Background Paper on West Hawai'i Aquarium 'White List'

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An essential component of the proposed West Hawai'i Regional Fishery Management (WHRFMA) Rule (HAR 13-60.4) is the establishment of a list of fish species (aka 'White List') which can be taken by aquarium collectors in the WHRFMA.

Public testimony at all geographic levels was strongly in support of the proposed aquarium provisions which includes the White List. This testimony is summarized below. Noteworthy is the fact that the strongest suppport (85%) came from West Hawai'i, the area most closely associated with the proposed rule.

Summary of Public Testimony on HAR 13-60.4 relating to Aquarium Collecting

	In Support			**In Oppositon**	
	No.	%		No.	%
All Testimony	888	76%		281	24%
State of Hawai'i	521	77%		156	23%
Hawai'i Island	489	82%		104	18%
West Hawai'i	461	85%		81	15%

Although most of the opposing testimony was broadly against any aquarium collecting and thus any rules relating to its management, substantial testimony was more focused on concerns over the various species included on the White List.

The following Table lists the White List species and provides population estimates and the percentage of the population taken by aquarium collectors in areas open to collecting. "Catch" is the average aquarium catch over FY 2010 - 2012 and "30'-60' Population" is an estimate of the total numbers of fish (excluding recently settled Young of the Year - YOY) in open areas of hard bottom reef habitat in 30'- 60' depths. Population estimates are derived from Division of Aquatic (DAR) survey densities (2010-2012) and area estimates from NOAA habitat maps. "Catch as % of Population" is the % of the species' population in collected open areas taken annually by aquarium collectors. "E" indicates an endemic species. "N/A" indicates a lack of survey data, which for 4 of the 5 species is due to its prime habitat being deeper than DAR survey areas. For those 4 species; Psychedelic Wrasse, Tinker's Butterflyfish, Flame Wrasse and Hawaiian Longfin Anthias we do not know the status of their populations in open or protected areas. The other of these 5 species, the Eyestripe Surgeonfish, is not a deep water species but rather the adults are rarely encountered on our fixed survey transects but are

frequently seen out on the reef. Juveniles of this species are not found on mid depth transects but rather appear to inhabit shallow, often turbid (e.g. embayments/harbors) habitats. Given the low numbers collected and commonly sighted adults, at the present time there is little concern regarding aquarium collecting impacts on this species.

Scientific Name	Common Name		Catch	30'-60' Population	Catch as % of Population
Acanthurus achilles	Achilles Tang		9,801	13,666	77.38%
Zebrasoma flavescens	Yellow Tang		295,047	848,622	34.77%
Ctenochaetus hawaiiensis	Chevron Tang		2,602	20,055	12.97%
Acanthurus nigricans	Goldrim Surgeonfish		381	4,887	7.80%
Macropharyngodon geoffroy	Shortnose Wrasse	E	252	4,398	5.73%
Coris gaimard	Yellowtail Coris		614	14,660	4.19%
Naso lituratus	Orangespine Unicornfish		4,272	113,994	3.75%
Forcipiger flavissimus	Forcepsfish		1,413	40,109	3.52%
Chaetodon quadrimaculatus	Fourspot Butterflyfish		662	21,745	3.05%
Chaetodon miliaris	Milletseed Butterflyfish	E	313	10,995	2.84%
Acanthurus olivaceus	Orangeband Surgeonfish		786	33,776	2.33%
Ostracion meleagris	Spotted Boxfish		152	7,086	2.15%
Ctenochaetus strigosus	Goldring Surgeonfish (kole)		38,431	2,570,143	1.50%
Chaetodon kleinii	Blacklip Butterflyfish		53	3,909	1.36%
Pseudojuloides cerasinus	Smalltail Wrasse		244	21,012	1.16%
Lutjanus kasmira	Bluestripe Snapper		52	6,597	0.78%
Gomphosus varius	Bird Wrasse		338	56,196	0.60%
Centropyge potteri	Potter's Angelfish	E	1,022	218,489	0.47%
Hemitaurichthys polylepis	Pyramid Butterflyfish		181	41,536	0.44%
Halichoeres ornatissimus	Ornate Wrasse		926	211,100	0.44%
Chaetodon multicinctus	Multiband Butterflyfish	E	1,293	339,871	0.38%
Centropyge fisheri	Fisher's Angelfish		74	22,478	0.33%
Sufflamen bursa	Lei Triggerfish		209	63,330	0.33%
Xanthichthys auromarginatus	Gilded Triggerfish		29	9,500	0.31%
Melichthys niger	Black Durgon		79	26,632	0.30%
Dascyllus albisella	Hawaiian Dascyllus	E	149	55,463	0.27%
Paracirrhites forsteri	Blackside Hawkfish		45	16,888	0.26%
Thalassoma duperrey	Saddle Wrasse	E	656	314,539	0.21%
Acanthurus thompsoni	Thompson's Surgeonfish		133	71,774	0.19%
Cirrhitops fasciatus	Redbarred Hawkfish		9	7,574	0.12%
Pseudocheilinus octotaenia	Eightline Wrasse		126	183,657	0.07%
Acanthurus nigrofuscus	Brown Surgeonfish		809	1,381,650	0.06%
Canthigaster jactator	Hawaiian Whitespotted Toby	E	97	211,100	0.05%

Pseudocheilinus tetrataenia	Fourline Wrasse		81	301,873	0.03%
Cephalopholis argus	Peacock Grouper		1	27,609	0.00%
Acanthurus dussumieri	Eyestripe Surgeonfish		61	N/A	N/A
Anampses chrysocephalus	Psychedelic Wrasse	E	387	N/A	N/A
Chaetodon tinkeri	Tinker's Butterflyfish		217	N/A	N/A
Cirrhilabrus jordani	Flame Wrasse	E	96	N/A	N/A
Pseudanthias hawaiiensis	Hawaiian Longfin Anthias	E	75	N/A	N/A
N/A - Species not adequately surveyed in transects					
N/A - Species occurs in habitats deeper than transects					

Based on the analysis of those species for which we have good data, aquarium collecting is having the largest impact on Achilles Tang (77.38% of 30'-60' open area population collected annually) and yellow tang (34.77% collected). For most of the species on the white list for which we have monitoring data, collecting impact, in terms of the % of the population being removed annually, is relatively low with 12 species having single digit % catch and 20 species having % catch values <1%.

It should be noted that catch as a percentage of the *total* population of a species in these depths is lower than indicated in the above table since total population would include fishes in the protected FRAs and MPAs as well. Examples of total population (and catch %) are shown in the following Table and can be compared with the table above.

30'-60' hard bottom habitat					
	Open Pop	FRA Pop	MPA Pop	Total Pop	Catch as % of Total Pop
Achilles Tang	12,887	2,236	3,753	18,876	51.92%
Yellow Tang	863,411	1,163,537	279,426	2,306,373	12.79%
Chevron Tang	20,404	10,623	5,231	36,259	7.18%
Goldrim Surgeonfish	5,369	1,677	1,478	8,525	4.47%
Shortnose Wrasse	4,296	1,118	341	5,755	4.38%
Goldring Surgeonfish	2,614,933	2,007,813	438,870	5,061,616	0.76%

It should further be noted that the % catch does not include targeted fishes which occur in waters shallower than 30' or deeper than 60'. As such the annual catch estimates for many, if not most, species substantially overestimate the % take of the total population in West Hawai'i waters.

Even with these considerations the catch of Achilles Tang as a % of its West Hawai'i population is high. Achilles has had low levels of recruitment over the past decade (Figure 1) and substantial numbers of larger fish (i.e. 'breeders') are taken for human consumption as it is a prized food fish.

Substantial population decline of Achilles Tang populations in West Hawai'i is evident from several data sources. As can be seen in Figure 1, Achilles Tang have declined in FRA and Open areas over the last decade. A similar trend is apparent within MPAs for Achilles Tang except for the last two years when their numbers have increased albeit overall densities remain low.

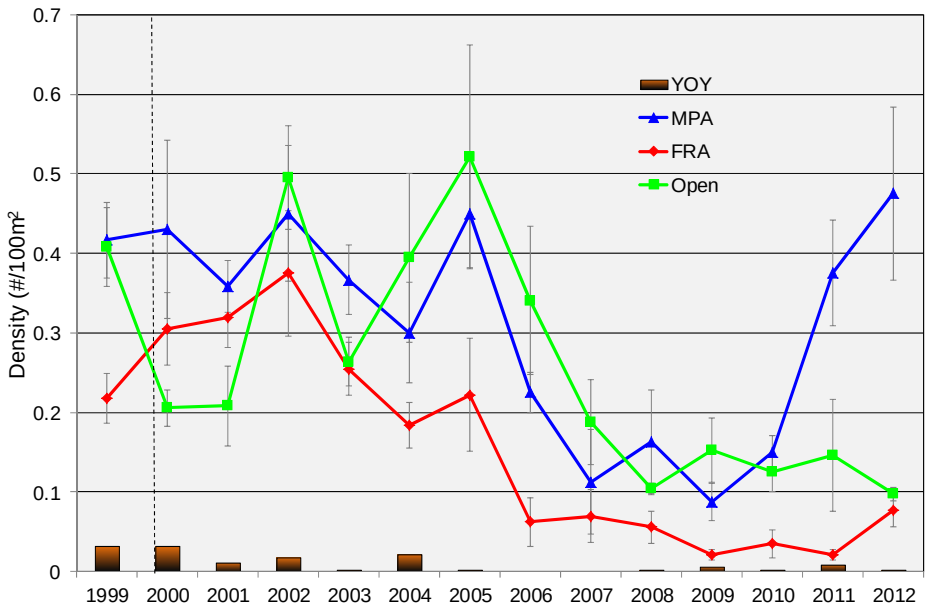


Figure 1. Overall changes in Achilles Tang abundance in FRAs, MPAs and Open areas, 1999-2012. Bars indicate mean density (June-Nov) of Achilles Tang Young-of-Year (YOY). YOY are not included in trend line data.

