

THE SERPENTINE PROJECT



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SUMMARY

The Serpentine Project is a waterfowl, raptor and wildlife census on the Serpentine Wildlife Management Area (SWA) and Serpentine Annex (SA) in Surrey, British Columbia. The site is adjacent to the lower Serpentine River and bordered on two sides by Highway 99 and Highway 99A. The project was commissioned by Ducks Unlimited Canada (DUC) and the Ministry of Environment, Lands and Parks (MOELP), who together share management responsibilities for the SWA and SA.

The main goal of a Wildlife Management Area is to conserve and manage wildlife habitat (Ministry of Environment, Lands and Parks, 1988). The abundance of agricultural land in the region coupled with an extensive dyke system has reduced the amount of wetland available for wintering waterfowl. The SWA and SA currently provide wintering habitat for waterfowl in the form of mixed wetland and terrestrial (upland) habitat. DUC and MOELP manipulated the site in 1997, installing drainage devices to maintain water levels as well as planting various types of plants and hedgerows aimed at providing good foraging material and habitat for waterfowl and other birds.

The Serpentine Project involves weekly visits to the Serpentine Wildlife Management Area. During each visit counts of all species of waterfowl, raptor and other wildlife within the SWA and the SA were recorded. The site is divided into 11 management units (MU). Each count was related to specific management units and habitat types within. This data collection helped to determine which habitat type provided the best winter ground for various species of waterfowl and raptors.

Between November 1999 and April 2000, 29 species of birds were observed using the SWA and SA with the American Widgeon being the most frequently observed. In addition, North Pen and South Pen were observed to have the highest usage by waterfowl and the Serpentine River and Triangle Marsh were observed to have the greatest diversity. The Northern Harrier and Bald Eagle were the most common raptors seen and most frequently observed in South Pen and East Marsh.



ACKNOWLEDGMENTS

We thank Dan Buffett from Ducks Unlimited Canada for his direction and guidance on the Serpentine Project. Dan Buffett supplied the protocol for the five ‘Serpentine Census Projects’, aerial photos and digitized photographs of the SWA. Oliver Busby from the Ministry of Environment, Lands and Parks has provided census training and help with waterfowl and raptor identification. He has also assisted by providing background information about the site history. We thank Danny Catt for making edits and giving advice on report writing.



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1.0 INTRODUCTION

In North America, the loss of wetlands and the associated declines in waterfowl populations have become real environmental concerns. Waterfowl are a diverse group of birds that have a wide variety of needs for survival and recruitment. Management for waterfowl has become increasingly difficult due to the loss of many wetland habitats to urban development and agriculture.

The Boundary Bay area is located in the lower mainland of British Columbia (Figure 1) and includes portions of Surrey and Delta. In this area, agriculture and dyking initiatives have reduced the complexity of the terrestrial and wetland habitat that is essential for many wintering waterfowl species. Waterfowl utilizing these areas are being forced to adapt to a new food supply as wetlands have been drained and grassland-nesting cover has been converted to cropland (Delta Farmland Wildlife Trust, no year). Although many waterfowl are opportunistic feeders (Ringelman, 1990) and have learned to capitalize on abundant food provided by agriculture, this land does not provide all waterfowl requirements.

Local farmers and landowners in the Boundary Bay area have expressed their concern to local governments and agencies regarding waterfowl in the area (Busby, 1999). They claim that waterfowl wintering in their fields are having a negative impact on their crops and land. Some farmers in the area receive compensation for planting winter crops or providing grasslands as foraging habitat for waterfowl (Delta Farmland wildlife Trust, no year).

The formation of the Serpentine Wildlife Management Area (SWA) in 1972 has benefited waterfowl wintering in the Boundary Bay area. Ducks Unlimited Canada (DUC) and the Ministry of Environment (MOELP) have made a joint effort to provide waterfowl with wetland and terrestrial habitats within the agricultural framework of the area. This effort provides some relief to local farmers by attracting waterfowl to the engineered SWA and off of farmer's cropland. The manipulation of water and plant species within the SWA offers much more to waterfowl in the form of wintering habitat than fields used for

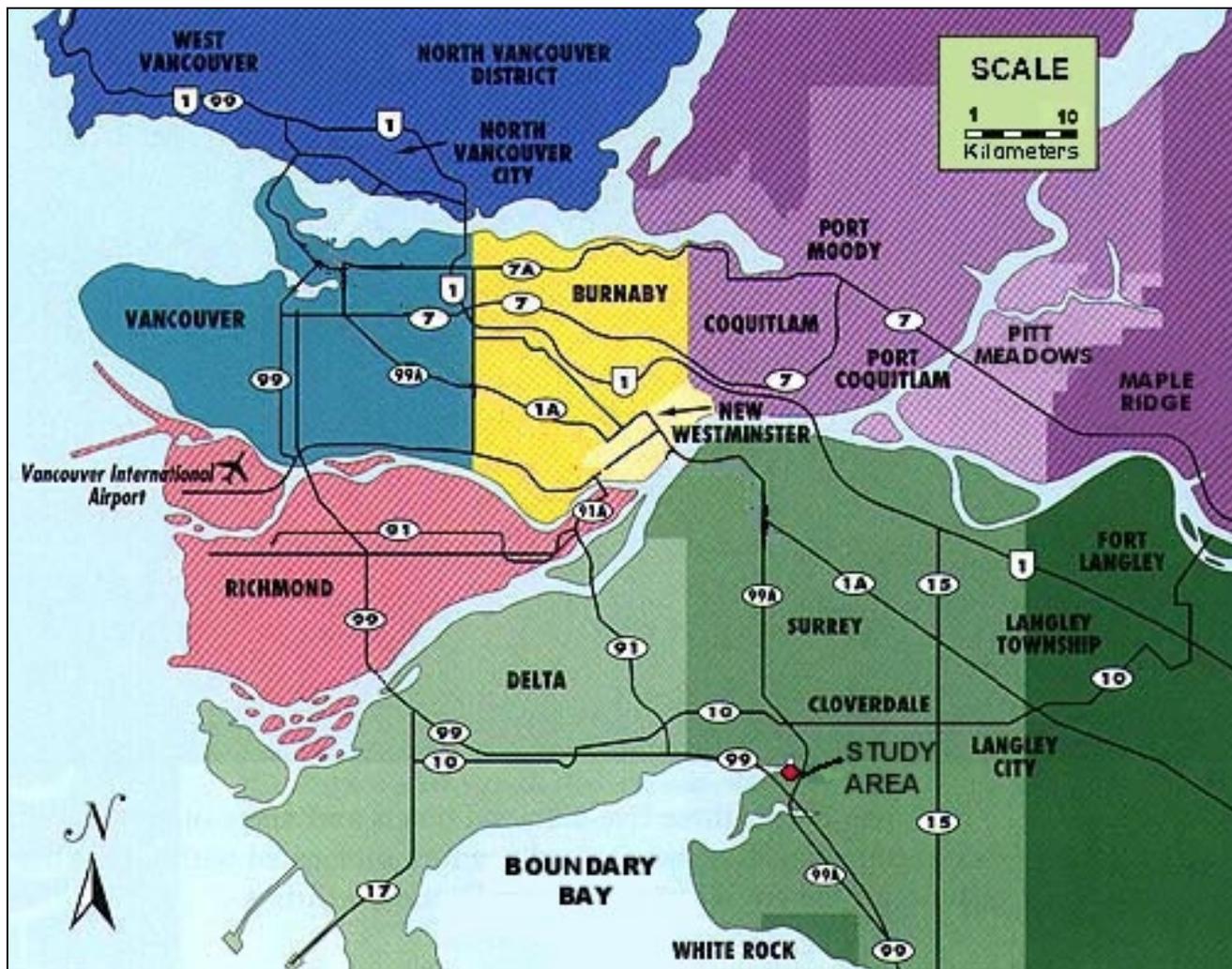


agricultural purposes. It creates a balance of wetland and upland habitats to support a variety of waterfowl species.

The main goal of provincial Wildlife Management Areas is to conserve and manage wildlife habitat (Ministry of Environment, Lands and Parks, 1988). The purpose of our study is to inventory waterfowl, raptors and other wildlife throughout the Serpentine Wildlife Management Area, Serpentine Annex (SA) and the Serpentine River. The objectives of our study are:

- to collect baseline information on waterfowl and raptor use of the wildlife management area,
- to relate the abundance and distribution of waterfowl to various habitat enhancements

Dan Buffett from Ducks Unlimited Canada and Oliver Busby from the Ministry of Environment are jointly working on the management of the Serpentine Wildlife Management Area and are overseeing the project. As volunteers, Scott Cagianca and Jennifer Young carried out the Serpentine Census project from November 1999 to April 2000.



SOURCE: Altered map from [www.vancouver .bc.com/Tourism/Map](http://www.vancouver.bc.com/Tourism/Map)

FIGURE 1. MAP OF THE STUDY SERPENTINE WILDLIFE MANAGEMENT AREA WITHIN THE LOWER MAINLAND, BC.



