INVESTIGATION OF THE MARINE COMMUNITIES OF MIDWAY HARBOR AND ADJACENT LAGOON, MIDWAY ATOLL, NORTHWESTERN HAWAIIAN ISLANDS

A report to

U.S. Fish and Wildlife Service
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Summary

A survey of the marine communities of Midway Atoll harbor and surrounding lagoon was conducted at 12 sites from September 5 to 9, 1997. The primary focus of these surveys was the invertebrates of the fouling communities present on artificial substrates. Occurrence of reef fishes at each site was also recorded, and algae was collected and identified from four stations. A total of 444 taxa were identified (47 algae, 316 invertebrates, and 81 fishes) from all stations. Approximately 250 invertebrate and 35 algae species are considered new records for Midway Atoll. All fishes observed were previously record form the atoll.

Only three invertebrates identified in this survey are considered to be nonindigenous species in the Hawaiian Islands. One introduced bryozoan, *Amathia distans,* dominated the fouling communities at most stations where artificial substrates were available. Another introduced bryozoan, *Schizoporella errata,* was also common at the same stations. A nonindigenous barnacle, *Chthamalus proteus,* recently introduced from the Caribbean, was common on pier pilings inside Midway harbor. No introduced invertebrates were present in natural habitats. The introduced snapper, *Lutjanus kasmira,* was also present along the reef outside the lagoon.

The threat to the native reef community by established nonindigenous species is considered minimal. The presence of these introduced species at Midway, especially *Chthamalus proteus,* suggests that vectors of future, potentially more deleterious introductions exist. Transport of these introductions was most likely as fouling on ship bottoms, but other sources of introductions, such as ballast water carried in ships, should be guarded against to protect the relatively pristine reefs of Midway Atoll.

Introduction

Midway is a remote Pacific atoll at the northwestern end of the Hawaiian Island chain, approximately 2800 miles west of the California coast and 2200 miles east of Japan. It is comprised of two main islands: Sand Island, which is approximately 3 square miles in area and is inhabited, and the smaller, uninhabited Eastern Island. The atoll was first recorded by western explorers in July, 1859. In 1903, Midway came under the jurisdiction of the United States Navy and has been continuously occupied since. First used as a base for trans-oceanic telephone cable operations, it came to serve as a remote, but critical base of naval operations in the years leading to World War II. In 1938, the harbor and its entrances between Sand Island and Eastern Island were dredged to allow passage of the larger naval vessels, and Midway became a base of Eastern Pacific operations from that time on. The Naval Air Station was commissioned in 1941. After World War II, the Naval facility continued to be used as an important refueling stop for both ships and aircraft. In 1997, the Navy relinquished its caretaker status to the U.S. Fish and Wildlife Service. Now managed as a wildlife refuge and eco-tourism site, it continues to be used as a port of call by both aircraft and ships, though not to the extent of former usage.

Human-mediated transportation of nonindigenous species to the atoll has resulted in the unintentional introduction and establishment of numerous terrestrial exotic species. As a result of geographic and evolutionary isolation, island ecosystems like Hawai‘i are generally thought to be more sensitive to biological invasions than continental areas, and introductions of alien species are often detrimental to native populations (Vitousek and Walker 1989). Research regarding biological introductions to Hawai‘i has placed emphasis on terrestrial and freshwater communities (Moulton and Pimm 1986), but recently, attention has focused on the occurrence of introduced species in the marine environment (Coles et al. 1997).

Studies have demonstrated the importance of ships as transport mechanisms for marine species (Carlton 1987), most significantly through bottom fouling organisms and ballast water discharge. Given Midway Atoll's lengthy history as a port of call for ships from around the world, particularly from other parts of the Pacific, it was reasonable to assume that introductions of alien species have already occurred there. Unfortunately, no base-line survey of near-shore marine invertebrates has previously been conducted for the atoll. Therefore, the extent of such introductions and their impact was unknown. An investigation of the harbor and surrounding lagoon fauna of Midway was essential for a more comprehensive understanding of the biogeography of native and nonindigenous marine organisms of the Hawaiian Archipelago.

Methods

The nearshore marine communities of Midway Harbor and the surrounding lagoon at Midway Atoll, Northwestern Hawaiian Islands were surveyed between 5 and 9 September 1997 to define the characteristics of the marine biota and detect the occurrence of nonindigenous marine invertebrates. Sampling was conducted at 12 stations around and within the atoll (Figs. 1 & 2). Benthic organisms were collected from a variety of substrata using standard collecting techniques while using snorkel or SCUBA. Sampling locations were chosen to assure that a wide range of environmental conditions were assessed. The primary focus was placed upon fouling organisms which adhere to hard artificial surfaces such as cement dock pilings, but other natural substrates were investigated as well. The infaunal and epibenthic fauna of the sediments at some stations were also sampled using a hand held coring device. Visual observations of large benthic invertebrates and fishes were also recorded at each station. Organisms collected were preserved in 70% EtOH and returned to the Bishop Museum laboratory where they were sorted and identified to the lowest taxonomic level possible. Some individuals will be sent to specialists for verification of the identifications reported here. Given the difficulty of identifying some organisms and the instability of taxonomy in general, several of the species names in this report will undoubtedly need revision.

Station descriptions

Station 1 and 2 - Inner harbor supply dock and recreational fishing/dive dock. (depth 0 -10 m)

Two concrete and wooden piers, just inside the harbor entrance to the north, protected from oceanic conditions. The marine habitats and associated invertebrates of these neighboring stations were very similar and the samples and observations were combined. Artificial substrates sampled included concrete dock pilings and a portion of the metal sheet piling present around the entire circumference of the inner harbor. The introduced bryozoan, *Amathia distans,* dominated the fouling community at these stations, especially on dock pilings. Other bryozoans, including the introduced *Schizoporella errata,* and two ascidians, *Didemnum* sp., and *Botryllus* spp., were also very abundant. *Spondylus* sp., a large native bivalve, covered the sheet piling under the docks and was present on pilings also. A few sponges, including an undescribed species in the family Chalinidae, *Mycale* sp., *Iotrochota* sp., and *Dictyodendrilla* spp., were growing on the pilings. Many reef fishes were observed around the piers. Two large schools of *Mulloidicthys vanicolensis* and *Priacanthus* sp. juveniles were present under the recreational fishing and diving pier.

Station 3 - Harbor sheet piling (depth 0 - 6 m)

Metal sheet piling along the inside of the harbor on the south side. This station had many similar fouling organisms as found on the dock pilings at Stations 1 and 2. *Amathia distans* was much less abundant, being replaced by heavy turf algal growth. The introduced barnacle, *Cthamalus proteus,* was also present in the high intertidal zone. The corals *Pocillopora meandrina* and *P. damicornis* were present below the tide line. Large *Spondylus* sp. were also common. A variety of typical small reef fishes were present along the sheet piling, including several chaetodonids and wrasses. A small seagrass bed of *Halophila hawaiiana* was found at the base of the sheet piling, just inside the harbor.

