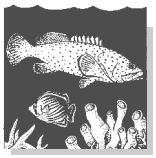


Adaptive management of aquarium fish collecting in Hawaii

by Brian N. Tissot [1]

Because aquarium fish collectors are highly selective and often capture large quantities of species of high value, the potential for overexploitation is high. Although many authors have discussed the potential impacts of the aquarium trade on reef fishes, there are no conclusive studies documenting the magnitude of impacts on natural populations, despite repeated calls for such studies to help develop sustainability in the aquarium trade industry. In Hawaii, the Division of Aquatic Resources (DAR) ignored public concerns about the aquarium industry for over 25 years largely due to the lack of a definitive study.

Concern over the effects of aquarium collecting on reef fish in Hawaii occurred in the early 1970s, principally regarding the Kona coast of the island on Hawaii (Walsh, 1978). Early concerns were based on multiple-use conflicts between collectors and recreational dive tour operators over apparent declines in nearshore reef fishes. These concerns prompted DAR to instigate monthly collection reports of all permit holders in 1973 and data from these reports have been the primary basis for management of the aquarium industry up to the present (Katekaru, 1978; Miyasaka, 1997).

Based on these reports about 90,000 fishes with a value of US$ 50,000 were harvested in 1973, with the annual harvest increasing to 422,823 with a value of US$ 844,843 in 1995 (Miyasaka, 1997). Moreover, during this period there was a shift in collecting from the island of Oahu in the 1970s and 80s, to the Kona and Milolii areas of the island of Hawaii in the late 1980s and early 1990s. Between 1993 and 1995 the harvest from Kona increased 67% and accounted for 59% of the state harvest (Miyasaka, 1997). Thus, increased harvesting of reef fishes was occurring in the prime tourist areas of the Kona coast.

Although a total of 103 fish species were collected state-wide in 1995, over 90% of the harvest was focused on seven species (in decreasing order of preference): *Zebrasoma flavescens, Ctenochaetus strigosus, Acanthurus achilles, Naso lituratus, Forcipiger flavissimus, Chaetodon multicinctus,* and *Zanclus canescens*, with *Zebrasoma* accounting for 72% of the total harvest (DAR, unpublished data). Thus, given the increasing rate of harvest focused on a small number of species, the potential for overexploitation of these fishes was high.

Beside the issue of fish harvesting, there was also concern over the effects of aquarium collectors on the reef community. Observations by local divers of large areas of broken and bleached coral in collection areas suggested some destructive harvesting practices. Moreover, because 80% of the catch consisted of herbivorous fishes (primarily *Zebrasoma*), and reductions in the abundance of herbivores can cause algal overgrowth of corals (Lewis, 1986), there were long-term concerns about impacts to overall reef health.

Impact assessment

Although efforts were made in the 1970s to estimate the impact of collectors in Kona (Nolan, 1978), flaws in experimental design prevented valid conclusions. In 1996, Leon Hallacher (Univ. Hawai'i–Hilo) and I conducted a state-sponsored study to provide an objective estimate of the impact of aquarium collectors on reef fishes in Kona (Tissot & Hallacher, 1999).

We used a paired control-impact design to estimate the impact of collectors on fish abundance by comparing differences in abundance at sites where collecting was known to occur (impact sites), relative to geographically adjacent sites where collecting was prohibited (control sites). We established four study sites that served as two replicate control-impact pairs where abundance was estimated using a visual strip-transect search method on four 50 m transects at each site. During each survey we estimated the abundance of 19 species, including ten aquarium species and nine species not targeted by collectors that provided data to support the assumptions of the experimental design (see Tissot & Hallacher, 1999). We also surveyed coral and macro-algal abundance before and after the study to detect the presence of destructive harvesting practices and changes that might occur due in reductions in herbivory.

1. Programme in Environmental Science and Regional Planning, Washington State University, Vancouver, WA, USA 98686. E-mail: tissot@vancouver.wsu.edu. Web site: http://oasis.vancouver.wsu.edu)

The results of our two-year study indicated that eight of the ten fishes targeted by aquarium collectors were significantly reduced in abundance at impact relative to control areas (Figure 1). The magnitude of these declines were high, ranging from 57% in *Acanthurus achilles* to 38% in *Chaetodon multicinctus*. In contrast, only one of the nine non-target species varied significantly between these areas, supporting our conclusions that aquarium collectors were causing significant reductions in targeted fishes.

There were no consistent, or significant, differences between control and impact sites in the extent of bleaching, broken coral, and changes in coral cover that indicated destructive fishing practices.

