

**Lāna‘i Nonindigenous Marine
Species Surveys**

**Hawaii
Biological
Survey**

Final Report March 2006

COVER

Inside of “Cathedrals” between Mānele Bay and Mānele Harbor on Lāna‘i Island.

Inset at bottom right: Introduced invasive octocoral *Carijoa riisei*
growing on reef surface near the Cathedrals entrance.

Lāna‘i Nonindigenous Marine Species Surveys

Prepared for:

**Division of Aquatic Resources
Department of Land and Natural Resources
1151 Punchbowl St. Room 330
Honolulu, HI 96822**

Prepared by

S. L. Coles, K. Longenecker and H. Bolick

Hawai‘i Biological Survey

Bishop Museum

Honolulu, Hawai‘i 96817

March 2006

Contribution No. 2006–012 to the Hawai‘i Biological Survey

Copyright © 2006 Bishop Museum
All Rights Reserved
Printed in the United States of America



BISHOP MUSEUM

ISSN 1085-455X

EXECUTIVE SUMMARY

A baseline survey of the marine biota of the island of Lānaʻi was conducted in May 2005. This was first comprehensive study that has been made on this island for all components of its marine nearshore community. Samples and observations were taken at seven sites around the island, and all macroalgae, macroinvertebrates and fish species collected or observed were recorded. On-site observations without collections were made at two other sites. Identified species were designated as native, nonindigenous (introduced) or cryptogenic (neither demonstrably native nor introduced) according to criteria used for previous introduced species surveys in Hawaiʻi. A total of 294 taxa were observed or identified from collected specimens, which included 16 introduced or cryptogenic species and three new reports for the Hawaiian Islands. The 16 introduced and cryptogenic species comprised 5.4% of the total identified taxa and included seven cnidarians, one polychaete, two pericards, one decapod, one bryozoan, two ascidians and three fish. By station, the introduced/cryptogenic component ranged 3 to 7 species and 3.8% to 6.8% of the total biota. The stations included two sites at or near Kaunapali Harbor, Lanai's principal harbor for inter-island shipping. The percent component values are similar to those that have been determined on ocean-exposed reef areas elsewhere in the Hawaiian Islands but the harbor value is well below the values in other Hawaiian harbors that are more isolated from open ocean circulation than Kaunapali Harbor. No invasive introduced algae and only two invasive introduced invertebrates were found on the surveys. These were a single colony of the octocoral *Carijoa riisei* in the vicinity of "Cathedrals" between Mānele Bay and Harbor, and a single stomatopod *Gonodactylaceus falcatus* at the site closest to Mānele Harbor.

Table of Contents

	Page
Executive Summary	1
Introduction	3
Site Descriptions and Methodology	3
Results	7
Discussion and Conclusions	9
Acknowledgments	13
References	13
APPENDIX Species recorded at Lāna‘i stations, March-February, 2005	16

Figures

Figure	Page
1. Locations of Lāna‘i survey stations.	6
2. Distribution of total taxa and nonindigenous +cryptogenic species among stations.	9

Tables

Table	Page
1. Lāna‘i Reef Station Locations and Descriptions.	4
2. Coordinates and depths of Lāna‘i stations.	5
3. Distribution of major taxonomic groups among Lāna‘i stations.	8
4. Introduced and cryptogenic species identified at survey stations.	10
5. Numbers of marine nonindigenous (N), cryptogenic (C) and total taxa determined from the Hawaiian Islands, Johnston Atoll, Guam, and American Samoa.	11

Introduction

For the past ten years, staff of the Bishop Museum have conducted baseline surveys of the marine biota present in harbors and on coral reefs throughout the Main and Northwestern Hawaiian Islands, Johnston Atoll, and American Samoa. Initially, studies in the Main Hawaiian Islands focused on O‘ahu’s principal harbors (Coles et al 1997, 1999a, 1999b), Kāne‘ohe Bay (Coles et al. 2002a), Waikīkī, and Maunalua Bay (Coles et al. 2002b), Kaho‘olawe (Coles et al 1998), Midway (DeFelice et al 1997) and French Frigate Shoals (DeFelice et al.. 2002) in the Northwestern Hawaiian islands. More recently, studies were completed for coral reefs and two harbors each on the main neighbor islands of Kaua‘i, Moloka‘i, Maui and Hawai‘i (Coles et al. 2004a, 2004b, in press), and Kalaupapa, Moloka‘i (Godwin and Bolick 2006). These surveys have focused on detecting the presence and abundance of introduced species and comparing them to the numbers of native species that occurred in the various marine environments. The last major unknown area was the marine environment of the Island of Lāna‘i. The present study was therefore conducted in 2005 to fill this remaining information gap.

A review of the available published and unpublished literature pertaining to the marine environment of Lāna‘i revealed no information that would be useful for baseline comparison with the comprehensive surveys for marine biota conducted for this study. The few previous studies available were concerned with non-biotic subjects (Grigg and Jones 1997, Hawai‘i State Harbors Division 1987, DHM 1990) or were limited to site-related descriptions of the composition of the macroalgal, coral and fish communities with some supplementary information of water quality parameters (Dollar 1984, Orcutt et al. 1988, U.S. Fish and Wildlife Service 1995, Brock and Kam 1999). Moreover, of the 37 specimens cataloged in the Bishop Museum marine invertebrates collection (<http://www.bishopmuseum.org/research/natsci/invert/databases.html>), all were collected from deep water or pelagic samples except for three *Pavona maldivensis* (listed as *P. pollicata*) from ca. 10 m at unspecified sites. The present study therefore constitutes the first comprehensive determination of the species composition of a variety of marine habitats of Lāna‘i, with emphasis on the introduced marine species that may occur there.

Site Descriptions and Methodology

Surveys were conducted from February 28 to March 4, 2005 at the eight sites listed in Tables 1 and 2 and shown in Figure 1. Three sites (LA1, LA2 and LA6) were deployed in the vicinities of Division of Aquatic Resources (DAR) fish monitoring transects, and one (LA5) was deployed in the vicinity of a Coral Reef Assessment Monitoring Program (CRAMP) Rapid Assessment Transect Survey (RATS) site. Diving observations that were planned for Mānele Harbor could not be completed because of ongoing dredging operations that caused muddy conditions and zero visibility, and the nearest station was located just outside the harbor at LA1. However, observations and collections were conducted at the main pier of Kaunalapau Harbor and on a coral reef 265 m southeast of the Kaunalapau pier.

Scuba was used at Stations LA1 to LA7 by three observers who recorded all macroalgae, macro-invertebrates and fishes that could be identified on site in the vicinity of a triangular sampling area of 312 m² at each station (Method described in Coles et al. 2004a and Coles et al. in press). At Station 8, macrobiota were recorded by two observers (SLC and HB) while snorkeling across a transect from the beach to a blue hole locally called “Bottomless”, 320 m offshore. Also, observations were made during

Table 1. Lānaʻi Reef Station Locations and Descriptions

Station LA1. East Mānele Bay. 28-Feb-05. (Latitude 20°44'32.8", Longitude 156°52'54.1)

DAR MAE 3 m fish transect site 650 east of Mānele Harbor Dock. Depth 3-4 m. Visibility poor (< 5 m) with high surge of up to 6 m laterally from southwest swell. Substratum solid consolidated limestone with high coral coverage of ca. 60% dominated by *Porites lobata*, *P. evermanni* and *Pocillopora meandrina*. Macroalgae was also abundant, especially red turf algae.

Station LA2. West Mānele Bay. 28-Feb-05. (Latitude 20°44'24.5", Longitude 156°53'9.3) DAR MAW 10 m fish transect site 340 southeast of Mānele Harbor Dock. Depth 6-9 m. Visibility poor (ca. 3-5 m) with high surge of up to 3-5 m laterally from southwest swell. Gradually sloping reef from 20-30 depth with high coral cover of ca. 75% dominated by *Porites compressa*, *Porites lobata* *Porites rus* and *Montipora putula*. A thin coat of fine sediment covers non-live coral reef surfaces

Station LA3. Kaunalapau Harbor. 1-Mar-05. (Latitude 20°47'11.1", Longitude 156°59'30.6"). Nearest harbor pier: 6.2 km. Nearest boat ramp: 6.3 km. Depth 0-7.5 m. Visibility good, ca. 15 m. Substratum is three tiers of concrete pier pilings extending to 8-m depth backed by concrete sandbag wall and fronted by fine sand bottom with numerous cobble to boulder size rocks and cables rods and other debris. Bottom continues as gradual sloping coarse sand at >9 m depth. Good coral cover totaling ca. 15-20% on pier pilings and rocks, dominated by *Montipora putula*, *Pavona varians* and *Pocillopora meandrina*. The dock and harbor are highly exposed to open ocean swells, which caused surge of ca 1 m laterally. At the west end of the pier the jetty continues and is composed of large basalt boulders with coral cover of ca 30%.

