February 2014

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Report to the Western Pacific Fishery Management Council

NOAA Fisheries Pacific Islands Region Observes 10 Year Milestone

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PACIFIC ISLANDS REGION
NOAA FISHERIES

Building a Legacy of Science & Management

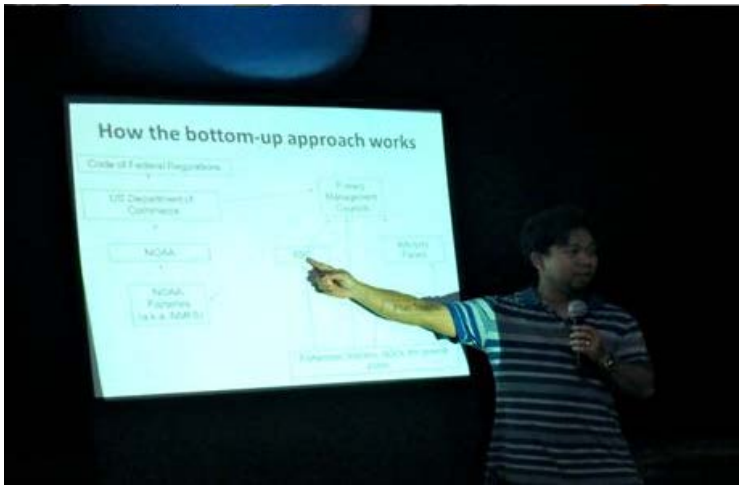
Pacific Islands Fisheries Science Center

The Pacific Islands Fisheries Science Center (PIFSC) conducts research in a wide variety of programs that may be of interest to the Western Pacific Fishery Management Council (Council). This report is organized around the research divisions of the PIFSC as a series of highlights.

SOCIOECONOMICS AND PLANNING GROUP

Fishers Provide Input Regarding Reef Fish ACLs in the CNMI

On November 19th, 2013, PIFSC social scientists Leila Sievanen and Cindy Grace-McCaskey, along with Marlowe Sabater of the Council, hosted a workshop designed to incorporate fishers' knowledge and perceptions into deliberations regarding the setting of annual catch limits (ACLs) for reef fisheries in the CNMI. Current ACLs in the region are based primarily on fisheries landings data that are widely considered to be incomplete. Augmenting the information gaps with fishers' knowledge is expected to complement the understanding of patterns and trends noted in available fisheries data.



Marlowe Sabater explains the importance of bottom-up management.

During the workshop, Sievanen and Grace-McCaskey solicited feedback from members of Saipan's reef fishing community regarding previously collected interview data. The interviews had been conducted with 38 Saipan fishers and vendors and 5 locally-based fisheries managers during September 2013. Interview topics included: the nature and perceived importance of local reef fisheries, local knowledge of coral reef ecosystems and associated species, and perceptions about various management strategies.

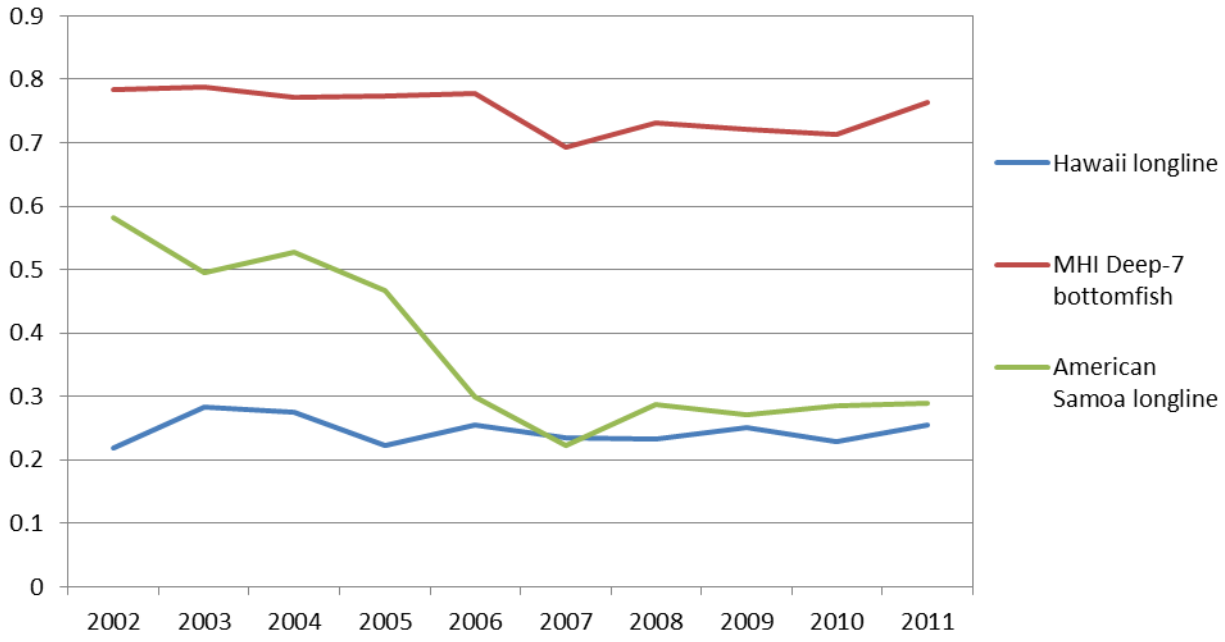
Reef fishing occurs alongside military and tourism use in Saipan's coastal zone.

The scientists then invited the fishers and vendors who participated in the study, along with additional reef fishers and agency representatives from the region to attend the 3-hour evening workshop at the Carolinian Ut in Garapan. Local counterparts Arnold Palacios and Jack Ogumoro helped to coordinate and officiate the event. At least 45 reef fishers, 3 vendors, and 5 agency representatives attended the workshop and participated in the identification of social, ecological, economic, and management uncertainty (SEEM) factors for the ACL specification in the CNMI.

The workshop was part of an ongoing bottom-up approach to ACL analysis in a setting with relatively little valid fisheries data. As such, it was an important step toward utilizing the rich local and traditional knowledge held by CNMI fishers and involving them directly in regional fisheries planning and management processes. Marlowe Sabater will use the results of the original interview research and more recent workshop in a formal SEEM analysis scheduled for February 2014.

Economic Performance of three Main Commercial Fisheries in the Pacific Islands Region

Economists Hing Ling Chan and Minling Pan reported basic economic performance measures for three Pacific Islands Region commercial fisheries using a set of "national standard" indicators (Tier 1 indicators). The fisheries assessed were: Hawaii longline, American Samoa longline, and main Hawaiian Islands (MHI) bottomfish. The "standard"



Gini coefficients for various Hawaii fisheries by year, 2002-2011. The Gini coefficient indicates how equally revenue is distributed among active vessels or permit owners. The Gini scale goes from 0 to 1: a value of 0 means each vessel earned equal revenue, while a value of 1 means a single vessel earned all the revenue.

indictors included aggregate landings; number of permits, trips, and active vessels; season length; days at sea; aggregate revenue; and ACL and its utilizations. Recently, Chan and Pan added to the roster of indicators an estimate of the Gini coefficient, which measures the equality of the distribution of revenue among active vessels/permits in the fishery. A value of zero for the Gini coefficient represents a perfectly equal distribution of revenue amongst vessels in a fishery, whereas a value of one represents a perfectly unequal distribution, in the case that a single vessel earns all of the revenue.
The graph above shows the Gini coefficients for the three fisheries. Among them, the Hawaii longline fishery has the lowest Gini coefficient (i.e., most equal revenue distribution) whereas the MHI commercial Deep-7 bottomfish fishery has the highest Gini coefficient (i.e., most concentrated revenue distribution). Also, the Gini coefficient for the Hawaii longline fishery is relatively stable; the Gini coefficient ranged from 0.22 to 0.28 between 2002 and 2011 and averaged 0.24.

For the Hawaii Deep 7 bottomfish fishery, revenue was calculated by license holder instead of by vessel. In this fishery, multiple fishermen may fish in the same vessel but report their revenue separately under each individual's Commercial Marine License (CML). Alternatively, a fisherman may fish using different vessels through the year and report catch and revenue by individual CML. Therefore, the Gini coefficient essentially measures the equality of the distribution of revenue among active fishermen (CML holders) in the fishery. Compared to the Hawaii longline fishery, the Gini coefficient for the Hawaii Deep 7 bottomfish fishery is high; it averaged 0.75 during the period of 2002-2011 and ranged from 0.69 to 0.79. The high Gini coefficient of this fishery is due to the fact that participants in the fishery show a large range of effort levels, i.e., participants whose motivation is primarily commercial and who participate at a high level of effort on one end of the spectrum and those whose motivation is primarily non-commercial and who participate at a lower level of effort at the other end of the spectrum. In addition, the fishermen in the Deep 7 bottomfish fishery usually participated in other fisheries (like the pelagic handline fishery) which are not included in the Gini coefficient analysis.

