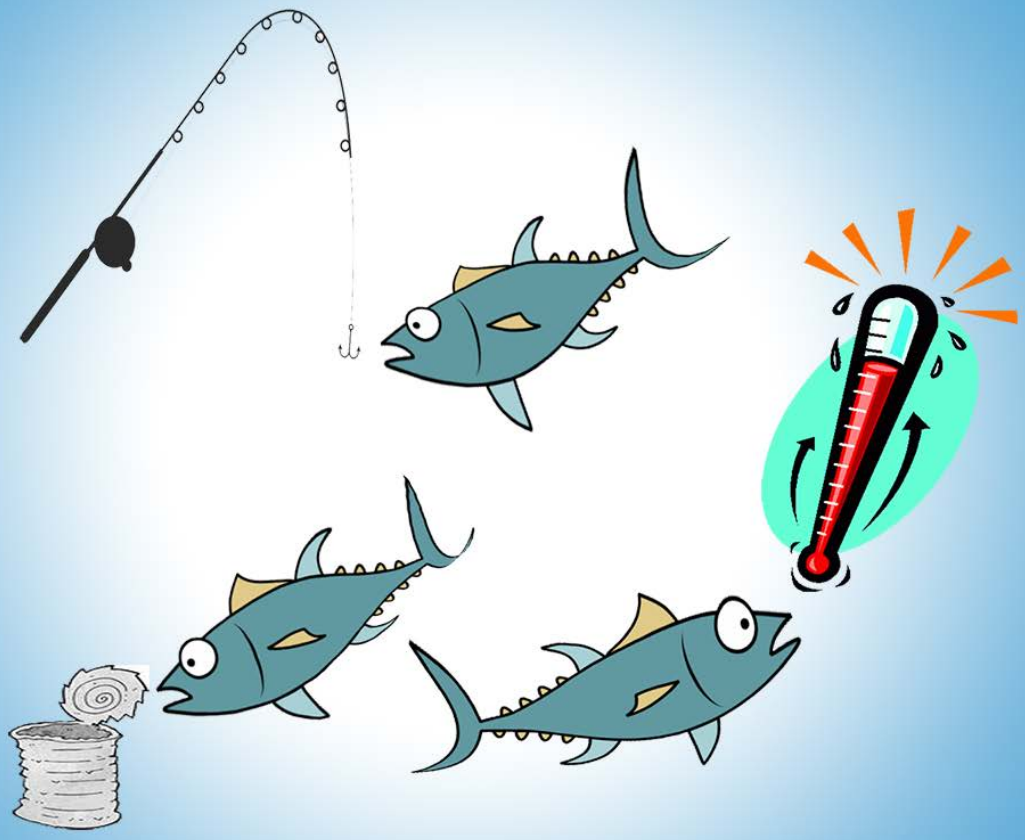
Proceedings of the 67th Annual Tuna Conference

Lake Arrowhead, CA

May 16-19, 2016



Tuna Trials and Tribulations: Is All Hope Lost?

Proceedings of the 67th Annual Tuna Conference

Lake Arrowhead, California
May 16- 19, 2016

Matthew T. Craig – Chair
Stephanie Flores – Coordinator

Southwest Fisheries Science Center
8901 La Jolla Shores Drive
La Jolla, CA 92037

This meeting is for frank discussion of ideas, some of which may not be fully developed by the presenter(s). These proceedings are produced as an aid to the meeting and as an informal memory guide; they should not be cited. If readers wish to cite information or an idea from these pages, they should contact the author(s) so that a more proper citation can be used.

PREFACE

Welcome to the 67th Annual Tuna Conference. The goal of the Tuna Conference is to provide an open and informal forum for scientists, engineers, managers, fishermen, and non- governmental organizations from around the world to exchange information and ideas including recent research findings on tunas and 'tuna-like' species. The free and open exchange of ideas is the key to the Conference's success.

This year the theme of the conference is **"Tuna Trials and Tribulations: Is all hope lost?"** Recent stock assessments, direct counts, and casual observations have indicated that tuna and tuna-like species have declined to critically low levels and face an increased risk of extinction if current trends continue. Yet, after decades of high landings and increased global demand, they are still among the most persistent species of the sea. This leaves one to speculate that tuna and tuna-like species may possess certain traits which make them resilient to high levels of fishing pressure. This year's Tuna Conference will focus on the population status of these fishes and their unique biological, physiological, and behavioral traits that may help or hinder their ability to withstand the enormous pressure exerted upon them and, ultimately, if all hope is lost for future of these species

A total of 27 oral presentations and 10 posters touching on various aspects related to this theme and other topics on large pelagic fishes will be presented over the course of four days.

Four student scholarships were awarded this year. The Tuna Conference Scholarship was awarded to Kady Lyons for her talk entitled "Bioaccumulation of organochlorines in three species of predatory sharks occupying multiple trophic levels." The Manuel Caboz Memorial Scholarship was awarded to Sam Williams for his talk entitled "Genetic analysis of Black Marlin (*Istiompax indica*) from the central Indo-Pacific reveals multiple populations." In addition, our industry partners graciously sponsored two scholarships. The Wildlife Computers Scholarship was awarded to Nerea Lezama-Ochoa for her talk entitled "Incidental catch of Manta and Mobula rays in the Eastern Pacific Ocean." The Desert Star Systems Scholarship was awarded to Isabel Haro for her talk entitled "Reproductive biology of Wahoo (*Acanthocybium solandri*) in the Galápagos Marine Reserve." Travel for the four award winners was further supported by the International Seafood Sustainability Foundation. All of these students presented impressive scientific work, research goals, and progress. We wish them continued success in their graduate and post-graduate careers.

We wish to thank a suite of volunteers for assisting with the Tuna Conference. We are especially gratefully to JoyDeLee Marrow, long-time Tuna Conference Coordinator for IATTC, who provided invaluable advice and detailed instructions on how to organize and coordinate the Conference. We also thank John Hyde, Russ Vetter, Jeanne Wexler and Alex DaSilva for reviewing the student scholarship applications and John Hyde, Owyn Snodgrass, Stephen Stohs and Nick Wegner for moderating the scientific sessions. Christine Patnode maintained and updated the Tuna Conference website. We thank Rex Ito and Prime Time Seafood for donating the sashimi-grade tuna for the poster session and the sashimi preparation team. A special thanks to the U.C.L.A. Conference Center personnel for accommodating our numerous requests. We are grateful to a whole team of SWFSC and IATTC staff members, too numerous to be named here, for general assistance with transporting supplies and people to this year's Conference.

We gratefully acknowledge generous donations to the Tuna Conference to help support student scholarships, the Sushi Social/Poster Session, and the Tuna Barbecue. Donations this year were received from the American Fishermen's Research Foundation, American Tuna Boat Association, Desert Star Systems LLC, International Seafood Sustainability Foundation, Monterey Bay Aquarium Foundation, Wildlife Computers, and Prime Time Seafood Inc.

The abstracts contained in the Proceedings are listed in alphabetical order under their respective presentation type (either Oral or Poster). All abstracts are considered reports of preliminary work. If readers are interested in the information presented in the abstracts, they should contact the author(s) directly, and no abstract should be cited without prior consent from the author(s).

In closing, we would like to thank you all for participating. We hope you have a productive and enjoyable time and look forward to seeing you back next year at the 68th Tuna Conference!

Matthew T. Craig
67th Tuna Conference Chair

Stephanie Flores
67th Tuna Conference Coordinator

67th TUNA CONFERENCE AGENDA

Monday, 16 May 2016

11:00 Registration opens in the Lakeview (continued throughout Monday and Tuesday morning)

13:30 Welcome and Introduction (Pineview)

SESSION 1: Fisheries Modelling, Harvest and Bycatch I (Moderator: Stephen Stohs)

13:40 A power analysis to determine the effect of EFP sample size on estimator precision. **Stephen Stohs**.

14:00 A Bayesian space-state Cormack-Jolly-Seber model to estimate age-specific fishing and natural mortalities for Atlantic tropical tuna. **Michelle Sculley** and David Die.

14:20 "Quota shifting": How allocating Bigeye Tuna quota from a U.S. territory to the United States satisfies the conservation and management objective for the stock. **Jarad Makaiau**

14:40 Tuna trials and tribulations: International Seafood Sustainability Foundation efforts toward bycatch mitigation and a comprehensive management strategy for tropical tuna resources. **David Itano**, Laurent Dagorn, and Gala Moreno.

15:00 Break (30-minutes)

15:30 Exempted fishery trials for Swordfish off the U.S. west coast. **Chugey Sepulveda**, Craig Heberer, and Scott Aalbers.

15:50 An analysis of finfish bycatch in the California large mesh drift gillnet fishery. **Gwendal LeFol**, Stephen Stohs, and Heidi Dewar

16:10 Incidental catch of Manta and Mobula Rays in the eastern Pacific Ocean. **Nerea Lezama-Ochoa***, Martin Hall, and Nick Vogel.
*Recipient of the Wildlife Computers Fellowship

16:30 Collaborating with the International Seafood Sustainability Foundation seeking practical solutions to reduce fishing mortality on Bigeye Tuna and Silky Sharks in the eastern Pacific Ocean. **Kurt Schaefer** and Daniel Fuller.

18:30 Dinner followed by 'Welcome Gathering' in the Tavern

Tuesday, 17 May 2016

8:00 Breakfast

SESSION 2: Genetics (Moderator: John Hyde)

10:00 Enhancing fishery data monitoring through genetic techniques: A capacity building pilot project to monitor shark landings and trade in Ecuador. **John Hyde,** Wess Merten, J. Martinez, D. Cardeñosa, S. Caballero, J. Giles, L. Cimo

10:20 Genetic analysis of Black Marlin (*Istompax indica*) from the central Indo-Pacific reveals multiple populations. **Samuel Williams***, Michael Bennett, Julian Pepperell, Jess Morgan, Jennifer Ovenden.
**Recipient of the Manuel Caboz Fellowship*

10:40 Using 'omics approaches to help improve data in stock assessments. **Catherine Purcell**, Andrew Severin, Owyn Snodgrass, Matthew Craig, Sofia Ortega Garcia, John Hyde

11:00 Development and application of markers panels for genetic monitoring of Atlantic Bluefin Tuna (*Thunnus thynnus*). **Jan McDowell.**

12:00 Lunch

SESSION 3: Life History and Movements (Moderator: Nick Wegner)

13:30 Off-FAD movements of FAD-associated Yellowfin Tuna. **Kim Holland**, David Itano and Hannah Wood.

