Reconnaissance of Intertidal and Subtidal Zones of Back Island, Behm Canal, Southeast Alaska

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EXECUTIVE SUMMARY

A diver reconnaissance of the intertidal and subtidal zones of Back Island, Southeast Alaska, was performed May 20-22, 1986. The specific objectives were to catalog potentially vulnerable shellfish, other invertebrates, and plant resources, and to identify potential herring spawning sites. This effort was designed to supplement the existing ecological data base for Back Island that would be used during the National Environmental Policy Act (NEPA) documentation process. A NEPA document will be prepared that describes the site environment and assesses impacts from the proposed construction and operation of the Southeast Alaska Acoustic Measurement Facility (SEAFAC). Nine diver transects were established around Back Island. Particular attention was devoted to proposed locations for the pier and float facilities and range-operations and shore-power cable run-ups.

BATHYMETRY AND SUBSTRATE CHARACTERISTICS

The rocky intertidal shoreline has a generally shallow slope and is composed of cobble, gravel, and sand substrates interrupted by rock outcrops. At least one steep-sloped rocky substrate is present on the northeast side of the island. Nearshore subtidal substrates are also primarily gently sloping with cobble, gravel, sand, and bedrock outcrops. Again, there is at least one steep-sloped rocky area. Wave action is slight to negligible, but may become intensified during storms. Tidal currents were also slight or undetectable at all transect locations during the survey.

INTERTIDAL AND SUBTIDAL ECOLOGY

The marine ecosystem of Back Island is typical of rocky shorelines of the protected North Pacific Coast. Four organisms generally dominate intertidal habitats: acorn barnacles (Balanus glandula), rockweed (Fucus

distichus), blue mussels (Mytilus edulis), and ochre sea-star (Pisaster ochraceus). Each is indicative of one of four stratified zones extending from the high-water line to a depth of about 3 m. Each zone supports a unique assemblage of fauna and flora.

The dominate organisms encountered in subtidal habitats (to a depth of 20 m) include eelgrass (Zostera marina) and brown algae (Agarum sp. and Costaria costata). Eelgrass occurs on fine-grained sediments, generally between 3 and 8 m on both east and west shores, and supports a variety of invertebrates (crabs, nudibranchs, limpets, snails, starfish, sea urchins, sea cucumbers, sea anemones). The brown algae are attached to cobbles and are encountered at most transect locations at depths of greater than 6 m, and support a different invertebrate fauna (shrimp, chiton, snails, starfish, sea cucumber, sea urchins, sponge, oyster, sea anemones, octopus).

HERRING SPAWNING

While shoals of small herring were encountered in surface waters of Back Island at the time of our surveys, no spawn or spawning adults were observed in the zones of eelgrass or Agarum sp. Our surveys, however, did confirm the presence of suitable spawning substrate (eelgrass, Agarum sp.) at most transect locations. The State of Alaska Department of Fish and Game has confirmed that herring spawning occurs in early April throughout early May and, depending on year-class strength, occurs along most beaches of Back Island.

MARINE MAMMALS

Incidental to the main objectives of our study, several small whales, possibly beaked whales (Ziphiidae), and several small pods of harbor porpoise (Phocoena phocoena) were observed near Back Island at the time of our diver reconnaissance.

ACKNOWLEDGMENTS

This final report summarizes studies conducted May 1, 1986, through July 30, 1986, by Pacific Northwest Laboratory (PNL) for the David Taylor Naval Ship R & D Center (DTNSRDC), Puget Sound Detachment, Bremerton, Washington, under contract TD-2201. This project was under the technical direction of Dr. John A. Strand, Earth Sciences Department. Mr. James S. Young, also from the Marine Sciences Section, Earth Sciences Department, organized and performed the dive surveys of Back Island. He was assisted by Mr. James A. Coley, Marine Research Laboratory, Operations, Projects, Crafts and Engineering Services Department.

The authors wish to acknowledge the advice and help of Mr. Charles Osborn, U.S. Department of Interior, Fish and Wildlife Service, and Mr. Dennis Blankenbeckler, State of Alaska Department of Fish and Game. Mr. Osborn accompanied the PNL dive team on surveys of the intertidal and subtidal zones of Back Island in the vicinity of the proposed pier facility. Mr. Blankenbeckler provided valuable information on herring spawning sites in the vicinity of Back Island.

