

**The Succession of Marine Life  
on the *Chaudiere*, a Ship Reef  
in Sechart Inlet, British Columbia**



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## Summary

On December 5, 1992, the HMCS *Chaudiere* sank to the bottom of Sechelt Inlet, becoming the first of four obsolete Restigouche-class Canadian Navy destroyers to be deliberately scuttled in British Columbia's coastal waters. The project was managed by the Artificial Reef Society of British Columbia (ARSBC).

The task of preparing the ship for ocean disposal involved removal of all contaminated materials and potential sources of pollution. The ARSBC also cut numerous access holes in the decks and hull of the ship to make it safe for exploration by recreational divers. Before the ship was scuttled, Environment



Canada officials carried out a series of inspections to ensure that the ship met all existing environmental requirements for ocean disposal.

Since the sinking, the *Chaudiere* has become a very popular dive site. It is located in a sheltered fjord where tidal currents and wave action are minimal, and where underwater visibility can exceed 30 metres during the winter months.

Over time, the hull has been colonized by many different kinds of marine life. The colonization process has been a gradual and ever-changing one. Based on video and still photography documentation, this report describes the general sequence and rate of colonization with reference to the most conspicuous invertebrate, algal and fish species.

## Siting, Orientation and Stability

The *Chaudiere* lies on its port side on a sloping mud bottom in a bay just north of Kunechin Point, Sechelt Inlet. The buoy moored near the mortar bay is located at N 49° 37.694', W123° 48.699'. The vessel lies on a bearing approximately SSE to NNW, with the bow pointing to the SSE. The bow is offshore at a depth of about 30 m, while the shallowest point of the stern is at about 18 metres. The plan of the ARSBC had been to sink the ship upright and in somewhat shallower water, but the vessel became excessively

top-heavy during the scuttling and rolled over onto its port side north of the intended siting axis. The hull is lying in a very stable position and there is no evidence that it has shifted since the day it was scuttled. Due to the slope of the bottom and the shape of the hull, the bow of the ship is cantilevered over the bottom.

The location of the *Chaudiere* is subject to negligible to mild tidal currents and is too deep to be affected by wave action. Water clarity on the wreck is usually good to excellent, even when there is a turbid layer of plankton at the surface. During winter months visibility of 20 to 30 metres is typical.

## **Marine Life colonizing nearby Rocky Reefs**

Although the *Chaudiere* lies on a mud bottom, there is a rocky reef just off the stern of the ship. This reef supports marine life typical of Sechelt Inlet, such as plumose anemones, crinoids, vase tunicates, brachiopods and sea stars. Tube-dwelling anemones colonize mud pockets between the rocky reefs.

Due to its essentially enclosed nature and limited water exchange, Sechelt Inlet is characterized by a relatively low diversity of marine organisms, although certain adaptive species (such as vase tunicates) can be found in very large numbers.

## **Colonization of the Ship**

In order to prepare species lists and note changes in community structure over time, the results of 15 videotaped dives made on the *Chaudiere* over the course of 10 years were reviewed and the observations tabulated. Additional comments were made from other dives where still photography was carried out or where subjective observations noted.

It should be noted that the *Chaudiere* is a very large ship (111 metres long) and that some parts of it are in relatively deep water. Recreational, no-decompression dives tend to be quite short (less than 30 minutes) so that usually only a specific part of the ship can be videotaped on a single dive. For this reason the videotaped records did not always document the same structures on the ship, resulting in gaps in the comparability of the records.

At the time of sinking, parts of the underside of the hull of the *Chaudiere* were already colonized by barnacles, mussels, tubeworms and anemones. These marine organisms were living on the propeller shafts and hull of the vessel while it was moored in Esquimalt for many years and while the ship was located in Vancouver Harbour.