13:50 New growth and maturity parameter estimates for Swordfish in the southwest Pacific. **Jessica Farley**, Naomi Clear, Kyne Krusic-Golub, Paige Eveson, Dale Kolody, Jock Young.

14:10 Reproductive biology of Wahoo (*Acanthocybium solandri*) in the Galápagos Marine Reserve. **Isabel Haro-Bilbao***, Mitchell Zischke, Pelayo Salinas-de-León, Ian Tibbetts
***Recipient of the Desert Star Scholarship*

14:30 Morphometric features of the sagitta otolith of Dolphinfish (*Coryphaena hippurus*) from the northern part of the Eastern Pacific Ocean. **Sofía Ortega-García**, Ulianov Jakes-cota, Rubén Rodríguez-Sánchez, and M.S. Zuñiga-Flores.

TUESDAY, MAY 17TH - POSTER SESSION (with sushi) – Sashimi donated by Prime Time Seafood, Inc. and beverages donated by Wildlife Computers and CLS America.

16:30 Seasonal movement patterns of Swordfish in the eastern Pacific. **Scott Aalbers**, Chi Lam, Justin Stopa, and Chugey Sepulveda.

Fishing for answers: Spatial and temporal trends in recreational catch and movements of Yellowtail (*Seriola lalandi*) in the Southern California Bight. **Noah Ben-Aderet**.

Habitat use and movements of Blue Sharks (*Prionace glauca*) in the eastern north Pacific. **Heidi Dewar**, Dave Holts, Sandy McFarlane, Oscar Sosa-Nishizake, and Barbara Block

Bioenergetics of captive Yellowfin Tuna (*Thunnus albacares*). **Ethan Estess**, Dane Klinger, Daniel Coffey, Adrian Gleiss, Ian Rowbotham, Andrew Seitz, Luis Rodriguez, Alex Norton, Barbara Block, and Charles Farwell.

Developing a mortality tag: From theory to practice. **William Goldsmith**.

Analysis of the size and condition factor of dolphinfish (*Coryphaena hippurus*) in waters off Baja California Sur. **Sofía Ortega-García**, Ulianov Jakes-Cota, Rubén Rodríguez-Sánchez and Alexander Klett-Traulsen

An overview of the Argos system**. Thomas Gray.**

Nursery origin and connectivity of Swordfish (*Xiphias gladius*) in the North Pacific Ocean. **Veronica Quesnell**, Robert Humphreys, Jay Rooker, Heidi Dewar, and David Wells.

Short-term movements and body temperature measurements in the Opah, *Lampris guttatus*. **Nicholas Wegner**, Owyn Snodgrass, Daniel Cartamil, Chugey Sepulveda, James Wraith, Heidi Dewar, Russ Vetter, Suzanne Kohin, and John Hyde.

FISHCPR (Fish Catch, Photo, Release) - Highly Migratory Species Catch and Release Smartphone App. **James Wraith**, Brad Nunn and Suzanne Kohin.

Wednesday, 18 May 2016

8:00 Breakfast

SESSION 4: Fisheries Modelling, Harvest and Bycatch II (Moderator: Matt Craig)

9:00 Importance of Bigeye Tuna to Hawaii's Fisheries. **Russ Ito**.

9:20 Mexican Bluefin Tuna ranching and sales: Commercial world vs. politics and posturing. **Rex Ito.**

9:40 Update of the global status of tunas and billfishes, have they recovered? **Maite Pons** and Ray Hilborn

10:00 A history of the north east Pacific Albacore fishery from a fisherman's perspective. **John La Grange.**

10:20 Effects of air exposure on post-release mortality rates of White Marlin caught in the U.S. offshore fishery. **John E. Graves**, Benjamin J. Marcek, and William M. Goldsmith

10:40 Coffee Break (20-minutes)

SESSION 5: Feeding and Physiology (Moderator: Owyn Snodgrass)

11:00 Global trophic ecology of Yellowfin, Bigeye and Albacore Tunas: can spatial analyses be used to hypothesize predation changes in a warming ocean? **Leanne Duffy** *et al.*

11:20 Bioaccumulation of organochlorines in three species of predatory sharks occupying multiple trophic levels. **Kady Lyons***, Dovi Kacev, Antonella Preti, Heidi Dewar, and Suzanne Kohin.
***Recipient of the Tuna Conference Scholarship*

11:40 The rewilding of the California Current: Marine mammal forage requirements and implications for HMS fish management. **Russ Vetter** and Sam McClatchie

12:00 Lunch

13:30 Research activities of Yellowfin Tuna (*Thunnus albacares*) early life history conducted at the IATTC's Achotines Laboratory during 2015-2016. **Jeanne Wexler**, Daniel Margulies, Vernon Sholey, and Maria Stein

13:50 Comparative laboratory studies of food selectivity and feeding behavior of Yellowfin (*Thunnus albacares*) and Pacific Bluefin (*Thunnus orientalis*) Tuna larvae during the first week of feeding. **Maria Stein**, Daniel Margulies, Jeanne Wexler, Vernon Scholey, Susana Cusatti, Yang-Su Kim, Alvaro Diaz, Tomoki Honryo, Yasuo Agawa, Yoshifumi Sawada**.**

14:10 Close-kin genetics as a fishery independent method for estimating spawning stock in Pacific Bluefin Tuna. **Matt Craig**, John Hyde and Russ Vetter.

18:30 Dinner – Tuna Barbeque sponsored by the American Fishermen's Research Foundation, American Tuna Boat Association, Lotek Wireless Inc., and Prime Time Seafood Inc. Followed by campfire social.

Thursday, 19 May 2016

8:00 Breakfast

9:30 Tuna Conference Business Meeting

12:00 Lunch

END OF MEETING

Oral Presentation Abstracts (In order of presenting author last name)

CLOSE-KIN GENETICS AS A FISHERY INDEPENDENT METHOD FOR ESTIMATING SPAWNING STOCK IN PACIFIC BLUEFIN TUNA

Matthew Craig, John Hyde and Russ Vetter

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Pacific Bluefin Tuna, *Thunnus orientalis* (PBF) is an iconic species that is highly sought after for the quality of its flesh and its attributes as a fighting fish for sport. Exceptionally high prices and a trans-Pacific migratory pattern make PBF a highly targeted species at almost all life stages and regions of the Pacific. As with many highly migratory species, estimates of spawning stock in Pacific Bluefin Tuna are difficult to measure in a fishery-independent manner. Close-kin genetic tagging is a new method which makes use of the rapidly advancing field of genetic research. The overarching goal of the technique is to take advantage of heritable genetic information that can be collected from each and every individual sampled and use this to obtain an estimate of the spawning stock biomass for use in assessment models. The "ultimate" data that are used in the estimation process are parent-offspring-pairs, or POPS. These are individual fish whose parental history (offspring-mother or offspring-father) are detected. This presentation will review ongoing efforts to implement this method for Pacific Bluefin Tuna.

GLOBAL TROPHIC ECOLOGY OF YELLOWFIN, BIGEYE AND ALBACARE TUNAS: CAN SPATIAL ANALYSES BE USED TO HYPOTHESIZE PREDATION CHANGES IN A WARMING OCEAN?

Leanne M. Duffy*, Jock W. Young, Robert J. Olson, Frederic Ménard, Petra Kuhnert, Heidi R. Pethybridge, Valerie Allain, Monique Simier, John M. Logan, Nicolas Goñi, Michel Potier, Evgeny Romanov, Felipe Galván-Magaña, Matthew J. Lansdell, Michelle Staudinger, Melanie Abecassis, C. Anela Choy

* Inter-American Tropical Tuna Commission, 8901 La Jolla Shores Dr., La Jolla, CA 92037-1509, USA

We developed a global database of predator-prey interactions of three species of high trophic level tunas: Yellowfin (*Thunnus albacares*), Bigeye (*T. obesus*) and Albacore (*T. alalunga*), collected over a 40 year period from the Pacific, Indian and Atlantic Oceans. We used the database to quantitatively assess broad, macro-scale trophic patterns in pelagic ecosystems. A modified classification tree approach showed significant spatial differences in the principal prey consumed by all three species of tunas, reflecting regional distributions of micronekton. Generalized additive models revealed that diet diversity was mainly driven by regional-scale processes and tuna size. Diet diversity of Yellowfin and Albacore was greatest in regions typically characterized by low levels of primary production, whereas in regions of high productivity, diet diversity was generally low. Ontogenetic spatial patterns in diet diversity were found for Bigeye, with larger fish less affected by concentrations of primary production. These results suggest that the current expansion of warmer, less productive waters in the world's oceans may alter foraging opportunities of these tunas due to changes in the regional abundance of prey resources. Such a hypothesis is testable if well-planned and long-term diet monitoring programs are established.

NEW GROWTH AND MATURITY PARAMETER ESTIMATES FOR SWORDFISH IN THE SOUTHWEST PACIFIC

Jessica Farley*, Naomi Clear, Kyne Krusic-Golub, Paige Eveson, Dale Kolody, Jock Young

*CSIRO Oceans and Atmosphere, GPO Box 1538, Hobart, Tasmania 7001
Australia

A large study has just been completed to re-estimate growth and maturity parameters for Swordfish (*Xiphias gladius*) in the southwest Pacific. The work was undertaken to determine the degree to which regional differences in parameter estimates obtained in previous studies in the Pacific were methodological or due to spatial variation in life-history.

Sectioned anal fin rays and whole otoliths were obtained from a Swordfish study undertaken in Australia in the early 2000s. Of the 1558 rays available, 423 rays were selected and ages re-estimated by counting increments. The ray-based growth curves obtained for male and female Swordfish were different to the curves obtained in the earlier study, confirming that reading methods varied between studies. An inter-laboratory calibration exercise confirmed that the reading method used in the current study was consistent with other labs in the Pacific.

To evaluate the use of otoliths, 311 were selected from fish with a ray-based age estimate. A thin transverse section was prepared from each otolith and age was also estimated by counting increments. A direct comparison of age from rays and otoliths showed a clear bias; ray age was lower on average than otolith age for females > 7 years and males >4 years. In older/larger fish, age estimates from otoliths are likely to be more reliable as rays are subject to vascularization and bone remodeling. The results suggest that Swordfish live longer and grow slower than previously estimated.

