FRI-UW-8716
October 1987

CHARACTERIZATION OF PUGET SOUND MARINE FISHES: SURVEY OF AVAILABLE DATA

by

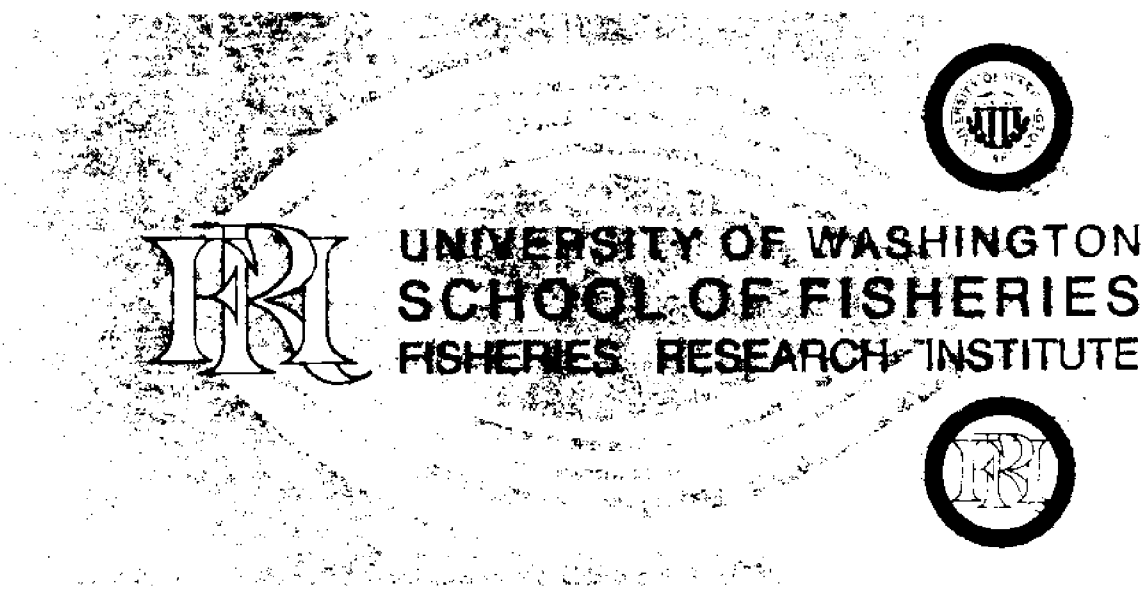
Lawrence L. Moulton and Bruce S. Miller

FINAL REPORT

October 1987

for

Washington Sea Grant Program in Cooperation with
U.S. Environmental Protection Agency,
Puget Sound Estuary Program
EPA Interagency Agreement
No. DW13932556-01-0



FRI-UW-8716
October 1987

FISHERIES RESEARCH INSTITUTE
School of Fisheries
University of Washington
Seattle, WA 98195

CHARACTERIZATION OF PUGET SOUND MARINE FISHES: SURVEY OF AVAILABLE DATA

by

Lawrence L. Moulton and Bruce S. Miller

Final Report
October 1987

October 1987

for

Washington Sea Grant Program in Cooperation with
U.S. Environmental Protection Agency,
Puget Sound Estuary Program
EPA Interagency Agreement
No. DW13932556-01-0

Approved

Date 2-10-88

Robert C. Francis, Director

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

Introduction

The objective of this project is to develop an inventory of the more extensive data sets on marine fishes in Puget Sound. Information on location, date, gear used, number of sets made, depths sampled, and types of data recorded were reviewed and included in the inventory to determine if these data were available in sufficient temporal and spatial coverage, and of sufficient quality, to evaluate trends in selected species over time.

Methods

The inventory was conducted by:

1. interviewing people from various organizations who are familiar with, or routinely work with, the type of data needed for the characterization study, and
2. reviewing historical data sets identified through the interviews.

Prior to initiating the data survey, an advisory work group was formed of people familiar with marine fish investigations in Puget Sound. Possible data sources were identified by the work groups, and these sources were reviewed to evaluate their suitability for inclusion in the characterization study.

The data evaluation focused on the objective of the characterization phase, which is evaluating trends over time. The main criteria used for selecting a data set for further evaluation and possible inclusion in the characterization phase were:

1. three or more years of information using consistent methods at a specific location were available; or
2. the data set does supplement similar information or extends the period of record from other sources;
3. the data set appeared to have the detail needed to reveal changes over time in species composition, abundance or size structure of marine fish in a specific area; and
4. the group of fish species being evaluated for change is not overly affected by fishing pressure.

The twelve regions of Puget Sound utilized by DeLacy et al. (1973) to evaluate species distribution were used to evaluate the geographical distribution of the available data.

Results

Data from long-term University of Washington investigations by Drs. DeLacy, English and Miller offer the best data available for certain locations throughout Puget Sound. Other data sets, however, also provide usable information. Of these additional sets, the Washington Department of Fisheries trawl surveys provide considerable long-term coverage of regions in northern Puget Sound. In addition, the Department of Fisheries herring spawning ground surveys contain annual estimates of spawning density of Pacific herring at sites around Puget Sound. The significant data sources identified are:

1. University of Washington, College of Fisheries trawl logs;
2. Dr. English (UW Oceanography Dep.) trawl logs;
3. Dr. Miller (UW School of Fisheries) trawl logs;

4. Drs. DeLacy/Miller (UW School of Fisheries) beach seines;
5. Drs. DeLacy/Miller (UW School of Fisheries) ichthyoplankton sampling from Elliott Bay;
6. UW Friday Harbor Marine Lab logbooks;
7. WDF commercial trawl data;
8. WDF herring spawning surveys;
9. WDF bottomfish sportfishing records; and
10. Navy monitoring by trawls at Bangor Submarine Base

Aside from the long-term data sets identified above, there are a number of short-term studies that have been conducted in various regions that could assist in interpreting long-term trends.

Recommendations

We recommend continuing with the characterization process because of the long-term series available for several of the regions, particularly Central Puget Sound, Whidbey Basin, Port Orchard, Bellingham Bay and the San Juan Islands. It is recommended that the following priority be used for analysis of data for the characterization of Puget Sound fishes:

1. Research otter trawl data sets, focusing on Port Orchard, Port Gardner and Bellingham Bay, with further evaluation of Port Madison and Case Inlet data.
2. WDF herring spawning survey data.
3. Elliott Bay ichthyoplankton data series, with possible inclusion of Port Orchard and central basin data.
4. Research beach seine data focusing on the Golden Gardens data sets.
5. WDF commercial trawl data, focusing on Pacific cod, English sole, rock sole, sand sole and starry flounder.
6. Friday Harbor logbook data, focusing on sites with long-term sampling series by a consistent method.

INTRODUCTION

One of the main phases of the EPA Bay Program is to characterize the study region through a system-wide synthesis and analysis of existing data on water and sediment quality and the abundance of living resources. The objectives of this synthesis and analysis are to identify spatial and temporal trends in the estuarine system and evaluate probable causes for these changes. One of the initial steps in the characterization process is to identify the existing data and determine which portions are suitable to adequately describe trends in the study area.

The objective of this project is to develop an inventory of the more extensive data sets on marine fishes in Puget Sound. Information on location, date, gear used, number of sets made, depths sampled, and types of data recorded were reviewed and included in the inventory to determine if these data were available in sufficient temporal and spatial coverage and of sufficient quality to evaluate trends in selected species or populations over time. An additional benefit of the project is the identification of the various collection methods used over the years, which can be used to develop the more extensive data sets and may help define standardized methods so that future investigations can be conducted in a compatible fashion.

METHODS

The inventory was conducted by (1) interviewing people from various organizations who are familiar with or routinely work with the type of data needed for the characterization study and (2) reviewing historical data sets identified through the interviews. Prior to initiating the data survey, an advisory work group was formed of people familiar with marine fish investigations in Puget Sound (Table 1). A number of possible data sources were identified at the first work group meeting on June 8, 1987. These sources, and others previously known by the investigators, were reviewed to evaluate their suitability for inclusion in the characterization study (Table 2).

Where possible, the data were personally examined by study personnel to evaluate the available information. Because of the large amount of information, it was not possible to examine each trip record, as was originally planned. Information from representative trips was evaluated to conserve project time and to allow a wider range of information sources to be examined. In some cases (identified in Table 2), the data could not be personally examined and the description of the data by the interviewed person was used to evaluate its suitability.

Table 1. Participants in Advisory Work Group

Name	Affiliation
John Armstrong	EPA
Steve Brown	Tetra Tech
Allan DeLacy	UW (retired)
Cathy Evans/Greg Bargman	WDF
Alan Mearns	NOAA
John Palmisano	CH_2M Hill
Gary Walters	NMFS

Table 2. Potential data sources identified at the June work group meeting.

Potential Source	Evaluated by Interviews	Personally Inspected	Potentially Usable
Bangor Submarine Base Trawling	YES	YES	YES
Consultants			
Dames and Moore	YES	NO	NO
PTI (formerly of TETRA TECH)	YES	NO	NO
Battelle Sequim Lab Records	YES	NO	NO
Evergreen College	YES	NO	NO
Peninsula College, Port Angeles	YES	NO	NO
Seattle Aquarium Records	YES	NO	NO
Shannon Point Lab	YES	NO	NO
University of Washington Records			
COF Trawl Logs	YES	YES	YES
Dr. DeLacy/Miller Beach Seine Logs	YES	YES	YES
Dr. English Beam Trawl Logs	YES	YES	YES
Dr. Miller Trawl Logs	YES	YES	YES
Dr. DeLacy/Miller Egg Sampling	YES	YES	YES
Friday Harbor Lab Logbooks	YES	YES	YES
Western Washington Univ. Logs	YES	NO	NO
Washington Dept. Fisheries			
Groundfish Trawl Surveys	YES	YES	YES
Herring Spawning Surveys	YES	YES	YES
Port Susan Hake	YES	NO	NO
Artificial Reef Surveys	YES	YES	NO
Sportfishing Surveys (bottomfish)	YES	YES	NO

The data evaluation focused on the objective of the characterization phase, which is evaluating trends over time, and therefore the focus was on identifying areas or locations within Puget Sound that have been repeatedly sampled over a number of years. There are many sites that have been studied for one or two years for which excellent data are available, but which provide little opportunity to evaluate long-term trends. Conversely, there are data sets that have long-term coverage within a region, but may have substantial variability in methods. Thus the selection or rejection of a particular data set is not necessarily a statement on the quality of the data, but merely reflects its suitability for evaluating the long-term trends within an identified region of Puget Sound. Where there has been substantial variability in methods, data sets are discussed and a recommendation is made to include or reject these from the characterization study.

The main criteria used for selecting a data set for further evaluation and possible inclusion in the characterization phase were:

1. three or more years of information using consistent methods at a specific location were available; or
2. the data set supplements similar information or extends the period of record from other sources; and
3. the data set appeared to have the detail needed to reveal changes over time in species composition, abundance or size structure of marine fish in a specific area; and
4. the group of fish species being monitored for change is not overly affected by fishing pressure.

The units of measure originally used to describe the various nets are retained; in most cases these are English units (i.e., feet and inches). We considered that this would be less confusing than converting all units to the metric system. The only net measurements consistently described in metric units are the 3 meter beam trawl and the diameters of various plankton nets.

Puget Sound was divided into twelve regions to help evaluate the geographic distribution of the available data (Figure 1). These regions are those utilized by DeLacy et al. (1973) and Miller and Borton (1980).

Figure 1 here.

Figure 1. The 12 sampling areas used to group reports of fish occurrence in Puget Sound.

RESULTS

Survey of Available Data

The data available from long-term University of Washington investigations conducted by Drs. DeLacy, English and Miller offer the best long-term data available for certain locations throughout Puget Sound. Other data sets, however, also provide quite usable information. Of these additional data sets, the Washington Department of Fisheries trawl surveys provide considerable long-term coverage of regions in northern Puget Sound. In addition, the Department of Fisheries herring spawning ground surveys contain annual estimates of spawning density of Pacific herring at specific sites around Puget Sound. A description of the coverage and methods used by the various researchers follows.

College of Fisheries (COF) Trawl Logs*

These records cover a period from 1949 to 1976, with a few additional records to 1980. Most of these data were collected or recorded under the direction of Dr. Allan C. DeLacy. The geographical coverage ranged from Case Inlet in southern Puget Sound to Orcas Island and Bellingham Bay in northern Puget Sound, with a substantial effort in the central Puget Sound region (Table 3). Gear used were a variety of otter trawls (Table 4), but most of the more usable time-series information was taken with the basic research trawl, which had a 1.25-inch stretched mesh cod end (Table 4). The other nets used were similar in overall dimensions, but the cod ends were usually 3.5 and 4.5 inches stretched mesh. Two research vessels were used, the **R/V Oncorhynchus** and the **R/V Commando.**

Data commonly recorded included a measure of effort (usually duartion of trawl and distance covered), species occurrence and usually some indication of relative abundance, including nearly complete counts, the exception being species that were highly abundant in a haul (i.e., hundreds or thousands of individuals). In many cases, length frequencies of the dominant species were recorded. There was a series of training cruises that utilized the basic research trawl and revisited the same six locations from 1965 to 1976. In this time period, there were normally two, and up to four, trips per year covering sites in central and northern Puget Sound. These cruises normally had nearly complete data sets with total counts and length measurements.

*The College of Fisheries was changed to the School of Fisheries, a division of the College of Ocean and Fishery Sciences, in 1983.

Table 3. Summary of otter trawl data sets contained in College of Fisheries logs.

Region	Site	Year	Hauls by Season				Gear	Depth range (m)	Species list	Count by species	Length data
			Win	Spr	Sum	Aut					
1. South Puget Sound	Carr Inlet	49			1		1	50	x	x	
		50		1	5	10	2,3,4	12-160	x	x	
		51	30	1	4	4	3,4	20-150	x	x	
		52		2		8	3	20-54	x	x	
		55				3	3	38-56	x	x	
		56	3		9		3,4,5	28-60	x	x	*
		57	4				3,4,5	40-56	x	x	
		67				3	7	70	x	x	
	Case Inlet	49			1		1	32	x	x	
		50		2			2	60-80	x	x	
		51			2		3	16-50	x	x	
		56			3		5	36-70	x		
		67				1	7	64	x	x	
3. Central Puget Sound	Murden Cove	66		9			3	20-80	x	x	
		67		8			3	20-254	x	x	
		68		4	6		3	20-40	x	x	
		69		5			3	20-40	x	x	
		70		2		1	3	34-80	x	x	
		71		4			7	30	x	x	
		73		2			7	54-250	x	x	
		74				1	3	30	x	x	
		76		1			3	30	x	x	
	Port Madison	49	5		2	2	1	10-164	x	x	
		50	2		2	1	1,3	20-80	x	x	
		51		2	1	1	3	16-80	x	x	
		53	1		1		3,4	40	x		
		58				1	4	60	x	x	
		59		1			3	80	x		
		70		1			6	56	x		
	West Point to Skiff Point	65		2			5,6	236-276	x	x	x
		66	4	4		3	3	224-260	x	x	
		67				1	3	248	x	x	
		68		1	1		3	252-256	x	x	
		69		1		1	3	240	x	x	
		70				2	3	238-300	x	x	
		71		1		1	3,7	254-260	x	x	
		72				1	3	260	x	x	
		73				1	3	240	x	x	
		74		1		1	3	240-290	x	x	
		75		1			3	240	x	x	

Table 3. Summary of otter trawl data sets contained in College of Fisheries logs - cont'd.

Region	Site	Year	Hauls by Season				Gear	Depth range (m)	Species list	Count by species	Length data	
			Win	Spr	Sum	Aut						
4. Seattle	Golden Gardens	49		4	7	8	1	10-110	x	x		
	to Meadow Pt.	50	5	16	8		1,2,3	20-210	x	x		
		51		16	7	2	3	12-280	x	x		
		52	4	10		4	3	14-100	x	x		
		53		2		1	3	16-240	x	x		
		54		4			3	24-220	x	x		
		55		5			3	20-260	x	x		
		56		4			3,5	18-230	x	x		
		57	2	3		1	3,4	24-200	x	x		
		59		11			3	10-220	x	x		
		60		4			3,5	20-48	x	x		
		61		5			3	20-200	x	x		
		62		3			3	20-200	x	x		
		63		4			6	20-200	x	x		
		64		5		2	6	20-200	x	x		
		65		2			3	40	x	x		
5. Port Orchard	Battle Pt. to	52	3		1	15	3,4	24-46	x	x		
	Fletcher Bay	53	10	4	2		3,4	18-40	x	x		
		54	1	5			4	34-40	x			
		55				2	5	44-48	x			
		56				3	4	40	x	x		
		57		5			3	24-40	x	x		
		58	3		1		3,5	40	x	x		
		59	6	11		1	3,5	40	x	(some)		
		60	7	10			3,5	40	x	(some)		
		62		6	3		3	20-40	x	x		
		66		1			3	30	x	x		
		67	1	4			3,7	20-40	x	x		
		70		2		1	3,7	20-40	x	x		
		73				1	3	40	x	x		
		74	3				7	40	x			
		75					3	40	x	x		
		76	2				3	40	x	x		
7. Whidbey Basin	Holmes Harbor	49			1		1	64	x	x	x	
		52			2	4	3,4	48-60	x	x		*
		53	34	12	7	8	3,4	10-64	x	x		*
		54	8	4		4	3,4,5	32-56	x	x		*
		55	6			2	3,4,5	40-62	x	x		*
		56	6		6	4	3,4,5	16-58	x	x		*
		57	3			2	3,4,5	36-48	x	x		
		58			2		3,5	40-44	x	x		

Table 3. Summary of otter trawl data sets contained in College of Fisheries logs - cont'd.

Region	Site	Year	Hauls by Season				Gear	Depth range (m)	Species list	Count by species	Length data
			Win	Spr	Sum	Aut					
7. Whidbey Basin - cont'd.	Penn Cove	52		2	4		3	34-44	x	x	
		53			4	2	3,4	30-36	x	x	
		54		3	3	4	3,4,5	28-40	x	x	*
		55				2	3,5	38-40	x	x	
		56			4	2	3,4,5	30-38	x	x	*
		57				2	3,4	24-28	x	x	
		58			2		3,5	20	x	x	
	Saratoga Pass off Penn Cove	65		1			6	70	x	x	x
		66	1	2			3	64-80	x	x	
		67			1		3	54	x	x	
		68		1	2	1	3	60-70	x	x	
		70		1		1	3	60-80	x	x	
		71		1		1	7	56-66	x	x	
		72				2	3	70	x	x	
		73		1		1	3,7(m)	90-100	x	x	
		74		1		1	3	66-80	x	x	
		75	1				3	76	x	x	
		76		1			3	80	x	x	
	Saratoga Pass (South)	65		2			5,6	118-140	x	x	x
		66	1	1		1	3	120-140	x	x	
		67			1	1	3	136	x	x	
		68		1	2	1	3	124-130	x	x	
		69		1		1	3	130	x	x	
		70		1		1	3	120-122	x	x	
		71		1		1	3,7	130	x	x	
		72				1	3	120	x	x	
		73		1			7(m)	132	x	x	
	Gedney Is.	65		2		1	5,6	106-110	x	x	
		66	1	2		1	3	110	x	x	
		67			1	1	3	100-102	x	x	
		68		1	1	1	3	106-112	x	x	
		69		1		1	3	110	x	x	
		70		1		1	3	110	x	x	
		71		1		1	3,7	110	x	x	
		72				1	3	120	x	x	
		73		1		1	3,7(m)	120	x	x	
		74		1		1	3	110	x	x	
		75	1				3	132	x	x	
		76		1			3	100	x	x	

Table 3. Summary of otter trawl data sets contained in College of Fisheries logs - cont'd.

Region	Site	Year	Hauls by Season				Gear	Depth range (m)	Species list	Count by species	Length data
			Win	Spr	Sum	Aut					
10. Bellingham Bay	Bellingham Bay	65		2		1	5,6	34-54	x	x	
		66	1	2		1	3	26-32	x	x	
		67			1	1	3	30-32	x	x	
		68		1	2	1	3	28-30	x	x	
		69		1		1	3	30	x	x	
		70		1		2	3	26-32	x	x	
		71		1		1	3,7	30	x	x	
		73		1		1	3,7(m)	30	x	x	
		74		1			3	30	x	x	
		75	1				3	30	x	x	
		76		1			3	30	x	x	
11. San Juan Islands	East Sound, Orcas Is.	49			1		1	34	x	x	
		50		2			3	32-36	x	x	
		65		2		1	5,6	30	x	x	x
		66	1	2		1	3	30-32	x	x	
		67			1	1	3	30	x	x	
		68		1	1		3	30	x	x	
		69		1		1	3	30	x	x	
		70		1		1	3	28-34	x	x	
		71		1		1	3,7	28-30	x	x	
		73		1		1	3,7(m)	30-32	x	x	
		74		1			3	30	x	x	
		75	1				3	30	x	x	
		76		1			3	32	x	x	
	Lopez Sound	70				1	3	50	x	x	
		71		1		1	3,7	40	x	x	
		73		1			7(m)	40	x	x	
		74		1		1	3	40-54	x	x	
		75	1				3	52	x		
		76		1			3	50	x		

Key to gear in Table 4.
7(m) indicates Net 7 used with a 1.5-inch mesh liner.
"x" indicates data are available, blank indicates either no data or incomplete evaluation.
* = gear test, which indicates evaluation of nets with different mesh cod ends.

