Abstract

The Stanley Park Barrow's Goldeneye Survey 1999-2000 was made possible through a co-operative effort between the Canadian Wildlife Service (CWS) and the British Columbia Institute of Technology (BCIT). The intent of the survey was to collect baseline data to estimate the abundance and distribution of Barrow's Goldeneye (*Bucephala islandica*) observed along the Stanley Park foreshore in Vancouver, British Columbia (BC). In addition, the compilation of consistent baseline data was important to determine the impacts of the November 24, 1999 and February 12, 2000 canola spills that occurred in Burrard Inlet on the populations of waterfowl species on the Stanley Park foreshore.

During the 1998-1999 wintering season a BCIT student by the name of Brenda T. Rotinsky conducted the Stanley Park Barrow's Goldeneye Survey. The CWS requested that this year's survey follow Brenda T. Rotinsky's guidelines and recommendations from the 1998- 1999 Barrow's Goldeneye survey. Both studies were in accordance with a 1995 to 1997 feasibility study conducted by the CWS. The study was to determine the viability of collecting base line data to estimate the abundance of Barrow's Goldeneye (BAGO) along the Stanley Park sea-wall foreshore.

Stanley Park and its surrounding ocean foreshore are valued for their potential as wildlife habitat, in particular, for breeding and wintering populations of birds. The foreshore has a rocky shoreline and extensive mussel beds, which are favorable as wintering habitat for BAGO.

Data were collected from Wednesday, November 3rd, 1999 to Wednesday, April 12th, 2000 to document the following:

- Physical age characteristics of different aged individuals fitted with nasal disks.
- Age and sex ratios of BAGO.
- Abundance and distribution of all sea birds observed
- Observer variability in data collection.
- Time of day and seasonal variability of BAGO abundance and distribution.
- Feeding behavior of BAGO.

- Pair and mate guarding behavior of BAGO.

The results of the data analysis from Wednesday, November 3rd, 1999 to Wednesday, April 5th, 2000 shows the following:

- **Age Characteristics:** In 1995 the CWS began a study to determine the differences in plumage among the different age classes of BAGO. A total of 530 juvenile BAGO were tagged at Riske Creek, near Williams Lake, during each of the breeding seasons between 1995 and 1998. The juvenile BAGO were fitted with nasal disks coded to group individuals of similar age classes. The observed absence of nasal disk tagged BAGO may indicate that the community of BAGO breeding at Riske Creek, BC does not winter along the Stanley Park foreshore.

- **Abundance:** The number of BAGO utilizing the Stanley Park foreshore has varied greatly throughout the 1999-2000 wintering season. BAGO began to appear along the foreshore by the beginning of November and remained until late April. There were general fluctuations in the number of BAGO observed each survey day, this may be attributed to the movement of birds into and out of the survey area. In addition, this variation can be a result of the oil spills that occurred during the wintering season. No direct relationship between the abundance of BAGO observed and the total species of sea birds was found. The differences in the trends in the numbers of BAGO observed in the 1999-2000, 1998-1999 and 1995-1996 wintering seasons may be due to variances in overall weather patterns.

- **Distribution:** The distribution of BAGO across the different survey zones indicates that the BAGO are not evenly distributed along the Stanley Park foreshore. The greatest number of BAGO can be observed in areas that generally have less boat traffic, have greater food availability, and have close proximity to the open ocean. It is evident that there is a relationship between the distribution of BAGO observed and the total species of sea birds observed. A factor attributing to these findings may be that the wintering waterfowl may require similar habitat. However, due to the canola oil spills, a significant decrease in the total species of sea birds, using the Stanley Park foreshore was observed. The extent of the damage to the existing bird

populations have yet to be determined. Whether the decrease numbers of BAGO was directly related to movement in and out of the survey area location or whether these numbers indicated significant deaths in the populations is difficult to determine.

- **Observer Variance:** Variability between technicians in the number of BAGO observed along the Stanley Park foreshore may be attributed to the variance of technician experience, weather and sea bird behavior.

- **Time of Day and Seasonal Variance:** The number of BAGO observed in the morning was greater in both winter and spring months than in the afternoon. The decrease in observed BAGO from morning to afternoon may be attributed to bird movement out of the survey area at night.

- **Pair Information:** There was a constant presence of paired BAGO along the Stanley Park foreshore from early November through mid-April. Pairing behavior has been observed along areas where rocky shoreline exists. Areas along the foreshore where high concentrations of BAGO pairs were observed may be due to favorable habitat for territorial behavior. The pairs were spaced linearly and continuously. A trend in the number of BAGO pairs observed suggests that pairing occurred after individuals arrived on the Stanley Park foreshore.

Several recommendations were made in order to improve the accuracy and data collection methods in future Stanley Park Barrow's Goldeneye Surveys. Continue use of the Stanley Park foreshore delineations, collection of behavior data, and the maintenance of consistent starting times for each survey day should be made.

Acknowledgments

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1.0 Introduction

1.1 Background

The Stanley Park Barrow's Goldeneye (*Bucephala islandica*) Survey is a co-operative effort between the Canadian Wildlife Service (CWS) and the British Columbia Institute of Technology (BCIT). The study was ongoing through the 1999-2000 Barrow's Goldeneye wintering season. In order to have consistency of data, the CWS requested that the 1999-2000 survey follow the guidelines and recommendations from the 1998-1999 Barrow's Goldeneye study (Rotinsky, 1999). Both studies were in accordance with a 1995 to 1997 feasibility study conducted by the CWS (Schneider, 1997). The objective of the feasibility study was to conduct base line data for estimating the abundance of Barrow's Goldeneye (BAGO) along the Stanley Park foreshore.

The world's population of BAGO can be broken down into three isolated populations located in either Iceland, eastern North America, or western North America (Savard and Dupuis, 1999). The western North American population makes up 70% of the world population. Most of these BAGO breed at a variety of locations in the interior of British Columbia (BC) and winter on the Pacific coast. They begin to arrive on the coast when the lakes of the interior begin to freeze, forcing them to leave on the search for wintering habitat. These beautiful diving ducks can be found on the coast from late October to early November up until mid to late April (Schneider, 1997; Watts and Breault, 1996). While wintering BAGO will gather in inlets, harbours, bays, and anywhere with extensive rocky shores and mussel beds (Campbell *et al*., 1990). It is estimated that 3000 individual BAGO are present in Burrard Inlet over the wintering season, making them interesting study subjects (Schneider, 1997).

BAGO return to the same wintering location each year, establishing long-term pair bonds (Savard, 1985). It is only after molting at different locations that the pairs reunite on their wintering grounds. Generally, their territories are usually established away from other large wintering flocks, excluding conspecifics and other ducks (Savard, 1987). The large wintering flocks are usually made up of non-paired and juvenile BAGO as well as Surf Scoters (*Melanitta persipicillata*), Lesser Scaup (*Aythya affinus*), Greater Scaup (*Aythya marila*),

Common Goldeneye (*Bucephala clangula*), and Bufflehead (*Bucephala albeola*).

Barrow's Goldeneye are found in both salt and fresh water, often in fairly large flocks. They are excellent divers and feed primarily on blue mussels (*Mytilus edulis*), crustaceans and marine algae. Like other sea ducks, BAGO are daytime foragers and tend to congregate in large groups in protected waters at night (Savard, 1987).

It seems possible that local competition for food between the BAGO and Common Goldeneye may occur on wintering areas, since there appear to be no significant differences in foods consumed (Johnsgard, 1965). There also appears to be no major habitat differences that tend to keep the two species separated on wintering areas (Johnsgard, 1965).

Populations of BAGO are healthy on Canada's west coast but there has been growing concern for the eastern population (Boyd, 1999; Savard and Dupuis, 1999). It is estimated that the eastern population has been reduced to approximately 2000 to 4000 individuals, which indicates a decline of 35% over the past 15 years (Savard and Dupuis, 1999; Savard and Robert, 1997). Loss of habitat, logging practices, and hunting are contributing factors to the rapid decline of the eastern BAGO population. It is believed that the fall hunting season may affect the BAGO. The BAGO appear to be more vulnerable to hunting than the Common Goldeneye (COGO) because they tend to stay close to shores and can easily be attracted by decoys. In order to manage the species it is important to have complete life history information on those that are healthy as well as those considered at risk. Documenting the physical changes from juvenile plumage to adult plumage is necessary when determining various BAGO age classes. The growth of the BAGO juvenile results in more defined plumage, particularly the check crescent and chevron markings in males.

1.1.1 Canola Oil Spills

On November 24th, 1999 and February 12, 2000 oil spills occurred in Burrard Inlet consisting of approximately 2000 tonnes of canola oil. An investigation to determine the source of the spill was launched by Environment Canada and Transport Canada (Environment Canada Media Advisory, 1999). In addition, waterfowl and shoreline surveys were conducted by Environment Canada and the Coast Guard to direct cleanup efforts and determine environmental impacts (Environment Canada Media Advisory, 1999).

1.1.1.1 Physical Effects on Waterfowl and Other Water Birds

Although canola oil is vegetable based and is of low risk to humans and the marine environment, it presents a significant threat to waterfowl. Acute spills or chronic low-level pollution affects the physiology and behavior of aquatic birds. Some birds affected by the spill may not survive because oil weights their plumage so heavily that their flying capabilities or buoyancy is significantly reduced. In addition, loss of insulation may lead to hypothermia and death. Death may result from ingestion or inhalation of toxic petroleum products, such as gasoline and kerosene. However, the canola spills that occurred in Burrard Inlet were not toxic to the waterfowl using the Stanley Park foreshore. These physiological changes to the birds are compounded by the effects of generalized stress. The impact of oil contamination may interfere with sexual behavior, fertility, embryonic survival and the growth of chicks (American Petroleum Institute, 1985). Ingested oil can cause hormonal changes, alterations in courtships behavior, changes in size and development of ovaries and disruptions in egg laying (American Petroleum Institute, 1985).

1.1.1.2 Survival of Oiled Waterfowl

Each oil spill is unique, thus making it difficult to predict the effects on wildlife. Ultimately oceanographic, climatic and temporal factors determine the distribution of oil on water and land. In addition, the size of the bird population using the area will influence survival rates (Macintosh, 2000). Survival rates of a large bird population depend largely on such factors as the local weather, the species and physical condition of the bird, and the type of oil. In general, it is these same factors which will determine successful rehabilitation rates.

Air and water temperatures, which are determined by weather and climate, influence the rate of dispersal and persistence in the environment. It is in colder waters that the volatile and water-soluble components of oil remain (American Petroleum Institute, 1985).

Tides, winds, currents, and coastal formations determine the speed of oil movement and habitat contamination (American Petroleum Institute, 1985). Generally, rough seas and vigorous waves increase evaporation and the dissolution of oil, depositing remaining residues on water bottoms. Such activity is more effective in the open ocean than in a bay or inlet, where oil is likely to be deposited near shore.

Weather conditions and food availability will also affect the survival time of an untreated bird. Marginally oiled birds are able to survive and preen themselves clean more easily in clement weather when food availability is greater (American Petroleum Institute, 1985).

Data collection prior to and following the oil spills will be a critical factor in determining the overall impacts of the oil spills on waterfowl populations along the Stanley Park foreshore.

1.2 Purpose

During the 1999-2000 wintering season, weekly seabird surveys were conducted along the Stanley Park foreshore. Data were collected to document the following:

- Physical age characteristics of different aged individuals fitted with nasal disks.
- Age and sex ratios of BAGO.
- Abundance and Distribution of all sea birds observed.
- Observer variability in data collection.
- Time of day and seasonal variability of BAGO abundance and distribution.
- Feeding behavior of BAGO.
- Pair and mate guarding behavior of BAGO.

1.3 Barrow's Goldeneye Ecology

1.3.1 Range

Barrow's Goldeneye breed in Iceland, southwestern Greenland, northern Labrador, and from southern Alaska and Mackenzie District southward through the western states and provinces to California and Colorado. They winter primarily along the Pacific coast from Alaska to central California, and on the Atlantic coast from southern Canada to the mid-Atlantic states (Johnsgard, 1965). Figure 1 is a map of the breeding and wintering distributions of the BAGO in North America.

Figure 1. Breeding and wintering grounds of Barrow's Goldeneye (*Bucephala islandica*) in North America. (Johnsgard, 1965).

1.3.2 Wintering Grounds

The majority of the continental population of BAGO winter along the Pacific coast. A large population of BAGO winter from Juneau, Alaska southward along coastal Alaska. They also winter abundantly along the coast of BC, and sometimes may be found in BC's interior. The birds of the interior Rocky Mountain population usually do not migrate to salt water, but winter close to their breeding grounds on available open water. In addition, BAGO are quite common in the Puget Sound region of Washington, where they constitute approximately nine percent of the wintering diving ducks (Johnsgard, 1965). The coasts of Washington, Oregon, and northern California contain a small portion of the western BAGO population as well.

The wintering habitats used by the BAGO include both fresh and salt waters, with the greatest numbers occurring in freshwater or brackish habitats. BAGO prefer brackish estuaries and calm fresh waters to saline water on open coastlines with heavy surf (Johnsgard, 1965).

1.3.3 Breeding Grounds

The breeding distribution and habitat of the western BAGO population is associated with montane rivers and lakes, whereas the smaller northeastern population can be found in tundra or sub tundra habitats. In Alaska BAGO breed as far west as the base of the Alaska Peninsula, extending into the interior northeastwardly through McKinley National Park to Porcupine River. In western Canada the species breed in southern Yukon, southwestern Alberta, and in most regions of BC. However, the largest population of BAGO breed in the relatively dry and sparsely wooded belt between the Okanagan and Cariboo districts. Barrow's Goldeneye breeding in Washington have been reported in the Selkirk and the Cascade mountains, the Okanogan Highlands, and the Grand Coulee area in the center of the state. In addition, breeding occurs sparsely in the mountains of central Oregon on certain lakes (Johnsgard, 1965).