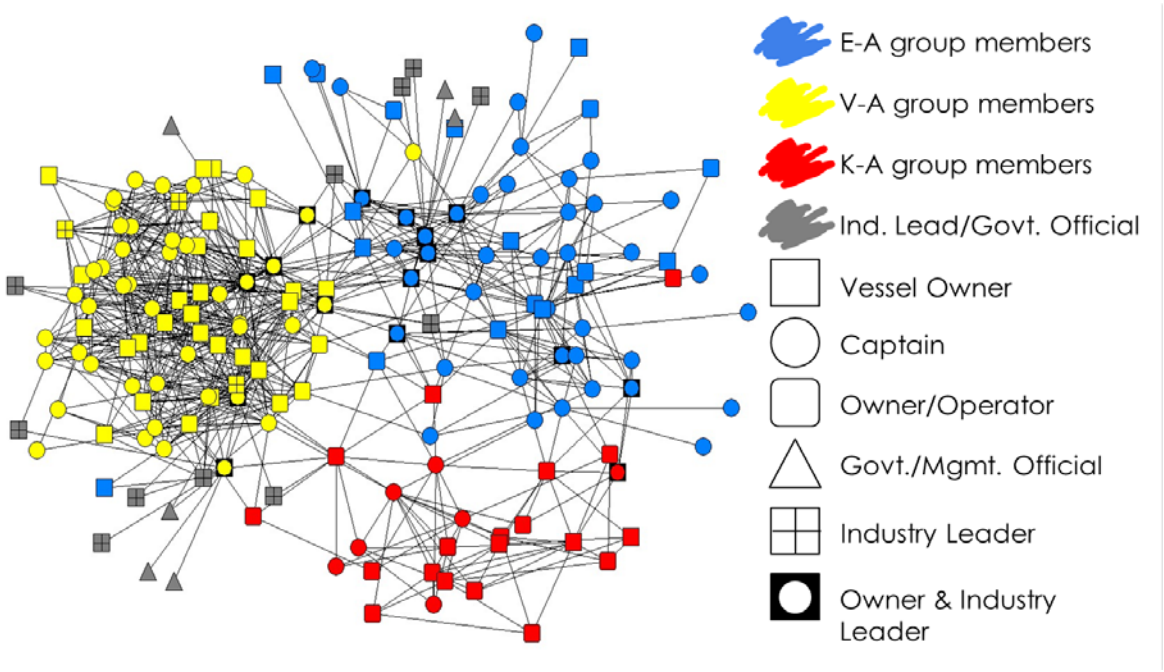
While the Gini coefficients for both the Hawaii longline fishery and the MHI bottomfish fishery were stable, the Gini coefficient for the American Samoa longline fishery showed great changes during the period of 2002-2011. For the American Samoa longline fishery, the Gini coefficient was 0.58 in 2002 and dropped to 0.22 in 2007, while the average was 0.43 during this period. This decline was due to the decline in the number of small vessels (<=40 feet) between 2002 and 2006 that had the lowest revenue. Since then, the majority of the vessels have been large vessels (>70 feet) and revenue by vessel has become more equally distributed, contributing to a drop in the Gini coefficient to values between 0.27 and 0.29.

Information Sharing Networks in Hawaii's Longline Fishery – An Ongoing Study

PIFSC researchers have initiated a study to understand how Hawaii longline fishermen's social relationships, and specifically information-sharing networks, might influence outcomes in the fishery. The study used a survey to collect information about

whom fishermen most frequently contacted for information and advice on fishery regulations, vessel technology, and bycatch, and how often.

The fishery is currently made up of three distinct ethnic groups: Korean-American fishers, Vietnamese-American fishers, and European-American fishers. The study indicates that most trusted information sharing occurs within, rather than across, ethnic groups. Results also show that the Korean-American fishing community, and to a lesser extent the European-American community, substantially lack trusted relationships with industry leaders and fishery management officials. The study suggests that, for now, fishery managers can ensure information dissemination throughout the fishery by contacting each ethnic group separately. The study suggests that in the long term information-sharing would be enhanced via increased interaction and trust between ethnic groups, and between fishers and management officials. Results from this phase of the project have recently been published in the peer-reviewed journal Ecology and Society (http://www.ecologyandsociety.org/vol18/iss1/art23/)



Hawaii's longline fishery information sharing networks, adapted from Barnes-Mauthe et al. 2013, *Ecology and Society* 18(1):23. Shapes represent actors, lines represent information sharing ties. E-A = European-American fishers, V-A = Vietnamese-American fishers, and K-A = Korean-American fishers.

Subsequent analysis explored whether specific socio-demographic or other personal characteristics might be contributing to this "social network capital." Results showed that ethnicity, activity in local fishing organizations, information sharing attitudes, and measures of human capital (such as title/tenure and experience fishing) were significant factors. This suggests that when substantial or controversial change is desired or necessary, individuals with higher levels of fishing experience and who have lived in the community longer, or those with positive attitudes toward information sharing and who

are more active in fishing organizations (without holding a formal position in those organizations) might be more effective at disseminating such information.

SCIENCE OPERATIONS GROUP

Monument Science

The PIFSC Monument Science program helps in the Center's efforts to meet monument proclamation requirements to "assess and promote monument-related scientific exploration and research" as well as other requirements of NOAA and NMFS. Over the past year the program has assisted in many areas:

Marianas Trench Marine National Monument (MTMNM)

- Produced MTMNM Ecosystem Science Plan, available for circulation Mar 01, 2014.
- Held a Workshop in Saipan, May 21-22, focused on fisheries science implementation needs for local, regional and national interests. A workshop report was submitted to PIFSC editorial entitled: MTMNM and Marianas Archipelago Ecosystem Science Implementation Plan Workshop Report.
    - Currently writing a Marianas Trench Marine National Monument Science Action Plan for the next 5 years based on the workshop outcomes.
- PIFSC held a one day meeting in Saipan discussing joint research projects to be conducted onboard the NOAA Research Vessel Oscar Sette in spring 2014.
    - Received 12 proposals from CNMI and Guam scientists and are in the process of coordinating and facilitating these projects into the planned 2014 cruise.
- Coordinated with Schmidt Ocean Institute, UH, PMEL and Woods Hole on two planned research cruises to the MTMNM onboard the Schmidt research vessel *Falkor*.
- A CRED Marianas Archipelago Rapid Assessment and Monitoring Program (MARAMP) cruise is planned for Spring 2014.

Pacific Remote Islands Marine National Monument

- Conducted a Deep-7 Bottom Fish research cruise around Johnston Atoll, led by Dr. Robert Humphreys.

NEPA Support

Per the National Environmental Policy Act (NEPA), PIFSC currently conducts research under a collection of programmatic environmental assessments (EAs). These EAs include: the Marine Turtle Research Program (MTRP), the Marine Turtle Assessment Program (MTRP), Research Activities Conducted by the Coral Reef Ecosystem Division (CRED), Elasmobranch Bycatch Reduction in Domestic and International Fisheries, Research to Support Reduction of Sea Turtle Bycatch in Domestic and International Fisheries, Research and Enhancement of Hawaiian Monk Seals (HMSRP), and

Cetacean Research in the Pacific Ocean (CRP). These EA documents are available on the PIFSC internet site at http://www.pifsc.noaa.gov/nepa/documents.php.

PIFSC is also in the process of writing a new EA that includes all fisheries research and fisheries-related ecosystem research activities. This EA is part of a national initiative, which is being directed by the NMFS Office of Science and Technology. This EA would support an application and consultation under the Marine Mammal Protection Act and Endangered Species Act, respectively, for the potential incidental take of protected species. As a result of this initiative, each Science Center in each of the NMFS-defined regions in the nation would have a comprehensive incidental take authorization for fisheries and fisheries-related ecosystem research activities. In the Pacific Islands Region, this EA would primarily include research that is conducted in the Fisheries Research and Management Division (FRMD) and Coral Reef Ecosystem Division (CRED) at PIFSC. This EA would not include directed take research activities on endangered species or marine mammals, such as the Hawaiian monk seal.

CORAL REEF ECOSYSTEM DIVISION

Scientists Complete Surveys of Coral Reef Ecosystems around Oahu

CRED scientist Paula Ayotte surveys coral reef fishes using the stationary-point-count method. *NOAA photo.*

Last fall, CRED scientists completed two-weeks of surveys of coral reef ecosystems around Oahu as part of the Pacific Reef Assessment and Monitoring Program (Pacific RAMP) in the main Hawaiian Islands (MHI). These shore-based, small-boat operations (mission SB-13-20) augmented the surveys undertaken last August during the PIFSC research cruise HA-13-04 aboard the NOAA Ship *Hi`ialakai*, marking the completion of the fifth such research effort by PIFSC in the MHI. Pacific RAMP, part of the National Coral Reef Monitoring Plan of NOAA's Coral Reef Conservation Program (CRCP), is designed to provide a consistent, comparable flow of information to document and report the status and trends in environmental conditions and living resources of the nation's coral reef ecosystems in the Pacific.

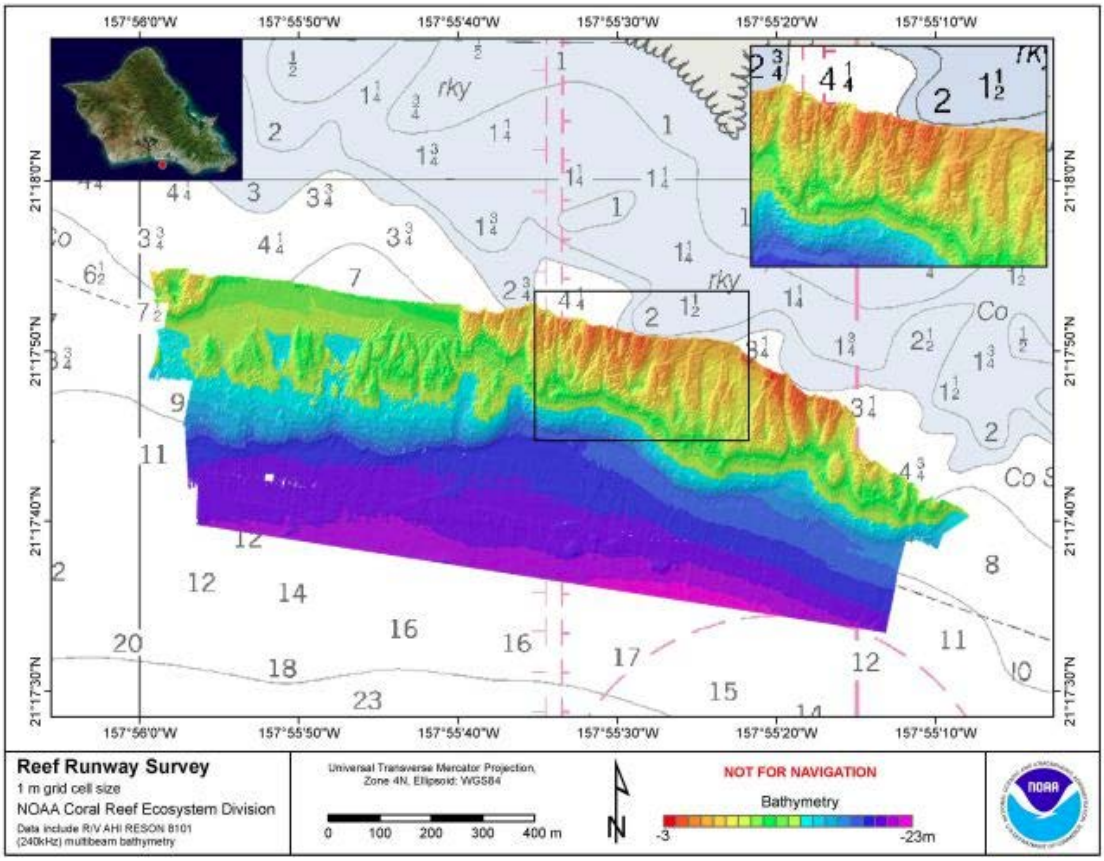
During the SB-13-20 mission, from October 18 to November 6, 2013, scuba divers conducted Rapid Ecological Assessments (REAs), focusing on the acquisition of data to

