RE-EXAMINATION OF THE RELATIONSHIP BETWEEN CONSTRUCTED IMPOUNDMENT AGE AND WATERBIRD USE

Josette L. Maillet

Canadian Wildlife Service, Atlantic Region, PO Box 6227, 17 Waterfowl Lane, Sackville NB E4L 1G6

Colin M. MacKinnon

Canadian Wildlife Service, Atlantic Region, PO Box 6227, 17 Waterfowl Lane, Sackville NB E4L 1G6

J. Bruce Pollard

Institute for Wetland and Waterfowl Research, Stonewall PO Box 1160,
Oak Hammock Marsh, Manitoba R0C2Z0, Canada

Canadian Wildlife Service Technical Report Series No. 290

This publication may be cited as:

Maillet, J. L.; MacKinnon, C. M.; Pollard, J. B. 1999. Re-examination of the Relationship Between Constructed Impoundment Age and Waterbird Use. Technical Report Series No. 290, Canadian Wildlife Service.

Issued under the Authority of the
Minister of Environment
Canadian Wildlife Service
Environmental Conservation Branch

Catalogue no. CW69-5/290E
ISBN 0-662-25913-0

Copies may be obtained from:

Canadian Wildlife Service
Atlantic Region Headquarters
PO Box 6227, 17 Waterfowl Lane
Sackville, New Brunswick, Canada
E4L 1G6

ABSTRACT

The relationship between impoundment age and waterfowl and wetland obligate bird use of 32 selected freshwater impoundments in the Chignecto border region was examined in 1996. Previous studies have indicated that primary productivity declines with impoundment age after initial flooding. Waterfowl and marshbird productivity was assumed to decline with impoundment age as well, concurrent with the observed decline in nutrient levels. An examination of wetland avifauna use versus age of impoundment was the focus of this study.

Waterfowl and wetland obligate bird surveys of all 32 impoundments were conducted from May to August, 1996. Spearman's correlation coefficient was calculated for impoundment age and each of the following variables: total waterfowl numbers, waterfowl brood numbers, American Black Duck (*Anas rubripes*) breeding pairs, Ring-necked Duck (*Aythya collaris*) breeding pairs, and Blue-winged Teal (*Anas discors)* breeding pairs. In addition to waterfowl, three marsh bird species were included in the data analysis: American Bittern (*Botaurus lentiginosus*), Sora Rail (*Porzana carolina*) and Pied-billed Grebe (*Podilymbus podiceps*).

Statistical analysis generally showed slightly positive, though statistically non significant correlations between impoundment age and waterfowl and marshbird numbers, or significant positive correlations with age, for total waterfowl broods and Ring-necked Duck breeding pairs. Furthermore, analyses of historical data involving the compilation of past aerial brood survey data, indicated a statistically significant positive relationship between brood production and impoundment age. Therefore, waterfowl and marsh bird numbers may remain constant, or actually increase as impoundments age rather than decline. Possible interpretations are discussed in terms of the significance of a hemi-marsh vegetative structure and philopatry of female waterfowl in ensuring wetland avifauna numbers, semi-independent of impoundment age.

RÉSUMÉ

On a examiné en 1996 la relation entre l'utilisation de 32 bassins d'eau douce de la région frontière de Chignecto par des espèces de sauvagine et d'autres oiseaux aquatiques et l'âge de ces bassins. Des études menées antérieurement ont révélé que la productivité primaire diminuait proportionnellement à l'âge des plans d'eau après leur aménagement. La productivité des espèces de sauvagine et d'oiseaux de marais était présumée diminuer elle aussi proportionnellement à l'âge des bassins, parallèlement à la diminution observée des quantités de matières nutritives. L'étude visée par le présent rapport avait pour but d'examiner la relation entre l'avifaune des zones humides et l'âge des plans d'eau.

Des dénombrements d'espèces de sauvagine et d'oiseaux aquatiques dans les 32 bassins ont été effectués de mai à août 1996. On a établi un coefficient de corrélation de Spearman pour l'âge des bassins et chacune des variables suivantes : effectif total des espèces de sauvagine, nombre de couvées chez ces espèces et nombre de couples nicheurs de Canards noirs (*Anas rubripes*), de Fuligules à collier (*Aythya collaris*) et de Sarcelles à ailes bleues (*Anas discors*). Outre ces espèces de sauvagine, trois espèces d'oiseaux de marais ont été incluses dans l'analyse : Butor d'Amérique (*Botaurus lentiginosus*), Marouette de Caroline (*Porzana carolina*) et Grèbe à bec bigarré (*Podilymbus podiceps*).

En général, l'analyse statistique a permis d'établir des corrélations légèrement positives, bien que non statistiquement significatives, entre l'âge des plans d'eau et le nombre total de couvées de sauvagine et de couples nicheurs de Fuligules à collier. De plus, des analyses des résultats de dénombrements aériens de couvées effectués antérieurement indiquent l'existance d'une relation positive statistiquement significative entre la production des couvées et l'âge des bassins. Dès lors, l'effectif des espèces de sauvagine et d'oiseaux de marais pourrait demeurer constant, ou même augmenter, proportionnellement à l'âge des plans d'eau plutôt que diminuer. Des interprétations possibles sont présentées quant à l'importance d'une structure végétative semipalustre et de la philopatrie des femelles des espèces de sauvagine pour le maintien des effectifs de l'avifaune des zones humides dans une semi-indépendance à l'égard de l'âge des plans d'eau.

ACKNOWLEDGEMENTS

The need to answer a pertinent management question, as well as establish the general methodology, were originally outlined in 1996 by the two junior authors. The majority of this paper was developed as an honours thesis in the Science (Biology) program at Mount Allison University, Sackville N.B. by Josette Maillet, the senior author, who successfully defended the thesis on April 10, 1997. We would especially like to thank the internal supervisory committee at Mount Allison, comprised of Dr. F. Baerlocher (supervisor), Dr. R.B. Aiken, and Dr. H. Harries for their comments and direction.

We would like to thank John Wile of Ducks Unlimited Canada for providing helpful encouragement and suggestions as well as for the arrangement of funds (HRDC) for the project research assistant Lisa Bulman.

Surveying 32 impoundments by canoe every two weeks required a team effort, and more specifically a second pair of hands using a paddle. We would like to thank Don Colpitts, Andrew MacFarlane, Peter Austin-Smith Jr., Mario Cormier and Lisa Bulman for their assistance and patience in the field, and for maintaining their enthusiasm regardless of the long days and sometimes unfavourable weather conditions.

We would also like to thank Dr. Henry Murkin of Ducks Unlimited Canada for reviewing this paper and providing suggestions and comments.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

Over 550 controlled freshwater impoundments are managed by the Canadian Wildlife Service (52) and Ducks Unlimited Canada (>500) in the Maritime Provinces, many of which are situated on dykeland soils. These impoundments were established to maintain or replace wetland habitat while maximizing wetland obligate bird use through active management.

Optimum productivity levels of these impoundments in terms of nutrients and waterfowl have been assumed to be reached between 1.5 and 4 years after initial flooding, without any intervention in terms of management (Whitman, 1974). This elevation in productivity occurs for several reasons. Upon initial flooding, waterfowl use increases rapidly presumably related to an increase in the availability of invertebrates (food) and the establishment of preferred plant communities (food and cover) in response to available soil and water conditions.

Previous studies have indicated that with age, productivity declines as impoundments become dominated by solid monotypic stands of emergent vegetation in shallow areas or the complete elimination of vegetation in deeper areas (Whitman, 1974; Beauchamp and Kerekes, 1980; Kantrud, 1986). Furthermore, Murkin et. al. (1982) and Kaminski and Prince (1981), found that emergent vegetation structure of a wetland may influence waterfowl use of an area. Higher densities and diversity of breeding waterfowl were found in wetland habitats approximating a hemi-marsh vegetative structure, a heterogeneous interspersion of emergent vegetation cover and water in a 50:50 cover to water ratio.

It has been assumed that waterfowl and marsh bird numbers would eventually decline with impoundment age as a result of a decline in overall productivity in dykeland impoundments with extended flooding . The objective of this study was to determine whether a decline in wetland avifauna abundance does occur with impoundment age

2.0 STUDY AREA

The study was conducted in the New Brunswick - Nova Scotia border region between the head of the Bay of Fundy and the Northumberland Strait (Figure 1). During the end of the last glaciation, approximately 14, 000 years bp (Roland, 1982), the area adjacent to the Bay of Fundy was much higher than present, and the Cumberland basin at this time was essentially a shallow lake, surrounded by peat bogs (Ganong, 1903). Approximately 4000 years ago, the Chignecto coastal lowlands, and much of the area under the present day salt marshes, were covered by a predominantly hemlock-hardwood forest (Ramsay, 1963). As the land subsided and the mean sea level rose, the land was flooded by salt water, converting this system to a brackish, and eventually a saltwater lagoon (Ganong, 1903; Roland, 1982).

The Chignecto Isthmus is underlain by Carboniferous strata consisting of coarse grained sandstone that was deposited 300 million years ago (Roland, 1982). Increasingly strong tidal currents in the Cumberland basin resulted in the rapid erosion of the sandstone lining the channels between the Bay of Fundy and the upland areas. The deposition of silt carried inland at the highest tides, exceeded the rate of subsidence, resulting in the formation of the salt marshes and the ensuing bogs and lakes further inland (Ganong, 1903).

