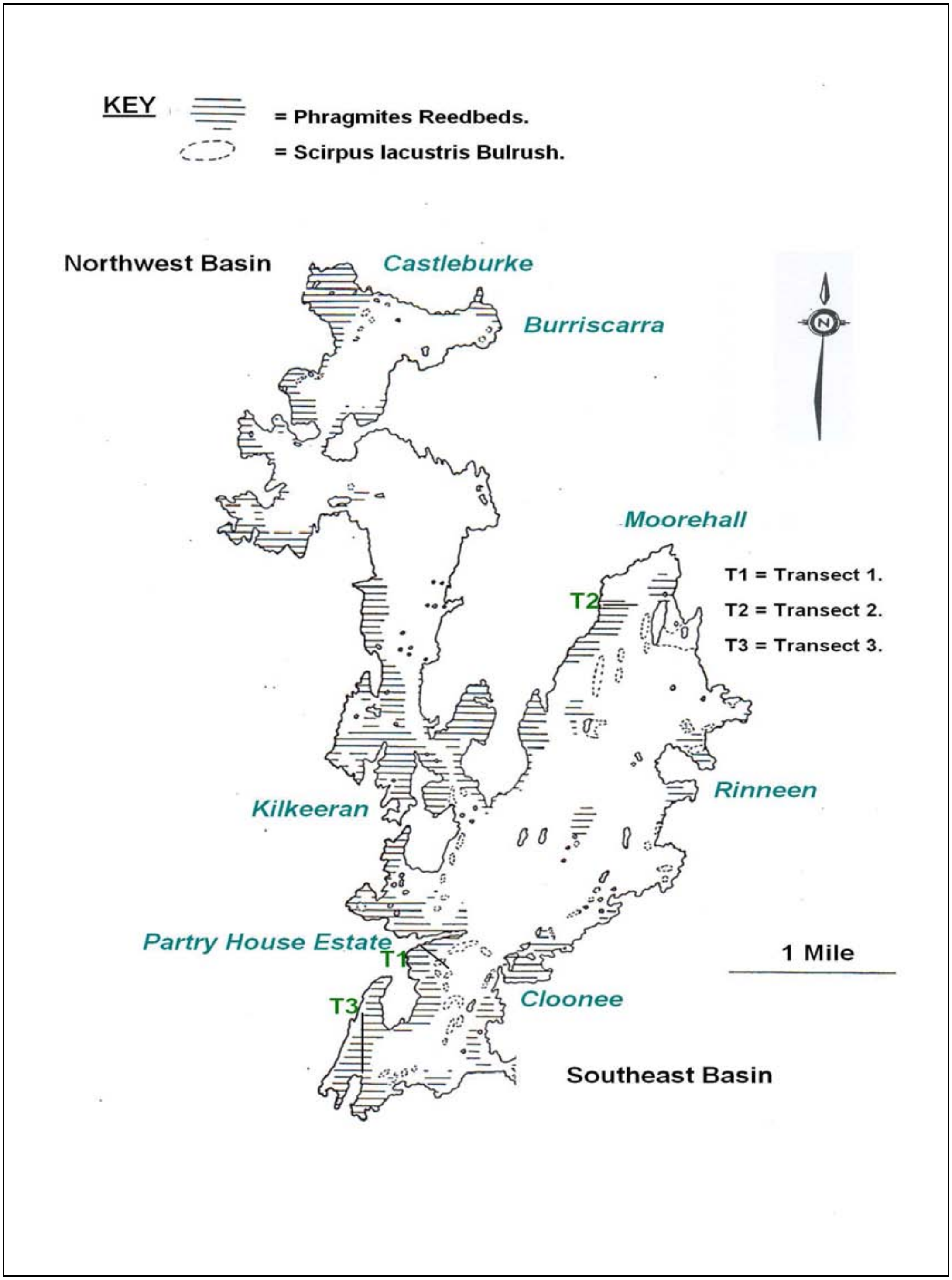


Plate 27. Reedbed (*Phragmites communis*) at Lough Carra.

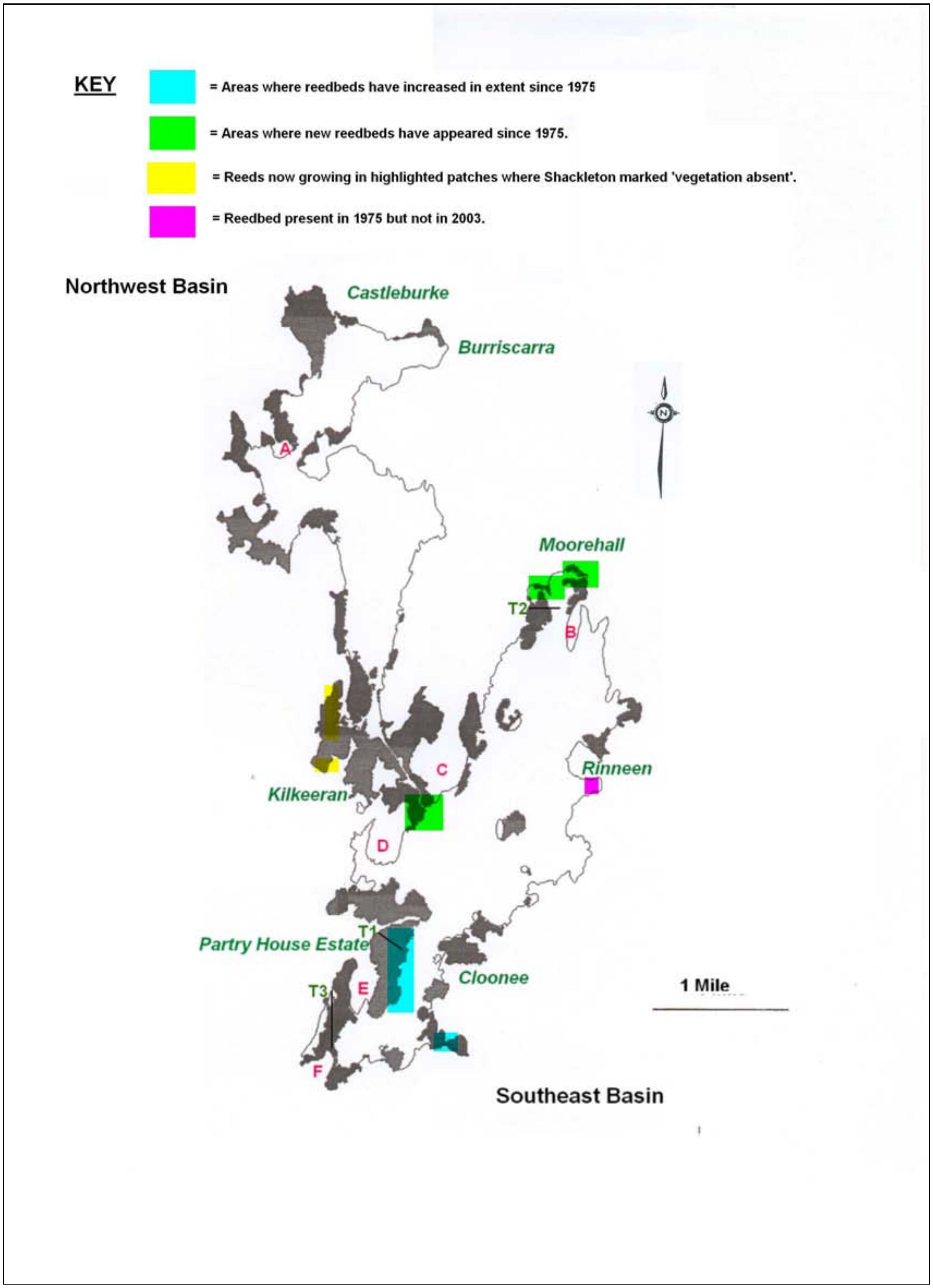
6.2.3 Comparative Analysis

From his distribution map and notes from his survey work, Huxley's research shows that the extent of the reedbeds on Lough Carra has increased over the 28-30 years since Shackleton's study in 1975, in some areas the increases in extent are subtle while in others they are more obvious (see Map 8). As Huxley (2006) states,

> The extent and density of the reedbeds have changed. There are areas where the reedbeds are now less dense than they were 30 years ago and there are areas where they are more dense. In general the extent of the reedbeds is greater now than it was 30 years ago.

There are three easily identifiable areas on the lake where very large stands of reeds are present and these are termed as the 'main beds' for the purpose of analysis. These main beds are situated at the top or northern end of the northwest basin near Castleburke, at Kilkeeran at the bottom or southern end of the northwest basin and along the western shores of the southeast basin where the beds begin below the Kilkeeran Peninsula and continue along the shores around Moynish Point and down into the bottom end of the lake. Firstly to look at these three areas, changes have occurred in the *Phragmites* beds at Kilkeeran in the northwest basin and between Leamnahye Island and the head of Moynish Point in the southeast basin. At Kilkeeran, near its western shore, there are now reedbeds present where there was open water before and also where on Shackleton's 1975 map he has denoted these areas with the letters V.A. (Vegetation Absent). Also new beds have

Map 8. The main changes in the distribution and extent of the Common Reed (*Phragmites communis)* on Lough Carra from Huxley (2003) after Shackleton (1975). Map by Huxley with annotation by Meehan.



appeared at the mouth of the Kilkeeran channel between the north eastern tip of the peninsula and Otter Point where it opens out onto the larger expanses of the southeast basin. In the southeast basin the reeds have extended greatly out onto the open water where the lake narrows between the shores of two estate lands, namely Partry House and Cloonee. There are now reedbeds visible from the shoreline at Partry House Estate where there were none in 1975 (Huxley, 2006) and if the beds continue to expand, the channel between Partry and Cloonee may get narrower in years to come.

There have been further appearances of reedbeds where there were very little or none before, for example in the eastern and western corners of Moorehall and in small bays on the western shores of the southeast basin. In terms of the geographical spread of the reedbeds over the two basins, both studies show there are stretches of shoreline where there is a complete absence or very little growth. Two particularly barren stretches occur from Burriscarra in the top right corner of the northwest basin down to where the beds at Kilkeeran begin. The second starts below Conor's Island near Moorehall and continues down to where the smaller reedbeds at Cloonee begin; however, even on the shores of Cloonee the growth is patchy and more scattered. Huxley has formed a hypothesis regarding these low growth areas. He believes that it may at least partly be related to the weather and particularly wind direction. When looking at the distribution maps, it is clear that the barren stretches of shoreline mentioned above are located on the eastern shores of their respective basins. The hypothesis cultivates the idea that low growth occurs due to these easterly shores being exposed to the prevailing winds coming out of the west for most of the year. Therefore, the higher levels of growth and distribution occurs along the western sides of both basins where there is more shelter from the elements and particularly the prevailing westerly winds. The only exception to this rule, can be seen in a large bay to the east of Derrynafraha Island and to the north of Otter Point. Here in this bay on the eastern shore, the reeds have thrived and grown extensively. There are two important factors to be considered that shed light on their success here. Firstly, the bay is narrow, long and for the most part is sheltered due to elevated countryside that surrounds it and secondly it is very shallow in depth with the marl bottom being clearly visible and so provides the Common Reed with an ideal habitat and conditions in which to grow. These factors apply to the whole area of Kilkeeran in general and are why the *Phragmites* have colonised its narrow channels and bays so extensively. The water levels in this part of the lake are very low and so much so that during the summer months it can be difficult to get a boat through the shallows.

In terms of reed density, results from the survey work carried out by Huxley (2003) using the three transects as laid out by Shackleton (1975), show that in places the reeds are less dense while in other areas they are denser. Huxley (2006) states that the changes in density through some of the main reedbeds are difficult to interpret and that while changes have taken place, they are not consistent. This in turn makes analysis of how these changes may effect the waterfowl who use them more difficult, however as there was a lack of consistency in the density of the three reedbeds through which the transects cut, it seems unlikely that a lack of uniformity in density in some areas would have a serious negative effect on the lakes waterfowl. In 1975, Shackleton also mapped the distribution of the bulrush (*Scirpus lacustris*) on the lake and as part of his on-going research on Lough Carra, Huxley also intends to re-map the distribution of this species. However even by casual observation when out on or around the lake, one can see that this species is spreading very rapidly and these changes have been more consistent than the changes in the density of the reedbeds. As Huxley (2006) states,

> ...there has been a very large increase in the density and extent of the growth of the bulrush (*Scirpus lacustris*) and its very marked and on-going. There are more this year than there were last year, and more last year than the year before and so on.

The changes in the extent and density of the bulrush is a reflection of the overall changes in the extent and density of the emergent vegetation around the lake in general. Possibly due to human intervention, the water levels do not drop as low as they used to (Huxley, 2006). Furthermore, Lough Carra is undergoing eutrophication. These factors as well as the suitable natural environmental conditions on the lake, appears to be leading to more extensive and dense reedbeds, bulrushes and other associated aquatic species. These are examples of the more obvious changes in the extent and density of the *phragmites* reedbeds and the bulrush (*Scirpus lacustris*) on the lake but there has occurred more subtle less obvious changes too which will be highlighted in the forthcoming paper on the subject by Huxley. The extent of the *Phragmites* beds is of great importance to the waterfowl species on Lough Carra and as mentioned, from the comparative data not only have they remained intact since the 1970s but have in fact increased in many areas also.

6.3 Island Habitat Analysis

In the island accounts section of Chapter 5, a brief habitat description was provided for each of the islands surveyed as part of this study over 2005 and 2006 and it was noted that all feature a habitat dominated by either mature deciduous woodland with a mixture of smaller trees and shrubs or with mainly small tree species and shrubs. The former habitat applies to the larger islands (Islands 58, 21, 22, 23, 16 and 17) while the smaller islands (Islands 61, 12, 37 and 49) incorporate more the latter habitat type. These are general descriptions and the woodland cover varies in density and character between islands and also varies on different parts of individual islands. For example Gleneary (Island 58) was particularly difficult to search when conducting fieldwork over the two years as its northern and central parts were covered in mature trees and dense pockets of smaller trees and shrubs, however the woodland is more open with less density towards its southern end where the rookery on the island is located. These characteristics are associated with the size of the island in question and the type of soils found there as this will inevitably dictate the type of habitat that will develop and to what extent.

In most cases on the islands, there are four zones which were identified by Praeger, Neff (Anon, 1978) and Shackleton (1975). The first is known as the Hydrophyte Zone where emergent species such as the Common Reed (*Phragmites communis*) and the Bulrush (*Scirpus lacustris*) are found. Near the waters edge is the *Schoenus* Zone where plants associated with wet soils are present such as Black Bog Rush (*Schoenus nigricans*) and Northern Bedstraw (*Galium boreale*). In the *Sesleria* Zone further from the water's edge (this zone was categorised as grassland by Shackleton, 1975), the drier soils support grassland species such as Purple-Moor-Grass (*Molina caerulea*) and Quaking Grass (*Briza media*). In the *Schoenus* zone Willows are quick to colonise but the woodland zone usually begins in the higher and better drained soils (Stronach, 1981) and often the smaller trees or scrub gives way to more mature woodland towards the centre of the larger islands. Both Kelly (Anon, 1978) and Shackleton (1975) carried out research on the woodland and scrub on the islands and around the shores of the lake. It was identified that the smaller islands with open scrub held species such as Ash (*Fraxinus excelsior*), Grey Willow (*Salix cinerea*), Holly (*Ilex aquifolium*) and Hazel (*Corylus avellana*) amongst others. These were also present on the fringes of the larger islands along with Hawthorn (*Crataegus monogyna*) and Blackthorn (*Prunus spinosa*). Kelly as part of his studies, surveyed Castle

Island where he listed the following species as being present in the central wooded areas, Ash, Wych Elm (*Ulmus glabra*), Hazel, Hawthorn, Blackthorn, Holly, Spindle Tree (*Euonymus europaeus*), Elder (*Sambucus nigra*), Wild Cherry (*Prunus spinosa*), Grey Willow and Sycamore (*Acer pseudoplatanus*). He also mentions low woody species such as Bramble (*Rubus fruticosus*), Wild Rose (*Rosa sherardii*) and Ivy (*Hedera helix*) and what he terms as 'dominant herb species' namely Hogweed (*Heracleum sphondylium*) and Nettle (*Urtica dioica*).

The mature or almost mature woodland found on the islands of Lough Carra exhibit the pinnacle species found in the latter stages of ecological succession. The slow natural progression of ecological succession on the islands was described by Stronach (1981, p. 35),

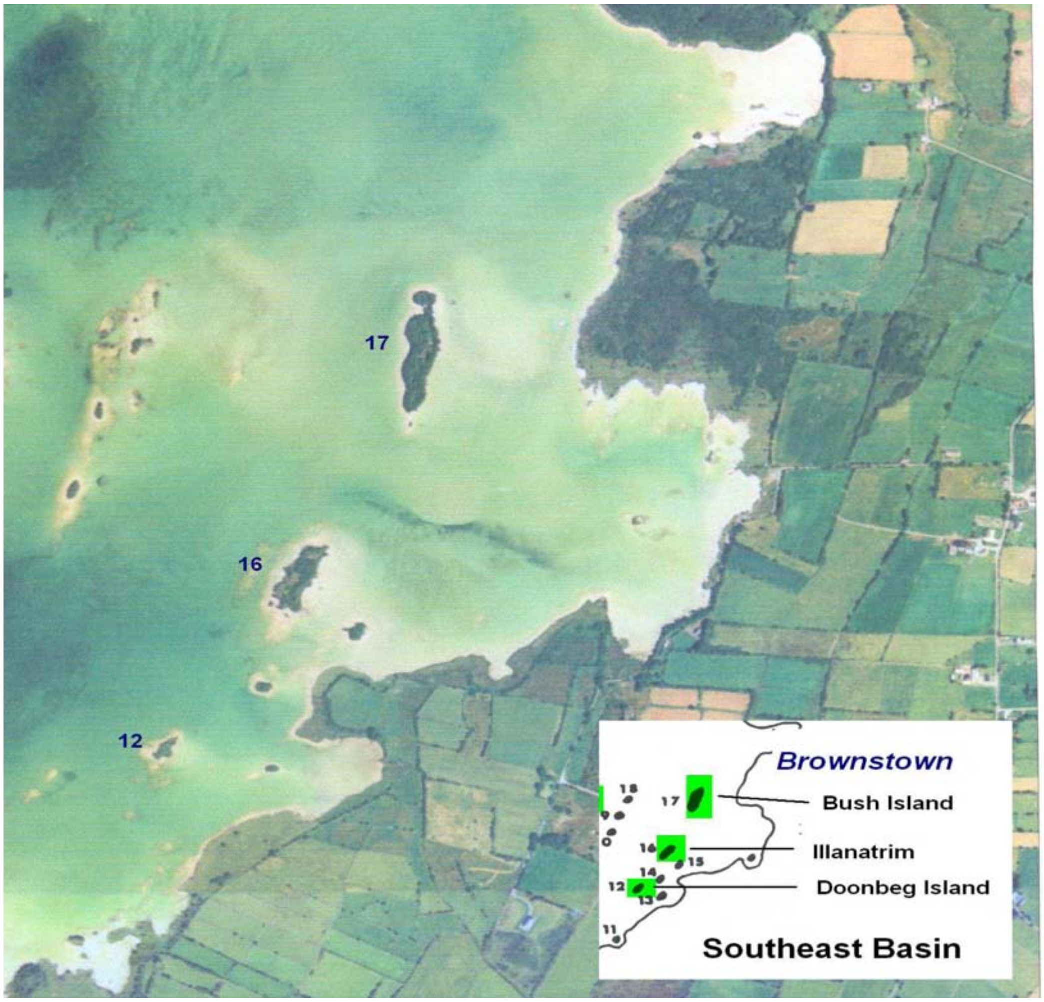
> On these islands, the plant succession was presumed to start on open rocky sites, passing to a vegetational type with weeds, then a period consisting of colonisation by sedges and grasses, here *Schoenus nigricans, M. caerulea* and *Sesleria*. The next stage, a light woody vegetation gradually built up to mature woodland.

Stronach (1981), states that all these stages of ecological succession were noticeable on the islands and points out that Ruttledge also noticed the natural progression to woodland. In 1943, Ruttledge studied a colony of Black-headed Gulls (*Larus ridibundus*) on Lakeview Island near his home at Cloonee in the southeast basin. At this time the habitat on the island consisted of a thin covering of weeds which was ideal for the breeding gulls. By 1973 the habitat on Lakeview Island had reached the woodland stage of succession with the mature trees reaching up to 30 feet in height (Stronach, 1981), this change occurred within a time-span of 30 years. Stronach goes on to mention that, the time-span of his studies was not long enough to notice major vegetational changes associated with ecological succession on the islands but does note that the steady growth of young Birch trees in the *Sesleria* zone on Bush Island (Island 17) was very noticeable. Interestingly, Shackleton's colour coded maps from 1975 provide evidence for the habitat type found on the islands from that period. On Bush Island, his map indicates that the island is fringed by plants found in the *Schoenus* zone and that the more central areas consist of a grass and limestone habitat. It is apparent that the young Birch trees on Bush Island noticed by Stronach were an indication of a habitat entering the light woody stage of succession as his studies took place during the period when Shackleton was carrying out his research. When on field visits to Bush Island in 2005 and 2006 the author noted that the interim of 30 or so years had visibly through succession, moved the habitat from grassland with young trees to a wooded stage with mature Birch (*Betula pubescens*), Buckthorn (*Rhamnus cathartica*), Hazel (*Corylus avellana*) and other species creating scrub woodland that is quite dense in places. Even though Bush Island was in a more advanced state of the process, the time-span of 30 years between the research by Stronach and Shackleton and this study was in tune with the time it took the process of ecological succession to reach the woodland stage on Lakeview Island as noted by Ruttledge. The same evidence for ecological succession can be found on Illanatrim (Island 16, see Map 9) which on Shackleton's map had a similar open habitat to Bush Island in 1975 but which is now covered in scrub woodland like its neighbour.

6.3.1 Doonbeg Island – A Comparative Analysis

During the early stages of his research at Lough Carra, Stronach identified one particular island as holding the highest density of Mallard (*Anas platyrhynchos p*) nests (34 per acre) and producing the most successful nests out of all the islands that he surveyed. This was Doonbeg Island (Island 12), situated just south of Illanatrim and not far from the shores of Brownstown on the eastern shores of the southeast basin (see Map 9). Stronach believed that the habitat on Doonbeg was the key to its success as a nest site for Mallard and so he initiated an experiment to simulate the habitat found there on another island on the lake. The vegetation on island 12 at the time consisted of open areas of Black Bog Rush with light clumps of Holly, young Ash, Hornbeam and Willow. Doonbeg was also the only island on the lake that Stronach produced a map for showing the distribution and density of the nests found there and the distribution and extent of the habitat found on it. This provided an ideal opportunity within the scope of this study, to re-map the vegetation on Doonbeg Island to assess the changes that may have occurred since the late 1960s (Stronach does not provide an exact year for the map but intimates that the analysis of the habitat on island 12 took place in the early stages of his research). The comparative data could then be used to test the hypothesis that due to the natural process of ecological succession over a 30 year time-span, many of the islands on Lough Carra no longer provide the optimum breeding habitat for wildfowl and particularly Mallard.

Map 9. Aerial photograph of Doonbeg Island, Illanatrim and Bush Island, located near the shores of Brownstown in the Southeast Basin of Lough Carra..



Aerial photograph produced using Ordnance Survey of Ireland Trail Master software 2005.

6.3.2 Methodology

On 14th October 2006, the author with Colin Gallagher spent three hours on Doonbeg Island mapping the current distribution and extent of the vegetation there. This was approached in three distinct steps. Firstly, a 50 m measuring tape was set up through the long axis of the island (from the southern end to the northern end) and working in an anti-clockwise direction starting on the eastern side, a hand held tape was used to get offset measurements (from the 50 m tape to the water's edge) and the outline of the island was plotted in this way. It should be noted that in order to plot the point that protrudes out from the south-western corner of the island, the start of the 50 m tape was secured to a pole and set out in the shallow water off the southern end (see Map 10). Secondly, offsets from the 50m tape were again used to plot the extent and distribution of the vegetation on the island, the use of offsets was particularly appropriate for this task as the trees on the island grow in four distinct clumps. Lastly, after mapping the distribution and extent of these four areas, the species in each were identified and those trees that were noted as being larger or more mature were highlighted for later annotation in the final map. Single trees that stood outside the four main areas or those that were growing in smaller groups were also identified and included. Photographs were then taken of the habitat on the island after the completion of the fieldwork to compliment the map.

6.3.3 Findings

One of the first noticeable differences when comparing the two maps, is that the shape of the island drawn for this study differs from that found in the older one. Stronach does not mention what methodology he used to produce the older map but the corner which protrudes out from the south-west of the island is absent in his and the general shape of the island is more rounded overall. The author believes that there may be a plausible explanation for this due to a combination of two factors. Firstly, the methodology used for drawing the map for this study was very exact and has been used before by the author and Colin Gallagher on archaeological excavations, while Stronach may have been less concerned about defining the exact shape of the island and so drew a rough outline. It is not hard to imagine that Stronach did not spend a great deal of time on accurately plotting the shape of the island but it is doubtful that he overlooked the protrusion from the south-western corner, as it is a very obvious feature and so the second factor may be related to ecological succession. It is possible that the south-western protrusion had no growth on it during the Stronach era and was a more stony area which was slower to be colonised by the lower species in the succession process than the rest of the island. Then eventually with time it became colonised by weeds and then *Schoenus* and grasses and so on through to its current stage which sees it colonised by a growth of mainly young trees. A similar process to that observed by Ruttledge on Lakeview Island over a 30 year time-span and as suggested by Stronach himself (see quotation on previous page). This hypothesis is strongly supported by evidence of this occurring in different parts of the lake, for example just off the southern end of Illanatrim (Island 16, see Plate 32, p. 259), there is a rocky area surrounded by shallow water and here ecological succession has taken hold with *Schoenus* growing over the stones and young trees appearing in the centre. This may at least partly explain some of the other anomalies on the older map such as the more deeply rounded bay on the eastern side as the shape or outline of the island slowly changes due to new growth over stony areas around its shores. Despite these differences, Stronach's map still highlights the distribution and extent of the trees and shrubs on Doonbeg Island and so a comparative analysis to assess possible changes due to ecological succession is still possible.

The evidence for changes in the habitat on Doonbeg Island through succession lies in the fact that the extent of the trees has greatly increased and so too has species diversity. There are six new tree species now present in addition to those four listed by Stronach. He identified Holly (*Ilex aquifolium*), Ash (*Fraxinus excelsior*), Willow (*Salix cinerea*) and Hornbeam (*Carpinus betulus*) as growing on the island. Today Buckthorn (*Rhamnus cathartica*), Hawthorn (*Crataegus monogyna*), Elder (*Sambucus nigra*), Hazel (*Corylus avellana*), Guelder Rose (*Viburnum opulus*) and Sycamore (*Acer pseudoplatanus*) are also present. What Stronach referred to as light clumps of cover consisting of a mixture of those four species are now dense stands of both mature and semi mature trees consisting of a mixture of ten species including smaller shrubs and low woody species such as Bramble (*Rubus fruticosus*) and Guelder Rose. Also the young Ash trees that he mentions have reached maturity and can be seen growing in all the four areas identified in the new survey. The Ivy on the island is no longer restricted to the one area as marked on the older map but grows across the ground and over the older trees in areas 2 and 4 in conjunction with the dense cover. The area marked 3 on the new map is an area of new growth that was not present during the Stronach era while the area marked 1 on the south-western corner may be an area of new growth or an extension of an existing area. On the older map Stronach marks the rest of the island outside those areas with light cover as consisting of *Schoenus* or Black Bog Rush (*Schoenus nigricans*) but did not mention if there were areas that also held plants associated with the *Sesleria* zone. It was identified from the new survey that the Black Bog Rush grows mainly on the fringes while the rest of the island outside the four main groups of trees was covered in a mixture of grasses and sedges associated with the *Sesleria* zone with Purple Moor-Grass growing extensively. The colonisation of the island by trees is set to continue until like so many of the other islands on Lough Carra it is a densely wooded habitat. Saplings are present on the edges of the four main areas of tree cover on the island and more are present in the *Sesleria* zones. With this phase of ecological succession, the open areas holding the *Sesleria* plant communities will become smaller as the trees, smaller shrubs and Ivy spreads and takes over (see Maps 10 & 11). For analytical purposes the 4 main groups of trees on the island are referred to as Areas 1-4 and below are details of each based on the survey notes taken on 14th October 2006.

Area 1:

This is possibly an area of new growth located in the south-western corner of the island and which may not have existed when Stronach drew his map in the late 1960s. There were three species present in Area 1 - Ash, Willow and Buckthorn.

Area 2:

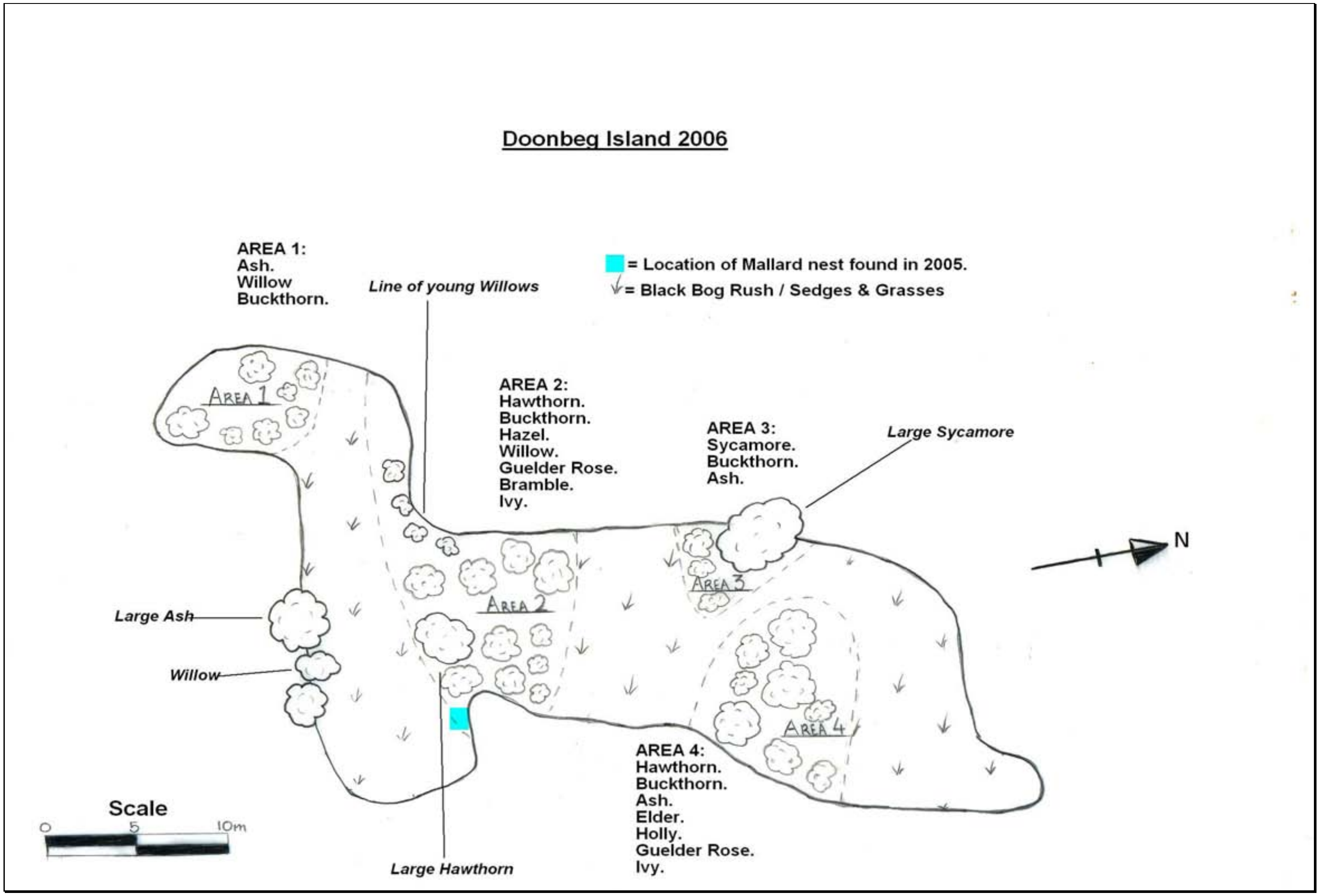
This is the largest of the 4 areas (10x10m) and it highlights the rate of growth on the island. One large area of trees is now present where formerly Stronach marked as one small clumps consisting of light cover. Today Hazel, Hawthorn and Buckthorn form a dense stand which starts on the eastern side of the island and spreads across it to the western side. Guelder-Rose grows on the boundaries of this stand and Ivy has spread across the ground throughout. There is one large Hawthorn on the southern side of this group and on the western edge four young Willows are growing in a line.