derive estimates of the diversity, relative abundance, biomass, and size-class structure of reef fishes and corals. Divers from the CRED instrumentation team collected data on water temperature, salinity, carbonate chemistry, and other physical characteristics of the reef environment with an assortment of oceanographic monitoring instruments. They collected water samples. They deployed autonomous reef monitoring structures (ARMS) to assess the taxonomic diversity of cryptic invertebrate species on coral reefs and also installed arrays of calcification accretion units (CAUs) and bioerosion monitoring units (BMUs) to assess the effects of ocean acidification on rates of reef carbonate deposition.

Data collected by the scientific staff of this mission contribute to information that provides the scientific basis necessary for sound management of the marine resources of coral reef ecosystems in the MHI.

Researchers Resurvey Ship Grounding Site off South Shore of Oahu

In January, 2014, scientists in the Coral Reef Ecosystem Division (CRED) completed a small-boat mission (SB-13-25) during which they resurveyed the grounding site of the *USS Port Royal*, which ran aground in February 2009 nearly 1 km south of Reef Runway off the south shore of Oahu. The work was requested by the State of Hawaii, Department of Land and Natural Resources (DLNR).



Bathymetry around the *USS Port Royal* grounding site.

On January 9, CRED staff members Frances Lichowski, Faith Knighton, Rhonda Suka, Jeremy Taylor, and John Rooney used the NOAA R/V *AHI*, to collect acoustic data and video and still imagery of the seafloor with a Reson SeaBat 8101 multibeam echosounder and a camera sled.

The original goal of this mission also was accomplished: the team installed and conducted a patch test to calibrate the SeaBat 8101 echosounder on the R/V *AHI* and made sure the vessel and equipment were ready for upcoming acoustic and optical surveying around Maui in February. In addition, the team tested a new strobe light for the CRED camera sled (called a "TOAD", for towed optical assessment device) under survey conditions and made adjustments to camera settings to improve the quality of still imagery collected by the sled.

The acoustic and optical data collected on January 9 and during similar surveys will help fill gaps in existing data sets, enhancing their utility for spatially based management of the resources of coral reef ecosystems.

The accompanying map shows bathymetry (data on the depths and shapes of underwater terrain) from a previous survey of the grounding site of the *USS Port Royal.* The earlier survey was conducted with a multibeam sonar by the CRED mapping team in December 2010, also at the request of DLNR. Bathymetry grids from both the 2010 and 2014 surveys will be compared to look for movement of rubble or other changes.

Students Connect with NOAA Coral Reef Scientists

In November 2013, students across the globe engaged in dialog with CRED scientists through interactive webcasts and social media. CRED oceanographers Kevin Lino and Roberto Venegas, both team members of NOAA's Coral Reef Conservation Program, answered questions from K-12 students and teachers during two live events, the result of a NOAA Reef Smart collaboration with the nonprofit organization JASON Learning.

CRED oceanographer Roberto Venegas, a STEM Role Model for JASON Learning, displays a sea star.

These events helped the kids link the science fundamentals they are learning in school to real-life applications of coral reef science and hopefully encouraged them to imagine future careers in science, technology, engineering, and mathematics (STEM). STEM Role Models Lino and Venegas interacted with

students, and the students used video and sent forms with questions to the event moderator, who selected as many as possible to pass along to the live event hosts and featured guests.

On November 7, more than 1200 students and teachers watched the webcast with Lino and on November 14, more than 1600 students and teachers watched the webcast with Venegas, a record for the JASON's STEM careers series. Students from as far away as Alaska and Sydney, Australia, submitted questions.

Kevin Lino, another STEM Role Model for JASON Learning, surveys bigeye trevally using a towboard at Wake Atoll. *NOAA photo by Jason Helyer*

In addition to the live interviews, the JASON Learning project provides a multimedia database of STEM career profiles that tell the stories of Role Models with text-based interviews, photos, and video clips.

ECOSYTEMS AND OCEANOGRAPHY DIVISION

Seaglider Deployed in Acoustic and Oceanographic Survey off Kona

The joint UH-PIFSC Seaglider launched off Kona in early December was recovered on 2 January 2014. During its nearly month-long deployment, the Seaglider made 135 dives that spanned the entire length of the Kona coast and collected numerous recordings of cetacean clicks and whistles (Fig. 1). In addition to collecting acoustic data, the glider collected environmental data such as temperature, salinity, current velocity, and chlorophyll concentration during each of its dives. Now that the glider has been recovered, we can start comparing the acoustic data to the environmental data to determine where and in what environments cetaceans are detected. Ultimately, we'd like to figure out why cetaceans seem to be found in distinct "hotspots" along Kona.

Another goal of the mission was to learn how to make the best use of Seagliders on future missions. After we've analyzed the acoustic data from this Seaglider deployment, we'll redeploy the glider, putting to use what we've learned so far. Based on the depths, locations, and durations of recorded cetacean sounds, we can refine the glider's sampling, or "listening", routine. Cetacean sound data can require a lot of space on the glider's storage disk, so the glider can't record data for its entire deployment. Rather, the hydrophones that collect data turn on and off on a preset schedule. This schedule balances the need to collect enough recordings to determine how cetaceans are using their Kona habitat with details such as the hydrophones' battery life and disk space.

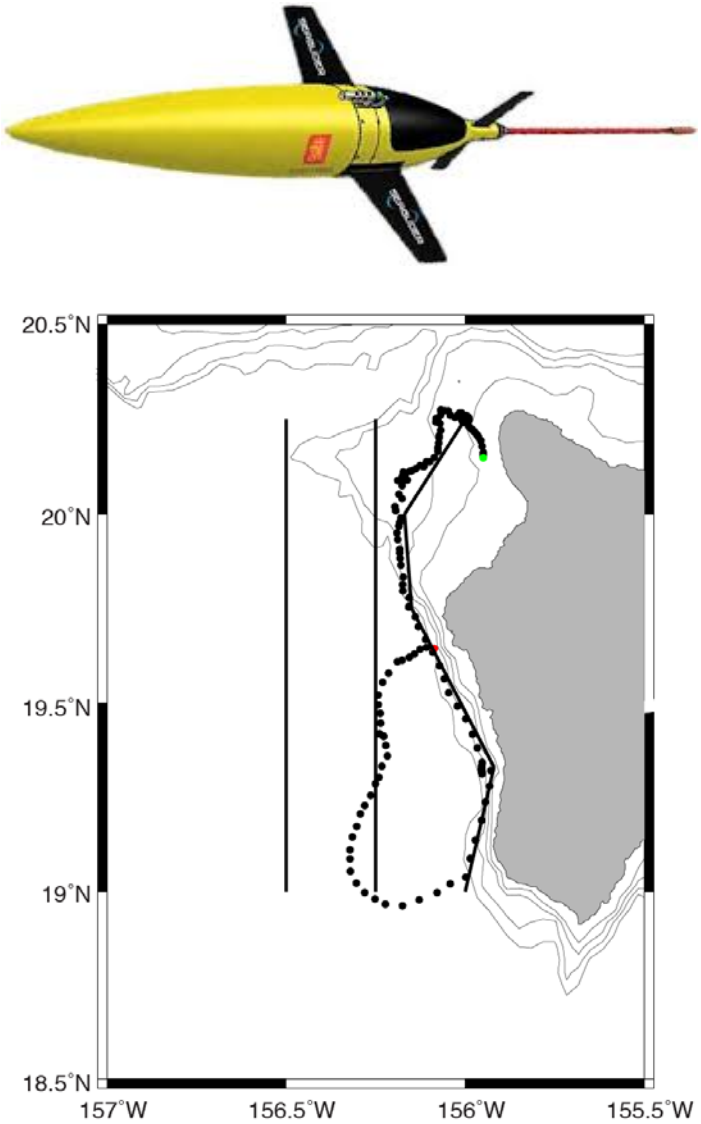


Figure 1. <u>Top</u>: Seaglider. <u>Bottom</u>: Seaglider track (black dots) and planned transects (three thick black lines). Green dot shows the deployment site. Red dot shows the recovery site. Depth contours in 500m intervals from 500 – 2000m. The Seaglider completed the easternmost transect and the southern part of the central transect. Future deployments will hopefully span all three transects.