These newly exposed lands, which consisted of particularly fertile soils due to the rich inorganic deposits, formed vast expanses of salt marsh along the upper Bay of Fundy and similarly along the Northumberland Strait shore of the Chignecto Isthmus. Food and other resources provided by these marshes were used by native peoples (Turnbull, 1988). The marshes provided excellent staging areas for migratory birds. Acadians referred to the marshes between Sackville and Aulac N.B. as 'Tintamarre', meaning 'racket' or 'hubbub' in reference to the noise made by huge flocks of migratory birds in the area. These marshes were drastically altered by the first European settlers primarily for the purpose of reclamation for agriculture. The first dikes and sluice gates on the Chignecto Isthmus were those constructed by the French settlers (Acadians) in the later 1600's, as these areas were drained and farmed, most often for hay (Ganong, 1903; Nova Scotia Department of Agriculture and Marketing, 1987).

After the expulsion of the Acadians in 1755, New England Planters, Yorkshire Settlers and United Empire Loyalists continued the farming tradition of these lands. When the demand for hay declined in the early 1900's, many of these areas were no longer considered to be prime agricultural land, and were often abandoned (Nova Scotia Department of Agriculture and Marketing, 1987).

Throughout the 1960's, the Canadian Wildlife Service (CWS) acquired some of the more poorly drained lands at the head of the marsh, and in cooperation with Ducks Unlimited Canada (DUC), began to restore wetlands. Through a management agreement, 52 water-controlled impoundments ranging in size from 1.2 to 40.5 ha (3 to 100 acres) were constructed on six of the regions' ten National Wildlife Areas (NWA's).

A freshwater impoundment, within the context of this study, is essentially an area that has been dyked on all or most sides to retain surface water flow. Due to precipitation and the geography of the marshes, most impoundments are adjacent to each other in a series, and water levels are controlled by control structures (MacKinnon et. al., 1995). The dyke material is excavated on site resulting in a borrow pit or channel that runs inward and adjacent to the dyke. As most of these impoundments have little or no watershed, much of the water for initial flooding and maintenance comes from precipitation.

The majority of the freshwater impoundments used in this study were situated within the Tintamarre and Shepody NWA's in New Brunswick, and Wallace Bay and Chignecto NWA's in Nova Scotia. The location and number of impoundments surveyed are as follows: 10 at Tintamarre NWA, 12 at Shepody NWA, 4 at Chignecto NWA and 3 at Wallace Bay NWA. To provide a wider cross-section of impoundment age, additional freshwater dykeland impoundments at the Missaguash Marsh (n=1) and the East Amherst Marsh (n=2) both in the NS/NB border region were included. All impoundments are situated on Fundy dykeland soils in the Nova Scotia - New Brunswick border region (Figure 1) with the exception of the 3 Wallace Bay impoundments situated along the Northumberland Strait. The recent history of the Wallace Bay marshes is very similar to the Fundy dykelands, i.e. they are located on soils that were once salt marshes that were subsequently dyked and drained for the purpose of agriculture.

3.0 METHODS

The 32 freshwater impoundments selected for this study ranged in age from 1 to 27 years after their initial flooding (Table 1). The age of each impoundment was determined from CWS/DUC records. Each impoundment was surveyed for bird use and all waterfowl and wetland obligate bird surveys were carried out by canoe, using binoculars and a spotting scope. The purpose of the surveys was to get an index of waterfowl and wetland obligate bird numbers rather than a complete census. A total of five surveys were conducted on each impoundment throughout the summer from the beginning of May to the end of August, 1996. Surveys were conducted at roughly one month intervals, thus encompassing the spring staging, breeding, brood, and fall staging periods. Each survey period required between 1.5 - 2 weeks to survey all 32 impoundments depending on weather conditions. To avoid visibility bias, surveys were not conducted when wind speed exceeded 30 km/h or during periods of heavy rain (Wishart, 1983). Wind speed occasionally increased considerably during a survey; however, if the particular survey included a series of impoundments in one area, the survey was continued until completed. Surveys were conducted during the early morning hours usually terminating by 1000 h, or during the evening, beginning after 1700 h.

Each impoundment was surveyed systematically following routes pre-determined by air photo interpretation. Maps for all impoundments were traced from aerial photos. The route that would allow for maximum coverage of habitats through the impoundment was then traced on the maps. During the first survey, each of the routes were followed according to the maps, and flagging tape was used to mark emergent vegetation so that the same routes were followed for all subsequent surveys . The size of the impoundment (ha) and the length of the route (m) were determined for each impoundment. Time required to conduct each survey was also recorded.

All species and numbers of wetland avifauna were recorded including waterfowl, waterfowl broods, other wetland-obligate birds, passerines and raptors. Only some waterfowl and wetland-obligate birds provided sufficient sample sizes for statistical comparisons. When identification of waterfowl species was uncertain, individuals were recorded as unidentified waterfowl, and if possible, were listed as either dabblers or divers.

In addition to wetland avifauna surveys, conductivity was measured mid-summer (survey 3) with a conductivity meter (YSI Inc., Model 33, S-CT Meter) in order to derive an indication of total dissolved solids for each of the impoundments. General notes on vegetative structure and plant species composition was also recorded during surveys.

3.1 Data Analysis

Data were plotted, and the presence of outliers violated assumptions for parametric procedures i.e. linear regression or Pearson's correlation coefficient. Due to these violations, data were analyzed using non-parametric techniques (Spearman's correlation coefficient) in order to utilize all data collected (i.e. retention of extreme values). Spearman's r can therefore be considered less sensitive than Pearson's r to occasional outliers (Watt, 1993; Zar, 1974).

Spearman's correlation coefficients were computed for impoundment age and the following variables: total waterfowl; breeding pairs; waterfowl broods; total numbers of three marsh bird species; American Bittern, Pied-billed Grebe and Sora Rail, and conductivity measurements taken mid-summer (survey 3) .

3.2 Waterfowl

For each impoundment, breeding pairs, broods and total waterfowl were derived as the number per meter of the survey route. Given the abundance observed, we selected Ring-necked Ducks (*Aythya collaris)*, American Black Ducks (*Anas rubripes*) and Blue-winged Teal (*Anas discors)* as representative waterfowl species for subsequent analysis.

For breeding pairs, survey 1 (May 2 - May 10, 1996) was chosen as the most appropriate survey to estimate the number of American Black Duck breeding pairs, while survey 2 (May 26 - June 7, 1996) was selected as the appropriate survey for estimating Ring-necked Duck and Blue-winged Teal breeding pairs (B. Pollard, unpubl. data). The timing of these surveys corresponded to the optimal period of censusing breeding populations as migrants breeding elsewhere would have departed by this time, pair bonds are still maintained (Dzubin, 1969), and the largest proportion of the population should be in late prenesting, egg laying or early incubation (Wishart, 1983). The estimated number of breeding pairs was calculated accordingly for each species as described by Wishart (1983). In addition to breeding pairs, total adult waterfowl per meter of survey route within each impoundment was calculated and included all species observed, combining all five surveys.

3.3 Broods

All waterfowl broods observed were recorded and assigned an age class as described by Gollop and Marshall (1954). Broods observed were identified to species when possible and the number of ducklings in each brood was recorded. The total number of broods observed per impoundment was calculated, following the methodology outlined by Wishart (1983) by crossing off duplicate brood observations across time.

In addition to the above noted brood surveys, statistical analyses of aerial brood survey data collected between 1970 and 1988 were also included to provide additional tests of the hypothesis that waterbird use of the impoundments declines with impoundment age.

3.4 Marsh birds

All surveys were combined and used to calculate total numbers per meter of survey route within each impoundment of American Bitterns (*Botaurus lentiginosus*) and Pied-billed Grebes (*Podilymbus podiceps*), both of which were identified either by sight and/or vocalizations. For Sora Rails (*Porzana carolina*), only the first two surveys corresponding with peak breeding activity could be used to calculate total numbers, as the identification of Sora Rails usually depended on vocalizations.

4.0 RESULTS

4.1 Waterfowl

A statistically significant positive correlation between Ring-necked Duck breeding pairs and impoundment age was found (Spearman's $r = 0.38$, $p<0.05$, $n=32$) (Figure 3).

Although the relationships were not significant, positive correlations were also found for total waterfowl (Spearman's $r = 0.01$, $p>0.05$, $n=32$)(Figure 4), and American Black Duck breeding pairs versus impoundment age(Spearman's $r = 0.10$, $p>0.05$, $n=32$)(Figure 5).

A notable exception to these positive correlations is a statistically significant negative correlation found between Blue-winged Teal breeding pairs and impoundment age (Spearman's $r = -0.35$, $p<0.05$, $n=32$)(Figure 6).

An analysis of total numbers of broods versus impoundment age indicated a significant positive correlation (Spearman's r = 0.45, p<0.01, n=32) (Figure 2). Furthermore, analyses of historical data also indicated a statistically significant positive relationship between duck production and impoundment age for both June (F=4.504, P<0.05, df=119) and July (F=6.303, P<0.02, df=149) aerial brood surveys conducted from 1970 to 1988.

4.2 Marsh birds

Positive, though non-significant correlations were found for numbers of American Bittern (Spearman's r = 0.25, p>0.05, n=32)(Figure7), and Sora Rails (Spearman's r = 0.25, p>0.05, n=32)(Figure8), while Pied-billed Grebe numbers showed a slightly negative though non significant correlation with impoundment age (Spearman's r = -0.08, p>0.05, n=32)(Figure 9).

