

**A PLAN FOR PROTECTING THE NATURAL RESOURCES OF
YAQUINA BAY, OREGON FROM OIL SPILLS**

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I. INTRODUCTION

Yaquina Bay lies in the mid-coast region of the Oregon coast, approximately 125 miles south of the Columbia River and about 216 miles north of the California border. It is the fourth largest estuary in the coastal zone, covering 3,910 acres at mean high tide. Wetlands encompass 1,353 acres of this area, including 534 acres of mud flats and 819 acres of tidal marshes. Because of the extensive amount of shallows, the bay is very important biologically, playing a vital role in primary production and providing nurseries, breeding grounds, critical habitats, and nesting areas for numerous organisms. It also has a substantial migratory salmon population and is an important stop over and resting area for numerous migratory waterfowl.

The natural amenities of the Yaquina Bay area have made it one of the major recreational centers of the Oregon coast. Activities such as sightseeing, shore and boat fishing, clamming, pleasure boating, camping, picnicking, nature viewing, and beachcombing are extremely popular. As a result, the developed state parks and extensive tourist facilities at Newport are all heavily used particularly in the summer months.

These same natural resources attracted early explorers and settlers to the area and eventually resulted in its development into an important commercial center. Today the city of Newport harbors a large commercial fishing fleet and several fish processing plants, whereas, Toledo, at the head of the bay, supports a large forest products industry. Yaquina Bay also sustains a commercial oyster industry and a salmon aquaculture industry.

In addition to Yaquina Bay's commercial and recreational usage, it is also the site of Oregon State University's Marine Science Center. This complex provides extensive coastal and oceanographic research facilities for federal, state, and university scientists and students.

Given this general background, it is not too difficult for us to imagine the disastrous consequences a large oil spill or similar pollution incident could have on the sensitive natural resources and resource related industries of Yaquina Bay. Names associated with oil spill disasters such as the AMOCO CADIZ and the ARGO MERCHANT bring to mind scenes of dead fish, devastated beaches, and oiled birds, all abhorrent to most Oregonians who take particular pride in their natural environment.

To date, a combination of good luck and limited oil tanker traffic have spared Oregon's environment for the most part. There have, of course, been many oil spills, but no major disasters. Of the documented incidents, the most extensive was the 26,000 gallon TOYOTA MARU oil spill which occurred on the Columbia River in 1978. Fortunately, the spill caused limited apparent damage. It did, however, focus the attention of the state of Oregon on the extreme vulnerability of our natural resources to such incidents. It was clear that if sensitive areas are to be protected in the future, plans must be formulated prior to the occurrence of a spill rather than during or after. As a consequence, the Oregon Department of

Environmental Quality sought and obtained federal funding to develop a resource protection plan for the Columbia River. The plan entitled, An Oil Spill Protection Plan for the Natural Resources of the Lower Columbia and Willamette Rivers, was completed in 1979. It identified sensitive natural resources and suggested suitable protection methods.

The success of that document, as judged by its favorable reception, led the State to seek further funding to do similar studies for the Oregon coast. Although the entire coast is highly vulnerable, Coos Bay and Yaquina Bay were singled out for protection plans because they are significant deep water ports and, therefore, more likely to have shipping related spills. Ultimately, it is hoped that protection plans will be developed for the entire coastal area.

The present study of Yaquina Bay is thus an extension of the earlier work done on the Columbia River system. As with the previous work, the major premise is that any oil discharged into the marine or fresh water environment would inevitably affect both natural and manmade resources. Consequently, the rapidity and effectiveness of the oil spill response is of prime importance in avoiding potentially serious damage. The key to a fast response is contingency planning which includes notification procedures, delegation of authority, personnel and equipment deployment, and prior identification of all potentially affected resources. As suggested earlier, the latter component is often left out of contingency plans and, therefore, the major thrust of this study is to:

1. Identify and rank by priority all vulnerable resources in the study area,
2. Designate specific areas for protection and determine how physical processes will effect their vulnerability,
3. Suggest suitable protective and cleanup response measures,
4. Map resource locations, boom sites, containment areas, and access points,
5. Suggest data needs and technical improvements, and
6. Supplement present oil spill contingency plans.

The following narrative details how to use the developed natural resource chart and protection chart, describes the reasons for this approach, outlines factors that will effect the resource protection effort, and relates how oil will affect the various natural and manmade components of Yaquina Bay.

II. NATURAL RESOURCE AND PROTECTION CHART USAGE

Extensive mapping of the natural resources of Yaquina Bay was completed during the development of the Yaquina Bay Natural Resource Inventory in 1977 by Wilsey and Ham. Reproductions of these maps are included in

Appendix C for reference to specific sites and organism relationships. A major difficulty associated with such mapping is the extreme complexity of the biological community, particularly in the tide flat areas. To represent such complexity accurately involves either highly detailed maps or a large number of maps, neither of which, for obvious reasons, is suited to an emergency response situation. As a result, a general resource map was developed for use by the spill response team. This chart is included in the pocket at the back of the report along with a Resource Protection Chart.

The Resource Map of Yaquina Bay shows three generalized sensitive areas as indicated by three different patterns. The first two categories, shellfish beds and fish spawning and nursery areas, are fairly self-explanatory. The third component, significant natural areas, is a catch-all for those locations which may contain a variety of vulnerable resources, including marshes, eel grass beds, shellfish beds, benthic organisms, juvenile fish nurseries, waterfowl resting and feeding areas, and a host of other biological entities. The three categories can and do overlap.

All the significant natural areas are identified by number so they can be referenced to the table at the top of the chart. Likewise, all manmade structures which could be affected by oil such as log booms, marinas, and water intakes are identified by letters. The table lists all the potentially sensitive resources of Yaquina Bay and their distribution by river mile, number, and letter. The importance of a particular resource, as judged by organism concentration and sensitivity, is indicated by the size of the dot. As can be seen, the lower bay contains the largest concentration of susceptible items.

There are two columns on the right hand side of the table. The first one indicates the seasonal sensitivity of a resource and its priority for protection. The second recommends strategy for protecting that particular organism or structure. Sections III and IV provide details as to how these criteria were determined.

On the Protection Map are indicated boom sites, possible diversion locations, boat launches, road access areas, and the location of tide gates. The numbers, letters, and symbols can be referenced to the key at the top of the chart which contains information about each point such as, length of boom needed, tidal currents, and the size of boat ramps. A detailed description of the protection measures is contained in Section IV.

The two charts are the heart of the protection plan. The on-scene coordinator (OSC) should be able to look at them and quickly obtain a general idea as to the type of measures he will need to employ. Numerous factors must be considered, comprising variables like: winds, tides, location of spill, type of oil, amount spilled, weather conditions, availability of protection and clean-up equipment and the list goes on. The rest of the report will attempt to deal with these problems so that appropriate decisions can be made as expediently as possible.

III. RESOURCE PRIORITIES

The methods employed to determine the importance and the protection priority of a resource were adopted from guidelines set forth by the U.S. Environmental Protection Agency publication, Handbook for Oil Spill Protection Clean-up Priorities and by the Oceanographic Institute of Washington's document entitled, An Evaluation of Oil Spill Clean-up Capabilities in the Columbia River Basin System.

The important potentially sensitive areas of Yaquina Bay can be divided into five general categories:

1. Natural ecosystems, which includes: critical habitats, endangered species, reproductive and rearing grounds, wildlife concentration areas, salt marshes, and mud flats.
2. Resource management areas, which includes: aquaculture sites, wildlife refuges, historical locations, and areas used for educational purposes.
3. Consumptive water usage which would include: industrial process and cooling water, fish rearing supplies, and aquarium usage.
4. Recreational areas, which include: parks, boat launches, beaches, diving areas, boating areas, and fishing and hunting sites.
5. Water dependent industrial and commercial sites such as: log storage, waste disposal, marinas, commercial fishing areas and beachfront properties.

The overall sensitivity of an area to oil contamination is based on four complex and interrelated factors: (1) environmental-ecological, (2) aesthetics, (3) economic, and (4) social.

An area which is important for all four reasons would obviously have a high priority. Generally speaking, ecologically or environmentally important areas need the highest protection priority because they have no ability to protect themselves, may be impacted for a long time period, and since cleanup is usually not feasible or desirable. Recreational facilities such as parks which could probably be cleaned up after a spill are given a lesser priority. Industrial or commercial facilities are usually given the lowest protection priority because they are not natural resources.

Using the above rationale, the following priority scheme is proposed:

- Priority 1 -- Critical habitats important for the preservation of a species.
Endangered species as identified by the Endangered Species Act.
Reproduction and rearing areas for all organisms.

- Priority 2 -- Wildlife concentration areas such as resting and feeding sites.
- Priority 3 -- Private/governmental aquaculture facilities such as fish hatcheries and research stations.
- Priority 4 -- Recreation facilities such as parks *and marinas*
~~Marinas.~~
- Priority 5 -- Water dependent industries such as log storage.

Certain factors could alter this scheme on either a collective or individual basis. For example, seasonality could effect resource priority. A fish concentration area could have a priority two rating during the fall and winter months because oil would not threaten the existence of the species. The same area, however, could have a first priority rating during the spawning season in spring. On the descriptive chart at the top of the resource chart, resources are prioritized on a seasonal basis.

There may also be overriding economic and safety factors which would alter the priority structure. An event which threatens human life would certainly override ecological factors. Similarly, a spill which might economically cripple an area could change the priorities. Decisions of this nature would have to be made on a case-by-case basis.

IV. PROTECTION MEASURES

The first line of defense against oil spills is prevention. Properly maintained equipment, adequate cleanup systems, rigorous inspection programs for ships, oil transport vehicles, oil handling facilities and industries, and thorough training programs for individuals who handle oil products all make essential contributions to the prevention of oil spills. In spite of the efforts to implement these measures, it has been estimated that 75 percent of all spills are directly or indirectly attributable to human error. Equipment failure or malfunction accounts for most of the other 25 percent. The obvious implication of this is that even if the technology was perfect, oil spills resulting from error or negligence could still threaten the environment. When we consider that, the movement of petroleum from the oil field to the consumer may require from 10 to 15 transfers and as many as 6 different transportation modes, it becomes readily apparent why spills occur so frequently.

Protection measures are thus an important second line of defense. Sensitive environments, particularly those which harbor rare or endangered organisms, must be protected from oil spills if at all possible. Although nature is remarkably flexible, a species may not recover if its numbers are greatly reduced.

The obvious and most desirable protection measure is containment of the oil at the spill site by isolating the area, eliminating the flow of oil, and/or placing barriers to prevent movement away from the site. The most

common containment device is the oil boom, but other methods include sorbent barriers, air and water hose spray, and air barriers. Quick response is required to contain a spill at the spill site. In most cases, some or most of the oil will escape into the dynamic estuarine system which makes protection of the environment the next response action. This is where a natural resource protection plan becomes particularly useful.

As mentioned above, three methods are commonly used to protect sensitive areas:

1. Physical devices such as a boom.
2. Sorbent barriers.
3. Dispersants.

Booms can be used to seal off a sensitive location by creating a barrier to surface oil movement. This assumes that the oil will be less harmful in some other area. The present day oil boom, however, is usually only effective in currents of less than one knot and waves less than two feet high. When these conditions are exceeded, the use of a diversionary boom or a series of booms may be the only alternative. The diversionary boom is usually deployed at some angle to the current in a diagonal, chevron or cascading pattern. This method may be used to divert oil away from a sensitive spot or to divert oil into a suitable containment spot where it can be picked up with sorbent materials or skimmers.

Dispersants which cause the surface area of an oil film to greatly increase may be used to protect shore lines, reefs or natural aquatic resources, such as fishing banks or oyster beds. This is accomplished by applying a dispersant on the slick sufficiently distant from the sensitive area to avoid an effect from either the dispersant or a dispersed emulsified oil. Although the technology of dispersants has greatly improved and they are no longer as toxic to aquatic life as they once were, they are still generally only useful in open ocean situations. A dispersant would rarely be recommended for use in a confined area such as a bay because it would drive the oil onto sensitive shoreline areas and concentrate the toxic components of the oil. Other materials which are sometimes used to protect areas from the effect of oil spills include: sinking agents, flocculents, burning agents, and absorbent materials. All of these have limited application. Sinking agents have been successfully used in deep water situations, but would rarely be useful in an estuary where sinking would blanket important benthic habitat. Burning agents are generally technologically and environmentally unacceptable. For small spills flocculents and absorbents may be very useful, but large volumes of such materials cause significant retrieval and disposal problems. The use of any of the above materials must be carefully considered on a case-by-case basis weighing the benefits against the possible harmful effects. Because of the confined nature of Yaquina Bay, it appears that oil booms and possibly absorbent materials are the only feasible protection devices.

With this in mind, the protection plan represented on the chart presents a practical approach to the protection of Yaquina Bay's natural resources. Considering the fact that it is impossible to predict all situations, the plan represents an ideal situation by indicating all places where booming and protection are desired. In all probability, it will not be possible to boom all the designated sites and decisions will have to be made according to actual spill conditions as to what priority areas should or need to be protected.

V. PHYSICAL FACTORS AFFECTING THE OIL SPILL RESPONSE

Oil movement and behavior in an estuary such as Yaquina Bay is controlled by a complex interaction of physical processes including: tidal activity, local winds, seasonal flows of the Yaquina River and air and water temperatures.

A. Tidal Action

Under most circumstances, the major processes to be concerned with are the tides which cause significant surface currents in many places in the estuary. The tides are of the mixed semi-diurnal type with paired highs and lows of unequal duration and amplitude. The mean tidal range at Newport is 6.0 feet, the diurnal is 7.9 feet, and the extreme is 11.5 feet. The tidal range increases upstream to Toledo where the mean range is 6.8 feet. The time difference between peak tides at Newport and Toledo is about 50 minutes. The head of tide is at Elk City at river mile 26 and it has about a two hour lag time from Newport.

Currents resulting from tidal action range from 4.0 feet per second at the entrance of the bay to about 0.5 feet per second at Toledo. Maximum ebb current velocities are slightly greater than flood current velocities due to the effects of river discharge. The maximum velocities occur in the navigation channel and in the entrances to the numerous sloughs such as Parker Slough, Johnson Slough, and McCaffrey's Slough. Table 1 details the available information on the tidal action at Yaquina Bay.

Table 1

High Slack to Low Slack: 6 hours plus or minus 40 minutes.

Tide Range: Mean 6.0 feet, diurnal 7.9 feet.

Time of Slack Water at Newport: 30 minutes plus or minus 10 minutes after the tide change.

Locational Time Differential: Plus 50 minutes at Toledo and plus 120 minutes at Elk City.

