



Padilla Bay

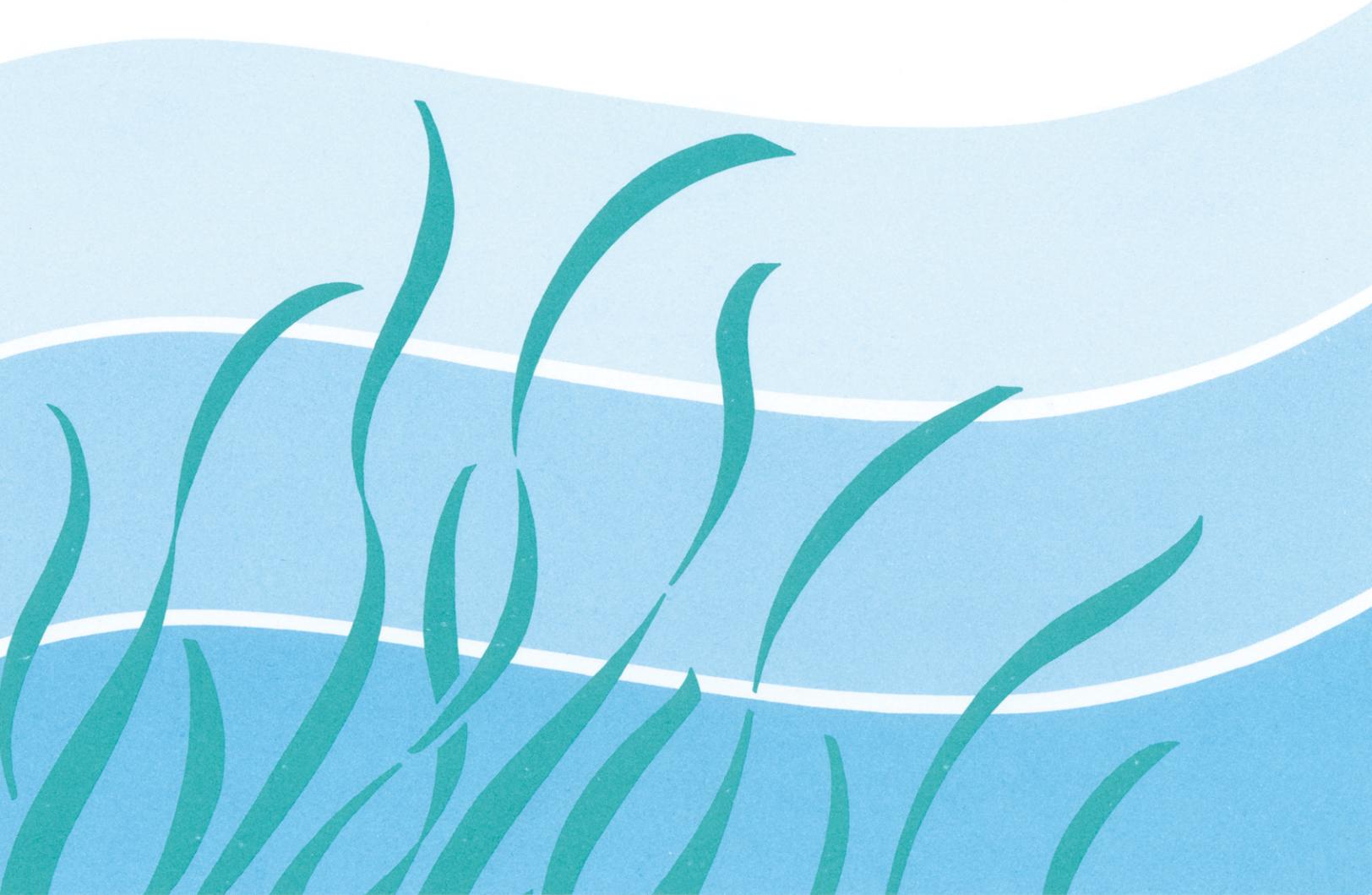
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A PRELIMINARY INVENTORY OF THE BIOTA OF PADILLA BAY

Robert Jeffrey

1976



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A PRELIMINARY INVENTORY
of the
BIOTA OF PADILLA BAY

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Introduction

As a relatively unspoiled estuarine habitat in northern Puget Sound, Padilla Bay produces and supports a variety of birds, mammals, fishes, and invertebrates. These contribute significantly to the economic, recreational, and aesthetic qualities of the region. This much can be stated confidently in the light of what has been learned elsewhere of the productivity and far-ranging benefits of estuaries. Yet to safeguard Padilla Bay from either slow deterioration or outright destruction, it is necessary to document its present values beyond question.

The purpose of this report is to provide a starting point for establishing the importance of the bay as it now exists. Most of the surveys drawn together in this preliminary inventory represent some effort at quantitative appraisal, but much additional work of a more rigorous nature will be needed. The report reveals at least some of the areas for which new information will be required to fully clarify the contributions of Padilla Bay to the greater ecosystem and economy of northern Puget Sound. It would be premature and not within the compass of the report to attempt to describe, beyond commenting on the apparent, the food chains and other interdependencies of the community. However, the diversity and density of life indicated by investigations to date are persuasive evidence, we submit, of a productive ecosystem and a critically important resource.

Contributors to the report are listed below, but thereafter are identified only by their respective organizations. Herbert H. Webber and Gary F. Smith of the Huxley College of Environmental Studies (Western Washington State College) made available data from the sampling of invertebrates and fishes from the intertidal and subtidal zones of Padilla Bay. Terence R. Wahl of the Department of Biology of Western Washington State College supplied an annotated checklist of birds and the information on the gull colony. Russell Orrell, Mark Pederson, Bob Trumble, Mary Aguero, and Lynn Goodwin provided reports on salmon fry, bottom fish, and invertebrates from the files of the Department of Fisheries. Robert Jeffrey and Richard Parker summarized the available information in Game Department files on waterfowl, other birds, and mammals. The above contributions represent preliminary, unpublished data and should not be used in publications without the specific consent of the respective contributor. In addition, through the kind permission of Professor Robert Sylvester of the University of Washington, we have relied heavily on a study made under his supervision for the Texas Company (Sylvester and Clogston 1958).

General Description

As arbitrarily bounded on the west (Figure 1), Padilla Bay contains 14,500 acres. The bay is shallow, with nearly 60 percent of the bottom being exposed at mean lower low water and with only a very restricted area south of Hat Island exceeding 15 feet in depth. Fresh water discharge into the bay is limited, deriving entirely from surrounding slopes and diked farm land. The water of the bay, therefore, is usually clear, and the median salinities, as calculated from data given in Sylvester and Clogston (1958), average 2.7 percent (seawater = 3.4 percent).

In this environment flourish extensive beds of the dominant plant species, eel-grass (Zostera marina). Marine algae and diatoms also are important producers associated with the eel-grass. This type of estuary is among the most productive of ecosystems (Odum 1971:359-360) with large surpluses of foods, both organisms and materials, being exported to the inhabitants of deeper water. Typically, the food resource also contributes to the support of numerous permanent and temporary residents. These would include many of the commercially important species of fish and most birds and mammals found in the bay or its shoreline habitat.

Huxley College comment: "Compared with other mud-flat areas in northern Puget Sound (Fidalgo Bay, Drayton Harbor), the intertidal area of Padilla Bay tends to have the most mixed substrate. That is, there are large areas where the mud is mixed with gravel, particularly in the higher levels of the tidal zone. The sampling location (H1, Figure 1) is typical for most of the eastern shore of Padilla Bay."

Vegetation

Department of Game: "The use of aerial photos was combined with observation from a low flying plane to construct an outline map of the eel-grass beds. The area occupied by this species was then determined by planimeter to be roughly 10,600 acres, or 73 percent of the area of the bay (Figure 1)."

Huxley College: "Algal forms are limited in the intertidal zone on the sampling site (H1, Figure 1). Colonial diatoms are abundant over much of the mud surface. Of the macro algae only Tiffaniella synderae, a red alga, was found with any regularity. At a subtidal station southeast of Hat Island (H2, Figure 1), three species of algae occurred with the eel-grass (Appendix D). The dry weight of eel-grass and the wet weight of the algae were secured from a series of 0.25 m² quadrats."

Botryoglossum farbulanum } dbl.
Monostroma fuscum } check
Urospara sp.

Figure 1. Podilla Bay showing extent of eel-grass beds, and location of survey sites and important habitats.