5.0 DISCUSSION

Waterfowl and wetland obligate bird use of an impoundment does not necessarily decline with increasing impoundment age as previously assumed as this study has generally shown a positive correlation between waterfowl numbers and impoundment age. The exception to this general pattern of duck use was a negative correlation between Blue-Winged Teal and impoundment age. The observed Blue-winged Teal response was largely driven by observations on one date (none observed on six older impoundments).

Two of the three marsh bird species investigated showed positive, though non-significant correlations with impoundment age. However, as all of the impoundments surveyed are managed as shallow freshwater marshes, they may not provide ideal habitat for diving marsh birds such as the Pied-billed Grebe. Deeper water areas preferred by

Pied-billed Grebe are often present in the borrow pit along the innermost edges of the impoundment along the dykes, and may often provide limited suitable foraging areas for these marsh birds. We are uncertain why a positive Pied-billed Grebe response was not detected as surveys conducted at other locations have shown that similar impoundments provide breeding habitat for Pied-billed Grebes (Erskine, 1992; Pollard et. al., In Press).

Upon initial flooding, freshwater impoundments undergo a series of changes that influence the flora of the marsh in a series of successional stages (Baldassarre and Bolen, 1994). A grassy meadow consisting of a diversity of grasses and forbs is usually present on the abandoned agricultural fields. After initial flooding, this existing vegetation is killed, presumably resulting in a rapid release of nutrients from the decaying plants, providing habitat and nutrients for aquatic invertebrates which subsequently colonize these newly flooded habitats (Beauchamp and Kerekes, 1980; Cook and Powers, 1958).

Whitman (1974) noted that approximately one year after flooding, impoundments are characterized by submerged and floating leaf aquatics including duckweeds and pondweeds. These plants are highly utilized and preferred plant foods of waterfowl, both adults and broods. These areas not only provide important plant foods, but also important invertebrate foods which are a necessary part of the diet for breeding females (Krapu and Reinicke, 1992) and broods (Sedinger, 1992). However, suitable nesting cover for over water nesting species, as well as cover for broods were found to be sparse after only a year post flood.

Whitman (1974) suggested that impoundments between the age of 1.5 and 4 years after flooding may reach optimal habitat conditions for waterfowl. Stands of emergent vegetation such as cattail, bulrush and sedge provide cover as they establish throughout the impoundment. Invertebrate numbers typically increase as emergent communities develop (Whitman, 1974). However, with time and continued flooding, these emergent stands may become very dense, excluding floating - leaf and submerged aquatics. This may result in decreased food and structural resources for the entire aquatic community (Gilinsky, 1984).

Emergent rooted plants are generally low in food value to waterfowl and other marsh birds, though they may provide cover for nesting and predator avoidance. Increasing emergent plant densities have been shown to reduce algae production and standing crop as the amount of light reaching the water is reduced due to shading by emergents (Robinson et. al., 1997). As well, although invertebrate populations may increase initially as emergent communities become established (Murkin and Ross, In Press), the increasing density of these plants may restrict the movement of young broods and limit the accessibility to these invertebrates (Whitman,1974). Furthermore, Whitman (1974) also found that as this succession continues, invertebrate populations contain a number of taxa that are less abundant and less attractive as food sources for waterfowl (eg. Erpobdellidae, Glossiphoniidae, Oligochaeta). This decline in invertebrate abundance was only observed in the first few years following initial flooding as Whitman's study included impoundments that were 1 to 8 years of age . Whether invertebrate numbers remain relatively stable or continue to decline over the longer term is not known.

Macro and micro-nutrient levels have been shown to decrease as impoundments age following construction (Whitman, 1974, Beauchamp and Kerekes, 1980, although see Cook and Powers, 1958). Whitman (1974) observed that at approximately four years of age, soil and water conditions are characterized by a decline in fertility as alkalinity, conductivity, and mineral nutrients in the water are most noticeably affected at that age. Furthermore, Kadlec (1962), suggests that some of these nutrients may eventually become bound in the substrate in partially decomposed dense vegetation and become unavailable to many forms of aquatic life.

Whitman (1974) and Beauchamp and Kerekes (1980) noted a significant decline in conductivity for impoundments ranging from newly flooded to eight years of age. In this study, no significant differences in conductivity were found for impoundments ranging from 1 to 27 years. It is possible that the initial decline in conductivity may be relatively rapid, then may remain constant or decline very slowly as impoundments age.

Emergent vegetation, perhaps more than any other single feature may epitomize the physiognomy of wetlands, and habitat structure available for wetland obligate birds (Baldassarre and Bolen, 1994). Extensive monotypic stands of emergents such as *Typha* spp. may dominate impoundments under stable hydrological conditions, inevitably resulting in a decrease in habitat heterogeneity (Kantrud, 1986; Fredrickson and Laubhan, 1994) and subsequent waterfowl productivity (Kantrud, 1986; Weller, 1981, Fig. 7). Natural changes and alterations to vegetation do occur however, as a result of grazing by muskrats and periodic flooding caused by variations in weather.

Results from studies conducted on experimentally manipulated cattail marshes have indicated that dabbling duck pairs are most abundant in wetlands with a cover to water ratio of 50:50(Murkin, 1982). This 50:50 or hemi-marsh condition implies equal amounts of cover and water; however, the interspersion of these two components is an important factor in determining bird use of a site. A hemi-marsh is therefore one in which the interspersion of emergent vegetation and water is complex with many coves and islands of vegetation dispersed throughout the wetland (Mackinnon et. al.,1995). The majority of impoundments in our study approximated this condition.

Densities of dabbling ducks were also found to be positively correlated with invertebrate numbers under hemi-marsh conditions (Murkin, 1982; Kaminski and Prince, 1981). Kaminski and Prince (1981) further suggested that breeding dabbling ducks use cover:water interspersion as a proximate cue to habitats rich in aquatic invertebrates.

In addition to its impact on invertebrate numbers, the vegetative structure of a marsh may also determine the number of breeding pairs that will use an area. Territorial behaviour occurring during nest establishment inevitably leads to the spacing of individual pairs (Owen and Black, 1990). The visual isolation provided by emergents may be an important factor in determining pair use of a particular area (Kadlec, 1962, Murkin et. al., 1982). Furthermore, the spacing of nests in emergent cover may also have an anti-predator function as scattered nests may be more difficult to locate (Owen and Black, 1990). Ideal marshlands for waterfowl and other wetland obligate birds are therefore presumed to be those in which stands of emergents are extensively interspersed with zones of submerged and floating-leaf aquatics.

The positive relationship found between numbers of broods and impoundment age may also reflect the influence of female philopatry. Familiarity with an area is likely to increase a female's foraging efficiency (Rohwer and Anderson,1988), and females tend to show a propensity to return to an area where they have previously been successful in rearing broods (Doty and Lee, 1974). The benefits of returning to a natal or breeding site may be of particular importance to females as they may remain on the breeding grounds for up to four months and are responsible for the parental care of offspring. Female philopatry may therefore result in higher numbers of broods being produced in older impoundments.

Changes in vegetation structure and composition, invertebrate communities, and soil and water conditions have been observed to occur as part of the impoundment aging process. Nutrient levels have been observed to decline with impoundment age (Beauchamp and Kerekes, 1980), however; levels may decline rapidly in the first few years after initial flooding but remain stable for many years afterwards.

6.0 SUMMARY

Thirty-two freshwater impoundments in the Chignecto border region were selected to study the relationship between waterfowl and wetland avifauna use and impoundment age. Earlier studies conducted have indicated that primary productivity declines with impoundment age (Beauchamp and Kerekes, 1980). The focus of this study was to determine whether waterfowl and wetland obligate bird numbers decline with increasing impoundment age.

Statistically significant positive correlations were found between waterfowl brood numbers and impoundment age ($p<0.01$), as well as between Ring-necked Duck breeding pairs and impoundment age ($p<0.05$). Furthermore, analyses of historical data also indicated a statistically significant positive relationship between duck production and impoundment age for both June ($p<0.05$) and July ($p<0.02$) aerial brood surveys conducted from 1970 to 1988. Positive, though non significant correlations were found between total waterfowl and impoundment age, as well as for American Black Duck breeding pairs and impoundment age.

A statistically significant negative correlation between Blue-winged Teal breeding pairs and impoundment age was detected. These findings are based on the results of a single breeding pair survey during which no Blue-winged Teal were observed on six of the oldest impoundments. Adults as well as broods were observed on later surveys in these same areas.

No statistically significant relationship was found between Pied-billed Grebe, American Bittern, or Sora Rail abundance and impoundment age.

Conductivity measurements were used as an indicator of general productivity. A negative but non significant correlation was found between conductivity and impoundment age. A negative slope is consistent with results reported by Beauchamp and Kerekes (1980) and Whitman (1974) in which a decline in conductivity was found with increasing impoundment age.

A general decline in waterfowl and wetland obligate bird use of constructed impoundments with increasing impoundment age was not observed in this study. These results are contrary to effects suggested by Beauchamp and Kerekes (1980) and Whitman (1974). Studies conducted by Murkin (1982) and Kaminski and Prince (1981) suggest that a hemi-marsh vegetative structure is correlated with higher densities and diversity of waterfowl selecting these areas as breeding grounds. Nutrient levels in older impoundments may be adequate to support and maintain breeding waterfowl and wetland obligate birds. Furthermore, female philopatry, in addition to habitat diversity may ensure consistent waterfowl numbers and productivity regardless of impoundment age, assuming some undefined threshold in productivity is maintained. This investigation suggests the maintenance of a hemi-marsh vegetative structure may be of primary importance in ensuring waterfowl productivity of an impoundment, and may be more of a determinant of wetland avifauna use than impoundment age.