We also found no differences in the abundance of macro-algae between impact and control sites, suggesting that reductions in herbivory associated with harvesting were not having a significant effect on algal abundance. However, we did not obtain data on the abundance of filamentous algae, sea urchins, or nutrient concentrations; factors which must be examined to adequately test this hypothesis.

Adaptive management

Based on the results of our study the current system of monthly catch reporting appears to be providing poor data for the management of aquarium fishes. Because these reports are not compared to actual catches, there is no quality assurance that the reports are accurate. Based on an evaluation of the reported catch relative to a rough estimate of potential yield from our impact assessment, the 1998 harvest could have been generated from ~1.5% of the available reef area in west Hawaii (Tissot & Hallacher, 1999). Because this number appears low relative to the observed activities of the ~50 aquarium collectors operating in west Hawaii, the catch reported by collectors may be underestimated, perhaps by an order of magnitude.

In response to continued strong public outcry over the aquarium collecting issue and the results of our study, the state legislature passed a bill in 1998 to improve the management of fishery resources in west Hawaii. A major thrust of the bill, which became Act 306, was to improve management of the aquarium industry by protecting a minimum of 30%

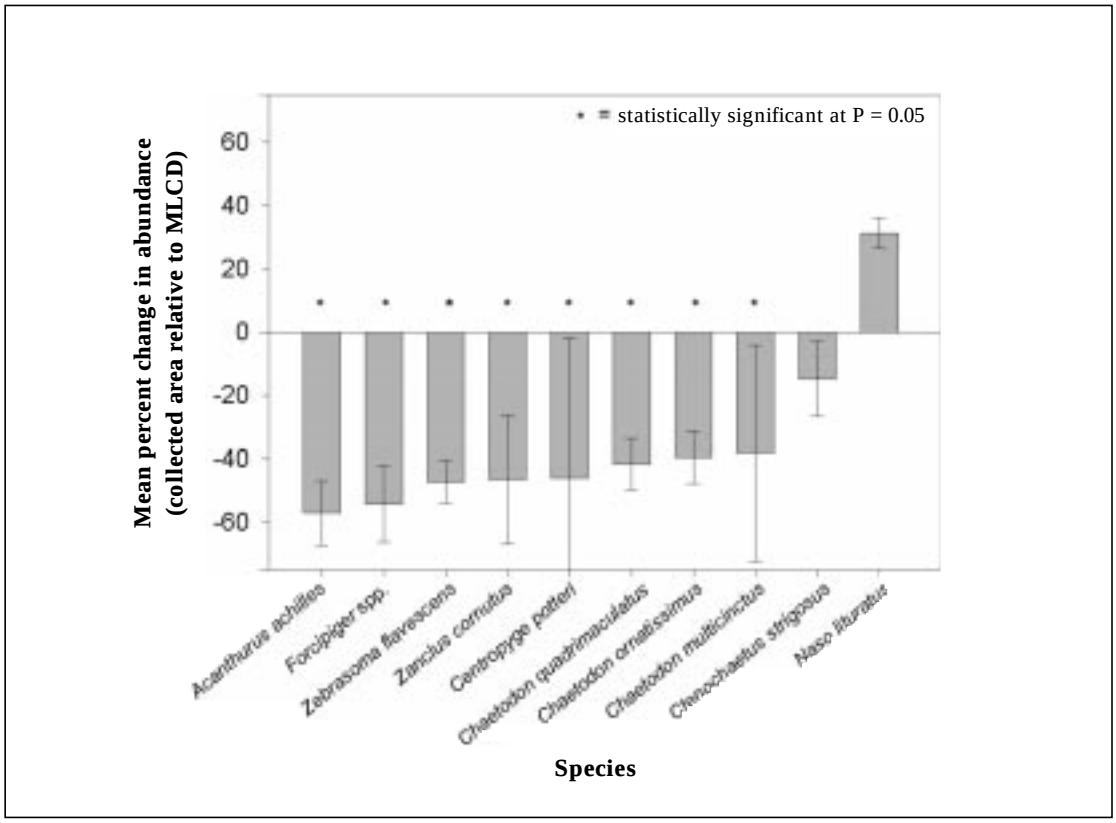


Figure 1. **Mean percent change (± S.E.) in collected aquarium fishes at impact relative to control sites in Kona, Hawaii. Significant impacts were detected using a two-way repeated measure ANOVA with impact and study areas as factors and surveys as repeated measures (see Tissot & Hallacher, 1999)**

of the west Hawaii coastline through the establishment of Fish Replenishment Areas (FRAs)—marine reserves where aquarium fish collecting is prohibited. Because the life history of aquarium reef fishes is poorly known, marine reserves have been widely recommended as the best approach for promoting the sustainable harvest of aquarium reef fishes (Randall, 1978; Wood, 1985; Andrews, 1990) and reef fishes in general (Bohnsack, 1998).