Commercial aquarium landings of Achilles Tang have been declining in West Hawai'i over the past two decades. This has occurred in association with a recent dramatic increase in the ex-vessel value of the fish (Figure 2).

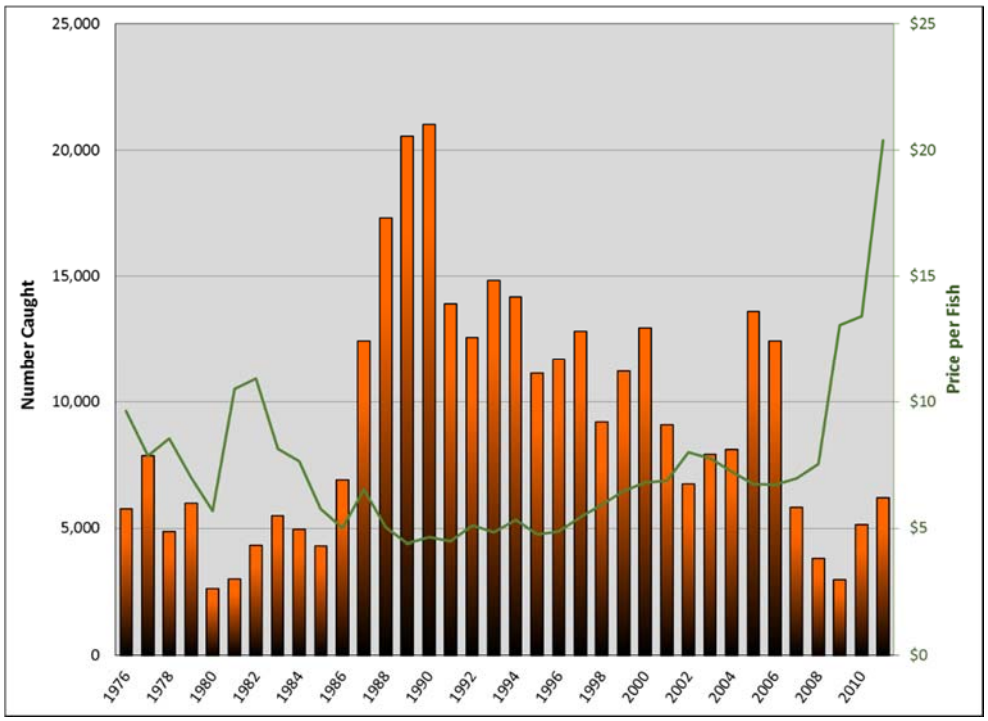


Figure 2. West Hawai'i commercial Achilles Tang aquarium landings and value

Data from 3 long term studies show a similar pattern of decline over the past 3 decades (Figs. 3, 4 & 5).

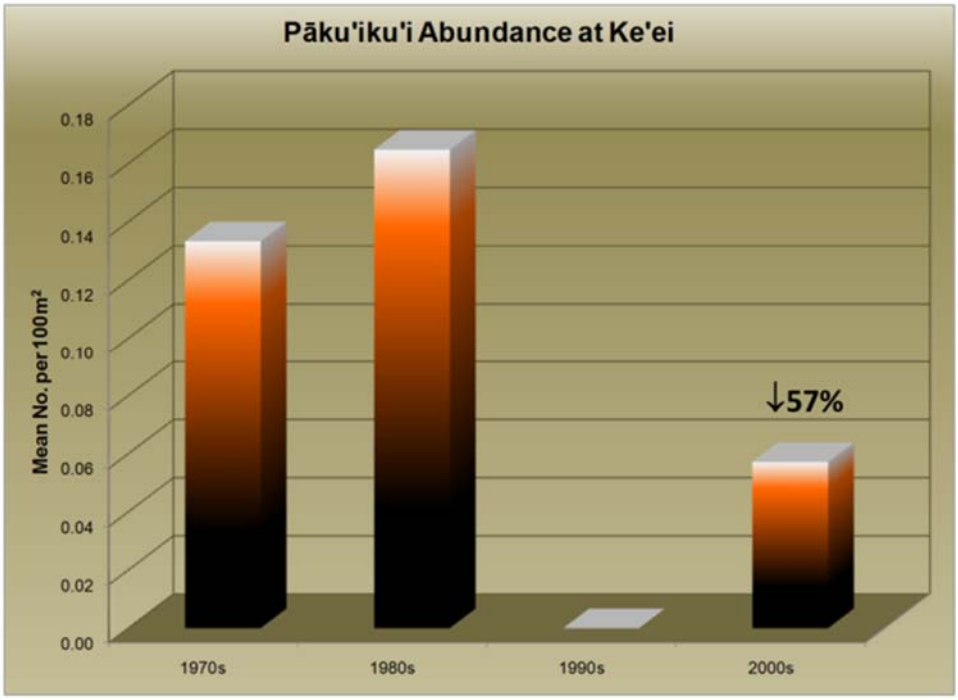


Figure 3.

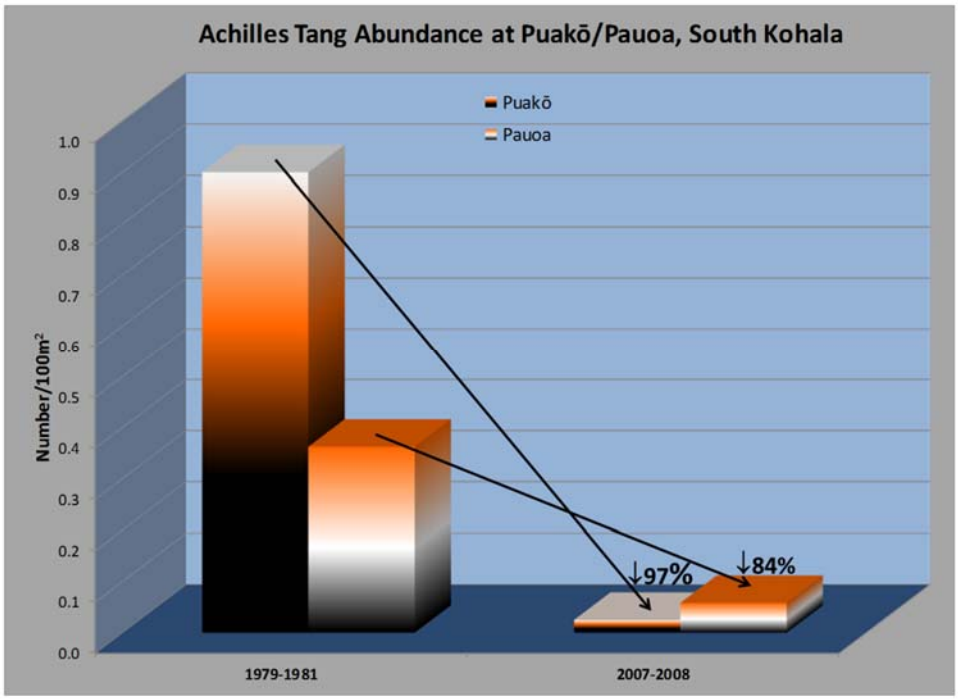


Figure 4.

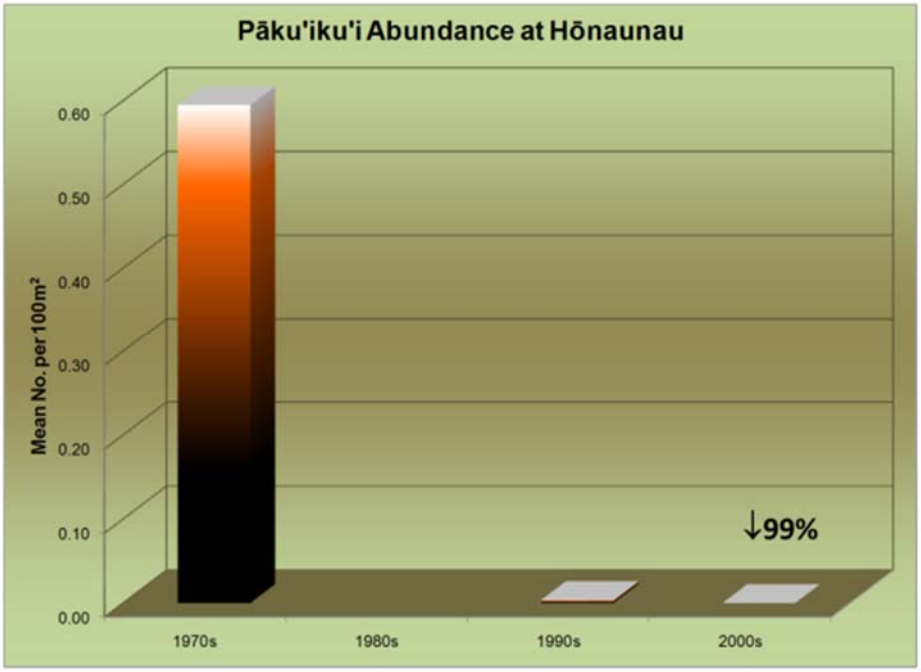


Figure 5.

