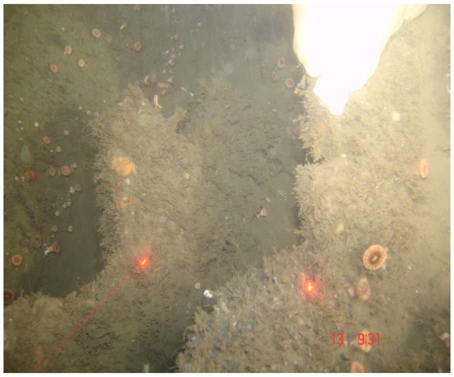
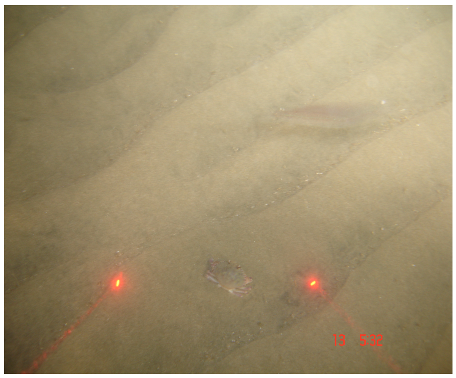


Subtidal Habitats and Associated Macrobenthic and Fish Communities Observed Offshore Coastal California Along Fiber Optic Cable Routes



Prepared for:

ICF INTERNATIONAL

May 2015

Prepared by:

APPLIED marine SCIENCES

4749 Bennett Drive, Suite L
Livermore, CA 94551
925.373.7142

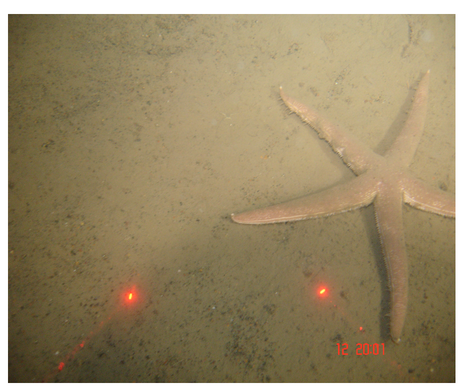


Table of Contents

1 Introduction

Beginning in the 1960s, the use of drop cameras, camera sleds, manned submersibles, remotely operated vehicles (ROVs), and more recently autonomous underwater vehicles (AUVs) have been employed to survey and assess subtidal habitats and associated macrobenthic communities. Macrobenthic species are typically those organisms that live in or on aquatic substrates and can be seen with the naked eye (typically greater than 0.5 mm in size). Continued improvements in video and still image cameras capable of working in low light environments have significantly enhanced the marine scientist's ability to effectively identify to genus and species the animals captured on video and still images, and therein the value of photoreconnaissance surveys.

Offshore California, most of the scientific surveys of subtidal habitats and associated marine flora and fauna conducted beyond the nominal range for SCUBA divers (23-60 meters/75-200 feet) have primarily been conducted at locations where oil and gas operations were being conducted in the Santa Barbara Channel and Santa Maria Basin (Battelle, 1991; Nekton, 1981; Nekton and Kinnetic Laboratories, 1983) or in association with electric, pipeline, or fiber optic cable routes (AMS, 2008; MBARI, 2004; SAIC 1999a; SAIC, 1999b; SAIC, 1999c, MBC, 2002).

The purpose of this scientific review is to present a description of the subtidal habitats and associated macrobenthic biota observed offshore coastal California and primarily Southern California, from ROV surveys conducted along proposed fiber optic cable routes. Most of these surveys have been conducted in depths ranging from 15 meters (50 feet) to 185 meters (600 feet) and deeper as required by the agencies for the proposed route. For the purposes of this review, the analysis covers the water depth range of 0-185 meters (0-600 feet).

2 Previous Fiber Optic Cable Route and Other Surveys Offshore California

Beginning in 1999, visual and photographic surveys have been conducted for multiple fiber optic cable routes and landings in California coastal waters. These include:

- MCI/WorldCom fiber optic cable project, Montana del Oro/Morro Bay (SAIC 1999a);
- AT&T US/China fiber optic cable project, Morro Bay and Point Arena (SAIC,1999b);
- Global West fiber optic cable project, San Diego, Manhattan Beach, Santa Barbara, and Morro Bay (SAIC 1999c);
- Tycom fiber optic cable project, Hermosa Beach (MBC 2001);
- Monterey Bay Aquarium Research Institute (MBARI) MARS fiber optic cable project, Monterey Bay (MBARI 2004);
- AT&T AAG S-5 fiber optic cable project, Montana del Oro/Morro Bay (AMS 2008).

In addition to the above listed surveys that primarily employed ROVs to conduct the visual surveys, some routes employed SCUBA divers to survey and assess the shallower water segments of the route and landfall locations. These include:

- Pacific Crossing and Pan American Crossing fiber optic cable landing, Grover Beach (AMS 2002);
- Tycom fiber optic cable project, Hermosa Beach (MBC 2001).

Finally, the effects of physical disturbance to coastal subtidal hard substrate habitats and associated marine biota and the recovery of those marine communities following disturbance has been extensively studied in conjunction with offshore oil and gas exploration and production operations in the Pacific Outer Continental Shelf. The results of these scientific investigations are best presented in:

- A Survey of Prominent Anchor Scars and the Level of Disturbance to Hard-Substrate Communities in the Point Arguello Region (Hardin *et. al* 1993);
- Recolonization of Deep-Water Hard Substrate Communities: Potential Impacts from Oil and Gas Development (Lissner *et al.* 1991).

Information from all of these studies have been used in the preparation of this paper on the types of subtidal habitat observed along the California coast, primarily in Southern and Central California in water depths ranging from 0 to 100 fathoms (180 meters).

3 Subtidal Habitats and Associated Macrobenthic Biological Communities

Subtidal habitats are typically characterized as either soft or hard substrate. Depending on water depth, currents, wave energy, and other physical conditions, the soft substrate can range from coarse sands, (typically observed in high energy and/or shallow water depth environments) to fine muds (low energy/deeper water depth environments). Similarly, hard substrate can be initially divided into natural (rocky outcrop) or artificial (concrete, pilings, steel, etc.) substrate and further characterized by elevation or rise above the seafloor. The typical descriptors used for categorizing elevation of hard substrate above the seafloor are:

- Mixed bottom – a combination of coarse sand, gravel, cobble, and small boulders;
- Low relief - exposed bedrock and rocky outcropping rising approximately < 0.3 meters (<1 foot) from the seafloor;
- Moderate Relief - exposed rocky outcroppings that typically rise above the seafloor approximately 0.3-1.0 meters (1-3 feet) from the seafloor;
- High relief - exposed rocky outcropping that typically rise >1.0 meter (>3 feet) from the seafloor.

Some reports and marine scientists only characterize relief as low or high

Many of the above cited deep-water hard substrate biological assessments have documented that with increasing elevation above the seafloor you typically observe an increase in species diversity and abundance inhabiting the hard substrate feature. These studies have demonstrated that water depth, current speeds, rate of sedimentation, and elevation off the seafloor are all key factors in determining the composition of biota inhabiting a specific hard substrate habitat (MMS 1991; Hardin 1994; Lissner & Shoakes 1897).

Additionally, with increasing water depth and the reduction of wave energy at the seafloor, the soft substrate community changes with depth, as sediment composition shifts from coarse sands with low organic content to fine muds with increasing organic content. This shift in sediment composition and energy also results in changes to the marine biota inhabiting the soft substrate habitat.

Contained within the Appendices of this report are four tables providing taxonomic listings of invertebrate and fish species observed during the above listed fiber optic cable route reconnaissance surveys and shallower water depth surveys of hard substrate habitat done by scientists employing SCUBA in Southern California. Table 1 is a master taxonomic list of invertebrate organisms observed and identifies the taxa's association with either hard or soft substrate habitat. Table 2 provides a breakout of observed invertebrate taxa by water depth range. Table 3 is a master taxonomic list of all fish and shark species observed in these surveys. Table 4 is a breakout of the fish species by depth range.

It should be noted when reviewing the above tables, especially Tables 2 and 4 that quite frequently no hard bottom habitat may be present along a proposed fiber optic cable route within a specific depth range. As a result, no species would be reported occurring for that depth range and does not indicate that specific species do not occur in that location, rather since no suitable habitat was present along that cable route within the depth range, no species were observed.

3.1 Habitats and Associated Biota Observed in the 0-30 Meter Depth Range.

As mentioned above, most fiber optic cables begin their offshore routing at the point at which the cable exits an existing pipeline/outfall or horizontal bore hole in 12-25 meters of water depth, preferably in soft substrate habitat. Although hard substrate does occur in these shallower depths, the cable routes are routinely carefully selected to avoid them, especially in the very shallowest water depths. As a result, most of the fiber optic cable route reconnaissance surveys reviewed for this paper begin at the deeper depths within the 0-30 meter depth range. Recent survey work on shallow water reefs in Southern California has been done by Occidental College (Occidental 2007). Because scientists employing SCUBA equipment did these surveys, the taxonomic list for their work is more extensive than typically generated from an ROV survey. Tables 1 through 4 provide a more detailed listing of marine invertebrate and fish taxa observed during the Occidental (2007) surveys in the Southern California Bight. The following discussion of deep-water biota focuses primarily on observations made during the cable route surveys. The shallow water data provided by the Occidental (2007) report has been included to provide reference information on hard substrate communities in Southern California water depths shallower than fiber optic cable route characterizations typically assess.

3.1.1 Soft Substrate

Soft substrate habitat types typically observed in the 0-30 meters depth range included coarse sands through the surf and wave zone shifting to finer sands and muds (silts and clays) at the deeper water depths.

The most common alga and invertebrate taxa observed included the ornate tube worm (*Diopatra ornata), cancer crabs (Cancer sp.),* the slender crabs *(Cancer gracilis),* the masking crab *(Loxorhynchus crispatus), octopus (Octopus rubescens and O. bimaculatus/bimaculoides)*), the white sea pen (*Stylatula elongata*), the sea cucumber (*Parastichopus californicus*), the sunflower star (*Pycnopodia helianthoides*) occasional polychaete tube worms, *Pachycerianthus* anemones, the spiny sand star *Astropecten B. armatus*, the short-spined seastar *Pisaster brevispinus*, and the seastar *Petalster* (*Luidia) foliolata*, the sea pansy *Renilla kollikeri*), swimming crabs (*Portunus xantusii*), an occasional hermit crabs, and sand dollars (*Dendraster excentricus*). The sea stars *Asterina miniata* and *Mediaster aequalis* were occasionally observed in soft substrate located in close proximity to exposed hard substrate. In the coarser sand habitats, the invertebrate community was typically dominated by ornate tubeworms (*D. ornata*) and sand dollars (*D. excentricus*) when they were present in colonies occupying fairly narrow bands. Algal populations of very small red and brown algae have been reported occasionally occurring attached to worm tubes (MBC 2001). In the deeper water depths of this depth range, where the sediments shift to finer muds, brittle stars (*Ophiura spp*.) start to occur.

Additionally it is not uncommon to observe various species of drift algae along the seafloor including giant kelp (*Macrocystis pyrifera*) and feather boa kelp (*Egregia meanzinii*) when hard substrate is located nearby.

3.1.2 Hard Substrate

Hard substrate habitat types typically observed in the 0-30 meters depth include mixed bottom (a combination of coarse sand, cobble, and small rocks less than 0.3 meters in height above the seafloor, low substrate consisting primarily of exposed bedrock and small boulders, and occasionally higher relief (>1 meter) above the seafloor.

The biological community inhabiting these hard substrate habitats is typically characterized as being dominated by a dense mat of turf species (a mixture of small hydroids, bryozoans, tunicates, and sponges), occasional red and brown alga, and the white-plumed anemone (*Metridium farcimen* (=*giganteum*)). Other species that were reported present at some locations included surf grass (*Phyllospadix sp.)* in the very shallow depths of this zone*,* the sea anemone (*Actinaria unident*.), strawberry or club-tipped anemone (*Corynactis californica*), the swimming anemone (*Stomphia coccinea*), squid (*Loligo sp*.), crab (*Cancer sp*.), the masking crab (*Loxorhynchus crispatus*), the bat star (*Asterina miniata*), the red sea star (*Mediaster aequalis), the* giant-spined sea star (*Pisaster giganteus*) and other Pisaster sea stars, brittle stars (*Ophiura spp*.) and occasional sea hares (*Aplysia californica*).

3.2 Habitats and Associated Biota Observed in the 30-100 Meter Depth Range.

3.2.1 Soft Substrate

Soft substrate habitats normally observed in the 30-100 meter depth range include scattered mixed bottom and coarse sand substrate where bottom currents or wave energy continue to wash the seafloor and fine muds. The coarser sand substrates are normally only seen at the shallower depths of this depth range. The finer mud substrate is typically pockmarked with burrow holes.

The soft substrate macrofauna is dominated by several species of sea pens (*Ptilosarcus gurneyi, Stylatula elongata, Acanthoptilum spp.)*, the sea slug (*Pleurobranchea californica*), and the leafy flat star (*Petalaster (luidia) foliolata*). Also frequently observed were crabs (*Cancer sp*.), the red sea star (*M. aequalis*) and multi-armed sea star (*Rathbunaster californica*), *Cerianthidae* anemones, the swimming anemone (*Stomphia coccinea*), the ornate tubeworm *(D. ornata*) in the coarser sediments, brittle stars (*Ophiuroids*) and the sunflower star (*Pycnopodia helianthoides*). One noticeable difference between surveys conducted in Central California and Southern California is the presence of the sea cucumber *Parastichopus californicus*. It is observed more frequently in Southern California than farther north.

3.2.2 Hard Substrate

Hard substrate habitat types observed in the 30-100 meters water depth range include mixed bottom in the shallower depths and low, moderate, and high relief. The predominant hard substrate community appears to be dominated by turf, and the white-plumed anemone (*Metridium farcimen* (=*giganteum*)). Also commonly occurring were cup corals (*Paracyathus stearnsii*), assorted crabs (*Cancer spp*.) and shrimp, the red sea star (*M. aequalis*), the swimming anemone (*S. coccinea*), and brittle stars (*Ophiuroids*). Additionally, soft gorgonian corals are occasionally observed including *Lophogorgia chiliensis* and *Eugorgia rubens*.

3.3 Habitats and Associated Biota Observed in the 100-183 Meter Depth Range.

3.3.1 Soft Substrate

The soft substrate habitat exclusively observed in the 100-183 meters depth range is soft mud. The macrobenthic community in this depth range is characterized by sea pens (*S. elongata, Virgularia spp.*), the leafy flat star (*P.* (*luidia*) *foliolata*), crabs (*Cancer spp*.), and assorted shrimp. Other commonly or frequently occurring taxa include the sea slug (*P. californica*), the red sea star (*M. aequalis*), several species of sea anemones (e.g. *Urticina* spp.) the multi-armed sea star (*R. californica),* the free-living polychaete (*Chloeia pinnata*), pink sea urchin (*Allocentrotus fragilis*), brittle stars (*Amphiodia sp*. and Ophiuroidea.) and the sea cucumber (*P. californicus*).

3.3.2 Hard Substrate

Hard substrate habitat types observed in the 100-183 meter water depth range are the same as those present in the 30-100 meter (90-300 feet) water depths. The macrobenthic taxa are similarly characterized with turf, cup corals, and the white-plumed anemone (*M. farcimen* (=*giganteum*)) being the most often observed. Also commonly observed were the giant basket star (*Gorgonocephalus eucnemis*), brittle stars (Ophiuroidea), various species of crabs (*Cancer spp*.) and the red sea star (*M. aequalis*). Also commonly observed at some locations are crinoids (e.g. *Florometra serratissima*).

It is at these deeper water depths (and deeper) where the deep-water corals have been reported occasionally present along fiber optic cable routes. Based on favorable high relief, current speeds, and sedimentation rates, branching hard and soft corals have been reported including the branching white coral *Lophelia sp*. and the California hydro coral *Stylaster californicus (= Allopora californica*). *Stylaster* can also occur in shallower water depths where conditions are favorable, although frequently in a very small, stunted form (Occidental 2007).

4 Fish Communities

The distribution of fishes off California is influenced by depth, substrate type, temperature, and ocean currents, which when integrated often define fish habitat (Love and Yoklavich 2006). Fish communities in Santa Monica Bay, including the vicinity of the proposed cable landing sites in Hermosa Beach and along the shallow offshore route, have been studied intensively over the past few decades as part of one of the few long-term quarterly monitoring programs (1974-present) in the Region (Occidental 2007). This ongoing research, combined with data from fiber optic cable reconnaissance surveys, and nearshore monitoring programs, is the basis for describing fish communities in this paper. Although many marine resources, including fishes, are typically distributed by depth and habitat type, the following description of fish communities is divided by substrate type. A master list of fish species observed during several fiber optic cable reconnaissance surveys and monitoring projects in southern California is presented in Table 3; these species are distributed by habitat or substrate type. Table 4 presents fish species observed during these surveys by depth.

