Final Report

Life history of Hawaiian "redfish": a survey of age and growth in 'āweoweo (*Priacanthus meeki*) and u'u (*Myripristis berndti*).

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Dingell-Johnson Federal Sportfish Restoration Project

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Scope and Need for Project

Hawaii's coral reefs are a significant natural resource, providing hundreds of millions of dollars per year in economic value through fishing and ocean-related tourism**.** To promote the sustainability of Hawaiian coral reef fisheries, it is vital for resource managers to possess key life history information on targeted fishery species. As with most areas of the world, the state of Hawaii faces a critical gap in our understanding of the impact of fishing pressure on many marine species largely due to a collective lack of data regarding life history parameters. To date, very little information has been gathered in terms of the longevity, fecundity, age at maturity, or feeding habits of many of Hawaii's marine fishes.

One group of priority taxa for life history study identified by the Hawaiian Coral Reef Fisheries Local Action Strategy are the Hawaiian "redfish", a group of ecologically important carnivorous reef fishes with members in the families Holocentridae and Priacanthidae. "Redfish" are of particular importance to local fisheries, yet there is surprisingly little demographic information for these fishes throughout the archipelago. Thus, there is a critical need to increase our understanding of the life history traits of "redfish" populations through a dedicated scientific study, particularly within the MHI where intense fishing pressure on these species has created an urgent need to compile critical life history parameters. These data will better inform managers, scientists, and the public about the population dynamics of these species, their susceptibility to overfishing, and appropriate management actions to promote the vigor of their populations.

Project Goals

The goals of this project are threefold: (1) to collect specimens, and to process, catalog and archive anatomical structures critical for determination of life history parameters (e.g., otoliths, gonads, gut contents) from Hawaiian "redfish"; (2) to perform a directed analysis of the age and growth of 'āweoweo (*Priacanthus meeki*) and u'u (*Myripristis berndti*); and (3) to remove and archive tissues suitable for analysis of demographic parameters from a suite of coral reef species being collected for other research purposes throughout Hawaii. The results and discussions for these three goals are contained in the following sections.

Project Goal 1 – Collecting, processing and archiving anatomical structures relevant to "redfish" demography.

"Redfish" in the main Hawaiian Islands continue to be a favorite target for many fishermen. An informal survey of fishers on the island of O'ahu revealed that past "redfish holes" which at times yielded hundreds of individuals in a single night have ceased to produce fish (William Aila, 2008 pers. comm.). Consequently, areas rich in these species are kept secret so as to reduce the number of fisherman who visit these localities and increase the benefit to individual fisherman. Still, the situation on O'ahu seems to reflect a pattern consistent with the over exploitation of the "redfish" fishery. The status of this fishery is less well known to us on outer islands, however our survey and collection of "redfish" within safe diving limits on the island of Maui indicates a

similar situation. On the island of Kauai, fishermen still enjoy a reasonable harvest of these species. A hook-and-line collection was made by Patrick Conneley and one additional fisherman on the island of Kauai that yielded more than 50 "redfish" in approximately one hour of fishing (Figure 1). On the island of Hawaii, we have been informed of "redfish" schools in the 1000's by the owners and operators of Big Island Spearguns. Thus, it appears that isolated areas of high abundance still exist for Hawaiian "redfish". However, it remains to be known how quickly the population may recover; on a return trip to the same site, P. Conneley was unable to catch any redfish.

We collected 163 specimens of *M. berndti* and 103 specimens of *P. meeki* from Oahu, Kauai, the island of Hawaii, and the Papahānaumokuākea Marine National Monument. Our collections in the main Hawaiian Islands were hampered by reduced numbers of these species, especially *P. meeki*, at safe diving depths for collection with pole spears. This is presumably due to the high level of fishing effort for these desirable species. After limited collection success using SCUBA, our methods shifted to hook-and-line capture, the preferred gear utilized by recreational fisherman targeting redfish in Hawaii. Our more recent collections have shown that this method can yield a much higher CPUE. With the low abundance of these species in nearshore waters, an additional year of sampling would be required to meet our desired minimum target of 300-400 specimens per species. In addition, another year of sampling would facilitate the collection of smaller/younger specimens to increase the size range of the demographic functions for each species, and histological examination of gonads to identify age-at-maturity information for the redfish.

We made successful collections of both species within the Papahānaumokuākea Marine National Monument, and although this area is not a priority within the LAS program, these specimens elevated our sample sizes for the target species and provide the potential for future demographic comparisons between populations in the MHI and NWHI.