Table 4. Key to otter trawls used by College of Fisheries, 1949-1976.

Trawl number	Trawl designation used in log books	Head rope (feet)	Foot rope (feet)	Throat mesh (in)	Cod end mesh (in)	Comments
1	0					
2	1	35	42	2.5	1.5	
3	2,4,9,12,15 16,18,19	47	57	2.5	1.25	Most commonly used net
4	3,8	46	56	4.25	3.5	
5	5,10	47	57	4.5	4.5	
6	13	46	56	3.5	3.5	
7	17	70	95	4.0	3.5	In 1973 this net was used with a 1.5-in mesh liner

Additional areas that were sampled frequently were normally within easy access to the university, and thus provided convenient sampling opportunities (e.g., the Golden Gardens-Meadow Point area) or were a known source of specific species complexes and life history stages (e.g., spawning flatfish in Port Orchard).

The data exist as hand-written entries in a set of log books stored at the School of Fisheries, University of Washington. For those cruises in which detailed length information was recorded, the length data are stored on the original field data sheets in a separate set of three-ring binder notebooks. A gear notebook describes the sizes and mesh composition of each net used and notes differences between the various nets used over the years. An example of the records is included in Appendix A.

Dr. English Trawl Logs

These records cover the period from 1964 to 1978 and were all collected with a 16 ft semi-balloon otter trawl attached to a 10 ft (3 meter) beam. The body of the net had a 1.25-inch mesh with a 0.25-inch mesh cod end liner. Data collected included total counts and length measurements of captured fish; information on crabs and shrimp was also a primary concern. External disease information was also collected for many of the sampling sites. The best time series of information is from Port Gardner, sampled from 1965 to 1978, and adjacent sites at Mukilteo and Tulalip, sampled from 1973 to 1977 (Table 5). An interesting feature is that some of the areas surveyed overlap the locations and times of R/V **Commando** training cruises; thus there may be an opportunity to compare the species and sizes captured by the different gears. Some of the data have been published in theses (Cooney 1965, Zebold 1970) and reports (English 1976, 1979; Salo 1969), and thus some detailed analysis has been conducted.

The data are stored on magnetic tape and computer cards at the Fisheries Research Institute at the University of Washington. Information on file structure and the original cruise records are also available; examples are provided in Appendix B.

Dr. Miller Trawl Logs

These records begin in 1969 and are continuing. Two gear types have been used: from 1969 to 1980 sampling was conducted with a 16-ft semi-balloon otter trawl (0.25-inch stretched mesh cod end) attached to otter boards, while after 1980, a 25-ft otter trawl has been used. Routinely collected information included total counts, length measurements and

Table 5. Summary of Dr. English data collected with a 3-m (10-ft) beam trawl.

Region	Site	Date or season	Year	No. of trips	No. of sets	Depth range (m)	Species list	Species count	Length	Disease incidence
1. South Puget Sound	Case Inlet	Oct-Nov	64	2	17	10-120	x	x	x	
		Jul-Dec	65	5	67	10-120	x	x	x	
		Jan-Dec	66	13	156	10-120	x	x	x	
		Jan-Sep	67	9	116	10-120	x	x	x	
	Carr Inlet	May	64	1	6	10-80	x	x	x	
		Aug-Nov	66	2	22	10-80	x	x	x	
		Mar-Sep	67	3	33	10-80	x	x	x	
3. Central Puget Sound	Port Madison	Aug	64	1	6	10-120	x	x	x	
		Aug-Dec	65	3	16	10-120	x	x	x	
		Jan-Dec	66	13	77	10-120	x	x	x	
		Jan-Nov	67	8	46	10-120	x	x	x	
4. Seattle	Duwamish Head	Jul-Dec	65	5	41	10-120	x	x	x	x
		Jan-Dec	66	13	199	10-120	x	x	x	x
		Jan-Feb	67	2	14	10-120	x	x	x	x
	Duwamish River	Jan-Dec	67	4	16	10-20	x	x	x	x
	Meadow Pt.	Apr-Aug	64	5	84	20-80	x	x	x	
		Apr-Aug	65	2	38	5-80	x	x	x	
5. Port Orchard	Port Orchard	May-Sep	64	4	173	10-40	x	x	x	
		Jan-Dec	65	7	260	10-40	x	x	x	
		Jan-Dec	66	14	52	10-40	x	x	x	
		Jan-Nov	67	7	37	10-40	x	x	x	
7. Whidbey Basin	Mukilteo	Jun-Nov	73	6	74	5-80	x	x	x	x
		Jan-Dec	74	9	121	5-80	x	x	x	x
		Feb-Apr	75	2	26	5-80	x	x	x	x
	Port Gardner	Dec	65	1	8	5-150	x	x	x	x
		Mar-Dec	66	5	40	5-150	x	x	x	x
		Mar-Oct	67	3	23	5-150	x	x	x	x
		Jun-Nov	73	6	100	5-150	x	x	x	x
		Jan-Dec	74	11	195	5-150	x	x	x	x
		Jan-May	75	6	124	5-150	x	x	x	x
	Tulalip	Jun-Nov	73	6	96	5-120	x	x	x	x
		Jan-Dec	74	9	142	5-120	x	x	x	x
		Feb-Apr	75	2	31	5-120	x	x	x	x
	Port Susan	Dec	65	1	13	5-125	x	x	x	x
		Mar-Dec	66	5	55	5-120	x	x	x	x
		Mar-Oct	67	3	30	5-135	x	x	x	x

Table 5. Summary of Dr. English data collected with a 3-m (10-ft) beam trawl - cont'd.

Region	Site	Date or season	Year	No. of trips	No. of sets	Depth range (m)	Species list	Species count	Length	Disease incidence
7. Whidbey Basin - cont'd.	Holmes Harbor	Feb-Dec	66	5	20	10-60	x	x	x	x
		Feb-Oct	67	3	12	10-60	x	x	x	x
	Penn Cove	Sep	67	1	9	5-30	x	x	x	x
						5-30	x	x	x	x
						5-30	x	x	x	x
	Utsalady	Winter				5-30	x	x	x	
		Spring				5-30	x	x	x	
		Summer				5-120	x	x	x	
		Fall				5-40	x	x	x	
	Saratoga Pass	Winter				10-100	x	x	x	
		Spring				5-120	x	x	x	
10. Bellingham Bay	Guemes Channel	Jul-Sep	74	2	16	5-21	x	x	x	x
		Jan-Apr	75	3	24	5-20	x	x	x	x
11. San Juan Islands	Orcas Island East Sound	Jul-Sep	74	2	32	5-22	x	x	x	x
		Jan-Apr	75	3	48	5-22	x	x	x	x
12. Georgia Straits	Cherry Point	Jul-Sep	74	2	16	5-25	x	x	x	x
		Jan-Apr	75	2	16	5-20	x	x	x	x

disease incidence by species. Most of the information collected in the central Puget Sound region is related to investigations near Metro's present or planned outfalls or nearby control areas (Table 6). More recent investigations have included studies in Commencement Bay, Elliott Bay, Port Gardner and Saratoga Passage. The latter two locations provide possible ties to the Dr. English trawl series and one **R/V Commando** training cruise site, particularly since the sampling in 1986 used both a 25-ft otter trawl and a 10-ft beam trawl. The primary objective of the beam trawl was crab and shrimp sampling, but records of fish catch were also taken. In addition, there is an intensive 1-year trawl series adjacent to Case Inlet. The detailed seasonal information provided by this series will help to structure the analysis of the multiyear data sets, since the distribution of many of these species varies greatly by season.

The data are all stored on magnetic tape at the Fisheries Research Institute at the University of Washington; examples of the data formats are included in Appendix C.

Drs. DeLacy/Miller Beach Seine Logs

From 1949 to 1967, beach seine sampling was conducted almost annually at Golden Gardens (Table 7). These sampling trips often consisted of sampling series during an extreme tide cycle to examine tidal influences on fish distribution. The gear consisted of either a 60 ft or 120 ft beach seine that was set offshore (usually 100 or 200 ft) parallel to the beach using a small skiff; the net was then pulled to shore by crews pulling on ropes attached to the ends of the net. The net was constructed of 1.25-inch stretched mesh wings with a 0.75-inch stretched mesh bag. The wings were 10-ft deep near the bag and tapered to 3 ft at the end. Data collected were total counts and, usually, length measurements and total weight of each species.

Similar methods were used at other beaches in central Puget Sound, including Alki Point, West Point, Smith Cove, Point Pully and Seahurst Park. In the mid to late-1970s, substantial beach seine sampling was conducted at shoreline sites around the San Juan Islands as part of the DOE Puget Sound Baseline Program (1974 to 1976) and along the Strait of Juan de Fuca as part of the MESA Puget Sound Project (1976-1979). Both programs were under the direction of Dr. Miller and utilized consistent gear and methodology.

The data from Golden Gardens are stored in the original field log books and on data sheets at the School of Fisheries, University of Washington (examples in Appendix D).

Table 6. Dr. Miller data derived from sampling with 16-ft and 25-ft otter trawls.

Region	Site	Date	Year	Gear	No. of trips	No. of hauls	Depth range (m)	Species List	Count by Species	Length	Weight	Disease incidence
1. South Puget Sound	Stadium (Case Inlet)	Mar-Dec	73	16'	9	54	2-40	x	x	x	x	x
		Jan-Feb	74	16'	2	12	2-40	x	x	x	x	x
	Drayton Passage	Feb-(Nov)	87	25'	4	60	20-100	x	x	x	x	x
3. Central Puget Sound	Commencement Bay	Jun-Sep	86	25'	2	17	20-156	x	x	x	x	x
	Pt. Pully	Apr-Dec	75	16'	3	90	5-90	x	x	x	x	x
		Jan-May	76	16'	2	50	5-90	x	x	x	x	x
		Jun-Nov	82	25'	3	24	15-180	x	x	x	x	x
		Jan-Dec	83	25'	4	32	15-180	x	x	x	x	x
	Seahurst	Jun-Nov	82	25'	3	24	15-180	x	x	x	x	x
		Jan-Dec	83	25'	4	32	15-180	x	x	x	x	x
	Tramp Harbor	Jun-Nov	82	25'	3	24	15-180	x	x	x	x	x
		Jan-Dec	83	25'	4	32	15-180	x	x	x	x	x
	Vashon (NE)	Jun-Nov	82	25'	3	24	15-180	x	x	x	x	x
		Jan-Dec	83	25'	4	32	15-180	x	x	x	x	x

Table 6. Dr. Miller data derived from sampling with 16-ft and 25-ft otter trawls - cont'd.

Region	Site	Date	Year	Gear	No. of trips	No. of hauls	Depth range (m)	Species List	Count by Species	Length	Weight	Disease incidence
4. Seattle	West Point	Feb-Dec	73	16'	11	66	3-90	x	x	x	x	x
		Jan-Dec	74	16'	11	66	5-75	x	x	x	x	x
		Mar-Nov	75	16'	9	90	5-95	x	x	x	x	x
		Jan-May	76	16'								
	Alki Point	Apr-Dec	73	16'	7	42	3-90	x	x	x	x	x
		Apr-Dec	75	16'	9	54	5-70	x	x	x	x	x
		Jan-May	76	16'	5	30	5-65	x	x	x	x	x
	Elliott Bay	Jul-Sep	86	25'	2	17		x	x	x	x	x
7. Whidbey Basin	Saratoga Pass	Jul	86	25'	1	8	20-80	x	x	x	x	x
	Port Gardner	Feb-Sep	86	25'	4	76	20-145	x	x	x	x	x
10. Bellingham Bay	Bellingham Bay	Feb-(Nov)	87	25'	4	60	15-35	x	x	x	x	x

Table 7. Summary of Golden Gardens beach seine data, 1950-1974.

Year	Net length (feet)	Number of hauls by season				
		Winter	Spring	Summer	Autumn	
50	60	6	23	2	3	
51	60	6	20	1	4	
52	60	8	16	6	1	(Includes 7 hauls at Carkeek Beach)
	120		13			
53	60			2		
	120	2	5			(Includes 5 hauls at Carkeek Beach)
54	60		2	1		
	120	3	24		2	
55	120	6	16			
56	120		27			
57	120		11			(Includes 4 hauls at Carkeek Beach)
58	120		6			(Includes 2 hauls at Carkeek Beach)
59	60		15	2		
60	60		6			
61	120		7			
62	120		6			
63	120		38			
64	60		9			
	120		12			
65	60				2	
	120		15			
67	120	3	10			
72	120		3			

More recent series, such as the METRO, DOE Puget Sound Baseline and MESA programs are on magnetic tape, using the same formats as those in the Dr. Miller otter trawl files.

Dr. DeLacy/Miller Flatfish Ichthyoplankton Sampling

This series consists of a narrowly focused data set compiled between 1955 and the present. The sampling consisted of collecting primarily flounder eggs (and some larvae) in Elliott Bay during the spawning season as part of a course on early life history of marine fishes. Gear used included 0.5-meter plankton nets, 20- and 60-cm bongo nets and various experimental nets and plankton pumps. Often, part of the exercise was to compare different gear types. Information collected included number of eggs per volume of water strained, with sampling occurring at a variety of depths. The data set may provide interesting information on the consistency of flatfish spawning in an area adjacent to heavy industrial development.

The data are stored in a three-ring binder at the Fisheries Research Institute; there has been no attempt to transform the data into computer files. A representative data set is provided in Appendix E.

Friday Harbor Logs

The information on marine fish from the Friday Harbor logs consists of four types of data: (1) otter trawl records, (2) beach seine records, (3) night light sightings and (4) tidepool records. The logs cover a period from 1950 to 1987, with most of the records being entered on a 2-year cycle. This pattern arises because the fish ecology course alternated annually with the biological oceanography course. The locations covered vary by gear type, since each of the survey methods samples totally different habitat. The most extensively covered areas by sampling method are:

Otter Trawling:	East Sound, Orcas Island West Sound, Orcas Island Upright Head, Lopez Island Lopez Sound, Lopez Island
Beach Seine:	Argyle Bay, San Juan Island Westcott Bay, San Juan Island Deadman Bay, San Juan Island Eagle Cove, San Juan Island
Night Light:	Friday Harbor Labs Dock
Tidepools:	Iceberg Point, Lopez Island

The otter trawling has been conducted with two trawls. Between 1950 and 1983, the research trawl had a 48-ft head rope, 64-ft foot rope, 3-inch mesh in the throat and a 1.5-inch mesh in the cod end. After 1983, the 25-ft otter trawl used by Dr. Miller, described above, was adopted as the primary sampling trawl. Beach seining was also conducted as described above for the DeLacy/Miller beach seine sampling. Night lighting consists of hanging a waterproof light under water off the Labs dock after dark and watching organisms attracted to the light. Normally small species, pelagic juveniles and larvae that occupy the surface portion of the water mass are attracted to the light. Specimens are collected by dip net and identified. Tidepool sampling consists of bailing out the tidepool with a bucket, adding anesthetic to the remaining water and then dipnetting the fish. Fish living under rocks are collected by turning over the rocks and capturing the exposed fish.

The data are stored in the original logbooks at the Friday Harbor Laboratories Synoptic Collection; there has been no effort to transfer the information to computer format.

Washington Department of Fisheries

The Washington Department of Fisheries has long-term data on a number of marine fisheries. The most appropriate data sets appear to be (1) information on marine fish collected in the trawl fishery, (2) herring spawning surveys and (3) bottomfish sportfish records.

Trawl Surveys: The trawl survey data consist of logbook summaries maintained by the fishermen since the mid-1950s. Until 1986, the logbooks were voluntary but now the program is a mandatory part of the fishery. Prior to 1986, there was 50-90 percent participation in the voluntary program. Information consists of catch by species and effort for each fishing area. Most of the data are from the Gulf of Georgia, Northern San Juans, Bellingham Bay, Saratoga Passage, Holmes Harbor and Discovery Bay, since these are the areas of greatest effort. Hood Canal was an important area in the past, but trawling is discouraged in this area at present. There was generally low effort in central and southern Puget Sound, in part because of the high incidence of parasites in bottomfish. Since the data are in a standardized database used by the Department, it should be possible to retrieve information in a form more compatible with specific project needs. Examples of the summary catch data from 1969 and 1984, along with total effort by area for 1984, are provided in Appendix F.

Herring Spawning Surveys: Surveys of representative herring spawning areas have been made annually for the past 10 years. Surveys consist of sampling marine vegetation and other substrates from depths between 0 to -50 ft in tidal elevation, at 200- to 400-yard intervals along the shorelines of spawning grounds. The surveys estimate the number of tons of spawning fish in each year and are made to coincide with the estimated time of peak spawning. The same areas have been sampled each year with new areas added as they are discovered. Maps are produced of the areas used. In addition, there are acoustic estimates of adult herring near the spawning areas. Herring spawn in shallow water, and the spawning areas are highly vulnerable to surface contaminants; thus the surveys might quickly detect changes in habitat use by spawning fish. Examples of the type of data collected are provided in Appendix G.

Bottomfish Sportfishing Records: These records consist of estimates of total removal for each species from the salmon punchcard areas. The data are primarily from 1973 to the present, since prior to 1973 there was no consistent effort to include bottomfish in the total counts. These data are of more limited value because of the many unknown factors that affect the ultimate sport catch, such as target species, gear used, type of area fished, etc. Records from 1975 and 1985 are included in Appendix H.

Most of the data are stored on the WDF computer system and are available through the WDF offices at the NOAA Sand Point facility. The trawl data and bottomfish sportfishing records are on computer files. The herring spawning data are in progress reports with annual maps detailing the spawning locations. Additional detail can be provided by the biologists working on the specific projects.

Additional data sources available from WDF include hydroacoustic estimates of hake in Port Susan (1979-1986), surface townetting for juvenile herring (1979-1985) and diver monitoring of artificial reefs. These data sources are considered too limited in coverage to meet project objectives.

Navy Monitoring Studies at Bangor

The Navy has been conducting trawling at the Bangor Submarine Base as part of their monitoring program. The Navy records have been collected in a standardized fashion since 1979, with similar trawl data gathered between 1973 and 1978. The sampling presently consists of night trawls taken at seven stations. All sampling occurs during one annual cruise conducted during July or August. Two 10-minute hauls are taken at each station in

water depths of 15-25 ft. Data collected consist of count by species for each haul. Because of the short sampling interval (one or two days), the data are considered to be too limited to be of significant value in the analysis, but would provide good supplemental information for other studies in the region.

The data are published in annual reports that are sent out for agency review. Original data records are at the Naval Ocean Systems Center in Hawaii. The results of the 1985 survey are included as Appendix I.

Miscellaneous Data Sources

Aside from the long-term data sets identified above, there are a number of short-term studies that have been conducted in various regions that could assist in interpreting long-term trends. These short-term studies could provide additional detail on marine fish populations within a region and help extend the period of record provided by the long-term data sets. Often these short-term studies occur as reports or publications. Following are some of the more obvious choices for inclusion.

Smith (1936): This document is a report on the commercial otter trawl fishery in Puget Sound. Abundance data and biological observations were made on marine fish populations from all regions of Puget Sound. Gear used were commercial otter trawls with 4.25- to 5.0-inch stretched mesh cod ends.

CH_2M Hill (1984): The report contains data from a Bellingham Bay trawl survey (25 ft trawl) that can supplement records from the other identified sources. In addition, the report contains a detailed summary of almost all fish sampling in Bellingham Bay up to 1984 and would assist in developing a trend analysis for the bay.

Finally, it could be very useful to use the data by Miller and Borton (1980) and Mearns (1988) to look at the presence/absence of species in the twelve geographical areas of Puget Sound since the 1890s, i.e., a chronological analysis of the data rather than geographical as in Miller and Borton (1980).

Summary of Data Availability by Region

Region 1. South Puget Sound

The two sources of information that provide the most promise for evaluating trends in marine fish in South Puget Sound are the records from Case Inlet and Carr Inlet in both the

COF logs and the Dr. English data set. The COF logs cover the period from 1949 to 1957 and 1967 for Case Inlet and Carr Inlet, respectively, while the Dr. English data cover 1964-1967. In addition, an intensive study by Dr. Miller consisting of monthly trawl surveys over a 1-year period in 1973 at the north end of Pickering Passage, adjacent to Case Inlet, provides detail of annual patterns. There are a number of individual cruises or surveys in other inlets or passages, but they would be of limited value for evaluating time trends.

Region 2. Colvos Passage

This small region primarily consists of Colvos Passage on the west side of Vashon Island, but also includes Tacoma Narrows. There has been little marine fish sampling in this region. There were seven COF trawl trips between 1949 and 1951, then another in 1967. No additional data sources have been identified.

Region 3. Central Puget Sound

The region consists of the central Puget Sound basin between Tacoma and the south end of Whidbey Island. The area has been subjected to substantial investigation because of its proximity to research institutions, such as the University of Washington. The most extensive time series of marine fish data are the COF trawl series at Murden Cove and at midchannel between West Point and Skiff Point. An additional series of interest is the Dr. English beam trawl data from Port Madison between 1964 to 1967.

Region 4. Seattle

This region is a somewhat arbitrary subdivision of the central Puget Sound region established because of the intensive study efforts and extreme metropolitan development. The region extends from south of Alki Point to Edmonds and shoreward of the midchannel line. The relevant data sets include the COF logs from Golden Gardens and Meadow Point (1949 to 1971), DeLacy/Miller beach seine logs from Golden Gardens, West Point and other Seattle-area beaches, DeLacy/Miller ichthyoplankton surveys, Dr. Miller trawl logs from West Point, Alki Point and Duwamish River, and Dr. English trawl logs from Duwamish River.

