

4. SUBZONE DESCRIPTION

The following pages include a detailed analysis of the parameters in each subzone which can affect or be affected by an oil spill incident. Categories included are meteorology, hydrology, biology, and technology. Listed below are the topics covered.

1. Geography.
2. Currents.
3. Winds
4. Waves
5. Natural physical resources
6. Man-made physical resources

No attempt has been made, in this section, to evaluate the consequences relating these parameters with an oil spill.

The text on each subzone is supplemented by tables and charts. For a given subzone, the geographical outline (orientation and scale) in the various charts is identical. Thus, the reader, by comparing charts, can attain an overall picture of how the various parameters are distributed in any locale. When compared to the set of charts delineating oil handling facilities in Section II-C, it is interesting to note that those areas which are abundant in resources are also heavily populated by oil operations.

a. Subzone 1: Strait of Juan de Fuca

1. Geography

The Strait of Juan de Fuca separates the southern shore of Vancouver Island, Canada, from the northern coast of the state of Washington. This important body of water is the connecting channel between the Pacific Ocean and the inter-island passages extending southward to Puget Sound and northward to the inland waters of British Columbia and southeastern Alaska.

At its entrance, and for 50 miles eastward to Race Rocks, the Strait has a width of about 12 nautical miles, and then it has a width of about 16 nautical miles for 30 miles to Whidbey Island. The waters are generally deep until near the shore with few outlying dangers, most of which are in the eastern part. The shores on both sides are heavily wooded, rising rapidly to elevations of considerable height, and except in a few places, are bold and rugged.

The shores of the Olympic Peninsula bordering the Strait and characterized by relatively virgin areas, especially west of Port Angeles. Most near-shore lands are privately owned, with the Makah Indians occupying the northwest tip of the area, and the Department of Natural Resources holding several tracts spaced intermittently. West of Port Townsend the density of privately owned individual tracts increases more, particularly around Sequim Bay and Discovery Bay and in the vicinity of Port Townsend.

In this general area, the prevailing uses can be categorized as either recreational or small residential in nature. The region supports relatively few residents, but is very popular with the weekend visitor from the more populous parts of Washington. Built-up areas are few, occurring primarily in the vicinity of the larger towns such as Port Angeles, Port Townsend, and Neah Bay. Minor ports are located at Sekiu, Pysht, and New Dungeness Bay.

The coastline is generally steep with narrow beaches of coarse sand and large boulders, except in the more protected areas and bays, where the gradient is gradual and the intertidal zone composition is mixed sand and gravel. A broad shelf of gravelly shorelines extends from Port Angeles to Puget Sound with the shallow sandy-mud flats of Dungeness in between. Moving westward from Port Angeles, there are larger sweeping sandy beaches lined by pine forests and gentle slopes, and small bays with small rock formations within them.

Highway 101 services the general area but does not provide access to beach and shore areas. Access is quite restricted because of the proliferation of private ownership. The water can be reached at the larger towns or parks.

2. Currents

The currents in the Strait of Juan de Fuca may attain velocities of 2 to 4 knots varying with the range of the tide and are influenced by strong winds. Eastward of Race Rocks in the wider portion of the Strait, the velocity is considerably less. At Race Rocks and Discovery Island the velocity may be 6 knots or more.

The flood current entering the Strait sets with considerable velocity over Duncan and Duntze Rocks; but instead of running in the direction

of the channels, there is a continued set toward Vancouver Island shore which is experienced as far as Race Rocks. The flood current velocity is greater on the northern shore of the Strait than on the southern.

(See Figure II-A2.)

The ebb current is felt most along the southern shore of the Strait and between New Dungeness Light and Crescent Bay, as shown in Figure II-A3. There is a prevailing set southward and westward especially during large tides. With wind swell against the current, a short choppy sea is raised near the entrance to the Strait. Tide rips occur off the prominent points and in the vicinity of the banks. These are particularly heavy off Cape Flattery, Race Rocks, Dungeness Spit, and Point Wilson; at times becoming dangerous to small vessels.

3. Winds

The wind conditions in the Strait of Juan de Fuca, west of Port Angeles to Cape Flattery, are predominantly easterly with speeds exceeding 20 miles per hour (MPH) during the period from October to March. East of Port Angeles, winds are westerly with speeds to 20 mph during this period. From April until September, winds are generally westerly to 20 mph. Figure II-A4 summarizes the monthly wind patterns.

4. Waves

Waves generated at sea may enter the Strait of Juan de Fuca in the form of swells. In addition, shorter period waves may be initiated in the Strait due to the relatively long fetch and predominantly moderate wind stress on the water surface. During the period from October to March, the wind direction in the Strait normally tends to oppose the progress of swells from the ocean and waves up to 13 feet may occur during storms. From April until September, prevailing 20 mph winds acting along the 60 mile fetch over a long duration may produce wind waves of up to 6 feet in height which interact with the swell conditions to create even greater height.

5. Natural physical resources

The following outline describes the natural physical resources present in and near the waters of subzone 1. Figure II-A5 through II-A7 should be referred to for specific locations.

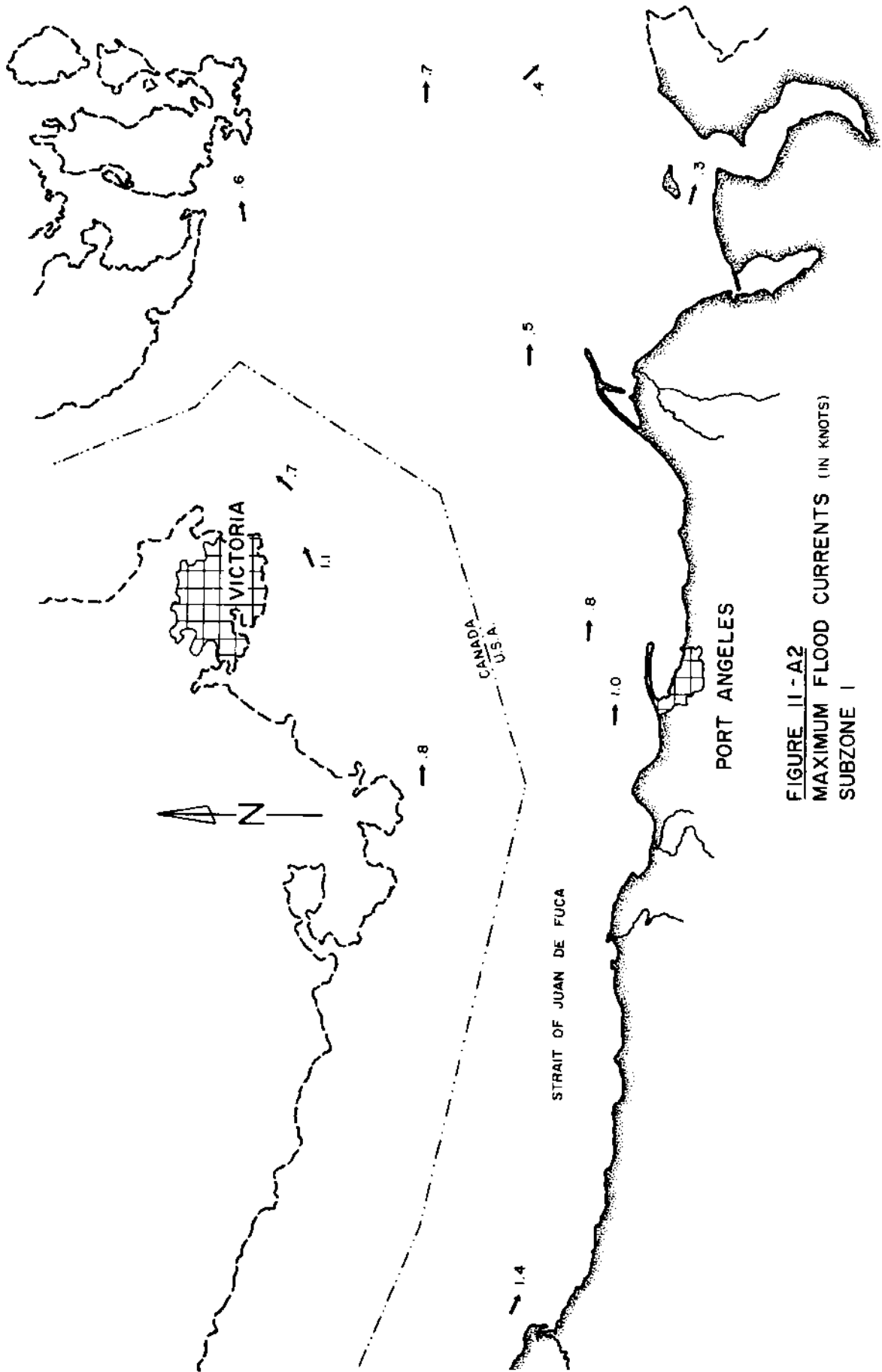


FIGURE 11-A2
 MAXIMUM FLOOD CURRENTS (IN KNOTS)
 SUBZONE 1

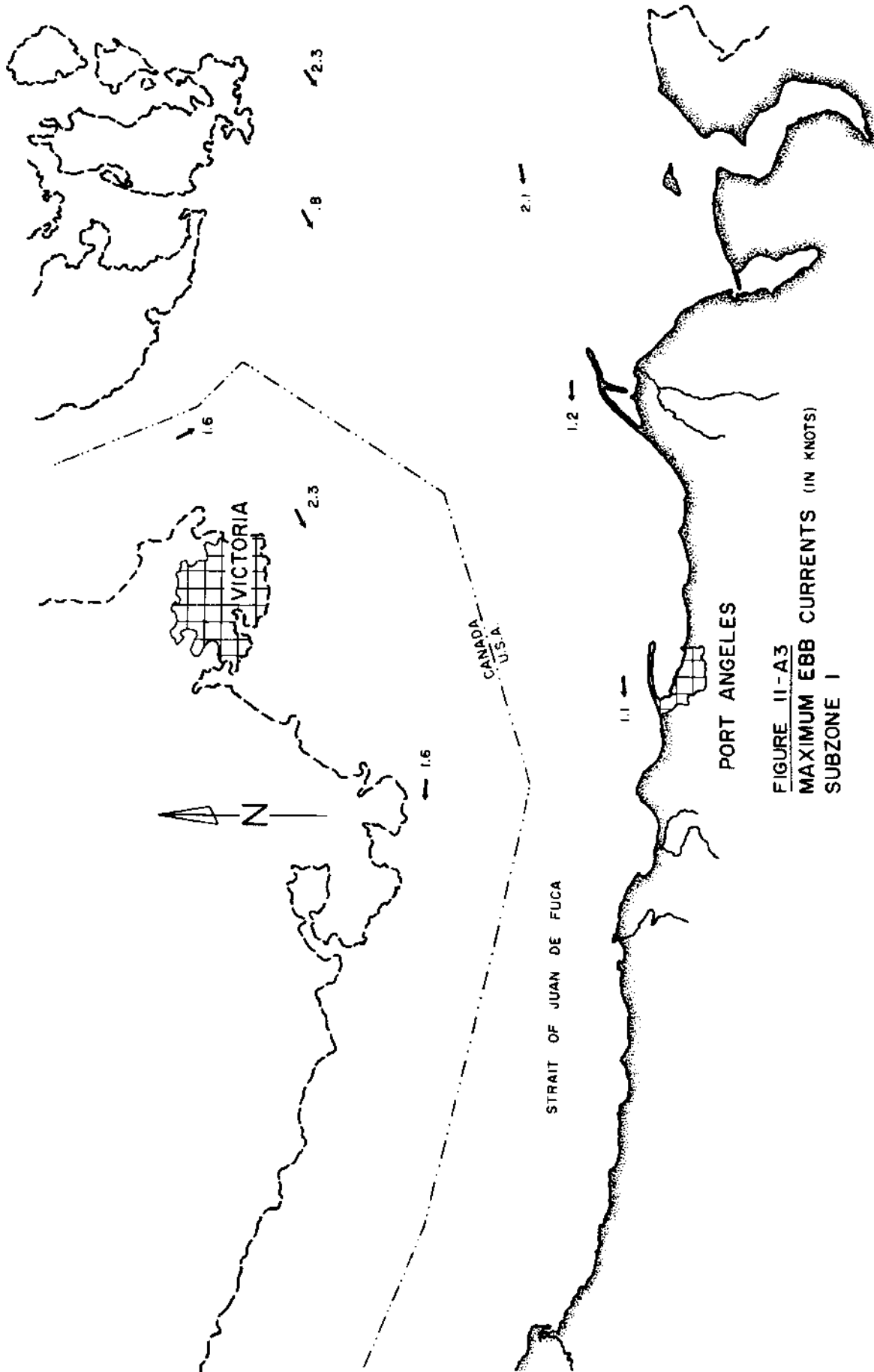


FIGURE 11-A3
 MAXIMUM EBB CURRENTS (IN KNOTS)
 SUBZONE 1

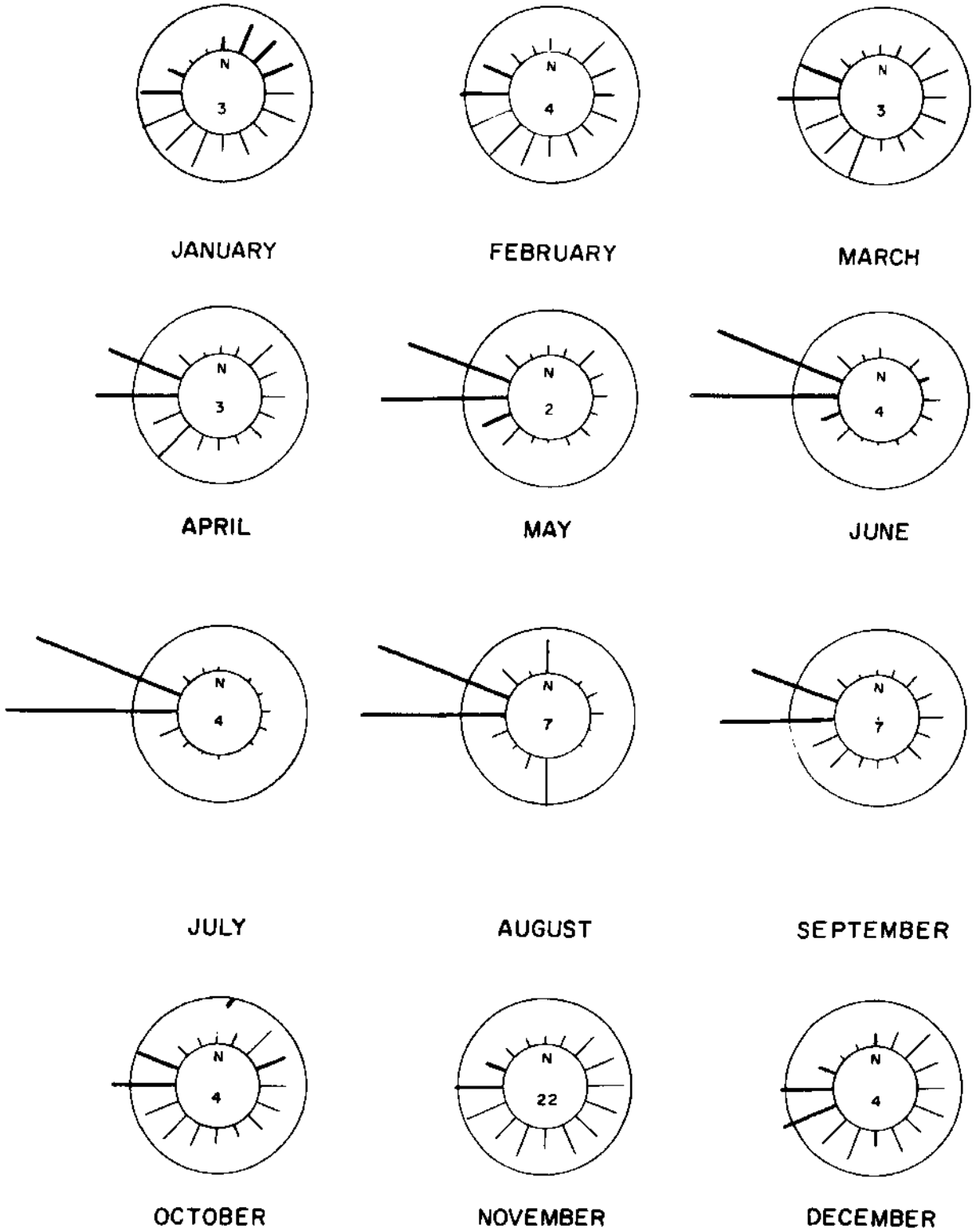


FIGURE II-A4, WIND PATTERNS FOR PORT ANGELES AFTER HARRIS, 1954. WIDTH OF BAR INDICATES MONTHLY AVERAGE WIND VELOCITY, EACH RADIAL UNIT INDICATES 10 % OF TOTAL OBSERVATIONS, CENTRAL NUMERAL INDICATES PERCENTAGE OF CALM WIND. 0 - 10 MPH — , 11 - 19 MPH —²²

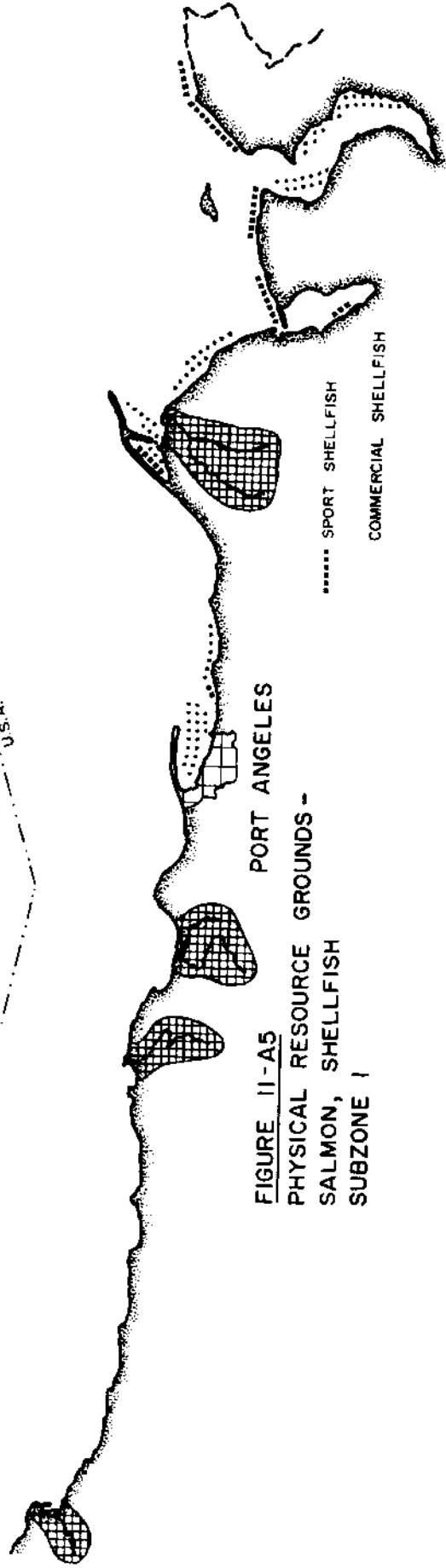
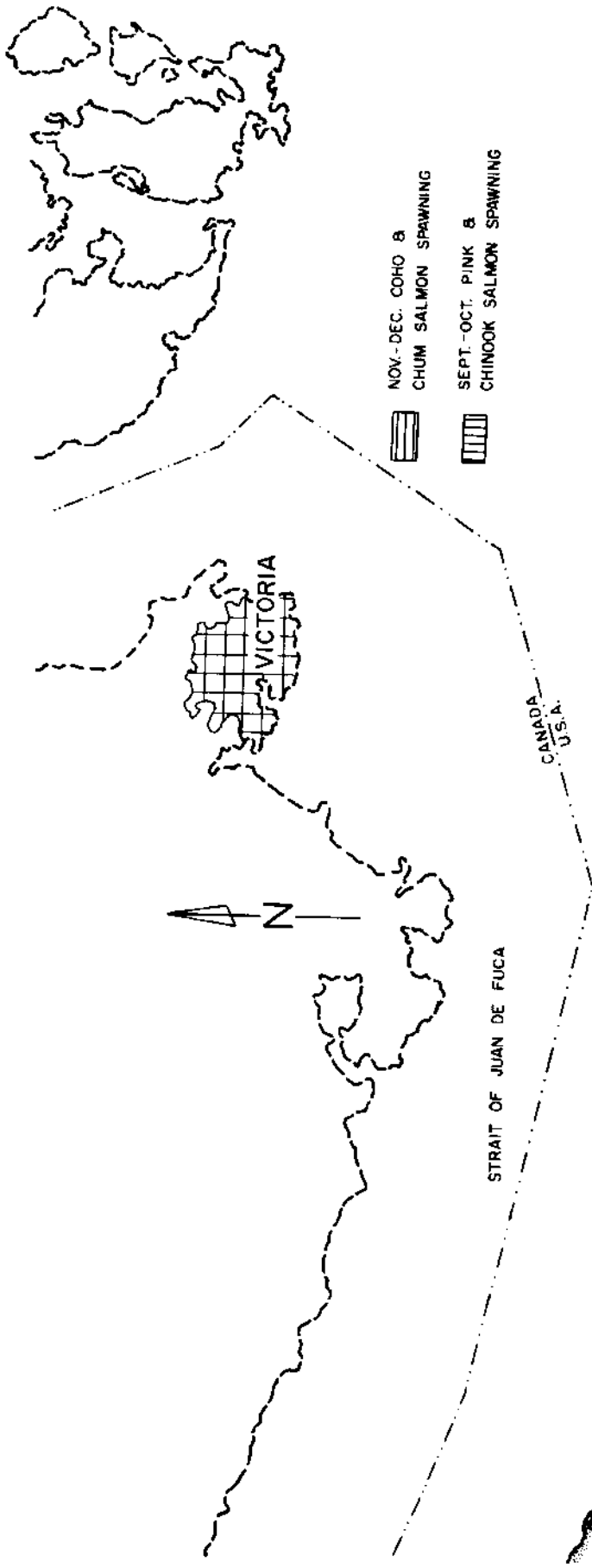