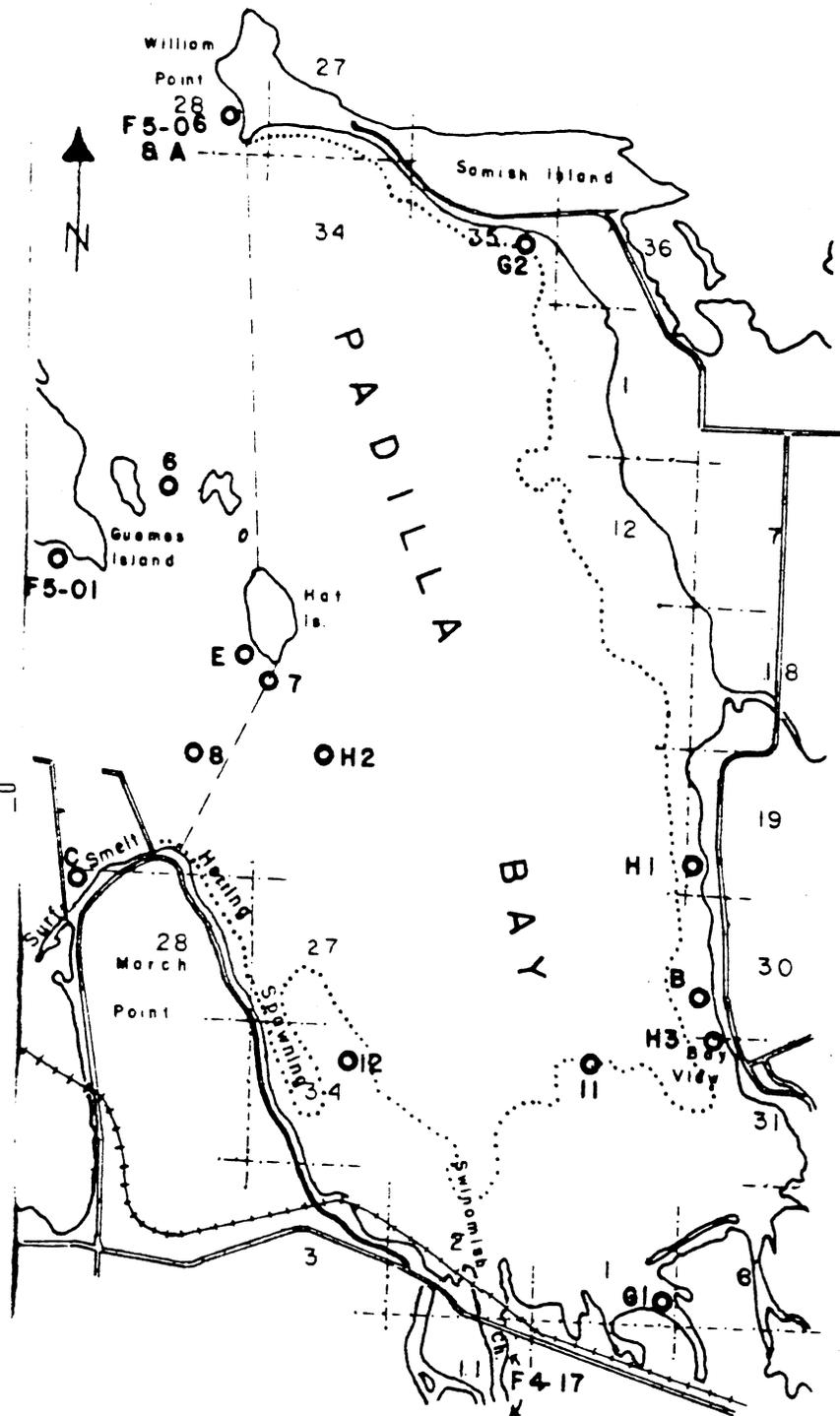
LEGEND

- Arbitrary western boundary of bay.
- Upper limit of eel-grass.
- 12 Section numbers
- H2 Survey site (see text).
-

SCALE

Miles

1/2 0



Sylvester and Clogston (1958) identified six species of marine algae and in places they were described as forming a thick covering or a rich growth. (The narrative description of the intertidal survey at stations A, B, C, and E has been summarized in Appendix A. Locations are shown in Figure 1.) These investigators reported dense growths of eel-grass at two of the stations and found colonies of diatoms attached to the leaf ends. Nineteen forms of diatoms were collected at plankton survey stations in or near Padilla Bay. The five stations 6, 7, 8, 11, and 12, (Figure 1), were sampled in late March and again in mid-June and results are detailed in Appendix B.

Invertebrates

Sylvester and Clogston (1958) obtained bottom-dredge samples at stations 6, 7, 8, and 12. Over 40 forms of invertebrates were retrieved, with molluscs and crustaceans dominating the lists. The descriptive comment is quoted below; the species lists may be found in Appendix C.

"Station 6. Between Huckleberry and Saddlebag Islands. March 23, 1958; 42 fathoms. The bottom was of shell and mud. The characteristic fauna consisted of very many bryozoans and hydroids on shells; numerous Crustacea including isopods, shrimps, spider crabs, true crabs, and hermit crabs; many molluscs, particularly small clams; and Polychaete worms. Some brown algae, Laminaria sp. was seen.

"Station 7. South of Hat Island. March 23, 1958; 5 fathoms. The bottom was muddy sand with shells, small clams, serpent stars and Polychaete worms as the characteristic fauna.

"Station 8. North of March Point. March 23, 1958; 5 fathoms. This station is just north of the light off March Point. The bottom was composed of muddy sand with shells, small clams, serpent stars and Polychaete worms as the characteristic fauna; being similar to Station 7.

"Station 12. Padilla Bay in channel to Swinomish Slough. March 23, 1958; 2.5 fathoms. The bottom consists of sand with scattered shells of Clinocardium.

"The eight intertidal stations four in or near Padilla Bay (Figure 1) were surveyed when the tidal elevation was below mean-lower-low water. Because of the dependence upon these tides, the study extended from late June to early August."

The identification and occurrence of the invertebrate forms for the intertidal survey have been summarized in tabular form (Appendix A). Some 72 forms were recorded from the intertidal stations with molluscs and crustaceans together accounting for over half of these (20 and 19 respectively).

Huxley College: "Distribution of intertidal organisms is minimal in the upper part of the beach (H1, Figure 1). Limpets, snails and barnacles are found where gravel substrate is encountered. Amphipods and shore crabs are also abundant.

"In the mid- and low-tide zones, infauna are common. Polychaetes and bivalves are the dominant forms. Of the polychaetes, Abarenicola and Capitella were most common. Of the bivalves, Macoma, Mya, and Transennella are most frequently encountered.

"Much of the subtidal area of Padilla Bay consists of eel-grass beds. We have sampled approximately three-quarters mile south and east of Hat Island (H2, Figure 1). As with other eel-grass habitats in northern Puget Sound, the eel-grass beds of Padilla Bay are rich in both diversity and density of organisms. Polychaete, clam, and crustacean species are common in the eel-grass community. In Appendix D, invertebrate forms occurring in amounts greater than 0.1 g in the eel-grass samples are listed with the mean wet weights. These numbered 32; however, the total number of species found was 129."

Department of Fisheries: "No quantitative surveys of either the shellfish stocks or the Dungeness crab (Cancer magister) resource have been completed for Padilla Bay. An intensive recreational fishery on hard-shelled clams exists around March Point and at Samish Island. Commercial landings of the Dungeness crab provide an index to the production of this species. For Padilla Bay, these have averaged 79,200 pounds during the past ten years (1966-1975) with the high amount of 131,700 pounds having been landed in 1975. There no longer is any significant production of oysters (Crassostrea gigas) in the bay."

Vertebrates: Fishes

Department of Fisheries: "Padilla Bay is an area of significant ecological importance to the life histories of marine fish species inhabiting Bellingham Bay, the San Juan Island waters, and the Gulf of Georgia. Specifically, Padilla Bay is a holding area for maturing herring (Clupea harengus). It is a spawning and nursery area for herring and other species of baitfish (Figure 1). This is a nursery area for many species of flatfish such as English sole (Parophrys retulus), Dover sole (Microstomus pacificus), rock sole (Lipidoptsetta bilineata), sand sole (Psettichthys melanostictus), and starry flounder (Platichthys stellatus). It is an important route of migration for juvenile chinook salmon (Oncorhynchus tshawytscha), coho (O. kisutch), Pink (O. gorbuscha), and chum salmon (O. keta). Finally, this area, in its present state, supports a wide array of estuarine organisms that are foraged upon by commercial species.

"Juvenile pink and chum salmon begin their seaward migration immediately upon emergence from the gravel of the spawning beds. Once they reach saltwater, they spend up to four months in the shoreline areas before moving offshore and seaward. Coho and some chinook spend a year in freshwater before migrating out to sea. Padilla Bay is an important route for these juvenile salmon. A portion of the juvenile salmon produced by the Skagit River travel north through the Swinomish Channel and out through Padilla Bay. From the north, juvenile salmon originating in the Nooksack River, Samish River, and Chuckanut, Oyster and Colony creeks travel south through Padilla Bay.

"Marine surveys of pink and chum fry abundance have been conducted by the Department on a regular basis since 1963. The results of these and related surveys for southeastern Guemes Island, William Point, the easterly shoreline of Padilla Bay and the Swinomish Channel are shown in Appendixes E, F, and G. Counts of up to 4,375 chum and 1,664 pink per mile have been recorded in the Swinomish Channel, (area 4, sub-area 17 - designated F 4-17 in Figure 1) while at William Point (F 5-06, Figure 1), 8,300 chum and 3,608 pinks per mile have been counted. A sampling area near the southeast shore of Guemes Island (F 5-01, Figure 1) yielded counts of 10,000 chum and 5,207 pink fry per mile. The Padilla shoreline, in a special survey conducted in 1970, produced high counts of 485 chum and 3,557 pink fry per mile (Appendix G).

"While Padilla Bay is important to all juvenile salmon as a migration route, it is of special importance to pink and chum salmon as a rearing area. During the three to four months these fish spend in the near-shore area, they are feeding and growing; a good supply of food is essential to their survival.

"Gerke and Kaczynski (1972) found that the predominate component of the pink and chum diets in near-shore areas was epibenthic (living on or near the bottom) organisms. A summary based upon the findings of this report is presented in Appendix H. Juvenile pink salmon relied upon epibenthic organisms for 53.9 percent of their diet; for juvenile chum salmon, the percentage was 59.6. Since epibenthic organisms are the main components in the pink and chum diets in near-shore areas such as Padilla Bay, the maintenance of the environment of these organisms is essential to the welfare of the fry. As Gerke and Kaczynski say in their report, 'The distinct ecological zone that epibenthic forms inhabit makes them extremely susceptible to changes in the beach habitat brought about by domestic and industrial development of intertidal and subtidal areas.'"

Huxley College: "Beach seines were conducted in Padilla Bay in August and October of 1974 (site H3, Figure 1). From catches obtained, it is clear that Padilla Bay has a diversity of fish species that is equal to that of other mud-flat areas." For a list of the 19 fish species see Appendix J. Among the fishes appearing in the sample were chinook salmon, chum salmon, herring and surf smelt (Hypomesus pretiosus). Sylvester and Clogston (1958) list two additional species (Appendix A) and the Department

of Fisheries lists three species of sole and two of salmon not found in the Huxley samples. Thus, 26 species of fish have been identified for Padilla Bay.

Vertebrates: Birds and Mammals

Department of Biology, W.W.S.C.: "We have banded glaucous-winged gull (*Larus glaucescens*) chicks on the colony on the west side of the Swinomish Channel, north of the railroad bridge for several years. Banding accomplishments are listed by year in Table 1.

