ELECTRONIC SUPPLEMENTARY MATERIAL S1

Benthic and fish surveys – Sampling methodology

Stationary point counts (SPCs) were used at each site to collect detailed data on fish communities (species composition, individual size) and visual estimates of benthic hard-bottom habitat (percent cover of hard coral, crustose coralline algae, turf algae, macroalgae and sand) across depth (0-30 meters). In addition, structural complexity was visually estimated on a scale from 1 (very low) to 5 (very high). In cases where sites were allocated on what turned out to be soft seabed, the survey was not conducted. Site locations were rerandomized before each cruise and always separated by at least 100 m.

A pair of divers simultaneously conducted SPCs in 7.5 m radius cylinders (visually estimated) extending from the substrate to the limits of vertical visibility. One SPC-pair was made of two concurrent and adjacent SPC located along a single 30 m transect line, laid across the substratum with markings at 7.5 m, 15 m and 22.5 m to help the divers locating the mid point and the two edges of their survey plots. If the divers could not see the edge point of their cylinder (i.e. horizontal visibility was < 7.5 m) the survey was cancelled. Otherwise one or two SPC-pairs were conducted per survey, the site data being the average of all of those.

Each count consisted of two phases: first, the divers recorded a list of all species observed during 5 minutes within their cylinder. Then, through rapid visual sweeps of the plots, they recorded number and size (total length to the nearest cm) of all fishes on the list. In cases where a species was observed during the first phase but had left the cylinder when came the tallying phase, divers recorded an estimate of size and number based on the first encounter and marked the data record as “non instantaneous”. However, for rarely encountered or highly mobile species, size and number were noted as soon as first seen in order not to miss opportunity to gather data on them. Divers mostly remained at the centre of the cylinder until the end of the tally part at which time they swam through the plot area, carefully searching for small and cryptic species that would otherwise be underrepresented.

ELECTRONIC SUPPLEMENTARY MATERIAL S2

Categorisation of fish data

Trophic level and functional group categorisation of 194 fish species based on their diet and feeding behaviour.

TROPHIC LEVEL FUNCTIONAL GROUP		DIET
Large predators (Apex predators)		Feed mainly on big fishes
Small predators		Feed mainly on small fishes and octopus
Large invertebrate feeders		Feed mainly on large invertebrates that have an important impact on ecosystem functioning (e.g. crabs, starfishes, sea urchins, …)
Small invertebrate feeders		Feed mainly on small benthic invertebrates (e.g. worms, shrimps, gastropods, small crustaceans, …)
Planktivores		Feed mainly on plankton/zooplankton
Corallivores		Feed mainly on coral polyps
Obligate detritivores		Feed mainly on decomposing plant and animal parts
Herbivores	*Browsers*	Feed on macroalgae
	Scrapers	Feed mainly on algal turf and remove some part of the reef substratum as they feed
	Grazers	Feed intensely on filamentous algae without scraping or excavating the reef as they feed

Species Code	Taxon Name	Family	Trophic level
CHOR	Chaetodon ornatissimus	Chaetodontidae	Corallivore
CHME	Chaetodon meyeri	Chaetodontidae	Corallivore
CHLT	Chaetodon lunulatus	Chaetodontidae	Corallivore
PLJO	Plectroglyphidodon johnstonianus	Pomacentridae	Corallivore
CHQU	Chaetodon quadrimaculatus	Chaetodontidae	Corallivore
CHMU	Chaetodon multicinctus	Chaetodontidae	Corallivore
CADU	Cantherhines dumerilii	Monacanthidae	Corallivore
EXBR	Exallias brevis	Blenniidae	Corallivore
CHRE	Chaetodon reticulatus	Chaetodontidae	Corallivore
CHUN	Chaetodon unimaculatus	Chaetodontidae	Corallivore
ARME	Arothron meleagris	Tetraodontidae	Corallivore
PESP	Pervagor spilosoma	Monacanthidae	Corallivore
CHLI	Chaetodon lineolatus	Chaetodontidae	Corallivore
CHTR	Chaetodon trifascialis	Chaetodontidae	Corallivore
CTST	Ctenochaetus strigosus	Acanthuridae	Detritivore (exclusively)
CTHA	Ctenochaetus hawaiiensis	Acanthuridae	Detritivore (exclusively)
TRIG	Balistidae sp	Balistidae	Herbivore (Grazer)
BLEN	Blenniidae sp	Blenniidae	Herbivore (Grazer)
CISP	Cirripectes sp	Blenniidae	Herbivore (Grazer)
CIOB	Cirripectes obscurus	Blenniidae	Herbivore (Grazer)
CIVA	Cirripectes vanderbilti	Blenniidae	Herbivore (Grazer)