FIGURE II-A5
 PHYSICAL RESOURCE GROUNDS -
 SALMON, SHELLFISH
 SUBZONE I

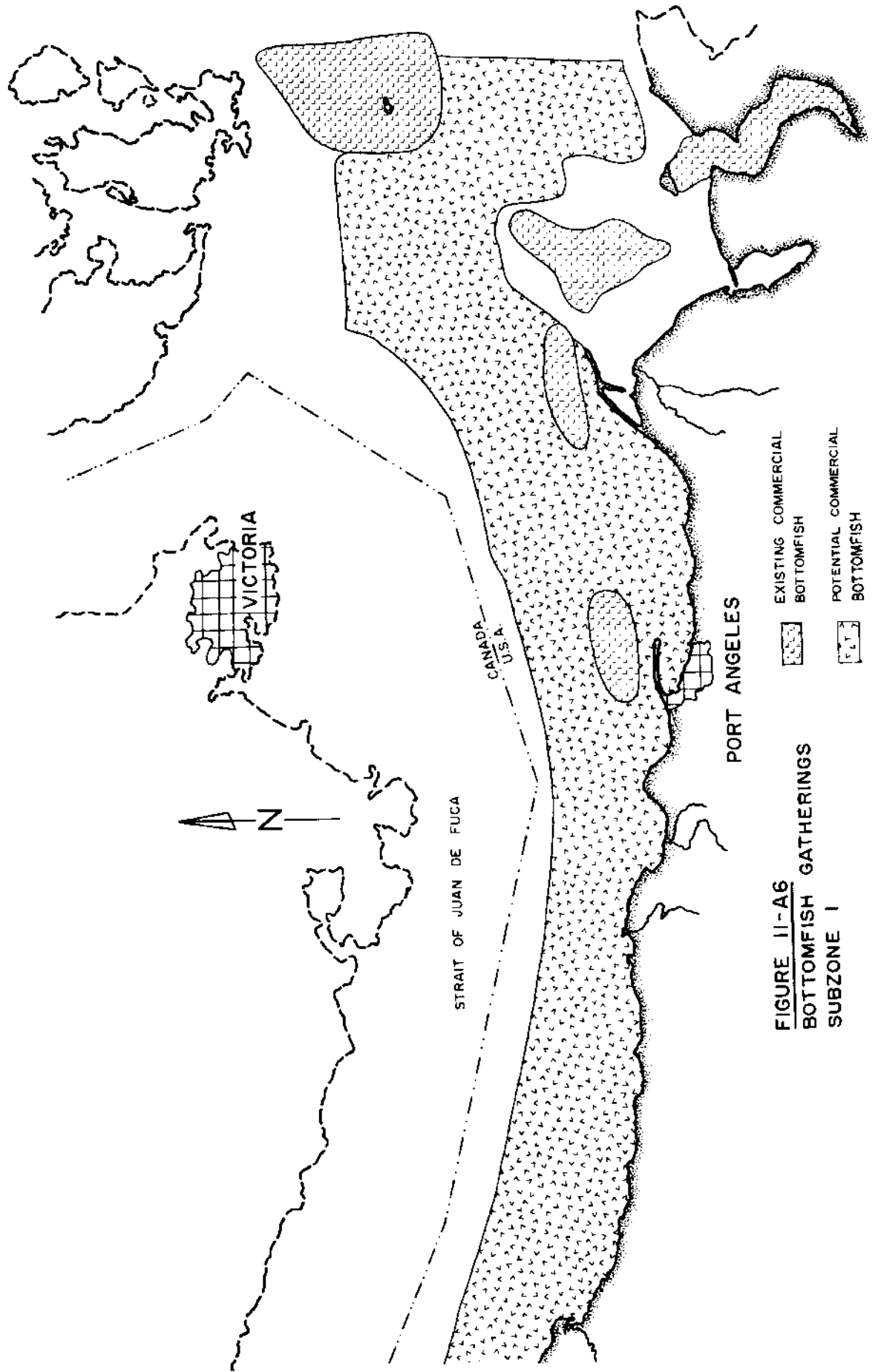


FIGURE II-A6
BOTTOMFISH GATHERINGS
SUBZONE I

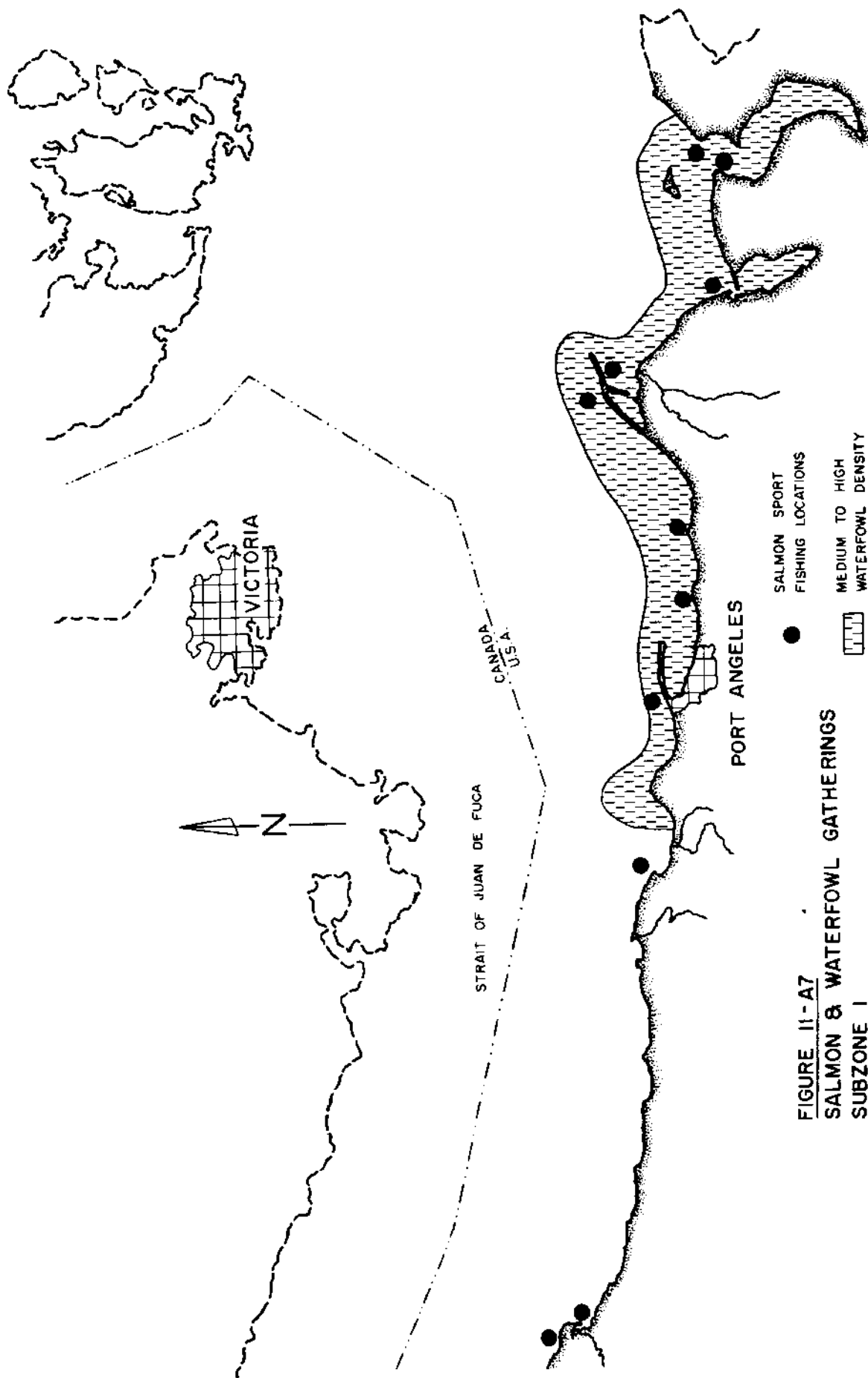


FIGURE 11-A7
 SALMON & WATERFOWL GATHERINGS
 SUBZONE 1

i. shellfish

Crabs: Dungeness crabs amply inhabit this zone, especially in sandy estuaries from the Elwha River to Port Townsend. Red and box crabs appear throughout the region.

Oysters: Pacific oysters are scattered lavishly near Dungeness, Port Townsend and Kilisut Harbor. Other species of oysters not common in this area.

Clams: Butter, littleneck, and Manila clams are common in sheltered areas such as Washington Harbor, Kilisut Harbor, Port Discovery, Oak Bay, Port Townsend, Neah Bay, and Sequim Bay. Other areas along the coast are generally too exposed for clam habitat.

Shrimp: Scattered beds of coon stripe shrimp are in the deep waters from Port Townsend to Dungeness Spit. Spot and pink shrimp are found near Protection Island.

Other shellfish: Moderate amounts of California mussel are located from Elwha River to Port Townsend. The blue mussel is common throughout the zone. Some pink and rock scallops occur from Port Angeles to Port Townsend. Rock scallops are found near the mean low water line. Seasonal migrations of squid occur in Port Discovery, Washington Harbor, Oak Bay, Port Townsend, and Sequim Bay. Large octopus populations are found near Port Angeles, Dungeness, Port Discovery, and Port Townsend.

ii. fish

Salmon: Salmon are common all year round. The largest number occur in spring and summer. Highest concentrations are between Waddah Island, Port Townsend, and at Neah Bay, Port Angeles harbor, and Sequim and Discovery Bays. (See Figure II-A7.)

Other fish: All commercial bottom fishing occurs in the eastern part of the Strait, with Port Discovery being the primary area. Figure II-A6 depicts the geographic distribution.

iii. waterfowl

This is an area of high waterfowl density throughout the area especially near Dungeness Spit as noted in Figure II-A7.

6. Man-made physical resources

The man-made resources of interest in this study are those which are adjacent to the waters of Puget Sound. These include state parks, launching ramps, and rental moorages for vessels. The ramps and moorages include both public and private facilities. The following table summarizes this information. Figure II-A8 depicts the locations in subzone 1.

TABLE II-A3: MAN-MADE RESOURCES, SUBZONE 1²³

<u>Location</u>	<u>State Parks</u>	<u>Launching Ramps</u>	<u>Rental Moorages</u>
Neah Bay/Seiku	0	9	9
Port Angeles	0	1	2
Dungeness Bay	1	2	0
Sequim Bay	2	2	0
Discovery Bay	<u>0</u>	<u>2</u>	<u>0</u>
SUBZONE 1 - TOTAL	3	16	11

Three launching ramps and one rental moorage in this subzone are open to the general public.

b. Subzone 2: San Juan Islands-Bellingham

1. Geography

The San Juan Islands are bounded on the south by the Strait of Juan de Fuca, to the west by Haro Strait, to the north by the Strait of Georgia, and to the east by Rosario Strait. The straits and many channels between the islands have natural water depths of several hundred feet. The San Juan Archipelago consists of about 172 islands, although a total of 473 islands (rocks) are visible at low tide.²⁴ The islands are generally wooded and rocky. Numerous beaches of rock and gravel with some sand are visible only at low tide. The islands have about 376 miles of salt water shoreline.

The principal harbor facilities in this subzone are located at Bellingham, Anacortes and Friday Harbor. The islands have shorelines which are primarily steep and rocky, of limited accessibility, and which are bordered by rugged terrain of considerable relief. The major estuarine

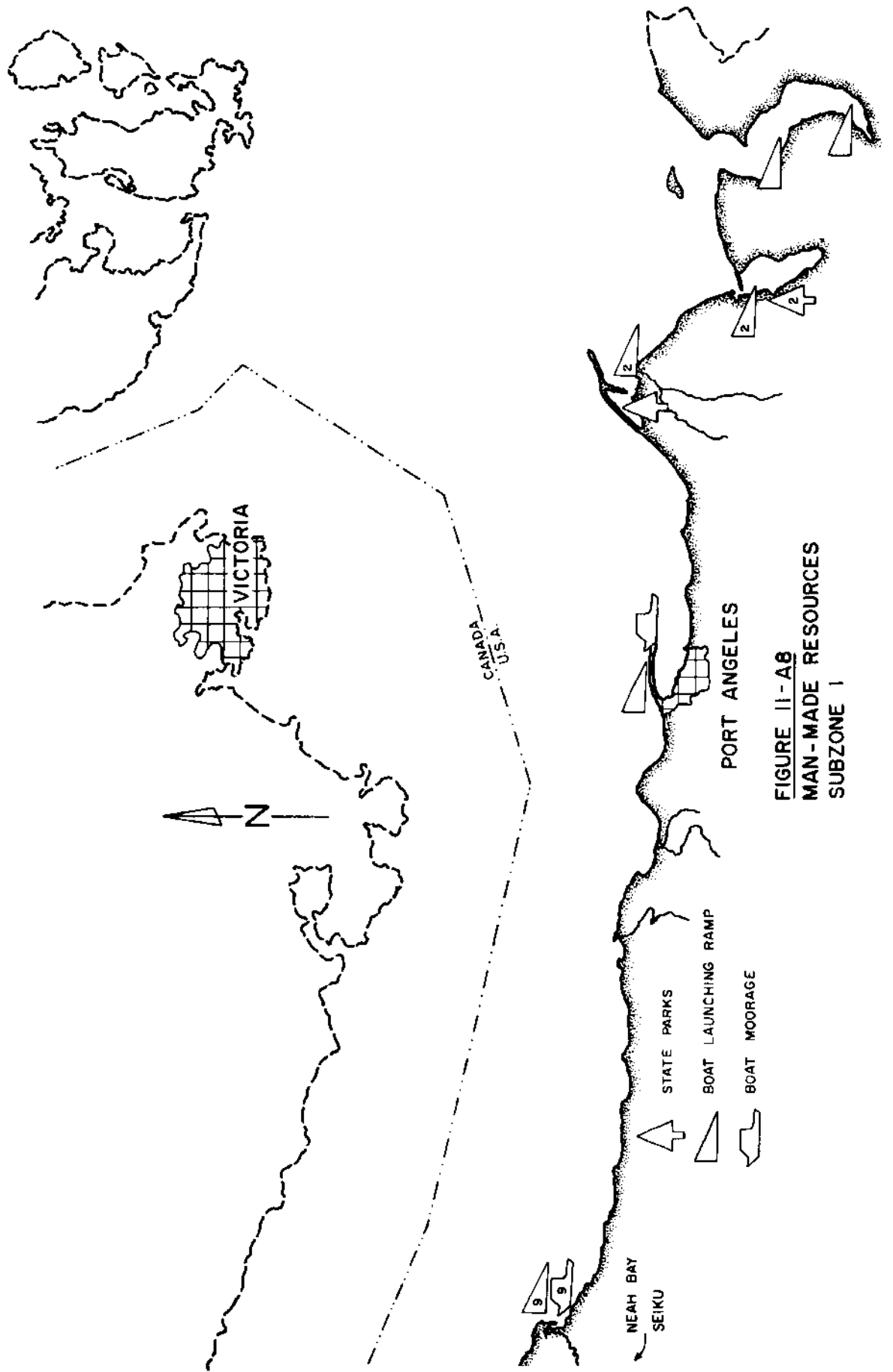


FIGURE 11-A8
MAN-MADE RESOURCES
SUBZONE 1

areas exist west of Bellingham, near Lummi Island and east of Anacortes in Padilla Bay. With the exception of the industrial, maritime, and commercial fishing operations at Bellingham and Anacortes, the remainder of the subzone is predominantly recreational and residential in use. Although there are 12 state parks and several public beaches in this region, much of the near-shore land is privately owned.

2. Currents

Due to the large number of constrictions to tidal flow, tidal currents in the San Juan Archipelago can attain very high local velocities.

In Haro Strait the flood current sets northward through the Strait, and the ebb in the opposite direction as shown on Figure II-A9 and II-A10. The ebb usually runs longer and has a greater velocity than the flood. At its northern entrance the flood sets eastward on both sides of Sucia Islands and eastward across Alden Bank. The velocity in Haro Strait is 1 to 5 knots. Off turn point the ebb may attain a velocity of 6 knots during large tides. The current develops moderate velocity between Sucia Islands and Orcas Island. Heavy tide rips occur on middle bank, northward of it, and around Discovery Island. Tide rips also occur between Henry Island and Turn point. Heavy, dangerous, tide rips are prevalent between East point and Patos Island and for 2 miles northward in the Strait of Georgia.

The currents in Lopez, Thatcher, and Obstruction Passes develop peak currents of 3 to 7 knots as they enter into Rosario Strait, creating hazardous conditions for smaller craft.

In the Strait of Georgia, the tidal currents are not nearly as strong as those in the channels leading to it from the Strait of Juan de Fuca. The currents in the Strait of Georgia attain velocities of about 3 knots at times, particularly during the freshets of the summer.

3. Winds

During the period from October to March, the winds are generally from the south-southwest to 20 mph. From April to September, winds tend to be southerly with velocities of 10 to 20 mph. Figure II-A11 shows monthly wind patterns for Bellingham.

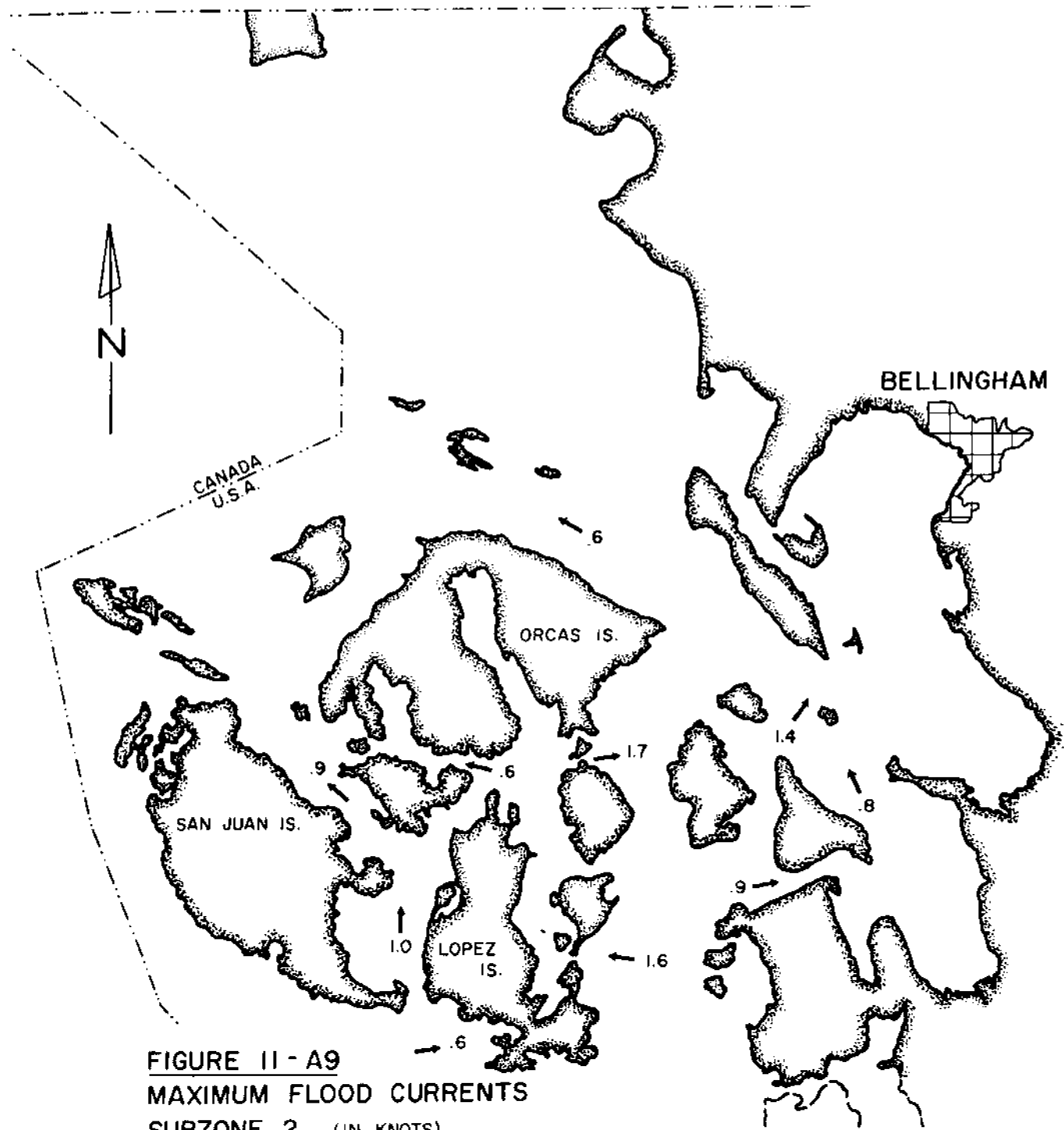


FIGURE 11 - A9
MAXIMUM FLOOD CURRENTS
SUBZONE 2 (IN KNOTS)

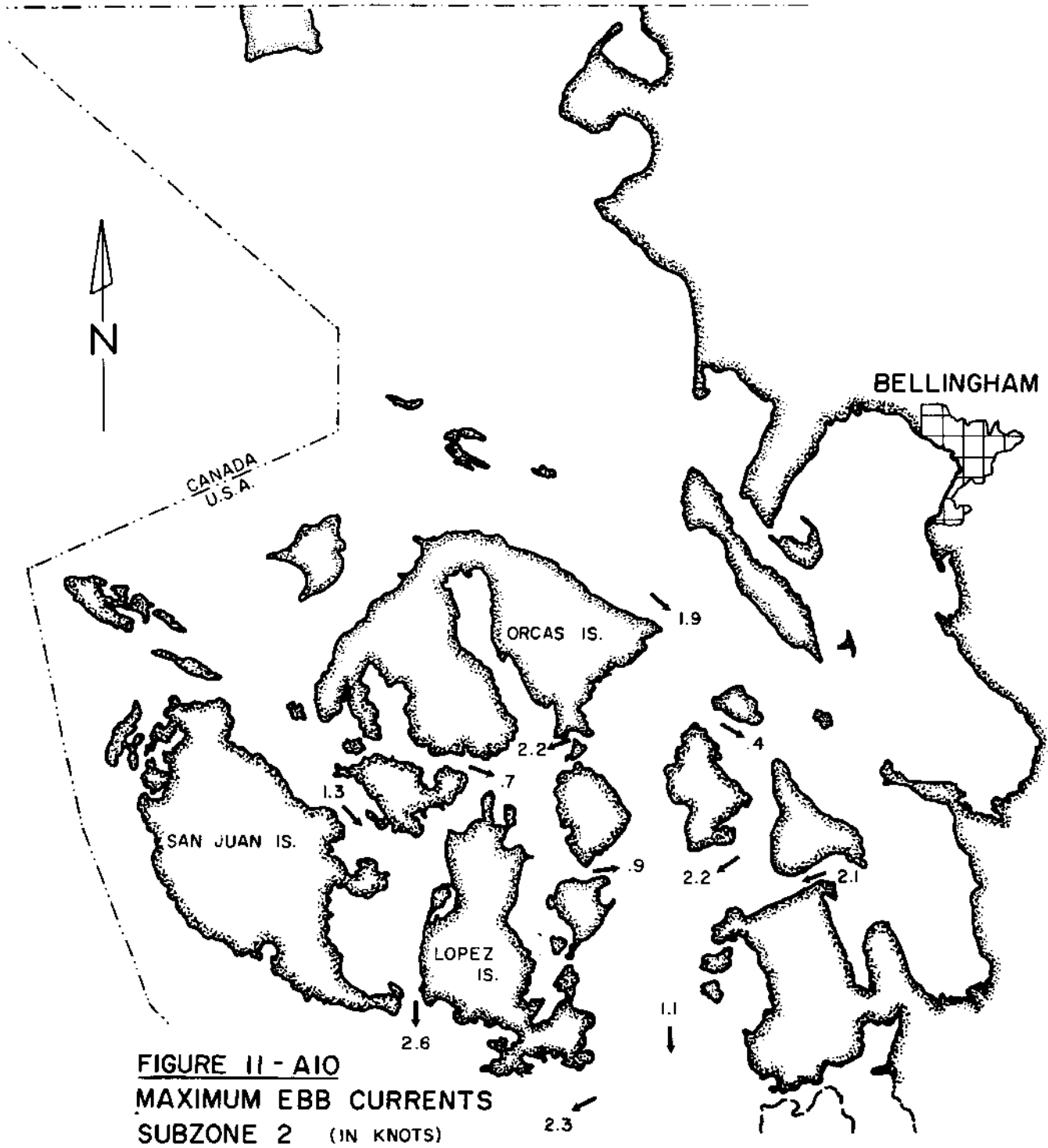
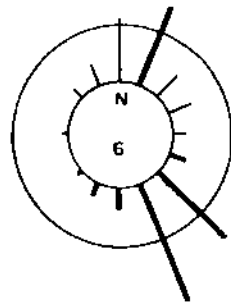
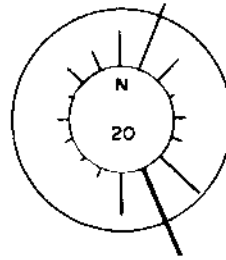


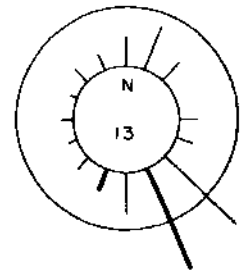
FIGURE II - A10
MAXIMUM EBB CURRENTS
SUBZONE 2 (IN KNOTS)



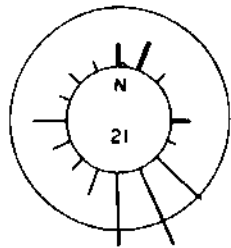
JANUARY



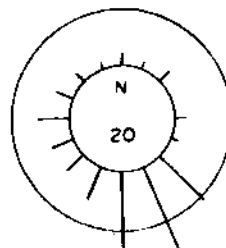
FEBRUARY



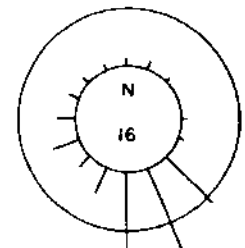
MARCH



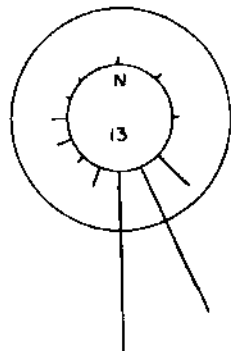
APRIL



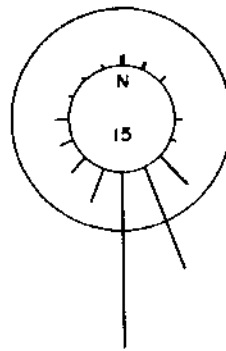
MAY



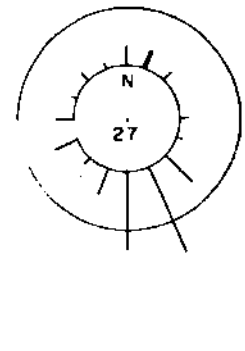
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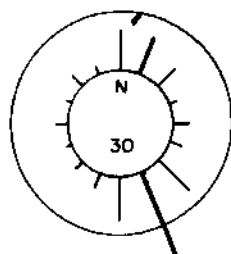
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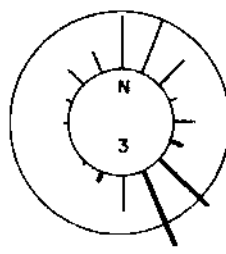
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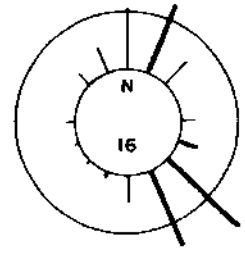
SEPTEMBER



OCTOBER



NOVEMBER



DECEMBER

FIGURE II-A11, WIND PATTERNS FOR BELLINGHAM AFTER HARRIS, 1954. WIDTH OF BAR INDICATES MONTHLY AVERAGE WIND VELOCITY, EACH RADIAL UNIT INDICATES 10 % OF TOTAL OBSERVATIONS, CENTRAL NUMERAL INDICATES PERCENTAGE OF CALM WIND. 0-10 MPH —, 11-19 MPH — 25

4. Waves

During the period from October to May, the maximum wave height in the Bellingham area may reach 5-1/2 feet. In all parts of the San Juan Islands not exposed to waves from the Strait of Juan de Fuca, the maximum wave height is less than 4 feet. Areas exposed to the Strait of Juan de Fuca may experience waves and swell of the size prevalent in the Strait. From June-September, maximum wave height will be less than 2 feet in the Bellingham-San Juan Islands region.

5. Natural physical resources

The proliferation of natural physical resources related to this subzone of Puget Sound is easily seen from a quick glance at Figures II-A12 through II-A14. The following describes the areas presented on the maps:

i. shellfish

Crabs: Dungeness crab are abundant throughout the zone. Areas of highest quantity occur around Sucia and Waldron Islands, Lopez Sound, Hunter Bay, Mud Bay, San Juan Channel, Upright Channel and Griffin Bay. Other areas rich in not included are Padilla, Boundary, Semiahmoo, Birch, Lummi, Bellingham, Samish, and Mitchell Bays, as well as the channels between the islands and the mainland and Spencer Spit. They are also located near Similk Bay and near Hope Island-Seal Rocks in Skagit Bay. Red crabs are moderately abundant in shallow waters in Skagit Flats and near oyster beds.

Oysters: Pacific oysters grow in moderate quantities along Dewey Beach in Similk Bay, and on gravelly and mud beaches from Skagit Island to Swinomish Flats. Pacific oysters also are found from Drayton Harbor (Clayton Beach) south, to the southern part of Samish Bay; William Point to Bay View (Padilla Bay). Lesser amounts inhabit Birch, Lummi, and Bellingham Bays, as well as the west side of Samish Bay, and areas along rocky beaches. Olympia and Kumamoto oysters occur only in Samish Bay.