Region 5. Port Orchard

The Port Orchard region consists of the narrow channels and inlets west of Bainbridge Island. The area contains a diverse assemblage of marine fish, is a flatfish spawning area and is easily trawled because of the moderate water depths; thus the area has received substantial sampling effort. The most extensive series is the COF trawl logs from 1952 to

present. Dr. English trawl logs also indicate substantial effort in the area, with over 500 hauls between 1964 and 1967. The area has also had extensive ichthyoplankton sampling, which could be tied to the Elliott Bay ichthyoplankton surveys.

Region 6. Hood Canal

There are few long-term records for marine fish in Hood Canal, most likely because of the long travel distance from research institutions. The most promising source is the Navy trawling records at the Bangor submarine base.

The Navy records have been collected in a standardized fashion since 1979, with additional information gathered since 1973. Data collected consist of count by species for each haul.

The COF records from Hood Canal were also evaluated. These consist primarily of shrimp trawl logs that have been collected since 1964. Since the sampling was targeting on invertebrates, the marine fish data is less complete than for other COF records, but at times a complete species list was maintained. Few counts were ever recorded.

Region 7. Whidbey Basin

The Whidbey Basin is the area east of Whidbey Island. This area has been sampled extensively and three data sources, COF logs, Dr. English logs and WDF trawl surveys, provide excellent temporal coverage of this region. Four areas within the region, Holmes Harbor, Penn Cove, Saratoga Passage off Penn Cove and the east side of Gedney Island, were regularly sampled from the **R/V Commando**. Dr. English regularly sampled at Mukilteo, Tulalip and Port Gardner between 1973 and 1978, with additional multi-year sampling at Port Susan and Holmes Harbor. Trawl sampling by Dr. Miller is continuing in Port Gardner, and thus current data are available for comparison with the historical data. The current sampling consists of both beam trawl and 25-ft otter trawl sampling, which provide an opportunity to compare the performance of the two gears.

Region 8. Admiralty Inlet

This region covers the area between Point No Point and Port Townsend. No long-term sampling areas were identified.

Region 9. Strait of Juan de Fuca

This region also has not received long-term sampling. There is a limited series of beach seine sampling at a number of sites as part of the MESA program from 1976 to 1979.

Region 10. Bellingham Bay

Bellingham Bay, a station in the **R/V Commando** training cruise series, provided a continuous series of information from 1965 to 1976. In addition, the area has consistent coverage in the WDF trawl survey records. A thorough presentation and analysis of available marine fish data from the Bellingham Bay region, with additional 1983-1984 trawl data (25 ft trawl) from the vicinity of Post Point, are contained in CH_2M Hill (1984). Additional sampling by Dr. Miller with a 25-ft trawl is continuing in 1987.

Region 11. San Juan Islands

There are a variety of long-term data records dating from 1950 for the San Juan Islands region because of collecting by researchers at the Friday Harbor Labs (see FHL logs above). The data are primarily from trawling, beach seine and night-light sampling. In addition, East Sound, Orcas Island (1965 to 1976) and Lopez Sound (1971 to 1976) were stations in the **R/V Commando** training cruises.

Region 12. Georgia Strait

Little long-term information exists for the Georgia Strait. Since the area is a popular commercial trawling area, the WDF trawl surveys provide the most complete record for the region.

RECOMMENDATIONS

We recommend continuing with the characterization process because of the long-term series available for several of the regions, particularly Southern Puget Sound, Central Puget Sound (including Seattle), Whidbey Basin, Port Orchard, Bellingham Bay and San Juan Islands regions. The COF and Dr. English logs have the best time-series information and can be supplemented with some of the additional data from other sources. We also recommend a generalized chronological characterization based upon species presence/ absence by utilizing the data of Miller and Borton (1980) and Mearns (1988).

The Golden Gardens beach seine data provide a long-term record of nearshore habitat use in an area that has been increasingly developed. Field notes included in the surveys refer to habitat changes noted during construction of the Shilshole Marina and breakwater; other long-term changes may become apparent with more detailed analysis.

The WDF herring spawning surveys provide a good opportunity to follow a time-series of the critical life stage for an individual species at widely separated locations and probably

deserve special treatment in a characterization document. Similarly, the flatfish spawning areas at Duwamish Head and Port Orchard may deserve similar treatment. As the study progresses, other specialized studies that document critical habitats may become apparent and these could be incorporated.

A possible characterization document that uses the above data sources is outlined in Table 8. One of the difficulties with the available information is the variety of gear types used by the different investigators. This can largely be overcome by analyzing within a gear type and avoiding comparisons across vastly different methods, as illustrated in the outline. For some gear types, there was substantial overlap in sampling times and locations. In many cases, such as a number of the COF cruises and recent studies with small otter and beam trawls, data were collected to allow direct comparison of gear performance. In these cases, it should be possible to compare the sampling biases of the gears, which could also help develop recommendations on standardizing sampling gear utilized in the future. Such gear evaluations are included as an initial step for each of the data types.

Since population levels are continually changing because of natural flucuations, the test will be to determine if the data are sensitive enough to reveal such natural changes, which can then be compared to areas where man-induced changes may have occurred. For this reason, it is advisable to include data from areas with low population density as well as urban areas.

The time-series analysis for the otter trawl and beach seine data would be carried out at three levels, dictated to some extent by the completeness of the data. The most basic analysis would consider species occurrence, probably using some sort of grouping (cluster) analysis as performed by Wingert and Miller (1979). That analysis, however, did not consider time in the evaluation of species groups. The second level of analysis would compare catch rates of various species, with the catch rates assumed to indicate some measure of abundance at a site. The final level would be length-frequency analysis of selected species from those surveys where sufficient detail is available for a reasonable length of time, likely not less than 5 years.

The commercial trawl data from WDF may provide good indices of abundance for adults of selected species, but any analysis would need to carefully evaluate the patterns to separate effort and harvest effects from natural changes in the populations. This may be accomplished to some extent by comparing catch data with information from the research

Table 8. Preliminary outline for a characterization report on Puget Sound marine fishes.

1.0 Introduction
- 1.1 Goals and Objectives of the Characterization Study
- 1.2 History of Puget Sound Marine Fish Investigations

2.0 Methods
- 2.1 Data Review
- 2.2 Data Management Process (evaluation and quality control procedures)
- 2.3 Analytical Process

3.0 Results
- 3.1 Otter Trawl Investigations
  - 3.1.1 Comparison of Research Trawls (to establish comparability between gears used)
    a. Species composition
    b. Catch per effort
    c. Size distribution of selected species
  - 3.1.2 Time-Series analysis of trawl catches at selected sites
    a. Stability of species composition at selected sites (probably group the historical record into 5 year intervals and compare between intervals)
    b. Abundance patterns of selected species (again probably on 5 year groupings
    c. Analysis of changes in size distribution of selected species (this would be based on a few data sets carefully selected because of completeness, similarity of gear and comparability of depths sampled)
- 3.2 Golden Gardens Beach Seine
  - 3.2.1 Evaluation of beach seine selectivity by deployment method and tide stage
  - 3.2.2 Time-series analysis of beach seine catches
    a. Stability of species composition (probably partition by multi-year intervals as in the trawl surveys, but would include major partitioning around construction of Shilshole breakwater and marina)
    b. Abundance patterns of selected species (partitioned as in a.)
    c. Patterns in size distribution of selected species (this would rely on the more extensive seining efforts primarily during spring, where there is nearly complete coverage of size data)
- 3.3 Wash. Dept. Fisheries Commercial Trawl Records
  - 3.3.1 Description of factors affecting trawl catch rates of dominant species by area (this section would include an analysis of the response of catch rate to varying effort, i.e., a sensitivity analysis to determine if changes are caused by changes in the fishing pattern or may be due to fish population changes)

Table 8. Preliminary outline for a characterization report on Puget Sound marine fishes - cont'd.

3.3.2 Time trend analysis of selected species by area (probably Pacific cod, English sole, rock sole, sand sole and starry flounder)
a. Patterns of catch rate by area
b. Comparison of patterns apparent from commercial trawls with patterns described by research trawls

3.4 Wash. Dept. Fisheries Herring Spawn Surveys
3.4.1 Evaluation of survey methodology for period of record
3.4.2 Patterns of abundance and spawner distribution at each monitored site

3.5 Elliott Bay Flatfish Ichthyoplankton
3.5.1 Evaluation and comparison of methods
3.5.2 Time-series analysis of egg densities and development stages (this would require developing an abundance index, probably stratified by depth)

4.0 Discussion
4.1 Evaluation of methodologies used to sample the various habitats utilized by marine fish (this section would also deal with recommendations for standardizing gear types)
4.2 Observed trends in marine fish data and possible factors causing the observed patterns (this section would be the main discussion of the time-series analysis; the analysis of causative factors would be subjective in this report, but would indicate the direction for further work if observed changes are thought to be caused by deterioration in habitat quality near developed areas)

trawl analysis in areas where there is substantial overlap (i.e., Bellingham Bay, Holmes Harbor and Saratoga Passage).

The herring spawning surveys would provide the most straightforward analysis because of the relatively short time series and the consistency of the methods. Conversely, the Elliott Bay flatfish egg data may present more of a hurdle because of the small window of time (January) that has been sampled over the years, but it should probably remain under consideration because of its potential value.

In summary, we predict that a time series analysis of marine fish data sets will elucidate long-term trends in Puget Sound fish assemblages. However, the time-series analysis would still be of significant value for establishing a baseline against which the results of future monitoring efforts can be compared and evaluated. The review of the data presented in this report already indicates that while many of the beach seine and trawl sites were regularly sampled from the 1950s to the 1970s, there has been a less complete record for the last 10 years as the studies have become more oriented to short-term projects. Monitoring efforts that include sampling of marine fish should consider incorporating the sites with long-term baseline information into the study design to provide some means of evaluating future changes that may occur.

This data review was not meant to be an exhaustive review of all available data on marine fish, but was a quick examination of the best time-series information from major data sets to determine if a valid characterization project was possible. Other more restricted data sets were evaluated to determine their suitability as supplemental information. It is likely that more of these restricted sources will become known to us if the project continues; these would be evaluated and, if suitable, included.

On the basis of our evaluation of the available data sets, we recommend that the following priority be used for analyzing data for the characterization of Puget Sound fishes:

1. research otter trawl data sets, focusing on Port Orchard, Port Gardner and Bellingham Bay, with further evaluation of Port Madison and Case Inlet data;
2. WDF herring spawning survey data;
3. Elliott Bay ichthyoplankton data series, with possible inclusiong of Port Orchard and central basin data;
4. research beach seine data focusing on the Golden Gardens data sets;

5. WDF commercial trawl data, focusing on Pacific cod, English sole, rock sole, sand sole and starry flounder; and

6. Friday Harbor logbook data, focusing on sites with long-term sampling series by a consistent method.

This order of priority is based on an evaluation of the potential that the analysis will provide useful results for making decisions on the significance of long-term changes within Puget Sound.

LITERATURE RELEVANT TO PROJECT OBJECTIVES

Chew, K.K. and Q.J. Stober. 1983. Renton Sewage Treatment Plant Project: Seahurst Baseline Study. Phase I Draft Annual Report for the Period 1 April 1982 to 31 March 1983. Fish. Res. Inst., Coll. Fish., Univ. Washington, Seattle. 1028 p. (Sampling with 25 ft otter trawl and 120 ft beach seine at Seahurst, Pt. Pully, Tramp Harbor and Aquarium [NE Vashon Island] in 1982.)

Chew, K.K. and Q.J. Stober. 1984. Renton Sewage Treatment Plant Project: Seahurst Baseline Study. Fish. Res. Inst., Coll. Fish., Univ. Washington, Seattle. FRI-UW-8413. 2300 p. (Sampling with 25 ft otter trawl and 120 ft beach seine at Seahurst, Pt. Pully, Tramp Harbor and Aquarium [NE Vashon Island] in 1982 to 1983 and Saltwater State Park in 1983.)

CH_2M Hill. 1984. Application for variance from secondary treatment requirements. Section 301(h) Clean Water Act. Submitted to USEPA by City of Bellingham, Wa. (Presentation and analysis of historical marine fish data from Bellingham Bay and results of trawling at Post Point, 1983-1984.)

Cooney, R.T. 1967. Diel differences in trawl catches of some demersal fishes. M.S. Thesis, Univ. Washington, Seattle. (Results of 3-m beam trawling in Port Orchard, 1964-1967.)

DeLacy, A.C., B.S. Miller and S.F. Borton. 1972. Checklist of Puget Sound fishes. Washington Sea Grant Program WSG 72-3. 43 p.

Dinnel, P.A., D.A. Armstrong, B.S. Miller and R.F. Donnelly. 1986. Puget Sound dredge disposal analysis (PSDDA). Disposal site investigations: Phase 1 trawl studies in Saratoga Passage, Port Gardner, Elliott Bay and Commencement Bay, Washington. Final Report. Fish. Res. Inst., Coll. Fish., Univ. Washington, Seattle. (Results of 3-m beam trawl and 25 ft otter trawl in Port Gardner, Saratoga Passage, Elliott Bay and Commencement Bay, 1986.)

English, T.S. 1976. Trawling observations in Port Gardner, Washington 1973, 1974, and 1975. Biological baseline and monitoring study for Port Gardner and adjacent waters. A summary report for the years 1972 through 1975. Wash. St. Department of Ecology, Olympia, Wa. (Results of 3-m beam trawling at Mukilteo, Port Gardner and Tulalip, 1973 to 1975.)

English, T.S. 1979. Biological systems acoustical assessments in Port Gardner and adjacent waters. 1 September 1978 to 30 June 1979. Annual Report. Dept.

Oceanography, Univ. Washington, Seattle. 86 p. (Data summary from 3-m beam trawling at Mukilteo, Port Gardner and Tulalip, 1973 to 1978.)

Mearns, A. 1988. NOAA publication in preparation on exotic fish occurrences.

Miller, B.S. and S.F. Borton. 1980. Geographical distribution of Puget Sound fishes: maps and data source sheets. Fish. Res. Inst., Coll. Fish., Univ. Washington, Seattle, Wa.

Miller, B.S., B.B. McCain, R.C. Wingert, S.F. Borton and K.V. Pierce. 1976. Ecological and disease studies of demersal fishes near Metro operated sewage treatment plants on Puget Sound and the Duwamish River. Fish. Res. Inst., Coll. Fish., Univ. Washington, Seattle. 135 p. (Results of 16 ft trawl and 120 ft beach seine sampling at West Point, Alki Point and Point Pully and trawling in the Duwamish River, 1975.)

Miller, B.S., Lawrence L. Moulton and S.F. Borton. 1974. Influence of sewage and waste disposal on specific areas of Puget Sound: Some biological considerations of proposed sewage treatment plant sitings at Stadium and Union, Washington. Final Report. Fish. Res. Inst., Coll Fish., Univ. Washington, Seattle. FRI-UW 7415. 68 p. (Results of sampling with 16 ft otter trawl at Stadium in southern Puget Sound and Union in southern Hood Canal in 1973, monthly cruises were conducted at each location.)

Miller, B.S., C.A. Simenstad, J.N. Cross, and K.L. Fresh. 1979. Nearshore fish and macroinvertebrate assemblages along the Strait of Juan de Fuca including food habits of the common nearshore fish. Final Report of three years' sampling (1976-1979). NOAA, MESA Puget Sound Project, Fish. Res. Inst., Coll. Fish., Univ. Washington, Seattle, Wa. (Results of beach seine sampling at various sites along Strait of Juan de Fuca.)

Miller, B.S., C.A. Simenstad, K.L. Fresh, F.C. Funk, W.A. Karp, S.F. Borton, and L.L. Moulton. 1977. Puget Sound baseline program; nearshore fish survey. Final Report to Wash. St. Dept. Ecology, June 1974-June 1977. Fish. Res. Inst., Coll. Fish., Univ. Washington, Seattle, Wa. FRI-UW-7710. 220 p. (Results of 120 ft beach seine sampling in northern Puget Sound and the San Juan Islands, 1974-1976.)

Miller, B.S., R.C. Wingert and S.F. Borton. Ecological survey of demersal fishes in the Duwamish River and at West Point, 1974. Fish. Res. Inst., Coll. Fish., Univ. Washington, Seattle. 35 p. (16 ft trawl and 120 ft beach seine sampling at West Point and trawl sampling in the Duwamish River, 1974.)

Moulton, L.L., B.S. Miller and R.I. Matsuda. 1974. Ecological survey of demersal fishes at Metro's West Point and Alki Point outfalls. Wash. Sea Grant WSG-TA 74-11. Seattle, Wa. 39 p. (16 ft trawl and 120 ft beach seine data from West Point and Alki Point, 1973.)

Salo, E.O. 1969. Estuarine ecology research project. Final Rept. for the period June 1, 1965-September 30, 1968. Fish. Res. Inst., Coll. Fish., Univ. Washington, Seattle. (Contains 1967 to 1968 data on 3-m beam trawl catches from Duwamish River, Duwamish Head, Port Gardner and Skagit Bay, includes disease incidence.)

Smith, R.T. 1936. Report on the Puget Sound otter trawl investigations. Washington State Dep. Fish., Biol. Rep. 36B. 61 p. (Information on species caught by commercial otter trawls in Puget Sound, coverage is entire Sound, includes biological information and relative abundance based on 4.25 to 5.0 inch mesh trawls.)

Stober, Q.J. and K.K. Chew. 1984. Renton Sewage Treatment Plant Project: Duwamish Head Documentation. Fish. Res. Inst., Coll. Fish., Univ. Washington, Seattle. 327 p. (Beach seine and trawl data from Elliott Bay, Duwamish Head and Smith Cove, 1984.)

Zebold, S.L. 1970. Inter- and intraspecific comparisons of the diel distributions and the food and feeding habits of five species of demersal fishes from the Duwamish Head, Puget Sound, Washington. M.S. Thesis, Univ. Washington, Seattle. (Reports results of 3-m beam trawling at Duwamish Head, 1965-1967.)

EXAMPLES OF SELECTED DATA SETS

A. COLLEGE OF FISHERIES TRAWL DATA

7010

TRAINING CRUISE SUMMARY TRIP 7010

April 23, 24, 1970 Otter trawl 2 1/2" x 1 1/4"

	7010C		7010D		7010E		7010G		7010H	
	No.	cm.	No.	cm.	No.	cm.	No.	cm.	No.	cm.
Anoplopoma	4	43					1	36		
Bathyagonus	2	20	1							
Cith. sordidus							4	15		
Clupea	1	27					10	12	29	12
Cymatogaster							91	--	4	--
Gadus							1	78		
Hexagr. stelleri							4	21		
Hippoglossoides							2	28	2	18
Hydrolagus male	13	32	4	30	13	35	2 ♂♀			
Hydrolagus female	9	29	5	44	13	36				
Isopsetta							3	35	24	33
Lepidopsetta							8	27	7	16
Leptocottus							24	17	64	17
Liparis pulchellus									2	--
Lumpenus maculatus									1	--
Lycodes brevipes	1	27								
Lycodopsis					33	20				
Lyopsetta	91	19	101	20	88	20				
Merluccius	6	36	3	30	3	23				
Microgadus	1	23			8	20	28	17	358	15
Microstomus	15	34								
Parophrys	21	35	1	31			132	17	150	19
Platichthys							55	32	18	33
Porichthys							2	16	31	19
Psettichthys							19	27	56	24
Raja binoculata							1	96		
Sebas. caurinus	1	35			2	35				
Spirin. thaleichthys									2	8
Squalus male	2	66 ?Sex?	2	90	♂ 21	69	13	57		
Squalus female					♀ 14	68	12	58	♀ 9	93
Theragra	11	37	2	39	11	35				
Xeneretmus					9	14				

Place	Hat Island	Langley	Penn Cove	Bellingham Bay	East Sound
Depth	55 fm	60 fm	30 fm	13 fm	14 fm
Time (PST)	0840	1014	1150	1634	0555
Duration in min.	20	15	20	20	20
Weight in lbs.	100 lbs	40 lbs	180 lbs	158 lbs	212 lbs

SPECIES _____ TRIP NO. ~~7910~~ E

DATE _____ HAUL NO. _____

LOCATION _____ GEAR _____ TIME _____

_____ TIME HAULED _____ DEPTH _____

WEATHER _____ DISTANCE HAULED _____

Ser. No.	Length	Sex	
~~Metadoxa~~	#13		Crangon Shrimp
Molpadia			Count 38
Hydrolagus			
26	39	m	
	33	F	
	45	F	
	35	m	
	47	F	
	43	F	
	39	F	
	35	m	
	37	m	
	36	m	
	41	F	
	39	F	
	38	F	
	37	m	
	29	F	
	37	m	
	37	m	
	49	F	
	35	m	
	36	F	
	38	m	
	27	F	
	35	F	
	33	m	
	37	m	
	20	m	
31 lb. total			

SPECIES _____ TRIP NO. 7010E

DATE 4-23-70 HAUL NO. _____

LOCATION _____ GEAR _____ TIME _____

_____ TIME HAULED _____ DEPTH _____

WEATHER _____ DISTANCE HAULED _____

Ser. No.	Length	Sex
	Merluccius.	
#2	38 cm	
	15 cm	
#33	Lycodopsis pacificus.	
2 1/4 lbs	21	IIII
	22	II
	20	IIII
	18	III
	19	IIIII
	23	I
	17	I
		33
Measured		
#9	12	
	14	
	18	
	16	
	16	
	16	
	12	
	13	
	12	