Location (Main Channel)	River Mile	Maximum Current Velocity in feet per second		Est. distance traveled by water parcel during 6 hour tide cycle
		ebb tide	flood tide	
Yaquina Bay Entrance ^(a)	0	3.9 est.	4.1 est.	10.4 miles
Highway #101 Bridge ^(a)	1.0	3.6 est.	3.2 est.	8.8 miles
Newport ^(d)	1.5		1.9	4.8 miles
Marine Science Center ^(c)	2.0	2.1		5.4 miles
Yaquina ^(a)	4.3	1.8 est.	1.7 est.	4.6 miles
Bouy 21 ^(b)	5.0	2.3	1.8	5.4 miles
River Bend ^(d)	5.4		1.4	3.6 miles
Poole's Slough ^(c)	6.5	1.7		4.4 miles
Bouy 29 ^(b)	7.6	1.4	1.0	3.2 miles
Nute's Slough ^(c)	9.8	1.3		3.4 miles
Bouy 45 ^(b)	11.0	1.1	0.8	2.6 miles
Toledo ^(d)	13.0		0.5	1.6 miles
Elk City ^(d)	26.0		0.8	2.2 miles

The above measurements which are obviously limited in number were also taken at different times and tide stages, thus considerable variation can be expected at any given time. The overall trend, however, shows decreasing current velocity as one proceeds upstream to Toledo.

(a) Tidal Current Tables 1981

(b) After Neal, 1966

(c) Unpublished Data, DEQ, 1981

(d) After Goodwin, 1970

The estimated distance a water parcel could move upstream or downstream during the time between slack waters, was calculated from the following formula:

$$\text{horizontal displacement} = \frac{2VT}{\pi}$$

where:

V = maximum tidal current in feet/second

T = time in hours from low slack to high slack tide

π = 3.14

Thus if the tidal velocity is 3.0 feet per second and it is 6 hours between slack waters, the calculation would be: horizontal displacement = 3.0 feet per second X 3600 seconds per hour X 6 hours X 2 divided by 3.1416 X 5280 feet per mile. There are obvious limitations to the use of this equation. First, since tidal current velocity decreases upstream, the computed travel distance upstream will be more than the actual movement. Likewise, the estimated downstream movement will be less than the actual movement. Second, wind is not considered and moderate to strong winds could have a very pronounced effect on oil movement. Third, the tidal currents will vary daily according to the tidal cycle. Nevertheless, the use of this equation will give the oil spill response coordinator a general idea of how far upstream or downstream oil may move between tide changes.

The change in current velocity over the six hour period between slack waters can be plotted on a graph (Figure 1) and this curve can then be used to estimate the tidal current velocity at a given point during the cycle. For example, at one hour before and after slack water, the current will be about 50 percent of the maximum. At two hours before and after slack water, the current will be about 90 percent of the maximum velocity.

On this same graph (Figure 1), one can also determine approximately how far a parcel of water will move during a six hour interval. Thus, with a maximum current velocity of 3.2 feet per second, one can calculate using the equation $HD = \frac{2VT}{\pi}$ that the horizontal displacement will be 8.2 miles. If the spill occurred two hours after slack water, the distance it moved (using the graph) would be 8.2 - 2.0 or 6.2 miles. Obviously, these values are very rough since wind and decreasing upstream current velocity are not considered.

The strength of the tidal currents for a given location will also vary according to the height of the tide, with spring tides causing much greater currents than neap tides. Figure 2 demonstrates the type of variations in velocities which can be expected. The difference between a 10 foot tide and a 4 foot tide can be more than 3.0 feet per second and could mean the difference between the success or failure of an oil boom.

Figure 1: Current velocities vs. travel distance for a parcel of water

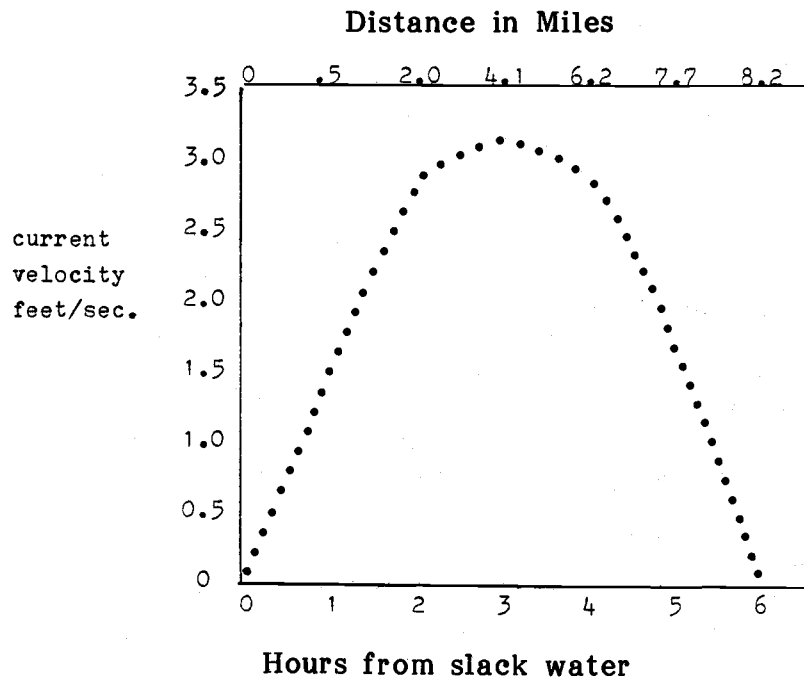
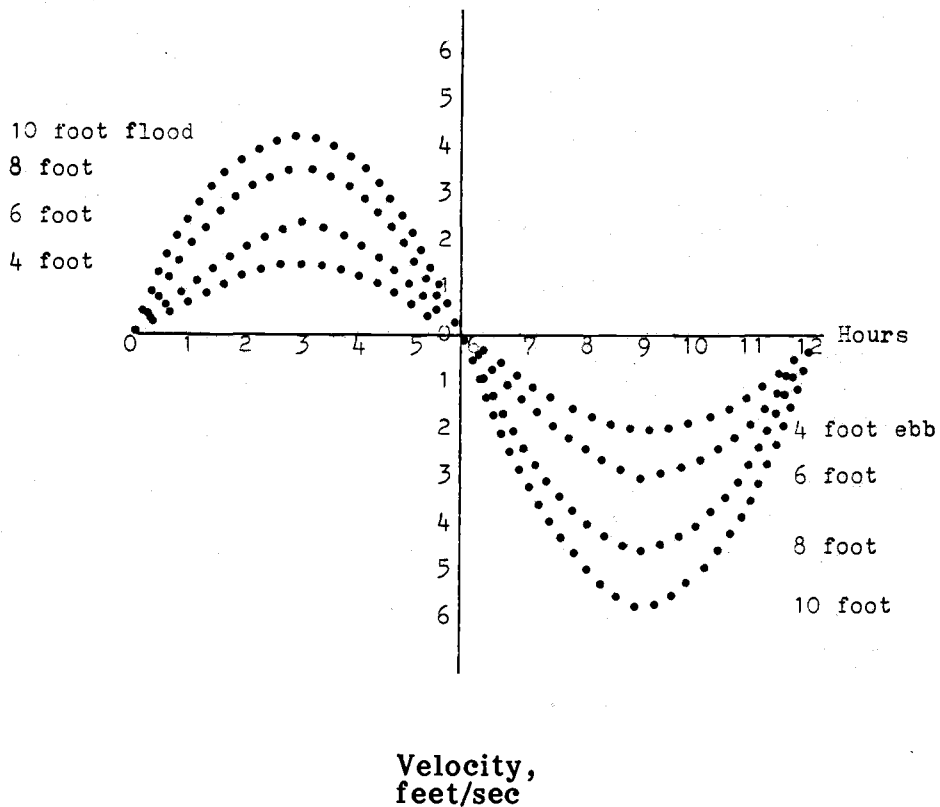


Figure 2: Variations of current velocity relative to selected tidal ranges at Hwy. 101 Bridge.



Adapted from: Tidal Current Tables, 1981.

Using the chart, the equation, and the graphs, a fair prediction can be made of how tides will effect oil movements in Yaquina Bay. The response team should also be able to use this information plus the current measurements at the various boom sites to determine how effective oil boom will be and during what times it will be most efficient. Considering that the strongest boom will lose its effectiveness at currents of over 1.5 feet per second, it is apparent from the first graph that when currents are strong, the period of effective usage will only be about two hours around each tide change. In an area with strong currents, the response team will have to consider diversionary booming or some other form of response.

The tidal currents of Yaquina Bay will cause significant oil spill response problems which will have to be evaluated very carefully by the on-scene coordinator on a case-by-case basis. In some instances, the value of placing an oil boom may be negated by the amount of time it will be effective and by the fact that the boom will have to be moved every six hours. Difficult decisions will have to be made. The information provided here is meant to help facilitate those decisions, but not make them.

B. River Flows

If tidal and basin characteristics are ignored or considered constant, river discharge would then be the principal factor affecting the hydrographic system of Yaquina Bay. During the summer and early fall, the volume of the salt water intrusion (tidal prism) substantially exceeds the volume of fresh water discharged into the estuary from the river. Under this condition, tidal action forces mixing of the fresh and salt water to the extent that on a given cross section through the estuary, the salinity is essentially constant from top to bottom. With this flow regime, there is a general slow net drift of water outward at all depths measured at about one-tenth of a knot. The back and forth tidal motion is superimposed on this slow, outward drift.

During the winter when river discharge is high, fresh water flowing downstream partially overrides the more dense saline water forced inland by the tides. Although salinity is least at the surface due to the dilution from fresh water and is greatest near the bottom, salinity changes in the vertical direction are usually gradual. With this regime, there is upstream movement of saline water at the bottom with a superimposed back and forth tidal movement and a downstream movement at the surface.

The flow of the Yaquina River is going to influence oil movement to some extent. An equation has been developed by Calloway (EPA) to predict the extent of salt water intrusion as a function of river discharge. This equation reads:

$$LS = 32.2 - 2.9 \log_e Q$$

where:

LS = the salinity intrusion in miles

Q = river flow in cubic meters per second

The river flow ranges from 1.3 cubic meters per second in late summer to 87 cubic meters per second in winter. The tidal prism will thus range from 27 miles upstream during low flows to 20 miles upstream during high flows. It is apparent that river flows will not effect oil movement greatly, but during high winter runoff there will be fresh water overriding the dense salt water and this will increase downstream oil movement in the Yaquina River.

C. Wind Patterns

The generally sheltered nature of Yaquina Bay will be advantageous for dealing with oil spill response mechanisms. In the narrow upper bay particularly, winds will be a minor factor. On the broad expanse of the lower bay, winds blowing either up or down the bay could cause problems with boom deployment and significantly affect oil movement. In general, it can be anticipated that winds in excess of 20 miles per hour will generate waves high enough to negate the value of oil booms.

Winds of a lesser velocity may also significantly alter oil movement. Weather records indicate that winter winds are predominantly from the east, 38 percent and southeast, 17 percent. Easterly winds will push oil towards the mouth of the bay and against northern shorelines. In the summer, the winds are predominantly from the north, 27 percent and from the northwest, 25 percent which move oil to the southern side of the bay.

At the mouth of the bay, prevailing winds and currents will cause oil to drift north in the winter and south in the summer and impact beaches in these respective directions (see Appendix B for weather data).

D. Air and Water Temperatures

Both air and water temperatures can play a part in the behavior of spilled oil. High air temperatures will increase the evaporation rate of the volatile components of an oil and decrease its total volume. Since the lighter, more volatile parts are more toxic to aquatic life, the toxicity of the oil will be significantly decreased. The heavier oil which remains will sink faster and this may hinder recovery and impact benthic fauna.

Cold air and water temperatures may slow oil movement and help protection efforts but prolong the oil's toxic effects. Extreme cold temperatures which result in ice formation, however, will physically hinder the response and cleanup efforts.

The climate of the Newport area is marked by rather mild and fairly uniform air temperatures. The average temperature in January is 43.5° F while in August it is 58° F (see Appendix B). As a consequence, air temperatures will probably not be a major factor under most circumstances, but will usually result in some evaporation. Likewise, water temperatures are fairly constant, normally in the low 50's except in the upper bay in late summer and should have little impact on oil behavior.

E. Properties of Oil

The properties of an oil will effect both its movement in the estuary and its impact on the resources of the estuary. The light distillates, such as gasoline and kerosene tend to be very toxic but evaporate quickly, so they will have significant short term effects but few long term effects. Diesel fuel and the heavy fuels will not evaporate rapidly and will persist in the environment causing long-term problems. The heavier fuels may sink causing coating of the benthic organisms and substrate. The following table provides information about the various kinds of oil and their impacts.

Table 2. Properties of Oil

<u>Type</u>	<u>General Classification</u>	<u>Specific Gravity</u>	<u>API Gravity</u>	<u>Viscosity</u>	<u>Flash Point °C</u>	<u>Substrate Penetration</u>	<u>Toxicity</u>
Gasoline	Light Distillates	0.65-0.75	60	4-10	-40	very high degree	very high direct and indirect toxicity
Jet Fuel		0.8	48	1.5	55		
Kerosene		0.8	50	1.5	55		
Diesel No. 2	Heavy Distillates	0.85	30	15	55	very low degree	little chemical effect, serious physical interference
No. 4		0.85	30	15	55		
No. 6		0.9	25	50	60		
Bunker		0.98	10	300-3000	80		
Crude	Crude Oil	0.8-0.95	5-40	20-1000	variable	highly variable	highly variable

from: Fingus et al. 1979

VI. RECOVERY

Once an oil spill has been contained and sensitive areas are protected, the contained oil must be recovered before it has an opportunity to escape into the environment again. Usually this involves a combination of various physical methods depending on the situation. These include:

1. Skimmers which, as the name implies, are used to skim oil off the surface of the water. They come in a large variety of shapes and sizes varying from small unmanned machines to large self-propelled manned apparatus.
2. Sorbents which act through the process of absorption and adsorption to selectively remove oil from water. These can be natural or synthetic but are usually only practical in small areas because of the expense of recovery and disposal problems.
3. Manual removal using buckets, shovels, rakes, etc. can be resorted to for viscous or semi-solid oil provided there is adequate labor available and the quantities of oil are not too large.

Any methods used must be environmentally acceptable. As will be discussed in the next section, there are instances where cleanup and removal will cause more harm than leaving the oil to degrade by natural processes.

VII. CLEANUP AND REMOVAL

It is rare when oil spilled on water can be completely contained and recovered before some of it reaches the shoreline. Cleanup of the shoreline areas is considerably more difficult and time consuming than containment and recovery operations on water. It should be emphasized that the physical removal of oil from some types of shoreline may result in ecological and/or physical damage far in excess of that which would occur if oil removal were left to natural processes. The decision to initiate cleanup and restoration activities on oil contaminated shore areas should be based on careful evaluation of social, economic, aesthetic, and ecological factors.