4.1 Hard Substrate

Nearshore rocky reefs in the Southern California Bight (SCB) are highly variable in terms of both abiotic and biotic reef structure, and metrics of the associated macroinvertebrates (see above discussion) and fishes (Pondella et al. 2011). Surveys conducted during the Regional Bight monitoring program documented a total of 78 fish species on or near rocky reef habitat. The most dominant fish species in terms of numerical density during the Regional Bight program were the schooling blacksmith (*Chromis punctipinnis*) and senorita (*Oxyjulis californica*), followed by kelp perch (*Brachyistius frenatus*). Other schooling species that were commonly collected included tubesnouts (*Aulorhynchus flavidus*), opaleye (*Girella nigricans*), jacksmelt (*Atherinopsis californiensis*), topsmelt (*Atherinops affinis*), and blue rockfish (*Sebastes mystinus*). These species are found throughout the water column, in the midwater, and within and around giant kelp (*Macrocystic pyrifera*) canopy. Note that no kelp forests occur near the proposed landing sites or along the proposed offshore route. In addition to water column fish species, numerous demersal (i.e., fishes living on or near the sea floor) species are associated with rocky reef and hard bottom habitat, including kelp bass (*Paralabrax clathratus*), California sheephead (*Semicossyphus pulcher*), garibaldi (*Hypsypops rubicundus*), and black perch (*Embiotoca jacksoni*) (Pondella et al. 2011). Fish assemblages on deep-water rock outcrops are dominated by rockfishes such as yellowtail rockfish (*Sebastes flavidus*), bocaccio (*S. paucispinis*), chilipepper (*S. goodei*), widow (*S. entomelas*), and greenspotted and starry (*S. constellatus*) rockfishes (Love and Yoklavich 2006). These same species are expected to be found in the vicinity of hard bottom features along the offshore cable route.

4.2 Soft Substrate

Soft bottom habitat is the most widespread benthic habitat on the southern California shelf (Allen 1982, 2006; Allen et. al 2011). Demersal fishes occupying this habitat are relatively sedentary compared to pelagic fish species and respond more readily to changes in the benthic environment. Allen et al (2011) reported a total of 135 species of fish that were collected during the 2008 Regional trawl survey of the Bight monitoring program, with a median value of 11 fish species per haul for the entire SCB. Fishes that are found in shallow water soft bottom habitats are typified by flatfishes such as sanddabs (*Citharichthys* spp.), California halibut (*Paralichthys californicus*), lizardfish (*Synodus luciocepsis*), shiner surfperch (*Cymatogaster aggregata*), and pink seaperch (*Zalembius rosaceus*) (SAIC 1999b). Pelagic species that are common in the bays and nearshore areas off Hermosa Beach include northern anchovy (*Engraulis mordax*), topsmelt, California grunion (*Leuresthes tenuis*), and Pacific sardine (*Sardinops sagax*) (SAIC 2010). Other common species associated with soft bottom habitats in the area include white croaker (*Genyonemus lineatus*), queenfish (*Seriphus politus*), and white surfperch (*Phanerodon furcatus*) (SAIC 2010). Soft-bottom habitats on the upper and middle slope (water depths from approximately 200 to 1,000 meters are characterized by moderate numbers of fish species, including flatfishes such as Dover sole (*Microstomas pacificus*) and California halibut, rockfishes, Pacific hake (*Merluccius productus*), sablefish (*Anoplopoma fimbria*), and skates (CSLC 2005; see Table 3).

4.3 Magnusson-Stevens Act Managed Fish Species

This Essential Fish Habitat (EFH) assessment is in accordance with the 1996 amendments to the Magnuson-Stevens Fishery Management and Conservation Act. The landing sites in Hermosa Beach are located in an area designated as EFH for three Fishery Management Plans (FMPs): Pacific Coast Groundfish (PFMC 2014), Coastal Pelagic Species (CPS) (PFMC 2011), and Highly Migratory Species (HMS) (PFMC 2011b).

The CPS live in the water column, not near the sea floor, and are usually found from the surface to over 1,000 m deep (PFMC 2011a). There are 6 species of coastal pelagics managed under the CPS FMP, including Jack mackerel (*Traxchurus symmetricus*), krill (Euphausiids), Pacific mackerel (*Scomber japonicas*), Pacific sardine, market squid (*Loligo opalescens*), and Northern anchovy (Table 3).

All of the 83 groundfish species managed under the Pacific Groundfish FMP are found in diverse habitats at various stages in their life histories throughout the Study Area (proposed landing sites and offshore route). Some species are broadly dispersed during specific life stages, especially those with pelagic eggs and larvae, while other species may have limited distributions (i.e., adult rockfishes in nearshore habitats) with strong affinities to a particular location or substrate type. Estuaries, sea grass beds, canopy kelp, rocky reefs, and other "areas of interest" (e.g., seamounts, offshore banks, canyons) are designated Habitat Areas of Particular Concern (HAPCs) for groundfish managed species.

Fish species managed under the Pacific Groundfish FMP known to inhabit Southern California waters include 13 species of flatfishes, 39 species of rockfish (*Sebastes* spp. and *Scorpaena guttata*), 2 species of thornyheads (*Sebastolobus* spp), 6 species of roundfishes, cabezon, kelp greenling, lingcod, Pacific cod, Pacific hake, and sablefish (Table 3). There are also nine species of skates, sharks, and chimeras managed under this plan (Table 3).

EFH for HMS includes all marine waters from the shoreline to 200 nm (370 km) offshore, and no HAPCs have been adopted for HMS in the Study Area. There are 5 species of shark managed under the HMS management plan, including bigeye thresher shark (*Alopias superciliosus*), blue shark (*Prionace glauca*), common thresher shark (*Alopias vulpinus*), pelagic thresher shark (*Alopias pelagicus*), and shortfin mako shark (*Isurus oxyrinchus*). In addition, there are 5 species of tunas managed under this plan and include albacore tuna (*Thunnus alalunga*), bigeye tuna (*T. obesus*), Northern bluefin tuna (*T. orientalis*), skipjack tuna (*Katsuwonus pelamis*), and yellowfin tuna (*T. albacares*) (Table 3). Striped marlin (*Tetrapturus audax*) is the only species of billfish managed under the HMS management plan; while broadbill swordfish (*Xiphias gladius*) is the only species of swordfish and dorado (mahi mahi) (*Coryphaena hippurus*) is the only species of dolphin fish managed under this plan (Table 3).

5 Marine Mammals

More than 40 species of marine mammals are reported as occurring within Santa Monica Bay, all of which are protected under the Marine Mammal Protection Act (MMPA) (City of Hermosa Beach 2014). These include 34 species of cetaceans (whales, dolphins, and porpoises) and six species of pinnipeds (seals and sea lions) (Carretta et al. 2013; Leatherwood and Reeves 1983; Reeves et al. 1992). Additionally, the southern sea otter (*Enhydra lutris nereis*), a representative of the weasel family, Mustelidae, is also occasionally observed in the area. Six species of cetaceans are federally listed as endangered, while two species of pinnipeds and the southern sea otter are listed as threatened under the Federal Endangered Species Act (FESA). Marine mammals commonly observed in the area include California sea lions (*Zalophus californianus*) and Pacific harbor seals (*Phoca vitulina*). The most common dolphins in Santa Monica Bay, including offshore of the proposed landing sites off Hermosa Beach, are bottlenose dolphins (*Tursiops truncatus*), but Pacific white-sided (*Lagenorhynchus obliquidens*) and Risso's dolphins (*Grampus griseus*) are also occasionally observed (OCS 2015). Other marine mammal species observed in Santa Monica Bay, although less frequently, include gray whales (*Eschrichtius robustus*), humpback whales (*Megaptera novaeangliae*), blue whales (*Balaenoptera musculus*), fin whales (*B. physalus*), minke whales (*B. acutorostrata*), sperm whales (*Physeter macrocephalus*), and killer whales (*Orcinus orca*).

6 Species of Special Concern

Inhabiting California's coastal subtidal region are several species of special concern, which include not only those species protected under either FESA or the California Endangered Species Act (CESA), but also species that provide a keystone or critical habitat for marine communities (e.g. surfgrass, kelp beds, deep-water corals, especially branching and rarely occurring corals), or species that are designated as having a scientific, recreational, ecological, or commercial importance by the National Oceanic and Atmospheric Administration (NOAA), the California Department of Fish and Wildlife (CDFW), or the California Coastal Commission (CCC). Under FESA, CESA, and the Marine Mammal Protection Act, the marine mammals discussed in Section 5 (Marine Mammals) above are all considered species of special concern. Similarly, there are FESA/CESA protected and Magnusson-Stevens Act (MSA) managed fish species that are considered species of special concern and are similarly discussed in Section 4 (Fish Communities) above. Finally, there are many marine birds that are FESA, CESA, or protected under the Federal Migratory Bird Act, that are not part of this discussion.

The following discussion is focused on marine invertebrates and alga that inhabit the coastal subtidal waters of California to a depth of 100 fathoms.

6.1 FESA/CESA Protected Species

6.1.1 White Abalone *(Haliotis sorenseni)*

White abalone is an herbivorous gastropod that lives in rocky ocean waters and generally grows to be 5-8 inches long (NOAA 2015b). White abalone are found in open low and high relief rock or boulder habitat interspersed with sand channels, and are generally found at depths of 24-30 meters (80-100 feet) (NOAA 2015b). Historically, white abalone was found from Point Conception, California, to Punta Abreojos, Mexico, in the Pacific Ocean. However, since the mid-1990s, extremely low numbers of isolated survivors have been identified occurring along the mainland coast in Santa Barbara County and at some of the offshore islands and banks in the middle portion of the range (NOAA 2015b). White abalone is listed as endangered under FESA. The most significant threat to white abalone is related to the long-term effects that overfishing has had on the species. Surveys conducted in Southern California show that at least a 99% reduction in white abalone density has occurred since the 1970s (NOAA 2015b).

6.1.2 Black Abalone (*Haliotis cracherodii*)

The black abalone is a large marine gastropod mollusk found in rocky intertidal and very shallow subtidal habitats. It is listed as endangered under FESA. They reach maturity at about 3 years old and Southern California populations primarily eat giant kelp and feather boa kelp (NOAA 2015a). During low tides, these marine gastropods can typically be found wedged into crevices of intertidal and shallow subtidal rocks. Black abalone range from Point Arena, CA to Bahia Tortugas and Isla Guadalupe, Mexico (NOAA 2015a). Black abalone has experienced significant declines in abundance and has gone locally extinct in most locations south of Point Conception, CA. The primary factors leading to the decline are overfishing and withering syndrome, which struck black abalone at the northern Channel Islands in 1985 (NOAA 2015a). The disease appears to be more prevalent in the southern portion of black abalone range (south of Point Conception, CA) where water temperatures are relatively warmer. Die-offs also seem to occur in habitats where water temperatures are elevated by thermal discharge of power plants. Scientists estimate the abundance of black abalone prior to overexploitation and withering syndrome at over 3 million (NOAA 2015a). Increasing distance among potentially spawning males and females, has led also to reproductive failure as the population density decreases.

6.2 Soft Substrate Species

Sand dollars (*D. excentricus*) frequently form dense beds in the shallow subtidal zone of open sandy beaches in water depths between 5 and 10 meters, typically just offshore of the wave zone. As would be expected, they move locations frequently and are easily subject to physical disturbance. Most cable landings go beneath the seafloor at water depths ranging between 10 and 25 meters, connecting with the horizontal bore hole or existing pipeline to connect to the onshore segment of the cable. As such, it is unlikely that sand dollar beds would be affected by fiber-optic cable installations.

6.3 Hard Substrate (Sessile) Invertebrate Species

In general, hard substrate habitat occurrence offshore California, when compared to the extent of soft substrate habitat, is relatively limited. As indicated in the discussion above, the occurrence of high-relief hard substrate typically results in the presence of species that may be considered more susceptible to impacts from mechanical disturbance, such as cable installation. The most susceptible species to these types of impacts are usually large (e.g., more than 0.3 m in height), slow growing (i.e., a few to several centimeters per year), and relatively delicate/brittle or soft/friable in body form (e.g., branching corals and erect sponges, respectively) (Lissner *et al*. 1991; Hardin *et al*. 1994).

These species are of special concern because their natural history characteristics result in recolonization and recovery following natural or human-related disturbance that requires years to accomplish, especially species with limited dispersal abilities and slow growth.

Large erect sponges (Demospongiae) are typically represented by few families, ranging in color from tan to yellow, orange, red, and blue (SLO 1999). Many of these species are expected to be slow growing, and similar to *Allopora* in requiring several years to achieve sizes of 30 cm or more (e.g., Lissner *et. al* 1991; Hardin *et. al* 1994).

6.4 Deep-Sea Corals

Deep-sea or cold-water corals are a diverse group of organisms with thousands of species found worldwide. Many of these corals provide habitats for a myriad of marine species. Deep-sea corals occur primarily on hard bottom substrate on the continental shelf and slope, offshore canyons, and on oceanic island slopes and seamounts.

Deep-sea coral ecosystems are typically long lived, slow growing, and fragile, which makes them especially vulnerable to physical disturbance and damage. Along the west coast of North America, 101 species of corals have been identified, consisting of 18 species of stony corals, 7 species of black corals, 36 species of gorgonian or soft corals, 8 species of true soft corals, 27 species of pannatulaceans or sea pens, and 5 species of stylastid corals. Many of these species and taxa are designated as "structure-forming," meaning they are known to provide vertical structure above the seafloor that can be utilized by other invertebrates or fish (NOAA 2010; Whitmire and Clarke 2007).

The most common stony corals observed offshore California are the solitary cup corals (e.g., *Balanophyllia elegans*, *Paracyathus stearsii*) and branching corals (e.g., *Lophelia pertusa, Oculina profunda, Madrepora oculata*, *Dendrophyllia oldroydae, Astrangia haimei, Labyrinthocyathus quaylei* and *Coenocyathus bowersi*). Black corals, which are represented by only seven species, are considered vary abundant along the Pacific coast, with *Antipathes sp*. and *Bathypathes sp*. exhibiting coast wide distributions, while the other five species appear to be limited to seamounts (Whitmire and Clarke, 2007). Gorgonians are the most populous group of corals off the Pacific coast. *Eugorgia rubens* (purple gorgonian) and *Adelogorgia phyllostera* (orange gorgonian) are commonly observed in the nearshore coastal waters, whereas *Paragorgia arborea* (bubblegum coral), although found in high abundance region-wide, inhabits water depths greater than 200 meters. Gorgonian and black corals have branching tree-like forms and can occur singly or form thickets. These three-dimensional features and vertical structures provide habitat for numerous fish and invertebrate species and enhance the biological diversity of many deep-sea ecosystems.

Included with deep-sea corals are sea pens (order Pennatulacea), which occur over soft-bottom substrates and are the most abundant coral taxon in the region. Some sea pens are quite mobile and can move from one location to another. *Stylatula sp*., *Anthoptilum grandiflorum* and *Umbellula sp*. are the most common taxa, all of which are found coast wide. Although groves of pennatulaceans have been shown to support higher densities of some fish species than adjacent areas (e.g., Brodeur 2001), they are not considered to be structure forming.

Lace corals or stylasterid corals have been observed colonizing moderate to high-relief rocky habitats from the intertidal zone down to shelf water depths. Only five species from three genera are known to occur along the Pacific west coast with *Stylatula californicus* (*Allopora californica*) being the only species known to occur in California. Note that Cairns (1983) synonymized *A. californica* to *Stylaster californicus*. Because of, widespread and historic use and immediate name recognition of "*Allopora*" by most marine scientists, this discussion uses the original name (*Allopora*) to avoid confusion.

Allopora has a calcareous skeleton and forms upright pink to dark blue branching colonies. This species is characterized by very slow growth (e.g., 5 to 10 years to reach sexual maturity, possibly more than 20 years to grow to a height of 30 cm) (Thompson, *et al*. 1993; Gotshall 1994). *Allopora* has no planktonic larval stage and fertilization between adult colonies more than 10 meters apart is limited.

In recent years, NOAA has developed an increased interest in these ecosystems and especially the potential for impacts from bottom contact fishing activities (NOAA 2012). Deep-sea coral are being evaluated for designation as EFH within the Pacific Coast Groundfish FMP, and likely will be designated once the 5-year review is complete.

Unfortunately, there is limited information concerning known occurrences of deep-sea coral offshore Southern California. This is due in part to the difficulty and expense of locating and surveying deep-sea hard substrate habitat. Much of what the scientific community knows about their presence is as a direct result of manned submersible and ROV surveys of fiber optic cable routes or oil and gas exploration sites. Christmas tree coral (*Antipathes dendrochristos*), a species of black coral that occurs in the Southern California Bight, has been documented around Piggy Bank and on Hidden Reef north of Santa Catalina Island; there are also a few documented occurrences around San Nicolas Island (Huff et al. 2013). Huff et al. (2013) mapped ocean currents, primary productivity (chlorophyll), and temperature against known locations of Christmas tree coral to develop a predictive model for the SCB. These environmental correlates predict bands of low occurrence, interspersed with isolated pockets of high occurrence, in the project area. Specific locations of coral within these bands of low occurrence and pockets of high occurrence depend on the availability of hard bottom substrate. Guinotte and Davies (2014) developed a habitat suitability model for multiple species of deep-sea coral for the U.S. West Coast. They reported bands of suitable habitat associated with specific bathometric features in the project area. Both studies show suitable deep-sea coral habitat in places that would be crossed by the proposed cable routes. Specific locations where the proposed cable routes may encounter deep-sea coral are the following:

- Bottom slopes south of the Channel Islands and around Piggy Bank;
- High relief bottom between Santa Barbara Island and the Channel Islands;
- High relief bottom between San Nicolas Island and the Channel Islands.

6.5 Kelp and Sea Grasses

The giant brown kelp, *Macrocystis pyrifera*, forms large dense forests in the nearshore waters of Southern California and throughout the Channel Islands where clear water allows them to grow in water depths exceeding 100 feet. These kelp forests are home to many marine animals and act as spawning and nursery grounds for many invertebrates and fish. *Macrocystis* anchors itself to the seafloor by attaching its holdfast to small boulder sized rocks or rocky outcropping. The closest *Macrocystis* beds to Hermosa Beach are 5-7 km to the south at the Palos Verdes shelf and approximately 19 km to the north at the southern edge of the Malibu coast (MBC 2001).

Surfgrass (*Phylospadix*) is a flowering marine plant in the family *Zosteraceae* and can be found throughout coastal California where suitable habitat occurs. It is most commonly observed attached to rocks in the middle to low intertidal zone, but where conditions are favorable, it can occur to depths of 40-50 feet. No known surfgrass beds occur near Hermosa Beach, with the largest know occurrence offshore Topanga Canyon to the north (Occidental, 2007).