Ovary histology was also obtained from a swordfish study undertaken in Australia in the 2000s. The histology (n=685) was re-read using criteria which specifically included the identification of maturity markers, such as muscle bundles and “brown bodies”, to distinguish immature from regenerating females. The predicted length (and age) at 50% maturity was much lower than the estimate obtained in the earlier study, again confirming that reading methods varied between studies. The new maturity parameters are within the range of values for Swordfish worldwide.

We recommend that the new otolith-based growth and maturity parameter estimates be included in future stock assessments for swordfish in the southwest Pacific. We also recommend that otolith-based age estimation is investigated for other Swordfish (billfish) stocks.

EFFECTS OF AIR EXPOSURE ON POSTRELEASE MORTALITY RATES OF WHITE MARLIN CAUGHT IN THE U.S. OFFSHORE FISHERY

John E. Graves, Benjamin J. Marcek, and William M. Goldsmith

Virginia Institute of Marine Science, College of William & Mary, P.O. Box 1346
Gloucester Point, VA 23062 USA

White Marlin *Kajikia albida* are targeted in recreational fisheries in tropical and subtropical waters of the Atlantic Ocean. Off the east coast of the United States, the vast majority of White Marlin are released after capture. Federal regulations prohibit anglers from removing White Marlin from the water unless the fish is to be retained, but the numerous photographs of anglers holding White Marlin out of the water posted on the internet each summer demonstrate that there is considerable non-compliance with this management measure. To better understand the effects of air exposure on post-release survival of White Marlin, we attached pop-up satellite archival tags (PSATs), programmed to release after 30 days, to individuals caught on natural baits rigged with circle hooks and removed from the water for periods of one (n=6), three (n=5), and five (n=7) minutes. We compared our results with those from a previous study in which PSATs were used to follow the fate of 59 White Marlin caught on circle hooks and not removed from the water. We found the proportion of post-release mortalities to increase with air exposure duration, and the overall rate of post-release mortality for White Marlin with air exposure (33.3%) was significantly higher than for those that remained in the water (1.7%). These data provide strong support for the current U.S. regulation prohibiting removal of a White Marlin from the water if the fish is to be released. Effective communication of the deleterious effects of air exposure on White Marlin should help to deter the practice of removing fish from the water within the recreational angling community, which has been supportive of other conservation measures for this species.

REPRODUCTIVE BIOLOGY OF WAHOO (*ACANTHOSCYBIUM SOLANDRI*) IN THE GALÁPAGOS MARINE RESERVE

Isabel Haro-Bilbao[1], Mitchell T. Zischke[2], Pelayo Salinas-de-León[3] and Ian R. Tibbetts[1]

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[2] Purdue University, 195 Marstellar St, West Lafayette IN 47906, United States

[3] Charles Darwin Research Station, Galápagos Islands, Ecuador

The Wahoo, *Acanthocybium solandri* is a migratory fish of increasing commercial importance in the Tropical Eastern Pacific (TEP); however, a lack of life history information has hampered stock assessments and fisheries management. This study seeks to quantify reproductive dynamics of Wahoo in the TEP, specifically the Galápagos Marine Reserve (GMR), a protected area located in the equatorial Pacific.

A total of 156 female (54-175cm FL) and 141 male (56-204cm FL) Wahoo were collected by observers aboard the Galápagos artisanal fishing fleet during 2011-2013. Ovaries and testes were both macroscopically and microscopically examined to estimate spawning seasonality, length at 50% maturity (L_{50}), fecundity and spawning frequency. While previous studies based on presence of larvae have suggested a year round spawning for Wahoo in the equatorial Pacific, only the males analyzed in this study showed an annual spawning. Females, however, presented a clearly seasonal spawning during warmer months (December to May), similar to that reported for female wahoo in non-equatorial regions of the Atlantic and Western Pacific. Additionally, two individuals with gonads showing simultaneous presence of male and female tissue were characterized, representing the first description of intersex condition for the species.

Reproductively active females spawn on average every 3.5 days, and the number of eggs released per female ranged between 1.2 and 6.2 million oocytes, with no significant correlation with body length. While L_{50} was estimated at 110.2cm fork length, landing data collected during 2011-2013 showed that approximately 90% of catches corresponded to individuals over that length, suggesting that fishing industry in the GMR is mainly focused on mature Wahoo. The information provided by this study will be essential for the development of stock assessments and monitoring programs for artisanal fisheries in the region.

OFF-FAD MOVEMENTS OF FAD-ASSOCIATED YELLOWFIN TUNA

Kim Holland[1], David Itano[1] and Hannah Wood[2]

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Ambient FADs (both drifting and anchored) have become a dominant factor in tuna fisheries throughout the world. Consequently, the influence of FADs on the behavior and dispersal of tunas remains an important research topic. Similarly, the range of movement of tuna found within archipelagic waters (and whether or not they move into international waters) has important management implications. Whereas dispersal can be investigated using tag-recapture methods, behavioral data must be obtained from electronic tags. At medium to large scales, light-based geolocation is the primary way of determining movement patterns of tagged fish. In recent years, light based geolocation techniques have become increasingly sophisticated and "user friendly". In this presentation we use one of the most recent methods of analyzing light-based movement data ("GPE3") and compare it with previous methods of analyzing the same data set. We used these techniques to elucidate the on-FAD/off-FAD movement patterns of Yellowfin Tuna caught at anchored FADs in Hawaii.

ENHANCING FISHERY DATA MONITORING THROUGH GENETIC TECHNIQUES: A CAPACITY BUILDING PIOT PROJECT TO MONITOR SHARK LANDINGS AND TRADE IN ECUADOR

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Recent listings of several shark species under CITES appendix II requires improved monitoring of fishery products to ensure compliance with the new rules. Though fishery agents and observers are typically highly-skilled at identifying whole sharks to species, these identification skills are challenged when presented with cryptic products (e.g. meat, skin, minor fins). Though a variety of technologies can be employed to aid in these identifications, the countries that routinely deal with these restricted species often lack the infrastructure and training to implement their use. To address this issue, NOAA, WWF, and the government of Ecuador entered into an agreement to develop a pilot-scale lab to give Ecuadorian fishery agents the tools and training to utilize basic genetic techniques to improve their monitoring of shark products. To date, we have provided basic lab equipment, conducted two training workshops, and a dedicated lab space has been set up in Manta, Ecuador. I will give a brief review of the project, discuss logistical difficulties, and show a short video.

TUNA TRIALS AND TRIBULATIONS: INTERNATIONAL SEAFOOD SUSTAINABILITY FOUNDATION EFFORTS TOWARD BYCATCH MITIGATION AND A COMPREHENSIVE MANAGEMENT STRATEGY FOR TROPICAL TUNA RESOURCES

David Itano [1], Laurent Dagorn [2], Gala Moreno [1]

[1] International Seafood Sustainability Foundation (ISSF)

[2] Institut de Recherche pour le Développement (IRD)

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The International Seafood Sustainability Foundation (ISSF) formed in 2009 as an international coalition bringing scientists and the tuna industry together with input from environmental groups to improve the management and sustainability of global tuna stocks. ISSF focus areas includes (i) support for tuna conservation and management; (ii) eliminating illegal, unreported and unregulated fishing; (iii) capacity management and (iv) bycatch reduction.

Research efforts to date have concentrated on identifying and testing solutions to reduce non-target catch (oceanic sharks and finfish) and fishing mortality of tuna of undesirable size harvested by large-scale purse seine fisheries operating on fish aggregation devices (FADs). Research trials benefit greatly by placing scientists onboard commercially operating tuna purse seine vessels. Cruises have been conducted in all major FAD fishing regions of the world, recognizing that regional variability in oceanography and species composition may influence mitigation efforts.

Bycatch reduction research on tuna purse seine vessels will be described within different stages of the searching and fishing operation, namely: passive mitigation efforts; bycatch avoidance before setting; live release of bycatch from the open net; and best practices procedures for release from the deck. The focus of the program is to identify and scientifically evaluate technical solutions to bycatch reduction and improved targeting. These efforts are guided and reviewed by the tuna industry through a series of workshops where tuna scientists and fishing vessel captains interact to develop practical solutions to bycatch reduction.

MEXICAN BLUEFIN TUNA RANCHING AND SALES: COMMERCIAL WORLD VS. POLITICS AND POSTURING

Rex Ito

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You have undoubtedly heard the statement: "96% of the Bluefin Tuna have been fished out of the Pacific Ocean." At the same time commercial and recreational fishing experts have stated: "The 2013 Bluefin Tuna season in Mexico and off of California was the *best we've ever seen*--and the *2014-15 seasons were even BETTER*." Who/what are we to believe?

From the viewpoint and data from a former aquaculture biologist/Bluefin ranching owner/tuna importer and wholesaler, the "sky is falling" scenario being purported by the majority of scientific bodies just don't add up to what the commercial Bluefin Tuna industry is seeing and experiencing.

With all due respect for the scientists behind the studies and the Bluefin Tuna itself, commercial and recreational user groups in the Eastern Pacific see a very different strategy and motive behind the data being analyzed, the conclusions, and the enormous effect it has on the commercial Bluefin Tuna ranching business.

Points to consider:

- Just the facts. Both quantity and size ranges of ranched Mexican Bluefin have been increasing year on year, to the point where the majority of tuna stocked in 2015 campaign were 40-80kg size class.
- Follow the Money. Contrary to popular belief, Japan no longer is the short, mid, or long-term customer who pays ridiculous prices for precious Bluefin Tuna. Conspicuously the fishery management strategy coming from the Western Pacific protects their industry, to the detriment of the Eastern Pacific user groups.
- The way forward. Science, not politics or political fishery posturing can be achieved if commercial, NGOs and science community work together.

IMPORTANCE OF BIGEYE TUNA TO HAWAII'S FISHERIES

Russel Ito

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Pacific Islands Fisheries Research Center
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Bigeye Tuna is the most important commercial fish species in Hawaii. It comprises almost half of Hawaii's commercial pelagic catch by weight and accounts for more than 60 percent of total revenue. Although several of Hawaii fisheries catch Bigeye Tuna, deep-set longline fishing was, by far, the fishery with largest catches. Catch of Bigeye Tuna by Hawaii's fisheries has been on a increasing trend albeit somewhat constrained by Regional Fisheries Management Organization Conservation and Management Measures. The catch-per-unit effort levels for the longline and seamount handline fisheries have been steady. The mean weight of Bigeye Tuna caught by Hawaii's fisheries exhibited year to year variability but did not show a clear trend. The longline fishery caught large Bigeye Tuna while the troll and handline fisheries caught mostly juvenile fish.