CIVA	Cirripectes vanderbilti	Blenniidae	Herbivore (Grazer)
CAZO	Calotomus zonarchus	Scaridae	Herbivore (Browser)
KYHA	Kyphosus hawaiiensis	Kyphosidae	Herbivore (Browser)
NALI	Naso lituratus	Acanthuridae	Herbivore (Browser)
KYCI	Kyphosus cinerascens	Kyphosidae	Herbivore (Browser)
CACA	Calotomus carolinus	Scaridae	Herbivore (Browser)
KYVA	Kyphosus vaigiensis	Kyphosidae	Herbivore (Browser)
NAUN	Naso unicornis	Acanthuridae	Herbivore (Browser)
CHUB	Kyphosidae sp	Kyphosidae	Herbivore (Browser)
NASP	Naso sp	Acanthuridae	Herbivore (Browser)
KYSA	Kyphosus sandwicensis	Kyphosidae	Herbivore (Browser)
MENI	Melichthys niger	Balistidae	Herbivore (Browser)
PLSI	Plectroglyphidodon sindonis	Pomacentridae	Herbivore (Grazer)
CEPO	Centropyge potteri	Pomacanthidae	Herbivore (Grazer)
STFA	Stegastes fasciolatus	Pomacentridae	Herbivore (Grazer)
ZEFL	Zebrasoma flavescens	Acanthuridae	Herbivore (Grazer)
ACNF	Acanthurus nigrofuscus	Acanthuridae	Herbivore (Grazer)
ACNC	Acanthurus nigricans	Acanthuridae	Herbivore (Grazer)
ACNR	Acanthurus nigroris	Acanthuridae	Herbivore (Grazer)
ACLE	Acanthurus leucopareius	Acanthuridae	Herbivore (Grazer)
ACAC	Acanthurus achilles	Acanthuridae	Herbivore (Grazer)
ACAN	Acanthurus achillesXnigricans hybr	Acanthuridae	Herbivore (Grazer)
ACTR	Acanthurus triostegus	Acanthuridae	Herbivore (Grazer)
ACGU	Acanthurus guttatus	Acanthuridae	Herbivore (Grazer)
ACLI	Acanthurus lineatus	Acanthuridae	Herbivore (Grazer)
ACOL	Acanthurus olivaceus	Acanthuridae	Herbivore (Grazer)
ZEVE	Zebrasoma veliferum	Acanthuridae	Herbivore (Grazer)
ACBL	Acanthurus blochii	Acanthuridae	Herbivore (Grazer)
ACDU	Acanthurus dussumieri	Acanthuridae	Herbivore (Grazer)
ACSP	Acanthurus sp	Acanthuridae	Herbivore (Grazer)
ACXA	Acanthurus xanthopterus	Acanthuridae	Herbivore (Grazer)
SURG	Acanthuridae sp	Acanthuridae	Herbivore (Grazer)
CHCH	Chanos chanos	Chanidae	Herbivore (Grazer)
CEFI	Centropyge fisheri	Pomacanthidae	Herbivore (Grazer)
CELO	Centropyge loricula	Pomacanthidae	Herbivore (Grazer)
MEVI	Melichthys vidua	Balistidae	Herbivore (Grazer)
SCPS	Scarus psittacus	Scaridae	Herbivore (Scraper)
SCDU	Scarus dubius	Scaridae	Herbivore (Scraper)
CHSO	Chlorurus sordidus	Scaridae	Herbivore (Scraper)
CHPE	Chlorurus perspicillatus	Scaridae	Herbivore (Scraper)
PARR	Scaridae sp	Scaridae	Herbivore (Scraper)
SCRU	Scarus rubroviolaceus	Scaridae	Herbivore (Scraper)
SCSP	Scarus sp	Scaridae	Herbivore (Scraper)
CLSP	Chlorurus sp	Scaridae	Herbivore (Scraper)
CASA	Cantherhines sandwichiensis	Monacanthidae	Herbivore (Grazer)
ABSO	Abudefduf sordidus	Pomacentridae	Herbivore (Grazer)
PAMA	Parablennius marmoratus	Blenniidae	Herbivore (Grazer)
ACMA	Acanthurus maculiceps	Acanthuridae	Herbivore (Grazer)
ASSE	Asterropteryx semipunctata	Gobiidae	Herbivore (Grazer)
CEFL	Centropyge flavissima	Pomacanthidae	Herbivore (Grazer)
CEIN	Centropyge interruptus	Pomacanthidae	Herbivore (Grazer)
STNI	Stegastes nigricans	Pomacentridae	Herbivore (Grazer)
STSP	Stegastes sp	Pomacentridae	Herbivore (Grazer)
CASO	Canthigaster solandri	Tetraodontidae	Herbivore (Grazer)

GOAT	Mullidae sp	Mullidae	Large Invert. Feeder
OPPU	Oplegnathus punctatus	Oplegnathidae	Large Invert. Feeder
INUM	Iniistius umbrilatus	Labridae	Large Invert. Feeder
MUMI	Mulloidichthys mimicus	Mullidae	Large Invert. Feeder
COBA	Coris ballieui	Labridae	Large Invert. Feeder
CAAM	Canthigaster amboinensis	Tetraodontidae	Large Invert. Feeder
CACO	Canthigaster coronata	Tetraodontidae	Large Invert. Feeder
THQU	Thalassoma quinquevittatum	Labridae	Large Invert. Feeder
COVE	Coris venusta	Labridae	Large Invert. Feeder
RHRE	Rhinecanthus rectangulus	Balistidae	Large Invert. Feeder
SUBU	Sufflamen bursa	Balistidae	Large Invert. Feeder

SUBU	Sufflamen bursa	Balistidae	Large Invert. Feeder
RHAC	Rhinecanthus aculeatus	Balistidae	Large Invert. Feeder
SUFR	Sufflamen fraenatum	Balistidae	Large Invert. Feeder
LUKA	Lutjanus kasmira	Lutjanidae	Large Invert. Feeder
ARHI	Arothron hispidus	Tetraodontidae	Large Invert. Feeder
FOFL	Forcipiger flavissimus	Chaetodontidae	Large Invert. Feeder
THLU	Thalassoma lutescens	Labridae	Large Invert. Feeder
THCR	Thalassoma duperrey/lutescens hy	Labridae	Large Invert. Feeder
THDU	Thalassoma duperrey	Labridae	Large Invert. Feeder
CIFA	Cirrhitops fasciatus	Cirrhitidae	Large Invert. Feeder
PAAR	Paracirrhites arcatus	Cirrhitidae	Large Invert. Feeder
PSOC	Pseudocheilinus octotaenia	Labridae	Large Invert. Feeder
OXBI	Oxycheilinus bimaculatus	Labridae	Large Invert. Feeder
NOTA	Novaculichthys taeniourus	Labridae	Large Invert. Feeder
CIPI	Cirrhitus pinnulatus	Cirrhitidae	Large Invert. Feeder
NESA	Neoniphon sammara	Holocentridae	Large Invert. Feeder
GOVA	Gomphosus varius	Labridae	Large Invert. Feeder
THTR	Thalassoma trilobatum	Labridae	Large Invert. Feeder
PAPL	Parupeneus pleurostigma	Mullidae	Large Invert. Feeder
SATI	Sargocentron tiere	Holocentridae	Large Invert. Feeder
PAIN	Parupeneus insularis	Mullidae	Large Invert. Feeder
PAMU	Parupeneus multifasciatus	Mullidae	Large Invert. Feeder
DIHO	Diodon holocanthus	Diodontidae	Large Invert. Feeder
COGA	Coris gaimard	Labridae	Large Invert. Feeder
MUFL	Mulloidichthys flavolineatus	Mullidae	Large Invert. Feeder
THBA	Thalassoma ballieui	Labridae	Large Invert. Feeder
THPU	Thalassoma purpureum	Labridae	Large Invert. Feeder
MUPF	Mulloidichthys pfluegeri	Mullidae	Large Invert. Feeder
PAPO	Parupeneus porphyreus	Mullidae	Large Invert. Feeder
SASP	Sargocentron spiniferum	Holocentridae	Large Invert. Feeder
BOBI	Bodianus bilunulatus	Labridae	Large Invert. Feeder
MOGR	Monotaxis grandoculis	Lethrinidae	Large Invert. Feeder
BAPO	Balistes polylepis	Balistidae	Large Invert. Feeder
DIHY	Diodon hystrix	Diodontidae	Large Invert. Feeder
GYZE	Gymnomuraena zebra	Muraenidae	Large Invert. Feeder
AENA	Aetobatus narinari	Myliobatidae	Large Invert. Feeder
SECO	Sebastapistes coniorta	Scorpaenidae	Large Invert. Feeder
COFL	Coris flavovittata	Labridae	Large Invert. Feeder
PSTE	Pseudocheilinus tetrataenia	Labridae	Large Invert. Feeder
LUFU	Lutjanus fulvus	Lutjanidae	Large Invert. Feeder
GYEU	Gymnothorax eurostus	Muraenidae	Large Invert. Feeder
INPA	Iniistius pavo	Labridae	Large Invert. Feeder
DEBA	Dendrochirus barberi	Scorpaenidae	Large Invert. Feeder
PRME	Priacanthus meeki	Priacanthidae	Large Invert. Feeder
CHIN	Cheilio inermis	Labridae	Large Invert. Feeder
GOVI	Goniistius vittatus	Cheilodactylidae	Large Invert. Feeder
NESP	Neoniphon sp	Holocentridae	Large Invert. Feeder
SACA	Sargocentron caudimaculatum	Holocentridae	Large Invert. Feeder
THDQ	Thalassoma duperrey/quinquevitta	Labridae	Large Invert. Feeder
THSP	Thalassoma sp	Labridae	Large Invert. Feeder
BRMU	Brotula multibarbata	Ophidiidae	Large Invert. Feeder
OPFA	Oplegnathus fasciatus	Oplegnathidae	Large Invert. Feeder
POSE	Polydactylus sexfilis	Polynemidae	Large Invert. Feeder
BIGE	Priacanthus sp	Priacanthidae	Large Invert. Feeder
HECR	Heteropriacanthus cruentatus	Priacanthidae	Large Invert. Feeder
INAN	Iniistius aneitensis	Labridae	Large Invert. Feeder
ECNE	Echidna nebulosa	Muraenidae	Large Invert. Feeder
TROB	Triaenodon obesus	Carcharhinidae	Large Predator
CAAB	Carcharhinus amblyrhynchos	Carcharhinidae	Large Predator
CAGA	Carcharhinus galapagensis	Carcharhinidae	Large Predator
CAME	Caranx melampygus	Carangidae	Large Predator
CAIG	Caranx ignobilis	Carangidae	Large Predator
APVI	Aprion virescens	Lutjanidae	Large Predator
SEDU	Seriola dumerili	Carangidae	Large Predator
CALU	Caranx lugubris	Carangidae	Large Predator
CASP	Caranx sp	Carangidae	Large Predator