7 Potential Effects of Fiber Optic Cable Installation and Operation on Subtidal habitats and Associated Macrobenthic and Fish Communities

The installation, maintenance, and ultimate abandonment/removal of a subsea fiber optic cable located in the coastal waters of California could result in disturbances to both soft and hard substrate habitats and would differ according to installation methods, which vary with water depth and substrate type. In shallow water soft-sediment areas, divers or ROVs are typically used to bury the cable using a water jet to create a channel in which the cable is laid. Typically, the cable channel is allowed to self bury. In deeper soft-bottom areas, a cable installation plow is employed that digs a 1-meter deep trench in the seafloor, places the cable into the trench, and then refills the trench with the excavated sediment.

In the event a proposed cable route contains hard substrate features, the final selected routing of the cable will be such that all hard substrate, especially high relief outcrops, is avoided to the maximum extent feasible. If placement along mixed bottom or low to moderate relief habitat is unavoidable, the cable is typically laid onto the seafloor and either a ROV or divers are used to properly position the cable around isolated exposed outcrops and in general, locate the cable so that minimum contact with hard bottom habitat occurs.

Numerous fiber optic cables have been installed in California coastal waters over the past several decades, with landfalls in Southern California (San Diego, Hermosa Beach, Manhattan Beach, and Santa Barbara), Central California (Montana de Oro, Grover Beach, Estero Bay, and Moss Landing), and Northern California (Pt. Arena). The CEQA EIRs prepared for these projects discuss in detail potential impacts to marine biota from the installation, operation and removal/abandonment of fiber optic cables. Prior to and after these installations, post survey cable inspections have been performed that provide some anecdotal information on the duration and severity of effects to marine habitats and biota from the cable installations.

7.1 Soft-bottom Habitat

Any effects to soft-sediment biota during cable installation, operation, or abandonment can be expected to be minimal and short-term. The use of a cable plow to create a temporary furrow along the seafloor into which the fiber optic cable is placed and immediately buried will result in a temporary disturbance of benthic infauna (animals living in the sediments of the seafloor) and epifauna (animals living on the surface of the seafloor). It is estimated that the actual area of disturbance is less than 8 meters wide, the size of the plow itself, with the most severe effects being limited to the 1-m wide trench. Most mobile invertebrates and fish can be expected to avoid the plow and return to the area shortly after the plow has left. Any benthic infauna inhabiting the upper biotic sediment layers disturbed by the plow and then replaced into the furrow on top of the cable can be assumed will be smothered and killed. The loss will be minimal and temporary, based on the extremely small area of the seafloor affected relative to the surrounding area. Recolonization will occur both by migration from adjoining, undisturbed seafloor areas and by natural recruitment.

Studies of offshore sand mining operations in the Gulf of Mexico and Atlantic Ocean have shown that recovery of benthic infauna to comparable productivity levels following burial or complete removal with the mined sand typically occurs within a few years following the disturbance (Hammer *et al.* 1993; Van Dolah *et al*.. 1992). The key factors to the speed of recovery were (1) when the impact occurred relative to seasonal periods of spawning and recruitment, and (2) the proximity of undisturbed sediment to the disturbed/impacted area. Because the disturbance to benthic infauna during cable installation does not involve sediment removal and the distance between disturbed and undisturbed sediment is typically less than 0.5 meters, recovery to pre-disturbance conditions is expected to be relatively quick. During the 2007 ROV survey of the AAG S-5 cable route, several other buried telecommunications cables were crossed. No detectable differences in benthic macrofauna were noticeable at these locations. At one cable crossing a slight depression in the seafloor was detected (AMS 2007).

Possible effects to sessile, less mobile epibenthic organisms would include temporary burial by relocated sediment during cable plow operation and possible crushing and/or dislodgement. Similar to the benthic infauna, recovery can be expected to occur, typically within a year. Because of the relatively small area of disturbance, no effect to the general productivity of the area should be expected.

In any coarse sand, shallow water areas of a cable route where divers or ROVs are typically used to bury the cable, the disturbance can be expected to be similar to the deeper finer sediment areas of the route where a cable plow is used. In the very nearshore areas of the route, in water depths less than 30 meters, the seafloor and associated biota experience frequent and regular disturbance from wave action. As a result of this high energy, constantly changing environment, the associated biological community has adapted to frequent exposure and burial. The infaunal community is typically limited in species diversity and consists primarily of filter feeders (e.g. tube worms, sand dollars, sand anemones) and detrital feeders (e.g. shrimp and crabs). These taxa tend to be highly mobile and as a result, any effects to the habitat and associated biota can be expected to be insignificant and undetectable within a few days or months of cable installation.

7.2 Hard-substrate Habitat

Impacts from cable installation can potentially be the greatest in hard substrate habitat within the cable route. The biota associated with hard substrate habitat is predominantly sessile, slow growing, and susceptible to crushing, dislodgement, and other physical disturbances. High-relief (> 1 meter in height) hard substrate areas, because of their higher species diversity, species abundances, and the potential presence of organisms sensitive to physical disturbances such as erect turf species, hard and soft hydrocorals, branching and erect sponges, etc., are generally considered to be more sensitive to impacts than low-relief (< 1 meter) hard bottom habitat (Lissner *et al*. 1991). Low-relief hard bottom habitat is often subject to higher turbidity and cycles of frequent burial by sand and exposure typically resulting in lower species diversity and abundances. These harsher physical conditions result in an associated biological community that is often more ephemeral and dominated by organisms that are more tolerant of high turbidity, sand scouring, or able to grow fast enough to avoid complete burial. Typical taxa observed in recent ROV habitat and macrobenthic taxa surveys for fiber optic cable routes in California include some cup corals, puffball and other similar sponges, gorgonian corals, and some species of anemones, such as *Stomphia* and *Urticina*.

The predominant species inhabiting moderate to higher relief hard substrate in water depths <200 meters (650 feet) include a turf community (mixtures of small hydroids, bryozoans, tunicates, and sponges), cup corals (*Paracyathus* and *Balanophyllia*), seastars (*Asterina* and *Henricia*), brittlestars (*Amphipholis*), various encrusting sponges, tunicates, bryozoans, red algae (at depths to about 30 m), rockfishes (*Sebastes spp.),* lingcod (*Ophiodon elongatus*), and painted greenling (*Oxylibius pictus*). Additionally, on hard bottom moderate to high relief features in water depths >100 meters (300 feet) the feather star or crinoid, *Florometra serratissima,* and the large plumose anemone *Metridium* are frequently observed. All of these taxa are capable of withstanding periodic physical impacts. Other species, such as the California hydrocoral, *Stylaster californicus (=Allopora californica),* the branching coral *Lophelia*, the colonial anemone, *Corynactis californica,* and large erect sponges are typically more sensitive to physical impact and may require longer time periods to recover. *Metridium* and *Corynactis* are common species on moderate and high relief substrate, whereas *Allopora and Lophelia* is only infrequently reported being observed in past cable route surveys.

The potential for post-lay effects is highly dependent on where the cable is located within a hard substrate area and how securely the cable is anchored to the seafloor in order to avoid possible suspension across hard bottom features. Suspensions often result in continued movement of the cable in response to currents in shallow depths (< 30 meters), causing abrasion of hard substrate. Based on observations made during past cable route and post-lay surveys in California coastal waters, the impacts to associated biota from post-lay movement appear to be minimal with careful placement of the cable. AMS (2007) reported during their survey of the AT&T Asia-America Gateway (AAG) S-5 cable, that ran parallel to previously laid fiber optic cables in low relief hard substrate, that they could not detect any noticeable impacts associated with previously laid cables in the area. In one survey, large erect sponges were observed growing on or over exposed cables (SAIC,1999), and another survey reported small-localized movements up to 10 cm in width being observed (SAIC-SLO 1999). Recovery of disturbed areas by immigration, asexual propagation or larval recruitment should begin occurring within months of the disturbance, although a study performed in the Pt. Arguello area suggests that the small areas of hard bottom habitat that might be disturbed by cable laying operations could take years to recover (Hardin, et al. 1993). These authors reported estimated mean time for recovery to background densities of 23 years for *Paracyathus stearnsi* and 19 years for *Lophogorgia chilensis* in areas disturbed by dragging anchors during pipe laying operations.

7.3 Fishes

Most of the environmental assessments prepared for underwater fiber optic cables (e.g., CSLC 2000a; CSLC 2000b; CSLC 2005) indicate that temporary displacement of some fishes from the immediate vicinity (e.g., tens of feet) of the cable route would occur during short-term passage of cable installation equipment. The impacts described in these documents would be considered temporary (i.e., hours) and localized (occurring over a very discrete area), and therefore less than significant. Extensive alteration or destruction of habitat or communities lasting more than 1 year is unlikely due to the small size of the cable, the very localized corridor represented by the route, and burial of the cable along most of the inshore route to a depth of 100 fathoms (185 meters/600 feet) of the route. Any disturbances to the bottom from installation methods are expected to return to pre-installation conditions in a relatively short amount of time (less than a year) and are typically verified during a post-installation survey.

7.4 Marine Mammals

No significant effects to marine mammals are anticipated from cable installation at the landing sites or along the offshore route. Many of the potential impacts such as disruption of migration route or increased noise during installation are considered temporary, lasting only hours (along the sea route installation) to a few days (at the cable landfall location) in any one location, and would not cause disruptions substantially different from normal ship traffic (e.g., noise) through the area (SAIC 2000). In addition, ship strikes of whales have become of growing concern for several species, with ship strikes to the highly endangered North Atlantic right whale receiving the most attention off the U.S. east coast (Calambokidis 2011). In 2007, four blue whales off the coast of California were found dead with direct or indirect indications of having been struck by ships. These four were all found in the vicinity of the Santa Barbara Channel and Los Angeles-Long Beach Harbors. Ship strikes during cable installation is highly unlikely since the speed of the ship during cable laying activities is slower (~0.5 to 1.5 knots while plowing) than migrating whales or the fast swimming sea lions. In addition, marine mammal observers are typically required on the cable laying ship as mitigation to further reduce the potential of a ship strike occurring during cable installation. The long-term presence of the fiber optic cable along the seafloor also would not significantly impede migration since it would be buried along most of the nearshore route where whales transit the coast during migrations and represent a very low profile (e.g., 1 to several inches) in hard bottom areas as a result of careful installation and post-lay inspection/adjustment of the cable in these areas. Also, as discussed in CSLC (2000a), cable slack would be stabilized at a level within the range of 2 to 3 percent in areas where the cable cannot be buried to ensure that the cable conforms to the slopes and peaks of the seabed so that it is not suspended substantially (e.g., more than 1 foot) above the bottom. This would prevent any spans from developing that could potentially entangle marine mammals (e.g., whales). Of the eleven known commercial fiber optic cable landings in coastal California waters installed since 2000, no known or reported entanglements between whales and fiber optic cables have occurred.

8 References

Allen, M.J. 1982. Functional structure of soft-bottom fish communities of the southern California shelf. Ph.D. Dissertation, University of California, San Diego. La Jolla, CA.

Allen, M.J. 2006. Continental shelf and upper slope. pp. 167-202 in: L.G. Allen, M.H. Horn, and D.J. Pondella, II (eds.), Ecology of Marine Fishes: California and Adjacent Areas. University of California Press. Berkeley, CA.

Allen, M.J., D. Cadien, E. Miller, D.W. Diehl, K. Ritter, S.L. Moore, C. Cash, D.J. Pondella, V. Raco-Rands, C. Thomas, R. Gartman, W. Power, A.K. Latker, J. Williams, J. L. Armstrong, and K. Schiff. 2011. Southern California Bight 2008 Regional Monitoring Program: Volume IV. Demersal Fishes and Megabenthic Invertebrates. Southern California Coastal Water Research Project, Costa Mesa, CA.

Applied Marine Sciences (AMS). 2008. Remotely Operated Vehicle (ROV) Biological Characterization Survey of the Asia America Gateway (AAG) S-5 Project Fiber Optic Cable Route Offshore Morro Bay, CA. Prepared for AT&T Corporation. May 2008. Pp 44 plus Appendices.

Battelle Ocean Sciences. 1991. California OCS Phase II monitoring program: Final Report. Report prepared for the U.S. Department of the Interior, Minerals Management Service, Pacific OCS Region, Camarillo, California. Contract No. 14–12–0001–30262. (MMS 91–0083)

Brewer, G.D., J. Hyland, and D.D. Hardin. 1991. Effects of oil drillin on deep-water reefs offshore California. American Fisheries Society Symposium 11:26-38.

Brodeur RD (2001) Habitat-specific distribution of Pacific ocean perch (*Sebastes alutus*) in Pribilof Canyon, Bering Sea. Continental Shelf Research 21:207-224

Cairns SD (1983) A generic revision of the Stylasterina (Coelenterata: Hydrozoa), Part 1, Description of the genera. Bulletin of Marine Science 33:427–508

Calambokidis, J. 2011. Ship Strikes of Whales Off the U.S. West Coast. American Cetacean Society Newsletter June 2011.

Carretta, J.V., E. Oleson, D.W. Weller, A.R. Lang, K.A. Forney, J. Baker, B. Hanson, K. Martien, M.M. Muto, M.S. Lowry, J. Barlow, D. Lynch, L. Carswell, R. L. Brownell Jr., D. K. Mattila, and M.C. Hill. 2013. U.S. Pacific Marine Mammal Stock Assessments: 2012. U.S. Department of Commerce, NOAA Technical Memorandum, NMFS-SWFSC-504. 378 p.

City of Hermosa Beach. 2014. E & B Oil Drilling & Production Project, Final Environmental Impact Report. Prepared for the City of Hermosa Beach by MRS, June 2014, SCH# 2013071038.

CSLC (California State Lands Commission), Monterey National Marine Sanctuary. 2005. Final Environmental Impact Report/Environmental Impact Statement for the Monterey Accelerated Research System (MARS) Cabled Observatory. Prepared for the California State Lands Commission and the Monterey Bay National Marine Sanctuary. Prepared by the California State Lands Commission, Monterey Bay National Marine Sanctuary, and Aspen Environmental Group. State Clearinghouse # 2004051138, Federal Docket # 04-11738, CSLC EIR/EIS # 731. July 2005.

CSLC (California State Lands Commission). 2000a. Final Environmental Impact Report for Global West Fiber Optic cable Project. SCH No. 99021067, EIR No. 692. Prepared for the CSLC by Science Applications International Corporation.

CSLC (California State Lands Commission). 2000b. Draft Environmental Impact Report: AT&T China-U.S. Cable Network, Segments S7 and E1, San Luis Obispo County. SCH No. 99051063, EIR No. 698. Prepared for the CSLC by Science Applications International Corporation.

Guinotte J. M., and A. J. Davies. 2014. Predicted Deep-Sea Coral Habitat Suitability for the U.S. West Coast. PLoS ONE 9(4): e93918. doi:10.1371/journal.pone.0093918.

Gotshall, Daniel W., 1994. Guide to Marine Invertebrates. Sea Challengers Publications. Paperback, 105 pp. ISBN 0-930118-19-7. Color photos and brief descriptions to many common invertebrates. Sections are arranged by type of animal.

Hammer, R. M., B. J. Balcom, M. J. Cruickshak and C. L. Morgan. 1993. Synthesis and analysis of existing information regarding environmental effects of marine mining. Jupiter, FL. 1-392.

Lissner, A., G. Taghon, D. Diener, S. Schroeter, and J. Dixon. 1991. Colonization of Hard-Substrate Communities: Potential Impacts from Oil and Gas Development. Ecological Applications 1:258-267.

Hardin, D.D., E. Imamura, D.A. Coates, and J.F. Campbell. 1993. A Survey of Prominent Anchor Scars and the Level of Disturbance to Hard-Substrate Communities in the Point Arguello Region. Prepared for Chevron USA Production Company. Prepared by Marine Research Specialists. 55 pp.

Hardin, D.D., J.T. Toal, T. Parr, P. Wilde, and K. Dorsey. 1994. Spatial Variation in Hard-Bottom Epifauna in the Santa Maria Basin, California: The Importance of Physical Factors. Marine Environmental Research (37) 165-193.

Huff, D. D., M. M. Yoklavich, D. L. Watters, S. T. Lindley, M. S. Love, M. S., and F. Chai. 2013. Environmental Factors that Influence the Distribution, Size, and Biotic Relationships of the Christmas Tree Coral Antipathes dendrochristos in the Southern California Bight. Marine Ecology Progress Series 494:159–177.

Leatherwood, S. and R. R. Reeves. 1983. The Sierra Club Handbook of Whales and Dolphins. Sierra Club Books, San Francisco. 302 pp.

Lissner, A.L., G.L. Taghon, D. Diener, S. Schroeter, and J. Dixon. 1991. Recolonization of Deep-Water Hard Substrate Communities: Potential Impacts from Oil and Gas Development. Ecol. Appl. 1(3) 258-267.

Lissner, A., and R. Shoakes. 1986. Assessment of Long-Term Changes in Biological Communities in the Santa Maria Basin and Santa Barbara Channel. Phase I. VOl I and Vol II. OCS Study MMS 86-0012a. National Technical Information Service No. PB86240363 and PB86240371.

Love, M.S. and M.M. Yoklavich. 2006. Deep Rock Habitats, Chapter 10, In: The Ecology of Marine Fishes: California and Adjacent Waters. 2006. L.G. Allen, D.J. Pondella, and M. H. Horn (eds.). University of California Press, Berkeley, 670 pp.

MBC, 2001. City of Hermosa Beach, Marine Biological Existing Conditions and Survey Results, Tycom Transpacific Fiber Optic Cable Project. Prepared for Ecology and Environment, Inc. Prepared by MBC Applied Environmental Sciences. September 2001.