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INTRODUCTION

In the course of the National Environmental Policy Act (NEPA) documentation process for the proposed Behm Canal Southeast Alaska Acoustic Measurement Facility (SEAFAC), David Taylor Naval Ship R & D Center (DTNSRDC) contracted Pacific Northwest Laboratory (PNL) to conduct a diver reconnaissance of the intertidal and subtidal zones of Back Island potentially affected by construction and operation of SEAFAC. In a previous study conducted for DTNSRDC based on a literature review and interviews of relevant professional resources (Strand et al. 1986), PNL found that there was inadequate data to prepare a description of the site and requisite assessments of impact, particularly as they related to valued shellfish resources, other invertebrates, and marine plants. Impacts in this situation pertain to concern that construction of the pier, float, and cable run-up facilities, leaching of creosote and other antifouling residues from docking facilities, fuel oil spills, etc., could potentially have an adverse impact on marine plant and animal communities in the immediate vicinity of Back Island.

This report presents the results of the diver reconnaissance conducted by PNL at Back Island May 20-22, 1986. Substrate types, vegetative zones and dominant invertebrate communities encountered at key locations proposed for construction are described. Additional data on the incidence of herring spawning at Back Island are also included.

It should be understood that the reconnaissance was qualitative in nature, and no attempt was made to rigorously quantify the distribution and diversity of indigenous aquatic organisms. A similar diver reconnaissance approach has been used by the U.S. Department of Interior, Fish and Wildlife Service and U.S. Department of Commerce, National Marine Fisheries Service to assess possible impacts of log rafting on intertidal and subtidal communities in Southeast Alaska (U.S. Department of Interior and U.S. Department of Commerce 1985).

METHODS

Transect lines were established perpendicular to the shoreline at key locations on Back Island (Figure 1) and extended seaward for 100 m as measured from the high-water line or to a maximum diver depth of 60 ft (18.3 m), whichever came first. Using SCUBA, observations of substrate composition and plant and animal communities were made at 10-m intervals along the line. Any key observations between the intervals were also noted. Depth was recorded at each interval.

Transects 1-3 were located in the vicinity of the proposed pier and float facilities; transect 7-9 were located in the vicinity of the proposed range-operation cable run-up. Transect 4 was placed at the proposed site of a shore-power cable run-up. Transects 5 and 6 were not located at any proposed site of construction, but were included to increase our knowledge of intertidal and subtidal ecology of Back Island.

Where possible, identifications of indigenous plants and animals were made in the field. A few plant specimens were dried and pressed for additional study. Also, a few animal species were preserved in 10% buffered formalin for later laboratory examination. The general taxonomic keys of Abbott and Hollenberg (1976) and Kozloff (1976) were used together with supplementary publications to identify specific taxonomic groups (Waaland 1977; Guberlet 1956; Kozloff 1973; Johnson and Snook 1927; Ricketts and Calvin 1939; Kessler 1985; and Barr and Barr 1983).

Additional information useful in identifying potential herring spawning sites at Back Island were derived from analysis and interpretation of data provided by the U.S. Department of Interior, Fish and Wildlife Service, and the State of Alaska Department of Fish and Game.

FIGURE 1. Diver Transect Locations of Back Island

RESULTS

DIVER SURVEYS

Transects 1-3

Transects 1-3 (Figure 2) were all quite similar with respect to substrate type, vegetative and animal zonation, and were typical of rocky shores on a protected Pacific coastline. From the high-water line to a depth of 3 m below mean lower-low-water, the substrate consisted of gravel and rubble interrupted by bedrock outcrops. Below 3 m, gravel and sand were encountered; below 10 m, the substrate was sand and silt. The intertidal and subtidal zones sloped gradually and generally little or no tidal current prevailed. Wave action was also negligible.

