

**DEEPWATER DEMERSAL FISHES  
OBSERVED FROM THE SUBMERSIBLE  
AVALON (DSRV-2)  
OFF THE FARALLON ISLANDS,  
24 JUNE 1985**



by  
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and  
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**MARINE RESOURCES  
TECHNICAL REPORT NO. 55**

**1987**

CALIFORNIA DEPARTMENT OF FISH AND GAME  
MARINE RESOURCES TECHNICAL REPORTS

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## ABSTRACT

On 24 June 1985 the U.S. Navy's Deep Submergence Rescue Vehicle AVALON [DSRV-2] was used to locate low-level radioactive waste containers and make observations of deepwater benthic fishes and invertebrates at the 900 m (2952 ft) radioactive waste disposal site approximately 4.4 km SW of the Farallon Islands off San Francisco, California. During the three hours on the bottom in depths of 975 to 1039 m (3198 to 3408 ft) five identifiable species of demersal fishes were observed: Dover sole, Microstomus pacificus; thornyheads, Sebastolobus spp.; deepsea sole, Embassichthys bathybius; sablefish, Anoplopoma fimbria; and Pacific hagfish, Eptatretus stoutii. Unidentifiable demersal fishes from the families Macrouridae and Zoarcidae were also observed. Several species of macroinvertebrates were also identified, including the tanner crab, Chionoecetes tanneri, and a large sea pen, Stylatula elongata. One low-level waste container was located. The biology of the observed fishes and their commercial importance is discussed.

This report should be cited as follows:

Gotshall, D.W. and R.S. Dyer. 1987. Deepwater demersal fishes observed from the submersible AVALON (DSRV-2) off the Farallon Islands, 24 June 1985. Calif. Dept. Fish and Game, Mar. Res. Tech. Rep. No. 55, 15 p.

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## ACKNOWLEDGEMENTS

This survey could not have been completed without the cooperation of the U.S. Navy, and specifically of Commander Stephen R. Cleal, USN Captain of the USS PIGEON; Lt. Commander William Pigg, USN Captain of the AVALON; and Lieutenant James Gant, Executive Officer of the AVALON. Robert N. Lea, California Department of Fish and Game, edited the manuscript and provided valuable criticism and suggestions for improving this report.

## INTRODUCTION

The U.S. Navy's Deep Submergence Rescue Vehicle AVALON [DSRV-2] was used by the Office of Radiation Programs, Environmental Protection Agency, to locate low-level radioactive waste containers and make observations of deep water benthic fishes and invertebrates at the 900 m (2952 ft) radioactive waste disposal site approximately 4.4 km SW of the Farallon Islands off San Francisco, California. The AVALON is one of two U.S. Navy rescue submersibles designed for removing the crews from disabled submarines unable to return to the surface. These submersibles carry a crew of three during rescue missions: a pilot, copilot, and a crewman to operate the rescue hatches and systems. The DSRVs are capable of transporting up to 24 rescued crewman to a surface ship or another submarine.

The objectives of the dive were to photograph any waste containers found; observe and document fishes, invertebrates and geological microstructures; obtain sediment core samples near waste containers; and make qualitative estimates of bottom current flow.

## METHODS

On our dive off the Farallon Islands there were two additional U.S. Navy crew members and six scientists aboard.



The AVALON was launched and retrieved by the twin-hulled mother ship USS PIGEON ASR-21. The AVALON is equipped with three functional view ports, approximately 127 mm in diameter, and an external video camera. Two of the view ports are located in the center sphere, one on the port side and one on the starboard side. These ports are placed in the lower third of the sphere and are directed at approximately a 45° angle downward and forward. This field of view allows observers to see objects alongside the DSRV as well as below. The AVALON has external lights, but these are not of sufficient candlepower to allow photography through the viewports even with high ASA films.

The view port in the forward sphere is used by the DSRV pilot but was also made available to the observers; its field of view is directly below the DSRV in the forward one-third of the vehicle. The video camera located in the forward portion of the DSRV can be directed to view objects in front, as well as directly below the observer. On this dive a 35mm stereo camera with strobes was mounted on the outside of the DSRV. Observations by the scientists were recorded on a cassette recorder as well as in a written log.

#### RESULTS

Five dives were scheduled, but inclement weather and high sea conditions allowed the completion of only one dive which took place on 24 June 1985. It began at 0615 h when the

AVALON cleared the launching cradle. At 0653 h at a depth of approximately 763 m (2502 ft) the external lights were turned on and we began observing components of the deep scattering layer, including some fishes that were probably members of the families Argentinidae and Zoarcidae (argentines and eelpouts). Invertebrates seen included: cnidarians, jellyfishes and siphonophores up to 7.6 m (26 ft) in length; ctenophores, comb jellies of the genera Beroe and Bolinopsis; decapods, shrimps; euphausiids; and chaetognaths, arrowworms of Sagitta spp.