Clams: The major clam producing areas include Portage, Bellingham, Chuckanut, Samish, Padilla, Fidalgo, and Burrows Bays. Butter and littleneck clams are bountiful in the Blaine-Pt. Roberts area, Birch, Portage, Samish, and Padilla Bays, and along the shores of most islands.

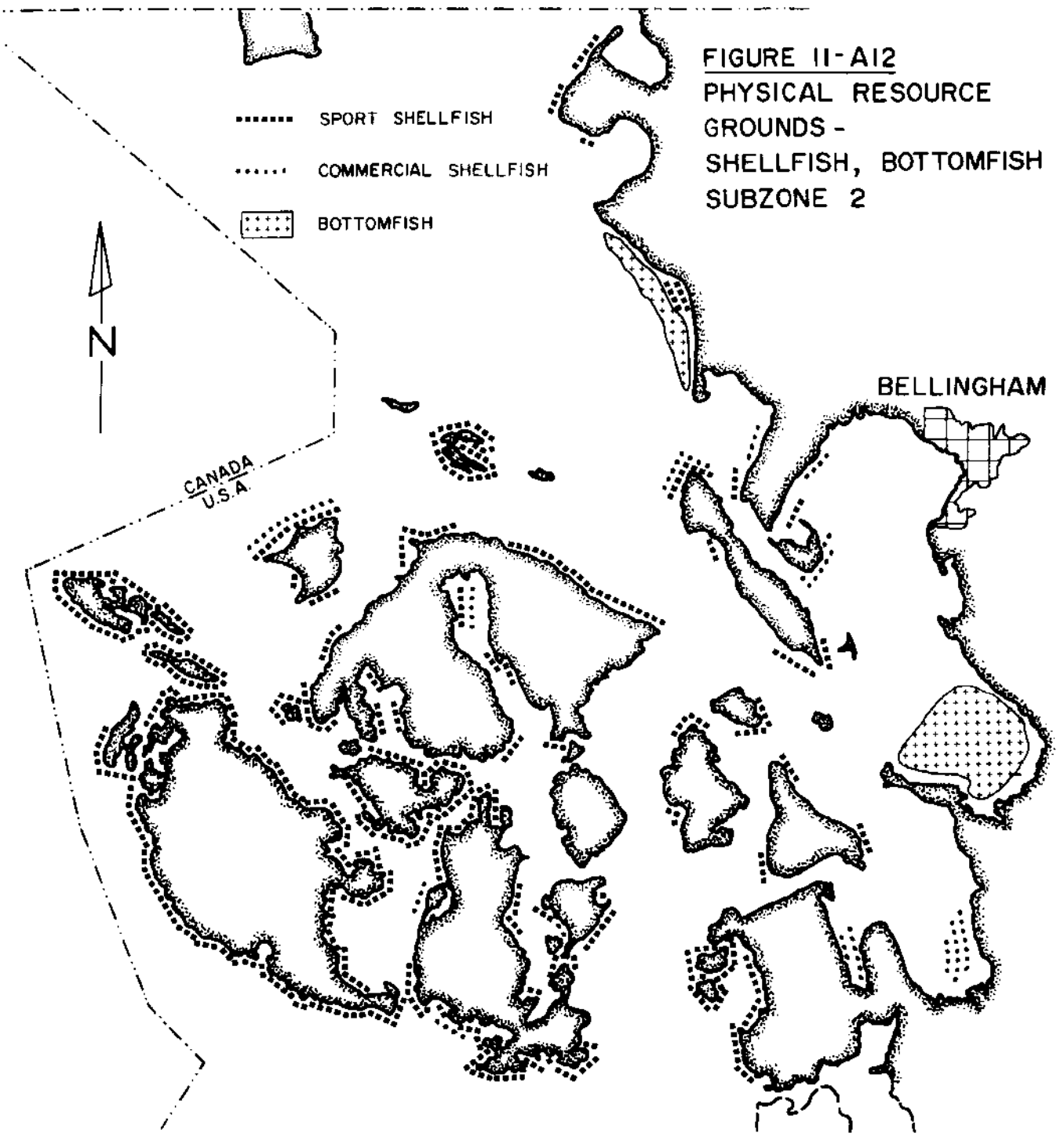
FIGURE II-A12
PHYSICAL RESOURCE
GROUNDS -
SHELLFISH, BOTTOMFISH
SUBZONE 2

- SPORT SHELLFISH
- COMMERCIAL SHELLFISH
- BOTTOMFISH



CANADA
U.S.A.

BELLINGHAM



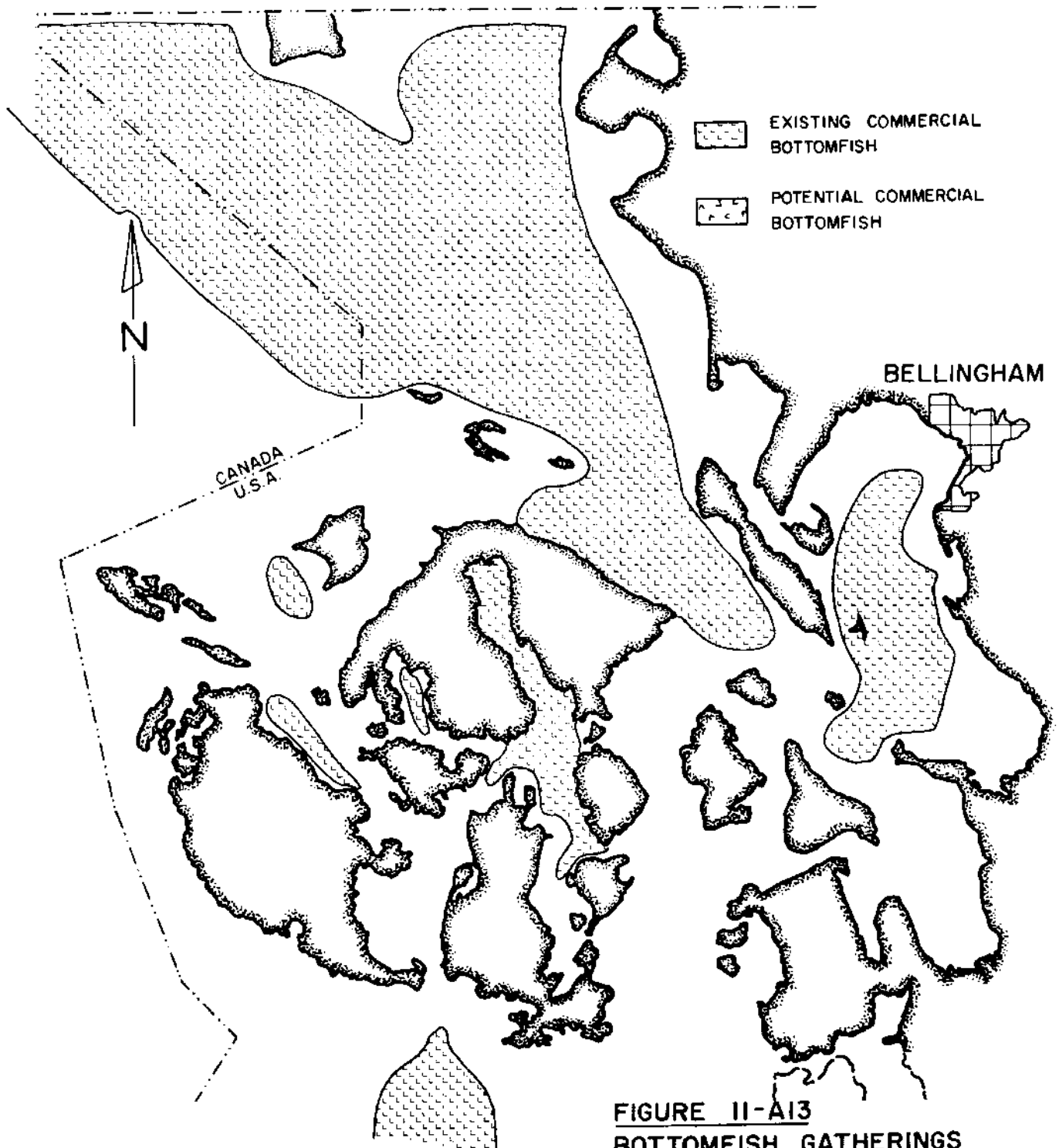


FIGURE II-A13
BOTTOMFISH GATHERINGS
SUBZONE 2

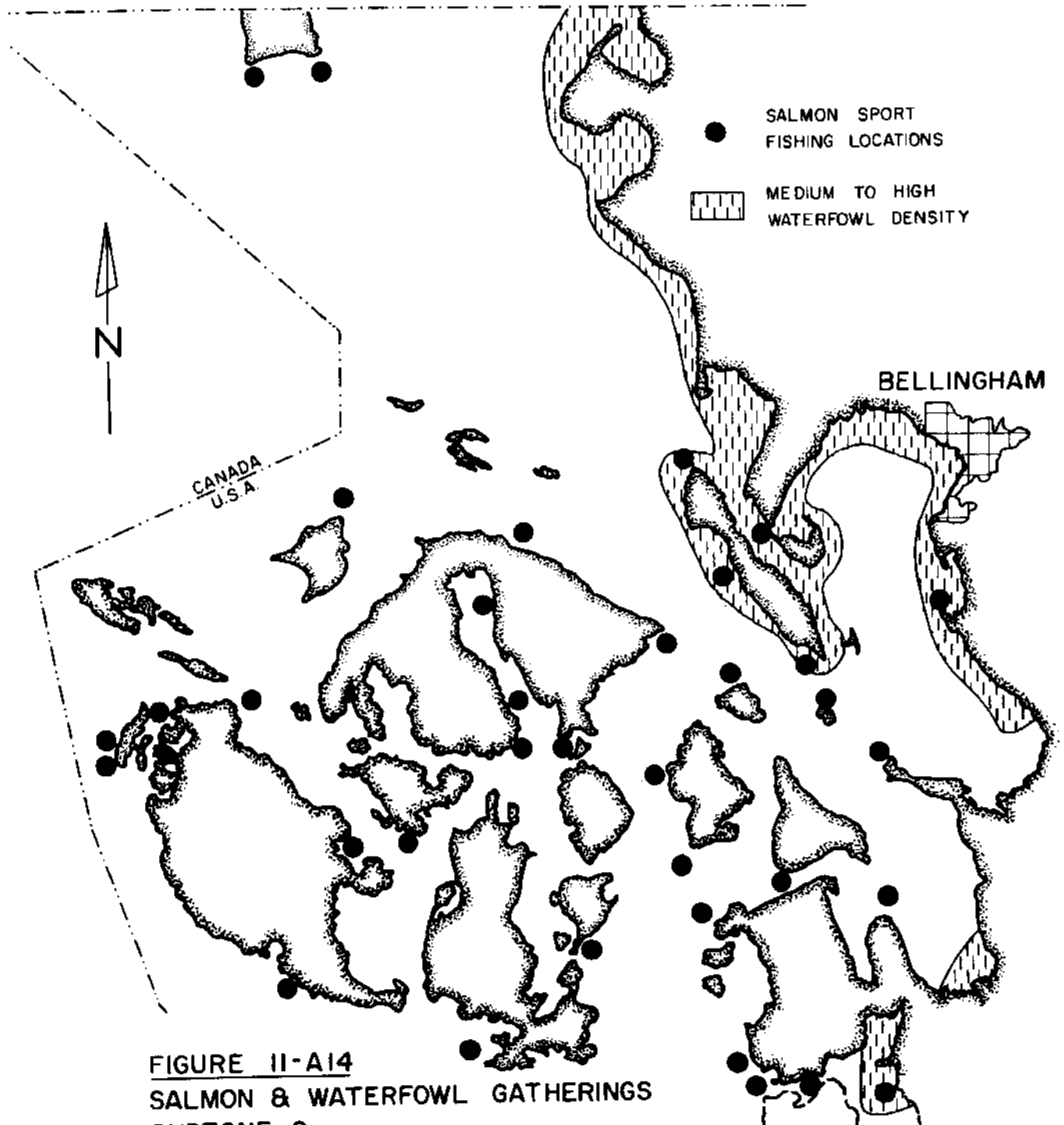


FIGURE II-A14
SALMON & WATERFOWL GATHERINGS
SUBZONE 2

They are also common, along with manila clams, in the northern part of Skagit Bay and from Dewey Beach to Swinomish Flats. Horse and softshell clams are plentiful on Skagit Bay. Geoducks are relatively scarce in this area.

Shrimp: Spot, pink and sidestripe shrimp are common in Bellingham Bay. These and coon stripe shrimp occur off Similk Bay in main channel, and in San Juan channel.

Other shellfish: Sporadic concentrations of squid occur around the San Juan Islands and in the general area of Skagit Flats. Pink scallop are found scattered around the larger bays. Rock scallops are common around the San Juan Islands. Pink scallops are found between Sucia and Waldron Island, and between Waldron and Stuart Islands, in parts of President Channel and in Upright Channel. Abalone, both pinto and red, occur around many of the San Juan Islands. Pinto abalone are most common in the northern San Juan Islands. Blue mussels are abundant on the rocky shores of San Juans and on most northern shorelines. California mussels are found in small numbers in much the same areas as the blue mussel. Octopi are very common throughout this area, especially around the San Juan Islands.

ii. fish

Salmon: Salmon are plentiful throughout the subzone the year round as shown on Figure II-A14. The San Juan Islands and Point Roberts are two of the most popular commercial fishing areas on Puget Sound. Salmon seem to congregate in many locations in this subzone, especially Harney Channel, Mosquito Pass, East Sound, Lopez Pass, and Guemes Channel near Anacortes.

Other fish: Principal commercial fishing locations include eastern Rosario Strait, Skagit Bay, south Samish Bay, outer Bellingham Bay to San Juan and north to Blaine, west to Rosario Strait, San Juan Channel, Saratoga Passage, and off Sucia Island and West Beach.

iii. waterfowl

Waterfowl density is generally low around the San Juan Islands. The common range of waterfowl usually extends from just west of Cypress Island north to the Canadian border, and south to Deception Pass. Medium to high

waterfowl density in Padilla and Samish Bay, around Lummi Island and Bellingham Bay. Medium to high waterfowl density occur near the shore from Padilla Bay to the Canadian border. A lower waterfowl density occurs around Point Roberts. Figure II-A14 illustrates the location of waterfowl in subzone 2.

6. Man-made physical resources

In addition to the abundance of natural resources, man-made resources are also plentiful around the waters of Subzone 2. The following table lists these resources by location, and these are shown in Figure II-A15.

TABLE II-A4: MAN-MADE RESOURCES, SUBZONE 2²⁶

Location	State Parks	Launching Ramps	Rental Moorages
Boundary Pass	3	0	2
Haro Strait	0	4	0
San Juan Channel	2	6	2
East Sound-Harney Channels	0	5	5
Strait of Georgia	3	1	1
Semiahmoo-Birch Bays	1	4	2
Lummi Is. (west side)	0	1	2
Hale Passage	0	1	1
Bellingham Bay	1	2	2
Burrows Bay	1	2	1
Guemes Channel- Padilla Bay	<u>1</u>	<u>3</u>	<u>3</u>
SUBZONE 2 - TOTAL	12	29	21

Twelve of the launching ramps and three rental moorages in this subzone are available to the general public.

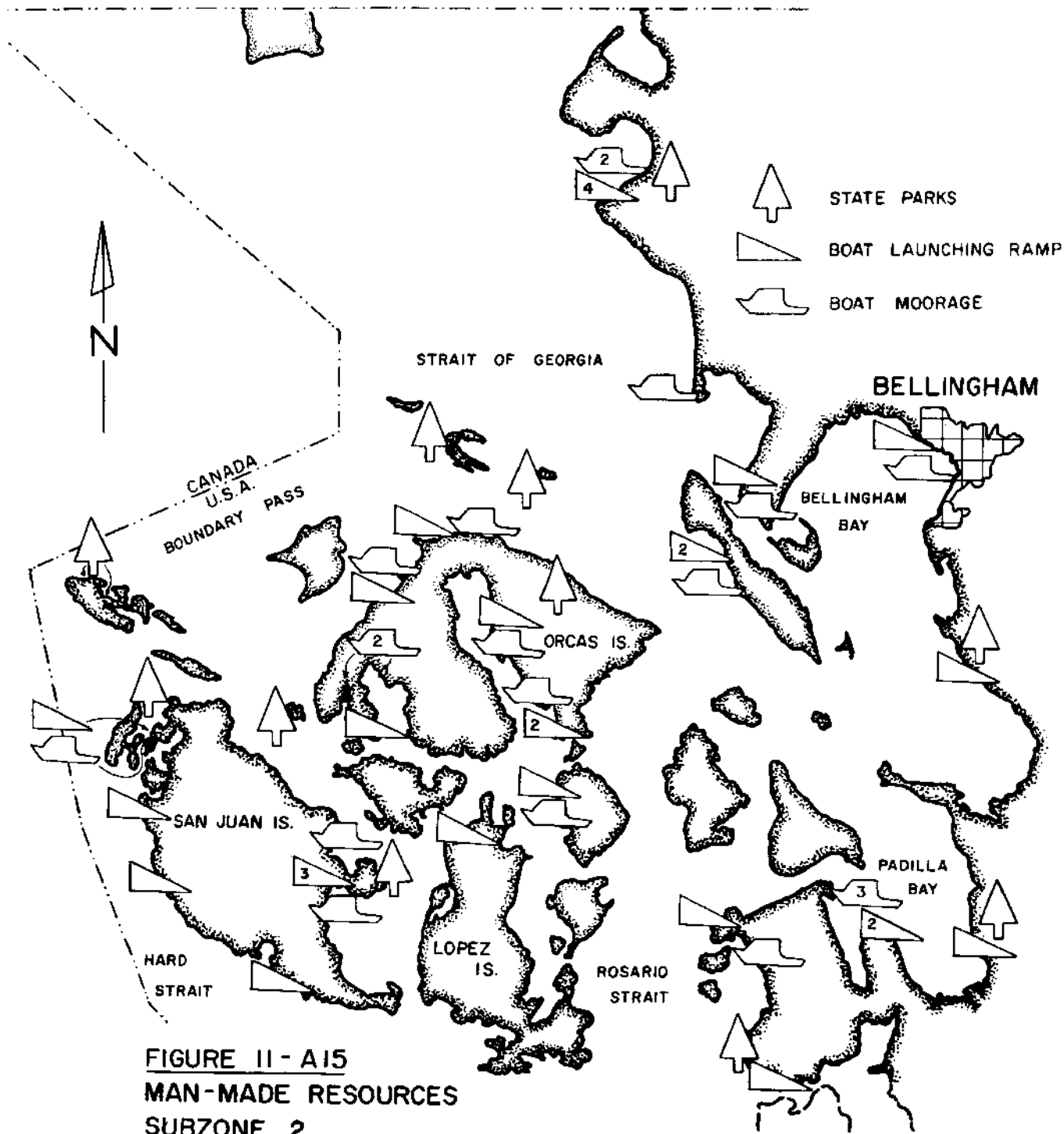


FIGURE II - A15
MAN-MADE RESOURCES
SUBZONE 2

c. Subzone 3: Whidbey Island-Everett

1. Geography

Located to the north of Puget Sound proper, this subzone includes several prominent geographical features. Whidbey Island, to the east of the Strait of Juan de Fuca, comprises 165 square miles of area and is the second largest island in the continental United States. Camano Island lies to the east of Whidbey Island and its 45 square mile area is enclosed by the bays and estuaries of Skagit Bay, Saratoga Passage, and Port Susan. Whidbey and Camano Islands are both agricultural and recreational in land use as are the mainland areas to the east of the subzone. Both islands are long and narrow, and no point on either is more than 2.5 miles from the sea. Most of the land surface is rolling uplands that range in altitude from 100 to 300 feet, but may exceed 500 feet in some places.

Whidbey Island has a number of minor harbors with ferry landings or piers for other local traffic. Minor harbors are located at Oak Harbor, Coupeville, Columbia Beach, Juan de Fuca, and Coronet Bays. Numerous single family recreational residences exist on the shorelands, usually on banks of considerable relief. The port of Everett is the most populated area of the subzone with industrial as well as recreational and residential land uses.

Most of the beaches in Similk and Skagit Bays are silty clay with some sand. Broad tide flats characterize Skagit Bay from Swinomish Slough to Stanwood. The Skagit Flats are exposed at mean lower low water (MLLW) for 1.5 to 2 miles bayward. Shallow mud flats extend into Port Susan and Skagit Bay 2 to 3 miles from the mouth of the Stillaguamish River. Broad tide flats also predominate in northern Port Susan. The shore between Kayak Point and Tulalip is shorter and steeper, with rock and gravel predominating as on the beaches exposed to considerable wave and current action on Whidbey and Camano Islands. Beaches from Everett south to Edmonds are predominantly faced by banks with narrow, sloping beaches consisting mostly of rock and gravel.

Accessibility from land to the beaches on Whidbey and Camano Islands as well as most of the tidelands of Skagit Bay to the north and from Everett to Edmonds to the south is hampered by the prevalence of steep banks or broad tidelands with only very intermittent connections by public roads.

The shoaling of the shorelines in many places restricts the accessibility of the beaches from the water by boat.

2. Currents

In Admiralty Inlet, the tidal currents are subjected to daily inequalities similar to those of the tides. Velocities of 2 to 5 knots occur from Point Wilson to Point No Point. In the more open waters of the Sound, southward of Point No Point, the velocities are much less. At Point Wilson and at Marrowstone Point, slack water occurs from one-half to one hour earlier near shore than in midchannel. In the winter when southerly winds prevail, there is generally a northerly surface drift which increases the ebb current and decreases the flood current. This effect is about .5 knot between Nodule and Bush Points. The tidal currents in the southern entrance to Possession are weak and variable.

With the exception of Deception Pass, tidal currents in the waters of Skagit Bay, Saratoga Passage and Port Susan are generally moderate to weak. Currents in the narrows of Deception Pass attain velocities of 5 to 8 knots and more, especially at times when strong eddies are formed along the shores. With westerly winds, heavy swells and tide rips form and make passage dangerous to small craft. Figures II-A16 and II-A17 summarize the flood and ebb current patterns, respectively.

3. Winds

During the period from October to March the winds are predominantly southerly to 20 mph. From April to September, the prevailing winds are northwesterly to 10 mps. Figure II-A18 shows monthly surface wind patterns for Everett.

4. Waves

From October to March, an effective fetch of over 30 miles to the east of Whidbey Island would cause wave heights of 6 feet at maximum in the area east of the southern part of Whidbey Island. In the region of Saratoga Passage and Port Susan, waves of a maximum height of less than 5 feet may be expected in the northern reaches. Waves in Possession Sound should be less than 2 feet.