Project Goal 2 – Assembly of demographic information for the priority species *M. berndti* and *P. meeki.*

Length-weight and length-length relationships were determined for *M. berndti* and *P. meeki.* These measurements are useful to convert total length (TL), a measure usually taken by fisherman, to standard length (SL), a measurement taken by biologists. In addition, biomass for these species may be calculated for data based on visual surveys of reef fish densities. The range of sizes for *P. meeki* collected was 15.5-29.5cm SL, and 13.5-23.5cm SL for *M. berndti* (Fig. 2). For both *P. meeki* and *M. berndti* the length-length relationship showed a linear relationship and fit the equations TL = 1.198(SL) + 1.6732 (R^2 = 0.9683) and TL = 1.2146(SL) + 1.5814 (R^2 = 0.9813), respectively (Figures 3-4). The length-weight relationship showed a typical exponential relationship and fit the equations $W = 0.0603(SL)^{2.7381}$ (R^2 = 0.9489) for *P. meeki* and $W = 0.0857(SL)^{2.7204}$ (R^2 = 0.9549) for *M. berndti* (Figures 3-4).

Given the low sample size for *P. meeki* coupled with an unusual otolith morphology, our analytical focus of demography has been on *M. berndti.* For this species we recorded a maximum age of 27 years. The relationship between age and growth was determined using the von Bertalanffy growth equation. The species showed a typical

rapid period of growth in the initial years (0-3) followed by an asymptotic slowing of growth rate. The von Bertalanffy growth parameters were estimated as: $L_\infty = 21.1449$, $k = 0.1475$, and $t_o = -4.4768$. The plot of this function is show in Figure 4.

Visual observations of gonad condition and sex allowed for a qualitative estimate of spawning season and age of maturity. For *P. meeki* mature (= showing solid white color indicative of maturing spermatozoa) in specimens as small as 22.5cm. Mature females (= showing yellow/orange color and swollen shape indicative of maturing oocytes) were as small as 25cm. Mature gonads for both sexes were observed in samples collected in June and September. For *M. berndti* mature males were as small as 18cm and mature females as small as 20cm. Mature gonads were observed in individuals collected in June and July, but not for those collected in May. While these observations provide tentative estimates, they must be confirmed with histological examination of gonads and a wider breadth of temporal sampling before any robust conclusions may be drawn.

Project Goal 3 - Cataloging and archiving tissues from Hawaiian reef fishes.

A major effort has been the archival and processing of specimens "on hand". Through this funding, we have been able to train two undergraduate technicians from the University of Hawaii at Manoa (Allexa Dow and Corrinne Brong). These students have made tremendous advances in their understanding of reef fish biology and demography, and have mastered the removal of otoliths from a suite of reef fishes. In total, these two technicians have processed over 2300 specimens from 35 species, taking measurements of total length, standard length, and weight, and removing and archiving otoliths and gonads where possible. At over 2500 samples from 35 species, this collection represents one of the largest archived collection of this type for Hawaiian reef fishes to date, both in terms of diversity of taxa and number of specimens. This collection continues to grow with more than 350 specimens recently deposited in our collection, and the continuation of this effort is dependent on renewal of this funding. Additionally, we plan to train at least one more undergraduate technician to assist in this work during the 2008/9 academic year.

Information Dissemination

One perennial problem in the collection of life history data is the dissemination of preliminary data prior to publication that allows for widespread access to these critical parameters. In addition to providing this report to the granting agency, our information will be added to a growing database of reef fish collections in the state of Hawaii created and maintained by researchers at the University of Hawaii, Hilo (funded by this program). To assist in the ease of access to this information by researchers both within and outside of the state of Hawaii, we have created a metadata record for the project with the Knowledge Network for Biocomplexity, a collaborative national network through NSF and NCEAS intended to facilitate ecological and environmental research. The online record is available at **http://knb.ecoinformatics.org/knb/metacat/ecfranklin.3.2/knb.** Finally, we anticipate publication of these data in a peer reviewed journal once sufficient sample sizes have been achieved to allow for statistical rigor.

Acknowledgements

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Figures

Figure 1. An atypical "redfish" haul by two fishermen in ~60min of fishing effort on the island of Kauai, May 2008. In this photo, there are 58 fish (CPUE = ~0.5 fish/min), mostly comprised of *Myripristis berndti.* (Photograph and Fisherman: Patrick Connely).