The design of the reserve network in Hawaii was generated from a community-based group, the West Hawaii Fishery Council. This council, which was organised by Bill Walsh (DAR), and Sara Peck (Univ. Hawaii Sea Grant Extension Service), consisted of representatives from the aquarium, dive tour, and hotel industries, plus shoreline gatherers, recreational divers, and representatives from each of the coastal areas in west Hawaii. Based on scientific input, the Council proposed a network of nine FRAs to minimise conflicts between the aquarium and dive tour industries and promote a sustainable fish harvest. In April 1999, ~1000 people attended a public hearing on the proposed reserve system—the largest attendance at any fishery management hearing in Hawaii — with 93% of the testimony in favor of the proposed management plan. If approved by the government, the reserves could be closed effective October 1999.

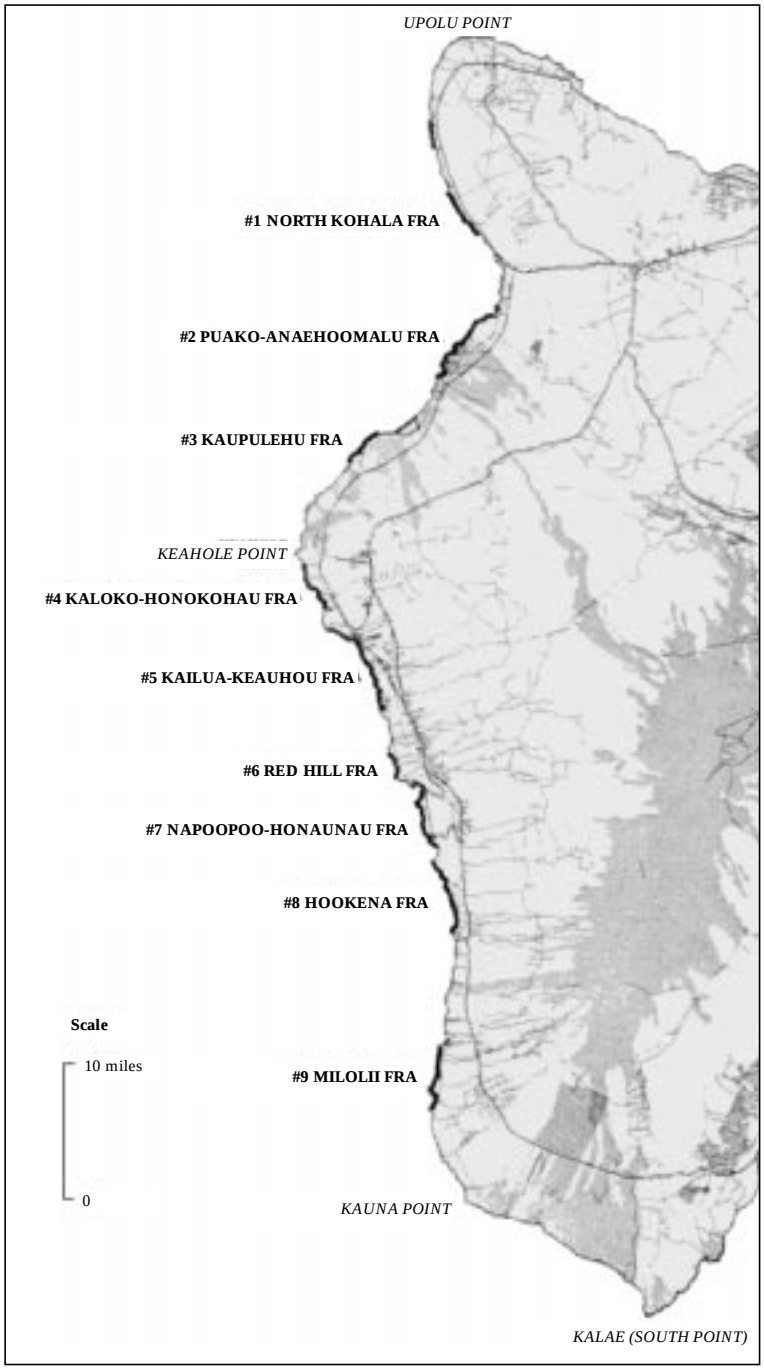


Figure 2. Map illustrating the nine Fish Replenishment Areas (FRAs) proposed by the West Hawaii Fishery Council in relation to existing protected areas. If enacted, 35% of the west Hawaii coastline would be closed to aquarium fish collecting. Source: Hawai'i Division of Aquatic Resources.