2.0 STUDY AREA

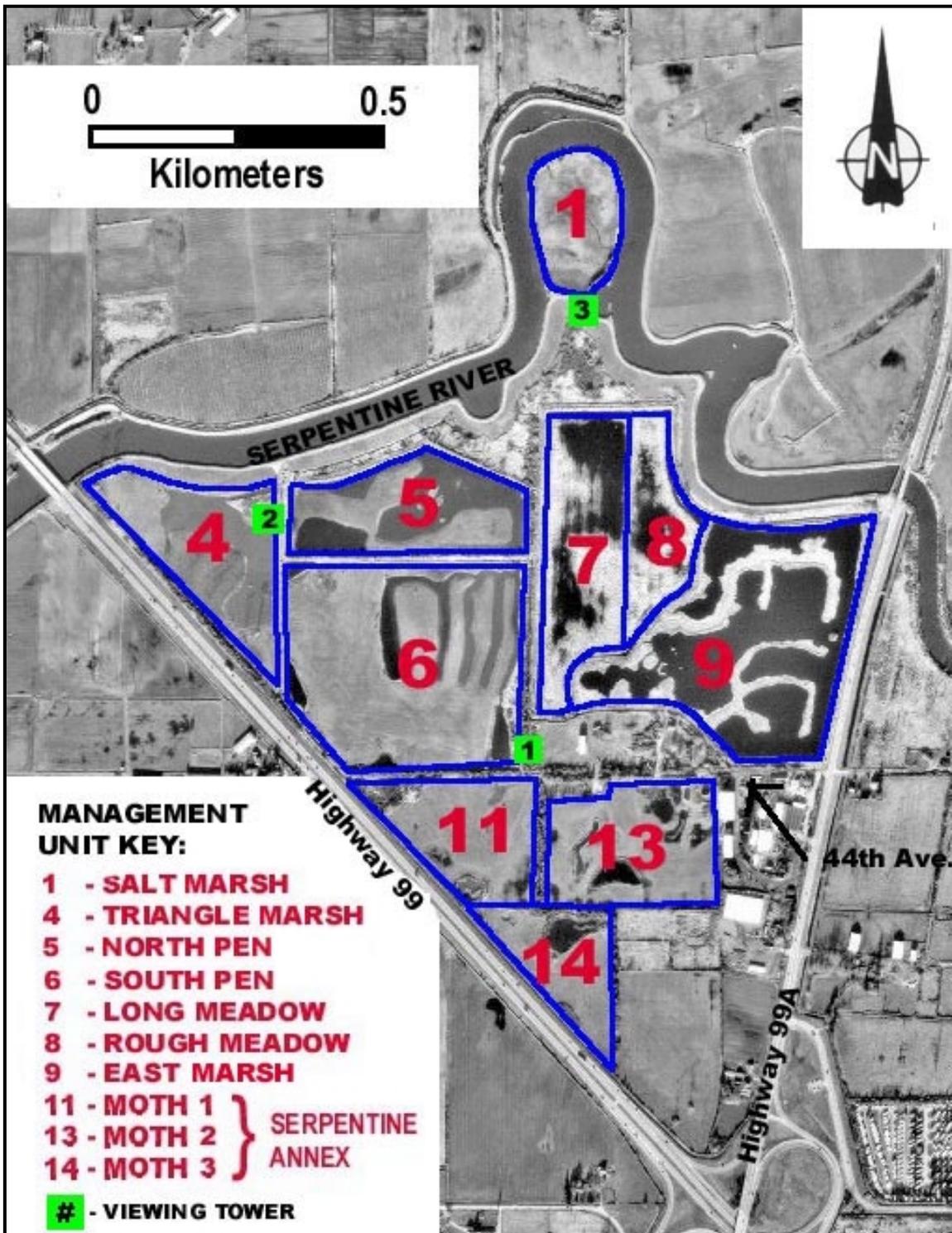
2.1 Site Description

The Serpentine Wildlife Management Area covers 71.3 hectares and is located in Surrey, BC and is bordered by Highway 99, Highway 99A, 44th Avenue and the Serpentine River (Figure 2). The area is accessible off Highway 99A by turning west on 44th Avenue and driving 500m along a gravel road to the SWA parking lot. The area south of 44th Avenue is referred to as the Serpentine Annex (SA) (Figure 2).

The SWA has been divided into smaller management units that have a mixture of upland and wetland habitat within them (Table I). A dyke trail system leads through the interior of the SWA and along the Serpentine River allowing access to the three covered viewing towers. The SA has no trail system.

Table I. *Relative Proportion of Upland and Wetland Habitat of Each Management Unit Surveyed in the Serpentine Wildlife Management Area.*

MANAGEMENT UNIT NAME (NUMBER)	ESTIMATED AREA (HECTARES)	UPLAND HABITAT (%)	WETLAND HABITAT (%)
South Pen (6)	18	75	25
Long Meadow (7)	13	50	50
East Marsh (9)	14	10	90
Triangle Marsh (4)	9	50	50
North Pen (5)	9	40	60
Salt Marsh (1)	4	80	20
Serpentine River (N/A)	-	10	90
Rough Meadow (8)	5	90	10
MOTH 1 (11)	7	80	20
MOTH 2 (14)	5	80	20
MOTH 3 (13)	7	50	50



SOURCE: Altered air photo provided by Ducks Unlimited

FIGURE 2. MANAGEMENT UNITS AND VIEWING TOWERS WITHIN THE SERPENTINE WILDLIFE MANAGEMENT AREA.



The upland habitat consists of various types of cover including short grasses, winter rye (*Lolium perenne*) and winter wheat (*Triticum aestivum*), long grass (old fields), including reed canary grass (*Phalaris arundinacea*), and areas with mud or gravel (Table II). Old fields have been left throughout the SWA, including parts of MU's 1, 2, 3, 4, 5, 6, 7, 8, 10 and 11, to provide habitat for small mammals, raptors and waterfowl.

Table II. Breakdown of Ground Cover in Upland Habitats of Management Units in the Serpentine Wildlife Management Area.

Management Unit Name (Number)	Short Green Grasses (%)	Long Grasses (%)	Muddy Areas (%)	Gravel (%)	Hedgerow (s) Present
South Pen (6)	95	5	-	-	Yes
Long Meadow (7)	35	40	25	-	Yes
East Marsh (9)	-	100	-	-	No
Triangle Marsh (4)	50	40	10	-	Yes
North Pen (5)	75	20	5	-	Yes
Salt Marsh (1)	-	70	30	-	Yes
Serpentine River (N/A)	10	-	-	90	No
Rough Meadow (8)	-	100	-	-	Yes
MOTH 1 (11)	80	10	10	-	Yes
MOTH 2 (14)	80	15	5	-	Yes
MOTH 3 (13)	60	-	40	-	Yes

Cover crops are planted during winter months to protect soils, control weeds, provide forage for waterfowl and enhance soil nutrients. An interior dyke system separates management units. By altering water levels within, it allows for a diversification of the wetlands. A salt marsh, MU 1, along the Serpentine River, has been created that is not dyked and allows for tidal influences. Hedgerows have been planted along the edges of management units to provide habitat for songbirds and a perching area for raptors.

Figure 3 shows a diversity of habitats within the SWA.



FIGURE 3. A DIVERSITY OF HABITATS WITHIN THE SERPENTINE WILDLIFE AREA, INCLUDING WETLANDS, UPLANDS AND HEDGEROWS. (PHOTO BY: JENNIFER YOUNG)

A variety of plant species exist within the SWA and SA. As managers, DUC and MOELP have manipulated the management units, using different planting strategies at different locations. In Long Meadow, South Pen and the Triangle winter rye has been planted and managed as a low grass cover crop specifically for American Widgeon (*Anas americana*). In MOTH 2 and MOTH 3, winter wheat has been planted and will be monitored for use by waterfowl. Throughout the SWA there is high concentration of reed canary grass and arctic rush (*Juncus arcticus*). Other vegetation includes wild rose (*Rosa pisocarpa*), cottonwood (*Populus balsamifera*), purple loosestrife (*Lythrum salicaria*), Himalayan blackberry (*Rubus discolor*), trailing blackberry (*Rubus ursinus*), black hawthorn (*Crataegus douglasii*), Pacific crab apple (*Malus fusca*), red alder (*Alnus rubra*), willow spp. (*Salix spp.*) and snowberry (*Symphoricarpos albus*).

2.2 History of Study Area

Boundary Bay is a major stopover for over 1.5 million birds migrating on the Pacific Flyway annually (Delta Farmland and Wildlife Trust, no date). The Fraser delta's international significance is attributed, in part, to its long frost free growing season and the rich alluvial soils producing some of the best agricultural lands in Canada.

Development in the Fraser delta over the past hundred years has resulted in a 70% loss of original wetland habitat due to dyking and drainage (Delta Farmland and Wildlife Trust,



no date). As the delta is of great importance to waterfowl, areas like the SWA have been set aside to provide a foraging area. This additional habitat reduces the impact of waterfowl on surrounding farmland.

Many waterfowl species have learned to use agricultural fields to their benefit. Over the past century, migration routes and wintering areas have changed in response to the availability of these foods (Ringelman, 1990). Some opportunistic feeders include the Mallard (*Anas platyrhynchos*), American Widgeon, Northern Pintail (*Anus acuta*) and the Green-winged Teal (*Anus crecca*) (Ringelman, 1990), all of which have been observed in the SWA.

The following is summarized from the Serpentine Wildlife Management Area Management Plan (Ministry of Environment, Lands and Parks, 1988). Dyke construction of the foreshores at the mouth of the Serpentine River between 1960 and 1970 heavily impacted the Boundary Bay tidal flats. The purpose of the dykes was to protect existing farmlands from tidal flooding and to create new land for agricultural use. Up until this time, the Serpentine land was privately owned and used for farming and hay production. In 1961 the Ministry of Transportation and Highways (MOTH) purchased the area presently called Serpentine Annex for the Highway 99 construction project. After the purchase of the land it was leased to local farmers. The land suffered during this period because of poor maintenance and periodic flooding. In 1966 the management of the Serpentine area North of 44th Avenue was assigned to the provincial government's Fish and Wildlife Branch. At this time public use of the area was fostered, and the land was used primarily for pheasant and waterfowl hunting.

In 1971 the Fish and Wildlife Branch in cooperation with DUC and the Douglas College Institute of Environmental Studies undertook an enhancement initiative for fish and wildlife. The first major project in the Serpentine area was the Fraser Valley Canada Goose Restoration Project (Mol, 2000). The project began in 1972 and involved dyke construction and water level management to provide marsh habitat for waterfowl. This initiative involved the planting of crops such as corn, barley, and smartweed (*Polygonum spp.*) which are all attractive to waterfowl. An environmental study center was also built



on the property. The aim was to attract Canada Geese (*Branta canadensis*) and American Widgeon to the property and away from nearby agricultural areas.

The northern portion of the property officially became the Serpentine Wildlife Area (SWA) on July 5th, 1973. This occurred under the Wildlife Act through Order-In-Council #1973-2387. The new SWA was closed to hunting immediately. The southern portion of the property below 44th avenue, known as the annex, is still controlled by MOTH with administrative responsibilities shared by MOELP and DUC.

DUC eventually set up their BC office in the Environmental Study Center on the SWA property. Throughout the 1980's DUC initiated management activities aimed at enhancing wildlife crop productivity. The Vancouver Natural History Society and other naturalist groups volunteered time and money to increase habitat diversity through the planting of native plants on the property. In 1992 and 1997 areas of the SWA were modified to create a combination of wetlands and uplands to further increase habitat diversity. At this time the Serpentine River dyke was widened and its shores planted with a diversity of plants and shrubs. Hedgerows were also planted between established management units within the property to provide habitat for songbirds and raptors.



3.0 METHODOLOGY

3.1 Materials

The following material are needed to complete this study:

FIELD MATERIALS	OFFICE MATERIALS
<ul style="list-style-type: none"> ▪ Field binoculars (2 Pairs - 8x25 & 9x25) ▪ Spotting scope ▪ Bird field guides (Stokes and Stokes, 1996) ▪ Tally whackers (4) ▪ Rubber boots and rain gear ▪ Field notebook, data sheet, pencils ▪ Vehicle and gas 	<ul style="list-style-type: none"> ▪ Microsoft Excel program ▪ Microsoft Word program ▪ Computer hardware ▪ Printer and paper ▪ Digitized photos (including air photos)

3.2 Methods

The method for counting and recording waterfowl, raptors and/or wildlife involved following a systematic route through the SWA and SA. The survey route leads to the three observation towers and other viewing locations where a spotting scope was used to identify and count waterfowl and raptors in each management unit. Field binoculars were also used in management units close to the viewing locations or towers. All individuals of each species of waterfowl, raptor and other wildlife were counted and their locations (upland or wetland) recorded on a data collection form (Appendix A). Counts were done independently for each management unit. For large concentrations of birds a tally whacker was used to keep track of the number of individuals. For very large groups (100 or more) of waterfowl a small portion of the flock was counted and a visual estimation of the total flock size was then made. During observation days, each raptor was counted once in the first management unit it was observed in. Surveyors tried to monitor the whereabouts of individual raptors to limit recounts.