At a depth of 776 m (2544 ft) we observed a California slickhead, Alepocephalus tenebrosus. This fish was 20 to 25 cm in length. A second slickhead was observed at 909 m (2982 ft).

At approximately 0711 h we reached the bottom at a depth of 975 m (3198 ft) and the AVALON began to search for low-level radioactive waste drums. During this search phase the DSRV remained 5 to 8 m off the bottom. Bottom fauna and substrate became difficult to observe when the AVALON was more than 7 m off the bottom due to the presence of a dense scattering layer which substantially reflected the light from the submersible. About 5 min after reaching the bottom, one of the observers saw a grenadier (family Macrouridae) at a depth of 991 m (3252 ft).

The first identifiable demersal fish sighting was a large

50 to 64 cm Dover sole, Microstomus pacificus, at a depth of 1039 m (3408 ft). Five minutes later a group of fishes composed of six Dover sole and six thornyheads (Sebastolobus spp.) was observed. At 0737 h we observed a deepsea sole, Embassichthys bathybius, approximately 50 cm in length.

The first observation of a sablefish, Anoplopoma fimbria, occurred at 0747 h at a depth of 994 m (3360 ft).

During the next 30 min we observed more Dover sole, thornyheads, and sablefish. At 0757 h we observed the first Pacific hagfish, Eptatretus stoutii. Large invertebrates observed during this period included unidentified anemones and sea stars, tanner crabs (Chionoecetes tanneri), large sea pens (Stylatula elongata), and a sea star, possibly of the genus Luidia. Another large hagfish (approximately 38 cm) was observed at 0810 h at a depth of 951 m (3118 ft).

At 0821 h the DSRV pilot spotted the first and only 55 gal low-level radioactive waste drum seen. It was identifiable by a wire rope lifting loop, which was characteristic of the drums disposed of from 1951 to 1954 (U.S. EPA Report 1975). Two thornyheads and one sablefish were very close to the drum. We spent the next hour near the drum making observations and collecting core samples using the manipulating arm of the DSRV. With the AVALON in a stationary position we were able to observe a southwesterly current. During this time, many sablefish gathered around the

DSRV, apparently attracted by the lights and activity. On several occasions there were as many as six sablefish simultaneously in view off the port side. This was also true for the video monitor. These fish ranged in size from an estimated 60 to 75 cm. The only other fishes observed here were a few eelpouts and what were probably snailfishes (family Liparididae) drifting above the bottom in the deep scattering layer. Many of these fishes were recorded on the video camera. We also observed several blue-black jellyfish drifting by the DSRV; about 3 to 4 cm in diameter and probably members of the suborder Anthomedusae.

At 0954 h the AVALON ran a 4 min transect on a course of 140°, at an altitude of 4.6 m above the bottom depth of 951 m (3120 ft). On this transect four thornyheads, two sablefish and several unidentified eelpouts were counted. At 1001 h we began our ascent to the surface.

During the dive the 35mm stereo camera failed after only a few shots were taken due to a blown fuse in the power supply. Observations on the dive were made from both the center sphere ports, as well as the pilot's view port and the video camera monitor.

#### DISCUSSION

The observed demersal fish consisted of five identifiable species, in addition to unidentified species from three families. Only three of the identified species are valuable

commercial or sport fishes. The presence of the deep scattering layer near the bottom, which contained a diverse assemblage of invertebrates and small fishes, and the presence of a noticeable current, contributes to the abundance of demersal species. Distribution, life history, and fishery data for the fishes observed during the dive is summarized below.

#### Family Myxinidae (Hagfishes)

The Pacific hagfish occurs from S.E. Alaska to central Baja California in depths of 18 to 945 m (60 to 3100 ft) (Eschmeyer, Herald, and Hammann 1983). Our observations of this fish at 966 m (3168 ft) establishes a new depth record for the species. Hagfishes are one of the most primitive groups of vertebrates and belong to the class Agnatha, the jawless fishes. The Pacific hagfish is a scavenger and a predator on other fishes. They use horny plates on the roof of the mouth and on the tongue to rasp into the body of other fishes. Hagfishes are considered pests by fishermen, particularly commercial gill netters. These slimy, eel-like fish bore into the insides of captured fishes and consume the flesh, leaving only the heads and skin for the fishermen. Early in 1987 a small commercial trap fishery for hagfish was initiated in Monterey Bay. The hagfish skins will be used to make leather.