MBARI (Monterey Bay Aquarium Research Institute). 2004. Biological Assessment. Contained in Appendix G of the Final Environmental Impact Report/Environmental Impact Statement for the Monterey Accelerated Research System Cabled Observatory. 2005. Prepared for the California State Lands Commission, Monterey Bay National Marine Sanctuary. Prepared by the California State

Lands Commission, Monterey Bay National Marine Sanctuary, and Aspen Environmental Group. State Clearinghouse # 2004051138, Federal Docket # 04-11738, CSLC EIR/EIS # 731. July 2005.

National Oceanic Atmospheric Administration (NOAA 2015a). Black Abalone (Haliotis cracherodii). Accessed on April 29, 2015. http://www.nmfs.noaa.gov/pr/species/invertebrates/blackabalone.htm

National Oceanic Atmospheric Administration (NOAA 2015b). White Abalone (Haliotis sorenseni). Accessed on April 29, 2015. http://www.nmfs.noaa.gov/pr/species/invertebrates/whiteabalone.htm

National Oceanic Atmospheric Administration (NOAA 2014). Biennial Report to Congress on the Deep Sea Coral Research Technology Program. 2012. Accessed April 29, 2015.

National Oceanic and Atmospheric Administration (NOAA). 2010. Coral Reef Conservation Program. 2010. NOAA Strategic Plan for Deep-Sea Coral and Sponge Ecosystems: Research, Management, and International Cooperation. Silver Spring, MD: NOAA Coral Reef Conservation Program. NOAA Technical Memorandum CRCP 11.

OCS (Ocean Conservation Society). 2015. Information on marine mammals taken from their website; http://www.oceanconservation.org.

Pacific Management Fishery Council (PFMC). 2011a. The Coast Pelagic Fishery Management Plan. PFMC, Portland. As Amended through Amendment 13, September 2011.

Pacific Management Fishery Council (PFMC). 2011b. The Fishery Management Plan for U.S. West Coast Fisheries for Highly Migratory Species. PFMC, Portland. As Amended through Amendment 2, July 2011.

Pacific Management Fishery Council (PFMC). 2014. Pacific Coast Groundfish Fishery Management Plan for the California, Oregon and Washington. PFMC, Portland, OR. As Amended through Amendment 5, May 2014.

Pondella, D., J. Williams, J. Claisse, R. Schaffner, K. Ritter and K. Schiff. 2011. Southern California Bight 2008 Regional Monitoring Program: Volume V. Rocky Reefs. Southern California Coastal Water Research Project, Costa Mesa, CA.

Reeves, R.S., Stewart, B.S., and Leatherwood, S. 1992. Sierra Club Handbook of Seals of Sirenians. San Francisco, CA: Sierra Club Books.

SAIC. 1999. Survey Report: Remotely Operated Vehicle (ROV) Biological Characterization Study for US/China Fiber Optic Cable Route off Morro Bay Region, California. Prepared by Science Applications International Corporation. Prepared for AT&T Corporation. December 1999.

SAIC. 2000a. Draft Survey Report: Remotely Operated Vehicle (ROV) Biological Characterization Study for Global West Network. Prepared for Global Photon Systems Inc. Prepared by Science Applications International Corporation. April 2000.

SAIC. 2010. Final 2008 Biological Surveys of Los Angeles and Long Beach Harbors. Prepared for the Ports of Los Angeles and Long Beach. April 2010.

SAIC-SLO (County of San Luis Obispo). 1999. A Hard-Bottom Survey of the Proposed MCI/WorldCom Fiber-Optic Cable Corridors: A Preliminary Overview. Prepared for The Cable Multi-Agency Coordinating Committee, San Luis Obispo, CA.

Thompson, B., J. Dixon, S. Schroeter, and D. Reish. 1993. Benthic Invertebrates. Chapter 8 In M. Dailey, D. Reish, and J. Anderson (eds.), Ecology of the Southern California Bight. University of California Press, Berkeley, CA.

Van Dolah, R. F., P. H. Wendt, R. M. Martore, M. V. Levisen and W. A. Roumillat. 1992. A physical and biological monitoring study of the Hilton Head Beach nourishment project. Hilton Head Island, SC. 1-86

Whitmire, C. E., & Clarke, M. E. (2007). State of deep coral ecosystems of the U.S. Pacific Coast: California to Washington. In S. E. Lumsden, T. F. Hourigan, A. W. Bruckner, & G. Dorr (Eds.), The State of Deep Coral Ecosystems of the United States (pp. 109-154). Silver Spring, MD: NOAA.

9 Appendices

***Table 1:* Master Macrobenthic Invertebrate and Alga Taxonomic List for Fiber Optic Cable Route Surveys Conducted in Coastal California Waters.**

Table 2: Macrobenthic Invertebrates and Alga Taxonomic List for Fiber Optic Cable Route Surveys Conducted in Coastal California Waters by Depth.

Table 3: Master Fish Taxonomic List for Fiber Optic Cable Route Surveys Conducted in Coastal California Waters.

Table 4: Fish Taxonomic List for Fiber Optic Cable Route Surveys Conducted in Coastal California Waters by Depth.

APPENDIX G.

Marine and Near-Coastal Biological Resources

Table G-1. Mean and Total Abundance for Infaunal Samples along the MARS Cable Route. Samples were 7.5 cm diameter push cores (0.3 mm sieve) or 0.1 m2 Smith-McIntyre grab smaples (* and shaded depths; 0.5 mm sieve). Source: MBARI (2004).

Taxonomic Group	25 m n= 9	44 m n= 9	47 m n= 9	60 m n =*3	90 m n =*2	325 m n =*2	450 m n =*2	640 m n= 9	770 m n= 11	795 m n= 10	885 m n= 10
Cnidaria											
Anthozoa											
Mean Abund.	0.00	2.00	0.56	0.00	0.00	0.00	0.00	0.00	0.27	0.50	0.20
Standard Dev.	0.00	1.73	1.01	0.00	0.00	0.00	0.00	0.00	0.47	1.08	0.42
Cnidaria											
Mean Abund.	0.00	0.00	0.00	8.00	0.50	40.00	1.50	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.00	0.00	11.31	0.71	18.38	2.12	0.00	0.00	0.00	0.00
Nemertea											
Mean Abund.	0.78	2.89	3.00	6.50	3.50	12.00	4.50	0.22	0.64	0.50	1.70
Standard Dev.	1.64	3.02	2.12	0.71	4.95	8.49	4.95	0.44	0.67	0.53	1.64
Sipuncula											
Mean Abund.	0.00	0.00	0.00	0.00	1.00	12.00	2.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.00	0.00	0.00	0.00	5.66	2.83	0.00	0.00	0.00	0.00
Echiura											
Mean Abund.	0.00	0.22	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
Standard Dev.	0.00	0.44	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32
Annelida											
Oligochaeta											
Mean Abund.	0.00	0.00	0.00	0.00	1.50	54.00	30.50	0.00	0.00	0.10	0.40
Standard Dev.	0.00	0.00	0.00	0.00	0.71	42.43	12.02	0.00	0.00	0.32	1.26
Polychaeta											
Mean Abund.	13.78	38.56	41.56	283.50	318.50	473.50	455.50	3.22	6.09	5.30	8.10
Standard Dev.	5.40	7.57	12.74	19.09	57.28	149.20	130.81	4.52	2.84	2.06	3.11
Arthropoda											
Caprellida											
Mean Abund.	0.00	0.22	0.11	0.00	0.50	390.50	24.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.44	0.33	0.00	0.71	470.23	14.14	0.00	0.00	0.00	0.00
Cumacea											
Mean Abund.	0.00	1.56	3.11	6.50	7.00	8.00	9.00	0.67	0.36	0.70	0.20
Standard Dev.	0.00	1.33	2.47	6.36	4.24	1.41	12.73	0.87	0.67	1.25	0.42
Decapoda											
Mean Abund.	0.00	0.00	0.00	1.00	0.00	1.50	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.00	0.00	0.00	0.00	2.12	0.00	0.00	0.00	0.00	0.00
Gammaridea											
Mean Abund.	0.11	2.44	3.78	16.50	26.50	401.50	37.50	18.67	15.09	8.60	0.30
Standard Dev.	0.33	2.35	1.20	4.95	4.95	218.50	7.78	11.12	5.66	4.60	0.48

Table G-1. Continued.

Taxonomic Group	25 m n= 9	44 m n= 9	47 m n= 9	60 m n =*3	90 m n =*2	325 m n =*2	450 m n =*2	640 m n= 9	770 m n= 11	795 m n= 10	885 m n= 10
Isopoda											
Mean Abund.	0.00	0.56	0.44	8.00	5.50	41.00	1.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	1.01	0.53	1.41	6.36	22.63	1.41	0.00	0.00	0.00	0.00
Ostracoda											
Mean Abund.	0.00	2.22	4.22	0.00	7.00	116.50	11.50	0.11	0.09	0.50	0.00
Standard Dev.	0.00	1.79	3.42	0.00	2.83	58.69	10.61	0.33	0.30	0.85	0.00
Pycnogonida											
Mean Abund.	0.00	0.00	0.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.00	0.00	1.41	1.41	0.00	0.00	0.00	0.00	0.00	0.00
Tanaidacea											
Mean Abund.	0.00	0.56	0.33	0.00	0.50	113.00	3.50	0.22	0.00	0.10	0.20
Standard Dev.	0.00	1.13	0.50	0.00	0.71	35.36	0.71	0.44	0.00	0.32	0.42
Mollusca											
Aplacophora											
Mean Abund.	0.00	0.11	0.67	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.33	0.71	2.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polyplacophora											
Mean Abund.	0.00	0.00	0.00	0.00	0.00	9.00	8.50	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.00	0.00	0.00	0.00	8.49	2.12	0.00	0.00	0.00	0.00
Gastropoda											
Mean Abund.	0.00	1.00	0.56	23.50	34.50	6.00	5.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	1.32	0.73	4.95	9.19	1.41	7.07	0.00	0.00	0.00	0.00
Bivalvia											
Mean Abund.	0.00	7.33	4.78	87.00	20.50	3.50	7.00	0.33	0.18	0.30	0.00
Standard Dev.	0.00	4.87	2.99	15.56	19.09	3.54	4.24	0.50	0.40	0.48	0.00
Scaphopoda											
Mean Abund.	0.00	0.56	0.33	33.00	2.50	0.00	0.50	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.73	0.50	4.24	3.54	0.00	0.71	0.00	0.00	0.00	0.00
Phoronida											
Phoronida											
Mean Abund.	0.11	0.78	1.22	3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.33	1.39	2.64	4.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Echinodermata											
Ophiuroidea											
Mean Abund.	0.00	1.00	0.44	92.00	19.50	63.00	12.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	1.00	0.73	29.70	26.16	14.14	9.90	0.00	0.00	0.00	0.00

Table G-1. Continued.

Taxonomic Group	25 m n= 9	44 m n= 9	47 m n= 9	60 m n =*3	90 m n =*2	325 m n =*2	450 m n =*2	640 m n= 9	770 m n= 11	795 m n= 10	885 m n= 10
Echinoidea											
Mean Abund.	0.00	0.11	0.00	1.00	2.00	4.00	0.50	0.11	0.00	0.10	0.10
Standard Dev.	0.00	0.33	0.00	0.00	1.41	1.41	0.71	0.33	0.00	0.32	0.32
Holothuroidea											
Mean Abund.	0.00	0.00	0.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.10
Standard Dev.	0.00	0.00	0.00	0.00	0.00	2.83	0.00	0.00	0.00	0.00	0.32
Hemicodata											
Enteropnuesta											
Mean Abund.	0.11	0.00	0.11	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.33	0.00	0.33	0.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Abundance	**134**	**559**	**588**	**1147**	**904**	**3511**	**1230**	**212**	**250**	**167**	**114**
(area m^2)	**(0.0395)**	**(0.0395)**	**(0.0395)**	**(0.3000)**	**(0.2000)**	**(0.2000)**	**(0.2000)**	**(0.0395)**	**(0.0483)**	**(0.0439)**	**(0.0439)**

Table G-2. Mean and Total Number of Taxa for Infaunal Samples Along the MARS Cable Route. Samples were 7.5 cm diameter push cores (0.3 mm sieve) or 0.1 m2 Smith-McIntyre grab smaples (* and shaded depths; 0.5 mm sieve). Source: MBARI (2004).

Taxonomic Group	25 m n= 9	44 m n= 9	47 m n= 9	60 m n =*3	90 m n =*2	325 m n =*2	450 m n =*2	640 m n= 9	770 m n= 11	795 m n= 10	885 m n= 10
Cnidaria											
Anthozoa											
Mean # Taxa	0.00	1.11	0.33	0.00	0.00	0.00	0.00	0.00	0.27	0.20	0.20
Standard Dev.	0.00	0.78	0.50	0.00	0.00	0.00	0.00	0.00	0.47	0.42	0.42
Cnidaria											
Mean # Taxa	0.00	0.00	0.00	0.33	0.50	1.00	0.50	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.00	0.00	0.58	0.71	0.00	0.71	0.00	0.00	0.00	0.00
Nemertea											
Mean # Taxa	0.33	1.00	1.11	0.67	0.50	1.00	1.00	0.22	0.55	0.50	0.70
Standard Dev.	0.50	0.71	0.33	0.58	0.71	0.00	0.00	0.44	0.52	0.53	0.67
Sipuncula											
Mean # Taxa	0.00	0.00	0.00	0.00	1.00	1.00	0.50	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00
Echiura											
Mean # Taxa	0.00	0.22	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
Standard Dev.	0.00	0.44	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32
Annelida											
Oligochaeta											
Mean # Taxa	0.00	0.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00	0.10	0.10
Standard Dev.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.32
Polychaeta											
Mean # Taxa	10.00	18.56	21.22	38.33	62.00	52.00	48.00	2.78	4.18	4.60	4.90
Standard Dev.	2.50	2.51	4.06	33.29	12.73	4.24	1.41	4.41	1.66	1.71	2.08
Arthropoda											
Caprellida											
Mean # Taxa	0.00	0.22	0.11	0.00	0.50	1.50	2.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.44	0.33	0.00	0.71	0.71	0.00	0.00	0.00	0.00	0.00
Cumacea											
Mean # Taxa	0.89	0.00	1.22	1.33	2.50	3.00	0.50	0.56	0.36	0.70	0.20
Standard Dev.	0.60	0.00	0.67	1.53	0.71	0.00	0.71	0.73	0.67	1.25	0.42
Decapoda											
Mean # Taxa	0.00	0.00	0.00	0.67	0.00	0.50	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.00	0.00	0.58	0.00	0.71	0.00	0.00	0.00	0.00	0.00
Gammaridea											
Mean # Taxa	0.11	2.00	3.00	3.33	10.50	16.00	8.00	5.67	5.36	3.50	0.30
Standard Dev.	0.33	1.66	0.50	3.06	2.12	0.00	1.41	2.40	1.21	1.08	0.48

Table G-2. Continued.

Taxonomic Group	25 m n= 9	44 m n= 9	47 m n= 9	60 m n =*3	90 m n =*2	325 m n =*2	450 m n =*2	640 m n= 9	770 m n= 11	795 m n= 10	885 m n= 10
Isopoda											
Mean # Taxa	0.00	0.44	0.44	2.33	2.00	7.00	1.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.73	0.53	2.08	1.41	1.41	1.41	0.00	0.00	0.00	0.00
Ostracoda											
Mean # Taxa	0.00	1.11	1.11	0.00	2.50	4.50	1.00	0.11	0.09	0.30	0.00
Standard Dev.	0.00	0.60	0.60	0.00	0.71	0.71	0.00	0.33	0.30	0.48	0.00
Pycnogonida											
Mean # Taxa	0.00	0.00	0.00	0.33	0.50	0.00	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.00	0.00	0.58	0.71	0.00	0.00	0.00	0.00	0.00	0.00
Tanaidacea											
Mean # Taxa	0.00	0.33	0.33	0.00	0.50	7.00	2.50	0.22	0.00	0.10	0.20
Standard Dev.	0.00	0.71	0.50	0.00	0.71	0.00	0.71	0.44	0.00	0.32	0.42
Mollusca											
Aplacophora											
Mean # Taxa	0.00	0.11	0.56	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.33	0.53	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polyplacophora											
Mean # Taxa	0.00	0.00	0.00	0.00	0.00	1.00	1.50	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.00	0.00	0.00
Gastropoda											
Mean # Taxa	0.00	0.67	0.56	5.00	6.50	4.00	1.50	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.87	0.73	4.36	0.71	1.41	2.12	0.00	0.00	0.00	0.00
Bivalvia											
Mean # Taxa	0.00	3.22	2.67	8.67	7.00	1.50	3.00	0.33	0.18	0.30	0.00
Standard Dev.	0.00	0.83	0.87	7.57	2.83	0.71	1.41	0.50	0.40	0.48	0.00
Scaphopoda											
Mean # Taxa	0.00	0.44	0.33	1.33	0.50	0.00	0.50	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.53	0.50	1.15	0.71	0.00	0.71	0.00	0.00	0.00	0.00
Phoronida											
Phoronida											
Mean # Taxa	0.11	0.33	0.33	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.33	0.50	0.50	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Echinodermata											
Ophiuroidea											
Mean # Taxa	0.00	0.56	0.33	3.00	4.50	5.00	3.50	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.53	0.50	2.65	4.95	0.00	0.71	0.00	0.00	0.00	0.00
Echinoidea											
Mean # Taxa	0.00	0.11	0.00	0.67	1.00	2.00	0.50	0.11	0.00	0.10	0.10

Standard Dev.	0.00	0.33	0.00	0.58	0.00	1.41	0.71	0.33	0.00	0.32	0.32

Table G-2. Continued.