A HISTORY OF THE NORTH EAST PACIFIC ALBACORE FISHERY FROM A FISHERMAN'S PERSPECTIVE

John La Grange

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The fishery for Albacore off the west coast of North America was developed in the early years of the 20th century, and was the beginning of the tuna canning industry in America. In spite of this long history of exploitation, and without much regulation of the fishery, the stock of Albacore in the North Pacific remains healthy. This stability is the result of features of the behavior of both the fish and the fishermen. While the behavior of Albacore is the result of their evolution and their interaction with the environment, the fishermen's behavior is primarily controlled by economics.

Fishermen, constrained by technology and price, are very sensitive to changes in Albacore abundance. Many west coast Albacore fishermen have alternative fisheries they can pursue if the Albacore season doesn't look promising, so there will typically be a decrease in fishing effort whenever the availability of Albacore decreases. This feedback mechanism, and the history of the fishery, leads me to believe that, without significant changes in technology or markets, the economics of the fishery will continue to prevent serious overfishing.

AN ANALYSIS OF FINFISH BYCATCH IN THE CALIFORNIA LARGE MESH DRIFT GILLNET FISHERY

Gwendal Le Fol[1], Stephen Stohs[2] and Heidi Dewar[2]

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The California Large Mesh Drift Gillnet fishery (CA DGN fishery) has targeted Swordfish (*Xiphias gladius*) within the exclusive economic zone off the West Coast of the United States since the late 1970s. Since its inception a number of regulatory changes have been implemented to reduce the take of non-target species. Concerns over marine mammal interactions led to the implementation of the Federal Fisheries Observer Program in 1990 to support compliance with the Marine Mammal Protection Act. The implementation of gillnet extenders in 1998 under the Pacific Offshore Cetacean Take Reduction Plan and the establishment of the Pacific Leatherback Conservation Area in 2001 have since contributed to reducing marine mammal and sea turtle interactions for this fishery into compliance with the Marine Mammal Protection Act and Endangered Species Act.

The tremendous dataset collected by fisheries observers since 1990 is rich with information on finfish bycatch in the CA DGN fishery. This component of the fishery remains largely under-studied in the context of the gear modifications and spatial closures that were originally aimed to benefit marine mammals, turtles and sharks. Results so far have shown that 98.7% of the bycatch is comprised of 18 species, 9 of which are managed under the Highly Migratory Species Management Plan and 5 of which are tunas or tuna-like species. The remaining 9 species are comprised of sharks and other finfish species that regularly interact with this fishery.

This research project aims to devise objective metrics by which the levels of market catches can be taken into account when assessing bycatch. Secondly, bycatch levels of several species will be compared to available population status data to gauge the potential for population level impacts of this fishery. Finally, possible relationships between the conservation measures listed above and trends in finfish bycatch over time will be explored.

INCIDENTAL CATCH OF MANTA AND MOBULA RAYS IN THE EASTERN PACIFIC OCEAN

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Manta and Mobula species are some of the most vulnerable species incidentally caught in different types of sets in the tropical purse seine fishery in the Eastern Pacific Ocean (EPO). In some regions, they are also targets of fisheries. The reduction of their populations appears to be significant in several regions and globally a decline in some species is strongly suspected. They play an important role in the food chain but yet we know little about their habitats, distributions or population sizes.

This work focuses on the distribution and habitats in which the species of Manta (*Manta birostris*) and Mobula rays (*Mobula japanica, Mobula munkiana, Mobula tarapacana* and *Mobula thurstoni*) from the EPO are more vulnerable to be caught by the tropical tuna purse seine fleet with the objective of using this information to reduce bycatch. For that, diversity patterns (based on the number of species and their abundance) of Manta and Mobulid ray species by areas, seasons, and years and their potential habitat distribution were analyzed from IATTC observer databases for the period 1993 - 2011. Differences between the different sizes of the species and the type of set (dolphin sets, school sets and floating object sets (mostly FAD sets)) were also analyzed to consider their relative significance for their population dynamics. Preliminary results showed that these species appear to be occasional seasonal visitors to coastal or offshore sites depending of the size, the species and type of fishing set. Thus, in general, they seem to be mainly aggregated in large numbers in school sets during spring and summer in the coastal upwelling regions of Costa Rica and Panama (Gulf of Papagayo and Panama) in relation with high chlorophyll concentrations, low surface temperatures and strong wind jets. In contrast, these species are distributed to lesser extent along the equatorial upwelling system in FAD sets and close to the coastal upwelling system of Peru during winter in dolphin sets.

The conservation of these populations is a high priority subject (Resolution C-15-04) and likely important for any scheme to implement ecosystem-based fisheries management. Thus, this work improved our knowledge about the habitat characteristics of these bycatch species and to identify their general distribution patterns.

BIOACCUMULATION OF ORGANOCHLORINES IN THREE SPECIES OF PREDATORY SHARKS OCCUPYING MULTIPLE TROPHIC LEVELS

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Elasmobranchs typically occupy higher trophic levels in food webs and, consequently, have a propensity to accumulate high organochlorine contaminant (OC) concentrations. Previous studies have demonstrated that young, pelagic elasmobranchs can maternally acquire organic contaminants from their mothers. However, less information is available regarding the dynamics of accumulation as elasmobranchs grow over the course of their lifetime, especially for large, pelagic sharks. Factors that can influence bioaccumulation include contaminant prey loads, trophic level, growth rate, sex and feeding rate. Bioaccumulation with respect to ontogeny was examined among three species of pelagic sharks (Shortfin Mako *Isurus oxyrhincus*, Common Thresher *Alopias vulpinus*, and Blue Shark *Prionace glauca*) that have varying diets and life history characteristics. Using recently collected and archived tissue from sharks caught in southern California, an area known for high contaminant levels, organic contaminants (polychlorinated biphenyls and chlorinated pesticides) were measured in livers of both females and males from a range of size classes for all species ($n = 122$). Significant differences were found in OC concentrations among species and by size (ANOVA $p < 0.0001$). Blue Sharks had the lowest concentrations, followed by Common Thresher and finally Shortfin Mako Sharks. While Common Thresher and Shortfin Mako Sharks showed growth dilution during juvenile stages, only Shortfin Mako Sharks were found to significantly bioaccumulate contaminants with size as adults ($p < 0.001$). Common Thresher Sharks showed continual decreases with size ($p = 0.0005$). Blue Sharks, on the other hand, showed no relationship between size and total contaminant load ($p = 0.47$). The difference among sharks is likely due to a combination of factors related to metabolism (i.e. feeding frequency) and foraging ecology. For example, large Shortfin Mako Sharks, which had the highest measured levels, also feed at the highest trophic level among these species and is expected to have the highest metabolic rate due to its size and regional endothermic strategy. Contaminant accumulation patterns appeared similar for males and females, although little or no data for males were available to compare to mature females. The results of this study suggest that foraging ecology and trophic level as well as energetic requirements impact the accumulation of organic contaminants. While information is limited on the physiological effect of OC contaminant exposure in elasmobranchs, information regarding factors that make species more prone to accumulate contaminants help advance these studies and has relevance for human health.

"QUOTA SHIFTING": HOW ALLOCATING BIGEYE TUNA QUOTA FROM A U.S. TERRITORY TO THE UNITED STATES SATISFIES THE CONSERVATION AND MANAGEMENT OBJECTIVE FOR THE STOCK

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Bigeye Tuna (*Thunnus obesus*) in the Western and Central Pacific Ocean (WCPO) is currently subject to overfishing. To address this problem, the Western and Central Pacific Fisheries Commission (WCPFC) adopted several conservation and management measures (CMM) to reduce fishing mortality in longline and purse seine fisheries by certain WCPFC member countries, including the United States. The objective of these CMMs is to *"ensure that fishing mortality for bigeye tuna will be reduced to a rate no greater than* F_{MSY} *(i.e.,* $F/F_{MSY} \leq 1.0$*)."* However, the management strategies adopted by the WCPFC also allows WCPFC member countries to enter into vessel-chartering agreements or other like instruments with one another. Typically, these instruments often involve a WCPFC member with a developed fishery entering into an agreement with a member with an emerging/developing fishery. Such agreements allow the former to fish on behalf of the latter. These types of agreements benefit WCPFC members with a longline Bigeye Tuna catch limit because they can acquire additional tuna quota from other members who may not fully utilize their limit, or have no limit at all.

In 2014, National Marine Fisheries Service and the Western Pacific Fishery Management Council implemented a process that allows the U.S. territories of American Samoa, Guam, and the Northern Mariana Islands to each allocate up to 1,000 metric tons of their Bigeye Tuna catch limit to longline vessels of the United States through specified fishing agreements. Opponents of this action termed the process, the "quota shifting" rule and sued NMFS, which the agency defended and subsequently won. This paper describes the process, and how an allocation of up to 3,000 mt of Bigeye Tuna from the territories to the United States is consistent with the objective of CMM 2014-01 in ending overfishing.

DEVELOPMENT AND APPLICATION OF MARKER PANELS FOR GENETIC MONITORING OF ATLANTIC BLUEFIN TUNA (*THUNNUS THYNNUS*)

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Genetic monitoring, which uses molecular markers to follow changes in populations over time, is an increasingly important component of conservation efforts because of the scope of information that can be obtained from a single, non-lethal sample. This information includes identification of genetic stocks, genetic tagging of individuals, parent-offspring analysis for estimates of abundance, changes in population genetic parameters such as loss of alleles, shifts in allele frequencies and estimates of effective population size. Previous genetic studies of Atlantic Bluefin Tuna have found small but statistically significant differences between samples of young-of-year (YOY) and spawning adults from the Gulf of Mexico and the Mediterranean Sea. However, the limited number of genetic loci and the lack of temporal samples have made it difficult to understand whether the observed differences are biologically meaningful. At the same time, there has been an increased interest in using genetic mark-recapture of both spawners and juveniles to estimate the total population abundance of spawners. The progress of the development and application of genetic marker panels to these outstanding questions will be discussed.