Fourteen surveys were done between November 1999 and April 2000. Surveys were not done on days with poor visibility (dense fog). The survey route illustrated in Figure 2 was walked once a week usually at about 8:00am and takes about 3 hours to complete.



The route direction remained the same throughout the study allowing waterfowl to be observed at different tidal levels. Date, start time, weather, tidal level (high, medium or low) and observation visibility were recorded at the start of each survey. The field collection data form is illustrated in Appendix A. Field data were transferred to a digital database for future analysis. This data were kept in a Microsoft Excel spreadsheet.

The detailed route description is as follows. Starting at tower 1, counts were made in management units 6, 7, part of 9 and 11. The trail was then taken northwest to tower 2, where counts in management units 4 and 5 were done. The dyke was then followed northeast along the Serpentine River to tower 3. Management unit 1 and part of the Serpentine River were counted from tower 3. Wildlife in the Serpentine River was counted and recorded by species and location (upland or wetland), while walking along the Serpentine River dyke. The Serpentine River dyke was taken east to an interior dyke between MU 8 and 9 where counts of waterfowl and raptors of those management units were taken while walking southwest back to tower 1. From tower 1, walking south through MU 11 into MU 14, counts were made in management units 14 and 15. Backtracking to the road near tower 1 and walking east to the edge of MU 13, counts were then taken of MU 13. Management units 2, 3 and 10 were not being observed for waterfowl, however raptor counts were being done in all management units throughout the SWA.



4.0 RESULTS

4.1 Species Observed

A total of 29 species of birds were observed using the SWA and SA throughout the survey period (Table IV), including 16 waterfowl species, 6 raptors species, 6 other water bird species and Western Meadowlarks.

Table III. Common and Latin Names of Waterfowl Found in the Serpentine Wildlife Management Area.

ORDER AND COMMON NAME	SCIENTIFIC NAME
<u>Order Anseriformes</u>	
American Widgeon	<i>Fulica americana</i>
Barrow's Goldeneye	<i>Bucephala islandica</i>
Bufflehead	<i>Bucephala albeola</i>
Canada Goose	<i>Branta canadensis</i>
Canvasback	<i>Aythya valisineria</i>
Common Goldeneye	<i>Bucephala clangula</i>
Common Merganser	<i>Mergus merganser</i>
Eurasian Widgeon	<i>Anus penelope</i>
Green-winged Teal	<i>Anas crecca</i>
Hooded Merganser	<i>Lophodytes cucullatus</i>
Mallard	<i>Anas platyrhynchos</i>
Northern Pintail	<i>Anas acuta</i>
Northern Shoveler	<i>Anas clypeata</i>
Red-breasted Merganser	<i>Mergus serrator</i>
Scaup spp.	<i>Aythya spp.</i>
Trumpeter Swan	<i>Cygnus buccinator</i>
<u>Order Charadriiformes</u>	
Short-billed Dowitcher	<i>Limnodromus griseus</i>
<u>Order Ciconiformes</u>	
Great Blue Heron	<i>Ardea herodias</i>
<u>Order Falconiformes</u>	
Bald Eagle	<i>Haliaeetus leucocephalus</i>
Cooper's Hawk	<i>Accipiter cooperii</i>
Merlin	<i>Falco columbarius</i>
Northern Harrier	<i>Circus cyaneus</i>
Red-tailed Hawk	<i>Buteo lagopus</i>
Sharp-shinned Hawk	<i>Accipiter striatus</i>
<u>Order Gruiformes</u>	
American Coot	<i>Fulica americana</i>

(continued...)



ORDER AND COMMON NAME	SCIENTIFIC NAME
<i>(... Continued)</i>	
Order Passeriformes	
Western Meadowlark	<i>Sturnella neglecta</i>
Order Pelecaniformes	
Double-crested Cormorant	<i>Phalacrocorax auritus</i>
Order Podicipediformes	
Pied-billed Grebe	<i>Podilymbus podiceps</i>
Western Grebe	<i>Aechmophorus clarkii</i>

4.2 Waterfowl Use by Management Unit

The overall usage of management units within the SWA by waterfowl is illustrated in Figure 4. Each percentage represents the average number of waterfowl per survey between November 1999 and April 2000. This includes both upland and wetland habitats of each management unit. North Pen and South Pen have the highest usage by waterfowl at 24% and 18% respectively, with Triangle Marsh and Long Meadow at 14% and 10%, respectively. On average there was little to no waterfowl activity recorded in MOTH 1, MOTH 2, Salt Marsh and Rough Meadow.

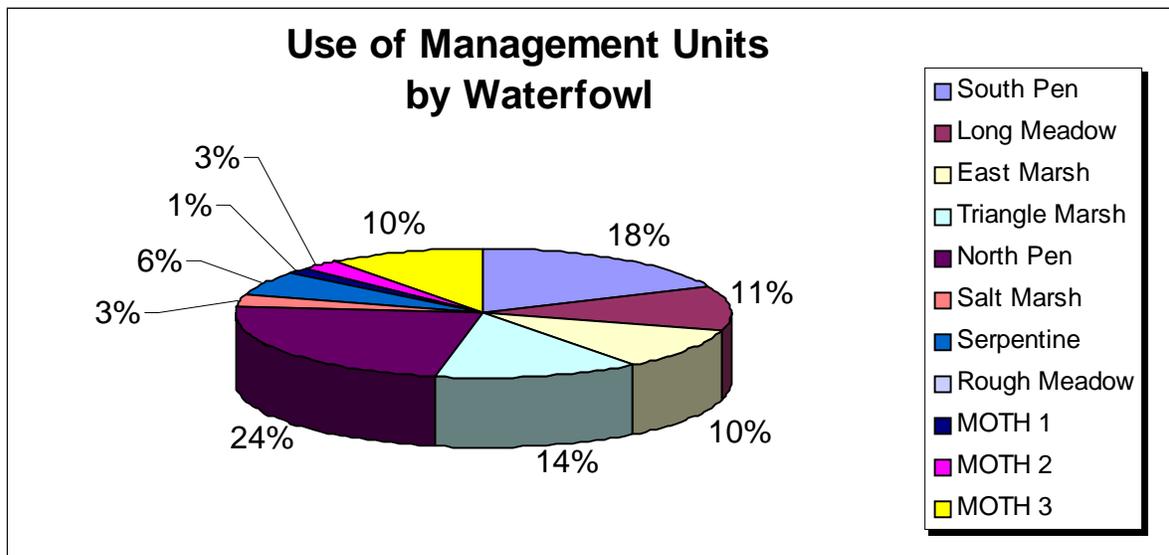


FIGURE 4. USE OF MANAGEMENT UNITS BY WATERFOWL IN THE SERPENTINE WILDLIFE MANAGEMENT AREA.



Surveys performed between November and April showed the American Widgeon was observed with the highest frequency in North Pen (Table III). American Widgeon and Scaup spp. were both seen in the Serpentine River with the highest frequency, in 93% and 86% of the surveys, respectively. Triangle Marsh was most frequented by Bufflehead and Mallard which were observed in 93% and 79% of the surveys, respectively. The Common Merganser was observed in the Serpentine River in 71% of the surveys. American Widgeon and Mallard were the two species most frequently observed in South Pen.

The use of upland habitat by waterfowl increased in almost all of the management units from November to January (Figure 5). This increase is apparent in South Pen where the average number of individuals using upland habitat increased from 0 in November to nearly 180 during January. Only the Salt Marsh was used as upland habitat in the month of November. Observation showed Triangle Marsh to have a steady use of its upland habitat component, whereas South Pen, North Pen, MOTH 1, MOTH 2 and MOTH 3 had inconsistent use. There was no upland habitat use observed in Rough Meadow (Figure 5). The average number of individual waterfowl using the wetland habitat declined from November to April in East Marsh, South Pen, Long Meadow and MOTH 3 (Figure 6). The average number of waterfowl observed in Triangle Marsh and the Serpentine was steady from November to April. North Pen had consistently high wetland use, and the Salt Marsh, MOTH 1 and MOTH 2 had consistently low use. Waterfowl were not observed using Rough Meadow. When comparing the upland habitat to wetland habitat, overall wetland habitat is used by a greater number of waterfowl species and individuals (Figures 5,6,7 and 8).



Table IV. Frequency of Waterfowl Observed in Upland and Wetland Areas of Management Units during 14 Days Surveyed.

WATERFOWL SPECIES	SOUTH PEN		LONG MEADOW		EAST MARSH		TRIANGLE MARSH		NORTH PEN	
	Upland	Wetland	Upland	Wetland	Upland	Wetland	Upland	Wetland	Upland	Wetland
American Widgeon	43%	86%	21%	36%		21%	57%	71%	29%	100%
Barrow's Goldeneye		7%								
Bufflehead		43%		17%		50%		93%		71%
Canada Geese	14%		21%	21%		21%	14%			7%
Canvasback						7%				
Common Goldeneye										
Common Merganser		7%		14%		43%		7%		
Eurasian Widgeon							7%	7%		
Green-winged Teal		14%	14%	57%		21%		14%		29%
Hooded Merganser		14%				36%		29%		
Mallard	50%	86%	29%	57%		57%	57%	79%	36%	71%
Northern Pintail	7%	21%		21%		14%		36%		50%
Northern Shoveler		21%		29%		29%	7%	7%		21%
Red-breasted Merganser										
Scaup Sp.		14%						14%		7%
Trumpeter Swan				7%	7%					
										<i>(...Continued)</i>



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(...Table III Continued)

WATERFOWL SPECIES	SALT MARSH		SERPENTINE		ROUGH MEADOW		MOTH 1		MOTH 2		MOTH 3	
	Upland	Wetland	Upland	Wetland	Upland	Wetland	Upland	Wetland	Upland	Wetland	Upland	Wetland
American Widgeon	36%	43%		93%			7%		21%	7%	21%	43%
Barrow's Goldeneye												
Bufflehead		7%		43%								
Canada Geese												
Canvasback												
Common Goldeneye				14%								
Common Merganser				71%								
Eurasian Widgeon				7%								
Green-winged Teal	14%	29%		7%			7%				14%	7%
Hooded Merganser				7%								
Mallard	36%	43%	17%	71%			29%	14%	36%	43%	29%	50%
Northern Pintail	7%	14%		14%								14%
Northern Shoveler								7%			7%	14%
Red-breasted Merganser				43%								
Scaup Sp.				86%								
Trumpeter Swan												