Given these factors, population declines and a substantial aquarium impact are not surprising. There is currently a proposed bag limit for aquarium collectors of 10 fish/person/day undergoing Hawaii Administrative rulemaking. Unfortunately aquarium catch analysis suggests that this bag limit will largely be ineffective to stem the species' decline since it is currently difficult for collectors to take 10 Achilles Tang per day (Figures 6 & 7).

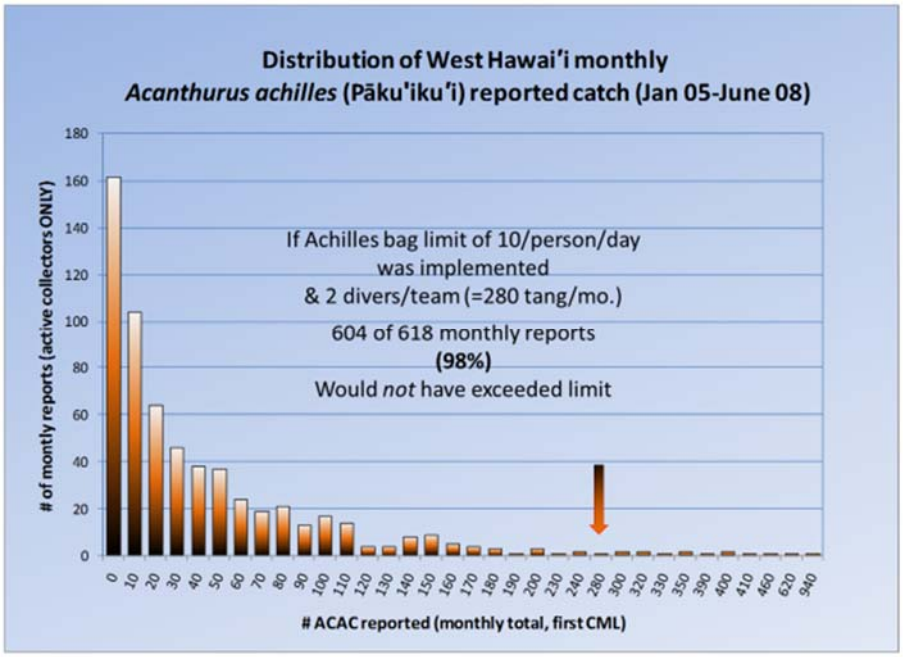


Figure 6.

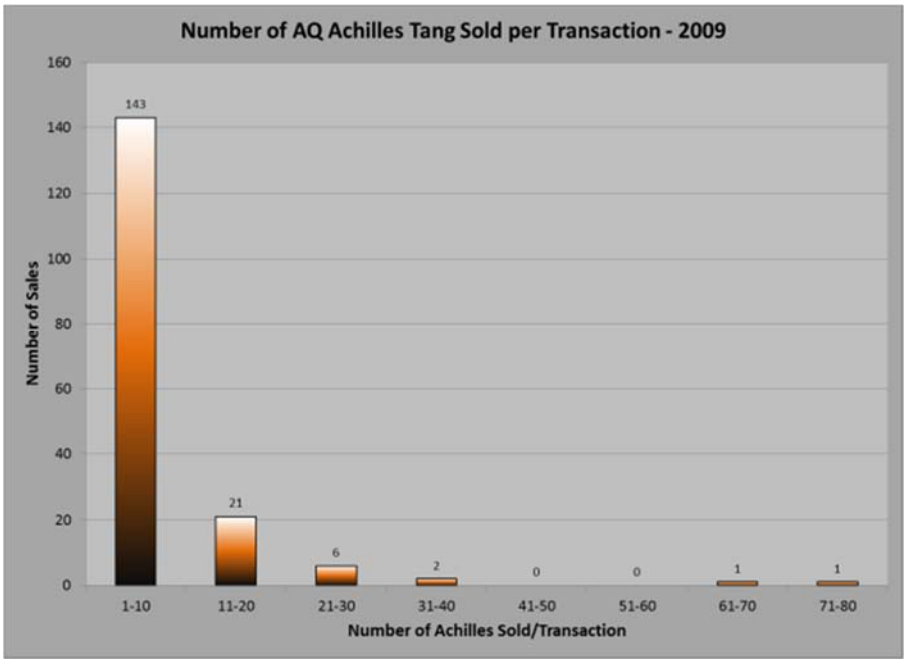


Figure 7.

Lastly Achilles Tang is the only species on the White List which is listed as an "Ecologically Unsustainable Species" by the sustainable Aquarium Industry Association (SAIA).

In contrast to Achilles Tang, yellow tang has generally recruited reliably over the years (Figure 8) and has increased markedly in the Fish Replenishment Areas (up 65% from '99/'01 to '10/'12).

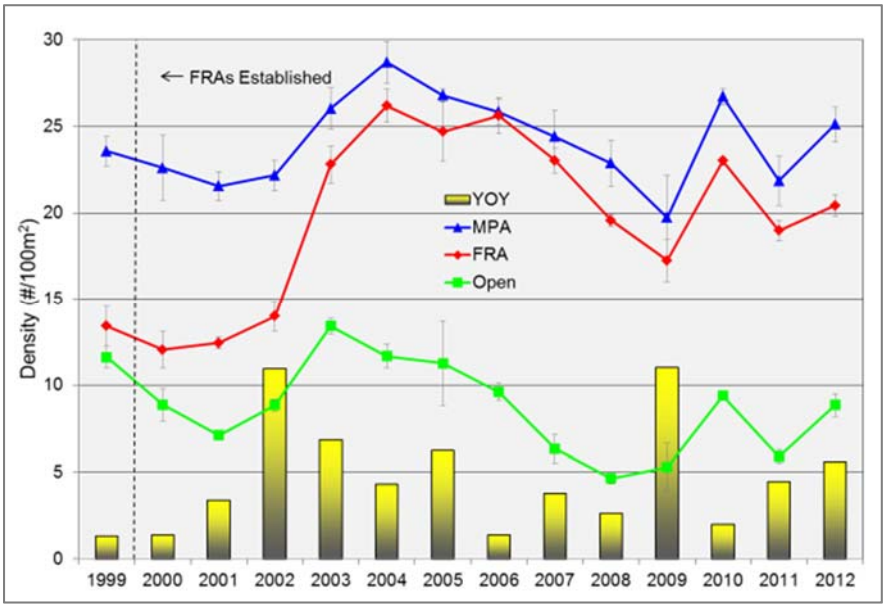


Figure 8. Overall changes in Yellow Tang abundance in FRAs, MPAs and Open areas, 1999-2012. Bars indicate mean density (June-Nov) of Yellow Tang Young-of-Year (YOY). YOY are not included in trend line data.

It is estimated that the number of Yellow Tang on mid-depth (30'-60') reefs in West Hawai'i has increased by 355,758 over the past 13 years (Figure 9).

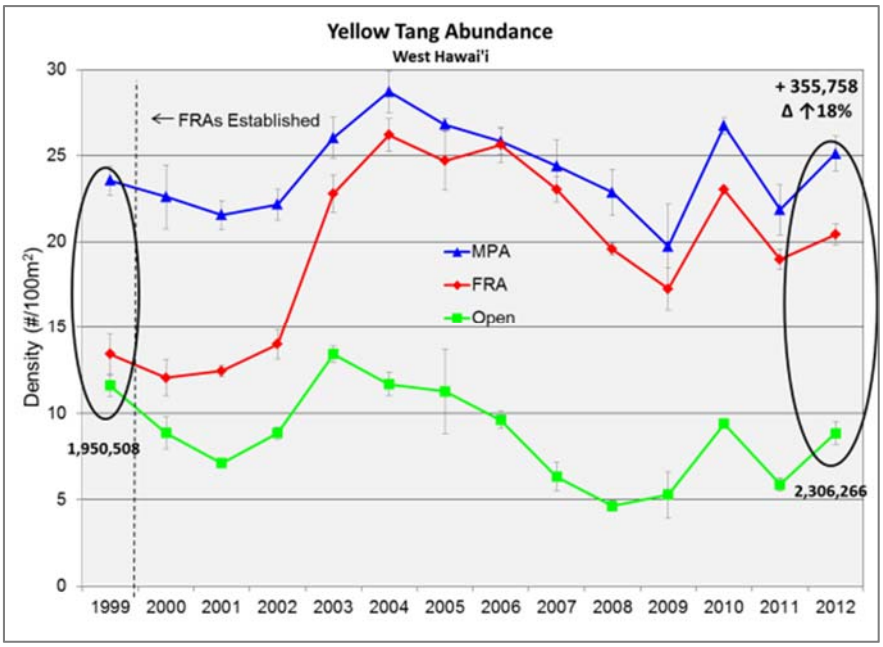


Figure 9.

Declines of Yellow Tang in open areas (down 24% over same period) have ameliorated in recent years as aquarium take has been decreasing from a previous period of continual and likely unsustainable increases (Figure 10). The price per fish paid by dealers to collectors has increased almost 1.8X since 2000 but has declined over the last three years, likely an effect of the U.S. economic recession.