Taxonomic Group	25 m n= 9	44 m n= 9	47 m n= 9	60 m n =*3	90 m n =*2	325 m n =*2	450 m n =*2	640 m n= 9	770 m n= 11	795 m n= 10	885 m n= 10
Holothuroidea											
Mean # Taxa	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.10
Standard Dev.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32
Hemicodata											
Enteropnuesta											
Mean # Taxa	0.11	0.00	0.11	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.33	0.00	0.33	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Taxa	**45**	**111**	**112**	**136**	**154**	**150**	**104**	**34**	**36**	**38**	**31**
(area m^2)	**(0.0395)**	**(0.0395)**	**(0.0395)**	**(0.3000)**	**(0.2000)**	**(0.2000)**	**(0.2000)**	**(0.0395)**	**(0.0483)**	**(0.0439)**	**(0.0439)**

Table G-3. Depth Distribution of Infaunal Taxa Collected along the MARS Cable Route. Source: MBARI (2004).

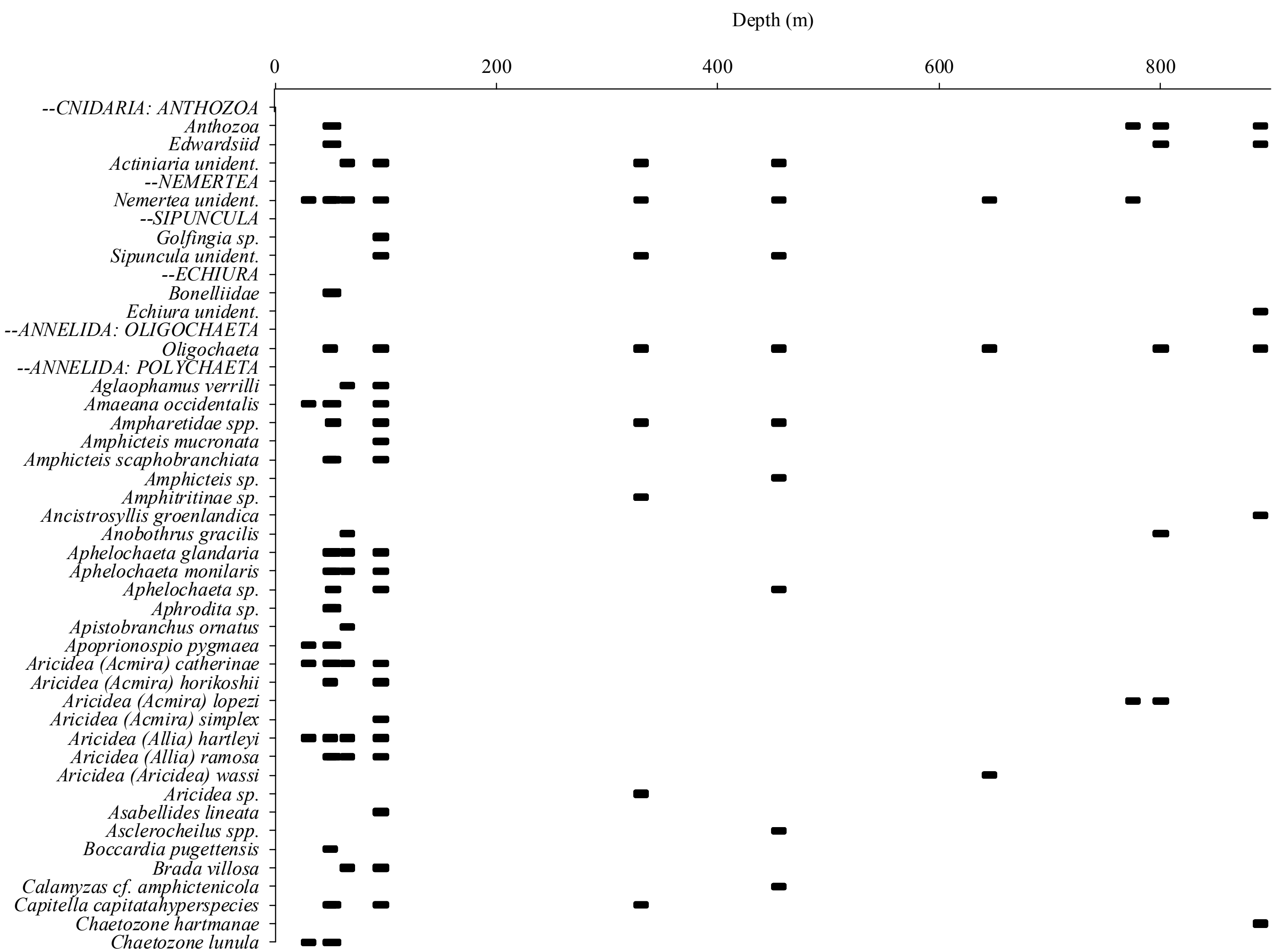


Table G-3. Continued.

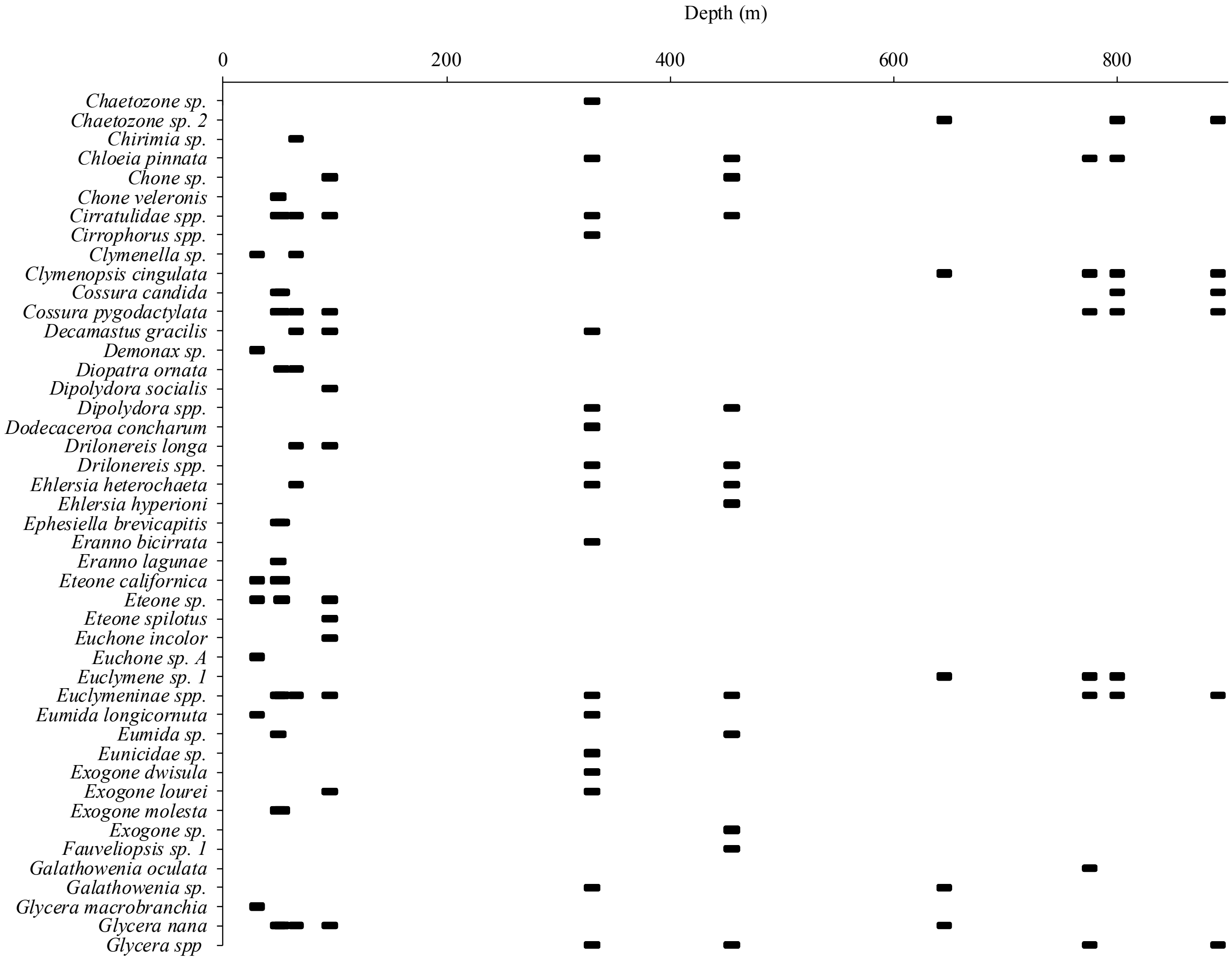


Table G-3. Continued.

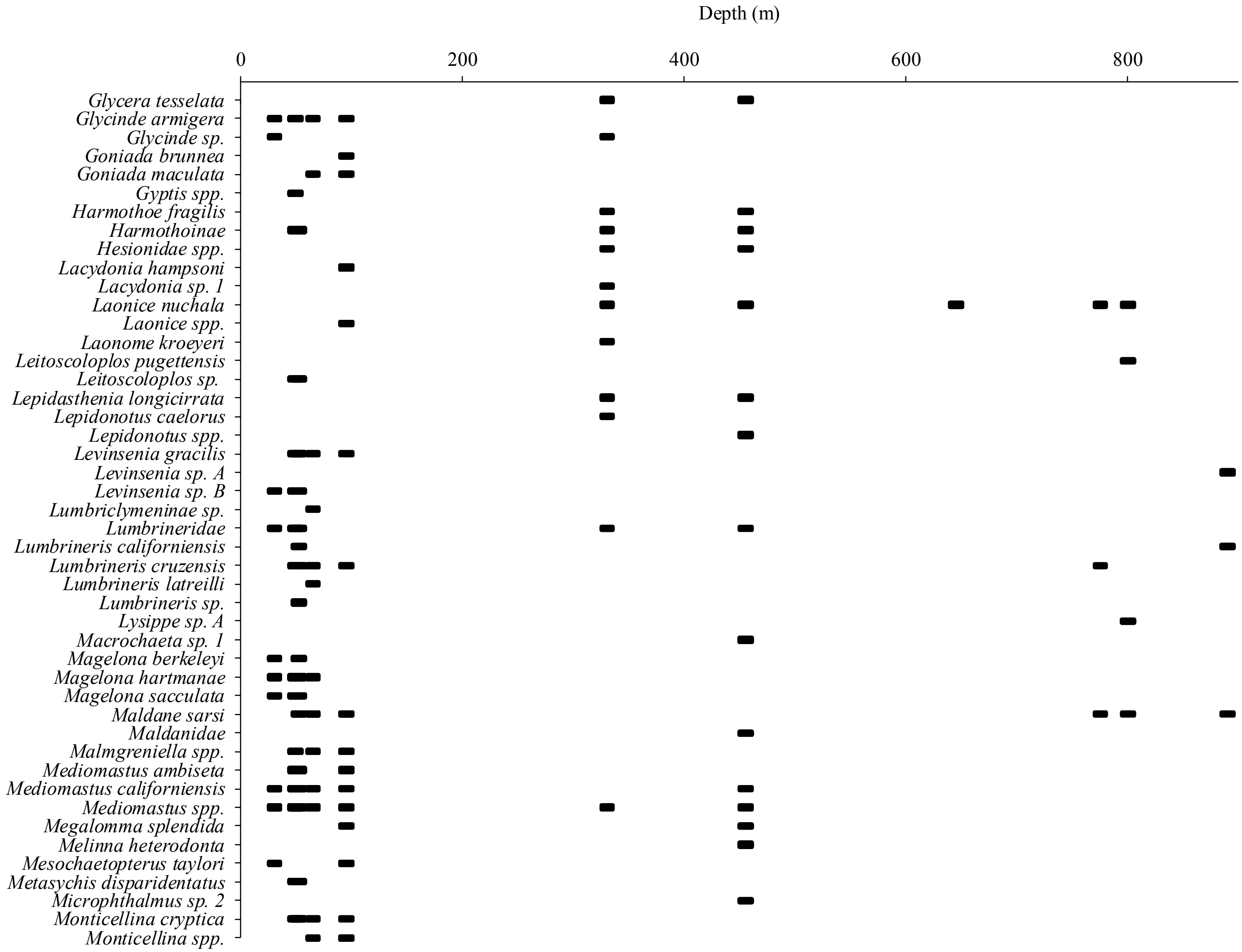


Table G-3. Continued.

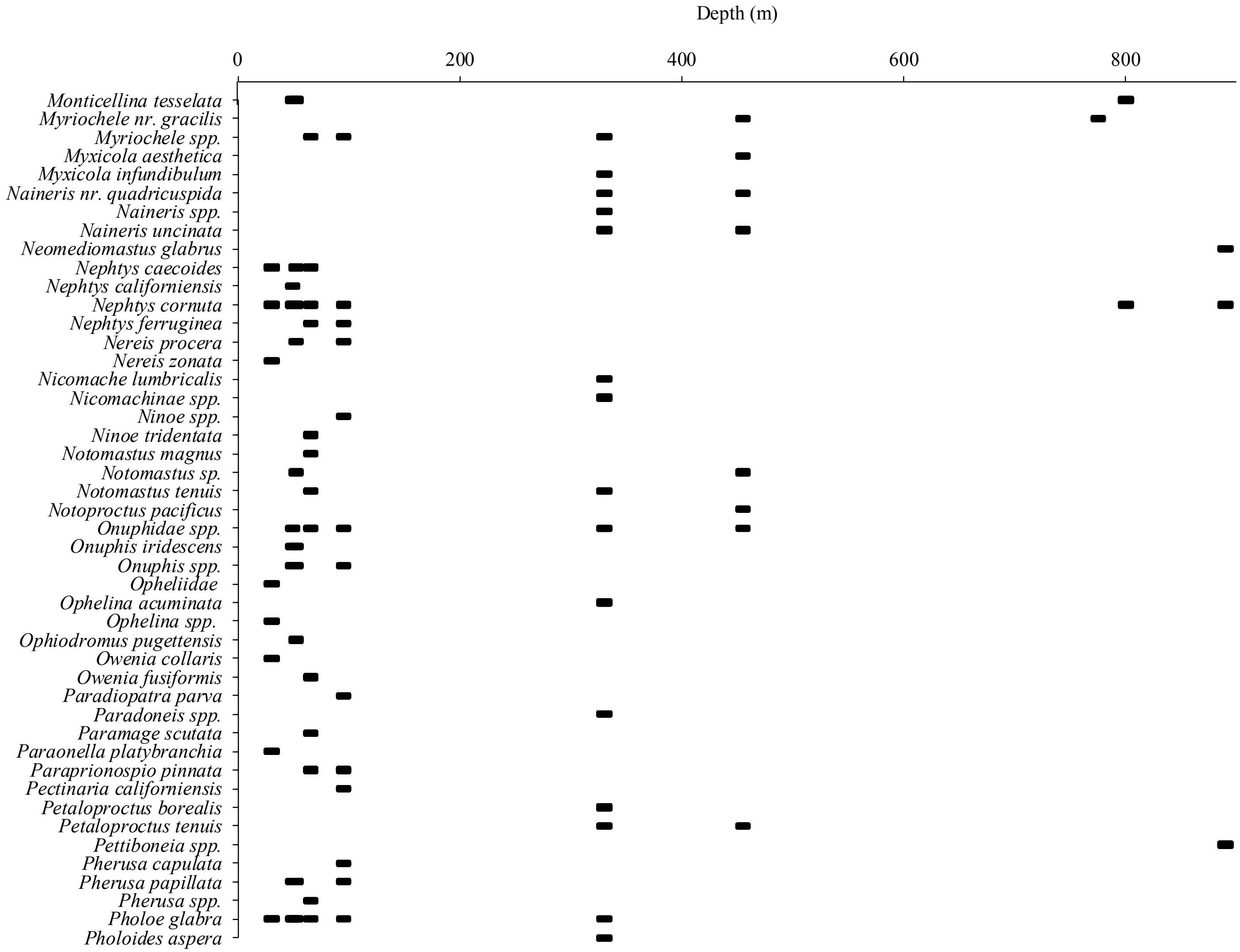


Table G-3. Continued.

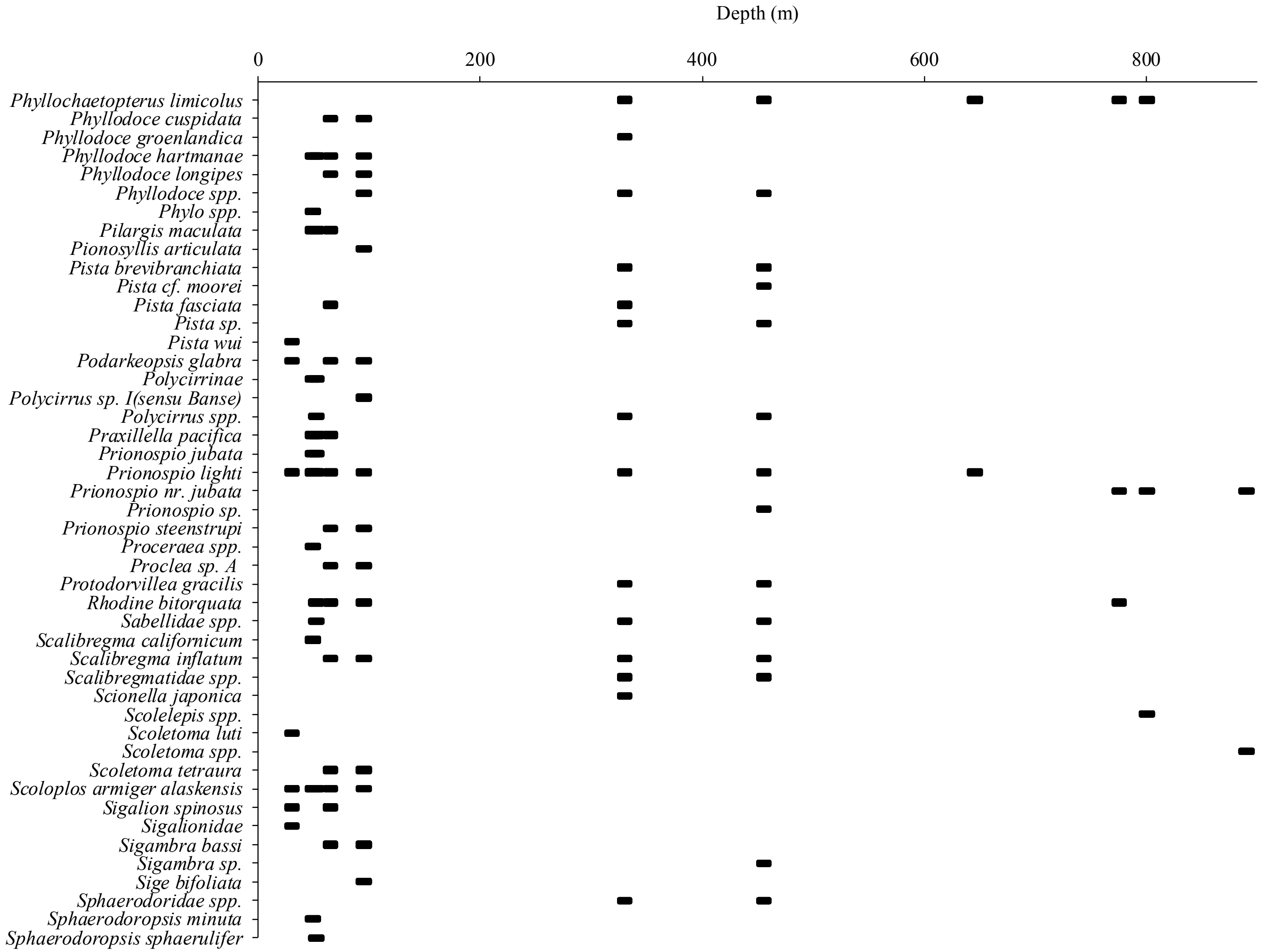


Table G-3. Continued.