Table 1 presents a list of taxa observed on the *Chaudiere* with estimates of abundance over time. General comments are as follows:

Dives carried out on **December 6, 1992**, (one day post-sinking) showed the hull to be lying in a stable position on its port side, with a downward slope from the stern (closest to shore) to the bow (offshore). There was a light layer of silt on many of the horizontal hull surfaces due to the sediment that had been disturbed when the ship hit the bottom. The lower edge of the transom showed damage from impact with a small bedrock reef located just off the stern of the ship. The only marine life observed was that living on the underside of the hull near the stern and on the propeller shafts. The underside of the hull was colonized by mussels and barnacles, while the shafts supported parchment tubeworms and a few small plumose anemones.



View of transom

By **February 14, 1993**, (72 days post-sinking), a thin layer of algae (likely a diatom mat) was observed on the upper (starboard) side of the hull. Large numbers of shiner seaperch hovered near the propeller shafts at the stern, attracted to the mussels and barnacles on the hull. Lesser numbers of pile perch were also observed.

By **June 20, 1993**, (7 months post-sinking) the upper (starboard) side of the *Chaudiere's* hull was coated with a brown diatom layer and a few scattered vase tunicates were observed attached to the hull. Colonies of hydroids were observed on some of the railings.

By **September 5, 1994**, (22 months post-sinking), the appearance of the *Chaudiere* had been transformed. Thousands of vase tunicates covered the hull, attached in dense clusters to railings, stanchions, gangways and many other edges on the hull. Many other invertebrate species, such as anemones, hydroids, tubeworms, mollusks and crustaceans were observed, although in small numbers relative to the incredible numbers of vase tunicates. Several species of fish were observed, dominated by large schools of shiner sea perch that hovered around the propeller shafts at the stern.



Vase tunicates

By **December 29, 1994**, (25 months post-sinking), the assemblage of invertebrates and fishes was similar to September, with even more vase tunicates colonizing the hull. Juvenile feather stars were found on the upper railings, along with juvenile plumose anemones. Large schools of shiner sea perch hovered over the mortar bay at the stern of the ship. Most of the mussels and barnacles previously found on the underside of the hull appeared to have been eaten. Some juvenile green urchins were found on the upper

surfaces of the hull, apparently grazing the diatom mat. The diversity of conspicuous invertebrates observed had increased to 15 taxa and seven species of fish were observed.

By **September 2, 1995**, (34 months post-sinking) large numbers of mature feather stars had colonized the railings, stanchions and structures on the upper (starboard) edge of the hull. Amongst conspicuous invertebrates, vase tunicates dominated, with enormous numbers attached all over the hull, including some of the deeper areas such as the forward gun barrels. Limited penetrations inside the hull revealed that vase tunicates were present, but in lower densities than were found on exterior surfaces.

By **February 10, 1996**, (39 months post-sinking) the numbers of vase tunicates had further increased and they occupied many more parts of the ship. Large feather stars were abundant on railings, stanchions and metal structures on the upper surfaces of the hull. Increased numbers of plumose anemones were found, especially on the upper surfaces where exposure to mild currents and planktonic food is favourable. Some of the plumose anemones reached 40 cm in height. More juvenile quillback rockfish were found, especially in the vicinity of the mortar bay. Large schools of shiner sea perch continued to reside near the stern, both by the propeller shafts and over the mortar bay area.

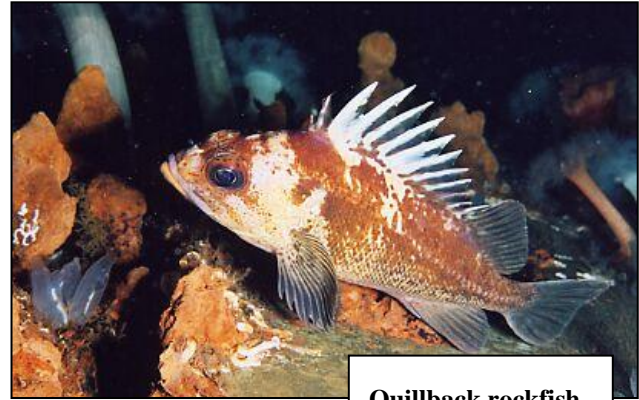


By **May 10, 1996**, (42 months post-sinking), the number of vase tunicates appeared to be steadily increasing. Many feather stars were present and the abundance of plumose anemones was also increasing. At the stern, the rudders were overgrown with plumose anemones and the shafts were laden with parchment tubeworms, plumose anemones and vase tunicates.