Full processing of the acoustic data will take time, but at this stage we can begin to make some observations about the physical environment the glider encountered during its deployment. For example, in Fig. 2 we see an abrupt shift in the current direction on dive 84, just after the glider passed south of 19.5°N. This shift suggests that close to shore the current flow was along the coast – northward north of 19.5°N and southward south of 19.5°N. We can also see that the depth at which the greatest chlorophyll concentrations were observed increased as the glider moved off the Kohala Shelf around dive 60 and that the chlorophyll concentrations decreased while the glider was at its southwestern-most points from dives 110 – 120. It will be interesting to pair these observations with the locations of cetacean clicks and whistles to determine how the animals might be making use of these differences in their Kona habitat.

This glider mission was a collaboration between the University of Hawaii SOEST Ocean Glider program (http://hahana.soest.hawaii.edu/seagliders/) and the PIFSC Kona Integrated Ecosystem Assessment program (Kona IEA; http://www.pifsc.noaa.gov/kona_iea/).

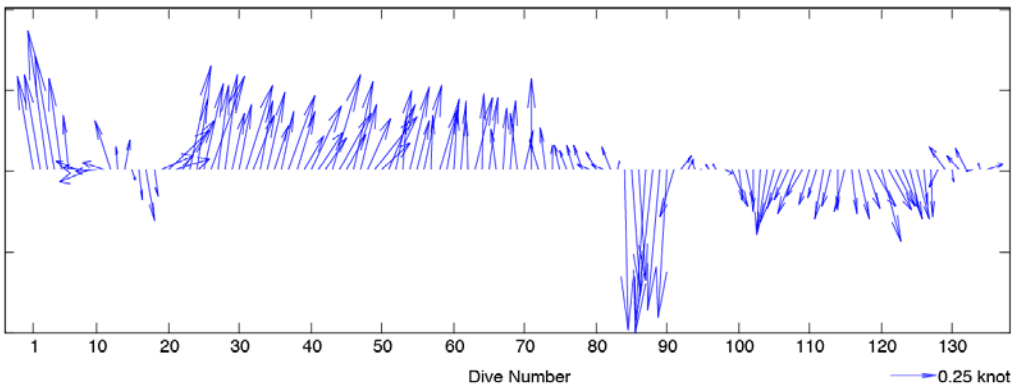


Figure 2. Seaglider-measured currents. Each barbed arrow shows the speed and direction of the depth-averaged current for one dive. Arrows pointing up indicate northward flow and those pointing down indicate southward flow. The currents bifurcate along the coast at approximately 19.5 N latitude (dive 84) with northward flow observed to the north of that location and southward flow to the south.

Forecasts of Climate and Fishing Impacts on the Pelagic Ecosystem: A Comparison of Two Ecosystem Models

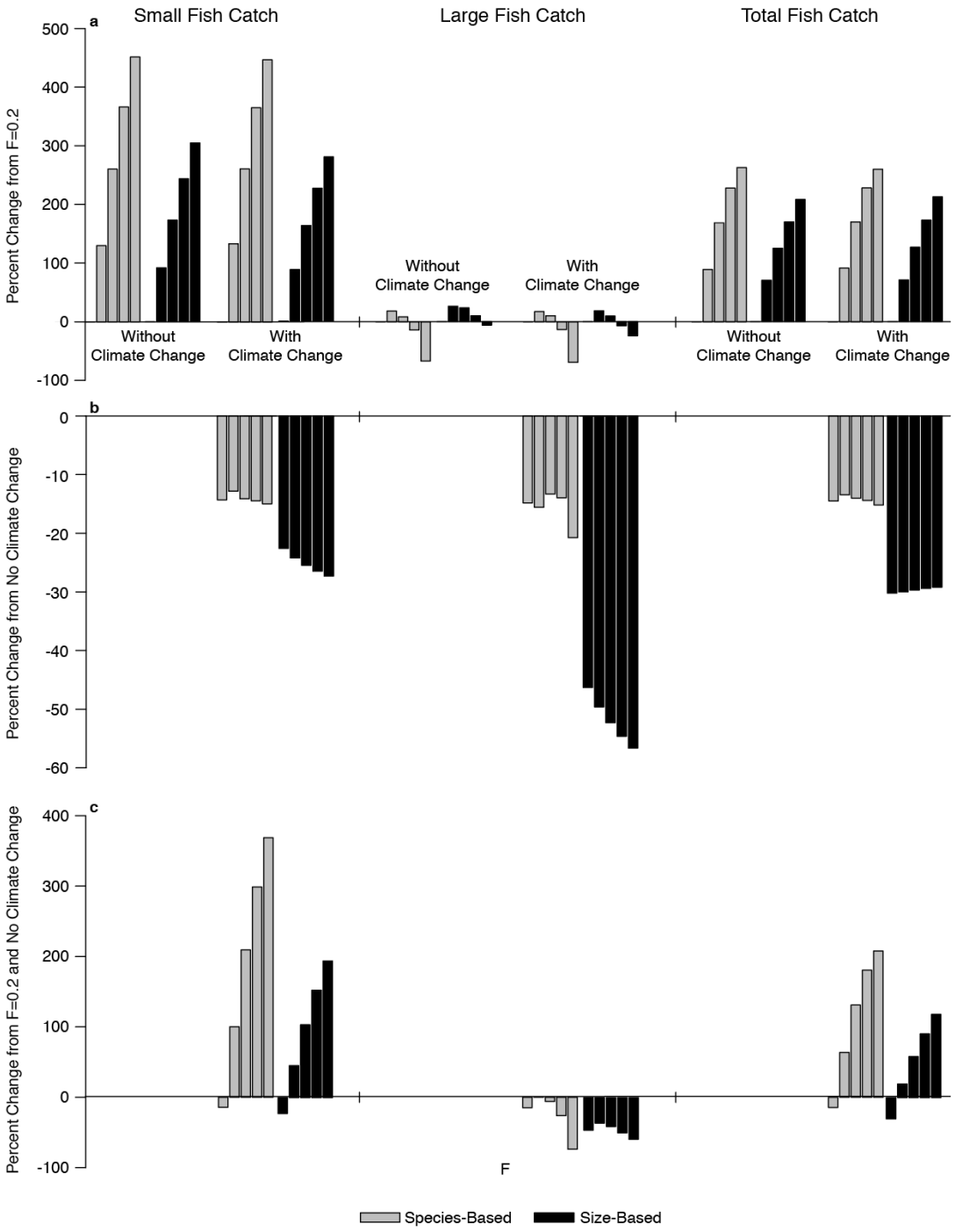
A recently completed study comparing two ecosystem modeling approaches found broad agreement between models on the impacts of fishing and climate change in the central North Pacific (CNP). The work was a collaboration between PIFSC scientists Phoebe Woodworth-Jefcoats, Jeff Polovina, and Evan Howell, and their colleague Julia Blanchard from the University of Sheffield.

The study compared a species-based model and a size-based model. Both models found that while total fish catch was projected to increase with increasing fishing mortality, the catch of large fish (> 15 kg) was greatest at moderate levels of fishing mortality (F = 0.4). Additionally, both models projected a decline in catch at all sizes and at all levels of fishing mortality in response to climate change. However, the magnitude of this decline varied between models, with the species-based model projecting declines of 13 – 21% and the size-based model projecting declines of 46 – 57%. When climate change and fishing mortality perturbations were examined in combination, changes in total fish catch and catch of small fish (< 15 kg) largely followed changes in fishing mortality. The relative impact of climate change vs. fishing mortality on catch of large fish varied by model.

Both ecosystem models used the same input climate scenario, represented through densities of small and large phytoplankton. These densities were projected by the NOAA Geophysical Fluid Dynamics Laboratory's prototype Earth System Model 2.1 (ESM2.1), which is a coupled climate and biogeochemical model. Over the 21st century, ESM2.1 projects reduced nutrient input to surface waters in the North Pacific, and as a result densities of both small and large phytoplankton are projected to decline.

The two ecosystem models used in the study represent two fundamentally different approaches to ecosystem modeling. The species-based model relies on detailed diet and trophic interactions, while the size-based model is built upon the premise that predation in the pelagic environment is largely determined by body size. That two such different models project similar responses to climate change lends confidence to our ability to model such impacts at a broad scale.

Disparities in the magnitude of catch decline in response to climate change raise interesting questions regarding which aspects of climate change will have the greatest impact on the CNP. When the declines in catch are examined in conjunction with the phytoplankton densities used to represent the impacts of climate change, the species-based model suggests that the CNP food web is more sensitive to changes in total phytoplankton density. Conversely, the size-based model suggests that changes in the size structure of CNP phytoplankton community will have a greater impact on catch. The two ecosystem models also suggest differing levels of ecosystem sensitivity to fishing and climate change when both factors are combined. The size-based model projects the catch of large fish to be most sensitive to climate impacts while the species-based model projects climate impacts to dominate at lower F values (0.4 and 0.6) and fishing impacts to dominate at higher F values (0.8 and 1.0). Differences such as these present an ideal test for an integrated size- and species-based ecosystem model.



Using mean fish catch for the period 2081 – 2100 as a measure, the graphs show percent change in the mean catch at each level of fishing mortality relative to (a) *F* = 0.2, without and with climate change (effect of increasing fishing mortality), (b) no climate change (effect of climate change at each *F* value, and (c) *F* = 0.2 and no climate change (effect of both increasing fishing mortality and climate change). From left to right, bars in each cluster indicate increasing fishing mortality: *F* = 0.2, 0.4, 0.6, 0.8, 1.0.

