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MESA

MARINE ECOSYSTEMS ANALYSIS PROGRAM

Coastal Zone
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COASTAL ZONE
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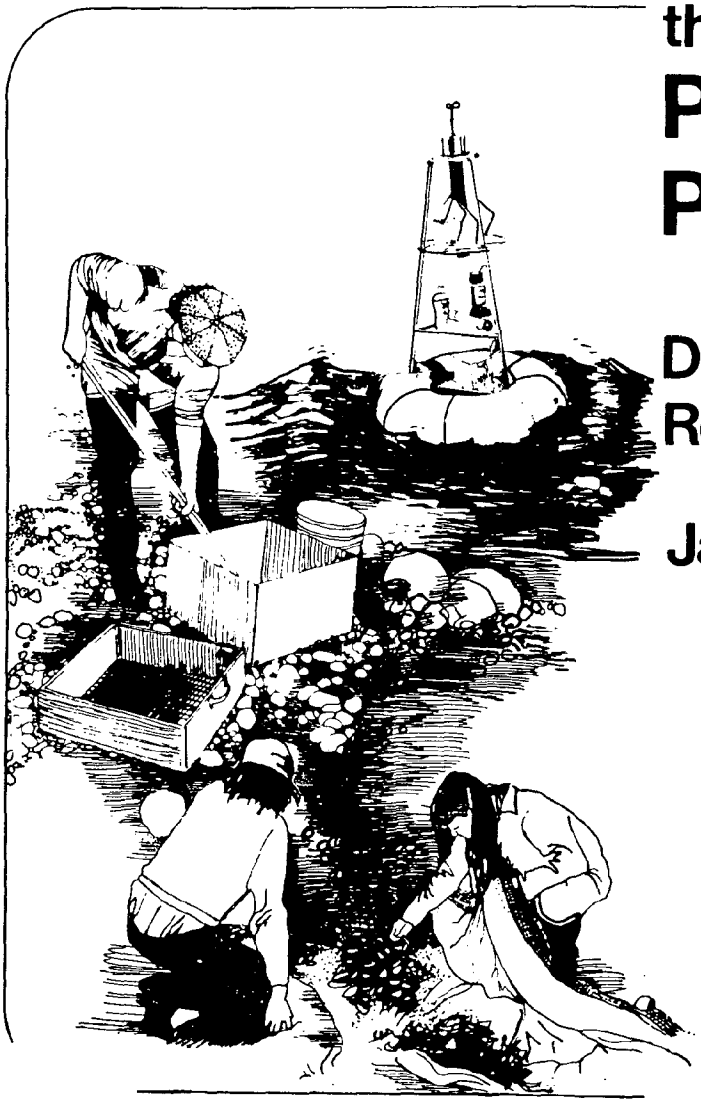

the PUGET SOUND PROJECT

Description of Research Activities

January 1978

U.S. National Oceanic + Atmospheric Administration.
& Research Laboratories

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL RESEARCH LABORATORIES
MESA PUGET SOUND PROJECT
7600 SAND POINT WAY NE
SEATTLE, WASHINGTON 98115

COASTAL ZONE INFORMATION CENTER
MAR 27 1978

The Marine Ecosystems Analysis (MESA) Program was established to focus the capabilities of NOAA and of federal, state, local and private agencies upon specific regional environmental problems through short-term intensive research projects. The first MESA project was initiated in the New York Bight region in 1972 with the purpose of ameliorating environmental impacts in a heavily polluted marine ecosystem. The Puget Sound Project was initiated in 1975. In contrast to the New York Bight, the Sound is perceived as being in a transitional stage: no large-scale environmental problems are evident but there are isolated water quality problems which often presage extensive environmental degradation. Thus the "problem" being addressed in Puget Sound is not restoration of a degraded environment but rather protection of a healthy environment against the increasing stresses associated with economic growth and industrial expansion.

The MESA Puget Sound Project has identified two major targets for research: (1) the impact of treated municipal and other waste discharges upon the ecosystem of Puget Sound, and (2) the potential effects of increased petroleum transport and refining activities in the Strait of Juan de Fuca and northern Puget Sound. The wastewater program is being conducted in the central basin of Puget Sound at a low funding level. The petroleum effort has received considerable pass-through funding from the Environmental Protection Agency and is in the middle of an intensive five-year program.

The output of the MESA Puget Sound Project will provide a large environmental data base for the region, upon which future regulatory, socio-economic, and resource management decisions may be based. The research activities in progress are described in the attached sheets. As a final effort, the project will synthesize the information gathered (with existing information) into a variety of publications and other products designed to assist in the coastal marine decision-making process.

Additional information can be obtained by contacting the Project Office at the above address or telephoning (206) 442-5590.

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CONTENTS

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TITLE OF STUDY	PAGE
Bibliography of Literature on the Puget Sound Marine Environment	1
Oil Spill Trajectory Model for Puget Sound, the Strait of Juan de Fuca, the San Juan Island, and Southern Georgia Strait.	3
Compendium of Current Environmental Studies in Puget Sound and Northwest Estuarine Waters	5
Wastewater Effluent Characteristics of Refineries in Washington State	7
Oil in Washington: Applicability of Models to Marine Environmental Questions and Ecological Impacts.	9
Northern Puget Sound Trophic Pathways	11
Puget Sound Publication Series.	13
Circulation in the Western Strait of Juan de Fuca	15
Evaluation of Water Quality in Hood Canal and Southern Puget Sound	17
Microbial Degradation of Petroleum Hydrocarbons	19
Baseline of Intertidal and Shallow Subtidal Benthos Along the Strait of Juan de Fuca	21
Petroleum Hydrocarbon Baseline for Northern Puget Sound and the Strait of Juan de Fuca	23
Distributions of Suspended Matter in Northern Puget Sound and Hydrocarbon Adsorptive Characteristics of Riverine Suspended Particulates	25
Community and Trophic Relationships of Nearshore Fish at Selected Sites Along the Strait of Juan de Fuca	27
Seasonal Distribution of Phytoplankton and Zooplankton in the Strait of Juan de Fuca.	29

CONTENTS Con't.

TITLE OF STUDY	PAGE
Physical Oceanography of the Puget Sound Central Basin	31
Strait of Juan de Fuca Aerial Drogue Study	33
Baseline of Intertidal and Shallow Subtidal Benthos Along the West Coast of Whidbey Island.	35
Marine Mammal Investigations in Northern Puget Sound and the Strait of Juan de Fuca.	37
Marine Bird Investigations in the Strait of Juan de Fuca and Northern Puget Sound	39

MESA Puget Sound Project

Date: Dec 1977

Title of Study: BIBLIOGRAPHY OF LITERATURE ON THE PUGET SOUND MARINE ENVIRONMENT

Principal Investigators: Eugene E. Collias, Alyn C. Duxbury
Department of Oceanography
University of Washington

Project Office Contact: Ronald P. Kopenski

Start Date: December 1975 End Date: September 1977

Purpose: One emphasis of the project is to make existing environmental information available to regional decision makers and resource managers. A key tool for making this information widely available is an annotated bibliography of literature. The University of Washington published such a bibliography in 1971. The project office, recognizing the volume of significant literature published since that time, has contracted with the university (through NOAA's Environmental Data Service) to update and broaden that bibliography.

Document Description: PUGET SOUND MARINE ENVIRONMENT: AN ANNOTATED BIBLIOGRAPHY

The bibliography contains 1980 annotated references to literature on the Puget Sound marine environment published prior to January, 1977. Entries cover all of the oceanographic sciences as well as topics such as pollution, history, planning and management, demography and socio-economics, and transportation, industrial, and petroleum activities. Entries are indexed according to (1) oceanographic regions, (2) river drainage basins, (3) water and land usage, and (4) subject. The entries are arranged in volume in alphabetical order using the first author's last name.

Research Methods: The original publication was employed as the base document. Each of the items contained therein was reviewed before inclusion into the new bibliography. In addition, searches were made of university libraries throughout the state, personal contacts were made with university and government researchers in the area, and searches were made of bibliographic files contained in computers (including NTIS, GEOREF, and SciSearch). Abstract services were inspected for relevent literature citations.

The output of these searches was then pared to remove articles or reports written by consultants or agencies for internal use or for very limited distribution, as these would not be readily available to the general public. Each of the entries was then coded according to a 15 digit code. An annotation describing the publication was then written and put on paper tape for entry into the computer. Sorting and printing was then performed via the computer.

Publication Schedule: Available from the MESA Project Office.

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MESA Puget Sound Project

Date: Dec 1977

Title of Study: OIL SPILL TRAJECTORY MODEL FOR PUGET SOUND, THE STRAIT OF JUAN DE FUCA, THE SAN JUAN ISLANDS, AND SOUTHERN GEORGIA STRAIT

Principal Investigator: Carl S. Smyth
Pacific Marine Environmental Laboratory
National Oceanic and Atmospheric Administration

Project Office Contact: Ronald P. Kopenski

Start Date: May 1976 End Date: September 1977

Purpose: An obvious consequence of transport and offloading of petroleum within the waters of Puget Sound is the possibility of a major spill. During the time required for mobilization of pickup resources, the spill may be advected some distance under the influence of estuarine flow, tides, and the wind. The capability to predict this surface movement can contribute much to the effectiveness of the oil clean-up operations as well as allowing timely protection of important natural or man-made resources. The purpose of this study is to develop an operational oil spill trajectory model which can be used in two modes: (1) prespill - development of likely spill scenarios and resultant oil trajectories for clean-up planning purposes, and (2) postspill - real-time prediction of trajectory for cleanup deployment purposes.

Research Components:

1. Development of a general trajectory model as a framework with functional "slots" into which specific modules providing the best prediction of surface winds, surface water motion, and oil spill component behavior would be "plugged-in" for the particular circumstances of the spill.
2. Extended development of the National Ocean Survey (NOS) tidal current table interpolation procedure as a temporary surface water motion module.
3. Development of a locally adapted regional meteorological model by means of which small-scale surface winds might be inferred from the sparse atmospheric data actually available.
4. Eventual development of a process-oriented hydrodynamic model to respond to seasonal and random fluctuations in nontidal driving forces.

Publication Schedule: A final report describing the model is scheduled for January, 1978. It will include documentation of the computer programs, listings, sample runs, a user's guide, and a review of testing and verification.

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Title of Study: COMPENDIUM OF CURRENT ENVIRONMENTAL STUDIES IN PUGET SOUND AND NORTHWEST ESTUARINE WATERS

Principal Investigators: Cam McIntosh, Gary Harshman
Oceanographic Institute of Washington (OIW)

Project Office Contact: Ronald P. Kopenski

Start Date: March 1974 End Date: Continuing

Purpose: The Compendium is a descriptive record of marine environmental research undertaken in the waters of Washington and British Columbia. Published annually, it is intended to provide a single source document for identification of research relevent to the needs of researchers and managers working in the same fields. The Compendium is supported by eight federal, state, and local governmental groups interested in coordination of research in the region.

Research Components:

1. The 1976 Compendium (published February, 1977) contains descriptions of 433 research projects underway in the marine waters of Washington and British Columbia. These are indexed according to key words, geographical area, investigator, performing organization, and supporting organization. The description of each research project includes:
   - investigator and his organization
   - dates of the study
   - geographical location
   - brief abstract of the study plan
   - supporting agency and funding level
   - publications and data availability

2. Quarterly updates are issued for changes in research projects contained within the Compendium.

3. The Oceanographic Institute of Washington offers a search service of its Compendium files (including information as yet unpublished) for parties who need the most up-to-date information on particular research projects.

Research Methods: Researchers and agencies involved in marine studies are contacted via personal interviews, questionnaires, and telephone inquiries. Information is transferred to standard forms, and indexed for inclusion in the subsequent Compendium.

Publication Schedule: Published by OIW in February of each year. Copies of the 1974 (the first), 1975, and the 1976 Compendia are still available.

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MESA Puget Sound Project

Date: Dec 1977

Title of Study: WASTEWATER EFFLUENT CHARACTERISTICS OF REFINERIES IN WASHINGTON STATE

Principal Investigator: Joseph Pizzo
Oceanographic Institute of Washington

Project Office Contact: Ronald P. Kopenski

Start Date: May 1976 End Date: November 1976

Purpose: In order to provide the requisite input for design of a hydrocarbon baseline for the Puget Sound region, it is necessary to assess the existing oil refineries as potential sources. This characterization includes the chemical characteristics, amounts processed, and final disposition of crude oils, refined products, and refinery wastes.