Barnacles (Balanus sp.) characterized the first zone at the top of the shore. This was followed by a zone of barnacles and seaweeds (B. glandula, the brown alga, Fucus distichus, and smaller seaweeds. A mid-tidal region (1-3 m) was marked by a zone of mussels (Mytilus edulis), barnacles (B. glandula), calcareous tube worms (Serpula vermicularis) and snails, species undetermined. Immediately below the zone of mussels was a zone of starfish (Pisaster ochraceus, Pycnopodia helianthoides, Evasterias troschelii), green algae (Ulva sp. and Monostroma sp.) and brown algae (Laminaria sp., Desmarestia intermedia). Between 3 and 6 m, a zone of eelgrass (Zostera marina) was encountered that contained a diversity of invertebrates including: crabs (Pagurus sp., Cancer productus, Cancer magister, Telmessus cheiragonus, Cryptolithodes typicus, Oregonia gracilis), nudibranchs (Archidoris sp., Melibe leonina, Dendronotus sp., limpets (Notoacmea scutum), snails (Lunatia lewisii), starfish (Dermasterias imbricata, P. helianthoides, Leptasterias hexactis), sea urchins (Strongylocentrotus drobachiensis), sea cucumber (Parastichopus californicus), tunicates (Corella willmeriana), and sea anemones (Pachycerianthus fimbriatus, Metridium senile). The eelgrass zone often included brown (Laminaria sp., Agarum sp., Fucus sp.) and red algae

FIGURE 2. Benthic Profiles for Transects 1-3 Showing Substrate Type and Predominant Flora and Fauna. Key to Substrate Type, Flora, and Fauna is Found in Table 1.

TABLE 1. Substrate, Flora and Fauna Key
Used in Figures 2-4.

KEY

SILT

SAND

GRAVEL

RUBBLE

COBBLE

BOULDER

BEDROCK

AGARUM

ZOSTERA

DESMARESTIA

HALOSACCION

ULVA

FUCUS

MONOSTROMA

Barnacles

Mussels

Scallop

Sea Urchin

Various Starfish

Pycnopodia

Sea Cucumber

Various Crabs

Shrimp

Nudibranch

Burrowing Sea Anemone (Pachycerianthus)

Limpet

Snails

(Contantineia simplex). Below the eelgrass zone (6 m), a more dense stand of brown algae (Agarum sp., Costaria costata) including an unidentified filamentous red algae were found.

Generally few fish species were encountered. Occasionally, the divers observed quillback rockfish (Sebastes malinger), kelp greenling (Hexagrammos decagrammus), and an unidentified sole.

Transect 4

Transect 4, proposed site of the shore-power run-up, (Figure 3) was located south of Transects 1-3. Its substrate types and biological composition were found to be similar to Transects 1 and 3. Bedrock extended from the high-water line to a depth of 3 m and supported a zone of Fucus distichus, barnacles (Balanus sp.), and snails (Littorina sitkana). Mussels (Mytilus edulis) were found at depths of 2 to 3 m. Below 3 m, the substrate changed to sand and gravel with scattered cobbles. Bedrock outcrops appeared occasionally along the remaining portion of the transect. Monostroma sp. and Desmarestia intermedia dominated a narrow zone just below the 3-m depth. Eelgrass (Zostera marina) formed a zone just over 20 m wide and extended to a depth of 5 m. Again, the eelgrass zone included brown algae (Agarum sp.). Beyond the eelgrass, Agarum sp. became the dominant vegetation. The nudibranch, Melibe leonina, was the most numerous invertebrate in both the eelgrass and Agarum sp. beds. Other animals encountered were starfish (Pycnopodia helianthoides), sea cucumbers (Parastichopus californicus), sea urchins (Strongylocentrotus drobachiensis), the lined chiton (Tonicella lineata), encrusting polychaetes (Serpula vermicularis), hermit crabs (Pagurus sp.), and the sponge (Myxilla incrustans).

Transect 5

Transect 5 (Figure 3) was located in the shallows on the south side of Back Island. The depth along the entire length of the transect did not exceed 3.5 m, and tidal current was negligible during the survey. The substrate was bedrock except for a few patches of sand 70 to 90 m from the

FIGURE 3. Benthic Profiles of Transects 4-6 Showing Substrate Type and Predominant Flora and Fauna. Key to Substrate Type, Flora, and Fauna is found in Table 1.

high-water line. Fucus distichus and Balanus sp. were found along the entire 100 m transect. Halosaccion glandiforme, Monostroma sp., Enteromorpha sp., Ulva sp. and a crustose coralline red alga were encountered 90 to 100 m from shore. Animals found along the transect were typical of shallow water rocky shores and included limpets (Notoacmea scutum, Acmaea sp.), six-armed starfish (Leptasterias hexactis), hermit crabs (Pagurus sp.), mussels (Mytilus edulis), and snails (Littorina sitkana, Searlesia dira).