MORPHOMETRIC FEATURES OF THE SAGITTA OF DOLPHINFISH (*CORYPHAENA HIPPURUS*) FROM THE NORTHERN PART OF THE EASTERN PACIFIC OCEAN

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The Dolphinfish, *Coryphaena hippurus*, is an epipelagic predator that inhabits temperate and tropical seas worldwide. In the Eastern Pacific Ocean (EPO) it ranges from 46°N to 38°S, where it is captured either incidentally or as a target species. Given its migratory nature, setting management measures requires to determine whether the fishing operations in EPO are affecting just a single or more than one stock. Genetic investigations conducted to date have been inconclusive in this regard, as a high genetic variability has been observed. In recent years, the use of otolith morphometry has allowed the identification of stocks of various fish species; thus, this study describes the morphometry of the sagitta otolith for different Dolphinfish sizes caught off Cabo San Lucas, Mexico. If the morphometry of these calcified structures is an adaptive result of a specific environment-related and life-history trait, then the environmental spatial heterogeneity and differences in population dynamics across EPO may affect the phenotypic characteristics of this bone and, ultimately, we may have a tool to discriminate between stocks. Nevertheless, to determine whether this tool is suitable to discriminate between stocks, fish samples collected throughout EPO and analyzed under a comparative approach are needed. In this work, the morphometric description is based on samples collected between January 2007 and December 2014. For each fish, fork length, weight and sex were recorded. The left sagitta otolith of each specimen was photographed, and the perimeter, area, length and width of each otolith were measured and recorded. Otolith contours were detected by transformation of grayscale images; in order to obtain automatic layouts, these were transformed to binary data using a threshold pixel value (intensity threshold). Otolith contours were reconstructed using Fourier coefficients (FC) through a Fourier's elliptical analysis. To assess the morphology pattern of otoliths between interval sizes and sexes, a principal component analysis was used with the FC data matrix, which was also applied to reduce data size. Otolith samples were compared between interval sizes and sexes using multivariate analysis of variance and canonical discriminant analyses. The results show that the main variation in otolith shape is observed in two specific otolith features: the point of separation between the rostrum and antirostrum, and the posterior separation of dorsal and ventral otolith wings.

UPDATE OF THE GLOBAL STATUS OF TUNAS AND BILLFISHES, HAVE THEY RECOVERED?

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Tunas and billfishes have experienced high exploitation rates for decades. Some have been declared as highly overfished with abundances far below sustainable levels. To be considered sustainable, a population should produce enough individuals to replace the ones that die each year due to natural causes and fishing. A stock is considered overexploited when the biomass (B) is below that which would support the maximum sustainable yield (B_{MSY}), and considered recovered or rebuilt if B increases and reaches B_{MSY}. Using data from the RAM Legacy database, we found that out of 40 stocks analysed (22 tunas and 18 billfishes), 25 have shown B below B_{MSY} at some point in the past. Today, eight of them are rebuilt and at least seven are showing signs of rebuilding. Atlantic stocks are showing the highest increase in abundance, however they are the same ones that have been overexploited to low abundance levels for decades. Fishing mortality (F) has reduced substantially in the last 10 years, with a corresponding stabilization and even increase in B, in particular for overexploited stocks such as North Atlantic Swordfish and Atlantic, Pacific and Southern Bluefin Tunas. The decrease in F is the product of strong governance and improvements in management and enforcement. The time and magnitude of the responses of B depended not only on the magnitude of the rate of change of F, but also on the biological characteristics of each species. Some species are more productive and then more resilient to intense fishing pressure than others. Among all stocks, marlins, caught as by-catch in large industrial pelagic fisheries, are still showing high F at low levels of B. Urgent management measures and a better understanding of the ecology and biology of billfish stocks are needed to improve their assessments and decrease fishing pressure. The message of this study is that although some stocks are still experiencing high fishing pressure, most are fished at sustainable levels and overfished stocks are showing signs of rebuilding. This year's theme of the Conference is: "Tuna Trials and Tribulations: Is all hope lost?"; we believe there is still hope and we are moving towards a better tuna fisheries management.

USING 'OMICS APPROACHES TO HELP IMPROVE DATA IN STOCK ASSESSMENTS

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Beyond providing insights into developmental processes, physiological responses, and evolutionary questions, genomic and other 'omic approaches can provide essential data for stock assessment models for a given species. Recently, these tools were successfully used to provide both biological data and population structure resolution to help inform stock models for species such as the Atlantic Herring, Turbot, and Atlantic Cod. Similarly, we are using genomic sequencing to develop sex-specific markers for two important commercial species, California Yellowtail (*Seriola dorsalis*) and Albacore Tuna (*Thunnus alalunga*). These markers will be indispensable for identifying sex either in immature fish or in individuals sampled non-destructively (i.e., fin clips from a tagged fish). This information will be particularly important for Albacore, where sex data could be key to improving current stock assessment models. In the Yellowtail project, we conducted genome-wide resequencing to identify genomic regions linked to sex-determination, while simultaneously screening populations for signals of local adaptation. A total of 90 wild male and female Yellowtail were collected from three locations in the eastern Pacific: coastal San Diego in Southern California, Cedros Island offshore of central Baja California, and La Paz in the southern portion of the Gulf of California in Baja California Sur. These sampling areas represented different oceanographic environments (e.g., temperature, salinity) and span the core range of *S. dorsalis* in the eastern Pacific. Using this approach, a single sex-determining region within the Yellowtail genome has been identified, and a putative sex-marker has been developed and is undergoing validation. Populations of Yellowtail also exhibited signals of local adaptation in several genes. For the Albacore project, a draft genome is being assembled for male and female individuals. Additionally, genome-wide resequencing was conducted on 20 individuals (10 of each sex) to help identify the sex-determining region in this species. This presentation will summarize the results of both projects, to date.

COLLABORATING WITH THE INTERNATIONAL SEAFOOD SUSTAINABILITY FOUNDATION SEEKING PRACTICAL SOLUTIONS TO REDUCE FISHING MORTALITY ON BIGEYE TUNA AND SILKY SHARKS IN THE EASTERN PACIFIC OCEAN

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The goal of the International Seafood Sustainability Foundation (ISSF) is the long-term conservation and sustainable use of global tuna fisheries, achieved through science-based practices, collaboration, and advocacy. The ISSF bycatch steering committee considers the most pressing conservation concerns for the tropical tuna purse-seine fisheries targeting tuna aggregations associated with drifting fish-aggregating devices (FADs) to be reducing fishing mortality on undesirable sizes of Bigeye Tuna and of sharks. Several investigations have been undertaken through the support of ISSF over the past several years, including at-sea experiments utilizing tuna purse-seine vessels, seeking practical solutions to those conservation concerns, but with limited success to date.

Recent studies have been conducted to evaluate factors contributing to catches of Bigeye by purse-seine vessels in the eastern Pacific Ocean (EPO), and other ocean areas. These include investigations of spatio-temporal distribution of catch and effort, fishing gear configurations, and fine-scale behavior of Bigeye relative to Skipjack and Yellowfin Tunas when associated with FADs. Although a large time-area moratorium on the use of FADs in the equatorial EPO would most likely be effective at reducing Bigeye fishing mortality it would negatively impact the Skipjack catch due to overlapping high catch areas. Also, it does not appear that reducing purse-seine net depth is a viable solution because of the minimum net depth required to catch Skipjack, and the small differences in depth distributions between Skipjack and Bigeye Tunas when associated with FADs. However, a study reported that in addition to area/time effects, the depth of FADs in the EPO was a significant factor as to Bigeye catch. An experiment is currently being conducted to evaluate the performance of 50 shallow (5m) versus 50 normal (37m) depth FADs in the EPO purse-seine fishery, including whether a significantly lower proportion of Bigeye is caught in sets on the shallow FADs. This research is being undertaken through a collaborative effort by Negocios Industriales Real S.A. (NIRSA), ISSF, and IATTC, for which preliminary results will be presented.

Recent studies have also been conducted to evaluate factors contributing to catches of sharks by purse-seine vessels in the EPO, and other ocean areas, including investigations of spatio-temporal distribution of catch, and fine-scale behavior of Silky Sharks relative to tunas when associated with FADs. Although a time-area closure in the EPO was defined and suggested as a management measure for reducing fishing mortality on adult Silky Sharks, it would have negatively impacted Yellowfin Tuna catch in that area, and it was not adopted by IATTC. Acoustic telemetry experiments have indicated that Silky Sharks maintain close proximity to tunas within mixed species aggregations associated with FADs, so there does not appear to be a specific time at which FAD sets could be made on tuna aggregations to reduce the vulnerability to capture of Silky Sharks. Back-down maneuver trials with a purse-seine vessel, following sets on tuna aggregations associated with FADs, will be conducted in early 2016 to evaluate whether backing down is a feasible method for the live release of Silky Sharks, and other non-tuna species. This research is being undertaken through a collaborative effort by the Jadran Group, ISSF, and IATTC, for which preliminary results will be presented.

A BAYESIAN SPACE-STATE CORMACK-JOLLY-SEBER MODEL TO ESTIMATE AGE-SPECIFIC FISHING AND NATURAL MORTALITIES FOR ATLANTIC TROPICAL TUNA

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A Bayesian space-state Cormack-Jolly-Seber model was used to estimate simulated tagging data for Atlantic tropical tuna: Yellowfin (*Thunnus albacares*), Skipjack (*Katsuwonus pelamis*), and Bigeye Tuna (*T. obesus*). The model estimates age-specific natural mortality and age- and region-specific fishing mortality and compares the accuracy of these estimates to a single parameter model estimating a single natural mortality and a region-specific fishing mortality. Uninformative lognormal priors are used for natural and fishing mortality while movement rates are assumed to be known from an external source and are not estimated within the data. Results vary greatly between the three species. In Yellowfin, the age-specific fishing mortality parameter estimates are less biased than single parameter fishing mortality estimates, which is expected given that the different gears targeting Yellowfin have significant differences in size selection. Yellowfin natural mortality parameter estimates are less biased when a single parameters is estimated rather than age-specific parameters, although this may be due to the small variation in natural mortality at age currently used in ICCAT stock assessments. The age structured model produced more biased results than the single-parameter model for Bigeye Tuna. For Skipjack Tuna, the fishing mortality parameters are more variable for the age-structured model, but on average no better than the single parameter model. The age structured model produced significantly more biased parameter estimates than the single parameter model. Future stock assessments should consider including age-specific parameters on a species to species basis as information becomes more available as they could significantly change the conclusions on stock status.