TABLE 1. Glaucous-winged gulls banded as locals at the Swinomish nesting colony in Padilla Bay.

Year	No. of Juveniles Banded
1969	200
1970	266
1971	373
1972	668
1973	752
1974	387
1975	418
1976	688

The nesting population in 1975 was estimated to be 500 pairs. Banding effort for 1969, 1970, 1975, and 1976 was not comparable to the other years when an attempt was made to band all chicks (resulting probably in 60 to 75 percent of the young being banded). The trend of steadily increasing numbers is felt to be real - making it the only colony in Puget Sound likely to have grown significantly in the period. Nesting at Padilla Bay apparently started from an overflow from established colonies - banded adults hatched in the Colville and Protection colonies were noticed in the early years at Swinomish. The adjacent garbage dump was closed prior to the 1974 nesting season and may have cut production that year. However, 1975 with lower banding effort showed an increase in gulls banded and in 1976 at least 100 more birds could have been banded. The increasing production in the Swinomish colony probably indicates the birds utilize the natural food sources of Padilla Bay to a large extent."

A checklist of those birds associated with the water, intertidal zone, and immediate shoreline of Padilla Bay was made available (Appendix K). The list contains 110 verified species, including 8 loons and grebes, 3 cormorants, 5 wading birds, 34 waterfowl, 11 raptors, 41 gulls, terns and shorebirds, 3 alcids, and 5 others.

"In addition to those listed, a number of other species may also utilize edge habitats (beaches, tidal flats, marshes) and thus may be linked with Padilla Bay to some extent. In summary, Padilla Bay is especially important for waterfowl, shorebirds, gulls and terns, and raptors. This general area supplies some of the very best falcon habitat in the Northwest."

Department of Game: "Band-tailed pigeons (Columba fasciata) visit a Padilla beach north of Bayview. Here, a secluded, gravelly foreshore lined with trees, which provide convenient perches, meets all of the requirements of a mineral site for bandtails. The birds have been flocking to this beach for as long as local people can remember. A great blue heron (Ardea herodias) nesting colony on Samish Island also has been in existence for many years. Between 100 and 200 pairs occupy the heronry, which is located in a seldom disturbed grove overlooking the intertidal foraging ground. Four active aeries of the bald eagle (Haliaeetus leucocephalus) are located on the most remote sections of the Padilla shoreline. Whether the activity involved is rearing a brood of young or simply dropping to the beach to sate a thirst for minerals, its successful achievement by these species depends upon there being old-growth or large trees near the water and a high degree of freedom from molestation.

"Aerial counts of waterfowl have been conducted regularly since 1953, when biweekly fall and winter flights were inaugurated for the four species of dabblers, mallard (Anas platyrhynchos), pintail (A. acuta), green-winged teal (A. crecca), and wigeon (A. americana). Averages representing counts of the past ten years in Padilla Bay have been calculated for these ducks (Appendix L). The wigeon ranks first in abundance at 44 percent of the total. Others, in order, are pintail - 30 percent, mallard - 14 percent, and green-winged teal - 11 percent. Although some dabbling ducks may be observed on Padilla Bay in any month of the year, late fall is the season of peak abundance. Beginning with the first migrants in August, dabbler numbers swell to an average of 28,000 by November. Normally, many seed-eating ducks disperse into the river valleys by December, but a record number of these species moved into Padilla Bay in December, 1975, resulting in counts as high as 118,800. This caused some distortion of the monthly average.

"Similar data does not exist for other duck populations of Padilla Bay. An annual sample count is made near the first of the year for diving and sea ducks. Unfortunately, only two of the census plots fall in Padilla Bay. Together they include two miles of shoreline and 11 percent of the area of the bay (Figure 1, G-1 and G-2). Some uncommon species such as the harlequin duck (Histrionicus histrionicus) and the redhead (Aythya americana) are seldom identified from the air. Two locally common species, the ruddy duck (Oxyura jamaicensis) and the red-breasted merganser (Mergus serrator), have not been recorded on the census plots principally because the two samples do not include all of the varied environments of the bay. Very similar species, such as the greater and lesser scaups (Aythya marila and A. affinis), are not separated, being recorded simply as 'scaup', 'goldeneye', or 'scoter'.

"In the ten years, 1965-1974, the census has recorded six species or species groups. They are canvasback (Aythya valisneria), scaup (mostly the greater scaup), goldeneye (predominately the common goldeneye Bucephala clangula), bufflehead (B. albeola), scoter (mostly the surf scoter Melanitta perspicillata), and old squaw (Clangula hyemalis). The average count on the plots has been about 655 ducks (Appendix M), leading to the estimate, 6,152 for the entire bay. This can be no more than a fraction of the annual peak for these populations; in late October single rafts containing 10,000 scaup have been observed on Padilla Bay.

"Both the black brant (Branta nigricans) and representatives of a population of brant (B. bernicla) occur on Padilla Bay as winter residents and migrants. The black brant is much more numerous, particularly in spring migration. Padilla Bay may host a third or more of the brant in the entire Pacific Flyway for a short period in April; on two occasions, over 50,000 have been counted (Appendix N). Eel-grass is the staple food of brant. Any condition or agent causing a reduction in the area of eel-grass available to these birds would also be likely to proportionately reduce the brant.

"A number of harbor seals (Phoca vitulina) take advantage of the isolation provided by low tides to haul out on channel banks far out in the intertidal zone of the bay. Our highest recent count was made October 1, 1974, when 45 were observed from a plane."

Conclusion

We have presented data that reveal the Padilla ecosystem to be a densely populated, diverse and complex community - one that now sustains a large number of species important to man. Additional quantitative surveys are indicated. One such, dealing with the subtidal benthos, is now being conducted by Huxley College. Also needed is a comparative analysis of the worth of Padilla Bay in terms of human use. Like the present report, such a preliminary analysis would make use of the available information and is suggested as an immediate sequel to this report.

Summary

Padilla Bay is a shallow, brackish arm of northern Puget Sound. The area of the bay is about 14,500 acres, of which 73 percent is occupied by eel-grass beds. Data are summarized from a total of 17 survey sites in or near Padilla Bay. Plant life, in addition to eel-grass, included 10 species of macro algae and 19 forms of diatoms. A subtidal station yielded 129 species of invertebrates in the benthic and epibenthic environments; some 72 invertebrate

species were identified from the intertidal sampling.

Twenty-six species of fish including several of commercial importance, were reported for Padilla Bay. Annual sample counts of juvenile pink and chum salmon combined with food-habits data emphasized the dependence of these species on Padilla Bay. Links were established between other important species of fish and shellfish and the Padilla environment.

Associated with the bay or its immediate shoreline are 110 species of birds, which were included in an annotated bird list. Conspicuous breeding birds include the glaucous-winged gull with a nesting colony of 500-plus pairs, the great blue heron with 100-200 nests, and the bald eagle with 4 active aeries overlooking Padilla Bay. Numbers of dabbling ducks averaged 28,000 at the fall peak, with a record count of 118,800. The winter population of diving ducks is about 6,200, but the bay is known to support many more during the fall. Padilla Bay is an important staging area for brant in spring migration. Over 50,000 have been counted there in April.

It was concluded that Padilla Bay represents a highly productive ecosystem, but that more investigations are needed to better define its value to man. It was recommended that the available information on human use of the bay be assembled into a second report.

References Cited

- Gerke, R.J. and V.W. Kaczynski. 1972. Food of juvenile pink and chum salmon in Puget Sound, Washington. Washington Dept. of Fisheries Tech. Rept. No 10. 27 pp.
- Odum, E.P. 1971. Fundamentals of ecology. W.B. Saunders Co., Philadelphia. 574 pp.
- Sylvester, R.O. and F.L. Clogston. 1958. A study of the preoperational marine environment in the vicinity of the Texas Company refinery Puget Sound Works, Anacortes, Washington. Prepared for the Texas Company. 157 pp + appendix.

APPENDIX A (continued)

Phylum	Reference Taxon	Form	Station				
			A	B	C	E	
Annelida	Polychaeta: Bristleworms	<u>Protothaca staminea</u> - Rock cockle	X	X	X		
		<u>Clinocardium nuttallii</u> - Cockle	X	X	X		
		<u>Schizothaerus nuttallii</u> - Horse clam	X	X	X		
		<u>Saxidomus nuttallii</u> - Butter clam	X	X	X		
		<u>Macoma nasuta</u> - Bent nose clam	X	X	X		
		<u>Serpula vermicularia</u> - Tube worm	X			X	
		Serpulids				X	
		<u>Amphitrite cirrata</u> - Tube worm	X		X		
		<u>Sabellid</u> - Feather duster worm	X				
		<u>Arenicola pusilla</u>	X	X			
<u>Glycera</u> sp.	X	X					
<u>Glycera americana</u>	X	X	X	X			
<u>Nereis</u> sp.			X				
Minute polychaetes		X					
Arthropoda	Copepoda: Copepods	Copepods	X		X		
		Harpacticids	X				
		<u>Balanus glandula</u>	X	X		X	
		<u>B. cariosus</u>	X			X	
		<u>B.</u> spp.			X		
		<u>Idothea wosnesenkii</u>	X		X	X	
		Sphearomids		X			
		<u>Caprella</u> sp.	X		X		
		<u>Orchestia</u> sp.				X	
		<u>Pugettia producta</u> - Kelp crab	X		X	X	
Decapoda: Shrimp, lobsters, true crabs	Copepoda: Barnacles	<u>Hemigrapsis nudis</u> - Shore crab	X		X	X	
		<u>H. oregonensis</u> - Shore crab	X	X	X	X	
		<u>Petrolisthes eriomerus</u> - Porcelain crab	X		X	X	
		<u>Pagurus granosimanus</u> - Hermit crab	X	X			
		<u>Cancer magister</u> - Dungeness crab	X		X		
		<u>Cancer productus</u>	X				
		<u>Upogebia pugettensis</u> - Ghost shrimp	X			X	
		<u>Telmessus cheiragonus</u> - Horse crab	X			X	