Research Components: Each of the major refineries in the Puget Sound region (U.S. refineries only) is characterized as to:

1. quantities and sources of incoming crude oil
2. operational processes
3. types and amounts of refined products produced at different times and from different crude oils
4. components of wastewater resulting from the refining processes (including stormwater runoff)
5. wastewater treatment processes

Sampling Methods: Only existing information was employed in the compilation of this report. Sources include the technical literature,government agencies, and information supplied by the petroleum industry.

Publications: This report is available for use in the MESA Project office and will be available early in 1978 as a published report.

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Title of Study: OIL IN WASHINGTON: APPLICABILITY OF MODELS TO MARINE ENVIRONMENTAL QUESTIONS AND ECOLOGICAL IMPACTS

Principal Investigator: Joseph Pizzo
Oceanographic Institute of Washington

Project Office Contact: Ronald P. Kopenski

Start Date: May 1976 End Date: October 1976

Purpose: To describe the potential role of models in providing solutions to state and local governmental management questions regarding marine environmental impacts which could result from development of the Puget Sound petroleum industry.

Research Components:

1. Description of various alternatives for development of the petroleum industry in Puget Sound through 1985.
2. Identification of management questions which might arise from this proposed development.
3. A listing of potential model applications for providing solutions to questions pertaining to marine resource management.

Study Approach: Four scenarios, expressing the basic petroleum development alternatives now foreseen for the Puget Sound region are identified. A list of 480 management questions and approximately 100 marine environmental impacts are developed through a literature review and personal interviews with 23 state and local government officials. One-third of the questions are categorized as marine environmental questions capable of being solved by using models.

The central environmental question regarding oil transportation and handling is found to be that of acceptibility of damage risk from spills. The priority marine questions are those with socio-economic implications, particularly those concerning damage from oil spillage to resources and to activities having commercial and recreational use and importance.

Publication: Available for use in the MESA Project Office.

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Title of Study: NORTHERN PUGET SOUND TROPHIC PATHWAYS

Principal Investigators: Bruce S. Miller
Fisheries Research Institute
University of Washington

Lewis J. Bledsoe
Center for Quant. Sci.
University of Washington

Project Office Contact: Edward R. Long

Start Date: March 1977 End Date: May 1978

Purpose: To synthesize available food web data into a comprehensive description of the marine trophic structure of northern Puget Sound.

Research Components:

1. Definition of foraging patterns of significant species found in the study area.
2. Quantification of the critical links in Puget Sound food webs.
3. Examination of the sources, mechanisms, and rates of flow of trophic energy (and potential pollutants) through the food webs.
4. Development of a graphical representation of nearshore food web structures by representative habitats and seasons with a semi-quantitative designation of the trophic significance of each link between predator and prey.

Research Methods:

1. A quantitative analysis of existing raw data residing in NOAA/MESA and FRI data bases.
2. A review of published and unpublished literature.
3. Quarterly and spot sampling of nearshore and neritic fishes and nearshore epibenthic plankton to fill anticipated data gaps in the information base. (This work is further described in another fact sheet entitled: Community and Trophic Relationships of Nearshore Fish at Selected Sites along the Strait of Juan de Fuca.)
4. Analysis of fish stomach specimens from northern Puget Sound, including presently stored specimens and additional data from the sampling program described in (3) above.

Publication Schedule: The final report is scheduled for May, 1978.

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Title of Study: PUGET SOUND PUBLICATION SERIES

Principal Investigators: Alyn C. Duxbury, Patricia Peyton
Division of Marine Resources
University of Washington

Project Office Contact: Howard S, Harris

Start Date: June, 1976 End Date: August, 1980

Purpose: One of the main objectives of the MESA Puget Sound Project is to provide environmental and ecological information to resource managers and regional decision-makers in a format useful for management purposes. Many of the targeted managers do not have scientific backgrounds, and hence much of the existing information concerning the Puget Sound environment is not available for their use. The Puget Sound Publication Series is envisioned as a series of approximately 15 "monographs" which present state-of-the-art understanding of the marine environment in easily comprehended form. The series is patterned after the highly successful (and widely used) New York Bight Monograph Series.

Research Components:

1. Determination of the scope, format, and approach of the interpretive publication series. (Completed November 1976)
2. Management of a publication effort resulting in approximately 15 separate volumes.
3. Promotion and marketing of the publication series.

Management Procedures:

1. Organization of an ad hoc planning committee to determine publication strategy.
2. Selection and hiring of a small core staff to manage the publications effort.
3. Selection of an advisory editorial board to assist with selection of authors, topics, style, etc., and to review drafts of publications.
4. Agreements with "expert" authors to write individual publications.
5. Drafting, editing, and publication of individual publications on a case-by-case basis.
6. Promotion and marketing efforts.

Publication Schedule:

1. Preliminary design effort. Complete. Report available from the MESA Project Office.
2. Publication of first issue scheduled for August-December, 1978.
3. Publication of last issue scheduled for June, 1980.
4. Final report scheduled for August, 1980.

TENTATIVE TOPICS

1. Physical and chemical properties of Puget Sound and its approaches
   Includes--salinity, temperature, density, nutrients, dissolved gases, alkalinity, transparency

2. Circulation of Puget Sound and its driving forces
   Includes--tides and tidal currents, net circulation, freshwater input and hydrology, wind-driven circulation and waves

3. Geological setting of the Puget Sound basin
   Includes--regional geology, surface and subsurface structure, beach classifications, and marine sediment formation and distribution

4. Shoreline processes, the dynamics of beaches in the Puget Sound region
   Includes--natural beach formation processes, modification of beaches and shorelines by man, and uses of coastal structures

5. Planktonic populations of Puget Sound, their systematics and distribution
   Includes--the cyclic pattern of plankton growth in Puget Sound, its causes and importance to the productivity of the Sound. Classes of plankton to be dealt with are phytoplankton, zooplankton and meroplankton (larval forms)

6. Intertidal and subtidal benthic flora and fauna of Puget Sound and its adjacent waters
   Includes--distribution and time variations in abundance of principal forms. Requires a discussion of the significance of the benthic populations in establishing the character of Puget Sound

7. Natural fish populations of Puget Sound, their abundance, location and migratory behavior
   Includes--discussions of the natural populations of both commercially and noncommercially important species, their distributions in time and space with controlling factors, and the dependency of one population on another. Must also include a discourse of man's impact on fish populations through enhancement and harvesting

8. Ecological importance and role of the bordering estuaries, marshlands and nearshore beach environments of Puget Sound
   Includes--the productivity of estuaries as nursery areas for Puget Sound, the importance of the marsh habitat, the role of river estuaries in establishing Puget Sound's biological populations

9. Mammals and waterfowl of the Puget Sound area
   Includes--resident and migratory populations, their abundance and distribution in time and space, their dependence on properties of the Puget Sound environment and importance to the region

10. Recreational uses of Puget Sound, including beach use, boating, marine parks, sports fishing and SCUBA diving
    Includes--description of present distribution and intensity of use and potential for further development. Must include importance and significance of recreational facilities to the quality of life in Puget Sound region and a discussion of economic impact

11. Commercial harvesting of fish, shellfish and seaweeds in the Puget Sound region
    Includes--commercial fisheries, the culture and wild harvest of shellfish, marine algae culture and harvesting, private culture and harvesting of commercially valuable fish stocks

12. Demographic patterns of the Puget Sound region and their impact on uses of Puget Sound
    Includes--siting of industries, port facilities and transportation requirements, ownership and use of shore zone in population centers

13. Jurisdictions, ownership and regulations pertaining to the management and control of the natural resources of Puget Sound
    Includes--federal, state, county, city and private roles

14. The waste product problem and the Puget Sound region
    Includes--domestic and industrial wastes as they affect water properties and air quality; importance of regional planning in handling waste treatment; significance of industrial exotic materials such as heavy metals, PCB's, toxic materials and waste heat from power sources; petroleum products

Title of Study: CIRCULATION IN THE WESTERN STRAIT OF JUAN DE FUCA

Principal Investigator: Glenn Cannon, James R. Holbrook
Pacific Marine Environmental Laboratory
National Oceanic and Atmospheric Administration.

Project Office Contact: Ronald P. Kopenski

Start Date: October 1975 End Date: December 1977

Purpose: To describe the temporal, longitudinal, and vertical ranges of the near-surface (upper 15 meter) and subsurface circulation in the Strait of Juan de Fuca.

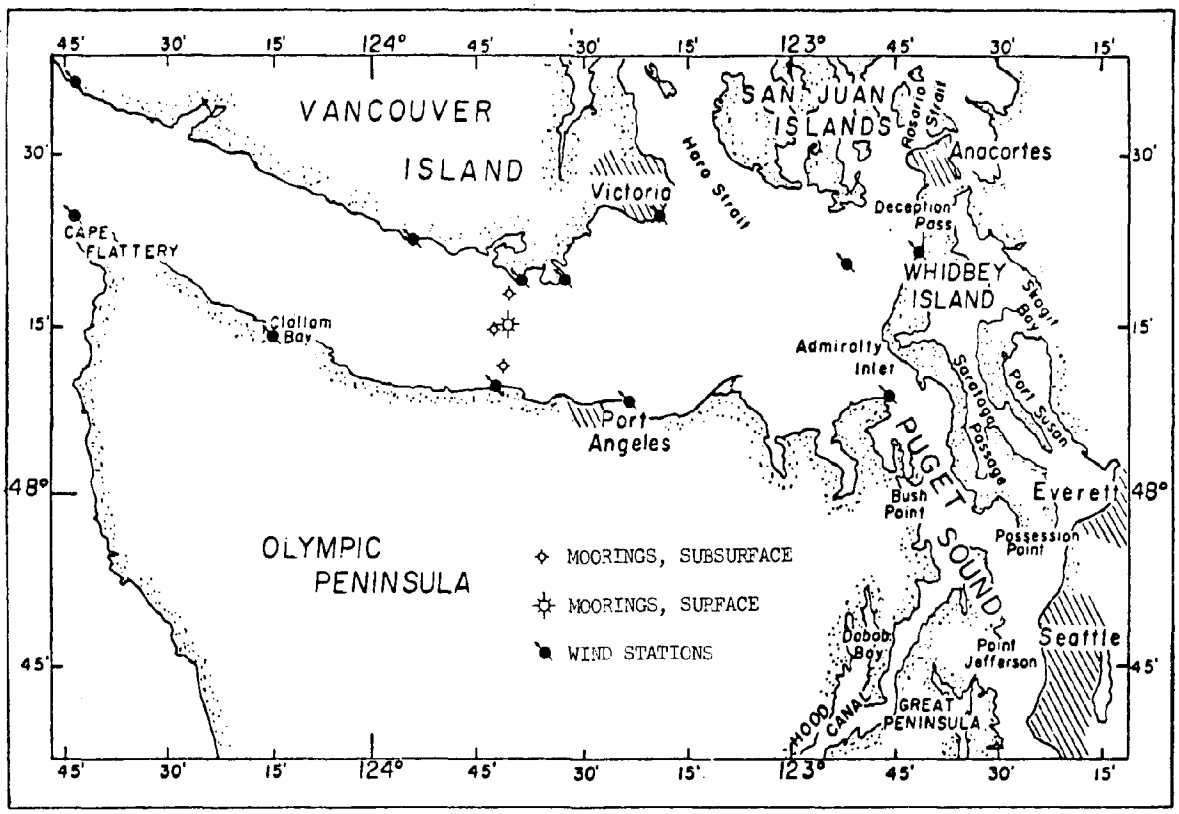
Research Components:

1. Description of the temporal, longitudinal, and vertical variations of the near surface currents.
2. Determination of the response of near-surface currents to local storms.
3. Description of the surface effects of internal waves generated by ebb tidal flows over the sill south of Victoria, British Columbia.
4. Description of flow through a section of the Strait at Slip Point where external oceanographic effects are minimized.
5. Description of the horizontal variation in intermediate-level flow during seasonal extreme conditions.
6. Description of the longitudinal accelerations experienced by near-surface currents under a variety of wind stress and river runoff conditions.