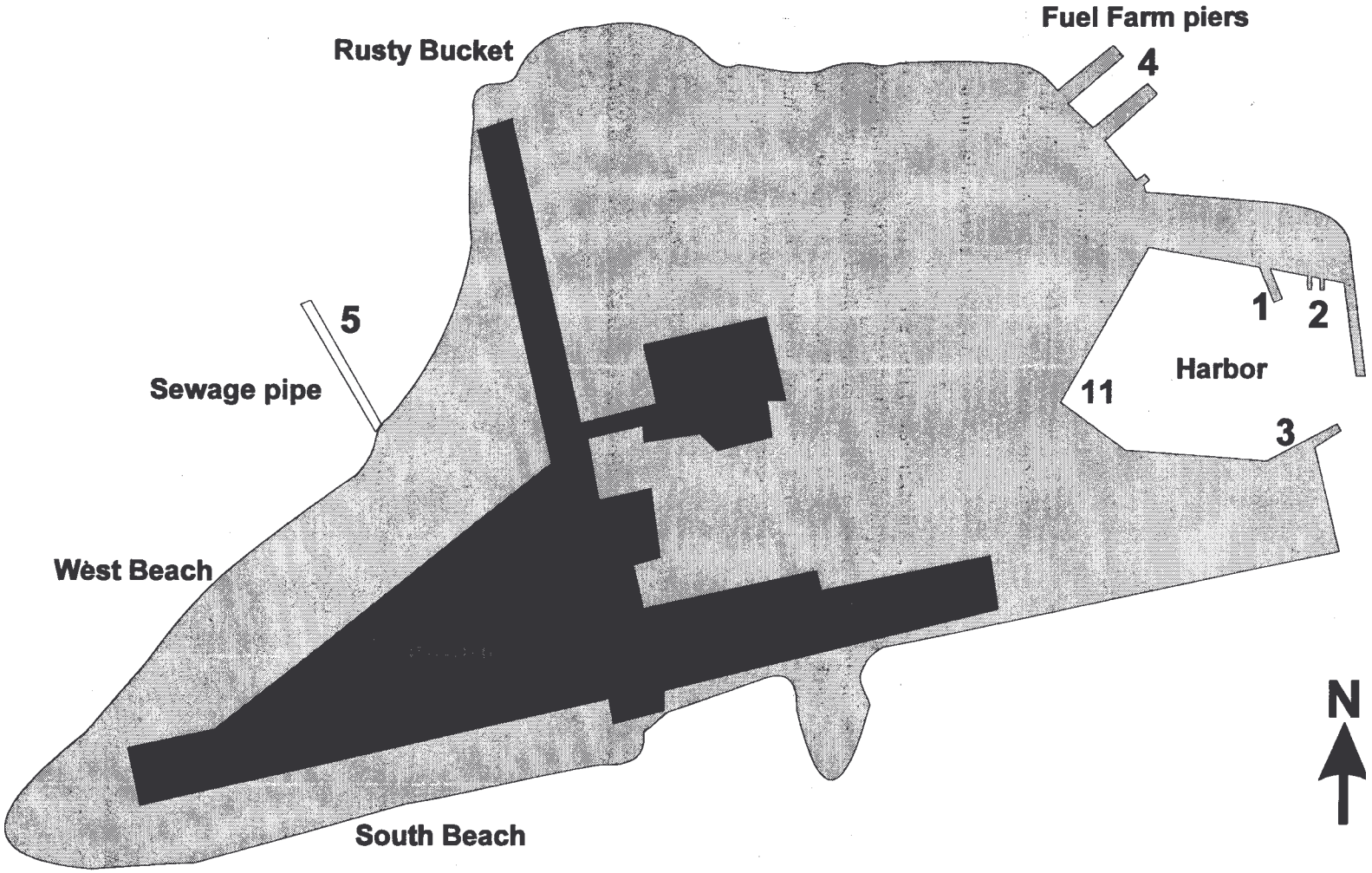

Figure 1. Map of Sand Island, Midway Atoll, Northwestern Hawaiian Islands showing locations of sampling stations 1-5. and 11.

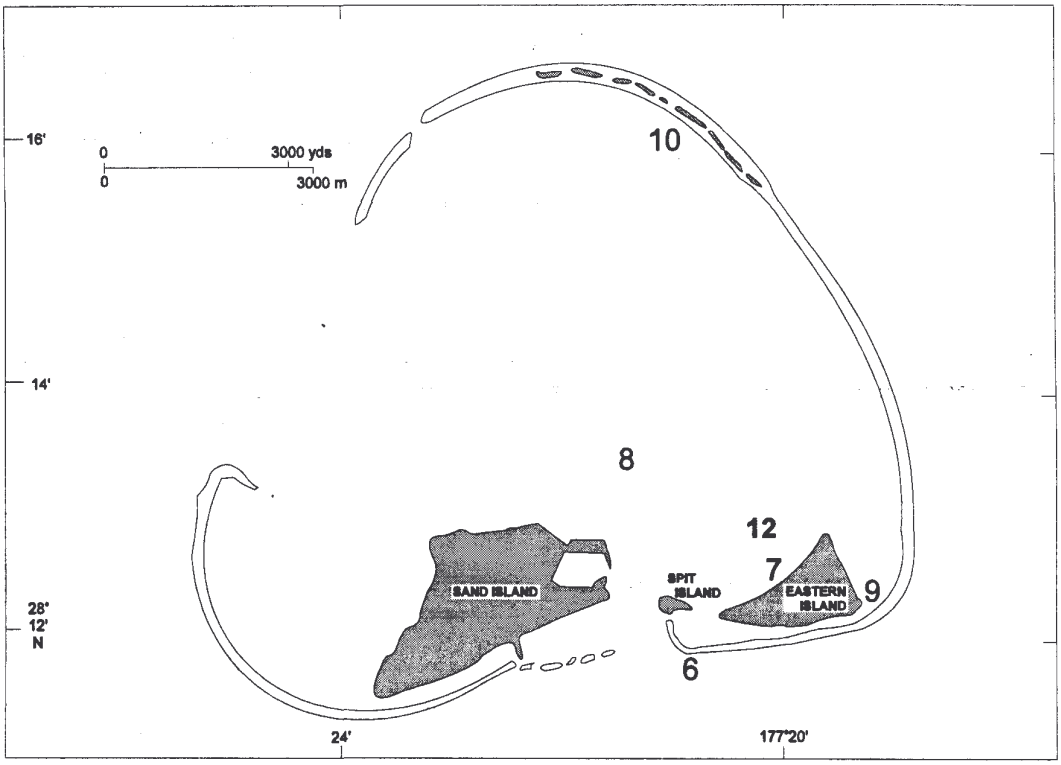

Figure 2. Map of Midway Atoll showing locations of sampling stations 6-10. and 12.

Station 4 - Fuel farm piers (depth 0 -13 m) ′

Large concrete piers on northeast corner of Sand Island used as a fueling station. The concrete pilings of this pier were heavily fouled with introduced bryozoans, primarily *Amathia distans,* with some *Schizoporella errata* as well. A large thinly encrusting red sponge, *Mycale* sp., and large *Spondylus* sp. bivalves were also abundant. *Pocillopora meandrina* and P. *damicomis* colonies were common. Schools of large fishes, such as *Kyphosis* sp., *Caranx melampygus,* and *Pseudocaranx dentex,* not observed inside the harbor, were present here.

Station 5 - West Beach sewage pipe (depth 1- 4 m)

Nonfunctional metal sewage pipe on West Beach extending to the northwest about 100m. The pipe was heavily fouled by filamentous green and brown algae. Several small lobster *(Panulirus* sp.) were found in the opening of the pipe, and *Pocillopora meandrina, P. damicomis,* and *Spondylus* sp. were the most abundant sedentary invertebrates observed along the pipe's length.

Station 6-South shore wreck (depth 5-15m)

This half-submerged barge on the reef crest near the channel entrance was free of many of the typical fouling organisms present inside the harbor. *Pocillopora meandrina* and *Porites lobata* were the most abundant sedentary invertebrates attached to the metal hull. Species richness of fishes was highest at this station. Forty-six species of fishes were observed, including the nonindigenous snapper, *Lutjanus kasmira.* A small school of medium sized sharks (~ 12 individuals, 4-6 ft.), probably *Carcharhinus galapagensis,* followed the researchers along the surface on the return swim to the boat at this station.

Station 7 - East Island pier (depth 0 - 8 m)

Small concrete and wooden dock on the north side of Eastern Island. The fouling community of this small pier on the northern side of Eastern Island was dominated by *Amathia distans* and several sponges common at inner harbor stations. Species richness of fishes was low, but a large school of juvenile *Priacanthus* sp. was present. In the unvegetated sand habitat nearby the sea cucumber, *Actinopyga obesa* was abundant. A sediment sample from the sand flats contained abundant microinvertebrates, including thousands of nematodes and *Nebalia* sp., an undescribed phyllocarid crustacean (a new record of this subclass in Hawaiian waters).

Station 8-Lagoon range marker (depth 0-10m)

Range marker to the northeast of Sand Island, surrounded by extensive sand flats and near the edge of the dredged channel that extends to the Fuel Farm. Pocilloporid corals were the dominant invertebrates growing on the concrete pilings of the range marker. The bryozoan, *Amathia distans,* and many species of algae were abundant, including *Ulva* sp.

