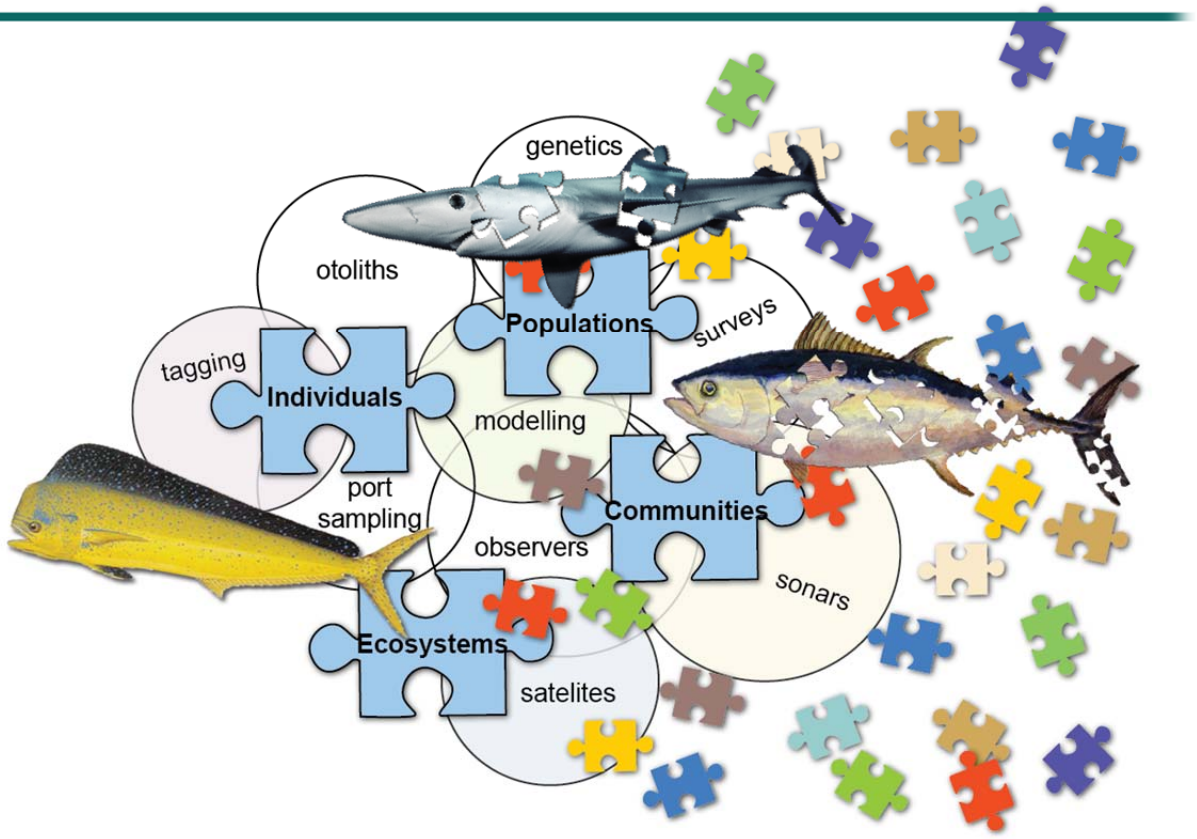
Proceedings of the 66th annual Tuna Conference

Putting the Pieces Together:

Integrating Methods for Understanding Large Pelagic Species



Lake Arrowhead, California,
May 18-21 2015

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PROCEEDINGS OF THE 66TH ANNUAL TUNA CONFERENCE

Lake Arrowhead, California,
May 18-21 2015

Carolina V. Minte-Vera[1], John Graves[2] - Co-Chairs
JoyDeLee C. Marrow[1]-Coordinator

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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.

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PREFACE

Welcome to the 66th Annual Tuna Conference. The goal of the Tuna Conference is to provide an open and informal forum for scientists, engineers, managers, fishermen, non-governmental organizations and other interested parties 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 key to the Conference's success.

The theme for this year's Tuna Conference is "***Putting the pieces together: Integrating methods for understanding large pelagic species.***" There are a host of challenges to the study of large pelagic species. Despite those often formidable obstacles, our knowledge of the biology, ecology and population dynamics of these animals has increased greatly over the past several decades. More recently, the combined and integrated use of different methodologies has provided new perspectives into the biology of large pelagic species- insights that have had important ramifications for the assessment and management of these species. Slowly, but surely, the pieces of the puzzle are coming together.

Many of the oral and poster presentations at this year's conference directly relate to the theme and, as always, there is a diverse and interesting series of presentations on the agenda. Over the course of the next four days, there will be 43 oral presentations in six sessions and an additional 15 presentations in the poster session, authored by a total of 170 scientists. Special thanks to this year's session moderators: Kurt Schaefer, Dave Secor, Heidi Dewar, Suzy Kohin, John Hyde, and Mike Laurs. We sincerely appreciate their time and efforts to keep things on time and running smoothly in their sessions.

The abstracts for the oral and poster presentations contained in the Proceedings are listed in alphabetical order of the first author (combined for posters and oral presentations). For your convenience, we added an author index at the end of the proceedings. 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).

This year there were many excellent applications for student scholarships and ranking the candidates was a very difficult task. Many thanks to Bill Bayliff, Liz Edwards, John Hyde, Dan Margulies, and Nick Wegner for helping to review the student packages. We are very pleased that, thanks to the generosity of our donors, funds were available to support a record of seven student scholarships this year. The Tuna Conference Scholarship was awarded to Matt Siskey for his talk titled "Historical effects of fishing on age structure and stock mixing in Northwest Atlantic bluefin tuna fisheries." The Manuel Caboz Memorial Scholarship was awarded to Maite Pons for her talk titled "Setting and enforcing total allowable catches could lead to rebuilding of tuna and billfish stocks." This was the inaugural year for the Margarita Tomlinson Scholarship and the John Tomlinson Scholarship. The Margarita Tomlinson Scholarship was awarded to Jon Lopez for his talk titled "Environmental preferences of tuna and non-tuna species associated with drifting fish aggregating devices (DFADs) in the Atlantic Ocean, ascertained through fishers'

echo-sounder buoys" and the John Tomlinson Scholarship was awarded to Carlo Pecoraro for his talk titled "Genomic analysis of population structure of yellowfin tuna (*Thunnus albacores*) at the global scale". Ashley Stoehr received the Wildlife Computers Scholarship for her talk titled "Thermal effects on aerobic muscle function in a deep-diving teleost and shark"; Veronica Quesnell received the Desert Star Systems LLC Scholarship for her talk titled "Utilization of otolith chemistry to examine swordfish (*Xiphias gladius*) connectivity throughout the North Pacific Ocean"; and Lisa Ailloud received the ADMB Award for her talk titled "Potential impacts of minimum weight regulations for Pacific bluefin tuna (*Thunnus orientalis*). Additional travel support for the seven award winners was graciously provided by the International Seafood Sustainability Foundation.

In addition to support for student scholarships and travel, the Tuna Conference benefits from generous donations to support the various "social" functions such as the Sushi Social/Poster Session, the Tuna Barbecue, Campfire and Tavern get-togethers. We thank Rex Ito and Prime Time Seafood for donating the sashimi-grade tuna for the poster Sushi Social/Poster Session, and we gratefully acknowledge all our donors from the Automatic Differentiation Model Builder Foundation, American Fishermen's Research Foundation, American Tuna Boat Association, Desert Star Systems LLC, Inc., International Seafood Sustainability Foundation, Monterey Bay Aquarium, Patrick Tomlinson, Prime Time Seafood Inc., and Wildlife Computers Inc.

We would like to thank also Craig Heberer, Kurt Schaefer, David Itano, Russell Ito, Kim Holland, Dan Fuller, Chugey Sepulveda, Scott Aalbers, Owyn Snodgrass and Rex Ito for volunteering to be our gracious team of sashimi and poke cutters. Millie DeLosReyes had handled all the bank transactions and picking up the students from the hotel. Our graphic designer Chris Patnode put her creativity to work on our cover page art, name tags, website and student certificates. A special thanks to the UCLA Conference Center personnel for accommodating our numerous requests. We are also very grateful to the team of SWFSC and IATTC staff members, too numerous to be named here, for general assistance with preparation for the conference, as well as the transportation of supplies and conference participants.