By **March 15, 1997**, (52 months post-sinking), large schools of shiner sea perch continued to occupy the stern of the ship. Pregnant copper rockfish were observed near the mortar bay, as were several lingcod. The numbers of vase tunicates seemed to be slightly fewer (although remaining relatively abundant) than previously, but the numbers of plumose anemones were steadily increasing at the stern and along mid-ship structures on the starboard side of the hull. Railings and stanchions forward were still fairly bare, but with a few plumose anemones and feather stars.

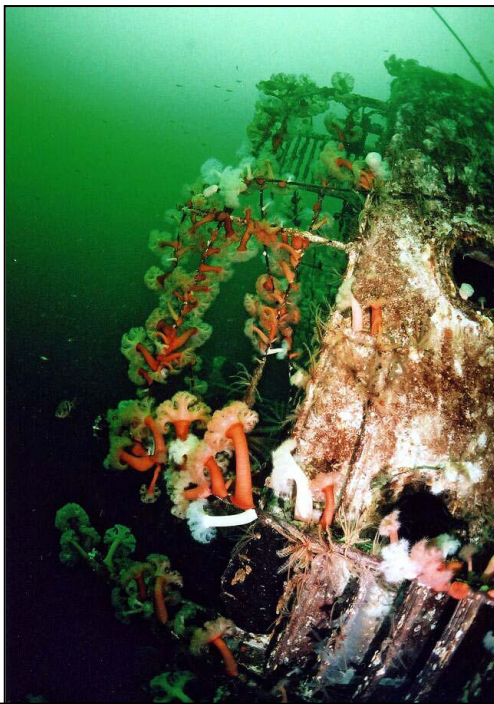
By **July 24, 1999**, (80 months post-sinking) the number of vase tunicates remained very high, colonizing all exterior and many interior parts of the ship. Feather stars were still present, but far fewer and more dispersed than the concentrations observed in February.

Several adult quillback rockfish were found in the area of the mortar bay. The number and size of the plumose anemones continued to increase, to the point that they were becoming one of the most conspicuous of the macro-invertebrates. The rudders and shafts were densely colonized by plumose anemones, along with clusters of parchment tubeworms. Two 30-cm long specimens of chimney sponge were found attached to a bulkhead well inside the ship.

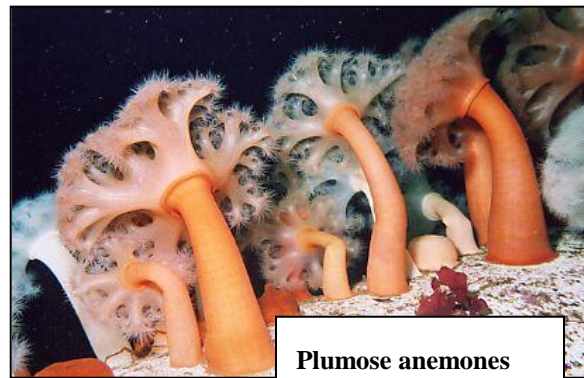


Quillback rockfish

By **June 23, 2000** (91 months post-sinking), the number of vase tunicates appeared to be fewer than before (while still very abundant), and the number of plumose anemones continued to increase, making it the most conspicuous macro-invertebrate on the reef. The number of feather stars appeared to have decreased.