EXEMPTED FISHERY TRIALS FOR SWORDFISH OFF THE U.S. WEST COAST

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A consistent decline in California Swordfish fishery revenue and participation has ensued over the past 30 years despite the presence of healthy stocks and robust markets. Fishery decline has been attributed in part to protected species bycatch mitigation measures that have closed the core fishing area and impacted the economic viability of the California drift gillnet fishery. In an attempt to provide the west coast with an additional low-impact option for harvesting local swordfish, PIER with support from NOAA Fisheries initiated experiments to develop and test deep-set buoy gear (DSBG) off southern California in 2011. DSBG is an artisanal gear type that strategically targets Swordfish and other highly migratory species below the thermocline during the day. In June of 2015, the Pacific Fishery Management Council (PFMC) recommended and NOAA Fisheries issued PIER a DSBG exempted fishing permit (EFP) to test DSBG off the California coast. Four cooperative vessels and one research vessel deployed DSBG on 125 fishing days (8h) during the 2015-2016 fishing season. Gear configuration was standardized across vessels and included the deployment of up to 10 individual pieces of gear per set. Total hook-count per 10-buoy set was maintained between 10 and 30, with most cooperative fishers using only 10 terminal 18/0 circle hooks baited with either mackerel (*Scomber* spp.) or squid (*Illex* spp.). A total of 161 Swordfish were landed during the initial study period, with catch rates ranging from 0.6 to 1.6 Swordfish/day. Consistent with previous (2011-2014) research trials, the EFP deployments resulted in relatively high selectivity for Swordfish and other valuable incidental species, with marketable catch comprising 97% of the total landings. Due to active tending and strike detection, all non-marketable species captured (3%), were released alive during the trials, further suggesting the low-impact nature of DSBG activities. Concurrent market development studies revealed an average price-point for Swordfish that was comparable to traditional harpoon-caught product and nearly double that of the CA drift gillnet fishery. DSBG EFP trials will continue throughout the 2016-2017 season, with additional research efforts focused on identifying more efficient gear designs that retain the selective attributes of DSBG.

COMPARATIVE LABORATORY STUDIES OF FOOD SELECTIVITY AND FEEDING BEHAVIOR OF YELLOWFIN (*THUNNUS ALBACARES*) AND PACIFIC BLUEFIN (*THUNNUS ORIENTALIS*) TUNA LARVAE DURING THE FIRST WEEK OF FEEDING

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The Inter-American Tropical Tuna Commission (IATTC) conducts research on the reproductive biology and early life history of Yellowfin Tuna (*Thunnus albacares*) at the Achotines Laboratory, Republic of Panama. Larvae hatched from eggs spawned at the Achotines Laboratory are routinely used in a variety of laboratory experiments designed to investigate the effects of key environmental and biological factors on pre-recruit survival.

The Fisheries Laboratory of Kinki University, located in Wakayama Prefecture, Japan, has been the world leader in studies of the spawning and rearing of Pacific Bluefin Tuna (*Thunnus orientalis*). In 2002, Kinki University successfully completed the life cycle of Pacific Bluefin in captivity, and has continued to expand and refine its studies of the reproductive biology and aquaculture of Pacific Bluefin.

In 2011, the IATTC, Kinki University, and the Autoridad de los Recursos Acuáticos de Panamá (ARAP) initiated a 5-year comparative study of the reproductive biology and early life history of Pacific Bluefin and Yellowfin. The joint project is being implemented under the Science and Technology Research Partnership for Sustainable Development (SATREPS). The joint research is being conducted mostly at the Fisheries Laboratory of Kinki University in Japan and the Achotines Laboratory in Panama.

As part of this collaboration, comparative laboratory studies of Yellowfin and Pacific Bluefin larvae have been conducted at both facilities. In this paper, we present the preliminary results from experiments conducted during the 2014 and 2015 experimental seasons. These experiments include a comparison of the ability of each species to feed exclusively on large prey items at first-feeding, a comparison between species of size-selectivity feeding patterns when offered both small and large prey items, and a comparison of prey selectivity patterns of both species when offered wild plankton as prey. Additionally, multiple diel feeding and gastric evacuation experiments were conducted with Pacific Bluefin larvae and the preliminary results from these experiments will be compared with previous results attained with Yellowfin larvae.

A POWER ANALYSIS TO DETERMINE THE EFFECT OF EFP SAMPLE SIZE ON ESTIMATOR PRECISION

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Exempted fishing permits (EFPs) are issued under the authority of the Magnuson-Stevens Act (MSA) to support testing of fishing methods in locations where or during times when necessary research activities are normally prohibited. One aspect of EFP authorization regards limits on fishing effort, which may include restrictions on gear, fishing days, number of vessels, times and areas open to fishing or other attributes of effort. A further effort limit may occur if hard caps are imposed on bycatch, resulting in possible EFP termination before the research is complete.

Limits on EFP effort have implications for conservation impacts and for the amount and quality of data collected. If too much effort is permitted, unacceptably high population impacts on protected species may result. Allowing too little effort can result in an inadequate sample size to produce precise, credible estimates of catch and bycatch rates. Imprecise estimates may lead to uninformed judgments on the potential conservation impacts or economic viability of the fishing methods being tested, at considerable expense to both fishers and the government.

This paper conducts a power analysis to explore the effects of EFP sample size on the precision of statistical estimators of catch and bycatch rates for selected species of interest. The analysis uses observer data for recent U.S. shallow-set and deep-set longline fishery landings to the U.S. West Coast. The methodology is applied to estimators of target species (Swordfish) catch rates and endangered loggerhead and Leatherback Sea Turtle bycatch rates. Simulation methods are used to demonstrate the effect of sample size on estimator precision, and to show how imposing caps on allowable catch counts may limit EFP effort below the nominally permissible amount.

YELLOWFIN TUNA (*THUNNUS ALBACARES*) RESEARCH AND ACTIVITIES CONDUCTED AT THE IATTC's ACHOTINES LABORATORY, PANAMA DURING 2015-2016

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The Inter-American Tropical Tuna Commission (IATTC) conducts research on the reproductive biology and early life history of Yellowfin Tuna at the Achotines Laboratory, Republic of Panama. Yellowfin broodstock have been spawning at near-daily intervals since 1996, and the resulting eggs, larvae and early-juveniles are studied in experimental investigations. A comprehensive review of our Yellowfin research was published in a book chapter during 2015, "Research on the reproductive biology and early life history of yellowfin tuna *Thunnus albacares* in Panama" in *Advances in Tuna Aquaculture* (Editors: D.D. Benetti, G.J. Partridge, A. Buentello).

In mid-2011, a 5-year joint study was initiated at the Achotines Laboratory and in Japan to conduct comparative studies of the early life histories of Pacific Bluefin and Yellowfin Tuna. The project was a joint study conducted by the IATTC's Early Life History (ELH) Group, Kinki University and the Autoridad de los Recursos Acuáticos de Panama (ARAP) which ended in March 2016. The project was funded by the Japan International Cooperation Agency (JICA) and the Japan Science and Technology Agency (JST). We present a brief summary of some of our experimental results from 2011-2015 of comparative investigations of growth potential and starvation resistance of larvae of both species. We also present a description of rearing of early-juvenile Yellowfin up to 158 days post-hatch and the world-first successful transfer of early-juvenile Yellowfin to a sea cage.

Other research activities during 2015 included a sampling and developmental growth series of Yellowfin larvae from hatching to 25 days post hatching. These samples will be analyzed in collaboration with Martin Tresguerres of SIO and Nick Wegner of NMFS for stage-specific mode of respiration, gill morphology, and osmoregulation of Yellowfin Tuna larvae.

Also during 2015, the 13th annual workshop took place at the Achotines Laboratory on the "Physiology and Aquaculture of Pelagics, with Emphasis on Reproduction and Early Developmental Stages of Yellowfin Tuna," that was organized by the IATTC's ELH group and the University of Miami.

Other projects that will be conducted at Achotines during 2016 include studying nutritional requirements in one-year old Yellowfin Tunas by Dr. Buentello of Texas A&M University, the acoustic properties of 40-60 cm Yellowfin Tuna in an offshore sea cage near Achotines that will be conducted by the International Seafood Sustainability Foundation, and a project conducted by Martin Hall and Marlon Ramon of IATTC to examine biodegradable and non-entangling FADs which is funded by the European Union.

GENETIC ANALYSIS OF BLACK MARLIN (*ISTIOMPAX INDICA*) FROM THE CENTRAL INDO-PACIFIC REVEALS MULTIPLE POPULATIONS

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The Black Marlin *Istiompax indica* is a highly migratory species and as a result is expected to show little genetic population structure throughout its broad geographic range. Tissue samples from 183 *I. indica* were collected from three geographic regions within the central Indo-Pacific and analyzed using mitochondrial and nuclear DNA markers. Nuclear genetic heterogeneity was found among populations in the south-western Pacific Ocean, eastern Indian Ocean and South China Sea (significant *F*ST values of 0.013 to 0.037). Combining information from nuclear markers with published movement and reproductive data suggests that reproductive philopatry plays a role in maintaining contemporary *I. indica* population structure. Analyses of the mitochondrial control region did not reflect this pattern, however it identified historical population structure. Differing patterns of genetic population structure revealed by mitochondrial and nuclear markers demonstrated that a transition must have occurred between historical and contemporary population structures. This restructuring presumably reflects a species whose populations have become genetically isolated before experiencing a period of secondary contact. The spatial subdivision evident among populations indicates that *I. indica* in this central Indo-Pacific region should be managed as three independent stocks, to guide the sustainability of this fisheries resource.

THE REWILDING OF THE CALIFORNIA CURRENT: MARINE MAMMAL FORAGE REQUIREMENT AND IMPLICATIONS FOR HMS FISH MANAGEMENT

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Landmark legislation passed in the mid-1970s led to the implementation of the Magnuson-Stevens Fishery Conservation and Management Act, the Marine Mammal Protection Act and the Endangered Species Act. Now, 40 years later we examine the relative magnitude of forage fish harvests and the increased demands of marine mammals for forage within the US west coast EEZ. In general exploited populations of pinnipeds and great whales have increased at near theoretical maximum demographic rates since the 1970's. Small cetacean populations were rarely targeted for direct harvest, and demographic impacts of bycatch and harassment mortality are poorly known. However, in some cases, small cetacean populations have also shown remarkable increases within the EEZ during this 40 year period. These increases may be due to migration into the EEZ due to direct and indirect effects of climate and forage distribution, as well as changes in local survivorship. Broad-scale surveys of marine mammals and fishery-independent forage surveys, coupled with high resolution physiological ecology studies of the bio-energetic demands of marine mammals, shed new light on the changing natural mortality (*M*) versus fishing mortality (*F*) of forage fish populations. Increasing numbers of pinnipeds and cetaceans has increased natural mortality of forage fishes in the last 40 years, but is not explicitly accounted for in current or anticipated forage fish assessments. We attempt a first order quantification of pinniped and cetacean forage fish predation, and compare its magnitude to estimates of forage fish catches. The basic theory of single species fishery management is that population growth rates and net gains in biomass are realized when populations are moved away from carrying capacity to a lower population density at maximum sustainable yield. When marine mammal populations experience only *M* while HMS populations experience *M* and *F*, the basic assumptions of fishery management may be invalidated and B_{msy} could ratchet down.