We are sad to report that Robin Allen, a past conference chair and former Director of the IATTC, passed away this year. A touching tribute to his life was written by W. Bayliff and M. Scott, can be found on page 5.

In closing, we would like to thank you all for participating. After all, it is the quality of your presentations and camaraderie that make the Tuna Conference such a great event (and yes, the beautiful venue contributes as well!). We hope you have a productive and enjoyable time and we look forward to seeing you back next year at the 67th Tuna Conference!

Carolina Minte-Vera
66th Tuna Conference Co-Chair

John Graves
66th Tuna Conference Co-Chair

JoyDeLee Marrow
66th Tuna Conference Coordinator

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Robin Leslie Allen
June 4, 1943 - March 18, 2015

Tribute to Dr. Robin Allen

Dr. Robin Allen, Director of the Inter-American Tropical Tuna Commission (IATTC), passed away in Blenheim, New Zealand, with his family at his side, on March 18, 2015.

Robin was first hired by the IATTC on February 16, 1976, to work on standardization of fishing effort, a task for which his brilliant quantitative skills were well suited. The IATTC's responsibilities were broadened in 1976 to address the contentious problems arising from the incidental mortality in tuna purse seines of dolphins that associate with tunas in the eastern Pacific Ocean and Robin was appointed as head of the newly-established Tuna-Dolphin Program in 1977. He recruited a young and energetic staff for the Program—a mix of biologists with keen quantitative skills and solid field experience. He and his staff built the basis for an observer program that was ultimately to become the finest in the world. He was also a hands-on biologist who led his team at sea aboard the purse seiner Gina Anne to ground-truth the accuracy of observer estimates dolphin herd size. It was on this cruise that his team found that Robin was a scientist in everything he did—the first research he conducted was in our cabin to find just the right closet that would provide just the right temperature to properly store a New Zealander's beer.

He served in that capacity until July 3, 1981, after which he returned to his native New Zealand to accept a position there. He then returned to the IATTC in 1995, and served as Assistant Director, under Dr. James Joseph, from July 24, 1995, to June 30, 1999. When Dr. Joseph retired on June 30, 1999, Robin succeeded him as Director on July 1, 1999. He continued in that position until September 19, 2007, after which he retired to his native New Zealand. He was succeeded on September 20, 2007, by Dr. Guillermo A. Compeán, the IATTC's present Director.

Important changes in the IATTC took place during Robin's tenure as Director. One was the adoption of rights-based management. Dr. Allen was co-editor of a book, "Conservation and Management of Transnational Tuna Fisheries," which devoted about half of its content to rights-based management. In addition, he was lead author of a chapter on rights-based management in world tuna fisheries in another book, sole author of an FAO Technical Paper on international management of tuna fisheries, and author of numerous high-quality papers, mostly on quantitative aspects of dolphin and tuna management. It was also during his tenure that long and hard work turned the Agreement for the International Dolphin Conservation Program from a paper construct to a fully-functioning program. Robin encouraged the great strides that were made in ecosystem research, tuna tagging, early life history research, stock assessment, and bycatch management.

Robin was a true gentleman. Management of a fishery that includes vessels registered in numerous nations, some highly developed and others less so, several different types of gear, and effort directed at different species and sizes of fish is not easy. Even more difficult is balancing the different goals of commercial and recreational fishermen, vessel owners, processors, and environmentalists. He listened intently to the positions of all these groups, and then recommended the best course of action and explained why he had made those recommendations. The representatives of the various groups knew that he wanted to do the right thing, and he was well respected for his integrity and fairness.

The Commission's staff appreciated Robin's patient leadership and quiet humor, his interest and curiosity about everything and everybody around him, and for the atmosphere he created for doing science. He encouraged and challenged the staff to take on projects that asked interesting questions, not just for management, but to improve our biological understanding of the ecosystem we were working with. By doing so, he continued to build the international reputation of the Commission and its scientists. The expertise of the Commission scientists is highly sought after, and heavily involved in cooperative research programs around the world. Lastly, he has been extraordinarily kind and open to everybody. His door was always open, and he was always ready to listen.

Robin served as Chairman of the 28th Tuna Conference, held at Lake Arrowhead in October 1977.

W. Bayliff and M. Scott, La Jolla, April, 2015

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AGENDA

66th Tuna Conference

Monday, 18 May 2015

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

13:30 Welcome and Introduction (Pineview)

SESSION 1: Bluefin Tuna (Moderator: Kurt Schaefer)

13:40 Synopsis of mixing levels of Atlantic bluefin tuna estimated from otolith stable isotope composition analysis, 2005 – 2014. **David H. Secor** and Jay R. Rooker

14:00 French Bluefin tuna fisheries in the Mediterranean Sea: Lessons from the past. **Bertrand Wendling**, François Poisson, Delphine Cornella, and Sophie Arnaud Haond.

14:20 Preferred habitat of juvenile southern bluefin tuna in the Great Australian Bight. **J. Paige Eveson,** A. Hobday, J. Hartog, T. Patterson, M. Basson, K. Rough, and C. Spillman.

14:40 Exploring movement and behavior of southern bluefin tuna caught and released at coastal areas around southeast Australia. **Sean Tracey**, Todd Lindstrom, Klaas Hartmann, Roger Hill, and Jaime McAllister.

15:00 Break (30-minutes)

15:30 Potential impacts of minimum weight regulations for Pacific bluefin tuna (*Thunnus orientalis*). **Lisa E. Ailloud***, Todd Gedamke, and John M. Hoenig.

*ADMB Scholarship/International Seafood Sustainability Foundation Travel Award winner

15:50 Historical effects of fishing on age structure and stock mixing in northwest Atlantic bluefin tuna fisheries. **Matt Siskey*** and David Secor.

*Tuna Conference Scholarship/International Seafood Sustainability Foundation Travel Award winner

16:10 A multistate model for survival and migration rates of juvenile southern bluefin tuna fitted to tag recovery and catch data. **Mark Chambers**, Leesa Sidhu, and Ben O'Neill.

16:30 Population Genomics of Large Pelagic Fishes, Including Tunas and Sharks. Píndaro Díaz-Jaimes, **Natalia Bayona-Vásquez**, Manuel Uribe-Alcocer

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

20:30 San Pedro - Terminal Island Tuna History Project (video trailer to the film). Craig Heberer and David Itano

Tuesday, 19 May 2015

8:00 Breakfast

SESSION 2: Putting the Pieces Together (Moderator: David Secor)

9:00 Just a FAD? Integrating ecology, biology, and fisheries to assess ecosystem impacts of tuna purse seine fishing on floating objects in the western Pacific Ocean. **Shane P. Griffiths**, Valerie Allain, Simon Nicol, Simon Hoyle and Tim Lawson.

9:20 Putting the RFMO reporting pieces together: Integrating HMS data from multiple fisheries guided by value stream mapping. **Jenny Suter**, John Childers, Karen Sender, Valerie Chan, and Keith Bigelow.

9:40 Setting and enforcing total allowable catches could lead to rebuilding of tuna and billfish stocks. **Maite Pons***, Ray Hilborn, Trevor Branch, Mike Melnychuk, and Olaf Jensen.

*Manuel Caboz Memorial Scholarship/International S Sustainability Foundation Travel Award winner

10:00 Estimating tuna growth: more difficult than it appears. **Mark N. Maunder** and Paul Crone.

10:20 Coffee Break (30-minutes)

10:50 Novel methods for abundance estimates and their use in stock assessment models and management procedures. **Ann Preece**, Campbell Davies, Mark Bravington, Rich Hillary, Paige Eveson, and Peter Grewe.

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11:10 One hook, one line, one fish at a time; tuna pole-and-line fishing in the 21st Century. **David Itano**.

11:30 The problem of illegal, unreported, and unregulated fishing in Somalia and what the international tuna community can do about it. **Sarah M. Glaser**.

12:00 Lunch

SESSION 3: Tropical Tunas and Swordfish (Moderator: Suzanne Kohin)

13:10 Purse-seine catch distributions and movements of bigeye tuna, relevant to their conservation in the IATTC convention area. **Kurt M. Schaefer**.