Area 3:

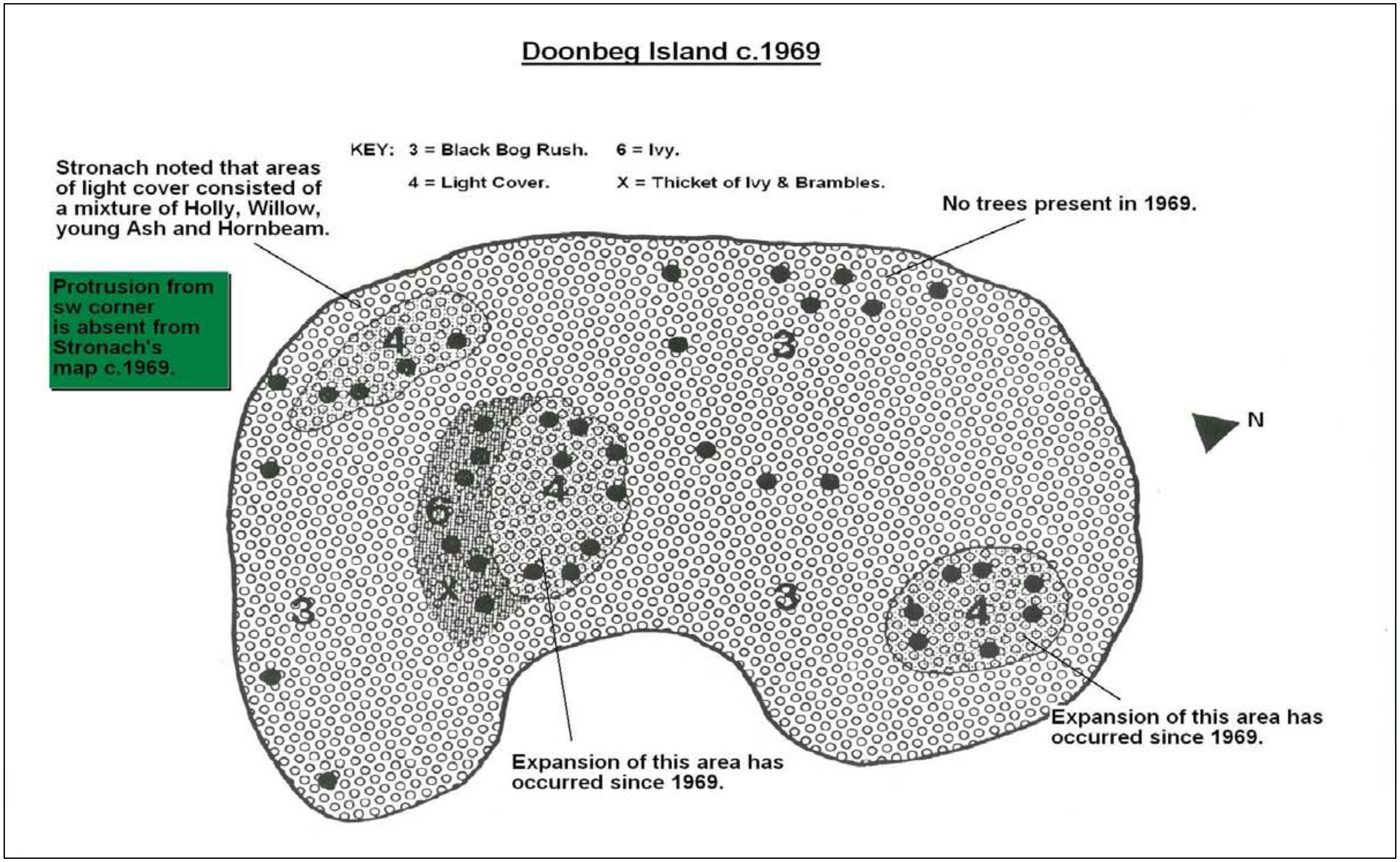
The smallest area on the island is dominated by one large Sycamore with Buckthorn and Ash also present. This is a new stand of trees which has appeared since the late 1960s and which will eventually meet with area 4 to form one dense clump growing across the island like area 2.

Area 4:

This is the second largest area on the island with Buckthorn, Holly, Hawthorn, Ash and Elder forming one large dense stand. Guelder Rose grows along the margins and the Ivy here surrounds the older trees and spreads across the ground beneath the trees. Stronach marked this as a small clump of light cover at the time of his map but now the trees have extended from the eastern shore across the island where they nearly meet up with area 3. A number of young trees including Ash are present in the zone of *Schoenus* and grasses between area 4 and the northern end of the island ensuring the extension of area 4 in the coming years.



Map 10. Sketch map illustrating the extent and distribution of vegetation on Doonbeg Island from a survey conducted by Meehan & Gallagher on 14th October 2006.



Map 11. The extent and distribution of vegetation on Doonbeg Island from a survey conducted by Stronach *et al. c.*1969. The black spots represent the locations of Mallard nests found *c.*1967-1969. No scale was given for the map.

Plates 28 & 29. Hog Island (Is. 21) showing heavily wooded habitat and Ivy growing over the ground between the trees.

Plates 30 & 31. Bush Island (Is. 17) showing trackway of mixed grasses and heavily wooded area.

Plates 32 & 33. The beginning of ecological succession on a small rocky zone off Illanatrim with a covering of Black Bog Rush and shrubs and the final stage as seen here on the heavily wooded Horse Island

Plates 34 & 35. Doonbeg Is: Looking towards Area 2 (note mixed grasses and mature cover, the long tape used for island measurements is also visible) and Area 3.

Plates 36 & 37. Doonbeg Is: Open *Schoenus* and *Sesleria* zones.

Plate 38 & 39. Doonbeg Is: From the east and area of new growth.

(Plates 38 & 39 by Colin Gallagher)

6.3.4 Stronach's Island Habitat Experiment

In the autumn 1971, on Horse Island (Island 22) just half a mile to the north of Doonbeg Island, a team of forest workers under instruction from Stronach felled large trees in the centre of the Island but left small patches of low vegetation in the centre of the clearing and a ring of trees around the edges. It was hoped that following this clearance of the larger trees from the centre, the process of ecological succession would develop a habitat similar to that found on Doonbeg Island and thus this would produce a higher density of Mallard (*Anas platyrhynchos p*) nests and a higher number of successful nests. Over the course of the years that followed the vegetation in the centre of Horse Island began to re-establish itself and Stronach commented,

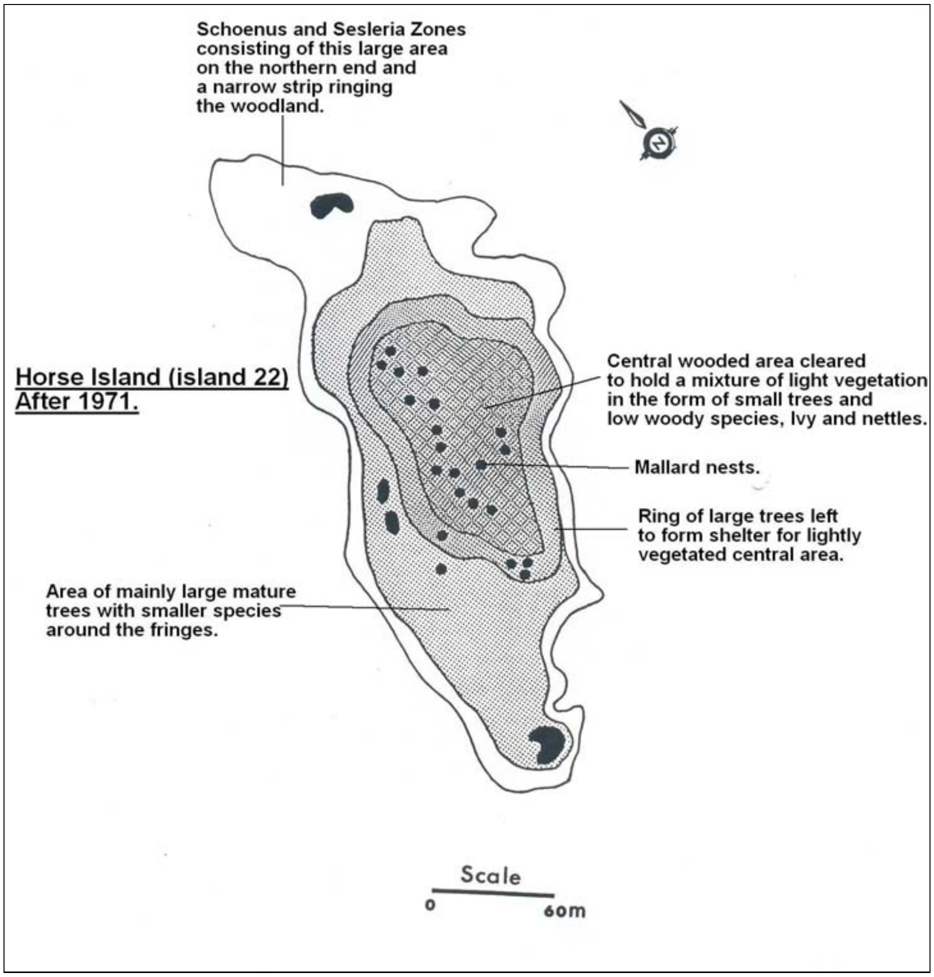
> There was little plant growth in 1972 until June, and then the coppices of Elder and the ground cover of grass, nettles and brambles started to grow. In 1973 the plant growth was more normal and the coppices produced well. There was an excellent cover of nettles in the open patches between the coppices…the coppices which grew best were Ash and Elder. Ivy on the ground spread quickly in the second year and had established itself well by 1974, making suitable nest sites, particularly around patches of light vegetation.
>
> (Stronach, 1981, p. 92).

In the years prior to the habitat experiment, the successful nests on Horse Island numbered five in 1969, two in 1970 and two in 1971. After the tree felling in the autumn of 1971, the breeding season of 1972 that followed produced four which declined to two in 1973 but then there occurred a large increase to nine successful nests in 1974. Density also increased in this year with the total number of nests found totalling 21 when prior to this the total was ten in 1969, seven in 1970, four in 1971, six in 1972 and four in 1973. After analysing these figures Stronach noted that the real benefit to nest production did not show until three years after the experiment was initiated.

> The third year produced not only a greater number of nesting birds, but also a large number of successful nests, indicating that the type of cover produced by the experiment was, not only used, but also suitable for a higher degree of success…the majority of nests were found in the felled area, rather than in the thick woodland ring.
>
> (Stronach, 1981, p. 95).

The number of years it took for the benefits of the experiment to become clear surprised Stronach but through his ringing programme he realised that the birds which were caught on Horse Island during the breeding season prior to the tree felling operation in 1971, never returned to breed there again. This led him to believe that the tree felling operation had caused enough disturbance for the birds to disperse and nest on other islands on the lake. So, it took the interim of three years for new birds to colonise the new habitat on Horse Island and ultimately support the hypothesis that this habitat type provided the optimum breeding sites for Mallard. In his opinion this optimum breeding habitat that existed on Doonbeg Island and which he re-created on Horse Island was a mixture of light cover and that Ivy growing on the ground was a particularly important component of this. Stronach produced a map of Horse Island (Map 12) showing that out of the 21 Mallard that bred on the island in 1974, 16 choose to nest in the new habitat created by the experiment and believed that island habitat management was a key issue in the conservation of local Mallard numbers.

Map 12. The distribution of Mallard nests on Horse Island (Island 22) at Lough Carra after Stronach *et al*. conducted a habitat experiment which created lighter cover in the centre of the island. Annotation by Meehan.



6.4 Possible Habitat Changes in the Lough Carra Sub-Catchments

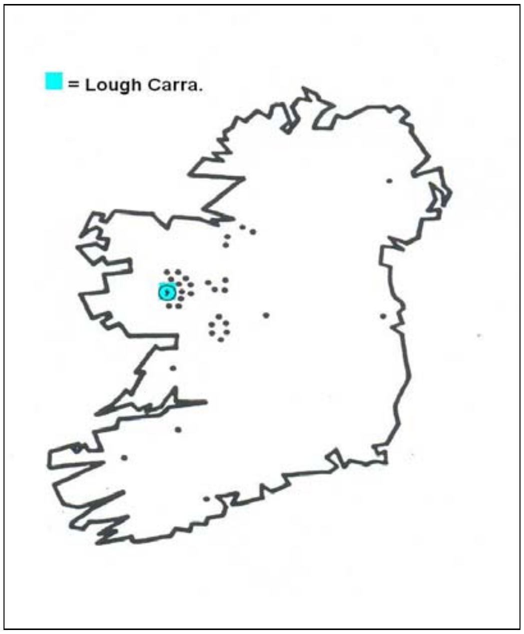
Introduction

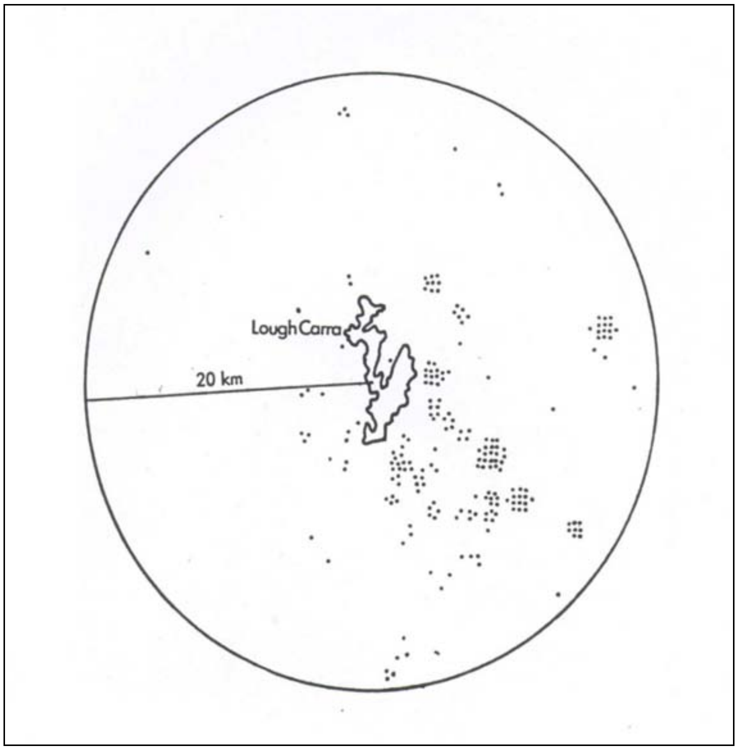
From 1967 to 1975 an intensive program of ringing was conducted at Lough Carra as part of the waterfowl project (1967-1980) headed by Brian Stronach. The main aim of this program was to ring both adult and immature Mallard (*Anas platyrhynchos p*) to help in the assessment of the overall population size and to learn more about the movements of the birds within Lough Carra and their possible longer migrations outside it. The birds (mainly Mallard but also some Teal, Tufted Duck and Pochard) were caught in 'swim in' traps which were baited with cereal grain and placed in a number of locations around the lake (Stronach, 1981). When caught, Stronach et al. placed metal rings supplied by the British Trust for Ornithology (B.T.O.) on their legs and took wing measurements and weighed the birds before releasing them. Hunters, both locally and nationally were then notified to check shot birds for the metal rings and if found they were asked to return the rings to Stronach directly or if shot outside Ireland, return them to the B.T.O. headquarters in Britain. With this system in place, Stronach *et al.* caught and ringed a total of 2,850 Mallard at Lough Carra between 1967 and 1975 (in which year the ringing program was run down) and this provided considerable data on the movements of birds, particularly Mallard, from the lake.

Over the eight years of the program a total of 355 ringed Mallard were shot and their rings recovered and from these birds, a very clear picture was formed which showed that the Mallard on the lake were mainly sedentary, as Stronach (1981, p. 83) notes, "…our data indicates that the Mallard being studied show only a marginal tendency to migrate, forming an almost closed population".

This hypothesis was supported by the fact that 90% of the 355 Mallard recovered were all shot within a 20km (12 miles) radius of Lough Carra while just 8.5% were recovered outside the 20km radius and of these just 1.5% came from outside Ireland (see Maps 13 & 14). Stronach (1981) notes that this tendency for flocks to remain locally with little movement outside a small radius was also observed by Mackey who was ringing wildfowl at Strangford Lough in the north during the same period. This led him to believe that the other wild Mallard flocks across the rest of Ireland behaved in a sedentary manner.

Map 13 & 14. Dispersal patterns of Lough Carra Mallard over Ireland and within 20km of Lough Carra from ringing studies by Stronach *et al.* 1967-1975.





***Maps from Stronach (1981).**

After further analysis of the ringing data another dispersal pattern emerged concerning the Mallard that were recovered within a 20km radius of the lake, as Stronach (1981, p. 78) explains,

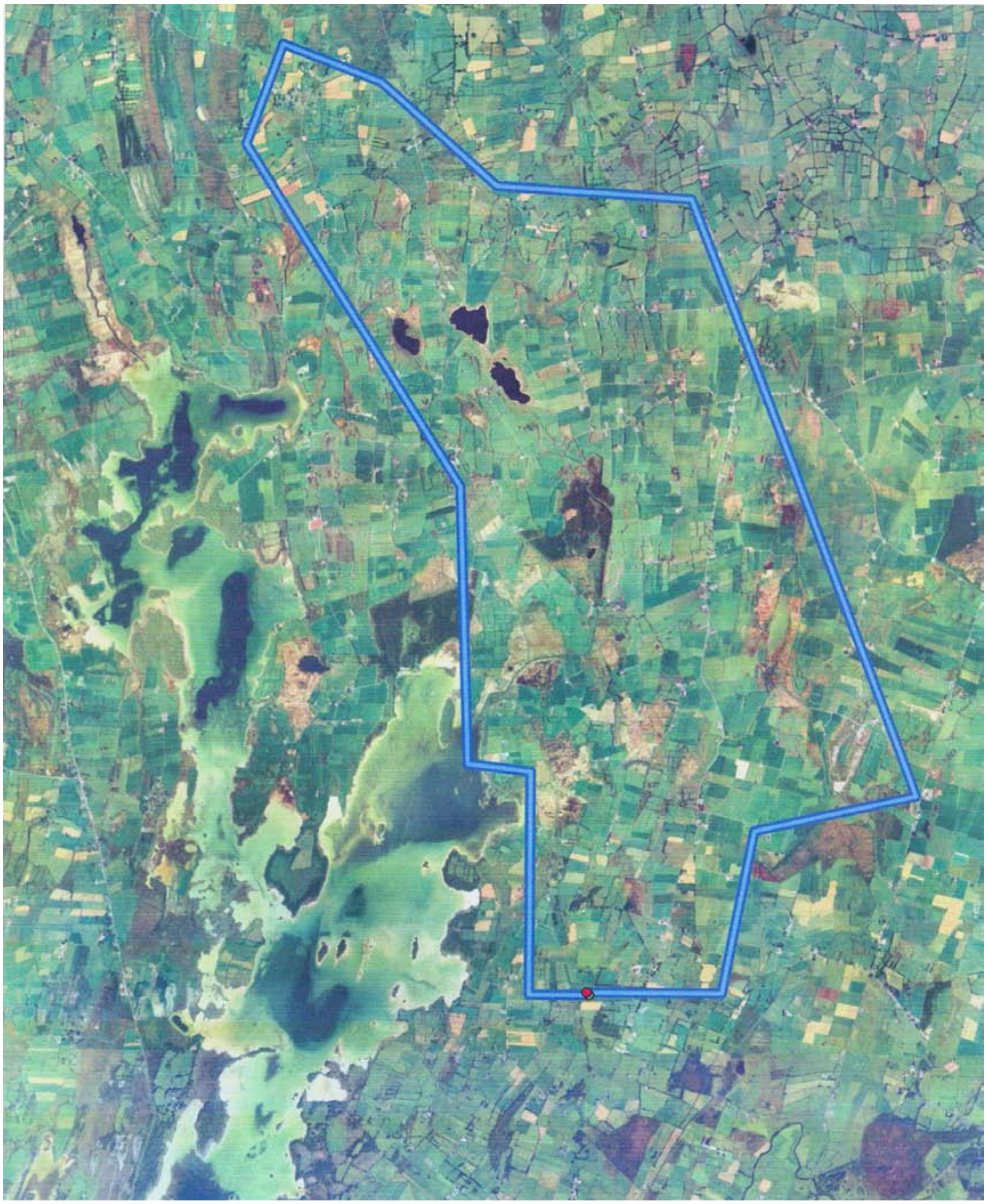
> It is clear that the birds are predominantly recovered to the east of the study area where the feeding grounds are on Carboniferous Limestone. To the West of the lake where the soils are acidic, few birds are collected because of the paucity of feeding grounds.

This pattern bore out the hypothesis that the Mallard were using the lake as a roosting site during the day and flying out to feeding grounds elsewhere just before or after dark and the ringing data showed that the lands to the east of the lake were the preferred feeding grounds for the majority of these birds. To the east of Lough Carra, within the 20km radius and the main Carra catchment lie the two Carra sub-catchments of Annie's River and Ballyglass which cover an area extending east, north and south from the shores of the southeast basin (see Map 15). With the development of hypotheses for the large-scale decline of in Mallard populations on Lough Carra since the 1960s/1970s, one of the objectives of this research was to investigate the possible habitat changes that may have taken place in the sub-catchments of Annie's River and Ballyglass. As the ringing data has proved that 90% of the birds ringed on Lough Carra utilised the eastern side of the lake, changes in the habitat in these areas may be a contributing factor to the declines that have occurred since the time of Stronach's study. Equally a correlation in negative habitat change and a decline in Mallard numbers could further develop the hypothesis and suggest that the areas outside the two sub-catchments but within the 20km radius zone may have undergone similar habitat changes and that this may have contributed to a decline in numbers.

6.4.1 Methodology

In 1981 Neil Lockhart carried out an Environmental Impact Assessment (E.I.A.) prior to a proposed drainage scheme planned for the two sub-catchments and produced the subsequent report for the Department of the Environment in 1982. As part of his work, Lockhart produced two colour coded maps which highlighted the extent and distribution of the habitat in the sub-catchments and outlined the importance of the turloughs in the area for waterfowl.

Map 15. Aerial photograph showing the location of the two sub-catchments of Annie's River and Ballyglass (highlighted) to the east of Lough Carra.



Aerial photograph produced using Ordnance Survey of Ireland Trail Master software 2005.

In the mid 1980s, the drainage scheme in the catchments went ahead and since the drainage of wetlands has long been the cause of serious habitat loss for waterfowl and waders in Ireland (Delany 1995, Crowe 2005, Smiddy & O'Halloran 2006) and worldwide, it was decided to use Lockhart's maps from the pre-drainage period to assess the changes that may have taken place as a result of the scheme. The original aim of this study was to re-map the habitat in the catchments using the same colour codes and scale as Lockhart; however it became clear after several visits to the catchments, that this approach was unworkable for two specific reasons. Firstly, due to the sheer scale of the area involved, to efficiently re-map all the habitats within the catchments would require more than one person carrying out the required fieldwork over many months. Also, due to the fact that the majority of the area covers land under private ownership, a simple door to door type approach to acquire permission to gain entry onto these lands would not have sufficed. Instead, an agreement possibly through a group meeting of many landowners would have been necessary to resolve this issue. This would have taken this element of the research beyond the realistic time-frame and boundaries of this study and into the territory of a separate project. Secondly, the habitats of use to waterfowl in the catchments are centred on and around the turloughs, small loughs and bogland while the majority of the remaining habitat is classified as agricultural lands, and so the re-mapping of these areas would have been for the most part, fruitless.

To gauge the possible negative effects of drainage on the habitats for waterfowl and particularly Mallard found in the sub-catchments a new methodology was developed. It was stated by Lockhart (1982), that one of the most valuable habitats for duck and waterfowl were the many turloughs and smaller loughs located within the Annie's and Ballyglass sub-catchments. The lowering or loss of these due to drainage would he noted, lead to a decline in numbers of waterfowl particularly due the changes it would bring to the feeding zones found in and around their shallow margins. For these reasons, the author investigated the current state of these habitats by (a) using aerial photographs set to the same scale as Lockhart's maps to assess if they have been reduced in size due to drainage or lost altogether and (b) by assessing the current numbers and species diversity of the waterfowl currently using the turloughs and in turn using this data as an ecological indicator of their current state. To assist in the latter approach, counts of waterfowl on the turloughs in the catchments made by Lockhart were used for comparison to those conducted by the author during the winter of 2005. Field visits were also made to the bogland adjoining Loughs Beg and Manan and the forestry plantation at Towerhill (as this plantation is situated on the bogland associated with the latter) to assist in the assessment of possible changes to the habitats in those locations. Software developed by the Ordnance Survey of Ireland (Trail Master, 2005) that was used to provide the aerial photographs of the turloughs was also used to identify possible habitat changes in both of the sub-catchments. To fill out the data collated using the methods described above, the author interviewed a member of the Carnacon (townland located within the Annie's River sub-catchment) gun club who has hunted in both the sub-catchments since 1979. This provided valuable data not only on the changes in duck numbers within the area but also valuable information on the effects of drainage from a local perspective. In addition the interview opened up a new avenue of investigation relating to land use changes in the sub-catchments.

From information gained through the aforementioned interview, the author became aware of possible negative changes to the feeding habitat for Mallard in the two sub-catchments and very possible, beyond. These changes were agriculturally based and would not have been covered by Lockhart's assessment of habitat loss due to drainage as the potential losses in this case are linked to changes in land use. It was decided to investigate the issue of land use change firstly on a national and county level, by examining the changes in farming practices in Ireland and Mayo and secondly by examining the changes that have taken place in practices on a local level that is around the shores of Lough Carra and including the sub-catchments. For data relating to County Mayo and Ireland the Teagasc report entitled *Enhancing and Visualising Data on Soils, Land Use and the Environment* (Coulter, McDonald & Lee, 1998) was referred to as was *Agriculture, Forestry & Fishing* (The Central Statistics Office, 2003 & 2004). While for data on a local level a paper (in press) on the 'Land use changes in the Lough Carra catchment' (Huxley & Thornton, 2004) was used. The interview with Art O'Sullivan (14th September, 2006) of the Carnacon Gun Club provided much valuable data on land use change in the Carra sub-catchments which also complemented the findings of the latter paper.

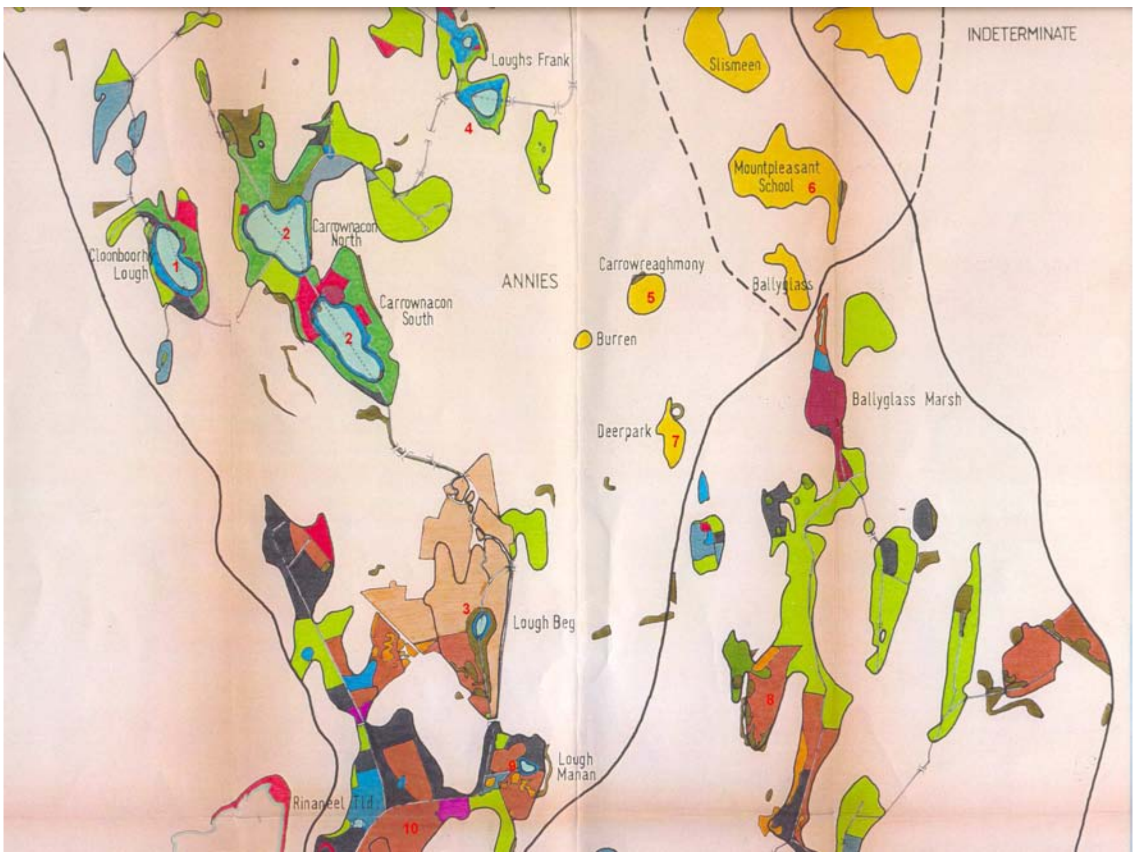
6.4.2 Habitat Changes in the Sub-Catchments – A Post Drainage Analysis

In the mid 1980s a scheme of arterial drainage was initiated and completed in the two Lough Carra sub-catchments of Annie's River and Ballyglass. This involved the digging of long drainage channels up through both areas and in the case of the Annie's River sub-catchment, the channels cut through the following small loughs; Carrownacon North, Carrownacon South, Cloonboorhy Lough, Loughs Frank (known locally and referred to herein as Lough Frank and Lough Joe), Lough Beg and Lough Manan. The following turloughs were also to be potentially effected by the scheme; Ballyglass Turlough, Mount Pleasant School Turlough, Slishmeen Turlough, and Carrowreaghmony Turlough. Lockhart (1982) states that the associated habitats of the loughs and turloughs such as open water, reedbeds and tussock and pool vegetation, are important as both breeding and wintering grounds for a variety of waterfowl including Mallard (*Anas platyrhynchos p*), Teal (*Anas crecca*) and Mute Swan (*Cygnus olor*). Also he classified these habitats as vital wintering grounds for Wigeon (*Anas penelope*), Shoveler (*Anas clypeata*), Tufted Duck (*Aythya fuligula*), Goldeneye (*Bucephala clangula*), Pochard (*Aythya ferina*), Red-breasted Merganser (*Mergus serrator*), Whooper Swan (*Cygnus cygnus*) and Bewick's Swan (*Cygnus columbianus*). Lockhart believed that a significant lowering of the loughs and turloughs in the sub-catchments would lead to a serious decline in most of the waterfowl species listed above. With the drop in water levels due to drainage, it would alter the feeding zones which separates waterfowl species and reduces competition,

> Dabbling species such as Mallard and Teal will be displaced from Cloonboorhy and Carrownacon Loughs if the water level is lowered to such an extent that no marginal shallows remain…Drainage often leads to the contraction or elimination of these feeding zones which results in increased competition between species and the eventual elimination of some or all of them.
>
> (Lockhart, 1982, p. 18).