During the spring and summer breeding habitat consists of sheltered lakes and ponds often in the vicinity of wooded areas. Providing favorable conditions for breeding, molting and protection from predators, BAGO will construct their nests in cavities in live trees, tree stumps, or tall dead stumps. In BC, the nest sites are mainly located in tree cavities of Douglas firs (*Pseudotsuga menziesii*) or aspens. The BAGO is an arboreal duck, laying its eggs in tree cavities. This habitat protects the clutch from predation, and provides a suitable environment for natal development. In addition, BAGO use artificial nesting-boxes, which are made available to them through various conservation practices. A local abundance of food rather than an availability of nest sites determine distribution patterns of BAGO in BC. Lakes that lack tree-nesting sites but have high food availability tend to support large breeding populations of BAGO (Johnsgard, 1965)

BAGO are synchronous molters, changing their plumage during a short period of approximately two weeks (Catt, 2000). During this period BAGO have restricted flying capabilities, which make them vulnerable to predators.

1.3.4 Food and Foraging

The BAGO are classified as diving ducks. Their legs are positioned in the back of their bodies and far apart, which makes it difficult for them to walk on land. Due to their physiological make up foraging techniques consist mainly of diving under the surface of the water.

In the wintering coastal areas of BC, the primary food consumed by the BAGO are insects, constituting 36 percent, plant vegetation 22 percent, mollusks 19 percent, crustaceans 18 percent, and other animal foods 4 percent. The insect category includes large quantities of dragon fly (*Odonata anisoptera*) and damsel fly (*Odonata zygoptera*), and naiads (*Odonata plecoptera*), caddis fly larvae (*Trichoptera*), midge larvae (*Chironomidae*) and various other aquatic insects. The major mollusk foods are blue mussels, amphipods (*Anamixidae*), isopods (*Crustacea isopoda*), and crayfish (*Orconectes*) dominate the crustaceans. The primary plant food consists of pond weeds

(*Potamogeton*), and wild cherry (*Prunus*). In addition salmon eggs are found to be an important food source for coastal birds, along with mollusks, crustaceans and marine algae (Johnsgard, 1965).

2.0 Study Area

2.1 Study Area Location

The study area can be accessed from Stanley Park, which is located in the Lower Mainland of British Columbia near Vancouver's downtown core. Figure 2 shows several travel routes to Stanley Park from various locations in greater Vancouver.

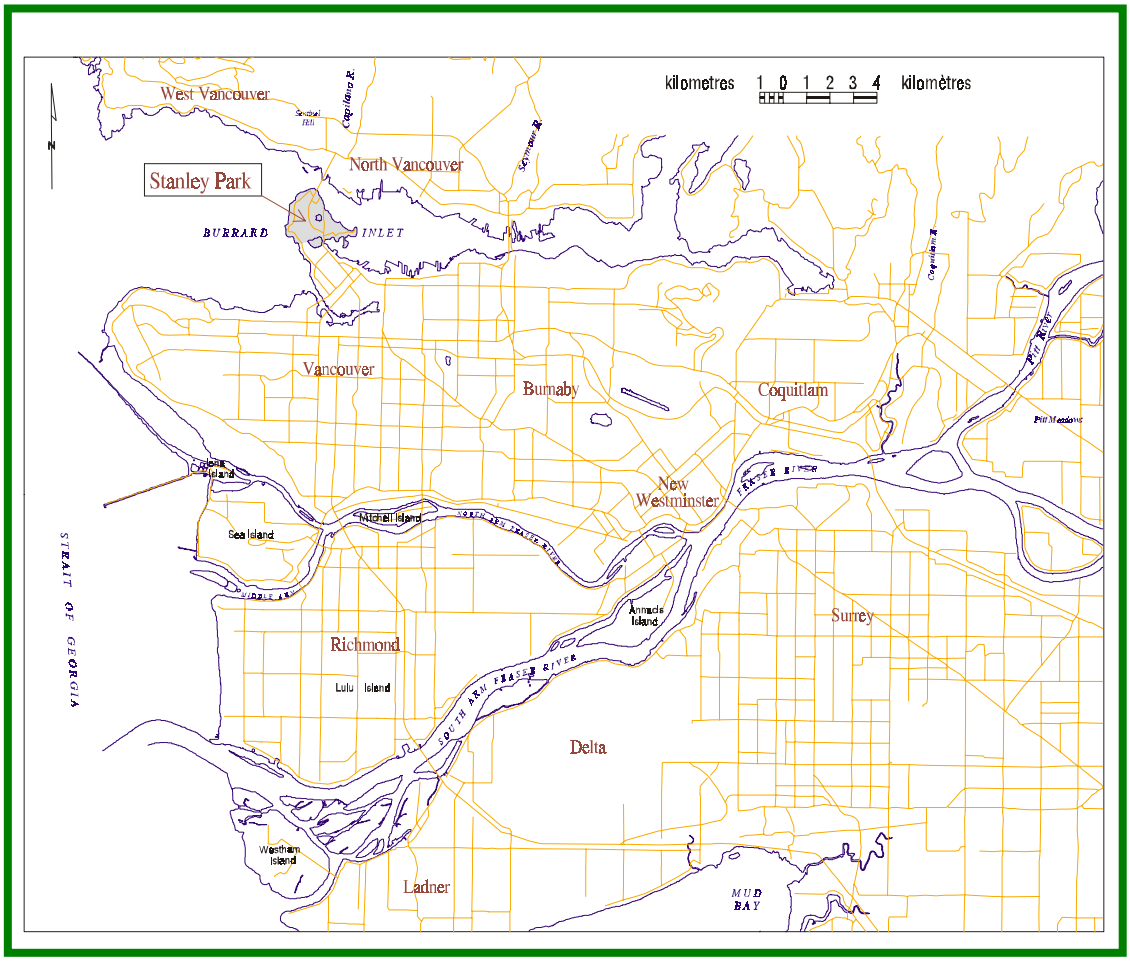

Figure 2. Travel routes to Stanley Park from various locations in Greater Vancouver, British Columbia. (Map: Stephen Williams. Source: Geological Survey of Canada, 1999)

2.2 Study Area Description

Stanley Park and its surrounding ocean foreshore is part of the Fraser River Delta, which is the most important wintering and migratory area for waterfowl in the province. The largest known winter concentration of BAGO in the world was found along the Stanley Park foreshore (Webber and Kautesk, 1988). Stanley Park is a 405-hectare coniferous and deciduous natural reserve that was established in 1888 by Lord Stanley (Gordon, 1999). The park is a mixture of Douglas fir, Western hemlock (*Tsuga heterophylla*), and Western red cedar (*Thuja plicata*). Essentially, the mild climate of this Fraser Lowland Ecosection, along with the rocky shoreline and extensive mussel beds, make this region prime wintering habitat for BAGO (Johnsgard, 1965). Also, Lost Lagoon, a sheltered water body, provides additional habitat for waterfowl.

Stanley Park is surrounded by ocean and encompasses Burrard Inlet, which contains a hundred square kilometers (km^2) of water surface within 190 km of shoreline (Watts and Breault, 1996). The shoreline extends from Point Grey Road (Rd) to Point Atkinson Rd. Burrard Inlet is the site of many industrial activities, ranging from cargo transportation and shipping to industrial processing. In addition, cruise ship operations are frequently utilizing this port. In 1996, the port handled 70,000 cruise ship passengers and 72 million tonnes of cargo (Tourism Vancouver, 1999). Port terminals, handling canola oil shipments, also add to the industrial activity that occurs in this high traffic area. It is at these specific terminals that both the November 24th, 1999 and the February 12th, 2000 oil spills occurred.

Human activity has created environmental concerns for Burrard Inlet (Watts and Breault, 1996). Due to the high utilization of this area, combined with the large abundance of waterfowl, it is essential that an ecosystem management approach be taken. Monitoring the birds along the Stanley Park foreshore is important in the event of an environmental disaster.

2.3 Survey Zones

The survey area is comprised of the foreshore of Stanley Park from Coal Harbor to the end of Second Beach (Figure 3). The ten-kilometer (km) stretch of seawall is divided into 21 zone delineations, beginning from Zone 66 through to Zone 45. The 21 zone delineations used for the BAGO survey 1999-2000 were adapted from those used by the Burrard Inlet Environmental Action Program (BIEAP) during the BIEAP bird survey project (Watts and Breault, 1996). Each zone consists of a pre-determined area encompassing the Stanley Park foreshore to the farthest distance on the water visible to the observer. Zone boundary locations were mapped by Brenda T. Rotinsky for the 1998-1999 survey (Rotinsky, 1999) and were recorded using a Trimble GeoExplorer II GPS unit and transferred to an orthophoto of Stanley Park using Arc View 3.0a.

Figure 3. **Stanley Park Barrow's Goldeneye Survey, 1999-2000 study area along the Stanley Park foreshore, Vancouver, BC, showing study zones delineations from Burrard Inlet Environmental Action Plan (BIEAP) (Watts and Breault, 1996)**

3.0 Materials and Method

3.1 Species Identification

Male: (Figure 4)

Head

- Glossy black head with purple iridescence.
- White crescent patch in front of yellow eye.
- Long, low and evenly rounded crown.
- Black bill, at least 12 millimeters (mm) in length.

Figure 4. Male Barrow's Goldeneye (*Bucephala islandica*). (Photo: C.N. Shumway. Source: Savard and Robert, 1997).

Body

- Length is approximately 46 centimeter (cm).
- Weight is approximately 959 grams (g).
- Extensively black body with white breast.
- Black and white scapulars form series of oval spots on folded wing.
- Orange webbed feet.

Female: (Figure 5)

Head

- Dark brown head.
- Relatively flat crown in shape.
- Yellowish orange bill.
- Yellow eyes.

Figure 5. Female Barrow's Goldeneye (*Bucephala islandica*). (Photo: Pierre Dupuis. Source: Savard and Dupuis, 1999)

Body

- Length is approximately 46 cm.
- Weight is approximately 590 g.
- Grayish brown body with ashy brown breast band and white neck.
- Grayish white tips on wing coverts.
- Orange webbed feet.

Juvenile Males: (Figure 6)

Head

- Brown head.
- Grayish white crescent patch in front of yellow eye.
- Long, low and evenly rounded crown.
- Black bill.

Figure 6. Juvenile Barrow's Goldeneye (*Bucephala islandica*). (Photo: C.N. Shumway. Source: Savard and Robert, 1997)

Body

- Grayish brown body with white breast.
- Gray and white scapulars developing on folded wing.
- Orange webbed feet.

Juvenile Females:

Head

- Dark brown head.
- Relatively flat crowned in shape.
- Yellowish orange on tip of black bill.
- Greenish yellow eyes.

Body

- Grayish brown body with ashy brown breast band and dark brown neck.
- Grayish white tips on wing coverts.
- Orange webbed feet.

3.1.1 Physical Differences between Barrow's Goldeneye and Common Goldeneye

A species that may often be confused with the BAGO is the Common Goldeneye (COGO).

Male:

Some of the key differences in the males of these two species are that the BAGO males have a white crescent moon shape on a dark, purplish head (Figure 4), while the COGO males have a round white spot on a dark greenish head (Figure 7).

Figure 7. Male Common Goldeneye (*Bucephala clangula*). Photo: Pierre Dupuis. Source: Environment Canada-Waterfowl Identification, 1999)

Females:

Females of these two species are more difficult to distinguish as they both have brown-heads and very similar body markings. BAGO females have a steep forehead and, usually, a mostly yellowish orange bill (Figure 5) in comparison to the COGO female, which have a sloping forehead and mostly dark bill (Figure 8). However, during the

breeding season the BAGO female's orange beak turns blackish like the beak of the COGO female. To differentiate between the two species, detailed

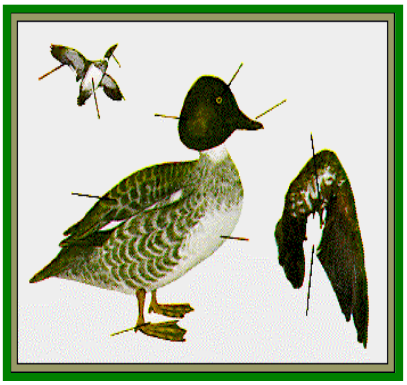

Figure 8. Female Common Goldeneye (*Bucephala clangula*). (Photo: Pierre Dupuis. Source: Environment Canada-Waterfowl Identification, 1999)

observations of the bird's general structure (shape of the beak and head) and the colouring of its upper body (wings and coat) must be made.

3.1.2 Behavioral Differences Between Barrow's Goldeneye and Common Goldeneye

Females:

Although similar in appearance to the COGO female, the BAGO female presents some behavioral differences. The head pumping movements displayed by BAGO take a rotary form rather than an elliptical one, as in the COGO. The "head flash up" posture is similar to that of the COGO, but during sighting, which is much more frequent in BAGO, "side to side" head movements occur as well. On the other hand, the "neck flash dip" posture of the female COGO is either lacking all together or performed very rarely in the female BAGO. Ritualized drinking is frequent in both female species and is usually a prelude to copulation. In addition, females of both sexes assume aggressive postures of the males and sometimes will attack other birds from underwater (Johnsgard, 1965).

Males:

Male differences in behavior and appearance serve to maintain species isolation and prevent hybridization. Goldeneyes typically perform social display in small groups of several males and one or two females. Aggressive behavior is displayed in both the BAGO male and the COGO male. The most common of these behaviors is the "laying-the-neck-on-the-water" posture, which precedes underwater attacks. "Rotary pumping" is the most frequent display and consists of rotary movements of the bill and head; it is directed to males, females, and even to downy young. The "couch" posture is frequent during sexual display and there is an associated clicking sound uttered with the bill

open. The crouch does not occur in the COGO, but in the BAGO it is a frequent prelude to the "head-throw-kick" display. This is a rapid toss back of the head in a simultaneous kick with both feet (Johnsgard, 1965).

3.2 Age Determination

Determining the ages of BAGO in the field is based on visual characteristics. Juvenile females are usually difficult to distinguish from adult females, especially from a distance. However, this distinction can be made by bill and eye colour. Adult females have a mostly yellowish orange bill, where as juvenile females have yellowish orange on the tip of their black bill. In addition, the eyes of adult females are a prominent yellow colour, which has not quite developed in juvenile female species. Juvenile females have a greenish yellow eye colour.