Station LA4. Kaunalapau Reef. 1-Mar-05. (Latitude 20°47'2.6", Longitude 156°59'28.3). Reef area 275-m southeast of Kaunalapau Harbor pier. Depth 6-12 m. Visibility excellent, ca. 20-30 m with no surge. Coral reef within embayment in excellent condition, which provides shelter from open ocean swell turbulence but is well mixed with oceanic seawater. High abundance and diversity of corals on limestone and basalt boulders. Coral coverage totaled ca 50-60 % of available substratum and was dominated by *Porites lobata* and *Porites compressa*. Thin coating of fine-grained terrigenous sediment covers non-live coral surfaces, which are interspersed with cobble to boulder size rubble and small sand channels.

Station LA5. Kalaeāhole Bay 2-Mar-05. (Latitude 20°52'38.7", Longitude 157°03'13.1) Ocean-exposed reef area at CRAMP RATS site Kalaeāhole LK1 1. Depth 9-14 m. Visibility excellent, ca. 30 m with no surge. Gradually sloping reef with good coral cover on landward side and cobble-boulder rubble area in coarse calcareous and volcanic sand on offshore side. Coral cover dominated by small *Porites lobata* and *Pocillopora meandrina* colonies fairly evenly dispersed on reef substratum.

Station LA6. Kāmala Bay. 2-Mar-05. (Latitude 20°44'10.7", Longitude 156°59'0.9"). Reef area ca. 670 m northwest of DAR PAW 4 m fish transect site at Pauloia Point. Depth 7-10 m. Visibility excellent, ca. 25 m with moderate 1-2 m lateral surge. Fairly flat area with large basalt boulders with thin crust of limestone and moderate coral cover of about 25% dominated by *Porites lobata*, *Pocillopora meandrina*, *Montipora capitata* and *M. patula*.

Station LA7. Shipwreck Reef 3-Mar-05. (Latitude 20°55'20.6", Longitude 156°59'33.6"). Approximate 200 m seaward of the wrecked ship near Shipwreck beach. Depth 8-9 m. Visibility intermediate, ca. 10 m. Fairly flat, barren reef with abundant macroalgae covering consolidated limestone intermixed with patches of coarse sand. Coral cover low, ca. 10%, with mostly small colonies of *Pocillopora meandrina* and occasional large stands of *Porites evermanni*. Invertebrates also observed and recorded along the hull of the wrecked ship.

Station LA8. Transect from Shipwreck Beach . 3-Mar-05 (Latitude 20°38'5.3", Longitude 156°29'57.6") to blue hole called "Bottomless" (Latitude 20°54'59.0", Longitude 156°53'51.6"), 320 m offshore. Depth 0.5-2 m. Visibility good, ca. 15-20 m. High energy, relatively flat fringing reef with medium coverage (ca. 25%) of a mix of reef coral dominated by *Porites evermanni*, *Porites lobata* and *Montipora* spp. with abundant macroalgae. Very few fish noted until reaching the blue hole, where they were abundant along with numerous green turtles.

Table 2. Coordinates and depths of Lāna‘i stations.

Sta.	Location	GPS Code	Date	NAD83							Depth (m)	
				Latitude N			Longitude W			UTM Z4		
				Deg	Min	Sec	Deg	Min	Sec	Northing	Easting	
LA1	Mānele DAR 3m	LA MAE 3M	28Feb05	20	44	32.8	156	52	54.1	2295089	720567	3-4
LA2	Mānele DAR 10m	LA MAW 10M	28Feb05	20	44	24.5	156	53	9.3	2294828	720130	6-9
LA3	Kaumalapau Harbor	LA KAUMHBR	1Mar05	20	47	11.1	156	59	30.6	2299810	709035	0-7.5
LA4	Kaumalapau Reef	LA KAUMARF	1Mar05	20	47	2.6	156	59	28.3	2299551	709104	6-12
LA5	Kalaeāhole	LAN KALAEI	2Mar05	20	52	38.7	157	03	13.1	2309807	702478	9-14
LA6	Kāmala Bay	LA KAMALA	2Ma-05	20	44	10.7	156	59	0.9	2294295	711699	7-10
LA7	Shipwreck Reef	LA SHIPWRK	3Mar05	20	55	20.6	156	54	33.6	2314974	717429	8-9
LA8	Shipwreck Beach	LA SHPWKBE	4Mar05	20	54	51.3	156	53	59.4	2314086	718428	0.5-2

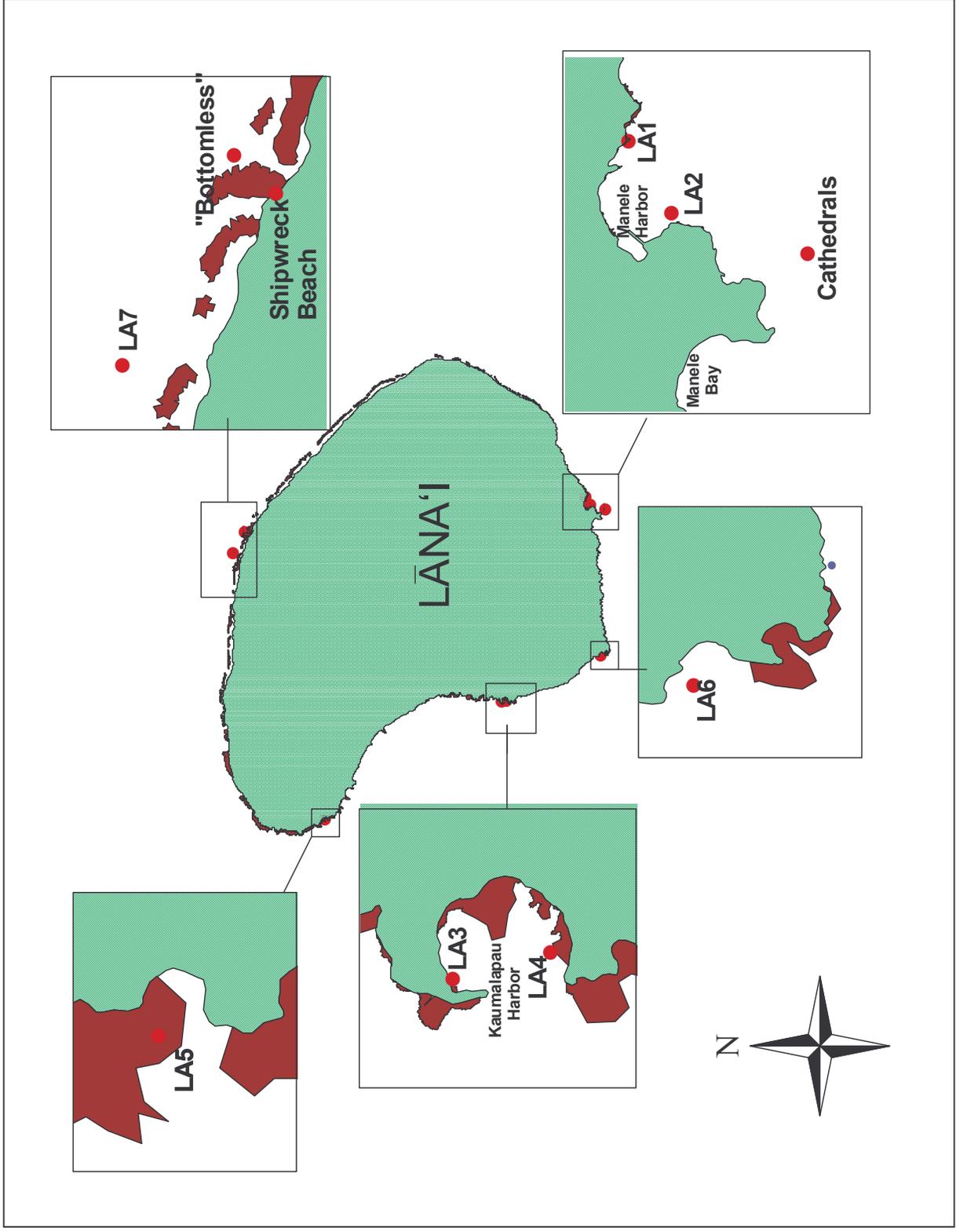


Figure 1. Locations of Lānaʻi survey stations.

dives in and around the caverns at “Cathedrals” just southwest of the entrance to the bay leading to Mānele Harbor.

Benthic specimens were obtained from a variety of habitats at Stations LA1-LA7. Large-organisms were collected by hand, and hard surfaces were scraped with a chisel into collecting bags and transported back to the laboratory. Macroalgae samples were frozen until later identification, and epiphytic organisms were rinsed from other algae samples and preserved in 70% ethanol for further processing. Collected organisms and substrata were inspected shortly after collection, and taxa requiring relaxation (i.e. hydroids, anemones, ophiuroids, holothurians, and ascidians) were held in a solution of saturated magnesium sulfate in seawater for at least 12 hours, transferred to 5% formalin-seawater and then into 70% ethanol. The remaining organisms were preserved directly in 70% ethanol for shipment to Bishop Museum.