When oil has polluted beaches in a populated area or areas of high recreational use, priorities and pressures for cleanup may differ from the priorities associated with remote or uninhabited coastline areas. If a shoreline area is heavily used by the public, then the length of time necessary for the removal of oil by natural process may be unacceptable and cleanup action will be required despite its possible ecological implications. Under most circumstances, however, biologically sensitive shoreline types should be given the highest priority for protection and cleanup measures. Detailed accounts of Yaquina Bay's habitat types and appropriate cleanup measures are given in Section VIII B.

VIII. THE IMPACTS OF OIL ON THE YAQUINA BAY ESTUARY

A. The Impacts on Living Organisms

Oil and its various components impact living organisms in a wide variety of ways. Possible direct effects include:

1. General Effects

- a. Death by coating and asphyxiation,
- b. Death by contact poisoning,
- c. Death by exposure to water soluble compounds,
- d. Death by exposure or hypothermia.

Possible indirect effects include:

- a. Food and feeding effort reduction,
- b. Contamination,
- c. Habitat displacement, thereby causing crowding and increased vulnerability to predation,
- d. Reproductive failures,
- e. Physical, chemical and behavioral changes, and
- f. Incorporation of sublethal amounts of oil into tissues resulting in reduced resistance of the organism to infection or stress.

The complex biological structure of Yaquina Bay is such that one or all of the above factors could affect a wide variety of organisms - perhaps destroying entire food webs. Such reactions would be impossible to accurately predict, but it is not difficult to project how the destruction of plankton populations by oil, for example, would affect the larval fish and shellfish which feed on the plankton, the adult fish which feed on the larvae, and waterfowl and marine mammals which feed on the fish. Fortunately, biological systems are remarkably flexible and may ultimately overcome disasters such as this and regenerate. Recovery will be slow, however, and for those species or habitats which are few in number regeneration may be impossible. It is therefore essential that these resources be given all possible protection.

2. Effects on Specific Populations

a. Endangered Species

In the Yaquina Bay area, there are no known rare or endangered fish or shellfish species. There are also no rare, endangered plant species. There is one mammal, the White-footed Vole, which inhabits stream banks and is considered rare, but it would not likely be affected by oil. In addition, there are a number of birds which are either part or full time residents of the area and are considered rare. These include the following:

- (1) Bald Eagles - a pair is known to feed in the upper bay. Their nest site is unknown.
- (2) Osprey - considered rare, can be found from April to October.
- (3) Snowy Plover - considered rare, but not endangered. Six percent of the known Oregon nesting population, (about 100 nests) are located in the sand dunes near the mouth of the Bay.
- (4) Caspian Tern - considered rare, occur in May, September, and October.

Other birds of peripheral or unknown status include the Horned Grebe, the Brown Pelican, the Common Egret, the Rhinoceros Auklet, and the Purple Martin.

b. Waterfowl and Water Dependent Birds

In the Yaquina Bay area there are 117 water associated bird species. On a given day, it is estimated that as many as 30,000 birds may use the estuary for resting and feeding purposes. Particularly during the late fall and winter months, bird populations are quite high due to large influxes of migratory waterfowl such as Canadian Geese and Black Brant. The protected shallows of Sally's Bend, Idaho Flats, and King's Slough provide excellent stopover areas and thus frequently have concentrated numbers of waterfowl.

Aquatic birds which spend most of their lives on or near the water surface are particularly susceptible to spilled oil and are often the most visibly affected organisms. Oil on their feathers results in the loss of natural weather proofing and bouyancy followed by death by pneumonia or drowning. Indirect effects include interference with the reproductive cycle resulting in high egg loss and low survival of the young.

c. Fish

Yaquina Bay contains 35 harvestable species of fish and numerous non-utilized species. The susceptibility of the various types of fish depends primarily on their spawning and feeding habits. Those pelagic fish which feed near the surface such as herring and anchovies are particularly likely to ingest floating oil and be adversely affected. Other fish which remain at depth are much less likely to be harmed by oil except during their juvenile stages when their larval forms are part of the planktonic population. Most larval fish occur during the spring making it the most sensitive time for the fish of Yaquina Bay. Effects of oil on fish include changing metabolic rates, coating of the gills and subsequent suffocation, poisoning, loss of food and habitat alteration.

d. Shellfish

Yaquina Bay contains commercially important populations of crab, shrimp, clams, and oysters and numerous other non-utilized shellfish which are very important to the estuarine food chain. During their larval stages, all shellfish are highly susceptible to the effects of oil and serious damage could be done to the population should a spill occur during the spring or early summer. The adult stages of crab and free swimming shrimp are not as likely to be affected but clams, oysters, and burrowing shrimp are highly vulnerable due to their filter-feeding habits. High concentrations of oil will cause death and lower concentrations will cause behavior and reproductive disorders and taint the flesh so it is unusable. Cage and rack culture of oysters could be seriously damaged.

e. Marine Mammals

California and Stellar's Sea Lions and Harbor Seals occur in Yaquina Bay. Harbor Seals are year around residents while the sea lions are most common during October through May. Although mortalities in these species from the effects of oil are rare, it can affect their ability to forage and may cause other chronic problems.

f. Benthic Organisms

Aside from clams, oysters and bottom dwelling shrimp, Yaquina Bay also supports a wide variety of other bottom dwelling organisms. Although they have no commercial importance, animals such as worms, amphipods and isopods are very important in the overall food chain and thus quite significant. Those species which inhabit intertidal areas are especially vulnerable to oil and could be affected for as long as the oil remains in the area.

g. Planktonic Organisms

The planktonic population includes zooplankton, phytoplankton, and the larval stages of many fish and shellfish. Because this group lives at the surface, it is highly susceptible to floating oil and mortalities can be expected to be quite high. Alterations in the planktonic population would have a very profound impact on the rest of the organisms in the Bay which depend directly or indirectly on this group for food.

B. Significance of Various Habitats, The Effects of Oil upon Them and Possible Cleanup Measures

The various shoreline types and their associated habitat will be described in descending order of sensitivity (see Table 3 for relative values).

Table 3. Relative Values of Habitat Types in Oregon's Estuaries

	<u>Submerged Lands</u>	<u>Coastal Tide Lands</u>	<u>Eel Grass</u>	<u>Coastal Salt Marsh</u>
Relative Area	very small	very small	very small	very small
Renewable or Nonrenewable	non	non	renewable	non
Vulnerability	very high	very high	very high	very high
Resiliency	fair	poor	good	poor
Diversity	very high	high	high	moderate
Social Importance:				
1) Commercial	moderate	moderate	low	low
2) Recreational	very high	very high	high	low
Vulnerability of Animals	variable	very high	high	very high
Diversity of Species	very high	very high	very high	high

from Wilsey and Ham, 1974

1. Tidal Marshes

a. Description

The tidal marsh vegetation type is composed of those communities of vascular, aquatic and semi-aquatic vegetation rooted in poorly drained, poorly aerated soil, which may contain varying concentrations of salt and which occur from low or high water inland to the line of nonaquatic vegetation.

In Yaquina Bay the major marsh areas are found in the middle and upper estuary and include Poole's and McCaffery's Sloughs and an area 1.9 miles downstream from Toledo on the south shore. Minor marshes are found at Fisher and Johnson Sloughs and major diked marshes are found along Nute's and Boone's Sloughs. These are located on the vegetative maps in Appendix C.

b. Importance

Tidal marshes are usually the most productive area in the estuary. The extensive plant production supplies food material to much of the bay and supports a wide range of organisms such as clams, crabs and polychaetes which in turn are food for fish, birds and mammals who also use the same areas for nurseries, feeding, protection, and nesting.

c. Effects of Oil

Oil can cause severe problems in marshes by adhering directly to the plants and also by contaminating the sediments. Because there is little or no flushing in these areas, oil may remain for years effectively destroying the most important primary production areas of the bay and impacting all the terrestrial and aquatic organisms which use the marsh.

d. Cleanup

The marshes of Yaquina Bay have poor water accessibility which will make cleanup very difficult. If cleaning is necessary, the best method is low pressure water flushing conducted from boats during high tide. Under certain circumstances, hand cutting of oiled vegetation may be possible but it is usually not recommended because of the severe disturbance caused by trampling.

If there are large accumulations of oil, trenching may be necessary to drain the oil back out to the recovery area. If accumulations are small, the "do nothing alternative" is probably the least damaging to the system. A trained biologist should always be consulted before any action is taken.

2. Tidal Flats (sheltered)

a. Description

Tidal flats include that area of land covered and uncovered by the daily tidal cycle. Tide flats consist of sediments, primarily gravel, sand, silt, and clay, washed into the estuary by the coastal rivers and the sea. In Yaquina Bay, extensive flats occur in the Sally's Bend area, and the area between the Marine Science Center and Hinton Point, and King's Slough. Minor flats occur along the bay and many other places. The most important part of these flats are the extensive eelgrass beds of Sally's Bend and those adjacent to the Marine Science Center.

b. Importance

The tide flats of Yaquina Bay support significant algal populations responsible for primary production, and as mentioned above, extensive eelgrass beds in some locations. There are large numbers of benthic invertebrates such as clams, worms, and shrimp in the tide flat areas. The variety of organisms increases in eelgrass areas because of the greater stability and protection. Invertebrate populations support grazing of both birds and fish and are seasonally very important for migratory waterfowl and juvenile fish. The flats are also important as haul out areas for seals.

c. Oil Impacts

Oil can have long term persistence on tide flats due to the lack of waves and currents. It can also become incorporated into the sediments and have long term deleterious effects on the burrowing invertebrates and the many organisms that directly or indirectly depend on them for food. In Yaquina Bay the biological diversity and exposure of the flats will make these areas susceptible to any kind of oil intrusion.

d. Cleanup

The tide flats of Yaquina Bay will be particularly hard to protect and clean up due to their exposure to wind, waves and currents. In some cases, tidal currents may be sufficient to carry oil back off the flats where it can be collected. If cleanup is needed, heavy equipment and large crews should be avoided because of the damage such activities can inflict to the fragile ecology. Instead, low pressure water flushing with small crews would be most desirable.

Once again the do nothing approach may be the best alternative and consultation with a trained biologist is mandatory before any action is taken.

3. Sheltered Rocky Shores

a. Description

Sheltered rocky shores are inter-tidal areas of rocky substrate paralleling the edge of the bay. In Yaquina Bay, most of the open shore line on both sides excluding the sloughs is composed of riprap or naturally occurring rock.

b. Importance

Because of the protection afforded by the cracks in the rocks, these can be very rich ecologically, providing a good habitat for many macroinvertebrates plus substrate for algae and attachment sites for barnacles and mussels. The rocky shores in the lower bay are particularly important for this reason.

c. Oil Effects

Oil in this habitat can physically smother the numerous attached plants and animals and result in the removal of natural habitat for new colonizers. Without wave action, the oil can persist for long periods.

d. Cleanup

Although it is possible to sand blast or steam clean rocks, these methods should be avoided unless absolutely necessary because of the great damage to any surviving organisms. If cleanup does seem necessary, low pressure water flushing is the recommended method.

4. Silt and Sand Beaches

a. Description

These consist of beach areas occasionally inundated by tides. They are rare in Yaquina Bay, but, of course, common on the ocean side of the bay entrance.

b. Importance

Beaches are usually not highly productive since species diversity and density are quite low. The major value is for public usage. However, there are some important clam beds as noted on the Resource Chart. Likewise, the beaches near Yaquina Bay entrance are used by the Snowy Plover, a rare shorebird species in Oregon.

c. Impacts

Usually minimal to aquatic life, but can cause significant problems to those species present and impact important recreational areas.

d. Cleanup

It is probably best not to cleanup here unless the public demands it. Large tar balls can be removed by hand, and small accumulations can be raked. Earth movers and bulldozers should be avoided unless absolutely necessary.

5. Open Waters

a. Description

Open waters consist of those parts of the estuary continuously covered by water and include those parts of the sloughs not exposed during low tide.

b. Importance

In Yaquina Bay, the open waters support populations of phytoplankton, zooplankton, fish, marine mammals, feeding waterfowl, and are an important migratory route for several kinds of anadromous fish.

c. Impacts

On open water, the oil could cause significant damage to planktonic organisms and this in turn would affect many fish species. Waterfowl, such as raptors which feed on the fish could also be impacted as could other waterfowl which depend on the estuary for resting and feeding.

d. Cleanup

Cleaning methods are limited but corralling oil and picking it up with skimmers may be the most useful. The best technique is to protect those bays which can be boomed and assume the tidal and river currents will carry the remaining oil to a place where it can be collected or where it will naturally disperse.

C. Other Resources Impacted by Oil

1. Natural Areas

Several significant natural areas have been identified by the Nature Conservancy. These have been located on the Resource Inventory maps in Appendix C.

The sloughs indicated on this map; Winant, McCaffery's, Poole's, Boone, and Nute's would be particularly sensitive to the effects of oil, because oil could be trapped here for extended periods, resulting in long-term damage to the tidal marshes within. For this reason, all sloughs with significant wetlands are identified for first priority protection. All eelgrass beds are identified as extremely limited ecotypes on the maps, and, therefore, are also candidates for first priority protection. In reality, however, protecting eelgrass beds will be very difficult because of their exposed character. Seal haulout (basking) sites as well as band-tailed pigeon areas are also considered unique and targeted for first priority protection if possible.

2. Archeological Sites

Fifty-six Yaquina indian villages are believed to have existed on Yaquina Bay, largely concentrated downstream of Elk City. At present there are two recorded sites in the area, one at the Marine Science Center and one near the south Highway #101 bridge approach. No detailed surveys have been done and no other sites are known, although they surely exist. It appears that oil spills would not pose significant direct threats to these sites because they are upland of the high tide line. Efforts to reach contaminated areas could cause trampling and possible erosion of important sites, however, and it would be valuable to have more accurate information regarding their locations.

3. Oregon State University Marine Science Center

This unique facility and the natural preserve adjacent to it are highly important to the state of Oregon and to the city of Newport. There is a definite advantage to having a facility such as this near a spill site, since highly trained scientists would be available to do spill related studies. On the other hand, a spill could also cause tremendous disruption to the center by contaminating its supply of bay water thereby threatening the existence of the marine aquaria and perhaps ruining various laboratory projects. Experiments being conducted in the bay could also be threatened. The loss of money and time associated with a spill disaster could be very substantial.

4. Marinas

A number of boat marinas exist along Yaquina Bay ranging from the extensive complex along the bayfront to several small boat basins. There is no question but that oil in these basins would affect many boats and would require extensive cleanup. In the case of South Shore Marina and Newport Harbor Marina, booming the entrances as recommended might protect the boats within. With the other marinas, it appears that little could be done to protect their facilities and customers.