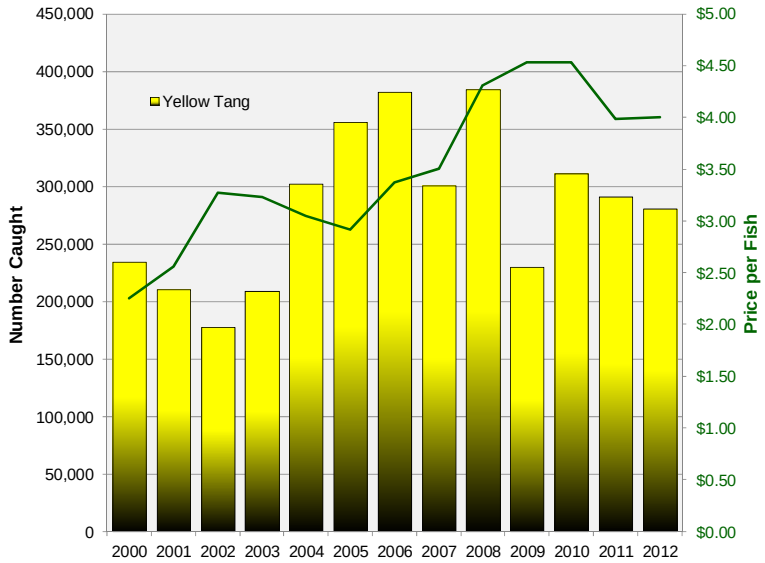


Figure 10. West Hawai'i Yellow Tang catch since FRA establishment and price per fish (adjusted for inflation)

Long term trends for Yellow Tang in West Hawai'i are variable depending on the area. In South Kohala they have declined by 9% at Puakō but have increased by 14% at nearby Pauoa (Figure 11).

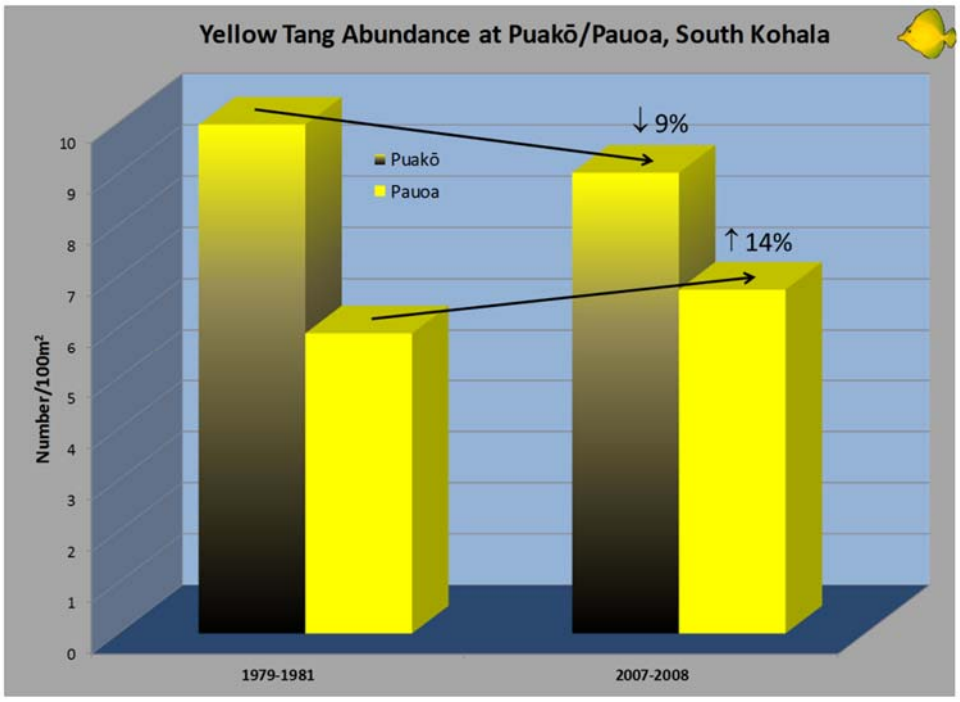


Figure 11.

In South Kona at Hōnaunau Yellow Tang populations are presently 17% of what they were in the 1970's with a distinct increasing trend in recent decades (Figure 12). Hōnaunau became an FRA in 2000.

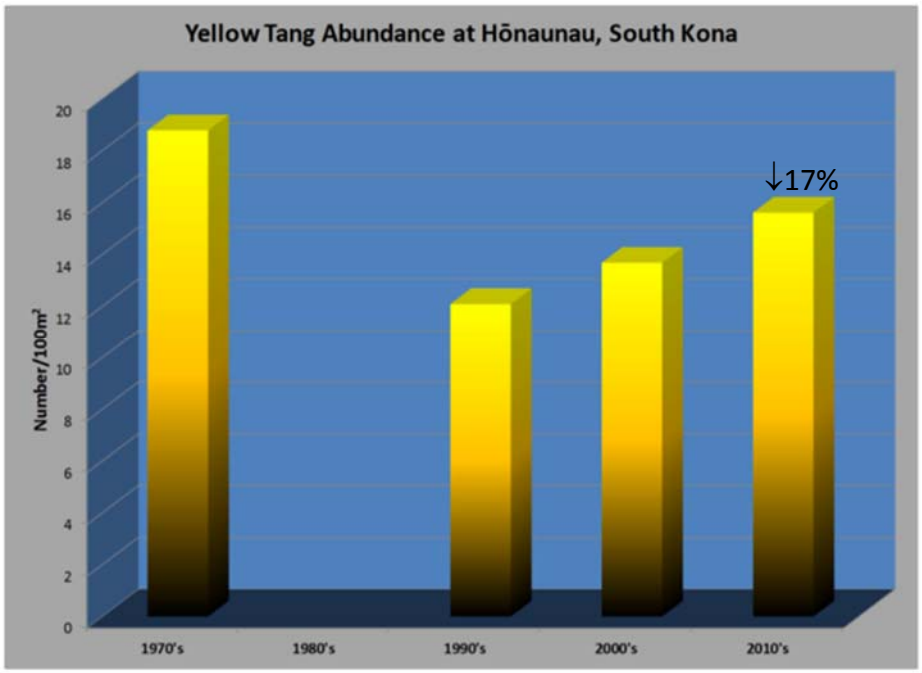


Figure 12.

A similar trend of recent increasing Yellow Tang abundance is evident at Ke'ei in South Kona where present abundance is not significantly different (4% less) than it was 40 years ago (Figure 13).

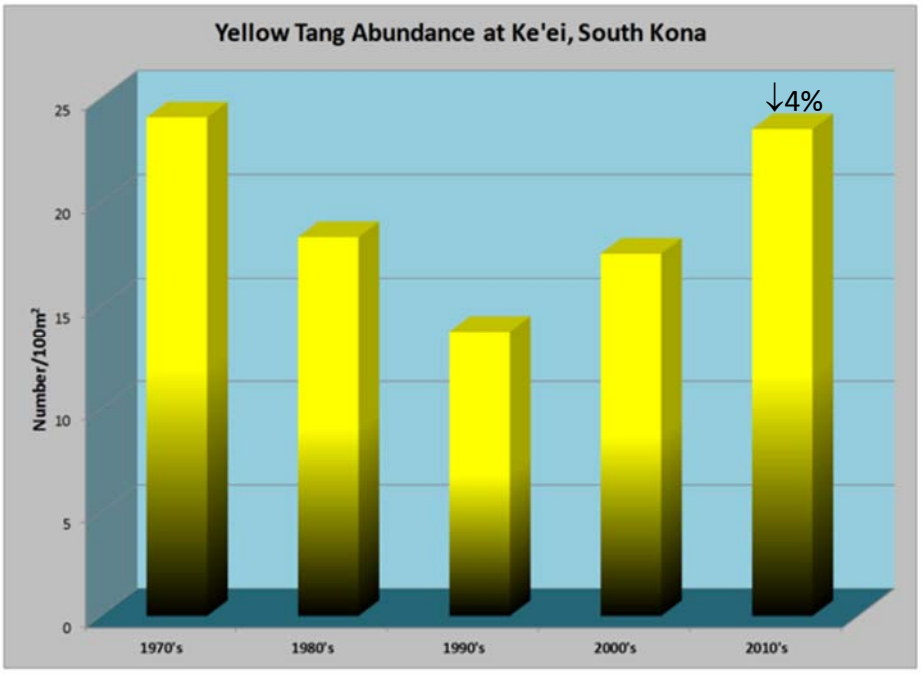


Figure 13. Note: Recruits not included.

As previously noted the percent take of Yellow Tang shown in the opening table represents only a portion of the total population present in open areas in 30'-60' depths and as such represents an overestimation of collecting impact. There are additional yellow tang in protected areas (FRAs and MPAs) and in shallower water where the breeder population resides during the day. Surveys conducted in 2006-2010 in the daytime adult Yellow Tang habitat (using Diver Propulsion Vehicles) found that there are no significant differences (Figure 14 t-test p=0.71) in the abundance of adult Yellow Tang in open vs. closed areas.

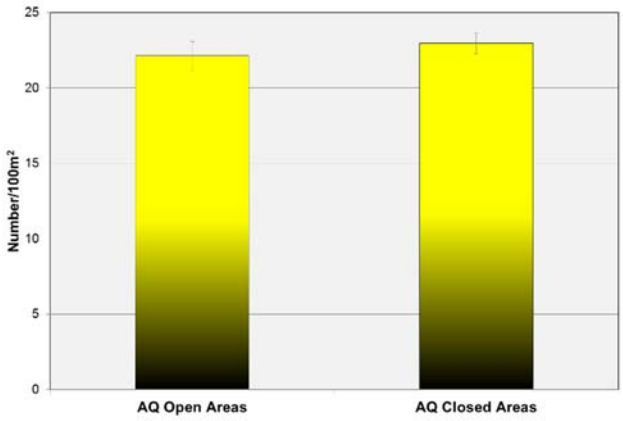


Figure 14. Adult Yellow Tang abundance in areas open and closed to aquarium collecting

The total estimated coastwise population of adult yellow tang in this depth range was estimated to be >2.5 million individuals in 2010.