Collected specimens were sorted into major taxonomic groups identified under dissecting microscope magnification to species or the lowest practicable taxa. Identifications were made using descriptions available in Reef and Shore Fauna of Hawai‘i Sections 1 to 4 (published), 5 and 6 (unpublished), various taxonomic references, and voucher specimens in the Bishop Museum collections. Where needed, specimens from various groups were sent to taxonomic experts (see Acknowledgments) for final identification. Identified organisms were assigned native, nonindigenous, or cryptogenic status based on Carlton and Eldredge (unpubl.) or, for newly reported species for Hawai‘i in consultation with taxonomic experts based on biogeographic distributions.

We designated species as nonindigenous, cryptogenic, or native according to Carlton and Eldredge (unpubl.) and the Checklist of the Marine Invertebrates of the Hawaiian Islands (http://www2.bishopmuseum.org/HBS/invert/list_home.htm). Taxa not identified to species were designated native unless they were previously known unnamed introductions, e.g. *Ascidia* sp. A (Abbott 1997, Carlton and Eldredge unpub.), or were new reports for Hawai‘i, in which case they were designated cryptogenic (i.e. of uncertain geographic origin *sensu* Chapman and Carlton [1991 and Carlton [1996]).

Results

All taxa identified on site or from collected specimens are listed in Appendix A by station, and the numbers of taxa in major taxonomic groups are shown in Table 3. A total of 294 taxa were identified for all sites, with 59 to 116 found at the seven sites where systematic collections were made. The highest numbers occurred at the two stations either nearest Mānele Harbor (LA1) or at the pier of Kaunalāpau Harbor (LA3), with the third highest number at Station LA6 in Kāmala Bay, which had the greatest number of fish species. Fishes comprised the most speciose taxonomic group, and numbers of fish species were higher at open coastline sites, generally with higher coral coverage. By contrast, peracarids (i.e. amphipods, isopods, and tanaids) the second most speciose group, showed greater numbers at the four sites (LA1-LA4) near or within the two

Table 3. Distribution of major taxonomic groups among Lāna‘i stations.

Taxa	Station									All Stations
	Cathedrals	LA1	LA2	LA3	LA4	LA5	LA6	LA7	LA8	
MACROALGAE		8	5	3	5	7	3	13	7	21
PORIFERA		4	1	7	2	2	2	2		11
CNIDARIA	1	13	16	17	15	14	14	10	9	34
POLYCHAETA		16	11	11	11	10	8	5		33
SIPUNCULA		1	1	1	1		1			1
MOLLUSCA		5	1	6	2	2	3	4		16
PERACARIDA		25	13	12	12	6	7	3		43
CIRRIPEDIA				1						1
DECAPODA		6	1	4	2	3	1	3		17
BRYOZOA				1	1					2
ECHINODERMATA		4	6	7	5	3	4	4	1	15
ASCIDIA	1	2	2	2	2	4	2			5
FISH		32	23	37	41	45	57	15	22	95
All Taxa	2	116	80	109	99	96	102	59	39	294

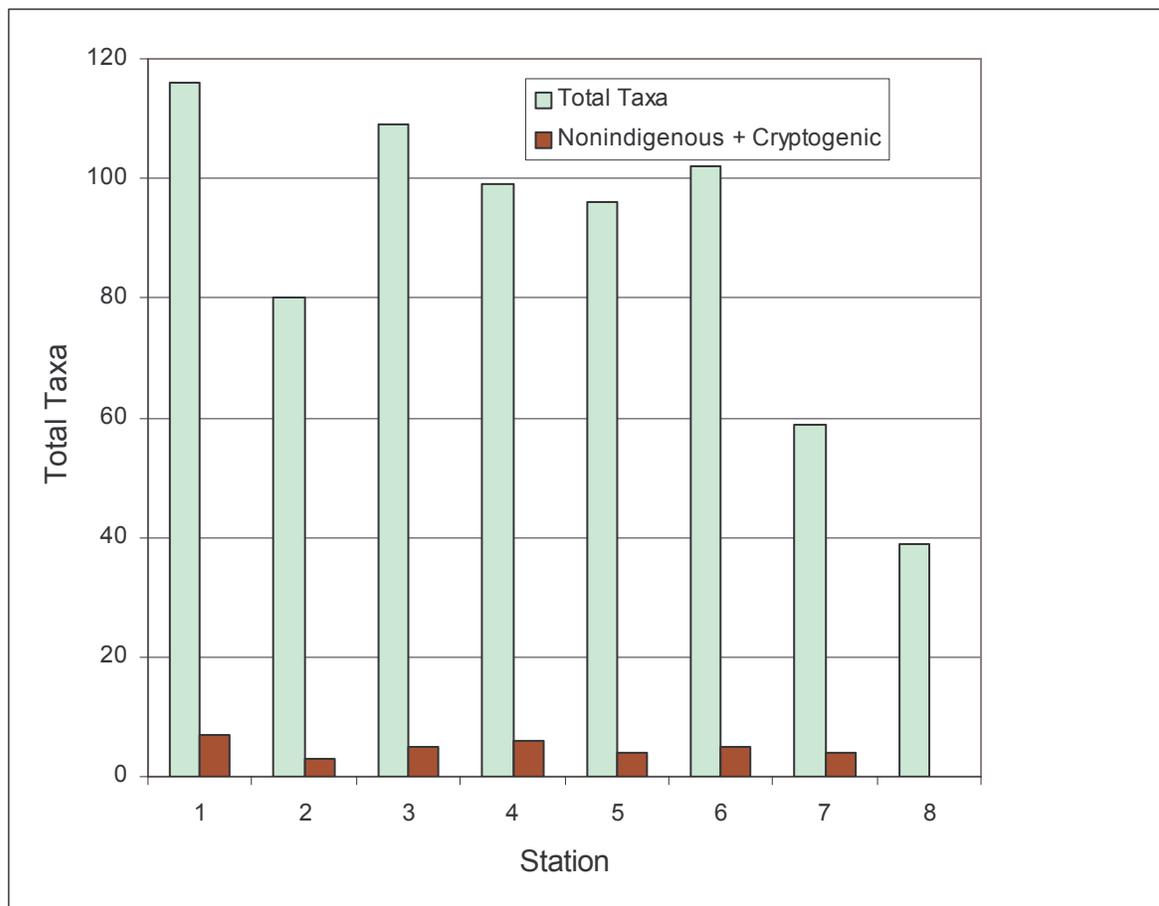


Figure 2. Distribution of total taxa and nonindigenous +cryptogenic species among stations

harbor areas. A similar pattern of higher numbers for the harbor-adjacent stations occurred for poriferans, cnidarians, polychaetes, mollusks and decapods.

Figure 2 shows the total numbers of total taxa and nonindigenous+cryptogenic species by station, and introduced and cryptogenic species are listed by station in Table 4. Six introduced and ten cryptogenic species were identified on the survey, comprising 5.4% of the total 294 taxa recorded. Three species, all hydroids, were new reports for the Hawaiian Islands and are designated cryptogenic, recognizing that these new reports may be due to previous lack of information for this taxonomic group rather than introductions.

Numbers of introduced or cryptogenic species recorded by station ranged 3 to 7 and these composed similar proportions of the total taxa at each site, ranging about 4 to 7 %. There was no indication of higher numbers of introduced or cryptogenic species at the dock area of Kaunalāpau Harbor (LA3) where fewer of these were found than at LA1, just outside of Mānele Harbor, or at LA4, the reef area across the bay from the Kaunalāpau dock.

Discussion and Conclusions

The available information for introduced species surveys conducted in the Hawaiian Islands and elsewhere in the Pacific is shown in Table 5. The 16 introduced and cryptogenic species comprising 5.4% of the total taxa determined for the present study is consistent with levels previously determined for coral reefs in Hawai'i. Although more introduced and species were found for surveys at Waikīkī (Coles et al. 2002b) and 41 reef sites throughout the Hawaiian Islands (Coles et al. 2004a, in press), more total taxa were also identified in these studies, resulting in introduced/cryptogenic components of 5.3% to 6.9%. Even lower component values of 0.3% to 3.9% were determined in coral reef areas elsewhere in the Hawaiian Islands (Coles et al. 1998, Defelice et al. 1998, 2002, Godwin and Bolick 2006) and 0.8% to 1.5% elsewhere in the Pacific (Coles et al. 2001, 2003, Paulay et al. 2002). A somewhat higher introduced/cryptogenic component of 7.9% was determined for coral reef sites near the entrances to harbors on the islands of Kaua'i, Moloka'i, Maui, and Hawai'i.

By contrast, introduced/cryptogenic species components previously determined for harbors in the Hawaiian Islands and Kāne'ohe Bay were substantially higher, ranging 14.5 % to 23% of the total identified taxa (Coles et al. 1997, 1999a, 1999b, 2002a, 2004b). These values are substantially higher than have been determined for major harbors elsewhere in the Pacific for Guam (Paulay et al. 2002) or American Samoa (Coles et al. 2003). Higher introduced/cryptogenic components in harbors may be due to their being the most likely point of introduction of non-native species as hull fouling or ballast water from vessels, or higher levels may be in part due to the characteristics of harbor water quality. The generally higher organic and nutrient loads of the relatively stagnant water within enclosed harbor is more likely to support the survival and propagation of introduced species, primarily filter feeders, from harbors with similar conditions elsewhere. Studies in the major harbors of O'ahu and in Kāne'ohe Bay have consistently shown greater numbers and proportions of introduced at sites nearest the harbor or bay entrances (Coles et al. 1997, 1999a, 1999b, 2002a). Similarly, an evaluation of major factors determining the presence of introduced

Table 4. Introduced and cryptogenic species identified at survey stations. Asterisks designate new reports for the Hawaiian Islands.