Transect 6

Transect 6 (Figure 3), located on the west side of the island, was composed of bedrock from the high-water line seaward to a 3-m-high ledge about 60 m from shore. Fucus distichus was the dominant alga on the bedrock, mixed with Halosaccion glandiforme, Monostroma sp., and Corallina sp. near the outer edge. Animals found on the bedrock were snails (Littorina sitkana, Searlesia dira), barnacles (Balanus sp.), limpets (Notoacmea scutum), mussels (Mytilus edulis), hermit crabs (Pagurus sp.) starfish (Pisaster ochraceus), and nudibranchs (Anisodoris sp.). Seaward of the ledge, beginning at a depth of 6.5 m, the bottom changed to sand and silt. The dominant alga was Agarum sp. occasionally mixed with Desmarestia intermedia and the red alga, Agardhiella sp. A band of eelgrass 23 m wide grew from the base of the ledge out to a depth of 8 m. Animals observed included starfish (Dermasterias imbricata and Pycnopodia helianthoides), burrowing anemones (Pachycerianthus fimbriatus), sea cucumbers, (Parastichopus californicus), and the nudibranch, Melibe leonina, again was found on eelgrass and the large brown alga Agarum sp.

Transect 7-9

Transect 8 (Figure 4) was at the proposed range-operation cable run-up and extended seaward from the island along a rubble-covered bottom of a narrow channel in the bedrock. It is through this channel that the range-operations cable is to be placed. Transects 7 and 9 (Figure 4) bracket the channel and lay mostly over bedrock. These three transect

FIGURE 4. Benthic Profiles for Transects 7-9 Showing Substrate Type and Predominant Flora and Fauna. Key to Substrate Type, Flora, and Fauna is found in Table 1.

locations revealed ecosystems somewhat different from the others, perhaps because of the greater slope (faster dropoff) and the more rocky substratum. The most notable change was the absence of eelgrass (Z. marina). Surprisingly again, tidal currents were negligible or undetected during the survey.

From the high-water line of Transect 8 to a depth of 3 m, few plants and animals, with the exception of hermit crabs (Pagurus sp.), were observed. Below 3 m and associated with sand, rubble, and some cobble, was a zone of green (Ulva sp.), brown (Desmarestia intermedia, Cyamathere triplicata), and red (Porphyra sp., Cryptonemia sp.) algae. Associated with the algae at a depth of 3 to 7 m were several species of starfish (P. helianthoides, P. ochraceus, D. imbricata). Below 6 m, sponges (Myxilla incrustans), scallops (Chlamys hastada hericia), calcareous tube worms (S. vermicularis), and sea cucumbers (Cucumaria miniata) were observed. A dense stand of brown (Agarum sp.) and calcareous red algae (Corallina sp.) were found below 4.5 m associated with sand, gravel, shells, and bedrock outcrops. Animals in this zone included both side-stripe (Pandalus hypsinotus) and coon-stripe shrimp (Pandalus danae), the chiton (Tonicella lineata), and the sea cucumber (P. californicus).

The bedrock substratum of Transects 7 and 9 extended from the high-water line to depths of 7 and 14 m, respectively. Seaward of the bedrock was a mixture of sand, gravel, and shells. Transect 9 was on a steep slope that reached the 18.3-m (60-ft) maximum diver depth short of the designed 100-m transect length. A shallow zone of Fucus distichus dominated the bedrock to a depth of 3.5 m, while the green algae Monostroma sp. and Ulva sp., the brown alga, Desmarestia intermedia, the red alga (Halosaccion glandiforme) were found in the lower part of this zone. Below 3.5 m, Agarum sp. was the most abundant alga, and it was often observed associated with the red algae Constantinea simplex, Gigartina sp., Pterochondria woodii, and the red calcareous alga Corallina sp. All of the animals found along Transect 8 were also found on either Transects 7 or 9.

Additional animals encountered were Balanus sp., M. edulis, Notoacmea scutum, and T. cheiragonus in association with F. distichus or D. intermedia. Found in the deeper zone of Agarum sp. were Melibe leonina, the butterfly crab (Cryptolithodes typicus), snails (Calliostoma ligatum, Crepidatella lingulata, Lunatia lewisii), sea urchins (Strongylocentrotus franciscanus), a sponge (Lissodendoryx firma), oysters (Ostrea lurida), sea anemones (Metridium senile), and octopus (Octopus sp.).