Station 9 - East Island backreef (depth 0 - 2 m)

Off the southeast corner of Eastern Island. Habitat was a typical shallow backreef and exposed reef flat. Growth on exposed limestone was primarily algae and some coral. Shallow-water reef corals *Pocillopora meandrina, P. damicomis, Porites lobata,* and *Montipora turgescens* (a new record for Hawai‘i) were present. The sea urchin, *Heterocentrotus mammillatus,* was abundant in the backreef habitat. No artificial substrates were present at this station. Coral rubble samples were taken from backreef areas. Fish observations were not recorded at this station.

Station 10 - Reef Hotel (depth 0 - 3 m)

Shallow backreef and reef flat on far the northeast portion of the atoll. Habitats at this station included artificial and natural substrates. "Reef Hotel" is the former location of a geological field station; only the metal pole supports of the field station remain in the shallow backreef protected by an exposed bench. Metal pilings of the field station were dominated by algal mats with abundant microcrustaceans. A variety of reef-building corals were present in the surrounding habitat and on nearby reef flats, including *Montipora turgescens,* a new report for the Hawaiian Islands. Abundance and species richness of fishes were high at this site. Large scarids were abundant. While snorkeling here, one of the researchers was approached by a medium-sized monk seal. No number or distinguishing marks were observed on this individual.

Station 11 - Harbor boat ramp wrack (high tide line)

Marine plant life at the high tide mark adjacent to the boat ramp was sampled for peracarid crustaceans. Only four species were found.

Station 12-Eastern Island sand flat (3m)

Carbonate sediments on the north side of Eastern Island were also sampled to investigate peracarid crustaceans. These lagoon sediments support a diverse assemblage of 30 species of peracarids.

Discussion

Benthic macrofauna and fish surveys

The organisms observed or collected at the 12 stations of the present study are listed in Appendix A (algae), B (invertebrates), and C (fishes). A total of 444 taxa were identified (47 algae, 316 invertebrates, and 81 fishes).

Algae from four stations were collected and identified (Appendix A). Although these surveys focused on invertebrates and fishes, a number of algal species were collected, especially from inside the harbor and on the Eastern Island back reef. Forty-seven algal taxa were identified, and no introduced species of algae were found. Turf algae was dominant at many of the stations, especially on the metal sheet piling that surrounds the inner harbor (stations 1-3), and on the metal pilings at Reef Hotel (Station 10). *Falkenbergia,* actually an alternate (sporangia!) phase of *Asparagopsis taxiformis,* was the dominant component of the turfs on artificial substrates at stations 1, 3, 4, and 10. *Spyridia filamentosa* was one of the most abundant macro-algae in the harbor. Only 13 of the 47 taxa identified in this survey have been previously reported from Midway (Buggein 1965).

Arthropod crustaceans were the most diverse invertebrate group collected during this survey (Appendix B). One-hundred forty four crustacean taxa were identified (46% of total invertebrate taxa), along with 60 polychaete (20%), 50 molluscan (16%), 17 poriferan (5%), 16 cnidarian (5%), and 29 other taxa (7%). Diversity of invertebrates was highest at Station 1&2, probably due in part to increased sampling effort inside the harbor (Table 1). Number of taxa identified from additional stations was similar (50 -100 taxa), except for Station 8, where available habitat and sampling effort was low. Only peracarid crustaceans were identified from stations 11 and 12, accounting for the low number of total taxa observed.

Table 1. Occurrence of major taxonomic groups at each station (see Figs. 1 & 2 for station locations).

Taxa	1&2	3	4	5	6	7	8	9	10	11*	12*
Porifera	13	5	4	0	2	3	0	1	0	0	0
Cnidaria	6	5	5	1	4	2	4	4	9	0	0
Polychaeta	23	17	22	18	13	14	4	6	15	0	0
Sipuncula	1	2	2	0	0	0	0	0	0	0	0
Crustacea	65	30	44	50	23	23	22	46	33	4	30
Mollusca	20	19	16	4	9	6	0	3	8	0	0
Ectoprocta	9	2	2	2	0	6	1	0	0	0	0
Echinodermata	3	4	0	3	1	2	1	3	5	0	0
Ascidacea	5	2	3	0	1	3	0	0	0	0	0
Total	145	86	98	78	53	59	32	63	70	4	30

* Only peracarid crustaceans were identified from stations 11 and 12.

Given the difficulty of identifying many of the invertebrates collected to species (esp. sponges and polychaetes), it is impossible to estimate the exact number of new species records for Midway as a result of this survey in this report. Many individuals could not be identified to species and are being sent to specialists for determination. Apparently there has been no systematic marine invertebrate survey of Midway conducted prior to this survey. A search of the Bishop Museum invertebrate collection uncovered 85 invertebrate taxa previously reported from Midway (Appendix D). The majority of the scattered collections previous to 1997 were made between 1920 and 1965. Since 1965, only 4 individual specimens have been collected and placed in the Bishop Museum collection. Sixteen of these species in Appendix D were recollected in the 1997 surveys, but numerous individuals not identified to species were not considered in this count. Approximately 250 of the invertebrate taxa found in this survey may be new reports for Midway Atoll.

Artificial substrates surveyed were densely colonized with a diverse fouling community. Some of the taxa that compose the fouling communities on artificial substrates in Midway are found in harbors throughout the Hawaiian Islands. The concrete and wood pilings of the inner harbor piers (Station 1&2) and the fuel docks (Station 4) supported the highest diversity of organisms in the survey. The inner harbor metal sheet piling (Station 3) also supported a diverse fouling community. Forty-two of the species found at Station 1&2 (30%), 32 at Station 3 (37%), and 25 at Station 4 (25%) were also reported from Pearl Harbor, Oahu in a recent survey of fouling organisms there (Coles et al. 1997). The dominant member of the fouling communities at Midway was *Amathia distans,* an introduced colonial bryozoan, which formed conspicuous masses on all artificial substrates surveyed. *Amathia distans* is frequently encountered in harbors throughout Hawai‘i, and large colonies like those observed at Midway are found in Pearl and Honolulu harbors.

Dock and sheet pilings also had populations of the Caribbean barnacle, *Chthamalus proteus.* The first official record of this species in the Hawaiian Islands was in Pearl Harbor in 1996, but it has since been reported throughout the main Hawaiian Islands, from Hilo Harbor north. It is believed that the species has been transported through the island chain on the hulls of ships and boats.

Reef communities at Midway appeared to be less diverse than comparable communities elsewhere in the island chain, a phenomenon that can be attributed to the high latitude at which the atoll lies (Midway lies close to the northernmost boundary of occurrence for hermatypic corals). Coral cover(< 20%) and species richness was low. The greatest diversity and abundance of reef corals occurred at "Reef Hotel" (Station 10). Coral species common elsewhere in Hawai‘i were observed here, such as *Montipora verrucosa, Pocillopora meandrina, P. damicomis, Porites lobata,* but the area was also widely colonized by *Montipora turgescens,* a species previously unrecorded in the Hawaiian Archipelago (Coles, in press).

Soft substrates were sampled within the harbor, at various points around Sand Island, and at Eastern Island. These are highly variable in structure - some were bare coral sands and muds, some had small but stable seagrasses beds *(Halophila hawaiiana),* while others were covered with drifts of algal detritus. Almost all sediment types were characterized by very large communities of benthic crustaceans, such as amphipods, isopods and tanaids (see Appendix B). These communities are similar in specific structure to those encountered in similar habitats elsewhere in Hawai‘i, with the

exception of a phyllocarid crustacean which has not been previously recorded in the Hawaiian Islands *(Nebalia* sp.). This was found in samples throughout the lagoon, but was most commonly occurred at Eastern Island, associated with drifts of algae. While it has not yet been identified to specific level, it is not considered to be an introduced species. (E. Vetter pers. *comm.).*

Eighty-one taxa of fishes were observed at stations 1-10. Diversity of fishes was highest at stations 4, 6, and 10 (Appendix C). A total of 258 species of reef fishes are known from Midway, and all fishes observed during this survey have been previously reported (Randall et al. 1993). In general, the reef habitats around Midway support a high biomass of fishes relative to the main Hawaiian Islands. Most fishes are also uncharacteristically unafraid of scuba divers, probably due to the limited spear fishing conducted at this remote location. Our observations agree with those of Randall et al. (1993). Sharks, probably *Carcharhinus galapagensis,* were common outside the lagoon, especially near the barge wreck on the reef near the channel entrance (Station 6). At this station, a school of approximately 15 sharks (2 m length) congregated around the dive boat before the dive and closely followed divers along the surface on the return swim to the boat after the dive. Randall et al. (1993) reported similar behavior by Galapagos sharks at Midway. The introduced snapper, *Lutjanus kasmira,* was present at Station 6.