Poster Presentation Abstracts (In order of presenting author last name)

SEASONAL MOVEMENT PATTERNS OF SWORDFISH IN THE EASTERN PACIFIC

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To address the need for information on North Pacific Swordfish stock structure and validate experimental deep-set fishing gear configurations, PIER has conducted tagging studies that identify regional variations in Swordfish depth distribution throughout the eastern Pacific. Cefas data storage tags (DSTs) have been deployed on 30 Swordfish captured on deep-set buoy gear (DSBG) between September, 2012 and January, 2016. To date, four individuals have been recaptured providing a total of 1,060 days of fine-scale (60 s) time series data (42 to 471 d). Vertical movement data were used to estimate sunrise and sunset times based on the regularity of Swordfish diel dive patterns. Daily geolocation estimates were generated using depth as a proxy for light level to derive inputs for a modified state-space model, in conjunction with mean daily SST and bathymetry data. Two Swordfish that remained in the eastern Pacific during the fall and winter months (41-155 days at liberty) exhibited consistent daytime dives (275-500m) along with a shallow nighttime depth distribution above the thermocline (<60m). In contrast, two Swordfish at liberty for >1 year exhibited considerably deeper mean daytime and nighttime depth distribution during extensive offshore movements into the western and central North Pacific. Sea-surface temperatures (SSTs) increased from a minimum of 16°C during the month of February to 28°C during March as Swordfish moved offshore, before reaching peak values of 30°C during the spawning season (April-May). Mean daily temperatures at depth (>250m) ranged from 4 to 12°C, with temperatures as low as 2.5°C recorded on extreme daytime dives (>1700m) in June. Contrasting extreme dives during portions of offshore migrations, Swordfish also exhibited periods of relatively shallow daytime depth distributions associated with periods of heightened horizontal movement in July. Examining spatio-temporal trends from long-term electronic tag recoveries will continue to provide information on Pacific Swordfish stock structure while supporting the development of selective fishery options.

FISHING FOR ANSWERS: SPATIAL AND TEMPORAL TRENDS IN RECREATIONAL CATCH AND MOVMENTS OF YELLOWTAIL (*SERIOLA LALANDI*) IN THE SOUTHERN CALIFORNIA BIGHT

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Yellowtail (*Seriola lalandi*) are intensely targeted throughout their eastern Pacific range, however, their larger ecological role within the Southern California Bight (SCB) marine community remains vague, largely because they are not a management priority. Yellowtail are thought to move north into the Southern California Bight (SCB) during May-October and abundance appears to be correlated to sea-surface temperature. However, analysis of fisheries dependent data suggests the largest (≥90 cm fork length) individuals inhabit near-shore waters of the SCB year-round. These observations suggest a structured pattern of space-use based upon physiological constraints and ontogenetic movements. To examine spatial and temporal trends in the fishery, recreational Yellowtail capture in southern California between 1936-2014 from all existing databases were analyzed by size, season, location, and sea-surface temperature. Catch was bi-modal with peaks at both immature and mature sizes, larger fish were caught inshore (<3 mi) while smaller fish were predominantly offshore (>3 mi). These trends varied predictably depending on season. Fish caught during winter were significantly larger than those caught during the remainder of the year. This defined spatial and temporal size segregation provided the motivation for a comprehensive tagging effort utilizing both conventional and acoustic tags within the southern SCB.

Currently, the recapture rate is above 20%, with time at liberty ranging from 24 hours to 24 months and recapture distance from 0-400km; smaller fish demonstrated higher vagility as compared to larger fish. These results suggest a pattern of shifting space use (habitat and mobility) with age, revealing novel evidence of ontogenetic changes in movement for a coastal marine fish. Currently, passive telemetry detections seem to confirm these results within the La Jolla kelp forest and adjacent inshore areas. This work is the first broad examination of California Yellowtail since 1960.

HABITAT USE AND MOVEMENTS OF BLUE SHARKS (*PRIONACE GLAUCA)* IN THE EASTERN NORTH PACIFIC

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In 2002 the SWFSC initiated a Blue Shark tagging program to examine movements and habitat use in the eastern North Pacific. Blue Sharks are targeted in Mexican waters and are common as bycatch in U.S. and international commercial fisheries. To date a total of 100 sharks (51 males and 49 females) have been tagged with some combination of SPOT (n=95) and PSAT tags (n=60) with 55 sharks carrying both tag types. The majority of sharks were tagged in the Southern California Bight although 14 sharks were tagged off Baja California Sur, Mexico and another 12 off southwest Canada. Five sharks died shortly after tagging and seven PSAT tags were recovered providing archival data on temperature, depth and light levels. For the 37 PSAT tags that provided data, 8 of which remained attached until the programmed pop-up date, the average deployment duration was 115 days. The mean SPOT tag track duration was 88 days, with 7 tags reporting for more than 300 days.

Data transmitted and recovered from the PSAT tags provide information on vertical and thermal habitat use. Blue Sharks occupied waters from 4.4 to 29.8 ^{o}C, with sea surface temperature ranging from 10.8-29.8 ^{o}C. A common pattern in archival records was repetitive dives to depths consistent with foraging in association with the deep-scattering layer. There were significant differences in the average maximum depth across all fish comparing day (154 m) and night (65 m), indicating a diel pattern. Archival records however, revealed a range of vertical movements with some periods of no diel activity. A comparison of size classes (either > or < 160 cm FL) reveals that smaller sharks have shallower average maximum depths (124 m) in comparison to larger sharks (175 m) which may be linked to behavioral thermoregulation and the increase in thermal inertia with size.

SPOT tag transmissions provided insight into geographic movement patterns. While seasonal patterns are difficult to discern given the limited number of long-term tracks, a number of patterns were apparent. The majority of fish moved south following release regardless of their initial tagging location. Females moved farther south than males. Of the 21 individuals that occurred south of 13^{o}N, 18 were females. These Blue Sharks were in waters associated with the north equatorial current and counter current. Interestingly, they were found at these low latitudes across seasons and size ranges. The occurrence of small females in the south differs from previous models of size and sexual segregation for Blue Sharks, although data for the eastern North Pacific were limited.

BIOENERGETICS OF CAPTIVE YELLOWFIN TUNA (*THUNNUS ALBACARES*)

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We utilized a unique opportunity to study the growth and bioenergetics of a highly migratory and commercially valuable marine predator under controlled environmental conditions. We maintained a captive population of Yellowfin Tuna (*Thunnus albacares)* in holding tanks throughout a twenty-year period, routinely collecting data on mass and length of individual fish over time. The water temperature of the holding tanks was maintained at 19.9 ± 0.9°C (mean ± s.d.) and the tuna were fed a diet amounting to 176 ± 36 $kJ \cdot kg^{-1}$ of tuna biomass·day^{-1} across the study period. We integrated length records with a prior model of Yellowfin Tuna age to generate a von Bertalanffy growth function for this captive scenario with the parameters 224.26 cm straight fork length (SFL), 0.10, and -1.72 years for L_{∞}, k, and t_o, respectively. We combined our growth model and analyses of tuna tissue energy with metabolic data from various sources to estimate a bioenergetic budget for this difficult-to-study marine predator. We found that the captive tunas in this experiment grew significantly slower (P= 0.01) than Yellowfin studied in the wild and in other captive scenarios. Our energetic budget indicates that a mere 7.8% of an ingested meal's energetic content was utilized for growth. Furthermore, we calculated a food conversion ratio of 37.2:1 for a mixed diet of squid, sardine, and vitamin gelatin, indicating that the captive Yellowfin require high energy intake levels to meet elevated metabolic demands associated with endothermy and constant swimming activity. We conclude with a discussion of the various factors influencing tuna bioenergetics including the role of water temperature, diet, and inter-species competition on growth and energy assimilation.

DEVELOPING A MORTALITY TAG: FROM THEORY TO PRACTICE

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Over the past two decades, pop-up satellite archival tags (PSATs) have emerged as a valuable tool for evaluating post-release (discard) mortality of highly migratory species released from commercial and recreational fishing gear. Such studies are critical for informing estimates of total fishing mortality for use in stock assessments, as well as for identifying best practices to ensure safe release. Unfortunately, most commercially available PSATs cost approximately $4,000 each, a price that makes large sample sizes cost-prohibitive and results in low-precision post-release mortality estimates that are of limited use to management. Here, I evaluate the applicability of a newly developed, low-cost PSAT for determining post-release mortality in large pelagic fishes. The tag uses solar rather than battery power and does not contain a depth sensor, and as a result costs roughly one quarter the price of other PSATs. I used high-resolution environmental data retrieved from PSATs previously deployed on White Marlin (*Kajikia albida*) and Atlantic Bluefin Tuna (*Thunnus thynnus*) to establish parameters for the new tag that enable the researcher, using only light and temperature data, to infer if a fish has 1) died and sunk to the bottom in shallow water, 2) been predated upon, or 3) died and sunk in water deeper than the tag's 1,500 m crush depth. Beta-testing began in 2015 with the deployment of PSATs on Atlantic Bluefin Tuna (30-day deployments) in order to assess the post-release mortality of large school (119 - 150 cm curved fork length) and small medium (150 - 185 cm CFL) size fish caught and released by recreational anglers along the U.S. east coast. Eleven tags were deployed in 2015, eight of which successfully archived and transmitted data via the ARGOS system. Throughout the tags' deployments, all eight fish demonstrated strong temporal changes in temperature consistent with vertical movement in the water column, from which I inferred survival following release. Of the three tags that did not transmit data, one failed due to power loss resulting from insufficient pre-deployment solar charging, while the other two tags failed for unknown reasons. Overall, the new PSAT shows promise as a cost-effective tool for detecting post-release mortality. Deployment of additional tags on Atlantic Bluefin Tuna during the 2016 field season will aid in further evaluating and refining the tag's design and reliability.

AN OVERVIEW OF THE ARGOS SYSTEM

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The Argos system is the satellite telemetry system of choice for biologists worldwide. In fact, species monitoring and Argos technology have grown together, and biology applications are the fastest growing of all programs in the Argos system. Enhancements to the system have provided a number of advantages to biologists such as increased sensitivity, improved location calculation, new low-power modulation, and broadening of the bandwidth.