HERRING SPAWNING

While several shoals of small herring (Clupea harengus) were seen near the water surface during diver surveys, no spawning adults were encountered in the zones of eelgrass or Agarum sp. It is known, however, that herring use both Back Island and Betton Island as spawning sites. Dennis Blankenbeckler of the Alaska Department of Fish and Game observed herring spawning at Back Island during 1973-1975, 1981, and 1983 (Figure 5). Depending on year-class strength, spawning was restricted to a relatively small area such as occurred between Back and Betton Islands in 1981, or was extended over a much wider area as occurred in 1983. Spawning time is also known to vary but generally begins in early April and ends in early May. Blankenbeckler (1985) also estimates that along each mile of shoreline where herring spawn in Southeast Alaska, upwards of one million fish may be produced.

OTHER OBSERVATIONS

Several (3-4) small whales, possibly beaked whales (Ziphiidae) and several small pods (3-6 individuals) of harbor porpoise (Phocoena phocoena) were observed near Back Island at the time of the diver reconnaissance. The whales were seen entering Clover Passage swimming in a generally easterly direction at a distance of about 400 m from the island. The porpoise often came within 100 m of the beach and were generally present at Back Island throughout our survey.

DISCUSSION AND CONCLUSIONS

BATHYMETRY AND SUBSTRATE CHARACTERISTICS

The rocky intertidal shoreline of Back Island has a generally shallow slope and is composed of cobble, gravel, and sand substrates interrupted by rock outcrops. There is at least one steep-sloped rocky substrate on the northeast side of the Island. Nearshore subtidal substrates are also primarily gently sloping cobble, gravel, and sand with bedrock outcrops. At least one steep-sloped rocky area is also present. Wave action was slight to negligible but may become intensified during storms. Tidal currents were also slight or undetected at all transects locations during the survey.

INTERTIDAL AND SUBTIDAL ECOLOGY

The marine ecosystem of Back Island is typical of rocky shorelines of the protected North Pacific Coast (Ricketts and Calvin 1939; Kozloff 1973). Four organisms generally dominate intertidal habitats: acorn barnacles (Balanus glandula), rockweed (Fucus distichus), blue mussels (Mytilus edulis), and ochre seastar (Pisaster ochraceus). Each is indicative of one of four stratified biotic zones: 1) barnacles are usually found at the highest intertidal zone, but may also occur in lower zones; 2) rockweed is found at the next lowest zone on gradually sloping shores between 15 to 60°; 3) the next lower zone is marked by mussels, which are often associated with barnacles; and 4) the seastar is characteristic of the lowest intertidal zone.

A generalized description of the organisms encountered in the subtidal habitats (maximum depth 20 m) of Back Island includes a zone of eelgrass (Zostera marina) and a deeper zone of brown algae (Agarum sp. and Costaria costata). Eelgrass occurs on fine-grained sediments and supports a variety of invertebrates (crabs, nudibranchs, limpets, snails, starfish, sea urchins, sea cucumbers, sea anemones), and brown and red algae. The deeper brown algae are found attached to cobbles and support a different

invertebrate fauna (shrimp, chiton, snails, starfish, sea cucumber, sea urchins, sponge, oyster, sea anemones, octopus) and red algae.

Eelgrass occurs subtidally both on the west and east shores. Accordingly, it is not restricted to the location of the proposed pier and float facilities (Transects 1-3). Eelgrass likely also occurs on the south shore of Back Island, but was not observed during the diver survey because of the relatively shallow depth of Transect 5. The divers never actually penetrated the subtidal zone at any point on the 100-m transect. Eelgrass does not exist on the northeast shore of the Island (Transects 7-9) because of the significantly steeper slope and the absence of fine-grained sediments at the generally preferred depth (3-8 m).

The different intertidal and subtidal zonation patterns and their composition found during the present study are nearly the same as found by VTN (1980, 1981, 1982a,b) at Boca De Quadra, Wilson Arm and Smeaton Bay (about 80 miles southeast of Ketchikan). The species compositions of subtidal habitats at Back Island are also similar to species compositions recorded at potential log rafting and transfer sites on nearby Dall Island, Jumbo Island, and Prince of Wales Island, (U.S. Department of Interior and U.S. Department of Commerce 1985).

Variations in the composition and position of intertidal zones between the present and past studies are believed attributable to local environmental factors including slope, exposure, freshwater runoff, and nutrient enrichment to the more protected areas of shoreline. Any variations of composition and zonation of subtidal plants and animals are likely attributable to differences in substrate type and slope, currents, deposition of sediments, and season. Unfortunately, few other data are available for Back Island and Behm Canal (Strand et al. 1986) on which to base additional comparisons.