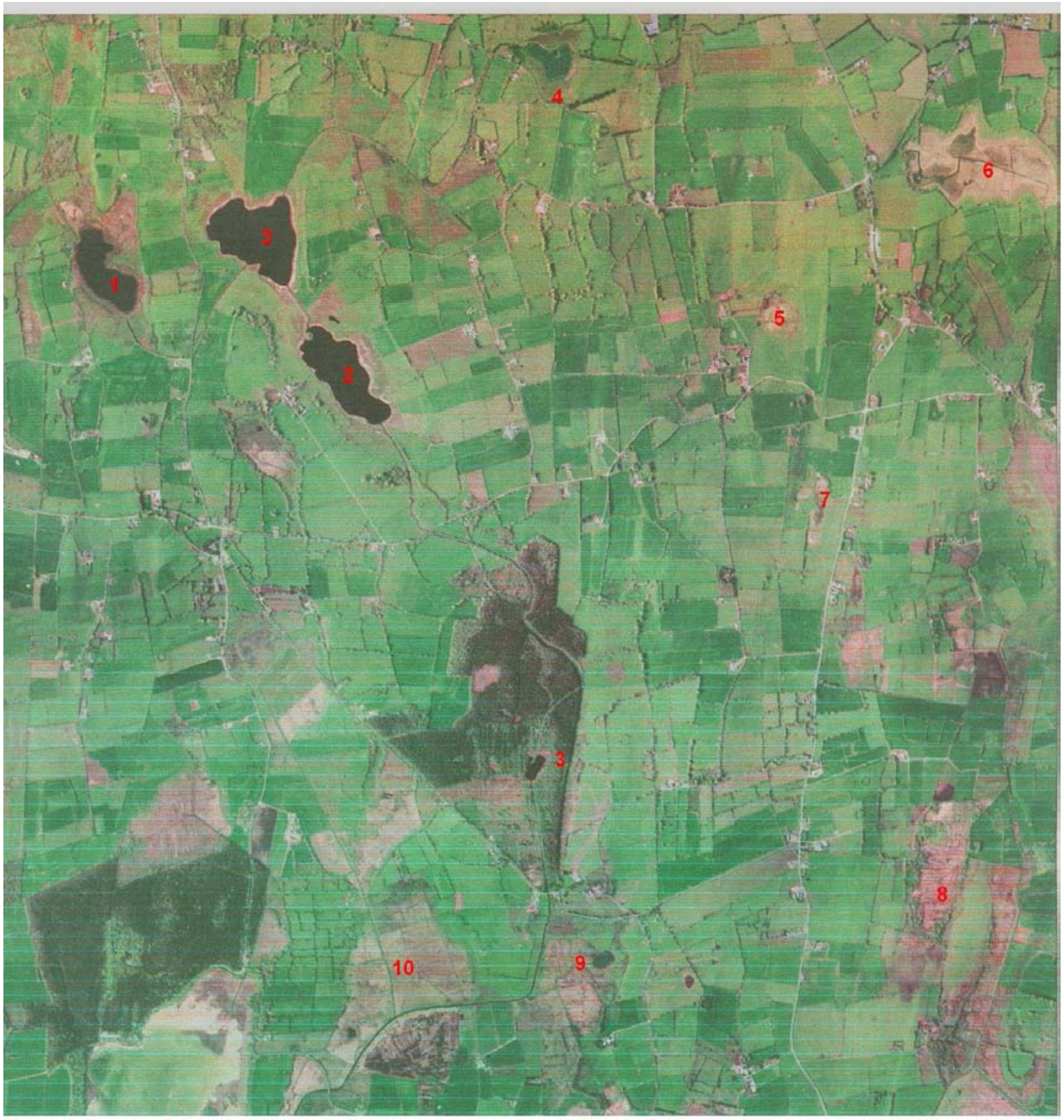
During the winter of 2005, the author went to each of the small loughs and turloughs in the sub-catchments and using Lockhart's map for comparison could see little change in their extent (Maps 16 & 17). The Carrownacon Loughs and Cloonboorhy Lough still maintained reedbed systems and damp pasture on their fringes and in those areas where they were noted as being present by Lockhart. These habitats were also noted at the smaller loughs of Frank and Joe, Beg and Manan and at four of the main turloughs in the catchments.

Map 16. Lockhart's colour coded map of the vegetation found within the Annie's River/ Ballyglass sub-catchments 1982 (pre-drainage). See below for keys.



Note: 1 = Cloonboorhy Lough, 2 = Carrownacon Lough North & South, 3 = Lough Beg (within the Towerhill forestry plantation), 4 = Lough Frank, 5 = Site of Carrowreaghmony Turlough, 6 = Site of the Mountpleasant School Turlough, 7 = Site of Deerpark Turlough, 8, 9 (adjacent to Lough Manan) & 10 = Bogland.

Map 17. Aerial photograph showing the location and extent of waterfowl habitats within the Annie's River/Ballyglass sub-catchments *c*.2005 (post drainage).



Note: 1 = Cloonboorhy Lough.

2 = Carrownacon Lough North & South.

3 = Lough Beg (located within the Towerhill forestry plantation).

4 = Lough Frank.

5 = Site of Carrowreaghmony Turlough.

6 = Site of the Mountpleasant School Turlough.

7 = Site of Deerpark Turlough.

8, 9 (adjacent to Lough Manan) & 10 = Bogland.

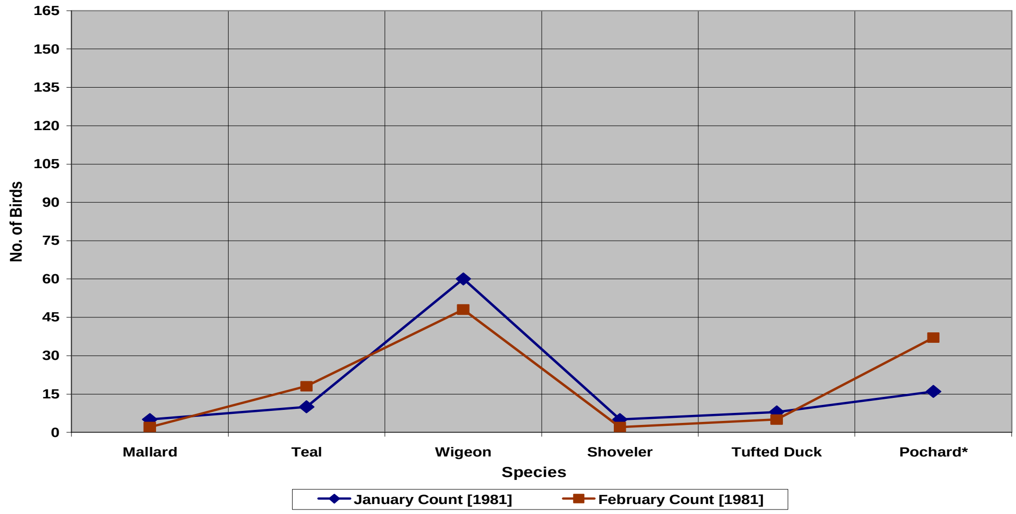
Evidence from the aerial photographs of these sites show that all are still intact and no major shrinkage of their waters has occurred. In terms of the turloughs, the main sites of Mount Pleasant School, Ballyglass and Slishmeen held waters during the winter visits to them and all held a number of waterfowl species. The turlough of Carrowreaghmony to the west of Ballyglass held water in November but was dried up when visited again in December. It is possible that this was due to drainage however it was noted that due to its small size, the receding of its waters may have been a natural occurrence. It was more difficult to assess the possible impact that the drainage scheme had on the turloughs due to their naturally fluctuating water levels. Carrownacon local Art O' Sullivan, who has hunted duck in these areas both before the drainage scheme and up to the present day states,

> I remember the drainage scheme going ahead and I remember them draining parts of Annie's and up through Towerhill. I don't think the drainage had an impact (on the duck), it lowered the turloughs slightly but made no difference to them. There was a turlough up near Carrownacon House that had wetlands around it and I used to shoot duck up there in the early 1980s and you still get duck going in there. The drainage hardened a bit of the marshland but I still see duck coming into those areas and the ponds and wet areas in Ballyglass and around Burriscarra still hold duck.

During the course of his research into the importance of these wetlands for birds, Lockhart (1982) conducted waterfowl counts between December and April and before drainage took place at seven sites. These were Cloonboorhy Lough (five counts), the Carrownacon Loughs (five counts), Mount Pleasant School Turlough (four counts), Carrowreaghmony Turlough (four counts), Slishmeen Turlough (three counts), Ballyglass Turlough (four counts) and Mullingar Marsh (three counts). For comparative data, the author conducted two counts in 2005 on 5th November and 20th December at all of those sites with the exception of Mullingar Marsh. The two counts were made primarily to assess that waterfowl were still using these wetlands and that they still maintained habitats needed to support a variety of species. During Lockhart's counts, he chose to record just duck species while for the counts for this study, the author recorded all waterfowl and wader species present on the loughs and turloughs and their associated wetlands. During the counts conducted in 2005, nine waterfowl species were recorded over the six sites visited and this included five duck species. The total number of all duck counted over the six sites from the November count came to 116 while the total for the December count was 343. In January and February 1981, Lockhart completed counts for all the same six sites and his duck totals came to 104 and 112 respectively. It should be noted that this data should not be interpreted the same way as the data from a counting program spanning several years, such as that on-going at Lough Carra. While the total numbers of duck were higher from the 2005 counts, both Lockhart's counts and those for this study were mere 'snapshots' of the waterfowl populations present in this small matrix of wetlands. The counts were conducted in different months and possibly in different weather conditions, while the author took a note of the weather during the count days in 2005, Lockhart does not mention count conditions in his report (1982). The real value of this data is that it highlights that a variety of waterfowl still use the six sites that were under threat from drainage and consequently the small loughs and turloughs must maintain the habitat to support them. Lockhart recorded Mallard, Teal, Wigeon, Shoveler, Tufted Duck, Pochard, Goldeneye and Red-breasted Merganser over the six sites. All these species were present in the six sites during the 2005 counts with the exception of the last three, that of Pochard, Goldeneye and Red-breasted Merganser. However, Lockhart's counts of the latter species were low and just from one site (Carrownacon Loughs) in two months. Besides the waterfowl, the wetlands adjacent to the loughs and turloughs held three wader species namely Lapwing, Golden Plover and Curlew in good numbers. This signifies that damp marginal pasture remains in the sub-catchments, the type of habitat that supports these species and is particularly favoured by probing waders such as the Curlew and Snipe. Obviously data from a more intense program of counting conducted well before, during and after the drainage scheme would be needed to ascertain all the changes, subtle or otherwise that may have taken place. It would be impossible to state that drainage had no effects on the numbers of waterfowl and waders using the loughs and turloughs in the sub-catchments without the data to back it up. However if negative habitat changes did occur after the scheme, based on the evidence presented here, these changes unless very slow to take hold, do not seem to have caused a major reduction in waterfowl numbers at these six sites.

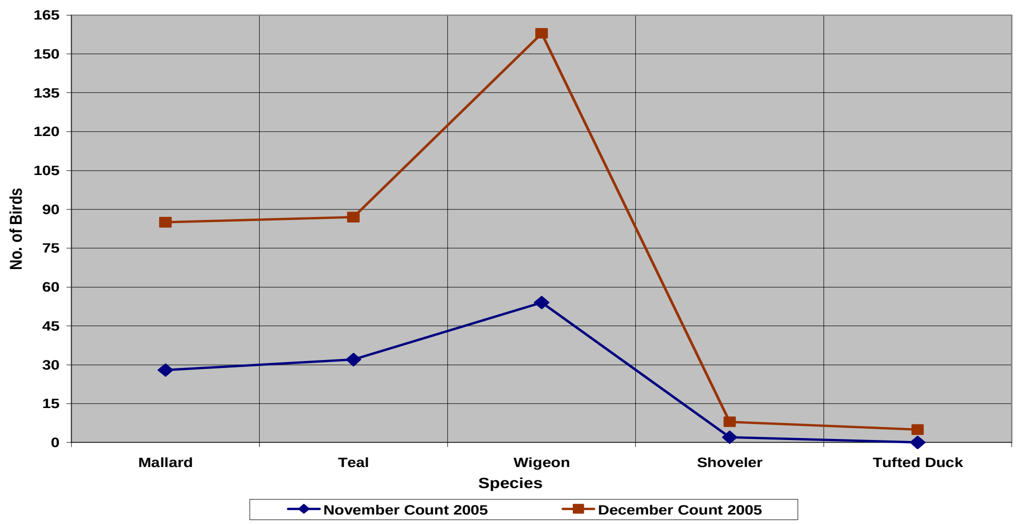
In terms of the value of specific sites, from the counts conducted in the 1980s and from the count data from this study, two sites held the highest numbers of waterfowl from the six sites covered and these were the Mount Pleasant School Turlough and the Carrownacon Loughs. Both of these were and still are highly valuable wetland habitats for species such as Mallard, Teal, Shoveler, Wigeon and Tufted Duck and also to waders such as Lapwing, Golden Plover and Snipe. The four remaining sites while not holding the same numbers are also valuable for many of those same species and the turloughs are vital to migratory species such as the Whooper Swan which were present on both the Carrowreaghmony Turlough and the Slishmeen Turlough during the counts for this study.

Figure 36. Lockhart's counts of six duck species from six wetland sites located in the Annie's River and Ballyglass sub-catchments in January & February 1981.



Note: ***Pochard present during Lockhart's counts but not for the counts during 2005.

Figure 37. Meehan's counts of five duck species from six wetland sites located in the Annie's River and Ballyglass sub-catchments in November & December 2005.



In his report Lockhart (1982) presents a list of bird species found in the sub-catchments and classifies what habitat is needed to support them. For most of the waterfowl species he recognises that open water is a vital habitat requirement but also for Mallard and Teal he notes that cut-away bogs are important. He does not present specific data relating to the use of the bogs in the catchments by these two dabbling species but bogs do provide nesting habitat for Mallard and for those birds that do not breed on Lough Carra. There is not a great deal of bogland in the catchments but there is an area just east of Lough Carra that due to its location in relation to the lake, would suit Mallard for feeding in and it is known that a certain number nest in the bogs found within the Annie's River sub-catchment (Huxley *pers. comm.*). From aerial photographs of the area these boglands to the east of the lake still exist but it is hard to determine whether they have been degraded due to drainage. There is no doubt that some areas of bogland have been degraded and lost as habitats due to the planting of commercial forestry. During the mid to late 1970s, two large areas which were formerly old demesnes were planted with Spruce Trees namely Moorehall and Towerhill which is within the Annie's River sub-catchment. At Towerhill the bog was drained for the plantation with the loss of ponds and marsh habitats that were used by the Mallard and as pointed out by Art O'Sullivan, used to be popular with local hunters. The small Lough (Lough Beg) which is situated in the plantation at Towerhill is no longer a suitable habitat for Mallard as the forest grows thick and high around it.

In the winter of 2005, the author made field visits to Towerhill and the boglands west and south of Lough Manan with the aim of assessing if there still exists suitable habitat for Mallard and other species of waterfowl. Lough Manan is small but is fringed by reedbeds and the adjacent bogland was wet underfoot with good cover for feeding duck and two Mallard were flushed from the lough. In the small remaining strips of bogland at Towerhill and in areas just south of Annie's River Lockhart (1982) does not note as much Gorse present in the early 1980s as there appears to be today. This may be due to drainage although there were still areas of wetter marsh type habitat with a mixture of tussock and pool vegetation within these boglands. From Annie's Bridge as far as Lough Manan, the banks of Annie's River along this stretch are intersected with drainage channels which at the time of the visits for this study were filled with water and some were quite long. These drainage channels and others like them have been identified as providing haunts for some species such as Moorhen and Teal (Martin 1993, Crowe *et al.* 2005). Aquatic vegetation and species associated with damp soils are also present along this stretch of the river, for example there are *Phragmites* reedbeds just north of Annie's Bridge and adjacent to the river which Lockhart (1982) noted on his map and that still exists today, as does a smaller area of *Schoenus* marsh to the east of the reedbeds.

The evidence presented here for the assessment of the possible effects that the drainage scheme carried out in the 1980s has had upon the habitats for waterfowl in the two sub-catchments, focused mainly on the current state of the small loughs and turloughs found within the two areas as these were identified by Lockhart (1982) as being of the most value to them. However, the author does not propose that the entire effects of drainage upon the region as a whole should be based upon the evidence from these habitats alone. The effects on the wet grasslands and bogland in the catchments was more difficult to assess without an in-depth study as judging by the visual evidence, some of the changes brought about by drainage may be quite subtle and require a more botanically based study. In terms of the wintering habitat for Mallard in the sub-catchments, the drainage scheme does not appear to have dramatically degraded the habitat for this species. In fact, there were more Mallard counted on 20th December over the complex of small loughs and turloughs (85 birds) in the sub-catchments than on Lough Carra (52 birds) during the same month.

6.4.3 Land Use Changes in the Carra Sub-Catchments

The pattern of Mallard (*Anas platyrhynchos p*) using Lough Carra as a roosting and loafing site during the day and then flying out at dusk into the surrounding countryside to feed was noted by Stronach (1981), Lockhart (1982) and Art O'Sullivan. As mentioned, from Stronach's long-term ringing studies at Lough Carra (1967-1975) where he ringed over 2,000 Mallard, it was established that a large number of these birds were going to the east of the lake to feed. During the course of this study, a hypothesis was developed involving a change in the availability of certain food sources in the sub-catchments and possibly beyond, due to less traditional and more intensive agricultural practices.

It is recognised that Mallards are opportunistic feeders which will take a variety of plant and animal foods through different methods including up-ending in the shallows for aquatic vegetation, seizing insects from the surface of the water and those that have become more domesticated will readily feed on bread crusts and other items given to them by the public (Martin, 1993). Another food source that they regularly exploit are cereal crops, with Barley, Maize and Oats constituting a major part of their diet in areas where those crops are grown. In the United States, Ringelman (1990) notes that the migratory routes of certain species including Mallard have changed in response to these foods, so much so that the growing of cereal crops has become a recognised component in the overall conservation and management of certain wildfowl species. In 1977, Whilde who conducted research into the different types of foods taken by Irish wildfowl noted that,

> The stomach contents of ninety-three wildfowl shot during the 1975-76 shooting season were examined. These comprised 55 Mallard, 19 Teal, 5 Tufted Duck, 1 Pintail, 1 White-fronted Goose…The preserved stomachs were supplied by wildfowlers from various parts of the country along with completed questionnaires giving measurements of the birds, the dates and times of shooting and of the habitats in which the birds were shot.
>
> (Whilde, 1977, p. 18).

The main objectives of Whilde's study was to identify the main foods taken by those wildfowl species and to investigate possible regional differences between the diets of species shot in different parts of the country. The 55 Mallard that were included in his analysis came from Counties Kerry, Galway, Clare, Waterford, Wexford and Mayo, in the case of the birds shot in Mayo these came from Ballinrobe and North Mayo. Whilde found that plant material (mainly seeds) occurred in all 45 Mallard (76.4%) stomachs containing food while animal material was found in only 15 (27.3%) stomachs. He noted that that some plant seeds were found only in birds shot in Ballinrobe and North Mayo, chiefly the seeds of Floating Sweet-Grass (*Glyceria fluitans* (L.)) but also the seeds of *Rumex* species (for example Great Water Dock, Broad-Leaved Dock) to a lesser extent. Two Mallard that were shot in Ballinrobe were found to have been eating Barley but Whilde reasoned that because duck traps in the area were being baited with Barley and other cereals (most likely with reference to the traps laid by Stronach et al. on Lough Carra), these items should not be classed as a major constituent of the natural Mallard diet. He goes on to state that,

> Cereal grains formed only a minor part of the Mallard diet probably because the majority of duck were shot in the latter part of the season when grain was scarce and in areas (Mayo) where tillage is practised only on a small scale.
>
> (Whilde, 1977, p. 19).

However Whilde's study exemplified the fact that Mallard are opportunistic feeders and will display differences in diet not only between counties but also within counties and regions. For example, one Mallard was shot in a potato field in North Mayo and had its oesophagus distended with small potatoes while another bird from the same area had 30 *Ranunculus* sp. Tubers in its oesophagus. Taken into account the time of year in which the birds were shot may partly explain why cereal grains formed a minor part of the Mallards diet but it seems that bias will occur when the larger proportion of the sample comes from a specific habitat type. For example, the Mallards from Mayo came from areas dominated by blanket bog but had the wildfowlers shot the birds in an area where tillage (albeit low key) was practised, such as over a field of oats, the results may have been different.

Besides providing valuable data on the diet of wildfowl in Ireland, Whilde's study also showed that wildfowlers can be a valuable source of information when wildfowl are being studied in a particular county or area. As mentioned, for this study, the author interviewed a wildfowler (Art O'Sullivan) who has been shooting in the Annie's River and Ballyglass sub-catchments since 1979. When asked about land use changes in the sub-catchments, he commented that he and members of the Carnacon Gun Club would often wait in the late evening by fields of oats in the Annie's River sub-catchment for the Mallard to come in and feed. However, since the dying out of tillage in the area since the early 1980s, he and fellow wildfowlers feel that the numbers of duck coming into the sub-catchments to feed have drastically declined,

> Going back to the early-mid 1980s, I remember nights where I would have seen 30-40 duck coming in to feed, you would be glad to see 5-6 duck coming in now. There is not one single field of oats in the region now that I have seen or can think of but there used to be. There would be at least 4-5 farmers who would have 8-10 acres of oats down. At that stage they would mix it with silage or something else for the cattle but there is nobody doing it now. There were two ponds that I used to love to shoot but the chances of duck coming in now are slim because there is no feeding for them in the few fields around.

In Ireland, since the mid-nineteenth century the area under oats and potatoes has largely declined due to a number of factors including the mechanisation of farming and a more varied diet. In 1847, the total area tilled for oat production came to 625,000 hectares and this dropped to 96,000 hectares by 1967 and from here it dropped to 21,000 hectares in 2003. The production of potatoes has also declined from a total area under crop of 65,000 hectares in 1967 to a total of 14,000 hectares in 2003 (The Central Statistics Office, 2004). Coulter, McDonald and Lee (1998, p. 6) note that,

> Tillage land is mainly concentrated southeast of a line running from Dundalk to Limerick but even within this band, the distribution is very uneven…the amount of tillage has greatly reduced over the two decades between 1970 and 1991. Gilmour and Walsh (1993) remarked that the area under tillage had declined in every county except Louth for the years 1980 to 1991.

In 2000, out of a total of 143 farms in the Connacht region, just 28 were recorded as practicing specialist tillage in Mayo and out of a total of 5,069 hectares given to cereal crops in the region just 598 hectares were in Mayo (Central Statistics Office, 2003). This statistic is quite small when the size of Mayo and the number of farms (12,531 family run farms in 2000) in the county are taken into consideration. The number of farms/hectares in 2000 that cultivated oats in winter was very low with ten farms covering three hectares but there were a greater number growing the crop in spring with 80 farms covering 120 hectares, yet again although larger, the latter statistic is still small considering the total number of farms in County Mayo. These figures are a reflection of a change in agricultural practices that has been evident in Ireland over the last few decades and which has seen much of the land previously used for tillage being converted to grassland. Farmers no longer grow cereal crops for use as cattle feed as this is now bought in and the need to produce crops for market or personal consumption is not great enough to sustain the practice.

It is clear that changes in agricultural practices have also taken place in the sub-catchments of Annie's River and Ballyglass, and in the Carra catchment as a whole. Art O'Sullivan whose own relatives farmed and grew oats for cattle feed in the sub-catchments tells of an area consisting of about 50 acres which was under the crop in his area alone. The decline in tillage appears to have been on-going and studies have shown that the practice has being slowly dying out in the region over the last few decades. Over the winter of 2002/2003, a study was carried out on farms found within the Lough Carra catchment and although the farms surveyed were not within the Annie's River and Ballyglass regions, the resulting data is very reflective of what is happening in these two sub-catchments. This knowledge is based on what is known from local knowledge and personal observation,

> The study was undertaken during the winter of 2002/2003 and took the form of surveys of farms, located within the Carra catchment, through interviews conducted by a local resident known, and apparently accepted, by all farmers interviewed. Each interview followed a structured questionnaire designed to record information on the farmer's landholding, livestock numbers, fertiliser, manure and slurry use and general farming practises, including drainage and the conversion of land from natural or semi-natural habitats to improved grassland or tillage. Each farmer was asked to provide information relating to the situation in 1970 and pertaining in 2002/2003…A total of 34 farms were covered with a current total land holding of 2,029 acres, amounting to around 7% of the catchment of Lough Carra.
>
> (Huxley & Thornton, 2004, p. 1).

One of the key findings from the study was that between 1970 and 2003, 483 acres or 25% of the total 2,029 acres of land surveyed was converted from natural or semi-natural habitat to intensive agricultural land and only a small percentage of this was given to tillage and most to grassland.

The changes in agricultural practices that brought about the conversion of semi-natural or natural habitats also lessened the areas previously used for tillage,

> Other changes to land use were recorded, including the decrease in tillage from 50 acres in 1970 (with crops grown mostly for local consumption) to just 0.5 acres in 2002 (potatoes for personal consumption). Land previously used for tillage being re-converted to grassland.
>
> (Huxley & Thornton, 2004, p. 4).

The figure of 50 acres over 34 farms under tillage in 1970 may not be large but put in context; these landholdings only represent 7% of the farms in the catchment. If one adds the 50 acres to the figure given by Art O'Sullivan for the area of land that he personally knew to be under tillage in the Annie's River sub-catchment in the late 1970s/early 1980s (8 farmers with 8-10 acres) , it comes to an area covering 100 acres from 44 farms. It is also worth noting that the 50 acres referred to by O'Sullivan were under oats alone and so if other tillage such as potato crops were added, the total acreage would have been greater. As mentioned, statistics show that there has been a significant decrease in the area under crops in Ireland, particularly oats and potatoes and this decline has been on-going since the mid-nineteenth century. The decline of tillage in the Carra sub-catchments and in the catchment as a whole has most likely been following a similar pattern with the decline since 1970 highlighted through the 2002/03 study and local testimony.

To the east of Lough Carra beyond the sub-catchments but within the 20km radius where a large proportion of Stronach's ringed Mallard were recovered, it would not be unreasonable to assume that similar changes in agricultural practices occurred within the same time-scale. In addition to oats and potatoes, there may have been other crop types such as Barley grown in these areas and the fact that Mallard will readily feed on cereal crops and in some cases potatoes, a decline in the growth of these will have an impact on the birds that were leaving Carra at dusk to feed on them. Even just a few acres of oats could sustain a large number of duck throughout the winter months and the disappearance of this food source since the 1970s strongly supports this hypothesis as a contributing factor in the decline of Mallard on Lough Carra since the later years of that decade.

Chapter 7: Discussion

7.1 Waterfowl Counting at Lough Carra & Count Methodology

The contribution and value of the data provided by the various waterfowl counting programmes that have taken place in Ireland since the small regional counts of the 1940s, to the Wetlands Enquiry and the Winter Wetlands Survey of the 1970s/1980s and presently through the Irish Wetland Bird Survey (I-WeBS), cannot be overstated. With an increase in pressure being put on wetlands from amongst other things, a growing population, industrial growth, intensive agriculture and the conversion of these habitats for development, information on the populations and diversity of waterfowl and waders using these sites and obtained from the count programs is vital. At some sites such as Lough Neagh (Salmon *et al*.), Ballycotton (Smiddy *et al.*) and Lough Carra (Stronach *et al.*), the counting of waterfowl over the course of the last few decades has not only provided a tool for monitoring the waterfowl at these locations, but it has also provided an insight into the consequences of environmentally negative activities on wetland ecosystems. Very often, this is the only ecological data available from which designations and other environmental protective measures can be implemented. Unfortunately, it is also often the case that this data is the only leverage that can be applied to force the relevant state agencies to fulfil their responsibilities, which includes the protection of Irish wetlands through the framework of designations under Irish and European legislation.

The waterfowl project at Lough Carra which ran from 1967-1980 constituted one of the most intensive research programmes involving the study of duck ever to be conducted in the country. The work by Brian Stronach and his research assistants went beyond the counting of waterfowl on the lake and included an in-depth study of the breeding biology and migratory movements of Mallard (*Anas platyrhynchos p*) and other species of Irish waterfowl. It also laid down the foundation for further studies such as that presented here and more research opportunities in the future. The number of counts or count coverage conducted by Stronach *et al.* with funding from the state has to date not been matched, with 333 counts taking place over 14 years. The coverage through the 1980s and 1990s provided an insight into the decline of some species on the lake but was low with just seven counts conducted between 1986 and 1999. The current trends and ‘health’ of waterfowl populations on Lough Carra were more difficult to assess until coverage improved dramatically from 2000 to the present time, due to counting under the I-WeBS scheme undertaken by Chris and Lynda Huxley. From the total number of counts conducted over the two eras (333 from 1967-1980 and 84 from 1986-2006), the 417 counts provided data on which research into trends and hypotheses for fluctuations can be based. There is one gap in the complete dataset from the overall counting programme (1967-2006) due to no counts taking place at the lake from 1981 to 1995 (bar one count in 1986 for which exact figures for all species were not available for Lough Carra). While it is possible to state that species such as Teal (*Anas crecca*), Mallard and Pochard (*Aythya ferina*) have declined dramatically and in the 14 years between the two eras, it cannot be said with certainty whether for some of those species the declines were sharp or gradual or with more variable fluctuations. While such data would have been highly valuable, its absence does not impede further study as it is still possible to compare data from both eras before and after the years that were bereft of counting. In terms of the present scheme, unlike the count programme from the Stronach era (1967-1980), the I-WeBS time-table for counting does not include the summer months, and so as with this study and for future research, all-year- round counting needs to take place for the attainment of comparative data in relation to both wintering and breeding populations.