APPENDIX A (continued)

Phylum	Reference Taxon	Form	Station				
			A	B	C	E	
Echinodermata	Holothuroidea: Sea cucumbers	<u>Eupentacta quinquesemita</u>				X	
		<u>Cucumaria miniata</u>				X	
	Echinoidea: Sea urchins	<u>Strongylocentrotus droebachiensis</u>				X	
		<u>Pisaster ochraceous</u>	X			X	
	Asteroidea: Sea stars	<u>Henricia leviuscula</u>				X	
		<u>Leptasterias hexactis</u>				X	
		Unident. serpent stars				X	
	Chordata	Ophiuroidea: Brittle stars					
Ascidiacea: Sessile tunicates		<u>Pyura haustor</u>				X	
		<u>Boltenia villosa</u>				X	
		<u>Cnemidocarpa finmarkiensis</u>				X	
Osteichthyes Bony fishes	Sculpin	X					
	<u>Pholis laetus</u> - Blenny				X		
	<u>Epigeichthys atropurpureus</u> - Blenny				X		
	<u>Sicyogaster maeandricus</u> - Cling fish				X		
	<u>Gasterosteus aculeatus</u> - Stickleback			X			
<u>PLANTS</u>							
Chlorophyta	Chlorophyta: Green algae	<u>Ulva</u> sp.	X	X	X	X	
Bacillariophyta	Bacillariophyta: Diatoms	Diatoms	X		X		
Phaeophyta	Phaeophyta: Brown algae	<u>Fucus furcatus</u>	X				
		<u>F.</u> sp.	X		X		
		<u>Costaria costatum</u>	X			X	
Rhodophyta	Rhodophyta: Red algae	<u>Laminaria</u> sp. <u>Gigartina</u> sp.	X			X X	
Spermatophyta	Zosteraceae: Eel-grasses	<u>Zostera marina</u>	X	X	X	X	

Station data: A July 18, 1958; tide -1.5 feet.
 B June 28, 1958; tide -1.4 feet.
 C June 28, 1958; tide -1.4 feet.
 E July 30, 1958; tide -1.3 feet.

APPENDIX B

Results of plankton surveys at five stations in or near Padilla Bay. From Sylvester and Clogston (1958). No collections were made at night. The net was a twelve-inch diameter, number 12 silk net. Collections were made by oblique tows in which the winch was geared to bring in the cable at about 10 meters per minute.

Station 6. Mid-channel between Huckleberry and Saddlebag Islands.

Depth - 40 fathoms

March 23, 1958

June 16, 1958

Diatoms:		Diatoms:	
<u>Biddulphia alternans</u>	some	<u>Biddulphia alternans</u>	some
<u>Coscinodiscus concinus</u>	numerous	<u>Coscinodiscus concinus</u>	numerous
<u>C. granii</u>	numerous	<u>C. centralis</u>	some
<u>C. centralis</u>	numerous	<u>Ditylum brightwelli</u>	some
<u>Ditylum brightwelli</u>	a few	<u>Rhizosolenia spp.</u>	some
<u>Rhizosolenia sp.</u>	a few	<u>Isthmia nervosa</u>	some
<u>Isthmia nervosa</u>	some	<u>Cheateoceros affinis</u>	numerous
Coelenterata; Hydrazoa:		<u>C. decipiens</u>	numerous
<u>Obelia sp. medusa</u>	a few	<u>Thalassionema nitzschioides</u>	a few
Annelida; Polychaeta:		<u>Melosira moniliformes</u>	numerous
Pot-trochophore stages	numerous	<u>Thalassiosira rotula</u>	some
Echinodermata:		<u>T. decipiens</u>	a few
Pluteus larva	a few	<u>Navicula distans</u>	a few
Chordata; Urochordata:		<u>Astrionella japonica</u>	some
<u>Oikopleura sp.</u>	some	<u>Nitzschia longissima</u>	a few
Arthropoda; Crustacea:		Coelenterata; Hydrazoa:	
Copepoda		<u>Obelia sp. medusa</u>	some
<u>Calanus finmarchicus</u>	a few	Ctenophora:	
<u>Microcalanus pusillus</u>	numerous	<u>Pleurobrachia bachei</u>	numerous
<u>Pseudocalanus minutus</u>	numerous	Annelida; Polychaeta:	
<u>Acartia clausi</u>	a few	Post-trochophore stages	some
<u>Corycaeus affinis</u>	numerous	Chaetognatha:	
<u>Microsetella norvegica</u>	some	<u>Sagitta elegans</u>	some
Nauplii and copepodids	numerous	Chordata; Urochordata:	
Cirripedia		<u>Oikopleura sp.</u>	some
Nauplii	numerous	Arthropoda; Crustacea:	

APPENDIX B (continued)

Station 6 (continued)

Decapoda		Copepoda	
Mysis stage of shrimp	a few	<u>Calanus finmarchicus</u>	a few
Zoea of crabs	numerous	<u>Microcalanus pusillus</u>	numerous
		<u>Pseudocalanus minutus</u>	numerous
		<u>Eucalanus elongatus</u>	a few
		<u>Acartia clausi</u>	a few
		<u>Corycaeus affinis</u>	numerous
		<u>Microsetella norvegica</u>	a few
		Nauplii and copepodids	some
		Cirripedia	
		Nauplii	some
		Amphipoda	
		Hyperiid (1 species)	some
		Decapoda	
		Mysis stage of shrimp	a few
		Zoea of crabs	some
		Megalops of crabs	numerous

Station 7. Padilla Bay, 200 yards off south end of Hat Island.
Depth - 5 fathoms

March 23, 1958

June 16, 1958

Diatoms:

<u>Biddulphia alternans</u>	some
<u>Coscinodiscus concinus</u>	numerous
<u>C. centralis</u>	some
<u>Ditylum brightwelli</u>	a few
<u>Isthmia nervosa</u>	some

Coelenterata; Hydrazoa:

<u>Obelia</u> sp.	a few
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Annelida; Polychaeta:

Post-trochophore stages	some
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Chordata; Urochordata:

<u>Oikopleura</u> sp.	some
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Arthropoda; Crustacea:

Copepoda

<u>Microcalanus pusillus</u>	numerous
<u>Pseudocalanus minutus</u>	numerous
<u>Corycaeus affinis</u>	numerous
<u>Microsetella norvegica</u>	a few
<u>Harpacticus</u> spp.	a few
Nauplii and copepodids	numerous

Diatoms:

<u>Biddulphia alternans</u>	a few
<u>Coscinodiscus concinus</u>	numerous
<u>C. centralis</u>	some
<u>Arachnodiscus erhenbergi</u>	a few
<u>Ditylum brightwelli</u>	a few
<u>Rhizosolenia</u> sp.	a few
<u>Isthmia nervosa</u>	some
<u>Cheateoceros affinis</u>	some
<u>C. decipiens</u>	some
<u>Pleurosigma</u> sp.	a few

Ctenophora:

<u>Pleurobrachia bachei</u>	very numero
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Annelida; Polychaeta:

Post-trochophore stages	some
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Chaetognatha:

<u>Sagitta elegans</u>	a few
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Chordata; Urochordata:

<u>Oikopleura</u> sp.	some
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APPENDIX B (continued)

Station 7 (continued)

Cirripedia		Arthropoda; Crustacea:	
Nauplii	numerous	Cladocera	
Cypris stage	a few	<u>Podon</u> sp.	one
Decapoda		Copepoda	
Mysis stage of shrimp	a few	<u>Calanus finmarchicus</u>	a few
Meiofauna of crabs	numerous	<u>Microcalanus pusillus</u>	numerous
		<u>Pseudocalanus minutus</u>	numerous
		<u>Acartia clausi</u>	a few
		<u>Corycaeus affinis</u>	numerous
		<u>Microsetella norvegica</u>	a few
		<u>Harpacticus</u> sp.	a few
		Nauplii and copepodids	numerous
		Amphipoda	
		Hyperiid (1 species)	a few
		Decapoda	
		Mysis stage of shrimp	a few
		Megalops of crabs	numerous

Station 8. Padilla Bay, 100 yards north of light dolphin marking north entrance to Swinomish Channel.

Depth - 9 fathoms

March 23, 1958

June 16, 1958

Diatoms:

<u>Biddulphia alternans</u>	some
<u>Coscinodiscus concinus</u>	numerous
<u>C. centralis</u>	some
<u>Ditylum brightwelli</u>	a few
<u>Isthmia nervosa</u>	some

Coelenterata; Hydrazoa:

<u>Obelia</u> sp. medusa	a few
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Annelida; Polychaeta:

Post-trochophore stages	a few
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Chordata; Urochordata:

<u>Dikopleura</u> sp.	some
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Diatoms:

<u>Biddulphia alternans</u>	a few
<u>Coscinodiscus concinus</u>	numerous
<u>C. centralis</u>	some
<u>Ditylum brightwelli</u>	a few
<u>Rhizosolenia</u> spp.	some
<u>Isthmia nervosa</u>	some
<u>Cheateoceros affinis</u>	some
<u>C. decipiens</u>	some
<u>Thalassionema nitzschioides</u>	a few

Coelenterata; Hydrazoa:

<u>Obelia</u> sp. medusa	a few
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Ctenophora:

<u>Pleurobrachia bachei</u>	very numerous
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Annelida; Polychaeta:

Post-trochophore stages	some
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APPENDIX B (continued)

Station 8 (continued)

Arthropoda; Crustacea:		Chaetognatha:	
Copepoda		<u>Sagitta elegans</u>	a few
<u>Microcalanus pusillus</u>	numerous	Chordata; Urochordata:	
<u>Pseudocalanus minutus</u>	numerous	<u>Oikopleura</u> sp.	some
<u>Corycaeus affinis</u>	numerous	Arthropoda; Crustacea:	
<u>Harpacticus</u> sp.	a few	Cladocera	
Nauplii and copepodids	numerous	<u>Podon</u> sp.	two
Cirripedia		Copepoda	
Nauplii	numerous	<u>Calanus finmarchicus</u>	a few
Cypris stage	a few	<u>Microcalanus pusillus</u>	numerous
Decapoda		<u>Pseudocalanus minutus</u>	numerous
Mysis stage of a shrimp	a few	<u>Acartia clausi</u>	a few
Zoea of crabs	numerous	<u>Corycaeus affinis</u>	numerous
		<u>Microsetella norvegica</u>	a few
		Nauplii and copepodids	some
		Decapoda	
		Mysis stage of shrimp	some
		Megalops of crabs	numerous

Station 11. Padilla Bay, three-quarters of a mile west of Bayview.