13:30 Bigeye tuna (*Thunnus obesus*) in the equatorial central Pacific Ocean: defining vertical movement, behavior, and habitat. **Daniel W. Fuller**, Kurt M. Schaefer, John Hampton, Sylvain Caillot, Bruno M. Leroy, and David G. Itano.

13:50 Fisheries for yellowfin tuna in Hawaii. **Russell Ito**.

14:10 Diel changes in the catch rates of tuna in the Gulf of Mexico pelagic longline fishery. **Daniel G. Foster**, Eric S. Orbesen, Charlie E. Bergmann, Lee Saxon, Adam G. Pollack, and Eric R. Hofmayer.

14:30 Coffee Break (30 minutes)

15:00 Pacific swordfish stock structure: Will we ever know enough? **Michael G Hinton**, Ching-Ping Lu, and Jaime Alvarado-Bremer.

15:20 Utilization of otolith chemistry to examine swordfish *(Xiphias gladius*) connectivity throughout the North Pacific Ocean. **Veronica A. Quesnell***, R. J. David Wells, Jay R. Rooker, H. Dewar, and Robert Humphreys.

*Desert Star Systems LLC Scholarship/International Seafood Sustainability Foundation Travel Award winner

15:40 Movements of the swordfish *Xiphias gladius* within the Pacific Leatherback Conservation Area. Chugey A. Sepulveda, **Scott A. Aalbers**, Craig Heberer, Suzy Kohin and Heidi Dewar.

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16:00 Exploring alternative fishery options for U.S. west coast swordfish. **Chugey A. Sepulveda**, Scott Aalbers, and Craig Heberer.

POSTER SESSION (with sushi) – Sashimi donated by Prime Time Seafood, Inc. and refreshments by Wildlife Computers

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16:30 Temporal effects of climate and regional scale variability on the abundance of albacore in the eastern North Pacific Ocean. **A. Jason Phillips**, Lorenzo Ciannelli, William G. Pearcy, and Richard D. Brodeur.

Current Management for Bluefin Tuna in California. **Alex Kesaris**.

Using genetic and genomic tools to piece together the population dynamics and the early-life development of the coastal pelagic species, *Seriola dorsalis*. **Catherine Purcell**, Andrew Severin, Kevin Stuart, Mark Drawbridge, and John Hyde.

Natural tracers reveal population structure of albacore (*Thunnus alalunga*) in the eastern North Pacific Ocean. **R. J. David Wells**, Michael J. Kinney, Suzanne Kohin, Heidi Dewar, Jay R. Rooker, and Owyn E. Snodgrass.

Stress physiology and post-release mortality rates of eight species of coastal shark after longline capture. **Heather Marshall**, Connor White, Karissa Lear, Robert Hueter, Greg Skomal, and Nick Whitney.

Comparison of bycatch, economic and production metrics across U.S. fisheries targeting tuna and swordfish. Heidi Gjertsen, Stephen Stohs, **Heidi Dewar**, Chugey Sepulveda, Scott Aalbers, and Craig Heberer

Feeding ecology of coastal sharks in the northwest Gulf of Mexico. **Jeffrey D. Plumlee** and R. J. David Wells

A Tale of Three Tails: Cryptic Speciation in a Globally Distributed Marine Fish of the Genus *Seriola*. Natalie Martinez-Takeshita, Catherine M. Purcell, Chris L. Chabot, Matthew T. Craig, Corinne N. Paterson, **John R. Hyde**, and Larry G. Allen.

Organochlorine Contaminants in Scalloped Hammerhead Sharks from the US Atlantic. **Kady Lyons** and Douglas H. Adams

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Reproductive biology of wahoo (*Acanthocybium solandri*) in the Galapagos Marine Reserve. **Isabel Haro-Bilbao**, Pelayo Salinas-de-León, Mitchell T. Zischke, and Ian R. Tibbetts.

Sustainable swimming speed and metabolic rate as indicators of fitness in aquaculture-raised California yellowtail, *Seriola dorsalis*. **Nicholas C. Wegner** and John R. Hyde.

Morphological discrimination between the dorsal-fin spines of the striped marlin *Kajikia audax*: reducing biases in age and growth estimations. Ulianov Jakes-Cota, Nancy E. Ruíz-Pérez, Rubén Rodríguez-Sánchez, and **Sofía Ortega-García**.

Ecological risk assessment of large migratory species in the western and central Pacific Ocean. **Chi-Lu Sun**, Po-Yuan Chen, Nan-Jay Su, Su-Zan Yeh.

Balancing growth and water quality in captive Bluefin (*Thunnus orientalis*) and yellowfin tuna (*Thunnus alabacares*). **Ian Rowbotham**, Chuck Farwell, and Alex Norton

Oxytetracycline age validation of an adult shortfin mako after six years at liberty. **Michael J. Kinney**, R. J. David Wells, Suzanne Kohin

Wednesday, 20 May 2015

8:00 Breakfast

SESSION 4: Environment, Climate, and Early Life History (Moderator: Mike Laurs)

9:00 Another piece to add: Empirical measurement of ambient oxygen from free swimming fishes. **Kim Holland**, Daniel Coffey, and Todd Lindstrom.

9:20 Increased detectability reveals climate-induced distribution shift in a mobile pelagic predator. **Nicholas Hill**, Andrew Tobin, Thomas Bridge, April Reside, and Julian Pepperell

9:40 Environmental preferences of tuna and non-tuna species associated with drifting fish aggregating devices (DFADs) in the Atlantic Ocean, ascertained through fishers' echo-sounder buoys . **Jon Lopez***, Gala Moreno, Cleridy Lennert-Cody, Mark Maunder, Igor Sancristobal, Ainhoa Caballero, Laurent Dagorn.

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*Margarita Tomlinson Scholarship/International Seafood Sustainability Foundation Travel Award winner

10:00 Variation of Sailfish (*Istiophorus platypterus*) catch rates and the influence of some environmental variables in the mouth of the Gulf of California. **Fátima Gisela Medina Jasso**, Sofía Ortega-García, and Raúl Octavio Martínez-Rincón.

10:20 Coffee Break (30-minutes)

10:50 Effects of environmental factors on the spatio-temporal distribution of dolphinfish catch rates off Cabo San Lucas, Baja California Sur, Mexico. **Hideki Yoshida-Hernández**, Sofía Ortega-García, and Raúl O. Martínez-Rincón.

11:10 Studies of tuna early life history conducted at the IATTC's Achotines Laboratory, 2014 – 2015. **Daniel Margulies**, Vernon Scholey, Jeanne Wexler, and Maria Stein

11:30 An update on comparative studies of growth and feeding dynamics of yellowfin (*Thunnus albacares*) and Pacific bluefin (*Thunnus orientalis*) larvae. **Maria Stein**, Daniel Margulies, Jeanne Wexler, Vernon Scholey, Susana Cusatti, Yang-Su Kim, Tomoki Honryo, and Yoshifumi Sawada

12:00 Lunch

SESSION 5: Bycatch (Moderator: Heidi Dewar)

13:10 Estimating bycatch of Chinese longline fishery using observer data. **Jiangfeng Zhu**, Xiaojie Dai, and Chen Yan.

13:30 Bycatch monitoring programme of the French Bluefin tuna longline fleet. **François Poisson**, Sophie Arnaud Haond, Hervé Demarq, Delphine Cornella, and Bertrand Wendling.

13:50 Spatio-temporal distribution of whale sharks (*Rhincodon typus*) caught by the tuna purse-seine fishery in the eastern Pacific Ocean. **Marlon H. Roman**.

14:10 The great white shark (*Carcharodon carcharias*) in Mexican waters: Its use, management and conservation. **Oscar Sosa-Nishizaki**.

14:30 Identification of Bull Shark nursery areas using vertebral chemistry. **Thomas C. TinHan**, R. J. David Wells, and Jay R. Rooker.

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14:50 Coffee Break (30-Minutes)

15:20 Business Meeting

16:00 Interactive demonstration of Wildlife Computers' new cloud-based WCPortal and the introduction of the GPE3 Location Probability Estimator software.