HERRING SPAWNING

While shoals of small herring were observed in the near-surface waters at Back Island, no spawn or spawning adults were observed in the zones of eelgrass or brown algae. It is likely that our survey was scheduled too late in the season to witness a spawning event. The Alaska Department of Fish and Game indicated that spawning occurs in early April through early May. Nonetheless, our surveys confirmed the presence of suitable spawning substrate (eelgrass, brown algae) at most transect locations. If Blankenbeckler's (1985) estimate of herring productivity (one million herring produced per mile of spawn) is accurate, it is likely that Back Island produces no less than one-half to two million fish annually, depending on year-class strength. This production figure is based on the assumption that herring spawn each year along a stretch of shoreline between one half and two miles in length at Back Island (Figure 5).

MARINE MAMMALS

Several small whales and harbor porpoise were sighted at Back Island during the diver surveys. These sightings suggested the need to carefully evaluate whether or not marine mammal surveys should be performed pursuant to satisfying the NEPA process. The time and use of Behm Canal by various marine mammal species should, perhaps, be considered in the construction and operation of SEAFAC.

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APPENDIX A

SUMMARY OF ORGANISMS OBSERVED IN INTERTIDAL
AND SUBTIDAL ZONES OF BACK ISLAND

TABLE A.1. (Contd)

TAXON	Transect Number								
	1	2	3	4	5	6	7	8	9
Porifera									
<u>Myxilla incrustans</u>				X			X	X	X
<u>Lissodendoryx firma</u>							X		X
Coelenterata (Anthozoa)									
<u>Pachycerianthus fimbriatus</u>	X	X	X			X			
<u>Metridium senile</u>			X				X		X
Annelida (Polychaeta)									
<u>Serpula vermicularis</u>			X	X			X	X	X
Mollusca (Amphineura)									
<u>Tonicella lineata</u>				X			X	X	X
Mollusca (Gastropoda)									
<u>Archidoris</u> sp.		X				X			
<u>Melibe leonina</u>	X	X	X	X		X	X		X
<u>Dendronotus</u> sp.			X						
<u>Notoacmea scutum</u>		X			X	X	X		X
<u>Acmaea</u> sp.					X				
<u>Lunatia lewisii</u>	X	X							X
<u>Littorina sitkana</u>	X	X	X	X	X	X			
<u>Searlesia dira</u>					X				
<u>Calliostoma ligatum</u>							X		X
<u>Crepidatella lingulata</u>							X		X
Mollusca (Bivalvia)									
<u>Mytilus edulis</u>	X	X	X	X	X	X	X		X
<u>Chalamys hastada hericia</u>							X	X	X
<u>Ostrea lurida</u>							X		X

TABLE A.1. (Contd)

TAXON	Transect Number								
	1	2	3	4	5	6	7	8	9
Mollusca (Cephalopda)									
<u>Octopus</u> sp.									X
Arthropoda									
<u>Balanus</u> sp.	X	X	X	X	X	X	X		X
<u>Cancer productus</u>		X							
<u>Cancer magister</u>	X	X							
<u>Cryptolithodes typicus</u>			X						X
<u>Oregonia</u> sp.		X	X						
<u>Pagurus</u> sp.	X			X	X	X	X	X	X
<u>Pandalus danae</u>							X	X	X
<u>Pandalus hypsinotus</u>							X	X	X
<u>Telmessus cheiragonus</u>			X						X
Echinodermata									
<u>Cucumaria miniata</u>							X	X	X
<u>Dermasterias imbricata</u>	X	X	X			X	X	X	X
<u>Evasterias troschelii</u>	X						X		X
<u>Henricia leviuscula</u>							X		X
<u>Leptasterias hexactis</u>	X				X				
<u>Parastichopus californicus</u>	X	X	X	X		X	X	X	X
<u>Pisaster ochraceus</u>		X	X			X	X	X	X
<u>Pycnopodia helianthoides</u>	X	X	X	X		X	X	X	X
<u>Strongylocentrotus</u>									
<u> drobachiensis</u>	X			X					
<u>Strongylocentrotus</u>									
<u> franciscanus</u>									X
Chordata (Urochordata)									
<u>Corella willmeriana</u>	X	X	X						

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