In 1995 the CWS began a study to determine the differences in plumage among the different age classes of BAGO. A total of 530 juvenile BAGO were tagged at Riske Creek, near Williams Lake (Figure 9), during each of the breeding seasons between 1995 and 1998 (Boyd, 1999). The juvenile BAGO were fitted with nasal disks coded to group individuals of similar age classes. For example, in 1999 a BAGO with a white nasal disk on the right side of its bill will be four years old, a BAGO with a blue nasal disk on the right side of its bill will be three years old, and a BAGO with a yellow nasal disk on the right side of its bill will be two years old. Nasal disks are simple plastic forms of various colours that are installed on each side of the bird's bill. All marked Goldeneyes have the same disk shape and colour on both sides of their bill, thus making identification easier. Visual observations, along with the recording of the colour, disk number, sex of the bird, date, and time will be made if any of these BAGO are observed on the Stanley Park foreshore. It is uncertain how many of these tagged BAGO are still alive. However, the CWS tagging operation at Riske Creek will allow for the monitoring of the western BAGO populations during plumage development and molting. A catalogue of BAGO at different ages will provide a tool for comparison of age class with common plumage characteristics.

The CWS has also used satellite telemetry as a means of tracking movements of BAGO to document breeding and wintering patterns. Satellite telemetry is a technique that consists of fitting birds with radios that transmit signals to satellites, which in turn relay the data to biologists (Savard and Robert, 1997).

Figure 9. **Barrow's Goldeneye (*Bucephala islandica*) fitted with nasal disks at Riske Creek, British Columbia. (Photo: Michael Robert. Source: Savard and Robert, 1997)**

3.3 Materials

For each survey day, beginning in the morning or afternoon, observations were made by walking or biking along the 10 km stretch of the Stanley Park sea-wall from Zone 66 to Zone 45 using the following materials:

- 2 Sets of Binoculars (10x)
- 2 Field Notebooks
- 1 Tripod
- Orthophoto Map from 1998-1999 Survey
- 1 Camera (35mm)/Film
- 1 Spotting Scope (45x)
- Air Photos of Stanley Park
- Bird Identification Books/Field Guides

3.4 Survey Methods

3.4.1 Abundance and Distribution of Barrow's Goldeneye

In order to be consistent with the 1998-1999 survey, surveys were conducted weekly from Wednesday November 3rd, 1999 to Wednesday April 5th, 2000 to obtain abundance and distribution data. On each survey day, morning (9:00am) and afternoon (1:00pm) observations were made while walking along the 10km stretch of sea-wall from Zone 66 through to Zone 45 (Figure 3). Observations distances ranged from 2 to 300 meters using binoculars (10x) or a spotting scope (40x). It took approximately three to four hours each day to collect and record relevant information such as:

- Start and end times.
- Weather conditions.
- Each individual bird sighted in the water.

- Total birds identified to species and location (Zone number).
- BAGO sex and age determination based on visual characteristics.

3.4.1.1 All Sea Birds

The abundance and distribution of the total number of sea birds observed along the Stanley Park foreshore were recorded using the above survey methods.

3.4.2 Observer Variance

Observer variance data were collected from Wednesday, January 19th, 2000 to Wednesday, January 26, 2000. Two technicians conducted total counts of all species of sea birds observed in the water along the Stanley Park foreshore. Beginning at 1:00 pm, observations were made walking along the 10 km stretch from Zone 66 to Zone 45 (Figure 3). The start time for each technician was staggered by 15 minutes.

3.4.3 Time of Day and Seasonal Variance

In both winter and spring time of day variance data were collected for BAGO. Beginning from Thursday, February 23, 2000 to Saturday, February 26, 2000 data were collected for the wintering season. From Thursday, March 30, 2000 to April 1, 2000 springtime variance was collected. On each survey day, location and total counts of BAGO observed in the water was recorded by one technician walking along the 10 km stretch of sea-wall from Zone 66 through to Zone 45 (Figure3). On each survey day data were recorded in the morning starting at 9:00 am and in the afternoon starting at 1:00 pm.

3.4.4 Pair Information

Pairs of BAGO were distinguished by their disassociation from larger groups of sea ducks, particularly BAGO using the Stanley Park foreshore. A pair bond between a male BAGO and a female BAGO was assumed if the pair was approximately 10 meters (m) away from an existing flock and no interactions between the pair and the flock were exhibited. In addition, pairing was assumed when a male and a female BAGO were approximately 1-5 m apart from one another and displayed behavioral interactions. On each survey day mating displays were recorded for each BAGO pair observed along the foreshore. The pair number and the location (zone number) were recorded. Also, observations were made as to whether the BAGO arrived as pairs and maintained their pair bond throughout the season or whether they arrived alone and paired up during the wintering season. This was determined by distinguishing individual BAGO that were tagged.

3.5 Data Analysis

Only data collected from Wednesday, November 3rd, 1999 to Wednesday, April 5th, 2000 was used for analysis, numbers otherwise indicated. Data were analyzed using Corel Quattro Pro and Microsoft Excel computer programs.

3.5.1 Abundance and Distribution

3.5.1.1 Barrow's Goldeneye

Trends in the abundance and distribution of the BAGO wintering population utilizing the foreshore were analyzed. Regression testing was conducted in order to analyze the relationship between the total number of BAGO vs. the average number of BAGO observed by zone and for each survey day.

3.5.2 Observer Variance

Observer variance was compared between the two technicians and analyzed by averaging the number of individuals of each species observed by each technician for each zone location.

3.5.3 Time of Day and Seasonal Variance

Time of day variance data for the winter were collected in mid-February of 2000 and time of day variance data for the spring were collected in late March and the beginning of April of 2000. This data was analyzed by averaging the abundance of individuals observed in the morning and afternoon and comparing the results by zone. Time of day variance data were analyzed for winter and spring differences.

3.5.4 Pair Information

Pair data were collected to determine trends in the abundance and distribution of observed BAGO pairs utilizing the Stanley Park foreshore during the 1999-2000 wintering season. A regression test was used to determine if there was a possible trend between the survey dates and the total number of BAGO pairs observed along the Stanley Park foreshore.

4.0 Results and Discussions

4.1 Species Observed

Table I is a list of the 21 species observed and the scientific name, species codes, average number of individuals sighted per survey, range of numbers of individuals per survey, and the frequency of each species on each survey day used during the Stanley Park Barrow's Goldeneye Survey, 1999-2000. For a complete listing of sea birds observed along the Stanley Park foreshore for the study period see Appendix 1and Appendix 2.

Table I. **Species of sea birds observed along the Stanley Park foreshore from Wednesday, November 3rd, 1999 to Wednesday, April 14th, 2000 during the Stanley Park Barrow's Goldeneye Survey, 1999-2000.**

Common Name	Scientific Name	Species Code	Average # of Individuals/ Survey	Range # of Individuals/ Survey	Frequency of Observation ✖:
Loons & Grebes					
Common Loon	*Gavia immer*	COLO	1	1-4	LOW
Western Grebe	*Aechmophorus occidentalis*	WEGR	4	1-10	MED
Horned Grebe	*Gavia immer*	HOGR	2	1-10	MED
Coots					
American Coot	*Fulica americana*	AMCO	0	1-1	LOW
Cormorants & Herons					
Double-crested Cormorant	*Phalacrocorax auritus*	DCCO	4	1-6	LOW
Pelagic Cormorant	*Phalacrocorax pleagicus*	PECO	5	1-11	HIGH
Great Blue Heron	*Ardea herodias*	GBHE	1	1-2	LOW
Geese					
Canada Goose	*Branta canadensis*	CAGO	2	0-1	LOW
Ducks					
American Wigeon	*Anas americana*	AMWI	45	1-45	HIGH
Mallard	*Anas platyrhynchos*	MALL	4	1-25	HIGH
Scaup Species	*Aythya sp.*	SCAU	24	1-59	HIGH
Bufflehead	*Bucephala albeola*	BUFF	3	0-12	
Common Goldeneye	*Bucephala clangula*	COGO	22	2-68	HIGH
Barrow's Goldeneye	*Bucephala islandica*	*BAGO*	450	335-582	HIGH
Oldsquaw	*Clangula hyemalis*	OLDS	1	1-3	LOW
Harlequin Duck	*Histrionicus Histrionicus*	HADU	4	1-8	MED
Hooded Merganser	*Lophodytes cucullatus*	HOME	0	1-2	LOW
Surf Scooter	*Melanitta perspicillata*	SUSC	1200	36-1960	HIGH
Common Merganser	*Mergus merganser*	COME	4	1-8	MED
Red-breasted Merganser	*Mergus serrator*	RBME	4	1-6	MED
Shorebirds					
Black Oystercatcher	*Haematopus bachnami*	BLOY	0	1-9	MED

✖: <5=LOW ✖: 5-10=MED ✖: >10=HIGH

4.2 Age Characteristics

Based on the observations made for the 1999-2000 survey no BAGO fitted with nasal disks were recorded. Their absence along the Stanley Park foreshore may indicate that these individuals are wintering elsewhere. A high number of these tagged BAGO return to the grounds at Riske Creek where they were initially tagged (Evans, 1999).

4.3 Abundance and Distribution

4.3.1 Barrow's Goldeneye

Abundance:

Barrow's Goldeneye utilized the Stanley Park foreshore extensively during the 1999-2000 wintering season (Figure 10). The data shows that large numbers of BAGO were present by the beginning of November, indicating their arrival along the foreshore during mid to late October. Based on previous studies by Rotinsky (1999) and Schneider (1997) the presence of BAGO occurred during this period. By mid January to the beginning of February the greatest numbers of BAGO were observed. A general decrease in BAGO began to occur during March, but it wasn't until mid April when this decline was more evident. A drastic rise in BAGO numbers was recorded for the beginning of April as well. For a complete listing of BAGO abundance and distribution data throughout the study period see Appendix 3 and Appendix 4.

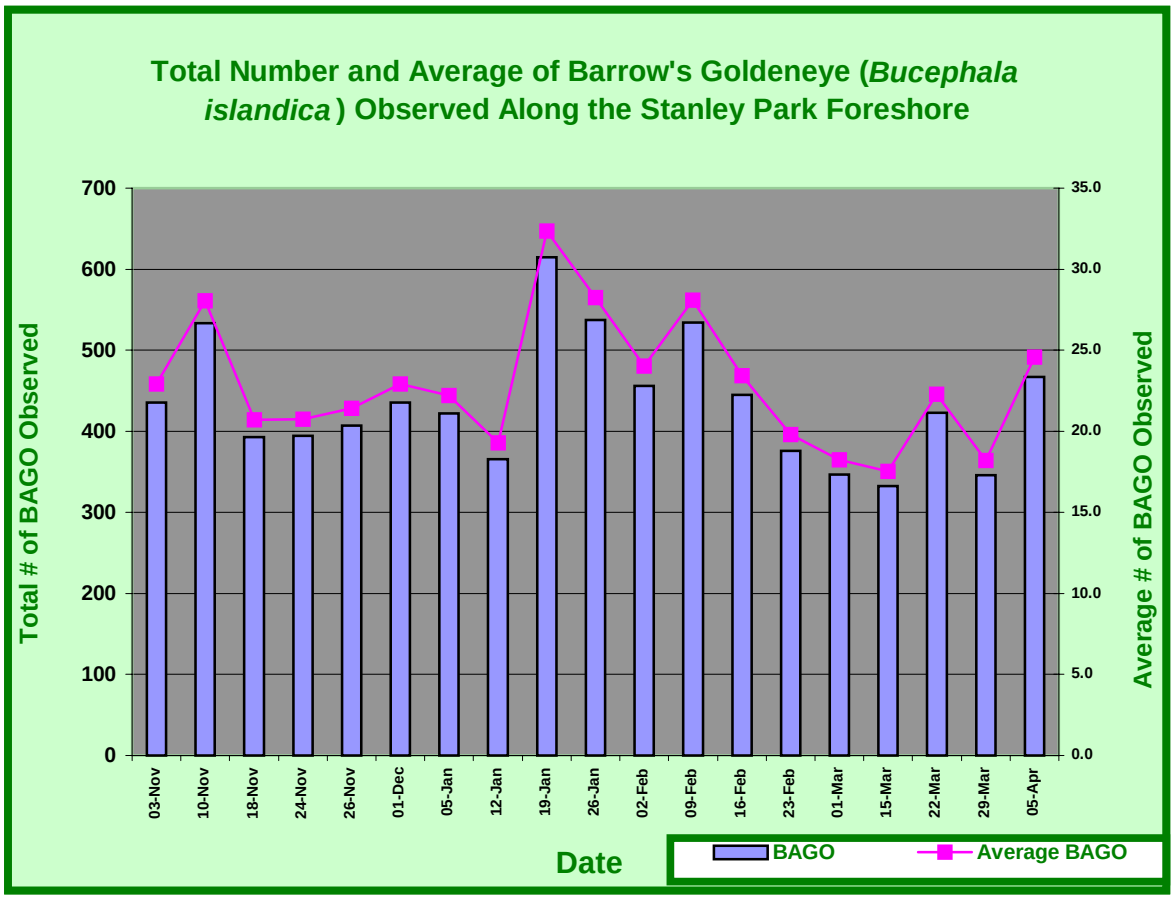

Figure 10. **Total number and Average of Barrow's Goldeneye (*Bucephala islandica)* observed along the Stanley Park foreshore, Vancouver, BC from Wednesday, November 3rd, 1999 to Wednesday, April 5th, 2000 during the Stanley Park Barrow's Goldeneye Survey, 1999-2000.**

For each survey day there was considerable fluctuation in the number of BAGO observed along the foreshore with several declines in the end of November and mid to late February. Generally, these fluctuations may be attributed to the movement of birds in and out of the survey area, or a result of the canola oil spills. When the first oil spill occurred on November 24th, 1999 only 394 BAGO individuals were observed compared with 533 observed on November 10, 2000. Similarly, on February 16th, 2000, four days after the second canola oil spill occurred,

a total of 445 BAGO were observed, in comparison to the total 534 observed the previous week.

This decline in numbers on both dates suggests that the oil spills impacted the wintering population by either forcing BAGO out of the survey area or that they were unable to escape the oiled waters, resulting in deaths. The studies conducted by Rotinsky (1999) and Schneider (1997) suggests there are approximately 3000 BAGO winter residents throughout Burrard Inlet. This may explain the degree of fluctuation that has occurred during each survey day, as groups of individuals may frequently shift their locations.