The changing of census methodologies from the boat based counts used in 1967-1980 to the land based counts since 1986 to the present time, was partly based on financial constraints as counts are presently carried out voluntarily and not by paid staff as was the case with Stronach *et al*. The development of better optics made the 'look-see' method of counting birds from the shore and as outlined by Bibby *et al.* (2000) more viable and a land-based count methodology ensured less under-recording of certain elusive species such as Little Grebe (*Tachybaptus ruficollis*). Nevertheless, due to the (in some cases) very large differences in numbers between the data from the old and new count programmes as highlighted in the severe declines of such species as Mallard and Teal, a testing of both methodologies for comparative purposes was clearly needed. As outlined in Chapter 4, the results of the six count calibration experiments showed that there was no significant difference in the data obtained when comparing the summed mean totals for all 15 waterfowl species recorded using both methods. Nor was there a significant difference between the land and boat based methods when comparing the numbers of those nine species recorded by Stronach *et al*. (1967-1980). When comparing the results for the numbers of individual species, the experiments showed that there were no significant differences between both methods for any except for three diving duck species, that of Goldeneye (*Bucephala clangula*), Tufted Duck (*Aythya fuligula*) and Pochard (*Aythya ferina*). This was only relevant to the first two as Pochard was only recorded on two out of the six experiments and so the sample was too small to work with.

The overall results clearly highlighted two important points, firstly, the decline in the numbers of Mallard (*Anas platyrhynchos p*), Teal (*Anas crecca*), Shoveler (*Anas clypeata*), Wigeon (*Anas penelope*) and Red-breasted Merganser (*Mergus serrator*) counted on Lough Carra since the 1960s/1970s, is not related to a bias in the data caused by the different count methods employed by Stronach *et al.* (1967-1980 by boat) and Delany, Colhoun, Huxley and Meehan (1995-2006 by land). Secondly, from observations made while out using the water based method, the movement of Tufted Duck and Goldeneye after being disturbed by the boat may have led to the double counting, particularly in relation to the latter. Large flocks of Tufted Duck and Goldeneye were often encountered during the boat counts in the upper reaches of the northwest basin and these may have included birds that were already counted in the southeast basin. After the observations over the 6 experiments, it became clear that these two species were most disturbed by the boat and that this is connected with their preference for open water. Other species encountered while on boat counts were more tolerant and would swim away from the boat as it approached; this included Red-breasted Merganser and Great Crested Grebe (*Podiceps cristatus*). While they can be seen near the shoreline at locations such as Moorehall, Tufted Duck and Goldeneye are more often found in rafts of various sizes out on the lake due to their deeper water requirements. This was not as relevant in relation to the dabbling species such as Mallard, Teal and Wigeon, which mainly inhabited the shores and vegetated margins of the lake. Although the census transects were designed to cover all likely loafing areas for Mallard and so in places ran near the shores of the lake, the boat very often caused more disturbance to the Goldeneye and Tufted Duck which were out on the open water. The double counting of these two diving duck species is a hypothesis that needs further investigation; if boat counts take place again in the future, it may be possible to place an observer at Burriscarra or Castleburke who using optics would be able to note whether flocks of diving duck arrive up to that part of the lake during the count. The implications of double counting on the dataset clearly depends on the scale of the statistical error it causes, for example for Tufted Duck on average there were 24 more birds counted by boat while for Goldeneye there were 66. If double counting was also occurring during the older survey, then hypothetically, after calibration, the old data would show that although Tufted Duck have declined on Lough Carra, the decline is not as great as calculated and that there is at least as many Goldeneye, if not more.

The boat count methodology is not suitable for counting waterfowl and waders under the present scheme in operation for Ireland (I-WeBS). Elusive species such as Little Grebe, Moorhen (*Gallinula chloropus*) and Water Rail (*Rallus aquaticus*) can be difficult to visually detect when counting from the shore (as noted by Huxley 2003 and Meehan 2004-2006), but this is even more the case when counting by boat as this methodology was not designed to cover the recording of these species. The noise from the engine of the boat also rules out the chances of recording these birds by their call as is sometimes the only way of detecting them while on land counts. Stronach (1981) ruled out counting from the shores of the lake due to its irregular shape but this study found that the geography assisted in the counting of birds from the land. Birds feeding or loafing on the shoreline were counted with binoculars while any species out towards the middle of the lake such as the diving ducks and Great Crested Grebes were identified and counted with the telescope. It seems to the author that bigger lakes such as Corrib/Mask would be more suited to a water based counts so as to accurately record species found far out on the open waters and out of telescope range. Although boat counts were up to two and three hours faster to complete, the recording of all species of waterfowl and waders as covered by the I-WeBS scheme is more beneficial and gives a clearer picture of the importance of Lough Carra and its associated wetlands to all species.

7.2 The Trends of Nine Species of Waterfowl at Lough Carra from 1967-2006 and Comparisons to Trends in Irish, British and European Populations

Note

In the pages that follow, where the author mentions 'the older survey' or 'the Stronach era' this is the reference given to the counts conducted by Stronach *et al*. from 1967 to 1980. Where 'the new survey' is mentioned this represents the counts conducted by Colhoun *et al.*, Delany *et al*., Meehan and Huxley from 1995 to 2006. The percentage difference in numbers of each species between the old and new surveys is derived from the mean annual counts for that species calculated from the old and new surveys. This section contains comparative analysis for the nine species of waterfowl recorded by Stronach *et al.* during the 1960s and 1970s. The analysis of the additional six waterfowl species recorded under the Irish Wetland Bird Survey from 1995 to 2006 (including counts for this study) can be found in the following section.

Mallard (*Anas platyrhynchos p*)

The Mallard is described as an extremely adaptable waterbird which can be found in a range of both freshwater and saltwater habitats and during the 1988-1991 Breeding Atlas there was an estimated 23,000 pairs breeding in Ireland (Gibbons *et al.* 1993). The Mallard has a widespread global distribution throughout the mid-latitudes in Northern Europe, Russia, Siberia, Asia and North America but it also touches the Arctic Tundra and the subtropical zone (Crowe *et al.* 2005).

Over the 14 years of counts conducted by Stronach *et al.* between 1967 and 1980, the lowest annual peak of Mallard recorded on Lough Carra came to 1,100 birds in 1980 and the highest annual peak recorded was 2,500 during a count in September of 1971. The latter maximum was never equalled during the older survey but the mean annual peak of Mallard on the lake from 333 counts was 1,636. The minimum and maximum annual peaks of Mallard at Lough Carra from 1995 to 2006 were 95 in 1998 and 409 in 1995 respectively and the mean annual peak from 84 counts came to 200 birds. The differences in these statistics tell of the plight of Mallard on Lough Carra. The species has declined by 88% since the older survey. From 1968 to 1975 in a breeding survey conducted over the 73 islands on the lake, Stronach *et al.* found a total of 1,251 Mallard nests. In his final report he published data for eight islands from the 73 surveyed which showed that from 1968-1973, the annual total of nests from the eight islands was between 44 and 105. After the breeding surveys for this study (2005-2006) it was found that three of those islands held no nesting Mallard and the annual totals for the remaining five islands was between five and ten nests. This means that the number of nests over eight of the islands surveyed by Stronach *et al.* and subsequently for this study, has dropped by 91%. This large-scale decline in nest numbers on islands that previously held good numbers of breeding birds is a reflection of a decline in the numbers of breeding pairs of Mallards on the lake as a whole. Stronach tells of a breeding stock of 100 pairs on average between 1968 and 1975 while the estimated breeding population on the lake over the breeding seasons of 2005 and 2006 was between 16 and 30 pairs, a decrease of about 70%-80% when compared to the older survey. The decline in the breeding population has also led to completely different fluctuation patterns which reflect the changes in the overall Mallard population both on the lake and in the catchments. It is recognised that annually in Ireland numbers peak in September and decline thereafter (Crowe *et al.* 2005). This is due to the swelling of breeding numbers by the recruitment of new birds into the resident population which leads to a build-up in numbers through the summer to a peak in the autumn. Following this peak, numbers often decline during October/November as habitats (e.g. smaller ponds, turloughs, marshland) outside the breeding zones become available again and cause the duck to disperse. This pattern was observed by Stronach (1981, p. 23), at Lough Carra,

> As the ducklings took to the wing the counts increased and usually reached a peak in September or October. The highest counts at this period were just over 2,000 birds. At periods of extreme cold weather large numbers of birds were recorded but usually the September/October figures were the highest…Rain usually fell in October and November causing the birds to disperse and the counts show a decline to about 1,300-1,500 birds and remained at that number until after Christmas unless there was some severe weather.

It was difficult to find a pattern in the count data from 1995 to 1998 as coverage during those years only provided at best two counts per year. However, from 2000 to 2004 there were counts made covering the months from September-March annually and counting was all year round for this study from 2005 to 2006. The data from this better coverage provides irrefutable evidence which shows that the fluctuation patterns of Mallard on Lough Carra have completely changed. From 2000 to 2006, the numbers in Mallard on the lake have peaked twice in the month of December and four times in the month of January.

From 1968 to 1974 the mean annual count of Mallard on the lake was 1,211 in January and 1,679 in September, from 2000 to 2006 the January and September means were 163 and 62 respectively, which highlights the reversal in fluctuation patterns.

Figure 38. The January/September peaks of Mallard (*Anan platyrhynchos p*) on Lough Carra 1968-1974.

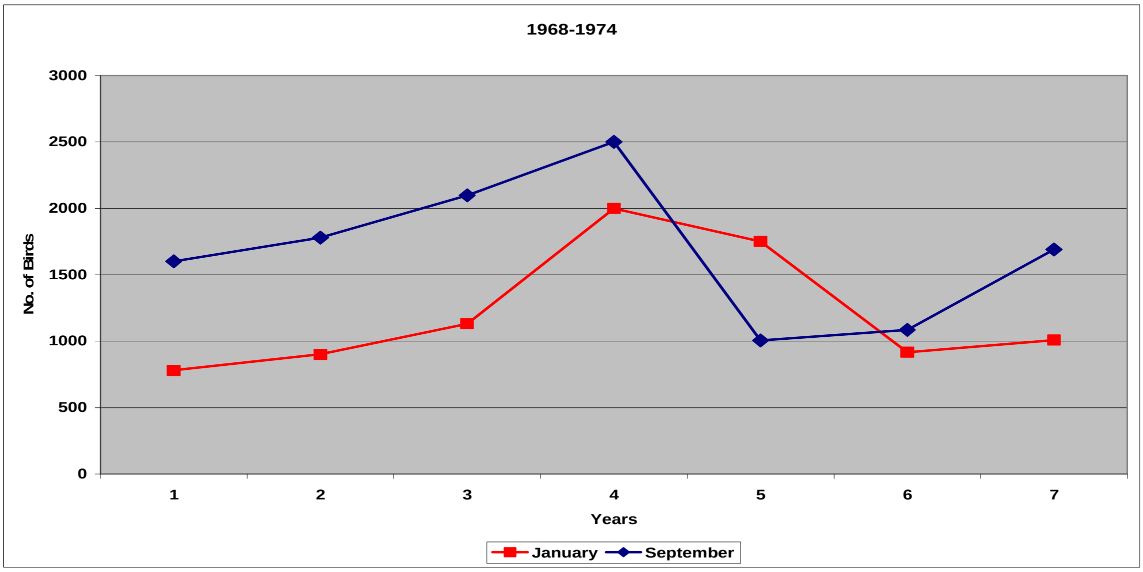
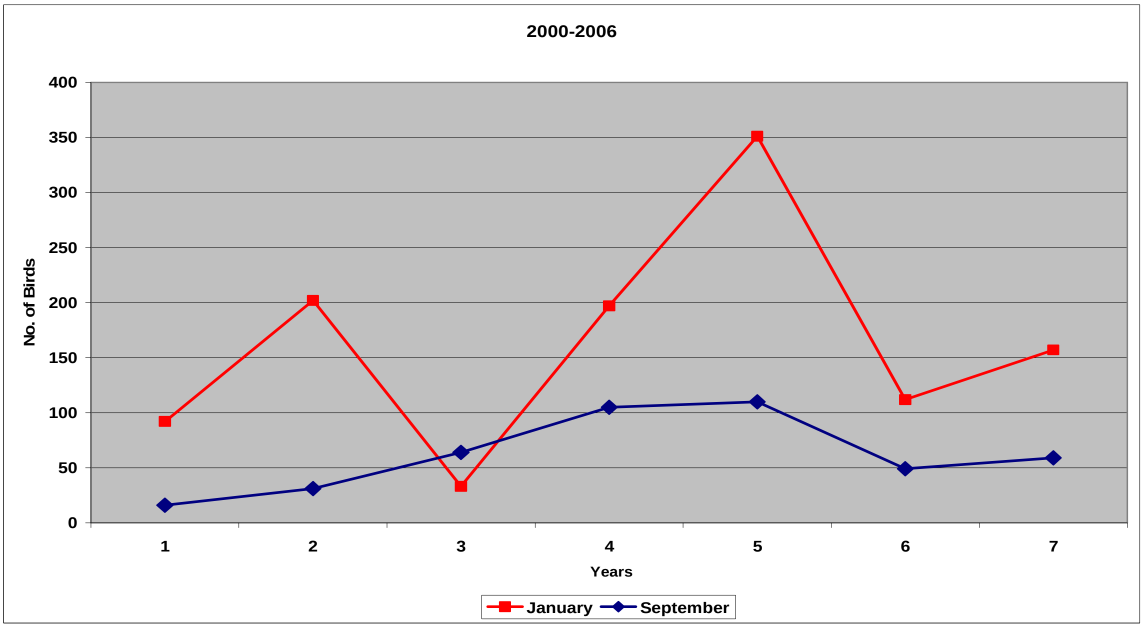


Figure 39. The January/September peaks of Mallard (*Anas platyrhynchos p*) on Lough Carra 2000-2006.



Note: The numbers 1-7 represent the count years 1968 to 1974 (fig. 38) and 2000 to 2006 (fig.39).

The mid-late winter peaks occurring in December and January over the past six years are clearly not linked to severe weather conditions as was the case with the winter peaks during the older survey as there have been relatively few winters over the period where long spells of severely cold weather have occurred. A possible explanation may be that some of the birds which have wintered outside Lough Carra, return to the lake to breed, this may include the birds that are present on the smaller loughs and turloughs in the sub-catchments and in the Carra catchment as a whole. While this is a possible hypothesis, it still does not fully account for some of the January peaks which have been between 95 and 409 birds. Based on the count data, not all these birds are staying on at the lake to breed as numbers usually decline after the January peak and are at breeding levels by about the middle of February/start of March. While the hypotheses for the occurrence of low counts in September when previously numbers had peaked in this month, have been strengthened by the evidence of predation and other factors leading to low recruitment. The new fluctuation pattern which highlights winter peaking needs further investigation and ideally, a programme of ringing such as that conducted by Stronach *et al*. (1967-1975). The recovery of ringed birds may then provide answers as to either the origin or destination of those additional birds that are present on the lake in the winter.

The crash in the Mallard population at Lough Carra appears to have occurred sometime in the late 1980s as Sheppard (1993) noted that the lake still held one of the most concentrated populations in the country and this was following the counts for the Winter Wetlands survey from 1984/85 and 1986/87. During this period, a site had to hold 800 or more Mallard to qualify it as a site of national importance and with a count of 1,447 birds it surpassed this threshold and was ranked as the 6th most important site in the country for the species. As the lake was not counted again until 1995, the decline in numbers must have occurred over the eight year period between the count as part of the Winter Wetlands Survey and that first count in 1995 as part of the new Irish Wetland Bird Survey (Colhoun, Pollitt *et al.*). This was a relatively short time span for such a large population of over 1,000 birds to crash so dramatically to a count of 409 in 1995. With a mean annual peak of just 179 since then to the present day, Lough Carra is no longer ranked as a site of national importance (threshold 840 birds) since the mid 1980s.

The wintering population of Mallard in Ireland has seen a 68% increase since the Winter Wetland survey (1984/85-1986/87) and in fact has grown from an estimated population of 20-50,000 birds in the 1970s to 84,080 birds in the 1990s. What has changed is the amount of nationally important sites which has gone from 20 in the mid 1980s to just seven today. The decrease in sites with lower concentrations of Mallard is thought to reflect a more scattered distribution throughout the country and not to be connected to declines in the overall population. Although the overall national population has grown and appears stable, declines and stability in local populations vary from site to site. This is particularly evident at sites like Lough Carra that have been the focus of long-term waterfowl counting programmes since the 1960s. At Lough Neagh Winfield *et al.* (1989) reported on the 'Long-term trends (1969-1988) in the numbers of waterfowl overwintering on Lough Neagh and Lough Beg, Northern Ireland' and found that,

> Overall the Mallard population has remained relatively stable with a slight drop on Lough Neagh and an increase on Lough Beg, with present average mid-winter numbers just below those of the 1960s at around 2,900 birds. Peak numbers of Mallard occur in September and October reflecting the large local breeding population.
>
> (Winfield *et al.* p. 30).

Since those counts at Lough Neagh between 1969 and1988 which included counts under the Winter Wetlands Survey (1984-1987), Crowe *et al*. (2005) report that there has been a 19% increase in the mean annual peaks of Mallard on Lough Neagh and Lough Beg based on the data from the I-WeBS scheme. It is noted that some of the dabbling duck species including Mallard are disturbed by wildfowling from Lough Neagh but wildfowl refuges have been created to help these displaced birds (Crowe *et al.* 2005). Meanwhile, Smiddy and O'Halloran's (2006) examination of population changes in the waterfowl of Ballycotton, County Cork over 35 years, 1970/71 to 2004/05, has shown a change in species diversity and numbers occurred at Ballycotton largely due to the loss of a coastal lagoon in 1990/91 through erosion, drainage and the development of estuarine habitat in its place. The paper examined counts prior to the loss of the lagoon (1970/71-1989/90) and after it was lost (1990/91-2004/05). The count data showed that a total of nine waterfowl species have disappeared and three have significantly declined over the 35 years of the study. Mallard was one of the three species in the latter category that has declined with mean annual peaks of 601 birds in the period 1970-1990 to peaks of 222 from 1990-2005.

More locally, at Lough Mask and Lough Conn, to the immediate southwest and north of Lough Carra, the programme of waterfowl counting has not been as intensive as that conducted at Lough Neagh, Ballycotton or Lough Carra but these lakes were counted at least once for the Winter Wetland Survey (1984/85-1986/87) and so comparisons can be made between the counts from the mid 1980s to those from the Irish Wetland Bird Survey (1994/95-2000/01). At Lough Mask, the Mallard population is reported to have declined by 17% since the Winter Wetlands Survey (Crowe *et al.* 2005), with a mean annual peak now of around 120 birds; it is noteworthy that this decline is not nearly as severe as that seen at Lough Carra (88% decline). At Lough Conn, Crowe *et al*. (2005) state that there has been a 34% increase in the total number of waterbirds using the lake but do not mention the fluctuations of Mallard, however it seems that populations on Conn have declined as the count from the Winter Wetlands Survey recorded 462 birds on the lake in the mid 1980s while the highest annual peak between 1995-2001 was 193 birds. While this would represent a decline of 59% between the two eras, a more complete dataset covering the intervening years would be needed before coming to definite conclusions.

Looking outside Ireland, in Britain, Kirby (1995) states that between 1966/67 and 1991/92, the Mallard population has remained relatively stable but it has been noted that there have been declines in the concentrated wintering populations at larger wetland sites with a 40% decrease occurring at some sites between 1987/88 and 1997/1998 (Joint Nature Conservation Committee, 2005). Again, this may reflect a more dispersed population rather than a decline in overall British populations, as even before this period, Owen *et al.* (JNCC, 2005) noted that only ten sites held more than 2,000 Mallard, despite its general abundance and widespread distribution. In Europe, Mallard populations are said to have been stable in the 20 year period from 1970 to 1990 but some countries experienced increases (such as the Netherlands and Sweden) while others experienced decreases (such as Romania and Spain) during this period. The Northwest European population (which includes the Irish population) is estimated to be about 5,000,000 birds but Delany *et al.* (1999) reported decreases in the numbers of birds counted between 1987-1996. However, more recently the Mallard populations within the 25 member states of the European Union have been classified as being stable with a favourable conservation status (Papazoglou *et al.* 2004).

The data collated on Mallard populations in Ireland, Britain and Europe highlights the contrasting fluctuations that occur between different populations both between and within countries. The general consensus is that this species can be hard to monitor due to its distribution over smaller wetland sites that are not covered by the counting schemes that are in operation within these various countries. This has led to an extrapolation factor (formula to estimate the number of birds missed due to scattered distribution outside counted sites) being applied to the count data in some countries such as Ireland and Britain (Kirby 1995, Crowe *et al.* 2005). What is evident is that because the Mallard populations in Ireland are relatively sedentary outside short hard weather movements within the country, the fluctuations at different sites usually can be related to changes in local conditions and are not necessarily linked to changes in populations elsewhere as would be the case with migratory or partial migratory species. After the examination of the relevant literature, no satisfactory correlation could be identified linking the decline of the Mallard populations at Lough Carra, to similar declines elsewhere. At the lake, the recovery of 355 ringed Mallard showed that this too was a closed or predominantly sedentary population as 90% of the birds were recovered within a 20km radius of the lake. The ramifications of this on the study into the decline of Mallard at a given site such as Lough Carra, is that the research must be for the most part, focused on local factors which may have contributed to the decline. While some of these causative factors for decline may not be unique to a particular site (for example, the predation of waterfowl by mink), the combination of certain factors can be. After 21 months of research, this study found strong evidence to support the hypothesis relating the decline in the Mallard population on Lough Carra to a combination of factors including high levels of predation by Hooded Crows (*Corvus corone cornix*) and American Mink (*Mustela vison*), a decline in food availability due to the decline of tillage crops grown in the Carra catchment and a change in the breeding habitat on the lake's islands.

Gadwall (*Anas strepera*)

The Gadwall is a dabbling species similar in size to the Mallard (*Anas platyrhynchos p*) with a distribution that was described as patchy in Europe, Britain and Ireland until an expansion in its population and range over the last few decades. This was partly due to an increase in suitable habitat in the form of man-made reservoirs and gravel pits but it was also due to the release of hand-reared birds into the wild (Fox & Salmon, 1989). In North America it has spread eastwards in range and increased in size for similar reasons (Fox & Salmon 1989, Crowe *et al.* 2005).

On Lough Carra Stronach *et al.* recorded Gadwall from 1968 to 1976 and commented that at that time, it was the least common of the dabbling duck found on the lake. The minimum annual peak from this period was 18 birds in 1976 and the maximum annual peak came to 73 in 1969, overall from the counts conducted during the older survey the mean annual peak was 43 birds. The trend of the Gadwall on Lough Carra from the peak of 73 birds in December of 1969 was one of steady decline, to the 18 birds which was the annual peak in 1976. Furthermore, this decline continued on into the mid-late 1980s with Sheppard (1993) noting that there were very few Gadwall left on the lake during the count for the Winter Wetlands Survey (1984/85-1986/87) when there used to be up to 50. The fluctuation from the new era of counting at Lough Carra shows a varied trend with a large increase in annual peaks from 1997 when just three birds were counted to 2003 when an annual peak of 82 birds was recorded. Since then the trend has returned to a downward projection with peaks of 62, 44 and 32 in 2004, 2005 and 2006 respectively. With such an extreme variation in trends, it is clear that more data from counts conducted over the coming years is needed to ascertain whether or not the population of Gadwall on the lake will reach a certain level and stabilise or whether they will continue to fluctuate in the patterns seen over the past few decades. Despite these fluctuations, the fact remains that the Gadwall is the only wildfowl species on Lough Carra that has not declined to some degree since the 1960s and 1970s with a mean annual count from 1995 to 2006 of 46 birds. In comparison with the older survey, numbers are up by 7% which is a small statistic but an increase nevertheless.

In addition to the slight increase in the overall population, the status of the Gadwall on Lough Carra has also changed since the older survey, as it was confirmed as a new breeding species on the lake after a female with a brood of four ducklings was recorded at

Moorehall on 13th June 2006. In some respects, its confirmed breeding status is not a surprising development as birds have been recorded in pairs on the lake as late as the middle of June in recent years, however up until 13th June 2006, breeding could only be described as suspected. Stronach (1981) also commented that it would not take much for the conditions on the lake to develop and provide the required breeding habitat for Gadwall to stay on and breed. The conditions on Lough Carra have certainly changed since Stronach made that remark with the lake now in the process of eutrophication (Huxley & Irvine *et al.* 2004), which by all accounts seems set to worsen over the coming years. The process brought on by amongst other things, the overloading of the lake's waters with nutrients and other agricultural run-off, in time leads to the development of new and lush areas of aquatic vegetation which is much suited to the needs of breeding and wintering Gadwall. Gibbons *et al.* (1993) note that the eutrophication of waterbodies in Britain during the 1980s led to an expansion in their range and numbers, and it is quite possible that their breeding numbers may increase on Lough Carra over the coming years.

The distribution and density of the Gadwall as a breeding species in Ireland over the past few decades is mainly based on the data from the two breeding atlases that took place between 1968-1972 (Sharrock *et al.* 1976) and 1988-1991 (Gibbons *et al.* 1993). It was recognised that the main breeding strongholds for this species was in County Wexford and at sites such as Lough Neagh in Northern Ireland. Sharrock (1976) comments that the species first bred in Ireland in 1933 and since has nested in six or seven counties but only regularly in those strongholds mentioned above. The breeding population in Wexford has certainly increased with Sharrock reporting the presence of 1-3 pairs while Hillis *et al.* (2006) report a population consisting of 20 pairs at Lady's Island Lake/Ring Marsh in 2004. The figures for the breeding populations at Lough Neagh are unclear although Winfield *et al.* (1989) mention the importance of locally breeding birds to the overall population on the lake. Neither Sharrock *et al.* (1976) or Gibbons *et al.* (1993) mention the numbers of breeding pairs at Lough Neagh but in 2004 there were 14 broods reported from the site (Hillis *et al.* 2006). Outside the sites mentioned, data on the numbers and distribution of confirmed breeders is patchy and lacking in clarity. It is quite possible that some pairs breeding on discrete wetlands went unrecorded but breeding and possible breeding were reported from counties Cork, Tipperary, Limerick and Galway where on Lough Corrib they seem to have bred as recently as 2000/01 (MacLochlainn, 2002). The number of confirmed breeding pairs using an extrapolation factor was estimated at 20 pairs in 1983 which rose to 30 pairs in 1990 (Fox, 1993), from 2004 Hillis *et al.* (2006) report that the Irish Rare Breeding Birds Panel (I.R.B.B.P.) have received more records of brood appearance for Gadwall than any year previously although they believe that it may reflect more fieldwork than an increase in breeding numbers. The fact remains however, that the broods reported in 2004 were again located in the Lough Neagh/Lady's Island regions and there are no records from outside these areas for that year which leaves its status as a rare breeder very much intact. It will be another two years before the data for breeding Gadwall in 2006 will be published but at that stage it is quite possible that Lough Carra may have a confirmed population of more than one pair.

In terms of overall populations in Ireland over the last few decades, the estimates for wintering populations that existed in the mid 1970s were reported by Fox and Salmon (1989) as being between 300-350 birds. They suggest that with the high counts recorded in the mid 1980s (such as 64 and 92 from Loughaderry and Ballycotton in County Cork and 116 at Strangford Lough in Northern Ireland) the population experienced growth between the two decades. This was in agreement with the findings of the Winter Wetland Survey (1984/85-1986/87) and in contrast to the declining trend seen at Lough Carra during the period. Sheppard *et al.* (1993) noted that numbers were increasing and Crowe *et al.* (2005) state that from the population of 300-350 in the mid 1970s, the population increased to 450 in the mid 1980s, and continued to grow up to an estimated population of 735 in the 1990s which shows an increase of 63% since the Winter Wetlands Survey. For a site to be of national importance, it must hold at least 20 Gadwall and a total of 16 sites qualified for the status based on counts conducted between 1996/97-2000/01 (Crowe *et al.* 2005). Lough Carra did not qualify between 1994 and 1998 but has been a site of national importance from then to 2001; despite the fluctuations of this species at the lake, numbers would have to drop alarmingly low for it to be excluded from the category in the coming years.

In Britain, the trend of both breeding and wintering Gadwall populations is one of rapid growth and expansion with a 12%-17% annual increase in the numbers of birds counted in mid-winter since 1960 and an estimated wintering population of 6,000 birds by 1985/86 (Salmon & Fox 1989, Kirby 1995). The breeding population grew from 1960 to 1985 by 4.5% and was estimated at 770 in the early 1990s (Gibbons *et al.* 1993). It is recognised that the increased growth of both the Irish and British populations since the 1970s was practically identical in magnitude (Crowe *et al.* 2005). It is hypothesised that the reason behind these increases was due in part to more immigrants arriving into the two countries from breeding stocks on the continent and particularly Iceland, where the breeding population has grown. The mid-winter peaks in this species have replaced autumn peaks in Britain and Ireland with possible emigration by locally breeding birds and immigration during the winter months by foreign birds from faster growing breeding populations (Salmon & Fox 1989, Kirby 1995, Crowe *et al.* 2005). As mentioned, Gadwall populations in Europe have increased and this is particularly evident in the Northwest European population which has more than doubled between 1986 and 1994, with populations going from 12,000 to 25,000 birds and since then this population has continued to increase (Joint Nature Conservation Committee, 2005). Within the 25 member states of the European Union, it was reported that the breeding and wintering populations both showed moderate increases from 1970 to 2000, while the wintering population from 1990 to 2000 showed a large increase. In 2004, BirdLife International regarded the conservation status of the Gadwall within the member states as favourable and populations as being secure (Papazoglou *et al.* 2004).

The increase in the numbers of Gadwall in Ireland was somewhat reflected in the populations on Lough Carra despite their fluctuations. This species is considered a rare breeder but present ecological conditions on the lake are favourable for a small but more regular breeding population which may form a nucleus of birds from which expansion may occur. Like the other species of waterfowl on Lough Carra, the Gadwall will be affected by predation from American Mink (*Mustela vison*) and Hooded Crow (*Corvus corone cornix*) amongst others. Due to its feeding habits, the Gadwall needs to spend long periods foraging food and it has been noted that this leaves it more prone to disturbance from man (Gibbons *et al.* 1993). This may prove to be a factor which impedes its breeding expansion at Lough Carra and has possibly led to lower numbers being recorded in 2005 and 2006. One of the favoured haunts of the Gadwall on the lake is at Moorehall where the vegetation provides it with feeding grounds and more recently a suitable habitat in which to rear a brood. However, Moorehall is also very popular with the public who walk, swim and picnic at the site particularly during the summer months and in the winter fireworks have been let off with regularity along the shoreline and from the car-park adjacent to the grounds of Moore Hall itself.

Shoveler (*Anas clypeata*)

The Shoveler is a dabbling duck which has a widespread global breeding distribution and can be found in Europe, North America, Canada, Siberia and Asia Those in northern regions tend to be more migratory while those in temperate latitudes such as Northwest Europe are described as being more sedentary or dispersive (Crowe *et al.* 2005).

The Shoveler found on Lough Carra are winter migrants and were counted on the lake during the older survey from 1967 to 1976 (Stronach *et al.*). During those years, the lowest annual peak recorded was 50 birds in 1967 and the highest peak was 500 birds in 1974, although peaks of 400 or over only occurred three times during this period. The mean annual peak was more reflective of the population on Carra at that time and this numbered 253 birds. From 1995 to 2006 the mean annual peak of Shoveler on the lake was 38 with minimum and maximum annual peaks of four and 66 birds in 2000 and 2006 respectively. These figures represent an 85% decline in the populations of Shoveler wintering on Lough Carra between the old and new surveys. The annual peaks from the new counting programme only equalled or surpassed the minimum annual peak from the older survey (50 birds) four times during the 84 counts from 1995 to 2006. In relation to the other species that have declined since the older survey, Shoveler shows the fourth highest rate of decline coming just after Mallard (*Anas platyrhynchos p*) which has declined by 88%.