Nonindigenous species

Only three invertebrates identified in this survey are considered to be nonindigenous species in the Hawaiian Islands. One introduced bryozoan, *Amathia distans,* dominated the fouling communities at most stations where artificial substrates were available. Another introduced bryozoan, *Schizoporella errata,* was also common at the same stations. A nonindigenous barnacle, *Chthamalus proteus,* recently introduced from the Caribbean, was common inside Midway harbor. These sedentary invertebrates are abundant in harbors throughout the Hawaiian Islands but do not appear to threaten reef systems where they occur. No introduced invertebrates were present on natural substrates.

The threat to the reef ecosystem by established nonindigenous invertebrates at Midway Atoll is minimal. However, despite the benign nature of these introduced species, their presence at Midway suggests that vectors of future, potentially more deleterious introductions exist. The best example of this potential is the presence of *Chthamalus proteus* at Midway. This Caribbean barnacle did not occur in Hawai‘i until the mid-1970s. Since it's introduction, it has spread throughout the Hawaiian Islands, and has also been recently reported from Guam. The mechanism of these introductions, and introductions to Midway, was most likely as fouling on ship bottoms. Other sources of introductions, such as ballast water carried in ships, should also be guarded against to protect the relatively pristine reefs of Midway Atoll.

Future work

The marine biodiversity of the Northwestern Hawaiian Islands (NWHI) is poorly understood. The discovery of the reef coral *Montipora turgescens* at Midway illustrates the lack of basic survey work done there. *M. turgescens,* previously unknown from Hawaii, was one of the most common corals on the shallow reef of the eastern lagoon (Coles in press). In the short duration of this study, and limited habitats sampled, the number of invertebrates and algae known from Midway was increased from about 100 species to nearly 400. A number of these species may prove to be new records for the Hawaiian Islands, and several are undescribed species. In order to fully understand the biodiversity of the Hawaiian Archipelago, basic and comprehensive surveys must be made in the NWHI. The infrastructure in place at Midway Atoll presents researchers with a unique opportunity to investigate a protected, pristine reef ecosystem, and a surveys of the marine communities of the NWHI should be initiated there.

Literature Cited

Buggein, R.G. 1965. A preliminary list of the algal flora of the Midways Islands. Atoll Res. Bull. 109: 1-11.

Canton, J.T. 1987. Patterns of transoceanic marine biological invasions in the Pacific Ocean. Bull. Mar.Sci. 41(2): 452-465.

Coles, S.L. 1998. First record of the reef coral *Montipora turgescens* Bernard, 1897 in Hawai'i (Cnidaria: Anthozoa: Scleractina). Bishop Mus. Occ. Papers 56:60-62.

Coles, S.L., R.C. DeFelice, L.G. Eldredge, and J.T. Carlton. 1997. Biodiversity of marine communities in Pearl Harbor, Oahu, Hawai'i with observations on introduced species. Dept. of Defense Legacy Project No. 109. Bishop Museum Tech. Report No. 10. 76 pp.

Moulton, M.P., and S.L. Pimm. 1986. Species introduction to Hawaii. *In* Mooney, H.A. and J.A. Drake (eds.), Ecology of Biological Invasions of North America and Hawaii. Ecol. Stud. vol. 58. Springer-Verlag, NY. p. 231-249.

Randall, J.E., J.L. Earle, R.L. Pyle, J.D. Parrish, and T. Hayes. 1993. Annotated checklist of the fishes of Midway Atoll, Northwestern Hawaiian Islands. Pac. Sci. 47: 356-400.

Vitousek, P.M., and L.R. Walker. 1989. Biological invasions by *Myrica faya* in Hawaii: plant demography, nitrogen fixation, ecosystem effects. Ecol. Monogr. 59: 247-265.

Appendix A. Occurrence of algae at four stations at Midway Atoll (see Fig. 1 & 2 for station locations).

Midway Inner Harbor (Stations 1 & 2)

Chlorophyta
Boodlea composita
Cladophora laetivirens
Halimeda sp.
Microdictyon setchellianum

Phaeophyta
Dictyota acutiloba
Padina sp.
Stypopodium hawaiiensis

Rhodophyta
Acrochaetium sp.
Centroceras clavulatum Ceramium fimbhatum
Chondria sp.
Falkenbergia[1]
Griffisthia metcalfii
Herposiphonia sp.
Hypnea chordacea
Galaxaura sp.
Jania sp.
Laurencia molokiniensis
Larencia nidifica
Laurencia sp. 1
Laurencia sp. 2
Laurencia sp. 3
Polysiphonia sp.
Spyridia filamentosa

Fuel Docks (Station 4)

Chlorophyta
Cladophora socialis
Codium arabicum

Phaeophyta
Lobophora variegata

Rhodophyta
Antithamnion antilanum
*Falkenbergia*1
Jania sp.
Laurencia succisa Spermothamnion sp.

Eastern Island backreef (Station 9)

Chlorophyta
Caulerpa racemosa
Halimeda sp.
Microdictyon setchellianum

Phaeophyta
Dictyota crenulata
Dictyota friabilis
Lobophora variegata
Sargassum polyphyllum
Sphacelaria novaehollandiae
Stypopodium hawaiiensis
Turbinaha ornata

Rhodophyta
Arthrocardia prolifera
Centroceras minutum
Ceramium sp.
Corallina elongata
Griffisthia heteromorpha
Herposiphonia crassa
Jania sp.
Laurencia majuscula
Laurencia nidifica
Polysiphonia sp.

Reef Hotel (Station 10)

Chlorophyta
Halimeda sp.

Phaeophyta
Dictyota acutiloba

Rhodophyta
Centroceras clavulatum
Ceramium sp.
*Falkenbergia^*
Herposiphonia sp.
Hypnea valentiae
Jania sp.
Polysiphonia sp.
Taenioma perpusillum

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[1] *Falkenbergia* is the sporangial stage of *Asparagopsis taxiformis.*

Appendix B. Occurrence of invertebrate taxa by station number (see Fig. 1 & 2 for station locations).

Taxa	1&2	3	4	5	6	7	8	9	10	11	12
PORIFERA											
Calcarea											
Heteropiidae											
Heteropia glomerosa (Bowerbank 1873)	x	x				x					
Leucettidae											
Leucetta sp.	x										
Demospongiae											
Callyspongiidae											
Callyspongia sp.								x			
Chalinidae											
chalinid n.g. n.sp.	x										
Chondrillidae											
Chondrosia chucalla de Laubenfels,					x						
Clionidae											
Cliona sp.	x	x									
Darwinellidae											
Aplysilla rosea (Barrios, 1876)	x										
Chelonaplysilla violacea (Lendenfeld, 1883)	x	x	x								
Dictyodendrillidae											
Dictyodendnlla sp. 1	x	x				x					
Dictyodendrilla sp. 2	x										
Dysideidae											
Dysidea sp.			x								
Haliclonidae											
Haliclona sp.	x										
Mycalidae											
Mycale sp. 1	x	x	x			x					
Myxillidae											
lotrochota sp.	x										
Suberitidae											
unid. suberitid	x		x								
Tethyidae											
Tethya sp.	x										
Thorectidae											
Cacospongia sp.						x					
CNIDARIA											
Hydroida											
Sertulariidae											
Dynamena sp.	x	x	x			x					
Haleciidae											
Halecium sp.	x		x								
Sertulariidae											
Sertularia sp.		x	x								
unid. hydroid							x				
Anthozoa											
Acroporidae											
Montipora capitata (Lamarck, 1816)									x		
Montipora turgescens Ehrenberg, 1834									x		
Agariciidae											
Pavona duerdeni Vaughan, 1907											

Appendix B (con.). Occurrence of invertebrate taxa by station number.