Theragra #11

Length	6.5 lbs
38	
36	
31	
35	
39	
38	
37	
30	
37	
36	
27	

Merluccius Productus #1 3 fish total

15	68/3 = 23cm

Microgadus #8

23
17
23
14
24
22
16
17

UNIVERSITY OF WASHINGTON 38 FISHERIES RESEARCH INSTITUTE

LENGTH TABULATIONS — HIGH SEAS SALMON TAGGING

AREA _____ GEAR _____ SPECIES _____

Date	4-22-70 7010E
Set No.	
Dir. Open	
Age	

Lyopsetta #88

LENGTH IN CENTIMETERS

5	
6	
7	
8	
9	
10	
11	
12	
13	
14	1
15	
16	11
17	11
18	11
19	111
20	111
21	11
22	111
23	1111
24	11
25	111
26	
27	
28	
29	
30	11 POUNDS
31	
32	
33	
34	
35	
36	
37	
38	
39	
40	
41	
42	
43	
44	
45	
46	
47	
48	
49	
50	
51	
52	
53	
54	
55	
56	
57	
58	
59	
60	
61	
62	
63	
64	
65	
66	
67	
68	
69	
70	
TOTAL	

UNIVERSITY OF WASHINGTON 59 FISHERIES RESEARCH INSTITUTE

LENGTH TABULATIONS — HIGH SEAS SALMON TAGGING

AREA 7010 G

GEAR — SPECIES

Date
Set No.
Dir. Open
Age

Length in centimeters	~~Platichthys~~ Psettichthys melanostictus 13 lbs	Parophrys 13 lbs	Isopsetta	Hippoglossoides
5			36 cm	29 cm
6			34 cm	28 cm
7			36 cm	2 Fish
8			3 fish	
9				
10			2 lbs	1/2 lbs
11		[illegible]		
12		[illegible]		
13		[illegible]		
14		[illegible]		
15		[illegible]	Citharichthys sordidus	
16		[illegible]		
17		[illegible]	15 cm - left	
18		[illegible]	15 cm	
19	II	[illegible]	14 cm	
20		[illegible]	15 cm	
21	III	[illegible]		
22	II	[illegible]	4 Fish	
23	I	[illegible]		
24	II	[illegible]		
25		[illegible]		
26	I	[illegible]		
27		[illegible]		
28	I			
29	II			
30	I			
31		I		
32	II			
33		122 Fish		
34				
35	I			
36	III			
37	19 Fish			
38–70				
TOTAL				

SPECIES _____ TRIP NO. 7010 G

DATE _____ HAUL NO. _____

LOCATION _____ GEAR _____ TIME _____

_____ TIME HAULED _____ DEPTH _____

WEATHER _____ DISTANCE HAULED _____

Ser. No.	Length	Sex										
Gadus	Macrocephalus											
	78 cm	11 lbs										
	1 Fish											
Squalus		12 ♀	23 lbs									
	69	F										
	58	"										
	49	"										
	50	"										
	57	"										
	85	"										
	52	"										
	62	"										
	53	"										
	52	"										
	48	"										
	60	"										
	64	M	130	24 lbs								
	48	"										
	75	"										
	60	"										
	50	"										
	49	"										
	47	"										
	58	"										
	63	"										
	55	"										
	70	"										
	52	"										
	55	"										
	25 Fish											

SPECIES ______ TRIP NO. ______

DATE ______ HAUL NO. 7010 G

LOCATION ______ GEAR ______ TIME ______

TIME HAULED ______ DEPTH ______

WEATHER ______ DISTANCE HAULED ______

Ser. No.	Length	Sex					Microgadus	
Hexagrammos stelleri							~~Microgadus~~	
#4	22			85/4 = 21 cm			Length	
½ lbs	24						21	9
	20						15	10
	19 / 4 fish						21	22
							18	26
Anoplopoma							23	24
½ lb	36 cm						12	11
							22	20
Parichthys							22	10
	16 cm						23	9
	16 cm						27	
							22	28 fish
Clupea							22	
# 10	11						10	
	13						11	
	13						22	
	10						10	
	13						11	
	11						10	
	12						13	
	10						WEIGHT = 3 lbs.	
	13							
	15							
Leptocottus								
# 24	19		16	20		14		
3 lbs	15		20	19		16		
	18		17	19		19		
	16		15	17		20		
	16		16	20		15		
	15		15	17		14		

Summary of Commando trip 6710. Otter trawl #17 with tickler chain, 2½ and 1¼ inch mesh.
April 12, 1967. Murden Cove to mid-channel.
*Portion of sample measured.

	6710-A		6710-B		6710-C		6710-D	
	# Fish	mm.	# Fish	mm.	# Fish	mm.	# Fish	mm
Agonus acipenserinus					1			
A oplopoma fimbria			5	343	8	381		
Atheresthes stomias					1	310		
Aulorhynchus flavidus	1							
Chitonotus pugetensis	1	12	2	118				
Citharichthys sordidus	1	222	69	213	2	221		
" stigmoeus	2	161						
Clupea pallasii	15	17	1	197				
Cymatogaster aggregata			3615	104*	25	105		
Damalichthys vacca	1	38	69	124	1	162		
Gadus macrocephalus	10	432	19	416				
Glyptocephalus zachirus					8	233	1	257
Hexagrammos stelleri			3	305				
Hippoglossoides elassodon	1							
Hydrolagus colliei male					216	271	96	271
female					287	286	101	276
Lepidopsetta bilineata	40	270	260	202	4	214		
Lycodapus mandibularis							1	
Lyopsetta exilis					54	216	5	284
Merluccius productus					2	438	1	370
Microgadus proximus			1475	154*	4	229		
Microstomus pacificus					37	297	2	322
Oncorhynchus tshawytscha			1	370				
Parophrys vetulus	69	357*	212	273	17	311		
Pleuronichthys coenosus	2	255*						
Sebastodes caurinus					56	219		
Squalus acanthias			5	653			6	372
Theragra chalcogramma			7	149	27	300		
Depth in FMS	10		20		25-45		127	
Time PST	0910		940		1340		1415	
Duration (min.)	10		10		10		10	
Weight (lbs.)	98		419		378		152	

Trawl summary for trip 6713, May 8, 1967. Port Orchard and Murden Cove
OT #16 (2½" and 1¾" mesh) with tickler chain relocated 10-minute hauls.
* Denotes partial measurement of sample.

	6713 A		6713 B		6713 C		6713 D		6713 E		6713 F		6713 G		6713 H	
	No.	mm.	No.	mm.	No.	mm.	No.	mm.	No.	mm.	No.	mm.	No.	mm.	No.	mm.
Agonopsis															2	177
Anoplopoma													4	326	6	360
Atheresthes													1	312	2	310
Chitonotus	3	118	3	116	1	98	1	71	2	94	4	131	4	75	2	110
Citha. scrdidus					3	196	1	202					230	224	128	214
" stigmaeus	3	163	2	161			1	151	2	157	2	112	1	158	3	156
Cymatogaster	300	120*	73	115	105	113	257	112*	86	125	11	136	183	134	207	131
Clupea	2	164	2	162	18	200	15	167					1	165		
Damalichthys	7	215	4	240	5	312	3	274	26	178	8	170	7	164	24	235
Embiotoca					1	269							1	181		
Eopsetta													1	366	1	290
Gadus	2	465			2	383	5	392	4	480	6	496	10	417	11	386
Glyptocuphalus															1	306
Hex. stelleri	1	314			3	314										
Hippoglossoides	1	306									1	307				
Hydrolagus													101	338	13	278
Lepidopsetta	34	205	30	184	91	257	76	202	9	237	2	252	296	201	108	192
Leptocottus			2	219					1	180						
Lycodopsis													1	238	4	250
Lyopsetta											1	185			1	230
Merluccius									1	350					2	452
Microgadus	2	197	6	228			6	138	86	208	49	213	41	212	51	191
Microstomus													37	297	54	223
Parophrys	156	257	186	238	137	329	83	313	402	221	103	235	49	264	81	273
Platichthys	4	301							2	462						
Pleuronichthys	2	254	1	232	2	239			15	274	4	281	9	255	11	256
Porichthys			2	212					13	196	14	174	4	157	9	108
Psettichthys	88	400	27	336					112	306	31	298			1	206
Raja binoc.									1	980	1	1020				
Sebastodes	13	330	1	285	16	320	2	326	28	331	10	332	39	303	51	210
Squalus	1	1003			4	696	4	793	5	852			5	416	1	350
Therega													4	173	5	220
Zaniolepis									2	131			1	179		

Place	Port Orchard		Murden Cove		Port Orchard		Murden Cove	
Depth	11 fms.	10-11 fms.	9-10 fms.	9-12 fms.	10-11 fms.	8-12 fms.	10-11 fms.	9-11 fms.
Time (PST)	13:32	14:00	15:20	16:06	20:30	20:50	22:33	23:30
Fish wt. (lbs.)	192.2	90.6	190.2	105.6	353.5	155.	306.	284.5

B. DR. ENGLISH BEAM TRAWL DATA

TAPE P3035

ID Password: OSCAR

Originally Entered Data

File No.	Location		Boxes	Records	Approx. Blocks
1	Port Orchard	(01)	1-5	8,559	159
2	"		6-10	9,285	323
3	"		11-15	9,132	427
4	"		16-20	7,384	536
5	"		21-25	8,374	626
6	"		26-31	10,076	720
7	"		32-36	9,021	816
8	"		37-42	8,566	895
9	Port Madison	(02)	1-4	5,564	962
10	"		5-8	6,537	1,029
11	Carr Inlet	(05)	1-4	5,953	1,096
12	Port Gardner	(06)	1-5	7,984	1,186
13	Case Inlet	(04)	1-5	9,431	1,304
14	"		6-10	9,449	1,406
15	"		11-15	9,224	1,505
16	"		16-20	9,327	1,602
17	"		21-25	9,256	1,692
18	"		26-30	9,244	1,783
19	"		31-35	9,095	1,871
20	Holmes Harbor	(08)	1-2	3,091	1,906
21	Case Inlet	(04)	36-39	7,363	1,975
22	Penn Cove	(09)	1-5	9,364	2,076
23	Meadow Point	(12)	1-2	3,537	2,138
24	Penn Cove	(09)	6-7	3,191	2,168
25	Case Inlet	(04)	36-39	7,363	2,237
26	Duwamish Head	(03)	6,7,9-13	7,609	2,316
27	"		1-5	8,837	2,410
28	Miscellaneous #1		--	1,743	2,439
29	Port Susan	(07)	all misc. boxes	12,982	2,568

NOTE: File 25 is a duplicate of File 21.

C. DR. MILLER TRAWL DATA

COLOR 47 ISTRIBUTION OF PUGET SOUND FISHES
FISHERIES RESEARCH INSTITUTE, COLLEGE OF FISHERIES
UNIVERSITY OF WASHINGTON

3240.4
Collection Fo
NODC Form

Station Header — File Type: 100 — File Identification Type: 1

Station Location: _____ Sequence Number (15–19)

Date Yr Mo Dy (24 26 28) Time Hr Min (30 32)

Latitude Deg. Min. Sec. Hemis. (34 36 38 39) Longitude Deg. Min. Sec. Hemis. (42 44 46 47)

Environmental Conditions:

	Depth	Bottle Number		
Sea: Surface Temperature	____ m		(50)	°C
Salinity	____ m	____	(53)	ppt
Dissolved Oxygen	____ m	____	(57)	% sat. ____ ml
Visibility (Secchi)	____ m		(60)	m
Subsurface Temperature	____ m		(63)	°C
Subsurface Salinity	____ m	____	(66)	ppt
Subsurface Dissolved Oxygen	____ m	____	(70)	% sat.

Loran C: Williams Lake, Port Hardy _____ (76) MZ(4)

Loran C: Williams Lake, George _____ (82) MY(2)

Sea State _____ Color _____

Weather: Wind Speed _____ km/hr Direction _____

Visibility _____ km Precipitation _____

% Cloud Cover _____ Air Temperature _____ °C

Biologic Sample Description — Type: 8 — Sequence Number (10–19)

Sample Number (22)

[Duplicate above: file type (col. 1–3), file I.D. (4–9) and station number (11–15)]

Date Yr Mo Dy (24 26 28) Time Hr Min (30 32)

Flowmeter Readings
end _____
start _____
total rev. _____

Habitat _____ (35)

Gear _____ (37) Sample Elevation (depth) (41) m

Depth to Bottom (44) m Area Sampled (52) m^2

Volume Sampled (61) m^3

Distance Fished (64) m Sampling Duration (min) (68) ____ : ____ hr min

Tide: Stage (69) Height (72) m

Plant Cover (75) % Photo Taken (76)

Compass Heading, Start (77) Light Intensity (78)

Current: Direction (79) Velocity (80)

Remarks _____

→ P.O.

Recorder _____

File type	File identification	Type	Station number	Sample number

Ecology of Puget Sound Fishes
FISHERIES RESEARCH INSTITUTE, COLLEGE OF FISHERIES
UNIVERSITY OF WASHINGTON

Form S 330.3M
SPECIES IDENTIFICATION
CREDDP Format

	Sequence number	Species	Code	LB Stage	Sub-sample	Count	Wet weight (grams)	Method	Dry weight (grams)	Area swept (m^2)	Remarks
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											
24											

ECOLOGY & DISTRIBUTION OF PUGET SOUND FISHES
FISHERIES RESEARCH INSTITUTE, COLLEGE OF FISHERIES
UNIVERSITY OF WASHINGTON

Form S240.22
Fish Examination
MESA/EDS Format

File type	File identification	Type	Station number
10		5	

Sample number

	Sequence number	Specimen number	Species	Code	Lt. Stage	Norm/Abn	Pay.Meth	Len.Type	Length (mm)	Round weight (grams)	Sex	Maturity	Age Meth	Age (yr)	Fin rot: Dors.	Anal	Caud.	P. Pec	L. Pec	R. Ven	L. Ven	AEN tumors: Total	Eyed	Blind	EP tumors: Total	Eyed	Blind	Endo. tum.	Remarks
	1-5	6-8																											
1																													
2																													
3																													
4																													
5																													
6																													
7																													
8																													
9																													
10																													
11																													
12																													
13																													
14																													
15																													
16																													
17																													
18																													
19																													
20																													
21																													
22																													
23																													
24																													

D. GOLDEN GARDENS BEACH SEINE DATA

SUMMARY OF BEACH SEINE TRIP 6309 APRIL 26, 1963
GOLDEN GARDENS 120' SEINE WITH 200' ROPE; ONE POSITION

Species Hauls	A	B	C	D	E	F	H	I	J	K	L	M	N	O	P	Q	R	S	G 340' net
Ammodytes tobianus	1																		5
Citharichthys stigmaeus	3			1													1		
Clupea pallasii																	1		
Cymatogaster aggregatta														28	108	21	29	10	1
Demalichthys vacca	2				2														
Embiotoca lateralis	8	1			1														
Enophrys bison	1																	1	
Hydrolagus colliei																	2		
Hypomesus pretiosus								1					1		1	1	1		
Lepidopsetta bilineata	4		3	1	6	6							1	1				1	
Leptocottus armatus	7	2	2		2	3	1	1		1		4	5	8	13	12	10	4	2
Lumpenus sagitta															1				
Oncorhynchus								5	4				1						
Parophrys vetulus	27	1	8	11	10	11	2	1		1	1		5	3	12	10	15	8	9
Platichthys stellatus	1	3	1			1	5	5	5	7	6	3	6	1	2	3	3	1	6
Pleuronichthys coenosus	7		1	3	3												1		
Salvelinus malma		1						3	2	1	2								
# Specimens	61	8	15	16	24	21	8	16	11	10	9	7	19	41	137	47	61	25	23
# Species	10	5	5	4	6	4	3	6	3	4	3	2	6	5	6	5	8	6	5
# Species (cum.)	10	11	11	11	11	11	11	13	13	13	13	13	13	14	15	15	17	17	
Total Weight (lbs.)	24	4	4	7	14	10	5	8	8	5	8	5	9	10	7	8	8	3	2
Time	1300	1320	1400	1420	1500	1520	1600	1620	1700	1715	1800	1820	1900	1920	2000	2020	2100	2120	1540
Temperature (F.)	50°	50°	50°	48°	50°	50°	50°	50°	50°	50°	49°	49°	49°	49°	49°	49°	49°	49°	50°
Light	13		11.5		10.5		10		10		9.5		5.75						
Tide (feet)	-2.5	-2.	-1.5	-1.	.5	1.5	4.	5.	7.	8.	10.	10.5	11.	11.5	11.	11.	10.5	10.	4.
Distance from stake(ft.)					240		114		54				15		10		21		

SUMMARY OF BEACH SEINE TRIP 5215
Date: May 15-16, 1952
Place: Golden Gardens

GEAR: Old 60' - U, F, H, J, L
New 120' - A, B, C, D, E
New 60' - G, I, K, M, N

	WEDNESDAY						THURSDAY								
	U	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Agonus												1			
Ammodytes		1						39				25			
Apodichthys	1		3	1	3			2			1	1			
Aulorhynchus	6		3	1					1			3		5	1
Chitonotus			4	1	1				2				2		
Cith. sord.			1												
Cith. stig.	1	3	10			2		1				1	2	1	
Cymatogas.	1		4			6	1	2		1	2	1	59		21
Damalich.	5	5	1	2	2								2	1	
Enophrys	1														
Gadus	1	57								1		4			1
Gasterost.									1	3			1		
Hexagram.	1	1	1												
Lepidop.	5	21	29	13	10	2	14		3	1	4	3	4	2	2
Leptocot.	3	6	1		3		2	1	2	3	1	3	1	1	
Lumpenus			1					1	1					1	
Odontopyxis					2		1				2		1		
Oligocottus							1								
O. gorbuscha						70					1		1		
O. kisutch	2														
Oxylebius	1														
Parophrys	49	6	29	6	2	4	11	10	11	23	6	21	8	16	3
Pholis laetus			1						1						
P. ornatus	1	3	2	1	1	1	1				1	1			
Platichthys	2	3		1		2		1	2	1	1		1		1
Pleuronich.		6	1	4	1		1					1	1		
Psychrolutes		1			1					3					
Raja			2												
Rhamphacottus		1													
Salmo clarkii		1													
Scorpaenichthys				1								1			
Sebastodes	1	2													
Syngnathus			3	1				3		1					1
Taeniotoca	5		3	3				1				2			
Xenopyxis							1								
Spec.	86	119	98	34	26	17	33	131	24	37	19	68	83	27	30
Total species	17	16	18	11	10	6	9	11	9	9	9	14	12	7	7
Fish Wt.	31	196	20	20	7	3	5	4	9	7	3	21	14	3	6
Weed Wt.	20	48	82	71	84	56	31	14	22	16	5	14	22	12	8
Cans	—	13	8	11	11	2	13	1	0	0	0	3	9	1	0
Invert. Wt.	—	5	—	—	6	—	—	6	—	—	2	—	2	2	—

SUMMARY OF BEACH SEINE HAULS 5214A to 5214F
Date: April 26, 1952
Place: Golden Gardens, Seattle
Gear: Beach seines 60.1 and 120.1 used simultaneously

NUMBER OF SPECIMENS BY HAUL AND BY SEINE

	A		B		C		D		E		F	
	60.1	120.1	60.1	120.1	60.1	120.1	60.1	120.1	60.1	120.1	60.1	120.1
Apodichthys		1	2	1				1				
A. harringtoni		1										
A. fenestralis				1								
Aulorhynchus				2								
Blepsias			3	1	1							1
Chitonotus		4	3	3		3		1	1			2
C. stigmaeus		2		1	2	1						1
Cymatogaster		2	1									
Damalichthys		10		3		3		1		4	1	2
Enophrys					1							
Lepidopsetta	2	12	2	13	3	5	2	2	1	1		14
Leptocottus	2	3			1		1			1	2	4
Liparis fucencis												1
Microstomus				1								
Odontopyxis				1	1							
O. gorbuscha			6	1								
O. kisutch		1										
Parophrys	12	14	7	9	1	10	4	6	17	1	17	9
Pholis laetus				3	1			2		2		2
Platichthys	4	4		1		1	1	2		3	4	1
Pleuronichthys		1	4	4							1	3
Psychrolutes		1										
Sebastodes				2			1					
Syngnathus	2	2	2			2	1	1	1		1	1
Taeniotoca	1	11		32		3	1	4	1	6	3	3
Total specimens	23	67	28	79	11	28	11	20	21	18	29	44
Total poundage	1.25	39.5	1.75	27.5	10	8.0	1.25	6.5	1.0	9.75	7.0	11.75
Total species	6	15	9	17	8	8	7	9	5	7	7	13
New species	6	15	6	8	4	0	1	0	0	0	1	1
Dropped species	0	0	3	6	7	14	10	14	12	16	10	11

SPECIES Tanner Crab Females TRIP NO. 5214

DATE _____ HAUL NO. 1-1

LOCATION _____ GEAR 12' TIME _____

_____ TIME HAULED ___ DEPTH ___

WEATHER _____ DISTANCE HAULED _____

Ser. No.	Length mm.	Sex
5214 A1	310	♀
2	216	♀
3	292	♀
4	265	♀
5	262	♂
6	270	♂
7	294	♂
8	264	♂
9	278	♂
10	260	♂
11	323	♂

SPECIES [illegible]

TRIP NO. 52

DATE

HAUL NO. 3

LOCATION

GEAR 20'

TIME

TIME HAULED

DEPTH

WEATHER

DISTANCE HAULED

Ser. No.	Length mm.	Sex
5214 B1	271	♀
2	268	♀
3	260	♀
4	239	♀
5	228	♀
6	261	♀
7	234	♀
8	238	♀
9	268	♀
10	264	♀
11	241	♀
12	279	♀
13	219	♀
14	240	♀
15	289	♀
16	288	♂
17	267	♂
18	251	♂
19	[illegible]	[illegible]
20	264	♂
21	261	♂
22	255	♂
23	257	♂
24	238	♂
25	241	♂
26	265	♂
27	291	♂
28	255	♂
29	214	♂
30	[illegible]	[illegible]
31	240	♂
32	265	♂

SPECIES [illegible] TRIP NO. 5214

DATE HAUL NO. 1

LOCATION GEAR [illegible] TIME

TIME HAULED DEPTH

WEATHER DISTANCE HAULED

Ser. No.	Length	Sex
5214 B1	258	♀
2	255	♂
3	254	♂
	Blepsias cirrhosus	
5214 B1	189	
	Aulorhynchus flavidus	
5214 B1	119	
2	116	
	Chitonotus pugetensis	
5214 B1	85	
2	7[illegible]	
3	72	
	Microstomus pacificus	
5214 B1	71	
	Odontopyxis trispinosus	
5214 B1	65	
	Sebastes auriculatus?	
5214 B1	65	
2	58	
	Artedius lateralis	
5214 B1	73	
	Hypsagonus? Lepidopsetta? [illegible]	
5214 B1	140	
	Pholis laeta	
5214 B1	1[illegible]	
2	1[illegible]	
3	190	

SPECIES [illegible] TRIP NO. [illegible]

DATE _____ HAUL NO. 1

LOCATION _____ GEAR [illegible] TIME _____

_____ TIME HAULED ___ DEPTH _____

WEATHER _____ DISTANCE HAULED _____

Ser. No.	Length	Sex										
[illegible]214B1	398	♀										
2	383	♀										
3	352	♀										
4	[illegible]	♂										
	Platichthys stellatus											
5214B1	74											
	[illegible]											
	[illegible]											
	1sr											
			Ouncorhynchus gorbuscha									
5214B1	35											

SPECIES Pacific ocean perch

DATE

LOCATION

WEATHER

TRIP NO.