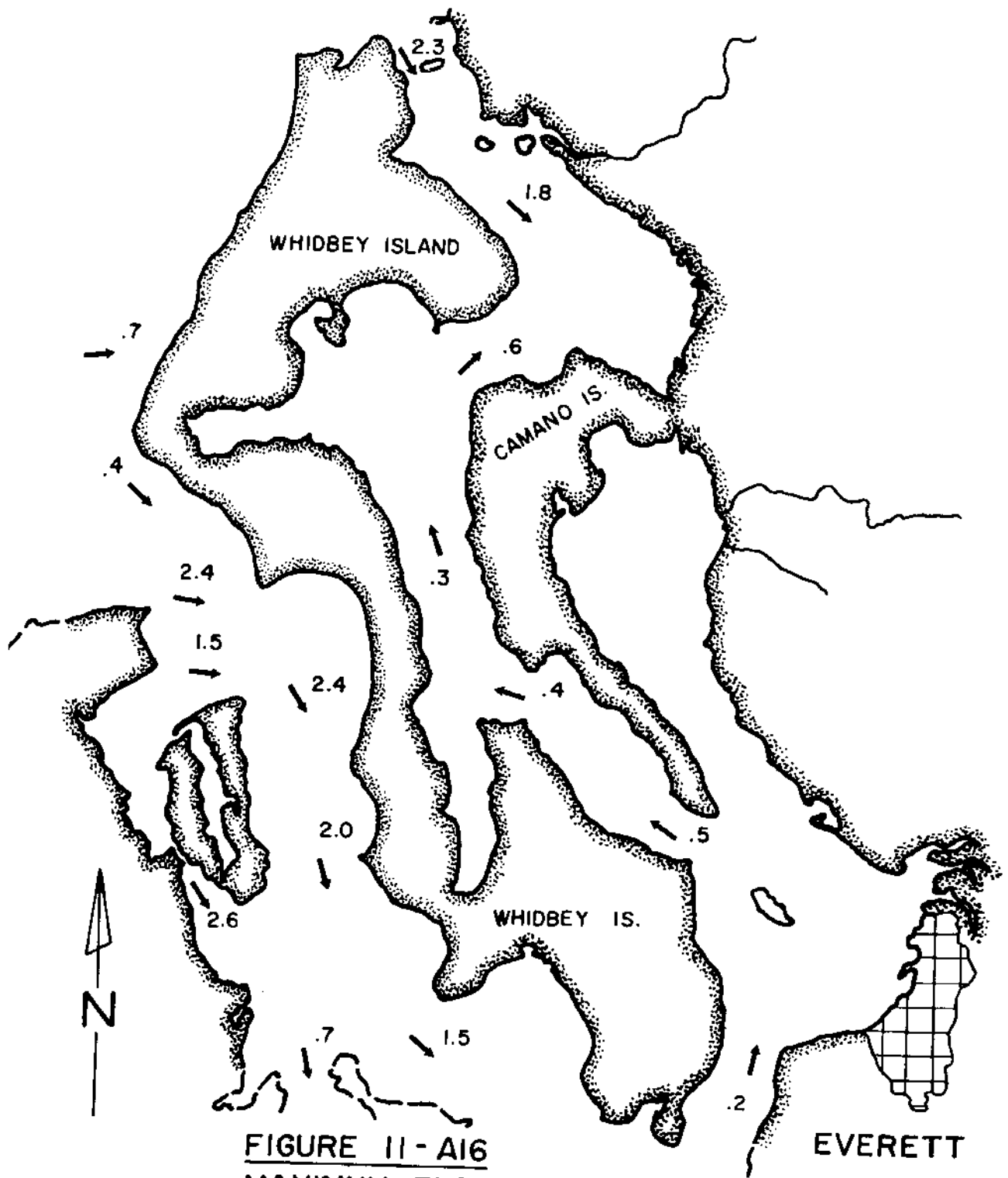


FIGURE II-A16
 MAXIMUM FLOOD CURRENTS
 SUBZONE 3 (IN KNOTS)

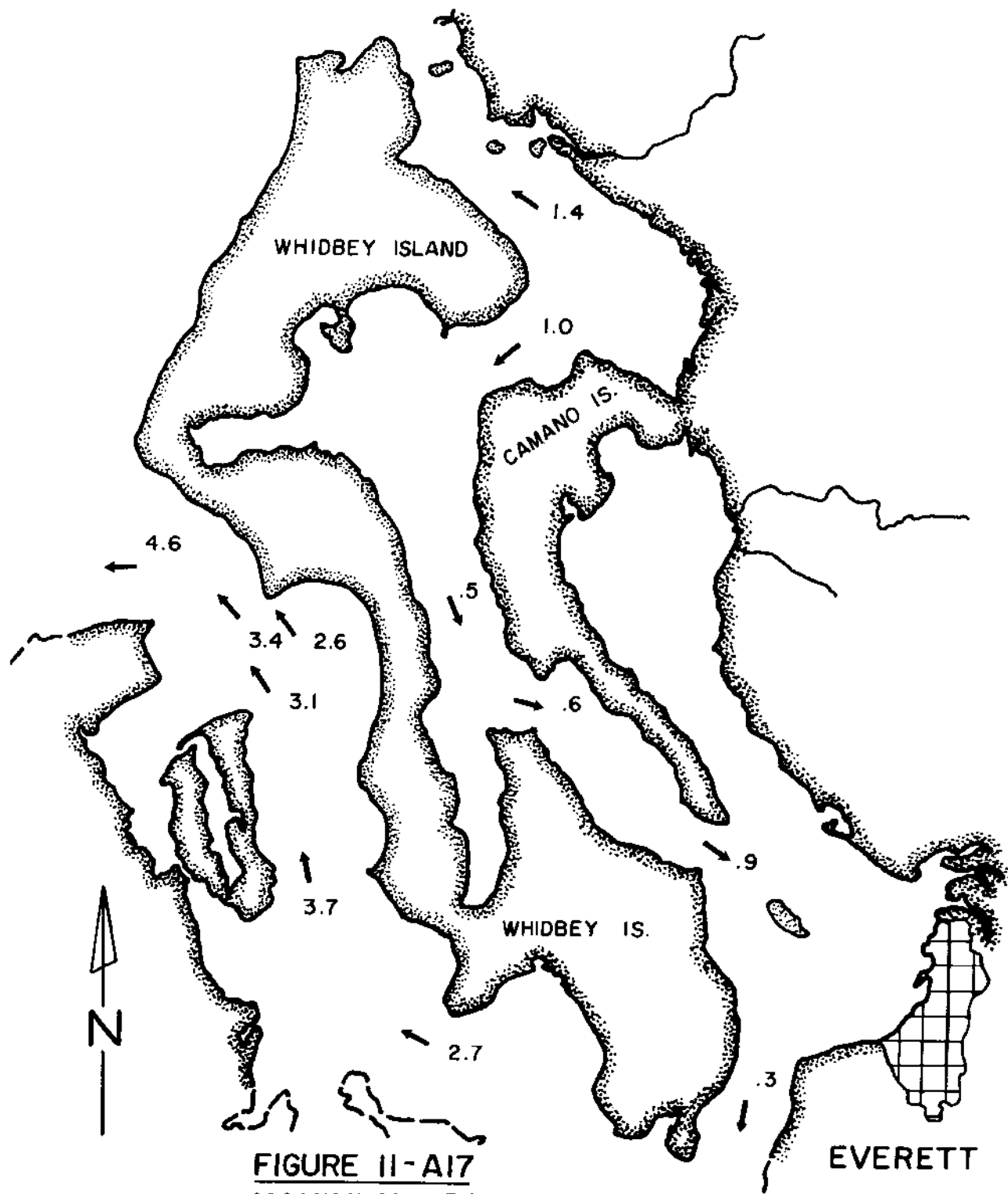
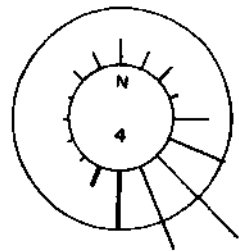
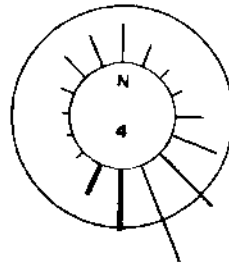


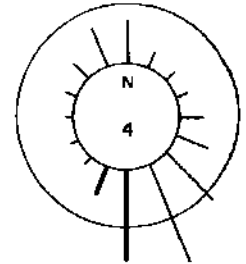
FIGURE 11-A17
MAXIMUM EBB CURRENTS
SUBZONE 3 (IN KNOTS)



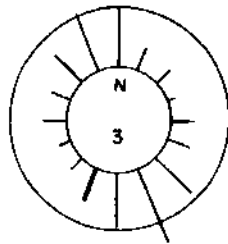
JANUARY



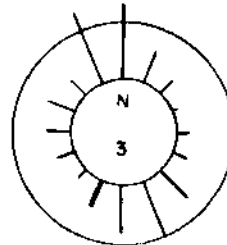
FEBRUARY



MARCH



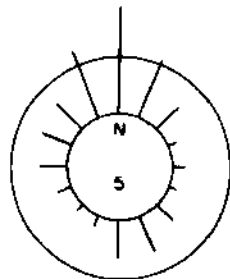
APRIL



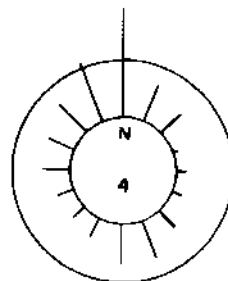
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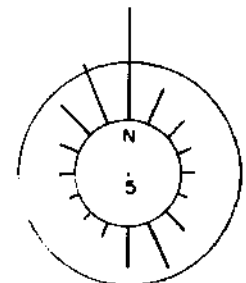
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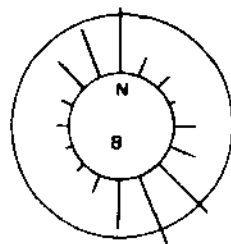
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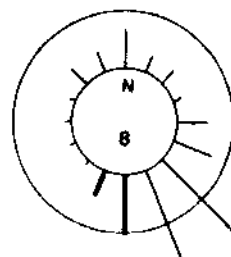
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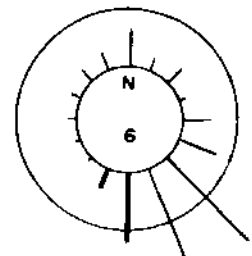
SEPTEMBER



OCTOBER



NOVEMBER



DECEMBER

FIGURE II-A18, WIND PATTERNS FOR EVERETT AFTER HARRIS, 1954. WIDTH OF BAR INDICATES MONTHLY AVERAGE WIND VELOCITY, EACH RADIAL UNIT INDICATES 10% OF TOTAL OBSERVATIONS, CENTRAL NUMERAL INDICATES PERCENTAGE OF CALM WIND. 0 - 10 MPH — , 11 - 19 MPH ———²⁷

From April until September, the waters of the subzone with the exception of those lying to the west and southwest of Whidbey Island should be predominantly less than 2 feet.

5. Natural physical resources

The Whidbey Island-to-Everett subzone is not as rich as other Puget Sound regions with respect to natural physical resources. The most plentiful species in this area are clams and marine fish. Figures II-A19 through II-A21 depict the distribution of the resources described below.

1. shellfish

Crabs: Dungeness crabs are found in only moderate quantities in this area, with the largest populations around Whidbey Island, especially the southern part. Large populations also occur in Saratoga Passage, Port Susan, Possession Sound, and in Cutlus, Useless, and Mutiny Bays. Dungeness crabs are also found in the Stillaguamish Flats, from Spee-bi-dah to Hermosa Point, from Mission Beach to Port Gardner, and near the shore of the Everett boat basin to Mukilteo past to Edmonds. Dungeness are common in the shallow waters around Gedney Island. Red crabs occur in the same general area.

Oysters: Generally speaking, oysters are not common in this subzone. Pacific oysters are in scattered locations in sheltered bays around Whidbey Island. Olympia and Kumamoto oysters are scarce.

Clams: The entire region is an excellent habitat for clams which are abundant on nearly all of the tidal zones. Littleneck and butter clams are especially plentiful from Mission Beach to Priest Point, around Edgewater Beach, and from Elliott Point to Edwards Point. Softshell clams and horse clams occur along the shore opposite Skagit Flats.

Other shellfish: Geoducks and scallops are found scattered in the deeper waters. Pink and spot shrimp are abundant in Saratoga Passage as far north as Oak Harbor; they also populate Possession Sound, Admiralty Inlet, and Port Gardner. Large number of squid are found in Saratoga Passage and Holmes Harbor. The greatest populations occur during the winter. Octopi are abundant throughout. Blue mussels are common throughout the region.

FIGURE 11-A19
 PHYSICAL RESOURCE GROUNDS -
 SALMON & SHELLFISH
 SUBZONE 3

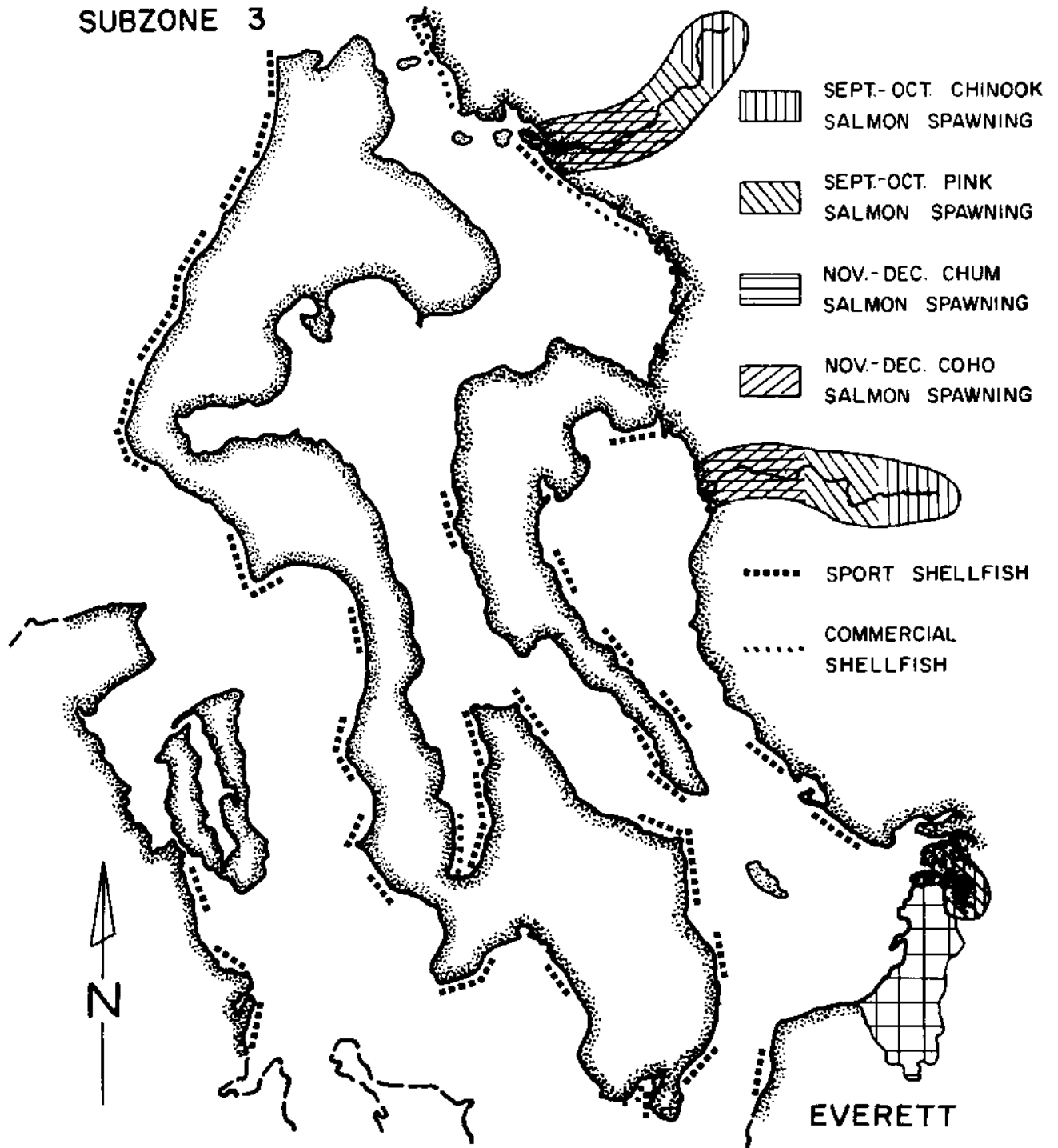


FIGURE II-A20
BOTTOMFISH GATHERINGS
SUBZONE 3



EXISTING COMMERCIAL
BOTTOMFISH



POTENTIAL COMMERCIAL
BOTTOMFISH

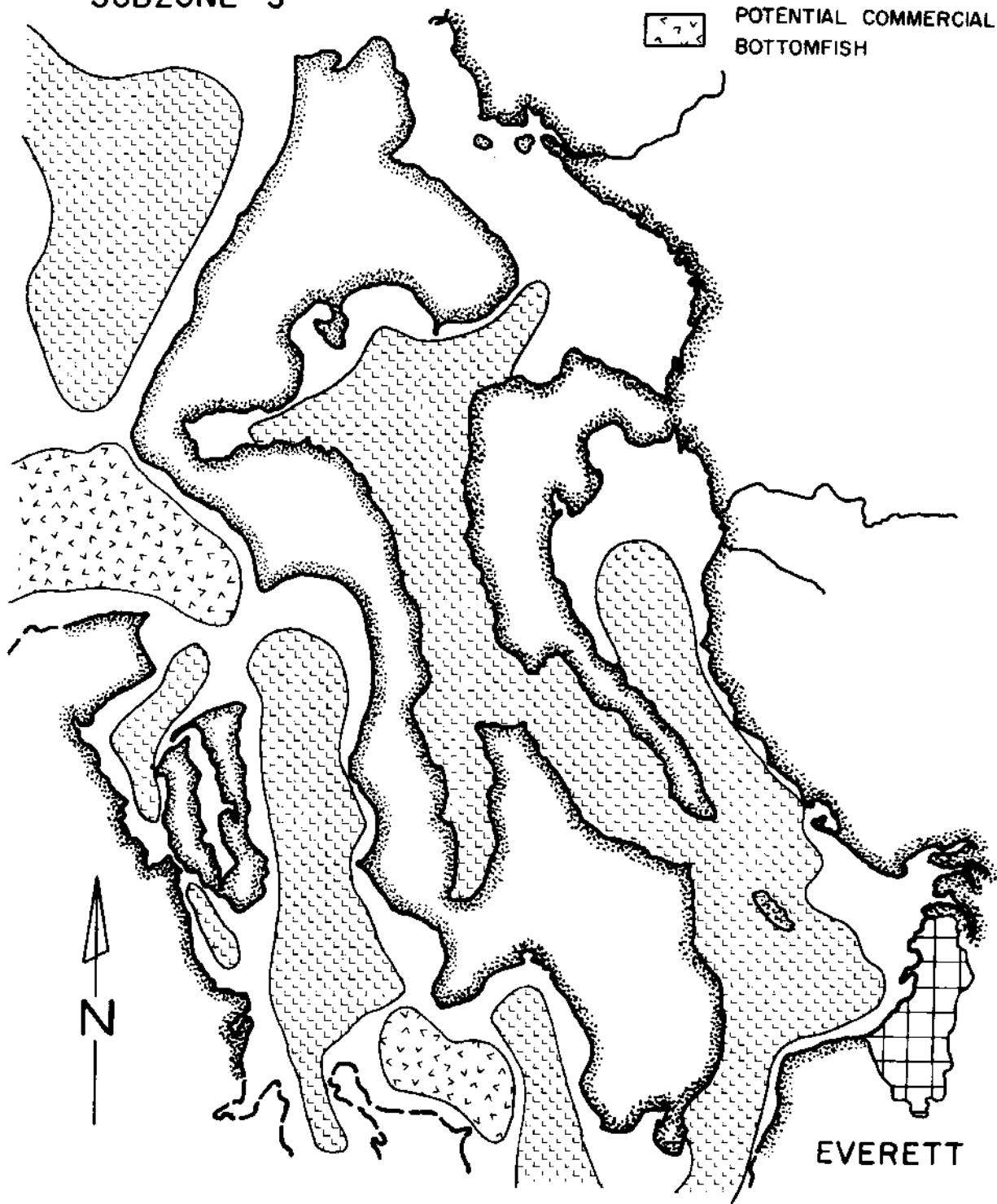
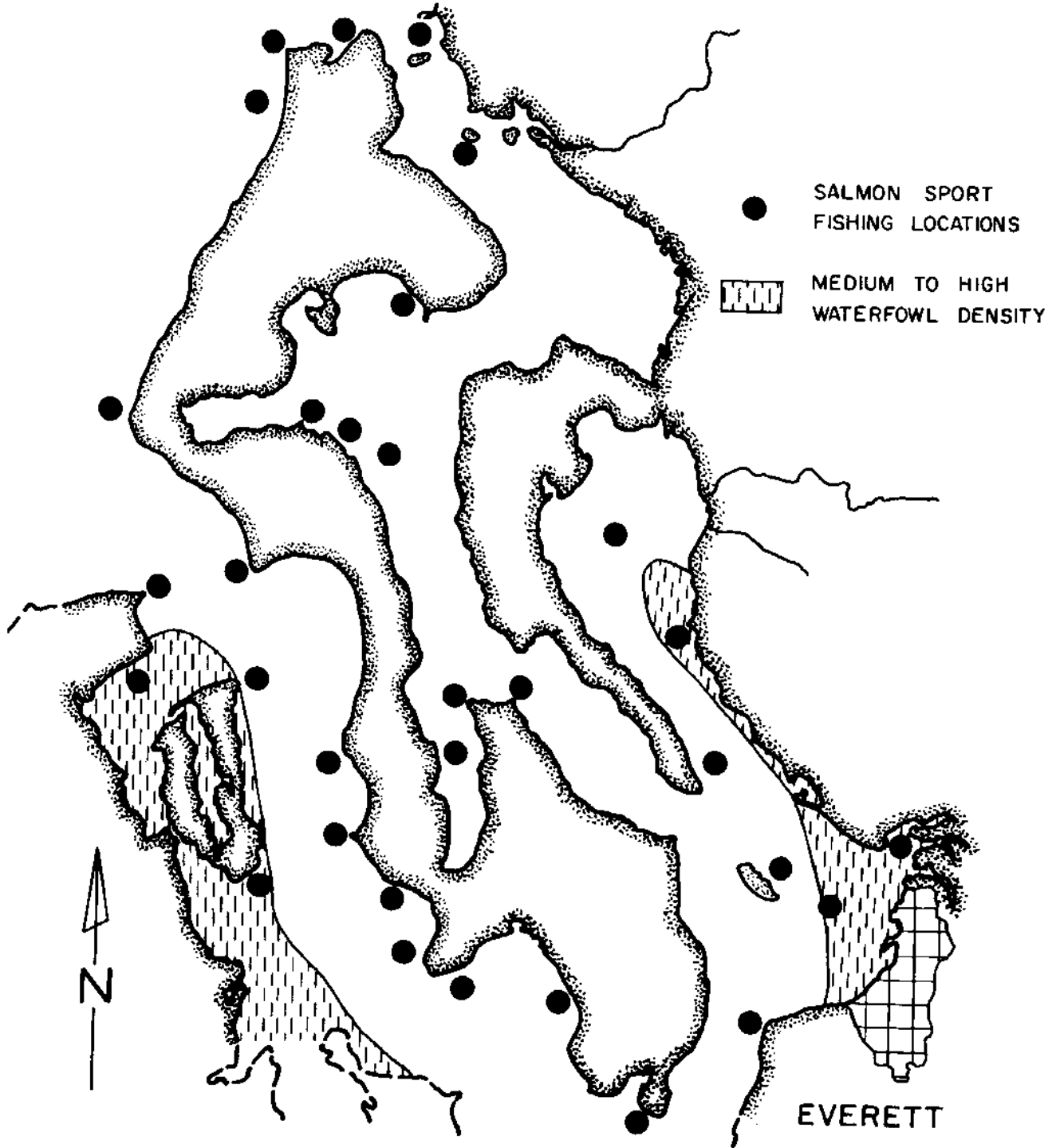


FIGURE II-A21
SALMON & WATERFOWL GATHERINGS
SUBZONE 3



ii. fish

The waters around West Beach, Bush Point, Point No Point, Possession Bay, near Edmonds, Richmond Beach, Camano Head, Baby Inland, Holmes Harbor are amply stocked with salmon. (See Figure II-A21.) Ground-fish, such as herrings, are found in Saratoga Passage and Holmes Harbor.

iii. waterfowl

Waterfowl are not common around Whidbey or Camano Islands. Medium to high waterfowl density exists in the entrance to Hood Canal and Port Townsend. High waterfowl density occurs in Port Susan and near the mouth of the Skagit River.

6. Man-made physical resources

Subzone 3, with its extensive shoreline, has a multitude of parks, launching ramps, and boat moorages. These are listed below, and their distribution is shown in Figure II-A22.

TABLE II-A5: MAN-MADE RESOURCES, SUBZONE 3²⁸

Location	State Parks	Launching Ramps	Rental Moorages
Skagit River mouth	0	3	2
E. side, Admiralty Inlet	3	3	1
Deception Pass	2	4	1
Saratoga Passage- Holmes Harbor	1	10	3
Skagit Bay	1	0	1
N. Possession Sound	0	1	1
Port Gardner	0	2	4
S. Possession Sound	1	2	0
Port Townsend	<u>3</u>	<u>6</u>	<u>2</u>
SUBZONE 3 - TOTAL	11	31	15

Not included were city and county parks, and private beaches, since these data were not available.

d. Subzone 4: Northern Puget Sound

1. Geography

Northern Puget Sound includes the most populated and industrialized of the subzones in this study. On the eastern shore of northern Puget Sound a nearly continuous urban/suburban complex extends over 60 miles from Everett to Seattle to Tacoma. The shores bordering this eastern part of the subzone have a very high density of industrial, residential, and recreational facilities, many of which are of very high economic value.

The eastern shore is dominated by narrow beaches of gravel and rocks and a few sandy beaches which are heavily utilized for recreational purposes. Generally, the shores are bordered by steep banks of considerable relief or by man-made structures such as piers, but accessibility from land is quite adequate by public roads.

The western shores of this subzone are predominantly residential and recreational. As bedroom communities of Seattle, settlements near ferry services are comparatively dense in residential use, whereas the areas not directly adjacent to the ferry landings at Kingston, Winslow, and Bremerton are slightly agricultural or primarily recreational. For the most part, the character of the shoreline of the western side of this subzone is uniformly narrow rocky beaches adjacent to banks or cliffs which are of rugged relief and of limited accessibility from land.

However, in comparison to the eastern shore of this subzone, the western shore is indented with numerous bays and long sheltered inlets. Port Madison, Liberty Bay, Dyes Inlet, and Sinclair Inlet are sheltered from the main body of Puget Sound by Bainbridge and Blake Islands to the east. The shores of these long narrow bays are muddy tide flats in some places, in contrast to the steeper rocky shores of the more unprotected waters.

2. Currents

The tidal currents in this subzone are relatively weak when compared to the conditions in other subzones as shown in Figures II-A23 and II-A24. From the main body of the Sound, from Point Wells to Elliott Bay and south to Point Pully, the tidal currents are normally less than a knot during peak ebb and flood. However, constricted passages such as Agate Passage and Rich Passage may exhibit local velocities up to 6 knots.