APSP	Apogon sp	Apogonidae	Planktivore
CARD	Apogonidae sp	Apogonidae	Planktivore
MYSP	Myripristinae sp	Holocentridae	Planktivore
NABR	Naso brevirostris	Acanthuridae	Planktivore
NAAN	Naso annulatus	Acanthuridae	Planktivore
CHKL	Chaetodon kleinii	Chaetodontidae	Planktivore
CHAC	Chromis acares	Pomacentridae	Planktivore
KUSA	Kuhlia sandvicensis	Kuhliidae	Planktivore
APKA	Apogon kallopterus	Apogonidae	Planktivore
GUCU	Gunnellichthys curiosus	Microdesmidae	Planktivore
APMA	Apogon maculiferus	Apogonidae	Planktivore
MYAM	Myripristis amaena	Holocentridae	Planktivore
OXTY	Oxycirrhites typus	Cirrhitidae	Planktivore
ABVA	Abudefduf vaigiensis	Pomacentridae	Planktivore
ABAB	Abudefduf abdominalis	Pomacentridae	Planktivore
CHLC	Chromis leucura	Pomacentridae	Planktivore
SPDE	Spratelloides delicatulus	Clupeidae	Planktivore
CHHA	Chromis hanui	Pomacentridae	Planktivore
NEMA	Nemateleotris magnifica	Ptereleotridae	Planktivore
CIJO	Cirrhilabrus jordani	Labridae	Planktivore
CHAG	Chromis agilis	Pomacentridae	Planktivore
DAAL	Dascyllus albisella	Pomacentridae	Planktivore
PTHE	Ptereleotris heteroptera	Ptereleotridae	Planktivore
PSBI	Pseudanthias bicolor	Serranidae	Planktivore
CHVA	Chromis vanderbilti	Pomacentridae	Planktivore
CHMI	Chaetodon miliaris	Chaetodontidae	Planktivore
HEPO	Hemitaurichthys polylepis	Chaetodontidae	Planktivore
CHOV	Chromis ovalis	Pomacentridae	Planktivore
HEDI	Heniochus diphreutes	Chaetodontidae	Planktivore
HETH	Hemitaurichthys thompsoni	Chaetodontidae	Planktivore
CHVE	Chromis verater	Pomacentridae	Planktivore
XAAU	Xanthichthys auromarginatus	Balistidae	Planktivore
MYKU	Myripristis kuntee	Holocentridae	Planktivore
ACTH	Acanthurus thompsoni	Acanthuridae	planktivore
MYBE	Myripristis berndti	Holocentridae	Planktivore
DEMA	Decapterus macarellus	Carangidae	Planktivore
NAHE	Naso hexacanthus	Acanthuridae	Planktivore
SNDP	Pinguipedidae sp	Pinguipedidae	Planktivore
SECR	Selar crumenophthalmus	Carangidae	Planktivore
XAME	Xanthichthys mento	Balistidae	Planktivore
ENPU	Encrasicholina purpurea	Engraulidae	Planktivore
MYVI	Myripristis vittata	Holocentridae	Planktivore
MABI	Manta birostris	Myliobatidae	Planktivore
GEPE	Genicanthus personatus	Pomacanthidae	Planktivore
ANTH	Anthias sp	Serranidae	Planktivore
PSHW	Pseudanthias ventralis hawaiiensis	Serranidae	Planktivore
PSTH	Pseudanthias thompsoni	Serranidae	Planktivore
SOLD	Myripristis sp	Holocentridae	Planktivore
NACA	Naso caesius	Acanthuridae	Planktivore
NAMA	Naso maculatus	Acanthuridae	Planktivore

CATY	Caracanthus typicus	Caracanthidae	Small Invert. Feeder
SAPP	Sargocentron sp	Holocentridae	Small Invert. Feeder
GOBI	Gobiidae sp	Gobiidae	Small Invert. Feeder
PUFF	Tetraodontidae sp	Tetraodontidae	Small Invert. Feeder
AMBI	Amblycirrhitus bimacula	Cirrhitidae	Small Invert. Feeder
CAJA	Canthigaster jactator	Tetraodontidae	Small Invert. Feeder
PASC	Parapercis schauinslandii	Pinguipedidae	Small Invert. Feeder
WRAS	Labridae sp	Labridae	Small Invert. Feeder
PSCE	Pseudojuloides cerasinus	Labridae	Small Invert. Feeder
GYMT	Gymnothorax melatremus	Muraenidae	Small Invert. Feeder
PLIM	Plectroglyphidodon imparipennis	Pomacentridae	Small Invert. Feeder
CHFR	Chaetodon fremblii	Chaetodontidae	Small Invert. Feeder
FOLO	Forcipiger longirostris	Chaetodontidae	Small Invert. Feeder
MAGE	Macropharyngodon geoffroy	Labridae	Small Invert. Feeder

