Tuna Trophic Ecology Annual Report 2002 –2003

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The Tuna Trophic Ecology Project has been proceeding along three parallel paths and all three areas have made significant advances and produced fascinating data in the past year. These three areas of research are 1. Stomach content analyses of yellowfin and bigeye tuna found in association with FADs and seamounts, 2. Investigation of the spatial and temporal dynamics of pelagic fish communities associated with anchored FADs and, 3. Tuna trophic status as determined by carbon and nitrogen stable isotope ratio analyses.

The tuna stomach contents component of this program is the longest established and has reached a level of maturity such that, although some data collection is continuing, the main tasks in the past year were data analysis and interpretation. A total of 1,338 samples (714 bigeye and 624 yellowfin) have been collected over the course of the project and so far 596 bigeye (83%) and 330 yellowfin (53%) have been analyzed.

Analysis of the stomach contents of the two target species (bigeye and yellowfin) in the various locations (associations) of interest (offshore FAD, nearshore FAD, seamount) is demonstrating that bigeye and yellowfin of similar size classes have different feeding ecologies in all the various associations. Generally stated, large yellowfin feed successfully at the offshore FADs but smaller yellowfin do not. On the other hand, small yellowfin (<75cm) feed well at the nearshore FADs (mostly on stomatopod larvae and flying gurnards). In contrast, bigeye of all sizes don't appear to feed well at any of the artificial structures (inshore and offshore FADs) that we have sampled. This seems to be due to a lack of availability of mesopelagic prey at these locations. Conversely, bigeye feed very well when associated with Cross seamount. This may be due to the fact that, in general, bigeye feed on organisms that occur deeper than those consumed by yellowfin tuna and certain seamounts seem to provide an enriched source of these mesopelagic prey. In all locations, the dietary overlap between bigeye and yellowfin of all sizes is minimal but is greatest when the animals are fond in association with Cross seamount.

Data collection is now focusing on obtaining stomach samples from long-line caught fish. Because longline fish are not usually caught in association with FADs or seamounts, the longline fish can be considered a 'control group' for the rest of the experiment. These samples are being collected through the collaboration of NMFS observers working on the Hawaii based longline fleet. We are also collecting small tuna from inshore FADs.

The investigation of the dynamics of FAD associated communities (mainly yellowfin and bigeye tuna) has dramatically accelerated in the past year and is already yielding extensive and fascinating results. All thirteen FADs around Oahu have been fitted with Vemco VR2 sonic data loggers and, to date, 74 FAD-associated fish have equipped with pulse-coded sonic tags that were implanted in the abdominal cavity. Ten of these fish were double tagged with geolocating archival tags. These tags were donated by Wildlife Computers Co. in a collaborative effort to gain more insight into the behavior of the FAD-associated fish while at the same time allowing Wildlife Computers to calibrate their latest geo-locating algorithms. To date, two yellowfin tuna carrying these archival

tags have been recaptured and the data successfully recovered. Thirteen additional fish have been recaptured that were carrying only acoustic tags. The data loggers on all the FADs have been recovered and interrogated at least twice and the data recovered. One transmitter has been recovered three times and redeployed. That is, it is now implanted in a fourth FAD-associated tuna!

The inter-FAD movement patterns and FAD-association dynamics results that these tagged fish are revealing are now in an active phase of analysis. At this point we are confident that data base is already sufficiently large that these data will yield a significant increase in our understanding of the influence of anchored FADs on the movement and distribution of yellowfin and bigeye tuna. The sonic tagging component of the overall Tuna Trophic Ecology Program is still in an active data collection phase and in the future more animals will be released with implanted coded tags. Similarly, we will continue to retrieve and download the VR2 data loggers to expand the existing database.

In the past year, stable isotope analysis of the comparative trophic ecology of bigeye and yellowfin tuna has hit full stride. This is largely because of the arrival of a PFRP sponsored Graduate Research Assistant with expertise in stable isotope techniques who is specifically employed to advance this aspect of the overall program. During the past year, initial laboratory and field feasibility and calibration experiments were successfully completed. These experiments provided information regarding future sample size requirements, sample variability and method error. To date, 340 samples have been prepared for analysis and, of these, seventy have been analyzed for carbon and nitrogen isotopes. A range of tissue types (liver, red muscle, white muscle) was analyzed from yellowfin and bigeye tuna of varying sizes. In the early stages of this research, particular emphasis was placed on specimens caught around nearshore FADs. This strategy was adopted to compliment the FAD-associated sonic tagging experiments that were being conducted at the same time (see above). Currently, emphasis is being placed on obtaining isotope signatures from a wider size range of specimens – especially larger specimens captured by the long line fleet.

Initial results show that carbon and nitrogen isotope ratio techniques will provide valuable insights into tuna trophic ecology. Carbon and nitrogen isotope ratios obtained from bigeye and yellowfin tuna indicate that different tissue have distinct signatures. This will allow any one of these tissues to be used to characterize the trophic status of tunas. In all cases, the signatures are consistent with the hypothesized trophic status of tuna. For example, isotope values of large yellowfin and bigeye tuna caught at the Cross seamount were nearly two trophic levels higher than those obtained from juvenile tuna caught at the nearshore FADs. Another interesting early result is that one 'cohort' of fish collected from a nearshore FAD had isotope values that were elevated above those of other 'cohorts' taken from other FADs or at other times. Two possible interpretations of these data are 1) that the elevated signatures were indicative of a school of fish that had recently experienced a starvation event or, 2) that particular group of fish foraged in an area where nutrient dynamics were different. These interpretations will be tested in the coming year when feeding experiments will be conducted with captive tuna.