FISHERIES RESEARCH AND MONITORING DIVISION

Bomb Radiocarbon Dating Used to Validate Age, Growth and Longevity of Bluespine Unicornfish

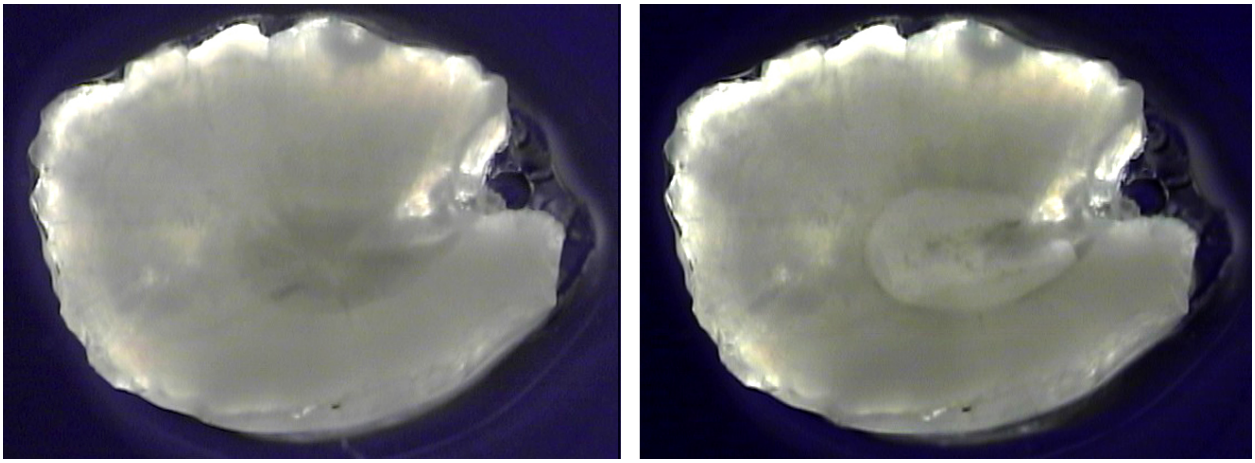
Scientists in the Life History Program (LHP) have collaborated with colleagues at the University of Hawaii-Manoa (UH) to validate age estimates up to approximately 50 years for the bluespine unicornfish (*Naso unicornis*), commonly known as 'kala', collected off Kaneohe Bay, Oahu. Jeff Eble, a recent graduate of the University of Hawaii, made the age estimates by counting growth zones visible in the pair of fish ear bones known as 'otoliths'. To test the validity of these estimates, Eble provided LHP researchers with the corresponding otolith of the pair for bomb radiocarbon dating.

Kala, or bluespine unicornfish (*Naso unicornis*). Photo courtesy of Richard Field, FishBase.

Bomb radiocarbon dating is a method of age validation for fishes that uses a radiocarbon signal created by atmospheric nuclear testing in the 1950s and 1960s. As a result of the nuclear testing, reef-building corals have stored this signal in their skeletons, which can be used to trace radiocarbon levels back to days before the nuclear testing. Fish otoliths can also store the radiocarbon signal, if the fish was alive during that time. By extracting the core (earliest growth) of the otolith and measuring radiocarbon, researchers can validate age estimates of the fish by correlating the otolith core value to coral reference values from Hawaii.

LHP researchers at PIFSC have been successful using this method on bottomfishes of Hawaii, but the bluespine unicornfish is the first reef fish tackled and it has provided some challenges. Otoliths of this species are very small and as a consequence the

earliest growth has a very low mass. Based on the size and weight of otoliths from juvenile bluespine unicornfish, the center of adult otoliths could be targeted properly using a micromilling machine. In the left image below, the earliest growth can be seen in the otolith as a more opaque region near the otolith center. The image on the right shows how the micromilling machine was used to remove the core or earliest growth.



Otolith from a bluespine unicornfish before (left) and after (right) the core was removed with a micromilling machine. The length and width of the extracted area on the right image was 2.3 mm by 1.8 mm, resulting in a mass of 0.9 mg.

Otoliths from the smallest to the largest bluespine unicornfish were analyzed for bomb radiocarbon. Based on a comparison of the measured radiocarbon values from these specimens to Hawaiian coral records, age was validated for 15 fish that ranged from 12 to 55 cm in fork length (FL). Validated age for these specimens ranged from 1 to 53 years and exemplified rapid growth in the first 10 years of life, and then maintenance of an asymptotic length near 50 cm FL for the remaining 40 years. These data will be combined with length-at-age results for other bluespine unicornfish, also from counting otolith growth zones, to determine growth parameters for this species.

Body Size at Sexual Maturity for Hawaiian Ehu Re-estimated

Researchers in the Life History Program (LHP) recently derived preliminary re-estimates of median body lengths at sexual maturity for female ehu (*Etelis marshi*) collected from the main Hawaiian Islands (MHI) and compared these estimates with those previously calculated for female ehu from the Northwestern Hawaiian Islands (NWHI) (DeMartini & Lau 1999 Fish. Bull. 97:449-458). Other biological characteristics were also studied. Plots of standardized Gonadosomatic Indices (GSI) versus body size (fork length, FL, in cm) suggest greater energy allocation to ovaries at smaller lengths in the MHI versus NWHI (Fig. 1). Fits of percentage maturity to body length using a logistic curve indicate that median length-at-maturity (L_{50}) of females is several cm smaller in the MHI than in the NWHI (Fig. 2); estimates of L_{50} were 24.5±0.3 cm and 27.7±1.0 cm FL) in the MHI and NWHI, respectively. To determine the relative extents to which these apparent geographic differences are influenced by latitude (e.g., water temperature), productivity,

or different histories of extraction by Hawaiian bottom fish fisheries in the MHI and NWHI, will require more data than presently available.

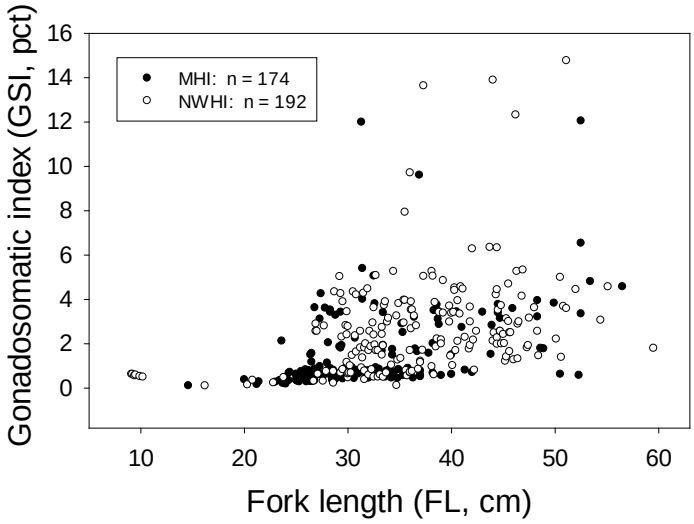


Figure 1. Scatterplot of Gonadosomatic Index (GSI = 100*[Gonad Wt./Gonad Free Body Wt.]) vs Fork Length (FL, cm) for female ehu (*Etelis marshi*). Data for fish from (a) the MHI are indicated by solid circles and those for fish from (b) the NWHI by hollow circles.

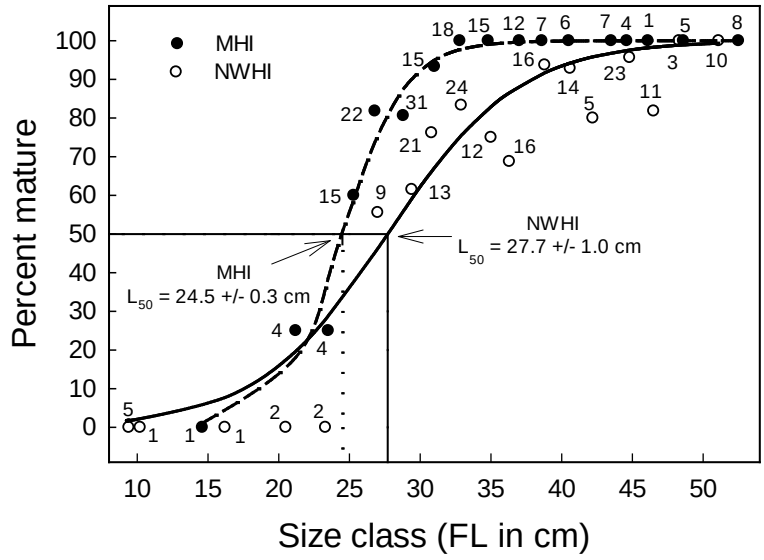


Figure 2 Curves (fitted using maximum likelihood) representing logistic equations of proportion mature by 2-cm FL class for female ehu (*Etelis marshi*) from (a) the MHI (solid circles and dashed line) and from (b) the NWHI (hollow circles and solid line), based on specimens collected during all months of year from the respective regions within the archipelago. Vertical drop lines (MHI: dashed line; NWHI: solid line) indicate estimated FL ± 1 SE at which a median (50 %) of females from the region are mature. Sample sizes (numbers of fish) for each 2-cm FL class are indicated.

Integrating Summaries of PIFSC's Biosampling Data into Archipelagic Fisheries Ecosystem Plan Team Reports

Staff of the Western Pacific Fisheries Information Network (WPacFIN) in the PIFSC's Insular Fisheries Monitoring Program (IFMP) have developed a way to integrate summary data from the Center's biosampling programs into Archipelagic Fisheries Ecosystem Plan (FEP) Team reports.

IFMP staff members are responsible for a variety of tasks including database, IT systems and other programming to build and maintain the WPacFIN data systems. They also support the Pacific Islands Region (PIR) Commercial Fisheries Biosampling (CFBS) market sampling program ("CFBS field work"), part of a national effort NMFS implemented in recognition of expanding data requirements to comply with the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006. Funding was provided to PIFSC, and other regional Science Centers, to implement pilot CFBS field programs.