Table 1: Salient features of the thirty-two impoundments selected for study

General Location	Impoundment Name	Age (years)	Size (hectares)
Shepody National Wildlife Area	Germantown A1	22	6.1
	Germantown A2	22	13.4
	Germantown B	22	28.4
	Germantown C	21	50.6
	Germantown D	21	68.9
	Germantown E	21	38.5
	Germantown F1	21	52.7
	Germantown F2	21	23.5
	Germantown G	21	62.8
	Germantown I	13	54.7
	New Horton C	16	38.5
	New Horton D	16	17
Tintamarre National Wildlife Area	Tintamarre 1	27	15
	Tintamarre 2	27	9.3
	Tintamarre 3	27	8.1
	Tintamarre 4	27	14.2
	Tintamarre 5b	27	10.1
	Tintamarre 5c	27	16.6
	Tower's Goose Extension	9	58.7
	Mud Bog	14	21.9
Chignecto National Wildlife Area	Amherst Point 1	23	36
	Amherst Point 2a	23	29.6
	Amherst Point 3	19	7.3
	Cove	13	12.5
Wallace Bay National Wildlife Area	Wallace Bay 1	24	52.7
	Wallace Bay 2a	23	34.8
	Wallace Bay 2c	23	9.7
East Amherst Marsh	Eddy Road 1	12	27.9
	Eddy Road 2	12	20.7
Missaguash Marsh	Fort Beausejour 1	1	19
	Fort Beausejour 2	1	19
	Beausejour	10	19

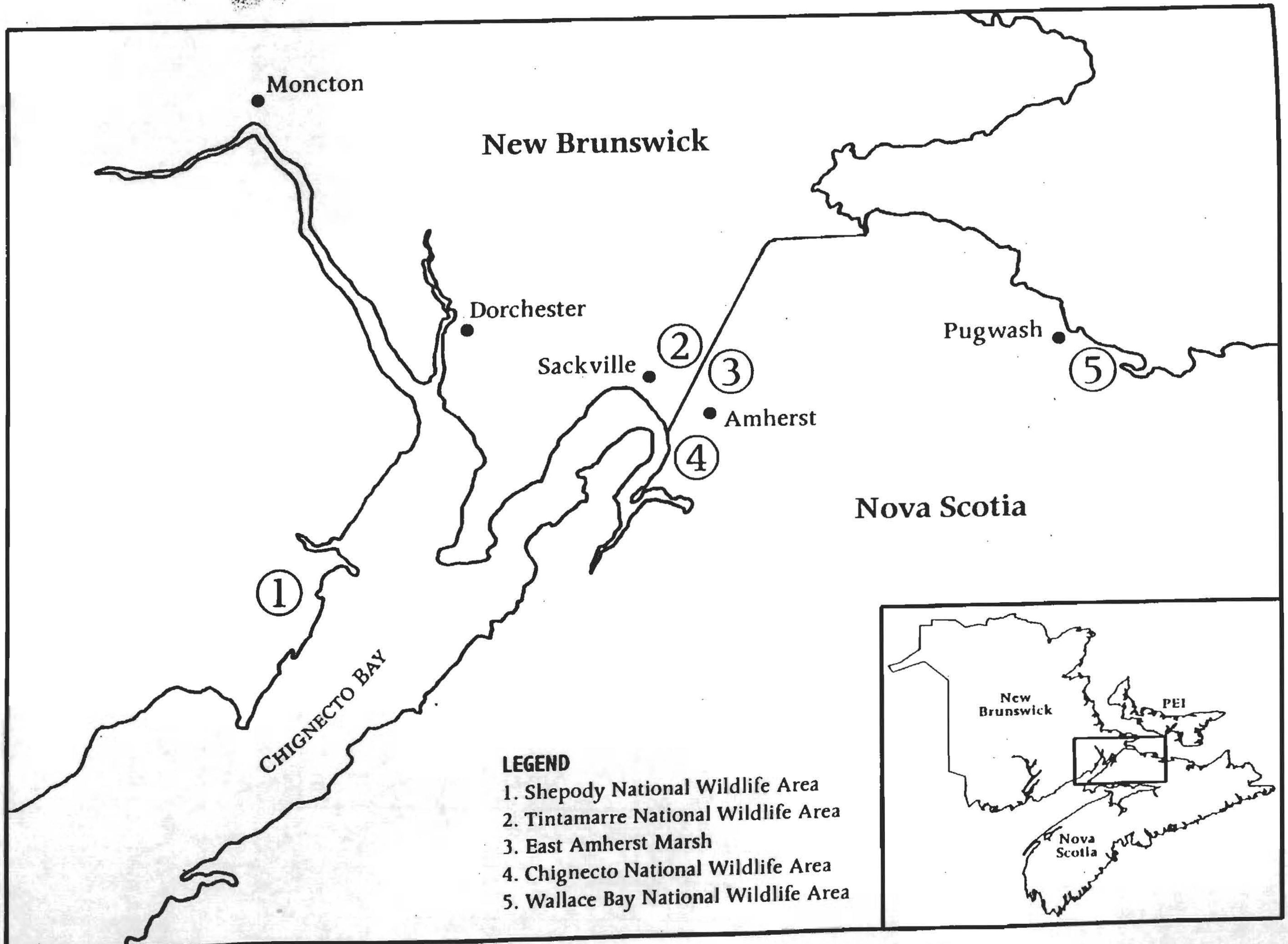

Fig. 1 Location of study sites within the greater N.B. and N.S. border region

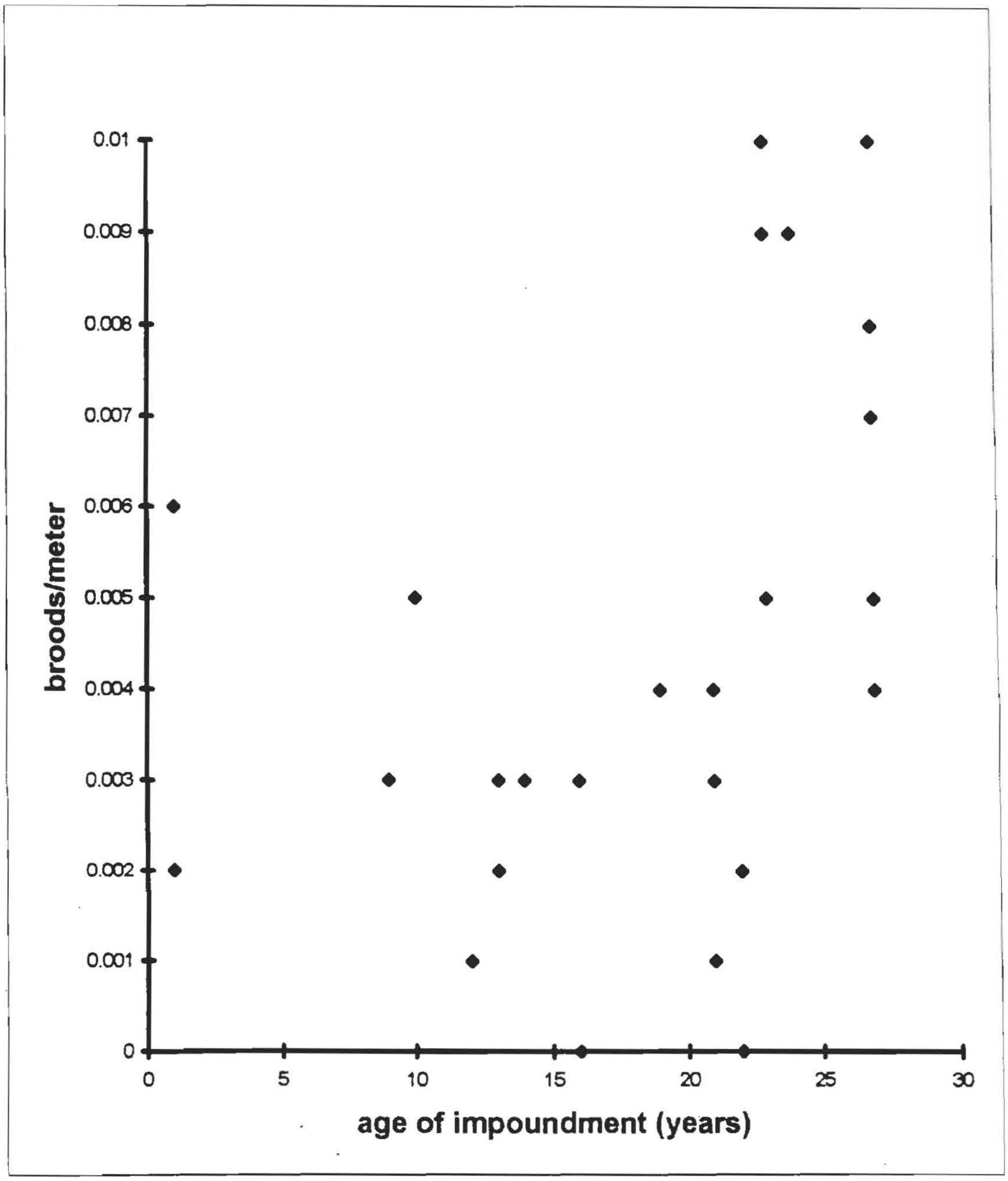

Figure 2: Total number of broods versus impoundment age Spearman's r = 0.45, p<0.01, n=32)

