Recruitment Dynamics of Scleractinian Corals in a Network of National Parks and Marine Protected Areas: West Coast Hawai'i Island

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Introduction:

•Maintenance of an adequate level of coral recruitment is vital to sustain coral populations and reef communities. Because coral early life stages are often more susceptible than adult stages to environmental stressors, knowledge of recruitment dynamics can help predict potential effects of disturbance from, and resilience to, environmental change.

Purpose:

•Establish a large scale, long term effort to assess recruitment of Scleractinian corals along the west coast of Hawai'i Island in support of long term benthic monitoring and marine protected area management.

•Determine spatial and temporal variation in coral recruitment.

Methods:

•9 sites along 130 km of the west coast of Hawai'i Island (Fig. 3)

•8 terracotta tiles randomly distributed at each site

•Tiles directly mounted to substrate using threaded rods (Fig. 1)

•Tiles replaced every six months (=summer & winter sampling rounds)= 72 tiles/round or 144 tiles/year

•Tiles cleaned and dried, searched with microscope for coral recruits

•2-3 years of data analyzed to date

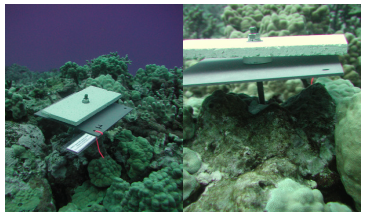

Figure 1: Terracotta tiles were mounted over PVC plates to create a refuge or "gap" habitat under tiles. Previous studies have shown corals recruit cryptically to the undersides or sides of plates, where predation pressure is lower.

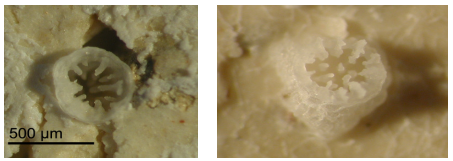

Figure 2: Examples of coral polyps on tile surface. Soaking tiles in 10% bleach solution cleaned tiles of fouling organisms and made coral skeletal structure more apparent.