HAUL NO. 6

GEAR

TIME

TIME HAULED

DEPTH

DISTANCE HAULED

Ser. No.	Length	Sex
521461	50	
2	76	
3	39	
4	41	
5	42	
6	44	
7	46	
8	57	
9	46	

SPECIES Lepidopsetta bilineata

DATE

LOCATION

WEATHER

TRIP NO.

HAUL NO.

GEAR

TIME

TIME HAULED

DEPTH

DISTANCE HAULED

Ser. No.	Length	Sex
52148	252	♀
2	278	♀
3	275	♂
4	283	♀
5	350	♀
6	293	♀
7	146	♂
8	129	♂
9	134	♂
10	74	Unsexed
11	73	"
12	76	"
13	76	"

E. ELLIOTT BAY PLANKTON DATA

FISHERIES 426 PLANKTON PROJECT

ELLIOTT BAY TRIP 6001

10 minute tows with 1/2 m. Nitex #0 nets; contamination time approximately 2 min.; Atlas meters #170 and 171 in cylindrical canvas throats. Stages are (1) cleavage including cap with plainly visible cells; (2-4, 7) to blastopore closure including "collapsed" embryos; (5-6) to hatching.
*indicates 16 cells or fewer.

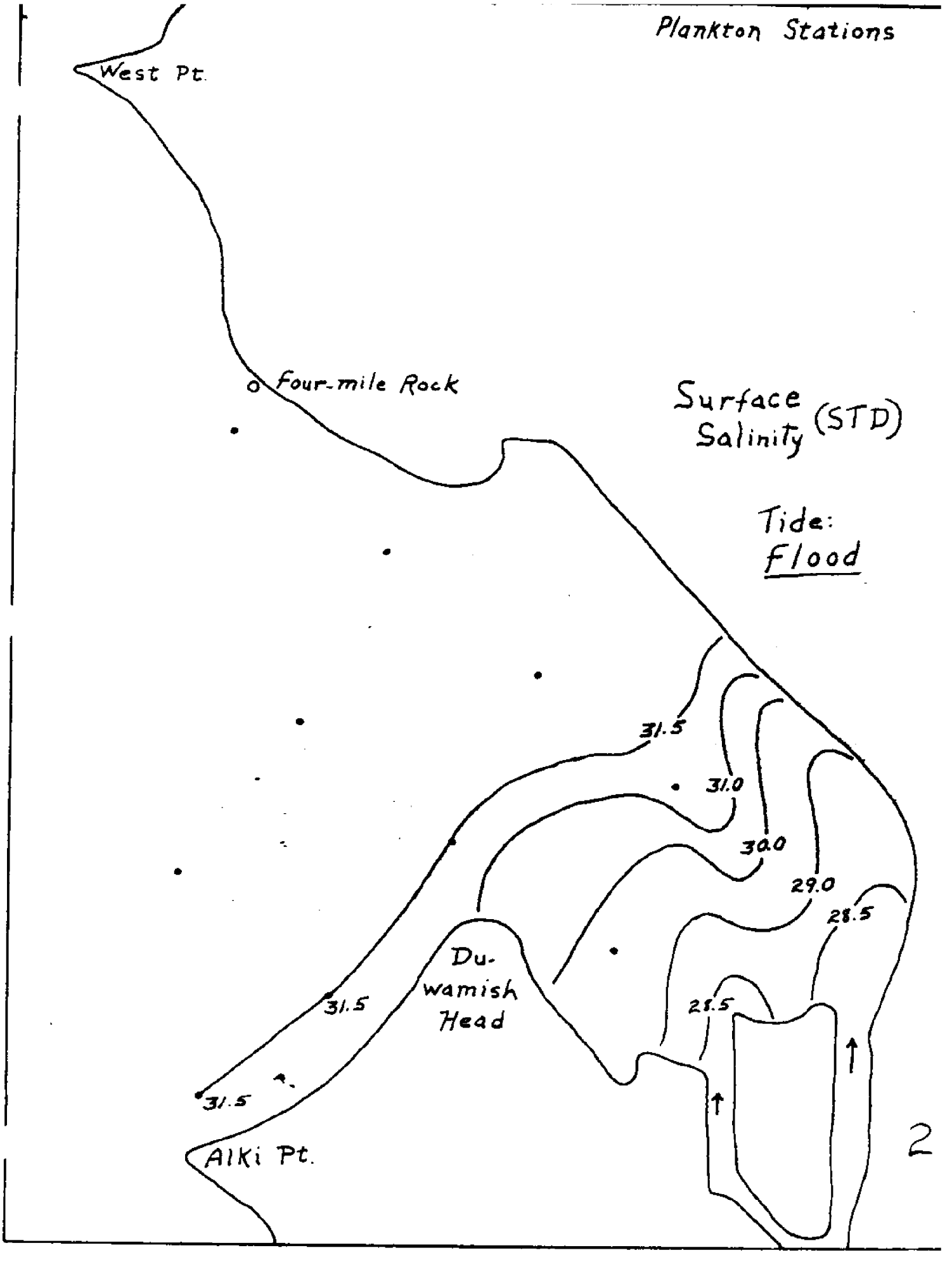
Stations:	I	47°38'08"	122°25'05"	VII	47°36'42"	122°24'39"
	II	47°37'33"	122°23'50"	VIII	47°35'53"	122°25'27"
	V	47°35'33"	122°22'18"	IX	47°35'21"	122°24'16"
	VI	47°36'10"	122°23'25"	XXIII	47°34'56:	122°25'06"

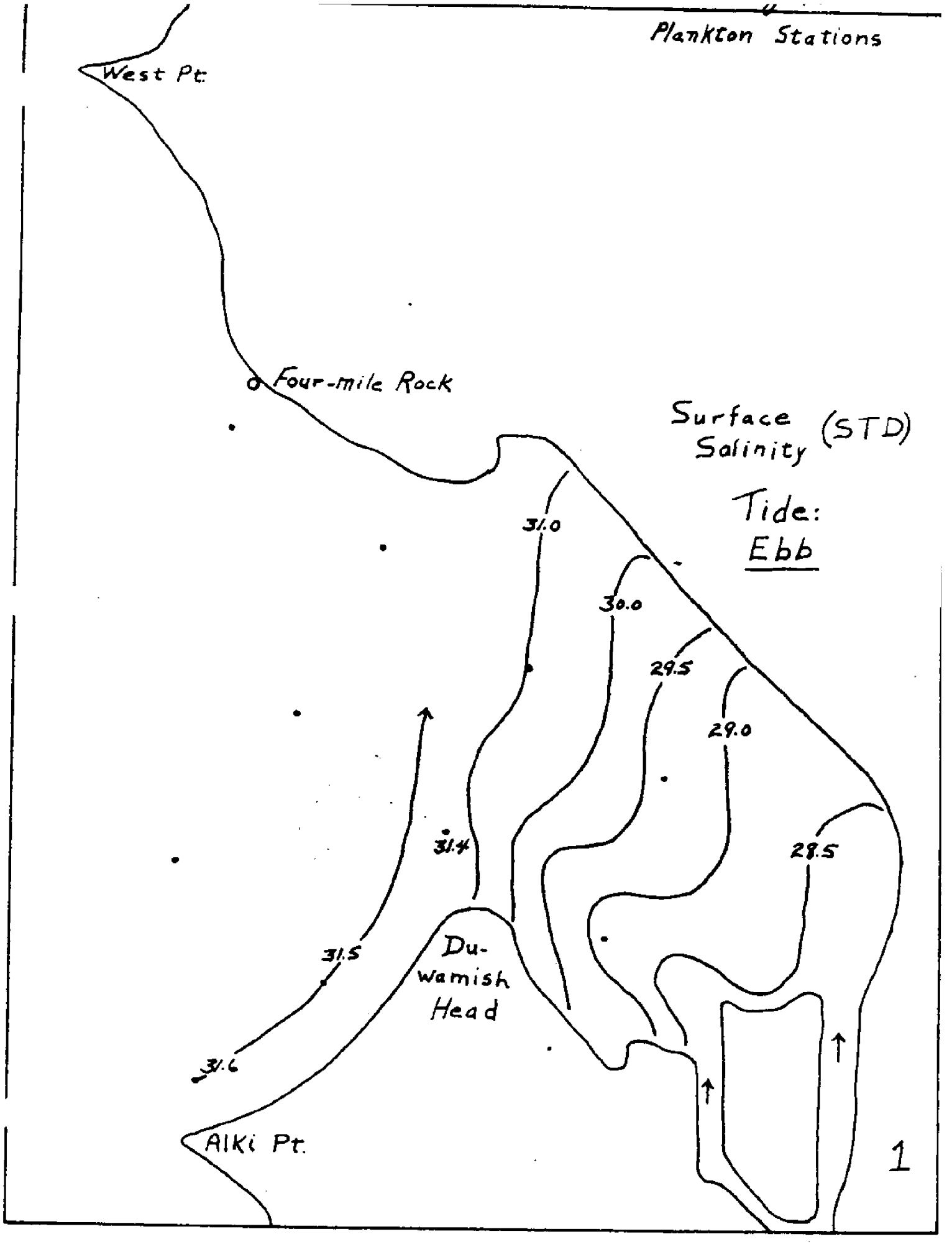
These positions are starting points of tows; typical sequence; V, VI, IX, XXIII (rounding Alki Pt.), VIII, VII (towing toward II), III, IV.

	Haul No.	Meter Rev.	Station	Depth m	Time	Surface Temp.	Total Ova	Stages 1	Stages 2-4,7	Stages 5,6	Total Staged
1-18	A-0	1748	V	0	1320	8.1	2340	19*	323	4	346
	A-1	2163	V	50			479	14*	97	3	114
	B-0	1626	VI	0	1340	8.2	903	23	74	6	103
	B-1	1734	VI	60			168	112*	47	7	166
	C-0	1584	IX	0	1357	8.3	879	14*	107	6	127
	C-1	1778	IX	60			79	33	42	4	79
	D-0	1490	XXIII	0	1414	8.3	314	15*	164	18	197
	D-1	1694	XXIII	60			16	2	5	9	16
	E-0	1326	VIII	0	1437	8.3	52	2	40	9	51
	E-1	1456	VIII	60			30	2	14	14	30
	F-0	1636	VII	0	1454	7.9	817	2	103	7	112
	F-1	1862	VII	60			40	1	32	6	39
	G-0	1304	III-IV	0	1521	7.9	667	3	144	23	170
	G-1	1265	III-IV	60			439	48	46	9	103
	H-0	1464	IV-SE IX	0	1538	7.9	402	8	143	6	157
	H-1	1362	IV-SE	60			287	102	36	6	144
1-19	I-0	1414	V	0	0812	6.4	696	8	109	7	124
	I-1	1668	V	60			292	1*	72	7	80
	J-0	1573	VI	0	0832	7.4	1600	8	157	2	167
	J-1	1692	VI	60			409	56*	60	10	126
	K-0	1480	IX	0	0849	8.1	277	9	81	20	110
	K-1	1490	IX	60			61	4	45	11	61
	L-0	1492	XXIII	0	0908	8.3	88	3	58	22	83
	L-1	1615	XXIII	60			66	29	26	8	63
	M-0	1229	VIII	0	0931	7.4	628	0	103	9	112
	M-1	1416	VIII	60			51	0	37	13	50
	N-0	1335	VII	0	0948	8.2	401	18	73	23	114
	N-1	1444	VII	60			16		6	10	16
	O-0	1330	III-IV	0	1014	7.7	514	15*	68	21	104
	O-1	1386	III-IV	60			1405	47*	46	4	97
	P-0	1452	IV-SE	0	1030	8.1	556	12	85	17	114
	P-1	1456	IV-SE	60			946	31*	170	5	206

	Haul No.	Meter Rev.	Station	Depth m.	Time	Surface Temp.	Total Ova	Stages 1	Stages 2-4,7	Stages 5,6	Total Staged
6001											
	S-0	1441	V	0	1343	7.4	1554	5	95	3	103
	T-0	1420	VI	0	1401	8.2	627	18*	82	9	109
	T-1	1626	VI	60			306	38*	57	8	103
	U-0	1320	IX	0	1416	8.2	430	14	106	12	132
	U-1	1518	IX	60			59	11	38	7	56
	V-0	1478	XXIII	0	1431	8.3	214	30	184	20	234
	V-1	1658	XXIII	60			64	39	12	12	63
	W-0	1475	VIII	0	1452	8.3	117	37	61	17	115
	W-1	1516	VIII	60			57	8	36	13	57
	X-0	1302	VII	0	1507	8.3	305	5	90	14	109
	X-1	1533	VII	60			55	9	36	9	54
	Y-0	1405	III	0	1530	8.1	472	8	93	8	109
	Y-1	1382	III	60			491	14	82	7	103
	Z-0	1432	IV	0	1546	7.2	505	17	81	10	108
	Z-1	1355	IV	60			496	51	64	7	122
1-20	AA-0	1467	V	0	0855	6.7	2586	18	86	9	113
	AA-1	1583	V	60			526	75*	114	16	205
	BB-0	1283	VI	0	0913	8.3	497	11	118	15	144
	BB-1	1407	VI	60			294	53	99	7	159
	CC-0	1364	IX	0	0930	8.4	267	8	78	28	114
	CC-1	1535	IX	60			116	3	99	9	111
	DD-0	1429	XXIII	0	0947	8.3	182	7	112	33	152
	DD-1	1498	XXIII	60			68	eggs lost			
	EE-0	1347	VIII	0	1010	7.8	507	5	40	15	60
	EE-1	1425	VIII	60			57	7	35	15	57
	FF-0	1411	VII	0	1028	8.0	550	9	74	19	102
	FF-1	1570	VII	60			43	2	25	16	43
	GG-0	1556	III	0	1053	7.2	1099	1	112	13	126
	GG-1	1570	III	60			815	86*	89	6	181
	HH-0	1521	IV	0	1109	7.1	603	6	127	22	155
	HH-1	1647	IV	60			249	39*	184	16	239
	II-0	1598	V	0	1130	7.5	2344	0	97	11	108
	II-1	1843	V	60			838	7	90	3	100
	JJ-0	1356	V	0	1308	7.5	391	5	106	6	117
	JJ-1	1460	V	60			1037	151*	136	8	295
	KK-0	1459	VI	0	1326	8.1	1635	5	95	8	108
	KK-1	1784	VI	60			181	24*	76	8	108
	LL-0	1399	IX	0	1343	8.3	593	36*	212	30	278
	LL-1	1672	IX	60			101	13	75	11	99
	MM-0	1331	XXIII	0	1359	8.3	91	5	75	8	88
	MM-1	1468	XXIII	60			64	11*	47	17	75
	NN-0	1422	VIII	0	1418	8.3	340	19*	69	17	105
	NN-1	1446	VIII	60			27	3	15	9	27
	OO-0	1300	VII	0	1434	8.3	705	2	101	9	112
	OO-1	1310	VII	60			112	17	81	14	112
	PP-0	1355	III	0	1454	8.3	559	9*	126	17	152
	PP-1	1558	III	60			356	79*	44	18	141
	QQ-0	1466	IV	0	1508	8.3	546	16	78	27	121
	QQ-1	1736	IV	60			351	27	63	2	92
	RR-0	1050	V	0	1527	8.1	874	4	103	6	113
	RR-1	1198	V	60			676	20	59	2	81

	Haul No.	Meter Rev.	Station	Depth m.	Time	Surface Temp.	Total Cva	Stages 1	Stages 2-4,7	Stages 5,6	Total Staged
6001											
1-21	SS-0	1384	V	0	0856	7.5	2048	6	64	5	75
	SS-1	1674	V	50			419	34*	123	6	163
	TT-0	1283	VI	0	0915	6.8	786	8*	86	13	107
	TT-1	1582	VI	60			240	35*	80	7	122
	VV-0	1288	IX	0	0931	7.4	626	1	134	6	141
	VV-1	1518	IX	60			46	5*	28	10	43
	WW-0	1170	XXIII	0	0949	7.9	231	1	176	43	220
	WW-1	1458	XXIII	60			40	0	22	10	32
	XX-0	1225	VIII	0	1009	8.2	369	4	99	14	117
	XX-1	1513	VIII	60			41	2	32	8	42
	YY-0	1232	VII	0	1025	7.0	2300	0	73	15	88
	YY-1	1505	VII	60			191	24	101	18	143
	ZZ-0	1422	III	0	1051	7.0	1614	6	112	2	120
	ZZ-1	1574	III	60			869	53	57	10	120
	AB-0	1376	IV	0	1108	6.7	999	16	89	6	111
	AB-1	1498	IV	60			347	11	75	11	97
1-22	AC-0	1314	V	0	1416	8.3	649	29	61	20	110
	AC-1	1456	V	40			657	19	68	6	93
	AD-0	1226	VI	0	1434	8.3	335	13*	85	16	114
	AD-1	1376	VI	40			66	14	39	12	65
	AE-0	1260	IX	0	1448	8.2	265	19	75	30	124
	AE-1	1524	IX	40			99	7	42	15	64
	AF-0	1019	XXIII	0	1505	8.3	47	0	14	27	41
	AF-1	1216	XXIII	40			34	0	18	16	34
	AG-0	1208	VIII	0	1523	8.2	124	14	69	44	127
	AG-1	1331	VIII	40			50	0	17	33	50
	AH-0	1374	VII	0	1538	7.8	2239	6	205	13	224
	AH-1	1358	VII	40			113	8	72	21	101
	AI-0	1260	III	0	1601	7.3	814	3	211	29	243
	AI-1	1224	III	40			234	48	136	14	198


Plankton Stations
West Pt.
Four-mile Rock
Surface Salinity (STD)
Tide: Flood
31.5
31.0
30.0
29.0
28.5
28.5
31.5
31.5
Du-wamish Head
Alki Pt.
2


Plankton Stations
West Pt.
Four-mile Rock
Surface Salinity (STD)
Tide: Ebb
31.0
30.0
29.5
29.0
28.5
31.4
31.5
31.6
Du-
wamish
Head
Alki Pt.
1

F. WDF COMMERCIAL TRAWL LOG DATA

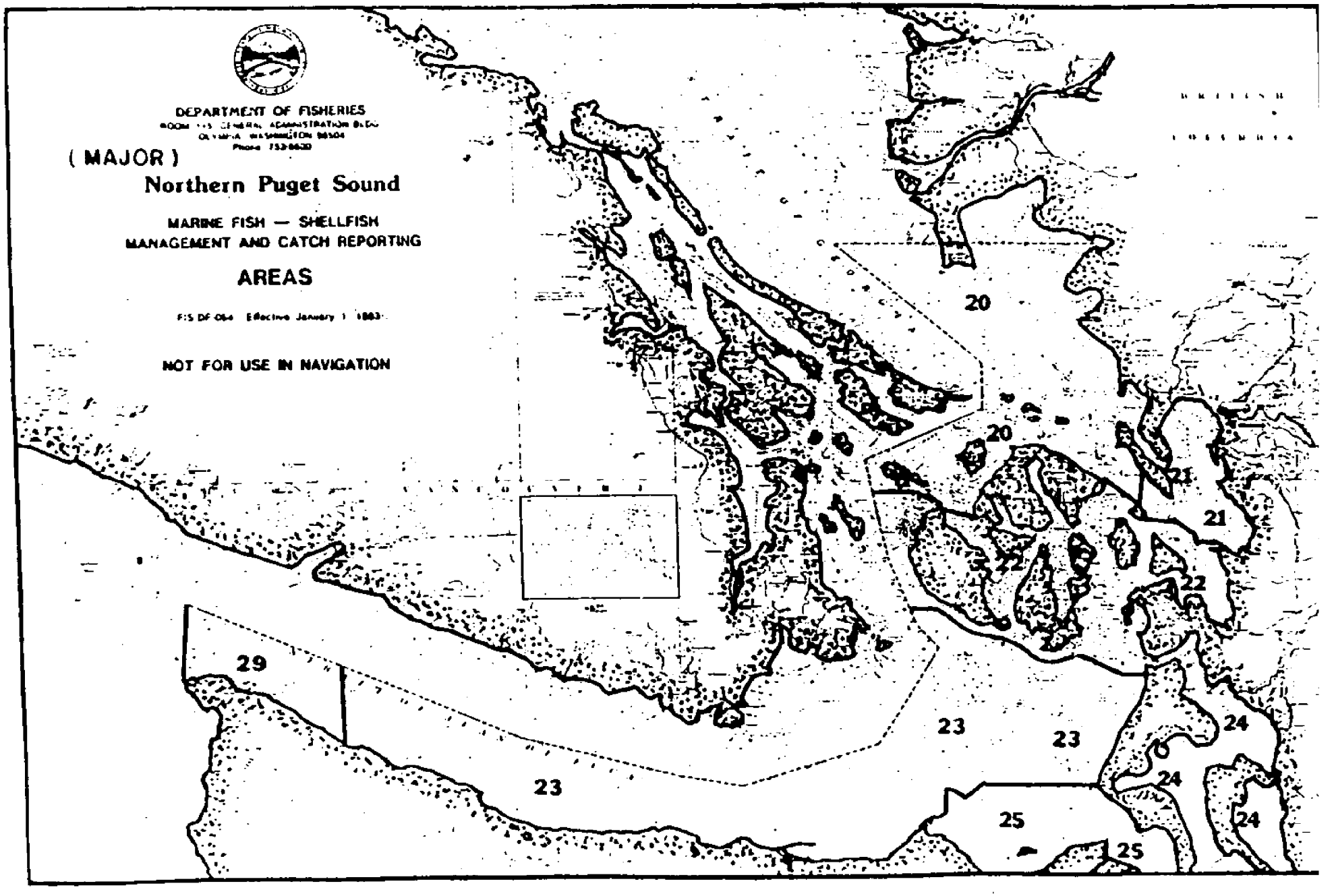


Figure 3. Washington State Statistical Areas in Northern Puget Sound.