The Goldring Surgeonfish (kole - *Ctenochaetus strigosus*) is the second most collected species in the West Hawai'i aquarium fishery representing 11% of the catch in recent years (FY '10-'12). As with Yellow Tang, recruitment has been reliable over the past 13 years and increased abundance is evident in both the FRAs and MPAs (Figure 15). Open areas are currently stable although, still lower in abundances than the protected areas (32% less than FRAs)

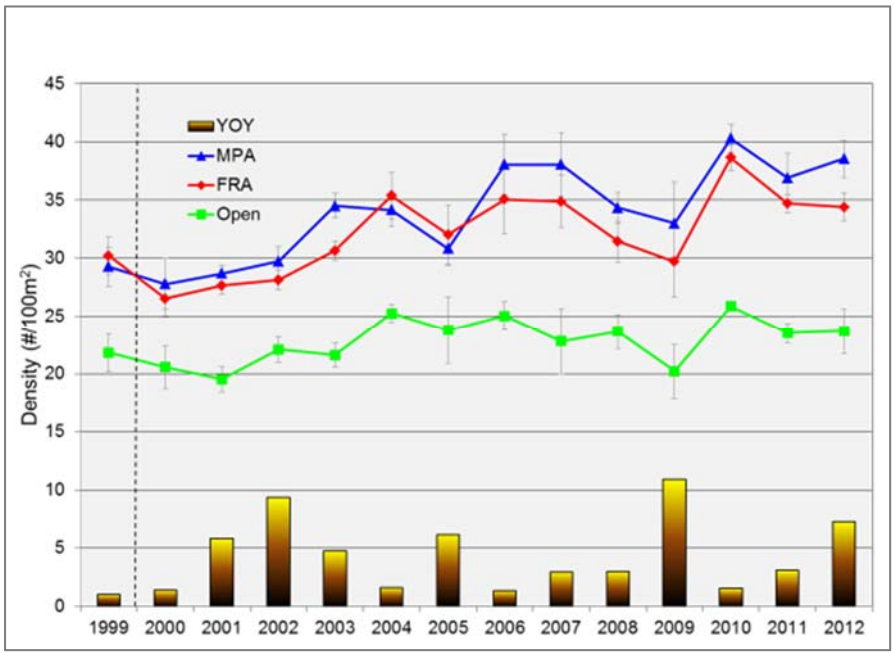


Figure 8. Overall changes in kole abundance in FRAs, MPAs and Open areas, 1999-2012. Bars indicate mean density (June-Nov) of kole Young-of-Year (YOY). YOY are not included in trend line data.

As with Yellow Tang, the overall kole population in the 30'-60' West Hawai'i reef areas has increased (by 23% - 948,662) over the past 13 years (Figure 16). Total kole population in this depth range is currently estimated to be 5,061, 533.

Long term West Hawai'i studies have found kole to have decreased at all 4 study sites with decreases ranging from 17% to 71% (Figures 17, 18, & 19). The most pronounced decreases occurred at the two South Kohala sites one of which (Pauoa) is totally open to harvesting while the other (Puakō) is an FMA that has been closed to aquarium collecting (i.e. no nets other than thrownets permitted) for 23 years. Given the length of protection from netting at the Puakō FMA it seems unlikely that the decline of its kole population is due to aquarium collecting activities. As with Achilles Tang, kole is regarded as a highly desired food fish by some fishers and targeted accordingly. Given the relatively low aquarium catch of this species relative to its West Hawai'i population (<0.76%) it seems inescapable that non-

aquarium harvesting activities are an important contributor to observed population declines in West Hawai'i.

Supporting this contention is a recent analysis utilizing DAR Commercial Marine License catch data and NOAA Marine Recreational Fishing Survey data (MRFS) which indicates that substantially more reef fish (excluding Yellow Tang), are taken by non-aquarium fishers in West Hawai'i in terms of numbers (3X) and biomass (8.6X) (Figures 20 & 21).

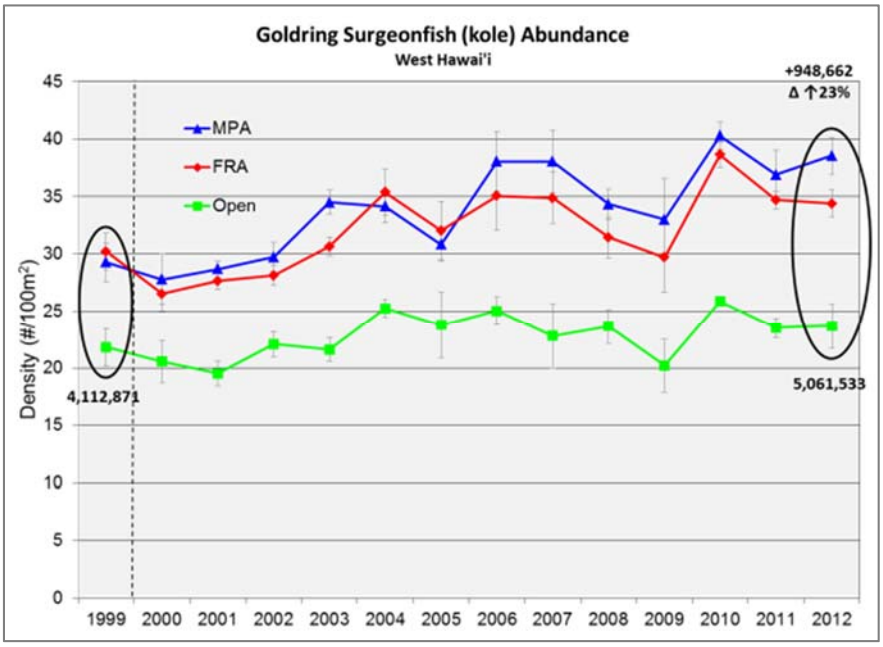


Figure 16.

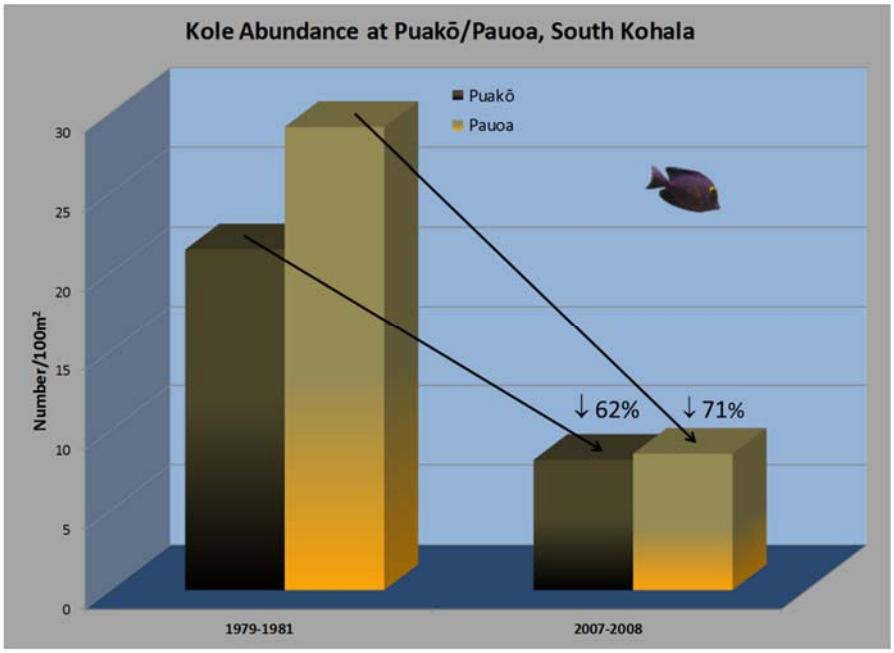


Figure 17.

Both Hōnaunau and Ke'ei (FRAs) have been closed to aquarium collecting for 13 years. As with Yellow Tang there has been an increasing trend in kole abundance since 2000 likely indicating the influence of protection from aquarium collecting.

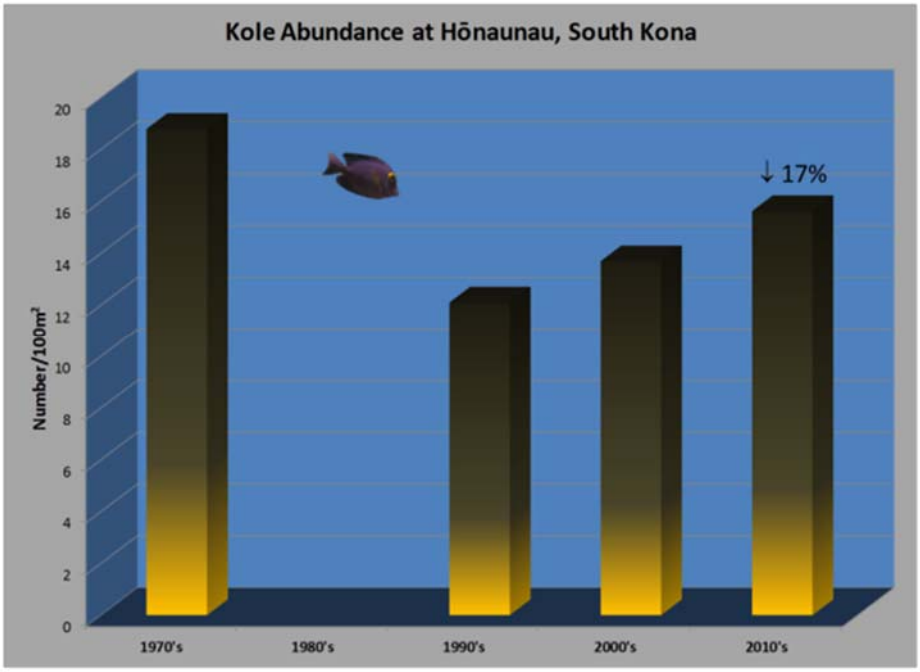


Figure 18.