Depth - 1 fathom

March 24, 1958

Not sampled in June due to low water.

Diatoms:

<u>Biddulphia alternans</u>	a few
<u>Coscinodiscus concinus</u>	numerous
<u>C. centralis</u>	some
<u>C. granii</u>	a few
<u>Isthmia nervosa</u>	very few
<u>Melosira moniliformes</u>	a few
<u>Pleurosigma normanii</u>	a few

Annelida; Polychaeta:

Trochophore larvae	numerous
Post-trochophore stages	numerous

Chordata; Vertbrata:

Unidentified fish eggs	a few
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APPENDIX B (continued)

Station 11 (continued)

Arthropoda; Crustacea:

Copepoda	
<u>Harpacticus</u> sp.	a few
Nauplii	some
Cirripedia	
Nauplii	some
Decapoda	
Zoea of crabs	some

Station 12. Swinomish Channel, opposite can buoy No. 17.

Depth - 3 fathoms

March 22, 1958

June 17, 1958

Diatoms:

<u>Biddulphia alternans</u>	a few
<u>Coscinodiscus concinus</u>	numerous
<u>C. centralis</u>	some
<u>Ditylum brightwelli</u>	a few
<u>Isthmia nervosa</u>	a few
<u>Pleurosigma normanii</u>	a few
<u>Navicula distans</u>	a few

Coelenterata; Hydrozoa:

<u>Obelia</u> sp. medusa	a few
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Annelida; Polychaeta:

Post-trochophore stages	some
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Chordata; Urochordata:

<u>Oikopleura</u> sp.	a few
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Arthropoda; Crustacea:

Copepoda

<u>Calanus finmarchicus</u>	three
<u>Microcalanus pusillus</u>	numerous
<u>Pseudocalanus minutus</u>	numerous
<u>Corycaeus affinis</u>	numerous
<u>Microsetella norvegica</u>	a few
<u>Harpacticus</u> spp.	some
Nauplii and copepodids	some

Cirripedia

Nauplii	some
Cypris stage	a few

Decapoda

Zoea	some
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Diatoms:

<u>Biddulphia alternans</u>	a few
<u>Coscinodiscus concinus</u>	numerous
<u>C. centralis</u>	some
<u>Ditylum brightwelli</u>	a few
<u>Rhizosolenia</u> sp.	a few
<u>Isthmia nervosa</u>	a few
<u>Cheatoceros affinis</u>	some
<u>C. decipiens</u>	some
<u>Navicula distans</u>	a few

Coelenterata; Hydrozoa:

<u>Obelia</u> sp. medusa	a few
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Ctenophora:

<u>Pleurobrachia bachei</u>	some
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Annelida; Polychaeta:

Post-trochophore stages	some
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Chaetognatha:

<u>Sagitta elegans</u>	a few
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Chordata; Urochordata

<u>Oikopleura</u> sp.	a few
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Arthropoda; Crustacea:

Copepoda

<u>Calanus finmarchicus</u>	a few
<u>Microcalanus pusillus</u>	numerous
<u>Pseudocalanus minutus</u>	numerous
<u>Corycaeus affinis</u>	numerous
<u>Microsetella norvegica</u>	a few
<u>Harpacticus</u> sp.	a few
Nauplii and copepodids	some

Cirripedia

Nauplii and cypris stages	some
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Decapoda

Megalops of crabs	numerous
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APPENDIX C

Results of dredge sampling at four stations in or near Padilla Bay from Sylvester and Clogston (1958). A rock dredge was used. Each haul was roughly equivalent in surface area covered, differing by type of bottom covered and by the current effect on the towing vessel. At least two hauls were made at each station. Each haul was screened in a series of three coarse-to-fine screens.

Station 6: Between Huckleberry and Saddlebag Islands.

March 23, 1958 42 fathoms

Bryozoa: Membranipora sp. circular colonies

Coelenterata:

Hydrozoa	<u>Abietinaria variabilis</u>	numerous
	<u>A. sp.</u>	numerous
	<u>Thuiaria argentea</u>	numerous
	<u>Halecium</u> sp.	numerous

Echinodermata:

Serpent star	<u>Ophiura lukeni</u>	some
	<u>O. sp.</u>	some

Annelida; Polychaeta:

Sea mouse	<u>Aphradite japonica</u>	few
	<u>Pectinaria brevicoma</u>	numerous
	Unidentified fragments of tube worms	

Mollusca:

Polyplacophora:

	<u>Ischnochiton mertensii</u>	some
	<u>I. cooperii</u>	some

Gastropoda:

Nudibranch	<u>Archidoria</u> (possibly <u>A. montereyensis</u>)	one
	<u>Polynices</u> sp.	a few, small
	<u>Trichotropus</u> sp.	numerous
	<u>Calyptraea fastigiata</u>	some

Pelecypoda:

	<u>Yoldia</u> sp.	numerous
	<u>Cardita</u> sp.	numerous
	<u>Acila</u> sp.	numerous

Scallops

	<u>Pecten hindsii</u>	a few, small
	<u>Humilarea</u> sp.	some
	<u>Nuculana</u> sp.	a few
	<u>Cardium</u> sp.	a few
	<u>Protothaca staminea</u>	one, small

APPENDIX C (continued)

Arthropoda; Crustacea;		
Isopod	<u>Rocinela angrestata</u>	very numerous
Shrimp	<u>Crago alaskensis</u>	four
	<u>Pandalus danae</u>	four
	<u>Spirontocaris brevirostris</u>	two
	<u>Spirontocaris</u> sp.	one
	<u>Oregonis gracilis</u>	many
	<u>Hyas</u> sp.	a few
	<u>Pagurus setosa</u> in <u>Polynices</u> shell	one
	<u>Cancer oregonensis</u>	some
	<u>Telmessus cheiragonus</u>	one
Station 7 South of Hat Island March 23, 1958; 5 fathoms		
Annelida: Polychaeta:		
	<u>Sternaspis fossor</u>	very many
	<u>Lumbrineria latreilli</u>	some
	<u>Nephtys ciliata</u>	some
	<u>Armandia brevis</u>	some
Echinodermata:	<u>Amphioda urtica</u>	numerous
Mollusca; Pelecypoda:		
	<u>Yoldia</u> sp.	a few
	<u>Nucula</u> sp.	a few
	<u>Macoma nasuta</u>	a few
	<u>Protothaca staminea</u>	a few
Arthropoda; Crustacea:		
	<u>Gammarid amphipod</u>	a few
	<u>Pinnixia schmitti</u>	a few
Station 8, North of March Point March 23, 1958; 5 fathoms		
Coelenterata:		
Hydrazoa	<u>Abietinaria</u> sp.	on cockle shells
Annelida; Polychaeta:		
	<u>Sternaspis fossor</u>	very numerous
	<u>Lumbrineria latreilli</u>	some
	<u>Nephtys ciliata</u>	some
	<u>Armandia brevis</u>	some
Echinodermata:	<u>Amphioda urtica</u>	numerous

APPENDIX C (continued)

Mollusca; Pelecypoda:

<u>Yoldia</u> sp.	a few
<u>Nucula</u> sp.	a few
<u>Macoma nasuta</u>	a few
<u>Protothaca staminea</u>	a few

numerous unidentified clam siphons

Arthropoda; Crustacea:

Gammarid amphipods	a few
<u>Pinnixia schumitti</u>	a few

Station 11, Padilla Bay, One Mile West of Bay View.

Not dredged due to shallowness of Padilla Bay and proximity of oyster beds. Heavy eel-grass.

Station 12, Padilla Bay in Channel to Swinomish Stough.
March 23, 1958; 2.5 fathoms

Echinodermata:	<u>Amphioda urtica</u>	a few
	<u>Leptasterias hexactis</u>	one

Arthropoda; -Crustacea:

<u>Crago</u> sp.	one
Gammarid amphipod, small, white	numerous

Station 14, Padilla Bay, 1.5 Miles West of Saddlebag Island. Not dredged because of shallow water. Heavy eel-grass.

APPENDIX D

Composition of the benthic community at a subtidal site in Padilla Bay

Location: 3/4 mile southeast of Hat Island (H2, Figure 1).

Depth: Minus 6 ft. (MLLW)

Sampling dates: August 13, 1975 (8 replicates). December 1, 1975 (10 replicates)

Collection Methods:

a. 0.25m² - Eelgrass, algae, epifauna, epiphytes, surface invertebrates > 3 cm.

b. 0.05m² X 15 cm. - Core, from within the 0.25m² quadrat.

Sampling techniques: All material was removed by a diver operated airlift.

Material is 1 mm. live sieved during collection.

Identification resolution: Identified to 2 mm.

All weights are in grams. Only species with mean wet weights greater than 0.1g are shown.