5. Water Intakes

There are a limited number of industrial and commercial ventures which use bay water for various purposes. The Marine Science Center uses bay water for the aquarium and for the maintenance of various experimental projects. The water is drawn off the bottom and filtered through the sand to some extent. Spills of light oil would cause no problems for this system, however, a heavy sinking oil could create some problems. The Center has the ability to store about 48 to 72 hours worth of water. Longer shutdowns would cause serious problems.

Oregon Aqua Foods, a commercial salmon rearing venture, draws water off the bottom of the bay for its rearing facilities adjacent to the Marine Science Center. As with the MSC, light oils would not be a problem, but heavy sinking oils could enter the system with severe consequences. At present, they would get by for no more than a few hours without fresh bay water.

The Undersea Gardens, a commercial aquarium venture, is in a similar situation. Their intake is located on the bottom, but could be impacted by heavy oils. They could get by for no more than 6 hours without obtaining fresh bay water.

Georgia Pacific at Toledo also has a water intake, however, it is fresh water, dammed so that bay water cannot intrude. It is assumed, therefore, that oil spills on the bay would cause no problems here.

There are currently three commercial oyster growers on the bay. As with the above enterprises, sinking oil would probably ruin the oyster beds and it appears that little could be done except to divert oil from the area of the beds. The generally exposed sites would make diversion difficult, but all efforts should be made to accomplish this, particularly in the case where floating rafts are utilized.

6. Recreation

Recreational activities such as fishing, clamming, boating, and beach usage could be severely impacted by a major spill on the bay. The economic consequences to the area with respect to tourist trade could be disastrous and long term if resources remain unusable or unsightly. Some businesses would very likely be forced to close. Unfortunately, little could be done except to ensure that protection and cleanup activities proceed as efficiently as possible.

There are two state parks at the entrance to the bay, Yaquina Bay State Park on the north side and South Beach State Park on the south side. A large spill on the ocean at the bay entrance or on the bay itself could severely impact those parks by making the beaches unusable which would further impact the tourist industry.

7. Log Storage

From about river mile 11.3 to about river mile 15, there are extensive rafts of stored logs (see Resource Chart in pocket). Oil could coat these logs and would have to be cleaned off before they could be used, thus incurring considerable expense. Little could be done to protect them, but the log booms themselves could be used as protective oil booms and thus protect other areas such as Depot Creek and Ollala Creek.

IX. POTENTIAL FOR SPILLS

A. Road Spills

Roads parallel much of the bay and the possibility for transportation accidents is always present. Such spills could severely impact local areas such as the marshes adjacent to the roads. Cleanup and protection measures could be employed on a more local basis using the resource and protection charts presented here.

The possibility of a road spill occurring in the Yaquina River and then washing into the bay also exists, and in fact has happened in the past. In most cases, the lower river is slow moving and presents good oil booming prospects. If the response is fast enough, significant problems might be avoided by containing the oil before it reaches the more sensitive resources of the bay itself.

B. Shipping Spills

In the last 4 to 5 years, little shipping activity has occurred in Yaquina Bay. Aside from 2 or 3 large lumber ships and some lumber barge movement, most activity has centered around the extensive commercial fishing boat traffic. There have been no commercial oil shipments for several years meaning that the size of an oil spill in Yaquina Bay is limited by the fuel capacities of the various ships which utilize the area. The largest fishing boats and tugboats have fuel capacities that range up to 10,000 gallons and the lumber ships have capacities of up to 50,000 gallons. The majority of the boats, however, carry less than 500 gallons. During the last 20 years, there have been no major spills but minor spills usually associated with refueling have been fairly frequent occurrences. Environmental damages resulting from these spills are not documented.

A significant change in this pattern of activity is anticipated by the Port of Newport. In June, 1982, the first of what is planned to be semimonthly log shipments left Newport harbor. These ships are about 550 feet in length and have fuel loads that may exceed 50,000 gallons. Should this become a regular activity as planned, the possibility of a large oil spill occurring in Yaquina Bay will be somewhat greater than it has been previously. Still the low frequency of passage will minimize the possibility of collisions or other accidents. Furthermore, since no refueling of these ships will occur, the chances of a major oil spill accident are still fairly low.

The future for shipping in Yaquina Bay is uncertain. Both the Ports of Newport and Toledo are looking at various possibilities for developing increased shipping traffic. Under consideration are a grain terminal and a terminal for refrigerated cargo vessels. Should developments occur which increase the passage of large ships in the Bay, the chances for large oil spills will increase correspondingly and the needs identified by this plan will take on increasing significance.

C. Spill Sites

The log ships described above will be docking at the Port of Newport's Terminals 1 and 2 located on the north shore at about River Mile 2. Presumably spills would be most likely to occur in the dock area and in the area from the turning basin in front of the terminal wharves downstream to the mouth of the Bay. The lower Bay would thus be impacted first by a spill and response activities will be concentrated there. Areas such as Sally's Bend would be particularly susceptible under these circumstances. Depending on the various climatic and physical conditions associated with the spill, it is possible that it would be more appropriate to try to contain the oil in Sally's Bend rather than protect this sensitive area as the plan suggests. A decision of this type could only be made after a careful evaluation of the environmental consequences. If isolating the oil in Sally's Bend would ensure protection of the rest of the Bay, then the decision might be justifiable. A trained biologist must be consulted in decisions of this nature.

Should the Port of Toledo develop some major shipping activity, then a large spill could potentially occur anyplace in the Bay and response activities will have to be coordinated according to the specific site location. Again difficult decisions will have to be made as to whether to allow contamination of one area in order to protect other areas.

X. AVAILABLE OIL SPILL EQUIPMENT AND EXPERTISE

A. Equipment

A comprehensive listing of the oil spill response equipment which is presently available at the various Oregon coastal ports is given in Appendix A. Although it appears to be an extensive amount of material, close examination reveals that only a minimal amount of this equipment is located in the Newport area. A spill of any significant size would, therefore, require that response gear be air-lifted, trucked, and boated in from the Coos Bay, Astoria and Portland areas. The lag time associated with getting this material on-scene will seriously hinder the success of any response effort. Except for that gear which can be air-lifted in, it's likely that at least one 6 hour tide cycle will have elapsed before most of the necessary equipment and crews can be on-scene. During this time, considerable environmental damage could occur.

The small volume of shipping traffic presently using Yaquina Bay will make it very difficult to justify the stockpiling and maintenance of a volume of expensive equipment sufficient to respond to a major oil spill. Hence the response lag will continue to be a reality. Should the Ports of Toledo and Newport proceed with plans to increase shipping traffic, then very serious consideration must be given to developing such a stock pile. This would be particularly critical if facilities for refueling cargo ships are ever developed. In the meantime, perhaps the most practical approach is to emphasize prevention through appropriate inspection and safety practices and quick response with limited equipment to contain spills at the spill site before they get out of control.

B. Expertise

To be effective, oil spill response personnel must be trained to use their equipment appropriately and efficiently. Moreover, they must understand and anticipate the reactions of oil in the environment. Since most of the trained people are in Portland, the response lag will be felt here as well. It has been suggested that perhaps local people such as police, firemen, fishermen and National Guard could assist in the initial response. With appropriate planning this may well be a good way to compensate for Yaquina Bay's relative isolation. Training is absolutely necessary, however, and it costs time and money. A strong commitment would have to be made by the people of the area to develop such a response capability.

C. Other Resources

An extensive set of slides of the various parts of Yaquina Bay was taken through the cooperation of the U.S. Fish and Wildlife Service in 1981. This slide file is available at the offices of the Department of Environmental Quality for use by the response team.

XI. DATA NEEDS

Yaquina Bay has been extensively studied due primarily to its proximity to Oregon State University's Marine Science Center. The available information on natural resources seems to be more than adequate for oil spill response needs. On the other hand, data on physical processes, particularly tidal current velocities, is very limited (see Table 1), and this severely restricts our ability to accurately predict oil movements. Coincidentally, the National Oceanic and Atmospheric Administration's National Ocean Survey will be conducting current velocity studies in Yaquina Bay in the fall of 1982, and the data obtained from that survey should fill the present gaps. When the information from this survey is available it will be appended to this report.

XII. SUMMARY AND CONCLUSIONS

This report represents an attempt to consolidate all the currently available information on Yaquina Bay which might pertain to an oil spill response situation and to provide guidelines for those whose responsibility it is to deal with the complex, response related activities. The information provided is assumed to be fairly complete. The major exception is the data on tidal current velocities which is limited by the small number of actual field measurements.

The core of the protection plan is contained on the two large charts (in the back pocket) which depict the important vulnerable resources and how they might best be protected. On one chart the sensitive resources are located, briefly described, and prioritized according to their seasonal sensitivity and relative importance. On the second chart, boat launches, access points, suggested boom sites, and diversion locations are depicted. The extensive narrative provides explanatory information on how to use the charts, resource priorities, appropriate protection measures, how physical processes will effect oil movement, recovery-cleanup-removal methods, how oil will impact natural resources, the potential for oil spills and available spill response equipment and personnel.

The booming scheme represents an ideal response situation since all places where protection is desirable are indicated for booming. During actual spill conditions, the size of a spill, its location, the type of oil, weather conditions, etc., will all be important factors in determining what can and should be done. In Yaquina Bay several problems exist which will make oil spill response particularly difficult. These are:

1. The tidal action and its associated tidal currents will make protecting some locations nearly impossible and may necessitate frequent movement of oil boom.
2. There is a lack of oil spill response equipment and expertise in the local area which means that materials will have to be brought in and this will result in considerable lost time.
3. Extensive areas of highly sensitive and exposed natural resources exist in Yaquina Bay and these will be very difficult to protect even under the best of conditions.

The probability of a major spill happening at the present time is fairly low, however, should such an event occur the scope of the above problems is such that protecting all of Yaquina Bay's resources would be physically impossible and the consequences would be disastrous. Although this plan cannot solve these problems, it is meant to provide information and guidelines so that the difficult decision making process will be easier and less time consuming, thereby assuring that the response effort will proceed in the most efficient manner possible.

XIII. RECOMMENDATIONS

It is strongly recommended that efforts be made to reduce the response time between the occurrence of a spill and the arrival of necessary equipment and personnel. The local community should investigate the feasibility of training local people and providing more response gear in the general area to decrease the response lag. In addition, valuable information could be obtained by conducting a simulated oil spill on the Oregon coast to exercise the coastal response system.

In the event that a material change in the volume of shipping traffic occurs in Yaquina Bay, the above actions will be absolutely essential if the integrity of the bay's natural resources are to be maintained. A change in the present situation would also necessitate a review and possible update of this document.

For the present, prevention of spills should be emphasized through the use of appropriate training, safety, and inspection practices.

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XV. APPENDICES

Appendix A. Available Oil Spill Response Equipment on the Oregon Coast - 1982. Courtesy of the U.S. Coast Guard, Portland District.

Astoria Area

1. U.S. Coast Guard - Astoria Air Station - 1000' Kepner Sea Curtain
160' sorbent boom
2 - 40# bales of sweep
6 - 40# bales 3M-156 pads
2. Nat'l Marine Fisheries Service-Hammond - 2 research vessels
3. Astoria Flight Service - Cessna 172
Piper Aztec
Piper Comanche 260
Piper Cherokee 140
4. Knappton Towboat Co. - 1000' Kepner Sea Curtain
40 - 40# bales 3M pads
2 deployment boats
5. Standard Oil-Astoria - 5 - 40# bales 3M pads

Tillamook

1. U.S. Coast Guard - 80' sorbent boom
1 - 40# bale of sweep
4 - 40# bales 3M-156 pads

Cape Disappointment

1. U.S. Coast Guard - 80' sorbent boom
1 - 40# bale of sweep
4 - 40# bales of 3M-156 pads

Depoe Bay

1. U.S. Coast Guard - 80' sorbent boom
1 - 40# bale of sweep
4 - 40# bales 3M-156 pads

Yaquina Bay

1. Georgia-Pacific Corporation-Toledo - 600' Kepner containment boom
24 - 45# bales sorbent oil
chips
400' sorbent oil boom

2. U.S. Coast Guard - 80' sorbent boom
1 - 40# bale of sweep
4 - 40# bales 3M-156 pads

3. Newport Aviation - 1 - Cessna 310
1 - Piper Turbo Arrow
1 - Cessna C 172
1 - Cessna C 177
1 - Piper PA28 117
1 - Piper PA28 181

Siuslaw River

1. U.S. Coast Guard - 80' sorbent boom
1 - 40# bale of sweep
4 - 40# bales 3M-156 pads

Umpqua River

1. International Paper-Gardiner - 240' sorbent oil boom
3 - 20# bales 3M-156 pads

2. U.S. Coast Guard - 80' sorbent boom
1 - 40# bale of sweep
4 - 40# bales 3M-156 pads

Coos Bay Area

1. Coos Head Timber Co. - 70' Acme floation coral
18-25# bales 3-M 240 pillows

2. Fibrex and Shipping Co. - 500' Acme containment boom

3. Georgia-Pacific Corp. - Acme Skimmer 100 gpm
100' Acme containment corral
1 oil mop 14E

4. Oregon Coast Towing Co. - 5000' Kepner containment boom
200' sorbent oil boom
2 deployment boats
48# sorbent oil swabs
600# sorbent oil chips
4 - 40# bales 3M 100 rolls
3 - 17# bales 3M 126 sweeps
22 - 20# bales 3M 156 pads

5. Texaco Inc. - 500' Kepner containment boom
200' sorbent oil boom

- 6. Standard Oil Co.
 - 500' Kepner containment boom
 - 6 - 20# bales 3M-156 pads
 - 80' Conweb sorbent boom
 - 4 - 80# Conweb blankets
- 7. Weyerhaeuser Co.
 - 100 gpm Acme oil skimmer
 - 240' sorbent oil boom
 - 4 - 47# bales 3M-240 pillows
- 8. Coos Aviation
 - Cessna 152's
 - Cessna 172
 - Cessna 182
 - Cessna 210
 - Cessna 337
- 9. N. Bend Air Station-USCG
 - 1000' Kepner sea curtain
 - 160' sorbent boom
 - 2 - 40# bales of sweep
 - 6 - 40# bales 3M-156 pads

Chetco River

- 1. Coast Marine Const. Inc.
 - 170' sorbent oil boom
 - 1 - 100 gpm Acme skimmer
- 2. U.S. Coast Guard
 - 80' sorbent boom
 - 1 - 40# bale of sweep
 - 4 - 40# bales of 3M-156 pads



This Plate was provided through the courtesy of The Portland District, U.S. Army, Corps of Engineers.