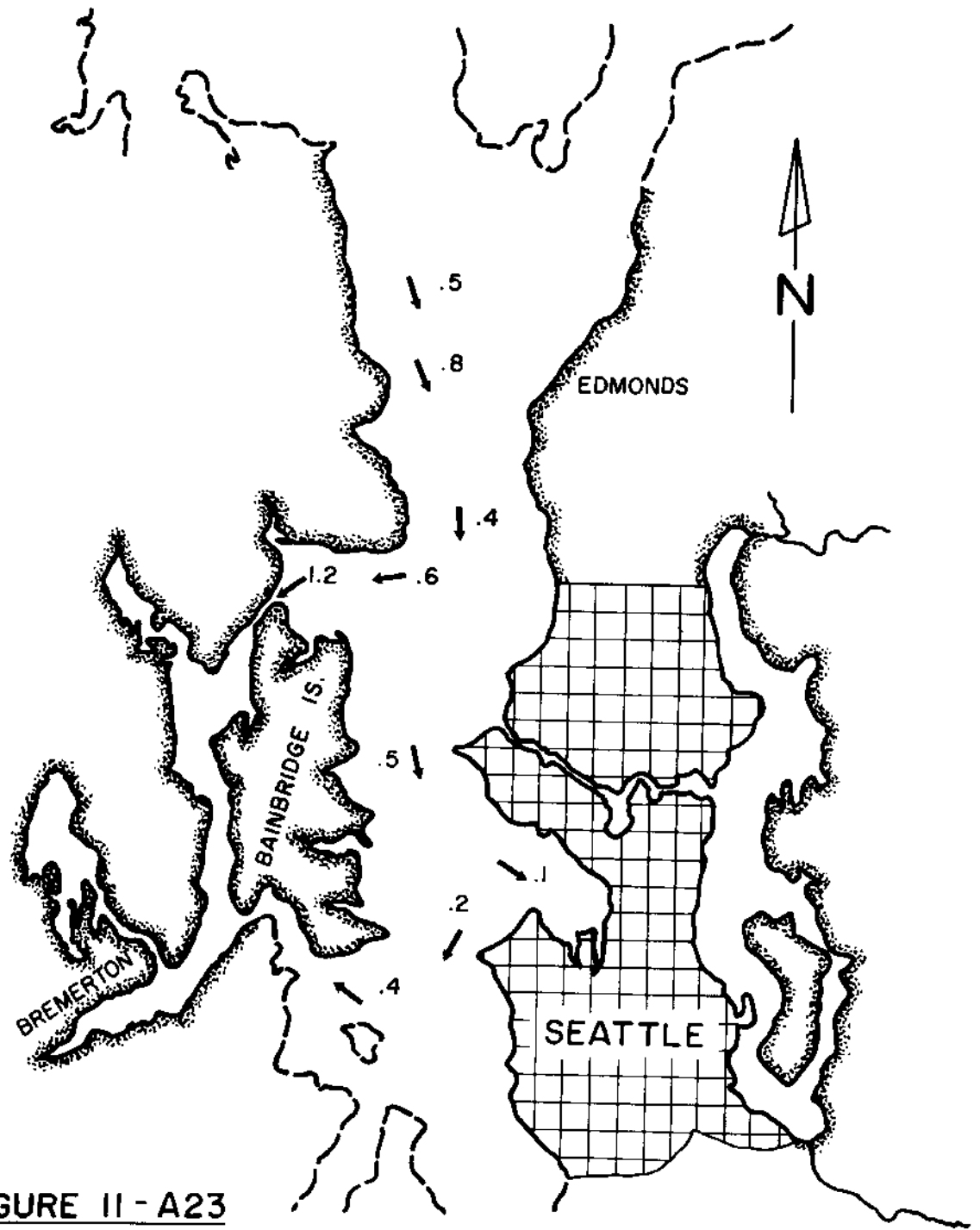


FIGURE II - A23
MAXIMUM FLOOD CURRENTS
SUBZONE 4 (IN KNOTS)

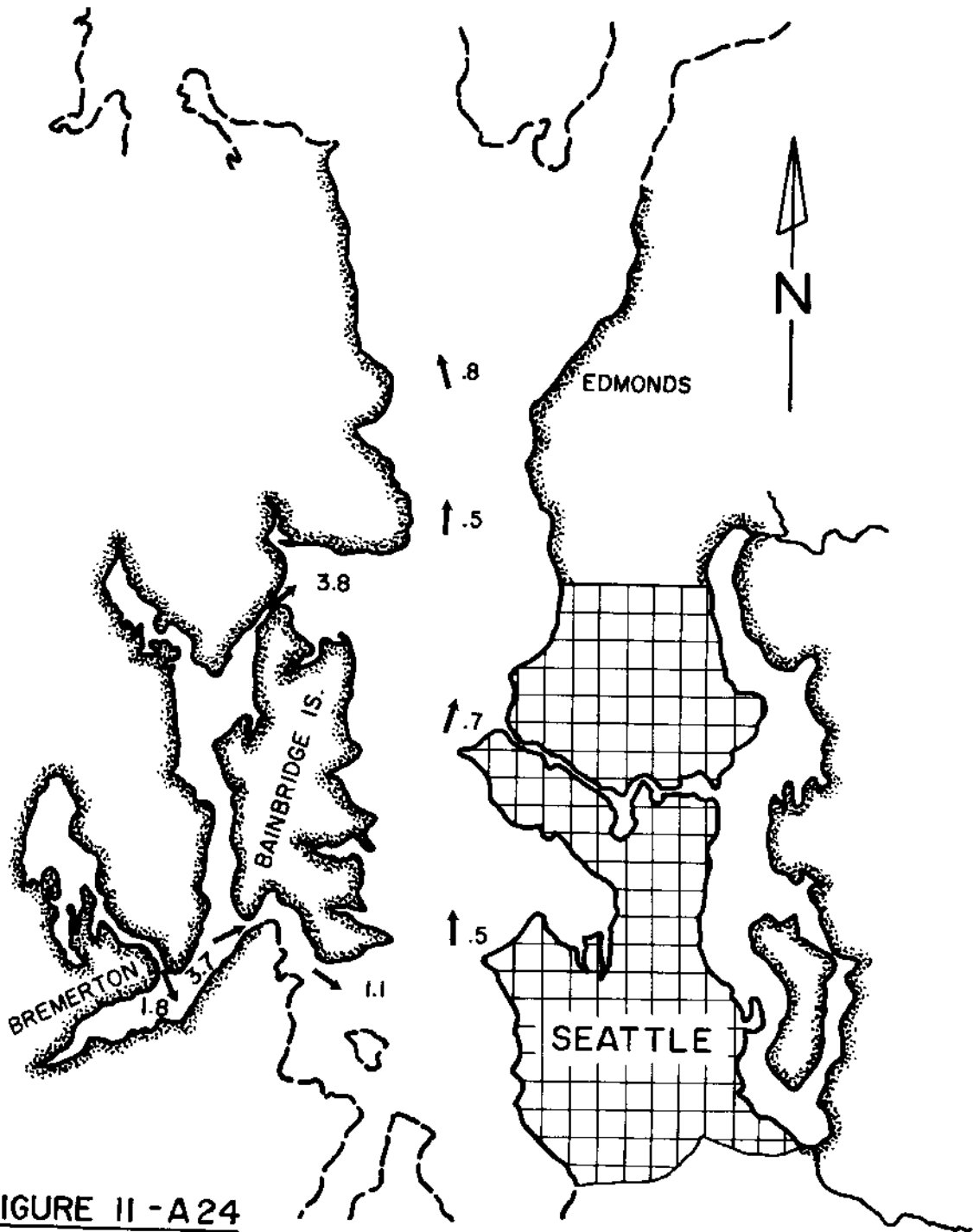
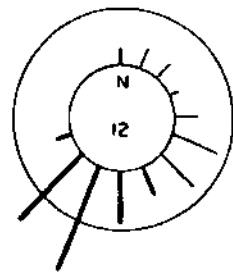
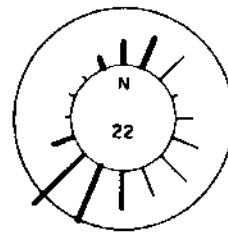


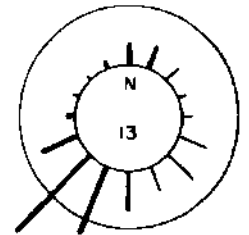
FIGURE II - A24
MAXIMUM EBB CURRENTS
SUBZONE 4 (IN KNOTS)



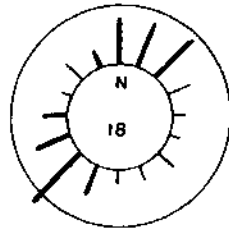
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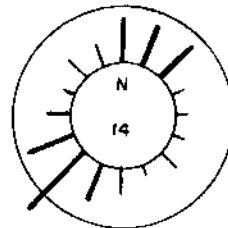
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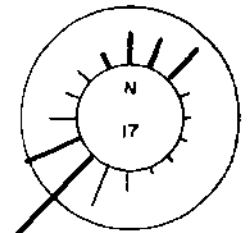
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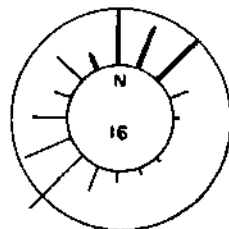
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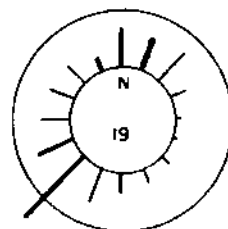
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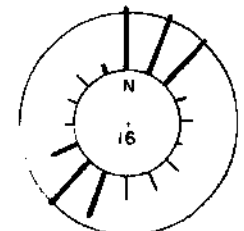
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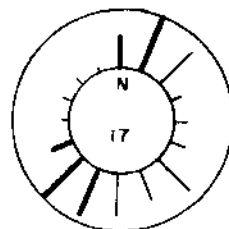
JULY



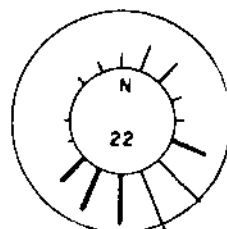
AUGUST



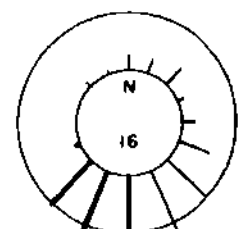
SEPTEMBER



OCTOBER



NOVEMBER



DECEMBER

FIGURE II-A25, WIND PATTERNS FOR SEATTLE AFTER HARRIS, 1954. WIDTH OF BAR INDICATES MONTHLY AVERAGE WIND VELOCITY, EACH RADIAL UNIT INDICATES 10 % OF TOTAL OBSERVATIONS, CENTRAL NUMERAL INDICATES PERCENTAGE OF CALM WIND 0 - 10 MPH —, 11 - 19 MPH — 29

3. Winds

From the period of October to March, the prevailing winds in this subzone are southwesterly to 20 mph. From April until May, the winds tend to be south-southwesterly to 10 mph, and from June until September, the surface winds tend to be northerly to 10 mph. Figure II-A25 depicts the monthly wind pattern in Seattle.

4. Waves

Throughout the year, the limited fetch in this subzone restricts wave heights to less than two feet in height except under the stress of anomalously high winds when the wave height may be up to 6 feet locally.

5. Natural physical resources

Though this subzone is heavily populated by man, a large and varied collection of sea life exists along the shores. Figures II-A26 and II-A29 show the distribution of this life, which is described below.

i. shellfish

Crabs: Dungeness and red crabs are found throughout this subzone, although they are not abundant.

Oysters: Oysters are uncommon throughout this region. Some occurrence of Pacific oysters is in Liberty Inlet and the enclosed part of Sinclair Inlet. Olympia oysters occur near Poulsbo and Bremerton in small numbers.

Clams: Littleneck, butter, and Manila clams are prevalent around Poulsbo, in Port Madison, and Fletcher Bay. Littleneck clams are also common from Edmonds to Meadow Point and from Point Pully to Alki Point.

Other shellfish: Sparse blue mussel populations are found on the eastern shore of this subzone, while they are moderate to heavy on the western shore. Geoducks are rather sparse, while a few pink scallops exist in Elliott Bay and along the Shilshole breakwater. Spot shrimp are common in many parts of Elliott Bay, along with pink shrimp. Squid occur sporadically in many of these areas. Octopi are abundant near Vashon Island and Bainbridge Island and near most rock breakwaters.

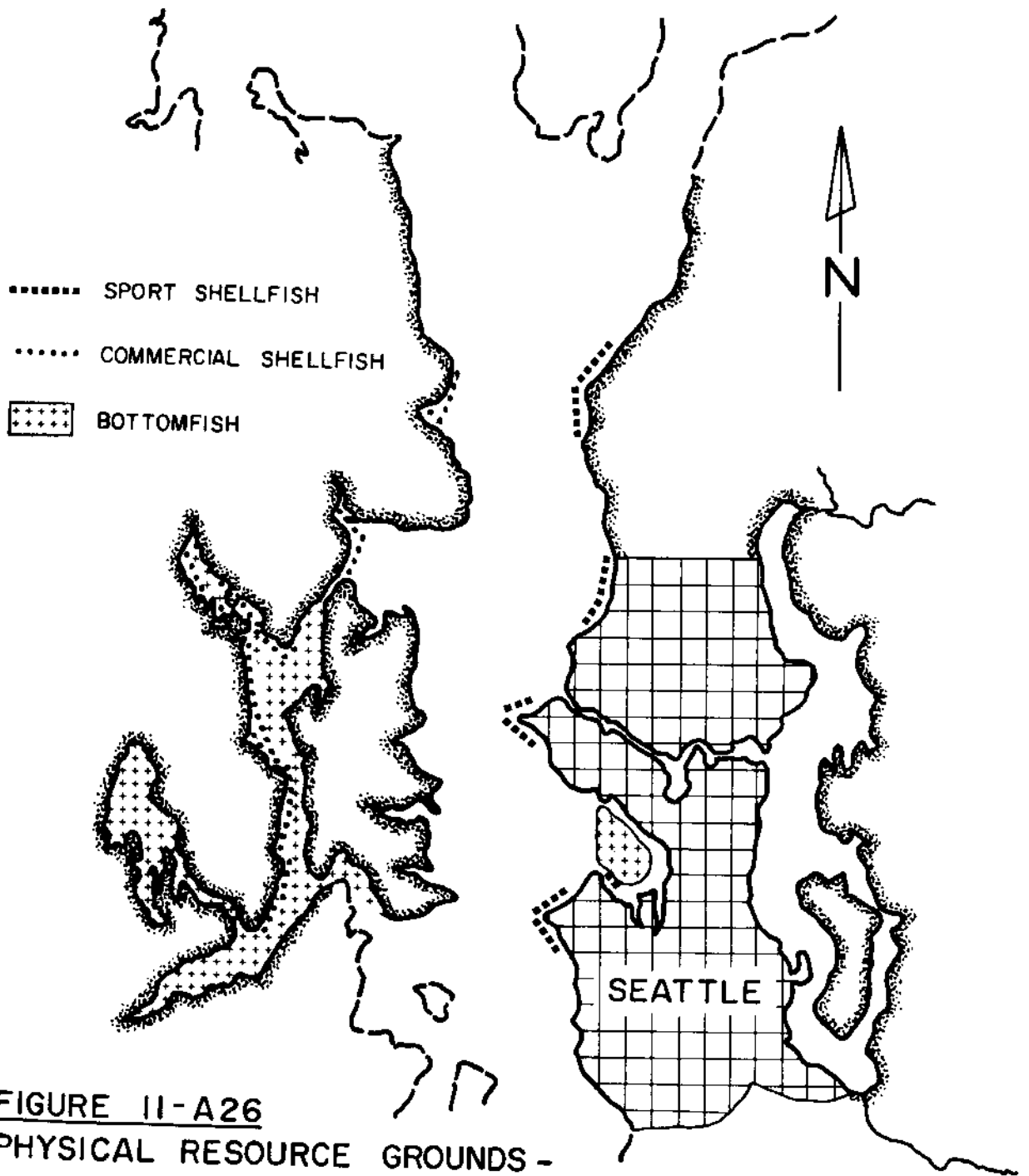


FIGURE II-A26
PHYSICAL RESOURCE GROUNDS -
SHELLFISH & BOTTOMFISH
SUBZONE 4

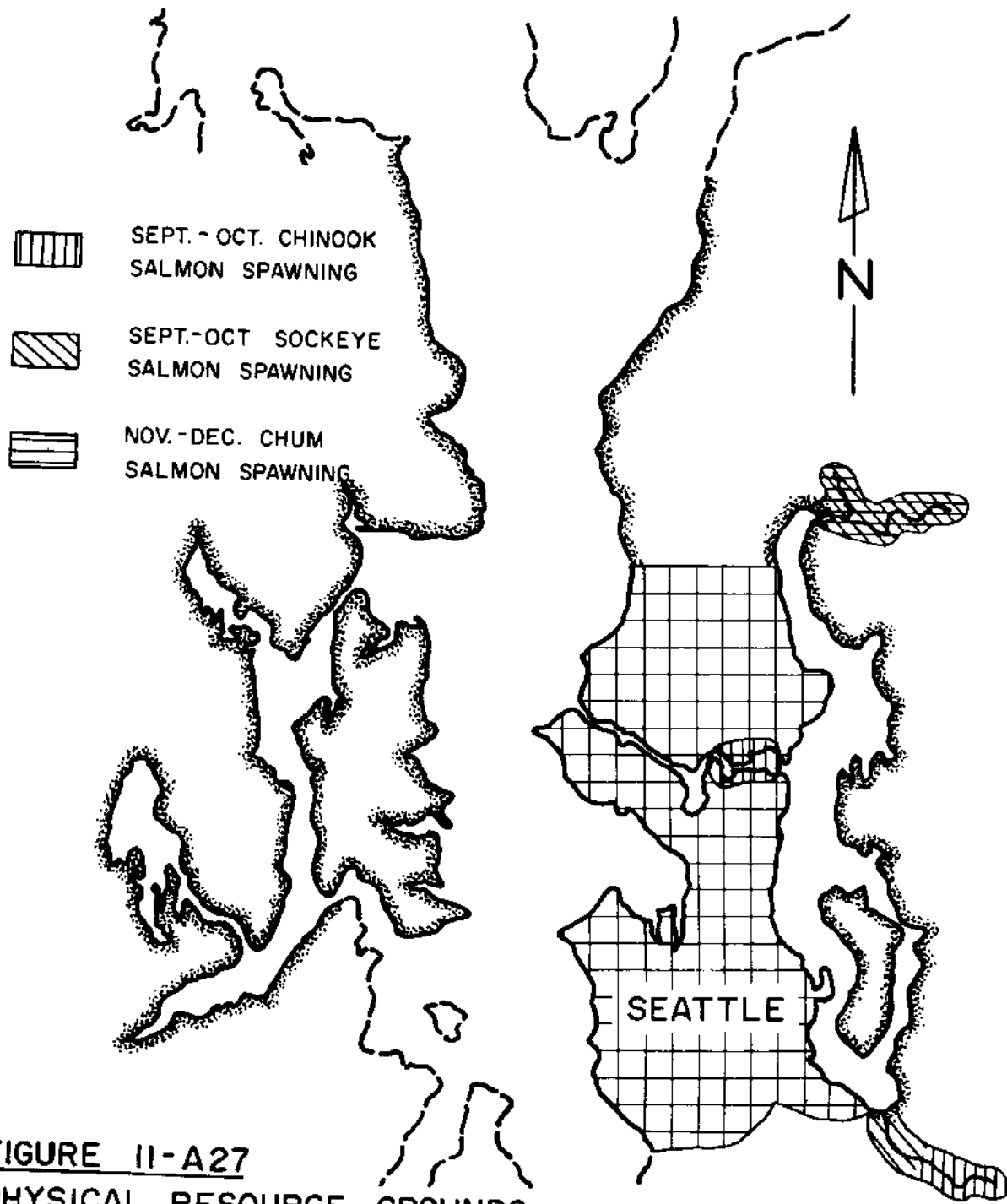


FIGURE II-A27
PHYSICAL RESOURCE GROUNDS -
SALMON, SUBZONE 4

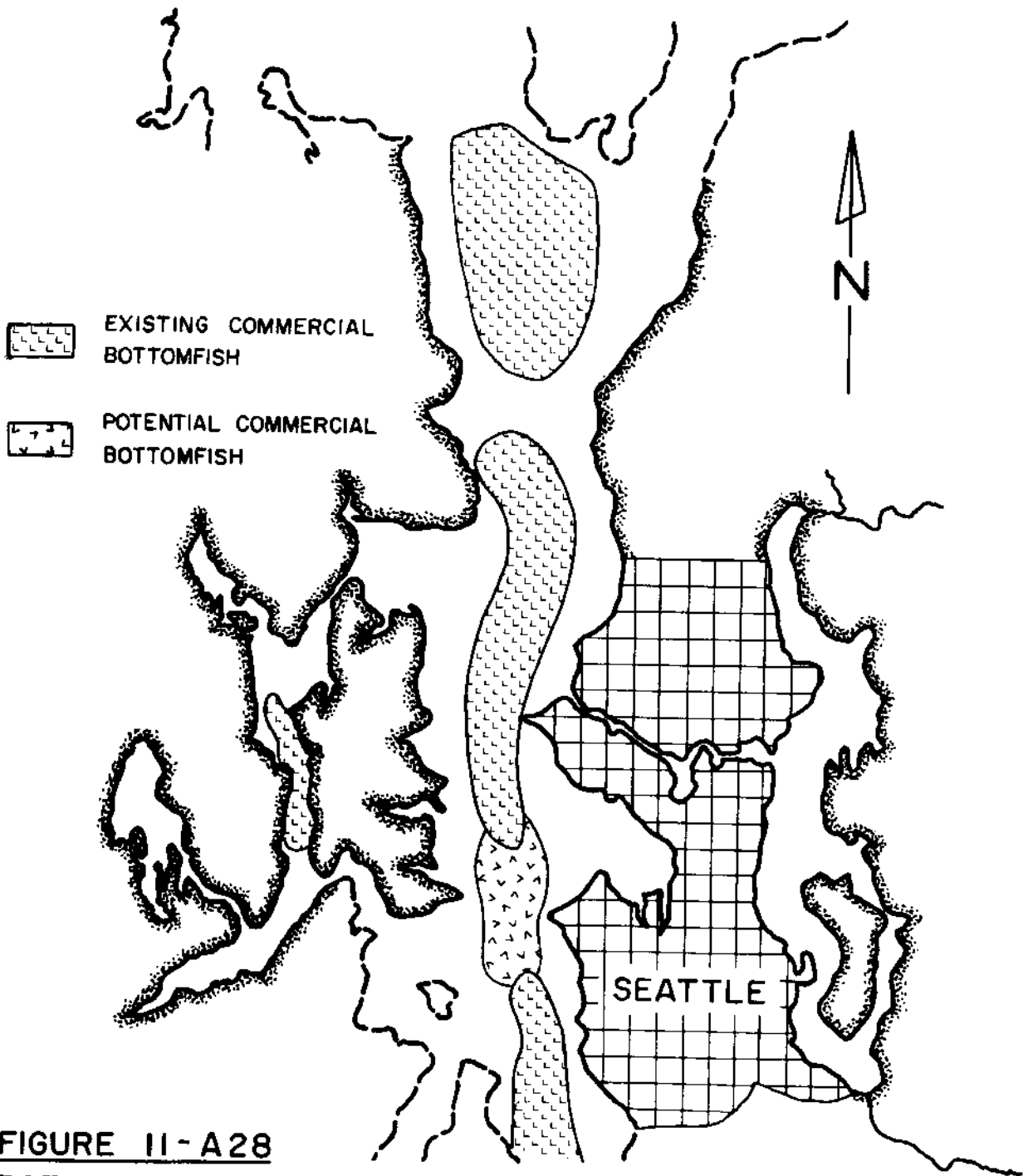


FIGURE II - A28
BOTTOMFISH GATHERINGS
SUBZONE 4

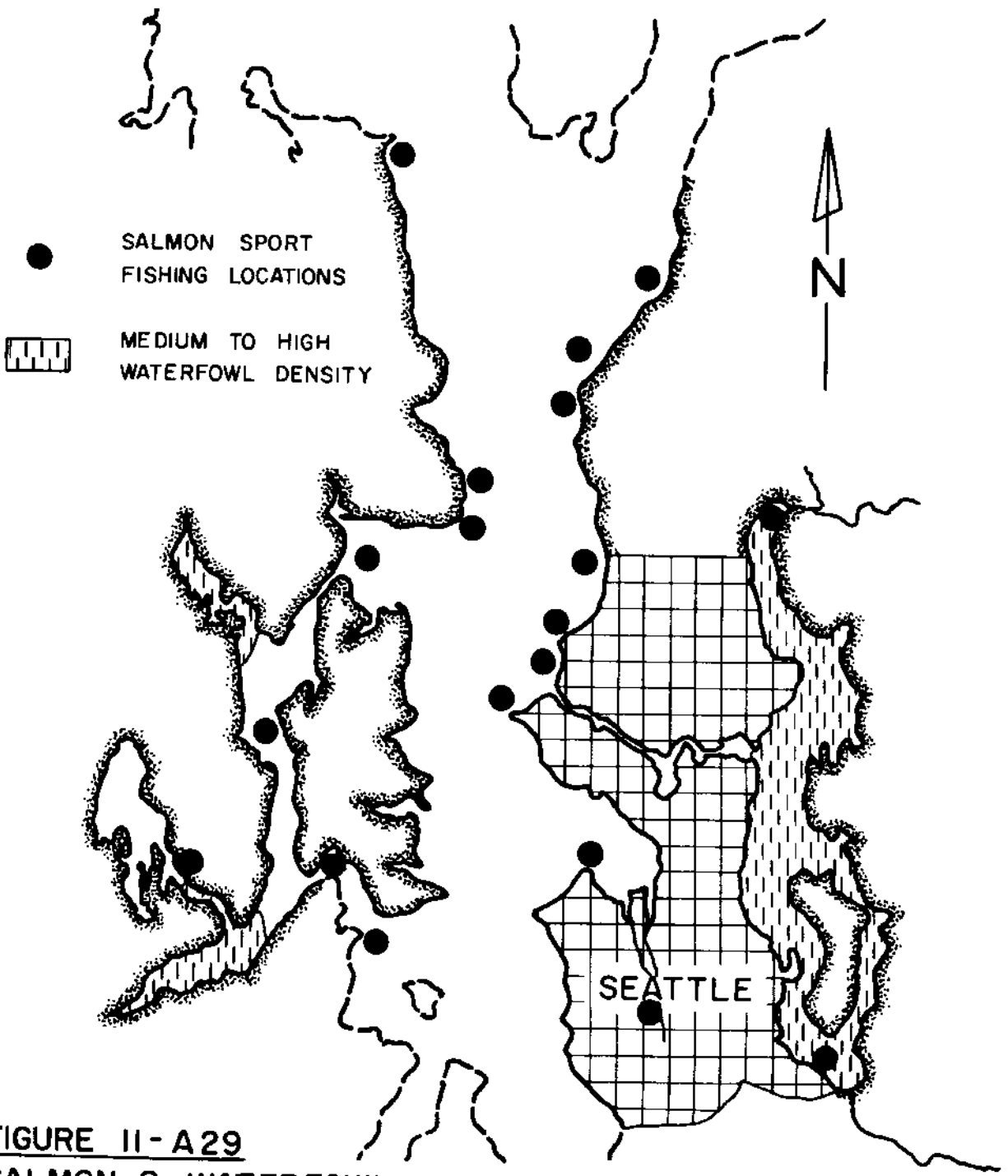


FIGURE II - A29
SALMON & WATERFOWL GATHERINGS
SUBZONE 4

ii. fish

Point No Point, Possession Bay, Ballard-Jefferson Head, Elliott Bay, and Manchester-Bremerton may have large numbers of salmon grounds at times, as well as Shilshole and Elliott Bays, and Richmond Beach to Meadow Point (see Figure II-A27). The major sport fishing grounds in this region include the Kingston-Port Madison area, Richmond Beach, Meadow Point, and Ballard, as shown in Figure II-A29.

iii. waterfowl

Waterfowl are found throughout this subzone, but are not abundant. Moderate to high waterfowl densities occur near Poulsbo and Port Orchard (see Figure II-A29).