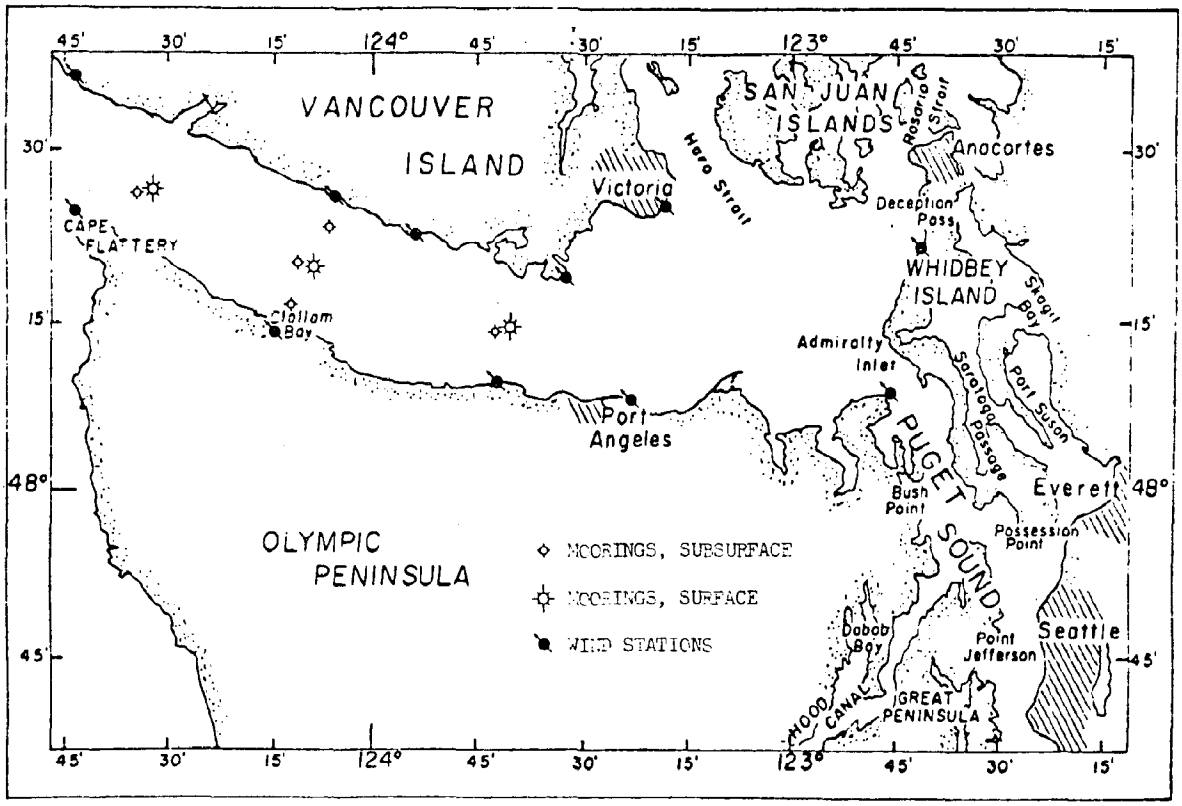
Sampling Methods: Three large oceanographic deployments: spring 1976, winter 1976-77, summer 1977.

1. Surface moorings with vector averaging wind recorders and near-surface vector averaging current meters. (3-month deployments)
2. Subsurface moorings with Aanderaa current meters equipped with temperature and conductivity sensors. (1-month deployments)
3. CTD surveys along the length of the Strait and in transverse sections.
4. Wind meter deployments at coastal locations using vector averaging and Aanderaa meters (1-3 month deployments).
5. Collection of meteorological data from the national U.S. and Canadian weather networks.

Publication Schedule: The final report is scheduled for May 1978.



1976 STATION LOCATIONS



1977 STATION LOCATIONS (BOTH DEPLOYMENTS)

Title of Study: EVALUATION OF WATER QUALITY IN HOOD CANAL AND SOUTHERN PUGET SOUND

Principal Investigator: Rick D. Cardwell
Pt. Whitney Shellfish Laboratory
Washington Department of Fisheries

Project Office Contact: Edward R. Long

Start Date: June 1976 End Date: August 1978

Purpose:

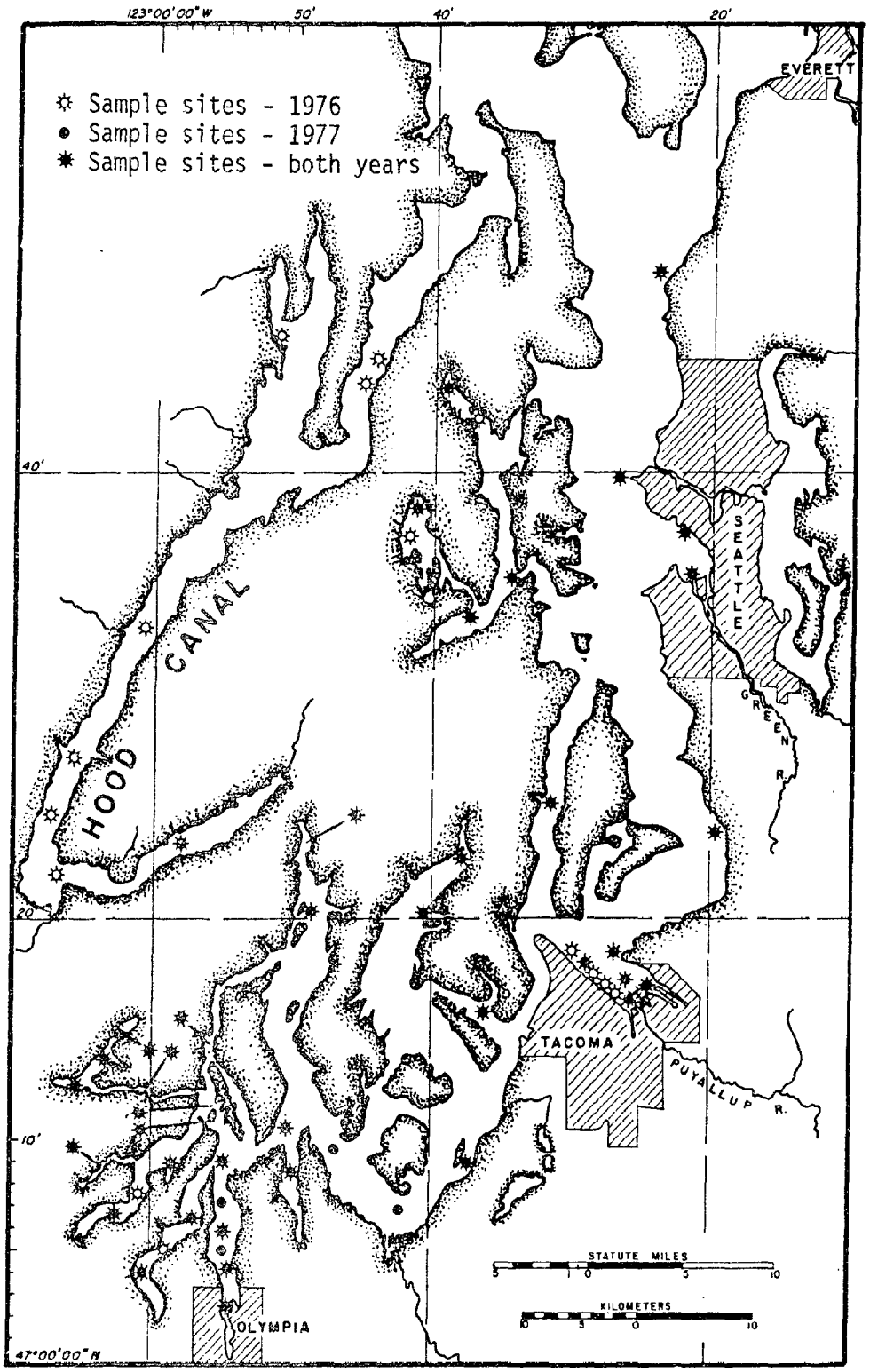
1. To continue the annual Washington Department of Fisheries assessment of water quality in Hood Canal and southern Puget Sound.
2. (2nd year only) To investigate the causes of mortality of larval Pacific oysters in selected inlets of the southern Puget Sound basin, and specifically to test the hypothesis that metabolites of Ceratium fusus (a planktonic organism) play a significant role in this mortality. In addition, to investigate the outflow from two municipal sewage treatment plants as possible sources of localized toxicity to oyster larvae.

Research Components:

1. Determination of the toxicity (to oyster larvae) of water samples from selected sites in Hood Canal and southern Puget Sound.
2. Correlation of toxicity statistics to select physical, chemical, and biological characteristics of the water samples.
3. Characterization of sewage discharges from the municipal treatment plants at Olympia and Shelton, Washington with regard to dissolved oxygen, 5-day biochemical oxygen demand, pH, ammonia, specific conductance, suspended solids, and residual chlorine. (2nd year only)
4. Experiments with laboratory-cultured and "wild" Ceratium fusus to determine if metabolites produced by this organism can cause mortality of oyster larvae, to determine differences in toxicity between physiologically different cultures, and to determine if municipal sewage discharges stimulate production of toxic metabolites. (2nd year only)

Sampling Methods: Water from selected sites at varying depths is collected once in September of each year for subsequent laboratory analysis. Samples are flown directly to the laboratory where freshly fertilized oyster larvae are exposed to the water samples for approximately 48 hours. Per cent mortality and abnormality of larvae are subsequently determined as an indication of water toxicity. Many of the water samples are also analyzed for dissolved oxygen, pH, salinity, temperature, ammonia, Pearl-Benson Index-sensitive substances, and total organic carbon.

Publication Schedule: The annual report for the first year is available from the MESA Project Office. The final report is scheduled for August, 1978.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Sample sites - 1976
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PUYALLUP R.
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KILOMETERS
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OLYMPIA
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Title of Study: MICROBIAL DEGRADATION OF PETROLEUM HYDROCARBONS

Principal Investigator: Dr. D.W.S. Westlake
Department of Microbiology
University of Alberta

Project Office Contact: Edward R. Long

Start Date: April 1977 End Date: June 1978

Purpose: The fractions of petroleum introduced into the marine environment meet with various fates. One of the most important is that of biodegradation into other compounds (either toxic or nontoxic) by one or more species of microorganisms over periods of time. The purpose of this study is to investigate the degradation of crude oil by mixed communities of microorganisms found in the Strait of Juan de Fuca/ northern Puget Sound region, determining the identity of the micoorganisms and the rates and products of degradation.

Research Components:

1. Characterization of hydrocarbon-degrading microbial communities and of the process of degradation for various concentrations of crude oil under the seasonal range of environmental conditions found in the region.

2. Determination of areas in the region where degradation rates are either rapid or slow, and examination of the relationship of these areas to known sources of hydrocarbons.