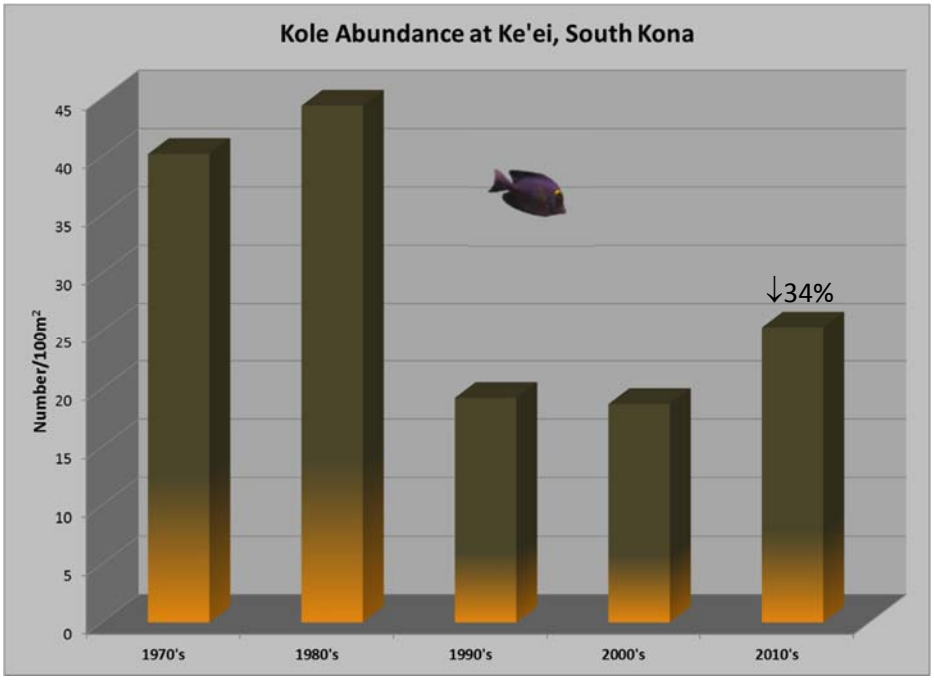


Figure 19. Note: Recruits not included.

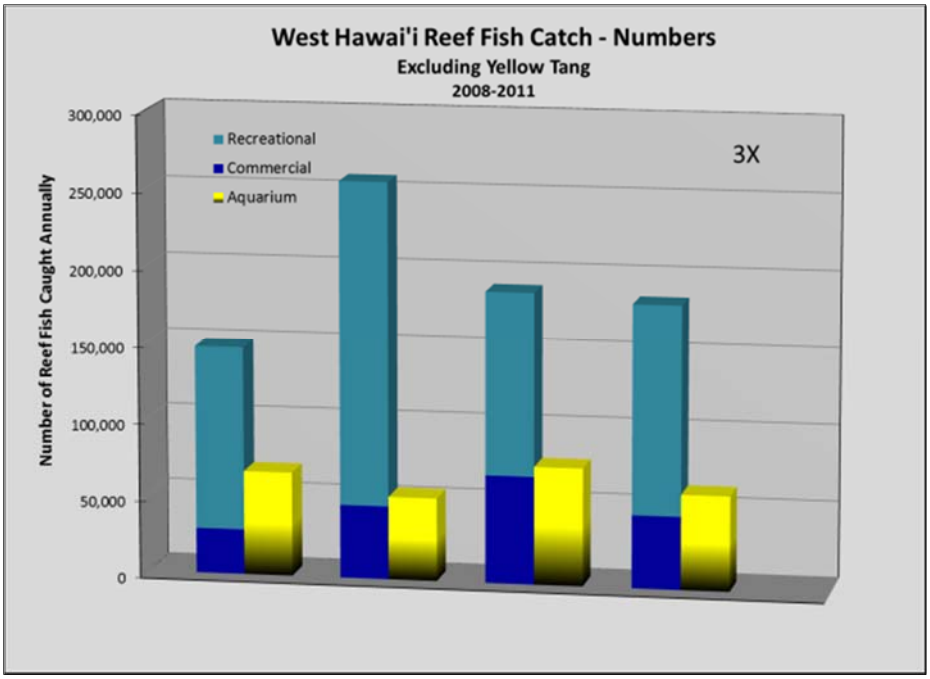


Figure 20.

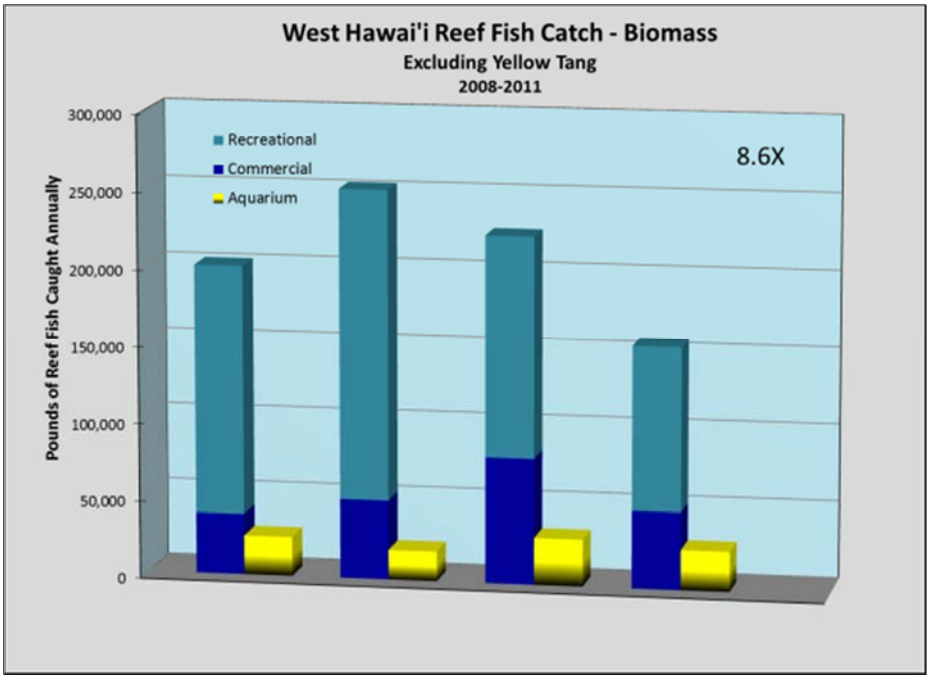


Figure 21.

Even with the documented declines in kole populations in West Hawai'i the species remains very abundant, at least in the smaller and mid-size ranges. Indeed, comparative surveys around the Main Hawaiian Island utilizing DAR and NOAA Coral reef Ecosystem Division (CRED) data (2006/2008)

indicates kole are substantially more abundant over most size ranges in West Hawai'i (excepting the largest size) than any of the other Main Hawaiian Islands (Figure 22).

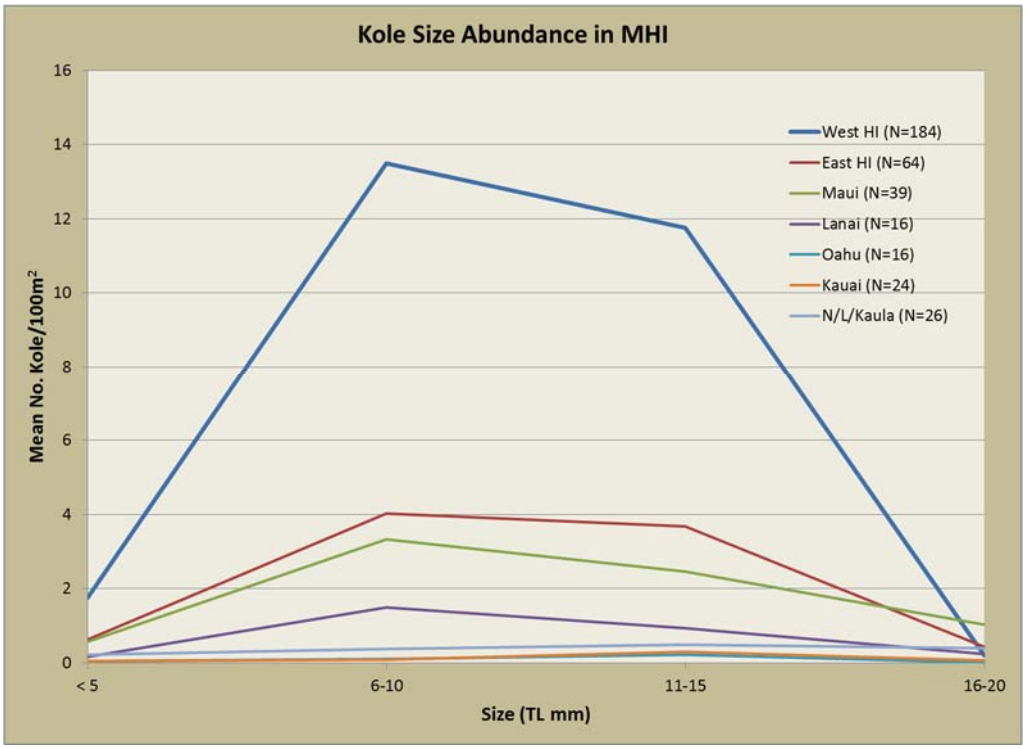


Figure 22.