View of superstructure, looking forward



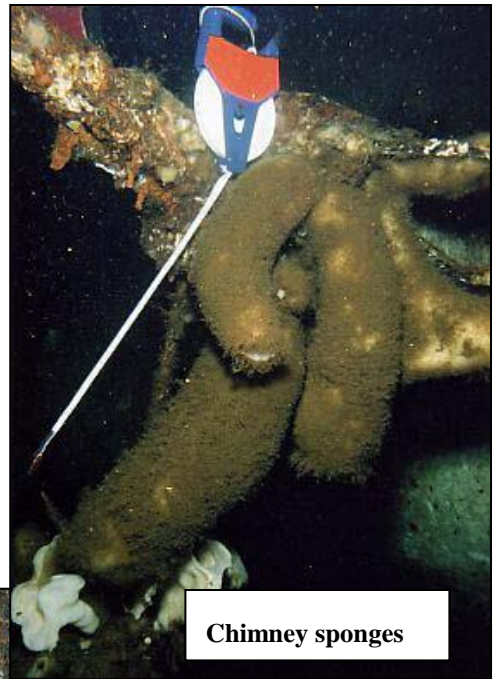
Plumose anemones

By **February 25, 2003** (122 months post-sinking), the number of plumose anemones continued to increase, with dense groups covering many areas of the ship. The largest plumose anemones reached a height of approximately 50 cm. Feather stars and vase tunicates were also abundant over the entire surface of the ship. Vase tunicates were also common in passages inside the vessel.

On the deeper parts of the ship two species of silica sponges were found. Chimney sponges were found in many areas of the ship including internal passages. The largest specimens observed were in a cluster off the port railing amidships, the longest tube measuring approximately 40 cm long. Cloud sponges are not as common, but specimens were found attached to the gun barrel, the hull near the bow and amongst the cluster of chimney sponges on the port side.

Due to the depth of the ship algae was found only on the starboard side of the hull exposed to the most ambient light. Both encrusting red algae and a bladed red alga were observed. The bladed red alga reached 15 cm in height.

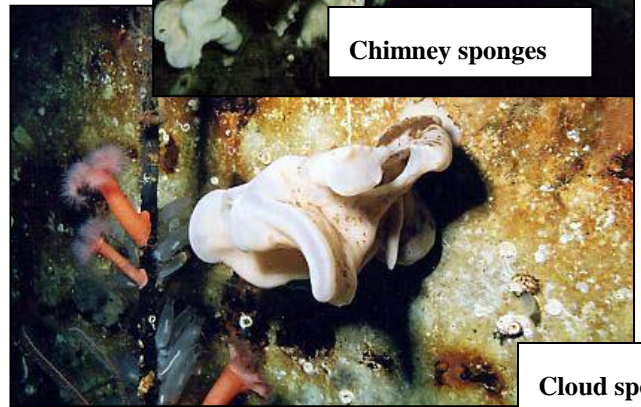
Several algal grazers were found, including chitons and green urchins.



Chimney sponges

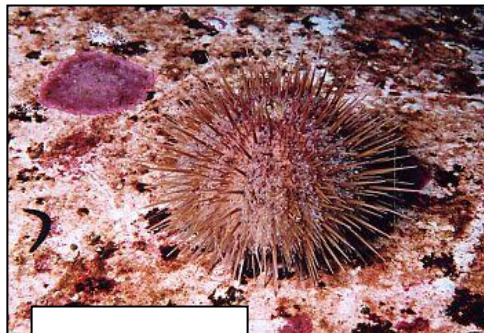


Bladed red alga



Cloud sponge

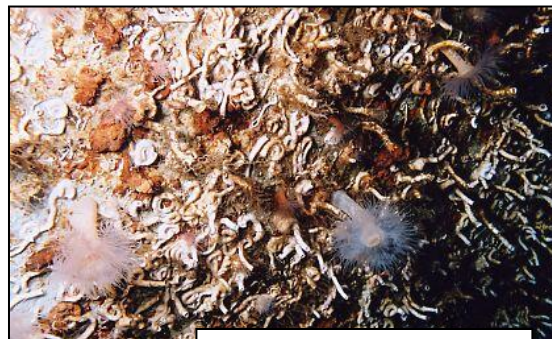
In the shadowed areas on the underside of the hull several species of calcareous tubeworms dominated the encrusting organisms, although plumose anemones and tunicates were also found.