Sampling Methods:

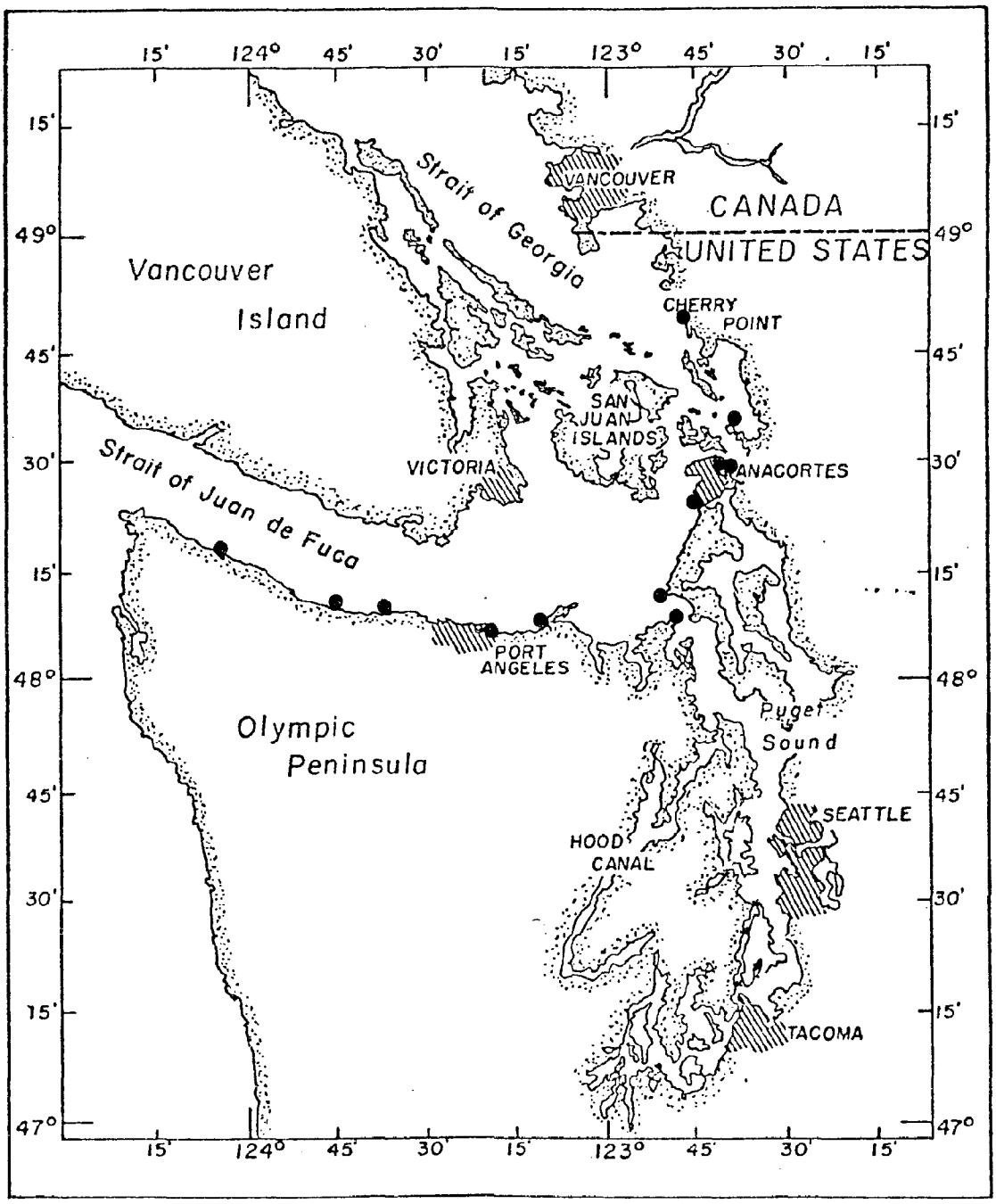
1. Twelve sites are chosen for sampling. Some are close to oil-related activities and some are in relatively pristine areas, thus allowing examination of geographic differences in degradation rates and microbial communities.

2. Sampling is conducted three times during the year (April, September, and December) to reflect climatic and hydrologic conditions representative of the region.

3. Using aseptic techniques, surface water and intertidal and subtidal sediment samples are collected (by hand) and tested for the presence, substrate preference, and degrading capabilities of microorganism communities in the laboratory.

4. Laboratory experiments include culturing mixed communities at different concentrations of Prudhoe Bay crude oil at various temperatures for periods of up to 28 days. Some cultures are inoculated with nutrients; others are not. Cultures are tested for aerobic and anaerobic degradation. Major colonies are identified and enumerated. Control cultures are incubated simultaneously, but without exposure to oil.

Publication Schedule: The final report is scheduled for June 1978.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VICTORIA
ANACORTES
Strait of Juan de Fuca
PORT
ANGELES
Olympic
Peninsula
Puget
Sound
SEATTLE
HOOD
CANAL
TACOMA

Title of Study: BASELINE OF INTERTIDAL AND SHALLOW SUBTIDAL BENTHOS ALONG THE STRAIT OF JUAN DE FUCA

Principal Investigator: Carl F. Nyblade
Department of Zoology
University of Washington

Project Office Contact: Edward R. Long

Start Date: April 1976 End Date: May 1978

Purpose: To document the abundance, distribution, and seasonal and annual variation in populations of organisms of each major habitat type present in intertidal and shallow subtidal zones of the Strait of Juan de Fuca (U.S. side).

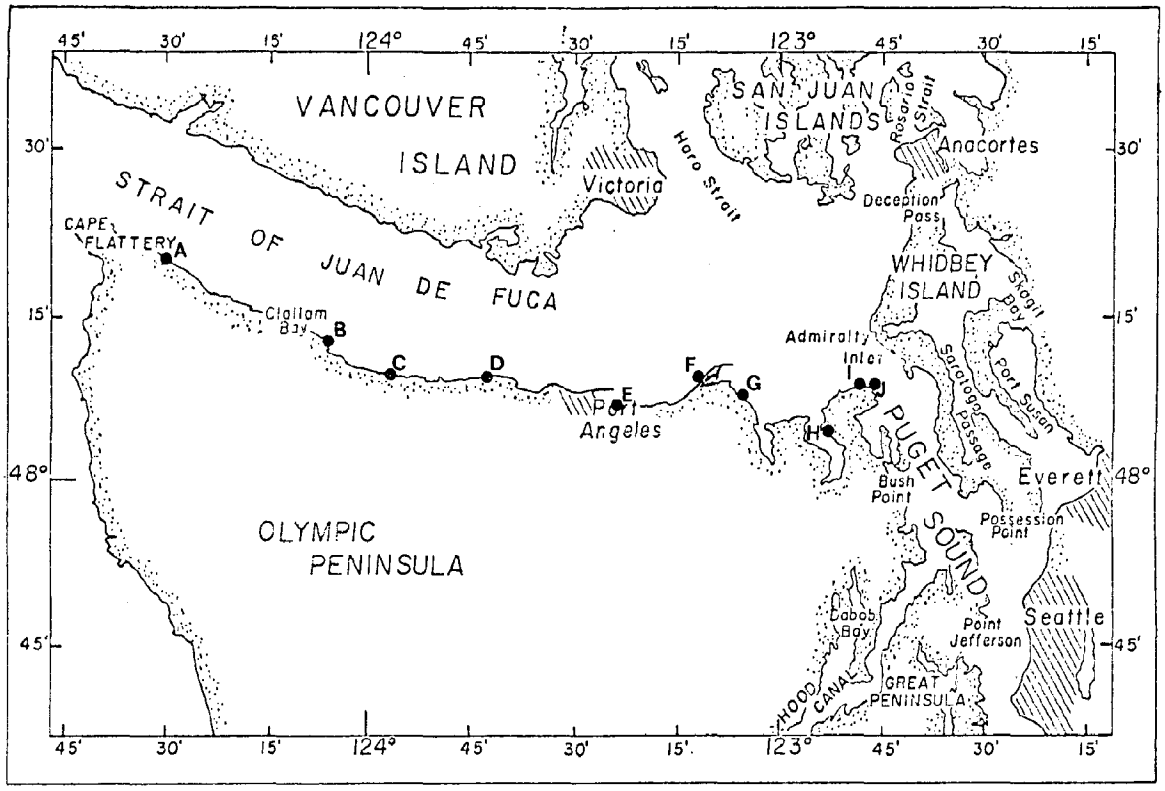
Research Components:

1. Defining of the habitat types present along the Strait of Juan de Fuca according to substrate and exposure.
2. Selection of ten sites (spread evenly over the length of the Strait) representative of the habitat types found along the Strait for detailed study.
3. Quarterly determination of community composition and biomass at each site.
4. Determination of vertical distribution for each site.

Sampling Methods:

1. Quarterly sampling for community characteristics at +6', +3', and +0' in the intertidal, and -5m and -10m in the shallow subtidal region
2. Additional sampling during the first summer quarter at +7', +5', +4', +2', +1', -2.5m, -7.5m.
3. Intertidal samples are hand collected using a variety of quadrats and cores, dependent upon substrate type; replication also depends upon substrate.
4. Subtidal samples are collected by the use of SCUBA hand collections (rock substrate) or by means of a .1m^2 Van Veen grab sampler (soft bottom).
5. At each station, quadrat sites are randomly selected along horizontal transect lines.
6. Water temperature, salinity, and sediment size description data are also collected.

Publication Schedule: The report on the first year's results is scheduled for December, 1977. The final report is due 31 May, 1978.



SAMPLING SITE	HABITAT	1976 Intertidal			1976 Subtidal			1977 Intertidal			1977 Subtidal		
		samples per year	number of elevations	replicates per level	samples per year	number of elevations	replicates per level	samples per year	number of elevations	replicates per level	samples per year	number of elevations	replicates per level
A. Kydaka Beach	sand	4	3	5	4	2	3	4	3	5	1	2	4
B. Pillar Point	rocky/sandy	4	3	4	4	2	3	1	3	4	1	2	4
C. Twin Rivers	sandy gravel	4	3	5	4	2	3	1	3	5	1	2	4
D. Tongue Point	rock	4	3	4	4	2	3	4	3	4	1	2	4
E. Morse Creek	cobble	4	3	4	4	2	3	4	3	4	1	2	4
F. Dungeness Spit	sandy gravel	4	3	5	4	2	3	4	3	5	1	2	4
G. Jamestown	muddy sand	4	3	3	4	2	3	4	3	2	1	2	4
H. Beckett Point	mud	4	3	3	4	2	3	4	3	2	1	2	4
I. North Beach Cobble	cobble	4	3	5	4	2	3	1	3	4	1	2	4
J. North Beach Sand	sand	4	3	5				4	3	5			

Title of Study: PETROLEUM HYDROCARBON BASELINE FOR NORTHERN PUGET SOUND AND THE STRAIT OF JUAN DE FUCA

Principal Investigators: W.D. MacLeod, George Snyder
NOAA National Analytical Facility
Northwest and Alaska Fisheries Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration

Project Office Contact: Edward R. Long

Start Date: February 1977 End Date: April 1978

Purpose: The waters of northern Puget Sound and the Strait of Juan de Fuca have not been subject to major oil spills, and thus hydrocarbon concentrations in the environment are thought to be low. With this situation liable to change due to the increasing oil traffic within the region, there are several reasons for documentation of present hydrocarbon levels. Foremost is the need to establish a baseline against which subsequent changes can be detected and assessed. Furthermore, knowledge of the present situation is required for the formulation of an effective monitoring program to determine impacts resultant from pollution incidents and trends in contaminant concentrations.

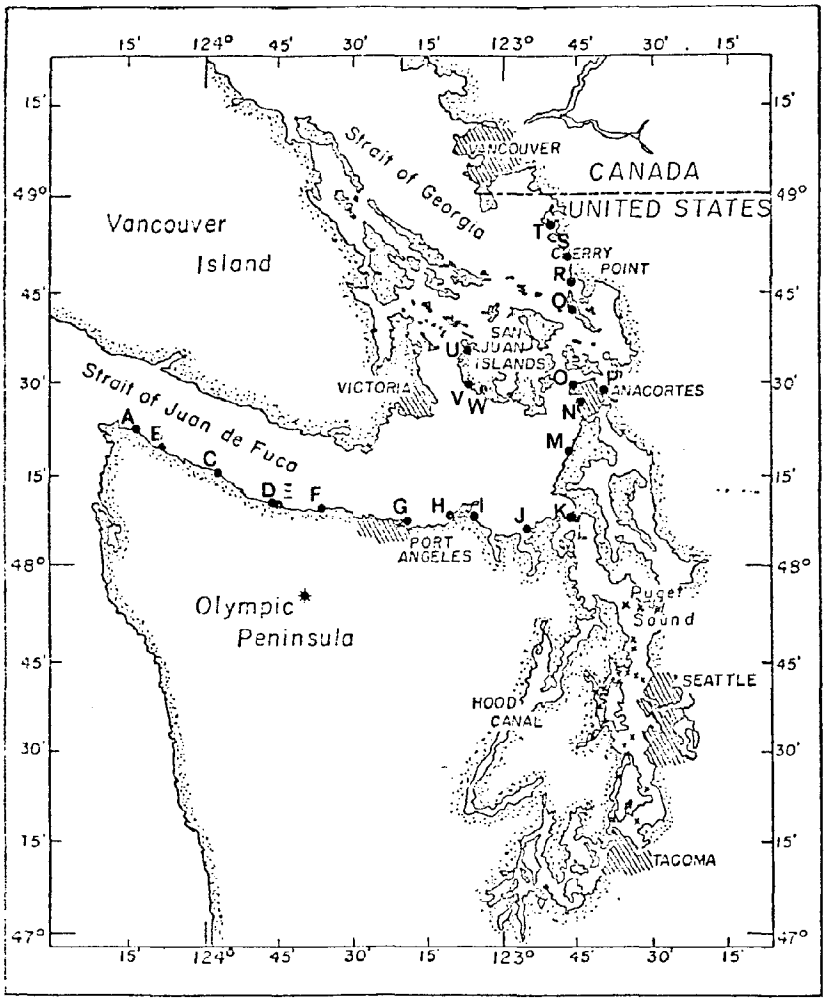
In a preliminary baseline design program a panel of petroleum experts was assembled, and a one-time field experiment was conducted in order to determine optimum sampling strategy. Mussels and sediments were selected for sampling. Sediments present a historical picture of hydrocarbon concentrations at the site. Mussels filter large amounts of water, quickly accumulating and eliminating contaminants; thus they present a short-term history of water-column contaminants.