The last count from the Stronach era was conducted in 1976 but the decline of this species was already occurring at Lough Carra in the mid 1980s with the lake being mentioned by Sheppard (1993) as one of the previously important sites which was showing a serious decrease in numbers. During the 1970s Lough Carra was both a site of national and international importance for Shoveler with populations breaking the thresholds of 50 birds (national threshold) and 200 birds (international threshold). The current threshold for a site to gain national importance is 35 birds or over and the annual peaks at Lough Carra reached these levels in some years and not in others. In the years 1995, 1996, 1997, 2002, 2003 and 2004 the lake qualified for national importance but for 1998, 1999, 2000, 2001 and 2005 it did not, 2006 was only counted until the end of August for this study and so whether it qualified in this year is not known. Crowe *et al.* (2005) note that numbers in Ireland build up from September, peak in January and decline thereafter. This was also the fluctuation pattern at Lough Carra, with peaks occurring in December/January and despite the large decline in the numbers counted, this was also the pattern over the 84 counts of the new survey

On a national level there has been a decline in the numbers of Shoveler in Ireland as a whole over the 1970s, 80s and 90s. Crowe *et al.* (2005) note that there has been a continuous decline since the 1970s and a 10% decrease in numbers since the Winter Wetlands Survey (1984/85-1986/87). The Irish population was put at between 6,500-8,500 birds in the 1970s, this dropped to 4,000 birds in the 1980s and dropped even further to 3,600 in the 1990s (Crowe *et al.* 2005). The trends in Shoveler numbers are rather varied from the late 1990s and into this decade, Crowe *et al.* (2005) report that numbers are continuing to decline while Colhoun (2002) reported notable increases from counts conducted for I-WeBS over 2000/01. From the I-WeBS data for 2003/04 and 2004/05, Shoveler are not named as amongst those species whose numbers have declined but were amongst species deemed as being relatively stable (Crowe & Boland, 2006). Some sites where long-term counting has taken place show a correlating trend to that seen in the overall Irish populations during these periods. At Lough Beg in Northern Ireland for example, Winfield *et al.* (1989) reported declines in Shoveler populations starting in the 1970s. The populations at this site used to regularly peak at *c.*150-300 birds and over during the 1960s but after a decline in the mid-late 1970s, peaks of just *c.*50-100 were recorded. Other notable sites that have declined since the mid-late 1980s include Lough Rea and Rahasane Turlough in County Galway. Sheppard (2002) who published findings from counts conducted at Lough Swilly from 1986 to 2002 commented that Shoveler had undergone one of the most severe declines at the site with an annual mean peak of 225 birds for the first three years of the counts to a mean of 45 from 1998 to 2002. Loughs Conn and Mask have virtually no records of Shoveler while in contrast Lough Corrib is a nationally important site for the species with a mean annual peak of 74 birds recorded from 1996/97-2000/01. Previous counts at Lough Corrib such as that from the mid-late 1980s are unknown and so the analysis of trends over a longer run of years is not possible.

In Britain the trends for wintering Shoveler show a reversal of those recorded in Ireland, Kirby (1995) proposes that there was a rapid expansion in numbers during the late 1960s/early 1970s and a slight increase during the remaining years of the latter decade. It is recognised that Shoveler populations in Britain have increased since the 1980s and declines were not reported at any stage from the 1970s to the mid 1990s with an estimated wintering population in 1995 of 10,000 birds (Kirby 1995, Crowe *et al.* 2005). The Northwest European Population (of which Ireland and Britain are part) is thought to have remained stable since the mid 1970s (Crowe *et al.* 2005) but populations within the countries of the European Union show trends of stability in the breeding populations and moderate increases in the wintering populations from 1970 to 1990 followed by moderate declines in both those populations from 1990 to 2000. In addition Shoveler were ranked as having an unfavourable conservation status within the 25 member states in 2004 (Papazoglou *et al.* 2004).

Amongst those who study bird movements and distribution, it is generally agreed that the knowledge on the populations of Shoveler in Europe is lacking. This has been partly attributed to their migratory patterns which can vary in intensity from year to year (Joint Nature Conservation Committee, 2005). These complex movements and the interchange of populations are not yet fully understood even through ringing studies. It is recognised that the birds which winter in Ireland and Britain come from breeding populations in France, northern Europe, the Baltic and western Russia, also both Ireland and Britain also host birds from the Icelandic breeding population (Crowe *et al.* 2005). It has been suggested that one reason for the decline of Shoveler numbers in Ireland may be due to the fact that Britain may receive more migrants coming from the east (Crowe *et al.* 2005), which has increased populations over the last few decades. Both Martin (1993) and Crowe *et al.* (2005) note that this species is very dependent on shallow waters due to their feeding habits. This makes them susceptible to habitat loss through the drainage of wetlands which in turn may have contributed to their decline in Ireland over the last three decades.

The decline of Shoveler on Lough Carra corresponds with the declines seen at other sites such as Lough Beg in the mid-late 1970s and later at Lough Swilly beginning in the late 1990s and it also correlates with the decline of this species on a national level from the 1970s through to the 1990s. The reasons for the decline at the lake may be more complex and not singularly connected with the declines in populations elsewhere but certainly it must be a contributing factor. While the decline has been substantial, it appears the current winter populations although low, may have stabilised.

Wigeon (*Anas penelope*)

The Wigeon like the Shoveler (*Anas clypeata*) is a dabbling species and a winter migrant to Ireland and Britain. From extensive ringing studies it is known that the birds wintering in Ireland come from two breeding populations found in Iceland and between Scandinavia and central Siberia (Owen & Mitchell, 1988).

Stronach (1981) noted that the Wigeon on Lough Carra are classic winter migrants which usually arrive in September and peak in January. This species was counted on the lake from 1968 to 1975 during which the lowest annual peak recorded was 45 in 1968 and the highest annual peak of 590 occurred in 1974, the overall mean annual count for Wigeon from this period came to 241 birds. Over the course of the new survey, the minimum and maximum annual peaks of eight and 313 occurred in 2002 and 2004 respectively and the mean annual peak came to 99 birds. If one compares the statistics from the two surveys, it is evident that there has been a decline of 59% in the numbers of Wigeon on the lake since the older survey. However, Wigeon are known to undertake both long and short migrations within winters when weather conditions turn severely cold. These hard weather movements are known to cause large fluctuations in populations with an influx of birds from Continental Europe and sometimes Britain (Owen & Mitchell, 1988). Stronach (1981) notes that the two large peaks of 380 and 590 over 1973 and 1974 were caused by an influx of Wigeon into the lake during spells of cold weather. It is therefore interesting to note that while numbers have declined, the scale of the decline (59%) would be less (39%) if these two large peaks were extracted from the calculations. The recent peak counts of 313 in February 2004 and 155 in January 2005 cannot not be related to periods of cold weather unlike the peaks from the older survey. From the count conducted as part of the Winter Wetlands Survey (1984/85-1986/87), Sheppard (1993) provides a record of 130 Wigeon for the lake, which does not intimate stability or decline amongst the population from that period. As with the counts from the older survey, the data from 1995 to 2006 shows that peaks occur most frequently on Lough Carra between December and February each year. Crowe *et al.* (2005) comment that the timing of peaks varies between sites, for example at Castlemaine Harbour in County Kerry and Lough Foyle in Londonderry, both of which are sites of national importance, peaks usually occur in October and decline thereafter while at the Little Brosna Callows in County Offaly, the peaks occur with more frequency in mid-winter. The trend at the latter site is similar to that found at Lough Carra and to trends found at most sites throughout Britain. During the new survey, it was also observed that the birds do not appear to be returning to Lough Carra as early as they used to during the 1960s/1970s, with none recorded before November from 2000 to 2004 while in 2006 just small numbers arrived back in October.

Sheppard (1993) stated that from counts conducted for the Winter Wetlands Survey (1984/85-1986/87) and those conducted as part of the Wetlands Enquiry over 1971/72-1974/75 (Hutchinson, 1979), the status of Wigeon in Ireland remained relatively unchanged but there had occurred increases and decreases in numbers at individual sites. Crowe *et al.* (2005) report a continued but slight decline since the mid 1970s with a 9% decrease in numbers counted since the Winter Wetlands Survey and a continued decline through the core counts for the Irish Wetland Bird Survey. The estimated wintering population in Ireland went from a total of 105,000 birds in the 1970s to 100,000 in the 1980s and down to 90,020 in the 1990s. I-WeBS count data for 2000/01, 2003/04 and 2004/05 shows a decline in Wigeon numbers through those count years (Colhoun 2002, Crowe & Boland 2006). At individual sites, Winfield *et al.* (1989) note that the numbers of Wigeon on Lough Neagh and Lough Beg remained stable from 1965 to 1988, with a slight increase in numbers on the former site from 1985 to 1988. In contrast Smiddy and O'Halloran (2006) state that Wigeon at Ballycotton increased through the 1970s, declined through the 1980s/1990s but then began increasing again from 2000 to 2005. At Lough Conn, the numbers of Wigeon from I-WeBS counts appear to be stable with between 66 and 200 birds recorded from 1999/00 to 2003/04 and numbers have possibly increased since a count of 45 was recorded during the Winter Wetlands Survey (1984/85-1986/87). Counting at Lough Mask has been less consistent but a count of 80 birds was reported from the Winter Wetlands Survey and apart from low counts of 11 in 1998 and 44 in 2004, populations appear stable from 1995/96 to 2005/06 numbering between 66 and 147 birds.

Kirby (1995) notes in Britain that between 1966/67 and 1991/92 five of the largest peaks occurred during winters with severe weather conditions, again highlighting the contribution that hard weather migrants make to British and Irish wintering populations. Kirby could identify no particular trend in the British Wigeon population but Crowe *et al.* (2005) state that it has been steadily increasing since the mid 1970s and Owen and Mitchell (1988) note that the numbers of Wigeon in Britain changed little from the early 1960s to the mid-late 1980s. The numbers of birds in the Northwest European population are said to have been stable through the 1960s and have increased since the 1970s with a current population estimate of 1.25 million birds. Within the European Union member states, a large increase in breeding populations and a moderate increase in wintering populations were reported in the 20 year period from 1970 to 1990. Since then to 2000, both breeding and wintering populations are said to be stable (Papazoglou *et al.* 2004).

The peaks of Wigeon on Lough Carra from 1968 to 1975 were at times caused by periods of cold weather and extreme cold periods brought about the even larger peaks such as that recorded in 1974 of just under 600 birds. The author was hoping to correlate these very substantial peaks with those observed in Britain by Kirby (1995) whose analysis covered counts from 1966/67 to 1991/92, however he reports that those large peaks in Britain occurred in the late 1970s and mid-late 1980s, and so they do not correlate with those recorded by Stronach *et al.* at Lough Carra. The national population of Wigeon has declined since the mid 1970s and those on Lough Carra it appears have done so since at least the mid-late 1980s. As the Irish wintering population continued to decline through the 1980s, there may be some evidence for correlation. In contrast, the numbers on Lough Conn to the north appear to be stable and certainly have not declined over the period from 1999 to 2004. The author did note while out conducting counts, that at times shooting in the lands adjacent to the lake caused disturbance to those species feeding or loafing on the shores of the lake nearby. This was also noted in relation to small groups of Wigeon grazing on the shoreline near Burriscarra at the northern end of the lake. While not effecting the birds directly (as they were not the quarry), constant disturbance from hunting may have been a contributing factor in the decline in populations since the mid 1980s.

Teal (*Anas crecca*)

The Teal is a small dabbling duck species which is a partial migrant with birds breeding in Ireland and Britain remaining fairly sedentary but these populations are supplemented by migrants arriving from Iceland, northern Europe and parts of western Russia during the winter. The most recent breeding atlas (1988-1991) estimated a national breeding population of between 400 and 675 birds although declines in this breeding stock since the atlas of 1968-1972 were suspected (Gibbons *et al.* 1993, Crowe *et al.* 2005).

Teal are the smallest of the five dabbling duck species found on Lough Carra and they are also the one species of wildfowl that has undergone the largest decline amongst populations on the lake. From counts conducted between 1967 and 1976 by Stronach *et al.* the lowest annual peak of 300 birds occurred in 1976 and the highest annual peak of 1,600 was recorded in 1971, this produced a mean annual peak of 732 birds from the old survey. Between 1995 and 2006, the lowest annual peak of 26 birds occurred in 1997 while the largest number recorded was 160 birds in 1998, producing a mean annual peak of just 66 birds from the new survey. The mean annual peaks from both eras reveal the extreme severity in the decline of Teal on Lough Carra with wintering populations falling by 91% since the 1960s/1970s. The peak of 1,600 birds in 1971, which was recorded in a period of severely cold weather, qualified the lake as a site of International importance (threshold 1,500 birds) and from 1969 to 1975 the counts of 550 and over ensured its continued status as a site of national importance (threshold 500). Although Teal numbers on Lough Carra were still high, they began to go into decline from the mid-late 1970s. From 1976 to the count for the Winter Wetlands Survey in the mid-late 1980s, numbers went from 300 to 118 birds, this led Sheppard (1993) to note that Lough Carra was no longer a site of national importance. Since then, winter numbers on the lake have never broken the 100 level apart from one count of 160 birds in 1998 although there was a slight increase in numbers from 2000 to 2006. The fluctuation patterns from the old and new surveys are the same for this species, with numbers usually building at the lake from October/November and peaking in December/January, this is also the trend for Teal elsewhere in the country (Crowe *et al.* 2005). There has also been a decline in the breeding populations of Teal on Lough Carra: while never a large population, Stronach (1981) noted that it usually consisted of between 10 and 20 pairs. The small but regular breeding population has all but disappeared from the lake with no birds seen beyond the month of April in 2005 and just three were seen in June of 2006. These three birds consisted of two males and one female but it is not known whether a pair from the group bred and no broods of Teal were ever seen on the lake over the counting programme of 2005 and 2006.

The trend in the wintering Teal population in Ireland has been one of both stability and increase. From the 1970s to the 1980s populations remained stable with numbers estimated at being between 30,000-50,000 during the former decade and 50,000 during the latter. The population from the mid-late 1980s and the time of the Winter Wetlands Survey, increased by 13% to 56,800 by the 1990s and numbers continued to grow albeit slowly since then through the counts for the Irish Wetland Bird Survey from 1994/94 to 1998/99 (Crowe *et al.* 2005). A slight decrease was evident from the I-WeBS data for 2000/01 but this was followed by a more stable trend through the counts for 2003/04 and 2004/05 (Colhoun 2002, Crowe & Boland 2006). Winfield *et al.* (1989) reported that despite a slight shift in the within-winter trends, the Teal populations wintering on Lough Neagh between 1965 and 1988 showed remarkable stability. Sheppard (2002) described the trends for Teal on Lough Swilly as erratic but reported increases in numbers with mean totals going from 997 in the early 1990s to 1,581 by the late 1990s and up to 1,729 in 2001/02. At Lough Conn, the mean annual peak for Teal was 47 birds between 1994/95 and 2003/04 which may reflect a decline as Sheppard reported 400 from counts as part of the Winter Wetlands Survey in the mid-late 1980s. Meanwhile the mean annual peak at Lough Mask from 1995 to 2004/05 came to 91, the Winter Wetland counts from this site reported 245 Teal from the mid-late 1980s although it must be said that the annual peaks over I-WeBS counts have been inconsistent with a count of nine in January of 1995 and a count of 298 in September of 1996. The annual peaks also reveal a fluctuation which may be different to that at Lough Carra with higher numbers present on Mask during the autumn months. As mentioned however, a more consistent and longer series of counts are needed for both Conn and Mask before definite trends in their waterfowl populations can be properly identified.

Teal were one of seventeen species of waterfowl that showed population growth in Britain between 1966/67 and 1991/92, with the only downward trend occurring between 1982 and 1986, after which populations recovered (Kirby, 1995). The increase in population growth was reported to have slowed since the early 1990s but has levelled off with a population of 130,000 birds estimated in the latter part of the decade. Teal are also highly susceptible to periods of severely cold weather and like their dabbling counterparts (such as Wigeon and

Shoveler) they tend to disperse to warmer regions within or outside the British Isles during these periods (Joint Nature Conservation Committee, 2005). European populations show similar trends to those seen in Ireland and Britain and it is thought the increases in certain years are a reflection of increases in the Northwest population particularly. This population, of which Ireland and Britain are part, experienced an annual growth rate of 2.5% over the years from 1967 to 1993 and since then populations are thought to be generally stable (Joint Nature Conservation Committee, 2005). The conservation status within the European Union is described as favourable and no declines were identified in either the wintering or breeding populations from 1970 and 2000, both were reported as being stable over this period (Papazoglou *et al.* 2004).

Based on the evidence presented above, it appears the severe decline in Teal numbers on Lough Carra since the 1960s/1970s cannot be related to such extreme declines in Ireland, Britain or Europe. Amongst the western lakes, while Lough Conn and Lough Mask appear to have experienced declines, the hypothesis is weakened by the fact it is based on isolated counts (possibly just one count from each lake) from the Winter Wetlands Survey (1984/85-1986/87) and not on data derived from long-term counting programmes covering the last few decades. Like the Mallard (*Anas platyrhynchos p*), it seems its decline on the lake may have been caused by negative factors originating from a local level. Certainly the small but regular breeding population of 10-20 birds present during the older survey, may have been decimated by predation from American Mink (*Mustela vison*) and local Teal numbers may have been affected by land use changes in the Carra sub-catchments (see decline hypotheses for more).

Pochard (*Aythya ferina*)

The Pochard is a migratory diving duck with breeding populations found in Europe, Russia, Siberia, and Asia. They were first established as a breeding species in Ireland in 1907 but confirmed breeding records were scant during the breeding atlas conducted in 1988-1991. Lough Neagh was identified as one of the breeding strongholds with between 7 and 15 pairs reported in 1999, outside of this site records are few and confined to Counties Westmeath, Tipperary, Cork and Offaly (Gibbons 1993, Crowe *et al.* 2005).

On Lough Carra, the Pochard is one of four diving duck species found on the lake and is one of two that are winter migrants (the other being Goldeneye *Bucephala clangula*). Pochard were counted by Stronach *et al.* from 1967 to 1977 when the lowest annual peak of 250 birds was recorded in 1971 and the highest annual peak of 890 birds was recorded in 1972, and across the ten years of counts the mean annual peak was 469 birds. From counts conducted between 1995 and 2006, the lowest annual peak was one bird recorded in 2000 and the highest annual peak was 190 birds recorded in 2001, the mean annual peak from the new survey was 54 birds. This severe crash in the numbers of Pochard on Lough Carra has seen the species decline by 89% since the old survey and establishes it as the wildfowl species that has declined most severely on the lake just behind the Teal (91%). From 1967 to 1977, Pochard would usually arrive onto the lake in late September but more often in October, from which point their numbers would build up and peak in December/January and then decline thereafter. The records of Pochard on Lough Carra from 2000, when count coverage improved reveals just how scarce they have become with just one bird recorded in 2000 and counts of two and one in January and March of 2003 and counts of between just 20 and 40 birds when they are actually present on the lake. Furthermore, the birds that do arrive do not always stay on the lake but appear to move on leaving either none present or just very low numbers. This is particularly evident in some years, for example in January of 2001 there were 190 Pochard on Lough Carra but by the next count conducted three and a half weeks later, there was not one bird left on the lake and this remained the case for the rest of that year until November when just one bird was recorded. The decline of Pochard at Lough Carra was very evident after the count conducted for the Winter Wetlands Survey in the mid-late 1980s recorded no birds on the lake and it was listed as no longer being a nationally important site for the species (Sheppard *et al.* 1993).

On a national level, the numbers of Pochard were reported to have declined from the 1970s to the 1980s with an estimated population of 35,000 dropping to 30,000 over that period. There then occurred an upward trend in fluctuations with a significant increase from the 1980s to a population estimate of 58,410 birds in the 1990s, an increase of 100% (Crowe *et al.* 2005). Colhoun (2002) reported a decrease in numbers counted during the I-WeBS scheme over 2000/01 while Crowe and Boland (2006) report stability in populations from 2003/04 and 2004/05. There are two highly important sites for Pochard in Ireland namely Lough Neagh (including Lough Beg) in County Antrim and Lough Corrib in County Galway. At Lough Neagh Winfield *et al.* (1989) noted that Pochard populations underwent short-term variations in numbers but there had been a decline which started in the late 1960s. This decline did not continue but fluctuations varied until about 1985 when there was an increase in Pochard numbers until 1988. However Allen *et al.* (2004) reported significant declines in populations over the following decade and a half, in 1990/91 a total of 40,928 birds were recorded on Lough Neagh but the following years saw a sustained decline resulting in a peak in 2003/04 of just below 10,000 birds. On Lough Corrib, numbers averaged above the threshold for international importance (3,500 birds) from 1994/95 to 2000/01 with counts of 9,633 and over recorded during the counts for I-WeBS. However, Crowe *et al.* (2005) observe that since then there has occurred a decline in numbers below previous levels resulting in the lake qualifying as a site of national importance but no longer one of international importance. This suggests that numbers on Lough Corrib have dropped from such mean counts as 11,637 (mean 1996-2000) to below 3,500 birds since 2000/01. Amongst other western lakes, there has been a highly significant decline in the numbers of Pochard wintering on Lough Cullin. In the mid 1980s, Sheppard (1993) reported flocks numbering 1,401 birds on the lake and mentioned the importance of Lough Cullin as a wintering site for the species. Since then with a recent peak of 431, birds the lake no longer qualifies as a site of national importance with numbers dropping by 92% (Crowe *et al.* 2005).

There was a slight decrease in the wintering populations of Pochard in Britain during the 1970s but since then, although the wintering population is smaller, numbers are reported to be stable at about 43,700 birds (Joint Nature Conservation Committee, 2005). What has been noted is that the changes that have taken place have been inconsistent between regions and habitats. For example, Allen *et al.* (2004) note that in areas such as the Ouse Washes and the Nene Washes both of which are prone to deep winter flooding, the numbers of Pochard are highly variable. At the latter site, from a peak count of 27 birds in 1999/00, numbers rose to 4,102 in the following winter. Pochard populations have also had mixed fortunes in Europe, increases were noted in the populations wintering in the Eastern Mediterranean/Black Sea area with numbers rising from 211,936 in 1997 to 410,208 in 1999 (Allen *et al.* 2004). Meanwhile, in the Northwest European population numbers increased greatly from the mid 1960s to the mid 1970s then decreased by 30% through the 1980s and 1990s. However, continuing with inconsistent fluctuations, this downward trend has levelled off and now appears to be in reverse (Joint Nature Conservation Committee, 2005). Breeding and wintering populations were reported to be stable in the European Union from 1970 to 1990 but moderate declines were noted in both populations between 1990 and 2000 (Papazoglou *et al.* 2004).

The decline of Pochard from the late 1970s on Lough Carra correlates with the slight decline in the Irish and British populations observed through that decade. However, unlike populations elsewhere, populations on Lough Carra did not recover through the 1980s. It appears that the 92% decline in the Lough Cullin population occurred during the late 1980s and there may be some correlation in the subsequent declines in the Lough Neagh population which began from 1991 onward. The downward trend in the Pochard populations on Lough Corrib commenced far more recently and the data from future I-WeBS counts will tell how low numbers will fall before stabilising or increasing. The various declines at those sites must have in part affected the numbers of Pochard coming to Lough Carra since the latter years of the 1970s and also the declines at bigger sites such as Lough Neagh and Lough Corrib have lessened the chances of a recovery in the Carra populations in the near future. These larger sites are thought to be staging posts for migratory birds before the re-distribution of flocks over the rest of the country as the winter progresses. However, the count data from 1995 to 2006 also suggests that the lake is no longer favourable as a haunt for Pochard throughout the winter months with birds departing the lake sometimes abruptly not long after arrival.

Tufted Duck (*Aythya fuligula*)

The Tufted Duck breeds across the high latitudes of Europe, Russia, Siberia, Asia and Africa but winters further south in northwest and central Europe and partially in Africa and Asia. Birds that breed in Fennoscandia and western Russia winter in the Baltic, North Sea and Atlantic coasts and Ireland also receives Tufted Duck from the Icelandic breeding stock (Crowe *et al.* 2005).

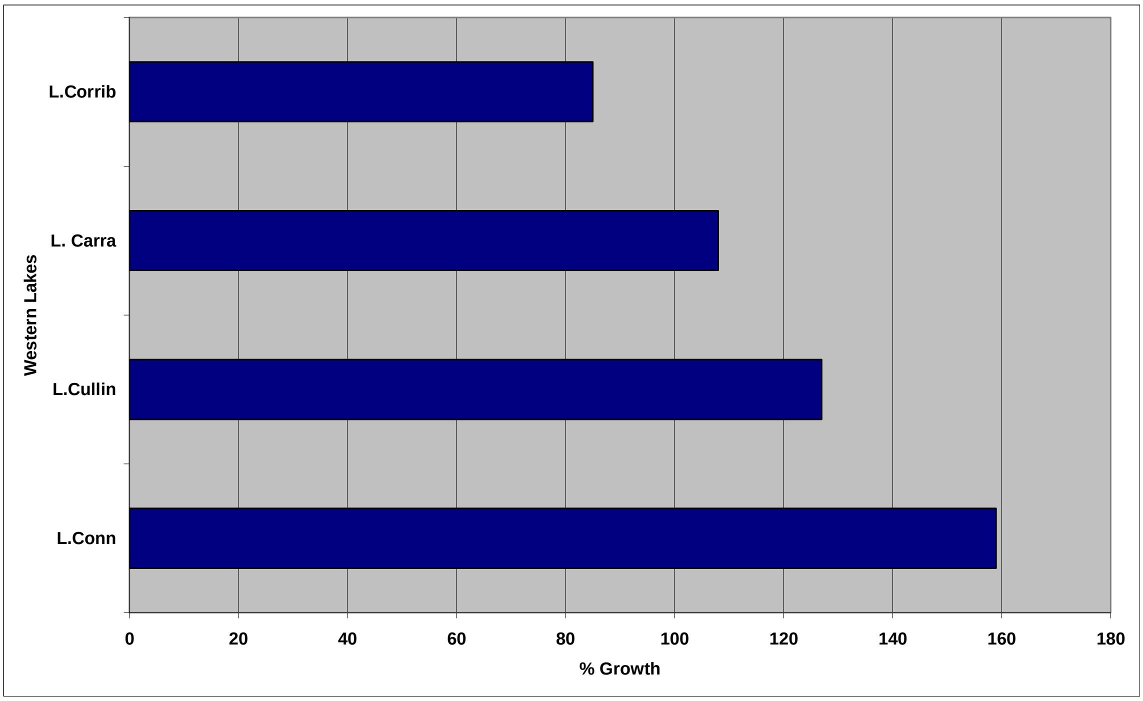
The Tufted Duck on Lough Carra are partially migratory with the small breeding population supplemented by migrants returning to winter on the lake each year. Through ringing studies conducted by Stronach *et al.* (1967-1975) and from the count data over both surveys, it appears that there is some interchange between summer and winter migrants on Lough Carra. Adult birds arrive at the lake to breed during the early part of the breeding season (May-June) and depart in the autumn for wintering grounds elsewhere while wintering birds that have summered elsewhere return to the lake in late autumn from which point numbers increase. During the older survey, Tufted Duck were counted from 1967 to 1976 and the minimum annual peak of 280 birds was recorded in 1974 while the maximum annual peak of 895 occurred in 1971, the overall mean annual peak for the period was 563 birds. From 1995 to 2006, the minimum annual peak of Tufted Duck on Lough Carra was 119 birds in 1996 and the maximum annual peak of 438 birds was recorded in 1995, the mean annual peak from the new survey was 238 birds. These figures highlight a decline of 58% in the numbers of Tufted Duck on Lough Carra since the 1960s/1970s. This decline in numbers appears to have 'bottomed-out' during the mid-late 1980s as Sheppard (1993) presents a count of just 82 birds during the Winter Wetland Survey (1984/85-1986/87) and mentioned that the lake was no longer a site of national importance for the species. Since 1995 and the commencement of counts under the Irish Wetland Bird Survey, there occurred one large peak of 438 in that year which dropped to 119 by 1996 but since then numbers have stabilised showing a slight upward trend with annual peaks from 1997 to 2006 averaging 229 birds. Also, Crowe *et al.* (2005) note that numbers on the lake have increased by 108% since the Winter Wetlands Survey and currently approach the threshold figure for national importance (550). The fluctuation of numbers on the lake is similar now to that for the rest of Ireland and to the fluctuations from the older survey with birds arriving on the lake in late autumn and building to a peak usually between November and February.

The overall Irish population of Tufted Duck is said to have grown since the 1970s and there has been an 80% increase in numbers since the mid-late 1980s. In the 1970s the population was estimated at 20,000 birds and this rose to 30,000 by the 1980s and further to 54,700 in the 1990s. While the population has been shown to fluctuate since the beginning of the I-WeBS programme in 1994/95, it is currently described as stable. Declines were noted in the Irish breeding population over the years between the two breeding atlases (1968-1972 and 1988-1991) but it is thought that this trend was connected to a decline in the breeding stronghold at Lough Neagh (Crowe *et al.* 2005). Lough Neagh which has been identified as a stronghold for Tufted Duck, Pochard (*Aythya ferina*) and diving duck in general showed a stable trend in populations through the 1960s,1970s and through the 1980s until the winter of 1987/88 when numbers peaked at previously high levels (Winfield *et al.* 1989). Since 1990/91, populations have fluctuated but there has been a decline in annual peaks since 2000/01 which continued until at least 2002/04. Amongst the western lakes there has been a substantial increase on Lough Corrib in County Galway since the mid-late 1980s with an increase in numbers of 85%. Sheppard (1993) presents a peak count of 672 birds from the Winter Wetlands Survey (1984/85-1986/87) while peaks of over 10,000 birds have been recorded between 1994/95 and 2000/01. At Lough Cullin there has been a similar increase in Tufted Duck populations since the Winter Wetlands Survey with numbers at this site increasing by 127% since the mid-late 1980s. The increase at Lough Conn has been even greater though, with an increase of 159% in the lakes Tufted Duck population over the same period. In contrast at Lough Mask numbers have declined since the mid-late 1980s by 31% resulting in the lake losing its status as a site of national importance.

The populations in Britain increased through the late 1960s and early 1970s but displayed a slight decline throughout the remainder of the latter decade. However, the population was said to be very stable through the 1980s/1990s and there was an increase in numbers from 1995/96 to 2000/01 (Kirby 1995, Allen *et al.* 2004). The Northwest population in Europe which includes the Irish and British populations was reported to be stable over the 23 years from 1974 to 1996 with a slight increase in numbers during the latter years of that period (Joint Nature Conservation Committee, 2005). Within the European Union numbers in both the breeding and wintering populations were reported as stable between 1970 and 1990 but both displayed moderate declines from 1990 to 2000 (Papazoglou *et al.* 2004).

There is a very solid correlation between the increases of Tufted Duck amongst the western lakes including Lough Carra. The rise in numbers on Lough Corrib (85%), on Lough Cullin (127%), Lough Conn (159%) and Lough Carra (108%) occurred during the same time frame, that is since the counts for the Winter Wetlands Survey in the mid-late 1980s. These increases may be due in part to the re-distribution of Tufted Duck from Lough Mask where numbers have declined by 31% over the same period. The stability and slight upward trend in numbers on Lough Carra over the course of the new survey (1995-2006) was also reflected in the estimated numbers of breeding pairs on the lake over 2005 and 2006 which went from 21 pairs in the former year to 43 in the latter.