Our current efforts are focused on monitoring these areas to evaluate the effectiveness of the reserve network to increase the abundance of aquarium fishes. In 1998, a group of researchers including Bill Walsh, Leon Hallacher and I, established 23 study sites in the nine proposed FRAs, eight sites where fish collecting will continue (impact sites), and six existing protected areas where aquarium fish collection is currently prohibited (control sites), to order to evaluate changes in abundance as the reserve system is implemented.

Our initial studies, which constitute baseline surveys before closure of the reserve system, confirm that aquarium collectors are causing significant reductions in abundance in four of the six proposed FRAs that could be adequately studied. Ongoing monitoring of these sites as Act 306 is implemented will provide an evaluation of the effectiveness of each reserve in the network. After five years, Act 306 mandates an evaluation and refinement of the management plan; at that point we hope to adapt the design of the reserve network based on the results of our studies to maximize the multiple-use of aquarium fishes.

References

ANDREWS, C. (1990). The ornamental fish trade and fish conservation. J. Fish Biology 37: Suppl. A, 53–59.

BOHNSACK, J.A. (1998). Application of marine reserves to reef fisheries management. Australian J. Ecology 23: 298–304.

KATEKARU, A. (1978). Regulations of tropical fish collecting. Hawaii Sea Grant College Program, Working papers No. 34. 35–42.

LEWIS, S. (1986). The role of herbivorous fishes in the organization of a Caribbean reef community. Ecol. Mongr. 56(3): 183–200.

MIYASAKA, A. (1997). Status report, Aquarium fish Collections, Fiscal Year 1994-95. Division of Aquatic Resources, Department of Land and Natural Resources, State of Hawaii. Honolulu, Hawaii, June, 1997. 10 p.

NOLAN, R. S. (1978). Hawaii tropical fish study. Hawaii Sea Grant College Program, Working papers No. 34. 27–34.

RANDALL, J. E. (1978). Marine reserves – an answer. Hawaii Sea Grant College Program, Working papers No. 34. 6–7.

TAYLOR, L.R. (1978). Tropical reef fish management: issues and opinions. Hawaii Sea Grant College Program, Working papers No. 34. 3–5.

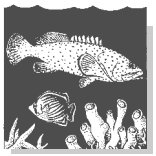
TISSOT, B.N. & L.E. HALLACHER. (1999). Impacts of aquarium collectors on reef fishes in Kona, Hawai'i. Final Report, Dept. of Land and Natural Resources, Honolulu, HI. 32 p.

WALSH, W.J. (1978). Aquarium fish collecting: promise or problem? Hawaii Sea Grant College Program, Working papers No. 34. 8–12.

WALSH, W.J. (1987). Patterns of recruitment and spawning in Hawaiian reef fishes. Env. Biol. Fish. 18(4): 257–276.

WOOD, E. (1985). Exploitation of coral reef fishes for the aquarium trade. Report to Marine Conservation Society, UK. 129 p.

YOUNG, L.G.L. (1997). Sustainability issues in the trade for wild and cultured aquarium species. Pages 145–151 in Marketing and Shipping Live Aquatic Products, '96, Seattle, Washington, 13–15 October, 1996. Northeastern Regional Agricultural Engineering Service Cooperative Extension, Ithaca, New York.



Live reef fish developments in Fiji

By Being M.Yeeting [1]

*Condensed from an article originally printed in the S*PC Fisheries Newsletter *88: 25–36 (1999).*

Background

Fiji is one of the very recent countries in the Pacific to get into the Live Reef Food Fish (LRFF) trade. With interest being shown by some overseas LRFF companies, it was identified as a potential income-generating project to pursue by the Fiji Fisheries Department under their Commodity Development Framework (CDF) programme in 1998. With the preliminary arrangements being negotiated for one overseas LRFF operator to start, Fiji has wisely decided to look seriously at the management and regulatory issues relating to this fishery based on experiences and lessons learned from other countries. The primary aim is to set up a LRFF industry that is sustainable in the long term. Fiji Fisheries therefore decided that the first step was to know about the extent of their LRFF resource and to set up a management structure in the form of policies, regulations and legislation for the trade.

Request for assistance

In August of 1998, a letter of request for assistance was received by the Secretariat of the Pacific Community (SPC) from the Ministry of Foreign Affairs and External Trade in Fiji on behalf of the Fiji Fisheries Department.

1. Secretariat of the Pacific Community, Noumea, New Caledonia. E-mail: BeingY@spc.org.nc