Research Components:

1. Preliminary sampling investigation to determine the magnitude of variability caused by a variety of natural and sampling factors, including composite size, tidal height, and laboratory analysis methods.
2. Quarterly sampling of mussels (18 sites) and sediments (19 sites) in northern Puget Sound and the Strait of Juan de Fuca. (duplicate samples)
3. Chemical analysis of composite samples of mussel and of sediment for each site to determine the concentration of a number of petroleum hydrocarbons.
4. Frozen storage of duplicate samples for future analysis.
5. Interpretation of data for spatial and temporal trends in occurrence, concentration, and composition of petruleum and related hydrocarbons.

Sampling Methods: Stratified random selection of individual samples which are combined to form composite mussel and composite sediment samples for each site. Ten individual samples per composite. All samples are taken between +1½ feet and +2½ feet elevations (MLLW).

Publication Schedule: Preliminary design report is available from the MESA Project Office. Final report is scheduled for April 1978. Data are available through the MESA Project Office.



Hydrocarbon Baseline Stations

	Station Name	Samples
A.	Baadah Point	both
B.	Kydaka Point	both
C.	Pillar Point	both
D.	Deep Creek (mussel)	mussel
E.	Deep Creek (sediment)	sediment
F.	Crescent Bay	both
G.	Ediz Hook (tip)	both
H.	Dungeness Spit	sediment
I.	Three Crabs	both
J.	Cape George	both
K.	Fort Casey	sediment
L.	Keystone Jetty	mussel
M.	NAS Whidbey	both
N.	Alexander's Beach	both
O.	Shannon Point	both
P.	March Point	both
Q.	Legoe Bay	mussel
R.	Sandy Point	both
S.	Cherry Point	sediment
T.	Birch Point	both
U.	Westcott Bay	mussel
V.	Andrew's Bay	sediment
W.	False Bay	both

Analytical Results Include

1. Microgravimetric determination of total aliphatic and aromatic hydrocarbons eluted from silica gel column chromatography.
2. Gas chromatographic determination of alkanes to include each of the n-alkanes from C_{14} to C_{31}, pristane, and phytane.
3. Gas chromatographic determination of aromatics to include:

n-propylbenzene	dibenzothiophene	chrysene
i-propylbenzene	phenanthrene	benz(a)anthracene
naphthalene	anthracene	benzo(e)pyrene
1-methylnaphthalene	fluoranthene	benzo(a)pyrene
2-methylnaphthalene	pyrene	perylene
biphenyl	methylphenanthrene	

4. Sample weight and dry weight determinations.
5. Total lipid determination on mussel tissue.
6. Total organic carbon analyses of sediment samples.
7. Sediment texture (grain size) and color.

MESA Puget Sound Project

Date: Dec 1977

Title of Study: DISTRIBUTIONS OF SUSPENDED MATTER IN NORTHERN PUGET SOUND AND HYDROCARBON ADSORPTIVE CHARACTERISTICS OF RIVERINE SUSPENDED PARTICULATES

Principal Investigators: Edward Baker, Joel Cline, Richard Feely
Pacific Marine Environmental Laboratory
National Oceanic and Atmospheric Administration

Project Office Contact: Ronald P. Kopenski

Start Date: July 1976 End Date: March 1978

Purpose: With the cutoff of Canadian crude oil delivery to the Puget Sound region, the Strait of Juan de Fuca and northern Puget Sound have experienced greatly intensified tanker traffic. Further intensification will occur if Puget Sound is selected as a transhipment point for Alaskan crude oil to be piped to the midwest. This increased tanker traffic creates an increased potential for significant additions of petroleum hydrocarbons to the marine environment. Once introduced, a combination of physical, chemical, and biological processes become operative in the destruction and removal of the oil. This study focuses upon the spatial and seasonal distributions of suspended particulate matter and its adsorptive characteristics relative to crude oil.

Oil agglutination to particles presents a serious problem for primary food chain detrital feeders and subsequently to higher levels of the food chain. Thus, it is of primary importance to determine the transport capacities and mechanisms by which petroleum hydrocarbons may be made available to detrital feeders in the water column as well as to benthic deposit feeders. And, as part of the project's hydrocarbon baseline, it is important to document the levels of petroleum hydrocarbons presently agglutinated to suspended particulate matter.

Research Components:

1. Determination of suspended particulate loading in the waters of northern Puget Sound (both vertical and horizontal extent) during (i) the period of maximum river flow, (ii) the period of minimum river flow, and (iii) during the rainy season.
2. Characterization of petroleum hydrocarbons which are presently adsorbed to suspended particulate matter in northern Puget Sound.
3. Characterization of the ability of river-borne suspended matter to adsorb Prudhoe Bay crude oil.
4. Determination of the concentrations of low molecular weight hydrocarbons which are dissolved in the water column.

Sampling Methods:

1. Nephelometer (light scattering intensity) profiles taken simultaneously with CTD measurements. Calibrated by analysis of water samples.
2. 24-hour anchor stations. Continuous pumping and centrifuging of seawater to obtain adequate suspended matter for hydrocarbon analysis.

3. Collection of suspended matter from the Fraser and Skagit Rivers for laboratory analysis of adsorptive capability with regard to Prudhoe Bay Oil. (including mineralogical and size analysis)
4. Water sampling at five depths for determination of dissolved low molecular weight hydrocarbons.
5. Utilization of ERTS imagery (satellite infrared photography) to produce suspended matter distribution maps based upon ground truth gathered by the three cruises.

Publications Schedule: Final report is scheduled for March 1978.

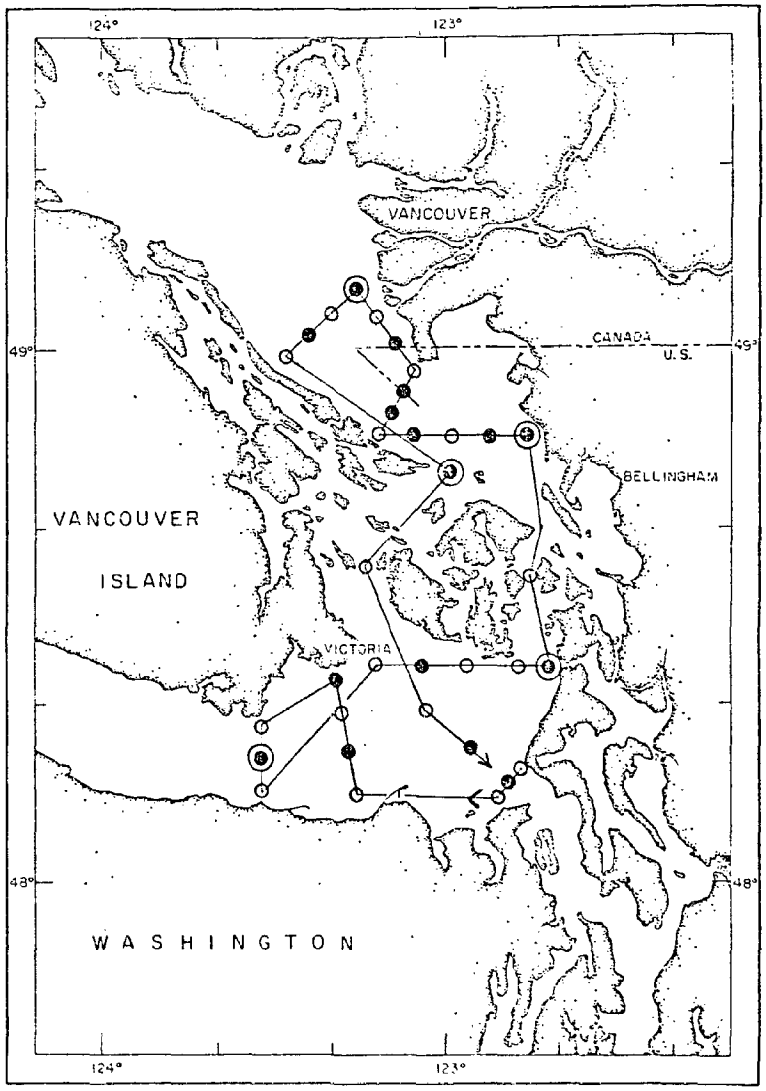


Figure 1. Station locations and cruise track for SPM and petroleum hydrocarbon observations in northern Puget Sound.

- O Nephelometer observations only.
- ● Nephelometer observations plus water samples for LMWH analysis.
- ◎ Anchor stations - time series and hydrocarbon sampling.

Title of Study: COMMUNITY AND TROPHIC RELATIONSHIPS OF NEARSHORE FISH AT SELECTED SITES ALONG THE STRAIT OF JUAN DE FUCA

Principal Investigator: Dr. Bruce Miller
Fisheries Research Institute
University of Washington

Project Office Contact: Edward R. Long

Start Date: 1 April 1976 End Date: 31 May 1978

Purpose: To characterize the principal biological populations and processes most susceptible to impact by petroleum, through a documentation of the major prey/predator relationships and pollutant pathways within the food web. Emphasis will be placed upon the invertebrates and fishes which occupy nearshore habitats and are vulnerable to the effects of oil.

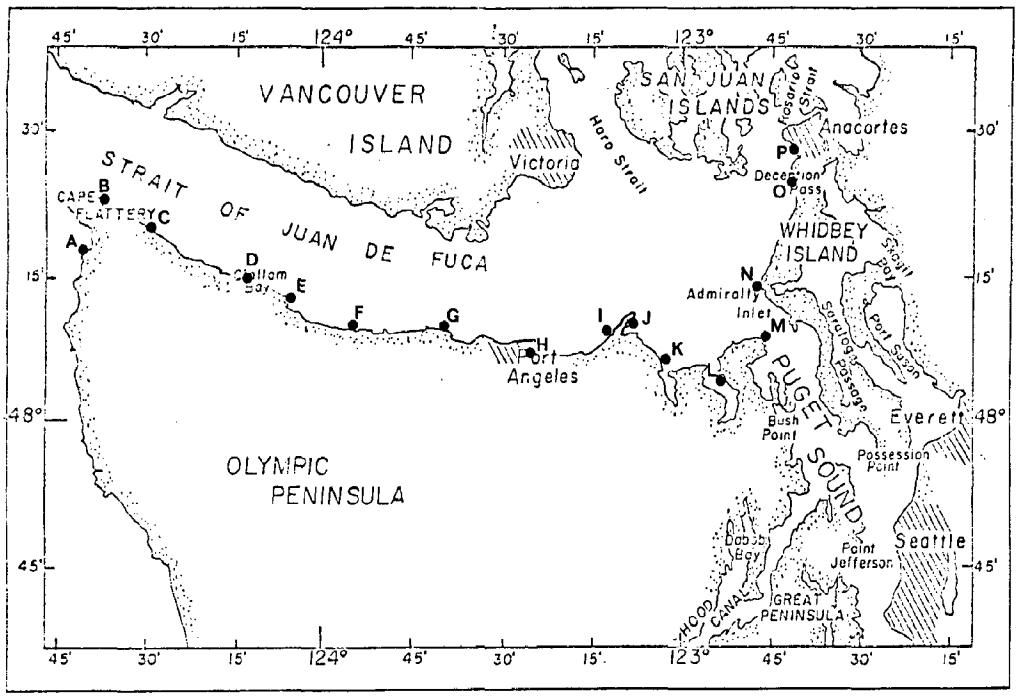
Research Components:

1. Sampling on a regular, seasonal basis the fishes occupying the littoral, inner littoral, and nearshore neritic waters.
2. Documenting the composition, distribution, abundance, standing crop and annual variability of the fish and macroinvertebrate communities inhabiting representative shoreline habitats.
3. Analyzing quantitatively the stomach contents of economically (recreational or commercial) or ecologically important species represented within the samples.
4. Determining the seasonal composition, abundance, and biomass of prey organism taxa constituting the diets of the important dominant species from the different habitats, and the annual variability in these data.
5. Identifying the trophic role of these species within the various fish communities, and in correlation with zooplankton and other invertebrate sources and pathways of matter and energy to the fish communities from lower or similar trophic levels.