Figure 40. The growth rate in Tufted Duck (*Aythya fuligula*) populations over four western lakes from the Winter Wetlands Survey 19845/85-1986/87 to the Irish Wetland Bird Survey 1994/95-2000/01.



Goldeneye (*Bucephala clangula*)

The Goldeneye is a highly migratory diving duck that has a circumpolar breeding distribution mostly across the high latitudes. In Europe it breeds in the north and northeast of the continent and migrates to northwest and central Europe in winter. The wintering populations found in Ireland and Britain are thought to be mainly from this breeding stock (Crowe *et al.* 2005).

The Goldeneye on Lough Carra are winter migrants and of the eight species of waterfowl that have declined on the lake, they have done so the least. Goldeneye were counted on the lake from 1967 to 1976 (Stronach *et al.*) and from that period the minimum annual peak was 85 birds which occurred in 1974 and the maximum annual peak was 180 birds recorded in 1972, the mean annual peak from the old survey was 117 birds. From 1995-2006, the minimum annual peak of Goldeneye on the lake was 42 birds recorded in 1998 and the maximum annual peak was 158 birds in 2004, this gives a mean annual peak from the new survey of 103 birds. The above figures and the annual peaks in general from 1967/76 and from 1995/2006, highlight the stability in the winter populations of Goldeneye on Lough Carra which have declined by just 12% between the two surveys. A downward trend in the population was evident from 1995 to 1998 when annual peaks dropped from 88 to 44 over that period but from 2000 to 2006 the annual peaks have numbered between 96 and 158 birds. The threshold figure for a site to qualify for national importance is 140 birds and Lough Carra reached and exceeded this number during 2002, 2003, 2004 and 2005 with an average peak of 149 birds from those years. The current monthly fluctuations in Goldeneye populations on the lake are similar to those found at other Irish sites and during the 1960s/70s, with birds usually arriving in October/November and building up to a peak between the end of November and the end of February in most years.

The Irish population of Goldeneye was reported to have increased since the Winter Wetlands Survey (1984/85-1986/87) by 41% with numbers increasing from 10,000 to 14,100 birds (Crowe *et al.* 2005), it is not known what the trend was from the 1970s to the 1980s as no data is presented for the former decade (for reasons unknown). Numbers are said to have remained stable through the 1990s despite fluctuations during the counts for the Irish Wetland Bird Survey over the seasons from 1994/95 to 2004/05 (Crowe *et al.* 2005). As with the other species of diving duck that occur in Ireland, Lough Neagh is a highly important site for Goldeneye and one of international importance. Winfield *et al.* (1989) reported great stability in the wintering population of Goldeneye on Lough Neagh over the 1960s, 1970s and early 1980s, while there occurred an increase in populations during the winters of 1986/87 and 1987/88. Over the 14 year period from 1991/92 to 2003/04 the numbers on Lough Neagh have declined from peaks of just under 14,000 to counts of around 4,000 birds, a decline which has been described as the most pronounced of any of the diving ducks over the same period (Allen *et al.* 2004). On Lough Conn there were low numbers recorded over the period 1995 to 1998 with a downward trend of 44 to 2 birds counted, this trend was reversed however from 2000 to 2003 with counts of 66 to 90 birds occurring within this period. Numbers on Lough Mask appear to have been stable over the course of the I-WeBS scheme 1995/96 to 2005/06 with annual peaks of between 63 and 124 birds while numbers on Lough Corrib are far lower than the numbers of Tufted Duck (*Aythya fuligula*) or Pochard (*Aythya ferina*) but no declines are mentioned with peaks averaging around 100 birds.

In Britain, the populations of Goldeneye are said to have remained relatively stable from the 1950s to the 1970s, from which point there occurred a slight decline. However, numbers stabilised and increased from the mid-late 1980s showing a similar fluctuation pattern to that seen in the Irish population during the same time-scale (Kirby, 1995, Crowe *et al.* 2005). Populations in Northwest Europe are said to have undergone a continued increase from 1974 to 1996 and they have grown by 50% since the mid 1980s. This large increase in numbers was largely due to the substantial growth in breeding populations in Poland, Finland, Sweden, Denmark and Estonia (Joint Nature Conservation Committee, 2005). Within the European Union between 1970 and 1990 large increases were reported in both the breeding and wintering populations of member countries while both populations were deemed to be stable from 1990 to 2000 (Papazoglou *et al*. 2004).

Despite the pronounced decline of Goldeneye on Lough Neagh, numbers of this species on Lough Carra over the two surveys are stable apart from a brief downward trend from 1995 to 1998. Interestingly, the decline in numbers on Lough Conn from 1995 to 1998 and subsequent revival from 2000 to 2003/04 mirrors the fluctuation in annual peaks at Lough Carra during the same years.

Red-breasted Merganser (*Mergus serrator*)

The Red-breasted Merganser is a diving duck and is mainly associated with marine habitats during the winter but tends to breed on lakes and rivers in the summer. They are described as having a circumpolar distribution and a large breeding range which spans northern Europe, Russia, Siberia and North America. It is recognised that the breeding populations found in Britain and Ireland are mainly sedentary but these are supplemented by birds which migrate from the continent, particularly during severe weather conditions (Crowe *et al.* 2005).

The Red-breasted Merganser is present all year round on Lough Carra but during the 1960s/1970s a greater number of birds, used to arrive at the lake in late spring from the coast to breed. Stronach (1981) provides only monthly counts for this species from 1967 to 1969 but annual peaks are known from 1967 to 1978 (bar 1977 for which no peak was given). During this period the lowest annual peak of Red-breasted Merganser on the lake was 20 birds recorded in 1967 and the highest annual peak was 50 birds which occurred in 1970, this gave a mean annual peak of 42 birds from the old survey. From 1995 to 2006, the lowest annual peak of one bird occurred in 1998 while the highest annual peak was 13 birds which occurred in 2000, this gave a mean annual peak of nine birds from the new survey. This count data reveals that the Red-breasted Merganser has declined by 79% since the 1960s/1970s although it should be noted that due to the monthly fluctuations of this species and the count coverage from 1995 to 2005, some of the peaks over this period may have been missed. The annual peaks of the Red-breasted Merganser on Lough Carra from 1967 to 1978 highlight the fact that they peak in numbers during the summer months usually between the end of April and start of July. However the counts at the lake since 1995 until 2005 were from September to March each year and so any peaks occurring during the summer months would have been missed. The decline in both breeding and wintering populations is still evident from the count data as the counting programme for this study included the summer months during 2005 and 2006. From this data, it is estimated that the breeding populations of Red-breasted Mergansers on the lake have dropped by 33%. There is clearly not the same numbers of birds migrating into the lake in the spring to breed with up to 49 recorded during the 1960s/1970s and up to just 12 counted from the new survey. The winter population has also declined with up to 20 birds present on the lake during the older survey but just up to 13 occurring now.

There is no data on the overall Irish population of Red-breasted Merganser during the 1970s but their numbers have grown considerably by 72% since the Winter Wetlands Survey (1984/85-1986/87), this increase saw numbers go from 2,500 during the 1980s to 4,311 during the 1990s. However, a significant decline in numbers has been noted since the 1997/98 season of the Irish Wetland Bird Survey (Crowe *et al.* 2005). Neither Winfield *et al.* (1989) or Allen *et al.* (2004) mention numbers at Lough Neagh but Sheppard (2004) comments that at Lough Swilly, which is a site of national importance (threshold 40), numbers, have been stable since 1998 to 2002. Amongst the western lakes, neither Loughs Mask nor Corrib are noted as nationally important sites for the species. The former lake held numbers of between four and 26 birds from 1994/95 to 2005/06 but no data is available on numbers that were on the lake in former decades and so trends are not known. There has been a marked decline in the populations on Lough Conn however, this site used to be of international importance up until the mid-late 1980s with counts of 50 Red-breasted Mergansers and over. Since then and over the counts from the Irish Wetland Bird Survey 1995 to 2004, counts have averaged between two to five birds apart from one peak in September 2003 when 31 birds were recorded.

The British populations of Red-breasted Merganser underwent a sustained increased from 1966/67 to 1991/92 and in 1995 the estimated population was 10,000 birds (Kirby, 1995). In Scotland, the Moray Firth which is recognised as an important site for the species saw a dramatic increase in numbers during the 1980s but this was followed by declines in the 1990s, both fluctuations were thought to connected to the populations and movements of Sprat (*Sprattus sprattus*) and Herring (*Clupea harrengus*) in the region (Joint Nature Conservation Committee, 2005). Crowe *et al.* (2005) note that there has been a continued increase in the numbers forming the Northwest European population from 1974 to 1996 with the current population estimate standing at about 170,000 birds. The breeding and wintering populations within the European Union have remained stable in the 30 year period between 1970 and 2000, with current breeding estimates at 50-67,000 pairs and a wintering population of 52,000 individuals (Papazoglou *et al.* 2004).

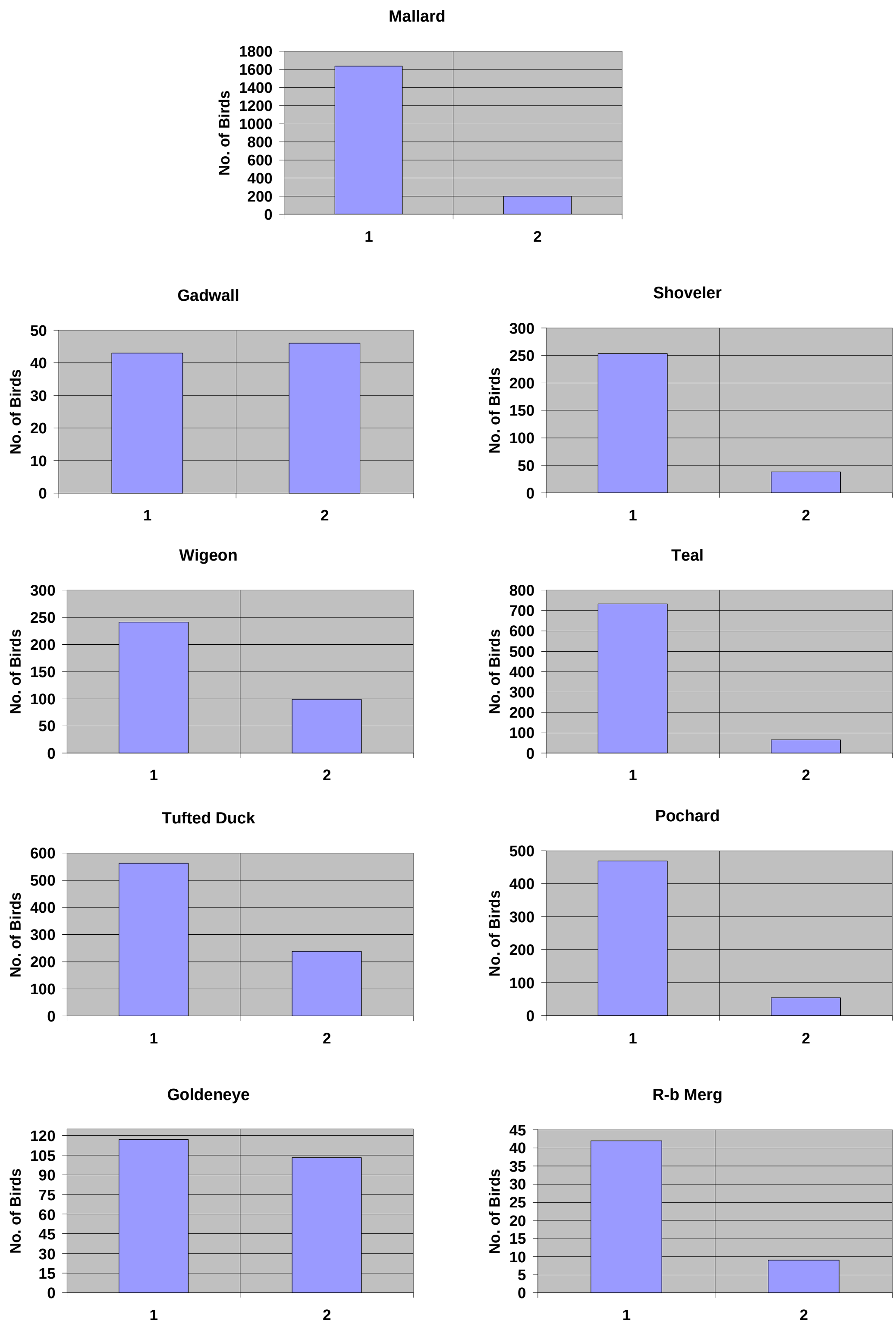
The decline in the local breeding population since the 1960s/1970s is strongly reflected in the overall populations of Red-breasted Mergansers on Lough Carra today. There may be a correlation with the large scale declines seen at Lough Conn from the mid-late 1980s. It is also possible that nest predation by the American Mink (*Mustela vison*) may be a major contributing factor in the decline at both lakes over the 1980s. Also, at Lough Carra the declines may also have been triggered by the suspected decline in certain fish species in recent years (The Western Regional Fisheries Board, 2007).

Table 27. The mean annual peaks and percentage change in the populations of nine waterfowl species on Lough Carra over two counting programmes.

	SPECIES*	Mean 1967-1980**	Mean 1995-2006	% Change
1	Teal	732	66	-91
2	Pochard	469	54	-89
3	Mallard	1,636	200	-88
4	Shoveler	253	38	-85
5	Red-br Merganser	42	9	-79
6	Wigeon	241	99	-59
7	Tufted Duck	563	238	-58
8	Goldeneye	117	103	-12
9	Gadwall	43	46	+7

Note: *****Species listed in descending order according to rate of decline.
******Not every species was counted from 1967 to 1980, e.g. Teal were counted from 1967-1976.

Figure 41. The mean annual peaks in the populations of nine waterfowl species on Lough Carra from 1967-1980 and 1996-2006.



Note: 1= 1967-1980 and 2 = 1995-2006.

7.2.1 General Discussion of Trends in Six Waterfowl Species at Lough Carra From 1995-2006

With a mean annual peak of 22 birds from 1995 to 2006, the Little Grebe (*Tachybaptus ruficollis*) has displayed a variable trend on Lough Carra over the period. An increase in numbers occurred from 1995 to 1997 followed by a dramatic decline to a peak of just six birds in 1998. However from 2000 to 2006 despite a fluctuation in numbers, this species displayed an upward trend from 17 to 30 birds over that seven year period. In Ireland, populations have been shown to peak in September/October and decline thereafter (Crowe *et al.* 2005). This fluctuation pattern was also evident at Lough Carra from 2000 when count coverage improved at the lake, with peaking occurring in September, October or November in all years except 2003 and 2006. Crowe *et al.* (2005) note that the Irish population of Little Grebe has increased by 26% since the Winter Wetlands Survey (1984/85-1986/86). The annual peaks for the second member of the *Podicipidae,* the Great Crested Grebe (*Podiceps cristatus*) on Lough Carra substantially increased from 2000 to 2003 when numbers went from six to 42 birds and since then, numbers have fluctuated between 21 and 37 birds. In most Irish sites, the numbers of Great Crested Grebes usually peak in September and remain relatively high until about January (Crowe *et al.* 2005). However at Lough Carra, annual peaks have occurred in March and also April/May with an annual spring passage of birds through the lake. The overall Irish population was reported to have increased from 3,500 birds in the 1980s to 7,030 birds in the 1990s but populations have fluctuated since. Further counts will reveal whether the population on Lough Carra will stabilise at current levels with a mean annual peak of 21 birds or decline in the coming years. If they continue to nest successfully in association with the gull colonies at Kilkeeran, the numbers of breeding pairs may increase and this could result in more birds being present on the lake during the autumn as young birds are recruited into the population.

Despite the availability of suitable habitat on and around the fringes of Lough Carra, Moorhen (*Gallinula chloropus*) numbers are not high on the lake, however despite fluctuating between 16 and 19 birds, their numbers have increased slightly between 2002 and 2006 with a mean annual peak of nine birds over the new survey. Adults with broods have been seen at Moorehall and Kilkeeran but both have been predated by American Mink (*Mustela vison*) in the past (Huxley *pers. comm.*). There was no consistency in their overall monthly fluctuations on the lake and peak months are not mentioned by Crowe *et al.* (2005) although two of the largest peaks on Lough Carra occurred in the months of March and April of 2004 and 2006. They are noted as being a ‘skulking species’ and no doubt because of this a certain percentage go unrecorded during counts at Lough Carra and other Irish sites. The trend in Coot (*Fulica atra*) on the lake from 1995 to 1998 was dominated by one large peak in January 1997 of 17 birds which has not been equalled since although a count of 15 birds occurred in February 2005. From 2000, the trend has been one of growth and stability to 2006 with a mean annual peak of 10 birds. Irish populations usually peak in November however numbers on Lough Carra have peaked three times in September, twice in February, once in March and once in April since 2000, showing much variability in monthly fluctuations. The Irish population was estimated at 30,000 birds in the 1980s which grew to 40,750 in the 1990s and numbers have increased by 36% since the Winter Wetlands Survey. However over the course of the Irish Wetland Bird Survey there has been an annual decline of 5% in the numbers of Coot counted (Crowe *et al.* 2005).

Cormorant (*Phalacrocorax carbo*) numbers on Lough Carra declined from a count of 26 to eight birds over the period 1996 to 1998 but from 2000 when count coverage improved numbers were shown to increase and stabilise. The trend from 2000 to 2006 is clearly dominated by one substantial peak which occurred in December 2004 when a count of 63 birds was recorded. It is not clear what brought such large numbers to the lake although their numbers do usually peak on Lough Carra in November/December. Reports from other inland sites suggest that Cormorants retreat to lakes and more sheltered areas during storms on the coasts, but weather conditions in November/December 2004 did not support this hypothesis. Winter peaks average at about 23 birds and following the large peak of 2004, the peaks of 2005 and 2006 returned to previous levels with counts of 36 and 21 birds respectively. The peaks during the winter months at Lough Carra do not mirror those at other Irish sites which show an annual peak in September: numbers on the lake from 2000 only started to build in the autumn until they peaked in mid-winter. This suggests a cycle of wintering birds leaving the lake to breed in the spring and then returning in the autumn from which point numbers build to a peak and the cycle continues. Crowe *et al.* (2005) note that the Irish Cormorant population increased by 40% since the Winter Wetlands Survey (1984/85-1986/87) and this increase has continued through the years of the Irish Wetland Bird Survey.

The Mute Swan (*Cygnus olor*) population on the lake went into a slight decline from 1996 to 1998 but has shown a slow but steady upward trend from 2000 to 2006 when counts went from 11 to 22 birds over that period. The resident breeding population has also shown stability since the 1960s/1970s with an estimated four to six pairs nesting on the lake in 2006 compared to a population of two to three pairs mentioned by Stronach (1981). The peak months for Mute Swan on Lough Carra have varied over the course of the new survey with three peaks occurring in the autumn which is in line with most other Irish sites, however peaks have also occurred in January and February. There has been a substantial growth in the Irish population of this swan species with a 111% increase in numbers since the Winter Wetland Survey (1984/85-1986/87). Populations in the 1970s were estimated at between 5,000 and 6,000 birds while in the 1990s estimates tell of a population consisting of 21,000 birds (Crowe *et al.* 2005).

In relation to the eight species of waterfowl listed in this study as scarce visitors to Lough Carra, it is worth noting that while Stronach *et al.* (1967-1980) had at least one record and in some years more, many have never been recorded during the new survey (1995-2006). These include Long-tailed Duck (*Clangula hyemalis*), Pintail (*Anas acuta*), Bewick's Swan (*Cygnus columbianus*) and Greylag Goose (*Anser anser*). The remaining four species, that of Scaup (*Aythya marila*), Common Scoter (*Melanitta nigra*), Whooper Swan (*Cygnus cygnus*) and Greenland White-fronted Goose (*Anser albifrons flavirostris*) although infrequent visitors to the lake during the 1960s and 1970s, they are recorded even less frequently today.

Of the three rare species that have been recorded on Lough Carra, the Smew (*Mergellus albellus*) has been recorded in 2003 by the Huxleys, 2004 by the author and the Huxleys and recently in 2007 (Chris & Lynda Huxley *pers. comm.*). If sightings of this species continue albeit infrequently, it may become a scarce winter visitor on the lake and not so much of a rarity.

7.3 Reedbed Analysis

It is recognised that the reedbeds on Lough Carra and reedbeds in general are highly valuable for waterfowl species as a feeding habitat, for shelter, moulting and rearing their young. When Shackleton conducted his fieldwork on the aquatic vegetation at Lough Carra in July/August 1975, the numbers of dabbling duck on the lake were still far greater than they have been over the course of the new counting programme. The findings of Huxley (2003) after he re-mapped the reedbeds as part of a comparative study on the aquatic vegetation highlighted two key points: (1) the extent of the reedbeds has increased since 1975 (2) the density has changed but not consistently, with some areas more dense now and others less dense than in 1975. It is not likely that this inconsistency in density in some areas within the reedbeds has had an effect on the dabbling duck species on the lake so as to contribute to such large-scale declines as those that have occurred amongst this group since the 1960s/1970s. The extension of the existing beds such as those at Kilkeeran and off the Partry House Estate and the appearance of new reedbeds in locations such as Moorehall have increased the available habitat for dabbling species in which to carry out the vital activities such as those mentioned above. It has been noted through the counts and fieldwork for this study, that the reedbeds on the lake still provide nesting habitat for species such as the Great Crested Grebe (*Podiceps cristatus*), Tufted Duck (*Aythya fuligula*), Mute Swan (*Cygnus olor*) and Moorhen (*Gallinula chloropus*). Also these species and including Mallard (*Anas platyrhynchos p*), Gadwall (*Anas strepera*), Coot (*Fulica atra*) and Little Grebe (*Tachybaptus ruficollis*) have been recorded with broods amongst the reedbeds at Kilkeeran, Moorehall, Burriscarra, Castleburke, Partry House Estate and other locations around the lake.

While the reedbeds at Lough Carra have increased in extent and shown variable changes in density in places, other marked changes are taking place at the lake in relation to the biodiversity and structure of aquatic plant species and communities. After numerous studies in the past few years by the Environmental Protection Agency (E.P.A), the Western Regional Fisheries Board and Dr. Ken Irvine *et al.*, there is solid scientific data which shows Lough Carra is becoming more eutrophic. The source of the problem lies mainly with intensive agricultural practices in the lake catchments which amongst other things has seen an increase in the application of fertilisers; an increase in the number of houses in the region has also loaded more nutrients into the system (Huxley & Thornton, 2004). Slurry, domestic cleaning agents, sewerage and other sources have led to the overloading of the lake's waters with nutrients and this has led to repeated algal blooms during the last five years and poor water clarity in the summer when the water turns green/brown in colour. Huxley (2006) also notes this has led to an increase in aquatic vegetation which is visibly evident over the past few years with the spread of the bulrush *Scirpus lacustris* and aquatic macrophytes (*Myriophyllum* spp.). Both of these species have undergone large increases in extent throughout the lake and new beds of both have also appeared where there were none present 10 to 15 years ago.

The eutrophication of the lake's waters may benefit some dabbling duck species as an increase in plants such as aquatic macrophytes around the fringes of the lake will increase food supply and the bulrushes will provide additional cover (Huxley, 2006). Winfield *et al.* (1989) identified aquatic macrophytes as a highly important food source for herbivorous waterfowl but believed that eutrophication can eventually lead to the replacement of these aquatic species with inedible phytoplankton. If the dabbling duck on Lough Carra are dependent or become more dependent on aquatic plants such as macrophytes as a food source, then such a substitution may have further negative effects on populations. As Lough Carra becomes more eutrophic it may effect waterfowl species in other ways as the ecology of the lake changes, for example fish diversity and fish populations may be altered due to the process which would directly effect the food source for some species such as the Red-breasted Merganser (*Mergus serrator*) and the Cormorant (*Phalacrocorax carbo*). Winfield *et al.* (1989) state that there is a direct correlation between the eutrophication of waterbodies and the number of Great Crested Grebes (*Podiceps cristatus*) it can support due to the increase of certain fish species. The data from waterfowl counts and from future studies into the level of eutrophication at the lake will no doubt help in the assessment that these changes in the lakes ecology may be having on waterfowl populations.

7.4 Drainage & Land Conversion

The drainage scheme that took place in the two Lough Carra sub-catchments of Annie's River and Ballyglass during the 1980s did not significantly lower the small loughs in these areas and the turloughs still hold water and associated damp pasture in the winter. A comparison was made of two counts made at these waterbodies during 2005 to those conducted by Lockhart in the early 1980s before the scheme went ahead. While it was noted that these were one off counts, the data obtained highlights the fact that nine waterfowl species and at least three wader species were still present over six wetland sites during the winter of 2005. In addition some of the counts recorded higher numbers of some species than were recorded on the counts conducted at Lough Carra over the same period, it was noted that the numbers of Wigeon (*Anas penelope*) were particularly high with a total of 212 birds recorded over the two counts. Other dabbling species that have declined on Lough Carra were also present in the small loughs and turloughs including Mallard (*Anas platyrhynchos p*) and Teal (*Anas crecca*), the counts of these species totalled 113 and 119 respectively from the 2005 counts. While there is still intact wetland habitat at the six sites mentioned above, it is acknowledged that the full effects that the sub-catchment drainage scheme has had on local waterfowl cannot be solely based on counts at the loughs and turloughs within those areas. These sites are useful as ecological indicators but there has obviously occurred more subtle, less visible changes in some of the wetlands in the area. A full in-depth investigation is needed to assess the changes in all habitats that may have occurred since the 1980s. This would have to involve local landowners, who would in many cases be the only source of information on changes to land and habitats in their area, this type of survey could possibly use the template used by Huxley and Thornton (2004) in their study of land use changes in the Carra catchment.

One of the aims of this research was to analyse the possible effects that the drainage scheme which took place in the 1980s in the two sub-catchments of Annie's River and Ballyglass may have had on the waterfowl habitats found in those areas. However, the author found that the issue of drainage is a complex one, with many routes for investigation and must involve a larger portion of the Carra catchment before conclusions can be drawn. This study found that of the seven species of waterfowl that have significantly declined on Lough Carra since the 1960s/1970s, significant declines of between 59% and 91% have occurred amongst the dabbling duck or *Anas* group. The loss or change of habitat found in the immediate areas around the lake would clearly have a negative effect on the populations of these species. From the study in an area (exact location not disclosed) of the Carra catchment, Huxley and Thornton (2004) found that between 1940 and 1970, 21% or 370 acres out of a total of 2,029 acres of semi-natural or natural habitat had been converted to intensive agricultural land and that between 1970 and 2003 a further 483 acres had been converted. They note that this represents close to 25% of the total 2,029 acres. From these land use changes spanning several decades, drainage did not take place on a large scale with about 3% of the total holdings being affected. However, Huxley and Thornton (2004, p. 7) point out that,

> While the figures for acreage of land drained are small, it is probable that over the catchment as a whole the proportion of land drained is much higher. Our reasons for this assertion include the fact that the study area contained only small areas of peatland, marsh and wet grassland and was, perhaps, atypical in that respect.

The study by Huxley and Thornton provides an insight into the changes that have taken place in land use since 1970 but it should be pointed out that the study looked at 34 farms representing about 7% of the catchment. Therefore, the drainage of dabbling duck habitats such as fens, marshland and peatland around the lakeshore and over the entire catchment has more than likely occurred on a far greater scale. Human intervention may also be a factor affecting the hydrology of the lake which as Huxley (2006) points out, has meant that the water levels do not drop as low as they used to which in turn could effect the areas on the shoreline where dabbling species feed, such as in the shallow fringes.

Another issue involving land use change in the Carra catchment is the noticeable decline in the lands under tillage. From the information supplied by the landowners to Huxley and Thornton and from the testimony of a local wildfowler who lives within one of the sub-catchments, the data clearly shows that the practice of tillage has declined up to and since the 1970s. From the Huxley and Thornton (2004) data it is known that tillage in an area representing roughly 7% of the entire catchment, has declined by over 90% since 1970. While in the sub-catchments, O'Sullivan, whose relations farmed and grew oats in the area, states that there has been a decline in tillage since at least the early 1980s. He knew of 8 to 10 farmers who each had at least 8-10 acres of oats down in the early 1980s but from that time and through that decade, a decline in the practice has ensued. O'Sullivan could think of no farmer now who practises tillage and from the Huxley and Thornton study, it is known that the decrease in tillage is a direct result of the conversion of lands for intensive agriculture. O'Sullivan and members of the Carnacon Gun Club used to hunt along fields of oats during the early 1980s and as they state, flocks of duck (and particularly Mallard) would arrive onto the fields in the evenings to feed. The source of grain crops and in some cases potatoes as a food source for Mallard has been noted from studies in North America (Ringelman *et al.* 1990). The loss of this food source which constituted roughly 100 acres amongst 44 farms that are known of (and of course this figure would be far greater over the entire catchment), must have had an effect, particularly on the Lough Carra Mallard population, which from Stronach's ringing data, are known to have flighted out within a 20km radius of the lake to feed. The author proposes that the drainage of suitable habitat and the change to intensive agricultural practices which has included the conversion of land previously used for tillage to grassland, are both strong factors that have contributed to the decline of Mallard and possibly to a lesser extent Teal since the 1960s/1970s.

7.5 Island Habitat Changes

The natural process of ecological succession is clearly noticeable on the islands of Lough Carra and was noted by both Ruttledge in 1943 and by Stronach during the 1960s. The first stage in the process sees islands with open rocky areas become colonised by a covering of weeds, then with grasses associated with the *Schoenus* and *Sesleria* zones as classified by Praeger, Neff (Anon, 1978) and Shackleton (1975). After a period of colonisation by these plant communities, the next stage starts with a light growth of small trees and shrubs which eventually leads to a thick covering of mature woodland. Depending on the size of the island and make-up of the soils found there, certain areas will reach the mature woodland stage while others consist of mainly scrub featuring a mixture of smaller tree species. In Chapter 6, the author noted that the ten islands visited during fieldwork in 2005 and 2006 all had habitats dominated by either mature woodland, dense woodland scrub or a mixture of both. The evidence of the impact that ecological succession has had on Lough Carra is not confined to these islands as it is clear even from visual evidence that the process has resulted in a habitat dominated by woodland existing on most if not all of the islands today. Over a six year period from 1968 to 1973, Stronach *et al.* examined a total of 1,251 Mallard (*Anas platyrhynchos p*) nests from their breeding surveys carried out annually over those years and this total is an indication of the high numbers of Mallard that were breeding on the islands 35 years ago. From the data he gathered during that time, Stronach (1981) was able to identify which types of habitat were available as nest sites for the Mallard, which was most/least used and which habitat type produced the most successful nests. He divided the available habitat on the islands into 4 categories as follows: (1) Heavy Cover, (2) Light Cover, (3) Open Vegetation and (4) Nests in Trees. The following is a brief description of each provided by Stronach (1981, p. 34):

1. Heavy Cover

Mature woodland mainly found on the larger islands. Trees in the top store included Ash, Wych Elm, Hazel, Hawthorn, Blackthorn, Holly, Spindle Tree, Elder, Wild Cherry, Wild Apple, Grey Willow, Sycamore and Scots Pine. The bottom store included species such as Bramble, Wild Rose and Ivy with Hogweed and Nettles. Nests were built beside trees, under logs, in thick brambles, in Blackthorn thickets, in Nettle patches and very frequently underneath Ivy growing on the ground.