In 2014, the first FEP data summary systems will be developed by WPacFIN to incorporate CFBS data. Progress has been made in each locality:

CNMI -- An analysis of data for Saipan shows that the CFBS program captures 100% of the island's night spear fishery, which is completely absent from creel survey data due to scheduling and logistics problems. Spear fishermen go out late at night and return before the creel survey day begins. They access the ocean using inaccessible areas and are at times seen out beyond the reef, but surveyors are not able to reach them to conduct interviews. The Saipan CFBS field program has also been able to cover 100% of vendors in this small island market, and a preliminary analysis shows local vendors, hotels and restaurants are reporting non-reef fish catch via CNMI's DFW commercial receipt-book program. This will make it possible for WPacFIN to include additional commercial reef fish catch information with confidence that data are not double reported, either by the creel or commercial tickets. Although the data summary is not yet automated as part of DFW's FEP report the summaries generated via a computer program written by WPacFIN for the CFBS contractor will be used to estimate weight by species and incorporate results into the CNMI FEP report for the upcoming April Archipelagic Plan Team meeting.

American Samoa -- Collaborative work by American Samoa's CFBS contractor will also provide a summary of CFBS data to staff working with boat-based and shore-based creel surveys to include in their CREMUS and offshore fishery reports in April.

Guam -- In Guam, IFMP will work with the Guam Fishermen's Cooperative to develop a non-confidential data summary that can be incorporated. The time frame and logistics dictate that the Guam report will be developed later this year.

Biosampling data for the three territories is being developed to improve the reliability of summary reporting. The cooperation of vendors and fishermen in areas without

mandatory reporting is gradually making it possible to improve summary data for the PIR. The continued success of the CFBS field program relies on maintaining this collaboration with agencies and entities throughout the region, while safeguarding confidential data.

Update on the Biosampling Programs –

Collection of otoliths, gonads, and fin clips to determine length-at-age growth curves, length at 50% maturity, and to verify species identifications via DNA sequencing, respectively, are on-going efforts of the bio-sampling teams in American Samoa, the Commonwealth of the Northern Mariana Islands (CNMI), and Guam. For American Samoa, the focus of life history studies is on two species, *Lutjanus gibbus* and *Myripristis berndti*. Sagittal otoliths from these two species are being readied for shipment to the otolith-ageing lab at Old Dominion University. The Life History Program has contracted this facility to conduct an age & growth study of both species to provide von Bertalanffy length-at-age growth curves. For Guam, LHP staff is mentoring Eric Cruz (NOAA Guam) in an age & growth study of *Etelis coruscans* (onaga) collected from Guam and Hawaii. Cruz recently completed his 2nd training session at PIFSC. By developing length-at-age growth curves of *E. coruscans* from both areas we may also detect whether regional growth differences exist.

Otolith-based age & growth studies require meticulous section preparations and experienced otolith readers to correctly interpret annual growth mark structures. By their very nature, these studies require more time to complete than fisheries managers desire. In order to provide timelier life history information, LHP is now working to develop “proxy” estimates based on preliminary analysis of available data. Proxy estimates are first being developed for size at maturity as this appears more amendable to this approach than age & growth studies. Based on analysis of monthly trends in female gonad weight-to-body weight, this ratio is expected to serve as a means to approximate both length at median maturity and identify spawning season. Initially efforts are being focused on determining proxy estimates for those species in the three territories (snappers, surgeonfish, squirrelfish) that do not undergo adult sex reversal (such as parrotfish and emperors), which can confound the data.

Productivity and Sustainability Analysis Conducted for Coral Reef Fishes in Guam

A Productivity and Susceptibility Analysis (PSA) was conducted to help the WPRFMC in prioritizing species to be assessed, identify species within a family that may be highly susceptible, and group species with similar vulnerabilities to overfishing,. As a first step in the project, both boat- and shore-based creel survey data (1982-2011) from Guam were obtained from WPacFIN and summarized. The most frequently landed coral reef species and families were identified, and spatial and temporal patterns in landings and fishing methods were examined.

Thirty-three of the most frequently landed coral reef species were identified and included in a PSA. The PSA assigned to each species in the analysis a relative score of vulnerability to overfishing as well as a score for the quality of the data used in the analysis. The vulnerability score was based on attributes describing the productivity of the species and the susceptibility of the species to overfishing. The 6 productivity attributes included in the analysis were: longevity, maximum size, von Bertalanffy growth coefficient (*k*), natural mortality rate, age at 50% maturity, and trophic level. The four susceptibility attributes included in the analysis were: fishery value, vertical distribution, geographic concentration, and behavior affecting catchability. A Ward's hierarchical cluster analysis was applied to the vulnerability scores to identify significant groups of species with similar vulnerability scores.

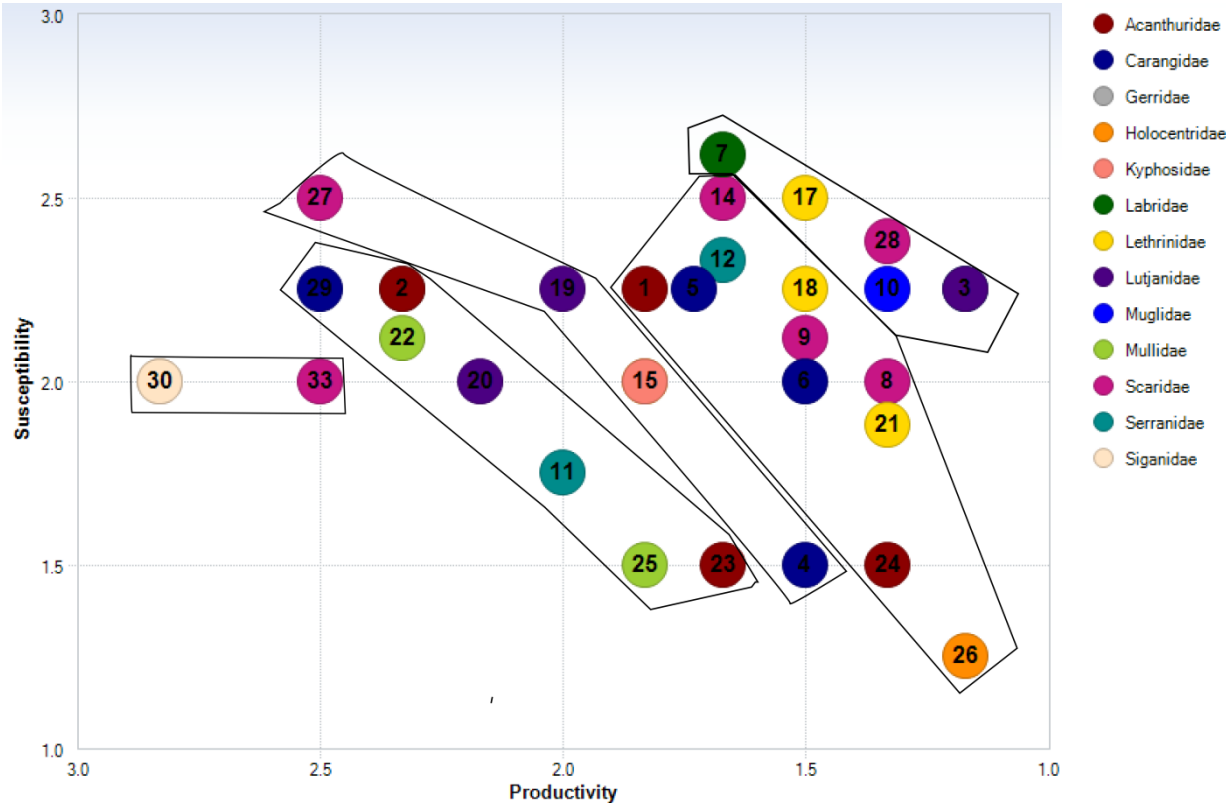


Figure 1. Results of a productivity and susceptibility analysis (PSA). Each number represents a species (Table 1). Each color represents a family. The 5 boxes represent the 5 clusters of species (based on vulnerability scores) identified by Ward's hierarchical cluster analysis.

Table 1 – Productivity and Susceptibility Analysis (PSA) results. Scores were based on 6 productivity attributes each given a score of 1 (low) to 3 (high) and 4 susceptibility attributes also scored 1 (low) to 3 (high). Final vulnerability scores indicate the species vulnerability to overfishing. Species with low productivity and high susceptibility had higher vulnerability scores and were more vulnerable to overfishing.