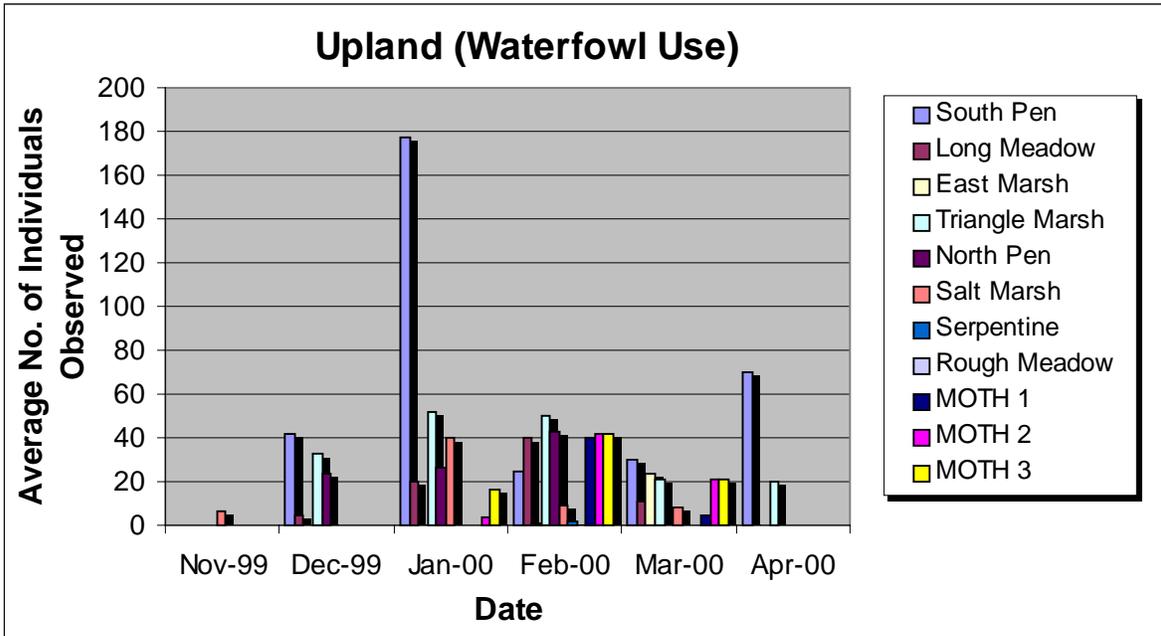


FIGURE 5. AVERAGE NO. OF INDIVIDUALS OF WATERFOWL USING UPLAND HABITAT WITHIN EACH MANAGEMENT UNIT PER MONTH.

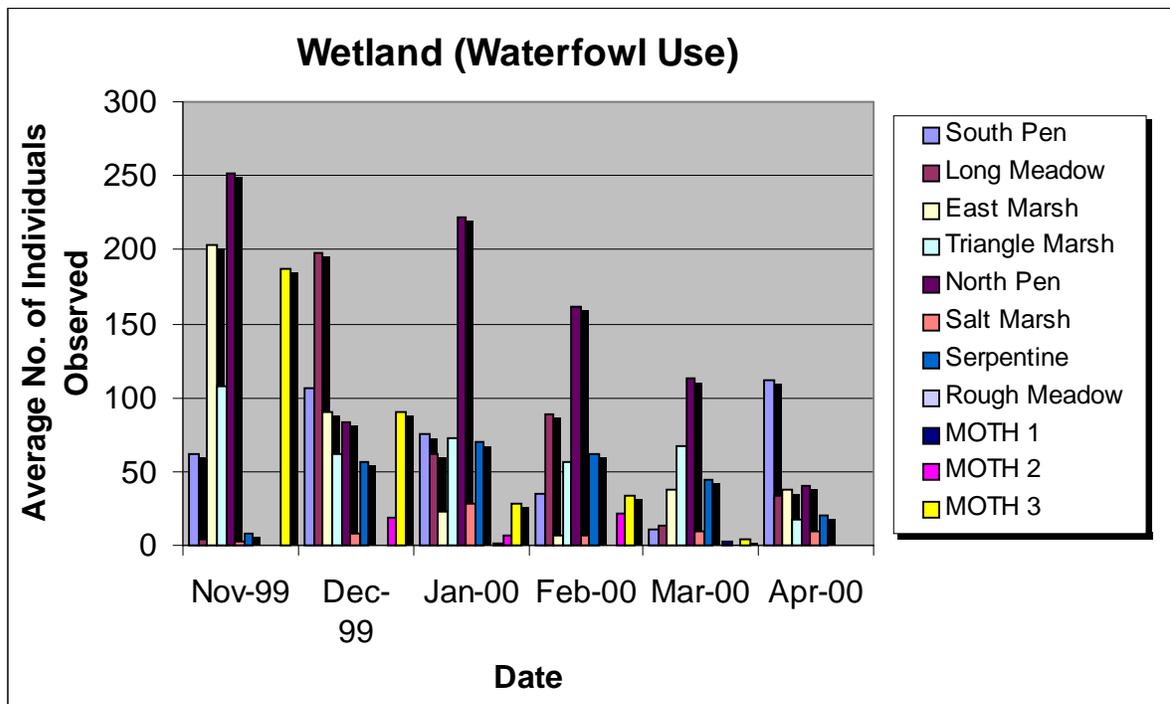


FIGURE 6. AVERAGE NO. OF INDIVIDUALS OF WATERFOWL USING WETLAND HABITAT WITHIN EACH MANAGEMENT UNIT PER MONTH.



4.3 Species Diversity of Waterfowl

Upland habitat use increased from November through April (Figure 7). The upland habitat within the management units of the SWA was not utilized by many species in the month of November (Figure 7). Only the upland habitats of Salt Marsh and Triangle Marsh were used by waterfowl species in this month. Diversity began to increase in December, and by January upland habitat in seven management units was used by at least one species of waterfowl. Triangle Marsh, the Serpentine River, Long Meadow and East Marsh were observed to have a general increase in the number of species utilizing upland habitat from November to April. Upland habitat use by waterfowl remained steady in South Pen during the study and no trend was observed in Salt Marsh, North Pen, MOTH 1, MOTH 2 and MOTH 3.

No waterfowl species were observed using wetland habitat in Rough Meadow. Every other management unit was observed to have been used by at least one species of waterfowl (Figure 8). Moth 1 and Moth 2 display the lowest use by waterfowl throughout the study. A high level of waterfowl diversity was observed throughout each month of the study. The Serpentine River and Triangle Marsh maintained the greatest species diversity from November to April. While the diversity of North Pen and South Pen declined through the same period (Figure 8).

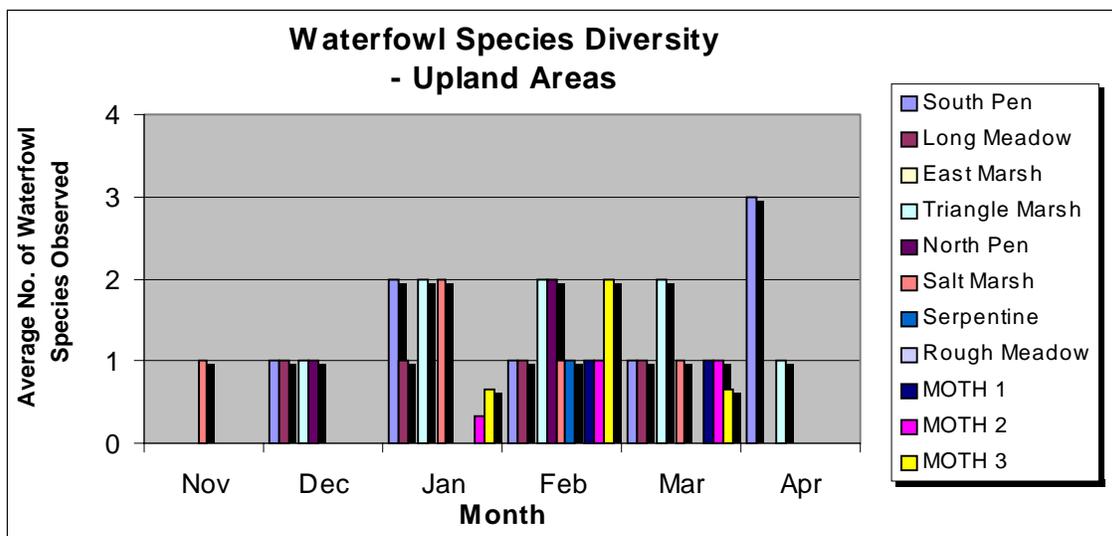


FIGURE 7. NUMBER OF WATERFOWL SPECIES OBSERVED WITHIN UPLAND AREAS OF EACH MANAGEMENT UNIT. (NOVEMBER 1999 TO APRIL 2000)

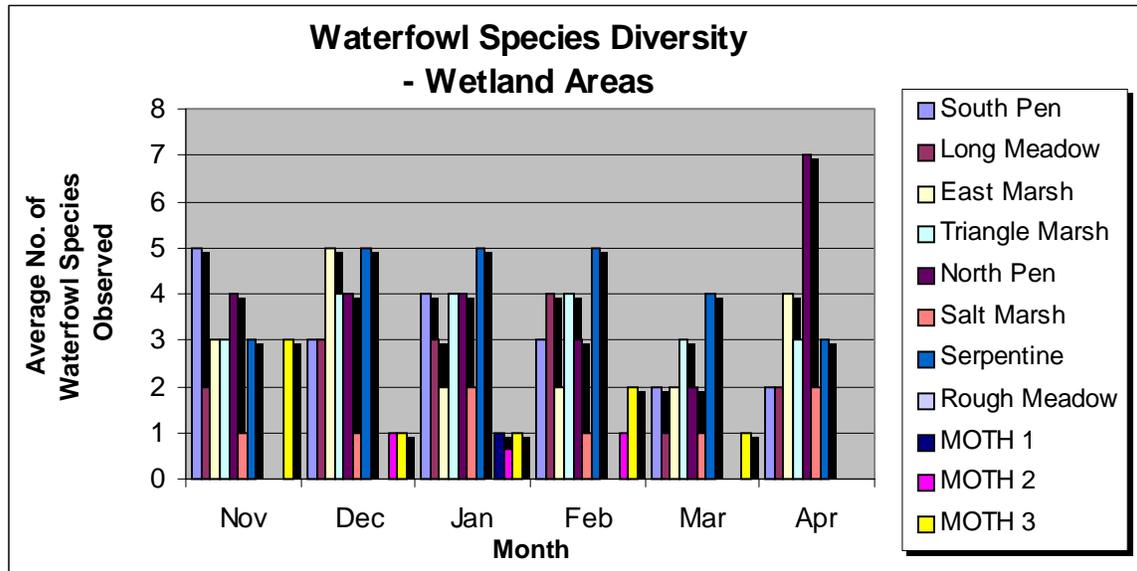


FIGURE 8. NUMBER OF WATERFOWL SPECIES OBSERVED WITHIN WETLAND AREAS OF EACH MANAGEMENT UNIT. (NOVEMBER 1999 TO APRIL 2000)

4.4 Species Trends

Figures 9 through 16 show the number of individuals of particular waterfowl species present and the tidal heights for the Boundary Bay area. These include Mallard, Northern Pintail, Green-winged teal, American Widgeon, Common Merganser (*Mergus merganser*), Hooded Merganser (*Lophodytes cucullatus*), Bufflehead (*Bucephala albeola*) and Canada Geese (*Branta canadensis*). These figures also illustrate the usage of wetland habitat versus upland habitat for the same eight species.