Left: *Montipora spp.* Right: *Porites spp.*

Recruitment Rates: West Hawai'i Island

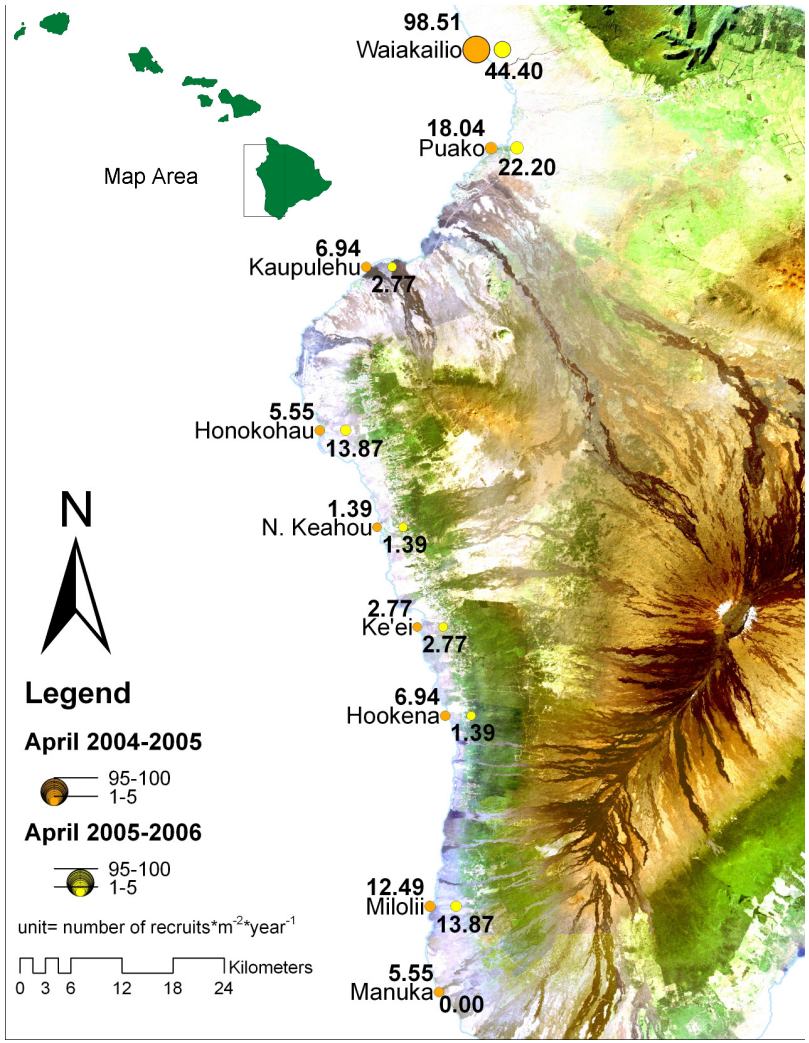

Figure 3: Map plot representing coral recruitment rates (no. recruits m^{-2}*$year^{-1}$) at 9 west Hawai'i sites over time. *Note:* Orange bubbles represent year 1 rates at actual site locations. Yellow bubbles are year 2 rates offset to show differences in recruitment between years. Top numbers are year 1 mean annual values, lower numbers are those for year 2. Data are from tiles sampled between April-October, the main coral spawning and recruitment period in Hawai'i.

Results:

•Recruitment rates averaged 14.6 recruits m^{-2}*$year^{-1}$ across all sites and times

•Much higher recruitment rates at northernmost site—Waiakailio Bay compared to other sites or regions (Fig. 3, 4)

•Most recruits were *Porites spp.,* followed by *Montipora spp.* and *Pocillopora spp.* (Fig. 4)

•97% of recruits appeared during summer season (April-October)

•No recruits were observed on upper surfaces of tiles, the majority were found on outer area of the underside of tiles

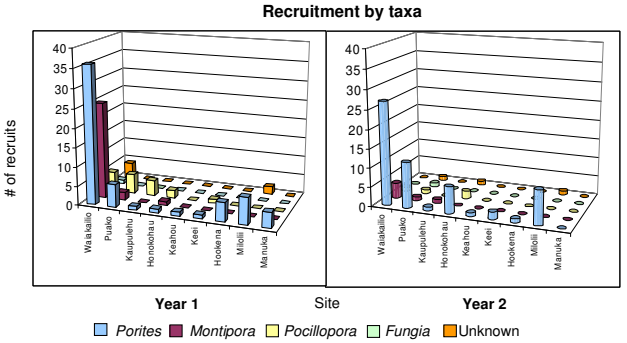

Figure 4: Coral recruitment by taxon. Recruits identified to genus and plotted from northern to southern most site, from left to right.

Conclusions:

•Recruitment on Hawai'i island driven almost completely by summer spawning events

•Factors driving recruitment dynamics are unknown. Recruitment does not correlate with large scale ocean circulation patterns off Hawai'i island. Possible influences on recruitment include smaller, sub-regional differences in ocean currents, habitat structure, disturbance regimes, anthropogenic influences, differences in coral life history characteristics, or natural variation in recruitment processes.

•Relative to other coral reef regions in Hawai'i and around the world, results thus far show west Hawai'i Island has low recruitment overall

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Mean coral recruitment rates worldwide

recruits m^{-2} $year^{-1}$

From Friedlander and Brown (2006) unless noted.