Toward the end of the survey period a steady decline in BAGO numbers was expected. As BAGO began to return to their breeding grounds in the beginning to mid April, a significant reduction in the total population observed along foreshore should have occurred. However, data suggests a rise in the number of individuals for this period. This increase on wintering grounds may be due to an increase in the number of migrants utilizing the foreshore as a resting location prior to traveling to their breeding grounds.

An analysis of variance (ANOVA) was conducted to determine if there was a possible trend in the abundance of BAGO and total of other sea birds observed (Figure 11). Based on the quadratic regression curve line shown in Figure 11 there is no trend in the number of BAGO and other sea birds observed along the foreshore. Generally, there is insufficient data to conclude that a trend is present. However, it appears that when there is a drastic rise in BAGO numbers, there is a lower number of other species. When there are minimal numbers of BAGO, there are fewer numbers of other sea birds as well. Although there is insufficient data to conclude this hypothesis, there is a slight indication that this may by occurring. See Appendix 5 for a complete listing of numbers that resulted from the ANOVA and the regression test.

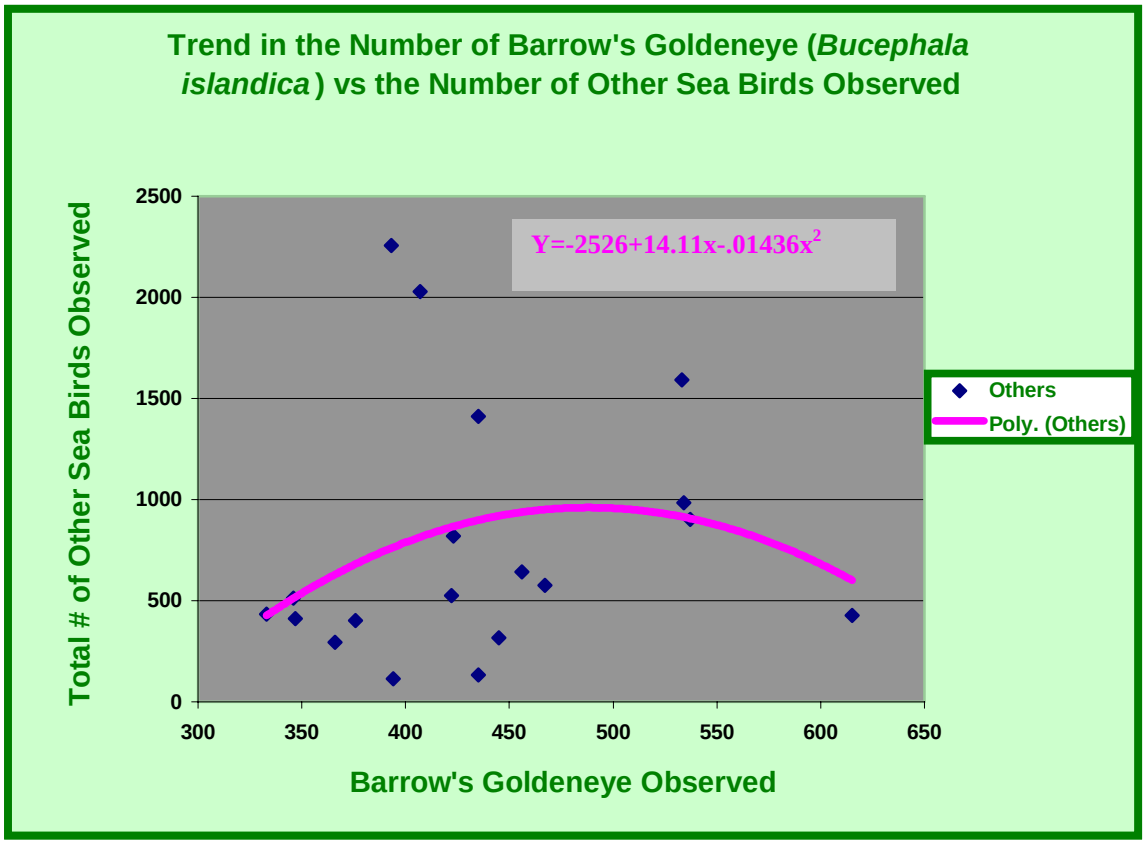

Figure 11. **Trend in the number of Barrow's Goldeneye (*Bucephala islandica*) and total of other sea bird species observed along the Stanley Park foreshore, Vancouver, BC, from Wednesday, November 3rd, 1999 to Wednesday, April 5th, 2000 during the Stanley Park Barrow's Goldeneye Survey 1999-2000.**

Based on the evidence presented in the analysis of variance a trend cannot be established. Often in order for a strong trend to be observed data must indicate a less than 5% assumption that a trend is possible (Smith, 2000). In Appendix 5 data show a 49% indication that there was no trend between the abundance of BAGO and other sea birds observed during the 1999-2000 wintering season. Variation in the number of BAGO observed and the total other sea birds observed can be a result of different foreshore utilization throughout the season. Increased food availability in various zones may be another factor contributing to this

variance. It was conclusive that timing requirements of migratory and resident bird utilization of the Stanley Park foreshore during the 1999-2000 was species dependent.

Similar numbers of BAGO have been observed along the Stanley Park foreshore for both the 1998-1999 and 1999-2000 survey periods, resulting in a comparable winter trend (Figure 12).

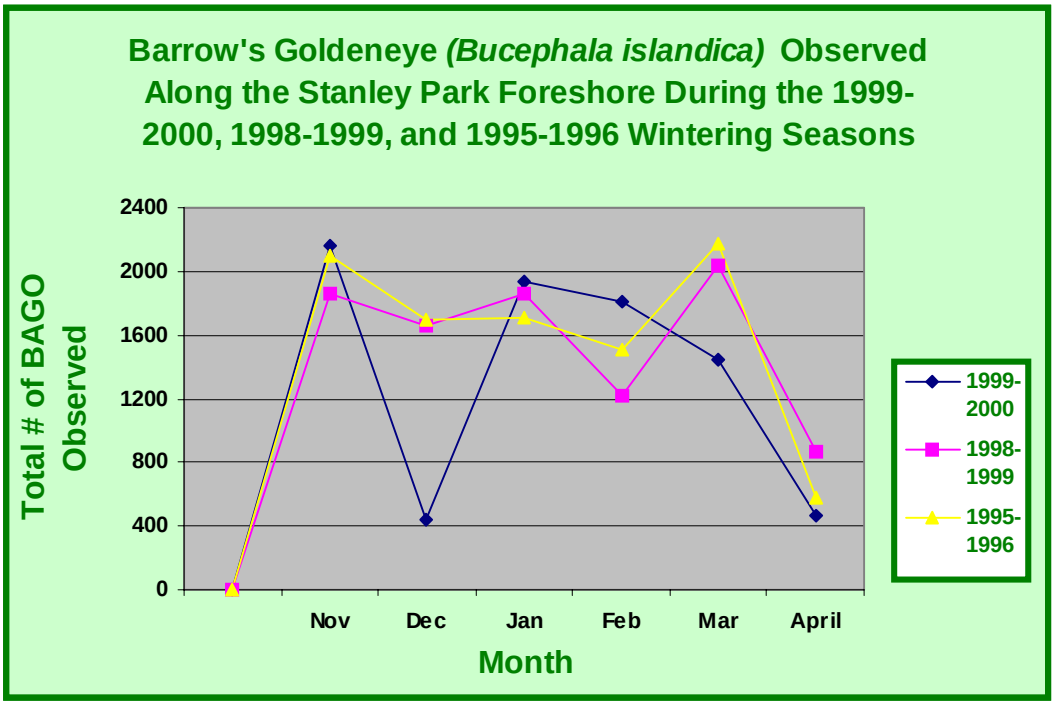

Figure 12. Comparison of the number of Barrow's Goldeneye (*Bucephala islandica*) observed along the Stanley Park foreshore, Vancouver, BC, during the 1999-2000, 1998-1999, and 1995-1996 wintering seasons

Both surveys indicate a reduction of BAGO observed mid-season. In 1998-1999 the decrease occurred in February whereas the 1999-2000 decrease occurred in two increments. The first decline in the number of BAGO was at the end of November and the second occurred in the latter portion of February and the beginning of March. Based on the 1995-1996 study conducted by Schneider a decline of BAGO individuals occurred as well. However, this decline varied greatly from both studies mentioned above, as it appeared in January. These yearly declines may be attributed to weather conditions or tidal influence (Schneider, 1997). In addition, the decline for the 1999-2000 survey occurred one to two weeks following both canola oil spills. Although, a yearly decline is expected for the wintering season, the oil spills may have enhanced this downward pattern.

During both the 1999-2000 and 1995-1996, a larger number of BAGO were observed by November and seemed to leave the Stanley Park foreshore earlier than in 1998-1999. An overall warmer wintering season in 1995-1996 and 1999-2000 may explain the variation in BAGO numbers between the survey years. It appears that the warmer climate may attract larger numbers of BAGO earlier in the season and for a shorter period of time.

. The data fluctuates considerably between each yearly survey conducted. The 1995-1996 data varied from 579 to 2171 individuals, suggesting greater movement of BAGO in and out of the survey area. The 1998-1999 data shows that a smaller fluctuation of individuals was observed (467 to 2162), indicating greater consistency in data than in previous years. Less BAGO movement in and out of the survey area occurred for this period. The greatest variance in BAGO numbers occurred in the 1999-2000 survey. BAGO individuals ranged from 467, which was observed for the month of December to 2162 for the month of November. The inconsistent data obtained for this years BAGO survey may be attributed to the canola oil spills that occurred throughout the wintering season. The impact on the sea birds utilizing the Stanley Park foreshore may have been one that forced them out of their habitat or may have resulted in deaths. In addition, the low numbers obtained for the month of December was a result of fewer surveys completed than in previous studies.

Distribution:

The distribution of BAGO across the 21 zones of the Stanley Park foreshore indicates that the BAGO wintering population is not evenly distributed. Based on observations made during the 1999-2000 survey, some zones have high utilization while others have very little if any (Figure 13). Variability occurred depending on zone location, weather, and temporal and seasonal periods.

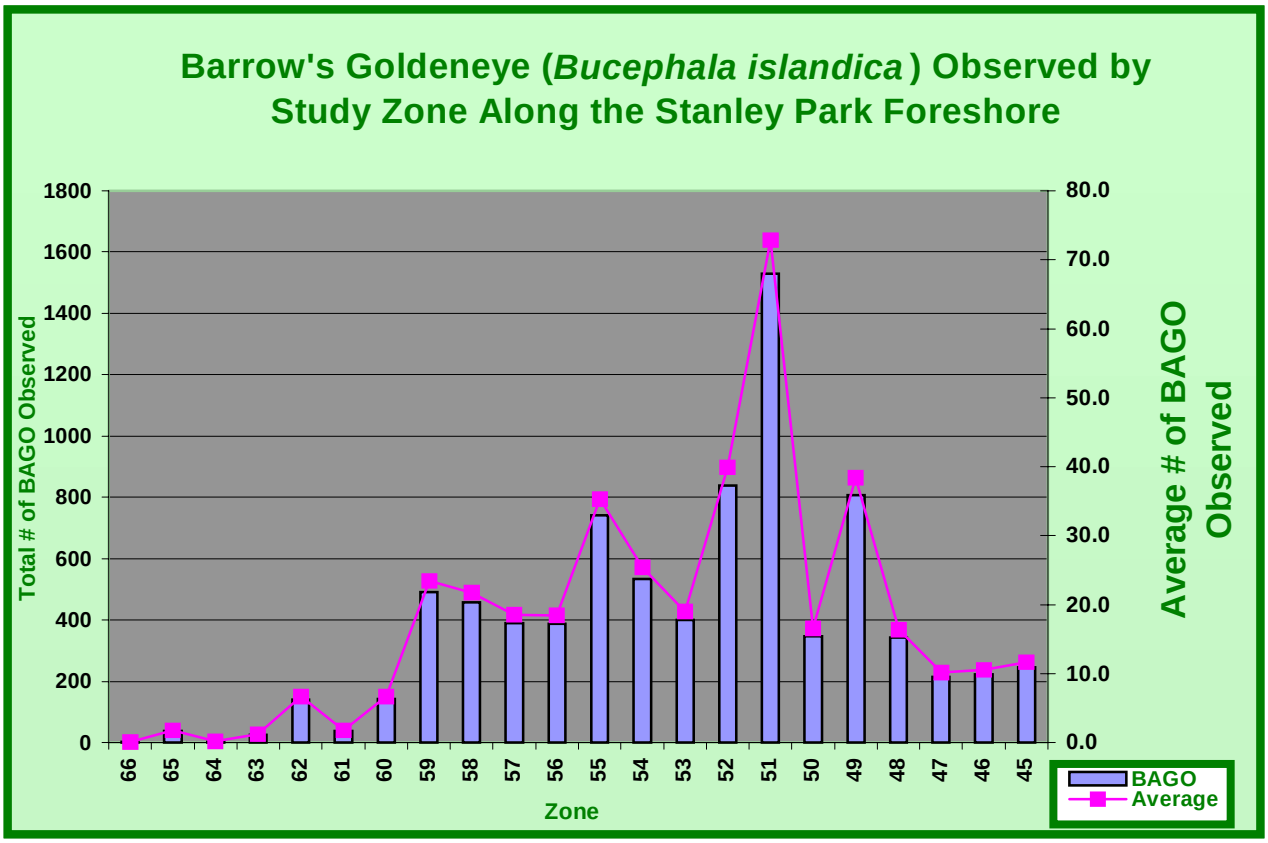

Figure 13. Total number and Average of Barrow's Goldeneye *(Bucephala islandica)* observed by study zone along the Stanley Park foreshore, Vancouver, BC from Wednesday, November 3rd, 2000 to Wednesday, April 5th, 2000, during the Stanley Park Barrow's Goldeneye Survey, 1999-2000.