The number of individual Mallards using the wetland habitat decreased from November through January. The upland habitat use by Mallard is lower than wetland habitat use, but more consistent (Figure 9). Individual numbers of Mallards observed ranged from 0 to nearly 500.

Throughout the study, upland habitat use by the Northern Pintail was minimal and the number of individuals ranged from 0 to 50 with an average of about 10 observed per survey (Figure 10). The greatest number of Northern Pintail were observed on January 19th when over 50 individuals were observed.



High numbers of Green-winged Teals were observed in November and December, then drastically decreased in January (Figure 11). Numbers of Green-winged Teals observed ranged from 0 to 100 and averaged at about 40 per survey.

American Widgeon were observed in wetland habitat in every survey and upland habitat in all but one (Figure 12). American Widgeon have shown consistent numbers throughout the study with a small decreasing trend from January through April. Numbers of American Widgeon observed ranged from 0 to 450.

Buffleheads were observed using only wetland habitat. Throughout the study individual number of Bufflehead ranged from 3 to 25 individuals per survey (Figure 13).

Bufflehead was the only waterfowl species that showed correlation with tidal levels (Figure 13). Individuals increased as tidal levels increased.

Canada Geese were first seen in the SWA on February 1st and their numbers have ranged from 0 to 150 (Figure 14). Canada Geese were observed using both wetland and upland habitats.

The highest number of Common Merganser observed was on December 22nd and has decreased since then (Figure 15). Their numbers range from 0 to 60 and were always found in wetland habitat. Hooded Mergansers decreased from November through April (Figure 16). They were never seen using upland habitat and ranged in number between 0 and 23 individuals. No Hooded Mergansers have been seen since January 25.

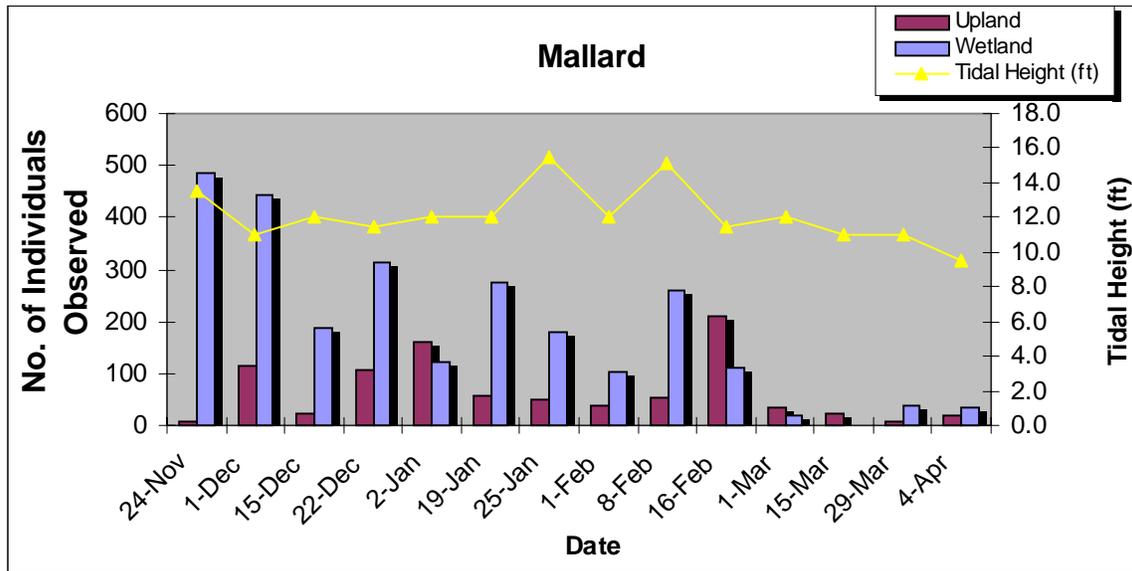


FIGURE 9. NUMBER OF MALLARD IN WETLAND AND UPLAND AREAS AND TIDAL HEIGHTS.

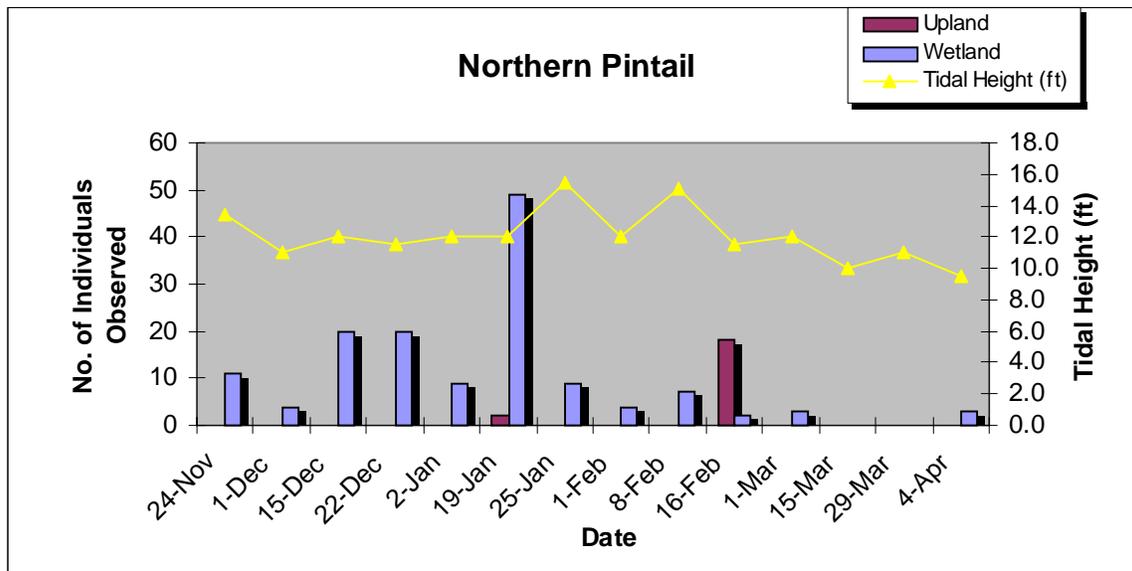


FIGURE 10. NUMBER OF NORTHERN PINTAIL IN WETLAND AND UPLAND AREAS AND TIDAL HEIGHTS.

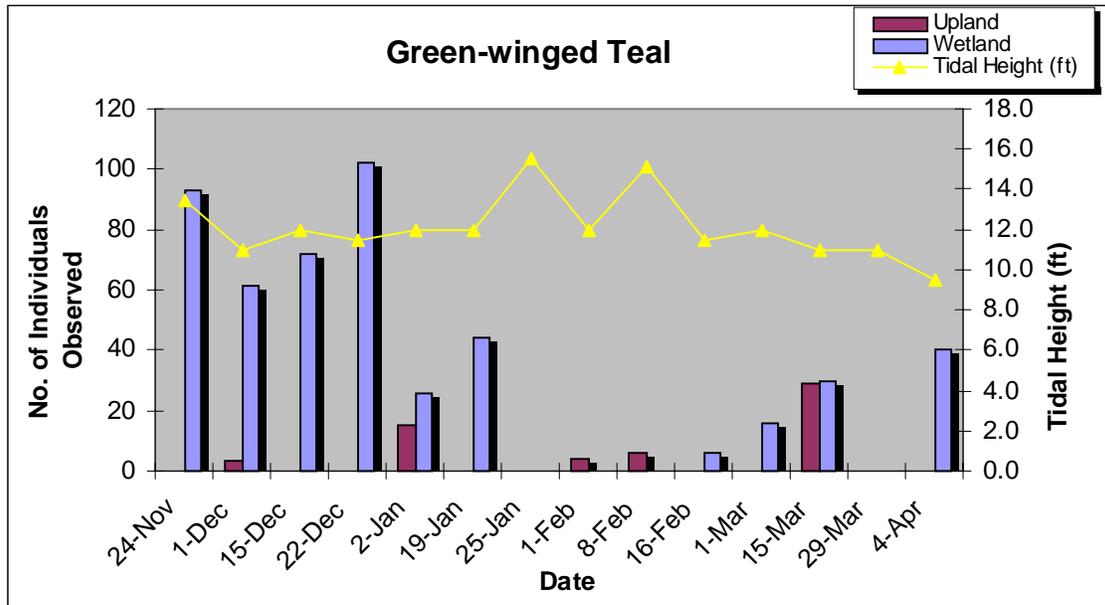


FIGURE 11. NUMBER OF GREEN-WINGED TEAL IN WETLAND AND UPLAND AREAS AND TIDAL HEIGHTS.

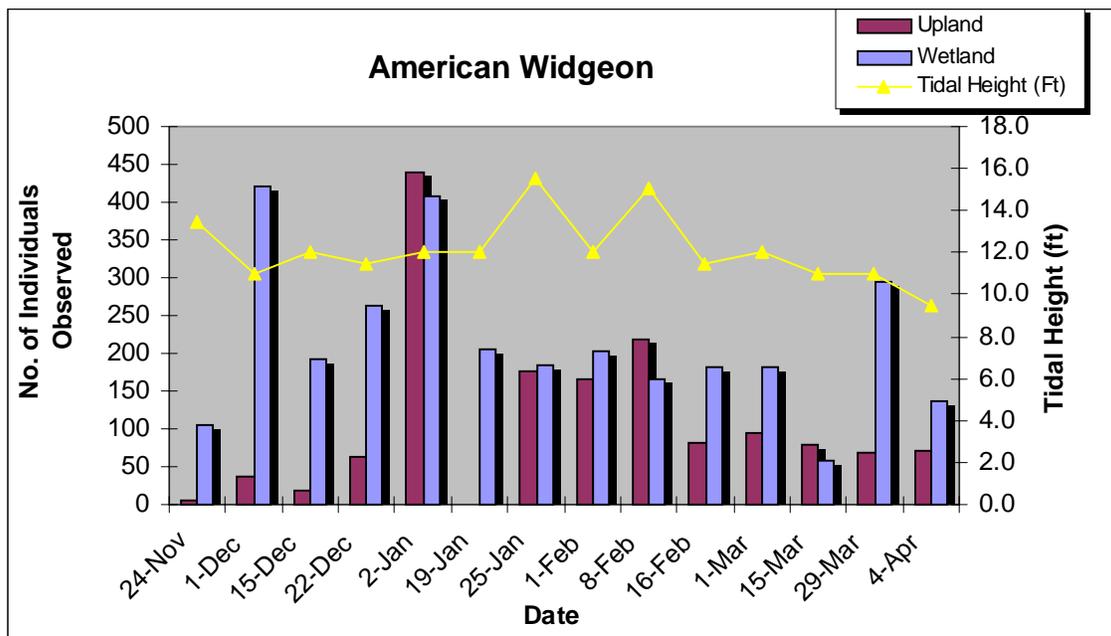


FIGURE 12. NUMBER OF AMERICAN WIDGEON IN WETLAND AND UPLAND AREAS AND TIDAL HEIGHTS.