Taxa	Family	Genus Species	Author Date	Status	Station												
					LA1	LA2	LA3	LA4	LA5	LA6	LA7	LA8					
HYDROZOA	AGALOPHENIIDAE	<i>Lytocarpia phyteuma</i> *	(Kirchenpauer, 1876)	Cryptogenic		x	x	x									
HYDROZOA	HALECIIDAE	<i>Nemalium lighti</i> *	(Hargitt, 1924)	Cryptogenic													x
HYDROZOA	KIRCHENPAUERIIDAE	<i>Ventromma halecioides</i>	(Alder, 1859)	Cryptogenic	x												x
HYDROZOA	PLUMULARIIDAE	<i>Monostaechas fisheri</i> *	Nutting, 1905	Cryptogenic													
HYDROZOA	HALOCORDYLIDAE	<i>Pennaria disticha</i>	(Goldfuss, 1820)	Introduced			x	x									
ANTHOZOA	RHIZANGIIDAE	<i>Culicia</i> n. sp.		Cryptogenic			x										
ANTHOZOA	TELESTIDAE	<i>Carijoa riisei</i>	(Duchassaing & Michelotti, 1860)	Introduced													
POLYCHAETA	CAPITELLIDAE	<i>Capitella capitata</i>	(Fabricus, 1780)	Cryptogenic													
TANAIDACEA	PSEUDOXUZIDAE	<i>Leptochelia dubia</i>	Krøyer, 1842	Cryptogenic	x	x	x	x	x								
AMPHIPODA	PODOCERIDAE	<i>Podocerus brasiliensis</i>	Dana, 1853	Introduced				x									
DECAPODA	GONODACTYLIDAE	<i>Gonodactylaceus falcatus</i>	(Forsskål, 1775)	Introduced	x												
ASCIDIACEA	DIDEMNIDAE	<i>Didemnum</i> sp. ? <i>candidum</i>		Cryptogenic	x	x	x	x	x								
ASCIDIACEA	ASCIDIIDAE	<i>Phallusia nigra</i>	Savigny, 1816	Introduced					x								
FISH	LUTJANIDAE	<i>Lutjanus fulvus</i>	(Forster, 1801)	Introduced	x												x
FISH	LUTJANIDAE	<i>Lutjanus kasmira</i>	(Forsskål, 1775)	Introduced													x
FISH	SERRANIDAE	<i>Cephalopholis argus</i>	Bloch and Schneider 1801	Introduced	x			x	x	x	x	x	x	x	x	x	x

Total Nonindigenous (N) & Cryptogenic(C) 16

Total Taxa 294

% N + C 5.4

7 3 5 6 4 5 4

116 80 109 99 96 102 59

6.0 3.8 4.6 6.0 4.2 4.9 6.8

Table 5. Numbers of marine nonindigenous (N), cryptogenic (C) and total taxa determined from the Hawaiian Islands, Johnston Atoll, Guam, and American Samoa.

Location	N	C	Total N + C	Total Taxa	% N + C	Source
Harbors and Embayments						
O‘ahu, Pearl Harbor	69	26	95	419	23.0	Coles et al. 1997, 1999a
O‘ahu, Commercial and Small Boat Harbors	73	27	100	585	17.0	Coles et al. 1999b
Kāne‘ohe Bay	82	34	116	617	14.5	Coles et al. 2002a
Hawaiian Neighbor Island Harbors	72	32	104	694	14.9	Coles et al. 2004b
Guam, Apra Harbor	27	29	46	682	6.7	Paulay et al. 2002
Pago Pago Harbor, Am. Samoa	17	11	28	977	2.9	Coles et al. 2003
Coral Reefs						
Waikīkī	19	33	52	617	6.9	Coles et al. 2002b
Kaho‘olawe	3	0	3	298	1.0	Coles et al. 1998
Midway Atoll	4	0	4	444	1.5	DeFelice et al. 1998
Johnston Atoll	5	5	10	668	1.5	Coles et al. 2001
French Frigate Shoals	2	0	2	617	0.3	DeFelice et al. 2002
Guam	41	44	85	2878	1.5	Paulay et al. 2002
Tutuilla, Am. Samoa	2	5	7	828	0.8	Coles et al. 2003
Hawaiian Neighbor Islands, near harbors	42	23	65	814	7.9	Coles et al. 2004b
Hawaiian Neighbor Islands, 41 reef sites	18	8	26	486	5.3	Coles et al. 2004a
Kalaupapa, Moloka‘i	12	9	3	306	3.9	Godwin and Bolick 2006
Lāna‘i	16	8	8	294	5.4	Present study

species on Hawaiian coral reefs determined that the degree of isolation from the open ocean was the major determinant of the numbers of introduced species recorded. Therefore, the relatively few introduced or cryptogenic species determined for the Kaunalapau Harbor dock site (LA3), is probably related to this location being fully exposed to open ocean conditions, as well as the relatively small few ocean going vessels that use the dock compared to more active harbors elsewhere in Hawai‘i.

Distributions of the major introduced invasive algae in the main Hawaiian Islands was summarized by Smith et al. (2002) from recent nearshore surveys conducted at depths of 3 m or less. However, no information was available from this study for the island of Lāna‘i. It is known from that survey and other sources that proliferation of *Hypnea musciformis*, introduced to Kāne‘ohe Bay from Florida in 1974, had reached very high abundances on nearshore reefs of south and west Maui beaches, where the algae accumulates in massive amounts requiring constant removal and has been responsible for beachfront property devaluation (<http://www.hawaii.edu/ssri/hcri/rp/publications-4/index.htm>). Fortunately, no *H. musciformis* or any other invasive algae, was detected on this survey for Lāna‘i, or on a previous survey of Kaho‘olawe (Coles et al. 1998). This may be somewhat surprising, given the proximity of these islands just across the Au‘au Channel from the west coast of Maui where the algae is so highly abundant, and that the algae was capable of being moved the much longer distance from O‘ahu to Maui. Its lack of presence on Lāna‘i and Koho‘olawe is probably due to the lack of habitation along their coastlines that could contribute nutrients from uncontrolled cesspools or injection wells such as has been implicated in eutrophication-related algal blooms on Maui (Smith and Smith 2006).

Regarding invasive introduced marine invertebrates, only two were recorded from the present survey, the octocoral *Carijoa riisei* (Duchassaing & Michelotti), in the vicinity of the entrance to “Cathedrals”, and the stomatopod *Gonodactylaceus falcatus* (Forsskål) at LA1, both sites near the entrance to Mānele Harbor. *Carijoa riisei* is the most problematical invasive marine invertebrate in the Hawaiian Islands with the greatest potential ecological and economic impact. Formerly considered to be a relatively benign introduction occupying under-utilized habitat primarily in harbors (Coles and Eldredge, 2002), it has since been detected in massive proliferations overgrowing black coral trees in the Au‘au channel at depths of 70 to 110 m (Grigg 2003, 2004; Kahng and Grigg 2005). Black corals at these depths are considered critical for producing larvae that provide settlement of recruits at shallower depths that support a \$30 million per year industry in Hawai‘i. The single colony found at “Cathedrals” was still small (ca. .25 m diameter) and should be considered for removal and monitoring at the site to prevent further spread. *Gonodactylaceus falcatus* was the first invertebrate species designated as introduced in Hawai‘i (Kinzie 1968, 1984) where it is considered to be invasive through its competition and displacement of the native stomatopod *Pseudosquilla ciliata* (Fabricius). *G. falcatus* is now widespread throughout the main Hawaiian Islands (Coles et al. 2004a, in press) but was not abundant even at the one site where it was recorded at the present study.

The overall results for this study indicate that few introduced or cryptogenic species have recruited to the Island of Lānaʻi, probably due to its relative isolation, low inter-island commercial traffic, and lack of substantial enclosed harbors. However, this situation is rapidly changing, with a rapid population increase and development of luxury homes on the island, and a shift from the sugar cane based economy of the past to a tourist based industry where hundreds of visitors daily are transported to and from Lānaʻi from West Maui on large tourist catamarans. These operators and the visitors they transport should be informed of the importance of maintaining Lānaʻi's waters and reefs in their present relatively pristine condition, and efforts should be implemented to reduce the likelihood of marine introductions.

Acknowledgements

Specimens of taxa that were possible new introductions or requiring species identification or verification were sent to or seen by the following experts, who are gratefully acknowledged for their assistance.

Algae: Mr. Jack Fisher, Department of Natural Science, Bishop Museum

Sponges: Dr. Barbara Calcini, Dipartimento di Scienze del Mare, Università Politecnica delle Marche.