A possible hagfish attack was observed and recorded on

the video camera. A hagfish approached a thornyhead head on, and when the thornyhead detected the presence of the hagfish it quickly reversed directions, presenting its tail to the hagfish. The hagfish then swam off several feet, paused, and then moved on since its possible victim had taken defensive action.

Hagfishes may be able to detect other fishes and then attempt to swim directly into the mouths of unsuspecting or weak victims. The slime on hagfishes probably protects them from the digestive juices of their victims.

We observed at least six Pacific hagfish, and they probably are a common component of the demersal fish of the study area.

#### Family Macrouridae (Grenadiers)

There are ten species of grenadiers that occur off central California (Hubbs, Follett, and Dempster 1979). Most of these species occur in deep to very deep water 183 to 3658 m (600 to 12,000 ft). Grenadiers feed on a variety of organisms, including polychaetes, molluscs, crustaceans, ophiuroids, and fishes. Fitch and Lavenberg (1968) consider grenadiers to be opportunistic feeders. The life history of most species is poorly understood. Grenadiers caught incidentally in the trawl fishery are marketed in central and northern California.

We observed only two or three grenadiers during our time

on the bottom.

Family Zoarcidae (Eelpouts)

At least ten species of eelpouts occur in the area off the Farallon Islands (Miller and Lea 1972). One of these is a mesopelagic species, the midwater eelpout (Melanostigma pammelas), which was probably one of the fishes we observed during our descent. The eelpouts we observed on the bottom were either the black eelpout (Lycodes diapterus), twoline eelpout (Bothrocara brunneum), or pallid eelpout (Lycodapus mandibularis). According to Fitch and Lavenberg (1968) not much is known of eelpout life history. Studies of three species; bearded eelpout (Lyconema barbatum), midwater eelpout, and pallid eelpout, suggest that eelpouts produce only a few (100 or less), large (1 to 4 mm diameter), ripe eggs (Gotshall 1971, Anderson 1980, Lancraft 1982). Midwater eelpout eggs are negatively buoyant, and it has been theorized that these eggs drift to the bottom and hatch. The newly hatched young spend about a year on the bottom before moving up in the water column, where they apparently spend the remainder of their lives (Robison and Lancraft 1984). These authors also theorized that mesopelagic and bathypelagic fishes having demersal larvae and juveniles, provide upward transport of organic material from the deep water benthos. Thus providing a possible pathway for hazardous material, that may be in their body tissues, to enter the pelagic food chain.

Food habits of the demersal, bearded eelpout have not been reported. Limited studies of some other demersal eelpouts suggest that they feed on almost any available benthic organism that will fit in their mouths (Fitch and Lavenberg 1968). The midwater eelpout feeds on pelagic crustaceans including: calanoid copepods, ostracods, euphausiids, gammarid amphipods, and decapods (Lancraft 1982).

The pallid eelpout, a mesopelagic fish that undergoes diel vertical migrations, apparently spawns all year (Anderson 1980). The number of ripe eggs ranges between 75 and 125. Stomach content analysis of pallid eelpouts indicated a wide variety of food items; including copepods, euphausiids, amphipods, mysids, decapods, and some fishes (Anderson 1980). Eelpouts are occasionally taken by commercial trawlers, but are not utilized.

#### Family Scorpaenidae (Scorpionfishes)

There are at least 65 species of scorpionfishes that occur off the west coast of North America. About 60 of these are rockfishes (Sebastes) that rarely occur deeper than 200 m (656 ft), while the remainder belong to the genera Scorpaena, Scorpaenodes, and Sebastolobus (thornyheads).

Thornyheads were the only members of the family that we observed during the dive. There are two species in this genus off California, Sebastolobus alascanus and S.



altivelis, the shortspine and longspine thornyheads respectively. Both species occur in the area we surveyed. However, based on trawl collections from Pt. Sur (Waldo Wakefield, Scripps Institution of Oceanography, pers. commun.) most fish collected in depths greater than 1000 m (3280 ft) are longspine thornyheads.

The shortspine thornyhead ranges from the Bering Sea to northern Baja California in depths of 24 to 1487 m (79 to 4,877 ft). The longspine thornyhead ranges from the Aleutian Islands to southern Baja California in depths of 31 to 1524 m (100 to 5,000 ft) (Eschmeyer et al. 1983).

Both species lay eggs that eventually float in masses near the surface. Thornyheads feed on crustaceans and other benthic invertebrates.

Since thornyheads do not possess a functional swim bladder, they usually survive the ascent to the surface when captured, and have been kept in aquariums for short periods. These distinctive fishes are very slow growing and probably are not sexually mature until about 8 to 10 yrs of age (Waldo Wakefield, Scripps Institution of Oceanography, pers. commun.). These fish are very important in the commercial trawl catch. Landings off San Francisco have increased during the last five years, reaching 631,000 pounds in 1984 (Table 1).