Of the 21 zones in the survey area, 0 of the zones had no BAGO utilization, 7 zones averaged between 1 and 10 BAGO per survey, 8 zones varied from 10 to 20 BAGO per survey, 3 zones varied from 20 to 30 BAGO per survey, and only 4 zones averaged more than 30 BAGO per survey. Areas that were used the least (zones 66, 65, 64, 62, 61, and 60) were sheltered from the open ocean and have high boat traffic and moorage sites along the east side of Stanley Park in Coal Harbor (Figure 3). Areas having high utilization (zones 55, 52, 51, and 49 on Figure 3) were those in the open ocean, containing extensive mussel beds for feeding and having low traffic. However, zone 55 located directly adjacent to the Lions Gate Bridge, is a high traffic area, but supports large numbers of BAGO. This area is frequently used because of the increased availability of mussel beds in this area. These results are very similar to those of previous studies (Rotinsky, 1999 and Schneider, 1997).

Distribution of BAGO observed along the Stanley Park foreshore was not consistent throughout the 1999-2000 wintering season (Figure 14). Utilization by individual BAGO varied seasonally. During November and December, high numbers of BAGO were observed feeding at zones 53 and 49, but had low numbers for the rest of the season. Similarly, in the January and February months high numbers were observed in zones 58, 55, and 51, but lacked BAGO the other months (Figure 3). For March and April this same pattern was not evident in any particular zone. This seasonal usage of specific zones along the foreshore may be a result of aggressive feeding behavior. Large groups of BAGO may forage in an area until the food source is depleted, then will move to similar habitat and repeat the process.

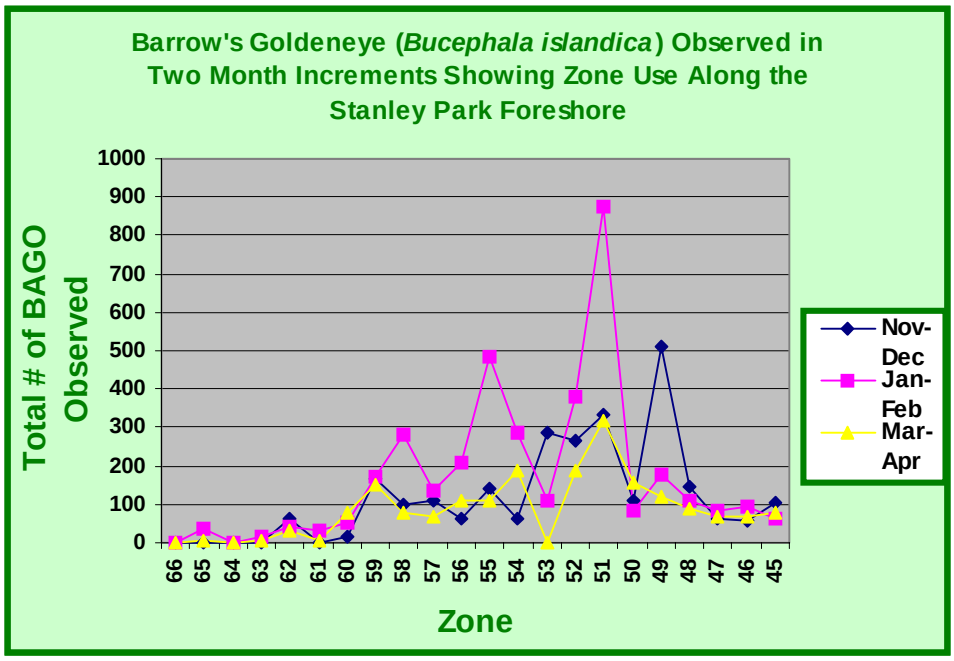

Figure14. Total number of Barrow's Goldeneye (*Bucephala islandica*) observed in two month increments showing zone use along the Stanley Park foreshore, Vancouver, BC, during the Stanley Park Barrow's Goldeneye Survey, 1999-2000

There was a strong relationship found between the distribution of BAGO observed and the total number of other sea birds along the Stanley Park foreshore (Figure 15). It appears that the zones that are being utilized by BAGO are also being used by other sea birds. This pattern of zone utilization may be related to similar habitat requirements such as food availability, shelter from high boat traffic and weather conditions.

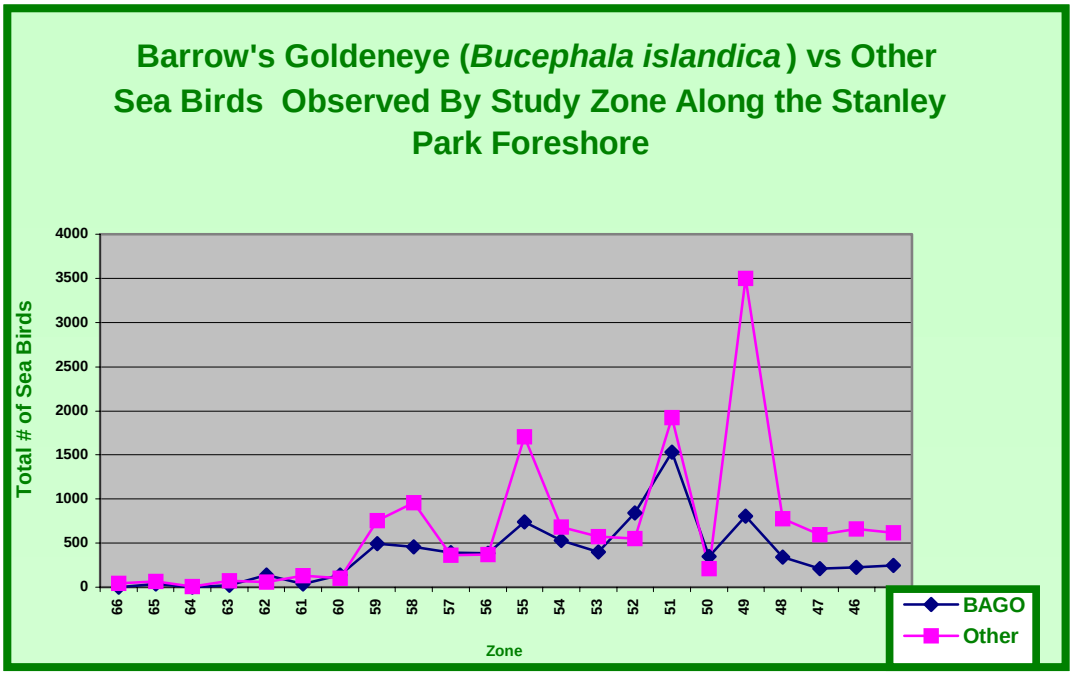

Figure 15. Number of Barrow's Goldeneye (*Bucephala islandica*) and Total of Other Sea birds observed per study zone along the Stanley Park foreshore, Vancouver, BC, from Wednesday, November 3rd, 1999 to Wednesday, April 5th, 2000 during the Stanley Park Barrow's Goldeneye Survey, 1999-2000

4.4 Observer Variance

Observer variance data were collected from Wednesday, Janurary 19th, 2000 to Wednesday, January 26, 2000. Two technicians conducted total counts of all species of sea birds observed in the water along the Stanley Park foreshore. Technician 2 observed a total of 191 more individuals than Technician 1 for the Janurary19, 2000 survey and 577 for the January 26, 2000 survey. A greater number of Surf Scoters (SUSC) and Scaup (SCAU) species were the only waterfowl that had large number differences (Figure 16). These differences were 103 SUSC and 76 SCAU for the first survey date. A total of 531 SUSC and 54 SCAU more individuals were counted for the second survey date. However, both technicians observed similar numbers of every other species for both observer variance survey dates. See Appendix 6 for a complete listing of the number of birds observed by each technician by species and by zone.

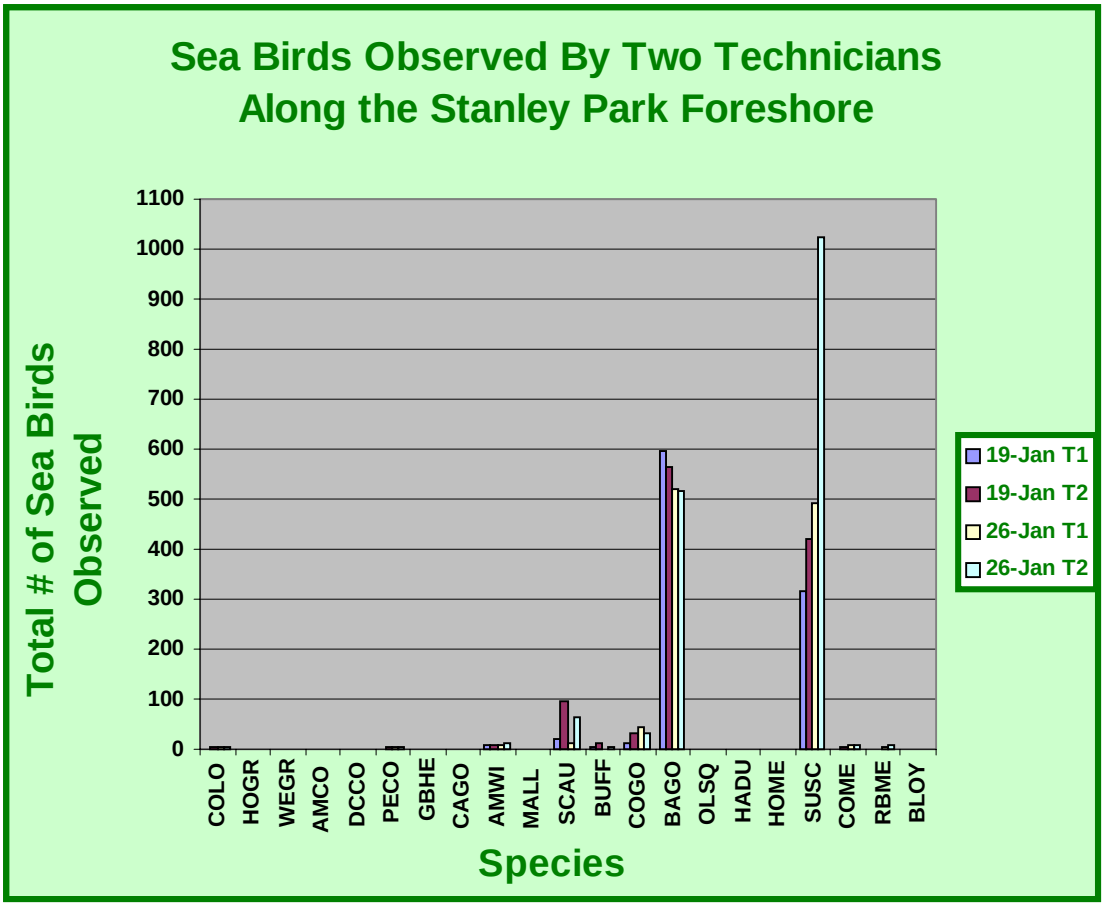

Figure 16. Total number of sea birds observed by two technicians along the Stanley Park foreshore, Vancouver BC, on Wednesday, January 19th, 2000 and Wednesday, January 26th, 2000 for the Stanley Park Barrow's Goldeneye Survey, 1999-2000.

The total number of species observed between technicians varied by 768, indicating some inconsistency overall. For both survey dates observer variance was found for species that were in large existing flocks. It is here that an approximate estimation was taken, opposed to an actual count. Since the number of individuals was so great, it was difficult to count every bird, thus the process of estimation was introduced. The variance can be justified through technician inexperience for estimating. In addition, number discrepancies may be attributed to the weather, sea bird behavior and bird movement in and out of the survey.

Bird observation in each zone did not fluctuate considerably between technicians showing an apparent pattern (Figure 17). Zones that had a relatively greater number of waterfowl had greater observer variance (zones 59, 58, 57, 56, and, 51 on Figure 3). It was in these areas that an estimation was conducted, opposed to an actual count. For zones 66, 65, 64, 63, 46, 48, and 49 similar numbers were counted resulting in less observer variability. The lack of discrepancy for these particular zones is partially due to reduced numbers of birds. Also, an actual count was conducted for these zones, opposed to an estimation. For a complete listing of the number of birds observed by each technician by species and by zone see Appendix 6.

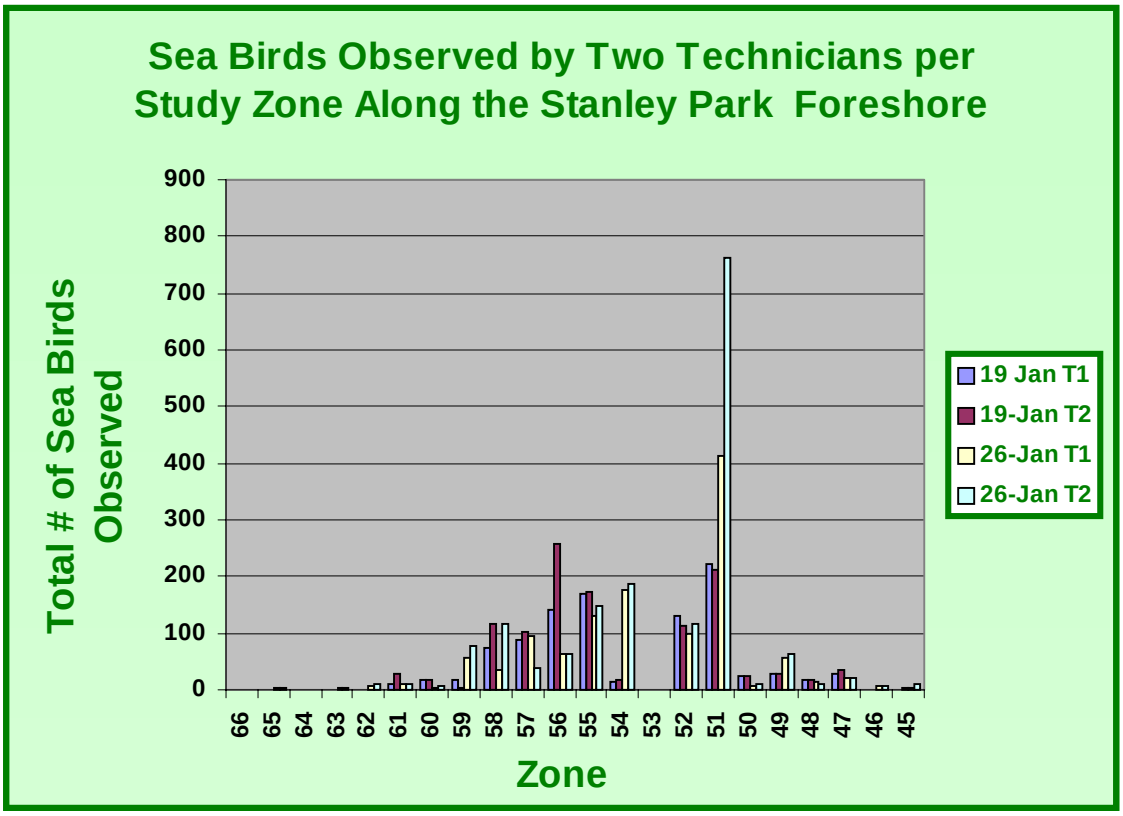

Figure 17. Total number of sea birds observed by two technicians per study zone along the Stanley Park foreshore, Vancouver, BC, Wednesday, January 19th, 2000 and Wednesday, January 26th, 2000 for the Stanley Park Barrow's Goldeneye Survey, 1999-2000.