JANUARY AND JULY WIND ROSES FOR SELECTED SITES

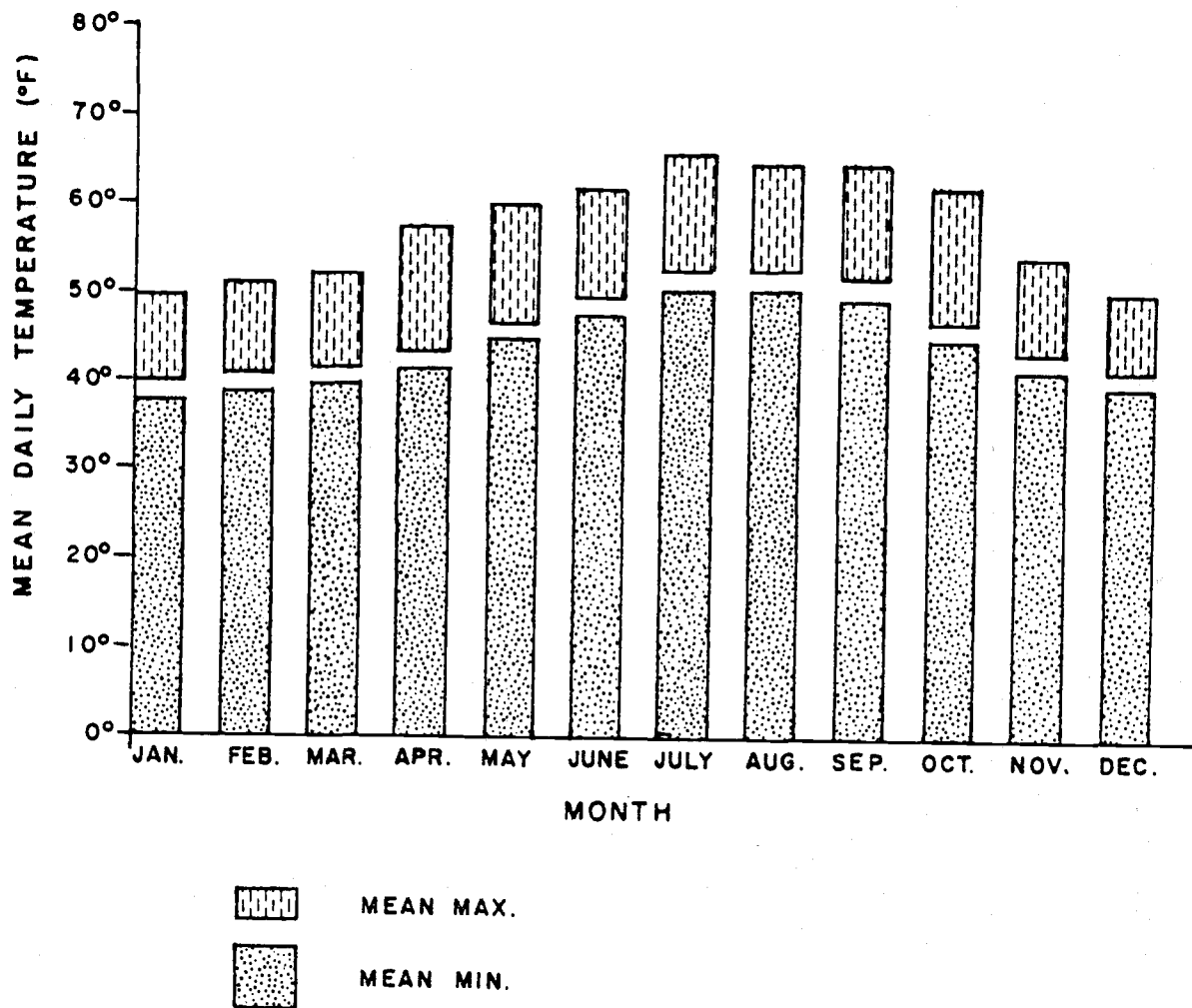
WIND SPEED AND DIRECTION, NEWPORT, OREGON (percent of time)JANUARY

Wind Speed (mph)	Direction								TOTAL
	N	NE	E	SE	S	SW	W	NW	
4 - 15	2.4	7.6	38.1	17.1	5.7	4.9	5.7	2.2	83.7
16 - 31	.2		.5	.4	5.3	2.0	.5	.3	9.2
32 - 47					.2		.1		.3
Total	2.6	7.6	38.6	17.5	11.2	6.9	6.3	2.5	93.2
Calm									<u>6.8</u>
									100.0

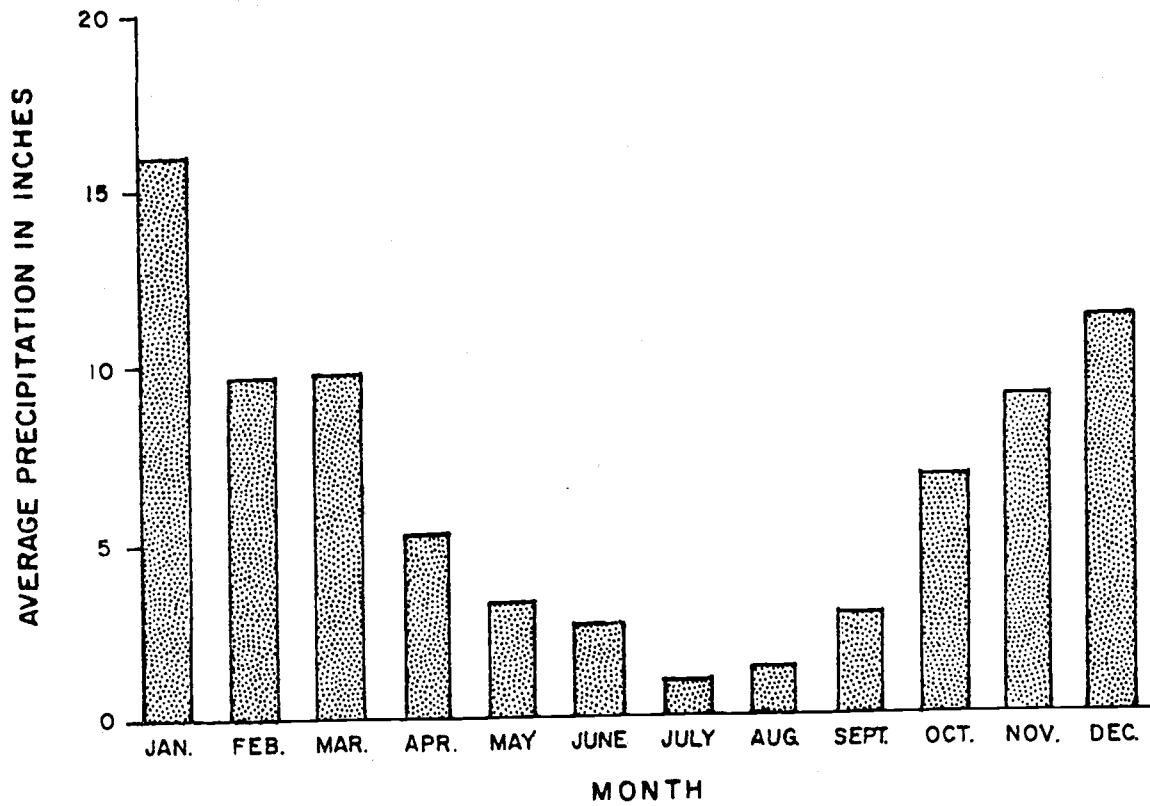
JULY

Wind Speed (mph)	Direction								TOTAL
	N	NE	E	SE	S	SW	W	NW	
4 - 15	17.5	.4	3.0	2.9	6.9	10.2	5.5	20.0	66.4
16 - 31	9.1			.1	.4			5.0	14.6
32 - 47									
Total	26.6	.4	3.0	3.9	7.3	10.2	5.5	25.0	81.0
Calm									<u>19.0</u>
									100.0

Reference: Taken from Bureau of Government Research and Service, Central Oregon Coast Vol. I Physical Conditions and Present Development, 1969, (A-6).

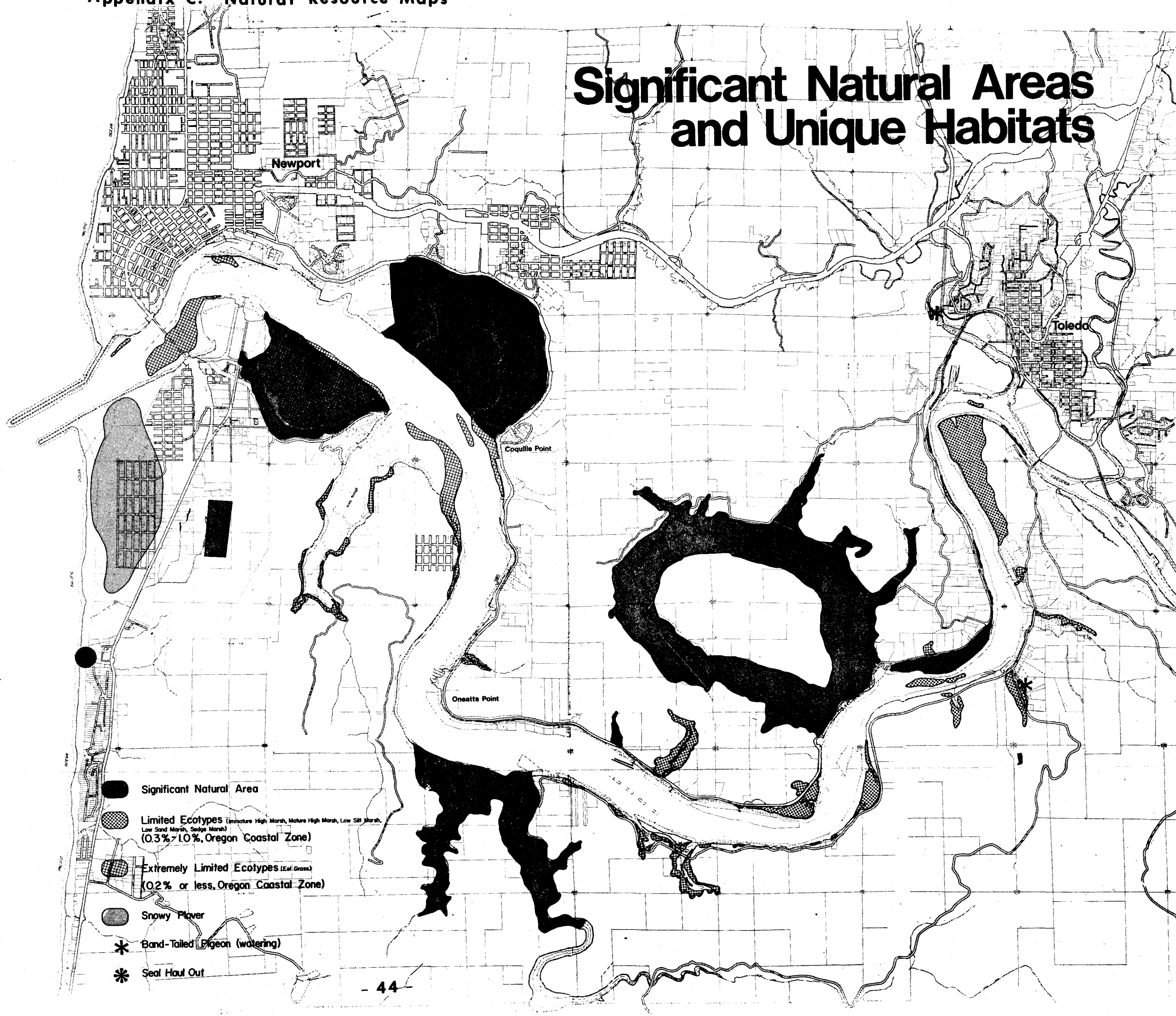


AVERAGE MONTHLY TEMPERATURE RANGE - NEWPORT,
1951 - 1960

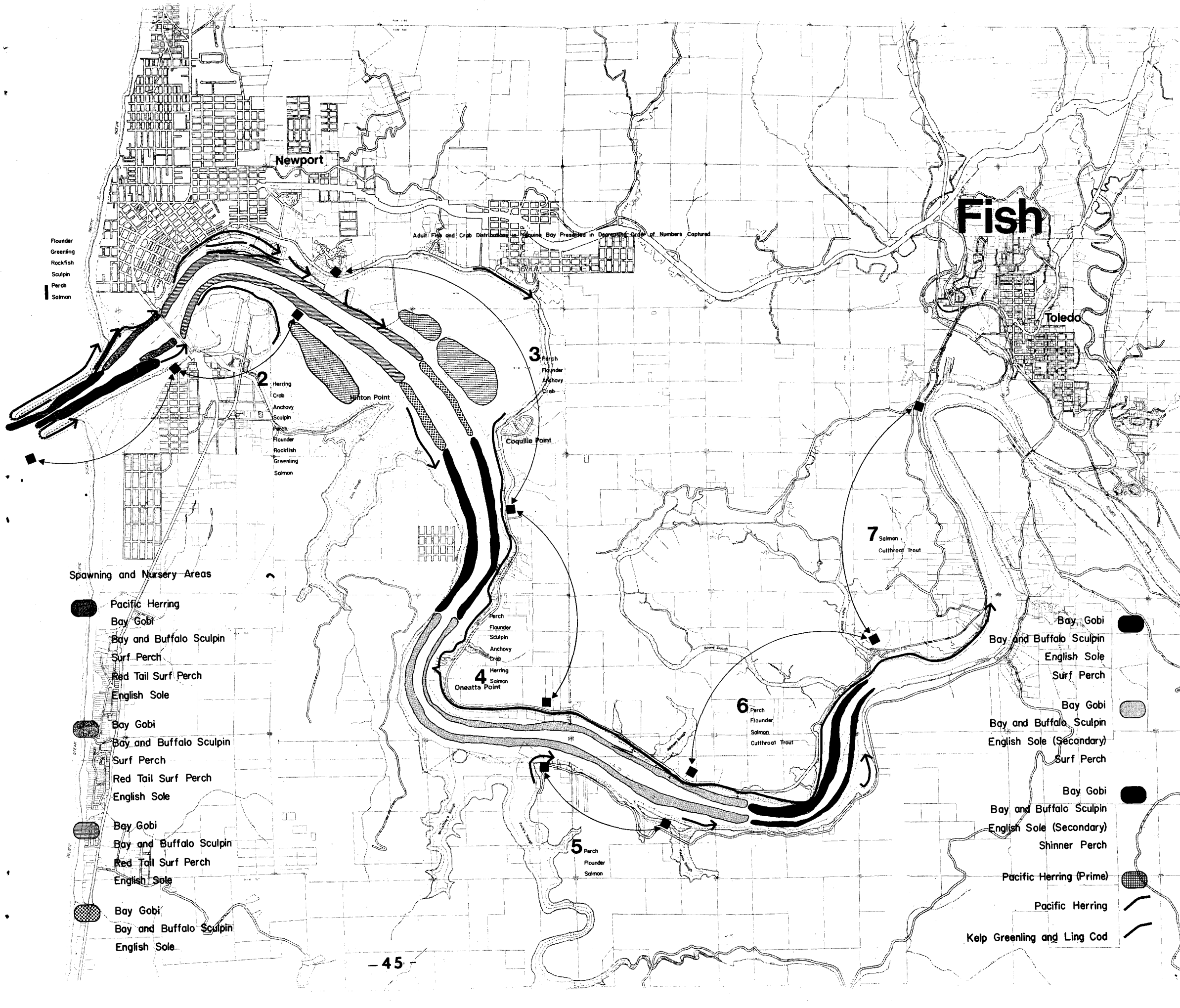


AVERAGE MONTHLY PRECIPITATION NEWPORT 1951-1960

Significant Natural Areas and Unique Habitats



- Significant Natural Area
- ▨ Limited Ecotypes (Immature High Marsh, Mature High Marsh, Low Silt Marsh, Low Sand Marsh, Sedge Marsh) (0.3%-1.0%, Oregon Coastal Zone)
- ▩ Extremely Limited Ecotypes (Eel Grass) (0.2% or less, Oregon Coastal Zone)
- Snowy Plover
- * Band-Tailed Pigeon (watering)
- * Seal Haul Out