Taxa	1,2	3	4	b	6	7	8	9	10	11	121
Anthozoa (con.)											
Dendrophyllidae											
Tubastrea coccinea Lesson, 1831					x						
Faviidae											
Cyphastrea ocellina Dana, 1846								x	x		
Leptastrea purpurea Dana, 1846					x						
Pocilloporidae											
Pocillopora damicornis Linnaeus, 1758	x	x	x			x	x	x	x		
Pocillopora meandhna Dana, 1846	x	x	x	x	x		x	x	x		
Poritidae											
Pontes lobata Dana, 1846	x	x			x		x	x	x		
Zoanthidae											
Palythoa tuberculosa (Esper, 1791)									x		
Zoanthus sp.									x		
ANNELIDA											
Polychaeta											
Amphinomidae											
Eurythoe complanata (Pallas, 1766)		x									
Capitellidae											
unid. capitellid				x							
Chaetopteridae											
Chaetopterus sp.		x				x					
Chrysopetalidae											
Paleanotus sp.				x							
Cirratulidae											
unid. cirratulid									x		
Dorvilleidae											
unid. dorvillid		x	x	x		x					
Eunicidae											
Eunice cariboea Grube, 1856		x							x		
Eunice sp. 1			x								
Eunice sp. 2	x				x						
Eunice vittata (delle Chiaje, 1828)		x									
Eunice sp.		x									
Lysidice ninetta Audouin & M. Edwards, 1833	x	x	x	x	x			x	x		
Lysidice sp.									x		
Nematonereis unicomis Schmarda, 1861	x	x	x	x	x				x		
Palola siciliensis (Grube, 1840)								x			
Glyceridae											
Glycera tesselata Grube, 1863								x			
Hesionidae											
unid. hesionid	x										
Lumbrineridae											
Lumbrineris dentata Hartmann-Schroder, 1965									x		
Lumbrineris inflata Moore, 1911	x	x	x								
Lumbrineris sphaerocephala (Schmarda, 1861)					x						
Lumbrineris sp.				x		x					

Appendix B (con.). Occurrence of invertebrate taxa by station number.

Taxa	1,2	3	4	5	6	7	8	9	10	11	12
Polychaeta (con.)											
Nereidae											
Perinereis curvata Holly, 1935					x						
Platynereis pulchella Gravier, 1901	x										
nereid sp. 1						x	x				
nereid sp. 2	x										
nereid sp. 3	x										
unid. nereids ,				x		x	x		x		
Onuphidae i											
Diopatra sp.		x		x							
Opheliidae											
Armandia intermedia Fauvel, 1902	x			x		x					
Polyophthalmus pictus Dujardin, 1839	x		x	x		x			x		
Phyllodocidae											
unid. phyllodocid						x			x		
Polynoidae											
Iphione muricata (Savigny, 1818)								x			
Thormora atrata (Treadwell, 1940)								x			
Sabellidae											
Branchiomma nigromaculata (Baird, 1865)	x	x	x		x	x					
Sabellastarte spectabilis (Grube, 1878)	x		x								
unid. sabellid	x										
Serpulidae											
Hydroides branchyacantha Rioja, 1941	x	x	x								
Hydroides elegans (Haswell, 1883)	x										
Hydroides sp. 1			x								
Spirobranchus corniculatus (Grube, 1862)	x		x		x		x				
Vermiliopsis sp.	x										
Vermiliopsis torquata Treadwell, 1943			x								
Spirorbidae											
unid. spirorbid	x										
Syllidae											
Brachiosyllis exilis (Gravier, 1900)	x	x	x	x					x		
Exogone verugera (Claparede, 1868)		x		x	x	x					
Trypanosyllis zebra (Grube, 1860)	x				x						
Typosyllis hyalina (Grube, 1863)		x									
syllid sp. 1	x		x								
syllid sp. 2	x		x	x	x	x					
syllid sp. 3			x	x					x		
syllid sp. 4	x		x		x						
syllid sp. 6			x	x		x					
syllid sp. 7			x	x							
syllid sp. 8									x		
syllid sp. 9									x		
syllid sp. 10				x		x					
unid. syllids	x	x	x	x	x	x	x	x	x		
Terebellidae											
Nicolea gracilibranchis Grube, 1878			x								
Thelepus setosus (Quatrefages, 1865)			x								
unid. terebellid		x									

Appendix B (con.). Occurrence of invertebrate taxa by station number.

Taxa	1,2	3	4	5	6	7	8	9	10	11	12
SIPUNCULA											
Phascolosomatidae											
Phasclosoma nigrescens Keferstein, 1865		x	x								
Phasclosoma stephensoni (Stephen, 1942)	x	x	x								
ARTHROPODA											
Pycnogonida											
unid. pycnogonid	x					x			x		
Cirripedia											
Balanidae											
Megabalanus tanagrae (Pilsbry, 1928)	x	x	x			x			x		
Chthamalidae											
Chthamalus proteus Dando & Southward, 1980	x	x									
Brachyura											
Dynomeniidae											
Dynomene sp.	x										
Majidae											
Perinea tumida Dana, 1852	x		x					x			
Schizophrys hilensis Rathbun, 1906	x		x	x		x					
Menaethius monoceros (Latreille, 1825)									x		
unid. majid								x			
Portunidae											
Thalamita Integra Dana, 1852	x					x					
Thalamita admete (Herbst, 1803)			x				x				
Thalamita sp (juv.)				x							
Portunus sp. (juv.)									x		
Trapeziidae											
Trapezia tigrina Eydoux & Souleyet, 1842			x								
Xanthidae											
Chlorodiella laevissima (Dana, 1852)	x	x	x	x				x			
Chlorodiella cytherea (Dana, 1852)	x										
Liocarpilodes integerrimus Dana, 1852			x								
Liomera supemodosus Rathbun, 1906	x										
Liomera bella (Dana, 1852)	x		x	x		x					
Liomera rugata (H. Milne-Edwards, 1834)			x								
Paractaea rufopunctata Guinot, 1969	x										
Phymodius nitidus (Dana, 1852)	x										
Phymodius sp.	x		x								
Pilodius flavus Rathbun, 1893	x	x		x							
Pilodius areolatus (H. Milne-Edwards, 1834)				x							
Platypodia semigranosa (Heller, 1861)	x										
Platypodia eydouxii (A. Milne-Edwards, 1865)	x	x	x			x					
Platypodia actoeoides (A. Milne-Edwards,	x										
Platypodia sp. (juv.)				x							
*Pseudoliomera speciosa (*Dana*,* 1852)	x										
Pseudoliomera variolosa (Borradaile, 1902)	x		x								
Tweedieia laysani (Rathbun, 1906)	x		x								
unid. xanthid								x			

Appendix B (con.). Occurrence of invertebrate taxa by station number.