Out of the 21 zones surveyed, technician 2 observed more individuals 11 times, less individuals 5 times, and the same number of individuals 5 times compared to technician 1 (for January 19, 2000). For the second survey date technician 2 observed more individuals 13 times, less individuals 2 times, and the same number of individuals 6 times compared to technician 1. Differences in bird counts for each zone may be attributed to the variance in technician experience or, weather and sea bird behavior.

4.5 Time of Day and Seasonal Variance

Observations from the 1999-2000 Barrow's Goldeneye Survey indicate that the number of BAGO observed from the morning to the afternoon decreased in both winter and spring (Figure 18). The number of BAGO observed in the morning decreased from the winter to the spring, as a result of bird movement out of the survey at night. It is in the evenings that BAGO concentrate in large groups in protected waters (Rotinsky, 1999; Savard, 1987), resulting in large numbers congregating in Lost Lagoon. Lost Lagoon may provide additional protection from weather conditions on the open water, from predation or provide an area for rest. In addition, more individuals were observed in the morning period of winter because utilization of sunlight for foraging was increased. However, the number of BAGO observed in the afternoon increased from the winter to the spring. Due to the increased amount of daylight hours in the afternoon in the spring, the number of birds observed along the Stanley Park foreshore increased from the winter. Having greater periods of sunlight may allow the BAGO to maximize on foraging and courting, before they leave for their breeding grounds. See Appendix 7 for a complete listing of the number of BAGO observed by zone and date during the time of day and seasonal variance testing.

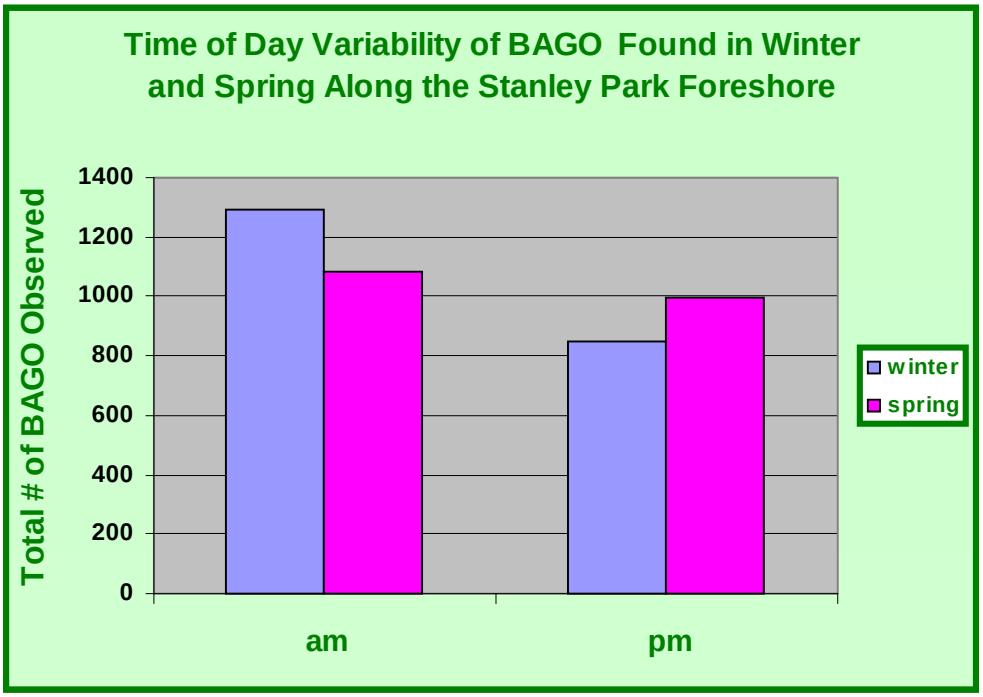

Figure 18. Time of Day variability of Barrow's Goldeneye *(Bucephala islandica)* found in the winter and spring along the Stanley Park foreshore, Vancouver, BC, during the Stanley Park Barrow's Goldeneye Survey.

4.6 Pair Information

Pair formation begins on BC's coastal waters as early as December, and most BAGO are paired before migrating in late March or April. First arrivals are observed on the Stanley Park foreshore in the last week of October. Adult males arrive in large flocks a few days before females and juveniles, which arrive in smaller flocks during the next two weeks (Rotinsky, 1999). BAGO returning to the Stanley Park foreshore may arrive alone and pair up at the beginning or end of the season, showing a dramatic rise in the number of pairs observed. They may arrive on the foreshore as pairs and maintain their pair bond and show a consistent pair presence throughout the season (Rotinsky, 1999).

There was a constant presence of pairing along the Stanley Park foreshore during the 1999-2000 BAGO wintering season (Figure 19). For a complete listing of BAGO pair data, see Appendix 8.

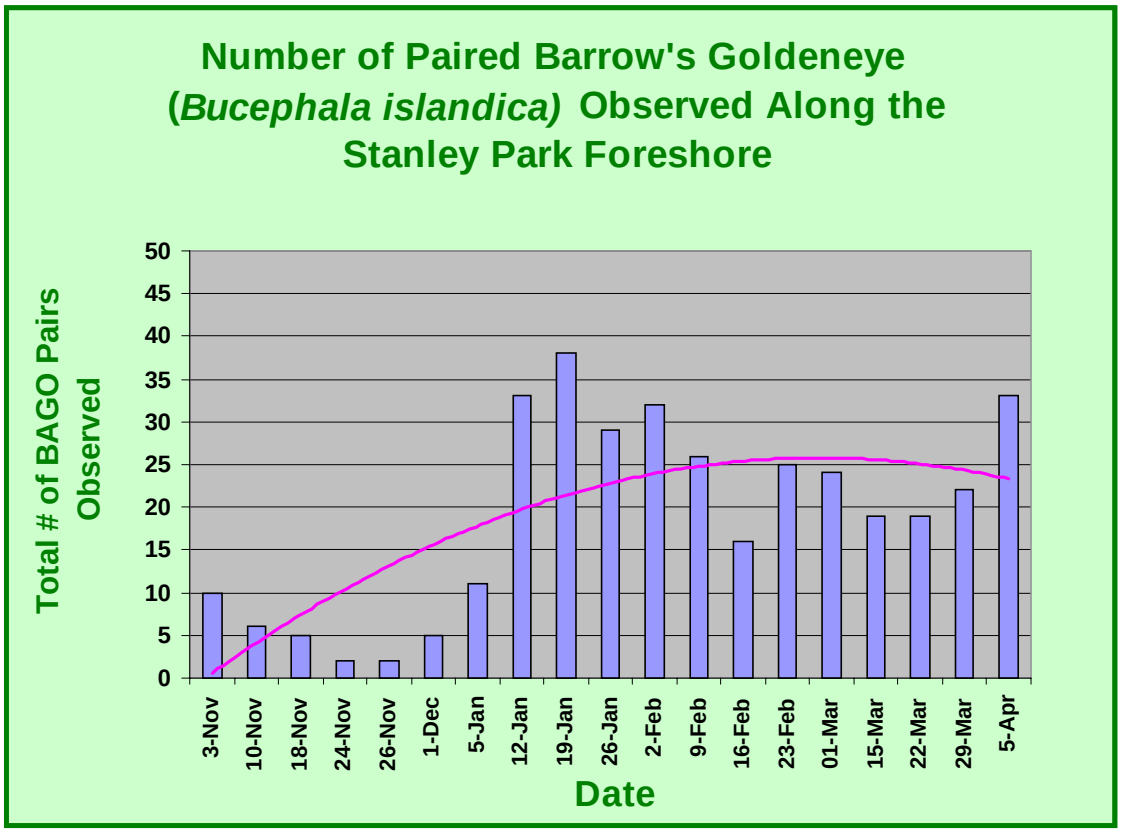

Figure 19. **Number of paired Barrow's Goldeneye (*Bucephala islandica*) observed along the Stanley Park foreshore, Vancouver, BC showing a possible trend from Wednesday, November 3rd, 1999 to Wednesday, April 5th, 2000 during the Stanley Park Barrow's Goldeneye Survey, 1999-2000.**

Based on the data collected for the 1999-2000 BAGO survey a possible trend in pair formation has occurred (Figure 19). The data shows that there were low numbers of pairs in the beginning of the season, increased numbers in mid-season, then decreased amounts towards the end of the season. The minimal numbers of pairs observed in November might be due to fewer pair migrants arriving from the interior breeding grounds. In addition, the November 24th, 2000 canola oil spill may have impacted the BAGO population, interfering with BAGO pairing. Also, this decrease in pair bonds may be attributed to

inexperienced pair identification, occurring in the first few weeks of the survey. At times it was difficult to distinguish pairs from non-pairs due to their absorption into larger flocks.

The peak in courting activity in the latter part of January to early February may be a result of increased numbers of migrants along the Stanley Park foreshore. This rise may be attributed to greater numbers of single BAGOs forming pair bonds. Fewer pair bonds were established towards the end of the 1999-2000 survey (March) indicating the return of the BAGO pairs to their breeding grounds. However, data shows a possible increase for April in the number of pairs observed along the Stanley Park foreshore. Warm spring weather conditions, food availability and preferable habitat may influence longer periods of wintering residency along the foreshore. Variability along the trend line may be attributed to the movement of paired BAGO into and out of the study area.

There appear to be no trend in the distribution of BAGO pairs and non-pairs during the wintering season (Figure 20). Areas where non-pairs were often observed were areas in which pairs were seen as well.

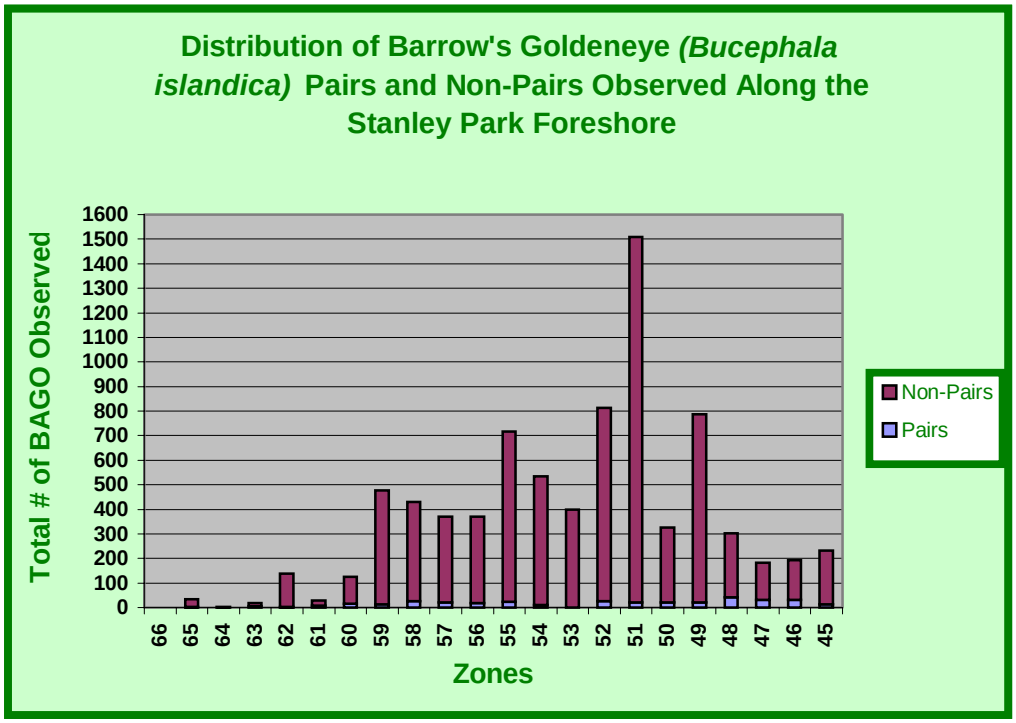

Figure 20. **Distribution of Barrow's Goldeneye (*Bucephala islandica*) pairs and non-pairs observed along the Stanley Park foreshore, Vancouver, BC, from Wednesday, November 3rd, 2000 to Wednesday, April 5th, 2000 during the Stanley Park Barrow's Goldeneye Survey, 1999-2000.**

Within certain zones there appear to be more pairs observed than in other zones. The highest numbers of BAGO pairs were observed in zones 52, 48, 47, 46, and 45 (Figure 3). This may be attributed to habitat availability, rocky shores and extensive mussel beds. Territories of pairs tended to be spaced out along the rocky shorelines almost in a continuous linear fashion. BAGO were most territorial in zones 49, 48, 47, 46, and 45, indicating habitat availability for territorial boundaries (Figure 3). In addition, most pairs observed seemed to maintain territorial boundaries, specifically in zones 58, 57, 55, 48, 47, 46, and 45 (Figure 3).

Data shows that there were a number of areas along the Stanley Park foreshore that had very few pair formations (zone 66, 65, 64, 63, 62, and 61 on Figure 3). Low utilization by BAGO pairs in these particular zones may be due to high boat traffic, lack of mussel beds and shelter from the open ocean.

4.7 Limitations of Survey Techniques

Limitations of survey techniques included shortcomings in data collection, such as poor visibility, adverse weather conditions, and bird behavior. Weather ranged from clear and sunny to overcast and rainy. This variety of weather conditions resulted in a range of visibility for the observers. Extreme winds and heavy rains tend to decrease the accuracy of the survey.