Newport

Fish

Toledo

Adult Fish and Crab Distributions in Yaquina Bay Presented in Descending Order of Numbers Captured

- Flounder
- Greenling
- Rockfish
- Sculpin
- Perch
- Salmon

- 2
- Herring
 - Crab
 - Anchovy
 - Sculpin
 - Perch
 - Flounder
 - Rockfish
 - Greenling
 - Salmon

- 3
- Perch
 - Flounder
 - Anchovy
 - Crab

- 7
- Salmon
 - Cutthroat Trout

- 4
- Perch
 - Flounder
 - Sculpin
 - Anchovy
 - Crab

- 6
- Perch
 - Flounder
 - Salmon
 - Cutthroat Trout

- 5
- Perch
 - Flounder
 - Salmon

- Bay Gobi
- Bay and Buffalo Sculpin
- English Sole
- Surf Perch
- Bay Gobi
- Bay and Buffalo Sculpin
- English Sole (Secondary)
- Surf Perch

- Bay Gobi
- Bay and Buffalo Sculpin
- English Sole (Secondary)
- Shinner Perch

- Pacific Herring (Prime)

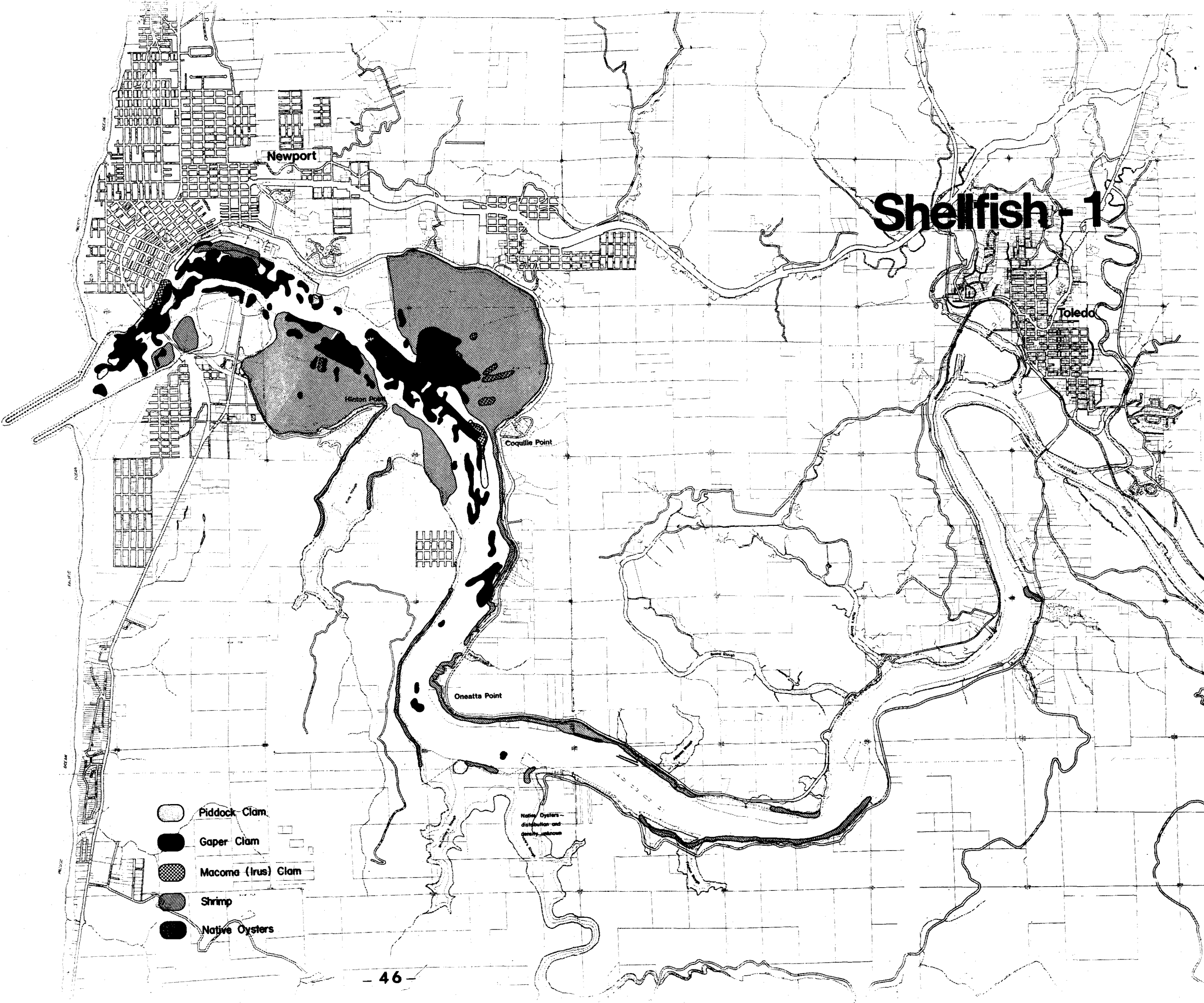
- Pacific Herring

- Kelp Greenling and Ling Cod

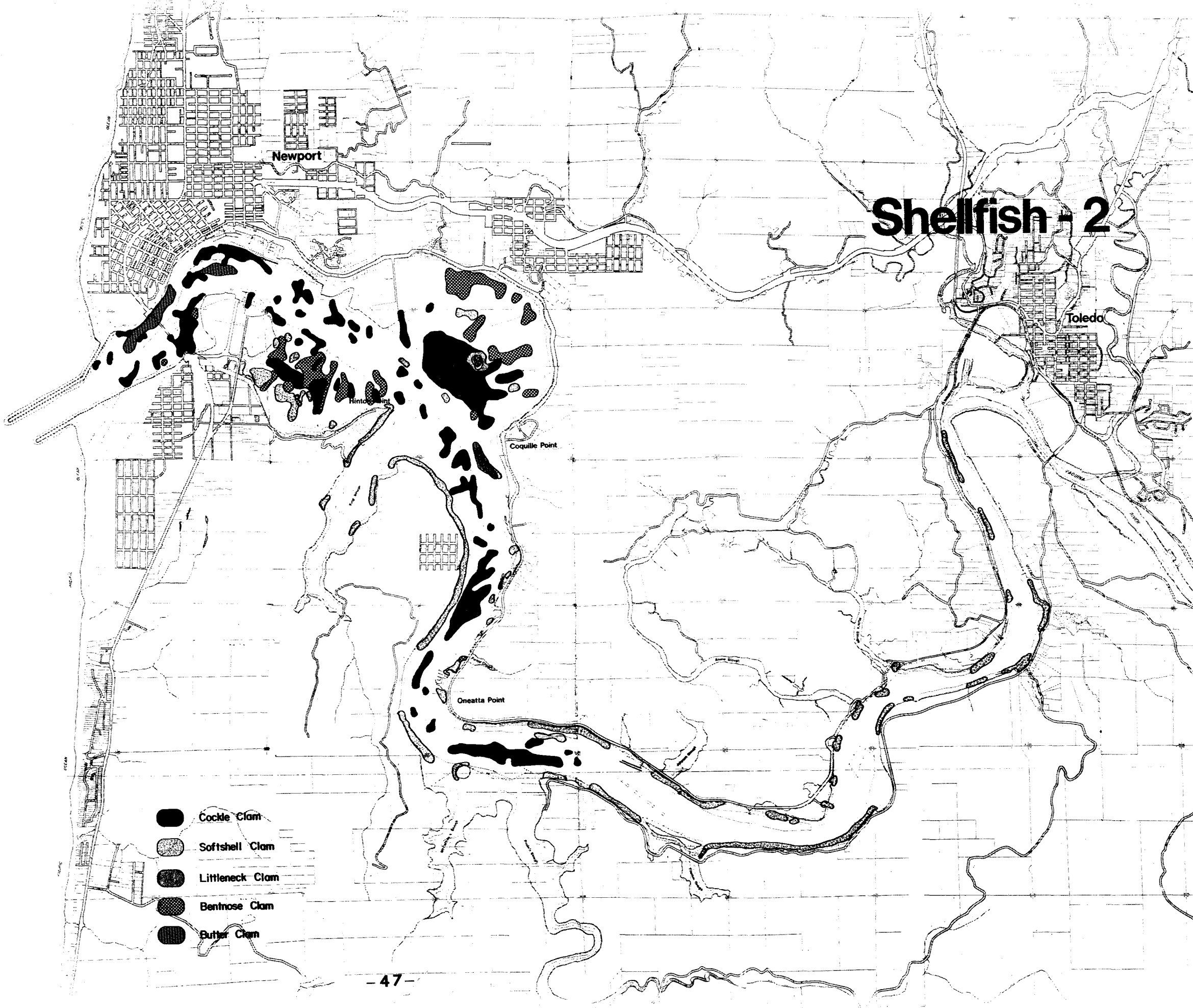
Spawning and Nursery Areas

- Pacific Herring
- Bay Gobi
- Bay and Buffalo Sculpin
- Surf Perch
- Red Tail Surf Perch
- English Sole
- Bay Gobi
- Bay and Buffalo Sculpin
- Surf Perch
- Red Tail Surf Perch
- English Sole
- Bay Gobi
- Bay and Buffalo Sculpin
- Red Tail Surf Perch
- English Sole
- Bay Gobi
- Bay and Buffalo Sculpin
- English Sole

Shellfish - 1

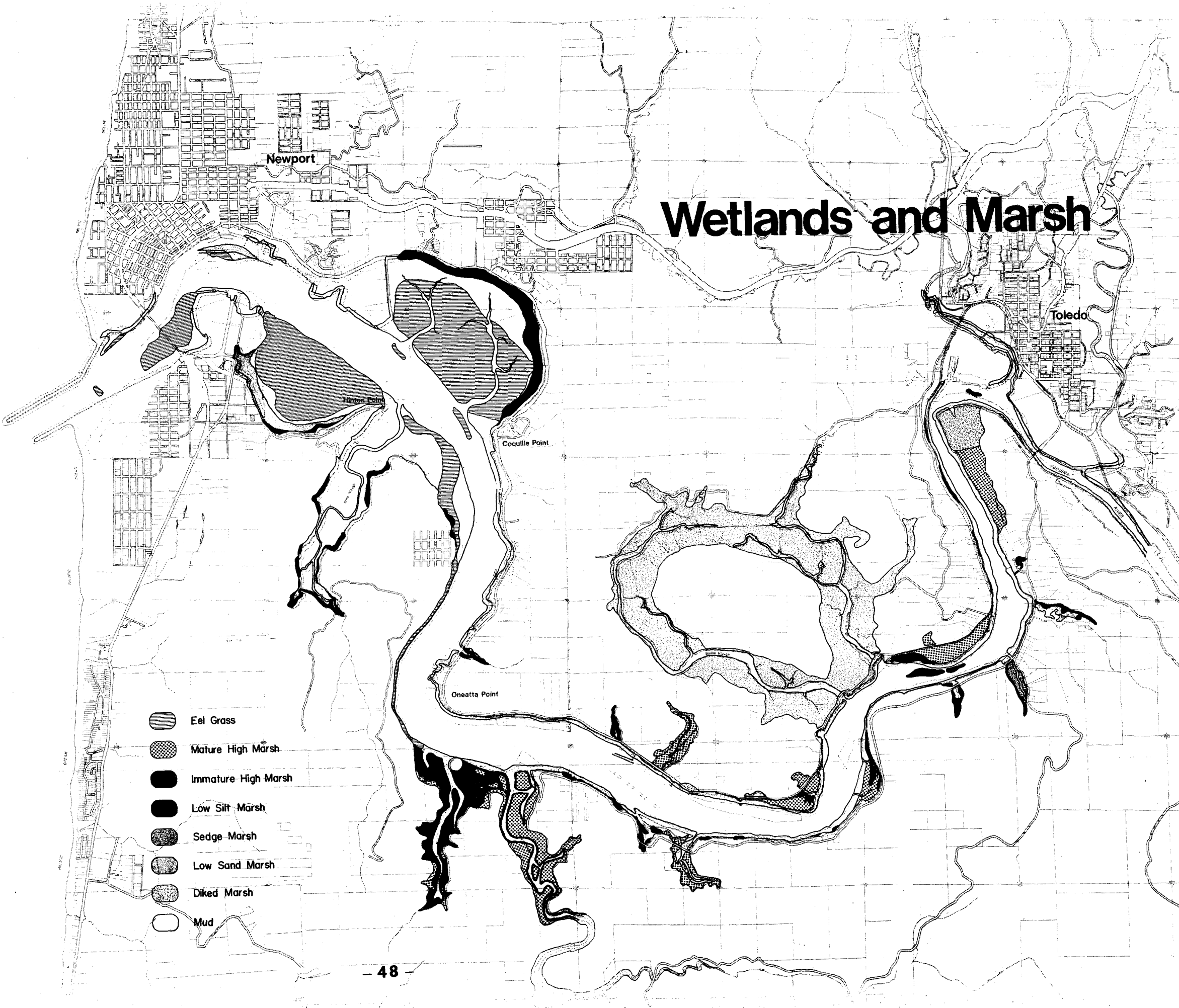










Shellfish - 2



- Cockle Clam
- Softshell Clam
- Littleneck Clam
- Bentnose Clam
- Butter Clam

Wetlands and Marsh



-  Eel Grass
-  Mature High Marsh
-  Immature High Marsh
-  Low Silt Marsh
-  Sedge Marsh
-  Low Sand Marsh
-  Diked Marsh
-  Mud