6. Man-made physical resources

The large populace residing in this subzone and their yen for water-related recreation is borne out by the vast number of large launching ramps and rental boat moorages. Though state parks are not prevalent due to the dominance of shoreline by municipalities, public beaches are nevertheless abundant. In the Seattle area alone, there are over 20 city and county beaches, mostly in the southeast area and along the western shore of Lake Washington.

State parks, ramps, and moorages are listed below and their locations are shown in Figure II-A30.

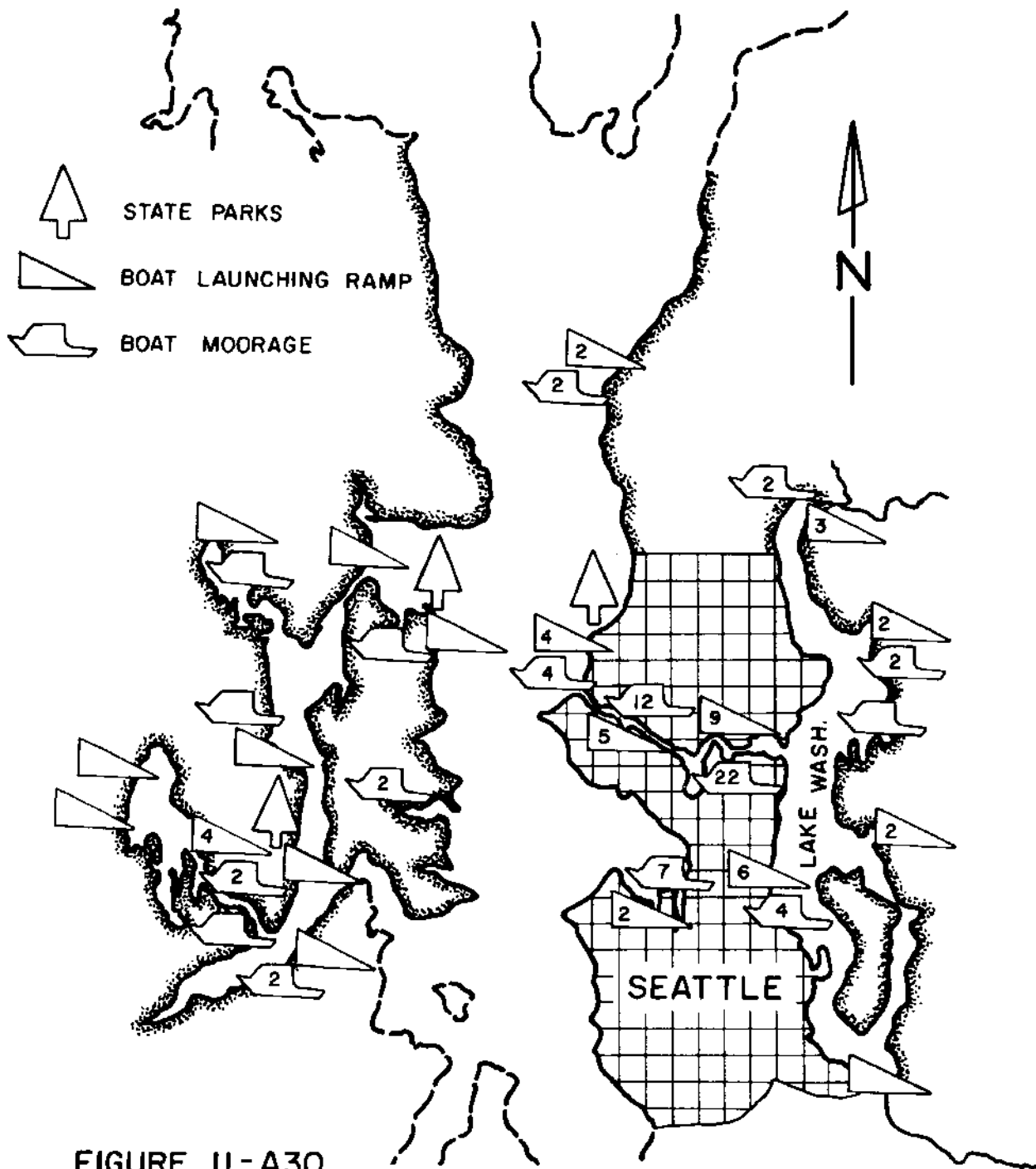


FIGURE II-A30
MAN-MADE RESOURCES
SUBZONE 4

TABLE II-A6: MAN-MADE RESOURCES, SUBZONE 4³⁰

Location	State Parks	Launching Ramps	Rental Moorages
Edmonds	0	2	2
Shilshole Bay	1	4	4
Salmon Bay	0	5	12
Lake Washington Ship Canal	0	9	22
Lake Washington	0	14	9
Duwamish River	0	2	7
E. Side Bainbridge Island	2	5	4
Sinclair Inlet- Port Orchard	1	4	6
Dyes Inlet	<u>0</u>	<u>6</u>	<u>2</u>
SUBZONE 4 - TOTAL	4	51	68

City parks and beaches are not shown on the map.

d. Subzone 5: Southern Puget Sound

1. Geography

Southern Puget Sound narrows from a typical width of approximately 5 nautical miles in the Northern Sound to form a complex system of long passages, embayments, and inlets which are predominantly 1-2 miles in width. Although this subzone contains the industrial cities of Tacoma and Olympia, the area is dominated by recreational and residential land use.

Numerous larger islands such as Vashon, Maury, Fox, McNeil, Anderson, Hartstene, and Squaxin are of limited accessibility by public and private ferry systems. In the eastern part of the subzone, from Point Pully to Nisqually Reach, the shoreline is typically narrow and sandy with gravel and rocks in some places. Generally, the steep beaches are bordered by steep banks or cliffs of considerable relief.

To the west, long narrow inlets such as Carr, Case, Hammersley, Totten, Eld, Budd, and Henderson as well as Nisqually Flats exhibit muddy

estuarine tidelands at the shallow ends. The many inlets in the western portion not only have banks adjacent to the shoreline in many cases, but also have dense vegetation and only limited public highway which constrains accessibility from land. The shoaling depths and irregular channels also hamper access of the shoreline from the water by boat in the western inlets.

Numerous small boat harbor/settlements for recreational craft are dispersed throughout the subzone.

2. Currents

Southern Puget Sound displays generally weak or variable tidal currents in most of the larger and open bodies of water. However, several very restricted passages often exhibit tidal currents of unusually high velocities due to large volumes of water which must be transported through them. Around Point Defiance and through the Tacoma Narrows, maximum tidal currents may reach velocities of up to 5 knots. Large eddies created are a menace to the navigation of smaller vessels.

South of Fox Island and at the mouths of the narrow inlets, maximum tidal currents up to 3 knots may occur locally. Weaker tidal currents in Colvos Passage during the tidal flood may become 1-1.5 knots northward during the ebb flow. Figures II-A31 and II-A32 depict the flood and ebb currents, respectively.

3. Winds

During the period from October to March, surface winds tend to be south-southwesterly with speeds to 20 mph. During April to May, prevailing winds are southerly to 20 mph, and from June to September the winds become northeasterly to 10 mph. Monthly wind patterns for Olympia are shown in Figure II-A33.

4. Waves

Throughout the year, the limited and interrupted fetch existing over the waters of the subzone as well as the moderate to light winds which prevail interact to produce waves of less than a maximum height of 4 feet from October to March. During the period from April to September, maximum wave heights are less than 2 feet.

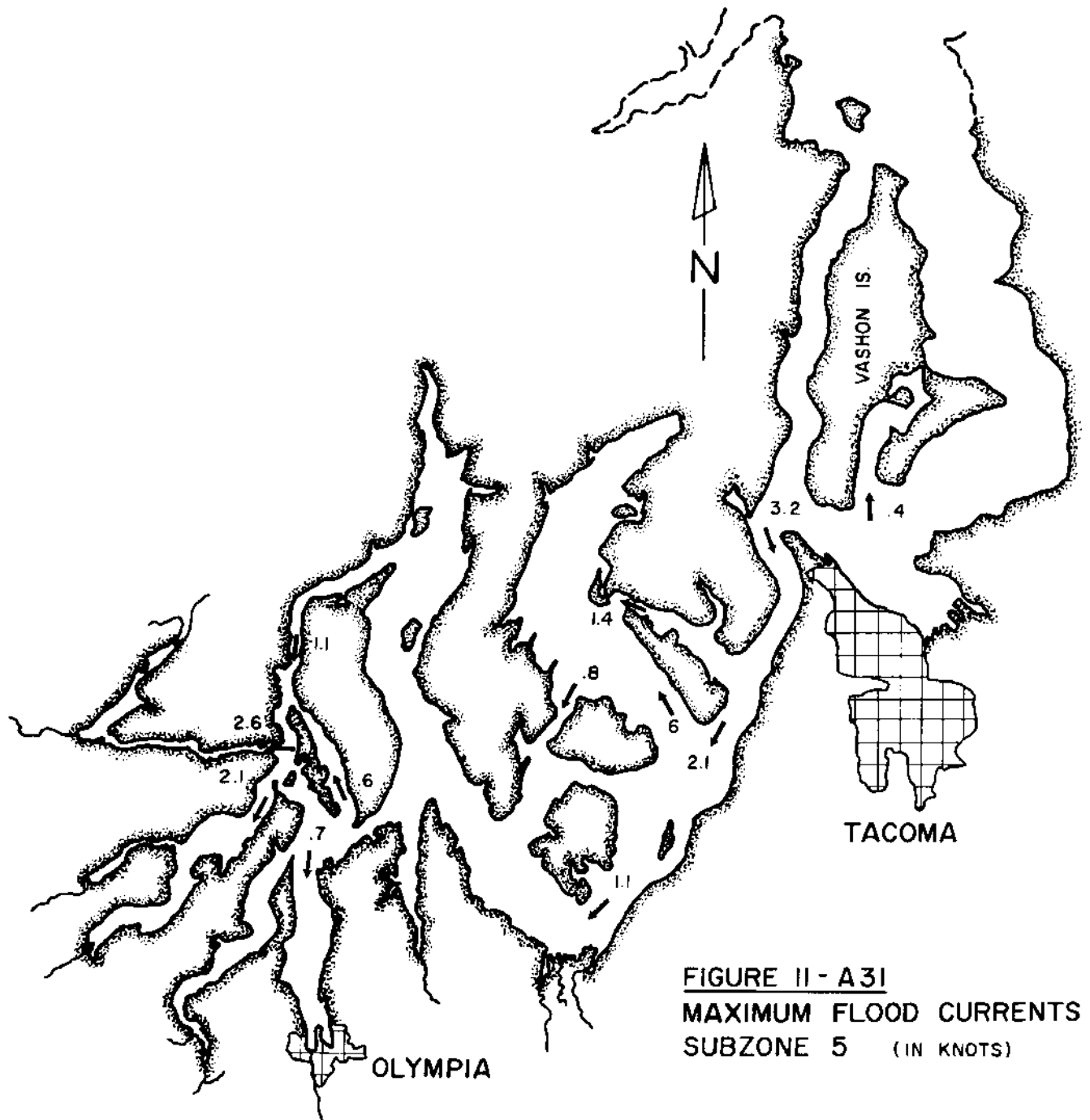


FIGURE II - A31
MAXIMUM FLOOD CURRENTS
SUBZONE 5 (IN KNOTS)

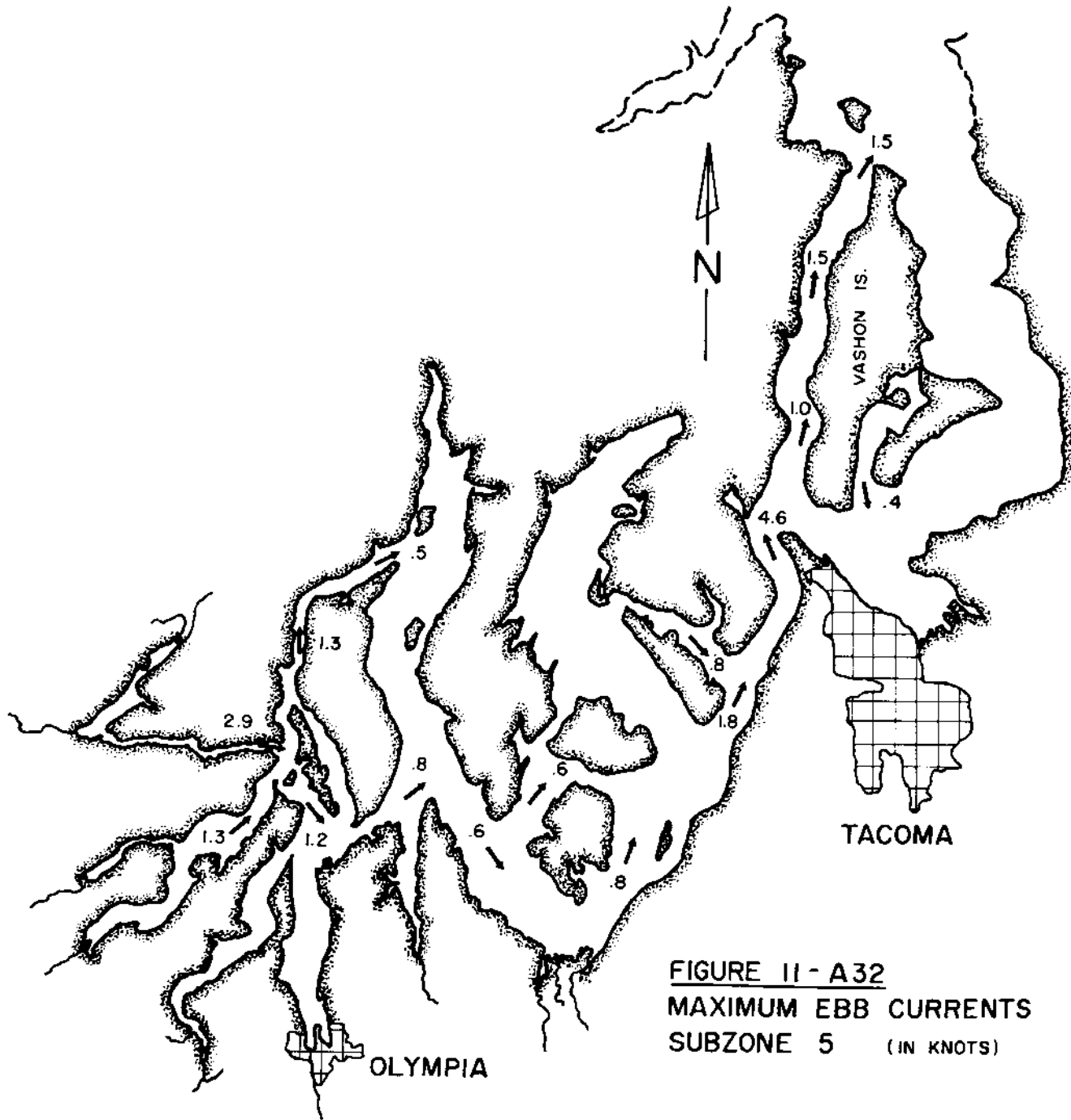
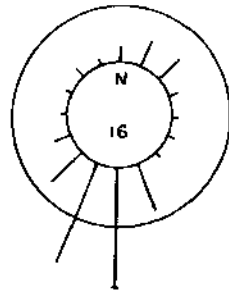
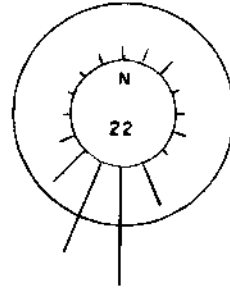


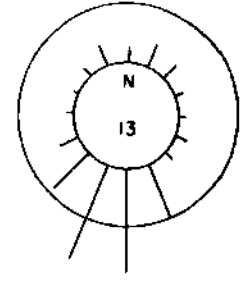
FIGURE 11 - A32
 MAXIMUM EBB CURRENTS
 SUBZONE 5 (IN KNOTS)



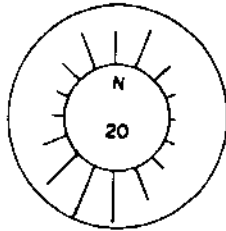
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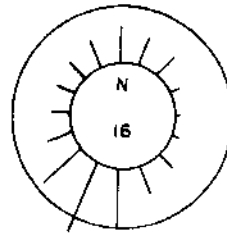
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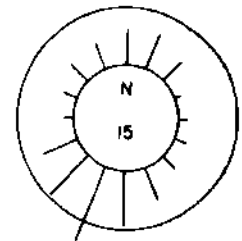
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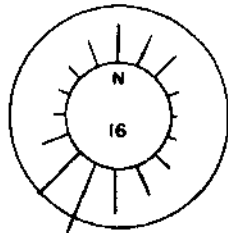
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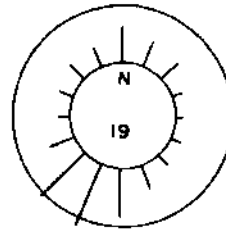
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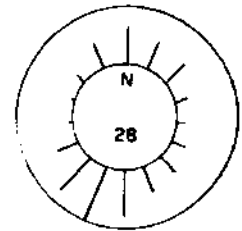
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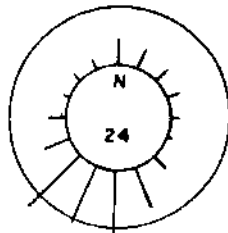
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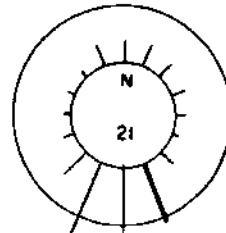
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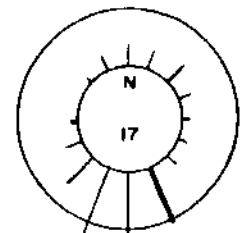
SEPTEMBER



OCTOBER



NOV.



DEC.

FIGURE II-A33, WIND PATTERNS FOR OLYMPIA AFTER HARRIS, 1954. WIDTH OF BAR INDICATES MONTHLY AVERAGE WIND VELOCITY, EACH RADIAL UNIT INDICATES 10 % OF TOTAL OBSERVATIONS, CENTRAL NUMERAL INDICATES PERCENTAGE OF CALM WIND. 0 - 10 MPH ———, 11 - 19 MPH ———³¹

5. Natural physical resources

The physical layout of this subzone is ideal for the large population of shellfish and marine fish which populate the shorelines and waters. The types and distribution of this sea life are detailed below, and shown in Figure II-A34 through II-A37.

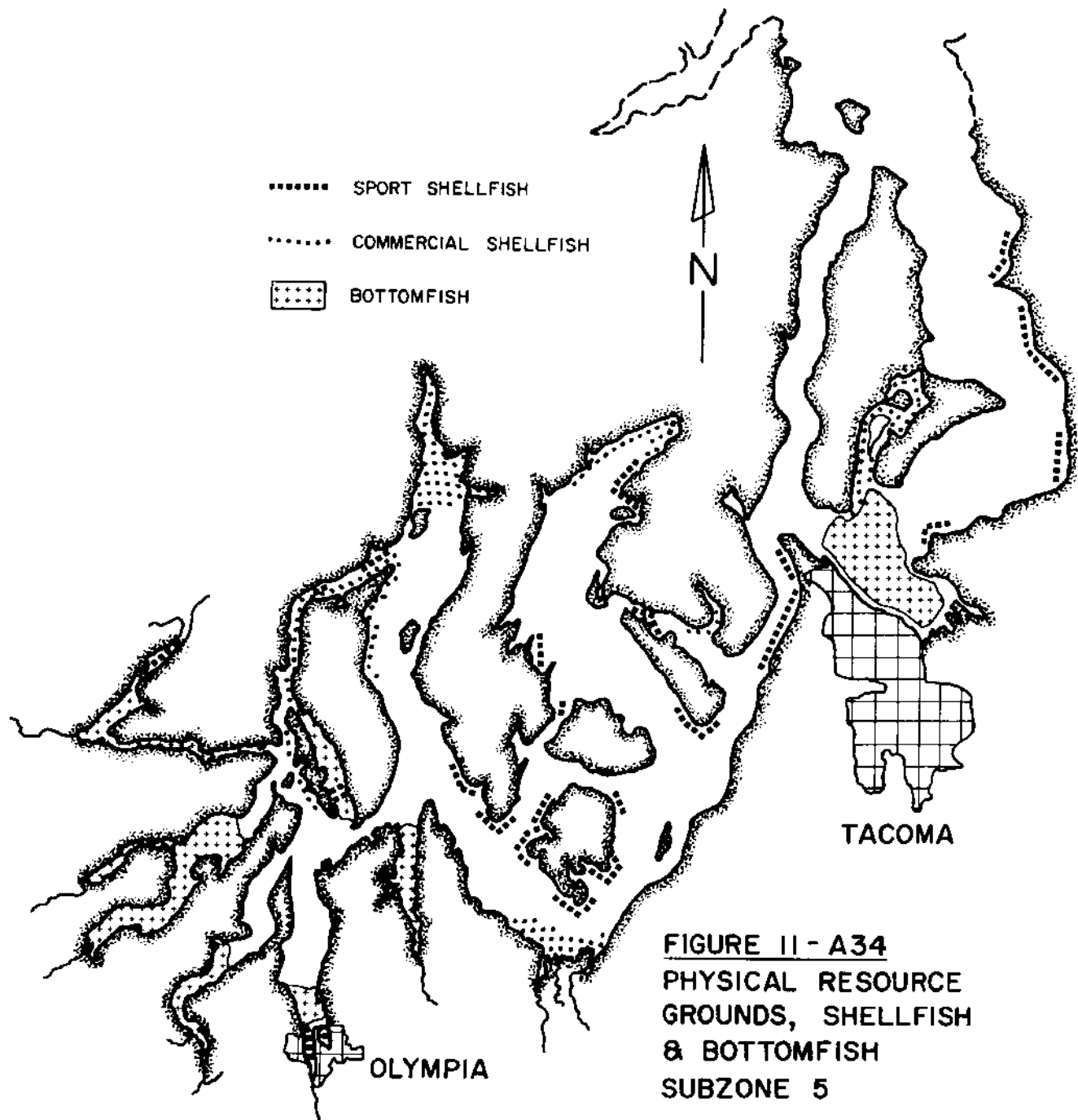
i. shellfish

Crabs: Dungeness crabs are found throughout the region although nowhere in great abundance. The richest concentrations are just north of Commencement Bay (especially in eelgrass), on Nisqually Flats, and in Oro Bay. Red crabs are also common near Nisqually Flats.

Oysters: Oyster Bay (Totten Inlet) is the most productive area in Puget Sound for Pacific oysters. The species of oyster is also common in Carr, Eld, Case, Budd, Skookum, and Henderson Inlets, Pickering and Peal Passages, near and Hope Island. Also Pacific oysters are plentiful in Oakland Bay and near the Nisqually Flats. Other beds include Dyes Inlet, in Ostrich, Oyster and Mud Pass and the enclosed part of Sinclair Inlet. Native and Kumamoto oysters are found in this area, mainly in north and south Case Inlet, Vaughn, North, and Rocky Bays, along Pickering Passage, in Oakland Bay; Skookum Inlet; Oyster Bay, from Rocky Point to Mud Bay in Eld Inlet; Silver Spit and Gull Harbor (Eld Inlet); and from Chapman Bay to South Bay in Henderson Inlet. Native oysters occur in small numbers in Sinclair Inlet.

Clams: Native littleneck, butter, and Manila clams are common around Bremerton, Rolling Bay, near Vashon Island. Manila clams are very abundant in Carr, Case, Skookum, Totten, and Budd Inlets, and Oakland Bay. Butter clams exist in much the same area as the Manila, and are most prevalent in Carr and Case Inlets. Large numbers of littleneck, butter, and horse clams are present from Point Pully to Dash Point. Softshell clams are abundant in muddy bottoms through most of the area.