MAGE	Macropharyngodon geoffroy	Labridae	Small Invert. Feeder
SADI	Sargocentron diadema	Holocentridae	Small Invert. Feeder
SAXA	Sargocentron xantherythrum	Holocentridae	Small Invert. Feeder
APAR	Apolemichthys arcuatus	Pomacanthidae	Small Invert. Feeder
CHTI	Chaetodon tinkeri	Chaetodontidae	Small Invert. Feeder
ZACO	Zanclus cornutus	Zanclidae	Small Invert. Feeder
ANCH	Anampses chrysocephalus	Labridae	Small Invert. Feeder
CHLU	Chaetodon lunula	Chaetodontidae	Small Invert. Feeder
CHAU	Chaetodon auriga	Chaetodontidae	Small Invert. Feeder
CHEP	Chaetodon ephippium	Chaetodontidae	Small Invert. Feeder
OSME	Ostracion meleagris	Ostraciidae	Small Invert. Feeder
ANCU	Anampses cuvier	Labridae	Small Invert. Feeder
ALSC	Aluterus scriptus	Monacanthidae	Small Invert. Feeder
PEAS	Pervagor aspricaudus	Monacanthidae	Small Invert. Feeder
PSEV	Pseudocheilinus evanidus	Labridae	Small Invert. Feeder
HAOR	Halichoeres ornatissimus	Labridae	Small Invert. Feeder
STBA	Stethojulis balteata	Labridae	Small Invert. Feeder
SCPA	Scorpaenodes parvipinnis	Scorpaenidae	Small Invert. Feeder
MABR	Malacanthus brevirostris	Malacanthidae	Small Invert. Feeder
MUVA	Mulloidichthys vanicolensis	Mullidae	Small Invert. Feeder
FOBR	Foa brachygramma	Apogonidae	Small Invert. Feeder
ATIN	Atherinomorus insularum	Atherinidae	Small Invert. Feeder
CHCI	Chaetodon citrinellus	Chaetodontidae	Small Invert. Feeder
COFU	Coryphopterus sp	Gobiidae	Small Invert. Feeder
FUDU	Fusigobius duospilus	Gobiidae	Small Invert. Feeder
PSMA	Psilogobius mainlandi	Gobiidae	Small Invert. Feeder
SAPU	Sargocentron punctatissimum	Holocentridae	Small Invert. Feeder
ANSP	Anampses sp	Labridae	Small Invert. Feeder
CAVE	Cantherhines verecundus	Monacanthidae	Small Invert. Feeder
PACH	Parupeneus chrysonemus	Mullidae	Small Invert. Feeder
LAFO	Lactoria fornasini	Ostraciidae	Small Invert. Feeder
DOEX	Doryrhamphus excisus excisus	Syngnathidae	Small Invert. Feeder
LAPH	Labroides phthirophagus	Labridae	Small Invert. Feeder

LIZA	Synodontidae sp	Synodontidae	Small Predator
SCPP	Scorpaenopsis sp	Scorpaenidae	Small Predator
NEED	Belonidae sp	Belonidae	Small Predator
CONG	Congridae sp	Congridae	Small Predator
GYSP	Gymnothorax sp	Muraenidae	Small Predator
GYJA	Gymnothorax javanicus	Muraenidae	Small Predator
PAFO	Paracirrhites forsteri	Cirrhitidae	Small Predator
SYVA	Synodus variegatus	Synodontidae	Small Predator
SCDI	Scorpaenopsis diabolus	Scorpaenidae	Small Predator
SAFL	Saurida flamma	Synodontidae	Small Predator
OXUN	Oxycheilinus unifasciatus	Labridae	Small Predator
PLAR	Platybelone argalus	Belonidae	Small Predator
PACY	Parupeneus cyclostomus	Mullidae	Small Predator
SCCA	Scorpaenopsis cacopsis	Scorpaenidae	Small Predator
CEAR	Cephalopholis argus	Serranidae	Small Predator
CAFE	Carangoides ferdau	Carangidae	Small Predator
SCLY	Scomberoides lysan	Carangidae	Small Predator
CAOR	Carangoides orthogrammus	Carangidae	Small Predator
APFU	Aphareus furca	Lutjanidae	Small Predator
AUCH	Aulostomus chinensis	Aulostomidae	Small Predator
COCI	Conger cinereus	Congridae	Small Predator
GYME	Gymnothorax meleagris	Muraenidae	Small Predator
ENCA	Enchelynassa canina	Muraenidae	Small Predator
GYUN	Gymnothorax undulatus	Muraenidae	Small Predator
FICO	Fistularia commersonii	Fistulariidae	Small Predator
SPBA	Sphyraena barracuda	Sphyraenidae	Small Predator
GYFL	Gymnothorax flavimarginatus	Muraenidae	Small Predator
TATR	Taenianotus triacanthus	Scorpaenidae	Small Predator
SYBI	Synodus binotatus	Synodontidae	Small Predator

TATR	Taenianotus triacanthus	Scorpaenidae	Small Predator
SYBI	Synodus binotatus	Synodontidae	Small Predator
PTSP	Pterois sphex	Scorpaenidae	Small Predator
ANCO	Antennarius commerson	Antennariidae	Small Predator
TYCR	Tylosurus crocodilus	Belonidae	Small Predator
ELBI	Elagatis bipinnulata	Carangidae	Small Predator
PSDE	Pseudocaranx dentex	Carangidae	Small Predator
HALF	Hemiramphidae	Hemiramphidae	Small Predator
MYCH	Myripristis chryseres	Holocentridae	Small Predator
NEAU	Neoniphon aurolineatus	Holocentridae	Small Predator
PROL	Pristilepis oligolepis	Holocentridae	Small Predator
SAEN	Sargocentron ensifer	Holocentridae	Small Predator
CYLE	Cymolutes lecluse	Labridae	Small Predator
CYPR	Cymolutes praetextatus	Labridae	Small Predator
EPIN	Epibulus insidiator	Labridae	Small Predator
ENPA	Enchelycore pardalis	Muraenidae	Small Predator
GYST	Gymnothorax steindachneri	Muraenidae	Small Predator
MORA	Muraenidae	Muraenidae	Small Predator
MYMA	Myrichthys magnificus	Ophichthidae	Small Predator
EUAF	Euthynnus affinis	Scombridae	Small Predator
KAPE	Katsuwonus pelamis	Scombridae	Small Predator
SEBA	Sebastapistes ballieui	Scorpaenidae	Small Predator
SESP	Sebastapistes sp	Scorpaenidae	Small Predator
EPQU	Epinephelus quernus	Serranidae	Small Predator
SAGR	Saurida gracilis	Synodontidae	Small Predator
SYDE	Synodus dermatogenys	Synodontidae	Small Predator
SYUL	Synodus ulae	Synodontidae	Small Predator