CLS America is engaged with managing the sales and customer support activities for all North American Argos users. This presentation will provide a technical overview of how the Argos system works, a walkthrough demonstrating how users access satellite transmitted data and demonstrate new technologies that have been, or will be, developed. In particular, technologies that aid in the collection and reporting of fishing, observing and tagging data with the goal of streamlining data communication from vessel to land.

ANALYSIS OF THE SIZE AND CONDITION FACTOR DOLPHIN (*CORYPHAENA HIPPURUS*) IN WATERS OFF BAJA CALIFORNIA SUR

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The putative stock of the Dolphinfish *Coryphaena hippurus* in the Eastern Pacific Ocean (EPO) ranges from 46°N to 38°S, where seasonal fisheries are developed in waters under the jurisdiction of different coastal countries and in international waters. The Dolphinfish is captured either incidentally or as a target species by artisanal and sport-fishing fleets along its distribution range. In Mexico, this species is reserved for sport-fishing up 50 nautical miles away from the shoreline; however, it is also caught seasonally by artisanal fisheries that operate along the Pacific coast. Off the Baja California Sur (BCS) southern region, the Dolphinfish supports a sport fishery all the year round. Besides the climate variability that affects fish stocks, in recent decades the increase of commercial catches of Dolphinfish in EPO by fisheries of coastal nations in the central and southern part of this range, coupled with the expansion of the recreational fishing fleet in BCS, have raised awareness on the current status of Dolphinfish stocks. Since a comprehensive assessment of Dolphinfish stocks along EPO is not currently available, we provide background on available time-series of data for Dolphinfish in BCS that may be used to develop Stock Status Indicators (SSIs), and provide a preliminary analysis for each SSI. First, the average fork length (FL) of fish landed in BCS, its use is justified because a constant selective fishing of larger fish occurs under recreational fishing, focusing on catches of large, trophy fish. Second, the study of fish condition (Fulton's *K* condition factor, KF) based on the analysis of length-weight data assuming that heavier fish of a given length are in better condition. Records of total weight (Wt) and FL for 25,500 fish sampled at Cabo San Lucas, Los Barriles and La Paz were analyzed for the period 1990-2015. The assembled 26-year time-series of SSIs are: 1) annual mean FL by sex; 2) KF by sex including all sizes and months; 3) KF for males in the 75-115 cm size range, caught from April through July; and, 4) KF for females in the 65-105 cm size range for the same months. For revealing the regularities and adaptive traits of fish to the environment, SSIs are related to annual anomalies in sea surface temperature (SST) and Chlorophyll-*a* concentration (Chl-a) for the coastal area off BCS. We used cumulative sum (CUSUM) plots to detect persistent changes in SSIs and environmental factors, providing a view of the stock history as well as of the variables that may be affecting fish condition. In our study region, SST showed a marked decline from 1998 through 2013, coinciding with the period named ¨global-warming hiatus by several authors, with an upward trend that resumed in 2014, with 2015 temperatures on course for another record-hot year. In general, SSIs time-series showed a low inter-annual variability until 1998, after which it exhibited a positive trend corresponding with the cold period followed by a negative trend associated with an upward trend in SST. Our findings support the hypothesis that trends in fish size and condition for the Dolphinfish are strongly influenced by oceanic conditions.

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NURSERY ORIGIN AND CONNECTIVITY OF SWORDFISH (*XIPHIA GLADIUS*) IN THE NORTH PACIFIC OCEAN

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Swordfish population structure in the North Pacific Ocean (NPO) is poorly understood with a number of questions still remaining. The purpose of this study was to examine nursery origin and connectivity of Swordfish (*Xiphias gladius*) throughout the NPO using otolith chemistry. First, juvenile Swordfish otolith core chemistry (proxy of nursery origin) was used to evaluate nursery-specific elemental signatures. Sagittal otoliths from juvenile (age-0) Swordfish were collected from 2000 to 2006 among four regional nurseries throughout the NPO including the Central Equatorial Pacific Ocean (CEPO), the Central North Pacific Ocean (CNPO), the Eastern Equatorial Pacific Ocean (EEPO), and the Western North Pacific Ocean (WNPO). Otolith core trace element concentrations were then measured for a suite of different elements and quantified using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS). Univariate tests indicated that the concentrations of three elements (^{24}Mg, ^{88}Sr, and ^{138}Ba) were significantly different among nurseries. Concentrations of ^{88}Sr were significantly higher in individuals collected from the CEPO while concentrations of ^{24}Mg were higher in individuals from the CNPO. Elemental concentrations from individuals collected from the EEPO exhibited the most variability relative to other regions. Overall classification success from quadratic discriminant analysis of juvenile Swordfish to their nursery of collection was 72%. Next, otolith core chemistry of sub-adults and adults collected from three foraging grounds where targeted fisheries exist (California, Hawaii, and Mexico) was examined to calculate nursery-specific contribution rates. Mixed-stock analysis indicated that the CEPO nursery contributed the majority of individuals to all three foraging grounds (California 96.8 ± 5.28%; Hawaii 56.5 ± 16.1%; Mexico 75.7 ± 12.8%). Results from this study will provide researchers and fisheries managers new information on connectivity of the Pacific Swordfish population in the NPO.

SHORT-TERM MOVEMENTS AND BODY TEMPERATURE MEASUREMENTS IN THE OPAH, *LAMPRIS GUTTATUS*

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Recent work has shown that the Opah exhibits a novel form of fish endothermy in which most of the body is maintained at temperatures above that of the environment. Temperature data leading to this finding were collected from freshly captured and euthanized animals and through short duration (< 3 h) trials of Opah swimming at depth but tethered to a leader and surface float for temperature logger recovery. The present study examines the internal temperature of free swimming Opah under less stressful and restrained conditions and for longer durations (up to 60 h) through the use of autonomous tags with a temperature stock inserted into the pectoral muscle. Depth and temperature data were collected from six free-swimming Opah (five were tagged with a PSAT coupled to an archival tag and one was outfitted with an acoustic transmitter and thermocouple). Internal temperature measurements were successfully recorded for three of these animals, yielding specific data on the effect of changes in depth and water temperature on body temperature. Opah endothermy will be discussed in relation to movements and habitat utilization.

FISHCPR (FISH CATCH, PHOTO, RELEASE) – HIGHLY MIGRATORY SPECIES CATCH AND RELEASE SMARTPHONE APP

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The Southwest Fisheries Science Center (SWFSC) Highly Migratory Species (HMS) group collects movement and migration data and compiles catch, tagging and recapture statistics for numerous large pelagic fish species including sharks, tunas and billfish. Data on catches, movements, spatial and temporal distributions and growth are vital to understanding and predicting the condition of fish stocks as mandated by the Magnuson-Stevens Fishery Conservation and Management Act. Monitoring the distribution and catch of HMS, many of which make annual migrations of several thousand nautical miles, is possible with the help and collaboration of recreational and commercial fishers.

The SWFSC manages a recreational billfish tagging program that has provided tagging supplies to recreational anglers since 1969. Over one thousand tags were released by cooperative anglers across the Pacific in each of 2014 and 2015. We also archive the data from the former California Department of Fish and Wildlife recreational shark tagging program (1983-2000). These data are supplemented annually with research shark tagging and some limited recreational shark tagging. Reporting of both releases and recaptures by recreational and commercial anglers is currently done by mail and requires manual entry into databases.

The SWFSC HMS group is developing a smartphone app called FISHCPR (for Fish Catch, Photo and Release) along with a companion webpage where anglers can input the location and time of capture of HMS including sharks, billfish, and tuna. The goal of this project is to implement new technology that will allow electronic reporting and dissemination of HMS recreational catch and release, and tag and release information with a focus on anglers fishing off the West Coasts of the U.S. and Mexico, and in Hawaii. An iOS beta version of the app has been completed and an Android version is currently in production, which will mirror the iOS version. The app allows anglers to report catch and release, tag and release, recapture, and attach photos. It also has an interactive map where anglers can view annual release locations and metadata. Three identification pages are included in the app for a select variety of sharks, tunas, and billfish. Additionally, a website will be developed to provide an outlet for anglers to view the activities of fellow anglers and track their catch and release history over time.

Obituaries

Cliff Peterson – Served as the Chair on the 12th Tuna Conference from September 25th to September 27th 1961.

Cliff Peterson, Assistant Director of the IATTC from 1965 to 1985, passed away on December 26, 2015. Cliff was born in Bremerton, Washington, USA, in 1926. He was drafted into the U.S. Army during World War II, and served in combat with the 10th Mountain Division in Italy in 1945. After the war, he studied at the University of Washington, from which he graduated in June 1951. After his graduation he worked for the Oregon Fish Commission until 1952, when he was hired by the IATTC to work on baitfish and estuarine oceanography in Puntarenas, Costa Rica. Puntarenas was not a comfortable place to live and work in during the 1950s, but Cliff managed to accomplish a considerable amount there; the following papers are based on what he did there:

Peterson, Clifford L. 1956. Observations on the taxonomy, biology, and ecology of the engraulid and clupeid fishes in the Gulf of Nicoya, Costa Rica. IATTC Bull. 1 (5): 137-280.

Peterson, Clifford L. 1960. The physical oceanography of the Gulf of Nicoya, Costa Rica, a tropical estuary. IATTC Bull. 4 (4): 137-216.

He then took a one-year leave of absence from the IATTC, beginning in August 1956, to work for the Food and Agriculture Organization of the United Nations in Venezuela on marine fisheries, particularly that for sardines (*Sardinella aurita)*. His report on that work is entitled Informe al Gobierno de Venezuela sobre la Evaluación de sus Recursos Pesqueros Marinos. After that he returned to the San Diego headquarters of the IATTC where, during the early 1960s, he was promoted to Assistant Director. He continued to serve as the IATTC's Assistant Director at its San Diego and La Jolla headquarters until his retirement in December 1985.

During his period as Assistant Director, he kept busy supervising the activities of the baitfish research being conducted in Costa Rica, Panama, and Ecuador, serving as editor of the IATTC's publications, and, to a considerable extent, handling personnel matters. He was the author or co-author of two additional IATTC Bulletins, one IATTC Special Report, and four papers in outside journals during that period. He retired in December 1985.

Cliff was a very kind person; he never had a harsh word for anyone. Much of his spare time was devoted to church work, particularly with Hispanic and Southeastern Asian immigrants to the United States.

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