In addition, bird behavior may contribute to incomplete observations. Diving sea birds may be missed during counting while they are underwater. Movements from one zone to another may have resulted in over and under representation of some species. Since this bias is known and constant throughout the Stanley Park Barrow's Goldeneye Survey 1999-2000 it was taken into account upon data anaysis.

4.8 Oil Spill

The wild birds that occupy the marine, estuarine, and freshwater habitats are often the most impacted by oil pollution. Acute spills and chronic low-level pollution may damage important bird habitats, including breeding and migration-staging areas and coastal area supporting dense populations of waterfowl (American Petroleum Institute, 1985).

An occurrence of an oil spill results in a high priority to protect and restore the affected habitat by using technologies which minimize ecological impacts (American Petroleum Institute, 1985). Futhermore, cleaning and rehabilitating individual birds contaminated by oil is done to reduce the damage to existing waterfowl populations.

The process of rehabilitation is a complex and intensive process that entails capture of the affected birds, rapid treatment for the immediate effects of oil, removal of the contaminant, specialized care and feeding and restoration of plumage waterproofing in preparation for release. The rescue and rehabilitation process for the November 24, 1999 and the February 12, 2000 canola oil spills were initiated by the British Columbia Society for the Prevention of Cruelty of Animals (BCSPCA), with the aid of several other non-government organizations (NGO), particularly, the Stanley Park Ecology Society.

4.8.1 Species Affected by Oil Spills

The effect of a particular spill on the survival of local populations or on a species as a whole is difficult to assess. In the Stanley Park foreshore certain species have been affected repeatedly, whereas others in the same habitat were only affected sporadically. The birds contaminated most frequently include open-water ducks (BAGO, SUSC, COME) and a number of grebes (HOGR, WEGR) and loons (COLO). Generally, these birds have behavioral similarities that may make them more vulnerable to an oil spill (American Petroleum Institute, 1985). Predominately these sea birds live on the open water in large flocks and capture their prey by diving and swimming below the water's surface. "These diving birds show no particular aversion to spilled oil and often dive and resurface in it. It is only heavy repeated oiling that eventually forces the waterfowl to leave the water and abandon their only source of food (Campbell et al., 1990).

Birds having more terrestrial or aerial habits, were less likely impacted by the spill (Macintosh, 2000). Such species include cormorants, gulls, geese and surface-feeding ducks and various species of waders and shorebirds such as herons and sandpipers. There is evidence to suggest that when aerial species swim into an oil slick, they are more likely to fly away immediately, thus minimizing contact with the oil. Also, having only small amounts of oil in their plumage there will be less of an

interference with flying and moving on land (American Petroleum Institute, 1985). Based on the rescue efforts of the hundreds of volunteers and the NGOs, a total of 230 sea birds were rescued on the Stanley Park foreshore 75 of which died as a result of the November 24,1999 canola oil spill (Macintosh, 2000). The Stanley Park Ecology Society collected a total of 67 sea birds 19 of which died (Macintosh, 2000). The following table is a summary of sea birds collected along the foreshore by the Stanley Park Ecology Society on the weekend after the oil spill (Table II).

Table II. Summary of oiled sea birds collected along the Stanley Park foreshore following the November 24, 1999 (Macintosh, 2000).

Sea Birds Collected Along the Stanley Park Foreshore From November 24, 1999 Canola Oil Spill			
Species	**Number Collected**	**Number of Survivals**	**Number of Deaths**
BAGO	**1**	**0**	**1**
COLO	**1**	**1**	**0**
HOGR	**23**	**20**	**3**
MALL	**1**	**0**	**1**
OLSQ	**1**	**1**	**0**
SCAU	**2**	**2**	**0**
SUSC	**21**	**1O**	**11**
WEGR	**17**	**14**	**3**
TOTAL	**67**	**48**	**19**

4.0 Recommendations

Some recommendations that may be used in order to improve the accuracy and data collection methods are as follows:

- Continue use of the Stanley Park foreshore delineations in order to keep data consistent in future studies.
- Increase time in observing territorial and pair behavior. This may aid in differentiating pairs from migrants within larger flocks.
- Collect time of day and seasonal variance data for the fall as well as winter and spring (Rotinsky, 1999)
- Distinguish between the various depths of water in each zone along the foreshore in order to determine the tidal influence on BAGO using the foreshore.
- Have one technician commence in the morning from 9:00 am to 12:00 pm and another commences in the afternoon from 1:00 pm to 4:00 pm on each survey day. This will aid in determining what time of the day sea birds are more or less abundant.
- Follow the survey times and dates from the previous Barrow's Goldeneye Survey in order to maintain consistency of data collection and analysis. This will be helpful when comparing data results from

5.0 Conclusion

The Stanley Park Barrow's Goldeneye Survey 1999-2000 was a continuation from Brenda T. Rotinsky's 1998-1999 study. It was a continuing documentation of distribution and abundance of observed BAGO and other sea birds along the Stanley Park foreshore. This report is a compilation of data collected on abundance, distribution, observer variance, time of day and seasonal variance, tidal influence, pair information, feeding behavior, and pairing behavior. The intent of this report was to combine this years survey data with that of Brenda's in order to create a record for future studies of the BAGO. The baseline data collected was crucial in determining the effects on the numbers of BAGO and other sea birds in the event of an environmental disaster. The importance of these observations and data collection has been evident in the effects that the November 24th, 1999 and the February 12th, 2000 canola oil spills had on some of the sea birds utilizing the foreshore. The data collected suggested the following:

- **Abundance:** The number of BAGO utilizing the Stanley Park foreshore varied greatly throughout the 1999-2000 wintering season. The majority of BAGO arrived in late October and early November and remained until mid April.

- **Distribution:** The distribution of BAGO across the 21 zones of the Stanley Park foreshore was not consistent throughout the wintering season. The greatest number of BAGO were observed in areas that generally had less boat traffic, have greater food availability, and have close proximity to open ocean.

- **Time of Day and Seasonal Variance:** A greater number of BAGO were observed along the Stanley Park foreshore in the morning during the winter and the spring than in the afternoon.

- **Pair Information:** BAGO pairs can be observed along the Stanley Park foreshore in zones having greater food availability, extensive shoreline, and low boat traffic. Pairs were spaced linearly and continuously along the shoreline.

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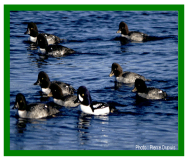
Appendices



FINAL REPORT

Stanley Park Barrow's Goldeneye Survey, 1999-2000 **May 10, 2000**

By Korie David

Appendix 1. Abundance and Distribution of all sea birds observed along the Stanley Park foreshore from Wednesday, November 3rd, 2000 To Wednesday, April 5th, 2000 during the Stanley Park Barrow's Goldeneye Survey, 1999-2000.

Species	3-Nov	10-Nov	18-Nov	24-Nov	26-Nov	1-Dec	8-Jan	12-Jan	19-Jan	26-Jan	2-Feb	9-Feb	16-Feb	23-Feb	1-Mar	15-Mar	22-Mar	29-Mar	5-Apr	Total
COLO	0	0	2	0	1	2	0	1	4	3	1	4	0	2	1	2	3	3	2	31
HOGR	10	13	7	1	4	2	0	0	1	1	1	1	0	2	1	1	0	1	1	47
WEGR	5	11	0	0	2	0	4	2	0	0	2	1	0	1	2	0	2	1	1	34
Coots																				
AMCO	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Cormorants & Herons																				
DCCO	3	2	4	1	2	3	2	1	1	1	4	3	0	3	5	5	5	6	2	53
GBHE	2	0	1	0	0	0	0	1	0	1	1	1	0	0	1	2	1	0	2	13
PECO	11	7	15	1	9	2	5	2	3	4	2	0	1	4	2	3	6	1	4	82
Geese																				
CAGO	13	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
Ducks																				
AMWI	26	9	30	17	0	1	0	16	9	9	24	8	16	24	32	42	45	27	9	668
BAGO	415	521	385	393	407	435	422	374	582	518	458	538	453	398	347	335	425	346	472	8224
BUFF	7	8	12	4	7	11	0	3	9	3	3	0	0	0	3	1	5	3	3	109
COGO	7	2	21	0	68	16	10	9	23	39	17	8	8	6	18	13	20	16	2	303
COME	5	4	2	0	0	0	5	0	3	8	1	2	0	4	1	3	7	1	3	49
HADU	5	8	5	6	0	5	0	1	2	1	5	5	0	2	4	3	4	4	1	61
HOME	0	0	0	0	0	0	1	0	1	0	0	0	0	0	2	1	0	0	2	7
MALL	21	5	0	0	0	0	0	1	0	0	4	2	2	4	1	8	6	2	0	56
OLSQ	0	0	0	0	0	0	3	0	0	0	0	0	2	1	0	0	0	0	10	16
RBME	0	0	2	0	5	0	2	2	1	6	3	1	7	2	3	2	1	3	0	40
SCAU	19	12	24	0	18	55	25	3	59	45	27	12	4	33	15	10	43	25	47	476
SUSC	1054	1390	1960	84	1909	36	468	244	359	758	544	891	269	293	319	330	669	397	478	12452
Shorebirds																				
BLOY	9	0	0	0	5	0	0	0	0	0	0	0	0	0	0	6	0	0	0	20
TOTAL	1603	1993	2474	507	2437	568	947	660	1070	1397	1097	1517	762	779	757	767	1242	836	1066	22811

Note: On December 8, 15, 22, 1999 data collection due to exams and Christmas holidays.

Note: On Januray 19 and January 26, 2000 survey days data were collected by two technicians and averaged.

Appendix 2. Abundance and Distribution of all sea birds observed by zone along the Stanley Park foreshore from Wednesday, November 3rd, 2000 To Wednesday, April 5th, 2000 during the Stanley Park Barrow's Goldeneye Survey, 1999-2000.

Zone	3-Nov	10-Nov	18-Nov	24-Nov	26-Nov	1-Dec	5-Jan	12-Jan	19-Jan	26-Jan	2-Feb	9-Feb	16-Feb	23-Feb	1-Mar	15-Mar	22-Mar	29-Mar	5-Apr	Tota
66	0	2	0	0	0	0	5	4	1	0	7	4	3	4	4	1	5	1	1	42
65	2	0	7	0	9	0	2	1	0	4	9	18	30	4	5	2	2	2	3	100
64	4	0	2	0	0	0	2	0	0	0	0	0	2	0	0	0	0	2	1	13
63	0	0	3	0	2	0	4	4	0	2	8	2	17	14	12	15	0	13	0	96
62	0	32	0	0	54	0	0	43	0	8	0	0	8	8	10	9	5	12	0	189
61	5	7	0	0	35	0	6	4	18	10	9	29	5	3	0	0	28	0	12	171
60	11	0	0	0	16	0	6	0	17	6	20	10	2	32	8	4	56	44	12	244
59	67	97	156	0	0	195	6	56	10	67	42	34	20	46	13	10	288	92	11	1210
58	102	7	27	0	297	8	56	72	96	75	76	116	27	31	42	23	28	19	46	1148
57	53	98	12	0	7	48	9	77	97	67	23	34	32	26	30	22	45	36	103	819
56	41	12	47	0	2	31	44	52	200	63	11	27	13	21	35	30	33	50	36	748
55	137	218	352	0	254	7	588	60	171	140	52	26	42	78	18	39	188	152	49	257
54	5	10	0	0	0	0	53	0	16	182	69	64	54	72	120	104	135	119	136	113
53	76	415	86	0	0	0	105	35	0	0	0	0	0	16	0	2	0	0	176	911
52	131	24	59	246	6	7	0	44	120	109	156	27	99	52	77	66	45	37	9	131
51	250	464	62	3	20	80	53	25	217	617	267	670	116	86	185	3	92	69	89	336
50	9	31	5	100	5	0	0	2	25	9	17	12	26	51	8	126	46	33	193	698
49	525	5	1200	10	1730	86	8	41	28	61	60	298	42	18	70	18	70	25	50	434
48	312	189	215	9	0	92	0	98	19	12	20	27	55	18	68	7	100	92	14	134
47	105	53	36	20	0	3	0	28	3	21	28	27	139	66	0	42	0	2	21	594
46	7	10	73	111	0	11	0	4	1	6	141	11	24	97	40	232	44	22	43	877
45	4	320	132	8	0	0	0	10	3	7	82	81	6	36	12	12	32	14	61	908
TOTAL	1603	1993	2474	507	2437	568	947	660	1042	1466	1097	1517	762	779	757	767	1242	836	1033	

Appendix 3: Abundance and Distribution of Barrow's Goldeneye observed along the Stanley Park from Wednesday, November 3rd, 2000 to Wednesday, January 26th, 2000 during the Stanley Park Barrow's Goldeneye Survey, 1999-2000.

	3-Nov			10-Nov			18-Nov			24-Nov			26-Nov			1-Dec			5-Jan			12-Jan			19-Jan			26-Jan		
Zone	P	M	F	P	M	F	P	M	F	P	M	F	P	M	F	P	M	F	P	M	F	P	M	F	P	M	F	P	M	F
66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	5	6	0	0	0	0	0	0	0	39	15	0	0	0	0	0	0	0	14	20	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	6	7	0	1	1
60	0	0	0	0	0	0	0	9	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	5	1	0	0
59	0	7	9	2	2	2	0	0	1	0	0	0	0	0	0	0	69	74	1	2	0	0	23	14	0	3	4	2	15	8
58	0	0	0	0	25	20	2	2	2	0	0	0	1	26	12	0	3	1	1	29	18	2	25	24	1	14	16	1	13	11
57	0	0	0	0	39	27	0	0	0	0	0	0	0	0	0	0	22	19	1	3	3	3	30	23	2	7	6	2	0	1
56	0	17	13	0	0	0	0	0	0	0	0	0	0	0	0	0	20	10	1	5	5	4	12	10	0	43	38	2	18	14
55	0	0	0	3	7	4	0	27	21	0	0	0	0	51	27	0	0	0	0	195	47	0	17	25	2	50	42	1	12	12
54	0	2	0	0	32	21	0	4	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	36	32
53	0	155	125	0	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	54	22	0	20	15	0	0	0	0	0	0
52	1	1	1	0	12	10	0	0	0	0	130	112	0	0	0	0	0	0	0	0	0	4	2	0	3	52	25	3	50	61
51	0	2	0	1	136	116	2	12	9	0	0	0	1	2	1	0	27	22	4	8	5	0	14	8	0	112	90	0	99	88
50	3	3	3	0	0	2	0	0	0	0	45	48	0	0	0	0	0	0	0	0	0	1	0	0	2	4	5	2	0	0
49	0	0	1	0	0	0	1	100	95	0	0	0	0	230	0	1	43	37	0	0	0	4	1	0	1	1	1	2	0	0
48	4	23	29	0	3	0	0	0	0	1	5	5	0	0	0	3	35	32	0	0	0	1	1	0	13	1	2	4	4	2
47	0	9	8	0	24	21	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	11	2	0	9	1	0	2	1	0
46	2	2	2	0	0	0	0	0	0	0	25	14	0	0	0	0	7	4	0	0	0	2	0	0	1	0	0	6	0	0
45	0	1	2	0	0	0	0	52	41	1	3	3	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
Total	10	222	193	6	289	232	5	206	177	2	208	182	2	348	55	5	226	199	11	300	100	33	161	139	38	298	241	29	249	230

Note: On December 8, 15, 22, 29, 1999 data collection were not completed due to exams and Christmas holidays.