Vegetation

Newport





Toledo

Shiloh Point








Coquille Point

Oneatta Point

Aquatic

-  Eel Grass
-  Fucus
-  Brown Algae
-  Enteromorpha

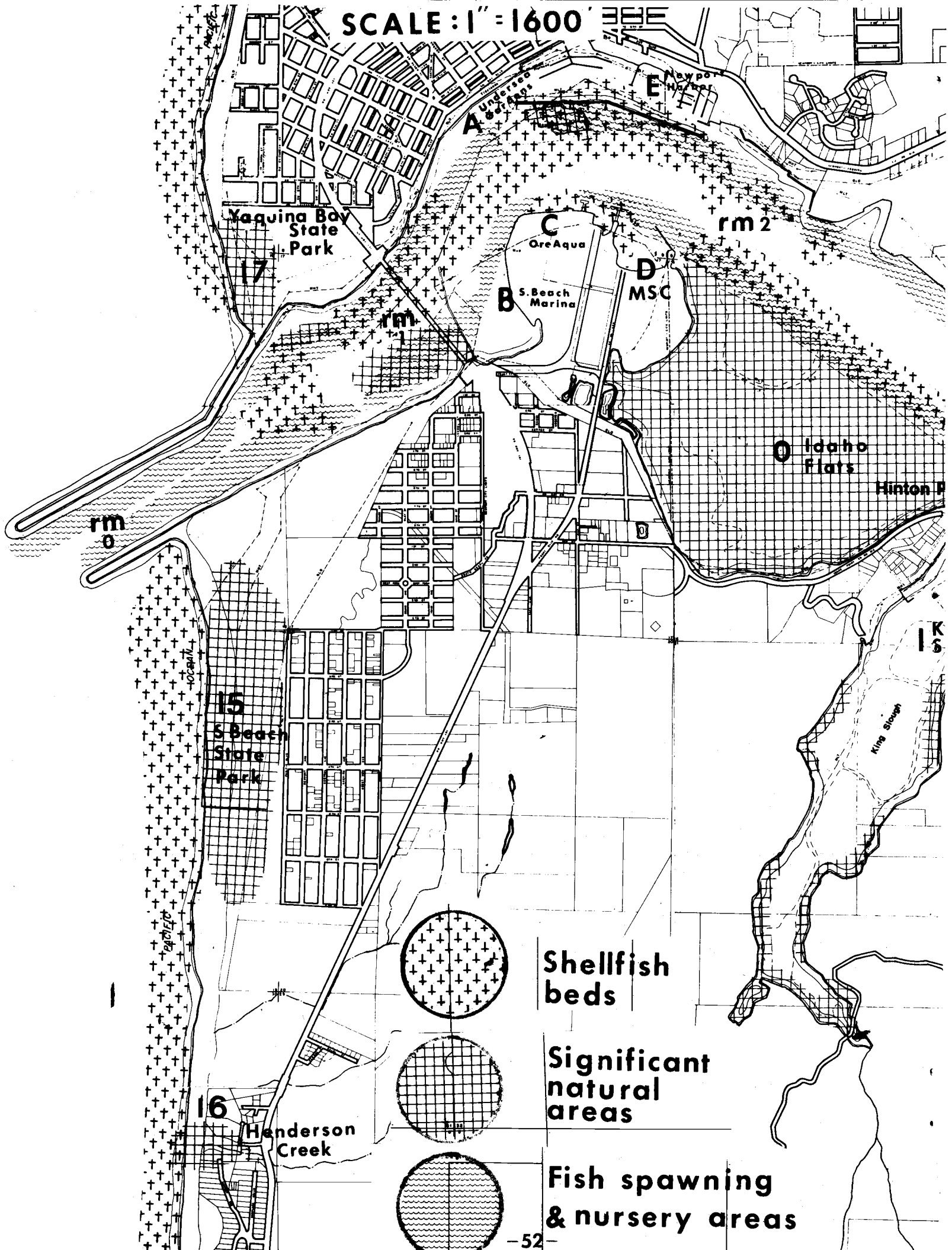
Terrestrial

-  Riparian Alder
-  Shore Pine
-  Grassland (Open/Agricultural)
-  Douglas Fir, Old Growth
-  Douglas Fir, 10-40 Years Growth
-  Douglas Fir, 0-10 Years Growth
-  Line of Native Vegetation

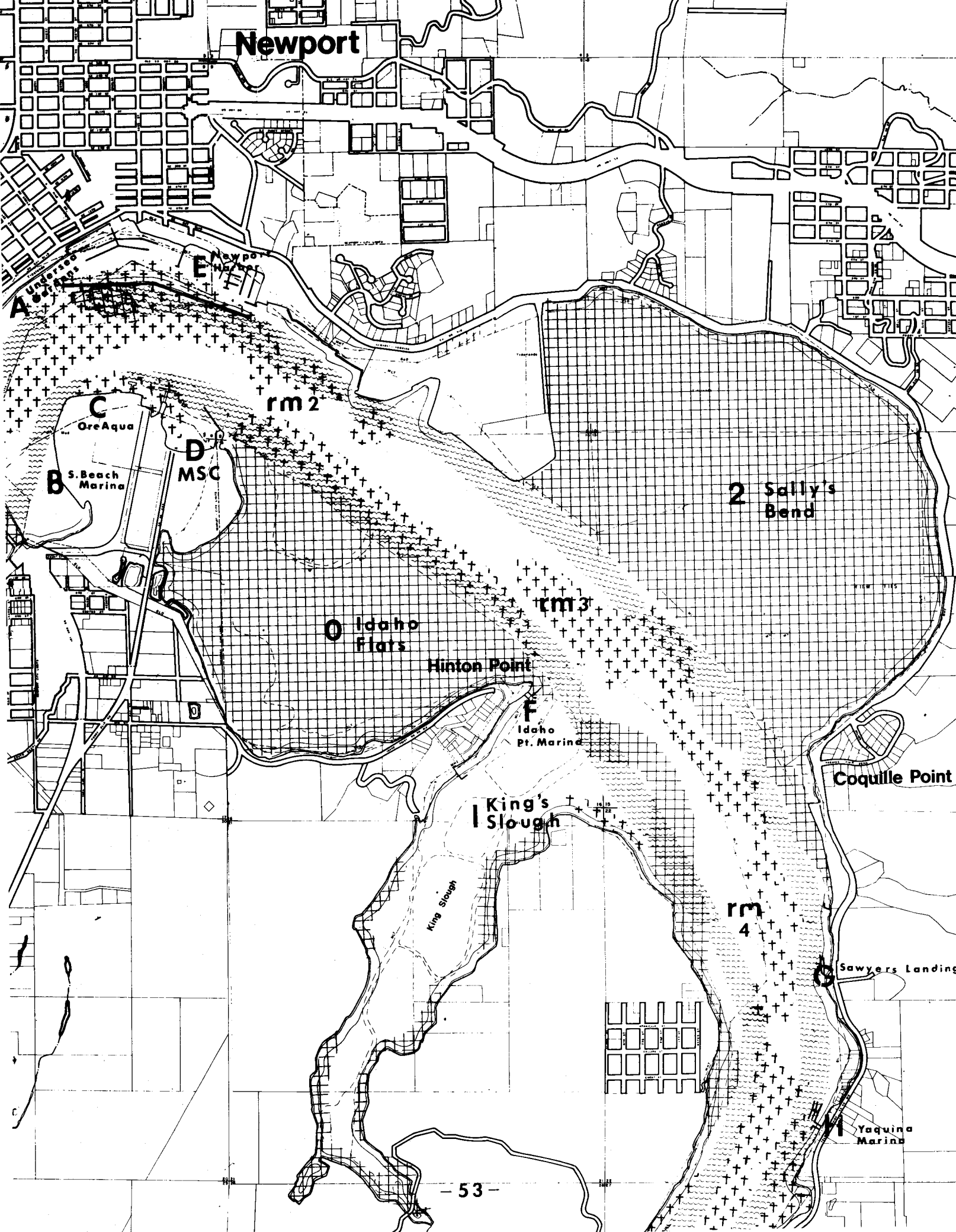
Appendix D. Vulnerable Resource Maps

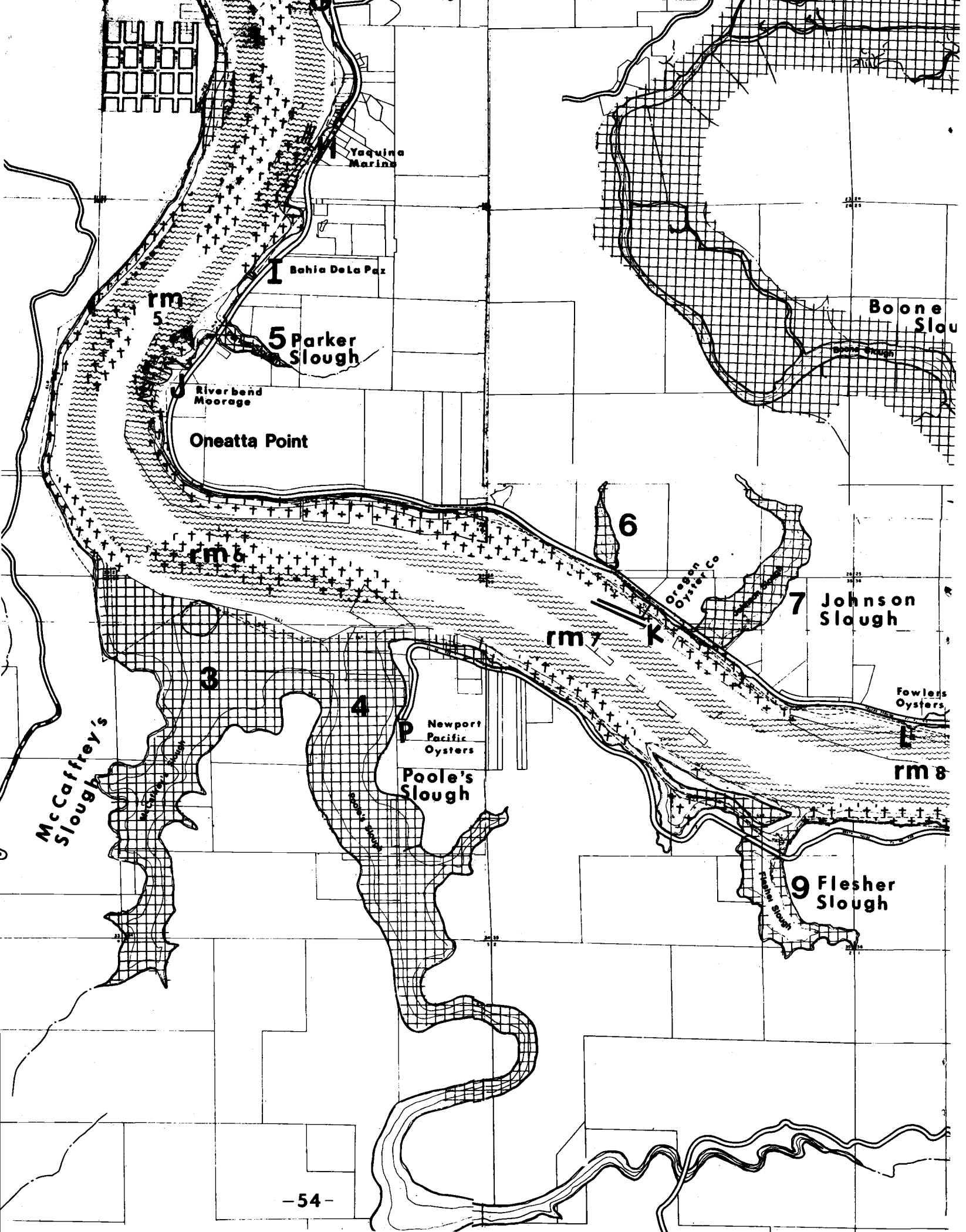
BIOLOGICAL RESOURCES	River Miles-Main Channel						SENSITIVE RESOURCE AREAS											Seasonal Priority				PROTECTION MEASURES																	
	0-1	1-3	3-6	6-10	10-14	14-	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14		15	16	17	W	Sp	S	F										
I. Flora																																							
◇Eelgrass beds	.	•	.				•		•																				1	1	1	1	divert from O&2						
◇Macro-algae	•	•	.	.			•	.	•																				2	2	2	2	none						
◇Marsh vegetation	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	1	1	1	1	divert 0234 boom sloughs						
◇Riparian vegetat.	3	3	3	3	none						
◇Mudflats(periphyt)	.	•	•	.	.		•	•	•	1	1	1	1	divert 01234 boom sloughs							
II. Fauna																																							
◇Shellfish																																							
a. clams	•	•	•	.			•	.	•																				2	1	1	2	divert 012		
b. crabs	•	•	•	.			•	.	•	1	1	1	2	divert 01234 boom 5679						
c. shrimp	•	•	.	.			•	.	•	2	1	1	2	divert 01234 boom 567							
d. other	•	•	.	.			•	.	•	2	1	1	2	divert 01234							
◇Benthos	•	•	•	.	.		•	•	•	2	2	2	2	divert 01234 boom 5679							
◇Plankton	•	•	•	.	.		•	•	•	1	1	1	1	divert 01234 boom 5679							
◇Fish																																							
a. Salmonids juveniles	•	•	•	•	•	•	•	.	•	.	•	.	.																					1		1	1	none	
adults																													1	1	1	divert 0234	
b. non-Salmonids juveniles	•	•	.	.	.		•	.	•	1	1	1	1	divert 01234 boom 5679						
adults	1	1	1	1	none							
◇Marine Mammals	•	•	•																	1	1	1	1	scare tactics							
◇Birds																																							
a. migratory	•	•	•				•	•	•		1	1						scare tactics			
b. non-migratory predators	2	1	2	2	scare tactics						
swimmers & divers	•	•	•	.	.	.	•	•	•	•	•	•															1	1	1	1	scare, divert 01234 & boom 5679								
wading birds	.	.	•	•	.	.	•	•	•	•	•	1	1	1	1	divert 01234 boom 101112							
shore birds	•	2	1	2	2	none							
COMMERCIAL AND OTHER RESOURCES																																							
water intakes		.					A	B	C	D	E	F	G	H	I	J	K	L	M	N	P														3	3	3	3	notify
marinas & boats			5	5	5	5	boom breakwaters						
aquaculture			2	2	2	2	notify							
log storage				.															.								5	5	5	5	none, utilize log booms								
parks	.																										4	4	4	4	none								
fishing areas																					4	4	4	4	none								