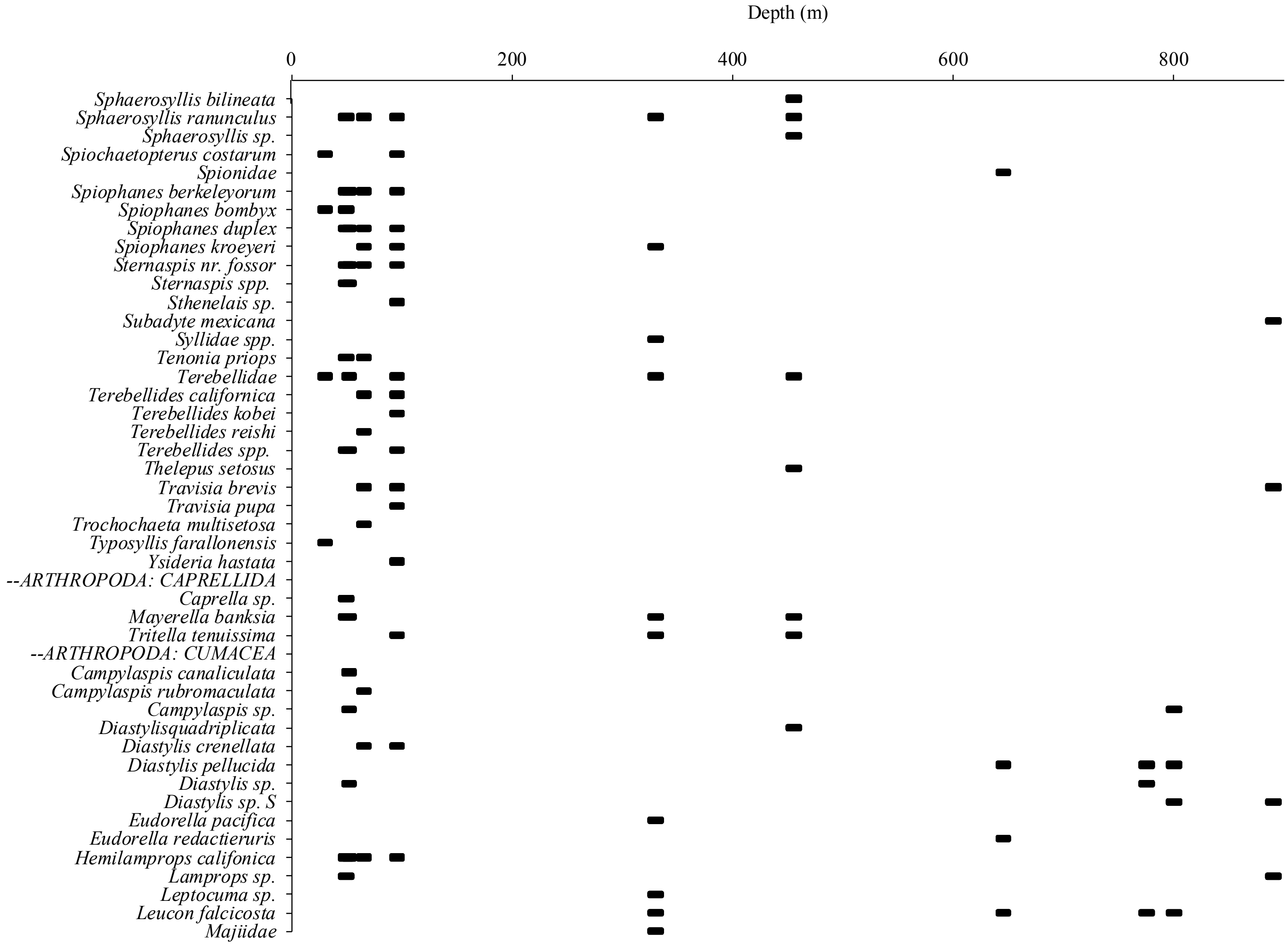


Table G-3. Continued.

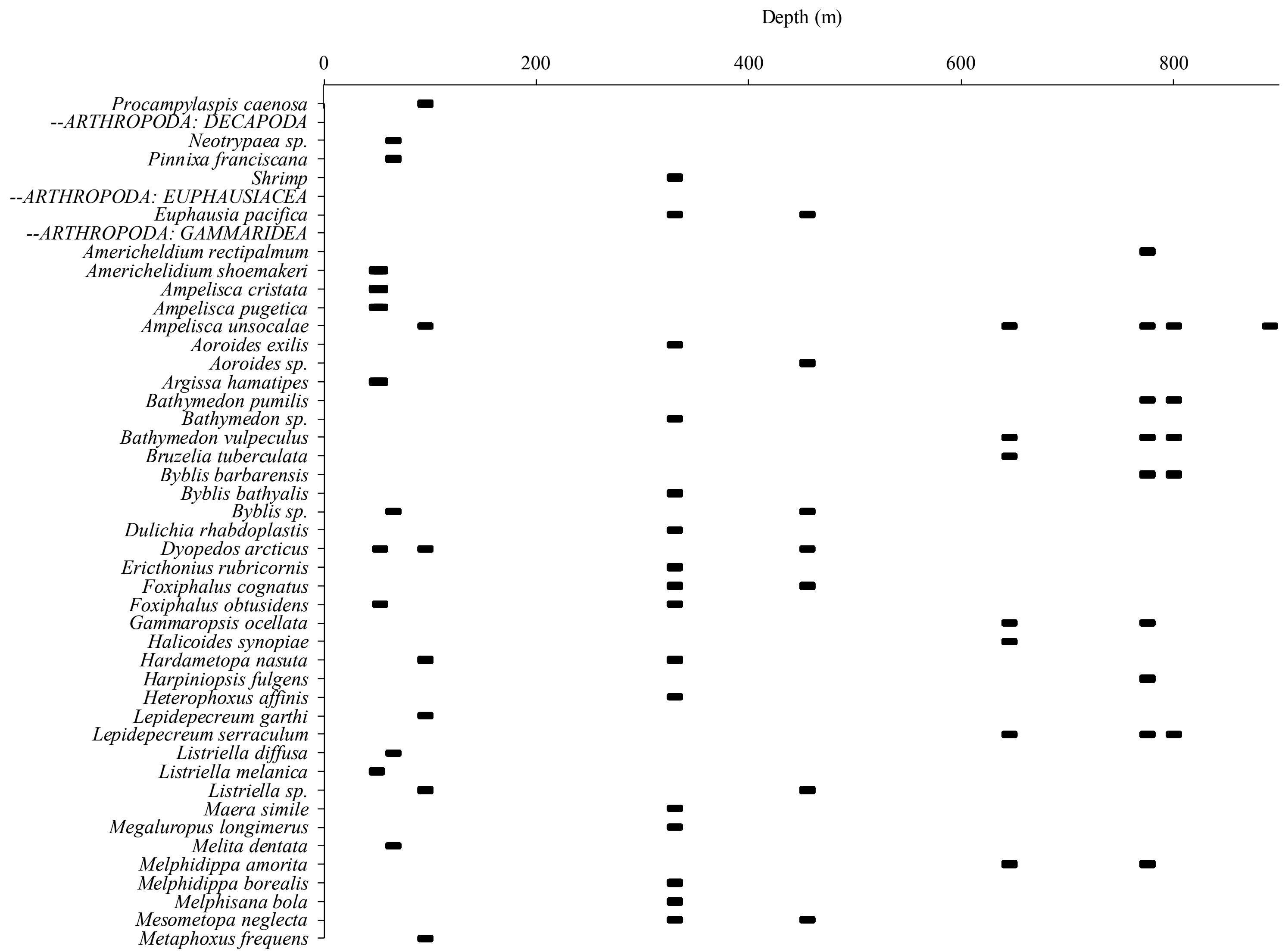


Table G-3. Continued.

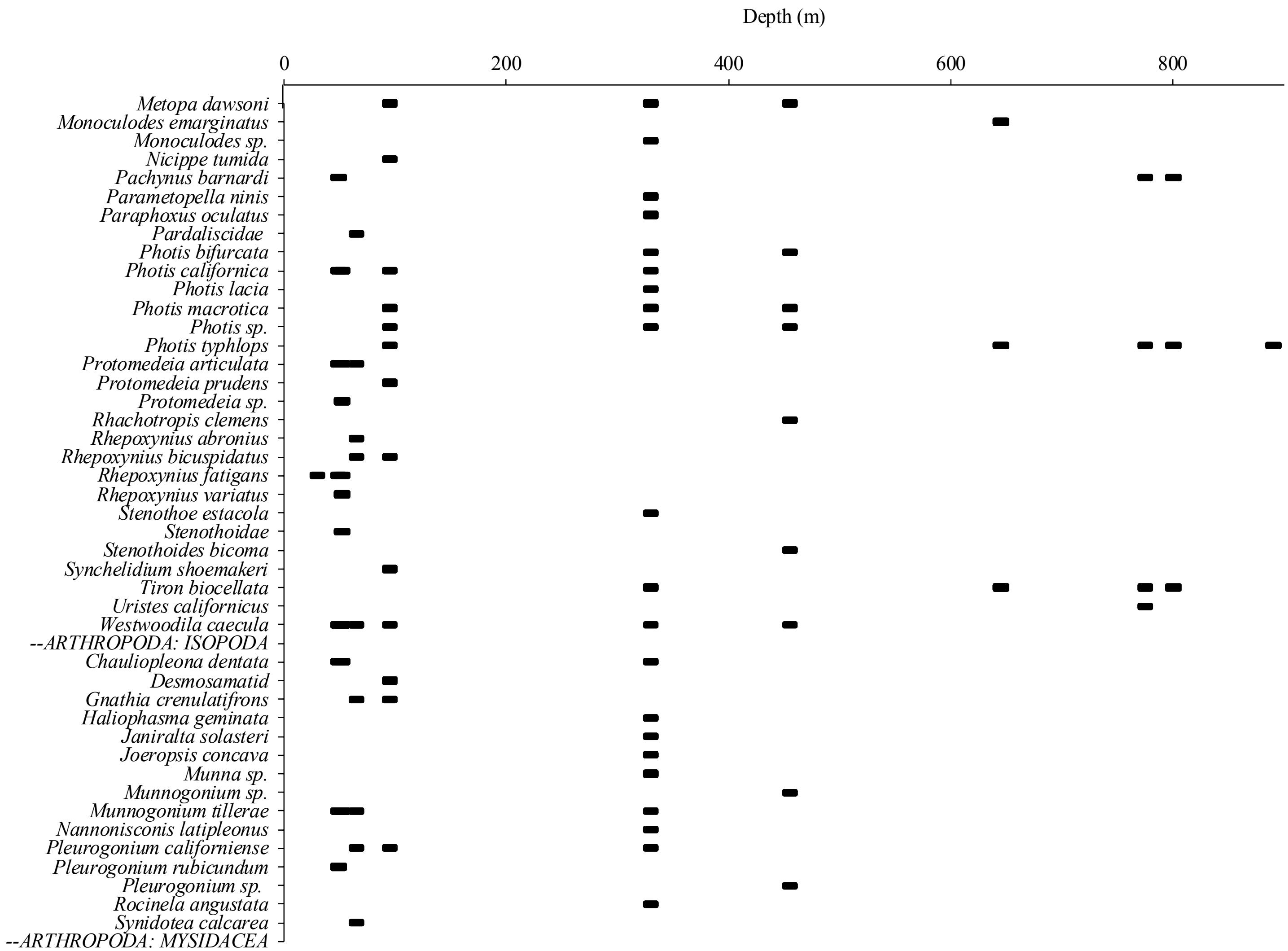


Table G-3. Continued.

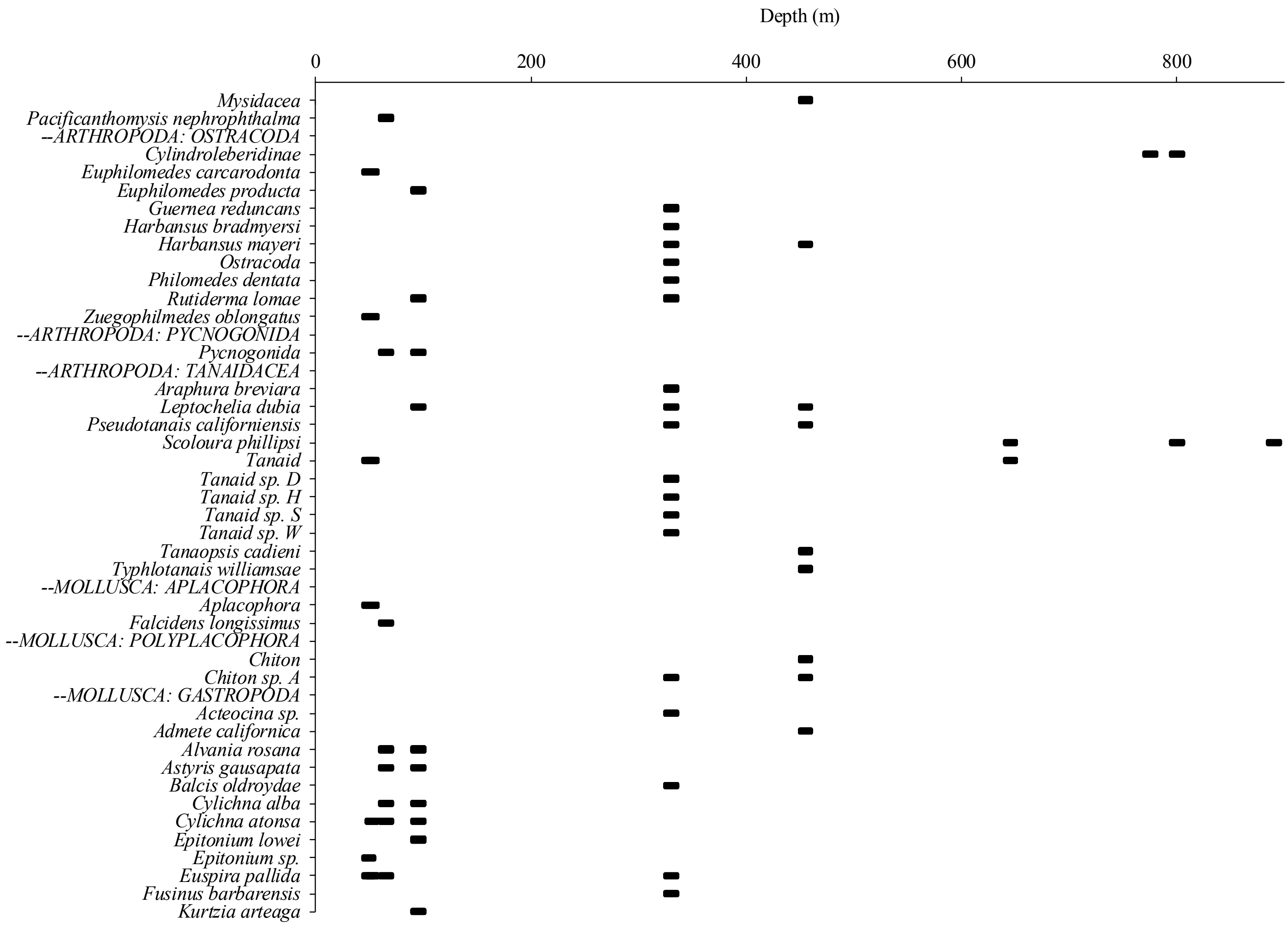


Table G-3. Continued.