Number	Species	Vulnerability	Productivity	Susceptibility
3	*Aprion virescens*	2.22	1.17	2.25
32	*Varioloa louti*	2.22	1.17	2.25
28	*Scarus schlegeli*	2.16	1.33	2.38
17	*Lethrinus obsoletus*	2.12	1.50	2.50
7	*Cheilinus trilobatus*	2.10	1.67	2.62
10	*Ellochelon vaigiensis*	2.08	1.33	2.25
14	*Hipposcarus longiceps*	2.01	1.67	2.50
18	*Lethrinus rubrioperculatus*	1.95	1.50	2.25
8	*Chlorurus microrhinos*	1.94	1.33	2.00
12	*Epinephelus merra*	1.89	1.67	2.33
9	*Scarus schlegeli*	1.88	1.50	2.12
21	*Monotaxis grandoculis*	1.88	1.33	1.88
26	*Sargocentron spiniferum*	1.85	1.17	1.25
6	*Caranx sexfasciatus*	1.80	1.50	2.00
5	*Caranx melampygus*	1.78	1.73	2.25
24	*Naso unicornis*	1.74	1.33	1.50
1	*Acanthurus lineatus*	1.71	1.83	2.25
19	*Lutjanus fulvus*	1.60	2.00	2.25
4	*Caranx ignobilis*	1.58	1.50	1.50
27	*Scarus psittacus*	1.58	2.50	2.50
15	*Kyphosus cinerascens*	1.54	1.83	2.00
16	*Lethrinus harak*	1.54	1.83	2.00
2	*Acanthurus triostegus*	1.42	2.33	2.25
13	*Gerres longirostris*	1.42	2.33	2.25
23	*Naso lituratus*	1.42	1.67	1.50
29	*Selar crumenophthalmus*	1.35	2.50	2.25
22	*Mulloidichthys flavolineatus*	1.31	2.33	2.12
20	*Lutjanus kasmira*	1.30	2.17	2.00
25	*Parupeneus barberinus*	1.27	1.83	1.50
11	*Epinephelus fasciatus*	1.25	2.00	1.75
33	*Chlorurus sordidus*	1.12	2.50	2.00
30	*Siganus argenteus*	1.01	2.83	2.00
31	*Siganus spinus*	1.01	2.83	2.00

Summarization of the creel survey data revealed the top landed coral reef species in Guam were *S. crumenophthalmus*, *N. unicornis*, and *S. spinus*. The Acanthuridae family has accounted for the largest portion of landings from 1982-2011. Results of the PSA indicated that the three species most vulnerable to overfishing based on the productivity and susceptibility attributes included in the analysis were: 1. *Aprion virescens*, 2. *Variola louti*, and 3. *Scarus schelegeli* (Table 1). Four species were identified as having low data quality: *C. trilobatus*, *S. schellegeli*, and *S. spiniferum*, and *E. vaigiensis*). The lack of data for these species may have inflated their vulnerability scores. Five significant clusters were identified. Species within a family were rarely grouped in the same cluster (Figure 1).

The project served as a first step in developing a framework for coral reef stock assessments in the Western Pacific. The results of this project may be used to identify highly vulnerable species that may serve as an indicator species for a family or may assist managers in identifying appropriate species to group for management. There are a number of uncertainties and assumptions associated with the creel survey data and PSA; these are discussed in the report of the study. The methods of the study may be applied to a larger number of species and to other regions in the future to help prioritize species for management.

U.S. Longline Bigeye Tuna Catch and Limits in 2013

PIFSC conducted bigeye tuna catch quota monitoring activities throughout calendar year 2013 to provide information on longline catches subject to catch limits. The final Internal Report (IR-2013-20), entitled "Advice on U.S. Longline Bigeye Tuna Catch in Relation to Limits in Effect for 2013", indicated record-high catches of bigeye tuna by large US longline vessels (>24 m overall length) in the Inter-America Tropical Tuna Commission (IATTC) area in the eastern Pacific Ocean. The fishery had a high likelihood of exceeding the 500 metric ton annual quota for these vessels in this area before the end of 2013. Catches by large vessels in the IATTC area could not be accurately forecast, and the report did not predict any specific date for reaching the IATTC area limit. Instead, the updates provided a graphical illustration of IATTC area catch over time with projection of when the IATTC limit might be reached based on trajectories of past years (Figure 1, adapted from IR-13-020ver9.0, issued 28 Oct). Using this information, US fishery managers took action to close the fishery by large vessels in the IATTC area from Nov 11 to Dec 31, 2013.

Later updates to IR-13-020 indicated the likelihood of reaching the Western and Central Pacific Fisheries Commission (WCPFC) Area limit for the US of 3,763 metric tons of bigeye tuna by early December, 2013. Based on this forecast, a date of Dec 5, 2013 was set by fishery managers for beginning the attribution of catches in the WCPFC Area to the Commonwealth of the Northern Marianas Islands (CNMI) for vessels under an arrangement described in Section 113(a) of the Consolidated and Further Continuing Appropriations Act of 2012. Subsequently, post-attribution forecast updates were provided indicating that fishing by vessels not participating in the CNMI arrangement

might continue fishing through years end without exceeding the WCPFC quota. No fishing was conducted by such vessels.

Catches landed in Hawaii that were caught outside the US Exclusive Economic Zone around Hawaii by dual permitted vessels with both American Samoa longline permits, and Hawaii longline permits, prior to the attribution date of Dec 5, were counted as catch belonging to American Samoa, and were not counted towards the US catch limit. After Dec 5, all dual permitted vessels that fished were also participants in the Section 113(a) arrangement such that their catches from Dec 5 onwards were attributed to CNMI rather than to American Samoa. Estimates for 2013 are not yet available for vessels actually fishing from, and landing catch in American Samoa.

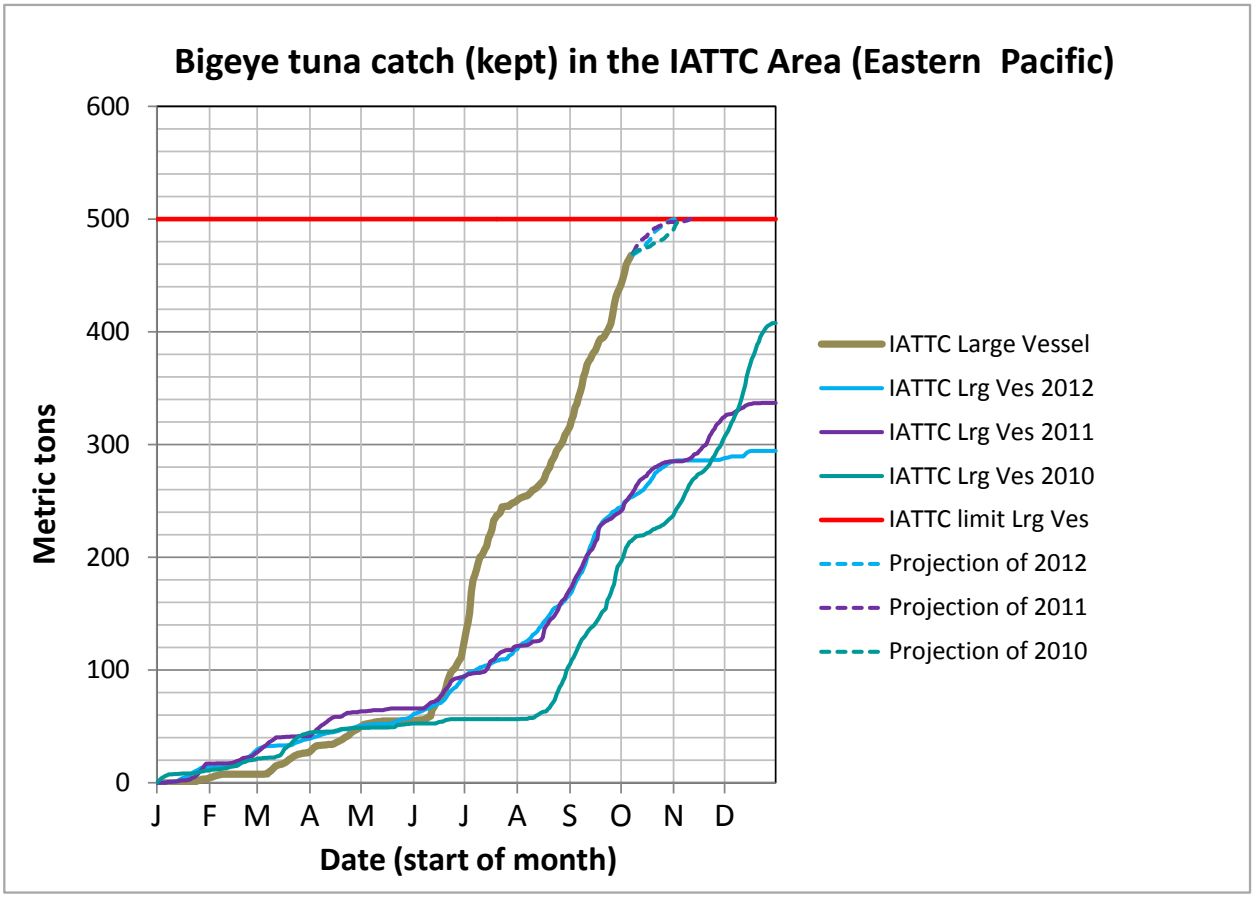


Figure 1. Cumulative US longline BET catch in the IATTC Area as known for early Oct, 2013 with projections (dotted lines) of future large vessel catch based on the trajectories of 3 prior years (2010-2012).

Cumulative catch totals for the different categories of fishing that relate to US catch limits for longline fishing are shown in Figure 2. Unfortunately, the very large catch in the IATTC area in October and early November of 2013 was unprecedented and unexpected, and the eastern Pacific quota for large vessels was exceeded in late October. The most recent (still preliminary) estimate totals 575 mt. In prior years

catches throughout the calendar year by large vessels never once reached 500 metric tons (Figure 1).

The forecasting of catch for the WCPFC area used to set the attribution date appears to have been fairly accurate. The most recent estimates for the US catch in the Western and Central Pacific (WCPFC Area) are very close to the limit of 3,763 mt. An official preliminary estimate will be provided to the Commission in April, 2014.

The WCPFC quotas for striped marlin were not implemented under US regulations in 2013, and there was no in-year reporting requirement for this species established by the WCPFC for 2013. Nevertheless, the preliminary summarization of early-2013 catch of striped marlin indicated that the WCPFC quota was unlikely to be reached. A description of the 3,763 metric ton (mt) US longline Bigeye tuna catch limit in the WCPFC Area, a link to the WCPFC Bigeye and Yellowfin Tuna Conservation Measure, and a link to the Compliance Guide that describes what catches are subject to the catch limit is available (http://www.fpir.noaa.gov/SFD/SFD_regs_6.html). Current status of catch limits are also updated regularly (http://www.fpir.noaa.gov/SFD/SFD_regs_3.html). Similar information on the 500 mt US longline BET catch limit in the IATTC Area (i.e., eastern Pacific) for vessels greater than 24 m in length is also available (http://www.fpir.noaa.gov/SFD/SFD_regs_4.html).