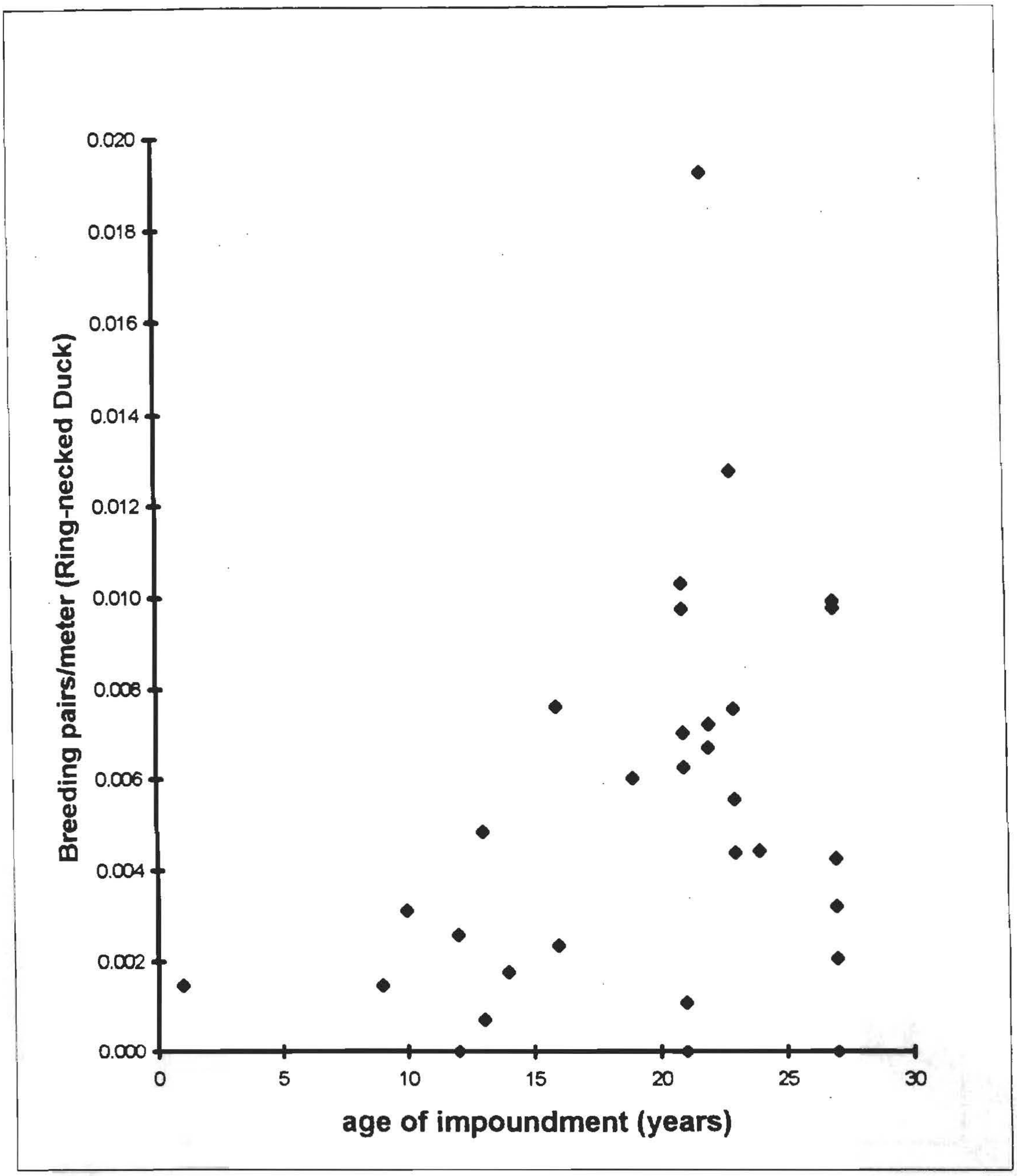

Figure 3: Ring-necked Duck breeding pairs versus impoundment age (Spearman's r = 0.38, p<0.05, n=32)

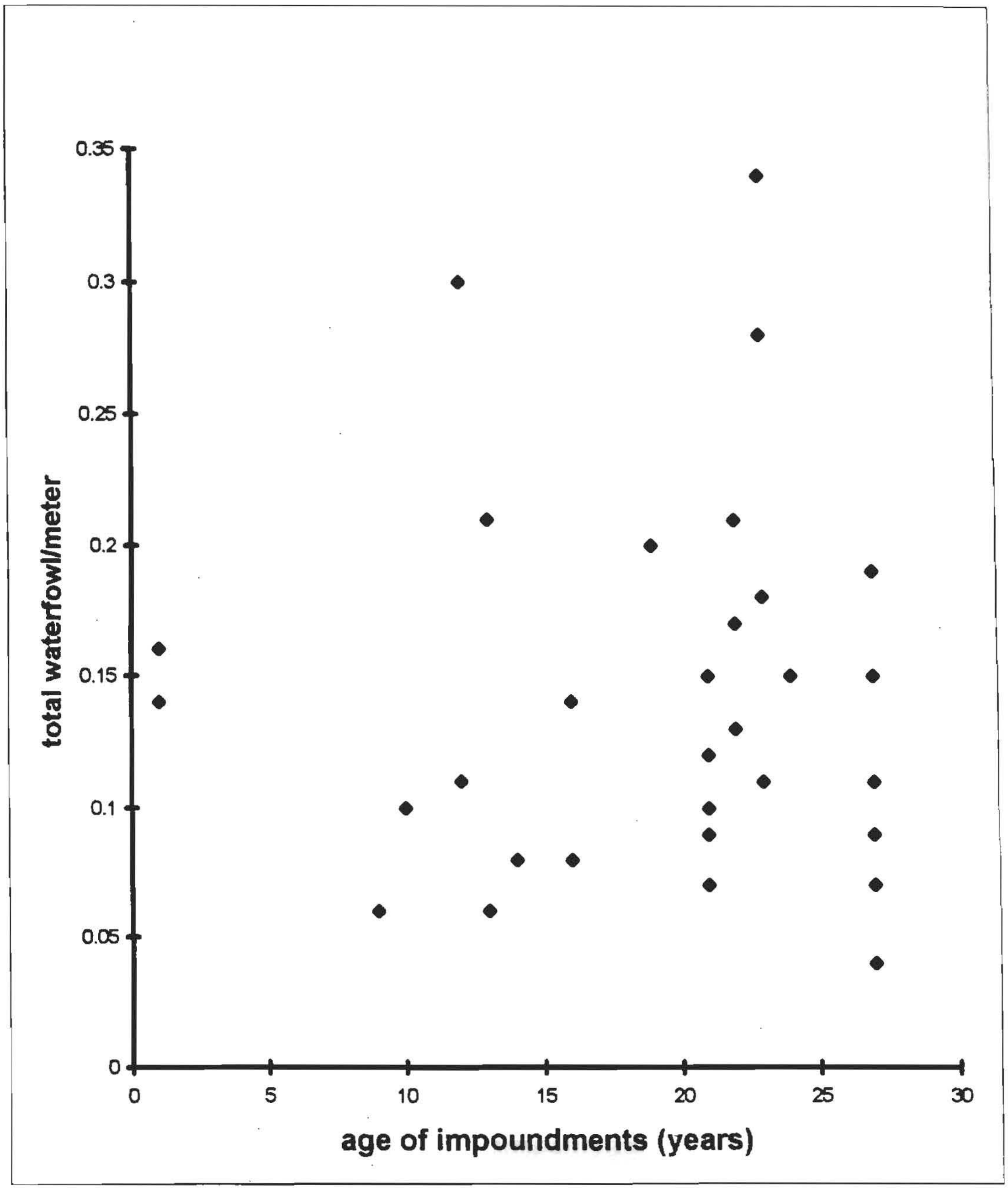

Figure 4 : Total numbers of all waterfowl species versus impoundment age Spearman's r = 0.01, p>0.05, n=32