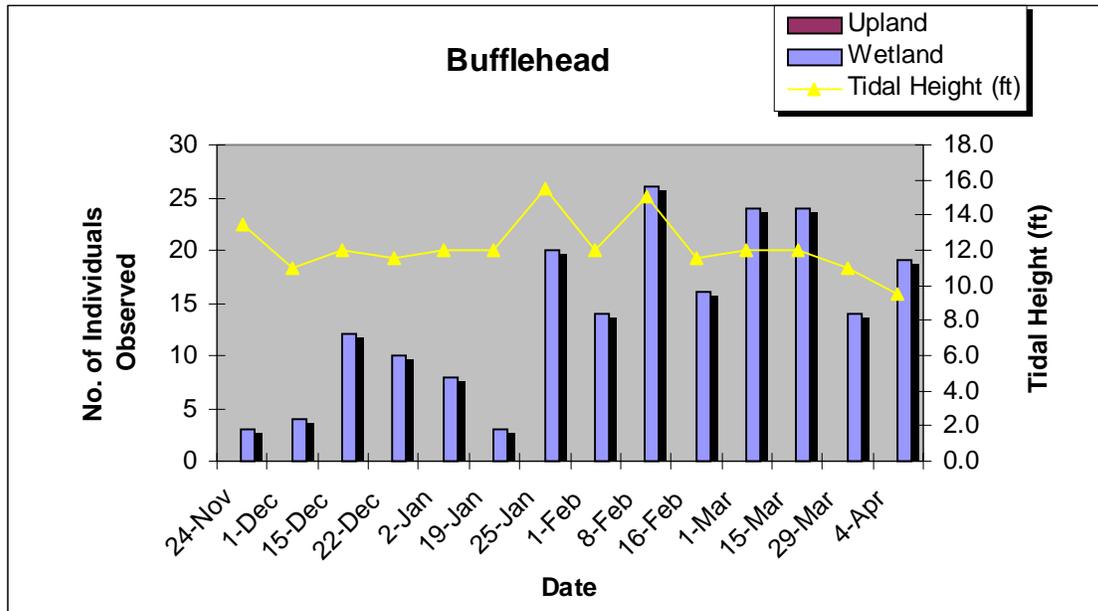


FIGURE 13. NUMBER OF BUFFLEHEAD IN WETLAND AND UPLAND AREAS AND TIDAL HEIGHTS.

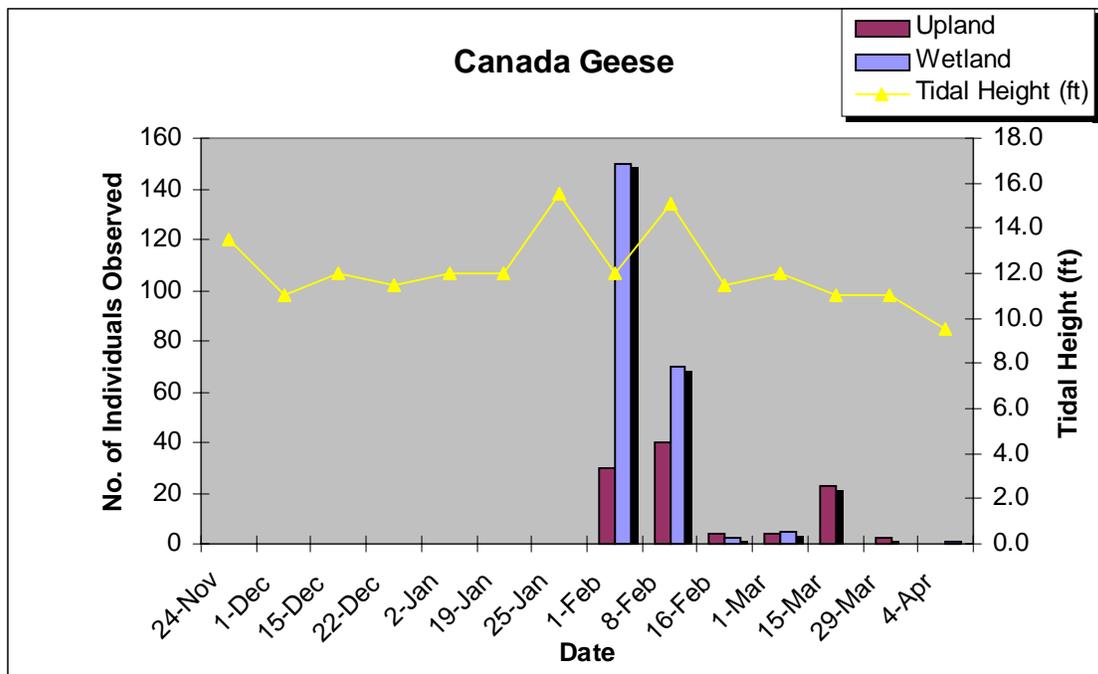


FIGURE 14. NUMBER OF CANADA GEESE IN WETLAND AND UPLAND AREAS AND TIDAL HEIGHTS.

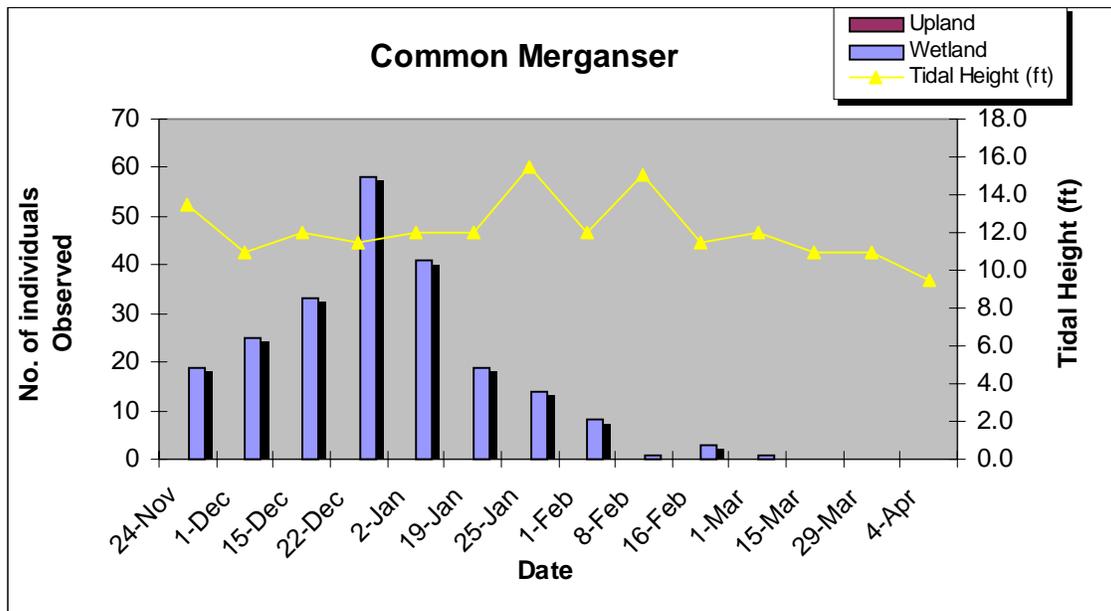


FIGURE 15. NUMBER OF COMMON MERGANSER IN WETLAND AND UPLAND AREAS AND TIDAL HEIGHTS.

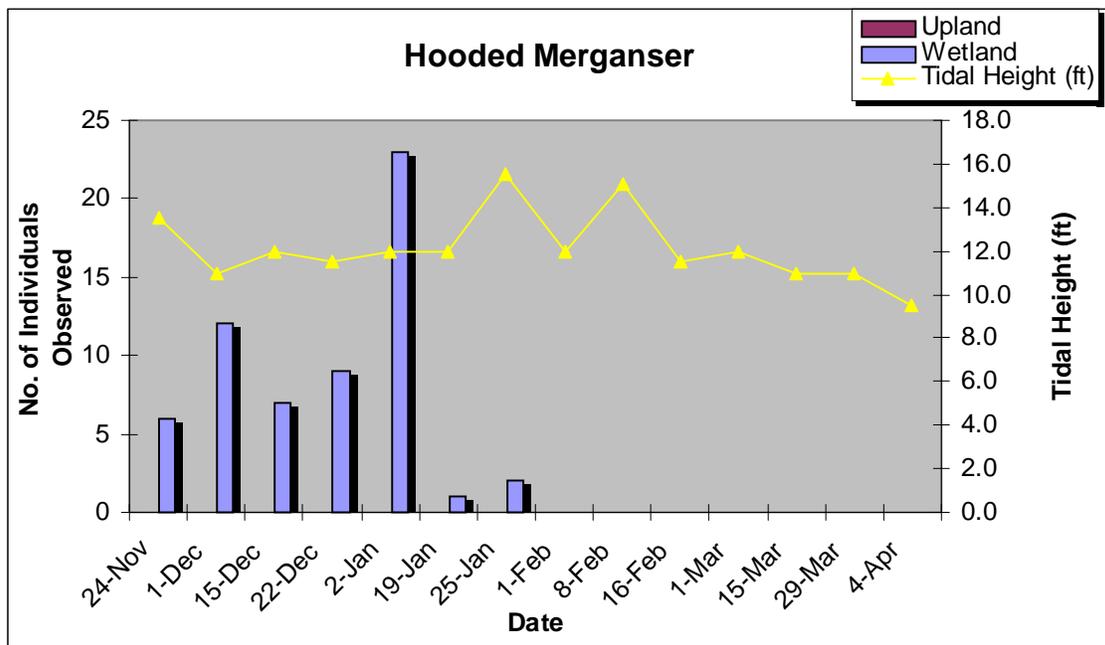


FIGURE 16. NUMBER OF HOODED MERGANSER IN WETLAND AND UPLAND AREAS AND TIDAL HEIGHTS.



4.5 Raptor Use

Six species of raptors were observed throughout the SWA from November through April. Figure 17 shows that of all the raptors observed, 54% of the raptors observed were Northern Harriers (*Circus cyaneus*) and 35% were Bald Eagles (*Haliaeetus leucocephalus*). Red-tailed Hawks (*Buteo jamaicensis*), Merlin (*Falco columbarius*), and *Accipiter sp.* were observed at 5%, 3% and 3%, respectively. No owls were observed, however, pellets were seen in all viewing towers on numerous occasions indicating raptor presence.