<u>Endemic Species on the WHFC White List</u>

A very common concern expressed regarding the white list is that it has a number of endemic species on it. An endemic species is a one whose presence is restricted to a defined geographic area. Of the 662 species of reef and shore fishes in the Hawaiian Islands it is currently estimated that 25% of them are endemic (Randall 2007). Many species endemic to the Hawaiian Islands also occur at Johnston Atoll. A number of Hawaiian endemics are important food species and are locally harvested both commercially and non-commercially. These include manini, āholehole, 'alai'ihi 'āweoweo, hāpu'u, kūmū, mamo, nabeta, nohu, uhu, 'upāpalu, a spiny lobster and all opihi.

Several researchers have commented on the relative abundance of endemic fishes. Gosline and Brock (1960) noted "*that many of the endemic fish of the Hawaiian Islands are the most abundant of their genera" and* similarly Hourigan & Reese (1987) state that *"many endemic species are the most abundant Hawaiian fishes in their families"*. Randall (2007) commented that "*native species have evolved in isolated outposts such as Hawaii for long periods of time and therefore have had ample opportunity to become fully adapted to their environment"*.

Of the 40 species on the WHFC White List, 10 (25%) are endemic to Hawai'i – the same as the average level of overall endemism. All but one (*Anampses chrysocephalus*) also occurs at Johnston Atoll. The

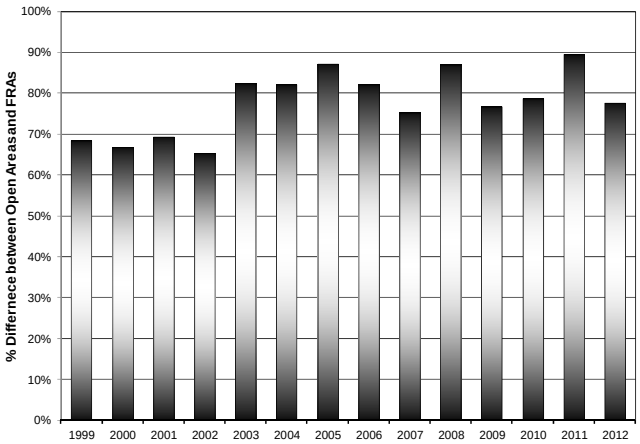
endemic White List species are listed in the table below as well as notes to relative abundance. Listed in the third column are population estimates on West Hawai'i reefs in hard bottom habitat in 30'-60' depths. The forth column lists the % of a species population in 30'-60' Open areas which is taken annually by aquarium collectors (based on FY 2010- 2012 records).

Endemic species on 'White List'

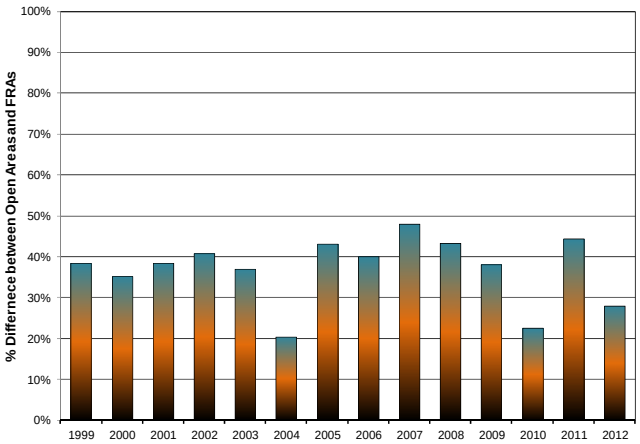
Species	Notes	30'-60' WHI Pop	% AQ Catch 30'-60' Open Areas
Canthigaster jactator	Most common Toby[1]	114,447	0.05%
Thalassoma duperrey	Most common inshore wrasse[1]	548,014	0.21%
Dascyllus albisella		56,512	0.27%
Chaetodon multicinctus		661,184	0.38%
Centropyge potteri	Most common angelfish[1]	310,666	0.47%
Chaetodon miliaris	Most common B-Fly[1,2]	9,347	2.84%
Macropharyngodon geoffroy		2,864	5.73%
Anampses chrysocephalus		N/A	N/A
Cirrhilabrus jordani	Common in right habitat[3]	N/A	N/A
Pseudanthias hawaiiensis	Abundant at 40-199m[4]	N/A	N/A
N/A - Species occurs in habitats deeper than transects			

[1] Randall, JE. 2007, [2] Brock, VE and TC Chamberlain. 1968, [3] Hoover, JP. 2008,[4] Chave, EH and BC Mundy. 1994

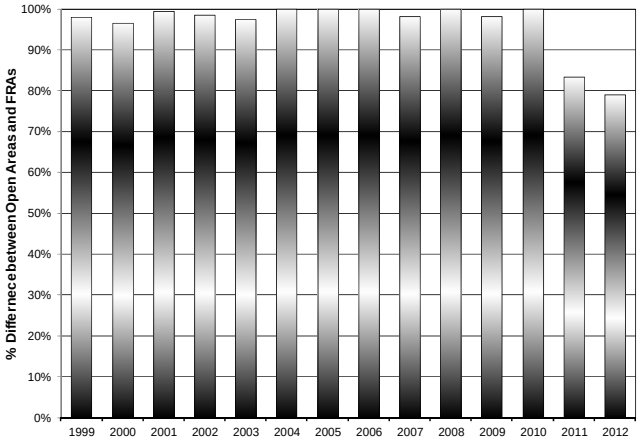
Figure 23 presents the difference in a species' abundance in West Hawai'i Fish Replenishment Areas (FRAs, n=9) relative to Open areas (n=9). Bars represent the % difference in abundance for each year from 1999 to 2012. Bars *above* the horizontal x axis indicate the species was more abundant in the Open areas (aquarium collected) than the FRAs. Similarly, bars *below* the x axis indicate greater abundance in the FRAs than the Open areas.