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TABLE 1. Commercial Fish Landings (thousands of pounds)  
in the San Francisco Area 1980-1984 for Three  
Species Observed From the AVALON Off the Farallon  
Islands

<u>Year</u>	<u>Thornyheads</u>	<u>Dover Sole</u>	<u>Sablefish</u>
1980	279	2,132	1,311
1981	400	2,446	1,625
1982	545	2,591	1,961
1983	303	2,282	938
1984	631	3,732	1,530

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Family Anoplopomatidae (Sablefishes)

There are only two members of this family in the North Pacific, the sablefish Anoplopoma fimbria and the skilfish Erilepis zonifer. The sablefish was one of the three most common fishes observed on the dive. Sablefish range from the Bering Sea to Cedros Island, Baja California to depths of 914 m (3000 ft) (Miller and Lea 1972). The sablefish we observed at 994 m (3360 ft) is a new depth record for the species. Larger fish are found in deeper water (Frey 1971). Adult sablefish feed on a variety of fishes, crustaceans, and tunicates (Frey 1971). Most sablefish stocks do not intermingle.

Tagging studies reported by Wespested, Thorsen, and

Mizroch (1983) indicate that most movements (65.3%) of sablefish tagged from 1971 to 1980 (3.8% of 34,640 tagged were recovered) were less than 100 nautical miles (nmi) from the tagging sites. However, 10.7% were recovered 500 or more nmi from release sites. Sablefish tagged from 1979 to 1983, and recovered in 1984 (0.7% of 18,530 tagged were recovered), showed that 55.6% moved 100 nmi or less. But 16.0% of these sablefish were recovered 500 or more nmi from release sites, and 5.2% of the total were recovered more than 1,000 nmi away (Shaw 1986).

Spawning takes place in the winter, and eggs drift in surface waters. Sport anglers fishing near deep reefs, 91 m (300 ft) or more, take small quantities of sablefish. Commercial landings off San Francisco, mostly from the trawl fleet, have ranged between 0.9 and 1.9 million pounds from 1980 to 1984 (Table 1).

#### Family Pleuronectidae (Righteye Flounders)

We observed only two of the eighteen species of righteye flounders that occur off San Francisco: the deepsea sole (Embassichthys bathybius), and the Dover sole (Microstomus pacificus). The other sixteen species occur in waters less than 800 m (2400 ft) deep.

Deepsea sole occur from the Bering Sea to the Mexican Border (Eschmeyer et al. 1983). Little is known of their life history. Deepsea sole are apparently not abundant and are considered an

unusual catch when captured by commercial trawlers. They are also not considered edible, having a high lipid content.

Dover sole range from the Bering Sea to central Baja California in depths of 27 to 915 m (90 to 3000 ft) (Miller and Lea 1972). Our observations of Dover sole at 1037 m (3,454 ft) extends the recorded depth range by at least 115 m (383 ft).

Dover sole diet consists of small members of the infaunal mud bottom community such as brittle stars, molluscs, polychaetes, and crustaceans (Frey 1971). Tagging studies indicate that while Dover sole make only short upcoast-downcoast movements; they do make extensive seasonal inshore-offshore movements (Frey 1971). Dover sole are winter spawners and their eggs are pelagic.

Rarely taken by sport anglers, Dover sole are the most important righteye flounder captured by California trawlers. Landings from the San Francisco area increased from 2.1 to 3.7 million pounds between 1980 and 1984 (Table 1).

#### RECOMMENDATIONS

1. The DSRV AVALON allowed for good viewing opportunities of the depth distribution, habitat, and in some cases behavior of some of these deeper dwelling fishes and invertebrates. Increased external lighting would allow greater photographic opportunities through the

view ports. Direct observations from a submersible coupled with video and photographic documentation can be a valuable tool for improving our understanding of marine life/habitat interactions.

2. The ability of the AVALON to accommodate four or five scientists in relative comfort permitted us to collect more visual data than if the scientific party had been very limited, as with the conventional three-man submersible. In the future we would suggest limiting the scientific party to five persons: two persons to share viewing at each mid-sphere port and one person to maintain a log and monitor the video screen.
3. Each observer should have a small hand-held tape recorder and a camera equipped with a rubber lens hood to protect viewports.
4. It would be valuable to conduct trawl surveys in those areas surveyed by the submersible during the same time of year in order to obtain biological specimens for taxonomic verification, and to obtain quantitative data on the invertebrates and fish observed in the benthic community. The trawl data might also identify species that avoid the submersible.

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