0.25m² quadrat sample

	8/13/75		12/1/75	
	<u>Mean</u>	<u>S.D.</u>	<u>Mean</u>	<u>S.D.</u>
EELGRASS (dry wt.)				
<u>Zostera marina</u>	24.7	8.3	5.9	2.9
ALGAE (wet wt.)				
<u>Botryoglossum farlowianum</u>	0	0	0.2	0.7
<u>Monostroma fuscum</u>	48.3	17.7	0.5	0.8
<u>Urospora sp.</u>	0.2	0.3	+	+
EPIFAUNA (wet wt.)				
Hydrozoa:				
<u>Obelia sp.</u>	0.7	0.4	0	0
Anthozoa:				
<u>Epiactis prolifera</u>	0.9	1.7	+	+
Mollusca:				
<u>Lacuna sp.</u>	0.3	0.3	+	+
Unknown Doridacea	0	0	0.2	0.1
Polychaetes:				
<u>Platynereis bicanaliculata</u>	0.3	0.3	+	+
<u>Harmothoe imbricata</u>	0.4	0.6	0	0
Isopoda:				
<u>Synidotea bicuspidata</u>	8.7	4.9	0.5	0.3
Amphipoda:				
<u>Metacaprella kennerlyi</u>	1.2	0.6	1.8	0.8
Gammarid amphipods	0.4	0.2	0.1	0.1
Bryozoa:				
Unknown Bryozoa	0.2	0.1	0	0
Echinodermata:				
<u>Leptasterias hexactis</u>	2.2	3.1	3.7	4.4

APPENDIX D (continued)

0.05m² x 15 cm core sample

	8/13/75		12/1/75	
	<u>Mean</u>	<u>S.D.</u>	<u>Mean</u>	<u>S.D.</u>
Hydrozoa:				
<u>Obelia</u> sp.	0.1	0.3	0	0
Nemertea:				
<u>Cerebratulus californiensis</u>	0.6	1.8	0	0
<u>Paranemertes peregrina</u>	0.2	0.4	0	0
Mollusca:				
<u>Macoma</u> sp.	0.4	0.3	0.5	0.4
<u>Macoma nasuta</u>	1.1	2.1	1.3	2.7
<u>Mya arenaria</u>	0.4	0.5	+	+
<u>Protothaca</u> sp.	0.2	0.2	0.3	0.2
<u>Transennella tantilla</u>	0.5	0.2	0.9	0.3
Polychaetes:				
<u>Mediomastus</u> sp.	+	+	0.5	0.3
<u>Nephtys</u> sp.	0.1	0.4	0.2	0.6
<u>Nereis</u> sp.	0.3	0.1	0.2	0.2
<u>Haploscoloplos elongatus</u>	0.2	0.2	0.1	0.1
<u>Owenia fusiformis</u>	1.5	0.4	1.3	0.6
<u>Harmothoe imbricata</u>	0.2	0.3	+	+
<u>Prionospio pinnata</u>	0.2	0.1	0.1	0.1
Isopoda:				
<u>Synidotea bicuspidata</u>	1.1	0.7	0.4	0.3
Amphipoda:				
Gammarid amphipods	0.2	0.3	0.2	0.1
Decapoda:				
<u>Cancer magister</u>	0	0	3.4	108.0
Echinodermata:				
<u>Leptasterias hexactis</u>	+	+	0.1	0.2
<u>Ophiuroidea</u> sp.	1.1	0.5	0.3	0.2
<u>Leptosynapta</u> sp.	0.4	0.3	0.3	0.2

Total Species Listed:36

Total Species Found:133

+ Indicates presence < 0.1g wet weight.

APPENDIX E

Counts of chum salmon fry on three areas adjacent to Padilla Bay, 1964-1975.

Swinomish Channel (Area 4, Sub-area 17)

Date	Tide*	Visibility	Fish/Mile
1964			1,100 ave. (no species breakdn.)
1965			600
May 9, 1975	EE	Good	4,375
"	EE	Good	750
"	EE	Good	64,030
"	EE	Good	475
May 27, 1975	EE	Excellent	825
"	EE	Excellent	0
"	EE	Excellent	0
"	EE	Excellent	0

Guemes Island (Area 5, sub-area 01)

April 21, 1967	EE	Fair	602
May 5, 1967	EE	Fair	145
June 1, 1967	HS	Fair	2,675
May 2, 1968	EE	Excellent	1,797
May 5, 1969	ME	Good	0
May 15, 1969	HS	Poor	500
May 22, 1969	HS	Fair	2,667
June 3, 1969	HS	Fair	10,000
June 12, 1969	LF	Fair	416
April 16, 1970	LS	Good	786
May 1, 1970	EF	Poor	20
May 7, 1970	HS	Poor	70
May 13, 1970	ME	Good	40
May 13, 1970	EF	Fair	570
May 13, 1970	MF	Excellent	2,127
April 29, 1971	MF	Poor	0
May 6, 1971	MF	Fair	0
May 21, 1971	LE	Fair	0
April 19, 1972	HS	Good	0
May 3, 1972	LS	Poor	0
May 20, 1972	MF	Poor	35
May 23, 1972	LF	Fair	200
June 6, 1972	LE	Good	0

(continued)

*Explanation of tide code: Numbers refer to feet above mean lower low water.
 LS = 1, EF = 2, MF = 3, LF = 4, HS = 5, EE = 6, ME = 7, LE = 8.

APPENDIX E (continued)

Date	Tide	Visibility	Fish/Mile
<u>Guemes Island (continued)</u>			
April 25, 1973	EE	Fair	0
May 16, 1973	LF	Poor	733
April 9, 1974	LS	Fair	0
April 24, 1974	EE	Good	0
May 1, 1974	EE	Good	330
May 20, 1974	EE	Good	0
June 7, 1974	LF	Good	320
May 2, 1975	ME	Good	250
May 9, 1975	HS	Good	7,583
May 27, 1975	LF	Excellent	1,666
June 13, 1975	EE	Good	6,000 (Lots of fish outside index area.)
<u>William Point (Area 5, Sub-area 06)</u>			
1964			1,500 ave. (no species breakdn.)
1965			8,300 ave.
1966			0 (one survey)
April 24, 1967	ME	Good	404
April 28, 1967	LS	Poor	0
May 15, 1967	LE	Good	1,470
May 25, 1967	EE	Poor	1,400
June 5, 1967		Poor	8
April 4, 1975	LF	Good	0
April 15, 1975	ME	Good	210
April 30, 1975	MF	Good	0
May 14, 1975	HS	Good	500
June 2, 1975	MF	Good	750
June 13, 1975	EE	Good	0
<u>Padilla Bay</u>			
May 10, 1967	LF	Poor	220
May 25, 1967	EE	Poor	75 (possible coho)

APPENDIX F

Counts of pink salmon fry on three areas adjacent to Padilla Bay, 1964-1974.

Date	Tide*	Visibility	Fish/Mile
<u>Swinomish Channel (Area 4, Sub-area 17)</u>			
1964			1,100 ave. (no species breakdn.)

Guemes Island (Area 5, Sub-area 01)

May 2, 1968	EE	Excellent	370
April 16, 1970	LS	Good	1,780
May 1, 1970	EF	Poor	165
May 7, 1970	HS	Poor	430
May 13, 1970	ME	Good	293
"	EF	Fair	4,180
"	MF	Excellent	5,207
April 19, 1972	HS	Good	0
May 3, 1972	LS	Poor	0
May 11, 1972	MF	Good	916
May 20, 1972	MF	Poor	680
May 23, 1972	LF	Fair	3,800
June 6, 1972	LE	Good	0
April 9, 1974	LS	Fair	0
April 24, 1974	EE	Good	0
May 1, 1974	EE	Good	2,020
May 20, 1974	EE	Good	4
June 7, 1974	LF	Good	596

William Point (Area 5, Sub-area 06)

1964			1,500 ave. (no species breakdn.)
March 22, 1968	HS	Good	0
April 16, 1968	LE	Good	34
May 1, 1968	MF	Fair	263
May 7, 1968	HS	Fair	38
May 15, 1968	LF	Good	736
May 23, 1968	EF	Good	0
April 16, 1970	EE	Good	0
April 28, 1970	ME	Good	2,014
May 15, 1970	EF	Fair	640
June 3, 1970	EE	Fair	0
April 6, 1972	EE	Fair	0
April 18, 1972	LE	Excellent	1,664
April 26, 1972	MF	Fair	0
May 1, 1972	MF	Fair	1,000

(continued)

*Explanation of tide code: Numbers refer to feet above mean lower low water.
 LS = 1, EF = 2, MF = 3, LF = 4, HS = 5, EE = 6, ME = 7, LE = 8.

APPENDIX F (continued)

Date	Tide	Visibility	Fish/Mile
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William Point (continued)

May 10, 1972	EF	Fair	0
May 18, 1972	ME	Good	3,608
May 23, 1972	MF	Fair	0
June 2, 1972	EE	Fair	36
June 9, 1972	ME	Fair	0
April 8, 1974	LF	Fair	0
April 17, 1974	LF	Good	0
April 23, 1974	LS	Fair	0
May 7, 1974	EE	Fair	1,850
May 16, 1974	LF	Poor	0
May 17, 1974	LE	Good	546
May 31, 1974	ME	Good	244

APPENDIX G

Counts of pink and chum salmon fry from a special survey of the shoreline of Swinomish Channel and Padilla Bay.

Date	Tide	Visibility	Fish/Mile		Section Number
			Pink	Chum	
<u>Swinomish Channel</u>					
May 5, 1970	MF	Good	55	8	36
	MF	Good	1,170	130	25
	MF	Good	160	19	24
	MF	Good	0	0	13
	LF	Good	1,664	186	11
	LF	Good	518	58	02
	LF	Good	810	90	03
	LF	Fair	494	56	01
 <u>Padilla Bay</u>					
April 28, 1970	HS	Fair	0	0	18
	HS	Fair	557	76	07
	EE	Fair	433	59	12
	EE	Fair	0	0	01
	EE	Poor	597	82	35
	EE	Fair	3,557	485	27
	HS	Fair	67	5	19
	HS	Excellent	368	32	30
	EE	Good	652	-	31
	EE	Good	12	2	01 (S. Padilla)
	ME	Good	1,603	84	28
	ME	Good	373	373	27
	ME	Good	137	7	25

APPENDIX H

Comparative importance of the habitat zones of organisms found in the diets of juvenile pink and chum salmon in Puget Sound. Gerke and Kaczynski (1972) calculated the index of importance (Number x size, expressed as a percentage of the total) for each food item. Averages of these indexes for all samples are shown.