Hydrozoans: Dr. Dale Calder, Royal Ontario Museum, Toronto, Canada

Ascidians: Scott Godwin, Department of Natural Science, Bishop Museum

The U.S. Fish and Wildlife Service provided supplemental funding for this project. Tony Montgomery of the Hawaii State Division of Aquatic Resources provided logistic field support and boat transportation, and we especially thank him for his assistance.

References

- Brock, R. A. and K. H. Kam 1999. Monitoring development of the south coast of Lānaʻi Island: a synopsis of eight years of data, p 205-221, in Maragos, J. E. and R. Grober-Dunsmore (eds). Proc. Hawaiʻi Coral Reef Monitoring Workshop. East-West Center, Honolulu.
- Carlton, J. T. 1996. Biological invasions and cryptogenic species. *Ecology* 77:1653-1655.
- Carlton, J. T., and L. G. Eldredge. In prep. Marine bioinvasions of Hawaiʻi: the introduced and cryptogenic marine and brackish water invertebrates of the Hawaiian Archipelago. Bishop Museum, Honolulu.
- Chapman, J. W., and J. T. Carlton. 1991. A test of criteria for introduced species: the global invasion by the isopod *Synidotea laevidorsalis* (Miers, 1881). *J. Crustacean Biol.*, 11((3)): 386-400.
- Coles, S. L., R. C. DeFelice, L. G. Eldredge, and J. T. Carlton. 1997. Biodiversity of marine communities in Pearl Harbor, Oʻahu, Hawaiʻi with observations on introduced species. Bishop Museum, Tech. Rep. No. 10. 76 pp.
- Coles, S. L., R. C. DeFelice, J. E. Smith, D. Muir, and L. G. Eldredge. 1998. Determination of baseline conditions for introduced marine species in nearshore waters of the island of Kahoʻolawe, Hawaiʻi. Bishop Museum Tech. Rep. No. 14. 26 pp.

- Coles, S. L., R. C. DeFelice, L. G. Eldredge, and J. T. Carlton. 1999a. Historical and recent introductions to non-indigenous marine species into Pearl Harbor, O‘ahu, Hawaiian Islands. *Mar. Biol.* 135: 1247-158.
- Coles, S. L., R. C. DeFelice, and L. G. Eldredge. 1999b. Nonindigenous marine species introductions in the harbors of the south and west shores of O‘ahu, Hawai‘i. Bishop Museum Tech. Rep. 15, 210 pp.
- Coles, S. L., R. C. DeFelice, and D. Minton. 2001. Marine species survey of Johnston Atoll June 2000. U.S. Fish and Wildlife Service, Pacific Islands Area Office, Bishop Museum Tech. Rep. 19. 58 pp.
- Coles, S. L., and L. G. Eldredge. 2002. Nonindigenous species introductions on coral reefs: a need for information. *Pac. Sci.* 56: 191-209.
- Coles, S. L., R. C. DeFelice, and L. G. Eldredge. 2002a. Nonindigenous species in Kan‘eohe Bay, O‘ahu, Hawai‘i. Bishop Museum, Tech. Rep. No. 24. 353 pp.
- Coles, S. L., R. C. DeFelice, and L. G. Eldredge. 2002b. Nonindigenous marine species introductions at Waikīkī and Hawai‘i Kai, O‘ahu, Hawai‘i. Bishop Museum Tech. Rep. No. 25, 245 pp.
- Coles, S. L., P. A. Reath, P. A. Skelton, V. Bonito, R. C. DeFelice, and L. Basch. 2003. Introduced marine species in Pago Pago Harbor, Fagatele Bay and the National Park Coast, American Samoa. Bishop Museum Tech. Rep. No. 26, Honolulu. 182 pp.
- Coles, S. L., L. G. Eldredge, F. Kandel, P. A. Reath, and K. Longenecker. 2004a. Assessment of nonindigenous species on coral reefs in the Hawaiian islands, with emphasis on introduced invertebrates Bishop Museum Tech. Rep. No. 27. 106 pp.
- Coles, S. L., P. A. Reath, K. Longenecker, H. Bolick, and L. G. Eldredge. 2004b. Assessment of nonindigenous marine species in harbors and on nearby coral reefs on Kaua‘i, Moloka‘i, Maui and Hawai‘i. Bishop Museum Tech. Rep. No. 29. 187 pp.
- Coles, S. L., F. Kandel, P. A. Reath, K. Longenecker, and L. G. Eldredge. In press. Rapid Assessment of Nonindigenous Marine Species on Coral Reefs in the Main Hawaiian Islands. *Pac. Sci.*
- DeFelice, R., C., S. L. Coles, D. Muir, and L. G. Eldredge. 1998. Investigation of the marine communities of Midway Harbor and adjacent lagoon, Midway Atoll, Northwestern Hawaiian Islands. Bishop Museum, Report prepared for the U.S Fish & Wildlife Serv., Honolulu. 30 pp.
- DeFelice, R., D. Minton, and S. Godwin. 2002. Records of shallow -water marine invertebrates from French Frigate Shoals, Northwestern Hawaiian Islands with a note on nonindigenous species. Bishop Museum Tech. Rep. 23. 78 pp.
- DHM Inc. 1990. Lāna‘i in-depth studies: Hawaiian Fishpond study, islands of Hawai‘i ,Maui, Lāna‘i and Kaua‘i.
- Dollar, S. J. 1984. Baseline assessment of the marine environment at Halepaloa Landing, Lāna‘i, Hawai‘i. Report prepared for Belt Collins and Assoc.
- Godwin, S. and H. Bolick. 2006. Inventory of intertidal and shallow subtidal marine invertebrates at Kalaupapa National Historic Park, Moloka‘i. Report prepared for National Park Service, Honolulu. 58 pp.

- Grigg, R. W. 2003. Invasion of a deep black coral bed by an alien species, *Carijoa riisei*, off Maui, Hawai'i. *Coral Reefs*, 22: 121-122.
- Grigg, R. W. 2004. Harvesting impacts and invasion by an alien species decrease estimates of black coral yield off Maui, Hawai'i. *Pac. Sci.*, 58: 1-8.
- Grigg, R. W and A. T. Jones 1997. Uplift caused by lithospheric flexure in the Hawaiian Archipelago as revealed by elevated coral deposits. *Mar. Geol.* 141: 11-25
- Hawai'i State Harbors Division. 1987. 2010 master plan for Kaunalapau Harbor Lāna'i. Hawai'i State Harbors Division, Department of Transportation.
- Kahng S. E. and R. W. Grigg. 2005. Impact of an alien octocoral, *Carijoa riisei*, on black corals in Hawai'i. *Coral Reefs* 24: 556 - 562
- Kinzie, R. A., III. 1968. The ecology of the replacement of *Pseudosquilla ciliata* by *Gonodactylus falcatus* (Crustacea: Stomatopoda) recently introduced into the Hawaiian Islands. *Pac. Sci.* 22:465-474
- Kinzie, R. A., III. 1984. Aloha also means goodbye: a cryptogenic stomatopod in Hawai'i. *Pac. Sci.* 38:298-311.
- Paulay, G., L. Kirkendale, G. Lambert, and C. Meyer. 2002. Anthropogenic biotic interchange in a coral reef ecosystem: a case study from Guam. *Pac. Sci.* 56:403-421.
- Orcutt, A., G. Lelesch, P. Bass, D. Bauer, J. Hodge, W. Jones, R. Nevins, W. Wilburn and M. Grimes. 1988. A coastal resource inventory of the Lopa-Naha Lāna'i coastline. Univ. Hawai'i Marine Option Prog. Contract No. P002394.
- Smith, J. E., C. M. Hunter, and C. M. Smith. 2002. Distribution and reproductive characteristics of nonindigenous and invasive marine algae in the Hawaiian Islands. *Pac. Sci.* 53:299-315.
- Smith, J. and C. Smith. 2006. The algal blooms on south Maui: do nutrients matter? *Eos Trans. AGU*, 87(36), Ocean Sci. Meet. Suppl., Abstract OS54J-06.
- U.S. Fish and Wildlife Service. 1995. Draft Fish and Wildlife Coordination Act report: Kaunalapau Harbor, navigation improvements, Lānai, Hawaii. Fish and Wildlife Service Ecological Services Div., Pacific Islands Ecoregion, Honolulu