Sampling Methods:

1. Beach Seining: a 37 meter x 2.4 meter net with a weighted bottom edge is set 30 meters off the beach and pulled to shore, thereby sweeping the subtidal region of the beach. Where the water is so deep that the upper edge of the net is submerged, a second pass is made with a floating net.
2. Tow netting: 10 minute tows of a 3x6 meter net along the water's surface as close to the shoreline as the water depth permits.
3. Tide pooling: isolated tidepools are partially drained and then the fish are anesthitized with dilute Quinaldine and hand collected.

Publication Schedule: annual report for first year - 1 May 1977
final report - 31 May 1978



	SITE	HABITAT	SAMPLING TECHNIQUE	SAMPLING FREQUENCY	76-77	77-78
A.	Cape Alava	exposed rock	tidepool	2/yr		X
B.	Baadah Point	exposed rock	tidepool	6/yr		X
C.	Kydaka Point	exposed sand	sinking beach seine	4/yr	X	X
			tow net	4/yr	X	X
D.	Slip Point	exposed rock	tide pool	6/yr	X	X
E.	Pillar Point	exposed rock	tow net	4/yr	X	X
			tide pool	6/yr		X
F.	Twin Rivers	exposed sand and gravel	sinking beach seine	4/yr	X	X
			tow net	4/yr	X	X
			tide pool	6/yr	X	X
G.	Observatory Point	exposed rock	tide pool	6/yr	X	X
H.	Morse Creek	gravel, cobble	sinking beach seine	4/yr	X	X
			tow net	4/yr	X	X
			tide pool	6/yr	X	X
I.	Dungeness Spit	exposed gravel	sinking beach seine	4/yr	X	X
			floating beach seine	4/yr	X	X
			tow net	4/yr	X	X
J.	Jamestown	mud, eelgrass	sinking beach seine	4/yr	X	
			tow net	4/yr	X	
K.	Gray's Marsh	mud, eelgrass	sinking beach seine	4/yr		X
			tow net	4/yr		X
L.	Beckett Point	protected gravel	sinking beach seine	4/yr	X	X
			floating beach seine	4/yr	X	X
			tow net	4/yr	X	X
M.	North Beach	exposed cobble	tide pool	6/yr	X	X
N.	Point Partridge	exposed cobble	tide pool	2/yr		X
O.	West Beach	exposed sand and gravel	sinking beach seine	4/yr		X
			floating beach seine	4/yr		X
			tow net	4/yr		X
P.	Alexander's Beach	sand	floating beach seine	4/yr		X
			tow net	4/yr		X

Title of Study: SEASONAL DISTRIBUTION OF PHYTOPLANKTON AND ZOOPLANKTON IN THE STRAIT OF JUAN DE FUCA

Principal Investigators: Jerry Larrance, David Damkaer
Pacific Marine Environmental Laboratory
National Oceanic and Atmospheric Administration

Project Office Contact: Edward R. Long

Start Date: January 1976 End Date: July 1978

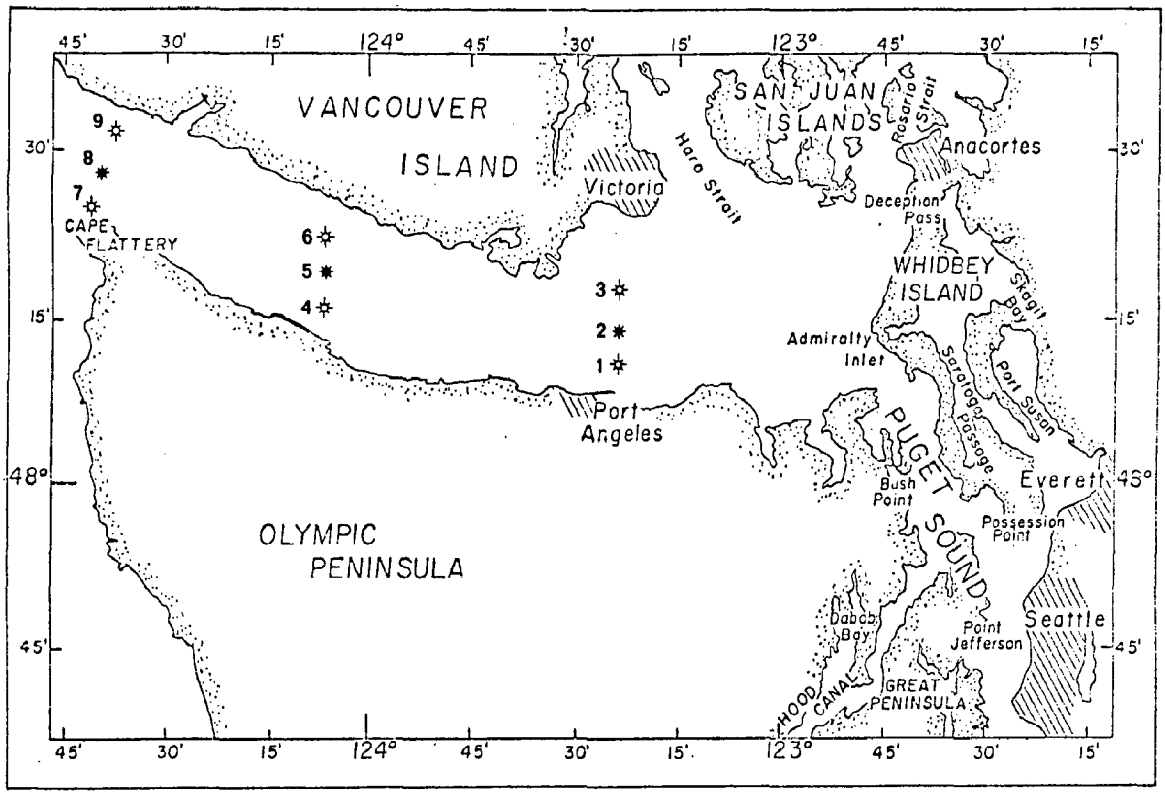
Purpose: Plankton populations, because of their high degree of interaction with the surrounding water and their proximity to the water surface are susceptible to the toxicity of floating oil. Potential effects include death, sublethal cellular and physiological effects, and the incorporation of hydrocarbons with upward transference through the food web. Little, however, is known about the distribution and abundance, seasonal cycles, or vertical migration of species found in the Strait of Juan de Fuca. Virtually nothing is known about the dynamics of communities, species successions or recruitment.

The purpose of this study is to develop a broad characterization of the planktonic populations in the Strait of Juan de Fuca, especially the icthyoplankton and planktonic stages of intertidal organisms. These planktonic groups represent economically valuable species. Emphasis will be placed upon determination of the major taxonomic groups, their horizontal and vertical distributions, and seasonal variability.

Research Components:

1. Sampling the planktonic populations on a regular basis at nine stations in the Strait of Juan de Fuca. During the first year the sample interval is six weeks; during the second year samples are taken quarterly.
2. Identification of the major taxonomic groups encountered, including zooplankton, phytoplankton, icthyoplankton, the planktonic stages of intertidal organisms, and fish eggs.
3. Analysis of water samples to determine chlorophyll *a* and phaeopigment concentrations through the water column.
4. Limited primary productivity experiments.
5. Characterization of the upper layers of the water column by means of a CTD profiling system.

Publication Schedule: The preliminary report on the first year's results is available at the MESA Project Office. The final report is scheduled for July, 1978.



Sampling Methods

	Parameter Measured	Method	Equipment Type	Depth(s)
all stations	zooplankton	oblique net tows	bongo, Larrance nets	50 meters to surface
	pleuston	horizontal net tows	pleuston surface sampler	surface only
mid-channel stations only	zooplankton	vertical net tows	vertical closing net	near bottom to 100 meters 100 meters to 50 meters 50 meters to 25 meters 25 meters to surface
	phytoplankton chlorophyll a phaeopigment	water samples	niskin bottles	50 meters, 40 meters, 30 meters, 20 meters, 10 meters, surface
	microzooplankton	water sample	niskin bottle	surface only
	salinity temperature	profiling	remote recording CTD package	100 meters to surface

Larrance net: a 60 cm diameter ring which is held within a 100x70 cm frame by two pivot points, with a 33 micrometer mesh net.

Title of Study: PHYSICAL OCEANOGRAPHY OF THE PUGET SOUND CENTRAL BASIN

Principal Investigator: Glenn Cannon
Pacific Marine Environmental Laboratory
National Oceanic and Atmospheric Administration

Project Office Contact: Ronald P. Kopenski

Start Date: September 1975 End Date: September 1978

Purpose: To characterize the mixing and advective processes operative within the Sound, thereby enabling estimates of flushing rates and pollutant retention times for management purposes.

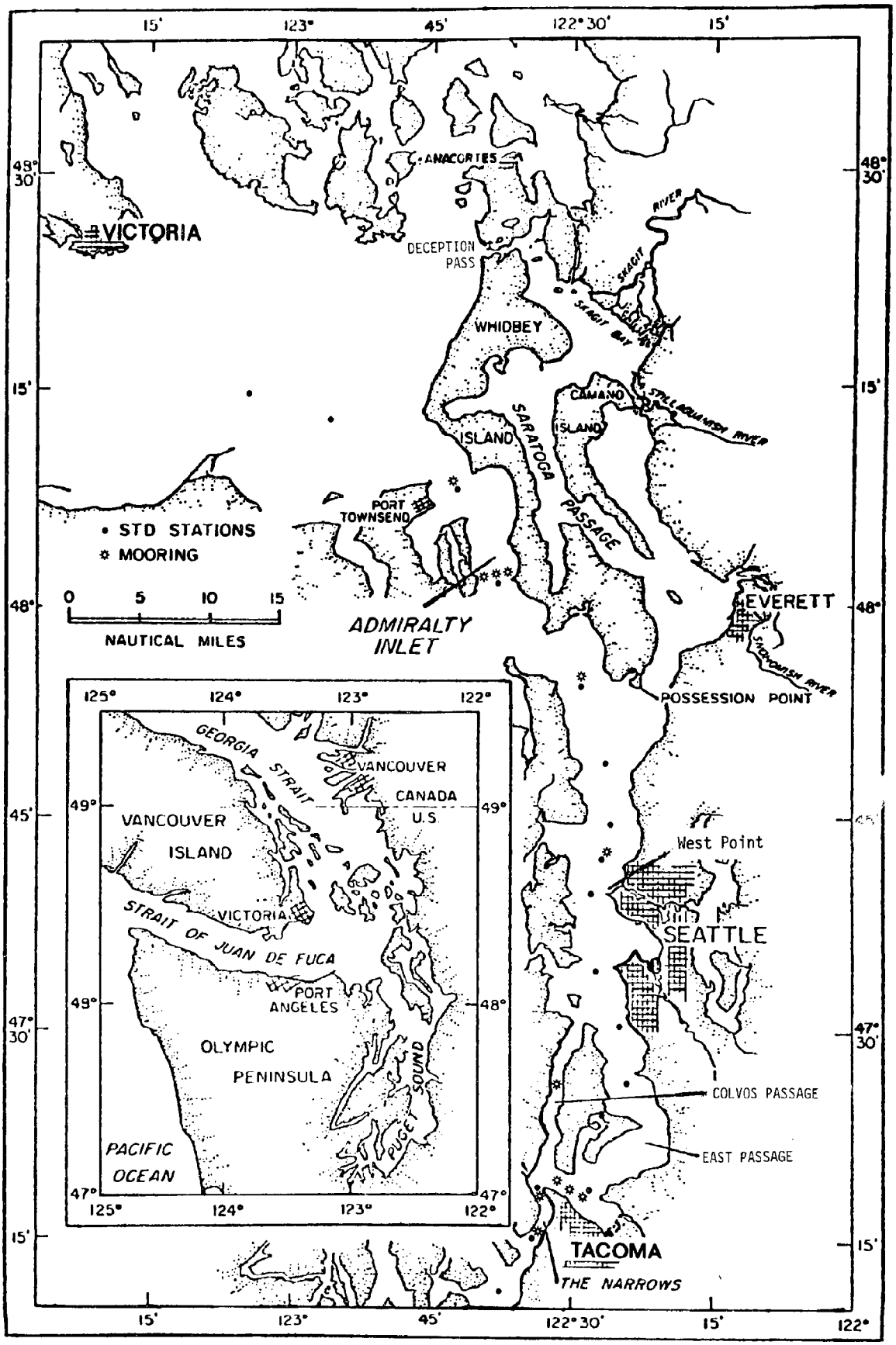
Research Components:

1. Determination of general circulation patterns within the central basin during periods of high and low runoff.
2. A separation of the dynamic components of the system driving forces, including winds, tides, and estuarine flow.
3. An estimate of the frequency of conditions favoring the surfacing of the effluent field at West Point.
4. An estimate of the flushing time for a soluble wastewater constituent.