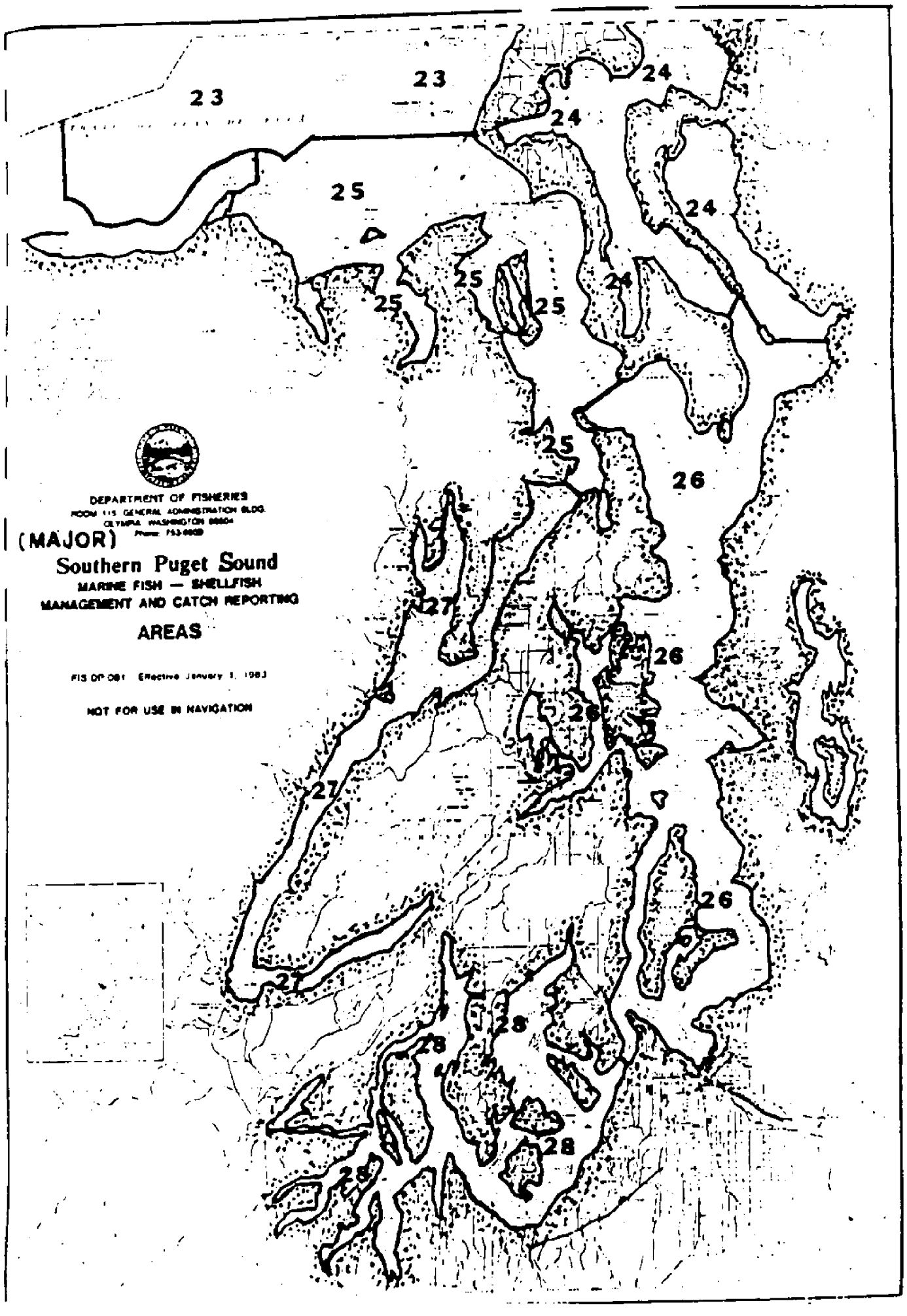


Figure 4. Washington State Statistical Areas in Southern Puget Sound.

Table 3: Tally of total unduplicated trawl effort (hours) by statistical area and month, 1984.

Stat. area	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
12	173	413	219	317	337	654	195	604	561	846	375	219	4913
13	281	719	945	740	1363	1207	2080	2245	1409	627	500	513	12629
14	112	135	322	308	371	171	63	173	158	280	150	164	2407
15	329	180	173	229	278	604	423	811	308	245	41	19	3640
16	264	213	700	798	1220	2019	2129	1951	831	410	40	132	10707
17	162	91	166	218	334	580	481	709	288	168	46	113	3356
20	861	925	1617	3018	2401	1664	261	385	704	697	932	501	13966
21	87	213	150	50	70	102	--	9	58	24	13	67	843
22	8	--	20	86	--	--	19	35	3	3	--	--	174
23	66	244	126	98	21	--	103	--	105	231	218	686	1898
24	1559	625	351	184	93	28	525	191	252	77	133	359	4377
25	919	539	1289	57	--	--	71	--	--	--	9	33	2916
26	824	882	--	235	435	351	516	191	595	295	520	71	4915
27	--	--	51	--	--	--	--	--	--	--	--	1	52
28	110	246	455	75	--	--	--	--	--	--	--	--	886
29	62	183	34	7	--	--	--	--	--	--	--	--	286
30	54	29	129	194	413	248	438	388	226	104	132	82	2437
32	61	--	152	1	144	92	216	116	141	--	--	--	923
48	--	--	--	2377	--	--	--	1780	--	--	--	1440	5597
49	--	--	--	319	--	--	--	4	--	--	--	321	644
50	--	--	--	49	--	--	--	--	--	--	--	177	226
51	--	--	--	113	--	--	--	--	--	--	--	1380	1493
52	--	--	--	32	--	--	--	--	--	--	--	26	58
55	59	--	--	--	--	--	--	--	81	--	--	--	140
Total	5990	5637	6899	9505	7480	7720	7520	9592	5720	4007	3109	6304	79483

MONTHLY 1984 TRAWL LANDINGS FOR STATISTICAL AREA 21 BELINGHAM- SAMISH BAY

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
FOODFISH													
SOLE GEN FLATHD	0.	0.	0.	0.	8.	0.	0.	0.	0.	0.	0.	0.	8.
BUTTER SOLE	177.	1113.	1679.	200.	52.	0.	0.	0.	0.	0.	0.	0.	3220.
C-O SOLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DOVER SOLE	0.	0.	0.	0.	0.	0.	0.	0.	53.	2.	0.	0.	54.
ENGLISH SOLE	194.	3591.	136.	172.	10.	1368.	0.	61.	94.	32.	416.	66.	6140.
PETRALE SOLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
REX SOLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ROCK SOLE	2102.	7989.	644.	488.	36.	0.	0.	0.	12.	54.	0.	291.	11616.
SAND SOLE	3093.	6268.	3095.	1860.	396.	187.	0.	70.	0.	126.	0.	1460.	16644.
SAND DABS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
STARRY FLOUNDER	6877.	20876.	6540.	1628.	7645.	3521.	0.	1895.	0.	0.	0.	10102.	65162.
TURBOT	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SABLEFISH	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LINGCOD	0.	0.	0.	0.	0.	0.	0.	0.	54.	167.	0.	0.	221.
TRUE COD	586.	360.	8.	734.	0.	1208.	0.	0.	17101.	1251.	0.	331.	21579.
POLLOCK	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
HAKE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
ROCKFISH GENRAL	215.	12.	0.	0.	7.	0.	0.	0.	30.	14.	0.	86.	363.
O PERCH NOMINAL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DOGFISH	2183.	0.	82.	385.	766.	6908.	0.	300.	2742.	7860.	0.	1029.	22254.
MISC. SPECIES	5404.	4843.	8285.	1594.	2188.	879.	0.	0.	0.	28.	0.	4661.	27883.
SUBTOTAL	19831.	52042.	19469.	7860.	11106.	13872.	0.	2326.	20086.	9534.	416.	18105.	173846.
REDUCTION													
ANIM. FOOD													
TOTAL	19831.	52042.	19469.	7860.	11106.	13872.	0.	2326.	20086.	9534.	416.	18105.	173846.

MONTHLY 1984 TRAWL LANDINGS FOR STATISTICAL AREA 28 CEN. PUGET SOUND

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
FOODFISH													
SOLE GEN FLATHD	0.	0.	0.	0.	76.	0.	0.	0.	0.	0.	0.	0.	76.
BUTTER SOLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
C-O SOLE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DOVER SOLE	697.	121.	0.	4962.	9413.	14119.	7437.	9887.	6362.	8493.	2531.	0.	62021.
ENGLISH SOLE	49386.	32629.	0.	30348.	80367.	55654.	41646.	22014.	27979.	44736.	35604.	4374.	404627.
PETRALE SOLE	0.	6.	0.	36.	6.	0.	0.	15.	7.	29.	10.	0.	109.
REX SOLE	0.	6.	0.	0.	18.	6.	0.	28.	0.	0.	0.	0.	58.
ROCK SOLE	4506.	7060.	0.	69.	4166.	311.	0.	0.	0.	108.	1383.	5316.	22897.
SAND SOLE	282.	27.	0.	0.	0.	0.	0.	0.	0.	922.	584.	0.	1794.
SAND DABS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
STARRY FLOUNDER	8783.	9387.	0.	258.	1945.	5909.	8791.	8478.	610.	1131.	19057.	772.	63022.
TURBOT	0.	100.	0.	0.	301.	345.	85.	0.	0.	0.	0.	0.	831.
SABLEFISH	0.	3.	0.	26.	55.	445.	218.	223.	6.	0.	0.	0.	976.
LINGCOD	0.	0.	0.	288.	0.	0.	0.	113.	0.	0.	286.	0.	648.
TRUE COD	53013.	32800.	0.	8201.	15421.	11433.	12602.	3861.	11292.	18217.	20281.	6838.	193559.
POLLOCK	103.	0.	0.	0.	563.	600.	36.	142.	22.	0.	0.	0.	1466.
HAKE	628548.	1893385.	0.	0.	0.	0.	0.	0.	0.	0.	18581.	0.	2540514.
ROCKFISH GENRAL	8158.	1420.	0.	4244.	2927.	1969.	132.	237.	407.	2439.	2052.	2498.	26484.
O PERCH NOMINAL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
DOGFISH	0.	0.	0.	0.	0.	4619.	878.	0.	0.	3070.	66528.	0.	74996.
MISC. SPECIES	2179.	2053.	0.	1235.	2114.	1324.	814.	700.	138.	203.	1905.	1457.	14131.
SUBTOTAL	753635.	1978788.	0.	49636.	97361.	96634.	72539.	45507.	46722.	77348.	168781.	21255.	3408207.
REDUCTION													
HAKE	21843.	10414.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	32257.
DOGFISH	14842.	55179.	0.	0.	0.	0.	0.	0.	0.	0.	13290.	0.	83311.
MISC. SPECIES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SUBTOTAL	36686.	65594.	0.	0.	0.	0.	0.	0.	0.	0.	13290.	0.	115568.
ANIM. FOOD													
ENGLISH SOLE	6578.	7265.	0.	0.	0.	0.	11400.	0.	0.	0.	0.	0.	25243.
MISC. SPECIES	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
SUBTOTAL	6578.	7265.	0.	0.	0.	0.	11400.	0.	0.	0.	0.	0.	25243.
TOTAL	796898.	2051647.	0.	49636.	97361.	96634.	83939.	45507.	46722.	77348.	182071.	21255.	3549018.

C. PUGET SOUND

1969 WASHINGTON TRAWL LANDINGS BY MONTH FOR STATE AREA 83 (PART OF PMFC AREA 4A)

SPECIES	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
FOOD FISH													
English sole	75,704	52,475		74,339	109,473	136,685	98,379	83,625	110,264	128,333	92,641	96,479	1,058,397
Rock sole	771									1,330	582		2,683
Petrale sole													
Dover sole	350			4,632	643		234	643	660	10,680	3,968	525	22,385
Rex sole													
Starry flounder	33,360	41,315							366	5,601	3,050	17,474	101,166
Other flatfish													
Halibut													
Sand sole	111	371											482
Turbot													
True Cod	5,880	4,159		1,290	4,244	5,372	3,163	2,268	5,231	6,590	1,262	1,988	41,455
Ling cod	50						232		100	115			497
Rablefish													
Pac. O. Perch													
Other rockfish	936	1,033		1,523	600	800		190	475	139			5,696
Misc. species	1,749	289								454		772	3,264
FOOD FISH SUB-TOTAL	118,911	99,642		81,784	114,960	142,857	102,058	86,726	117,096	153,250	101,503	117,238	1,236,025
Reduction (Meal)										192,800	421,400	86,900	701,100
Animal food	49,839	43,775		89,440	122,010	146,550	132,200	85,900	101,300	95,975	63,340	129,352	1,059,681
TOTAL	163,750	143,417		171,224	236,970	289,407	234,258	172,626	218,396	442,025	586,243	333,490	2,996,806

BELLINGHAM BAY

1969 WASHINGTON TRAWL LANDINGS BY MONTH FROM STATE AREA 82 (PART OF PMFC AREA 4A)

SPECIES	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
FOOD FISH													
English sole	255	187		4,059	68							2,552	7,121
Rock sole		194										980	1,174
Petrale sole													
Dover sole													
Rex sole													
Starry flounder	354	808		6,632	771						17,103	5,882	31,550
Other flatfish													
Halibut													
Sand sole	200	324		1,710	240						952		3,426
Turbot													
True Cod	308	110		34,881	863						116	2,910	39,188
Ling cod	29			1,042	40							210	1,321
Sablefish													
Pac. O. Perch													
Other rockfish												61	61
Misc. species													
FOOD FISH SUB-TOTAL	1,146	1,623		48,324	1,982						18,171	12,595	83,841
Reduction (Meal)					524							799	1,323
Animal food	851	8,922		29,143								8,611	47,527
TOTAL	1,997	10,545		77,467	2,506						18,171	22,005	132,691

G. WDF HERRING SPAWNING SURVEYS

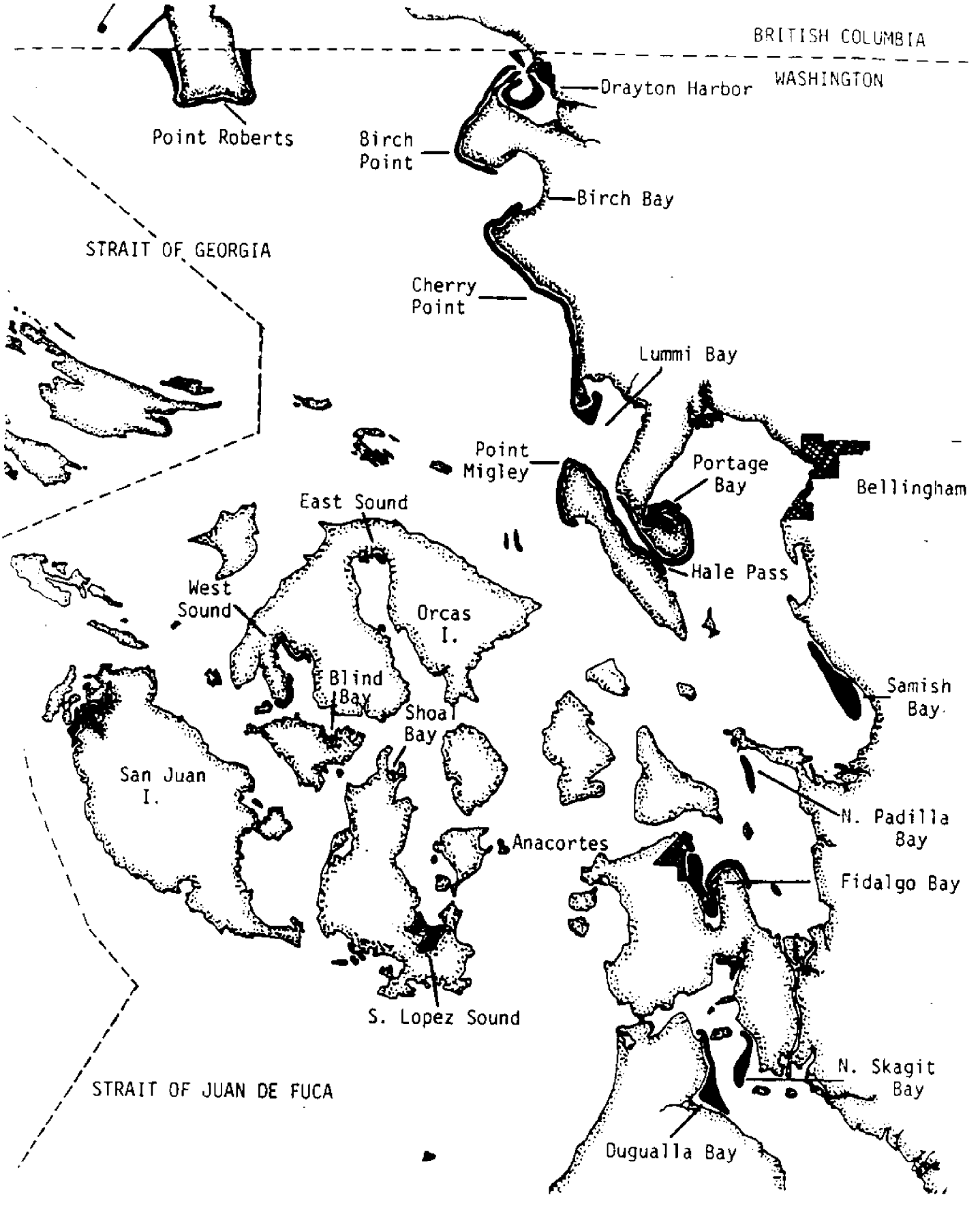


Figure 4a. Documented herring spawning grounds in northern Puget Sound and the Strait of Georgia.