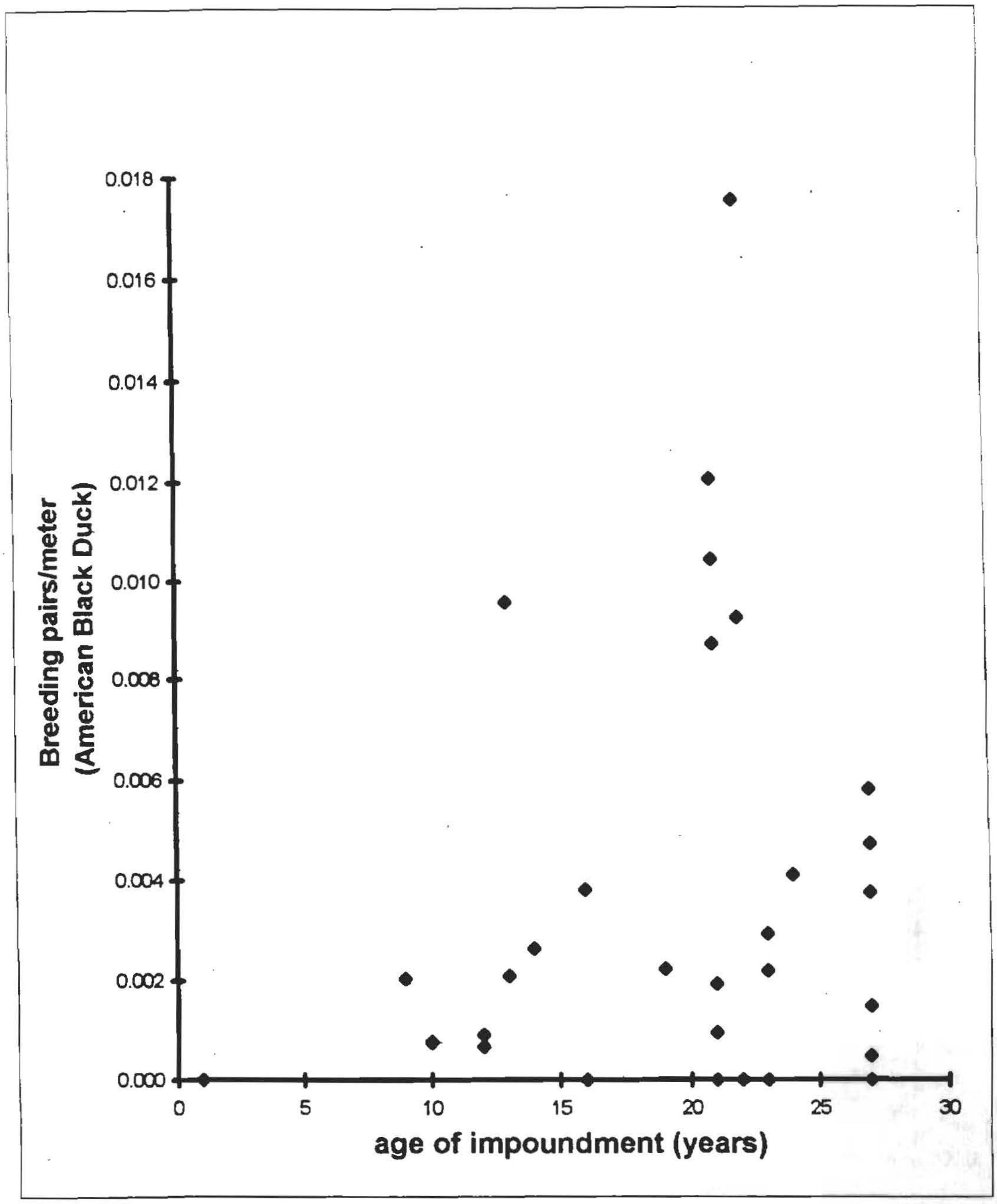

Figure 5: American Black Duck breeding pairs versus impoundment age Spearman's r = 0.10, p>0.05, n=32

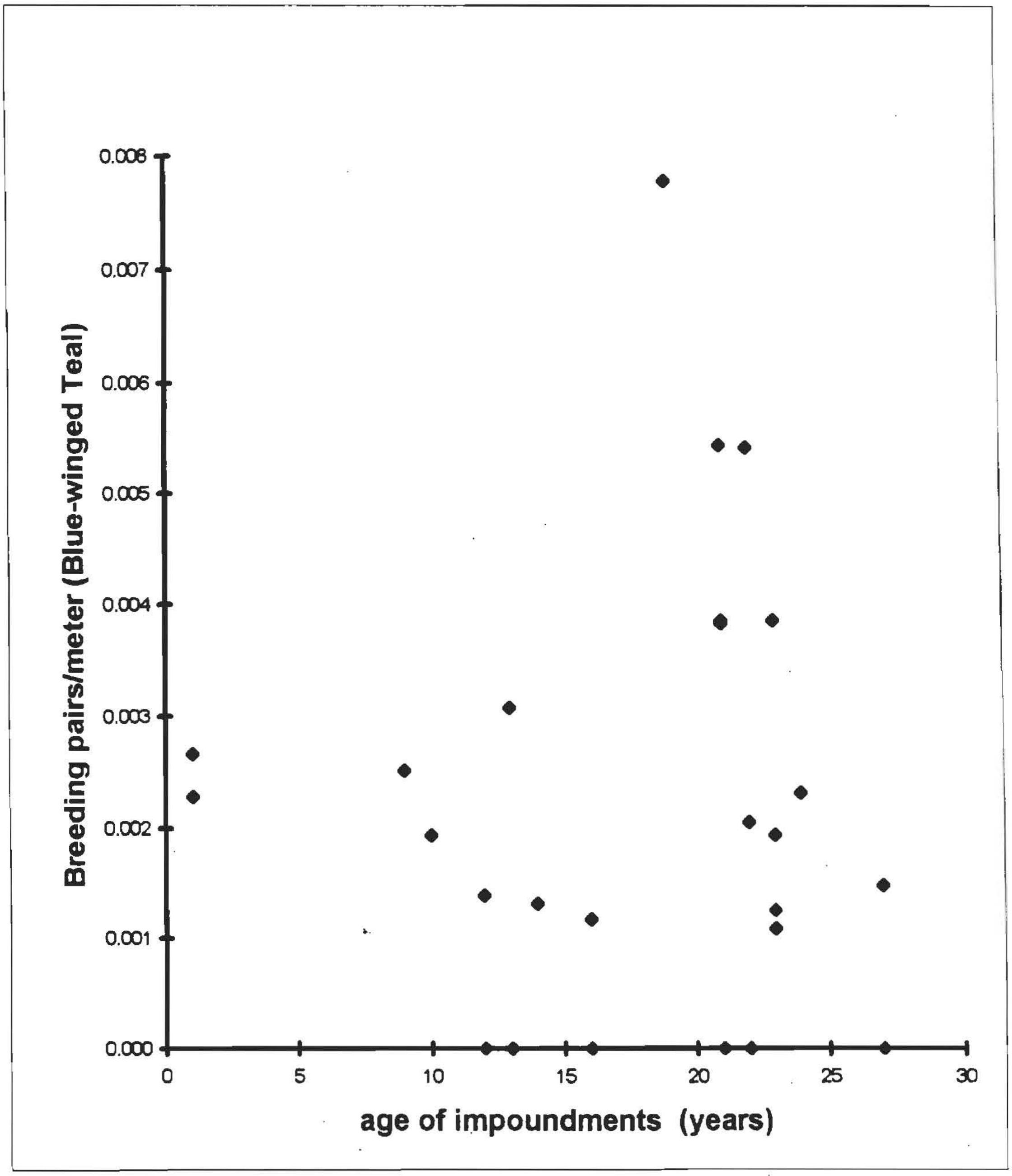

Figure 6: Blue-winged Teal breeding pairs versus impoundment age
Spearman's r = - 0.35, p<0.05, n=32

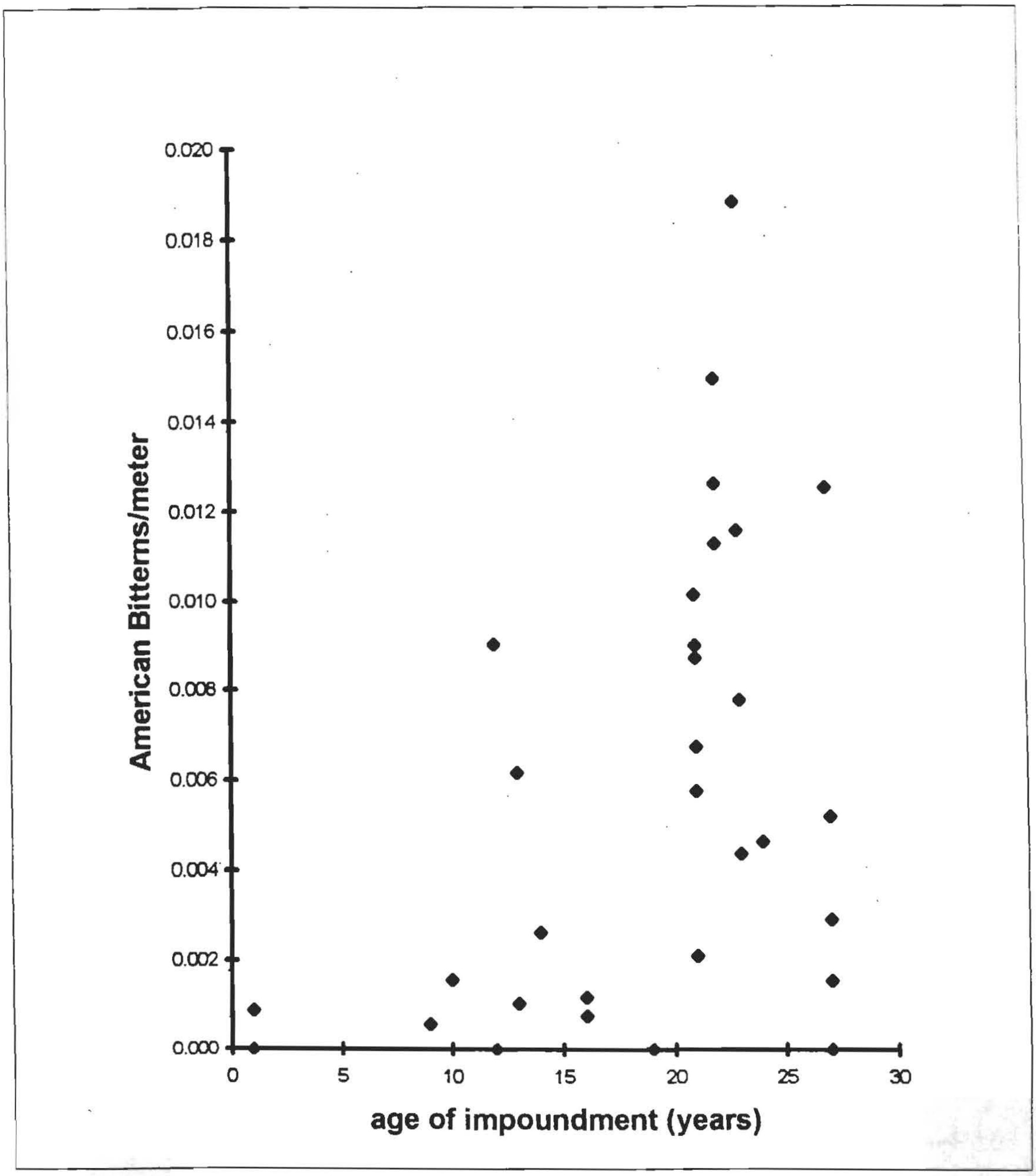

Figure 7: Total numbers of American Bittern vs. impoundment age Spearman's r = 0.25, p>0.05, n=32