Sampling Methods: Field work is being performed in conjunction with the National Ocean Survey of NOAA, which is conducting a tides and currents study in the same geographical area.

1. A single long-term (1 year) mooring off West Point.
2. Several series of short-term (1 month) current meter arrays at the Tacoma Narrows, Admiralty Inlet, and selected locations within Puget Sound.
3. Drogue tracking studies conducted off West Point
4. CTD surveys made during each of the deployments.
5. Long-term wind monitoring at West Point.
6. Synthesis of historical data collected during 1972-73.

Publication Schedule: The report of the first year's results is presently being processed for publication as a NOAA Technical Memorandum. It is available at the project office. The final report is scheduled for September 1978.


15'
123°
45'
122°30'
15'
48°30'
ANACORTES
VICTORIA
DECEPTION PASS
SKAGIT RIVER
SKAGIT BAY
WHIDBEY ISLAND
CAMANO ISLAND
STILLAGUAMISH RIVER
SARATOGA PASSAGE
PORT TOWNSEND
• STD STATIONS
* MOORING
0 5 10 15
NAUTICAL MILES
ADMIRALTY INLET
EVERETT
SNOHOMISH RIVER
POSSESSION POINT
125°
124°
123°
122°
GEORGIA STRAIT
VANCOUVER
CANADA
U.S
49°
VANCOUVER ISLAND
VICTORIA
STRAIT OF JUAN DE FUCA
PORT ANGELES
48°
47°30'
OLYMPIC PENINSULA
PUGET SOUND
PACIFIC OCEAN
47°
West Point
SEATTLE
COLVOS PASSAGE
EAST PASSAGE
TACOMA
THE NARROWS
122°

Title of Study: STRAIT OF JUAN DE FUCA AERIAL DROGUE STUDY

Principal Investigators: Curtiss C. Ebbesmeyer, J. M. Helseth
Evans-Hamilton, Inc.
Seattle, Washington

Project Office Contact: Ronald P. Kopenski

Start Date: July, 1977 End Date: October, 1977

Purpose: One primary purpose of the MESA Puget Sound Project is to develop a predictive capability for oil spilled into the waters of the Strait of Juan de Fuca and northern Puget Sound. This drogue study is intended to support the extensive oceanographic current meter deployments which form the main effort in this area. Specifically, the purpose of this study is to track surface drifters which simulate movement of oil slicks in a section of the Strait of Juan de Fuca.

Research Components:

1. Development of a series of drogue trajectories for comparison with and interpretation of current meter and CTD records which are being collected simultaneously by the MESA Project.

2. Color photographs which can be used to identify sediment plumes, eddies, and other visible evidence of circulation patterns.

Sampling Methods:

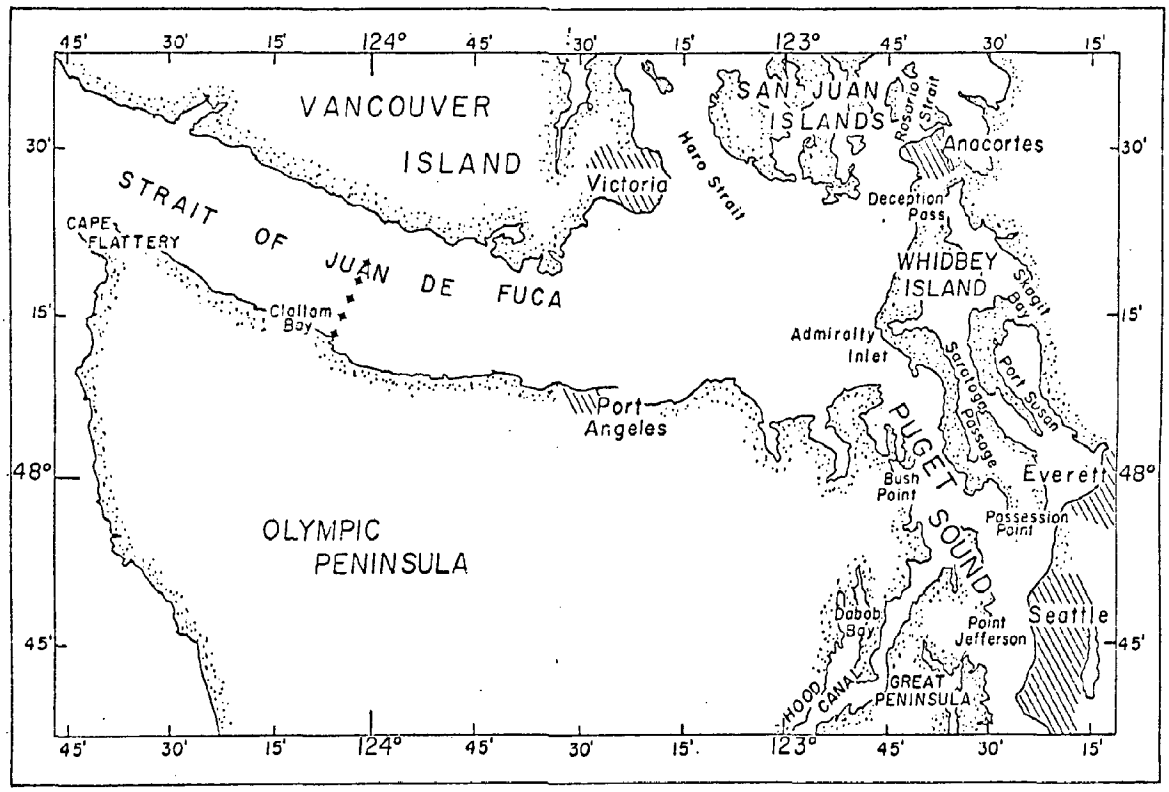
1. The drogues are launched for five consecutive mornings and tracked by air during daylight hours. (Drogues from the previous day's deployment are also tracked where possible.)

2. The drogues are deployed in a section across the Strait of Juan de Fuca at Pillar Point at half-mile intervals. This transect coincides with buoy deployment sites and CTD profile sites.

3. Tracking of the drogues is accomplished from a fixed-wing aircraft equipped with a Motorola Mini-Ranger Positioning System.

4. Thin foam pads (4' x 6') numbered on both sides serve as drogues.

Publication Schedule: The final report is available for use in the MESA Puget Sound Project office.



◆◆◆◆◆◆ Drogue Transect Line

MESA Puget Sound Project

Date: Aug 1977

Title of Study: BASELINE OF INTERTIDAL AND SHALLOW SUBTIDAL BENTHOS ALONG THE WEST COAST OF WHIDBEY ISLAND

Principal Investigator: Herbert H. Webber
Huxley College of Environmental Studies
Western Washington State College

Project Office Contact: Edward R. Long

Start Date: March 1977 End Date: May 1978

Purpose: To characterize the intertidal and shallow subtidal benthic communities of each major habitat type present along the west coast of Whidbey Island.

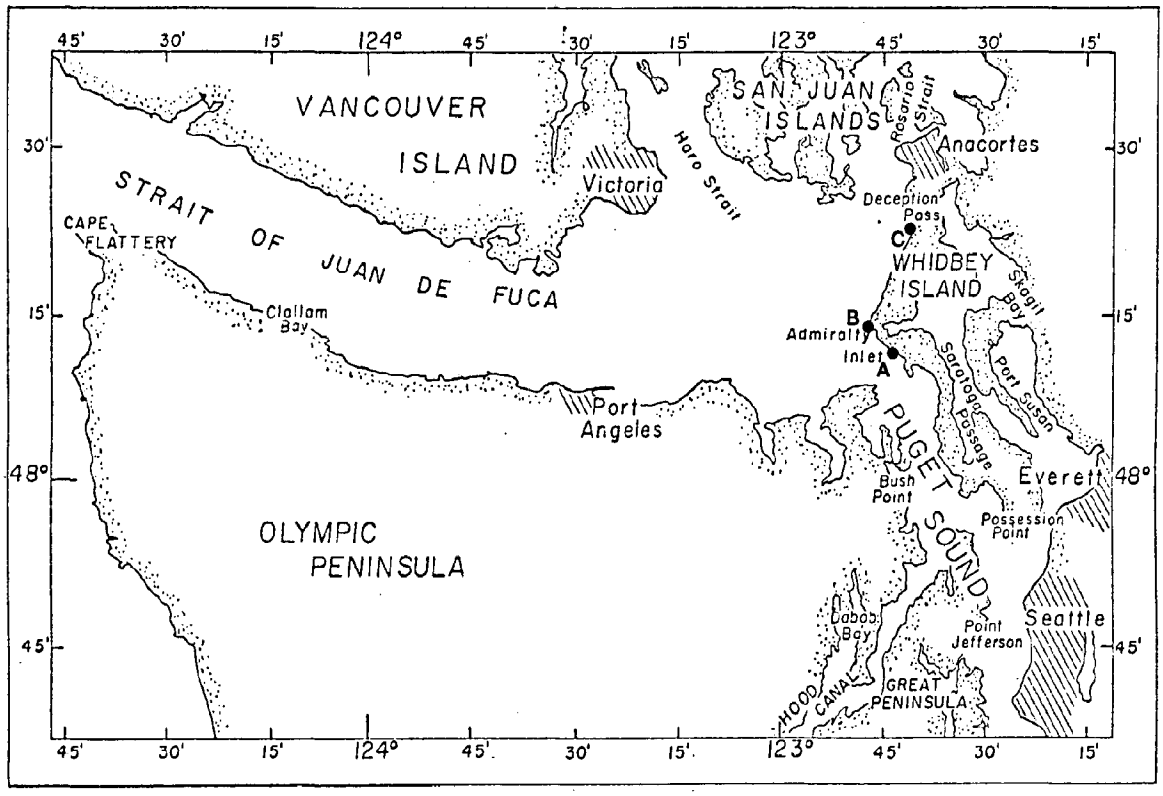
Research Components:

1. Definition of the habitats present between Deception Pass and Admiralty Head on Whidbey Island according to substrate type and exposure.
2. Selection of three study sites spread evenly over the area which are representative of the most common habitat types.
3. Quarterly determination of community composition, abundance, and biomass at each site.
4. Determination of vertical trends in distribution at each site.

Sampling Methods:

1. Quarterly stratified random sampling at +6', +3', and +0' in the intertidal and at -3m, -8m, and -15m in the subtidal.
2. Semi-annual stratified random sampling at +7', +5', +4', +2', and +1' in the intertidal.
3. Intertidal samples are collected by hand using a variety of quadrats and cores, dependent upon substrate type.
4. Subtidal samples are collected by divers aboard an underwater benthic sampling platform equipped with a suction device.
5. At each level, quadrat sites are randomly selected along horizontal transect lines.
6. Water temperature, salinity, and sediment size description data are collected at each site.

Publication Schedule: The report on the first year's results is scheduled for May, 1978.