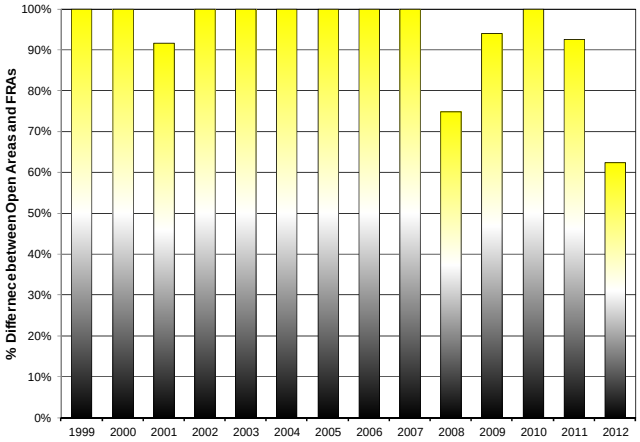
Canthigaster jactator



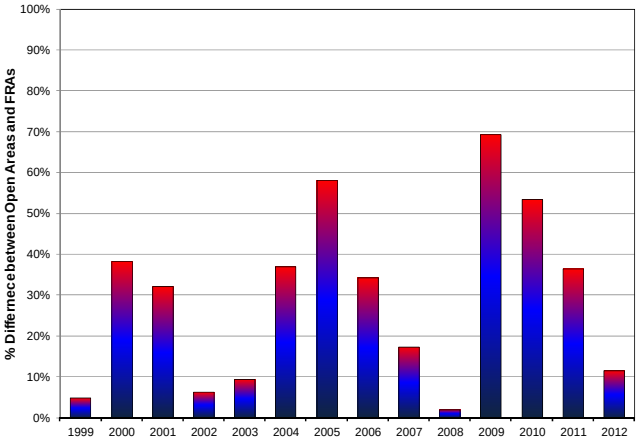
Thalassoma duperrey



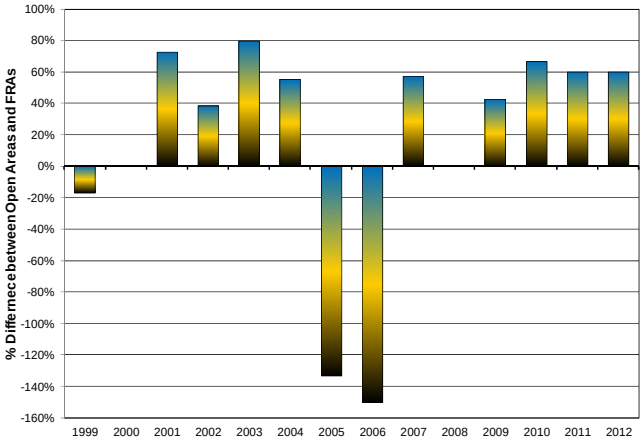
Dascyllus albisella



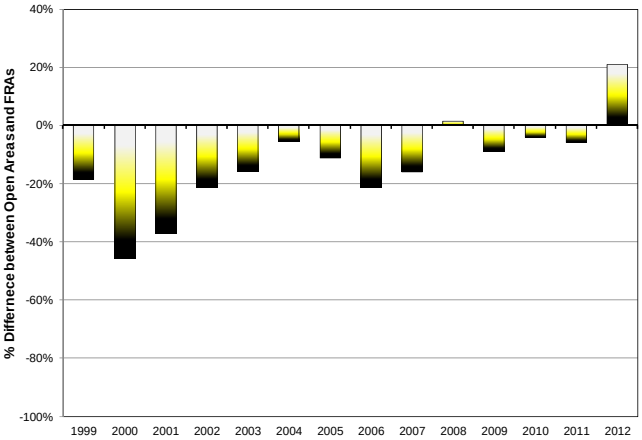
Chaetodon miliaris



Centropyge potteri



Macropharyngodon geoffroy



Chaetodon multicinctus

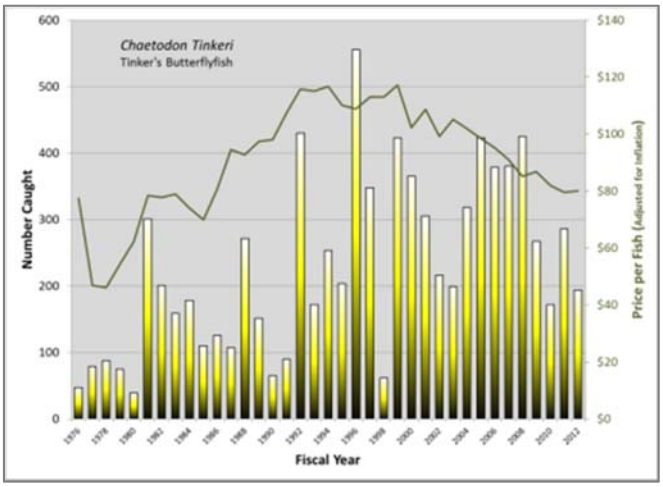
Figure 23. % difference in density between FRAs and Open areas. Bars below the x axis indicate densities are lower in the Open areas relative to the FRAs

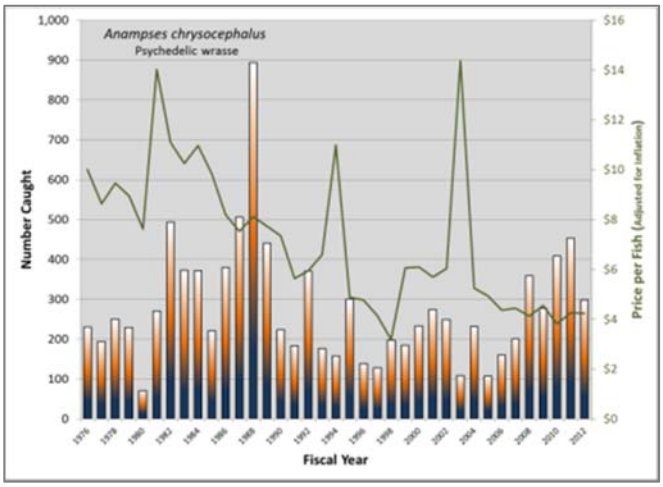
Of the 7 endemic species for which we have survey data, only a single species, the multiband butterflyfish (*Chaetodon multicinctus*), was consistently less abundant in the Open areas. However this difference has been decreasing in recent years and presently there are slightly more of this species in the open areas than in the FRAs. (Avg. 2010-2012). The % of the population of this species taken annually by aquarium collectors in recent years is 0.38% (see Table).

Six of 10 endemic species on the white list are regarded as being common in suitable habitat. For the 7 species for which we have data all of them have <6% of their open area population collected annually. Five of these 7 species have <1% of their population collected. Given past and present collecting preferences and effort, the inclusion of these endemic species on the white list appears to pose little or no threat to populations on West Hawai'i reefs.

There are 3 endemic species on the White List, Psychedelic Wrasse (*A. chrysocephalus*), Hawaiian Longfin Anthias (*Pseudanthias hawaiiensis*) and Flame Wrasse (*Cirrhilabrus jordani*), for which we do not have adequate population estimates to assess the impact of continued aquarium collection due to their deeper water habitats.. There is also another non-endemic species, Tinker's Butterflyfish (*Chaetodon tinkeri*), for which data is similarly lacking. Wherever possible other sources of data should be utilized to monitor the status of these species and their continued inclusion on the White List.

Figure 24 shows the West Hawai'i aquarium catch and price paid per fish (adjusted for inflation) for the 4 species noted above. Clear long term trends in catch numbers (vertical bars) aren't readily apparent for these species. It is clear that collection of Hawaii Longfin Anthias is a relatively recent development. The value of individual fish received by collectors has been increasing for Flame Wrasse and Hawaiian Longfin Anthias and decreasing for Tinker's Butterflyfish and Psychedelic Wrasse likely driven by market forces (i.e. aquarist preferences).





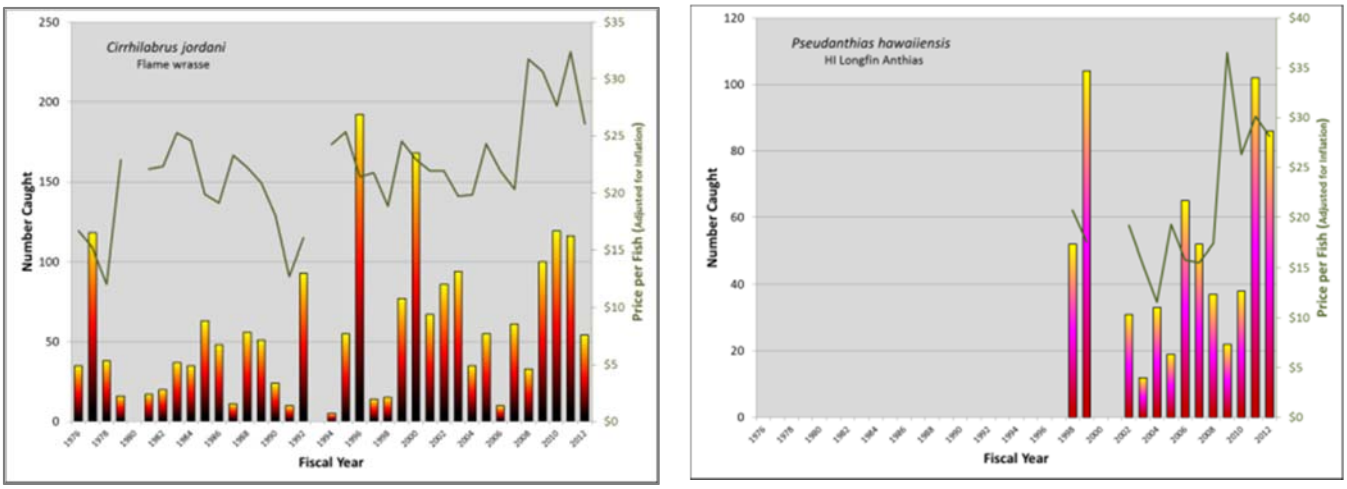


Figure 24. West Hawai'i aquarium catch (vertical bars) and value of selected species

The only other relevant sources of information on these four species are observations at depth from the dive logs of local technical divers Gerard and Vicky Newman. Dives ranged from a minimum depth of 60 feet (shallower dives were not cataloged) to a maximum depth of 331 feet. Figure 25 presents Gerard Newman's observations as percentage of dives on which a particular species was observed within a given type of management area over the period 2002-2011 (N=1,340 dives).

Tinker's Butterflyfish and Psychedelic Wrasse were substantially more common in the long term protected areas while Flame Wrasse and Hawaiian Longfin Anthias were more abundant in the FRAs. Sightings for all these species in all management areas did not exceed 25% of observational dives.

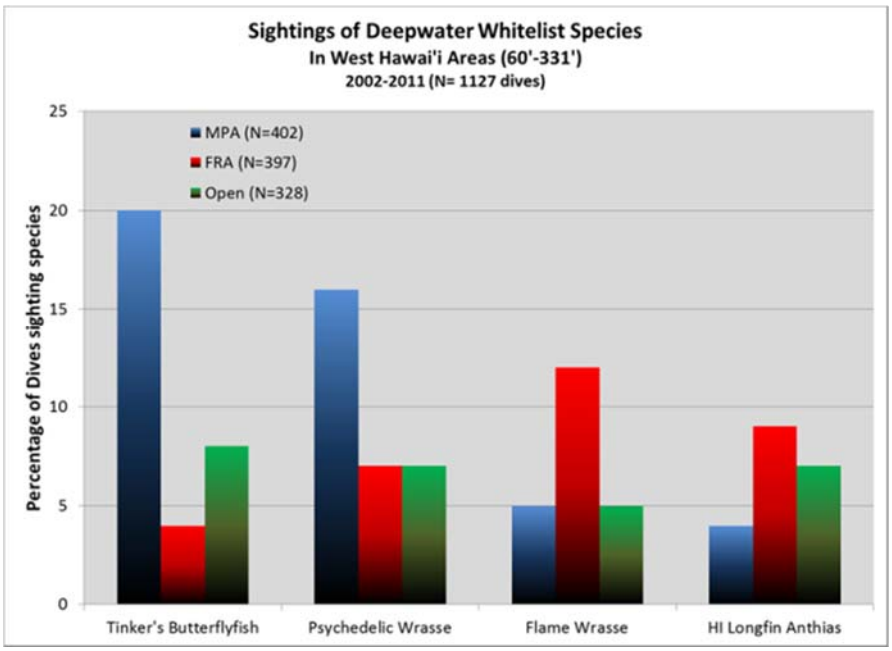


Figure 25.

Achilles Tang

Tinker's Butterflyfish

Psychedelic Wrasse male

Psychedelic Wrasse female

Flame Wrasse male

Flame Wrasse female

Hawaiian Longfin Anthias male

Hawaiian Longfin Anthias female

Figure 26. White List species of concern and those which lack adequate population estimates