Taxa	1,2	3	4	b	6	7	8	9	10	11	12
Reptantia											
Callianassidae											
Callianassa sp.				x							
Diogenidae											
Calcinus sp.						x					
Galatheidae											
Galathea spinosorostris Dana, 1852	x	x	x								
Porcellanidae											
Pachycheles pisoides (Heller, 1865) I	x	x	x					x			
Natantia											
Alpheidae											
Alpheus arimantel Coutiere, 1908	x										
Alpheus clypeatus Coutiere, 1905	x	x	x								
Alpheus collumanius Stimpson, 1860		x		x				x	^x		
Alpheus diadema Dana, 1852	x										
Alpheus gracilipes Heller, 1861		x									
Alpheus nanus (Banner, 1953)	x										
Alpheus paracrinatus Miers, 1881		x									
Alpheus pugnax Dana, 1852		x									
Alpheus rapax Fabricus, 1789		x									
Alpheus sp.				x							
Metalpheus hawaiiensis (Edmondson, 1925)	x		x	x							
Metalpheus paragracilis (Coutiere, 1898)	x	x	x	x		x		x	x		
Synalpheus charon Heller, 1861	x										
Synalpheus paraneomeris (Coutiere, 1905)	x							x			
unid. alpheids	x	x	x	x	x	x	x	x	x		
Hippolytidae											
Saron marmoratus (Olivier, 1818)			x								
Thor maldivensis Borradaile, 1915			x								
Thor paschalis (Heller, 1862)			x								
Thor sp.			x				x				
Palaemoninae											
Palaemon pacificus Stimpson, 1860	x										
Palinuridae											
Panulirus sp.	x			x							
Pontoniinae											
Periclimenaeus quadridentatus (Rathbun.1906)			x				x				
Periclimenes pusillus Rathbun, 1906			x								
Rhynchocinetidae											
Rhynchocinetes rugulosus Stimpson, 1860							x				
Stenopodidae											
Stenopus hispidus (Olivier, 1811)	x										
unid. shrimp				x			x				
Amphipoda											
Amphilochidae											
Amphilocus likelike Barnard, 1970			x	x		x	x	x	x		x
Amphilocus menehune Barnard, 1970	x		x	x	x	x	x		x		x
Gitanopsis pele Barnard, 1970								x			

Appendix B (con.). Occurrence of invertebrate taxa by station number.

Taxa	1,2	3	4	5	6	7	8	9	10	11	12
Amphipoda (con.)											
Ampithoidae											
Ampithoe kaneohe Barnard, 1970								x			x
Ampithoe poipu (Kroyer, 1945)									x		
Ampithoe akuolaka Barnard, 1970									x		
Ampithoe rarnondi Audouin, 1826	x	x	x	x	x	x	x	x			
Ampithoe sp. Barnard, 1970				x	x		x		x		x
Ampithoe waialua Barnard, 1970	x	x	x	x							
Cymadusa filosa Savigny, 1816	x	x	x						x		
Cymadusa hawaiiensis Schellenberg, 1938				x	x		x	x	x		x
Cymadusa oceanica Barnard, 1955	x			x			x				
Paragrubia vorax Chevreux, 1901	x	x		x			x	x	x		x
Anamixidae											
Anamixis stebbingi Walker, 1904	x		x				x				
Aoridae											
Aloiloinenue Barnard, 1970	x			x							
Aorides columbiae Walker, 1898				x				x			x
Aorides nahili Barnard, 1970				x	x			x	x		x
Bemlos aequimanus (Schellenberg, 1938)				x							
Bemlos intermedius (Schellenberg, 1938)				x							
Bemlos pualani (Barnard, 1955)				x							
Bemlos waipio (Barnard, 1970)						x					
Bemlos sp.					x				x		
Caprellidae											
unid. caprellids				x	x			x	x		
Colomastigidae											
Colomastix pusilla Grube, 1864	x		x			x					
Corophiidae											
Corophium insidiosum Crawford, 1937	x		x			x					
Erichthonius braziliensis (Dana, 1853)	x		x			x		x			
Eusiridae											
Eursiroides diplonyx Walker, 1909				x	x						
Pontogeneia pacifica Schellenburg, 1938								x			x
Isaeidae											
Gammaropsis alamoana Barnard, 1970	x										x
Gammaropsis atlantica Stebbing, 1888	x		x	x	x			x			
Gammaropsis kaumaka Barnard, 1970							x	x			
Gammaropsis pali Barnard, 1970	x			x				x			
Gammaropsis sp.	x		x		x			x			
Ischyroceridae											
Ischyrocerus kapu Barnard, 1970	x				x						
Ventojassa ventosa (Barnard, 1962)					x						
Leucothoidae											
Leucothoe hyhelia Barnard, 1970	x		x		x	x	x				x
Leucothoe lihue Barnard, 1962	x										
Leucothoe sp. Barnard, 1965									x		x
Leucothoides pottsi Barnard, 1970	x		x			x	x	x			x
Liljeborgiidae											
Liljeborgia heeia Barnard, 1970				x							

Appendix B (con.). Occurrence of invertebrate taxa by station number.

Taxa	1,2	3	4	5	6 I	7	8	9	10	11	12
Amphipoda (con.)											
Lysianassidae											
Lysianassa ewa Shoemaker, 1933	x	x	x	x					x		
Lysianassa sp. Barnard, 1970	x	x	x	x					x		
Melitidae											
Ceradocus hawaiiensis Barnard, 1955				x							
Elasmopus ecuad. hawaiiensis Schell., 1938								x			
Elasmopus hooheno Barnard, 1976				x							
Elasmopus rapax Costa, 1853	x		x		x	x		x	x		x
Elasmopus spinidactylus Chevreux, 1908											x
Eriopisella sechellensis upolu Barnard, 1970								x	x		x
Maera pacifica Schellenberg, 1938	x	x		x	x			x	x		x
Maera quadrimana (Dana, 1853)	x			x							
Maera sp.											x
Mallacoota insignis (Chevreux, 1901)									x		
Paradexaminidae											
Paradexamine maunaloa Barnard, 1970		x			x			x	x		
Phoxocephalidae											
Proharpinia sp.											x
Podoceridae											
Podoceros hanapepe Barnard, 1970											x
Podoceros talegus lawai Barnard, 1970	x						x	x			
Seba ekepuu Barnard, 1970									x		
Stenothoidae											
Stenothoe haleloke Barnard, 1970				x			x	x			x
Stenothoe valida Dana, 1853					x						
Talitrioidea											
Hyale grandicomis bishopae Barnard, 1970									x	x	
Hyale honoluluensis Dana, 1853								x	x		
Hyale iole Barnard, 1970										x	
Hyale laie Barnard, 1970	x	x							x		
Parhylalella sp.								x			
Isopoda											
Anthuridae											
Mesanthura hieroglyphica Miller, 1940	x										
Paranthura sp. Miller, 1940	x	x		x					x		
Cirolanidae											
Exocorallana? sp.	x			x				x			x
Janiridae											
Carpias algicola (Miller, 1940)	x	x	x	x	x	x	x	x			x
Stenetrium medipacificum (Miller, 1940)								x			
Joeropsidae											
Joeropsis hawaiiensis (Miller, 1940)		x		x	x	x		x			x
Joeropsis sp.		x						x	x		
Munnidae											
Munna acarina Miller, 1940			x								
Oniscidea											
Armadilloniscus hawaiianus Taiti & Ferrara,l989										x	
Haplophiloscia laevis Schultz, 1973										x	

Appendix B (con.). Occurrence of invertebrate taxa by station number.

Taxa	1,2	3	4	5	6	7	8	9	10	11	12
Isopoda (con.)											
Sphaeromidae											
unid. spheromids				x				x	x		x
Tanaidacea											
Apseudidae											
Apseudes n.sp.								x			
Apseudes tropicalis Miller, 1940	x	x		x				x			
Synapseudes minutus Miller, 1940		x			x		x	x	x		x
Paratanaidae											
Leptochelia dubia (Kroyer, 1842)	x	x	x		x	x	x	x	x		x
Tanaidae											
Anatanais insularis Miller, 1946	x	x		x	x	x		x			x
Parapseudes neglectus Miller, 1940			x	x		x		x			x
MOLLUSCA											
Gastropoda											
Atyidae											
Atys semistriata Pease, 1860		x			x	x					
Haminoea crocata Pease, 1860		x			x	x					
Haminoea curta A. Adams, 1850	x										
Haminoea cymbalum (Quoy & Gaimard, 1835)			x	x					x		
unid. atyid	x										
Calyptraeidae											
Crepidula aculeata (Gmelin, 1791)			x			x					
Cerithiidae											
Bittium parcum (Gould, 1861)				x							
Bittium zebrum (Kiener, 1841)									x		
Columbellidae											
Anachis miser (Sowerby, 1844)	x	x	x								
Anachis sp.						x					
Euplica varians (Sowerby, 1832)		x	x	x				x	x		
Euplica sp.	x	x	x								
Mitrella fusiformis (Pease, 1868)		x									
Conidae											
Conus sp.		x									
Cypraeidae											
Cypraea fimbriata Gmelin, 1791	x	x									
Eulimidae											
unid. eulimid											
Fasciolariidae											
Peristernia squamosa (Pease, 1863)	x	x	x								
Fissurellidae											
Diodora granifera (Pease, 1861)	x										
Diodora sp.					x						
Littorinidae											
Littorina pintado (Wood, 1828)		x									
Neritidae											
Nerita sp.		x									
Nerita plicata Linnaeus, 1758		x									

Appendix B (con.). Occurrence of invertebrate taxa by station number.