Green urchin



Smooth mopalialia

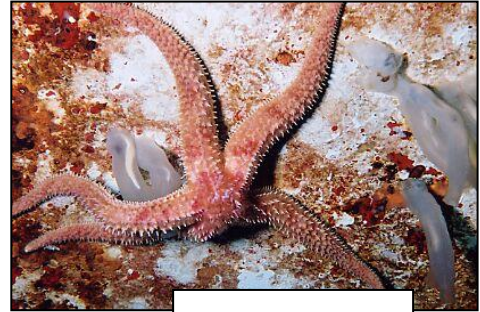


Calcareous tubeworms

Sea stars were not abundant on the ship. The two most commonly observed species were the sunflower sea star and the painted sea star. The latter was observed eating vase tunicates.

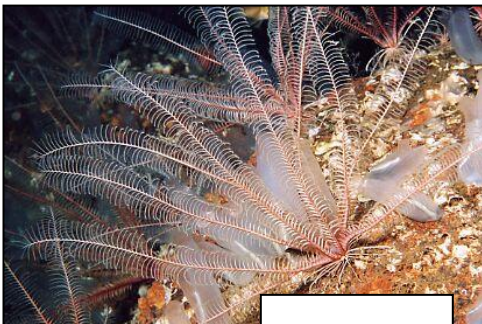


Sunflower seastar



Painted seastar

Other echinoderms observed included abundant feather stars and many giant sea cucumbers.



Feather stars



California sea cucumber

## Summary

Based on more than 50 video and observational dives made from December 5, 1992 to February 27, 2003, a list of conspicuous invertebrate and fish species was compiled with subjective comments on their abundance (Table 3). It should be noted that the analysis of video records for the presence/absence of marine organisms has limitations: many small and/or cryptic species cannot be distinguished due to the relatively low resolution of video images.

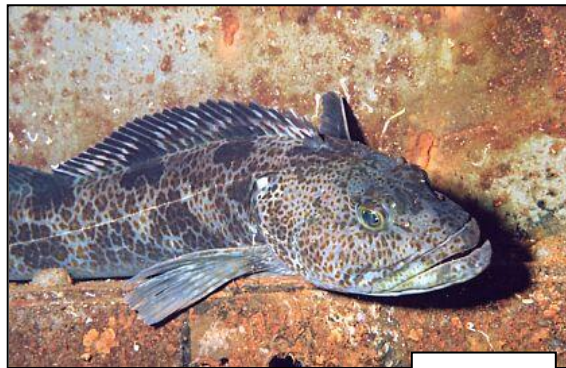
The video records showed that among the first colonizers of the *Chaudiere's* upper surfaces were hydroid colonies, which appeared within seven months of the sinking. At that time small numbers of juvenile vase tunicates were also observed. By September, 1994, (22 months post-sinking) the appearance of the *Chaudiere* had been transformed by dense colonies of the vase tunicate. One year later, September, 1995, (34 months post-



sinking) large numbers of feather stars were found on the starboard side railings and stanchions. By February, 1996, (39 months post-sinking) the numbers of plumose anemones had started to increase significantly and continue to increase over time. The numbers of feather stars had decreased, although they remained a conspicuous species. The number of vase tunicates continues to be high over the entire hull.

As of February 2003, 50 taxa of conspicuous invertebrates had been recorded. The most numerous species were plumose anemones, vase tunicates, feather stars, hydroids and tubeworms.

The diversity of fish recorded on the *Chaudiere* was relatively low, with 10 species observed. Numerically, the shiner sea perch is by far the most abundant species. This sea perch forms large, loose schools adjacent to the propeller shafts and mortar bay at the stern of the ship. Rockfish, especially quillback rockfish, are found throughout the ship. Other rockfish species observed include copper and yelloweye. Lingcod are found in several areas of the ship, feeding on shiner sea perch and juvenile rockfish.