ELECTRONIC SUPPLEMENTARY MATERIAL S3

Geospatial human and environmental data

A set of human-use and environmental variables – human population density, distance to potential impact (e.g. shore, stream), effluent discharge and stream disturbance data – was available for the Main Hawaiian Islands except for Lānaʻi and Niʻihau. The shoreline and stream data sets were both provided by the Hawaii State GIS Program and the distance in meters was calculated for each survey location using the Near tool. Human population density was derived from 2010 census blocks from the U.S. Census Bureau and the Hawaii State GIS Program. Values represent the total number of people in a census block. Circular buffers were used at 10 km radius from survey locations and data were included for all polygons that intersected a buffer. Data for Onsite Sewage Disposal Systems (OSDS) were developed by the University of Hawaii at Manoa to assess the health and environment risks posed by OSDS (Whittier and El-kadi 2009). From those, the total effluent in million gallons per day was derived for each survey location. Circular buffers were used at 10 km radius from the survey locations and data were included for all OSDS points that intersected a buffer. Stream disturbance data were assembled as part of the assessment of fish habitats in Hawaiʻi for the National Fish Habitat Action Plan (Esselman et al. 2011) and derived for each survey locations. These indexes were standardised from 0 to 1 across catchments and considered at the local scale, which represents stream disturbance at a particular stream rather than within a stream network (network scale). (See Table S3-1 and Table S3-2 below for detailed list of all the variables and indexes used in relation to stream disturbance)

References

Esselman, P. C., D. M. Infante, L. Wang, D. Wu, A. R. Cooper, and W. W. Taylor, 2011. An index of cumulative disturbance to river fish habitats of the conterminous United States from landscape anthropogenic activities. Ecological Restoration, 29:133-151.

Whittier, R. B., and A. I. El-kadi. 2009. Human and Environmental Risk Ranking of Onsite Sewage Disposal Systems - Final Draft.

Table S3-1. Land cover variables used to create indices of stream disturbance (from the NFHP 2010 Hawaiian stream risk of degradation assessment).

Variable description	Units	Scale	Source	Code
Total length of utility pipelines	m/km^2	1:24000	Hawaii Statewide GIS program[b]	Pipeleng
Total length of tiger 2002 roads (removed paths/trails)	m/km^2	1:100000	Hawaii Statewide GIS program[b]	Roadleng
Population density	pop/km^2	12 digit Census blocks	NOAA[e]	Popdens
Developed, open space	%	30m	NOAA[e]	Open
Developed, low intensity	%	30m	NOAA[e]	Low
Developed, medium intensity	%	30m	NOAA[e]	Medium
Developed, high intensity	%	30m	NOAA[e]	High
Percentage of imperviousness	%	30m	NOAA[e]	Imperv
Dams present on Hawaii streams	#/km^2	NA	ACE; National Inventory of Dams[a]	Dams
Number of sites from the Superfund National Priorities List	#/km^2	NA	EPA[d]	Cerclis
Majors from the Permit Compliance System (PCS)	#/km^2	NA	EPA[d]	Pcs
Number of sites from the Toxics Release Inventory (TRI) Program	#/km^2	NA	EPA[d]	Tri
The total number of underground injection wells within a watershed	#/km^2	NA	Hawaii DOH	Uic
Quarries located on islands with company name (gems, stones, gravel)	#/km^2	NA	Hawaii Statewide GIS program[b]	Mines
Intersections with tiger 2002 roads (modified to remove paths/trails)	#/km^2	1:100000	Hawaii Statewide GIS program[b]	RoadInter
Intersections with NHD ditches	#/km^2	1:24000	NHD 24K[c]	DitchInter
Land that was at one time pineapple or sugarcane plantations (combined)	%	30m	Hawaii Statewide GIS program[b]	FormPlant
Total length of ditches	m/km^2	NA	USGS Digital Line graphs,1983 Version, DAR	Ditchleng
Pasture/Hay	%	30m	NOAA[e]	Pasture
Cultivated Crops	%	30m	NOAA[e]	Crops

SOURCES
[a] http://www.lrn.usace.army.mil/
[b] http://www.state.hi.us/dbedt/gis/
[c] http://nhd.usgs.gov/data.html
[d] http://epa.gov/
[e] http://www.csc.noaa.gov/digitalcoast/data/ccapregiona

Table S3-2. Indices of stream disturbance made from land cover variables (Table S3-1) and used as predictor variables in the Boosted Regression Trees analysis of the occurrence of multiple benthic regimes in the Hawaiian Archipelago.

Index	Code	Variables included
Urban	UrbanIndex	Pipeleng Roadleng Popdens Open Low Medium High Imperv
A representation of urban disturbance within a catchment. This is a composite variable consisting of eight landscape level urban influences. Using variable weightings created through principle components analysis (PCA), an urban disturbance score was calculated for each catchment and standardized from 0 to 1.		
Point Source	PointIndex	Dams Cerclis Pcs Tri Uic Mines
A representation of the density of sources of point pollution within a catchment. This is a composite variable consisting of six point sources of pollution. Using variable weightings created through principle components analysis (PCA), a single point source pollution score was calculated for each catchment and standardized from 0 to 1.		
Fragmentation	FragIndex	RoadInter DitchInter
A representation of stream fragmentation, which may indicate migration limitations and disruption of the natural flow regime. The total density of road and ditch intersections were standardized 0 to 1 individually, then summed and standardized 0 to 1 across catchments		
Former Plantation	FormPlIndex	FormPlant
A representation of lands that were formerly pineapple or sugarcane plantations and may contribute to disturbance through legacy effects. The total amount of former plantation land cover within a catchment was determined by subtracting the percent current agricultural land from the percent former plantation for all catchments where agricultural land cover decreased by greater than 5%. In catchments where agricultural land decreased by less than 5%, it was assumed that all land formerly used for plantations was still currently being used for agriculture and was therefore not represented by this disturbance variable. This percentage was then standardized from 0 to 1 across catchments.		
Ditch	DitchIndex	Ditchleng
A representation of the relative density of ditch infrastructure. This is a single variable score in which density was standardized 0 to 1 across catchments.		
Agriculture	AgrIndex	Pasture Crops
A representation of agricultural disturbance within a catchment. The total percent of pasture/ hay or cultivated crops were summed and then standardized 0 to 1 across catchments.		