Taxa	1,2	3	4	5	6	7	8	9	101	11	12
Gastropoda (con.)											
Patellidae											
Cellana exarata (Reeve, 1854)			x								
Phasianellidae											
Tricolia (Hiloa) variabilis (Pease, 1861)								x	x		
Scaphandridae					.						
Acteocina hawaiensis Pilsbry, 1921		x									
Stomatellidae											
Synaptocochlea concinna (Gould, 1845)					x						
Thaididae											
Maculotriton bracteatus (Hinds, 1844)	x	x									
Morula foliacea (Conrad, 1837)	x		x								
Morula uva Roding, 1798					x						
Morula sp.		x	x								
Vexilla fusconigra Pease, 1860	x										
Triphoridae											
Triphora thaanumi Kay, 1979					x						
Triviidae											
Erato sandwicensis Pease, 1860		x	x	x	x	x			x		
Trochidae											
Trochus intextus Kiener, 1850									x		
Turridae											
Tritonoturris sp.	x		x								
Vermetidae											
Vermetus alii Hadfield and Kay, 1972	x		x								
unid. vermetid	x	x									
Sacoglossa											
Plakobranchidae											
Plakobranchus ocellatus van Hasselt, 1824	x										
Nudibranchia											
Doridacea											
unid. dorid	x										
Bivalvia											
Arcidae											
Barbatia nuttingi Dall et al., 1938					x			x	x		
Chamidae											
Chama iostoma Conrad, 1837			x								
Isognomidae											
Isognomon perna Linnaeus, 1767	x										
Lasaeidae											
unid. lasaeid									x		
Mytilidae											
Lithophaga fasciola Dall et al., 1938											
Ostreidae					x						
Ostrea hanleyana Sowerby, 1871	x										
Ostrea ?sandvichensis Sowerby, 1871		x									
Pectinidae											
Chlamys sp.	x		x								

Appendix B (con.). Occurrence of invertebrate taxa by station number.

Taxa	1,2	3	4	5	6	7	8	9	10	11	12
Bivalvia (con.)											
Pteriidae											
Pinctada radiata Leach, 1814	x		x								
Spondylidae											
Spondylus tenebrosus Reeve, 1856 i	x	x	x			x					
ECTOPROCTA											
Bugulidae											
Bugula sp.						x					
Crisiidae											
Crisia circinata Waters, 1914	x										
Diaperoeciidae											
Diaperoecia sp.	x										
Savignyellidae											
Savignyella lafontii Audouin, 1826	x					x					
Schizoporellidae											
Schizoporella errata (Waters, 1878)	x	x	x			x					
Scrupocellariidae											
Scrupocellaria sinuosa Canu and Bassler, 1927	x										
Vesiculariidae											
Amathia distans Busk, 1886	x	x	x	x		x					
Zoobotryon verticillatum (delle Chiaje, 1828)	x			x		x	x				
Watersiporidae											
Watersipora sp.	x					x					
unid. bryozoan	x										
ECHINODERMATA											
Asteroidea											
Acanthasteridae											
Acanthaster planci Linnaeus, 1758					x						
Echinoidea											
Diadematidae											
Diadema paucispinum Leske, 1778		x									
Echinothrix ?calamaris Pallas, 1774	x										
Echinometridae											
Echinometra mathaei Blainville, 1825	x	x		x			x	x	x		
Heterocentrotus mammillatus Linnaeus, 1758								x	x		
Holothuroidea											
Holothuridae											
Actinopyga obesa Selenka, 1867		x				x			x		
Holothuria atra Jager, 1833	x			x					x		
Ophiuroidea											
unid. ophiuroids		x		x		x		x	x		
CHORDATA											
Ascidacea											
Ascidiidae											
Ascidia sydneiensis Stimpson, 1855	x										
Didemnidae											
Didemnum sp. 1 (white)	x	x	x		x	x					
Trididemnum ?profundum (Sluiter, 1909)	x										
unid. didemnid	x		x								

Appendix B (con.). Occurrence of invertebrate taxa by station number.

Taxa	1,2	3	4	5	6	7	8	9	10	11	12
Polyclinidae											
Polyclinum constellatum Savigny, 1816		x				x					
Polyclinum ?*vasculosum* Pizon, 1908											
Pyuridae											
Herdmania momus (Savigny, 1816)						x					
unid. pyurid											
Styelidae											
Botryllus sp.	x										
Symplegma oceania Tokioka, 1961			x								
Total taxa	145	86	98	78	CO	59	32	63	70	4	30

Note: Only peracarid crustaceans were identified from stations 11 and 12.

Appendix C. Occurrence of fishes by station number at Midway Atoll (see Fig. 1 & 2).

Taxa	1,2	3	4	5	6	7	8	10
Carcharhinidae								
Carcharhinus galapagensis (Snodgrass & Heller, 1905)					x			
Muraenidae								
Anarchias seychellensis (Smith, 1862)	x							
Gymnothorax flavimarginatus (Rüppell, 1828)			x					
Hemiramphidae								
Hyporamphus acutus pacificus (Steindachner, 1900)						x		
Holocentridae								
Myripristis sp.			x		x			x
Sargocentron sp.								x
Aulostomidae								
Aulostomus chinensis (Linnaeus, 1766)			x					
Scorpaenidae								
Pterois sphex Jordan & Evermann, 1903		x	x		x		x	
Kuhliidae								
Kuhlia sandvicensis (Steindachner, 1876)	x				x			x
Priacanthidae								
Priacanthus meeki Jenkins, 1903	x	x	x		x	x	x	
Cirrhitidae								
Chellodactylus vittatus Garrett, 1864	x		x		x			x
Cirrhiitus pinnulatus (Bloch & Schneider, 1801)	x				x			x
Paracirrhites fbrsteri (Bloch & Schneider, 1801)		x			x		x	x
Apogonidae								
Apogon sp.						x		
Foa brachygramma (Jenkins, 1903)				x				
Carangidae								
Caranx melampygus Cuvier & Valenciennes, 1833			x					
Pseudocamx dentex (Bloch & Schneider, 1801)			x					
Seriola dumerili (Risso, 1810)	x							
Lutjanidae								
Lutjanus kasmira (Forsskål, 1775)					x			
Mullidae								
Mulloidichthys flavolineatus (Lacépède, 1801)				x				x
Mulloidichthys vanicolensis (Valenciennes, 1831)	x	x	x	x	x	x		x
Parupeneus bifasciatus (Lacépède. 1801)			x	x			x	
Parupeneus mutifasciatus Quoy & Gaimard, 1824	x	x	x				x	
Parupeneus porphyreus Jenkins, 1903			x		x	x		x
Kyphosidae								
Kyphosus bigibbus (Lacépède, 1802)	x	x	x	x	x			x
Chaetodontidae								
Chaetodon auriga Foreskal, 1775	x	x	x	x	x			x
Chaetodon fremblii Bennett.1829	x	x	x	x	x		x	x
Chaetodon miliaris Quoy & Gaimard, 1824	x	x	x	x	x	x		x
Chaetodon trifasciatus Park, 1797								x
Chaetodon ornatissimus Cuvier, 1831					x			x
Chaetodon unimaculatus Bloch, 1788								x
Forcipiger flavissimus Jordan & McGregor, 1898	x		x		x		x	
Pomacanthidae								
Centopyge potteri (Jordan & Metz, 1912)					x			
Holocanthus sp.			x					

Appendix C (con.). Occurrence of fishes by station number at Midway Atoll (see Fig. 1 & 2).