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

Frontier Village – Campfire and Social

Thursday, 21 May 2015

8:00 Breakfast

SESSION 6: Random Associations (Moderator: John Hyde)

9:00 Tunas and billfishes of the world. **Bruce B. Collette**, John E. Graves, and Valerie A. Kells

9:20 Genomic analysis of populations structure of yellowfin tuna (*Thunnus albacares*) at the global scale. **Carlo Pecoraro***, E. Chassot, A. Cariani, P. Grewe, F. Tinti, and Nathalie Bodin.

*John Tomlinson Scholarship/International Seafood Sustainability Foundation Travel Award winner

9:40 A species on the move: current understanding of white marlin genetic population structure. **Nadya Mamoozadeh**, Jan McDowell, and John Graves.

10:00 Thermal effects on aerobic muscle function in a deep-diving teleost and shark. **Ashley A. Stoehr***, Jeanine M. Donley, Scott A. Aalbers, Doug A. Syme, Chugey A. Sepulveda, and Diego Bernal.

*Wildlife Computers Scholarship/International Seafood Sustainability Foundation Travel Award winner

10:20 Coffee Break (20 mins)

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10:40 Age, growth, and length-weight Relationship of roosterfish (*Nematistius pectoralis*) in the Eastern Pacific Ocean. **Sofía Ortega-García**, Chugey Sepulveda, Scott Aalbers, Ulianov Jakes-Cota, and Rubén Rodríguez-Sánchez.

11:00 Otolith morphology of four mackerel species (*Scomberomorus* spp.) in Australia: species differentiation and prediction for fisheries monitoring and assessment. **Mitchell Zischke**, Lenore Litherland, Benjamin Tilyard, Nicholas Stratford, Ebony Jones, and You-Gan Wang.

11:20 Variation in feeding ecology and migration in striped marlin (*Kajikia audax*) off Cabo San Lucas, Baja California Sur, Mexico. **Tatiana A. Acosta-Pachon**, Sofia Ortega-García, and Brittany S. Graham.

11:40 Global Population Genetics of Dolphinfish (*Coryphaena hippurus*). **Natalia Bayona-Vásquez**, Píndaro Díaz-Jaimes, Manuel Uribe-Alcocer

12:00 Lunch

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Abstracts

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VARIATION IN FEEDING ECOLOGY AND MIGRATION IN STRIPED MARLIN (*Kajikia audax*) OFF CABO SAN LUCAS, BAJA CALIFORNIA SUR, MEXICO

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Investigating the feeding ecology and migration of top predators is critical to understand their role in food webs and monitor the effect of fisheries on food webs dynamics. However, little is known about the early life history of many migratory species, including striped marlin (*Kajikia audax*). Although the striped marlin is a commercially important species, there is currently no information about food habits throughout their life. To investigate potential ontogenetic changes in diet and/or movement of striped marlin, we compare stable isotope analysis of both muscle and annual growth rings in dorsal fin spines to investigate ontogenetic shifts in diet or movement of striped marlin caught off Cabo San Lucas, Mexico (CSL). We used dorsal spines to determine age and quantified stable isotope ratios of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) in each annual growth ring deposited in dorsal fin spines. We constructed retrospective isotopic profiles to detect any significant isotopic changes across ontogeny. We also compared patterns between individuals to investigate the possibility of individuals with different migratory histories aggregate off CSL. We found no relationship between marlin size (lower jaw fork length; LJFL) and $\delta^{15}N$ isotopic values in either tissue. Differences in mean $\delta^{15}N$ mean values across age classes were not significant and variation of $\delta^{15}N$ through life was less than 2‰. However, mean $\delta^{15}N$ between individuals varied by up to 6‰. $\delta^{13}C$ values increased as a function of age, and mean $\delta^{13}C$ significantly varied between age classes.

The lack of a trend between $\delta^{15}N$ isotopic values and LJFL suggests the possibility of a consistent trophic level for striped marlin throughout ontogeny; this is supported by a lack of significant difference in $\delta^{15}N$ values across age classes, as well as no change in food items from juveniles to adult stages, determined in previous stomach content studies. It should however be noted that migrations can mask a trophic shift. However, the difference (up to 6‰) in mean $\delta^{15}N$ between individuals suggests that striped marlin at CSL have mixed migratory histories, confirmed by previously satellite tags studies. $\delta^{13}C$ in dorsal fin spines increased as a function of age, potentially reflecting an ontogenetic shift in habitat and foraging location; based on known geographical gradients in $\delta^{13}C$, juveniles may reside and feed in offshore oceanic waters while adults spend more time in inshore waters. The challenge is differentiating between patterns associated with trophic shifts and migrations. Although, it would be unusual for a fish's diet not to expand with size, some studies using stable isotopes in white shark, also reveal no changes in calculated trophic position of juvenile and adult. Observed differences between isotopic values of muscle and dorsal fin spines are likely a result of the different biochemical composition of each tissue and different isotopic turnover times between tissues. The use of fin spines to construct retrospective isotopic histories can be used to investigate trophic dynamics and migratory histories of other pelagic species, for which population dynamics are often poorly known.

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POTENTIAL IMPACTS OF MINIMUM WEIGHT REGULATIONS FOR PACIFIC BLUEFIN TUNA *(Thunnus orientalis)*

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Simulation was used to estimate the first-order effects on yield, total biomass, and spawning stock biomass for five minimum weight restrictions on the Pacific bluefin tuna fishery. The projections included five levels of tolerated catch below the minimum size limit for a total of 25 management scenario evaluations. Data from the 2012 Pacific bluefin tuna assessment were used to populate the simulations and the most recent five-year averages for fishing mortality-at-age and numbers-at-age were used as the starting point and reference period for the projections. In all scenarios explored, substantial long-term increases in biomass and yield were predicted. The simulations suggest that the maximum yield per recruit occurs at a minimum weight of around 20 kg and a doubling of yield and an order of magnitude increase in spawning stock biomass are theoretically possible. Short-term losses in yield are evident for one to three years following implementation depending on the scenario. The results represented a best-case scenario and what might happen given the assumptions of the model with perfect implementation and no transfer of effort. Thus assumptions on growth, recruitment and transfer of effort were relaxed to make the simulation more realistic. The ultimate goals of this study are to explore the short term vs. long term trade-offs of a phased in management strategy, and determine an optimal management strategy whereby minimum size can be increased gradually as biomass rebuilds to minimize short term losses in yield.

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Global Population Genetics of Dolphinfish (*Coryphaena hippurus*)

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Genetic differentiation for pelagic fish in the marine realm is controversial. Particularly in highly mobile species, with large population sizes and therefore high genetic diversity levels, which usually hide the population genetic structure signal. Dolphinfish (*Coryphaena hippurus*) is an epipelagic, widely distributed and highly mobile fish. Nevertheless, its population structure and connectivity is poorly understood.

This study attempted to use molecular techniques to assess the spatial pattern of genetic diversity and connectivity of populations among ocean basins, in order to understand the species' population genetic structure at a global scale. Nineteen microsatellite loci were isolated and twenty four were genotyped in 725 samples from different locations worldwide, including the Mediterranean Sea. The genetic diversity was high with a mean observed heterocigozity of 0.815. The F-statistic estimates suggested a slight but significant divergence among ocean basins (F_{ST} = 0.006, p=0.002).

The observed pattern is similar to what has been observed in other pelagic fish, where there has been reported divergence between the Indo-Pacific and Atlantic besides a highly significant differentiation between the Atlantic and Mediterranean populations. Nevertheless, some extent of differentiations was also observed within Ocean basins, predominately within the Eastern Pacific Ocean, and between East and West Atlantic.

This spatial pattern is attributed first to geological and paleo-climate processes that originated the continental lands separating the main ocean basins, which restricted the distribution and the species´ movement by the decrease of surface ocean temperature during Pleistocene glaciations. But also, this recent divergence may arise due to ecological features as site fidelity and limited movements related with oceanographic characteristics such as currents and front sea water masses.