STATION	HABITAT	INTERTIDAL			SUBTIDAL		
A. Ebey's Landing	sandy gravel	4	3	4	4	3	3
B. Point Partridge	cobble	4	3	4	4	3	3
C. West Beach	sandy gravel	4	3	4	4	3	3
gradient sampling at each of the three sites (intertidal)		2	5	4			
		samples per year	number of elevations	replicates per level	samples per year	number of elevations	replicates per level

MESA Puget Sound Project

Date: November 1977

Title of Study: MARINE MAMMAL INVESTIGATIONS IN NORTHERN PUGET SOUND AND THE STRAIT OF JUAN DE FUCA

Principal Investigators: Clifford Fiscus, Robert DeLong, and Robert Everitt
Marine Mammals Division
NWAFC/NMFS/NOAA

Project Office Contact: Edward R. Long

Start Date: November 1977 End Date: February 1979

Purpose: The overall objective of the study is to develop a better understanding of the current population status of all species of marine mammals. Specifically, the study is intended to characterize the marine mammal populations which are vulnerable to the increasing petroleum-related activities within the region. Particular emphasis is placed upon characterization of the harbor seal population (the most prominent pinniped in the region), and upon those coastlines most vulnerable to oil incursions (i.e., along tanker routes).

Research Components:

1. Aerial surveys will be flown monthly over the year to identify haul-out areas, migration routes (cetaceans), time of migrant arrivals and departures, and peak population periods.

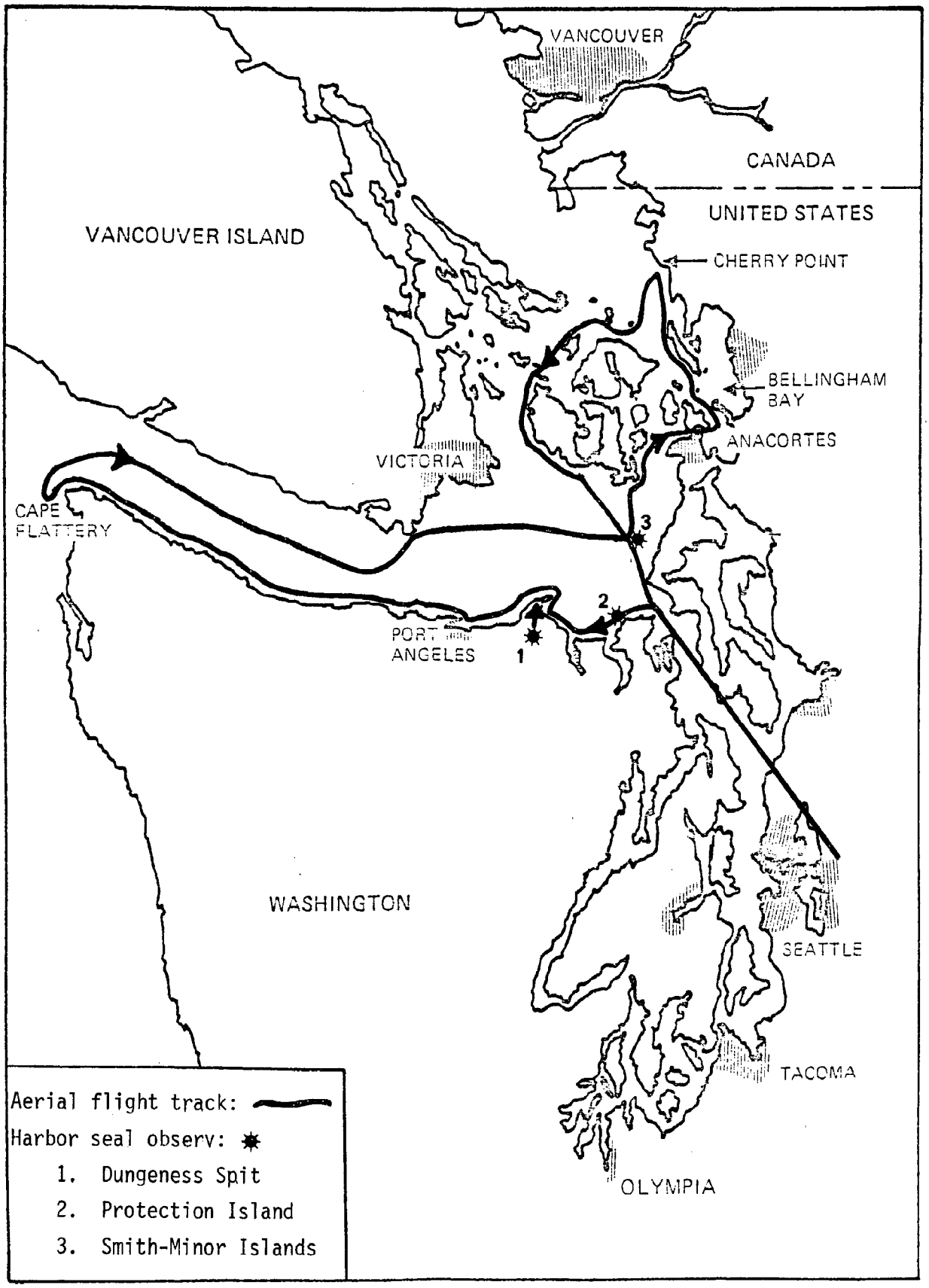
2. Coastline surveys of areas most vulnerable to oil will be made by small boat and by foot twice during the year. The sites include:
   - north Olympic Peninsula
   - Haro Strait (U.S. side only)
   - approaches to Anacortes
   - Bellingham Bay and Cherry Point

3. Monthly behavioral observations of harbor seals will be made at major hauling areas, including Protection Island, Smith-Minor Islands, and Dungeness Spit. Other areas may also be studied, if identified as important to the harbor seal population.

4. A comprehensive bibliography related to marine mammals in the study area will be compiled to provide historic data for comparison with the current situation, and to eliminate any duplication of effort.

5. The investigators will coordinate with scientists implementing killer whale and harbor seal research elsewhere in the Puget Sound region.

Publication Schedule: The final report is scheduled for February, 1979.


VANCOUVER
CANADA
UNITED STATES
VANCOUVER ISLAND
CHERRY POINT
BELLINGHAM BAY
ANACORTES
VICTORIA
CAPE FLATTERY
PORT ANGELES
1
2
3
WASHINGTON
SEATTLE
TACOMA
OLYMPIA
Aerial flight track:
Harbor seal observ:
1. Dungeness Spit
2. Protection Island
3. Smith-Minor Islands

Title of Study: MARINE BIRD INVESTIGATIONS IN THE STRAIT OF JUAN DE FUCA AND NORTHERN PUGET SOUND

Principal Investigators: David A. Manuwal
College of Forest Resources
University of Washington

Terrance R. Wahl
Wildlife Consultant

Project Office Contact: Edward R. Long

Start Date: December 1977 End Date: March 1979

Purpose: Marine birds constitute a major and highly visible component of the marine ecosystem of the Puget Sound region, a component which is highly vulnerable to the effects of spilled oil. Current information on marine birds consists of sightings recorded by hobbyists in readily accessible recreational areas and scientific surveys in selected parks and preserves. No region-wide systematic census has been conducted. The purpose of this study is to characterize the marine bird populations of the region via a variety of study methods and identify sub-regions and/or habitats of significance to these animals.

Research Components:

1. Determination of the distribution, abundance, and species composition of marine bird populations throughout the region at regular intervals for a period of one year.

2. Identification of spatial/seasonal trends in birds abundance and distribution.

3. Identification of geographic areas of major significance for the assemblage of marine birds.

4. An up-date of published distribution and abundance data for marine birds in this geographic region.

Sampling Methods:

1. Beach & estuary surveys. Transects will be made at selected sites to census marine bird populations along the shore and on nearshore water. Habitats selected according to importance to birds and exposure to potential oil spills.

2. Sea watches. Observers stationed on projecting jetties or points will census birds out to 500 meters, and will quantify migration along the shore.

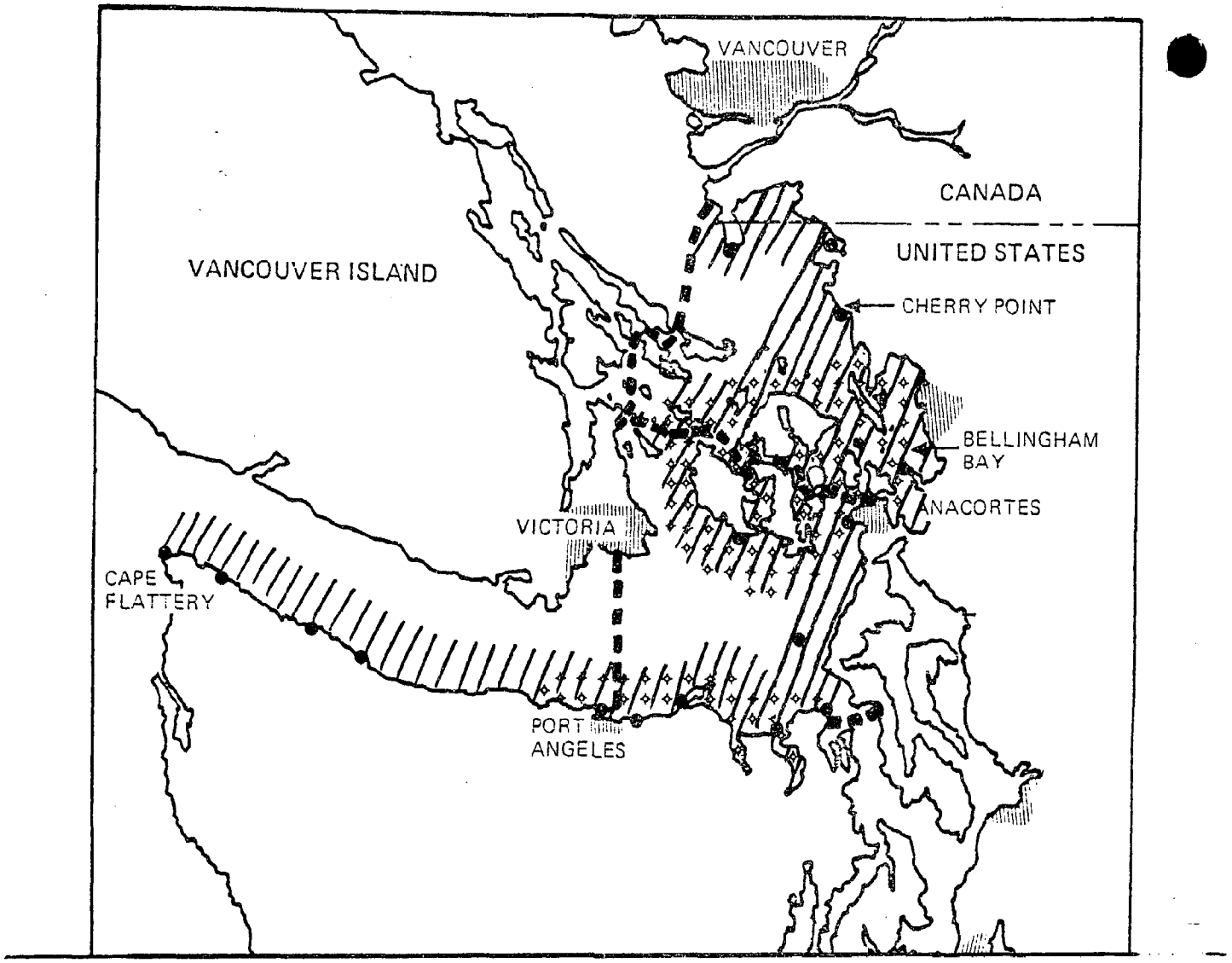
3. Ferry transects. Censuses will be made on commercial ferries transecting the eastern Strait of Juan de Fuca and northern Puget Sound.

4. Small boat transects. Censuses will be made by small boat along prescribed open water transects.

5. Aerial surveys. Regular overflights of the entire region will be conducted to locate seasonal concentrations of birds on a broad geographic scale.

6. Beached bird surveys. Mortality information on dead birds washed up on shore (and collected during other aspects of this study) will be tabulated as a tool for assessment of future oil-related mortality.

Publication Schedule: The final report is scheduled for March, 1979.



Ferry boat transects

Small boat transects

Aerial surveys

Various shoreline censuses

Aerial surveys will be conducted eight times during the study. All other census methods will be implemented approximately monthly during winter and summer, weekly or biweekly in spring and fall.

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