ELECTRONIC SUPPLEMENTARY MATERIAL S4

Boosted Regression Trees methodology

The categorisation of sites into different regimes was converted to presence-absence of each regime by survey site and analyzed using a binomial distribution. Cross-validation deviance (cv) and standard error (se) were used to estimate model performance, with lower values indicating a better model. To achieve model optimisation, three parameters were adjusted: tree complexity (tc), learning rate (lr) and bag-fraction. The tree complexity determines the number of nodes in a tree, while the learning rate establishes the contribution of each tree to the model, and the bag-fraction specifies the proportion of data to be selected at each step (stochasticity). Optimal values for these parameters were obtained by running in a loop (Richards et al. 2012) all possible combinations of tc (1-2-3-4-5), lr (0.01-0.001-0.005) and bag-fraction (0.5-0.75). The combination with lowest deviance was then selected to fit the final Boosted Regression Trees (BRT). Finally, the *gbm.simplify* routine (3) was used to perform a backward selection that potentially drops variables contributing very little and therefore increases predictive performance. The following variables were found to exert no influence on predicting the occurrence of the different regimes and so were removed from the final BRT models:

Calcifying regime

In the MHI: FormPindex – PoinIndex – DitchIndex – AgrIndex – UrbanIndex

In the NWHI: Reef Zones

Turf regime

In the MHI: FormPindex – PoinIndex – Population – DitchIndex – DistCoast – AgrIndex – UrbanIndex

In the NWHI: Reef Zones

Macroalgal/sand regime

In the MHI: FormplIndex

In the NWHI: Reef Zones

Reference

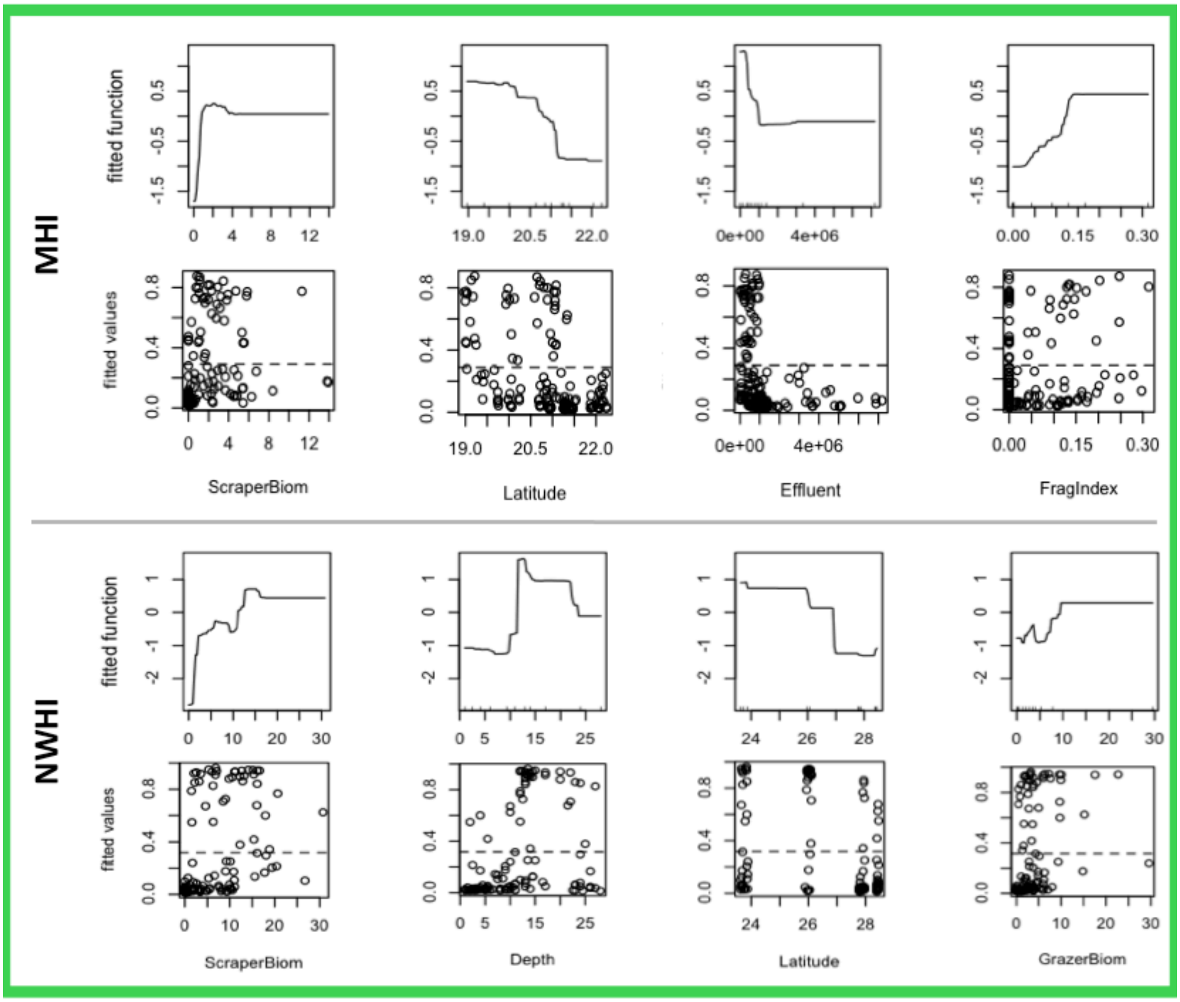
Richards, B. L., I. D. Williams, O. J. Vetter, and G. J. Williams. 2012. Environmental factors affecting large-bodied coral reef fish assemblages in the Mariana Archipelago. PloS one 7:e31374.

Table S4-1. Relative influence of human and natural variables on reef regimes: optimal parameters and predictive performance of the final Boosted Regression Trees models associating three benthic regimes to natural and human variables in the MHI and the NWHI. Cross validation deviance (cv) and standard error (se) were used as measures of model performance (the lower the values the better the model).