Area:	Port Susan		Anderson Isl.		Toandos	Penin.	Habitat Zone
Species of Salmon:	Pink	Chum	Pink	Chum	Pink	Chum	
No. of Surveys:	4	3	4	5	6	6	
Food Item	Average Index of Importance						
Barnacle nauplius	34.8	50.0				5.2	P
Eggs (invertebrate)	14.4	19.0	0.5		12.7		?
Copepodid	4.3	7.3			12.3	0.3	P
Hyperoid amphipod	0.5	0.7	95.8	121.5	0.3	0.8	E
Harpacticoid copepod	7.8	23.7		0.5	33.0	25.3	E
Gammarid amphipod	15.3	67.7		0.5	5.5	21.7	E
<u>Corycaeus</u>			0.5	0.3	22.7	2.7	P
<u>Cypris larva</u>			0.3		2.7	4.7	E
Mysis larva	16.3	49.7			1.3	3.7	P
<u>Calanus sp.</u>	0.3	0.3	0.3	0.3		5.5	P
<u>Podon sp.</u>	1.0	1.3					P
<u>Calanus pacificus</u>	1.3	1.7			4.8	6.3	P
<u>Calyptopis larva</u>	0.5	0.7			0.5	0.8	P
<u>Insecta</u>	1.3	6.3			0.7	3.7	T
<u>Mysid</u>						0.3	P
<u>Cumacea</u>	0.5	0.7					E
<u>Euphausid</u>					3.0	10.3	P
<u>Pseudocalanus</u>					3.8	4.2	P
<u>Bivalve larva</u>					2.7	1.7	P
<u>Conchoecia</u>					2.0		E
	<u>Pink Totals</u>		<u>Chum Totals</u>				
	110.4	36.4%	152.6	34.0%			P
	163.7	53.9	267.8	59.6			E
	27.6	9.1	19.0	4.2			Eggs
	2.0	0.7	10.0	2.2			T
	303.7	100.1	449.4	100.0			

Habitat zone code: P = pelagic, E = epibenthic, T = terrestrial.

APPENDIX J

Fish species found in beach seine conducted at Bayview State Park
by Huxley College:

(1) August 27, 1974 About 8:14 am Tide 0.0'
(2) October 8, 1974 About 4:42 am Tide -0.5'

Buffalo sculpin	<u>Enophrys bison</u>
Staghorn sculpin	<u>Leptocottus armatus</u>
Surf smelt	<u>Hypomesus pretiosus</u>
Shiner perch	<u>Cymatogaster aggregata</u>
Three-spine stickleback	<u>Gasterosteus aculeatus</u>
Chinook salmon	<u>Oncorhynchus tshawytscha</u>
Herring	<u>Clupea harengus</u>
Starry flounder	<u>Platichthys stellatus</u>
Crescent gunnel	<u>Pholis ornata</u>
Snake prickleback	<u>Lumpenus sagitta</u>
Spiny lumpsucker	<u>Eumicrotremus orbis</u>
Great sculpin	<u>Myoxocephalus polyacanthocephalus</u>
English sole	<u>Parophrys vetulus</u>
Penpoint gunnel	<u>Apodichthys flavidus</u>
Saddleback gunnel	<u>Pholis laeta</u>
Pipefish	<u>Syngnathus griseolineatus</u>
Silverspotted sculpin	<u>Blepsias cirrhosus</u>
Padded sculpin	<u>Artedius fenestralis</u>
Chum salmon	<u>Oncorhynchus keta</u>

APPENDIX K

A checklist of birds for Padilla Bay. An explanation of the codes for abundance and seasonal occurrence will be found at the end of the list. Abundance and occurrence notation refers to northwestern Washington, not necessarily to Padilla Bay. Species are divided into five groups according to their status in Padilla Bay.

1. Occurs regularly in significant numbers, including migration; forms a significant part of the annual ecology.

Common Loon	<u>Gavia immer</u>	CW
Red-throated Loon	<u>G. stellata</u>	CW
Red-necked Grebe	<u>Podiceps grisegena</u>	CW
Horned Grebe	<u>P. auritus</u>	CW
Western Grebe	<u>Aechmophorus occidentalis</u>	CW
Double-crested Cormorant	<u>Phalacrocorax auritus</u>	CW
Brandt's Cormorant	<u>P. penicillatus</u>	CW
Great Blue Heron	<u>Ardea herodias</u>	CR
Canada Goose	<u>Branta canadensis</u>	CW
Black Brant	<u>B. nigricans</u>	CW
Brant	<u>B. bernicla</u>	CW
Mallard	<u>Anas platyrhynchos</u>	CW,R
Pintail	<u>A. acuta</u>	CW
Green-winged Teal	<u>A. crecca</u>	CW
American Wigeon	<u>A. americana</u>	CW
Canvasback	<u>Aythya valisneria</u>	CW
Greater Scaup	<u>A. marila</u>	CW
Common Goldeneye	<u>Bucephala clangula</u>	CW
Bufflehead	<u>B. albeola</u>	CW
White-winged Scoter	<u>Melanitta deglandi</u>	CW
Surf Scoter	<u>M. perspicillata</u>	CW
Ruddy Duck	<u>Oxyura jamaicensis</u>	CW
Red-breasted Merganser	<u>Mergus serrator</u>	CW
Bald Eagle	<u>Haliaeetus leucocephalus</u>	CW
Peregrine	<u>Falco peregrinus</u>	CW
American Coot	<u>Fulica americana</u>	CW
Semipalmated Plover	<u>Charadrius semipalmatus</u>	CM
Killdeer	<u>C. vociferus</u>	CR
Black-bellied Plover	<u>Squatarola squatarola</u>	CW
Black Turnstone	<u>Arenaria melanocephala</u>	CW
Common Snipe	<u>Capella gallinago</u>	CR
Whimbrel	<u>Numenius phaeopus</u>	CM
Spotted Sandpiper	<u>Actitis macularia</u>	US
Greater Yellowlegs	<u>Totanus melanoleucus</u>	CM,UW
Lesser Yellowlegs	<u>T. flavipes</u>	CM
Pectoral Sandpiper	<u>Erolia melanotos</u>	CF
Baird's Sandpiper	<u>E. bairdii</u>	UM
Least Sandpiper	<u>E. minutilla</u>	CM
DuRLin	<u>E. alpina</u>	CW
Short-billed Dowitcher	<u>Limnodromus griseus</u>	CM

APPENDIX K (continued)

Long-billed Dowitcher	<u>L. scolopaceus</u>	CM
Semipalmated Sandpiper	<u>Ereunetes pusillus</u>	UF
Western Sandpiper	<u>E. mauri</u>	CM
Sanderling	<u>Crocethia alba</u>	UW
Parasitic Jaeger	<u>Stercorarius parasiticus</u>	CM
Glaucus-winged Gull	<u>Larus glaucescens</u>	CR
Thayer's Gull	<u>L. thayeri</u>	CW
California Gull	<u>L. californicus</u>	CM, UW
Ring-billed Gull	<u>L. delawarensis</u>	CM, UW
Mew Gull	<u>L. canus</u>	CW
Bonaparte's Gull	<u>L. philadelphia</u>	CM, W
Common Tern	<u>Sterna hirundo</u>	CM
Belted Kingfisher	<u>Megaceryle alcyon</u>	CR
Band-tailed Pigeon	<u>Columba fasciata</u>	CS
Common Crow	<u>Corvus brachyrhynchos</u>	CR
Northwestern Crow	<u>C. caurinus</u>	CR
2. Occurs irregularly to regularly in relatively small numbers, chiefly in migration.		
Arctic Loon	<u>Gavia arctica</u>	CW (deep water adjacent)
Eared Grebe	<u>Podiceps caspicus</u>	UM
Pelagic Cormorant	<u>Phalacrocorax pelagicus</u>	CW (deep water)
American Bittern	<u>Botaurus lentiginosus</u>	UM
Whistling Swan	<u>Olor columbianus</u>	CM
Trumpeter Swan	<u>O. buccinator</u>	UM
White-fronted Goose	<u>Anser albifrons</u>	UM
Snow Goose	<u>A. caerulescens</u>	CM
Blue-winged Teal	<u>Anas discors</u>	CS
Cinnamon Teal	<u>A. cyanoptera</u>	CS
European Wigeon	<u>A. penelope</u>	UW
Shoveler	<u>A. clypeata</u>	CW
Lesser Scaup	<u>Aythya affinis</u>	CW
Barrow's Goldeneye	<u>Bucephala islandica</u>	CW
Oldsquaw	<u>Clangula hyemalis</u>	CW (deep water)
Harlequin Duck	<u>Histrionicus histrionicus</u>	UW
Black Scoter	<u>Melanitta nigra</u>	UW
Hooded Merganser	<u>Lophodytes cucullatus</u>	UW
Red-tailed Hawk	<u>Buteo jamaicensis</u>	CR
Rough-legged Hawk	<u>B. lagopus</u>	CW
Marsh Hawk	<u>Circus cyaneus</u>	CW, US
Osprey	<u>Pandion haliaetus</u>	UM
Gyrfalcon	<u>Falco rusticolus</u>	UW
Merlin	<u>F. columbarius</u>	UW
American Golden Plover	<u>Pluvialis dominica</u>	UM
Ruddy Turnstone	<u>Arenaria interpres</u>	UM
Long-billed Curlew	<u>Numenius americanus</u>	UM
Solitary Sandpiper	<u>Tringa solitaria</u>	UM
Wilson's Phalarope	<u>Steganopus tricolor</u>	UM
Northern Phalarope	<u>Lobipes lobatus</u>	CM
Herring Gull	<u>Larus argentatus</u>	UW
Franklin's Gull	<u>L. pipixcan</u>	UF

APPENDIX K (continued)

Heerman's Gull	<u>L. heermanni</u>	CS (deep water)
Caspian Tern	<u>Hydroprogne caspia</u>	UM
Common Murre	<u>Uria aalge</u>	CW (deep water)
Pigeon Guillemot	<u>Cephus columba</u>	CW (deep water)
Marbled Murrelet	<u>Brachyramphus marmoratum</u>	CW (deep water)
Snowy Owl	<u>Nyctea scandiaca</u>	UW
Short-eared Owl	<u>Asio flammeus</u>	UW
Common Raven	<u>Corvus corax</u>	CR

3. Freshwater species occurring in small numbers in migration or in small to large numbers briefly when freshwater habitats are frozen.