Other shellfish: Geoducks are common on all sandy mud flats, especially on Nisqually Flats, in north Carr, north Case, Totten, and Eld Inlets and in Oakland Bay. Piddocks are found in clay bottoms near Point Defiance. Cockles are very common throughout the many inlets at the southern



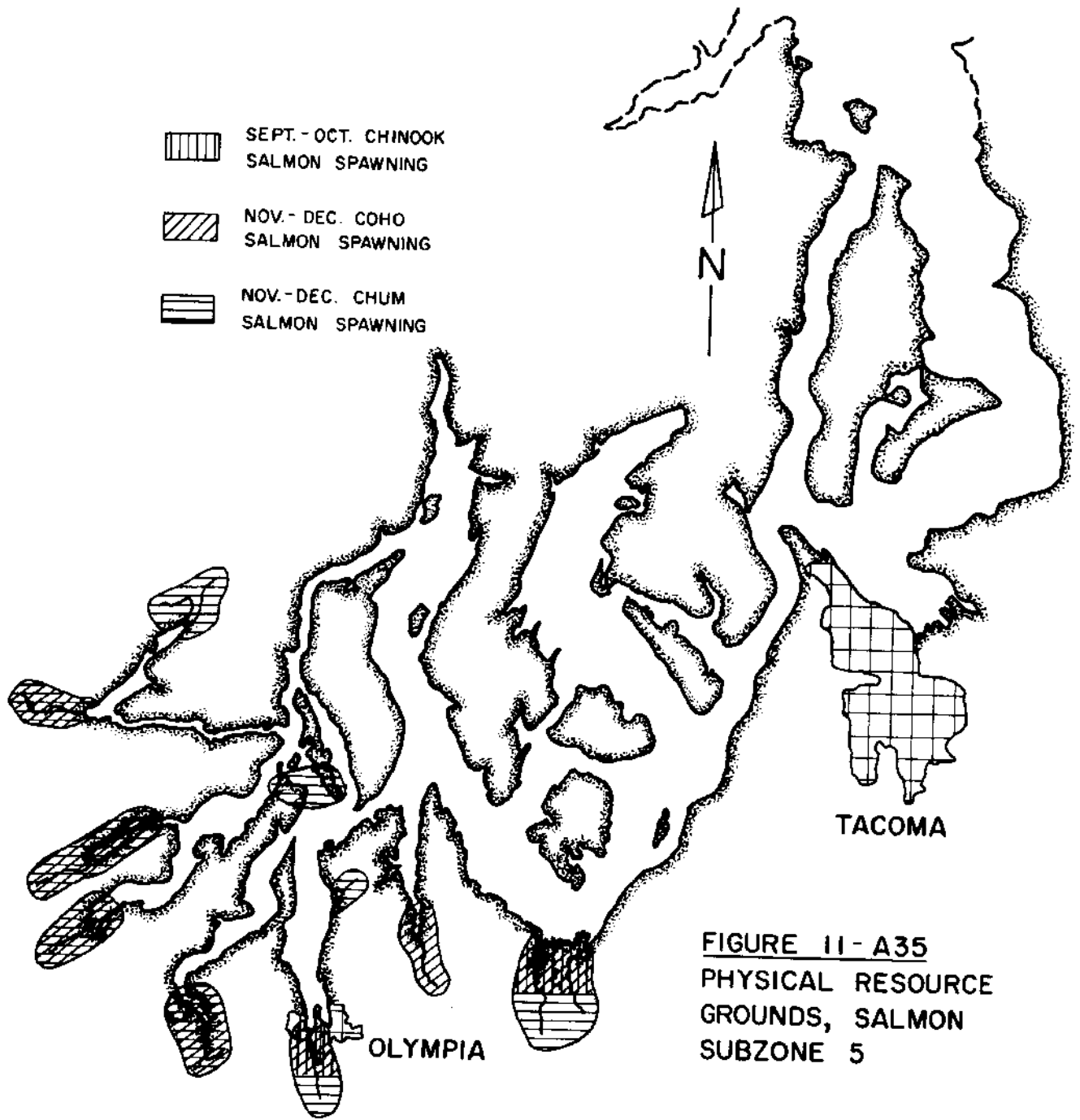
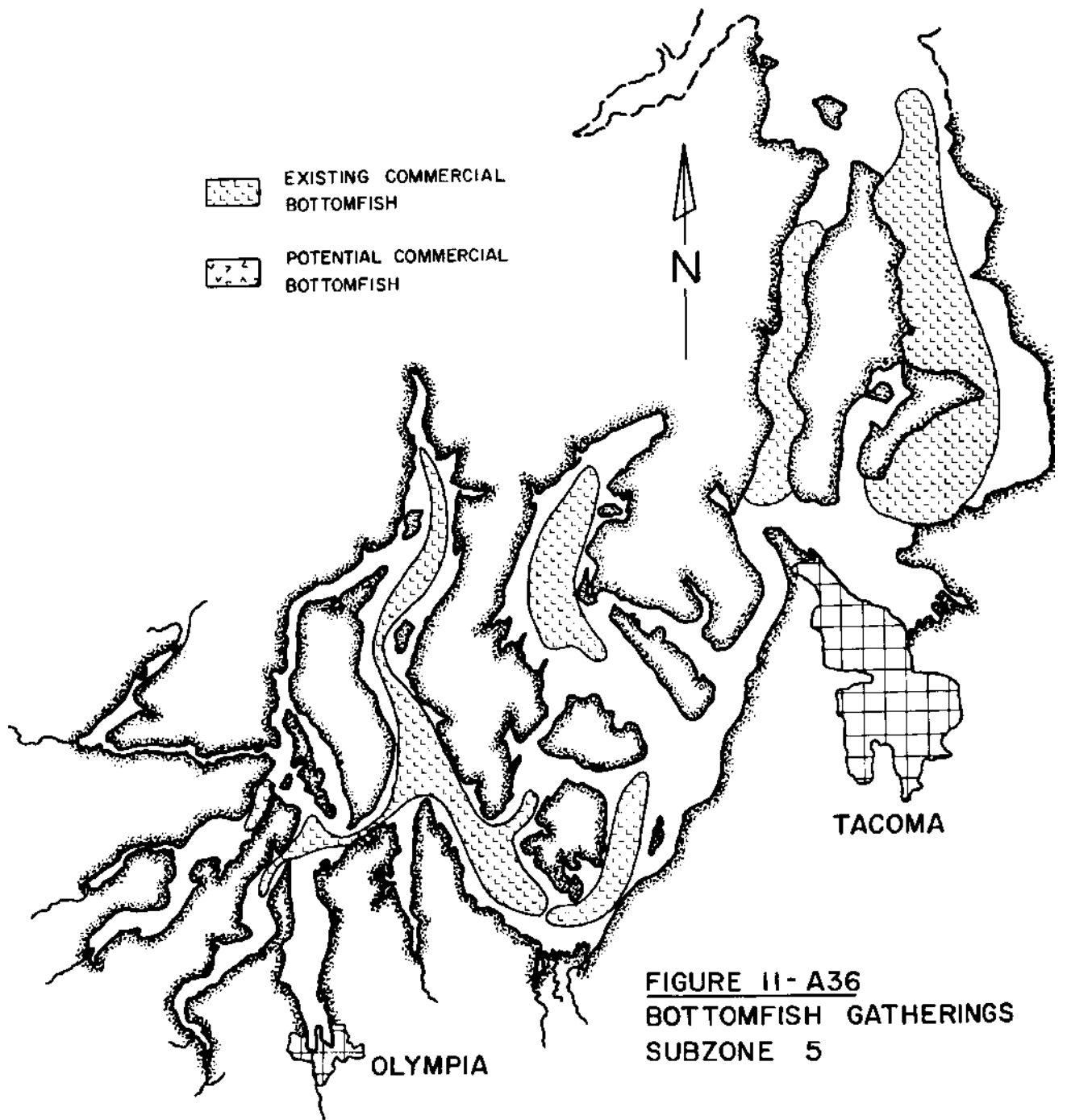
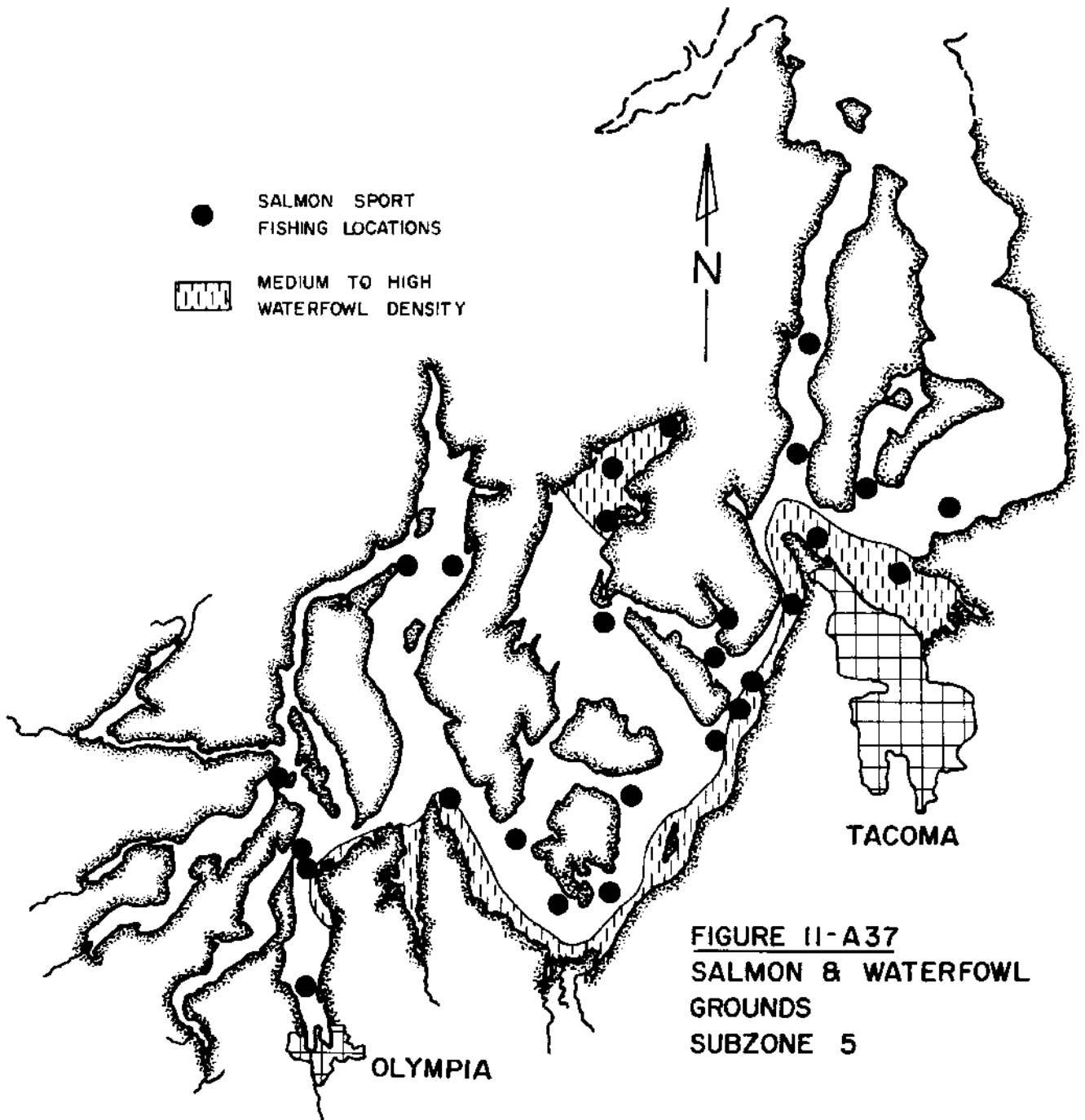


FIGURE 11 - A35
 PHYSICAL RESOURCE
 GROUNDS, SALMON
 SUBZONE 5





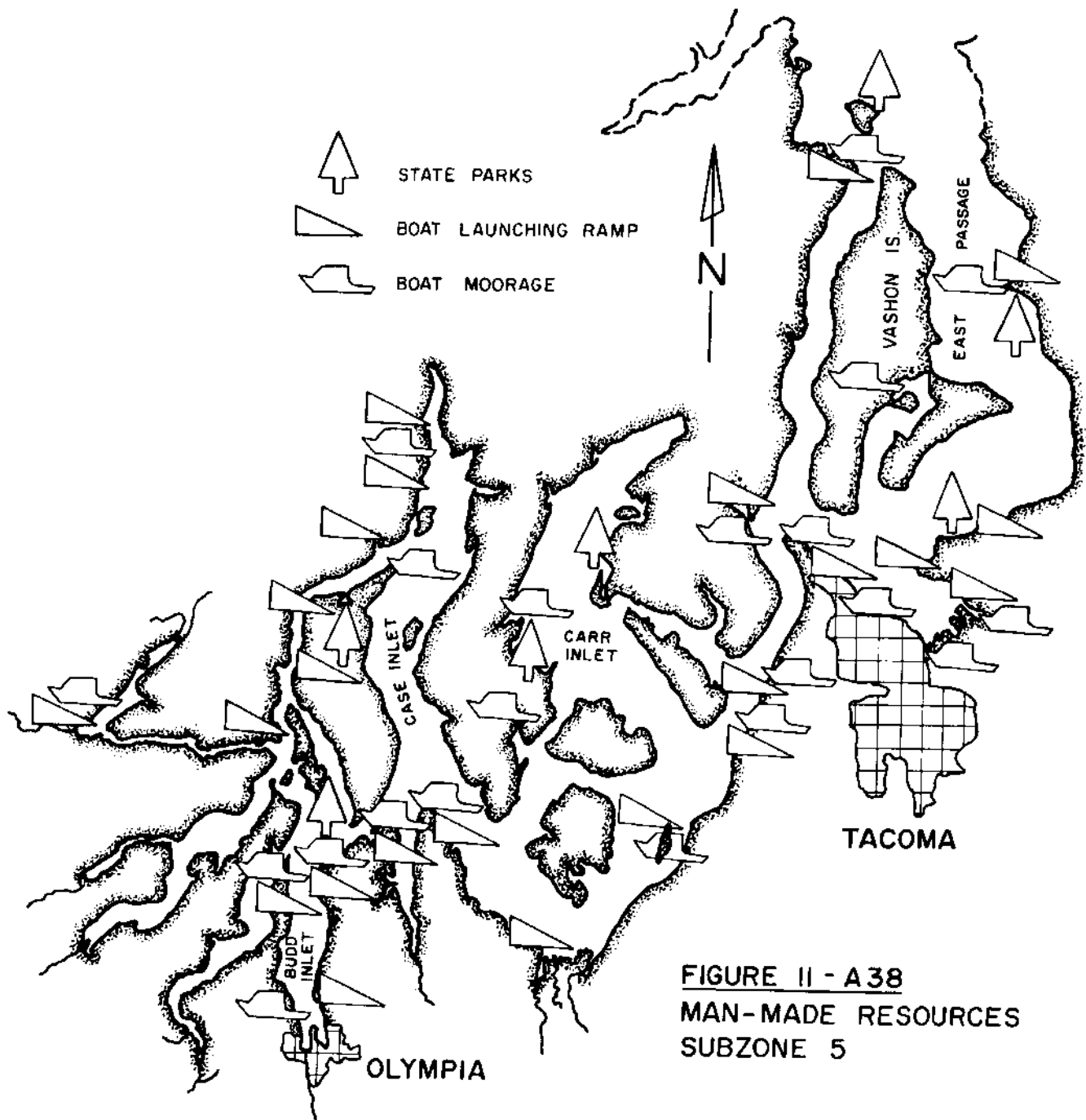


FIGURE II - A38
MAN-MADE RESOURCES
SUBZONE 5

end of the Sound, as are blue mussels, especially near Point Defiance. Four species of shrimp occur in this subzone. Pink shrimp dominate in the southernmost area, occurring in Carr Inlet, around McNeil Island, in Hale and Drayton Passages, near Anderson Island and Nisqually Beach and off of the east side of Hartstene Island. Spot shrimp dominant in East Passage and Dalco Passage. Pink scallops are common just north of Commencement Bay in water depths between 0 to 100 feet, and are found elsewhere in areas of strong currents and sandy bottoms. Large schools of squid are present in the Tacoma Narrows, Dolco Passage, Hale Passage, Wollochet Bay, Carr, Case, and Budd Inlets, and around Oakland Bay. Octopi are common around Fox and Anderson Islands, in Case and Carr Inlet, Dana Passage, Vashon Island vicinity, and around Point Defiance and the Tacoma Narrows.

ii. fish

Salmon are mostly found in the waters around Point Defiance, Point Evans, Wollochet Bay, Hale Passage, and "Sand Spit" (NW Fox Island), northern tip of Carr Inlet, Johnson Point, and Steamboat Island. Figure II-A35 depicts these locations. Most commercial fishing occurs north of the Tacoma Narrows except for Case and Carr Inlets. Sport fishing locations include Dash Point, Brown's Point, Tacoma Narrows, and Point Defiance (see Figure II-A37).

iii. waterfowl

Waterfowl are found in all areas of this subzone. Medium to high densities occur in Henderson Bay, Nisqually Reach, Budd Inlet and all along the east side of the Sound from Commencement Bay to Nisqually Flats, and from Nisqually Flats to Budd Inlet (see Figure II-A37).

6. Man-made physical resources

The protective inlets, plentiful in subzone 5, are ready-made for water-related recreational activities. There are six state parks, 30 launching ramps, and 39 rental boat moorages in this region of Puget Sound. Figure II-A38 shows the locations of these resources.

TABLE II-A7: MAN-MADE RESOURCES, SUBZONE 5³²

Location	State Parks	Launching Ramps	Rental Moorages
East Passage	1	1	1
W. side Narrows	0	1	4
S. Vashon Island	0	0	3
E. side Narrows	0	4	6
Case Inlet	2	7	2
Hammersley Inlet	0	1	1
Budd Inlet	0	6	6
Nisqually Reach	0	4	1
Commencement Bay	1	6	13
Carr Inlet	<u>2</u>	<u>0</u>	<u>2</u>
SUBZONE 5 - TOTAL	6	30	39

f. Subzone 6: Hood Canal

1. Geography

Hood Canal is a glacially formed waterway extending about 60 miles from its juncture with Admiralty Inlet between Tola Point and Foulweather Bluff, which also marks the Canal's only outlet. The Canal has a long shoreline, 242 miles, and deep waters in excess of 600 feet in some places. Dabob Bay is the Canal's principal extension.

Many parts of the shoreline are wooded nearly to the waterline. The shores are generally steep with the eastern shoreline being gentler than the more rugged western portion. Mixed sand and mud tidal flats occur near river mouths. Elsewhere the majority of Hood Canal consists of short, relatively steep gravel beaches comprised of medium to small gravel on the upper beach and coarse to large gravel with scattered boulders on the middle and lower tidal areas.

Highway 101 runs the length of Hood Canal along the western side. Much of the shore is in private ownership and direct access is difficult except at larger towns and parks. Vehicle access to the eastern shore is

quite limited with no single road spanning the full length of the Canal. The prevalent shoreline use is for single-family dwellings utilized mostly on weekends and during the summer months. The area is actually rather sparsely populated with no major resort or recreational complex in operation. Certain areas are used for commercial shellfish operations, but generally speaking, Hood Canal is primarily recreational in use.

All ports in Hood Canal can be described as minor and they include: Bangor, Seabeck, Brinnon, Pleasant Harbor, Holly, Eldon, Quilcene, Hoodsport, Union, and Port Gamble.

2. Currents

Tidal currents in Hood Canal at times attain velocities exceeding 1.5 knots. There are heavy tide rips northward of, and around, Foul-weather Bluff, sufficiently heavy to be dangerous to small boats and to break up log rafts. This is most pronounced when the ebb current from the main body of Puget Sound meets that from Hood Canal off the point, and particularly so with the ebb against a strong northerly or northwesterly wind. Off Point Hannon and Hazel Point, tide rips occur at time sufficiently strong to be troublesome to tugboats with log tows. Figure II-A39 and II-A40 summarize the flood and ebb current.

3. Winds

During the period from October to May, prevailing winds are southwesterly with speeds to 20 mph. From June to September, winds tend to be northeasterly with speeds to 10 mph.

4. Waves

Due to the closed and sheltered character of Hood Canal, waves do not exceed a maximum of 6 feet and are generally much less.

5. Natural physical resources

The climate and water conditions of Hood Canal enhance the growth of natural resources, both for commercial and sport purposes. Figures II-A41 through II-A44 depict the spawning grounds. The following paragraphs discuss in detail the specific types of resources of the region.

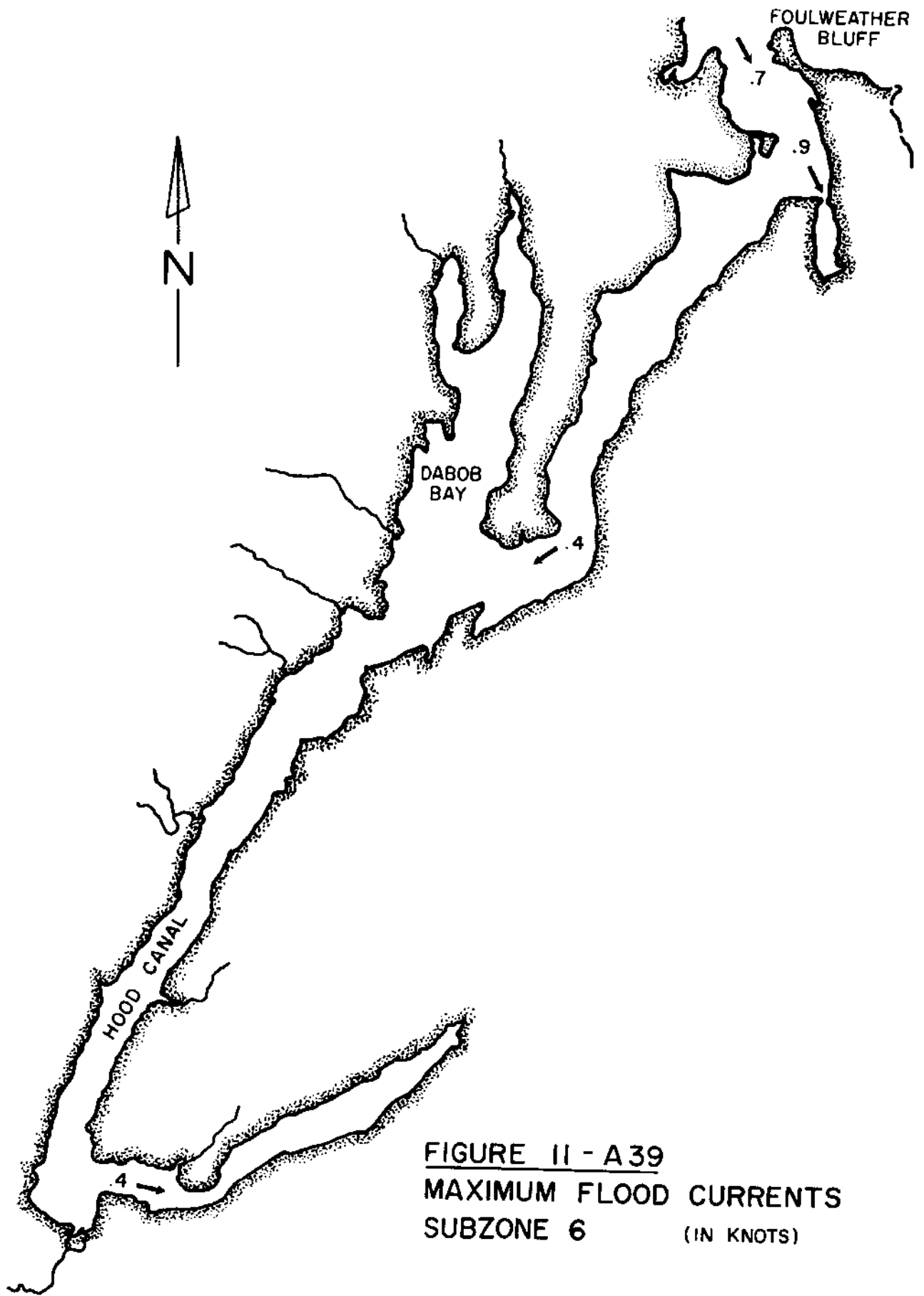


FIGURE II - A39
MAXIMUM FLOOD CURRENTS
SUBZONE 6 (IN KNOTS)

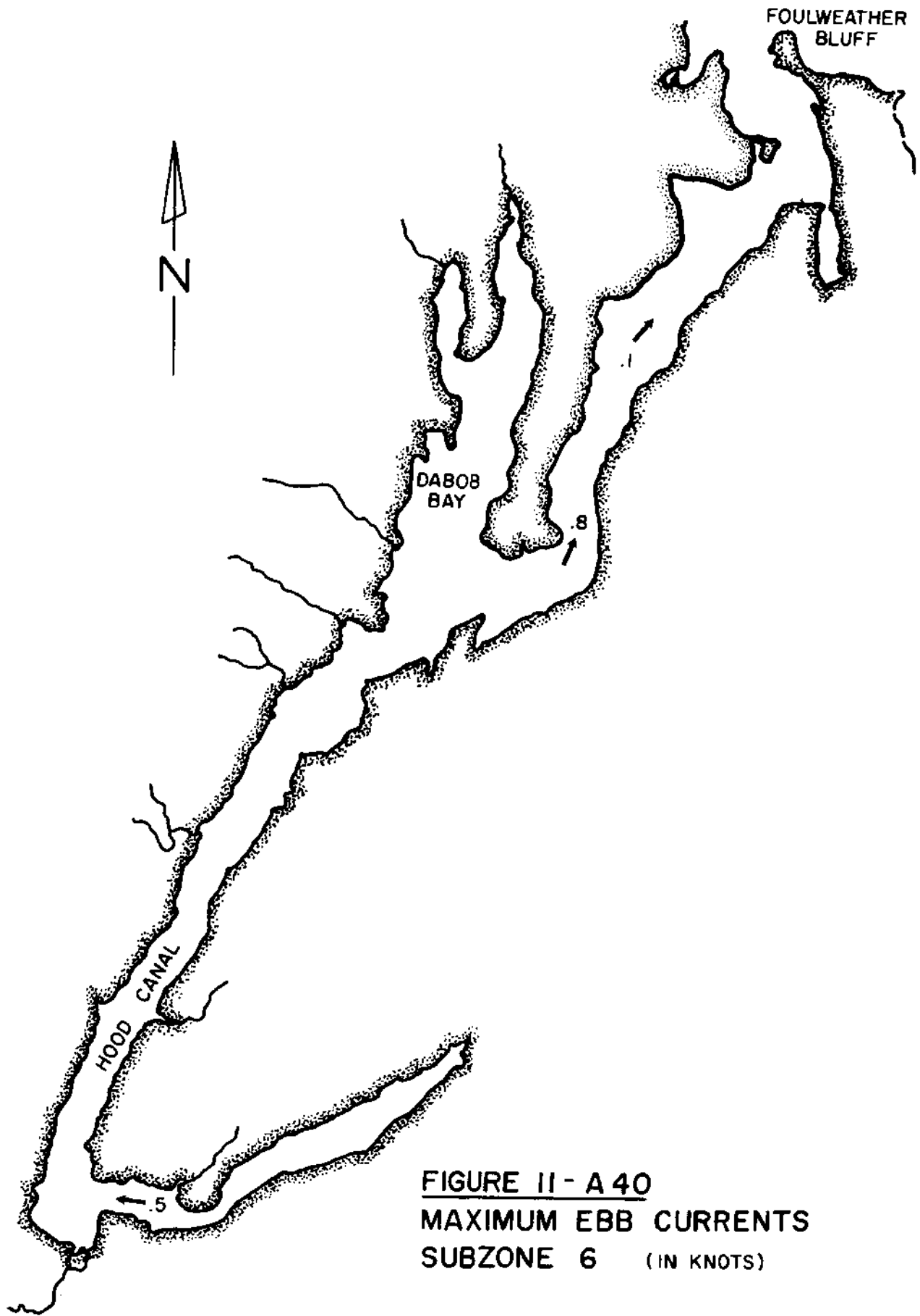


FIGURE II - A 40
MAXIMUM EBB CURRENTS
SUBZONE 6 (IN KNOTS)