APPENDIX

Species recorded at Lānaʻi stations, March-February, 2005

Taxa	Family	Genus Species	Author Date	Status	Station									
					Cathedrals	LA1	LA2	LA3	LA4	LA5	LA6	LA7	LA8 Tot. Sta.	
CYANOPHYTA	OSCILLATORIACEAE	<i>Lyngbya majuscula</i>	(Dillwyn) Harvey		x		x							2
CHLOROPHYTA	DASYCLADALES	<i>Neomeris annulata</i>	Dickie		x		x					x		3
CHLOROPHYTA	HALIMEDACEAE	<i>Halimeda</i> sp.			x		x				x	x		8
CHLOROPHYTA	SIPHONOCLADACEAE	<i>Dictyosphaeria vershuytii</i>	Fosse										x	1
PHAEOPHYTA	DICTYOTACEAE	<i>Dictyota</i> sp.							x			x		2
PHAEOPHYTA	SARGASSEACEAE	<i>Sargassum</i> sp.			x						x			2
RHODOPHYTA	BONNEMAIISONIACEAE	<i>Asparagopsis taxiformis</i>	(Delile) Trevisan			x			x			x		5
RHODOPHYTA	CRYPTONEMIACEAE	<i>Desmia hornemanni</i>	Lyngbye		x				x					5
RHODOPHYTA	GALAXAURACEAE	<i>Galaxaura acuminata</i>	Butters		x									2
RHODOPHYTA	GALAXAURACEAE	<i>Galaxaura rugosa</i>	(Ellis & Solander) Lamouroux										x	1
RHODOPHYTA	FLORIDEOPHYCEAE	<i>Gibsmithia hawaiiensis</i>	Doty											0
RHODOPHYTA	HALYMENIACEAE	<i>Halymenia</i> sp.										x		1
RHODOPHYTA	CORALLINACEAE	<i>Hydrolithon breviclavium</i>	(Foslie) Foslie										x	1
RHODOPHYTA	CORALLINACEAE	<i>Hydrolithon onkodes</i>	(Heydrich) Penrose & Woelkerling		x		x		x			x		7
RHODOPHYTA	CORALLINACEAE	<i>Hydrolithon</i> sp.											x	2
RHODOPHYTA	DELESSERIACEAE	<i>Dotyella ?hawaiiensis</i>												3
RHODOPHYTA	DELESSERIACEAE	<i>Martensia fragilis</i>	Harvey		x									1
RHODOPHYTA	CORALLINACEAE	<i>Jania</i> sp.											x	1
RHODOPHYTA	CERAMIACEAE	<i>Melanamansia ?glomerata</i>	(Agardh) Norris										x*	0
RHODOPHYTA		Turf algae			x									1
RHODOPHYTA		Unid. Coralline algae										x		3
PORIFERA	CALCAREA	<i>Calcispongia</i> sp.			x							x		3

Taxa	Family	Genus Species	Author Date	Status	Station									
					Cathedrals	LA1	LA2	LA3	LA4	LA5	LA6	LA7	LA8 Tot. Sta.	
PORIFERA	ANCORINIDAE	<i>Stelletta</i> sp.					x							1
PORIFERA	CHONDRILLIDAE	<i>Chondrosia chucalla</i>	de Laubenfels, 1936		x									1
PORIFERA	SPIRASTRELLIDAE	<i>Sphectospongia vagabunda</i>	(Ridley, 1884)		x					x	x			3
PORIFERA	TETHYIDAE	<i>Tethya diploderma</i>	Schmidt, 1870				x							1
PORIFERA	AZORICIDAE	<i>Leiodermatium</i> sp.			x									2
PORIFERA	MICROCIONIDAE	<i>Clathria</i> sp. (red)			x									1
PORIFERA	TEDANIIDAE	<i>Tedania</i> sp.				x								1
PORIFERA	MYCALIDAE	<i>Stylinos</i> sp.					x	x	x					3
PORIFERA	HALICHONDRIIDAE	<i>Hymeniacion chlorida</i>	(de Laubenfels, 1950)				x							1
PORIFERA		Unid. Porifera						x	x					3
HYDROZOA	AGALOPHENIIDAE	<i>Lytocarpia phyteuma</i>	(Kirchenpauer, 1876)					x	x			x		4
HYDROZOA	HALECIIDAE	<i>Nemalécium lighti</i>	(Hargitt, 1924)				x					x		1
HYDROZOA	HALOCORDYLIDAE	<i>Pennaria disticha</i>	(Goldfuss, 1820)						x	x				2
HYDROZOA	KIRCHENPAUERIIDAE	<i>Ventromma halecoides</i>	(Alder, 1859)		x									1
HYDROZOA	PLUMULARIIDAE	<i>Monostaechas fisheri</i>	Nutting, 1905								x			1
HYDROZOA	SERTULARIIDAE	<i>Sertularia</i> sp. cf. <i>?diaphana</i>					x		x					4
HYDROZOA	SOLANDERIIDAE	<i>Solanderia secunda</i>	Inaba, 1892								x			1
HYDROZOA		unid. Hydrozoa						x	x					5
ANTHOZOA	TELESTIDAE	<i>Carijoa riisei</i>	(Duchassaing & Michelotti, 1860)											0
ANTHOZOA	XENIIDAE	<i>Sarcothelia edmondsoni</i>	(Verrill, 1928)				x							4
ANTHOZOA	ACROPORIDAE	<i>Montipora capitata</i>	(Dana, 1846)		x	x	x	x	x	x	x	x	x	8

Taxa	Family	Genus Species	Author Date	Status	Station									
					Cathedrals	LA1	LA2	LA3	LA4	LA5	LA6	LA7	LA8 Tot. Sta.	
ANTHOZOA	ACROPORIDAE	<i>Montipora flabellata</i>	Studer, 1902			x	x					x		3
ANTHOZOA	ACROPORIDAE	<i>Montipora patula</i>	Verrill, 1864		x	x		x	x		x	x	x	7
ANTHOZOA	AGARICIIDAE	<i>Leptoseris incrustans</i>	(Quelch, 1886)				x							1
ANTHOZOA	AGARICIIDAE	<i>Pavona duerdini</i>	Vaughan, 1907			x	x	x						3
ANTHOZOA	AGARICIIDAE	<i>Pavona varians</i>	Verrill, 1864		x	x	x	x		x				5
ANTHOZOA	DENDROPHYLLIIDAE	<i>Tabastraea coccinea</i>	Lesson, 1829	x										0
ANTHOZOA	FAVIIDAE	<i>Cyphastrea ocellina</i>	(Dana, 1846)				x				x			2
ANTHOZOA	FAVIIDAE	<i>Leptastrea ?inequalis</i>	Klunzinger, 1879		x		x		x					3
ANTHOZOA	FAVIIDAE	<i>Leptastrea purpurea</i>	Dana, 1846		x		x	x		x				4
ANTHOZOA	FAVIIDAE	<i>Leptastrea sp.</i>							x					1
ANTHOZOA	FUNGIIDAE	<i>Fungia scutaria</i>	Lamarck, 1801		x							x		2
ANTHOZOA	POCILLOPORIDAE	<i>Pocillopora ?ligulata</i>	Dana, 1846			x								1
ANTHOZOA	POCILLOPORIDAE	<i>Pocillopora damicornis</i>	(Linnaeus, 1758)								x*	x		1
ANTHOZOA	POCILLOPORIDAE	<i>Pocillopora eydouxi</i>	Milne Edwards & Haime, 1860		x	x			x		x			4
ANTHOZOA	POCILLOPORIDAE	<i>Pocillopora meandrina</i>	Dana, 1846		x	x	x	x	x	x	x	x	x	8
ANTHOZOA	PORITIDAE	<i>Porites (Synaraea) rus</i>	(Forsskål, 1775)			x		x						2
ANTHOZOA	PORITIDAE	<i>Porites compressa</i>	Dana, 1846		x	x		x	x	x	x	x	x	7
ANTHOZOA	PORITIDAE	<i>Porites evermanni</i>	Vaughan, 1907			x	x	x		x	x	x	x	6
ANTHOZOA	PORITIDAE	<i>Porites lobata</i>	Dana, 1846		x	x		x	x	x	x	x	x	7
ANTHOZOA	RHIZANGIIDAE	Culicia sp.												1
ANTHOZOA	ZOANTHIDAE	<i>Palythoa caesia</i>	Dana, 1848		x	x	x					x		4
ANTHOZOA	ZOANTHIDAE	<i>Zoanthus sp. pink</i>											x	1