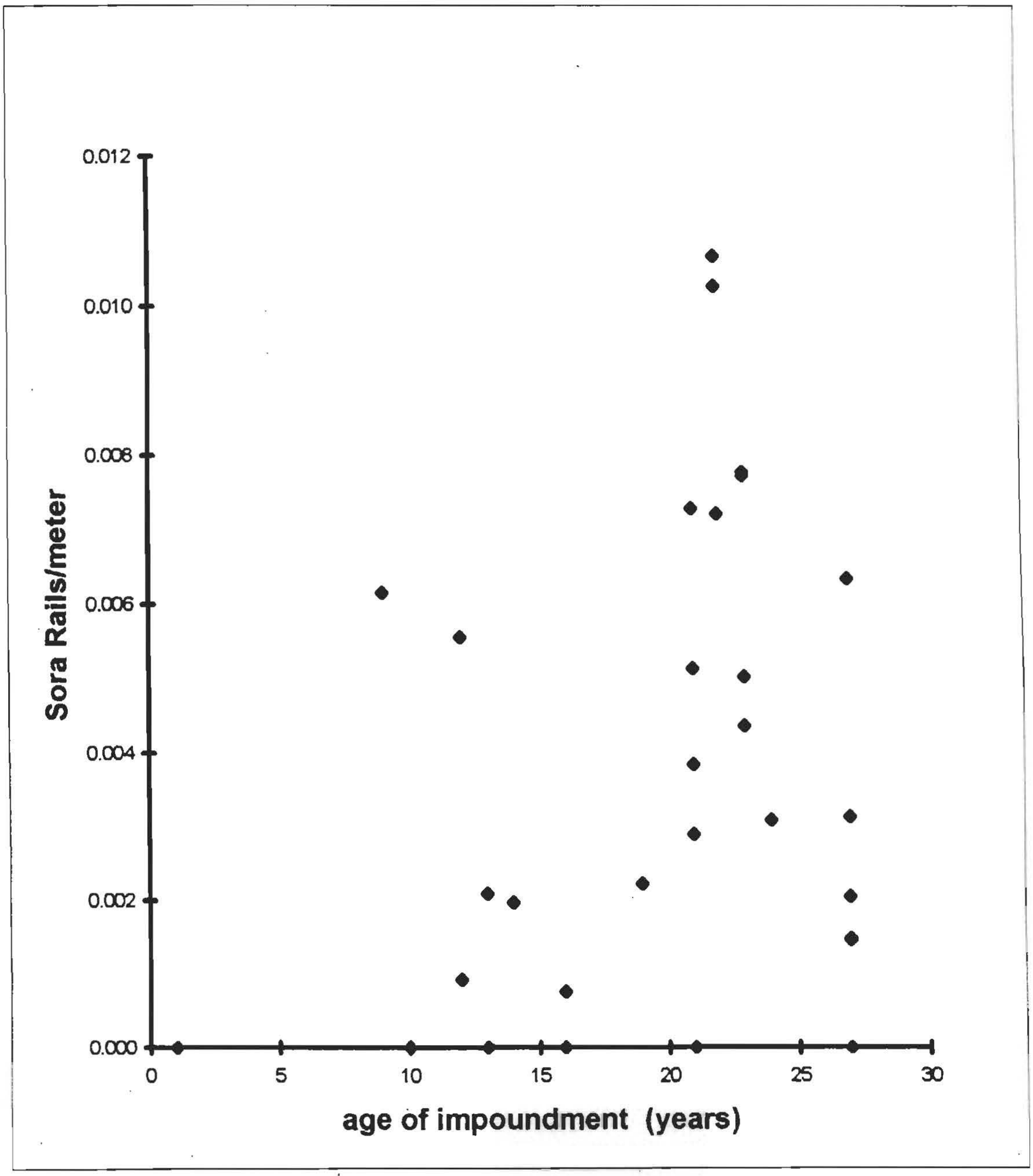

Figure 8: Total numbers of Sora versus impoundment age
Spearman's r = 0.25, p>0.05, n=32

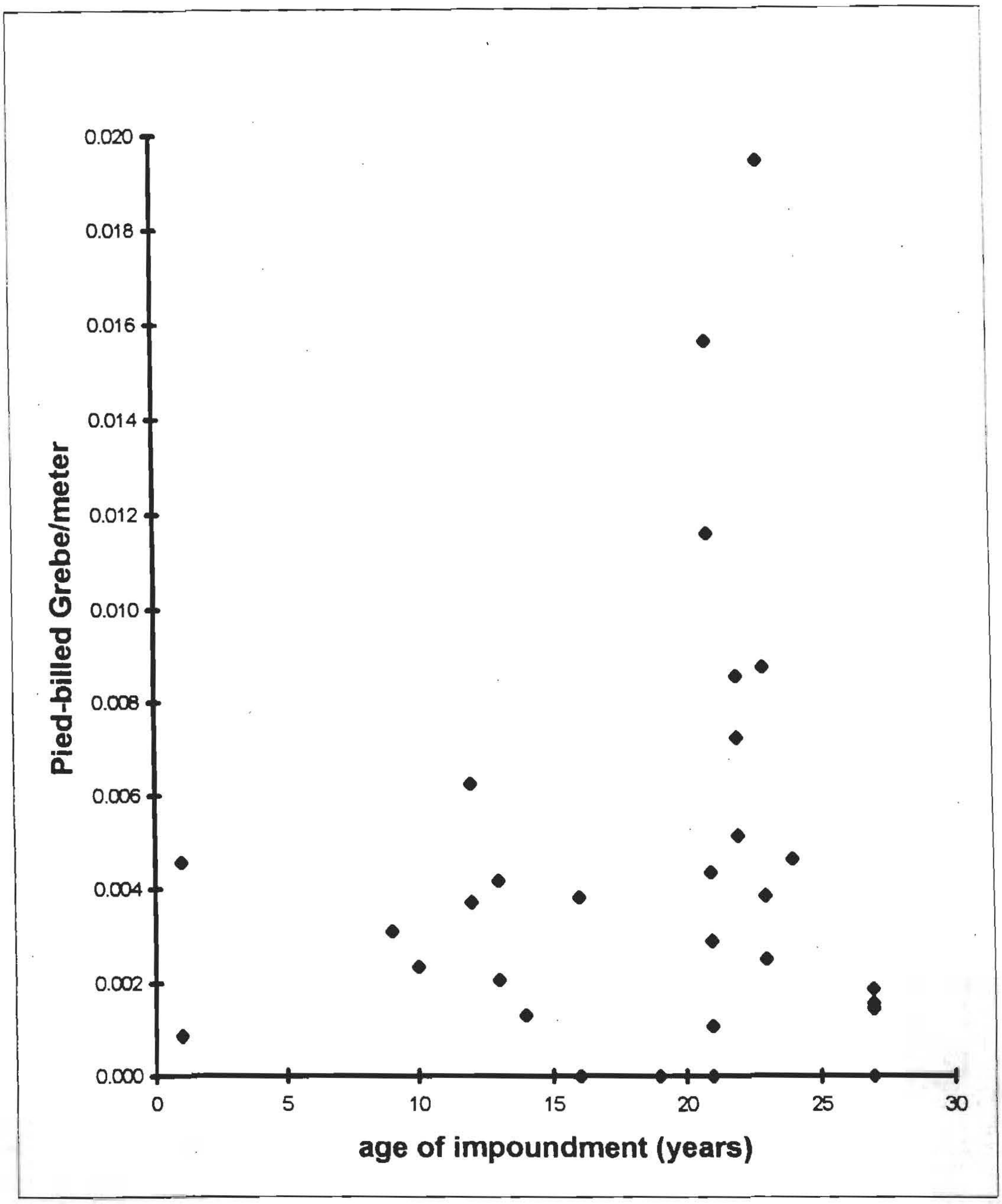

Figure 9: Total number of Pied-billed Grebe versus impoundment age Spearman's r = - 0.08, p>0.05, n=32