Pied-billed Grebe	<u>Podilymbus podiceps</u>	UW
Gadwall	<u>Anas strepera</u>	UM,W
Redhead	<u>Aythya americana</u>	UW
Ring-necked Duck	<u>A. collaris</u>	UW
Common Merganser	<u>Mergus merganser</u>	CW

4. Verified casuals.

Great Egret	<u>Casmerodius albus</u>	UW
Green Heron	<u>Butorides virescens</u>	UM
American Kestrel	<u>Falco sparverius</u>	CW
Sandhill Crane	<u>Grus canadensis</u>	UM
Black Oystercatcher	<u>Haematopus bachmani</u>	UM
Red Knot	<u>Calidris canutus</u>	UM
Marbled Godwit	<u>Limosa fedoa</u>	RM
Glaucus Gull	<u>Larus hyperboreus</u>	RW
Western Gull	<u>L. occidentalis</u>	UW

5. Almost certain casuals.

Yellow-billed Loon	<u>Gavia adamsii</u>	RW
White Pelican	<u>Pelecanus erythrorhychos</u>	RM
Willet	<u>Catoptrophorus semipalmatus</u>	RM
Rock Sandpiper	<u>Erolia ptilocnemis</u>	UW
Sharp-tailed Sandpiper	<u>E. acuminata</u>	RF
Stilt Sandpiper	<u>Micropalama himantopus</u>	RF
Buff-breasted Sandpiper	<u>Tryngites subruficollis</u>	RF
Long-tailed Jaeger	<u>Stercorarius longicaudus</u>	RF
Black-legged Kittiwake	<u>Rissa tridactyla</u>	UM
Arctic Tern	<u>Sterna paradisaea</u>	UM
Black Tern	<u>Chlidonias niger</u>	RM

Abundance Code

- C Common; often seen or heard in appropriate habitats.
 U Uncommon; usually present but not seen or heard on every visit to appropriate habitats.
 R Rare; present in appropriate habitats only in small numbers and seldom seen or heard.

APPENDIX K (continued)

Occurrence Code

- R Resident; present all year, although abundance may vary seasonally.
- S Summer visitor; includes spring and fall.
- W Winter visitor; includes spring and fall.
- M Migrant; spring and fall only.
- F Fall only.

APPENDIX L

Fall and winter aerial estimates of four species of dabbling ducks from 1966 to 1975. Dabblers are present in appreciable numbers from August through May in Padilla Bay

Date	Mallard	Pintail	Green-winged Teal	Wigeon	Total
October 6, 1966	600	3,000	3,000	600	7,200
" 18 "	500	7,500	2,600	9,500	20,100
" 31 "	1,400	7,000	6,300	8,500	23,200
November 11, "	6,800	7,500	7,700	19,800	41,800
January 3, 1967	600	600	800	1,600	3,600
October 11, 1967	500	13,400	2,500	9,900	26,300
November 1 "	200	2,600	3,700	11,400	17,900
" 12 "	900	2,300	2,000	9,300	14,500
" 27 "	200	700	3,400	6,300	10,600
December 13 "	400	600	800	600	2,400
January 2, 1968	2,400	1,100	3,100	3,200	9,800
October 7, 1968	800	5,400	7,500	4,400	18,100
" 18 "	400	4,500	5,100	7,400	17,400
" 31 "	2,200	3,300	2,900	13,700	22,100
November 18 "	4,900	7,500	4,800	29,700	46,900
December 6 "	1,800	500	600	2,000	4,900
January 6, 1969	1,400	1,100	1,100	2,400	6,000
October 6, 1969	1,300	5,700	3,100	7,900	18,000
" 20 "	7,700	27,600	3,900	7,500	46,700
November 21 "	1,600	3,600	1,300	9,300	15,800
December 1, "	6,400	8,500	2,500	24,100	41,500
January 5, 1970	2,400	1,100	600	11,900	16,000
October 5, 1970	300	5,000	2,800	4,000	12,100
" 12, "	4,300	10,200	5,000	10,800	30,300
" 26 "	1,800	11,900	7,200	5,600	26,500
November 2 "	2,200	7,900	4,700	7,600	22,400
" 9 "	2,000	12,300	7,500	11,100	32,900
" 18 "	2,300	3,800	2,700	27,700	36,500
December 4 "	900	6,900	6,100	27,700	41,600
" 21 "	1,200	1,500	2,100	13,000	17,800
January 3, 1971	6,100	7,200	1,500	24,300	39,100
October 4, 1971	7,400	12,400	2,900	7,500	30,200
" 11 "	6,200	14,900	7,200	6,100	34,400
" 28 "	2,400	21,800	9,500	17,200	50,900
November 10 "	8,500	8,200	2,500	9,600	28,800
" 17 "	15,200	16,200	None	10,100	41,500
" 30 "	8,800	18,000	5,300	15,100	47,200
January 5, 1972	6,600	8,000	1,900	18,500	35,000
October 10, 1972	5,200	4,300	5,600	11,400	26,500
" 17 "	10,500	20,600	9,400	14,600	55,100
" 23 "	5,100	15,200	7,000	19,300	46,600
" 30 "	8,000	15,200	7,500	15,400	46,100

APPENDIX L (continued)

Date	Mallard	Pintail	Green-winged Teal	Wigeon	Total
November 13, 1972	5,600	10,800	6,500	19,000	41,900
" 20 "	1,800	10,800	2,600	23,600	38,800
December 12 "	2,200	6,600	3,100	9,900	21,800
January 8, 1973	900	9,000	2,800	6,600	19,300
October 1, 1973	500	4,200	2,500	3,600	10,800
" 8 "	1,800	14,500	6,200	10,900	33,500
" 15 "	3,000	11,800	5,500	20,000	40,300
" 22 "	900	9,900	12,100	21,200	44,100
November 12 "	2,300	11,800	2,500	10,300	26,900
" 19 "	500	2,400	400	3,500	6,800
December 8 "	1,200	300	200	1,400	3,100
January 7, 1974	1,800	3,900	900	6,600	13,200
October 1, 1974	None	4,800	1,400	4,400	10,600
" 7 "	900	12,100	2,300	1,900	17,100
" 15 "	6,800	16,200	4,600	4,700	32,300
" 21 "	None	11,700	200	8,200	20,100
" 29 "	700	9,800	3,900	7,400	21,800
November 4 "	4,200	6,900	1,000	12,500	24,600
" 18 "	6,500	8,000	700	19,100	34,300
" 26 "	1,400	4,600	None	8,700	14,700
December 23 "	2,000	800	None	4,700	7,500
January 10, 1975	100	1,800	None	2,100	4,000
October 6, 1975	1,000	9,100	1,600	2,300	14,000
" 13 "	800	5,900	3,300	4,800	14,800
" 22 "	2,700	7,400	200	17,300	27,600
November 17 "	2,300	5,300	600	7,200	15,400
December 10 "	21,300	38,500	9,000	50,000	118,800
" 15 "	22,000	41,500	6,000	34,700	104,200
January 5, 1976	7,200	7,700	1,600	7,300	23,800

<u>Monthly Averages</u>					
October	2,760	10,530	4,670	9,290	27,250
November	3,910	7,560	3,000	13,540	28,010
December	5,940	10,570	3,040	16,810	36,360
January	2,950	4,150	1,430	8,450	16,980

APPENDIX M

Sample counts and expansion estimates for certain diving and sea ducks in Padilla Bay. The annual aerial count is made near the first of the year on two plots comprising 11 percent (1,544 acres) of the area of the bay.

Total Count, Both Plots						
Year	Canvasback	Scaup*	Goldeneye*	Bufflehead	Old Squaw	Scoter*
1965	0	131	25	43	18	87
1966	0	201	27	45	0	474
1967	1	57	3	131	0	119
1968	15	133	8	66	0	195
1969	10	571	11	427	3	80
1970	0	9	13	178	0	220
1971	15	33	9	377	4	273
1972	0	426	24	142	0	156
1973	85	475	10	411	0	69
1974	0	390	73	274	0	0

Summary

Species	Average of Plot Counts	Expansion of Sample Average
Canvasback	12.6	118
Scaup	242.6	2,280
Goldeneye	20.3	191
Bufflehead	209.4	1,968
Old Squaw	2.5	23
Scoter	<u>167.3</u>	<u>1,572</u>
Totals	654.7	6,152

*Similar species are not distinguished on aerial surveys.

APPENDIX N

Counts of brant in Padilla Bay, 1970-1976.

Date	Number of Brant	Date	Number of Brant
October 26, 1970	40	December 8, 1973	1,715
November 2 "	250	March 14, 1974	5,280
" 9 "	640	April 8 "	17,500
" 18 "	2,435	" 15 "	16,200
December 21 "	1,540	" 26 "	23,500
April 16, 1971	55,300		
		October 29, 1974	200
November 10, 1971	1,420	November 4 "	500
" 17 "	2,150	" 17 "	1,300
" 30 "	2,770	" 26 "	2,900
January 3, 1972	2,983	December 23 "	3,800
April 13 "	20,300	January 10, 1975	2,660
" 17 "	23,800	February 24 "	1,649
" 19 "	36,450	April 8 "	7,326
		" 14 "	38,370
October 23, 1972	100	" 18 "	51,250
" 30 "	175	" 25 "	44,700
November 13 "	910		
" 20 "	985	October 22, 1975	700
December 12 "	1,060	November 17 "	4,215
January 8, 1973	1,785	December 10 "	5,750
April 10, "	22,400	" 15 "	3,945
		January 5, 1976	3,465
October 15, 1973	30	March 1 "	2,891
" 22 "	525	April 1 "	10,202
November 19 "	1,900	January 30, 1974	3,270
" 12 "	1,750		

Monthly Averages

Month	Number of Brant
October	250
November	1,720
December	2,970
January	2,830
February	1,650
March	4,090
April	28,250