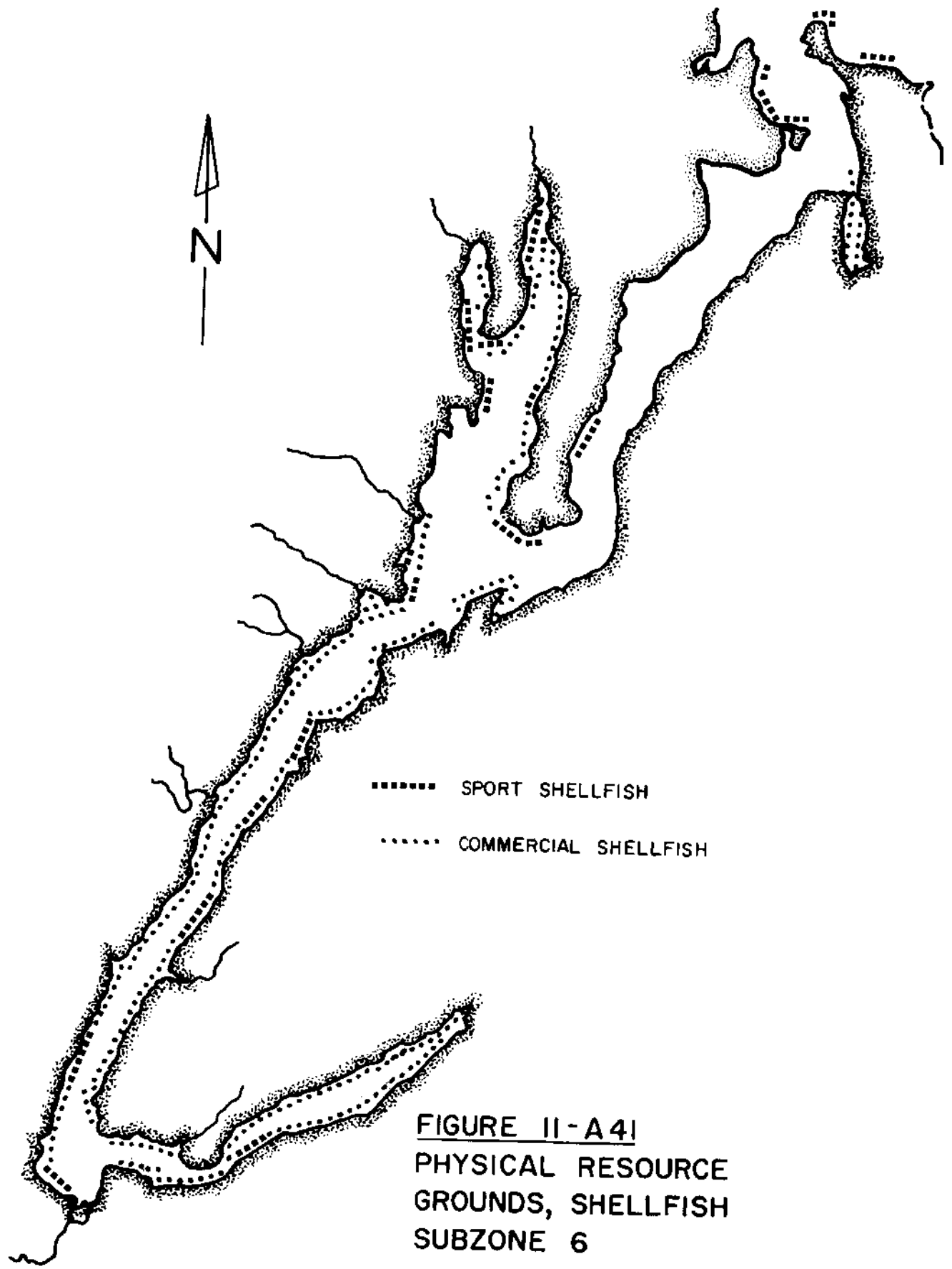


FIGURE II-A 41
PHYSICAL RESOURCE
GROUNDS, SHELLFISH
SUBZONE 6

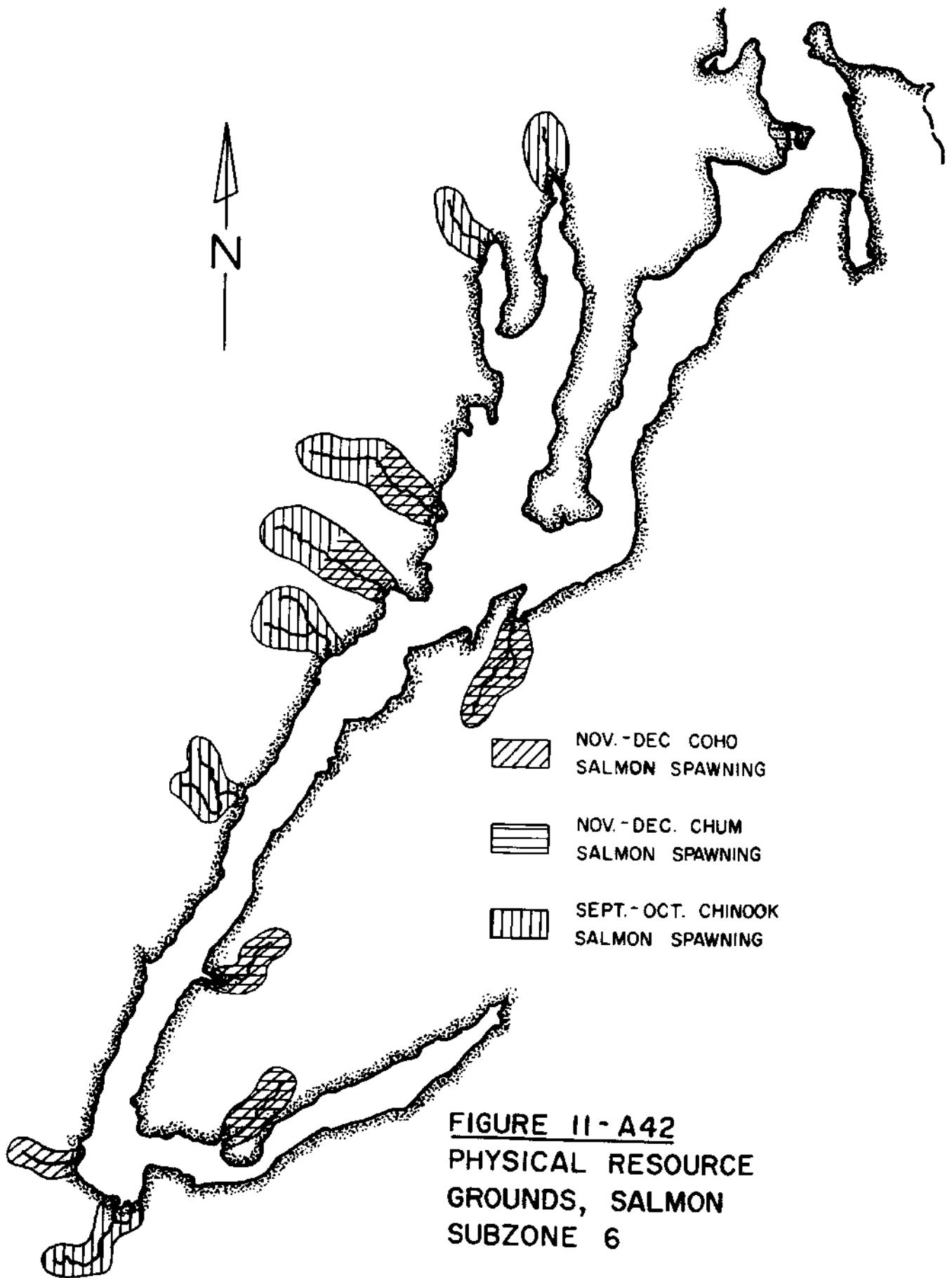


FIGURE 11-A42
PHYSICAL RESOURCE
GROUNDS, SALMON
SUBZONE 6

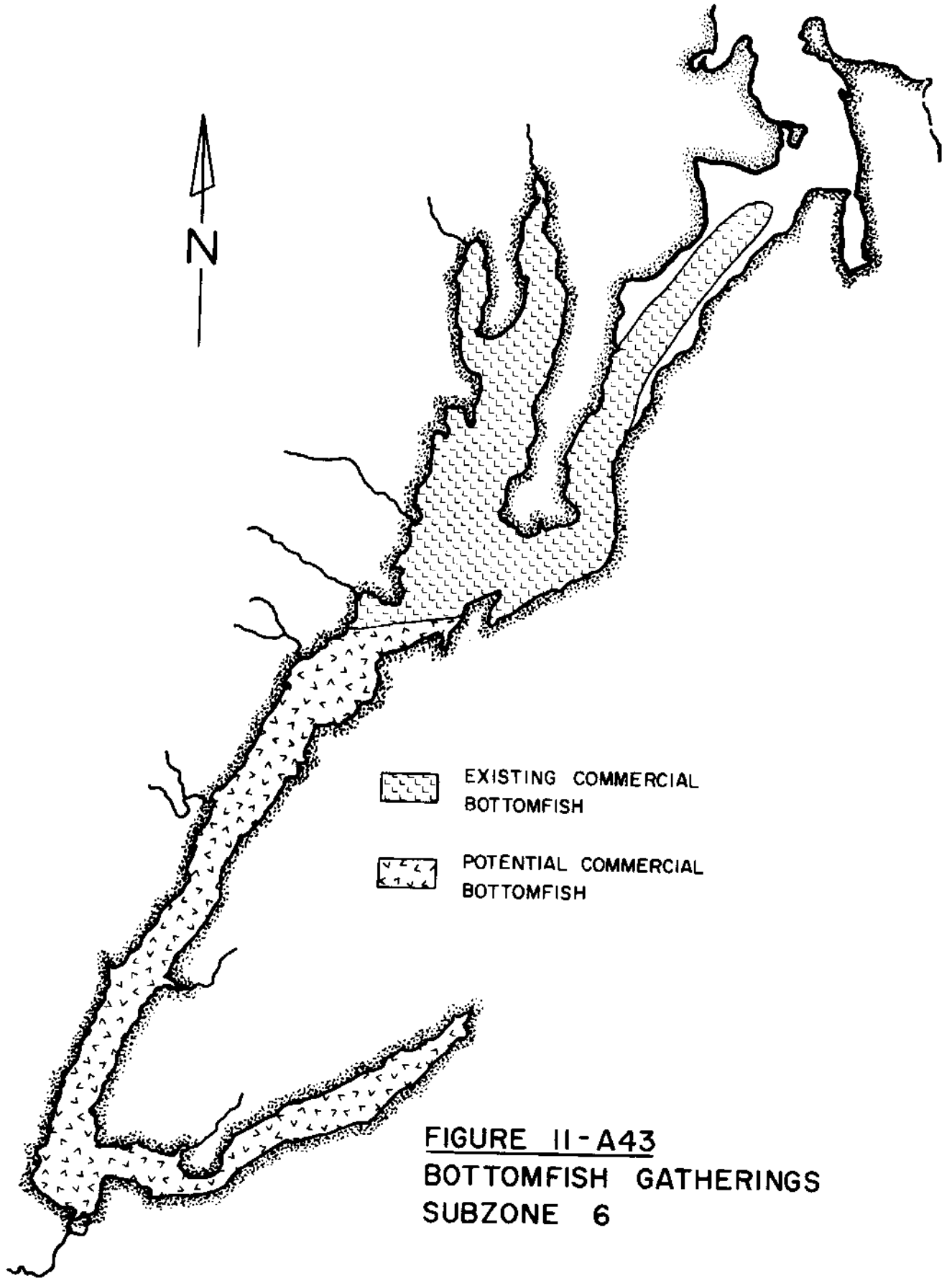


FIGURE II-A43
BOTTOMFISH GATHERINGS
SUBZONE 6

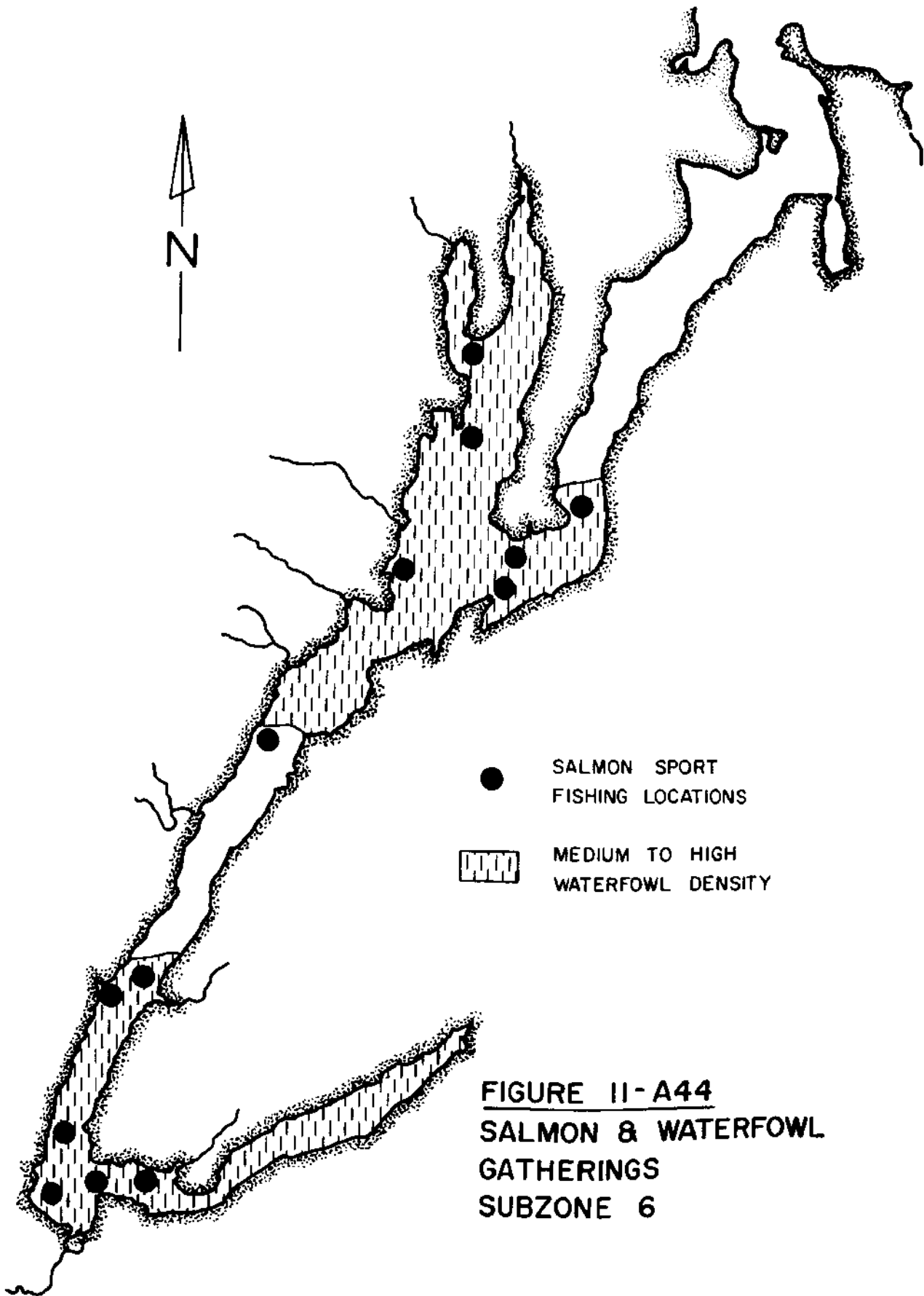


FIGURE II-A44
SALMON & WATERFOWL
GATHERINGS
SUBZONE 6

i. shellfish

Crabs: Dungeness crabs exist in shallow areas throughout the canal, but not in large numbers. Highest concentrations are at tidal flat dropoffs, and in sandy areas with eelgrass. The greatest concentration of Dungeness crabs appears to be in Quilcene Bay during the spring. Red crabs are moderately abundant from shore to about 60 feet deep throughout the canal.

Oysters: Pacific oysters are plentiful throughout the canal. Olympia oysters in limited numbers are found in the northern end of Dabob and Quilcene Bays, along Dosewallips Flats, and in Lynch Cove, along with scattered small populations throughout. Kumamoto oysters only in isolated locations.

Clams: Littleneck, horse, Manila, and butter clams exist on gravel beaches throughout the area. Softshells tend to be on the sandy mud flats near river mouth. Geoducks are in deeper waters. Clams are common throughout the area.

Shrimp: Spot shrimp are most abundant in the subzone. Also pink, coonstripe and sidestripe shrimp occur here. Shrimp are found throughout Hood Canal. The greatest quantities are found in Dabob Bay, Quilcene Bay, and off of Dewatto, Dosewallips River, Duckabush River, and Hoodport. Shrimp are usually found in 30 to 60 fathoms of water.

Other invertebrates: Blue mussels are in moderate abundance especially north of Oak Head. Pink scallops occur throughout on sandy bottoms with relatively strong currents at a depth of about 40 feet. Rock scallops are found near rock outcroppings throughout the area. Squid are readily available year round. Octopi are common, especially near crab concentrations.

ii. fish

Salmon exist in significant populations the year round. During winter and spring, chinook salmon congregate in Jackson Cove, Hazel Point (late spring), Oak Head, Pleasant Harbor, Bald Point, across from Sisters Point, and east of Union. During summer and fall, salmon are found throughout the canal with concentration noted in Figure II-A42. The major

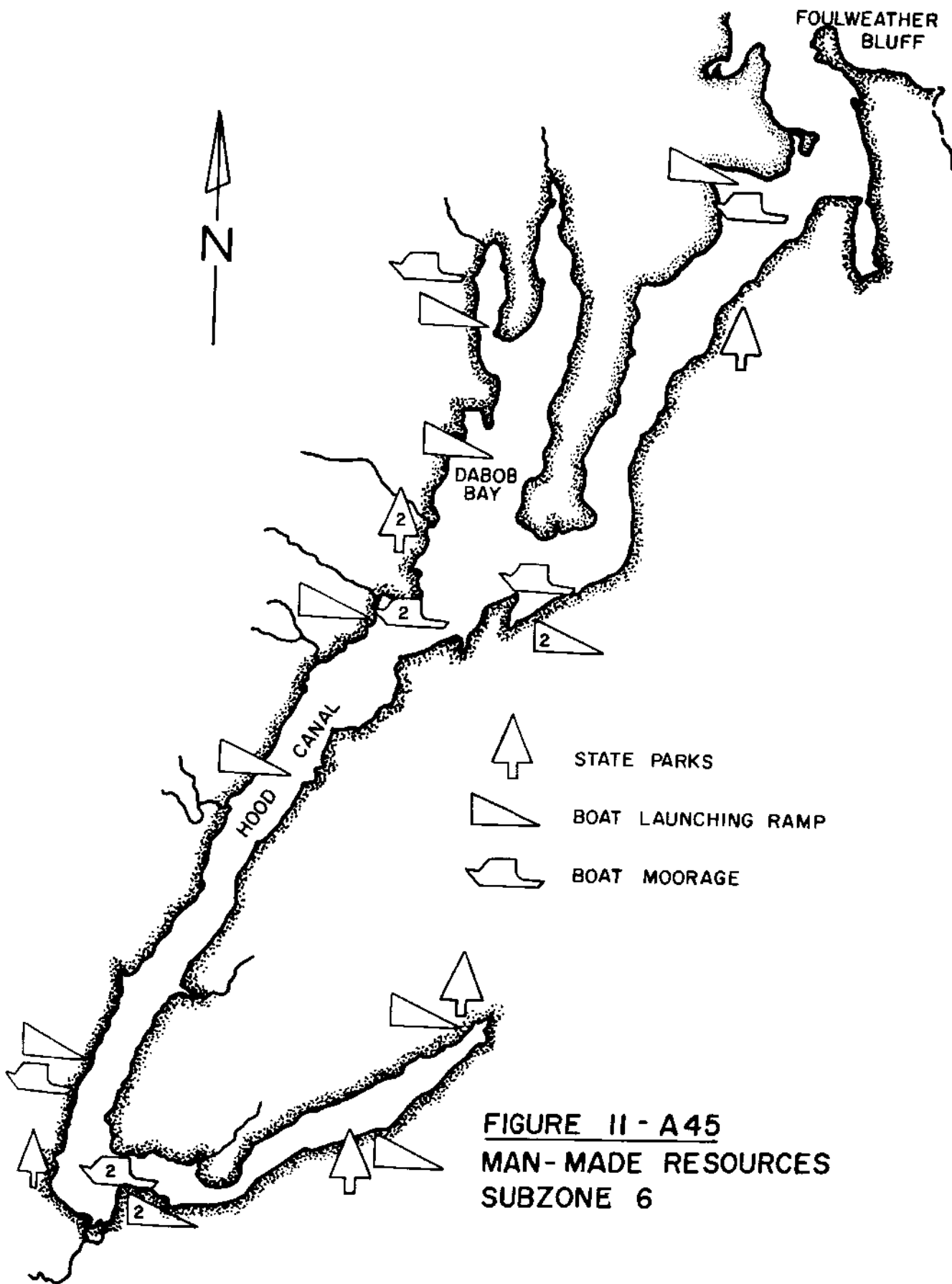


FIGURE II - A 45
MAN-MADE RESOURCES
SUBZONE 6

fish grounds in this subzone are at the entrance to Hood Canal, as shown in Figure II-A44.

iii. waterfowl

Waterfowl are found throughout Hood Canal, with medium to high density found across the entrance to the canal, approximately from Port Townsend to Port Gamble. Other concentrations are found in the general vicinity of Dabob Bay and in the entire southern portion of the canal, south of Dewatto Creek (see Figure II-A44).

6. Man-made physical resources

The closed waters of Hood Canal with its long shorelines are ideal for water-related recreation. This is evidenced by the numerous state parks, launching ramps, and rental moorages along the banks of the canal. The following table lists the number of facilities, which are shown in Figure II-A45.

TABLE II-A8: MAN-MADE RESOURCES, SUBZONE 6

<u>Location</u>	<u>State Parks</u>	<u>Launching Ramps</u>	<u>Rental Moorages</u>
S. Arm-Hood Canal	3	5	2
Central Hood Canal	0	1	0
North Arm-Hood Canal	1	4	2
Dabob Bay	<u>2</u>	<u>3</u>	<u>3</u>
SUBZONE 6 - TOTAL	6	13	7

The general public has access to 4 launching ramps and 2 rental moorages located in this subzone.

ENDNOTES SECTION II-A

- ¹Puget Sound and Approaches, A Literature Survey, University of Washington, Department of Oceanography, 1953, Volume 1.
- ²Ibid, p. 4.
- ³Ibid, p. 5.
- ⁴Ibid, p. 173.
- ⁵Ibid, p. 174.
- ⁶Ibid, p. 174.
- ⁷Ibid, p. 174.
- ⁸U.S. Naval Oceanographic Office, Glossary of Oceanographic Terms, Special Publication 35, 2nd edition, U.S. Government Printing Office, 1966, p. 64.
- ⁹Ibid, p. 165.
- ¹⁰Friebertshauser, M.S., and Duxbury, A.C., "A Water Budget Study of Puget Sound and Its Subregions," Limnology and Oceanography, in press.
- ¹¹Ibid.
- ¹²Puget Sound Task Force, Puget Sound and Adjacent Waters, Appendix XI, Fish and Wildlife, p. 3-1.
- ¹³Ibid, p. 3-40.
- ¹⁴Ibid.
- ¹⁵Puget Sound Task Force, Puget Sound and Adjacent Waters, Appendix XIII, Water Quality Control, pp. I-45 and I-46.
- ¹⁶Puget Sound Task Force, XI, p. 3-40.
- ¹⁷77th Annual Report, Washington State Department of Fisheries, p. 138.
- ¹⁸Ibid.
- ¹⁹Groundfish Report #9, Washington State Department of Fisheries, 1970.
- ²⁰Ibid.
- ²¹Puget Sound Task Force, Puget Sound and Adjacent Waters, Appendix VIII, Navigation.

²²Harris, R. G., Surface Winds over Puget Sound and the Straits of Juan de Fuca and their Oceanographic Effects, University of Washington, 1954, unpublished M.S. thesis.

²³Puget Sound Task Force, VIII, p. 11-12, 12-7.

²⁴Puget Sound Task Force, Puget Sound and Adjacent Waters Appendix X, Recreation, 1970, p. 12-1.

²⁵Harris

²⁶Puget Sound Task Force, VIII, p. 3-15, 4-12, 13-3.

²⁷Harris

²⁸Puget Sound Task Force, VIII, p. 4-12, 6-7, 7-11.

²⁹Harris

³⁰Puget Sound Task Force, VIII, p. 8-20, 8-21, 11-12.

³¹Harris

³²Puget Sound Task Force, VIII, p. 9-12, 10-7, 11-12.

³³Ibid, p. 11-12.