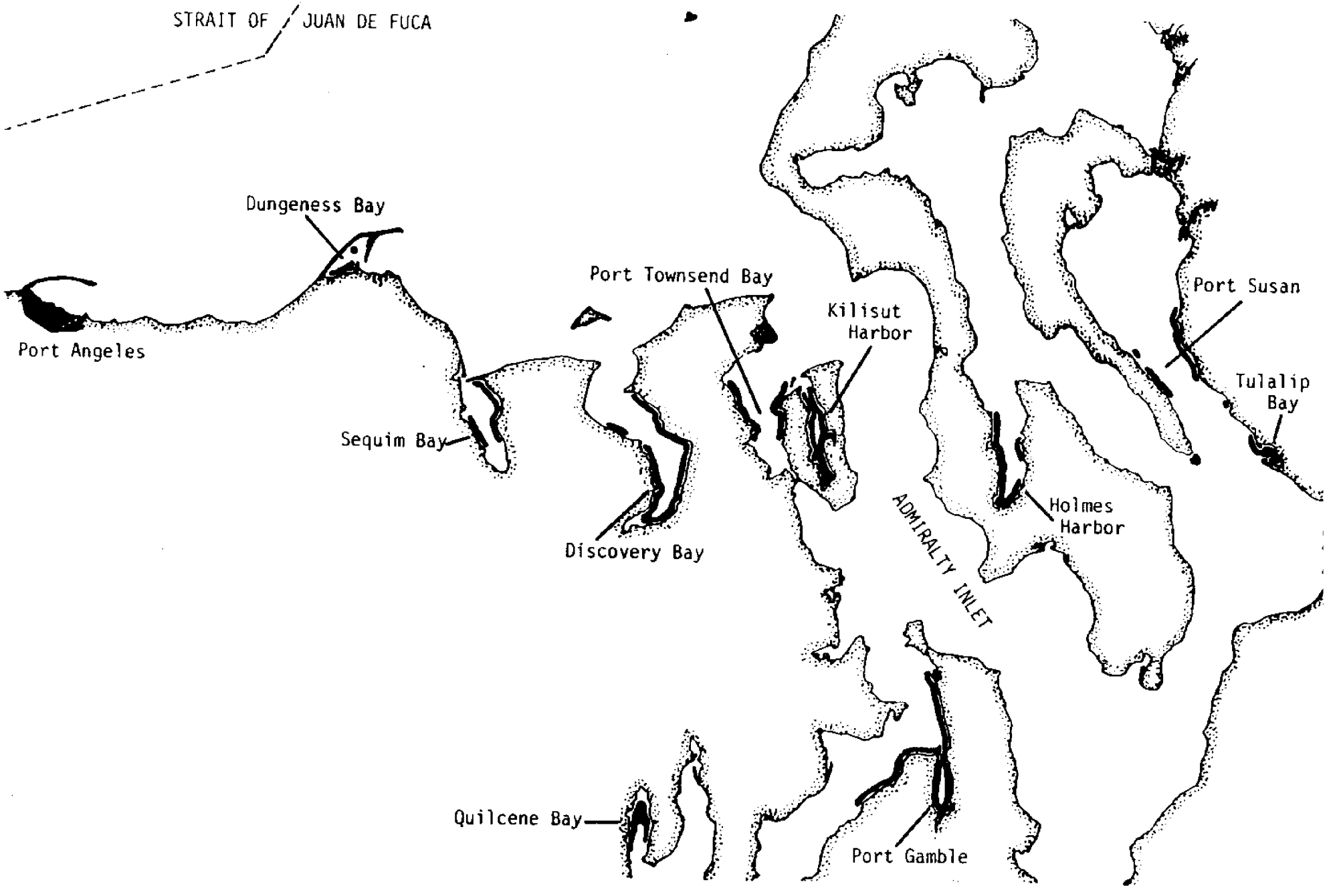


Figure 4b. Documented herring spawning grounds in the eastern Strait of Juan de Fuca.

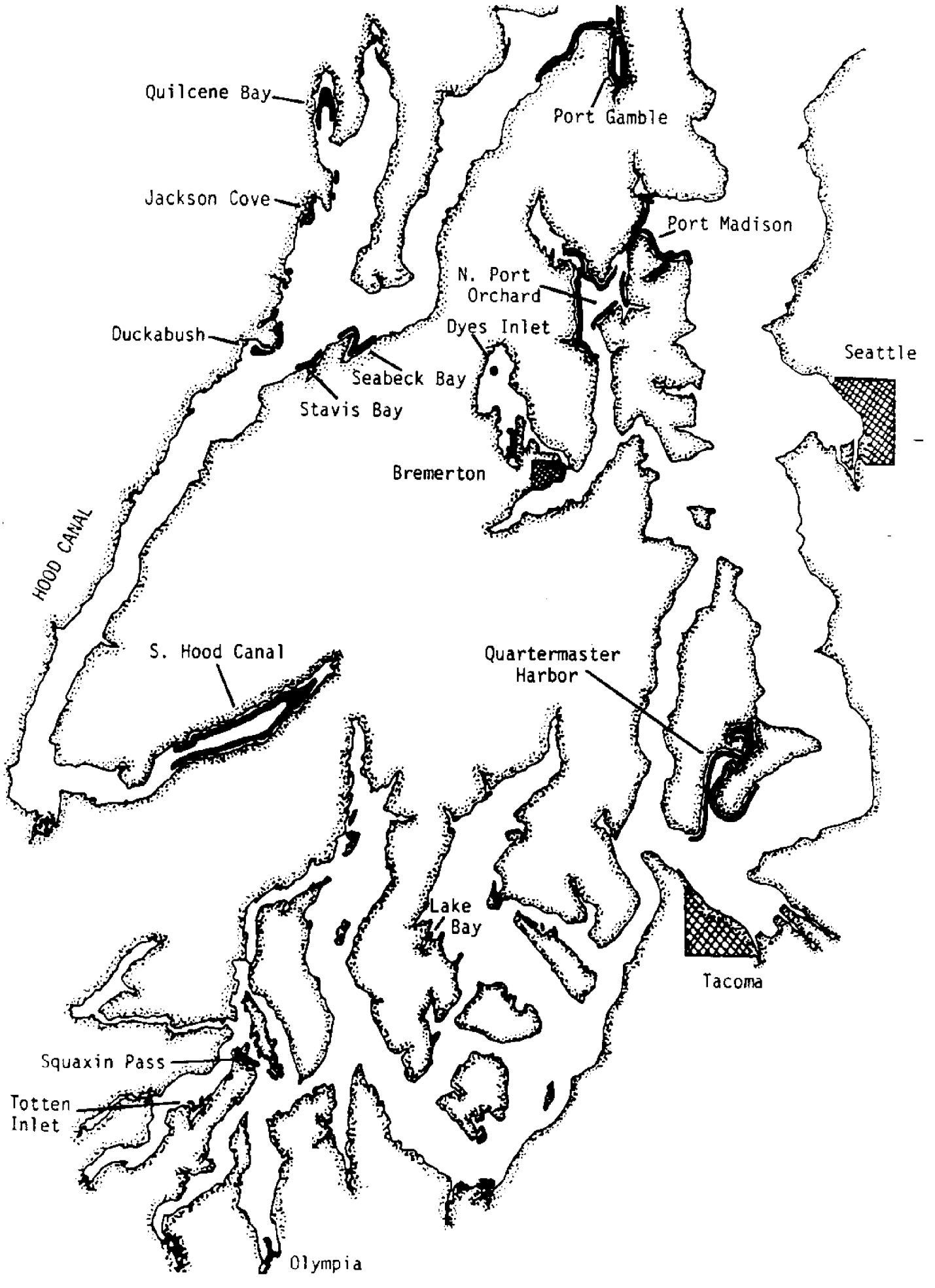

Quilcene Bay
Port Gamble
Jackson Cove
Port Madison
N. Port Orchard
Dyes Inlet
Duckabush
Seattle
Seabeck Bay
Stavis Bay
Bremerton
HOOD CANAL
S. Hood Canal
Quartermaster Harbor
Lake Bay
Tacoma
Squaxin Pass
Totten Inlet
Olympia

Table 1. Herring spawn survey results, Quartermaster Harbor, 1983.

Survey Date	Est. spawner biomass (tons)	Spawn Dates	Cummulative spawner biomass (tons)
January 24	52	1/23	52
January 31	132	1/28	184
February 7	129	1/28; 2/3	313
February 14	324	2/9, 10, 12, 13	637
February 22	75	2/16, 17, 18	712
February 28	124	2/25, 36, 28	836
March 7	7	3/6	843
March 14	66	3/9, 10, 11	909
March 21	0	-	909
March 28	0	-	909

Table 2. Herring spawn survey results, Port Orchard - Port Madison, 1983.

Survey Date	Est. spawner biomass (tons)	Spawn Dates	Cummulative spawner biomass (tons)
January 12	0	-	0
January 18	0	-	0
January 25	0	-	0
February 1	2	1/29	2
February 8	124	2/2, 3, 7	126
February 15	197	2/11, 12, 15	323
February 23	224	2/17, 19	547
March 1	6	3/1	553
March 8	0	-	553
March 15	1,073	3/7, 8, 10	1,626
March 22	0	-	1,626
March 29	25	3/26	1,651
April 4	0	-	1,651

Table 3. Herring spawn survey results, Port Gamble, 1983.

Survey Date	Est. spawner biomass (tons)	Spawn Dates	Cummulative spawner biomass (tons)
January 27	0	-	0
February 2	31	2/1	31
February 9	0	-	31
February 16	33	2/2, 4, 11	64
February 24	44	2/22, 23	108
March 3	2,290	2/27	2,398
March 9	9	3/2, 3	2,407
March 17	0	-	2,407
May 24	0	-	2,407
March 30	0	-	2,407

Table 4. Herring spawn survey results, southern Port Susan, 1983.

Survey Date	Est. spawner biomass (tons)	Spawn Dates	Cummulative spawner biomass (tons)
February 1	0	-	0
February 15	0	-	0
March 1	96	2/19, 21, 20-22, 23, 2/28	96
March 15	954	3/2-4, 5-7, 8, 9,	
	348	3/11, 12, 13, 14	1,050
March 29	0	3/24, 29	1,398
April 11	0	-	1,398

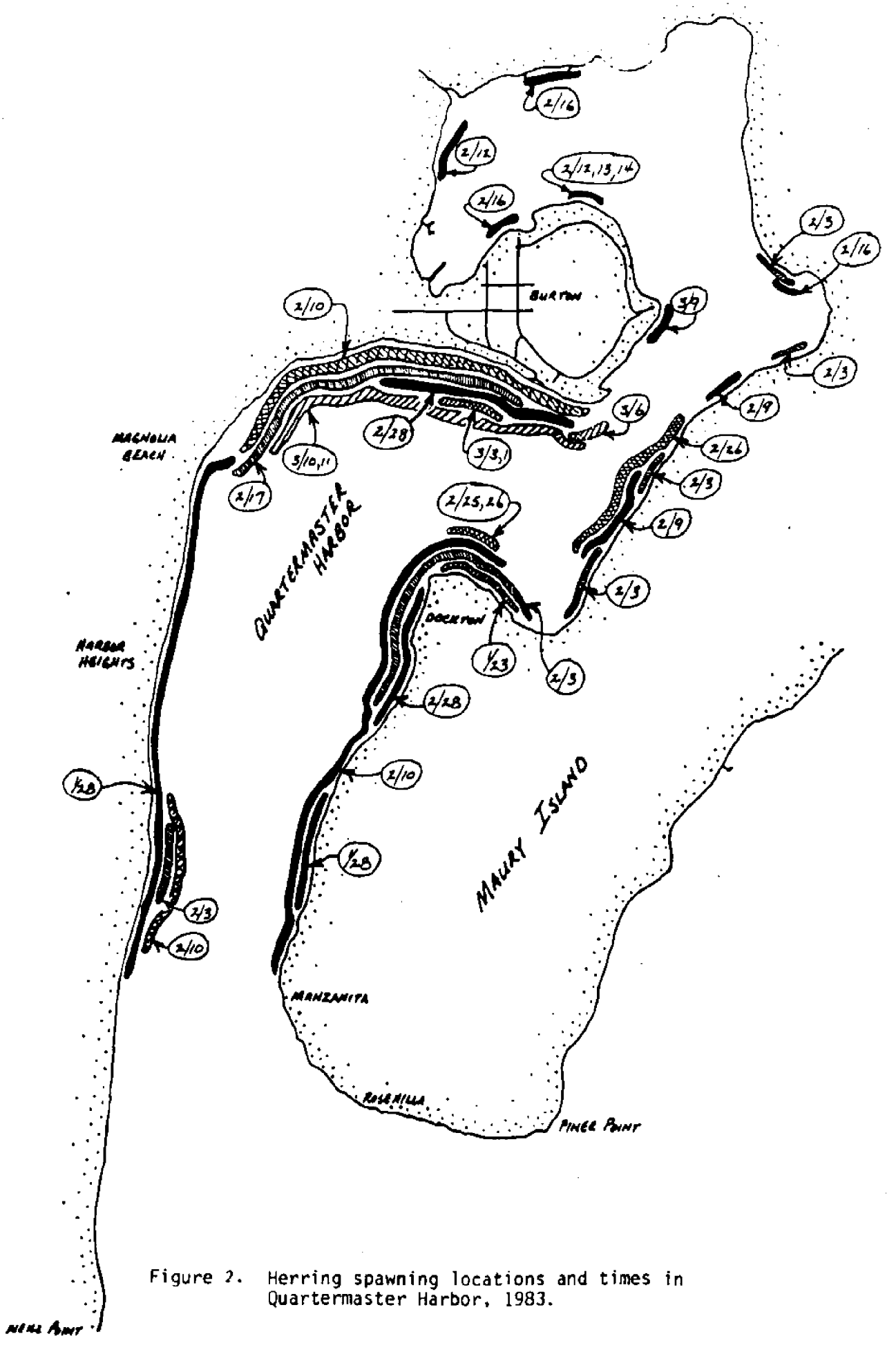


Figure 2. Herring spawning locations and times in Quartermaster Harbor, 1983.

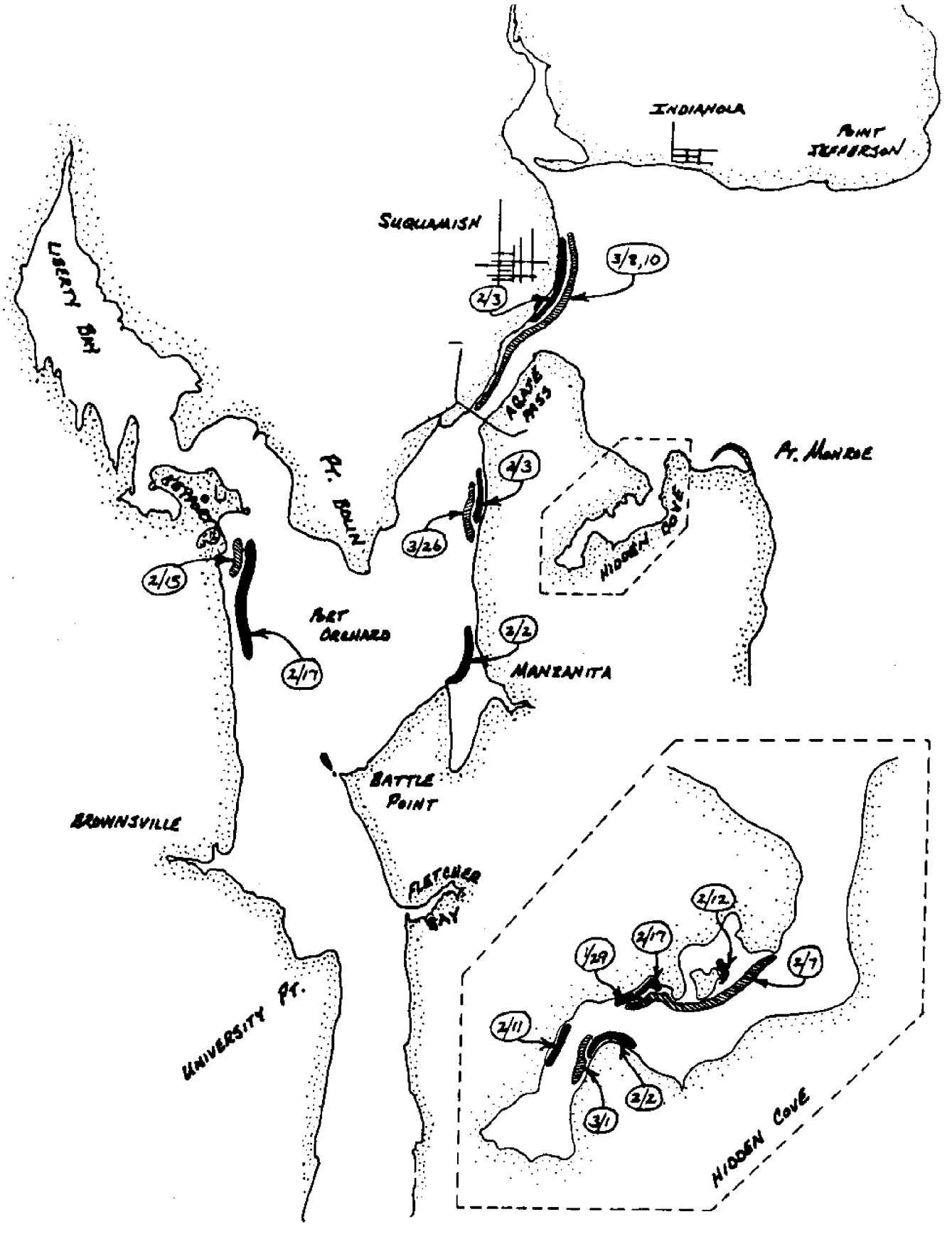


Figure 3. Herring spawning locations and times in Port Orchard - Port Madison, 1983.

H. WDF RECREATIONAL BOTTOMFISH CATCH

Table 7f. Recreational catch (in numbers of fish) and trips made by bottomfish anglers in each Puget Sound management region, 1975.

Species	Gulf - Bellingham	San Juan Islands	Juan de Fuca	Hood Canal	Central Sound	South Sound	West Juan de Fuca	TOTAL
Pacific halibut	2	21	283	1	4	0	0	311
Total flatfish	227	2043	2970	1846	7132	7403	43	21664
Butter sole	1	5	0	50	1	229	0	286
Dover sole	0	0	1	0	12	2	0	15
English sole	52	467	63	17	289	214	0	1102
Rock sole	155	1394	1529	546	1829	2477	39	7969
Sand sole	0	0	22	88	255	425	4	794
Sanddabs	13	118	1061	733	4360	2528	0	8813
Starry flounder	6	57	50	109	135	444	0	801
Arrowtooth flounder	0	0	29	2	38	26	0	95
Misc./unident. flatfish	0	2	215	301	213	1058	0	1789
Sablefish	49	437	376	128	2830	253	0	4073
Greenlings	125	1132	1560	22	193	150	160	3342
Lingcod	211	1891	3056	138	854	409	266	6825
Total rockfish	2109	18942	14538	1515	11921	28603	1416	79044
Black rockfish	299	2686	2803	26	465	944	568	7791
Bocaccio	0	0	82	0	38	102	0	222
Brown rockfish	15	128	322	255	1466	7700	0	9886
Canary rockfish	13	97	358	0	122	458	54	1102
Copper rockfish	754	6778	5111	619	3974	6583	0	23819
Quillback rockfish	815	7335	4189	452	4320	8581	48	25740
Yelloweye rockfish	45	410	191	13	72	29	37	797
Yellowtail rockfish	113	1018	876	13	381	631	97	3129
Misc./unident. rockfish	55	490	606	137	1083	3575	612	6558
Pacific cod	106	955	9558	363	12499	25815	0	49296
Pacific tomcod	35	312	26	6	228	15131	0	15738
Walleye pollock	0	0	90	24	1964	30207	0	32285
Pacific whiting	0	0	108	98	1227	384	0	1817
Striped seaperch	0	0	469	117	586	158	0	1330
Pile perch	0	0	242	60	341	431	0	1074
Sculpins	42	375	125	10	223	62	5	842
Skates	0	0	0	0	0	0	0	0
Spiny dogfish	7	62	173	1	722	98	0	1063
Plainfin midshipman	0	0	0	0	0	0	0	0
Ratfish	1	13	113	12	130	176	0	445
Misc. foodfish	343	3083	97	361	836	1789	0	6509
ANNUAL TOTAL	3257	29266	33784	4702	41690	111069	1890	225658
NUMBER OF TRIPS	1947	17530	14830	3809	22396	33510	252	94274

Table 7p. Recreational catch (in numbers of fish) and trips made by bottomfish anglers in each Puget Sound management region, 1985.

Species	Gulf - Bellingham	San Juan Islands	Juan de Fuca	Hood Canal	Central Sound	South Sound	West Juan de Fuca	TOTAL
Pacific halibut	141	1126	4877	43	215	0	1384	7786
Total flatfish	62	483	2372	578	19308	2636	109	25548
Butter sole	0	0	1	22	8	73	0	104
Dover sole	0	0	4	0	23	1	0	28
English sole	32	257	169	9	1066	129	0	1662
Rock sole	26	202	1497	214	4863	1030	69	7901
Sand sole	0	0	2	28	129	178	14	351
Sanddabs	2	12	603	151	12089	1010	0	13867
Starry flounder	2	12	42	27	220	94	16	413
Arrowtooth flounder	0	0	32	0	104	3	0	139
Misc./unident. flatfish	0	0	22	127	806	118	10	1083
Sablefish	0	0	668	121	4976	824	1	6590
Greenlings	242	1931	2499	19	136	80	378	5285
Lingcod	497	3979	4966	86	657	1239	4214	15638
Total rockfish	1876	15019	23564	9412	31126	20657	18063	119717
Black rockfish	255	2050	4349	96	592	927	12782	21051
Bocaccio	0	0	128	0	148	51	175	502
Brown rockfish	5	40	537	1305	4166	6015	0	12068
Canary rockfish	7	55	470	2	166	234	510	1444
Copper rockfish	690	5514	8198	2470	9910	5142	349	32273
Quillback rockfish	741	5926	6686	3065	11282	5829	533	34062
Yelloweye rockfish	33	268	302	33	170	12	884	1702
Yellowtail rockfish	91	728	1553	38	1546	295	743	4994
Misc./unident. rockfish	54	438	1341	2403	3146	2152	2087	11621
Pacific cod	0	0	5214	526	15322	8215	55	29332
Pacific tomcod	0	0	0	0	111	245	4	360
Walleye pollock	0	0	31	7	4206	125833	0	130077
Pacific whiting	0	0	107	27	1473	39	0	1646
Striped seaperch	0	0	0	231	66	77	0	374
Pile perch	0	0	0	116	75	572	0	763
Sculpins	33	251	2556	50	442	765	434	4531
Skates	0	0	0	0	0	19	7	26
Spiny dogfish	19	149	52	8	427	134	6	795
Plainfin midshipman	0	0	0	0	0	0	0	0
Ratfish	0	0	12	3	59	23	0	97
Misc. foodfish	4	30	118	29	4525	5433	29	10168
ANNUAL TOTAL	2874	22968	47036	11256	83124	166791	24684	358733
NUMBER OF TRIPS	3064	24518	47769	26783	48167	56815	4286	211402

I. NAVY TRAWLING RECORDS AT BANGOR

INTRODUCTION

The TRIDENT Biological Survey program has documented marine environmental conditions along the Naval Submarine Base (SUBASE), Bangor waterfront since 1973. Biological survey efforts provided baseline data for the TRIDENT Support Site Environmental Impact Statement (EIS) and monitored the marine ecosystem during construction of TRIDENT facilities. Per EIS stipulation annual biological monitoring has continued in order to prevent Navy activity from causing adverse environmental impact by detecting potential problems before they become significant.