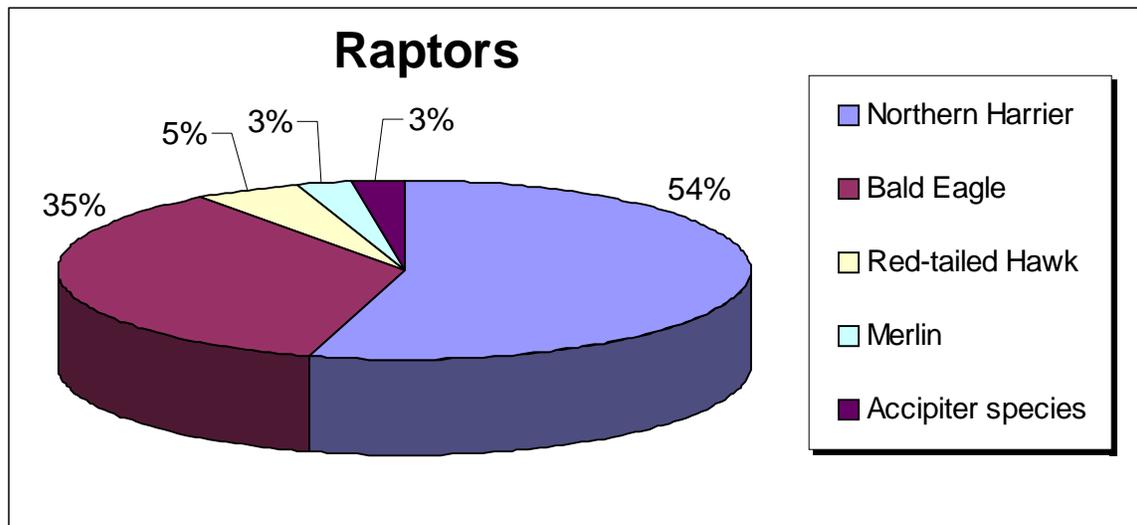


FIGURE 17. PERCENTAGE OF RAPTOR SPECIES FROM NOVEMBER 1999 TO APRIL 2000.

Raptors were observed in 10 of the 11 Management Units, as shown in Figure 18. No raptors were sighted in MOTH 3. The majority of sightings were in South Pen and East Marsh where a total of 10 individuals were seen in each.

The average number of raptors seen from November to April is shown in figure 19. Northern Harrier sightings increased over the winter reaching a high point on February 8th when five individuals were seen. Bald Eagle sightings increased from November through April and reached a high point on February 1st when five were seen.

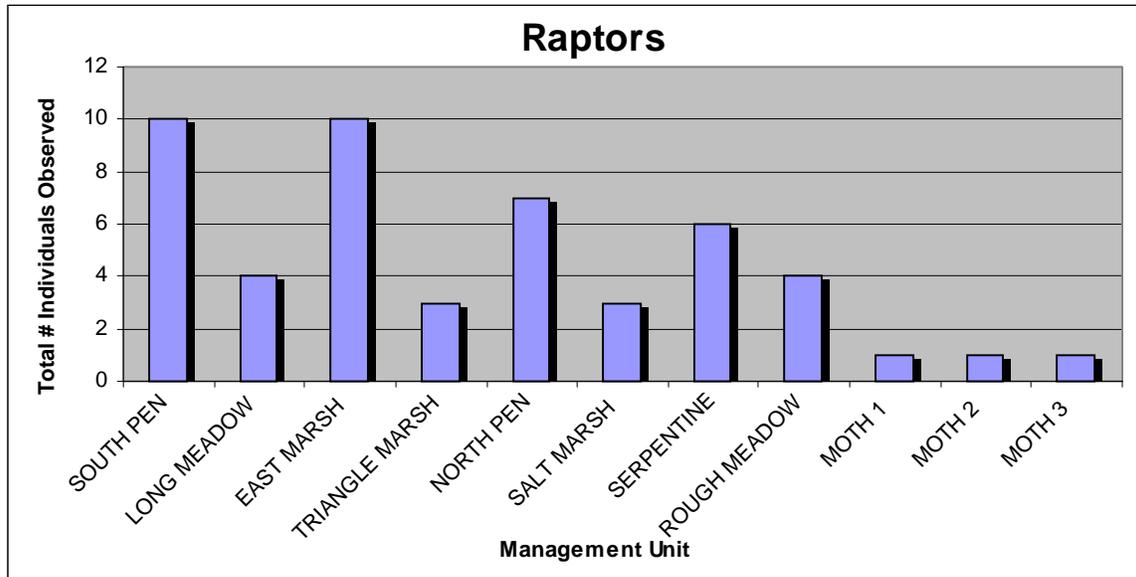


FIGURE 18. TOTAL COUNTS OF RAPTORS IN EACH MANAGEMENT UNIT OF THE SERPENTINE WILDLIFE MANAGEMENT AREA FROM NOVEMBER 1999 TO APRIL 2000.

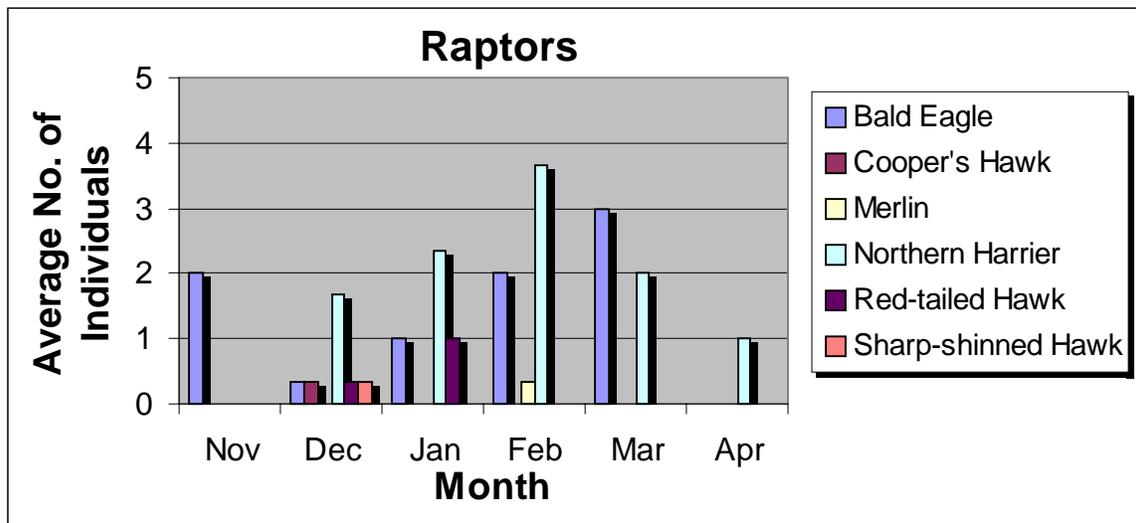


FIGURE 19. NUMBER OF RAPTORS OBSERVED IN THE SERPENTINE WILDLIFE MANAGEMENT AREA FROM NOVEMBER 1999 TO APRIL 2000.



4.6 Other Wildlife

Other species of wildlife seen in the Serpentine Wildlife Management Area from November 1999 through April 2000 include American Coot (*Fulica americana*), Pied-billed Grebe (*Podilymbus podiceps*), Western Grebe (*Aechmophorus clarkii*), Double-crested Cormorant (*Phalacrocorax auritus*), Coyote (*Canis latrans*), Short-billed Dowitchers (*Limnodromus griseus*), Western Meadowlarks (*Sturnella neglecta*), River Otter (*Lutra canadensis*) and a Harbour Seal (*Phoca vitulina*).

On March 1st, seven Western Meadowlarks were observed singing in red alder trees along the Serpentine River near Tower 3. Short-billed Dowitchers were observed on January 2 and March 1st feeding in muddy areas of the Salt Marsh. Cormorants were observed in the Serpentine River, South Pen and East Marsh throughout the study and are consistently found sitting atop posts located in a small bow in the river at the northwest corner of East Marsh. The American Coot and the Pied-billed Grebe have been observed mainly in wetland habitat in South Pen and East Marsh. The coots are usually found in small groups while the grebe has only been observed on its own. Pellets were found in all the viewing towers throughout the study indicating raptor presence.

Coyotes have been seen throughout the SWA. Coyote scat is found on most of the trail and dyke system within the SWA. The scat shows signs of small rodents and occasionally waterfowl.



5.0 DISCUSSION

5.1 Limitations

There are several factors limiting the accuracy of the surveys conducted during the Serpentine Project. One of the main factors is the frequent movement of waterfowl between management units. Water birds swim around ponds, move from wetlands to uplands and regularly fly in and out of management units and/or the SWA. Another factor is that many waterfowl and wildlife feed underwater and are not constantly in view when a particular management unit is being surveyed. They dive under water for periods of time and may or may not resurface in the same location, possibly leading to a no count or a double count. The lack of magnification strength of the spotting scope or binoculars can limit the observer's ability to make positive identification.

Raptors are frequently seen in the SWA. There is activity bias in the census data collected on raptors, as raptors in flight are more visible to the observer than raptors temporarily perched. Surveying the hedgerows for raptors may help determine a more accurate estimate for raptor numbers. It is difficult to determine if raptors have been previously counted because of their frequent movement within the SWA and SA.

5.2 Waterfowl Use by Management Unit

Waterfowl have different habitat preferences that vary with species maturity and the change of seasons. For this reason, a broad diversity of habitat types is important for waterfowl success (Mitsch and Gosselink, 1993). The varied use of most management units by waterfowl species was evident (Figure 4), although, use of wetland habitat far exceeds that of upland habitat (Figures 5 and 6). The SWA supports many diving ducks that utilize only wetland habitat, leaving only the dabbling ducks to utilize upland habitat.



5.3 Species Diversity of Waterfowl

The wetland habitat within the management units of the SWA is supporting a diverse array of species. During the six months of the study all management units, with the exception of Rough Meadow, recorded use by one or more species of waterfowl (Figure 7 and 8). Triangle Marsh, South Pen, North Pen and the Serpentine River were used by the greatest number of species. This is probably a result of their size and habitat diversity. Each of these management units is large and offers more wetland habitat than others. The size also offers security to a greater number of waterfowl species. They can group together and are further away from walking trails and hedgerows where predators, humans and dogs were more likely to bother them. Triangle Marsh, South Pen and North Pen also have large upland and wetland habitats offers easy access to both habitat types. Other management units either have mainly wetland, such as East Marsh, or uplands, such as MOTH 1, 2, or 3, limiting their use. The Serpentine River offers very limited upland habitat even though a high number of species were using the river. This may be due to the mix of fresh and salt water and the deeper waters used by many diving ducks, such as the Red-breasted Merganser, Common Merganser, Scaup spp., Common Goldeneye and Barrow's Goldeneye. Mallards, American Coots and American Widgeon's were occasionally seen using the dyke as well.