2. Light Cover

The species in this category were smaller, fewer in number and more diversified, the most frequent being Downy Birch, Hawthorn, Ash, Grey Willow and Holly. Ivy was also found growing on the ground in this habitat. Nest sites were not as numerous as in heavy cover. They were found beneath bushes, under Ivy and fallen trees, and between rocks. The most successful nest sites were found at the base of small trees where the branches still touched the ground.

3. Open Vegetation

This category combined the *Schoenus* and *Sesleria* zones of the botanical description. The Schoenus zone, which was wetter, contained more plant growth, and the stands of Black Bog Rush and Purple Moor-Grass provide good stands of cover. The majority of nests in this category were found in the Schoenus zone, either placed at the base of a clump of Black Bog Rush or Purple-Moor-Grass, the fallen stems of the plant forming sufficient cover to hide the nest. Early in the breeding season nests were found in the *Sesleria* zone but they were too exposed and many of them were robbed by predators.

4. Nests in Trees

Occasionally Mallards selected disused nests of the Hooded Crow, the crows having being killed during the predator control campaign. The height of the nests from the ground varied from 10-30 feet. Other forms of nest site in trees were either in holes or on fallen trees and sometimes on stumps.

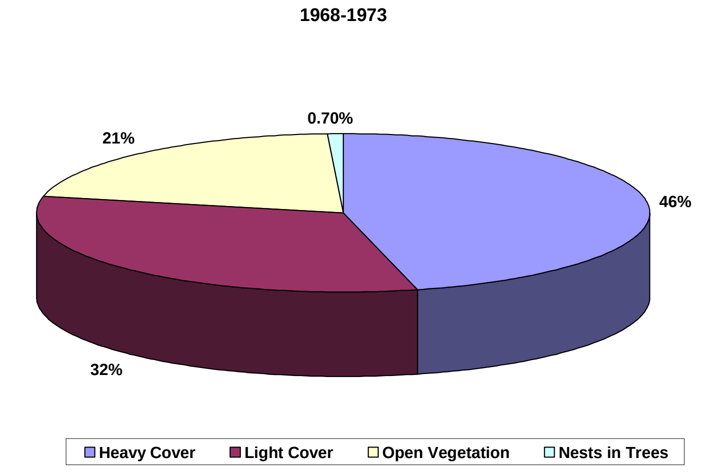
After identifying these categories Stronach found that 46% of the nests were found in heavy cover, 32% were found in light cover, 21% were found in open vegetation and 0.7% were found in trees. He also found that the nests sited in the light cover category were by far the most successful with 83% hatching successfully. The availability of the different habitat types on the islands during that time were broken down as, heavy cover-24% availability, light cover-20% availability and open vegetation-56% availability. Today, through ecological succession the habitat categories outlined by Stronach are not so clearly demarcated on the islands. The available habitat type is clearly dominated by heavy cover consisting of mature woodland and also the habitat associated with the light cover category has all but disappeared. On most islands it seems to have been replaced by dense thickets of small trees mixed with mature trees and not the smaller scattered clumps of light cover described above. A good example of this was found on Doonbeg Island which was described by Stronach as being in the light cover category during the late 1960s. From the survey work carried out as part of this study, it is known that through succession, there are now dense stands of mature and semi-mature trees on the island and more saplings set to grow. The open vegetation category is also affected by succession with the growth and spread of new trees; the areas of open vegetation particularly of the Sesleria or mixed grasses type as used to exist on Bush Island before succession advanced, become smaller and less available as nesting habitat; certainly this habitat type would no longer represent 56% of the habitat type available for nesting duck. Due to the predominant habitat type that currently exists, 53% or eight of the nests found during the breeding surveys for this study were located in heavy cover, none could be said to be located on islands with a light covering of trees, 40% or six were found in open vegetation 7% or one nest was located in the crook of a tree. Due to the widespread replacement of light cover with heavy cover the pattern of nest success in relation to habitat type has also changed, in 2005/2006 it was found that nests in heavy cover were more successful with a 38% success rate while nests in open vegetation had a 17% success rate, the nest found in the crook of a tree on Horse Island was predated.

The changes in vegetation on the islands on the lake has resulted in the loss of a habitat consisting of a light covering of small mixed tree species with an understore of nettles, Hogweed and Ivy growing across the ground. This habitat was scientifically proven through the island habitat experiment conducted by Stronach *et al.* during 1973 on Horse Island and from the nest density and success on Doonbeg Island, to be the most successful nesting habitat for breeding Mallard. This study found that there is still nesting habitat on the ten islands surveyed in 2005 and 2006 but through succession there is little of the optimum habitat described above and by Stronach (1981). When nests were found in heavy cover, they were nearly always located in Ivy and this now seems to be the preferred location for nests in this habitat type, particularly on the larger islands. Many of the islands were already well underway to the final wooded stages of ecological succession by the time Stronach commenced his research. He notes that historically domestic animals were kept on some of the islands which kept the process from advancing to the wooded stage. By the 1960s/1970s the tradition had died out and so many of the islands had developed woodland but today they are even more overgrown and dense. With the change in available nesting habitat it is possible and quite probable that later generations of breeding birds found more suitable nest sites elsewhere away from the lake. Stronach (1981, p. 35) supported this hypothesis;

> With a plant succession of this kind taking place one must expect a gradual shifting of nest sites, and with time possibly a variation in nest numbers as the cover matures…The alleged decline of duck in this part of Ireland over the past 20 years, as reported by wildfowlers and ornithologists, before this study started, may in part be accounted for by a gradual change in island vegetation. Stages in the plant succession moving towards ideal nesting cover (*Schoenus* and *Sesleria* to Ivy) or retreating from this (Ivy and timber) through maturing vegetation could be responsible for population changes due to loss of nesting habitat.

As Stronach notes above, it is quite likely that these changes in island habitats to a heavily wooded stage of the succession process, have contributed to the declines in the breeding Mallard population and in turn, to the population as a whole since the 1960s and 1970s.

Figure 42. The percentage of Mallard (*Anas platyrhynchos p*) nests found in available habitat types over 73 islands from 1968-1973 and over 10 islands on Lough Carra from 2005-2006. 100%=1251 nests (68/73). 100%=15 nests (05/06).



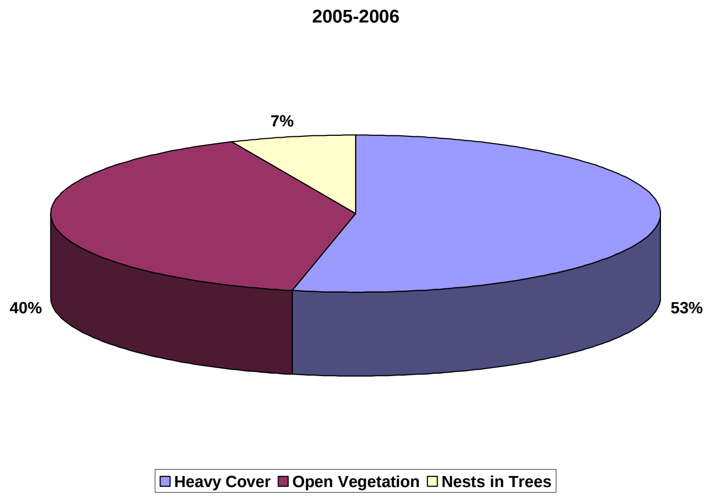
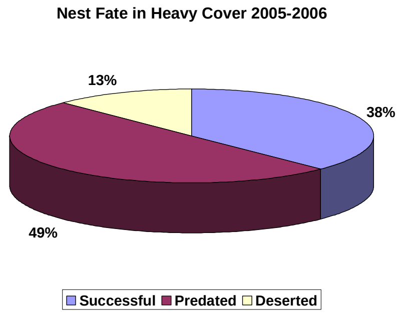
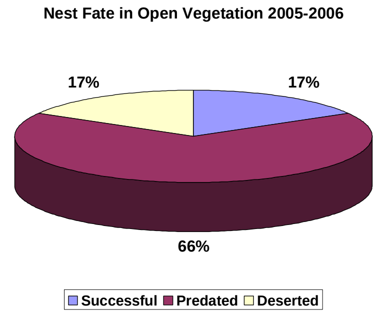


Figure 43. The percentage of successful, predated and deserted nests in relation to habitat type from 15 Mallard (*Anas platyrhynchos p*) nests found on 5 islands on Lough Carra 2005-2006.





7.6 Predation and Predators of Waterfowl and Their Nests on Lough Carra

Out of a total of 15 Mallard (*Anas platyrhynchos p*) nests found on five of the islands surveyed during 2005 and 2006, a total of nine or 60% were predated. When a nest was found predated, evidence from the damage to eggshells, damage to the nest itself and other cues were analysed in an attempt to identify the nest predator (Sargeant *et al.* 1998, Opermanis *et al.* 2001). For this study, the main aim was to identify that a nest was successful, predated or deserted but it was recognised that the identification of predator species would further assist in the investigation into the causes of the decline in Mallard breeding stocks on the islands.

The identification of nest predators can be a difficult task, in most cases it is not difficult to identify if the nest was predated by a mammal or avian predator but the problem arises when an attempt is made to identify the actual predator species. However, the margins of error for misidentification are greatly reduced when the potential nest predators at a given study site are identified (Sargeant *et al.* 1998). Also reasonable assumptions can be made based on the frequency in occurrence of certain predators within the area of a nesting site or colony. There were two possible classes of waterfowl predator at Lough Carra in 2005 and 2006 and these were mammal and avian. Of the former class, based on evidence for their presence and activity, there were two possible nest predators namely the American Mink (*Mustela vison*) and the Brown Rat (*Rattus norvegicus*). Of the latter class, again based on evidence for their presence and activity, there were two main possible avian nest predators, the Hooded Crow (*Corvus corone cornix*) and the Rook (*Corvus frugilegus*). The only other mammal predator at Lough Carra was the Otter (*Lutra lutra*) but given the scarcity of this species on the lake over the last few years and the lack of evidence for their inclination to predate Mallard nests, it is highly unlikely that they predated the nests on the islands during 2005 and 2006. Equally, when a nest was predated by an avian species, given their reputation for nest predation and constant presence around the islands, the Hooded Crow was the most likely culprit. This species was also identified by Stronach (1981) as being the main predator of Mallard nests on the islands during the 1960s/1970s. Although nine predated nests is a small sample, it must be remembered that it represents 60% of the total of nests found and also presents a valuable insight into the predators responsible for nest destruction and predation rates over five islands. The Hooded Crow and American Mink are suspected as being the main predators of the nests found during

2005 and 2006. The number of nests that each predated was fairly balanced with four assigned to the former predator and three assigned to the latter. The remaining two nests had evidence to support the presence of both a mammalian and avian predator and so these predated nests were assigned to both (mammal/avian).

Corvids including Hooded Crows are much given to the predation of nests and ducklings and the damage they cause to wildfowl breeding stocks has been well studied and recognised (Sargeant *et al.* 1998, Opermanis *et al.* 2001, Vaananen 2001, Ackerman 2002). At the start of the breeding surveys at Lough Carra which commenced in 1968, Stronach recognised that these predators were causing extensive damage to Mallard clutches on the islands. After conducting a predator control experiment between 1968 and 1973, Stronach *et al.* culled a total of 93 Hooded Crows over all the islands on the lake, although he did alternate between the islands found in the two basins also. From the results it was clear that Hooded Crows were responsible for the lack of nest success among the local Mallard breeding population, as Stronach (1981, p. 102) notes,

> In 1968, prior to the experiment, robbing (predation) was 60% and 52% in the eastern and western arms (Southeast and northwest basins) respectively. It dropped to 20% and 19% in 1969 and the nesting success rate for mallard increased from 37% to 73% and from 46% to 77% in the eastern and western arms respectively. In 1970 there was a slight increase in robbed nests, but the overall mallard nesting success rate was 64%, still well above the 1968 level. In 1971 31% fewer poisoned eggs were placed in the islands in the course of the experiment. The effect of this was an increase in the number of robbed nests, particularly in the western arm where 41% of the nests were robbed, and 28% in the eastern arm.

The destruction of wildfowl nests and the nests of other bird species by the Hooded Crow at Lough Carra has been documented before the 1960s/1970s. For example, Ruttledge in 1916, visited a number of the islands on the lake and stated,

> …we landed on one island which was strewn with the sucked eggs of Common, Gulls, Black-headed Gulls, Duck, a Lapwing and a Pigeon. This was the work of the Grey Crows; the eggs numbered well over a hundred I am sure.

(Ruttledge, 1916, p. 97).

It is also worth noting that during his trip in 1916 Ruttledge (1916, p. 96) also mentions the presence of Mallard on the lake at this time, "In another reedy inlet were more Tufted Duck, Coots, and on the shore a pair of Water Rails. Mallard were very numerous all day".

The predatory activity of these crows was still evident three decades later when the artist and author Robert Gibbings came to Lough Carra during the early 1940s at the invitation of Ruttledge who was residing at Cloonee House on the shores of the lake. Gibbings camped on one of the islands and explored others and it was on one of these trips that he discovered numerous predated eggshells, as he states (1944, p. 66),

> There is another island on Lough Carra, at the northern end, Castle Island by name, so called from the thirteenth century castle ruin that stands there, embedded in trees. There the hoodie crow consumes its plunder. At every step along the shore one finds empty shells, the sucked eggs of wild ducks, tame ducks, moorhens, domestic hens, thrushes and many others.

Although he does not name it but due to the geographical reference which he mentions, the island that Ruttledge visited in 1916 was almost most certainly Castle Island. While predation by the Hooded Crows would have been taking place over many islands, it was particularly highlighted on Castle Island due to the fact that it is reasonably easy to land on and explore. From 1916 to 1944 through to the 1960s/1970s and over the course of this research, predated eggs of different species including Mallard have been found on this island. Hooded Crows are still present on Castle Island and they had at least one nest there in 2006. Of the three predated nests found on Castle Island during the breeding surveys of 2005 and 2006, one was assigned to Hooded Crows and one was displayed evidence of predation from both Hooded Crow and American Mink. A total of eight predated eggs were also found, particularly along the northern shore of the island.

From the 15 Mallard nests found on five islands during this study four or 45% were assigned to an avian predator and this was most certainly the Hooded Crow. If Ruttledge (1916) and Gibbings (1944) were finding up to one hundred predated eggs which included wild duck eggs on Castle Island alone then the total of predated nests involving this species must have been far greater over all the islands on the lake. From Stronach's data it is clear that their populations on the islands were still quite high as he mentions counts of 37 in one day and up to ten nests on the islands. It does seem that currently their populations are not quite as high and may have been decreasing through the years since then and before this study. It is therefore also possible that there could be a correlation between the decline in Mallard nests on the islands and the numbers of Hooded Crows that predate them. With an abundance of food sources outside the islands it would not be unreasonable to assume that a decline in nest numbers would cause a reduction in the numbers of Hooded Crows visiting or nesting on them. The fact that there were so few Mallard nesting on the ten islands surveyed for this study means that even just a small population of Hooded Crows can keep nest numbers down and seriously reduce the chances of nest success amongst an already dwindling breeding population.

The exact year that the American Mink arrived at Lough Carra is not known but Ger O'Donnell (*The Irish Times,* 21st January, 2006) a conservation ranger with the National Parks & Wildlife Service states that they (the N.P.W.S.) trapped their first mink at Kylemore Abbey in 1996. However he also mentions that, according to other sources, mink were not present west of Lough Corrib in 1986 and that they have spread to places including Roundstone, Rosmuck and Renvyle over the ten years since then. This suggests that American Mink may have been present at Lough Corrib and the other western lakes since the mid 1980s and Huxley (2006) also believes that they arrived at Lough Carra about 20 years ago. Since their arrival, this alien invader has been known to predate the nests of terns, gulls, waders and duck species on Lough Mask, Lough Ree, Lough Derg and Lough Corrib (*The Irish Times,* 21st January, 2006). In 2006, the National Parks & Wildlife Service conducted a gull ringing project at Lough Mask and from where it was reported,

> One disturbing aspect of the project was the irrefutable evidence of the damage that mink are having on inland aquatic bird populations. This season at least half of the gull colonies were subjected to predation by mink. A large proportion of Common and Lesser Black-backed Gull clutches on the islet off Carrigeen Inishowen and on Ram's Island were effectively destroyed as were large numbers of Tufted Duck nests.
>
> (McGreal, 2006, p. 2).

This American equivalent of the European Mink (*Mustela lutreola*) is a non-native carnivorous predator that is an adaptable hunter but is mainly found along waterways, lakes and rivers. Their prey includes fish, frogs, waterfowl, eggs and domestic poultry, they also have been known to kill large numbers of hens in single attacks and this has been attributed to their instinct of storing surplus food in case of future food shortages

(Hofmann 2001, *The Irish Times*, 21st January, 2006). This species of mink was first brought to Ireland in 1951 to be reared and eventually slaughtered for the fur trade. During this decade fur farms started out as small enough operations but with the high monetary value gained through the sale of pelts, investment grew and subsequently so did the size of the farms, this led to stocks of 100 mink rising to stocks of 1,000 and over. As in Britain large numbers mink have been released into the wild in Ireland by animal rights activists and in 2003, it was reported that thousands had been released from a farm in Laois (*The Irish Times,* 21st January, 2006). The native Irish species that are subject to predation by the American Mink have no natural defences with which to protect themselves and equally, the mink in Ireland has no natural predators as it would in North America. With the release of so many mink into the wild and the abundance of habitat and food available to it, this species is now thriving in many areas, particularly wetlands.

American Mink are known to prey on a wide variety of bird species including waterfowl and seabirds. Opermanis *et al.* (2001) who studied duck nests and predators at Lake Engure in Latvia found that mink were responsible for destroying Mallard nests, particularly those occurring late in the breeding season and also large numbers of Tufted Duck nests. Mink have also been known to prey on Auk species, for example in Iceland a Mink den was found to contain over 200 predated Guillemot (*Uria aalge*) chicks (Clode & Macdonald, 2002) and they frequently predate the nests of gulls and Terns as has been seen from Lough Mask (McGreal *et al.* 2006). Clode and Macdonald (2002) studied the effects of Mink predation on nesting Terns (*Sterna spp.*) in the Western Isles of Scotland by comparing 1990 to 1993 breeding data with records before and after the arrival of mink. While their findings showed variability due to a number of factors including bad weather conditions which affected breeding success, they state that their study was compatible with other studies which showed that mink have a detrimental effect on island breeding terns. Also they note that tern colonies were larger (possibly for defensive reasons) and nest success lower in mink-inhabited areas.

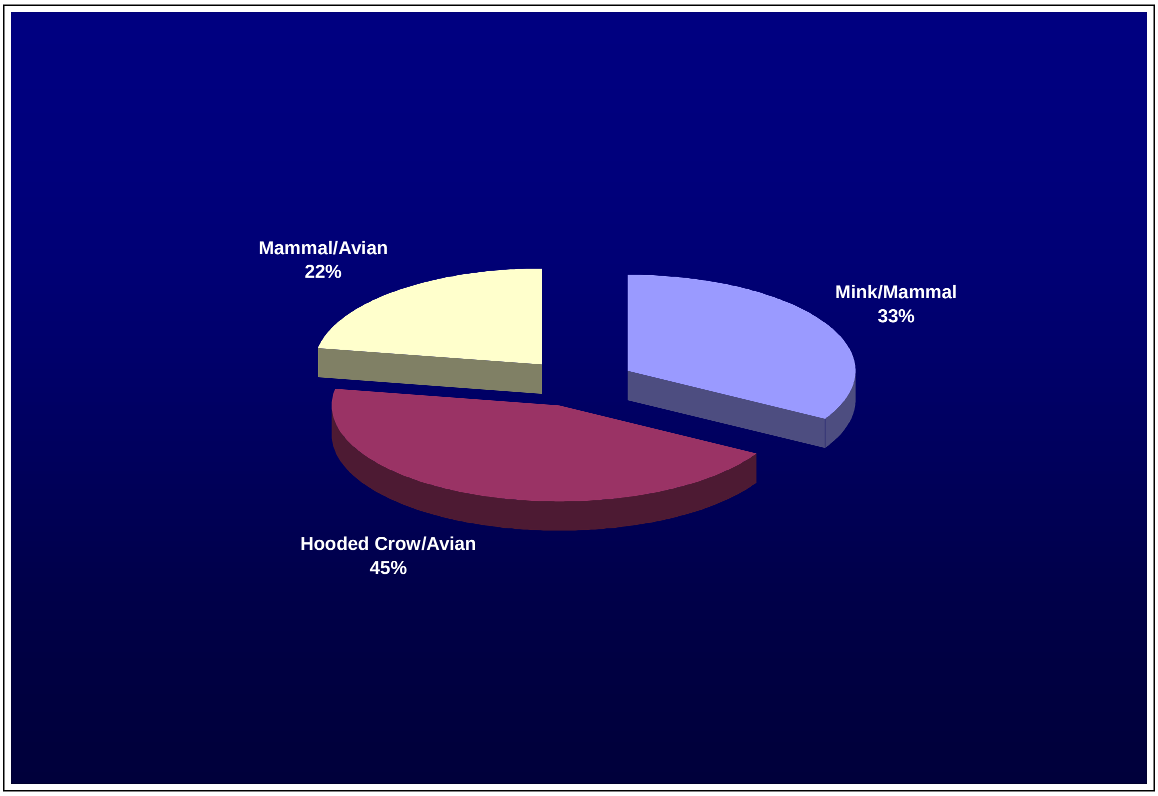
The evidence for the presence of American Mink on Lough Carra has been mounting well before the commencement of this study. There are frequent reports of sightings of the predator from anglers fishing on the lake and mink have been encountered around the shores. Huxley (2006) notes that the mink population over the last few years has been sufficiently high that even *ad hoc* trapping in locations such as Castleburke and Kilkeeran still catches adult mink. During fieldwork for this study adult mink were seen swimming out to islands and hunting along the shores of islands. Areas where they disposed of their kills were discovered to hold the remains of Tufted Duck (*Aythya fuligula*), Coot (*Fulica atra*), Mallard (*Anas platyrhynchos p*) and the remains of gull species such as Common Gull (*Larus canus*). Other evidence was also found on the islands such as droppings and tracks through the *Sesleria* and *Schoenus* zones which were very distinctive. From the total of 9 Mallard nests that were predated over 2005 and 2006, 33% were predated by a mammal species and from interpretation of evidences and the fact that on two occasions the scattered feathers of the hen were found near the nest site, the offender was the American Mink.

In the cases where there was evidence for assigning predation to both avian and mammalian predators it is possible that the time of year and the vegetation in which the nest was sited played a role in the predation pattern. For example, as the season progresses and the vegetation on the islands grew thicker and higher, Hooded Crows may find it more difficult to locate nests. However, if a mink arrived on the island and through hunting located and partially predated a nest, the crows being opportunistic feeders may have monitored the mink and so would be free to predate the remaining eggs from the nest once the mink had departed. This of course is a hypothesis and it could be merely by chance that both predators came upon the same nest or indeed the reverse may have occurred where the activity of the crows predating the nest attracted the mink. Clearly further study is needed before hypotheses could be developed in relation to specific predator interaction amongst these species. It was also difficult to assign predation to rats on the islands and it is not known what rat populations currently number. There was not too much evidence for this predator but as Stronach (1981) noted, this may be due in part to the fact that they sometimes eat the shells of a predated nest and so, do not leave much evidence at the scene.

There was one particular area on Lough Carra at the end of the Kilkeeran Peninsula which Tufted Duck (*Aythya fuligula*) and Great Crested Grebes (*Podiceps cristatus*) favoured as a breeding site. In 2005 and 2006, the author noted, when conducting counts and on separate field visits to the area, that there were more birds present in the latter year than there were in the previous one and there are signs that the numbers of both species are increasing. The reason for the success of this site for these nesting waterfowl is connected to the protection that has been afforded to them from what has been described as 'an umbrella colony' created by the breeding Black-headed Gulls (*Larus ridibundus*) and Common Gulls (*Larus canus*) which have established colonies on two small islands at the site. The association between colonial Larids and the breeding success of duck species and particularly Tufted Duck is well documented (Opermanis *et al.* 2001, Vaananen 2001). The data from both these studies and from others proves that duck which nest within the boundaries of gull colonies and more so those on solid islands, are better warned of and protected from attacks by predators such as the American Mink. At a lake in Finland, Vaananen (2001) who studied this relationship notes that the predation rate of Tufted Duck which nested within a colony of Black-headed Gulls was less than 10% while outside the colony it was 40%. The gulls he observed were not only capable of mobbing would be predators but their alarm calls acted as early warning indicators for the nesting duck. The same relationship was also found to be highly beneficial to nesting grebes which have been found to nest more successfully within the areas of Larid colonies for the same reasons. Another notable point is that the association of Tufted Duck with gull colonies may be due to the correlation in the breeding seasons for both the ducks and gulls. Black-headed Gulls and Common Gulls nest in April-May and May-June respectively and the timing of nesting Tufted Duck (May-June) usually correlates with this as would the breeding season of the Great Crested Grebe (April-July). Vaananen also noted that Tufted Duck who laid late clutches within colonies often fell victim to nest predators due to the fact that the gulls finished nesting before the nesting cycle of the duck was completed. Opermanis *et al.* (2001) found that unlike the Tufted Duck, Mallard were most likely not to nest in association with Larid colonies partly due to the timing of the breeding seasons which favours the Tufted Duck as mentioned above.

A large number of the Tufted Duck and Great Crested Grebes breeding at Lough Carra are nesting in association with the Larid colonies at Kilkeeran. This association in just one year through observation appears to have increased the breeding numbers of both species and may expand in the future. It may also be one of the factors that have contributed to the relative stability in the numbers of Tufted Duck breeding on the lake and the decline of Mallard populations over the years since the mink has arrived.

Figure 44. The percentage of Mallard (*Anas platyrhynchos p*) nests predated by different predator species on 5 islands on Lough Carra 2005-2006.



Notes: 100% = 9 nests.

Mink/Mammal refers to those nests predated by a mammalian species, most likely mink.

Hooded Crow/Avian refers to those nests predated by an avian species, most likely Hooded Crow.

Mammal/Avian refers to nests with evidence pointing to predation by both of the above.

7.7 Summary of Decline Hypotheses & Possible Fluctuation Factors for Individual Species

Mallard (-88%)

- High levels of nest predation on the islands by the Hooded Crow and American Mink.
- Predation on Mallard adults and chicks in the waters and reedbeds of the lake by American Mink.
- The loss of optimum breeding habitat leading to lower nest numbers and success on the islands due to the changes in vegetation brought about by the natural process of ecological succession.
- Loss of wetland habitat around the lakeshore and in the Carra catchment due to the conversion of semi-natural and natural habitats into grassland for intensive agriculture.
- Loss of reliant food source due to the decline of tillage crops such as oats and barley previously grown in the sub-catchments and the Carra catchment as a whole.
- No direct link between large scale decline in populations at Lough Carra and a decline in Irish, British or European populations.
- Possible correlation with smaller declines at Lough Conn and Lough Mask since the Winter Wetlands Survey (1984/85-1986/87), possibly due in part to the arrival of mink into these areas over the same period.

Teal (-91%)

- Small but regular breeding population decimated by American Mink predation.
- Loss of wetland habitat due to land conversion around the lakeshore and in the Carra catchment.
- Partial loss of food source due to the decline of tillage crops in the sub-catchments and in the Carra catchment as a whole.
- No direct link to population declines in Ireland, Britain or Europe.
- Possible correlation with declines at Lough Conn since the mid-late 1980s.
- Due to milder winters hard weather population peaks no longer occur with such frequency as they used to during the 1960s/1970s.

Shoveler (-85%)

- Loss of suitable feeding habitat due to changes in the hydrology of the lake which has resulted in water levels not dropping as low as they used to.
- Loss of wetland habitat around the lakeshore due to land conversion.
- Correlation with declines in Irish populations and at individual sites such as Lough Beg and Lough Swilly since the 1970s.
- Possible correlation with declines in the European breeding population from 1990-2000 which has contributed to a lack of recovery in populations at Lough Carra
- Due to milder winters hard weather population peaks no longer occur with such frequency as they used to during the 1960s/1970s.

Wigeon (-59%)

- Loss of some feeding or grazing areas on the lake shore due to changes in lake hydrology.
- Possible low-level re-distribution occurring with a certain percentage of birds using the small loughs and turloughs in the sub-catchments to overwinter away from the lake.
- Occasional disturbance from feeding areas by shooting taking place on lands adjacent to Lough Carra.
- Due to milder winters hard weather population peaks no longer occur with such frequency as they used to during the 1960s/1970s.
- Possible correlation with declines in the Irish population since the mid 1970s.

Pochard (-89%)

- Loss of suitable food supply due to changes in lake ecology which has led to this species visiting the lake in lower numbers and for shorter periods.
- Redistribution of flocks across Europe has led to declines at important Irish staging sites such as Lough Neagh since the 1960s (and greater declines since the early 1990s) and Lough Corrib since 2000/2001 and this has contributed to the declines at Lough Carra.
- Correlation with decline in the Irish and British populations from 1970s to 1980s but no correlation since then which has seen the Irish population increase and stabilise.
- Correlation between lack of recovery in numbers on Lough Carra and the large scale decline in the population wintering on Lough Cullin since the late 1980s.

Tufted Duck (-58%)

- Local breeding population partially effected by predation from American Mink particularly away from the gull colonies at Kilkeeran.
- Predation of adult and chicks by American Mink.
- Possibility of unknown levels of double counting occurring during boat counts from 1967-1976 leading to a bias in the old count data which suggests a larger wintering population during that period.

Red-breasted Merganser (-79%)

- Local breeding population decimated by predation from American Mink.
- Predation of adults and young in crèches by American Mink.
- The decline in fish stocks as noted by local anglers and the Western Regional Fisheries Board has contributed to declines in the overall population on Lough Carra.
- Correlation with the decline in numbers on Lough Conn since the Winter Wetlands Survey (1984/85-1986/87).

7.8 Lough Carra Designations & Management

Since 1968 Lough Carra has been granted protection under a number a number of Irish and European designations which are designed to protect and monitor the waterfowl and their habitats on the lake and also to stop the degradation of habitats located within the Carra catchment. These designations are outlined individually below followed by a discussion on their impact and the state bodies who are responsible for upholding and implementing them.

Wildfowl Sanctuary

Lough Carra was designated a Wildfowl Sanctuary in August 1968 initially under the Preservation Act of 1930 and since then under the 1976 Wildlife Act. In simple terms this means that no shooting/hunting is allowed on the lakes waters or on the islands of Lough Carra, however it does not apply to the lands adjacent to the lake which are open to shooting where landowners grant permission.

Special Protection Area (S.P.A.)

Special Protection Areas are designated by the European Union (Directive 79/409/EEC of 2nd April 1979) under the Birds Directive (Crowe *et al.* 2005). The legislation under this designation aims to protect vulnerable bird species and their habitats and promote the wise use of wetlands. Hickie (1996) notes that only activities that will not impact on the birdlife within Special Protection Areas are permitted and that the state is responsible for taking the appropriate action in stopping the degradation of S.P.As and any disturbance to the birds within them. S.P.A.s should protect threatened or vulnerable bird species and regularly occurring migratory species and are particularly applicable to wetland sites such as Lough Carra for this reason.

Special Area of Conservation (S.A.C.)