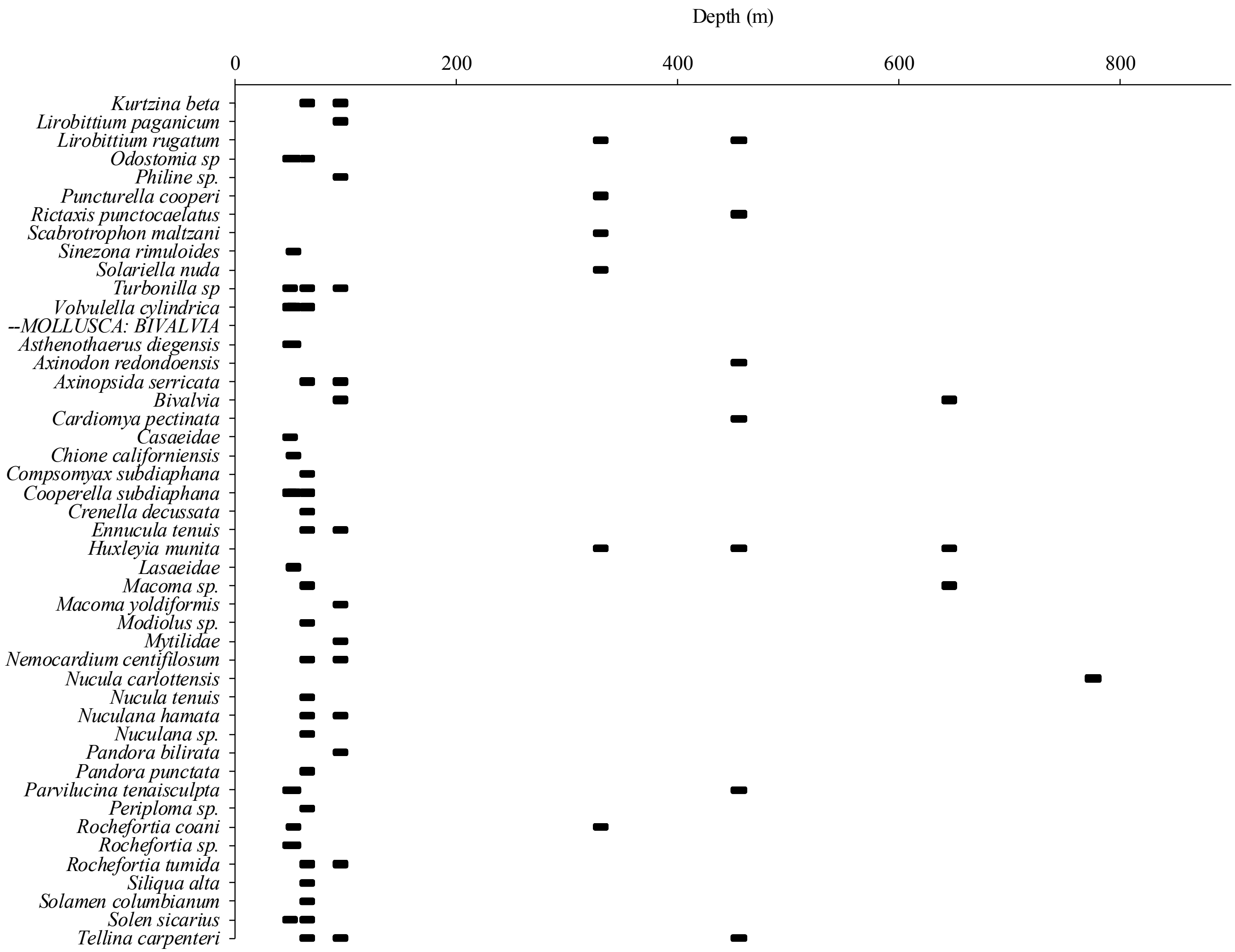


Table G-3. Continued.

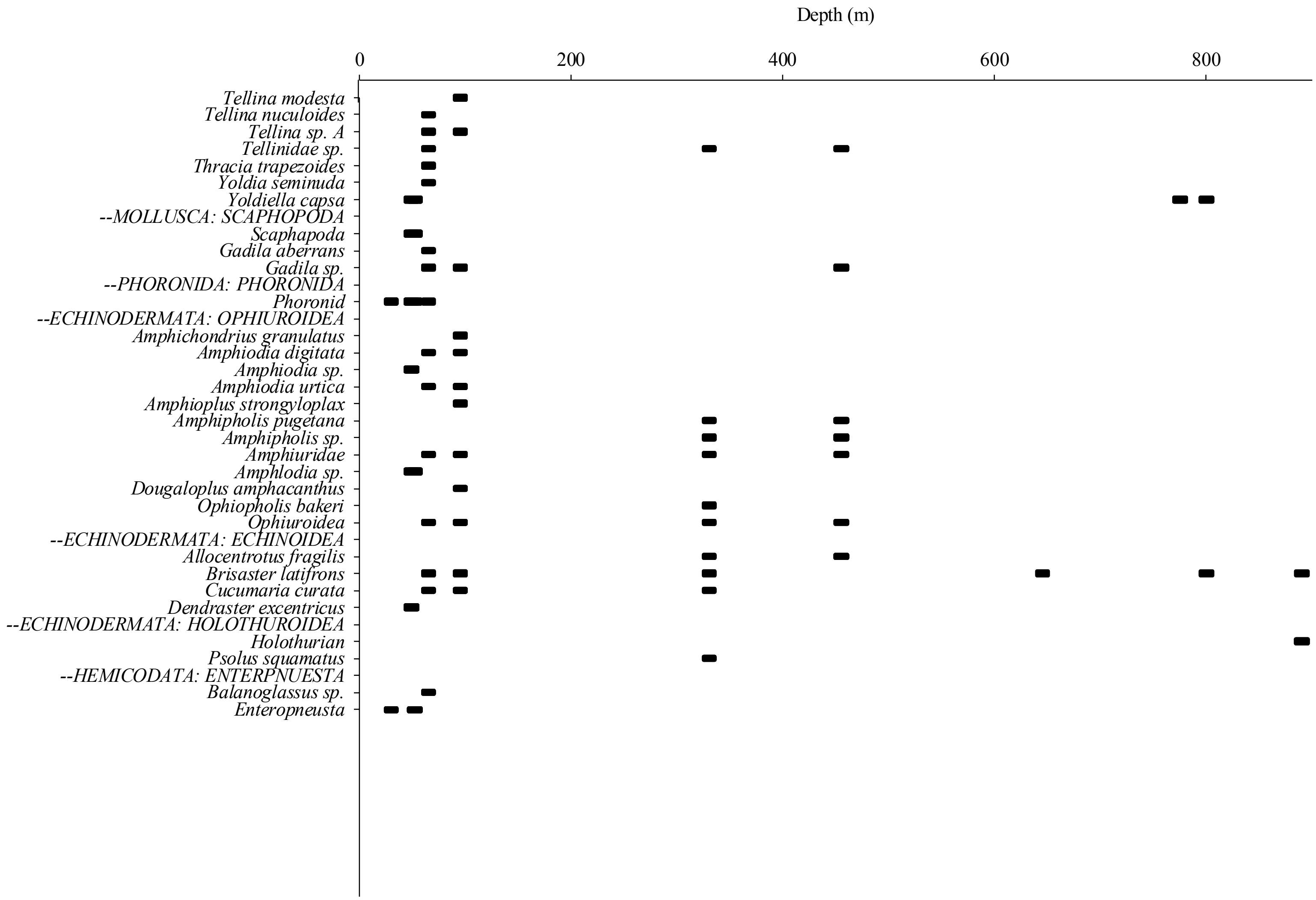


Table G-4. Mean and Total Abundance of Epifauna and Fishes Identified from ROV Surveys Along the MARS Cable Route. Each video sample was 25 m in length. Source: MBARI (2004).

Taxonomic Group	44 m n= 33	47 m n= 67	60 m n =10	90 m n =10	325 m n =10	450 m n =10	640 m n= 37	770 m n= 56	795 m n= 41	885 m n= 39
--Porifera										
Mean Abund.	0.00	0.00	0.30	1.40	1.20	1.80	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.00	0.50	2.40	3.50	2.30	0.00	0.00	0.00	0.00
--Cnidaria										
Actinaria										
Mean Abund.	0.00	0.12	0.00	0.20	1.40	1.30	0.14	1.27	0.54	2.21
Standard Dev.	0.00	0.44	0.00	0.40	1.40	1.30	0.35	1.70	0.81	2.81
Ceriantharia										
Mean Abund.	0.00	1.09	0.00	0.10	0.40	10.40	0.76	0.00	0.00	0.00
Standard Dev.	0.00	1.24	0.00	0.30	0.70	6.50	1.19	0.00	0.00	0.00
Corallimorpharia										
Mean Abund.	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.93	0.24	0.18
Standard Dev.	0.00	0.00	0.00	0.00	0.70	0.00	0.00	1.19	0.58	0.45
Pennatulacea										
Mean Abund.	0.30	8.22	3.20	10.70	0.00	0.00	4.76	2.54	9.61	40.49
Standard Dev.	0.47	6.28	5.00	5.80	0.00	0.00	3.24	3.44	9.70	53.90
--Annelida										
Polychaeta										
Mean Abund.	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
--Arthropoda										
Brachyura										
Mean Abund.	0.18	0.09	0.00	0.10	0.10	0.00	0.00	1.30	0.73	0.67
Standard Dev.	0.39	0.29	0.00	0.30	0.30	0.00	0.00	1.14	1.00	0.87
--Mollusca										
Gastropoda										
Mean Abund.	2.67	4.28	0.00	0.00	0.00	2.60	0.73	0.55	0.02	0.05
Standard Dev.	1.49	3.21	0.00	0.00	0.00	2.40	0.93	0.83	0.16	0.32
Nudibranchia										
Mean Abund.	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table G-4. Continued.

Taxonomic Group	44 m n= 33	47 m n= 67	60 m n =10	90 m n =10	325 m n =10	450 m n =10	640 m n= 37	770 m n= 56	795 m n= 41	885 m n= 39
Bivalvia										
Mean Abund.	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Octopoda										
Mean Abund.	0.00	0.10	0.00	0.00	0.00	0.10	0.00	0.02	0.00	0.00
Standard Dev.	0.00	0.31	0.00	0.00	0.00	0.30	0.00	0.13	0.00	0.00
--Echinodermata										
Asteroidea										
Mean Abund.	0.12	0.13	0.00	1.00	1.00	1.50	0.00	0.09	0.07	0.03
Standard Dev.	0.42	0.34	0.00	1.40	2.00	1.10	0.00	0.29	0.26	0.16
Forcipulatid										
Mean Abund.	0.00	0.01	0.00	0.30	30.30	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.12	0.00	0.50	25.30	0.00	0.00	0.00	0.00	0.00
Paxillosida										
Mean Abund.	0.00	0.15	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.40	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00
Spinulosida										
Mean Abund.	0.00	0.00	0.00	0.00	0.60	0.30	0.00	0.96	0.10	0.03
Standard Dev.	0.00	0.00	0.00	0.00	0.70	0.70	0.00	1.55	0.30	0.16
Valvatida										
Mean Abund.	0.00	0.04	0.00	0.20	0.90	0.10	0.03	0.00	0.00	0.00
Standard Dev.	0.00	0.21	0.00	0.40	0.80	0.30	0.16	0.00	0.00	0.00
Ophuiroidea										
Mean Abund.	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.07	0.03
Standard Dev.	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.26	0.16
Strongylocentrotidae										
Mean Abund.	0.00	0.00	0.00	0.00	10.80	0.00	0.05	0.27	0.27	0.05
Standard Dev.	0.00	0.00	0.00	0.00	8.00	0.00	0.23	0.56	0.67	0.22
Holothuroid										
Mean Abund.	0.00	0.00	0.00	0.10	1.30	0.00	0.00	0.02	0.00	0.00
Standard Dev.	0.00	0.00	0.00	0.30	1.00	0.00	0.00	0.13	0.00	0.00

Table G-4. Continued.

Taxonomic Group	44 m n= 33	47 m n= 67	60 m n =10	90 m n =10	325 m n =10	450 m n =10	640 m n= 37	770 m n= 56	795 m n= 41	885 m n= 39
Elasipodida										
Mean Abund.	0.00	0.00	0.00	0.00	0.30	0.00	0.05	0.00	0.00	3.18
Standard Dev.	0.00	0.00	0.00	0.00	0.70	0.00	0.23	0.00	0.00	18.06
--Vertebrata										
Rajidae										
Mean Abund.	0.00	0.01	0.00	0.10	0.00	0.10	0.00	0.02	0.00	0.00
Standard Dev.	0.00	0.12	0.00	0.30	0.00	0.30	0.00	0.13	0.00	0.00
Scyliorhinidae										
Mean Abund.	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.02	0.05	0.00
Standard Dev.	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.13	0.22	0.00
Agonidae										
Mean Abund.	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.00	0.00	0.00	0.90	0.00	0.00	0.00	0.00	0.00
Anoplopomitdae										
Mean Abund.	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00
Alepocephalidae										
Mean Abund.	0.33	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.92	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bothidae										
Mean Abund.	0.00	0.00	0.50	1.60	0.00	0.00	0.00	0.02	0.00	0.00
Standard Dev.	0.00	0.00	0.70	1.70	0.00	0.00	0.00	0.13	0.00	0.00
Embiotocidae										
Mean Abund.	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00
Liparididae										
Mean Abund.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.02	0.00
Standard Dev.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.16	0.00
Macrouridae										
Mean Abund.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00
Standard Dev.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00

Table G-4. Continued.

Taxonomic Group	44 m n= 33	47 m n= 67	60 m n =10	90 m n =10	325 m n =10	450 m n =10	640 m n= 37	770 m n= 56	795 m n= 41	885 m n= 39
Merlucciidae										
Mean Abund.	0.00	0.00	0.00	0.00	0.30	0.00	0.16	0.02	0.10	0.03
Standard Dev.	0.00	0.00	0.00	0.00	0.50	0.00	0.44	0.13	0.30	0.16
Moridae										
Mean Abund.	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.02	0.13
Standard Dev.	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.16	0.34
Myxinidae										
Mean Abund.	0.00	0.00	0.00	0.00	0.00	0.10	0.05	0.04	0.07	0.05
Standard Dev.	0.00	0.00	0.00	0.00	0.00	0.30	0.23	0.19	0.26	0.22
Ophidiidae										
Mean Abund.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00
Standard Dev.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00
Osteichthyes										
Mean Abund.	0.00	0.04	0.60	1.30	0.00	0.10	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.21	1.00	1.20	0.00	0.30	0.00	0.00	0.00	0.00
Pleuronectidae										
Mean Abund.	0.00	0.00	0.00	0.00	0.20	0.00	0.11	0.09	0.00	0.03
Standard Dev.	0.00	0.00	0.00	0.00	0.40	0.00	0.31	0.29	0.00	0.16
Pleuronectiformes										
Mean Abund.	0.03	0.04	0.30	0.60	0.40	0.10	0.00	0.32	0.07	0.00
Standard Dev.	0.17	0.21	0.50	0.90	0.70	0.30	0.00	0.61	0.26	0.00
Scorpaenidae										
Mean Abund.	0.00	0.00	0.00	0.00	0.20	0.00	0.03	1.34	0.29	1.15
Standard Dev.	0.00	0.00	0.00	0.00	0.40	0.00	0.16	1.34	0.51	1.90
Zoarcidae										
Mean Abund.	0.00	0.00	0.00	0.00	0.40	0.40	0.05	0.46	0.12	0.10
Standard Dev.	0.00	0.00	0.00	0.00	0.20	0.70	0.23	0.76	0.40	0.38
Total Abundance/m	0.145	0.611	0.204	0.648	1.820	0.872	0.281	0.421	0.499	1.935
Invertebrates	0.131	0.617	0.148	0.492	1.736	0.840	0.264	0.336	0.468	1.876
Demersal Fishes	0.015	0.005	0.056	0.156	0.084	0.032	0.017	0.085	0.030	0.059

Table G-5. Mean and Total Number of Taxa for Epifauna and Fishes Identified from ROV Surveys Along the MARS Cable Route. Each video sample (n) was 25 m in length. Source: MBARI (2004).

Taxonomic Group	44 m n= 33	47 m n= 67	60 m n =10	90 m n =10	325 m n =10	450 m n =10	640 m n= 37	770 m n= 56	795 m n= 41	885 m n= 39
--Porifera										
Mean # Taxa	0.00	0.00	0.00	0.30	0.44	0.80	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.00	0.00	0.48	0.53	0.79	0.00	0.00	0.00	0.00
--Cnidaria										
Actinaria										
Mean # Taxa	0.00	0.09	0.00	0.20	0.78	1.80	0.14	0.73	0.41	0.95
Standard Dev.	0.00	0.29	0.00	0.42	0.67	0.42	0.35	0.80	0.59	1.00
Ceriantharia										
Mean # Taxa	0.00	0.58	0.00	0.10	0.33	1.10	0.43	0.00	0.00	0.00
Standard Dev.	0.00	0.50	0.00	0.32	0.50	0.32	0.50	0.00	0.00	0.00
Corallimorpharia										
Mean # Taxa	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.52	0.20	0.15
Standard Dev.	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.50	0.40	0.37
Pennatulacea										
Mean # Taxa	0.30	0.94	0.78	1.10	0.00	0.00	1.57	1.07	1.27	1.13
Standard Dev.	0.47	0.30	0.44	0.32	0.00	0.00	0.69	0.71	0.87	0.95
--Annelida										
Polychaeta										
Mean # Taxa	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.00	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00
--Arthropoda										
Brachyura										
Mean # Taxa	0.18	0.09	0.00	0.10	0.11	0.00	0.00	0.71	0.44	0.44
Standard Dev.	0.39	0.29	0.00	0.32	0.33	0.00	0.00	0.46	0.50	0.50
--Mollusca										
Gastropoda										
Mean # Taxa	0.94	1.03	0.00	0.00	0.00	0.80	0.49	0.36	0.02	0.05
Standard Dev.	0.24	0.43	0.00	0.00	0.00	0.42	0.51	0.48	0.16	0.32
Nudibranchia										
Mean # Taxa	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Taxonomic Group	44 m n= 33	47 m n= 67	60 m n =10	90 m n =10	325 m n =10	450 m n =10	640 m n= 37	770 m n= 56	795 m n= 41	885 m n= 39
Standard Dev.	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table G-5. Continued.