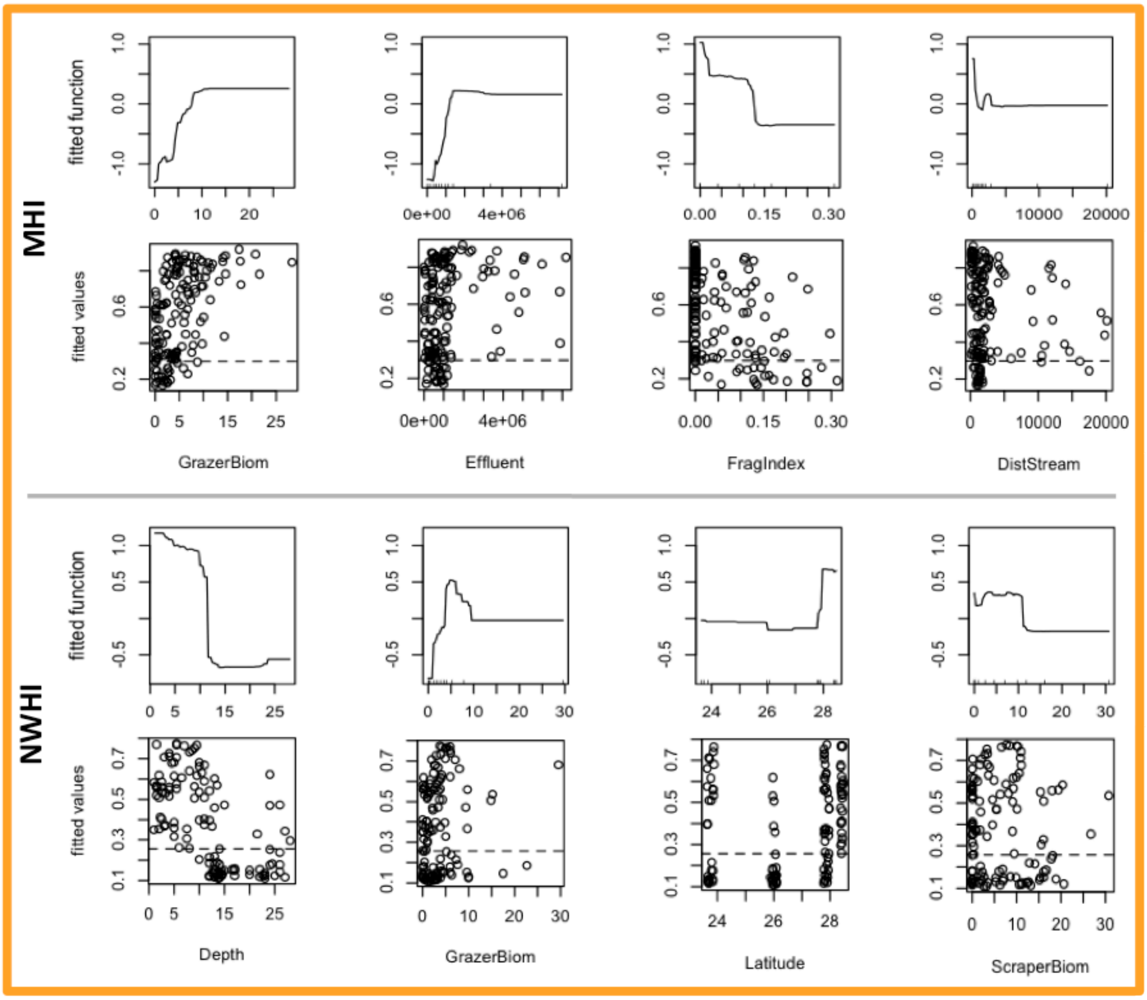
Regime	Region	Learning rate	Tree complexity	Bag-fraction	# of trees	Mean total deviance	cv	se
Calcifying	MHI	0.001	3	0.5	4050	1.113	0.737	0.095
	NWHI	0.0005	5	0.75	7950	1.23	0.612	0.05
Turf	MHI	0.001	5	0.5	2950	1.37	1.121	0.087
	NWHI	0.0005	5	0.75	4400	1.337	1.099	0.077
Macroalgal/ sand	MHI	0.0005	3	0.5	8200	0.974	0.645	0.048
	NWHI	0.001	4	0.5	2500	1.23	0.982	0.083

Plots of the fitted values in relation to each of the four most influential predictors for the different regimes: *(a) calcifying* regime, *(b) turf* regime, *(c) macroalgal/sand* regime. Although the mean values used as our unit of independent replication arrived from a large data collection across the entire archipelago, the mathematical replication was relatively low for a Boosted Regression Trees analysis as a means to identify threshold values. The plots below were used to give examples of preliminary thresholds in cases where we felt adequate replication existed along the covariate axis so as to allow interpretation of a threshold change in the fitted function.

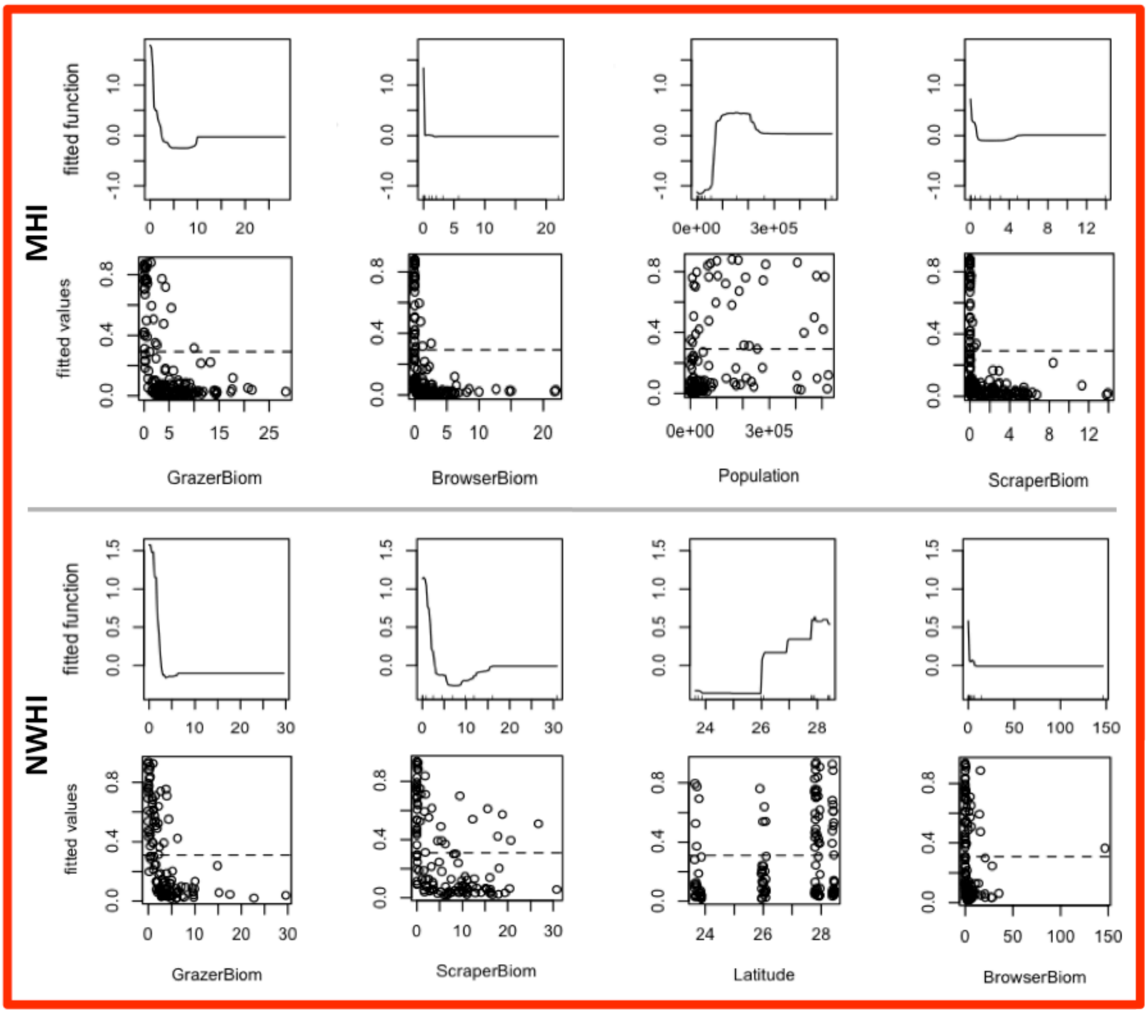
(a)



(b)