The number of species using the upland habitat was very limited in the month of November but shows a dramatic increase in January through to April (Figure 8). Waterfowl were frequently observed using upland habitat for sleeping by tucking their wings and beaks into their bodies. In addition, foraging activity was observed on the upland habitat, by dabblers such as American Widgeon and Mallards, usually in close proximity to wetlands.

5.4 Tidal Influences

Tide levels can influence waterfowl (Buffet, 1999). During low tides, water levels in the salt marsh drop and expose invertebrates and aquatic vegetation for foraging ducks. Waterfowl often follow tidal changes (Buffet, 1999) although little evidence is being



observed in our study. Based on our November to April surveys this trend has only been evident in Bufflehead. Other than Bufflehead, tidal changes in the Boundary Bay area appear to have no correlation to waterfowl occurrence or habitat selection in the SWA. This is illustrated in figures 9 through 16.

Possible reasons that tidal change has had little influence on waterfowl occurrence or habitat selection may be attributed to one of several limitations in the study. Waterfowl frequently move in and out of management units and tidal changes occur slowly over several hours. Longer and more timely (max and min high/low tide) observation periods are necessary to get a more accurate account of possible tidal influence. Another limitation in assessing tidal influence on waterfowl at the SWA is the infrequency of the observations. Tides varied very little between study observation days and included only higher tidal levels.

Common Merganser and Hooded Merganser are present year round on the coast, however their summer range utilizes more interior locations (Stokes and Stokes, 1996). These species peaked in late December and Early January in the SWA and decreased through to April (Figure 15 and 16). The Hooded Merganser was last seen on January 25th.

5.5 Water Level Changes

Drawdown drains are used to manage water levels within specific management units (Figure 20). One of the most effective management tools for providing waterfowl habitat is water level manipulation, provided it is well timed and controlled. Timing, speed, duration of drawdowns and flooding has important effects on plant species composition,



FIGURE 20. DRAIN FOR DRAWDOWNS, AS VIEWED IN NOVEMBER IN THE SWA.

plant production and bird usage. Lowering water levels concentrates floods in smaller areas, which increases the food availability. By creating habitat with abundant food sources many foraging birds will be attracted to the SWA. When water levels are high, the dominant waterfowl are diving-ducks, as they are able to access food in deeper waters.



This is marginally evident in our observations of Bufflehead and Mergansers. As the water levels decrease other species of waterfowl adapt to foraging in shallower waters (i.e. dabblers) and gradually replace the ‘deeper water’ species (Fredrickson, 1991). Lowering water levels slowly lengthens the optimum foraging period and places a large portion of invertebrates within the foraging ranges of a greater diversity of bird species. In the spring, releasing water from wetlands traps invertebrates making them available for waterfowl along the soil/water interface and in shallow waters. These protein rich invertebrates are required by pre-breeding and breeding female ducks, newly hatched waterfowl, molting ducks and shorebirds (Fredrickson, 1991). Over the past few years, DUC and MOELP have been experimenting with flooding and drawdowns to find optimal water levels for each management unit to achieve maximum biodiversity throughout the year. These drawdowns are still in the experimental stages and have not been taken into account in this study.

Due to their body size, larger dabblers, such as the Mallard, are able to make use of deeper waters than smaller dabblers, such as the Green-winged Teal. The Salt Marsh and Long Meadow both have shallow waters with muddy areas and often the smaller waterfowl species, such as the Green-winged Teal, were observed feeding in these management units. Mallards and American Widgeon were often seen in the moderately deep areas, such as those in North Pen, Triangle Marsh and South Pen. The deepest waters were found in East Marsh and the Serpentine River supporting mainly divers, such as the Common and Hooded Mergansers.

5.6 Raptors

Six species of raptors have been identified in the SWA. These species include Northern Harrier, Merlin, Bald Eagle, Red-tailed Hawk, Sharp-shinned Hawk and Cooper’s Hawk. The frequency of raptor occurrence has increased from November to January, with the Northern Harrier being the most common raptor observed in the SWA. The harrier appears most often hovering over tall grass searching for prey. This species is easier to identify from a distance than other species of raptors due to their V shaped wing formation while in flight as well as the prominent white band on the rump.



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Raptor distribution is distributed over all management units except for Moth 3 and may be attributed to its location. This management unit is not visible from most locations in the SWA; therefore, there is a very limited viewing time in these two management units.



6.0 CONCLUSIONS

The Serpentine Wildlife Management Area provides wintering grounds for waterfowl in the form of mixed upland and wetland habitat. The SWA and SA also provide valuable habitat for other water birds, raptors and wildlife.

The Serpentine Census Project began in November of 1999 and continued through April 2000. During this time 29 species of birds were observed within the SWA and SA.

The use by waterfowl of the 11 management units that were observed in the census varied considerably, as did the species diversity between management units.

North Pen and South Pen were observed to have the highest usage by waterfowl. These two management units offered more open space than other management units, as well as providing a mixture of wetland and upland habitat. The open space allows for large flocks of waterfowl to land and forage as a group. The upland habitat in these two management units consists of short grasses that are intermixed with wetland habitat. This combination provides easy access to both habitat types.

The Serpentine and Triangle Marsh management units were observed to have the greatest species diversity. These two units have the greatest tidal influence and provide habitat for not only dabblers but also diving ducks and other water birds.

The American Widgeon was the most frequently observed waterfowl species, followed by Mallards, within the SWA and SA. These two species were seen in all management units, except Rough Meadow, during the study. They were also observed using both the wetland and upland habitats.

The Northern Harrier was the most frequently observed raptor in the SWA and SA, followed by the Bald Eagle. Both these species were seen most often in South Pen and East Marsh. Harriers used the tall grasses and hedgerows in these units as hunting grounds and were often seen at low elevations circling for food. The Bald Eagles were most frequently observed perched in deciduous trees. Occasionally they were seen in flight over the tall grasses and hedgerows.



7.0 RECOMMENDATIONS

Upon completion of the waterfowl, raptor and wildlife Census Project on the Serpentine Wildlife Management Area the following recommendations have been made:

- More wetland habitat should be created throughout the SWA as the use by waterfowl of wetland habitat far exceeds that of upland habitat.
- The location of upland habitat should be monitored for grass type and use by waterfowl to determine what foraging material is most valuable as a management tool.
- Tidal influence should be monitored by staggering observation time/day to provide information on the impacts of tides on waterfowl and other birds in the SWA and SA.
- Water levels in wetland habitat should be monitored and controlled by drawdowns to provide a greater range of habitat, especially in the rainiest months.



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APPENDIXES



APPENDIX A. DATA COLLECTION FORM



**Ducks Unlimited Canada - B.C. Coastal Field Office
Waterfowl Census Record**

Project: Serpentine Wildlife Area
Census Method: visual
Water level: _____
Coverage: MU #

File # _____
Start Time: _____
Weather: _____
Observability: _____

Obs Date: _____

UNIT	SOUTH PEN		LONG MEADOW		EAST MARSH		TRIANGLE MARSH		NORTH PEN		SALT MARSH		SERPENTINE		ROUGH MEADOW		MOTH 1		MOTH 2		MOTH 3		
	UL	WL	UL	WL	UL	WL	UL	WL	UL	WL	UL	WL	UL	WL	UL	WL	UL	WL	UL	WL	UL	WL	
AMWI																							
BAGO																							
BUFF																							
CAGE																							
CANV																							
COGO																							
COME																							
EUWI																							
GWTE																							
HOME																							
MALL																							
NOPI																							
NOSL																							
RBME																							
Scaup Sp.																							
TRSW																							

Comments: _____



SERPENTINE PROJECT

Page 2 of 2

Project: Serpentine Wildlife Area
 Census Method: visual
 Water level: _____
 Coverage: MU #

File # _____
 Start Time: _____
 Weather: _____
 Observability: _____

Obs _____
 Date: _____

UNIT	SOUTH PEN		LONG MEADOW		EAST MARSH		TRIANGLE MARSH		NORTH PEN		SALT MARSH		SERPENTINE		ROUGH MEADOW		MOTH 1		MOTH 2		MOTH 3	
	UL	WL	UL	WL	UL	WL	UL	WL	UL	WL	UL	WL	UL	WL	UL	WL	UL	WL	UL	WL	UL	WL
AMCO																						
Cormorant																						
Coyote																						
MELA																						
PBGR																						
River Otter																						
SBDO																						
Seal																						
WEGR																						

UNIT	SOUTH PEN		LONG MEADOW		EAST MARSH		TRIANGLE MARSH		NORTH PEN		SALT MARSH		SERPENTINE		ROUGH MEADOW		MOTH 1		MOTH 2		MOTH 3	
	UL	WL	UL	WL	UL	WL	UL	WL	UL	WL	UL	WL	UL	WL	UL	WL	UL	WL	UL	WL	UL	WL
RAPTORS																						
BAEA																						
COHA																						
Merlin																						
NOHA																						
RTHA																						
SSHA																						

Comments: _____



APPENDIX B. SPECIES LIST.


APPENDIX B. Species List (Common and Scientific Names)

TABLE V. WILDLIFE SPECIES OBSERVED FROM NOVEMBER 1999 TO APRIL 2000 AT THE SERPENTINE WILDLIFE MANAGEMENT AREA DURING SURVEYS.

COMMON NAME	SCIENTIFIC NAME
American Coot	<i>Fulica americana</i>
American Wigeon	<i>Fulica americana</i>
Bald Eagle	<i>Haliaeetus leucocephalus</i>
Barrow's Goldeneye	<i>Bucephala islandica</i>
Bufflehead	<i>Bucephala albeola</i>
Canada Goose	<i>Branta canadensis</i>
Canvasback	<i>Aythya valisineria</i>
Common Goldeneye	<i>Bucephala clangula</i>
Common Merganser	<i>Mergus merganser</i>
Cooper's Hawk	<i>Accipiter cooperii</i>
Coyote	<i>Canis latrans</i>
Double-breasted Cormorant	<i>Phalacrocorax auritus</i>
Eurasian Wigeon	<i>Anas penelope</i>
Green-winged Teal	<i>Anas crecca</i>
Harbour Seal	<i>Phoca vitulina</i>
Hooded Merganser	<i>Lophodytes cucullatus</i>
Mallard	<i>Anas platyrhynchos</i>
Merlin	<i>Falco columbarius</i>
Northern Harrier	<i>Circus cyaneus</i>
Northern Pintail	<i>Anas acuta</i>
Northern Shoveler	<i>Anas clypeata</i>
Pied-billed Grebe	<i>Podilymbus podiceps</i>
Red-breasted Merganser	<i>Mergus serrator</i>
Red-tailed Hawk	<i>Buteo lagopus</i>
River Otter	<i>Lutra canadensis</i>
Scaup spp.	<i>Aythya spp.</i>
Sharp-shinned Hawk	<i>Accipiter striatus</i>
Short-billed Dowitcher	<i>Limnodromus griseus</i>
Trumpeter Swan	<i>Cygnus buccinator</i>
Western Grebe	<i>Aechmophorus clarkii</i>
Western Meadowlark	<i>Sturnella neglecta</i>