Special Areas of Conservation are designated under Article 3 of the European Union Directive (92/43/EEC) of 21st May 1992. This designation aims to protect natural habitats and associated flora and fauna under the Habitats Directive (Crowe *et al.* 2005). S.A.C.s are still in the proposed stage of implementation in Ireland but when full status is granted, the European Commission hopes to have a network of S.A.C.s throughout the European Union (Hickie 1996, Crowe *et al.* 2005). Presently Lough Carra is proposed as an S.A.C.

as part of a complex covering both it and Lough Mask (the Carra/Mask complex). There are a number of regulations under this designation including the requirement of the responsible authorities to implement a management plan for designated sites and to protect the nominated site from damaging developments.

Natural Heritage Area (N.H.A.)

This designation is described by Hickie (1996) as the base of the system for the protection of all natural Irish habitats and it overlaps with all the other designations mentioned above. Sites coming under this legislation are generally described as places where there is a co-existence between plants and animals and that have not been modified by human activity. In this sense it also encompasses the aims of the other designations in halting and preventing habitats and their associated fauna and flora from being degraded or damaged by such environmentally negative activities such as overgrazing, drainage, quarrying, afforestation, housing development, peat cutting and road building. The protective legislation that accompanies this designation was prevented from being enforced until the amendment to the Wildlife Act 2000. Before this amendment, sites including Lough Carra were proposed Natural Heritage Areas but now they receive legal protection from such damaging activities as mentioned above (Crowe *et al.* 2005).

The relevant state bodies and particularly the National Parks & Wildlife Service are responsible for overseeing and implementing the legislation and measures that are outlined in the above designations (Hickie, 1996), and which were designed to protect Lough Carra and its surrounding habitats. Since these designations were proposed and set in place, the relevant authorities have failed to protect the lake and designated habitats to the full extent of their responsibilities. Within the Special Area of Conservation in the Carra catchment there has recently occurred land conversion which has breached the laws under this designation (Huxley & Thornton, 2004). Furthermore, the National Parks & Wildlife Service under the legislation of the S.A.C. designation are responsible for the drawing up and implementation of a management plan for Lough Carra and the catchments. To date, there is a draft management plan which has not been implemented and the vital process of consultation with the relevant landowners has not yet taken place. There are a number of issues relating to the ecological degradation of the lake and its ecosystems that have not been addressed by the relevant bodies and the failure to address these issues has contributed to the declines seen in the populations of waterfowl on Lough Carra as presented in this study. For example, there has been to date no attempt to put into operation a programme of mink trapping at the lake despite the known presence of the invasive predator since the late 1980s, such programmes in Scotland, Iceland and elsewhere have been proved to increase seabird productivity and even the trapping out of female mink during the spring has kept sites mink-free during the critical breeding seasons for birds (Clode & Macdonald 2002, Mitchell *et al.* 2004). A similar model for Lough Carra involving the trapping of mink has been delayed by the logistics involved in such an operation but clearly action is needed. In addition there has been no monitoring of or intervention in relation to the land use changes which have led to the destruction of natural habitats around the shores of the lake. Nor have there been any follow up measures to assess the effects that these changes may have had on local waterfowl and wader populations. There has been no effort to meet with local community representatives from the area in order to curb such negative activities as firework displays which have caused disturbance to both breeding and wintering waterfowl on the lake and particularly at locations such as Moorehall where in addition, fireworks are seriously disturbing the winter roost of Starlings in the reedbeds at the site. Also there is a need for better consultation with local anglers who visit the larger islands on the lake to make them more aware of the few pairs of nesting Mallard present on these islands during the spring/summer.

The pollution of the waters of Lough Carra are probably the most well known and publicly debated issues relating to the ecological degradation of the lake over the past few years. There are a number of authorities involved in the monitoring and protection of the lakes waters including the Environmental Protection Agency (E.P.A.) and the Western Regional Fisheries Board (W.R.F.B.). However, Galway County Council and not Mayo County Council, are the main body responsible for the implementation of an action plan to stem the process of eutrophication and return the waters of Lough Carra to their former ecological state. Under the Water Framework Directive, Galway County Council must draw up and implement a management plan for Lough Carra and the Carra catchment but to date no plans have been drawn up and the deadlines within the Water Framework Directive state that plans must be put in place by 2012. Huxley (2006) states that the council plan on using the Nitrates Action Plan which is the basis for agricultural and forestry practices in the catchments; this plan is unsuitable, however, and is in effect a licence to pollute.

Chapter 8: Conclusions

This study found that the decline in waterfowl numbers on Lough Carra since the older survey (1967-1980) was on a larger scale and included a more diverse range of waterfowl species than previously thought. A total of seven species comprising of four species of dabbling duck (Teal *Anas crecca*, Mallard *Anas platyrhynchos p*, Wigeon *Anas penelope* and Shoveler *Anas clypeata*) and three species of diving duck (Pochard *Aythya ferina*, Tufted Duck *Aythya fuligula* and Red-breasted Merganser *Mergus serrator*) have declined by between 58% and 91% since the counts conducted in the 1960s/1970s. The lake, which used to host one of the largest and most concentrated Mallard breeding populations in the country consisting of 100 pairs and over, is no longer nationally important with a massive decline of 88% occurring between the mid 1980s and the mid 1990s. Comparative breeding surveys conducted in 2005 and 2006 found that the breeding Mallard population over eight islands has declined by 91% since the older survey. A change in island habitat and high levels of predation on nests and nesting females by American Mink (*Mustela vison*) and Hooded Crows (*Corvus corone cornix*) continues to suppress breeding numbers and prevent populations from making even a slight recovery. Evidence in the form of kills, tracks and droppings highlights the presence of mink on the islands and shows that this predator is quite capable of swimming out to the islands on Lough Carra, particularly those located close to its shores. As well as Mallard, the American Mink has also preyed upon Teal, Tufted Duck, Coot (*Fulica atra*), Moorhen (*Gallinula chloropus*) and Common Gull (*Larus canus*) with the remains of these species found on the islands visited during breeding survey work. The populations of Goldeneye (*Bucephala clangula*) on the lake have remained relatively stable since the 1960s/1970s with just a 12% decline since the older survey. Furthermore, since they have been recorded under the Irish Wetland Bird Survey scheme beginning in 1995, the numbers of Great Crested Grebe (*Podiceps cristatus*), Little Grebe (*Tachybaptus ruficollis*), Moorhen, Coot, Cormorant (*Phalacrocorax carbo)* and Mute Swan (*Cygnus olor*) have shown stability and at times have increased since count coverage improved from 2000.

Over the course of the research, Gadwall (*Anas strepera*) became a new breeding species on Lough Carra and its breeding pattern on the lake may become more regular in the coming years. The increase in Gadwall numbers and its confirmed status as a new breeding species may be related to the level of nutrient enrichment that has taken place on the lake over the past few years. Both Gibbons (1993) and Vaananen (2001) note that the expansion in range seen in this species is often connected to the development of lush green vegetation brought on by eutrophication on inland lakes and slow moving rivers. It was found that the declines witnessed in some species such as Pochard and Shoveler on Lough Carra correlated with declines in Irish, British and/or European populations over similar time-scales. Also noticeable was that the declines in five species of waterfowl including Pochard and Mallard on the lake, while not all on the same scale or within the exact time-frame, mirrored the declines in the populations of those same species on Lough Conn/Cullin located to the north of Lough Carra. Future research into the fluctuations of waterfowl populations at both sites may provide more insights as to the reasons for population declines and help with future management strategies such as the controlled removal of American Mink.

This study was based on the data from two waterfowl counting programmes conducted at Lough Carra between 1967-1980 and 1995-2006. The results from the six count calibration experiments conducted over 2005 and 2006 proved that the decline in the numbers of seven wildfowl species on Lough Carra since the old survey was not due to a statistical error caused by the use of two different count methods (boat and land counts) employed during the two counting programmes. The employment of the land count methodology is clearly more suited to the needs of the present counting programme (Irish Wetland Bird Survey) which aims to record all waterfowl and wader species at the lake.

From the comparative study by Huxley (2003) on the current distribution and density of the reedbeds at Lough Carra, it is clear that there have not been significant negative changes to the reedbed habitat available for waterfowl at the lake since 1975. It is highly unlikely that the inconsistent changes in reed density as pointed out by Huxley (2003, 2006) could have been a factor in the large scale decline that has taken place amongst the seven wildfowl species on Lough Carra since the 1960s/1970s.

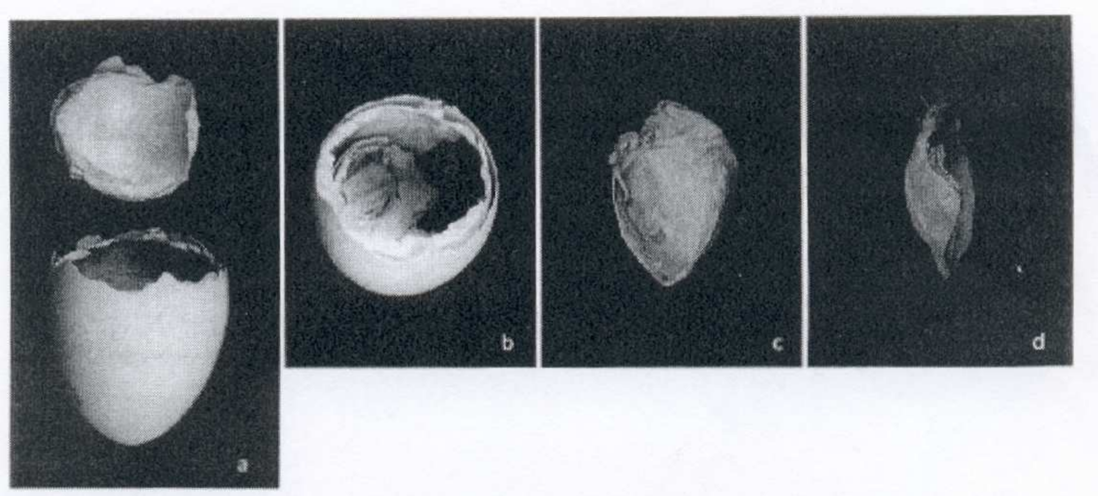
Land use changes in the Carra catchment emerged as an element in the decline hypotheses particularly in relation to the decline in certain dabbling species such as Mallard and Teal. The conversion from wetland habitats to land for intensive agricultural practices and the decline in tillage since the late 1970s and early 1980s have adversely affected the food sources for dabbling duck species in the Carra catchment. While the matrix of small loughs and turloughs in the Annie's River and Ballyglass sub-catchments are still intact despite the drainage scheme which took place in the 1980s, there is a need for an in-depth study and evaluation of the loss of wetland habitats in the sub-catchments. In the absence of such a study it would not be possible to fully state with confidence that the drainage scheme had a low impact of waterfowl habitats in the sub-catchments. The author feels that similar research to that conducted by Huxley and Thornton (2004), would be extremely beneficial for the assessment of waterfowl habitat loss that may have occurred over the whole Carra catchment due to land use changes since the 1970s.

Due to its size, location and rich blend of habitats and associated biodiversity, Lough Carra has been the subject of much study going back as far as the early part of the last century. Since then many of the studies conducted at the lake have proved that it is going through a slow process of ecological degradation, the visual evidence and facts from scientific data makes this statement irrefutable. There has been a decline in the numbers of seven waterfowl species on the lake as shown in this study, the numbers of certain fish species have declined, illegal structures have been erected on the lakeshore and limestone has been removed for the provision of boat slipways. Land conversion with resulting habitat loss has taken place within the boundaries of the Special Area of Conservation and the lake itself has become polluted with the process of eutrophication set to continue while the relevant authorities fail to act. The continuation of the Irish Wetland Bird Survey counts at Lough Carra is vital as it is the only means of monitoring waterfowl populations at the lake. As it stands, these counts are conducted on a voluntary basis from September to March each year. However, any worthwhile management plan should include at least a monthly count of waterfowl on the lake during the breeding months and possibly more in-depth breeding surveys in the coming years. Kilkeeran was noted in this study and in previous studies (Huxley, 2003) as a site of highly significant importance for breeding waterfowl and is also a site of immense biodiversity. The Kilkeeran peninsula is not monitored or managed and as a consequence, the waterfowl and waders who breed and winter at the site, have no protection from the degradation of their habitats. The site is also prone to much disturbance from the public during the summer months and the flora has been reduced due to effects of overgrazing. Due to the size and geography of the peninsula, a management plan facilitating the needs of farming, recreation and flora and fauna, would be very feasible.

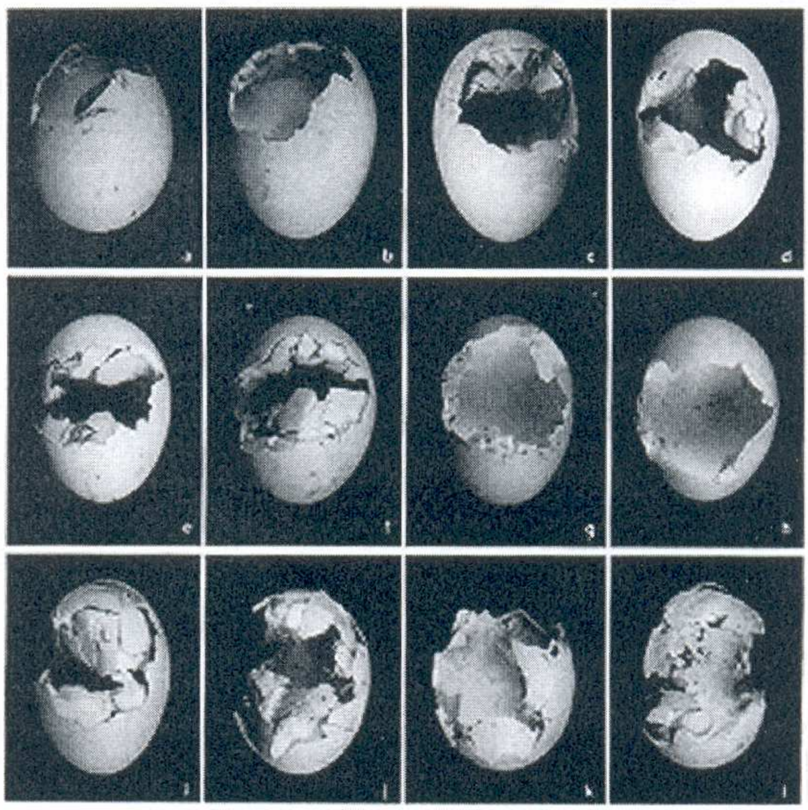
Without exception, all the designations currently in place with the aim of protecting and conserving the lake, its surrounding habitats and wildlife, are worthless unless the bodies responsible take action. An up-to-date management plan tackling all of the above issues required by law should be in place but is still not forthcoming. In terms of the waterfowl on the lake, there are numerous steps that could be taken in relation to protecting and improving populations, including the removal of mink, the management of island habitats, the provision of low cost and easily constructible artificial nest sites for Mallard and the promotion of environmental awareness amongst the communities around Lough Carra. All of these management strategies have been used in Britain, Europe and furthermore in countries with far fewer financial resources than Ireland.

Appendices

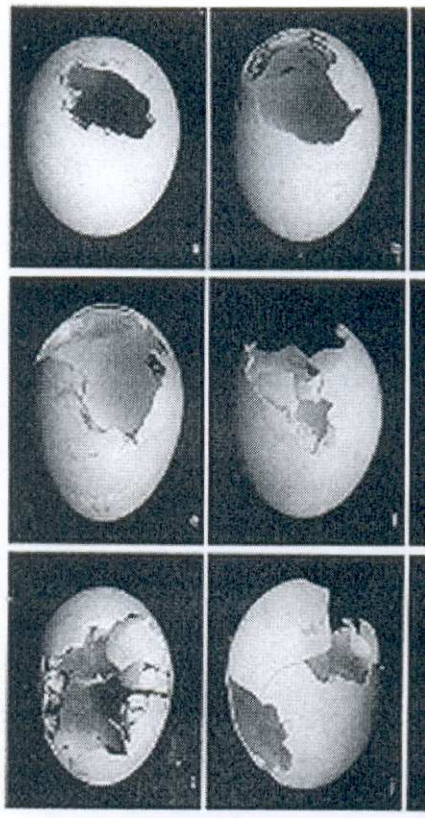
Appendix A



Photographs of successfully hatched duck egg from the studies of Sargeant *et al.* (1998).



Photographs of a duck eggs predated by American Mink (*Mustela vison*) from the studies of Sargeant *et al*. (1998).



Photographs of duck eggs after predation by American Crows (*Corvid* spp.) from the studies of Sargeant *et al*. (1998).

Bibliography

Aas, G. & Riedmiller, A. 1994. *Trees of Britain and Europe*. Harper Collins, London.

Ackerman, J.T. 2002. Of Mice and Mallards: positive indirect effects of coexisting prey on waterfowl nest success. *Oikos* 99 (3), 469-480.

Alerstam, T. 1990. *Bird Migration.* Cambridge University Press, Cambridge.

Allen, D., Mellon, C., Enlander, I., Watson, G. 2004. Lough Neagh diving ducks: recent changes in wintering populations. *Irish Birds* 7, 327-336.

Anon. 1978. An *Interim Report on the State of the Knowledge of the Natural History of an Area in South Mayo.* Internal Report.

Boland, H. & Crowe, O. 2005. The Irish Wetland Bird Survey: Results of waterbird monitoring in the Republic of Ireland in 2002/03. *Irish Birds* 7, 529-538.

Boland, H. & Crowe, O. 2006. The Irish Wetland Bird Survey: Results of waterbird monitoring in the Republic of Ireland in 2003/04 & 2004/05. *Irish Birds* 8, 21-34.

Bibby, C.J., Burgess, N., Hill, D., David, A., Mustoe, S.H. 2000. *Bird Census Techniques* (2nd edition). Elsevier Academic Press, London.

Brooks, S. & Askew, R. 2004. *Guide to Dragonflies & Damselflies of Britain.* Laminated field chart by the Field Studies Council, Shropshire.

Bullion, S., Strachan, R., Troughton, G. 2001. *A Guide to British Mammal Tracks and Signs.* Laminated field chart by the Field Studies Council, Shropshire.

Clode, D. & Macdonald, D.W. 2002. Invasive Predators and the Conservation of Island Birds: The case of the American Mink (*Mustela vison*) and Terns (*Sterna spp.*) in the Western Isles. *Bird Study* 49-2, 118-123.

Colhoun, K. 1998. *The Irish Wetland Bird Survey Report 1996/97.* BirdWatch Ireland, Dublin.

Colhoun, K. 2000. *The Irish Wetland Bird Survey Report 1997/98.* BirdWatch Ireland, Dublin.

Colhoun, K. 2001. *The Irish Wetland Bird Survey Report 1998/99.* BirdWatch Ireland, Dublin.

Colhoun, K. 2002. *The Irish Wetland Bird Survey Report 2000/01.* BirdWatch Ireland, Dublin.

Coulter, B.B., McDonald, E., Lee, J. 1998. *Enhancing and Visualising Data on Soils, Land Use and the Environment.* Teagasc Publication, Johnstown Castle Research Centre, Wexford.

Chinery, M. 2004. *Butterflies-An easy to use guide to Europe's most common species.* HarperCollins, Glasgow.

Crawford, P. 1999. *Living Britain-A Wildlife Celebration for the Millennium.* BBC Publications, London.

Crowe, O., McElwaine, J.G., Worden, J., Watson, G.A., Walsh, A., Boland, H. 2005. Whooper (*Cygnus cygnus*) and Bewick's (*C. columbianus bewickii*) Swans in Ireland: results of the International Swan Census, January 2005. *Irish Birds* 7. 483-488.

Crowe, O., Merne, O., Colhoun, K. 2005. (H. Boland and others (eds)). *Ireland's Wetlands and their Waterbirds: Status and Distribution.* BirdWatch Ireland, Wicklow.

Delany, S. 1996. *The Irish Wetland Bird Survey Report 1994/95.* BirdWatch Ireland, Dublin.

Delany, S. 1997. *The Irish Wetland Bird Survey Report 1995/96.* BirdWatch Ireland, Dublin.

Dunford, B. 2002. *Farming and the Burren.* Teagasc, Dublin.

Evans, G. & Swain, H.D. 1977. *Birds Eggs.* Frederick Waine and Company, London-New York.

Fossitt, J. 2000. *A Guide to Habitats in Ireland.* The Heritage Council, Ireland.

Fox, A.D. & Salmon, D.G. 1989. The winter status and distribution of Gadwall in Britain and Ireland. *Bird Study* 36, 37-44.

Fuller, R. 1997. *Wild Spring-In Praise of Nature.* Swan Hill Press, Shrewsbury.

Gibbings, R. 1945. *Lovely is the Lee.* J.M. Dent & Sons Ltd, London.

Gibbons, D., Reid, J.B., Chapman, R.A. 1993. *The New Atlas of Breeding Birds in Britain and Ireland: 1988-1991.* T & A.D. Poyser, U.K.

Harris, A., Tucker, L., Vinicombe, K. 1994. *Bird Identification.* Macmillan Press, London.

Hickey, D. 1996. *Evaluation of Environmental Designations in Ireland.* The Heritage Council, Ireland.

Hillis, J.P. 2005. Rare breeding birds in Ireland. 2003. The Second Annual Report of the Irish Rare Birds Breeding Panel (IRBBP). *Irish Birds* 7, 539-548.

Hillis, J.P. 2006. Rare breeding birds in Ireland. 2004. The Third Annual Report of the Irish Rare Birds Breeding Panel (IRBBP). *Irish Birds* 8, 97-106.

Huxley, C. 2003. *The Ecological Status of Lough Carra and its Surrounding Habitats,* Report to the Heritage Council.

Huxley, C. & Thornton, J. 2004. Land use changes in the Lough Carra catchment. Paper from the Proceedings of the Great Western Lakes: Ecology, Heritage and Management Conference, Castlebar.

Hoffman, H. 2001. *Wild Animals of Britain and Europe.* Harper Collins, London.

Holden, P., Porter, R., Wallace, I., Wright, D. 1981. *Birds of Prey.* Usborne Publications, London.

Jarvinen, A. 1990. Changes in the abundance of birds in relation to small rodent density and predation rate in Finnish Lapland. *Bird Study* 37, 36-39.

Kirby, J.S. 1995. Index Numbers for Waterbird Populations III: Long-term trends in the abundance of wintering waterfowl in Great Britain, 1966/67 to 1991/92. *Journal of Applied Ecology* 32, 536-551.

Laubergs, A. & Viksne, J. 2004. Elevated artificial nest sites for Mallard *Anas platyrhynchos p* in Latvia. *Biology* 676, 107-118.

Lockhart, N. 1982. *A Pilot Environmental Impact Assessment for a Drainage Scheme in the West of Ireland-Field Study: Lough Carra East (Draft Final Report) Volume 2.* Internal report for the Department of the Environment.

MacLochlainn, C. 2002. *Special Protection Areas for Birds in Ireland.* Duchas - The Heritage Service Publication.

Martin, P. 1993. *Wildfowl of the British Isles and North West Europe.* David and Charles Publishers, United Kingdom.

Mitchell, P.I., Newton, S.F., Ratcliffe, N., Dunne, T.E. 2004. *Seabird Populations of Britain and Ireland.* Joint Nature Conservation Committee Publication, United Kingdom.

Mullarney, K., Svensson, L., Zetterstrom, D., Grant, P.J. 1999. *Bird Guide: The Most Complete Field Guide to the Birds of Britain and Europe.* Harper Collins, London.

Murphy, S., Lewis, L.J., Kelly, T.C. 2006. The spatial ecology of wildfowl in Courtmacsherry Bay, southern Ireland, with particular reference to Shelduck (*Tadorna tadorna*). *Irish Birds* 8, 51-58.

Naysmith, F.H. 1999. The management of hypertrophic lochs: case studies in southwest Scotland. *Hydrobiologia* 395/396, 293-307.

Nudds, T.D. & Sjoberg, K. 1989. Posthatch brood amalgamation by Mallards. *The Wilson Bulletin* 101 (3), 503-505.

O'Dowd, G. 2001. Productivity, grazing pressure and phenology of a *Sesleria*-dominated grassland in the Burren National Park. *Tearmann* 1, 35-54.

Ogilvie, M. & Pearson, B. 1994. *Wildfowl – Hamlyn Bird Behaviour Guides.* Hamlyn, London.

Olney, P.J.S. 1963. The food and feeding habits of Tufted Duck (*Aythya fuligula). Ibis,* 55-62.

Olney, P.J.S. 1968. The food and feeding habits of the Pochard (*Aythya ferina). Biological Conservation* 1, 71-78.

Orton, D.A. 1989. *The Hawk Watcher-Adventures Among Birds of Prey in the Wild.* Unwin/Hyman, London.

Orton, R., Bebbington, A., Bebbington, J. 2000. *Guide to Commoner Water Plants.* Laminated field chart by the Field Studies Council, Shropshire.

Opermanis, O., Mendis, A., Bauga, I. 2001. Duck Nests and Predators: interaction, specialisation and possible management. *Wildlife Biology* 7, 87-96.

Owen, M. & Mitchell, C. 1988. Movements and migrations of Wigeon *Anas penelope* wintering in Britain and Ireland. *Bird Study* 35, 47-59.

Papazoglou, C., Kreiser, K., Waliczky, Z., Burfield, I. 2004. *Birds in the European Union: a status assessment.* BirdLife International, United Kingdom.

Poysa, H. 2001. Dynamics of Habitat Distribution in Breeding Mallards: assessing the applicability of current habitat selection models. *Oikos* 94 (2), 365-373.

Reihmanis, J. 2004. Relationships Between the Nest Predation Rates Caused By Different Waterfowl Nest Predators: an artificial nest experiment. *Biology* 676, 131-139.

Reynolds, J.V. 1990. The breeding gulls and terns of the islands of Lough Derg. *Irish Birds* 4, 217-226.

Rigelman, J.K. 1990. *Waterfowl Management Handbook- Managing Agricultural Foods for Waterfowl.* Fish & Wildlife (Colorado Division) Publication, United States.

Rowell, H.E. & Spray, C.J. (eds). 2004. *The Mute Swan* Cygnus olor (*Britain and Ireland populations) in Britain and Northern Ireland 1960/61 – 2000/01.* Waterbird Review Series, The Wildfowl & Wetlands Trust/Joint Nature Conservation Committee, Slimbridge.

Ruttledge, R.F. 1916. The birds of Lough Carra. *The Irish Naturalist,* 96-97.

Sargeant, A.B., Sovada, M.A., Greenwood, R.J. 1998. *Interpreting Evidence of Depredation of Duck Nests in the Prairie Pothole Region.* Northern Prairie Wildlife Research Centre Publication, Jamestown, United States.

Shackleton, J., Nash, D., Lewington, R. 2004. *A Guide to the Butterflies of Ireland.* Laminated field chart published by The Heritage Council.

Sharrock, J.T.R. 1980. *The Atlas of Breeding Birds in Britain and Ireland* (3rd Edition). T & A.D. Poyser, United Kingdom.

Sheppard, R. 1993. *Ireland's Wetland Wealth – The Report of the Winter Wetlands Survey 1984/85-1986/87.* The Irish Wildbird Conservancy, Ireland.

Sheppard, R. 2002. The wintering waterbirds of Lough Swilly, County Donegal. *Irish Birds* 7, 65-78.

Smiddy, P. 1992. The birds of Ballymacoda, County Cork. *Irish Birds* 4, 525-549.

Smiddy, P. 2005. Breeding waterfowl at Ballycotton, County Cork, 1960-2004. *Irish Birds* 7, 496-503.

Smiddy, P. & O'Halloran, J. 2006. The waterfowl of Ballycotton, County Cork: population change over 35 years, 1970/71 to 2004/05. *Irish Birds* 8, 65-79.

Sterry, P. 2004. *Complete Irish Wildlife.* Harper Collins, London.

Stronach, B.W.H. 1981. *An Ecological Study of Waterfowl on Lough Carra.* Internal Report for The Department of Lands and An Foras Taluntais.

Stronach, B.W.H., & Harrington, D. 1981. Dispersion of a Wild Mallard (*Anas platyrhynchos platyrhynchos*) Population in the West of Ireland. *Population Ecology of Game Species,* 279-285.

Sutherland, J. 1996. *Ecological Census Techniques: a handbook.* Cambridge University Press, Cambridge.

Svensson, L. & Delin, H. 1991. *Photographic Guide to the Birds of Britain and Europe.* Hamlyn, London.

The Central Statistics Office. 2003. *Agriculture, Forestry & Fishing.* Report by the Central Statistics Office, Ireland.

The Central Statistics Office. 2004. *Agriculture, Forestry & Fishing.* Report by the Central Statistics Office, Ireland.

Vaananen, M. 2001. *Numerical and Behavioural Responses of Breeding Ducks to Hunting and Different Ecological Factors.* University of Helsinki Publication, Finland.

Whilde, A. 1977. The autumn and winter food of Mallard *Anas platyrhynchos p* and some other Irish wildfowl. *The Irish Naturalists' Journal* 19, 18-21.

Winfield, D. K., Davidson, R., Winfield, I.J. 1989. Long-term trends (1965-1988) in the numbers of waterfowl overwintering on Lough Neagh and Lough Beg, Northern Ireland. *Irish Birds* 4, 19-42.

Unpublished Papers & Other Sources

Boland, H. & Crowe, O. I-WeBS Data. In litt.

Huxley, C. Reedbed Map and fieldnotes. In litt.

Huxley, C & L. I-WeBS Data. In litt.

McGreal, E. Gull-ringing project at Lough Mask. In litt.

Shackleton, J. 1975. A Study of Certain Aspects of the Vegetation of Lough Carra.

Newspaper Sources

Murdoch, A. January 21st 2006. 'Killing Machine'. *The Irish Times.*

Mooney, J. February 25th 2007. 'Climate change puts Irish wildlife at risk'. *The Sunday Times.*

Horan, N. February 11th 2007. 'Imported plants and fish choke habitats'. *The Sunday Independent.*

Shiel, T. June 28th 2006. 'Carra trout change diet to feed on grubs which thrive on dirty water…it's not a good sign for the lake's future'. *The Connaught Telegraph.*

Interviews

Chris Huxley: August 23rd 2006.

Art O'Sullivan: September 14th 2006.

Internet Sources

www.arkive.org/species.	American Mink (*Mustela vison*). Accessed on November 4th 2005.
www.ballintubber.mayo-ireland.ie.	Fishing in Lough Carra. Accessed on May 29th 2006.
www.birdwatchireland.ie.	Conservation work. Accessed on May 29th 2006.
www.ccs.st-and.ac.uk.	Control of North American Mink Outside Their Native Range. Accessed on November 4th 2005.
www.jncc.gov.uk.	Distribution and Population Trends for Wildfowl in Britain and Ireland. Accessed on August 1st 2005.
www.wwlearn.org.uk.	Mallard. Accessed on November 4th 2005.
www.wrfb.ie.	Wild Brown Trout Development Programmes for Loughs Corrib, Mask and Carra. Accessed on April 4th 2007.
www.wetlands.org.uk.	Mallard (*Anas platyrhynchos p)*. Accessed on February 2nd 2006.

Maps

Ordnance Survey of Ireland, Discovery Series, Map No. 38 – Galway/Mayo.

Ordnance Survey of Ireland, Ireland West.

Software (used for maps/aerial photographs)

Microsoft Encarta, 2001.

Ordnance Survey of Ireland, Trail Master, 2005.