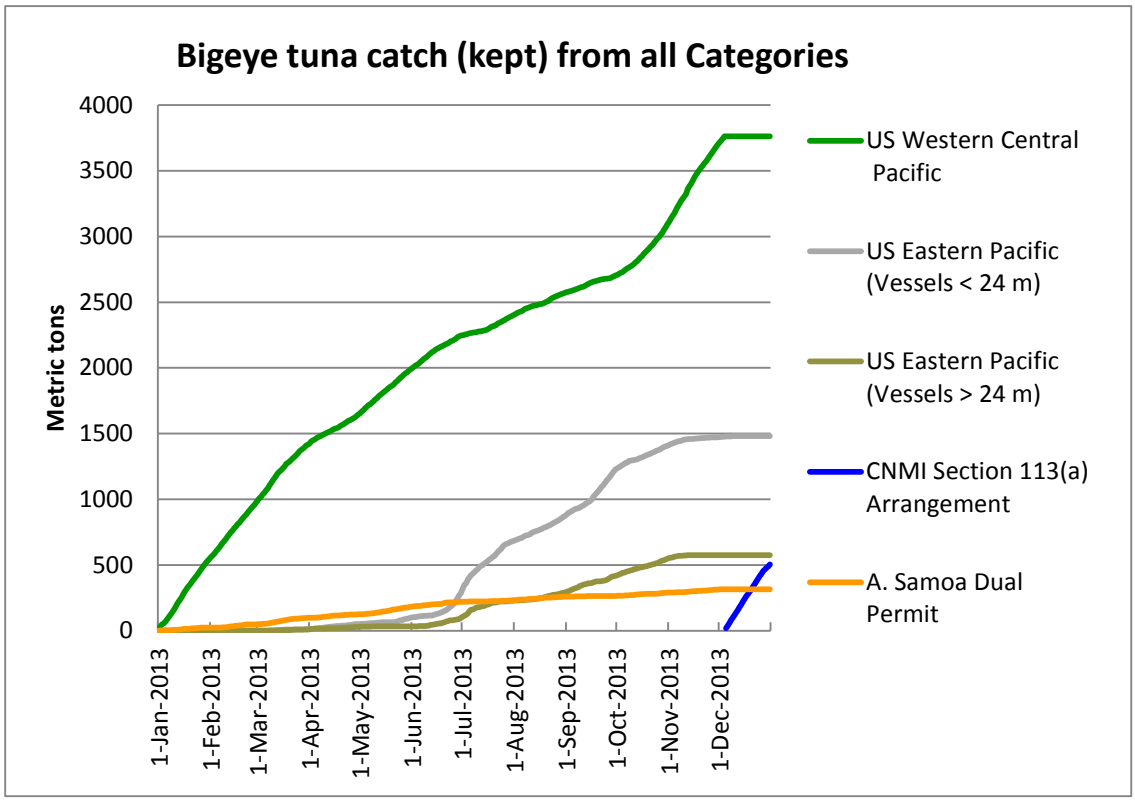
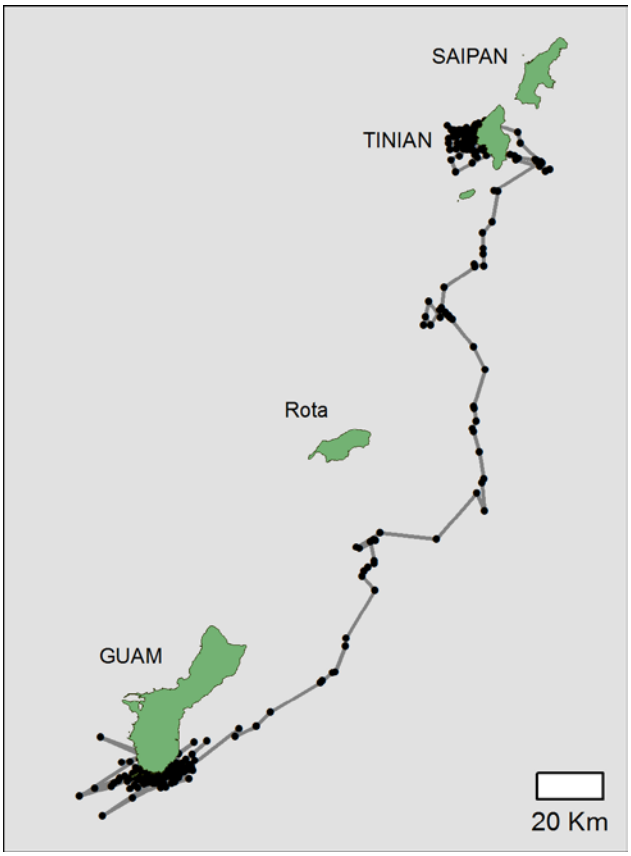


Figure 2. Cumulative catch totals for bigeye tuna by longline fishing categories. Estimates for 2013 are not yet available for vessels actually fishing from, and landing catch in American Samoa.

PROTECTED SPECIES DIVISION

Cooperative Turtle Research Advances in Marianas



In FY2014, PIFSC Marine Turtle Assessment (MTA) staff formalized research partnerships with the U.S. Navy NAVFAC and PACFLEET groups to understand the distribution of sea turtle populations in the Marianas Range Complex. The effort is aimed at understanding nearshore habitat use by sea turtles near strategic sites for the Navy, mostly in Guam, Tinian, and Saipan. As part of this study, we recently analyzed the first four months of transmitted biotelemetry data for 4 green turtles and 2 hawksbills. We documented areas of high habitat use near Garipan, Saipan and a migration of a subadult hawksbill from Fleming Point, Tinian to near Cocos lagoon, Guam.

Left: Satellite track of a subadult hawksbill, showing locations during 20 August–31 December 2013. The turtle migrated from Tinian, CNMI to Guam; (Kyle Van Houtan/MTA/PIFSC/NOAA.)

Turtle Nesting Population Assessed at Rose Atoll in American Samoa

MTA has engaged in two years of cooperative work with the U.S. Fish and Wildlife Service (USFWS) and American Samoa DMWR staff in monitoring sea turtles in American Samoa. In September 2013, PIFSC researchers T. Todd Jones and Shawn Murakawa and DMWR staff performed necropsies on 24 turtles stranded on Tutuila. In October and November, Kyle Van Houtan worked with DMWR, U.S. Coast Guard, and NOAA/PIRO staff to respond to the wastewater leak in Pago Pago Harbor and subsequent red tide event that caused 8 turtle strandings. In December, Kyle Van Houtan, T. Todd Jones, and colleagues from USFWS, DMWR, and the National Park Service traveled to Rose Atoll to survey nesting green turtles and attach satellite tags to nesting females. The team documented between 18-28 unique females over a three day period, estimating that between 72-112 females nested in the 2013 season and that as many as 216-336 females exist in this population. All estimates are preliminary and

subject to revision, but are substantially higher than any previous estimates for Rose Atoll.

National Park Service and NOAA staff with a tagged green turtle at Rose Island, Manua, American Samoa. *NOAA Photo/Kyle Van Houtan*

Technical Breakthrough in Tagging Enables Individual Identification of Hatchling Sea Turtles

Over the past 4 years scientists in the PSD's Turtle Research Program (TRP) have devised and demonstrated a first-ever effective, safe, humane, and practical means to tag newly hatched (5 cm) green turtles, enabling life-long individual recognition of the turtles. The marking of hatchlings in such a manner has been hoped for and periodically pursued by researchers for the past 50 years as a way to advance understanding of turtle ecology and population dynamics. While year-classes of hatchlings have been marked using carapacial tissue grafts and wire-coded tags, tagging to yield individual identities has not been realized.

Working closely with veterinarian Dr. Robert Morris and Jeffrey Pawloski of Sea Life Park Hawaii (SLPH), TRP researcher George Balazs collaboratively developed the

technique using the same Passive Integrated Transponder (PIT) microchip tags employed with larger sea turtles since the mid-1990's, when such tags came into common use to identify dogs and cats. The challenge for Balazs, Pawloski, and Morris was to insert the tag under the skin at a location on the hatchling where it would not only cause no harm, but also stay in place so that detection with a portable electronic reader would be possible as the turtle increased in size to adulthood (90 cm or more, about 100 kg).

Many tests were conducted using salvaged hatchlings that had died of various natural causes over the years. The outcome of this tedious work was determining that the ideal site for insertion of the PIT tag was a dorsal region of a hind flipper. Trials were then conducted on a small number of live captive-bred hatchlings at SLPH. A hind flipper of the turtle was first treated with 1% Lidocaine HCL USP pain block. After inserting the 11 x 2mm glass-encased sterile PIT tag, the tiny puncture of the injection site was sealed using a drop of Vetbond 3M Tissue Adhesive. After these trials, several groups of turtles were subsequently raised in captivity up to 45cm with no negative effect to health or rate of growth. The technique and results of the study were formally presented to peers at the 2013 International Sea Turtle Symposium.

The tagging technique has been approved for use under the US Fish and Wildlife Service permitting process. Thus far, 1,831 newly hatched green turtles from SLPH have been tagged and released into the wild using the new procedure. It is significant to note that the SLPH has been captive breeding green turtles since 1976, as a by-product of their educational display turtle lagoon built with a small sand nesting beach. During this time, over 14,000 newly hatched turtles have been produced and released into the Hawaiian seas by SLPH staff. Sea turtles at SLPH have been and continue to be a valuable asset for an array of high-value cooperative research endeavors.

Application of PIT tag on a newly hatched green turtle.

X-ray of green turtle shows location of PIT tag in dorsal region of right rear flipper (lower flipper in image) 1-yr after insertion.

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