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A MULTISTATE MODEL FOR SURVIVAL AND MIGRATION RATES OF JUVENILE SOUTHERN BLUEFIN TUNA FITTED TO TAG RECOVERY AND CATCH DATA

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Large scale tagging studies of southern bluefin tuna (SBT, *Thunnus maccoyii*) were run during the 1990s and 2000s. The studies incorporated a `Brownie' design which, given certain assumptions, allows juvenile survival rates to be estimated from the tag recovery data. Recoveries from the 1990s study were analysed by Polacheck et al. (2006, Can. J. Fish. Aquat. Sci 63: 534-548) who used catch-at-age data in an integrated model to infer the population size of cohorts at age 1 as well as juvenile survival rates of the same cohorts. The data from the 1990s study strongly influence estimates of natural mortality of juvenile SBT within the global stock assessment of SBT. By contrast, attempts to fit recoveries from the 2000s study to the model described by Polacheck et al. (2006) have been unsuccessful. In particular, differences in recovery rates between one-year-olds tagged off Western Australia (WA) and one-year-olds tagged off South Australia (SA) suggest a key assumption of the standard Brownie tag recovery model, that of homoogeneous recovery probabilities within strata, was violated. Recoveries from the 2000s study imply either a large proportion of juveniles were not resident in the Great Australian Bight over summer during the 2000s, or alternatively, juvenile natural mortality was consistently higher off WA than off SA over the same period. The nature of the recoveries from the 2000s study has meant these data are not currently used in the global stock assessment for SBT. We fit a multistate Brownie tag-recovery model to tag recoveries from the 1990s and 2000s tagging studies to investigate differences in the behaviour of juveniles belonging to cohorts covered by these two studies. Influenced by previous work, we augment the tag recovery data with estimates of catch-at-age from the Australian surface fishery. As a minor extension, we also integrate binomial and multinomial models for recaptures by scientists on tagging cruises. By permitting separate recovery probabilities for juveniles tagged in WA and SA, we estimate migration rates of one and two year olds from WA to SA allowing for permanent emigration from southern Australia. We also provide updated estimates of natural mortality and cohort size accounting for incomplete juvenile migration to the Great Australian Bight. We caution that the results should be considered preliminary until further model testing and exploration are carried out.

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TUNAS AND BILLFISHES OF THE WORLD

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Tunas and mackerels (family Scombridae) and billfishes (families Xiphiidae and Istiophoridae) comprise 61 species of epipelagic (surface-dwelling) fishes. Many of the species are important for commercial and/or recreational fisheries. They display marvelous adaptations to their epipelagic life which are of great interest to evolutionary biologists and ecologists. While there are many publications that focus on different aspects of their commercial and recreational value, their unique morphological adaptations, or the threats they face, up to now there has been no single source that contains comprehensive, inclusive, and up-to-date information on all 61 species. This book, to be published by Johns Hopkins Press, will contain accurate color illustrations of all the species, keys to their identification, distinguishing characters, distribution maps, biology (food, reproduction, predators and parasites), fisheries interests, and threats to their survival. The first author, Bruce Collette, is a Senior Scientist with the National Marine Fisheries Services and Chair of the Tuna and Billfish Specialist Group of the International Union for the Conservation of Nature and whose 55 year career has focused on the anatomy, taxonomy, and evolution of these fishes. The second author, John Graves, is Chairman of Fisheries Science at the Virginia Institute of Marine Science where he has dealt with genetics and population biology of many species of tunas and billfishes. The third author, Val Kells, is an accomplished marine science illustrator known for the accuracy and beauty of her illustrations. Much of the information on morphology comes from the FAO species catalogs on Scombridae and billfishes. Some of the information on biology, fisheries, and threat status comes from the IUCN Red List accounts of these species. Recently published material is being added and we are eager to receive new information on any of the tunas and billfishes.

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Population Genomics of Large Pelagic Fishes, Including Tunas and Sharks

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Pelagic fish species are the most exploited organisms in wildlife. A deeper knowledge of the natural history and biological features is a priority to delineate appropriate policies for conservation and management strategies.

In the last decades, molecular techniques have contributed to answer questions regarding the evolution and ecology of marine species, where the difficulty of direct observation is a major challenge. Besides, because some features of pelagic fishes, such as large population sizes, it is common to obtain high genetic diversity estimations that reduce the possibility of detecting significant estimations of genetic differentiation measures. For this reason, the detection of population units is a more complex task.

Thanks to the arising of new sequencing techniques and to the improvement of bioinformatics analyses, nowadays it is possible to address population questions about marine fishes with the analysis of a wider coverage of non-model species genome, which allows the scanning of a large set of molecular markers. This robust analysis permits a better understanding of the genetic patterns and even allows to make the distinction between neutral and adaptive variation.

In the Laboratorio de Genética de Organismos Acuáticos at UNAM, we have been applying RAD-Seq and mitogenomic techniques to address population genetic studies, as well as phylogenetic analyses, of large pelagic marine teleost fishes such as yellowfin tuna, dolphinfish, and also for some shark species such as hammerheads, bull sharks and bonnetheads. Our results will set the basis to address questions about their genetic population structure.

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PREFERRED HABITAT OF JUVENILE SOUTHERN BLUEFIN TUNA IN THE GREAT AUSTRALIAN BIGHT

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Large numbers of juvenile southern bluefin tuna (SBT) are found in the Great Australian Bight (GAB) during the austral summer, where they are caught in a valuable purse seine fishery. In recent fishing seasons, unexpected changes in the distribution of SBT were observed, which affected the timing and location of fishing activity and contributed to economic pressure. In this study, data from a large-scale archival tagging experiment conducted on juvenile SBT were used to investigate their habitat preferences in the GAB. This involved first estimating the most probable track of each fish from the light and temperature data on the returned archival tags (done using an in-house geolocation method), then comparing environmental observations for the entire GAB with observations at locations where fish were found to see if fish were concentrated within given ranges (indicating preferred habitat) or randomly distributed (no habitat preference). Both sea surface temperature (SST) and chlorophyll *a* were found to influence the distribution of SBT. Once habitat preferences were established, maps of the GAB could be produced showing regions of preferred SBT habitat for specified time periods. In addition, seasonal forecasts of SST produced by the Australian Bureau of Meteorology's Predictive Ocean Atmosphere Model for Australia (POAMA) were used to predict regions of preferred SBT habitat in the GAB up to two months in future. Because POAMA is strictly a physical model and does not simulate chlorophyll levels, only SST data could be included in the habitat forecasts. These habitat forecasts are being used by members of the purse-seine industry to help plan fishing operations. As the fishery is managed under a quota system, this information does not lead to increased catches, but should improve economic efficiency of the industry.

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DIEL CHANGES IN THE CATCH RATES OF TUNA IN THE GULF OF MEXICO PELAGIC LONGLINE FISHERY

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Hook timers (HTRs), temperature and depth recorders (TDRs) and pop-up satellite archival tags (PSAT) were deployed during fishery dependent experiments conducted in the Gulf of Mexico (GOM) pelagic longline fishery in 2005 and 2012. An analysis was conducted to describe the diel changes in the catch per unit effort (CPUE) of targeted yellowfin tuna *Thunnus albacares* and bycatch species, and to explore potential methods to reduce bycatch in the fishery. Bluefin tuna *Thunnus thynnus* bycatch in this fishery has been identified as a major source of fishing mortality in the western Atlantic bluefin tuna spawning grounds. During the 225 sets made, 1,132 yellowfin and 53 bluefin tunas were caught on hooks with HTRs, which revealed that 98% of yellowfin and 100% of bluefin tuna were hooked during either the daylight or twilight periods. HTR and hook effort data were used to estimate CPUEs for 16 time bins, eight daytime and eight night bins, standardized by sunrise and sunset times. The highest catch rates for yellowfin tuna were observed during the daytime periods just after sunrise and prior to sunset, with the lowest daytime CPUEs occurring around solar noon. In contrast, the highest catch rates for bluefin tuna occurred after solar noon. Yellowfin tuna catch rates were compared to data obtained from nine yellowfin tuna equipped with PSATs and a significant correlation was found between diel changes in catch rates and vertical behavior.