Taxa	Family	Genus Species	Author Date	Status	Station																
					Cathedrals	LA1	LA2	LA3	LA4	LA5	LA6	LA7	LA8 Tot. Sta.								
CNIDARIA	CORALLIMORPHARIA	Unid																			
CNIDARIA	ACTINIARIA	Corallimorpharia																			
POLYCHAETA	POLYNOIDAE	Unid Actiniaria																			
POLYCHAETA	POLYNOIDAE	<i>Iphione muricata</i>	(Savigny, 1818)																		
POLYCHAETA	POLYNOIDAE	<i>Iphione</i> sp. (juv.)																			
POLYCHAETA	CHRYSOPETALIDAE	<i>Palaenotus</i> sp.																			
POLYCHAETA	AMPHINOMIDAE	<i>Notopygos albiseta</i>	Holly, 1939																		
POLYCHAETA	AMPHINOMIDAE	<i>Notopygos</i> sp.																			
POLYCHAETA	AMPHINOMIDAE	<i>Pherecardia striata</i>	(Kinberg, 1857)																		
POLYCHAETA	PHYLLODOCIDAE	<i>Phyllodoce</i>																			
POLYCHAETA	PHYLLODOCIDAE	? <i>madeirensis</i>	(Langerhans, 1880)																		
POLYCHAETA	PHYLLODOCIDAE	<i>Phyllodoce</i> sp.																			
POLYCHAETA	PHYLLODOCIDAE	Unid. Species																			
POLYCHAETA	ALCIOPIDAE	Unid. Species																			
POLYCHAETA	SYLLIDAE	Unid. Species																			
POLYCHAETA	NEREIDIDAE	Unid. Species																			
POLYCHAETA	GLYCERIDAE	<i>Glycera tessellata</i>	Grube, 1863																		
POLYCHAETA	EUNICIDAE	<i>Eunice cariboea</i>	(Grube, 1856)																		
POLYCHAETA	EUNICIDAE	<i>Lysidice ninetta</i>	Audouin and Milne Edwards, 1833																		
POLYCHAETA	EUNICIDAE	<i>Marphysa corallina</i>	Kinberg, 1865																		
POLYCHAETA	EUNICIDAE	<i>Nematoneis unicomis</i>	Schmarda, 1861																		
POLYCHAETA	LUMBRINERIDAE	<i>Lumbrineris dentata</i>	Hartmann-Schroder, 1965																		
POLYCHAETA	DORVILLEIDAE	<i>Apophryotrocha</i> sp.																			
POLYCHAETA	DORVILLEIDAE	<i>Dorvillea</i>																			
POLYCHAETA	DORVILLEIDAE	? <i>angolana</i>	(Augener, 1918)																		
DORVILLEIDAE	DORVILLEIDAE	<i>Dorvillea angolana</i>	(Augener, 1918)																		
POLYCHAETA	SPIONIDAE	Unid. Species																			

Taxa	Family	Genus Species	Author Date	Status	Station										
					Cathedrals	LA1	LA2	LA3	LA4	LA5	LA6	LA7	LA8 Tot. Sta.		
AMPHIPODA	ISAEIDAE	<i>Gammaropsis haleiwa</i>	Barnard, 1970						x						1
AMPHIPODA	ISAEIDAE	<i>Gammaropsis pali</i>	Barnard, 1970		x										1
AMPHIPODA	ISAEIDAE	<i>Gammaropsis pokipoki</i>	Barnard, 1970			x									1
AMPHIPODA	ISAEIDAE	<i>Photis kapapa</i>	Barnard, 1970		x		x		x						4
AMPHIPODA	ISCHYROCERIDAE	<i>Ischyrocerus oahu</i>	Barnard, 1970		x										1
AMPHIPODA	ISCHYROCERIDAE	<i>Ischyrocerus oahu</i>	Barnard, 1970				x								1
AMPHIPODA	ISCHYROCERIDAE	<i>Leucothoe hyhelia</i>	Barnard, 1965		x					x					2
AMPHIPODA	MELITIDAE	<i>Elasmopus diptonyx</i>	Schellenberg, 1938								x				1
AMPHIPODA	MELITIDAE E	<i>Elasmopus molokai</i>	Barnard, 1970		x	x									2
AMPHIPODA	MELITIDAE	<i>Elasmopus piikoi</i>	Barnard, 1970						x						1
AMPHIPODA	MELITIDAE	<i>Maera quadrimana</i> (Dana, 1853)			x	x									2
AMPHIPODA	MELITIDAE	<i>Maera serrata</i>	Schellenberg, 1938		x										1
AMPHIPODA	PODOCERIDAE	Podocerus brasiliensis	Dana, 1853								x				1
AMPHIPODA	PODOCERIDAE	<i>Podocerus talegus lawai</i>	(Barnard, 1970)		x										1
AMPHIPODA	TALITRIDAE	<i>Hyale waimaea</i>	Barnard, 1970			x			x						2
AMPHIPODA	ANTHURIDAE	Unid. Species			x	x									2
ISOPODA	ANTHURIDAE	<i>Mesanthura hieroglyphica</i>	Miller and Menzies, 1952							x					1
ISOPODA	CIROLANIDAE	<i>Cirolana parva</i>	Hansen, 1941		x										1
ISOPODA	JANIRIDAE	<i>Bagatus algicola</i>	Miller, 1941		x	x			x	x	x				6
ISOPODA	JOEROPSIDAE	<i>Joeropsis hawaiiensis</i>	Miller, 1941		x										4
ISOPODA	MUNNIDAE	<i>Munna acarina</i>	Miller, 1941		x										3
ISOPODA	SANTIIDAE	Unid. Species			x				x						1
TANAIDACEA	APSEUDIDAE	<i>Apeudes tropicalis</i>	Miller, 1940		x				x	x	x				4

Station

Taxa	Family	Genus Species	Author Date	Status	Cathedrals	LA1	LA2	LA3	LA4	LA5	LA6	LA7	LA8	Tot. Sta.
TANAIDACEA	APSEUDIDAE	<i>Synapseudes minutus</i>	Miller, 1940				x							1
TANAIDACEA	TANAIDAE	<i>Anatanais insularis</i>	Miller, 1940						x					1
TANAIDACEA	TANAIDAE	<i>Tanais vanis</i>	Miller, 1940						x					1
TANAIDACEA	PSEUDOZUXIDAE	<i>Leptocheilia dubia</i>	Krøyer, 1842	Cryptogenic	x	x	x	x	x	x				6
CUMACEA		Unid. Species					x							2
DECAPODA	GONODACTYLIDAE	<i>Gonodactylaceus fulcatus</i>	(Forsskål, 1775)	Introduced	x									1
ARTHROPODA	ALPHEIDAE	<i>Alpheus brevipes</i>	Stimpson, 1860			x								1
ARTHROPODA	ALPHEIDAE	<i>Metalpheus rostratipes</i>	(Pocock, 1890)		x									1
DECAPODA	POR-TUNIDAE	portunid crab							x					1
DECAPODA	XANTHIDAE	<i>Liocarpilodes integerrimus</i>	Dana, 1852		x									1
DECAPODA	XANTHIDAE	<i>Liocarpilodes</i> sp.								x				1
DECAPODA	XANTHIDAE	Unid. Species			x									1
DECAPODA	MAJIDAE	<i>Perinea tumida</i>	Dana, 1852		x						x			2
DECAPODA	CALLIANASSIDAE	<i>Corallianassa ?borradatlei</i>	(DeMan, 1828)								x			1
DECAPODA	DIOGENIDAE	<i>Calcinus argus</i>	Wooster, 1982					x						1
DECAPODA	DIOGENIDAE	<i>Calcinus haigae</i>	Wooster, 1982		x		x							2
DECAPODA	DIOGENIDAE	unid. small hermits								x				1
DECAPODA	DIOGENIDAE	<i>Calcinus laevimanus</i>	(Randall, 1839)				x							1
DECAPODA	DIOGENIDAE	<i>Calcinus guamensis</i>	Wooster, 1982								x			1
DECAPODA	DIOGENIDAE	<i>Calcinus laurentae</i>	Haig & McLaughlin, 1984											1
DECAPODA	DIOGENIDAE	<i>Ciliopagurus strigatus</i>	(Herbst, 1804)											1
DECAPODA	DIOGENIDAE	<i>Dardanus sanguinocarpus</i>	Degener, in Edmonson, 1925							x				1
ECTOPROCTA		Unid. solitary bryozoa					x							2

Taxa	Family	Genus Species	Author Date	Status	Station										
					Cathedrals	LA1	LA2	LA3	LA4	LA5	LA6	LA7	LA8	Tot. Sta.	
ECTOPROCTA	VITTATICELLIDAE	<i>Vittaticella</i> cf. <i>uberrima</i>	Harmer, 1957					x							1
ASTEROIDEA	ACANTHASTERIDAE	<i>Acanthaster planci</i>	Linnaeus, 1758						x	x					3
ASTEROIDEA	MITHRODIIDAE	<i>Mithrodia</i> cf. <i>fisheri</i>	Holly, 1932						x						1
OPHIUROIDEA	OPHIOCOMIDAE	<i>Ophiocoma pica</i>	Muller and Troschel, 1842					x							2
OPHIUROIDEA	OPHIONEREIDIDAE	<i>Ophionereis</i> sp. Unid. Juvs.	Lyman, 1860						x						1
ECHINOIDEA	DIADEMATIDAE	<i>Echinothrix calamaris</i>	(Pallas, 1774)												3
ECHINOIDEA	TOXOPNEUSTIDAE	<i>Tripneustes gratilla</i>	(Linnaeus, 1758)						x						3
ECHINOIDEA	ECHINOMETRIDAE	<i>Echinometra mathaei</i>	(Blainville, 1825)						x						4
ECHINOIDEA	ECHINOMETRIDAE	<i>Echinostrephus aciculatus</i>	Agassiz, 1863												1
ECHINOIDEA	ECHINOMETRIDAE	<i>Heterocentrotus mammillatus</i>	(Linnaeus, 1758)						x						3
HOLOTHUROIDEA		Unid Holothuroidea								x					2
HOLOTHUROIDEA	HOLOTHURIDAE	<i>Actinopyga mauritiana</i>	(Quoy and Gaimard, 1833)												2
HOLOTHUROIDEA	HOLOTHURIDAE	<i>Holothuria (Halodeima) atra</i>	Jaeger, 1833												1
HOLOTHUROIDEA	SYNAPTIDAE	<i>Polyplectana kefersteini</i>	(Selenka, 1867)												2
ASCIDIACEA	DIDEMNIDAE	<i>Didemnum</i> sp. (pink)													3
ASCIDIACEA	DIDEMNIDAE	<i>Didemnum</i> sp. (red)													1
ASCIDIACEA	DIDEMNIDAE	<i>Didemnum</i> sp. cf. ?candidum													6
ASCIDIACEA	DIDEMNIDAE	Unid. Species	Savigny, 1816	Cryptogenic											4