Site, Island	Ocean	Substrate	Mean Recruitment Rate	†Range of Recruitment Rates	Attachment Method	Latitude	Reference
Hanalei Bay, Kauai, Hawaii	Pacific	Terracotta	7924	403-15386	direct	11 N	Friedlander and Brown (2005)
Great Barrier Reef, Australia	Pacific	Clay	4258	2050-7178	direct	10-23 S	Hughes et al. (1999)
Cape Tribulation, Australia	Pacific	Ceramic	2689	156-7944	–	14 S	Fisk and Harriott (1990)
Fiji	Pacific	Ceramic	734	322-1812	direct	17-18 S	Kojis and Quinn (2001)
Zanzibar, Tanzania	Indian	Terracotta	594	0-3000	–	6 S	Franklin et al. (1998)
Lord Howe Island, Australia	Pacific	Ceramic	538	178-1411	–	31 S	Harriott (1992)
[1]Tanguisson, Guam	Pacific	PVC	530	–	–	13 N	Neudecker (1976)
Great Barrier Reef, Australia	Pacific	Ceramic	489	144-1222	–	15 S	Fisk and Harriott (1990)
Puamana, Maui, Hawaii	Pacific	Terracotta	415	8-1792	direct	21 N	Brown (2004)
Taa, Tanzania	Indian	Terracotta	282	190-374	metal rack	5 S	Nzali et al. (1998)
Discovery Bay, Jamaica	Caribbean	Coral Slab	251	119-341	PVC frame	17 N	Rylaarsdam (1983)
Luminao Beach, Guam	Pacific	PVC	209	0-2433	direct	13 N	Birkeland (1981)
St. Thomas, Virgin Islands	Caribbean	Ceramic	134	89-180	direct	18 N	Kojis and Quinn (2001)
Olowalu, Maui, Hawaii	Pacific	Terracotta	122	95-233	direct	21 N	Brown (2004)
[2]*Heron Reef, Great Barrier Reef	Pacific	Ceramic	112.6	36.3-170	metal rack	23 S	Dunstan and Johnson (1998)
Bermuda	Caribbean	Ceramic	99	4-384	metal rack	29 N	Smith (1992)
Moorea, Tahiti	Pacific	Ceramic	82	38-125	metal rack	17 S	Gleason (1996)
Guana Island, Virgin Islands	Caribbean	Terracotta	59	2-296	metal rack	18 N	Carlon (2001)
Saipan, Northern Marianas	Pacific	Ceramic	49.3	–	direct	15 N	Kojis and Quinn (2001)
Solitary Islands, Australia	Pacific	Ceramic	44	6.0-88	metal rack	30 S	Harriott and Banks (1995)
Honolua Bay, Maui, Hawaii	Pacific	Terracotta	41	7.0-92	direct	21 N	Brown (2004)
[2]Moorea, Tahiti	Pacific	Terracotta	40.8	27.9-58.6	direct	17 S	Adjeroud (2007)
Kaneohe Bay, Oahu, Hawaii	Pacific	Concrete	36	0-124	resting block	21 N	Fitzhardinge (1993)
[2]Luminao Beach, Guam	Pacific	PVC	35	19.0-50.9	resting block	13 N	Birkeland et al. (1981)
[2]Eilat, Israel	Red Sea, Indian	Terracotta	25.3	17.8-32.7	metal rack	29 N	Glassom et al. (2004)
Northern Mariana Islands	Pacific	Ceramic	24	0-112	direct	14-15 N	Kojis and Quinn (2001)
Tinian, Northern Marianas	Pacific	Ceramic	22.5	–	direct	15 N	Kojis and Quinn (2001)
[2]West Hawaii, Hawaii	Pacific	Terracotta	14.6	0-98.5	direct	19-20 N	Basch et al. this study (2008)
[3]Kaneohe Bay, Oahu, Hawaii	Pacific	Concrete	7.8	0-11.5	resting block	21 N	Demers (1996)
[2]*Bahias de Huatulco, Mexico	Pacific	Terracotta	6.5	0.7-16.1	metal rack	15 N	Lopez-Perez (2007)
St. Croix, Virgin Islands	Caribbean	Coral Slab	6	4.0-18	–	18 N	Rogers et al. (1984)
[2]Asan Bay, Guam	Pacific	PVC	2	0-4.3	direct	13 N	Minton and Lundgren (2006)
[3]Waikiki Beach, Oahu, Hawaii	Pacific	Natural	0.2	.03-.32	perm. quadrats	21 N	Polacheck (1978)
Rota, Spain	Atlantic	Ceramic	0	–	–	36 N	Kojis and Quinn (2001)
[3]Kaneohe Bay, Oahu, Hawaii	Pacific	Coral	0	0	resting block	21 N	Polacheck (1978)

[1]Only control sites were used for recruitment rate calculation.

[2]Recruitment rate calculated by this study

[3]Recruitment rate from Brown (2004).

*Rate calculated from plates with 12 month deployment

†Range of recruitment rates is at the scale of site.

****This table provides estimates of relative coral recruitment rates for rough comparison (because of differences in methods, materials, taxa, and locations among studies).****