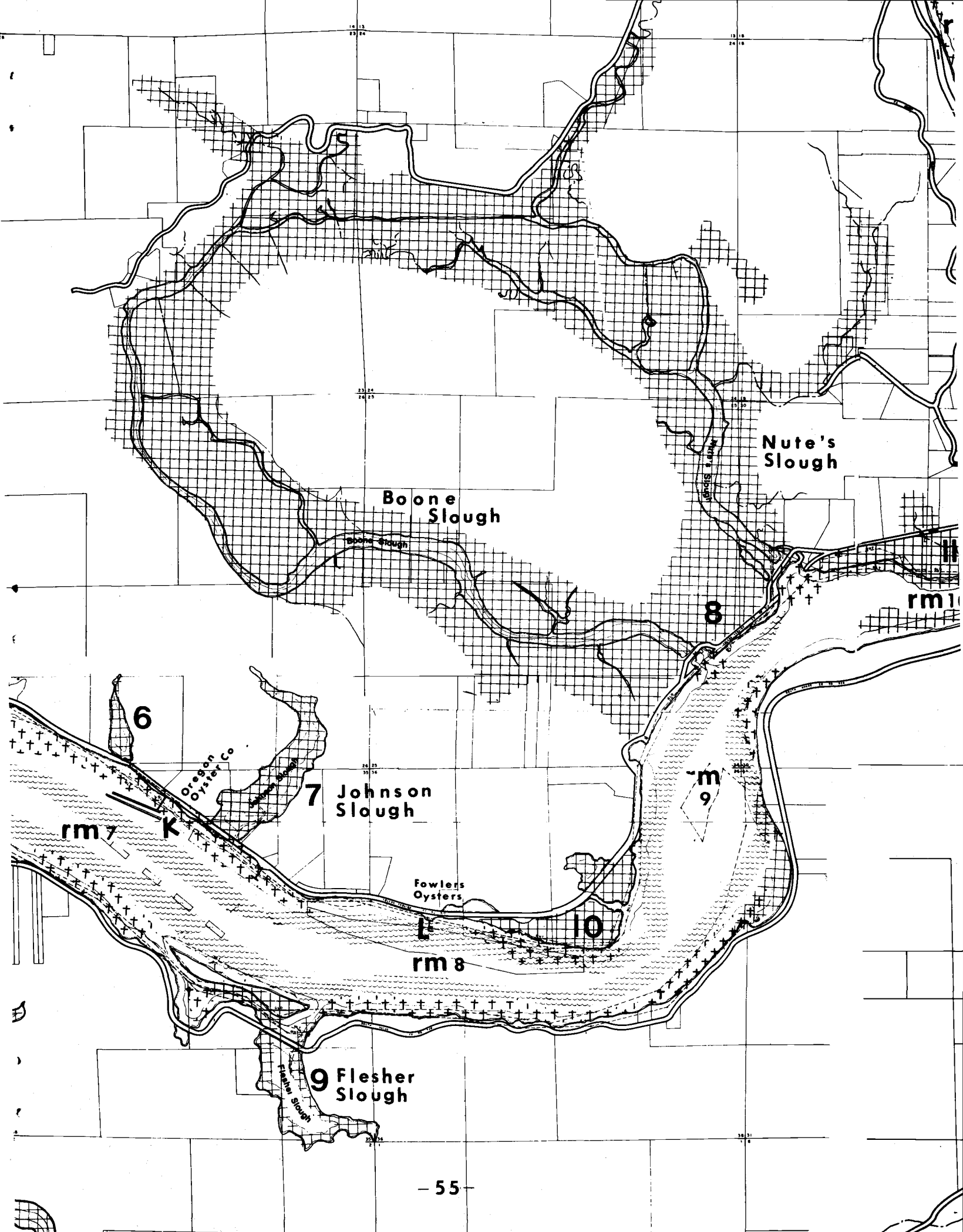
SCALE: 1" = 1600'

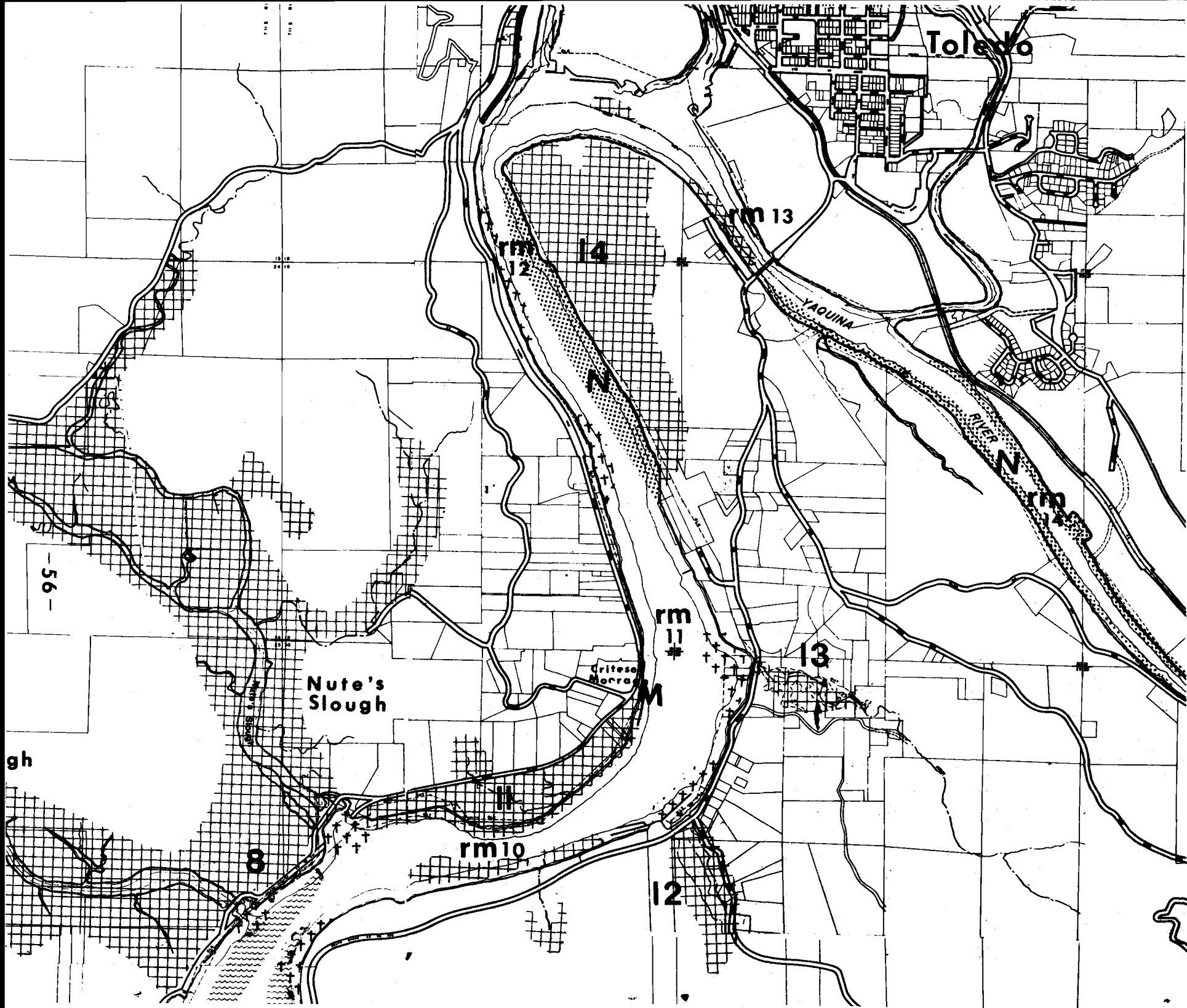


Newport









Toledo

YAQUINA RIVER

Nute's Slough

Grifeso Morra

-56-

gh

8

rm 10

12

rm 11

13

rm 13

14

rm 12

Appendix E. Resource Protection Maps

BOOM SITES, LAUNCH POINTS, ACCESS AREAS
AND DIVERSION LOCATIONS

LAUNCH POINTS (public)

- LS 1 -- 1 lane paved ramp
- LS 2 -- 1 lane paved ramp
- B -- South Beach Marina - 4 lanes paved

PRIVATE MARINAS w/ LAUNCH FACILITIES

- F -- Idaho Pt. Marina - 1 lane ramp
- G -- Sawyer's Landing - monorail launch
- J -- Riverbend Moorage - hoist launch

BOOM SITES: Highest priority **** lowest priority *

- ** bm 1 -- boom both ends of breakwater if boom available
-- strong tidal currents
- ** bm 2 -- boom breakwater if boom available
- *** bm 3 -- boom on incoming tide - 10 yds
- **** bm 4 -- boom on incoming tide, south side of bridge 50 yds
-- good road access
-- currents: 2.4 ft/sec. w/8' flood, 3.1 ft/sec. w/8'ebb
- ***** bm 5 -- boom at all times, multiple channels, boom entire
width 1000 yds. or possible diversion at pilings
-- currents: .8 ft/sec. w/8' flood, 1.0 ft/sec w/8'ebb
- **** bm 6 -- boom at all times, multiple channels, need booms of
50 yds, 30 yds, 10 yds, 10 yds, 20 yds, and 100 yds
for Pooles Slough entrance and 50 yds east end
-- currents: 1.0 ft/sec. w/8' flood, 1.3 ft/sec. w/8'ebb
- *** bm 7 -- boom on incoming tide 15 yds
-- road access only
-- currents: 1.5 ft/sec. w/8'flood, 1.9 ft/sec. w/8'ebb
- **** bm 8 -- boom at bridge on incoming tide - 40 yds
-- good road access and small boat access
-- strong tidal currents
- *** bm 9 -- boom on incoming tide - 10 yds.
-- road access only
- **** bm 10 -- boom on incoming tide - 20 yds
-- road access
-- currents: 1.3 ft/sec. w/8'flood, 1.7 ft/sec. w/8'ebb
- *** bm 11 -- boom on incoming tide-20 yds
-- boat access only
- *** bm 12 -- use available log booms
- *** bm 13 -- boom on incoming tide, north side of bridge, - 25yds
-- road access or small boat
-- tidal currents weak
- * bm 14 -- low priority, use existing log booms

tg TIDE GATES

- tg -- those areas marked tg have tide gates which should
keep oil out of sensitive areas if working properly
-- these must be checked

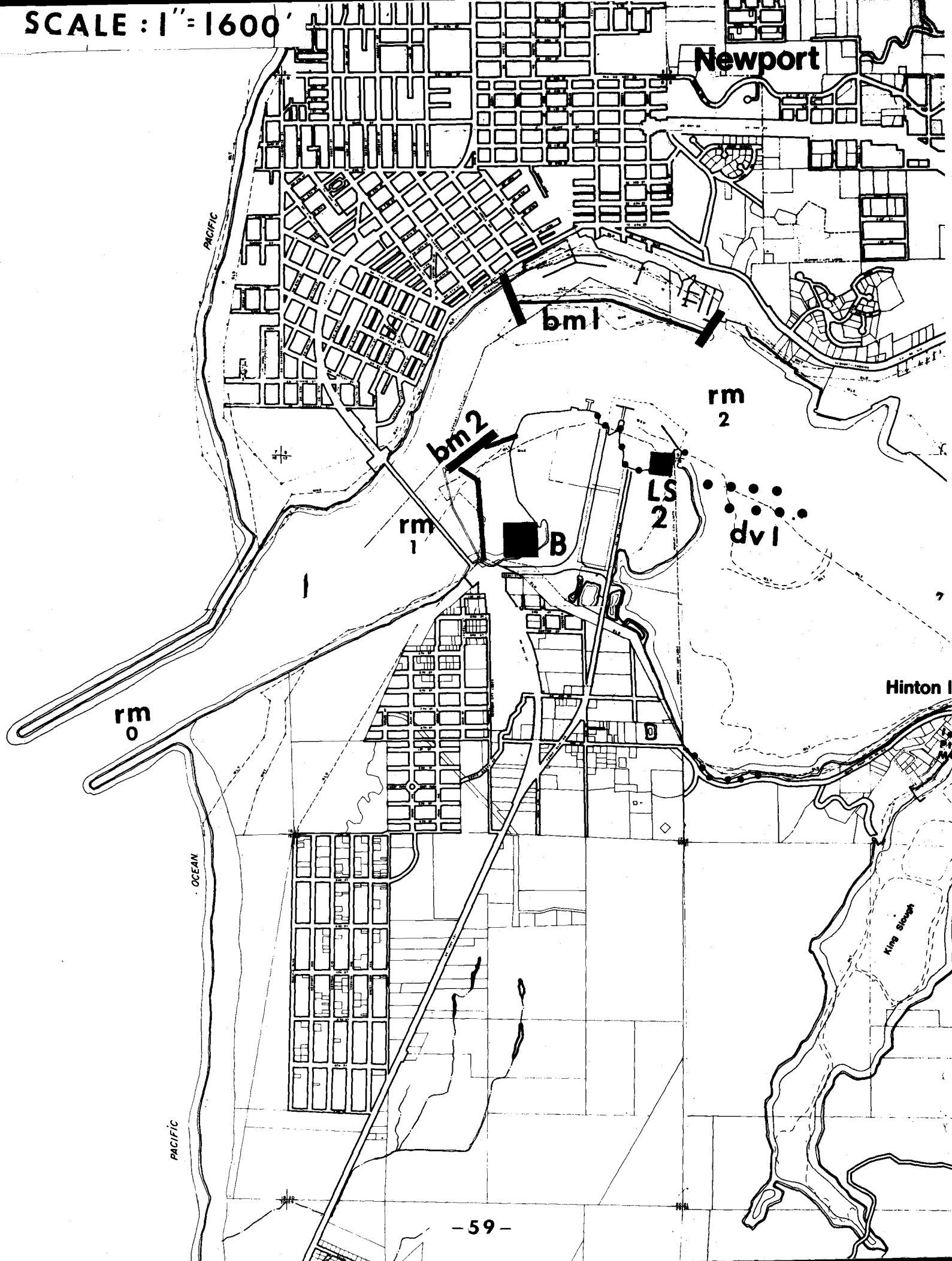
●●● DIVERSION LOCATIONS

- **** dv 1 -- should attempt to divert oil at this location if
wind from north on incoming tide
- *** dv 2 -- attempt diversion on incoming tide with south winds
- *** dv 3 -- same as dv 1
- *** dv 4 -- attempt diversion on outgoing tide with south winds

●●●● ACCESS AREAS

- areas indicated by small dots have good road access
to the shoreline, small boats could be launched from
many of these places

SCALE: 1" = 1600'



Newport

rm
2

dv 1

dv 2

rm
3

Hinton Point

Ischa Pt
Marina

dv 3

dv 4

Coquille Point

rm
4

G Sawyer's
Landing

bm
3