The distribution of bite depths for 167 yellowfin tuna, obtained from TDRs, indicates that bites primarily occurred on hooks that were in the deeper portion of the hook distribution. Calculations of CPUE by depth show that the highest catch rates occurred at depths greater than 100 m. A comparison of vertical CPUEs and depth utilization (PSAT data) suggests that yellowfin tuna could be more disposed to take baits during dives made below the mixed layer. Results of this study also suggest possible changes in fishing strategies that could lead to higher catch rates and improved quality of yellowfin tuna, while potentially reducing bluefin tuna bycatch in the GOM longline fishery.

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BIGEYE TUNA (*Thunnus obesus*) IN THE EQUATORIAL CENTRAL PACIFIC OCEAN: DEFINING VERTICAL MOVEMENT, BEHAVIOR, AND HABITAT

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Results presented are based on analyses of 8,217 days of time-series data, downloaded from 47 archival tags recovered from bigeye tuna (*Thunnus obesus*) released in the equatorial central Pacific Ocean. The analyses includes fish from 51–134 cm in length ($\bar{x}$ = 86.9 cm), 0.87–3.44 years of age ($\bar{x}$ = 1.89 years), that were at liberty from 36 to 851 days ($\bar{x}$ = 183 days). Evaluation of depth and temperature records resulted in the classification of three daily behavior types: characteristic, associative (associated with floating objects), and other. Proportions of time and average durations of behavioral events for three defined length classes, 54–79.9 cm, 80–99.9 cm, and 100–134 cm, are presented. The proportion of time and the durations of behavioral events, by fish length, are also compared. Spatial differences among average daily depths and temperatures for each behavior type, by fish length, and the apparent effects of environment, are also discussed.

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COMPARISON OF BYCATCH, ECONOMIC AND PRODUCTION METRICS ACROSS U. S. FISHERIES TARGETING TUNA AND SWORDFISH.

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Due to concerns about the dramatic reduction in vessels and landings by the California drift gillnet (DGN) swordfish fishery and the continuing interest in reducing bycatch, a number of research projects on alternative gear options to target swordfish are underway, including those on deep-set buoy gear (DSBG) and deep-set longlines (DSLL). In addition to field trials of two experimental gear types, a second important component of this research is to examine the gears in the broader context of all U.S. gears used to target swordfish and in some cases tuna. Project objectives include: 1) providing a more comprehensive view of bycatch in current and historic U.S. fisheries targeting primarily swordfish, 2) creating standardized metrics across fisheries to allow for more effective comparisons than just looking at bycatch numbers for individual fisheries in isolation, 3) comparing measures of economic viability across fisheries, and 4) measuring the potential for commercial volume of harvest. Fisheries under comparison include California DGN, California DSLL targeting tuna, California harpoon, Hawaii shallow-set longline, Hawaii DSLL targeting tuna, Atlantic pelagic longline, and Atlantic buoy gear. We also examine the California shallow-set longline for a historical comparison of shallow-set longline swordfish fishery bycatch levels prior to the implementation of requirements to use circle hooks and finfish bait.

To compare bycatch across diverse taxonomic groups, marine mammals, turtles and seabirds documented by observers were separated into two categories; "high priority" protected species if they were ESA listed or considered a strategic stock and "other" if they were not. The total take for all species was estimated based on observer coverage and then divided into landings to calculate the landings per individual take for the two species categories. Economic metrics were calculated as the ex-vessel profit per vessel. The commercial volume metric was the calculated as the metric tons of landings across the fleet. The CA DSLL, harpoon and buoy gear fisheries had little to no bycatch for either species category. Overall, the California DGN had low catch of "high priority" protected species and compared favorably to the other fisheries in terms of overall bycatch, profitability and commercial volume. A comparison of all metrics will be presented.

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THE PROBLEM OF ILLEGAL, UNREPORTED, AND UNREGULATED FISHING IN SOMALIA AND WHAT THE INTERNATIONAL TUNA COMMUNITY CAN DO ABOUT IT

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Fisheries off the coast of Somalia are compromised by a lack of effective governance. During the 1980s, foreign investment in Somalia's fisheries, new fisheries legislation in Mogadishu, and development of fishing cooperatives along the coast signaled interest in and awareness of the potential for fisheries in Somalia. Unfortunately, the civil war and overthrow of the Siad Barre regime in 1991 resulted in complete anarchy regarding Somalia's fisheries. Not only did domestic infrastructure (including roads, boats, and refrigeration) rapidly deteriorate, but foreign fishing fleets took advantage of the chaos and lack of naval patrols to fish unabated in Somali waters. Illegal, unreported, and unregulated (IUU) fishing flourished, some of it attributable to foreign tuna boats flagged to members of the Indian Ocean Tuna Commission (IOTC). Between 2000 and 2006, however, tuna fishing in Somali waters declined precipitously as the threat of pirate attacks deterred many fishing boats. Today, as the threat of piracy declines and the Somali Federal Government initiates a new foreign vessel licensing scheme, there is an important opportunity for the international community to support sustainable development of Somali fisheries.

To date, estimates of illegal fishing in Somali waters have been anecdotal and the scale and composition of fish catch has been unknown. Somali fishers report declining catches, physical damage to reefs from foreign trawlers, and crowding-out from larger, more sophisticated foreign fleets. Here, I present reconstructions of fish catch from both the Somali domestic fishery and the foreign fleets fishing in Somali waters. Tuna and tuna-like species make up an important component of this catch. Additionally, sustainability analysis shows that many targeted fisheries (especially sharks) are overfished at current levels. In the context of on-going civl conflict, terrorism from Al-Shabab, and a de-centralized approach to fisheries management, the international community should support the sustainable development of Somali fisheries in both direct and indirect ways. Directly, we should provide funds, training, and infrastructure to assist in building fisheries that provide jobs, income, and food. Additionally, we should support a legal vessel licensing scheme and strong monitoring, control and surveillance capabilities. Indirectly, we should insist our own vessels respect the newly-declared (2014) Somali EEZ and refrain from illegal and disruptive fishing practices until Somalia has the capacity to regulate fishing in its waters. Ultimately, in order for Somalis to develop profitable and sustainable fisheries for their own livelihoods, we need to ensure there are fish left to catch.

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JUST A FAD? INTEGRATING ECOLOGY, BIOLOGY AND FISHERIES TO ASSESS ECOSYSTEM IMPACTS OF TUNA PURSE SEINE FISHING ON FLOATING OBJECTS IN THE WESTERN PACIFIC OCEAN

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Fisheries that target predatory species occupying high trophic levels can have negative impacts on not only the target species, but the structure and functionality of the supporting ecosystem. Consequently, ecosystem-based fisheries management (EBFM) has become a desirable policy of many fisheries worldwide. The "Warm Pool" oceanographic province covers over 181 million km^2 of the Western Pacific Ocean and supports the largest and most valuable tuna fisheries in the world. These fisheries capture a range of high trophic level species using pelagic longline, pole-and-line, and purse seine either unassociated (PSU) or in association with floating objects (PSA). In recent years, the increased efficiency and catches of juvenile tunas made by the PSA fishery has raised concerns over the sustainability of bigeye, yellowfin and skipjack tunas. Furthermore, the increased PSA effort has increased the catch of non-target species (e.g. dolphinfish, wahoo and rainbow runner), for which new markets are being developed, but has raised concerns over the long-term sustainability of other less productive bycatch species such as pelagic sharks and billfish.

This paper describes the integration of regionally-specific ecological, biological and fisheries data into an Ecopath ecosystem model of the Warm Pool ecosystem to explore the potential ecological effects of PSA fishing. The model comprised 44 ecological functional groups and was calibrated to 111 time series of biomass, fishing mortality and catch data for 37 groups. Simulations investigated the potential impacts of fishery management strategies of changing the 2013 PSA effort by +/- 50% or 100% on the ecosystem structure and species biomass 10 and 30 years later.