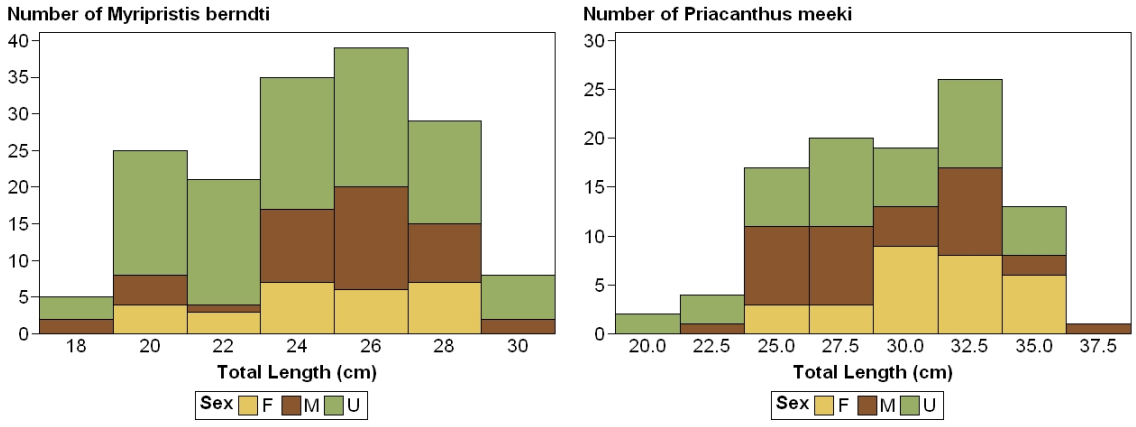

Figure 2. Total length frequency histograms for *Myrpristis berndti* and *Priacanthus meeki* partitioned by sex (F = female, M = male, U = unknown).

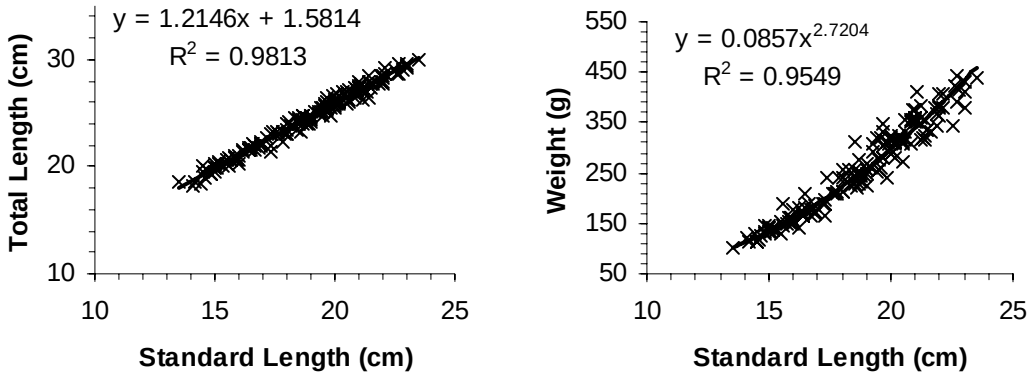

Figure 3. Length-length and weight-length relationships for *Myripristis berndti* (n = 162).

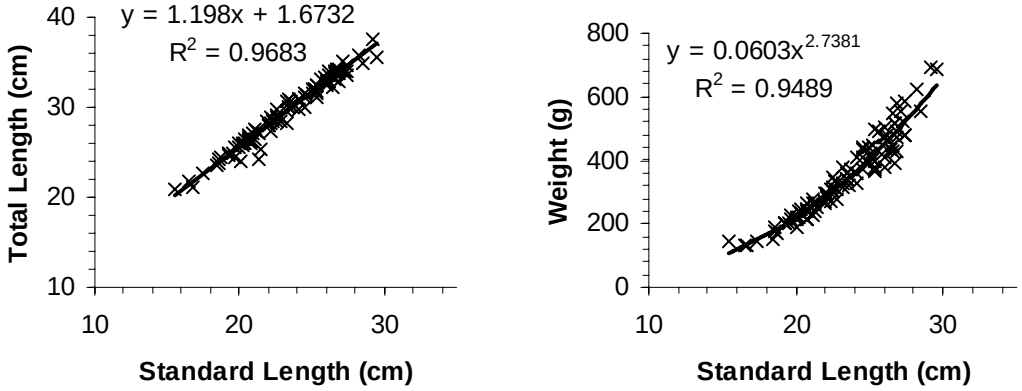

Figure 4. Length-length and weight-length relationships for *Priacanthus meeki*.

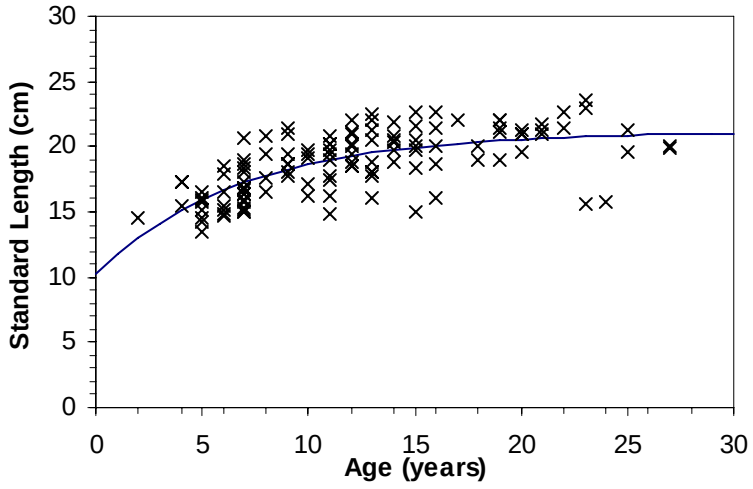

Figure 5. Von-Bertalanffy growth function for *Myripristis berndti* (n = 126, L_∞ = 21.1449, K = 0.1475, t_0 = -4.4786).