MHI
fitted function
fitted values
GrazerBiom
Effluent
FragIndex
DistStream
NWHI
fitted function
fitted values
Depth
GrazerBiom
Latitude
ScraperBiom

(c)

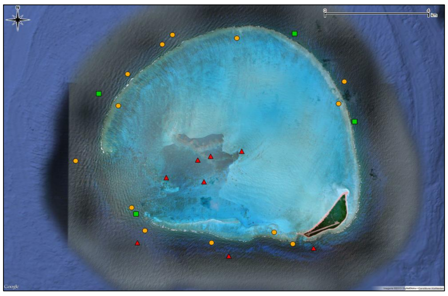

MHI
fitted function
fitted values
GrazerBiom
BrowserBiom
Population
ScraperBiom
NWHI
fitted function
fitted values
GrazerBiom
ScraperBiom
Latitude
BrowserBiom

ELECTRONIC SUPPLEMENTARY MATERIAL S5

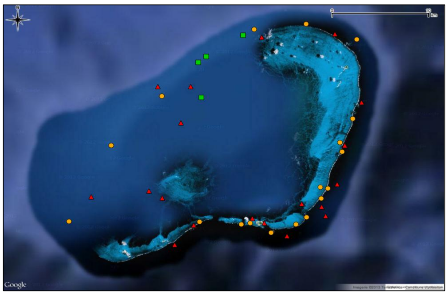
Categorisation of the sites

Mapping at an island scale of the 302 sites categorised in three distinct regimes: green squares represent structurally complex hard coral and CCA dominated sites; orange circles correspond to turf algae dominated sites and red triangles represent low complexity macroalgae and sand dominated sites. *MHI*, Main Hawaiian Islands; *NWHI,* North-western Hawaiian Islands. Note that the scales are different between islands.

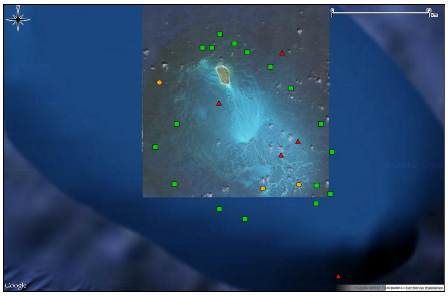
Kure Atoll (*NWHI*)



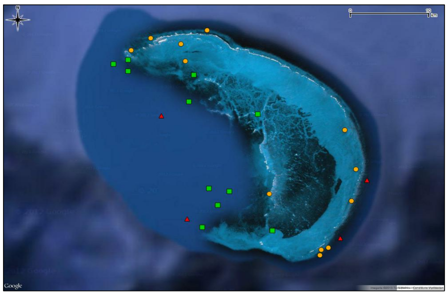
Pearl & Hermes Atoll (*NWHI*)



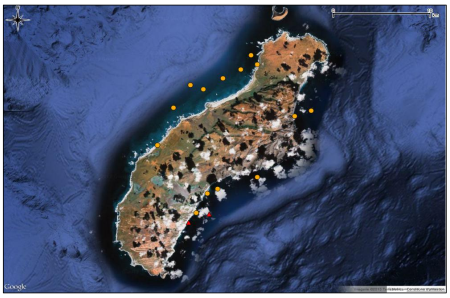
Lisianski Island (*NWHI*)



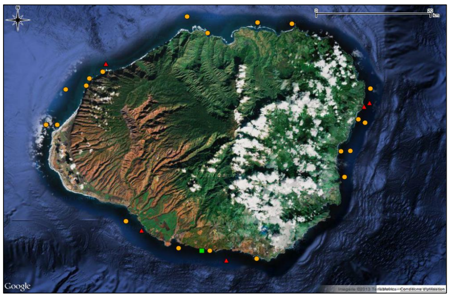
French Frigate Shoals (*NWHI*)



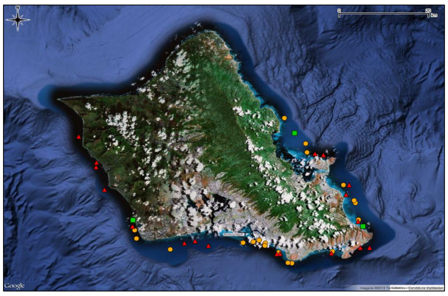
Ni‘ihau (*MHI*)



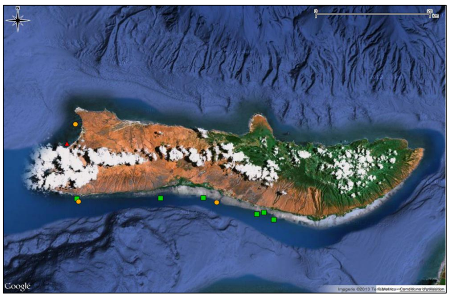
Kaua‘i (*MHI*)



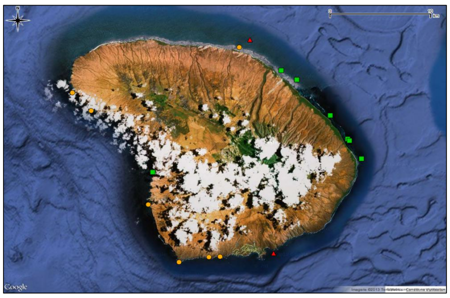
O‘ahu (*MHI*)



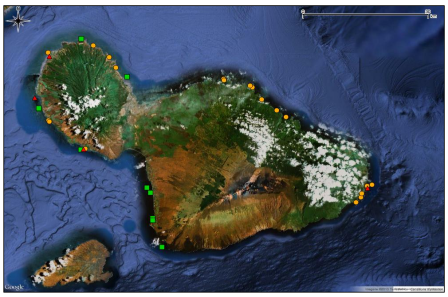
Moloka‘i (*MHI*)



Lāna‘i (*MHI*)



Maui (*MHI*)



Hawai‘i (*MHI*)

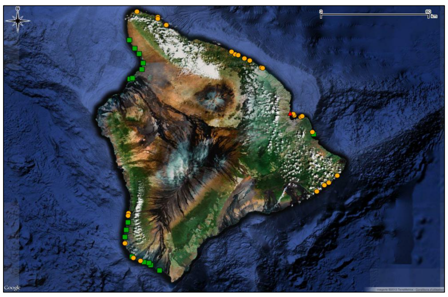


Table S5-1. Average values of the different benthic variables within each of the three regimes: *calcifying* (n=80), *turf* (n=153), and *macroalgal/sand* (n=69).

Benthic variable	*Calcifying* regime	*Turf* regime	*Macroalgal/sand* regime
Complexity (1 to 5)	3.0	2.2	1.7
Hard coral (%)	42.1	11.1	6.8
Crustose coralline algae (%)	14.4	4.3	3.1
Turf algae (%)	29.1	67.0	30.7
Sand (%)	6.9	8.5	21.6
Macroalgae (%)	7.4	8.8	38.1