Ecosystem indicators showed the ecosystem changed considerably since the early 1980s with an expansion of the fishery, increase in the mean trophic level of the catch and a decline in the biomass of higher trophic level (>3 TL) groups. Simulated changes to PSA effort generally resulted in modest changes (<20%) in the biomass of functional groups directly impacted by the fishery. There was little evidence that PSA fishing would cause significant disruption of the ecosystem integrity in the short term by causing trophic cascades, since the impacts of most fishery simulations did not propagate lower than a trophic level of 3. However, increases in PSA effort caused significant biomass declines in longer-lived bycatch species, namely Silky and White tip sharks. Interestingly, the biomass of potentially marketable bycatch species (e.g. wahoo, mahi) increased with increased PSA effort. This was because the predation mortality exerted by impacted shark and billfish species was greater than the fishing mortality. Therefore, this presents fishery managers with a complex trade-off where conservation and fishery objectives need to be balanced. These results demonstrate the value of ecosystem models for integrating ecological, biological, and fishery data to help disentangle some of the highly complex ecological interactions present in pelagic ecosystems. Consequently, these models can provide greater confidence in developing EBFM strategies that may achieve long-term ecological and fishery sustainability goals.

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REPRODUCTIVE BIOLOGY OF WAHOO (*Acanthocybium solandri*) IN THE GALAPAGOS MARINE RESERVE

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The wahoo, *Acanthocybium solandri* is a pelagic fish of high commercial value in the Tropical Eastern Pacific (TEP); however, a lack of life history information has hampered population assessments and fisheries management. This study presents the first available information on the reproductive biology of wahoo from the TEP, specifically the Galapagos Marine Reserve. A total of 156 female wahoo was collected by observers aboard the Galapagos artisanal fishing fleet during 2011-2013. Ovaries were both macroscopically and microscopically examined to estimate spawning seasonality and frequency, fecundity and size-at-maturity for females. Despite previous studies suggesting a prolonged spawning season throughout the year near the equator, a clear spawning season was identified in the warmer months (December to May), similar to results reported in the Atlantic and western Pacific Oceans. The similarity in reproductive biology of fish in those two regions and the Galapagos was also seen for size-at-maturity of females (L_{50} = 1070mm FL). Additional samples will be collected during December 2014-April 2015 to determine spawning frequency and total fecundity for the Galapagos wahoo population. This study will provide important information on the reproductive biology of wahoo in the Galapagos Marine Reserve that will be essential for monitoring and assessment of developing artisanal fisheries in the region.

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INCREASED DECTABILITY REVEALS CLIMATE-INDUCED DISTRIBUTION SHIFT IN A MOBILE PELAGIC PREDATOR

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Many taxa are undergoing rapid and substantial distribution shifts in response to anthropogenic climate change. For tunas and billfishes, data paucity and highly variable distributions have hampered detection of climate-induced distribution shifts. Although these species are known to be influenced by numerous environmental factors at fine scales, few studies investigating distribution shifts use appropriate spatio-temporal scales or explore factors other than temperature. Considering the ecological and commercial significance of these species, understanding their response to climate change is vital. Utilising a comprehensive citizen-science dataset, the aim of this study was to characterise the suitable habitat of an apex pelagic predator (black marlin, *Istiompax indica*) within the south-west Pacific Ocean (3-39^{o}S/142-180^{o}E) using high-resolution environmental data. Suitable habitat was modelled using narrow (monthly) time steps over a 16 year period (1998-2013) with a robust modelling technique (MaxEnt) to overcome inherent data limitations. Chlorophyll-a (47%) and sea surface height anomaly (30%) best explained the distribution of suitable habitat which varied at monthly, seasonal and inter-annual time scales. Inter-annual fluctuations correlated with Southern Oscillation Index, with suitable habitat penetrating further south (3^{o} latitude) during La Nina events. Regression analysis of monthly geometric mean points (n=196) revealed a significant poleward shift ($P<0.05$) in suitable habitat from 1998-2013 at a rapid rate of 7km/year. These findings demonstrate the benefit of using species distribution models fitted using narrow time steps and numerous environmental factors, enabling detection of a long-term shift in suitable habitat amidst substantial natural variability in a mobile marine species. With considerable change in the marine environment already documented, more studies of this nature are needed to aid in mitigating climate impacts and improving the adaptive capacity of fisheries management.

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PACIFIC SWORDFISH STOCK STRUCTURE: WILL WE EVER KNOW ENOUGH?

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Over the last three-plus decades stock assessments and research on swordfish in the Pacific have almost invariably included a statement along the lines of "The stock structure of swordfish in the Pacific Ocean is not well known." One might ask if this is a self-serving statement supporting calls for more research, -- a jobs bill for fisheries biologists and assessment scientists, so to speak. On the other hand, with perpetuation of highly valued fisheries at stake, is it forever out of reach, that point of practicality where enough is enough? We present a short history of the swordfish stock-structure "dilemma" faced by assessment scientists in the Pacific, results of our integrative approach to estimate geographical population structure, and dare we say for swordfish in the Pacific, the "ultimate" word on the subject?

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ANOTHER PIECE TO ADD: EMPIRICAL MEASUREMENT OF AMBIENT OXYGEN FROM FREE SWIMMING FISHES

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Ambient oxygen concentration is probably one of most important parameters in determining the limits of useable habitat for marine species. This is especially true for fishes with high metabolic rates such as billfishes and tunas. Not only does low oxygen limit the depths (and durations) to which fish can dive but may also be a factor in determining school size in active and schooling species such as tunas. Further, there is heightened awareness of expanding oxygen depleted zones in regions such as the Gulf of Mexico and Puget Sound and of the fact that oceanic oxygen profiles will probably alter in response to climate change. The precise lower limits of oxygen tolerance and of the impact of low oxygen on behavior has not been documented in the field because, to date, it has not been possible to empirically measure oxygen concentrations synchronously with the behavior of free ranging fishes. Here we present the results of the successful deployment of prototype pop-up and archiving satellite tags that measured *in situ* ocean oxygen levels while attached to two species of free-ranging sharks. In future, it should be feasible to adapt these methods for use on teleosts such as tuna and billfish, among others.

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ONE HOOK, ONE LINE, ONE FISH AT A TIME; TUNA POLE-AND-LINE FISHING IN THE 21ST CENTURY

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Early Polynesians hauled skipjack from the sea with hand crafted pearl shell lures that were handed down through generations. Japanese fishermen experienced with their own version of barbless hook skipjack fishing brought the technique to southern California in the early 1900s where the gear was soon adopted by Portuguese and Italian Americans. The size of bamboo poles and barbless "squids" quickly increased to handle large yellowfin tuna that supplied the US canned tuna industry for decades. The appearance of nylon net and modern purse seine gear signaled the end of the tuna clippers that quickly converted to seining. However, pockets of pole-and-line tuna fishing still exist, scattered across the globe where a favorable mix of tuna, baitfish, manpower and markets coincide. In recent years, pole-and-line caught tuna have been touted as an environmentally friendly product targeting specialty markets.

However, pole-and-line fisheries using wild-caught bait can impact coastal resources and can not supply the large volumes of tuna needed by the global canning industry. Non-profit organizations interested in promoting these fisheries offer technical assistance and outreach to minimize impacts to coastal ecosystems from live bait harvest and by assisting market demand for pole-and-line caught product. Contemporary pole-and-line fisheries, baitfish management issues, current challenges, future outlook and the role of eco-labeling and certification will be presented.

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FISHERIES FOR YELLOWFIN TUNA IN HAWAII

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Yellowfin tuna is an important species to fisheries and fish markets in Hawaii. This species ranked second in volume and value with 3.6 million pounds landed worth an estimated $12.5 million USD in 2013. Yellowfin tuna is a major component of the longline landings and is also targeted by the small boat troll and handline fisheries. There are distinct differences between fisheries including participation, their methods of capture and size of their respective catches of yellowfin tuna. Yellowfin tuna is a popular seafood product because fish markets can substitute this species of tuna for bigeye tuna since it has similar characteristics and can be prepared in a wide range of dishes ranging from high priced raw delicacies such as sashimi, poke to baking, grilling and frying for lower grades of fish. This presentation is an overview of Hawaii's fisheries for yellowfin tuna, description of the gear and fishing techniques, area of operation, annual catches, seasonality, size of catch, and recent developments such as the consideration of revising the State of Hawaii minimum size limit of 3 pounds.