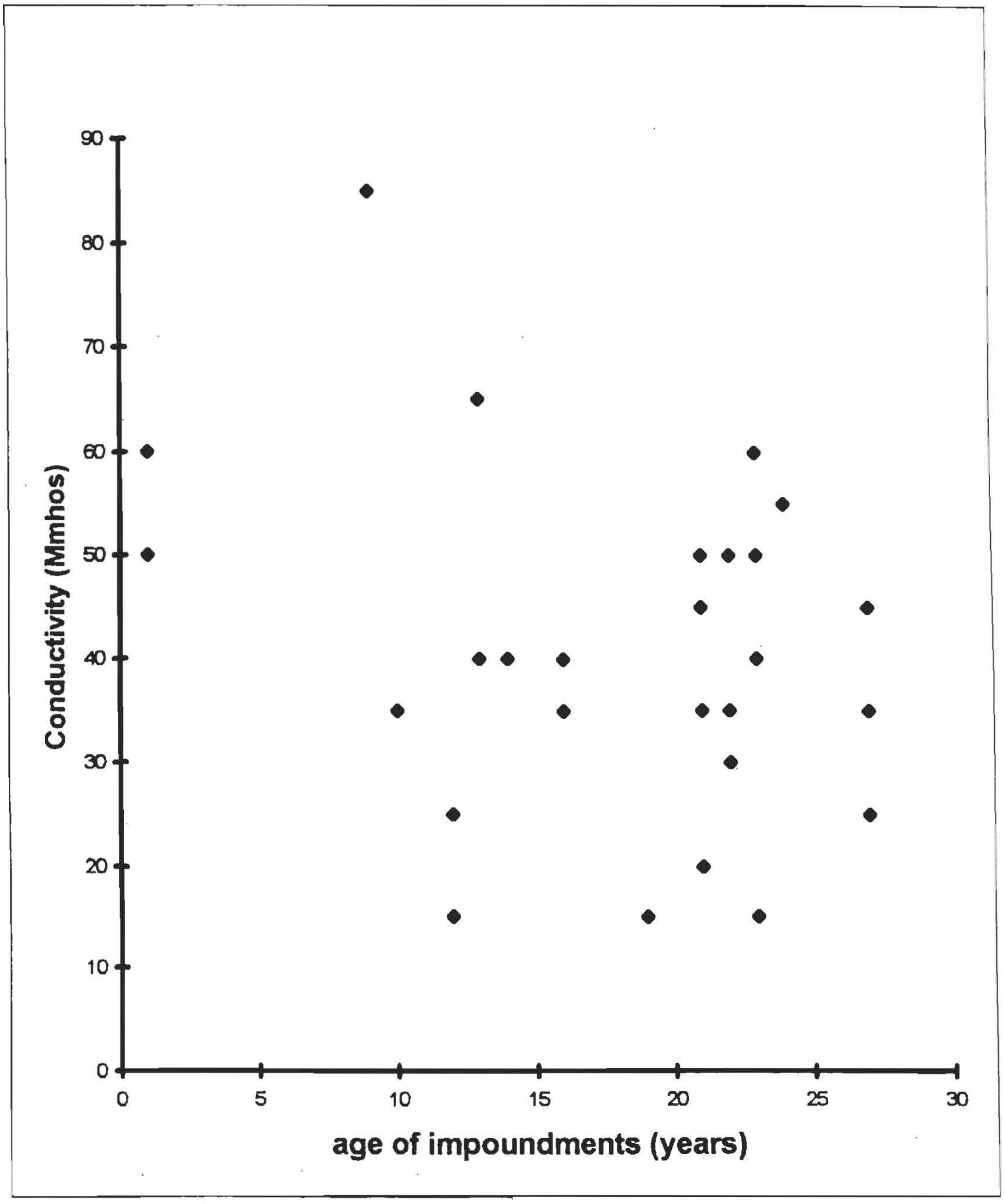

Figure 10 : Conductivity measurements vs. impoundment age
Spearman's r = - 0.22, p>0.05, n=32

7.0 LITERATURE CITED

Baldassarre, G. A. and Bolen, E.G. 1994. Waterfowl Ecology and Management. John Wiley & Sons, Inc. New York, NY.

Beauchamp, S.T. and Kerekes, J.J. 1980. Comparative changes in water chemistry within impounded and natural freshwater marshes at the Tintamarre National Wildlife Area. Trans. N.E. Sect. Wild. Soc. 37: 198-209.

Cook, A.H. and C.F. Powers. 1958. Early biochemical changes in the soils and waters of artificially created marshes in New York. N.Y. Fish. Game. 5:9-59.

Doty, H.A. and Lee, F.B. 1974. Homing to nest baskets by wild female Mallards, J. Wild. Manage. 38: 714-719.

Dzubin, A. 1969. Assessing breeding populations of ducks by ground counts. pp. 178-230 in Saskatoon wetlands seminar. Can. Wildl. Ser. Rept. Series no. 6. Ottawa.

Erskine, A.J. 1992. Atlas of Breeding Birds of the Maritime Provinces. Nimbus Publishing Ltd. And the Nova Scotia Museum.

Fredrickson, L.H. and Laubhan, M.K. 1994. Managing wetlands for wildlife. Pp. 623-647 *In* Bookhout, T.A. (ed.) Research and management techniques for wildlife and habitats. The wildlife Society. Bethesda, MD. 740 pp.

Ganong, W.F. 1903. The vegetation of the Bay of Fundy salt and diked marshes. Botanical Gazette, Chicago, Ill.

Gilinsky, E. 1984. The role of fish predation and spatial heterogeneity in determining benthic community structure. Ecology 65: 455-468.

Gollop, J.B. and Marshall, W.H. 1954. A guide for aging duck broods in the field. Miss. Flyway counc. Tech. Sect.

Kadlec, J.A. 1962. The effect of a drawdown on the ecology of a waterfowl impoundment. Ecology, 43: 267-281.

Kaminski, R.M. and Prince, H.H. 1981. Dabbling duck and macro invertebrate responses to manipulated wetland habitat. J.Wildl. Manage. 45:1-15.

Kantrud, H.A. 1986. Effects of vegetation manipulation on breeding waterfowl in prairie wetlands - A literature review. U.S. Fish. Wildl. Serv., Fish Wildl. Tech. Rep. 3.

Krapu, G.L. and Reinicke, K.J. 1992. Foraging ecology and nutrition. Pp. 1-29 *In* Batt, B.D.J., Afton, A.D., Anderson, M.G., Ankney, C.D., Johnson, D.H., Kadlec, J.A. and Krapu, G.L. (eds.) Ecology and management of breeding waterfowl. Univ. Minnesota Press. Minneapolis, MN. 635 pp.

MacKinnon, C.M., Hicks, R., Hanson, A. and McAloney, K. 1995. Freshwater marsh management on Canadian Wildlife Service National Wildlife Areas in the Atlantic Provinces *in* Waterfowl Habitat Restoration, Enhancement and Management In the Atlantic Flyway. Third Edition, Atlantic Waterfowl Council. Delaware Department of Natural Resources and Environmental Control.

Murkin H.R., Kaminski R.M. and Titman R.D. 1982. Responses of dabbling ducks and aquatic invertebrates to an experimentally manipulated cattail marsh. Can. J. Zool. 60:2342-2332.

Murkin, H.R. and Ross, L.C.M. In Press. Northern prairie marshes (Delta Marsh, Manitoba): macroinvertebrate responses to a simulated wet-dry cycle *in* Batzer, D., Rader, R.D. and Wissinger (eds.) Invertebrates in freshwater wetlands of North America: ecology and management. Van Nostrand Reinhold, New York, NY.

Nova Scotia Department of Agriculture and Maketing.1987. Maritime Dykelands.

Owen, M. and Black, J.M. 1990. Waterfowl Ecology. Chapman and Hall, New York, NY.

Pollard, J.B., Bauchman, C.M., and McAloney, K. In Review. The impact of Atlantic dykeland restoration on wetland-obligate avian species. Proc. 2nd Internat. Congress on Limnology and Aquatic Birds: Monitoring, Modeling and Management.

Ramsay, A. 1963. The composition of the submerged forest of Fort Lawrence, Nova Scotia. Unpubl. Thesis. Mount Allison Univ. Sackville, NB.

Robinson, G.C., Gurney, S.E. and Goldsborough, L.G. 1997. Response of benthic and planktonic algal biomass to experimental water-level manipulation in a prairie lakeshore wetland. Wetlands 17: 167-181.

Rohwer, F.C. and Anderson, M.G. 1988. Female-biased philopatry, monogamy, and the timing of pair formation in migratory waterfowl. pp. 187-221 *In* Johnston, R.F. (ed.), Current Ornithology, Volume 5. Plenum Press, New York, NY.

Roland, A.E. 1982. Geological Background and Physiography of Nova Scotia. Ford Publishing Co., Halifax, NS.

Sedinger, J.S. 1992. Ecology of pre-fledging waterfwol. Pp. 109-127 *In* Batt, B.D.J., Afton, A.D., Anderson, M.G., Ankney, C.D., Johnson, D.H., Kadlec, J.A. and Krapu, G.L. (eds.) Ecology and management of breeding waterfowl. Univ. Minnesota Press. Minneapolis, MN. 635 pp.

Turnbull, C.J. 1988. Reflections on a ground slate bayonet fragment from the Tantramar Marsh, upper Bay of Fundy. Can. J. Archaeology, 12: 87-101.

Watt, T.A. 1993. Introductory Statistics for Biology Students. Chapman and Hall, London.

Weller, M.W. 1981. Freshwater wetlands: ecology and wildlife management. Univ. Minnesota Press. Minneapolis, MN. 150 pp.

Whitman, W.R. 1974. The Response of Macro-Invertebrates to Experimental Marsh Management. 1974. unpubl.Ph.D. Thesis, University of Maine. Orono.

Wishart, R.A.(ed.) 1983. Biological Services Group Surveys Manual. Ducks Unlimited Canada, Winnipeg.

Zar, J.H. 1974. Biostatistical Analysis. Prentice-Hall, Inc. Englewood Cliffs, NJ.