**Lingcod**

**Table 1: List of Conspicuous Marine Life at the Chaudiere Ship Reef, with estimates of abundance.**

Abundance Code: Abundant (A)–observed in large numbers; Common (C)–observed in moderate numbers; Few (F)–observed sporadically or in small patches; Rare (R)–only one or two observed

COMMON NAME	TAXA	Dec 6 1992	Feb 14 1993	Jun 20 1993	Sept 5 1994	Dec 29 1994	Sept 2 1995
<b>INVERTEBRATES</b>							
<b>Porifera</b>							
Yellow encrusting	Demospongiae				F		F
<b>Cnidaria</b>							
Plumose anemone	<i>Metridium farcimen</i>	F	F	F	F		A
Hydrozoa	Hydrozoa			A	A		A
<b>Arthropoda</b>							
Acorn barnacle	<i>Balanus glandula</i>	C	C	C	C	C	C
Striped shrimp	<i>Pandalus danae</i>				F	F	F
Spider crab	<i>Chorilia longipes</i>				R	R	F
<b>Mollusca</b>							
Smooth pink scallop	<i>Chlamys rubida</i>				R		R
Bay mussel	<i>Mytilus edulis</i>	A	A	A	F		A
Rock jingle	<i>Pododesmus machrochisma</i>					F	
<b>Echinodermata</b>							
Sunflower seastar	<i>Pycnopodia helianthoides</i>				F	F	F
Painted seastar	<i>Orthasterias koehleri</i>				R	R	
Mottled seastar	<i>Evasterias troschelii</i>					F	
Green urchin	<i>Strongylocentrotus droebachiensis</i>				F	F	F
California sea cucumber	<i>Parastichopus californicus</i>					F	F
Feather star	<i>Florometra serratissima</i>					F	A
<b>Annelida</b>							
Parchment tubeworm	<i>Eudistylia vancouveri</i>	F	F	F	C	C	
Parchment tubeworm	<i>Schizobranchia insignis</i>	F	F	F	C	C	A
Calcareous tubeworm	<i>Serpula vermicularis</i>				C	C	A
Calcareous tubeworm	<i>Crucigera</i> spp.			F	A	A	A
<b>Urochordata</b>							
Vase tunicate	<i>Ciona savignyi</i>			F	A	A	A
Shiny orange tunicate	<i>Cnemidocarpa finmarkiensis</i>				F		R

<b>FISHES</b>							
Scalyhead sculpin	<i>Artedius harringtoni</i>				F	F	C
Lingcod	<i>Ophiodon elongatus</i>				F	F	F
Copper rockfish	<i>Sebastes caurinus</i>				F	F	F
Quillback rockfish	<i>Sebastes maliger</i>				F	F	F
Yelloweye rockfish	<i>Sebastes ruberrimus</i>					R	
Northern ronquill	<i>Ronquilus jordani</i>				R		R
Shiner seaperch	<i>Cymatogaster aggregata</i>		A	A	A	A	A
Pile perch	<i>Rhacochilus vacca</i>		C	C	C	C	C