Taxa	Family	Genus Species	Author Date	Status	Station											
					Cathedrals	LA1	LA2	LA3	LA4	LA5	LA6	LA7	LA8	Tot. Sta.		
ASCIDIACEA	ASCIDIIDAE	<i>Phallusia nigra</i>	Savigny, 1816	Introduced	x											0
OSTEICHTHYES	MURAENIDAE	<i>Gymnothorax flavimarginatus</i>	(Rüppell) 1830			x										1
OSTEICHTHYES	SYNODONTIDAE	<i>Synodus sp.</i>							x							1
OSTEICHTHYES	AULOSTOMIDAE	<i>Aulostomus chinensis</i>	(Linnaeus, 1766)			x				x						2
OSTEICHTHYES	SCORPAENIDAE	<i>Sebastapistes coniota</i>	Jenkins 1903								x					1
OSTEICHTHYES	CARANGIDAE	<i>Caranx melampygus</i>	Cuvier, 1833							x						1
OSTEICHTHYES	CARANGIDAE	<i>Decapterus macarellus</i>	Cuvier, 1833						x							1
OSTEICHTHYES	LUTJANIDAE	<i>Aphareus furca</i>	(Lacepède, 1802)						x							3
OSTEICHTHYES	LUTJANIDAE	<i>Lutjanus fulvus</i>	(Forster, 1801)	Introduced	x									x		2
OSTEICHTHYES	LUTJANIDAE	<i>Lutjanus kasmira</i>	(Forsskål, 1775)	Introduced							x			x		2
OSTEICHTHYES	LETHRINIDAE	<i>Monotaxis grandoculis</i>	(Forsskål, 1775)									x				1
OSTEICHTHYES	MULLIDAE	<i>Mulloidichthys flavolineatus</i>	(Lacepède, 1801)							x						2
OSTEICHTHYES	MULLIDAE	<i>Parupeneus bifasciatus</i>	(Lacepède) 1802											x		2
OSTEICHTHYES	MULLIDAE	<i>Parupeneus cyclostomus</i>	(Lacepède) 1801									x				2
OSTEICHTHYES	MULLIDAE	<i>Parupeneus multifasciatus</i>	Quoy & Gaimard, 1824													7
OSTEICHTHYES	MULLIDAE	<i>Parupeneus pleurostigma</i>	(Bennett) 1831									x				2
OSTEICHTHYES	MULLIDAE	<i>Parupeneus porphyreus</i>	(Jenkins, 1902)													1
OSTEICHTHYES	KYPHOSIDAE	<i>Kyphosus sp.</i>														3
OSTEICHTHYES	CHAETODONTIDAE	<i>Chaetodon ephippium</i>	Cuvier 1831													2
OSTEICHTHYES	CHAETODONTIDAE	<i>Chaetodon lunulatus</i>	Quoy and Gaimard, 1825													1

Taxa	Family	Genus Species	Author Date	Status	Station										
					Cathedrals	LA1	LA2	LA3	LA4	LA5	LA6	LA7	LA8 Tot. Sta.		
OSTEICHTHYES	POMACENTRIDAE	<i>Plectrogyphidodo n sindonis</i>	(Jordan and Evermann, 1903)										x	1	
OSTEICHTHYES	POMACENTRIDAE	<i>Stegastes fasciolatus</i>	(Ogilby, 1889)										x	x	7
OSTEICHTHYES	SERRANIDAE	<i>Cephalopholis argus</i>	Bloch and Schneider 1801	Introduced									x	x	5
OSTEICHTHYES	CARACANTHIDAE	<i>Caracanthus typicus</i>	Kroyer, 1845												0
OSTEICHTHYES	LABRIDAE	<i>Anampses curvier</i>	Quoy and Gaimard, 1824											x	2
OSTEICHTHYES	LABRIDAE	<i>Bodianus bilunulatus</i>	(Lacepède, 1802)											x	2
OSTEICHTHYES	LABRIDAE	<i>Coris gaimard</i>	(Quoy and Gaimard, 1824)											x	2
OSTEICHTHYES	LABRIDAE	<i>Coris venusta</i>	Vaillant and Sauvage 1875												6
OSTEICHTHYES	LABRIDAE	<i>Gomphosus varius</i>	Lacepède 1801											x	6
OSTEICHTHYES	LABRIDAE	<i>Iniistius pavo</i>	(Valenciennes, 1840)											x	1
OSTEICHTHYES	LABRIDAE	<i>Labroides phthirophagus</i>	Randall 1958												5
OSTEICHTHYES	LABRIDAE	<i>Macropharyngodo n geoffroyi</i>	(Quoy and Gaimard, 1824)												1
OSTEICHTHYES	LABRIDAE	<i>Oxycheilinus bimaculatus</i>	(Valenciennes, 1840)												2
OSTEICHTHYES	LABRIDAE	<i>Pseudocheilinus octotaenia</i>	Jenkins 1901												4
OSTEICHTHYES	LABRIDAE	<i>Pseudocheilinus tetraetania</i>	Schultz, 1960												2
OSTEICHTHYES	LABRIDAE	<i>Stethojulis balteata</i>	(Quoy and Gaimard) 1824												2
OSTEICHTHYES	LABRIDAE	<i>Thalassoma duperrey</i>	(Quoy and Gaimard, 1824)												8
OSTEICHTHYES	LABRIDAE	<i>Thalassoma trilobatum</i>	(Lacepède, 1801)												1

Taxa	Family	Genus Species	Author Date	Status	Station									
					Cathedrals	LA1	LA2	LA3	LA4	LA5	LA6	LA7	LA8 Tot. Sta.	
OSTEICHTHYES	ACANTHURIDAE	<i>Naso lituratus</i>	(Forster and Schneider) 1801		x	x	x	x	x	x	x	x	x	7
OSTEICHTHYES	ACANTHURIDAE	<i>Naso unicornis</i>	(Forsskål) 1775										x	1
OSTEICHTHYES	ACANTHURIDAE	<i>Zebrasoma flavescens</i>	(Bennett, 1828)		x	x	x	x	x	x	x			5
OSTEICHTHYES	ACANTHURIDAE	<i>Zebrasoma veliferum</i>	(Bloch, 1797)				x							1
OSTEICHTHYES	ZANCLIDAE	<i>Zanclus cornutus</i>	(Linnaeus, 1758)		x	x			x		x			4
OSTEICHTHYES	BALISTIDAE	<i>Melichthys niger</i>	(Bloch) 1786		x						x		x	3
OSTEICHTHYES	BALISTIDAE	<i>Melichthys vidua</i>	(Solander, 1844)					x			x			3
OSTEICHTHYES	BALISTIDAE	<i>Rhinecanthus rectangulus</i>	(Bloch and Schneider, 1801)									x	x	2
OSTEICHTHYES	BALISTIDAE	<i>Sufflamen bursa</i>	(Bloch and Schneider, 1801)				x	x	x		x			4
OSTEICHTHYES	BALISTIDAE	<i>Sufflamen fraenatus</i>	(Latrielle, 1804)									x		1
OSTEICHTHYES	BALISTIDAE	<i>Xanthichthys auromarginatus</i>	(Bennett, 1831)										x	1
OSTEICHTHYES	MONOCANTHIDAE	<i>Aluterus scriptus</i>	(Osbeck, 1765)										x	1
OSTEICHTHYES	MONOCANTHIDAE	<i>Cantherhines dumerilii</i>	(Hollard, 1854)										x	1
OSTEICHTHYES	MONOCANTHIDAE	<i>Cantherhines sandwichiensis</i>	Quoy & Gaimard, 1824										x	1
OSTEICHTHYES	MONOCANTHIDAE	<i>Pervagor aspricaudus</i>	(Hollard, 1854)											2
OSTEICHTHYES	OSTRACIONIDAE	<i>Ostracion meleagris</i>	Shaw and Nodder, 1796										x	1
CHLOROPHYTA		<i>Arothron meleagris</i>												0
OSTEICHTHYES	TETRADONTIDAE	<i>Arothron meleagris</i>	(Lacepède) 1798										x	3
OSTEICHTHYES	TETRADONTIDAE	<i>Canthigaster amboinensis</i>	(Bleeker) 1865										x	4
OSTEICHTHYES	TETRADONTIDAE	<i>Canthigaster jactator</i>	(Jenkins, 1901)										x	7
REPTILIA	CHELONIIDAE	<i>Chelonia mydas</i>	(Linnaeus, 1758)										x	1