Taxonomic Group	44 m n= 33	47 m n= 67	60 m n =10	90 m n =10	325 m n =10	450 m n =10	640 m n= 37	770 m n= 56	795 m n= 41	885 m n= 39
Bivalvia										
Mean # Taxa	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Octopoda										
Mean # Taxa	0.00	0.10	0.00	0.00	0.00	0.10	0.00	0.02	0.00	0.00
Standard Dev.	0.00	0.31	0.00	0.00	0.00	0.32	0.00	0.13	0.00	0.00
--Echinodermata										
Asteroidea										
Mean # Taxa	0.09	0.13	0.00	0.20	0.44	0.80	0.00	0.09	0.07	0.03
Standard Dev.	0.29	0.34	0.00	0.42	0.53	0.42	0.00	0.29	0.26	0.16
Forcipulatida										
Mean # Taxa	0.00	0.01	0.00	0.30	1.00	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.12	0.00	0.48	0.00	0.00	0.00	0.00	0.00	0.00
Paxillosida										
Mean # Taxa	0.00	0.13	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.34	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.00
Spinulosida										
Mean # Taxa	0.00	0.00	0.00	0.00	0.44	0.20	0.00	0.54	0.10	0.03
Standard Dev.	0.00	0.00	0.00	0.00	0.53	0.42	0.00	0.60	0.30	0.16
Valvatida										
Mean # Taxa	0.00	0.04	0.00	0.20	0.78	0.10	0.03	0.00	0.00	0.00
Standard Dev.	0.00	0.21	0.00	0.42	0.67	0.32	0.16	0.00	0.00	0.00
Ophuiroidea										
Mean # Taxa	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.07	0.03
Standard Dev.	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.26	0.16
Strongylocentrotidae										
Mean # Taxa	0.00	0.00	0.00	0.00	1.00	0.00	0.05	0.21	0.17	0.05
Standard Dev.	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.41	0.38	0.22
Holothuroid										
Mean # Taxa	0.00	0.00	0.00	0.10	0.22	0.00	0.00	0.02	0.00	0.00

Standard Dev.	0.00	0.00	0.00	0.32	0.44	0.00	0.00	0.13	0.00	0.00

Table G-5. Continued.

Taxonomic Group	44 m n= 33	47 m n= 67	60 m n =10	90 m n =10	325 m n =10	450 m n =10	640 m n= 37	770 m n= 56	795 m n= 41	885 m n= 39
Elasipodida										
Mean # Taxa	0.00	0.00	0.00	0.00	0.89	0.00	0.05	0.00	0.00	0.21
Standard Dev.	0.00	0.00	0.00	0.00	0.60	0.00	0.23	0.00	0.00	0.41
--Vertebrata										
Rajidae										
Mean # Taxa	0.00	0.01	0.00	0.10	0.00	0.10	0.00	0.02	0.00	0.00
Standard Dev.	0.00	0.12	0.00	0.10	0.00	0.10	0.00	0.13	0.00	0.00
Scyliorhinidae										
Mean # Taxa	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.02	0.05	0.00
Standard Dev.	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.13	0.22	0.00
Agonidae										
Mean # Taxa	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00
Anoplopomitdae										
Mean # Taxa	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00
Alepocephalidae										
Mean # Taxa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.02	0.00
Standard Dev.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.16	0.00
Bothidae										
Mean # Taxa	0.15	0.03	0.50	1.60	0.00	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.36	0.17	0.20	0.50	0.00	0.00	0.00	0.00	0.00	0.00
Embiotocidae										
Mean # Taxa	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00
Liparididae										
Mean # Taxa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.02	0.00
Standard Dev.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.16	0.00
Macrouridae										
Mean # Taxa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00
Standard Dev.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00

Table G-5. Continued.

Taxonomic Group	44 m n= 33	47 m n= 67	60 m n =10	90 m n =10	325 m n =10	450 m n =10	640 m n= 37	770 m n= 56	795 m n= 41	885 m n= 39
Merlucciidae										
Mean # Taxa	0.00	0.00	0.00	0.00	0.30	0.00	0.14	0.02	0.10	0.03
Standard Dev.	0.00	0.00	0.00	0.00	0.20	0.00	0.35	0.13	0.30	0.16
Moridae										
Mean # Taxa	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.02	0.13
Standard Dev.	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.16	0.34
Myxinidae										
Mean # Taxa	0.00	0.00	0.00	0.00	0.00	0.10	0.05	0.04	0.07	0.05
Standard Dev.	0.00	0.00	0.00	0.00	0.00	0.10	0.23	0.19	0.26	0.22
Ophidiidae										
Mean # Taxa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00
Standard Dev.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00
Osteichthyes										
Mean # Taxa	0.00	0.04	0.60	1.30	0.00	0.10	0.00	0.00	0.00	0.00
Standard Dev.	0.00	0.21	0.30	0.40	0.00	0.10	0.00	0.00	0.00	0.00
Pleuronectidae										
Mean # Taxa	0.00	0.00	0.00	0.00	0.20	0.00	0.11	0.09	0.00	0.03
Standard Dev.	0.00	0.00	0.00	0.00	0.10	0.00	0.31	0.29	0.00	0.16
Pleuronectiformes										
Mean # Taxa	0.03	0.04	0.30	0.80	0.40	0.10	0.00	0.27	0.07	0.00
Standard Dev.	0.17	0.21	0.20	0.30	0.20	0.10	0.00	0.45	0.26	0.00
Scorpaenidae										
Mean # Taxa	0.00	0.00	0.00	0.00	0.20	0.00	0.03	0.64	0.27	0.41
Standard Dev.	0.00	0.00	0.00	0.00	0.10	0.00	0.16	0.48	0.45	0.50
Zoarcidae										
Mean # Taxa	0.00	0.00	0.00	0.00	0.40	0.40	0.05	0.36	0.10	0.08
Standard Dev.	0.00	0.00	0.00	0.00	0.20	0.20	0.23	0.48	0.30	0.27
Total Taxa/m	0.007	0.011	0.020	0.064	0.116	0.084	0.021	0.019	0.021	0.021
Invertebrates	0.005	0.009	0.008	0.044	0.080	0.064	0.012	0.011	0.012	0.014

Demersal Fishes	0.002	0.002	0.012	0.020	0.036	0.020	0.009	0.008	0.010	0.006

Table G-6. Depth Distribution of Epifauna and Fish Taxa Observed Along the MARS Cable Route. Taxa occurring predominately on hard substrate are indicated by an asterisk (*). Source: MBARI (2004).

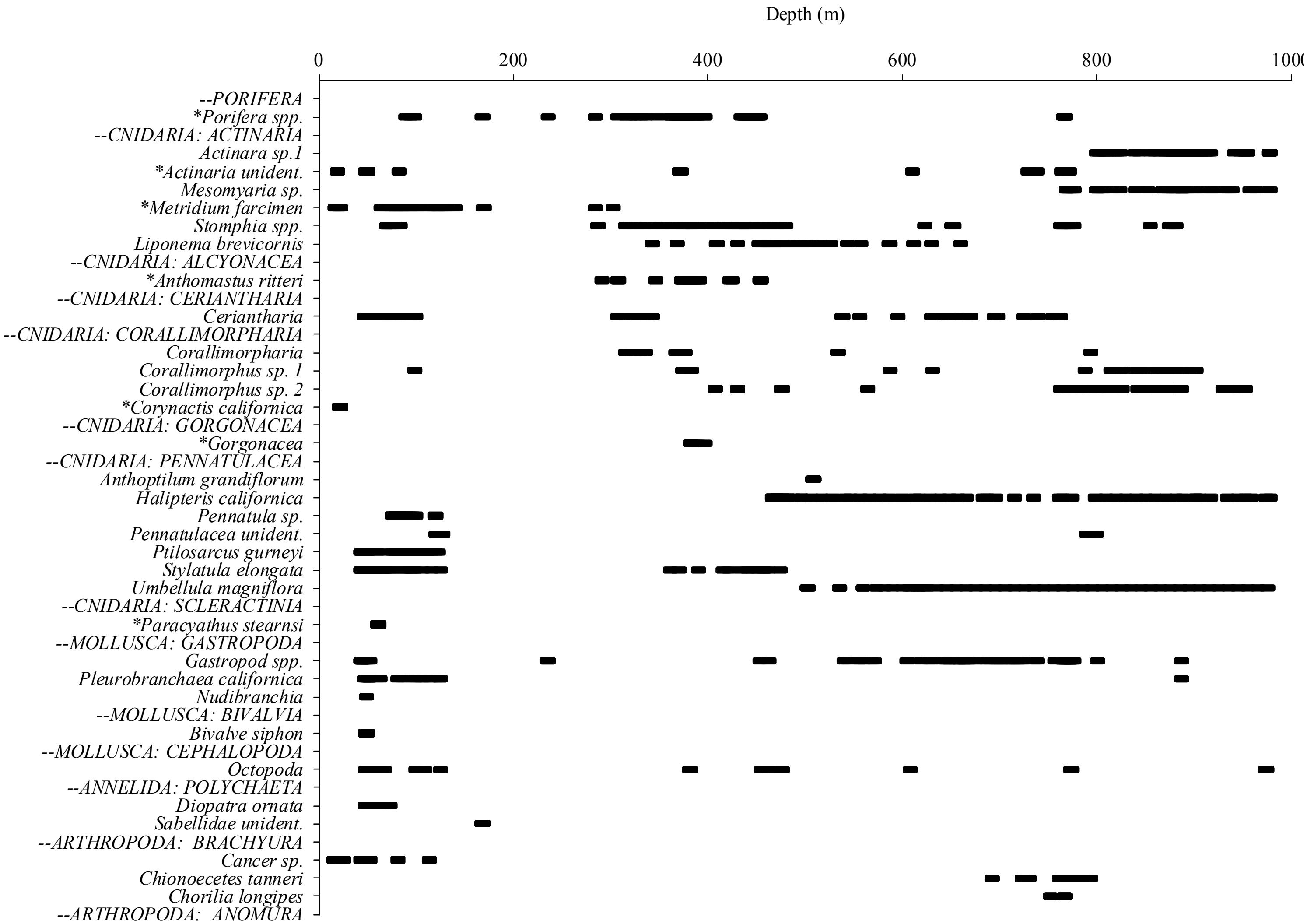


Table G-6. Continued.

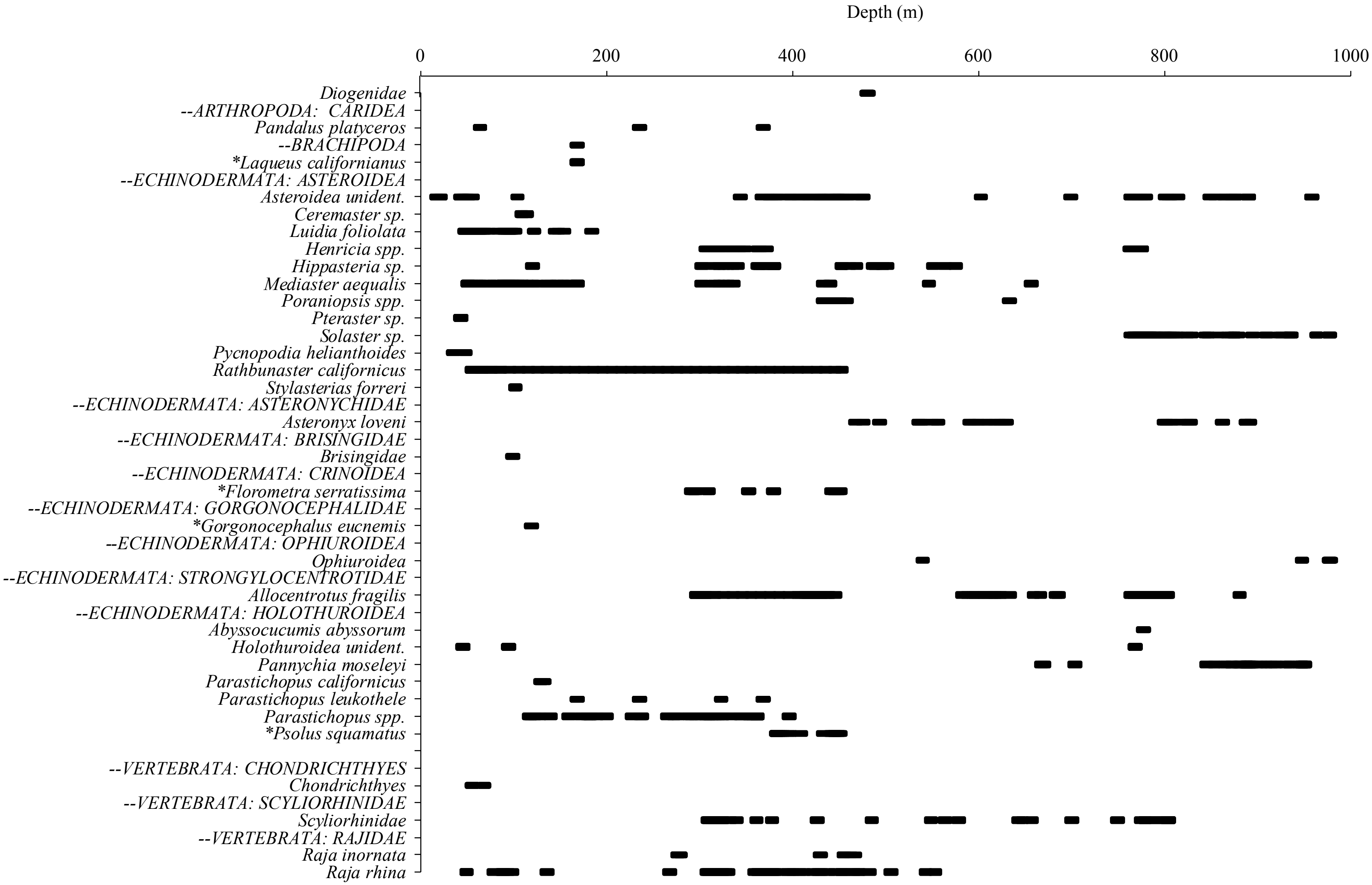


Table G-6. Continued.

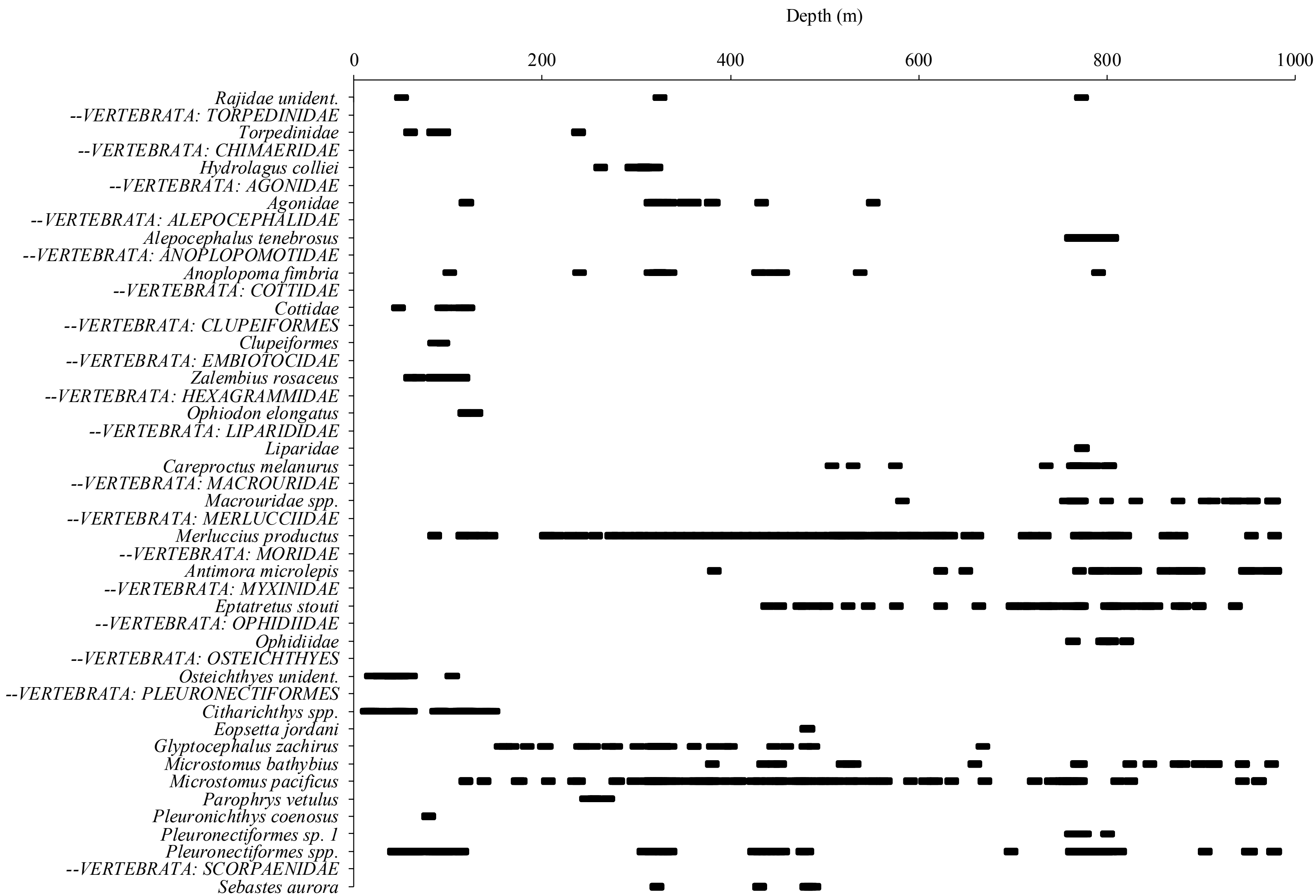


Table G-6. Continued.