COMMON NAME	TAXA	Feb 10 1996	May 10 1996	Mar 15 1997	July 24 1999	June 23 2000	Feb 26 2003
<b>INVERTEBRATES</b>							
<b>Porifera</b>							
Finger sponge	<i>Neosperiopsis rigida</i>						R
Yellow encrusting	Demospongiae	C	C	C	C	C	C
Buff encrusting	? <i>Halichondria</i> sp.						C
Scallop encrusting sponge	<i>Myxilla incrustans</i>						R
Chimney sponge	<i>Rhabdocalyptus dawsoni</i>				R		C
Cloud sponge	<i>Aphrocallistes vastus</i>						F
<b>Cnidaria</b>							
Plumose anemone	<i>Metridium farcimen</i>	A	A	A	A	A	A
Swimming anemone	<i>Stomphia didemon</i>						R
Hydrozoa	Hydrozoa	A	A	A	A	A	A
<b>Platyhelminthes</b>							
white horned flatworm	<i>Pseudoceros canadensis</i>						R
<b>Arthropoda</b>							
Sea spider	<i>Nymphon</i> sp.						R
Acorn barnacle	<i>Balanus glandula</i>						
Striped shrimp	<i>Pandalus danae</i>	F	F	F	F	F	F
Spider crab	<i>Chorilia longipes</i>	R					C
<b>Mollusca</b>							
Yellow discodorid	<i>Anisodoris nobilis</i>						R
Opalescent nudibranch	<i>Hermisenda crassicornis</i>						R
White-lined dirona	<i>Dirona albolineata</i>						R
Red aeolid	<i>Flabellina</i> sp.						R
Smooth mopalia	<i>Mopalia vespertina</i>						F
White-lined chiton	<i>Tonicella insignis</i>						F
Blue-lined chiton	<i>Tonicella undocerulea</i>						F
Smooth pink scallop	<i>Chlamys rubida</i>						F
Rock entodesma	<i>Entodesma navicula</i>						R
Northern horse mussel	<i>Modiolus modiolus</i>						R
Bay mussel	<i>Mytilus edulis</i>	F					F
Rock jingle	<i>Pododesmus machrochisma</i>	F	F				F
<b>Echinodermata</b>							
Slime star	<i>Pteraster tesselatus</i>						R
Sunflower seastar	<i>Pycnopodia helianthoides</i>	F	F	F	F	F	F
Painted seastar	<i>Orthasterias koehlerii</i>						F
Mottled sea star	<i>Evasterias troschelii</i>	F			F		R
Rose seastar	<i>Crossaster papposus</i>						R
Leather sea star	<i>Dermasterias imbricata</i>				R		
Daisy brittlestar	<i>Ophiopholis aculeata</i>						F
Long armed brittlestar	Ophiuroidea						R
Green urchin	<i>Strongylocentrotus droebachiensis</i>	F	F	F	F	F	C
California sea cucumber	<i>Parastichopus californicus</i>	F	F	F	F	F	C
Feather star	<i>Florometra serratissima</i>	A	A	A	A	A	A
<b>Annelida</b>							
Parchment tubeworm	<i>Eudistylia vancouveri</i>	C	C	C	C	C	C
Parchment tubeworm	<i>Schizobranchia insignis</i>	C	C	C	C	C	C
Calcareous tubeworm	<i>Serpula vermicularis</i>	A	A	A	A	A	A
Calcareous tubeworm	<i>Apotamus</i> sp.						R
Calcareous tubeworm	<i>Crucigera</i> spp.	A	A	A	A	A	A
Spaghetti tube worm	<i>Thelepus crispus</i>						F
<b>Brachiopoda</b>							
Smooth brachiopod	<i>Laqueus californianus</i>						F
<b>Bryozoan</b>							
Stalked cup bryozoan	<i>Bugula</i> sp.						F

COMMON NAME	TAXA	Feb 10 1996	May 10 1996	Mar 15 1997	July 24 1999	June 23 2000	Feb 26 2003
<b>Urochordata</b>							
Spiny sea squirt	<i>Halocynthia igaboja</i>						F
Transparent tunicate	<i>Corella willmeriana</i>						F
Peanut sea squirt	<i>Styela gibbsii</i>						R
Wrinkled sea squirt	<i>Pyura haustor</i>						R
Vase tunicate	<i>Ciona savignyi</i>	A	A	A	A	A	A
Shiny orange tunicate	<i>Cnemidocarpa finmarkiensis</i>	F	F	F	F	F	R

<b>FISHES</b>							
Scalyhead sculpin	<i>Artedius harringtoni</i>	C	C	C	C	C	C
Grunt sculpin	<i>Rhamphocottus richardsoni</i>		R				R
Lingcod	<i>Ophiodon elongatus</i>	C	C	C	C	C	C
Painted greenling	<i>Oxylebius pictus</i>						F
Copper rockfish	<i>Sebastes caurinus</i>	F	F	F	F	F	F
Quillback rockfish	<i>Sebastes maliger</i>	C	C	C	C	C	C
Yelloweye rockfish	<i>Sebastes ruberrimus</i>			R	R	R	F
Black-eyed goby	<i>Coryphopterus nicholsi</i>						R
Northern ronquil	<i>Ronquilus jordani</i>						
Shiner seaperch	<i>Cymatogaster aggregata</i>	A	A	A	A	A	A
Pile perch	<i>Rhacochilus vacca</i>	C	C	C	C	C	C
<b>SEAWEEDS</b>							
Encrusting red alga	<i>Lithothamnium</i> sp.						A
Bladed red alga	<i>Weeksia coccinea</i>						C