TRIDENT XV, the biological survey conducted during July 1985 (see table 1 for specific activity dates) was the first survey performed solely by SUBASE Bangor personnel, without the lead of the Naval Ocean Systems Center (NOSC). Basic monitoring strategies designed and refined by NOSC (survey procedures are recorded in references 1 to 4) were followed during TRIDENT XV. The biosurvey involved three field procedures: the marine fish, intertidal, and heavy metal surveys. The following presentation of TRIDENT XV data is consistent with results reported in past biological survey reports (references 1 to 7).

Table 1.

TRIDENT XV Biological Survey
Activity Schedule

2 July 85 / 0800 - 1200	-3.0 @ 1109	Intertidal Sampling: Station D
/ 1300 - 1500		Lab Workup
11 July 85 / 2030 - 2330	+10.0 @ 2409	Otter Trawl Sampling (OT1)
12 July 85 / 0900 - 1600		OT1 Lab Workup
17 July 85 / 0900 - 1200	-1.8 @ 1103	Intertidal Sampling: Station Z
/ 1300 - 1500		Lab Workup
25 July 85 / 2030 - 2330	+11.3 @ 2301	Otter Trawl Sampling (OT2)
26 July 85 / 0900 - 1600		OT2 Lab Workup
29 July 85 / 0730 - 1030	-2.1 @ 0921	Intertidal Sampling: Station C
/ 1130 - 1330		Lab Workup
30 July 85 / 0800 - 1100	-2.2 @ 1001	Intertidal Sampling: Station F
/ 1130 - 1330		Lab Workup
31 July 85 / 0830 - 1130	-2.3 @ 1054	Intertidal Sampling: Station A
/ 1230 - 1430		Lab Workup
1 Aug 85 / 0900 - 1230	-2.0 @ 1138	Intertidal Sampling: Station G
1330 - 1530		Lab Workup

MARINE FISH SURVEY

During TRIDENT Survey XV two otter trawl series were done along the seven stations (see figure 1) which have been sampled annually by night-time otter trawl since 1979. Trawls were conducted after sunset during three hour periods (2100-2400) at incoming tidal conditions on 11 and 25 July 1985. Consistent with past surveys (references 1-7), ten minute hauls were made with a spread-board otter trawl net to sample approximately 650 meters of bottom per station. The survey procedure differed in 1985 in that specimens were identified, enumerated and released during the trawl versus collecting the entire catch. Consequently, numerical data in the 1985 catch record (table 2) may not be as accurate as past records, but the integrity of species identification remains consistent with past trawls since questionable species were collected and identified using taxonomic references. Observations were made on the size range of species to note presence of juveniles and sexually mature adults.

RESULTS

1985 otter trawls took more than 1000 individual specimens representing 26 species from 15 families of fishes (see table 2). Two common species, tubesnouts (Aulorhynchus flavidus) and bay pipefish (Syngnathus leptorhynchus) were present but not enumerated. Table 3 show species distribution for combined station and series otter trawl abundance data. Four species were collected at each sampling station: shiner perch (Cymatogaster aggregata), striped seaperch (Embiotoca lateralis), copper rockfish (Sebastes caurinus), and english sole (Parophyrs vetulus). Summary otter trawl statistics are listed in tables 4, 5, and 6. Replication between the two trawl series was fairly good and consistent with patterns of previous sampling years.

The marine fish survey effort has produced seven years of comparable, baseline data on nearshore marine fish abundance and distribution along the SUBASE Bangor waterfront. Otter trawl records, such as table 2, have documented species composition and abundance per unit catch effort. A cumulative checklist of species collected since 1973 is shown in table 7. Fish community characteristics of species richness and diversity are summarized in table 8. Based on comparisons with these data, species composition and abundance indicate a diverse and reproducing assemblage of nearshore fish fauna present at the time of the 1985 survey. An apparent trend in species composition of trawl catches from early dominance by bottomfish species to present dominance by perch species supports the conclusion that additional SUBASE waterfront structures in Hood Canal have increased nearshore habitat for "piling community" fish species.

The 1985 survey involved an additional effort to collect and examine all species of demersal fish in trawl catches. In light of recent Puget Sound studies identifying possible links between chemical contamination and diseases of bottomfish (references 8 to 10), collected demersal fish were dissected and a gross visual inspection was made for biological abnormalities. All collected specimens appeared in healthy, good condition.

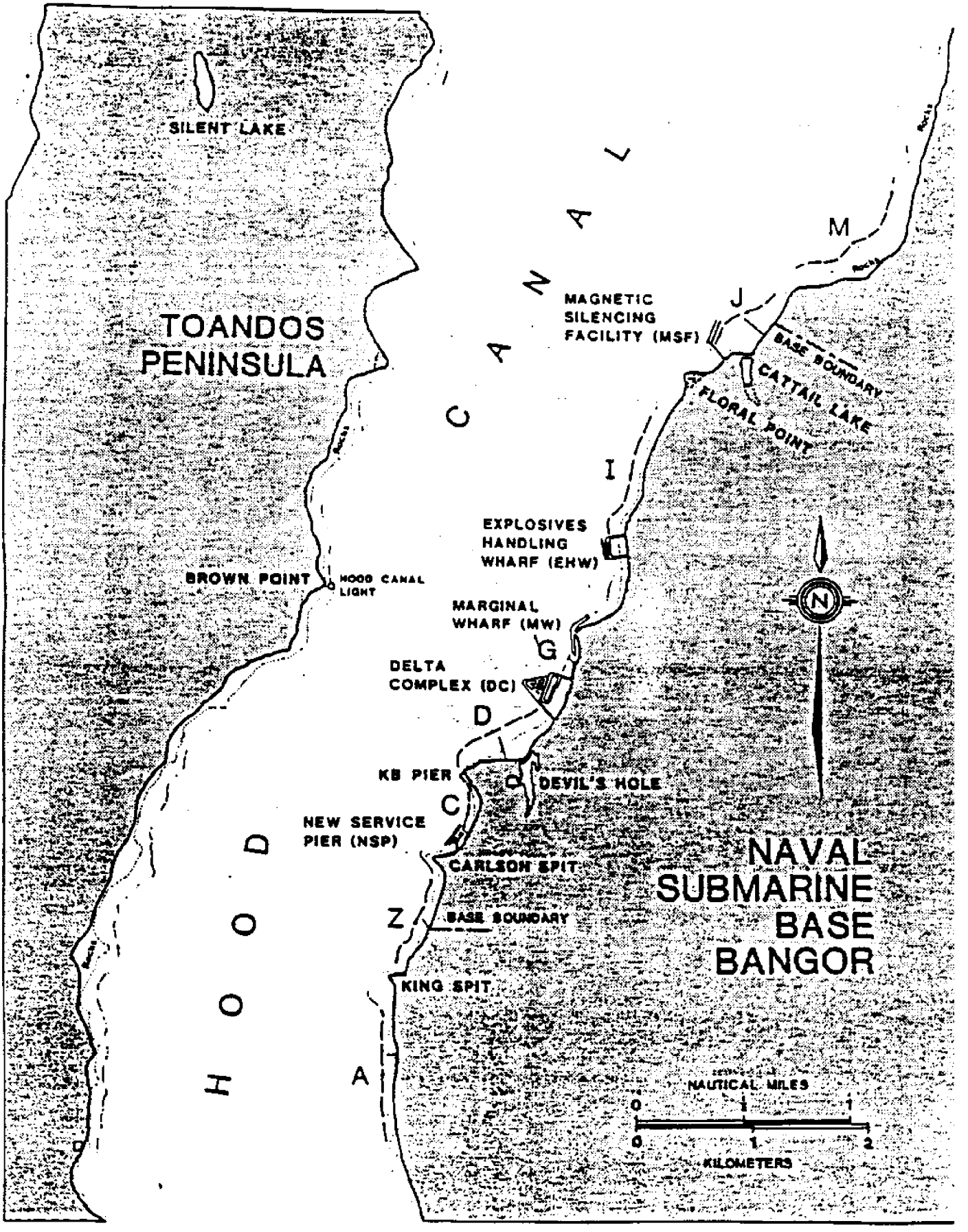


Figure 1. — — — indicates otter trawl routes.

Table 2. TRIDENT SURVEY XV (1985)

Otter trawl data

Species	Station A OT1	A OT2	Z OT1	Z OT2	C OT1	C OT2	D-E OT1	D-E OT2	I OT1	I OT2	J-K OT1	J-K OT2	M OT1	M OT2
Squalus acanthias											1			
Raja binoculata		1	5						2					3
Hydrolagus colliei		p[1]	2		p[1]		p[1]	1 p[1]	9 p[1]	4 p[1] p[1]	6 p[1] p[1]	3 p[1] p[1]	1 p[1] p[1]	26 p[1] p[1]
Clupea harengus pallasi	11 3	72 49	61 2	1 1	4 6	1	9	4 3	11 2	2 8	14	90 42		50 2
Porichthys notatus		1 2	8 1	1	10		1	3	102 1 1	1 2		7 3	1	3 4
Gadus macrocephalus	11	109	9 1	25	13	6	6	6	1 9	4	1	2 2	1	6 5
Microgadus proximus			2 4		3		1		5	1	1 1	4 9		
Aulorhynchus flavidus			2		1	2	1					3	1	5
Syngnathus leptorhynchus			3		10				7 3		1	6	10	19
Cymatogaster aggregata	1		15 2		16				8 1		2 1			6 1
Embiotoca lateralis		1 1												
Rhacochilus vacca	1		5	1			1					1		2
Lumpenus sagitta														
Apodichthys flavidus														
Pholis laeta														
Pholis ornata														
Sebastes caurinus														
Hexagrammos stelleri														
Artedius fenestralis														
Chitonotus pugettensis														
Enophrys bison														
Leptocottus armatus														
Myoxocephalus polyacanthocephalus														
Nautichthys oculofasciatus														
Psychrolutes paradoxus														
Citharichthys stigmaeus														
Lepidosetta bilineata														
Parophrys vetulus														
Platichthys stellatus														
Pleuronichthys coenosus														
Gasterosteus aculeatus														
Coryphopterus nicholsi														
Artedius lateralis														
Hippoglossoides elassodon														

[1]P= Present but not enumerated.

Table 3. TRIDENT XV (1985) Otter Trawl Species Distribution

Species	Distribution by % of total catch
Squalus acanthias	NP
Raja binoculata	.09
Hydrolagus colliei	NP
Clupea harengus pallasi	.48
Porichthys notatus	.57
Gadus macrocephalus	NP
Microgadus proximus	4.94
Aulorhynchus flavidus	P
Syngnathus leptorhynchus	P
Cymatogaster aggregata	31.24
Embiotoca lateralis	11.3
Rhacochilus vacca	NP
Lumpenus sagitta	12.44
Apodichthys flavidus	0.38
Pholis laeta	1.61
Pholis ornata	.86
Sebastes caurinus	19.66
Hexagrammos stelleri	.09
Artedius fenestralis	.67
Chitonotus pugettensis	NP
Enophrys bison	2.28
Leptocottus armatus	1.23
Myoxocephalus polyacanthocephalus	NP
Nautichthys oculofasciatus	.20
Psychrolutes paradoxus	4.18
Citharichthys stigmaeus	NP
Lepidosetta bilineata	1.52
Parophrys vetulus	4.56
Platichthys stellatus	.09
Pleuronichthys coenosus	.38
Gasterosteus aculeatus	NP
Coryphopterus nicholsi	NP
Artedius lateralis	NP
Hippoglossoides elassodon	.48

NP=not present
P=present but not enumerated

Table 4. Trident Survey XV (1985) Otter trawl data

Station	OT1	Combined #Species	OT2	Mean#ind/ Station	% Total
A	27	(11)	236+	131.0	25.0
Z	122	(17)	29	75.5	14.3
C	63+	(10)	9	36.0	6.8
D-E	20+	(10)	17+	18.5	3.5
I	162	(16)	22+	92.0	17.5
J-K	28+	(17)	172+	100	19.0
M	14+	(16)	132	73.0	13.9
Totals =	436+	(27)	617+		

Mean # ind/trawl series: 527 $\pm$ 128

Note: "+" indicates presence of uncounted juveniles

Table 5.
Otter Trawl Data - TRIDENT Survey XV (1985)

	Station						
	A	Z	C	D	I	J	M
#/Station	263	151	72	37	184	200	146
% Total	25.0	14.3	6.8	3.5	17.5	19.0	13.9
$\bar{x}$/station	131 ± 148	75.5 ± 65.8	36.0 ± 2.1	18.5 ± 2.10	92.0 ± 99.0	100 ± 102	73.0 ± 83.-
# species	11	17	10	10	16	17	16

Total Catch Per Trawl

	OT1	OT2	
#/trawl	436	617	Total # individuals - 1053
% total	41.4	58.6	Total # species - 27
# species	23	21	Mean catch per trawl = 527 ± 128

Species Present @ All Trawl Stations:

Cymatogaster aggregata - *Shiner Perch*

Embiotoca lateralis - *Striped Seaperch*

Sebastes caurinus - *Copper Rockfish*

Parophys vetulus - *English Sole*

OTTER TRAWL DATA SUMMARY

Table 6. Data summary for nighttime otter trawls conducted at SUBASE Bangor during 1979, 1980, 1981, 1982, 1983, 1984 and 1985. Numbers of individuals listed for each of two or three trawling periods; number of species (in parentheses) combined year totals.

Year

Station	1979 1		1979 2	1980 1		1980 2	1981 1		1981 2	Mean/ Station	%
A	171	(24)	363	41	(17)	83	14	(4)	-	134.8	34.8
C	33	(11)	7	9	(5)	12	5	(4)	8	12.3	3.8
D-E	21	(10)	24	12	(7)	6	11	(2)	-	14.8	3.8
I	17	(14)	30	25	(13)	30	0	(9)	35	22.8	7.1
J-K	66	(21)	85	31	(18)	65	9	(7)	-	51.2	13.2
M	56	(13)	55	109	(14)	385	31	(6)	-	127.2	32.9
Z	19	(11)	26	16	(5)	16	1	(3)	6	14.0	4.3
Totals =	383		590	243		597	71		49		100
Means:		486.50			420.00			60.00			

Station	1982 1		1982 2	1983 1		1983 2	1984 1	1984 2	1984 3	
A	71	(15)	20	16	(10)	43	38	18	74	(13)
C	29	(12)	64	25	(7)	12	2	61	264	(20)
D-E	21	(14)	37	25	(13)	34	33	24	124	(17)
I	16	(13)	26	25	(13)	75	54	138	15	(19)
J-K	72	(14)	24	34	(13)	24	55	121	74	(14)
M	74	(21)	80	112	(24)	106	68	312	560	(22)
Z	24	(9)	40	6	(5)	6	3	21	40	(13)
Totals =	307		291	243		300	253	695	1151	
Means:		299.00			271.50			699.70		

Table 6. continued

Station	1	1985	2	1982-1985 Mean/Station	%	1979-1985 Mean/Station	%
A	27	(11)	236	60.33	12.6	86.8	19.5
C	63	(10)	9	58.78	12.3	18.25	9.7
D-E	20	(10)	17	37.22	7.8	29.2	6.6
I	162	(16)	22	59.22	12.4	44.7	10.76
J-K	28	(17)	172	67.11	14.1	61.4	13.8
M	14	(16)	132	162.00	34.0	111.7	33.6
Z	122	(17)	29	32.33	6.8	25.0	6.0
Totals =	436		617		100.		100.
Means:		527.00					

Family	Genus/Species/Authority/Date	Common Name
Squalidae	*Squalus acanthias* Linnaeus, 1758	Spiny Dogfish
Chimaeriidae	*Hydrolagus colliei* (Lay & Bennett, 1839)	Ratfish
Batrachoididae	*Porichthys notatus* Girard, 1854	Plainfin Midshipman
Gadidae	*Gadus macrocephalus* Tilesius 1810	Pacific Cod
	Merluccius productus (Ayres, 1855)	Pacific Hake
	Microgadus proximus (Girard, 1854)	Pacific Tomcod
Aulorhynchidae	*Aulorhynchus flavidus* Gill, 1861	Tubesnout
Gasterosteidae	*Gasterosteus aculeatus* Linnaeus, 1758	Threespine Stickleback
Syngnathidae	*Syngnathus leptorhynchus* Girard, 1854	Bay Pipefish
Embiotocidae	*Cymatogaster aggregata* Gibbons, 1854	Shiner Perch
	Embiotoca lateralis Agassiz, 1854	Striped Seaperch
	Rhacochilus vacca (Girard 1855)	Pile Perch
Stichaeidae	*Anoplarchus purpurescens* Gill, 1861	High Cockscomb
	Lumpenus sagitta Wilimovsky, 1956	(Pacific) Snake Prickleback
Pholidae	*Apodichthys flavidus* Girard, 1854	Penpoint Gunnel
	Pholis laeta (Cope, 1873)	Crescent Gunnel
	Pholis ornata (Girard, 1854)	Saddleback Gunnel
Ammodytidae	*Ammodytes hexapterus* Pallas, 1811	Pacific Sand Lance
Gobiidae	*Coryphopterus nicholsi* (Bean, 1881)	Blackeye Goby
Scorpaenidae	*Sebastes caurinus* Richardson, 1845	Copper Rockfish
Hexagrammidae	*Hexagrammos stelleri* Tilesius, 1809	Whitespotted Greenling
Cottidae	*Artedius fenestralis* Jordan & Gilbert, 1882	Padded Sculpin
	Artedius lateralis (Girard, 1854)	Smoothhead Sculpin
	Clinocottus acuticeps (Gilbert, 1895)	Sharpnose Sculpin
	Enophrys bison (Girard, 1854)	Buffalo Sculpin
	Hemilepidotus hemilepidotus (Tilesius, 1810)	Red Irish Lord
	Leptocottus armatus Girard, 1854	Pacific Staghorn Sculpin
	Nautichthys oculofasciatus (Girard, 1857)	Sailfin Sculpin
	Psychrolutes paradoxus Gunther, 1861	Tadpole Sculpin
	Scorpaenichthys marmoratus (Ayres, 1854)	Cabezon
Agonidae	*Agonus acipenserinus* Tilesius, 1811	Sturgeon Poacher
Bothidae	*Citharichthys sordidus* (Girard, 1854)	Pacific Sanddab
Pleuronectidae	*Lepidopsetta bilineata* (Ayres, 1855)	Rock Sole
	Parophrys vetulus Girard, 1854	English Sole
	Platichthys stellatus (Pallas, 1811)	Starry Flounder
	Pleuronichthys coenosus Girard, 1854	C–O Sole
	Psettichthys melanostictus Girard, 1854	Sand Sole

Table 7. List of Hood Canal fishes collected during Trident environmental monitoring surveys (1979, 1980 and 1981). (Taxonomy based on Hart, 1973.)

List additions from 1982, 1983, 1984 and 1985 surveys.

Rajidae	Raja binoculata (Girard, 1854)	Big Skate
Clupidae	Clupea harengus pallasi (Valenciennes, 1847)	Pacific Herring
Zoarcidae	Lycodes diapterus (Gilbert, 1891)	Black Eelpout
Cottidae	Myoxocephalus polyacanthocephalus (Pallas, 1811)	Great Sculpin
Bothidae	Citharichthys stigmaeus (Gilbert, 1882)	Speckled Sanddab
Pleuronectidae	Hippoglossoidae elassodon (Gilbert, 1880)	Flathead Sole
	Lyopsetta exilis (Gilbert, 1880)	Slender Sole

OTTER TRAWL DATA SUMMARY

Table 8. Annual combined station and series total.

Year	# Fish Collected	# of Otter Trawls	# Species Represented	Families Represented	Species Diversity
1979	973	2	31	16	1.09
1980	840	2	30	15	0.922
1981	120	2	18	12	0.959
1982	598	2	30	16	1.08
1983	543	2	29	17	1.06
1984	2099	3	30	13	1.00
1985	1053	2	26	15	0.935

Species Diversity = diversity of species (H') as dertermined by the Shannon-Weaver diversity index:

$$H' = \frac{n \ln n - \sum_{i}^{k} f_i \ln f_i}{n}$$

where n is the sample size, f_i is the number of fish in species i, and k is the number of species.