Note: On January 19, 2000 and January 26, 2000 survey days data were collected by two technicians and averaged.

Totals for the survey zones will not equal as a result of this.

Appendix 4. : Abundance and Distribution of Barrow's Goldeneye observed along the Stanley Park from Wednesday, February 2nd, 2000 to Wednesday, April 5th, 2000 during the Stanley Park Barrow's Goldeneye Survey, 1999-2000.

	2-Feb			9-Feb			16-Feb			23-Feb			1-Mar			15-Mar			22-Mar			29-Mar			5-Apr		Grande
Zone	P	M	F	P	M	F	P	M	F	P	M	F	P	M	F	P	M	F	P	M	F	P	M	F	P	M	F	Total
66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
65	0	0	0	0	0	0	1	10	19	0	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3
63	1	0	0	0	0	0	2	0	0	1	2	5	1	0	0	1	0	0	0	0	0	0	2	1	0	0	0	25
62	0	0	0	0	0	0	2	1	0	0	4	2	0	4	4	0	3	4	0	0	0	0	2	7	0	2	4	140
61	2	1	1	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	2	1	0	0	0	1	0	0	38
60	0	8	7	1	0	1	1	1	0	1	6	7	3	0	1	2	0	0	3	10	10	1	15	17	0	2	3	141
59	1	17	9	2	14	16	1	10	8	0	9	8	1	4	2	0	2	3	0	47	51	2	14	10	2	4	3	492
58	4	19	12	4	14	17	0	11	10	2	12	7	2	19	19	2	8	6	1	0	0	0	3	5	1	3	3	457
57	2	3	4	1	9	12	0	7	2	1	5	4	1	5	3	2	1	0	2	12	15	1	10	7	2	0	0	389
56	0	2	3	1	12	13	1	6	6	3	2	5	2	8	10	0	10	7	1	6	8	0	22	17	4	5	3	388
55	4	5	4	2	5	4	0	7	18	3	9	9	0	2	3	2	5	6	2	13	14	2	13	10	3	13	16	741
54	0	34	30	0	35	21	0	30	14	1	26	23	1	5	7	2	33	37	1	9	9	3	11	14	1	25	19	533
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	400
52	5	11	19	1	9	12	0	28	23	3	22	32	2	20	25	1	12	8	0	11	15	2	7	10	2	39	26	839
51	1	45	40	5	120	83	0	60	56	0	15	12	0	45	38	0	0	0	3	38	38	2	24	19	3	55	47	1530
50	4	4	2	4	2	1	0	13	13	1	10	2	2	0	0	0	62	58	1	0	0	1	3	2	1	10	11	347
49	0	30	21	0	32	28	3	17	18	2	3	2	1	28	27	2	0	0	1	21	19	1	3	2	1	4	2	806
48	2	5	3	0	11	7	2	15	7	1	3	2	3	6	2	1	0	0	2	5	7	3	17	11	2	8	9	344
47	2	0	0	1	0	0	1	0	0	1	14	10	0	0	0	1	14	15	0	0	0	1	0	0	1	16	15	213
46	3	4	2	2	3	1	1	0	0	2	27	24	2	4	3	3	1	0	1	0	0	1	1	1	4	21	16	222
45	1	25	22	0	0	0	0	1	2	3	0	0	1	3	2	0	0	0	0	11	13	1	10	12	5	9	6	246
Total	32	213	179	26	266	216	16	217	196	25	171	155	24	153	146	19	151	144	19	185	200	22	157	145	33	217	184	7907

Appendix 5. **Complete listing of Regression Statistics, Analysis of Variance (ANOVA) test, and other Statistics for determining if there was a trend in the abundance of Barrow's Goldeneye (*Bucephala islandica*) and the total other sea birds observed along the Stanley Park foreshore, during the Stanley Park Barrow's Goldeneye Survey, 1999-2000.**

Summary Output	
Regression Statistics	
Multiple R	0.300906738
R Square	0.090544865
Adjusted R Square	-0.03071582
Standard Error	632.4950751
Observations	18

ANOVA					
	df	SS	MS	F	Significance F
Regression	2	597431.478	298715.739	0.74669597	0.49074919 < 0.05 to be significant
Residual	15	6000750.3	400050.02		
Total	17	6598181.778			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-2526.026511	2970.837309	-0.850274265	0.408540264	-8858.220236	3806.167214	-8858.220236	3806.167214
BAGO	14.11420748	12.22003783	1.15500522	0.266156863	-11.93220262	40.16061758	-11.93220262	40.16061758
BAGO2	-0.014359531	0.012023192	-1.19431939	0.250897901	-0.039986374	0.011267311	-0.039986374	0.011267311

Appendix 6. **Total number of each sea bird observed by each technician along the Stanley Park foreshore, Vancouver, BC, on Wednesday, January 19th, 2000 and Wednesday, January 26th, 2000, Stanley Park Barrow's Goldeneye Survey, 1999-2000.**

Zone	19 Jan T1	19-Jan T2	26-Jan T1	26-Jan T2	Total
66	0	1	0	0	1
65	0	1	4	4	9
64	0	0	0	0	0
63	0	0	2	2	4
62	0	0	7	9	16
61	9	27	10	11	57
60	18	16	5	7	46
59	16	3	56	77	152
58	75	117	34	116	342
57	89	104	94	40	327
56	142	257	64	62	525
55	168	173	132	147	620
54	15	17	176	187	395
53	0	0	0	0	0
52	129	112	100	118	459
51	221	213	414	764	1612
50	25	25	6	11	67
49	27	29	57	64	177
48	19	18	14	10	61
47	30	37	20	21	108
46	1	1	6	6	1
45	1	5	2	12	20
TOTAL	985	1156	1203	1668	5012

species	19-Jan T1	19-Jan T2	26-Jan T1	26-Jan T2	Total
COLO	2	5	3	3	13
HOGR	1	1	0	2	4
WEGR	0	0	0	0	0
AMCO	0	0	0	0	0
DCCO	0	2	1	1	4
GBHE	0	0	0	2	2
CAGO	1	4	4	4	13
CAGO	0	0	0	0	0
AMWI	9	8	9	11	37
BAGO	597	566	521	515	2199
BUFF	5	12	2	3	22
COGO	14	33	45	32	124
COME	2	3	7	9	21
HADU	2	2	1	1	6
HOME	1	0	0	0	1
MALL	0	0	0	0	0
OLSQ	0	0	0	0	0
RBME	0	1	4	7	12
SCAU	21	97	12	66	196
SUSC	318	421	492	1023	2254
BLOY	0	0	0	0	0
Total	971	1150	1098	1676	0

Appendix 7. Stanley Park Barrow's Goldeneye Survey, 1999-2000 time of day and seasonal variability
Data collected on Thursday, February 23, 2000 to Saturday, February 26, 2000 and Thursday, March 30, 2000 to Saturday, April 1, 2000.

	24-Feb		25-Feb		26-Feb		30-Mar		31-Mar		1-Apr		
Zones	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	Total
66	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	2	0	0	0	0	0	0	2
64	0	0	0	0	0	0	0	0	0	0	0	0	0
63	2	0	0	4	12	0	0	0	2	5	3	0	28
62	1	2	7	9	8	13	2	7	3	1	0	6	59
61	0	0	3	0	0	0	5	12	11	2	8	5	46
60	0	0	0	12	9	9	24	12	5	3	1	15	90
59	17	8	65	14	19	30	47	45	55	34	50	22	406
58	28	4	32	2	34	9	2	5	6	2	3	0	127
57	7	4	7	21	40	42	23	19	11	5	9	2	190
56	21	17	33	10	25	10	14	28	42	23	25	13	261
55	58	36	62	2	67	43	46	26	85	45	80	36	586
54	35	29	6	40	4	2	19	22	3	22	7	8	197
53	4	6	42	2	2	12	0	0	16	11	27	5	127
52	31	0	0	22	124	35	12	32	32	77	47	65	477
51	75	53	0	0	17	10	42	13	27	34	31	26	328
50	8	21	87	54	52	40	22	38	0	2	1	5	330
49	13	6	0	2	33	8	16	9	14	2	0	6	109
48	13	6	2	3	17	5	7	19	27	22	29	40	190
47	7	5	71	29	8	38	0	5	9	15	19	20	226
46	25	0	0	36	17	11	0	0	44	23	35	39	230
45	0	23	27	25	16	22	10	25	10	5	16	32	211
TOTAL	345	220	444	287	504	341	291	317	402	333	391	345	4220

Appendix 8. **Abundance and Distribution of Barrow's Goldeneye (*Bucephala islandica)* pairs along the Stanley Park foreshore from Wednesday, November 3rd, 1999 to Wednesday, April 5th, 2000 during the Stanley Park Barrow's Goldeneye Survey, 1999-2000.**

Zones	3-Nov	10-Nov	18-Nov	24-Nov	26-Nov	1-Dec	5-Jan	12-Jan	19--Jan	26-Jan	2-Feb	9-Feb	16-Feb	23-Feb	1-Mar	15-Mar	22-Mar	29-Mar	5-Apr	Total
66	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
65	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	3
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
63	0	0	0	0	0	0	0	0	0	0	1	0	2	1	1	1	0	0	0	6
62	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2
61	0	0	0	0	0	0	1	0	1	0	2	2	1	0	0	0	1	0	1	9
60	0	0	0	0	0	0	0	0	2	1	0	1	1	1	3	2	3	1	0	15
59	0	2	0	0	0	0	1	0	0	2	1	2	1	0	1	0	0	2	2	14
58	0	0	2	0	1	0	1	2	1	1	4	4	0	2	2	2	1	2	1	26
57	0	0	0	0	0	0	1	3	2	2	2	1	0	1	1	2	2	1	2	20
56	0	0	0	0	0	0	1	4	0	2	0	1	1	3	2	0	1	0	4	19
55	0	3	0	0	0	0	0	0	2	1	4	2	0	3	0	2	2	2	3	24
54	0	0	0	0	0	0	1	0	0	1	0	0	0	1	1	2	1	3	1	11
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52	1	0	0	0	0	0	0	4	3	3	5	1	0	3	2	1	0	2	2	27
51	0	1	2	0	1	0	4	0	0	0	1	5	0	0	0	0	3	2	3	22
50	3	0	0	0	0	0	0	1	2	2	4	4	0	1	2	0	1	1	1	22
49	0	0	1	0	0	1	0	4	1	2	0	0	3	2	1	2	1	1	1	20
48	4	0	0	1	0	3	0	1	13	4	2	0	2	1	3	1	2	3	2	42
47	0	0	0	0	0	1	0	11	9	2	2	1	1	1	0	1	0	1	1	31
46	2	0	0	0	0	0	0	2	1	6	3	2	1	2	2	3	1	1	4	30
45	0	0	0	1	0	0	0	1	1	0	1	0	0	3	1	0	0	1	5	14
TOTAL	10	6	5	2	2	5	11	33	38	29	32	26	16	25	24	19	19	24	33	359

Note: **On December8, 15, 22, 29, 1999 data collection were not completed due to exams and Christmas holidays.**

Note: **On January 19, 2000 and January 26, 2000 survey days data were collected by two technicians and averaged**

FINAL REPORT

Stanley Park Barrow's Goldeneye Survey, 1999-2000 **May 10, 2000**

By Korie David

Zones	24-Feb		25-Feb		26-Feb		30-Mar		31-Mar		1-Apr		Total
	am	pm	am	pm	am	pm	am	pm	am	pm	am	pm	
66	0	0	0	0	0	0	0	0	0	0	0	0	0
65	0	0	0	0	0	2	0	0	0	0	0	0	2
64	0	0	0	0	0	0	0	0	0	0	0	0	0
63	2	0	0	4	12	0	0	0	2	5	3	0	28
62	1	2	7	9	8	13	2	7	3	1	0	6	59
61	0	0	3	0	0	0	5	12	11	2	8	5	46
60	0	0	0	12	9	9	24	12	5	3	1	15	90
59	17	8	65	14	19	30	47	45	55	34	50	22	406
58	28	4	32	2	34	9	2	5	6	2	3	0	127
57	7	4	7	21	40	42	23	19	11	5	9	2	190
56	21	17	33	10	25	10	14	28	42	23	25	13	261
55	58	36	62	2	67	43	46	26	85	45	80	36	586
54	35	29	6	40	4	2	19	22	3	22	7	8	197
53	4	6	42	2	2	12	0	0	16	11	27	5	127
52	31	0	0	22	124	35	12	32	32	77	47	65	477
51	75	53	0	0	17	10	42	13	27	34	31	26	328
50	8	21	87	54	52	40	22	38	0	2	1	5	330
49	13	6	0	2	33	8	16	9	14	2	0	6	109
48	13	6	2	3	17	5	7	19	27	22	29	40	190
47	7	5	71	29	8	38	0	5	9	15	19	20	226
46	25	0	0	36	17	11	0	0	44	23	35	39	230
45	0	23	27	25	16	22	10	25	10	5	16	32	211
TOTAL	345	220	444	287	504	341	291	317	402	333	391	345	4220