Taxa	1,2	3	4	5	6	7	8	9	10
Opiegnathidae									
Opiegnathus fasciatus (Temminck & Schlegel, 1844)			x		x				
Opiegnathus punctatus (Temminck & Schlegel, 1844)					x				
Pomacentridae									
Abudefduf abdominalis (Quoy & Gaimard, 1824)	x	x	x	x		x	x		
Abudefduf sordidus (Forsskål, 1775)		x							x
Chromis sp.		x							
Chromis ovalis (Steindachner, 1900)					x				x
Chromis verater Jordan & Metz, 1912					x				
Dascyllus albisella Gill, 1862	x		x	x	x		x		x
Plectoglyphididon johnstonianus Fowler & Ball, 1924					x		x		
Stegastes fasciolatus (Quoy & Gaimard, 1824)	x	x	x	x	x		x		x
Labridae									
Anampses chrysocephalus Randall.1958									x
Anampses cuvieri Quoy & Gaimard, 1824		x		x	x				
Bodianus bilunulatus (Valenciennes, 1839)	x	x	x		x	x			x
Con's *ballieui* Vaillant & Sauvage, 1875					x				
Coris flavovittata (Bennett, 1929)		x	x		x				x
Cons *venusta* Vaillant & Sauvage, 1875					x				
Halichoeres omatissimaus (Garrett, 1863)		x							
Labroides phthirophagus Randall 1958					x				x
Macropharyngodon geoffroy (Quoy & Gaimard, 1824)									x
Stethojulis balteata (Quoy & Gaimard, 1824)					x				x
Thalasomma ballieui (Vaillant & Sauvage, 1875)		x		x	x				x
Thalasomma dupeirey (Quoy & Gaimard, 1824)	x	x	x	x	x		x		x
Thalasomma trilobatum (Lacépède, 1801)							x		x
Thalasomma so. (juv.) (Rüppell, 1838)						x	x		
Scaridae									
Scarus perspicillatus Steindachner, 1879		x	x		x				x
Scams psittacus Forsskål, 1775									x
Scams sordidus Forsskål, 1775									x
Scarus sp.	x		x				x		
Blennidae									
Istibennius zebra (Vaillant & Sauvage, 1875)									x
unident. blenny	x								
Gobiidae									
unident goby			x				x		
Acanthuridae									
Acanthurus leucopareius (Jenkins, 1903)	x		x		x				x
Acanthums nigroms Valenciennes, 1835			x		x				x
Acanthurus olivaceus (Bloch & Schneider, 1801)					x				
*Acanthurus triostegus (*Linnaeus, 1758)	x	x	x	x	x				x
Ctenochaetus strigosus (Bennett, 1828)	x		x		x				x
Naso unicomis (Forsskål, 1775)		x			x				x
Zebrasoma flavescens (Bennett, 1828)			x		x				
Zebrasoma veliferum (Bloch, 1797)					x				x
Zanclidae									
Zanclus cornutus (Linnaeus, 1758)	x		x		x				x
Balistidae									
Xanthichthys mento (Bennett, 1831)					x				

Appendix C (con.). Occurrence of fishes by station number at Midway Atoll (see Fig. 1 & 2).

Taxa	1,2	3	4	5	6	7	8	9	10
Monocanthidae									
Pervagor spilosoma (Lay & Bennett, 1839)	x	x	X	x			X		
Ostraciontidae									
Ostracion meleagris (Jenkins, 1901)									X
Tetraodontidae									
Arothron hispidus (Linnaeus, 1758)	x	x							
Canthigaster coronata (Vaillant & Sauvage, 1875)					x				
Canthigaster jactator (Jenkins, 1901)	x	x	x				X		
Diodontidae									
Diodon hystrix Linnaeus, 1758	x			x					
Total taxa	16	25	36	17	46	9	18	0	41

Note: Occurrence of fishes was not recorded at Station 9.

Appendix D. List of all species in Bishop Museum Invertebrate Zoology collection collected from Midway Atoll. (Note: Information from the Malacology collection is not included in this list.) *Species reported in Appendix 2 from 1997 survey.

CNIDARIA
- **Anthozoa**
  - Acroporidae
    - *Acropora* sp.
    - *Montipora* sp.
  - Agariciidae
    - *Pavona* sp.
  - Faviidae
    - *Cyphastrea* sp.
    - *Leptastrea* sp.
  - Fungiidae
    - *Fungia scutaria*
    - *Fungia* sp.
  - Pocilloporidae
    - *Pocillopora* sp.
  - Poritidae
    - *Porites* sp.
  - Thamnasteriidae
    - *Psammocora stellata*

ANNELIDA
- **Polychaeta**
  - Amphinomidae
    - *Eurythoe complanata* *
  - Eunicidae
    - *Eunice afra*
  - Nereidae
    - *Platynereis* sp.
  - Polynoidae
    - *Iphione muricata**
  - Terebellidae
    - unid. terebellid

ARTHROPODA
- **Cirripedia**
  - Balanidae
    - *Balanus* sp.
    - *Megabalanus tanagrae**
  - Lepadidae
    - *Lepas anatifera*
- **Stomatopoda**
  - Gonodactylidae
    - *Pseudosquilla ciliata*
    - *Pseudosquillisma oculata*

Appendix D (con.). List of all species in Bishop Museum Invertebrate Zoology collection collected from Midway Atoll.

Isopoda
- Limnoriidae
  - *Umnoria tripunctata*
  - *Paralimnoria andrewsi*

Natantia
- Alpheidae
  - *Alpheus collumianus**
  - *Alpheus diadema**
  - *Alpheus pacificus*
  - *Alpheus paragracilis*
  - *Synalpheus charon **
- Hippolytidae
  - *Lysmata paucidens*
  - *Palaemonidae*
  - *Harpiliopsis depressus*
  - *Pontonia medipacifica*

Reptantia
- Diogenidae
  - *Calcinus elegans*
  - *Calcinus latens*
  - *Dardanus deformis*
  - *Dardanus megistos*
- Porcellanidae
  - *Pachycheles sp.*

Brachyura
- Calappidae
  - *Calappa calappa*
  - *Calappa gal/us*
  - *Calappa hepatica*
- Dromiidae
  - *Cryptodromiopsis tridens*
- Geryonidae
  - *Progeryon sp.*
- Grapsidae
  - *Pachygrapsus plicatus*
  - *Planes cyaneus*
- Majidae
  - *Perinea tumida*
- Ocypodidae
  - *Ocypode pallidula*
- Portunidae
  - *Portunus pubescens*
  - *Thalamita Integra**
  - *Thalamita spiceri*
- Trapezidae
  - *Trapezia intermedia*

Appendix D (con.). List of all species in Bishop Museum Invertebrate Zoology collection collected from Midway Atoll.

ARTHROPODA (con.)
Brachyura (con.)
Xanthidae
Chlorodiella niger
Domecia hispida
Liomera monticulosus
*Lfomera supernodosus**
Lophozozymus dodone
Lophozozymus pulchellus
Lybia edmondsoni
*Pilodius areolatus**
*Pilodius flavins**
Phymodius laysani
Phymodius nitidus
Phymodius ungulatus
*Platypodia eydouxii**
*Pseudoliomera speciosa **
*Pseudoliomera variolosa **

ECTOPROCTA
Vesiculariidae
*Zoobotryon verticillatum **

ECHINODERMATA
Ophiuroidea
Ophiocomidae
Ophiocoma brevipes
Ophiocoma pica
Ophiocomella sp.
Ophionereididae
Ophionereis porrecta
Asteroidea
Ophidiasteridae
Linckia guildingii
Ophidiaster squameus
Mithrodiidae
Mithrodia bradleyi
Echinoidea
Brissidae
Brissus latecarinatus
Clypeasteridae
Clypeaster reticulatus
Clypeaster eurypetalus

Appendix D (con.)**.** List of all species in Bishop Museum Invertebrate Zoology collection collected from Midway Atoll.

ECHINODERMATA (con.)

Echinoidea (con.)

Echinometridae

*Echinometra mathaei**

Echinometra sp.

Echinostrephus aciculatus

*Heterocentrotus mammillatus **

Echinoneidae

Echinoneus cyclostomus

Toxopneustidae

Pseudoboletia indiana

Pseudoboletia sp.

Tripneustes gratilla