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MORPHOLOGICAL DISCRIMINATION BETWEEN THE DORSAL FIN SPINES OF THE STRIPED MARLIN *Kajikia audax*: REDUCING BIASES IN AGE AND GROWTH ESTIMATIONS

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In billfish like striped marlin *Kajikia audax*, the fourth spine of the dorsal fin is the hard structure most suitable for age estimation. Preliminary analysis indicated that during field collection, inadvertently the fifth spine may be collected instead of the fourth, making it necessary to corroborate the anatomical position of each structure before performing aging studies. The aim of the present study is to show that there are morphological features in the basal zone of the fourth dorsal fin spine of striped marlin that allow us to distinguish its anatomical position, even when the structure is collected individually and is no longer part of the intact fin. We applied three different multivariate statistical methods for distinguishing between the fourth and fifth spines based on coordinates and linear measurements between homologous landmarks located in their basal zone, and we evaluated their effectiveness based on how well their results agreed with each other. A significant morphological discrimination between the fourth and fifth spines was achieved with the three methods, which were in agreement for 98.5% of classification cases. The distance between apophyses in the lower part of the basal zone (D2), the distance from the lower-right apophysis to the upper-left apohysis (D6) and their ratio (D6/D2) are the morphological characteristics that greatly contribute to the discrimination for both spines. These morphological characteristics were used to generate a key to help identify the anatomical position of the spines collected and thus ensure than only the correct structure is used in age and growth studies of the striped marlin. A D6/D2 ratio of greater than 0.79 corresponds to the fourth dorsal-fin spine.

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CURRENT MANAGEMENT FOR BLUEFIN TUNA IN CALIFORNIA

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While highly migratory species are federally managed under the West Coast HMS Fishery Management Plan, the State of California's Department of Fish and Wildlife (CDFW) contributes to management as members of the Pacific Fishery Management Council (Council), by monitoring California based commercial and recreational HMS fisheries, and through state regulation and management of California fisheries in conjunction and conformance with federal laws and policies.

Pacific bluefin tuna was recently declared overfished and international management recommendations called for reductions in all catch of Pacific bluefin by 20-45 percent of the 2002-2004 average catch across Inter American Tropical Tuna Commission (IATCC) treaty nations, Pacific wide. CDFW staff serving on the Council's Highly Migratory Species Management Team analyzed catch and effort data from California's Commercial Passenger Fishing Vessel (CPFV) logbooks and sampling data from the California Recreational Fisheries Survey of private boats. This analysis was the basis for options developed by the Management Team to reduce recreational take, leading to a Council decision to reduce the bag limit of sport catch of bluefin tuna from 10 fish to 2 fish per angler per trip, with a six fish possession limit for multi-day trips; this action is expected to reduce the sport catch of bluefin tuna by thirty percent.

CDFW biologists and enforcement staff also participated in several workshops with the CPFV industry, NOAA Fisheries, and IATTC to cooperatively determine methods of filleting sport caught tuna that allows for differentiation of tunas with higher bag limits from bluefin tuna.

The process of conforming California regulations to proposed changes in federal laws through the Fish and Game Commission began concurrently with Council decision-making in order to have state laws implemented concurrently with federal laws for recreational take. The new federal laws also have a semiannual reporting requirement for commercial and recreational take of bluefin as required by IATTC treaty agreement. ; Currently, logbooks submitted by CPFV operators have a six-week delay from fishing date to uploading to CDFW databases. CDFW staffs are investigating methods to improve real time catch tracking, and a pilot program of electronic log submission is currently being tested. The CDFW is also cooperating with Sportfishing Association of California (SAC) and NOAA Fisheries on an SAC-administered sampling plan intended to improve biological data collection for bluefin and other tuna species.

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OXYTETRACYCLINE AGE VALIDATION OF AN ADULT SHORTFIN MAKO AFTER SIX YEARS AT LIBERTY

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The age and growth of the shortfin mako (*Isurus oxyrinchus*) has been studied since the early 1980s but gaps in our knowledge of this basic area of their biology still remain. Fundamental aspects of age and growth, such as band pair periodicity, have been questioned in recent work, with indications that juvenile shortfin mako (< 200 cm fork length, FL) in the northeast Pacific undergo more rapid growth than previously thought, leading to a band pair deposition rate of two band pairs per year rather than the more common one band pair per year. Unfortunately, a lack of recaptured adult shortfin mako has resulted in uncertainty as to whether this band pair periodicity continues into adulthood (> 200 cm FL) or not. This work presents findings on the recapture of a large adult male shortfin mako in the waters off of southern California after six years at liberty. Our results support the hypothesis that male shortfin makos experience a change in band pair deposition rate at or near maturity from two band pairs per year to one band pair per year.

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ENVIRONMENTAL PREFERENCES OF TUNA AND NON-TUNA SPECIES ASSOCIATED WITH DRIFTING FISH AGGREGATING DEVICES (DFADS) IN THE ATLANTIC OCEAN, ASCERTAINED THROUGH FISHERS' ECHO-SOUNDER BUOYS

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Understanding the relationship between environmental variables and pelagic species concentrations and dynamics is important for proper fishery management. Drifting fish aggregating device (DFAD)-associated tuna and non-tuna biomass data from the fishers' echo-sounder buoys operating in the Atlantic Ocean have been modelled as functions of environmental (Sea Surface Temperature, Chlorophyll-a, Sea Level Anomaly, Thermocline depth and gradient, Geostrophic current, Total Current, Depth), spatial (Longitude and Latitude), temporal variables (Month) and DFAD-inherent characteristics (DFAD speed, bearing and soak time) using Generalized Additive Mixed Models (GAMMs). Social interaction (presence of a fish, by taxonomic category) was also included in the model, but not found to be significant at this time scale. All variables were included in the analyses but only some of them were highly significant, and variable significance differed among fish species and sizes. In general, most of the fish biomass distribution was explained by the spatial-temporal factors, DFAD-inherent characteristics, and ocean productivity. Indeed, this study revealed different spatial preferences for tunas and non-tuna species and suggested the existence of active habitat selection. This improved assessment of spatial, environmental, and gear effects on tuna and non-tuna catchability in the purse seine tuna fishery will contribute to transfer of better scientific advice to regional tuna commissions for the management and conservation of exploited resources.

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ORGANOCHLORINE CONTAMINANTS IN SCALLOPED HAMMERHEAD SHARKS FROM THE U.S. ATLANTIC

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Elasmobranchs have a propensity to accumulate high contaminant levels, especially in species that occupy upper trophic levels. However, contaminant concentrations and the types of contaminants that marine fishes accumulate can vary with species, age, sex and environmental parameters. Therefore, contaminant concentrations and signatures can be used as another tool for examining elasmobranch ecology. Scalloped hammerheads (*Sphyrna lewini*) are a tropical cosmopolitan species; however, little is known about their long-term movement patterns and habitat use. Organic contaminants (PCBs and chlorinated pesticides) were measured in livers of both females and males from several age classes that were collected from U.S. Atlantic waters, including two near-term pregnant females and their embryos. Adult female hammerheads (n = 3) were found to have lower levels of PCBs compared to the younger, adult male (mean ± SD, 11.1 ± 1.0 versus 22.8 μg g^{-1} lw), but had substantially higher concentrations of pesticides (4.1 ± 0.9 versus 1.9 μg g^{-1} lw). Differences in standardized contaminant concentrations were observed between the adult male and females, with males having greater proportions of more chlorinated PCB congeners. These differences could be due to the ability of females to offload contaminants to offspring as well as sexual segregation in habitat use. Results from future contaminant studies with increased sample sizes from different localities will further our understanding of scalloped hammerhead health and ecology and aid in effective conservation.

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A SPECIES ON THE MOVE: CURRENT UNDERSTANDING OF WHITE MARLIN GENETIC POPULATION STRUCTURE

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Marine fisheries managers are often concerned with the identification of management units that reflect the biological organization of a species. Population genetic studies are one tool traditionally used to identify populations that may warrant management as distinct units. Detection of genetic differentiation among populations is especially difficult for marine fishes, however, because a small amount of gene flow between populations can mask genetic heterogeneity. This is especially true for large pelagic fishes, whose broad distributions are facilitated by an environment that lacks apparent physical barriers to dispersal. Detection of genetic differentiation among populations of marine fishes can be enhanced by sampling designs that target putative populations when naturally separated in space and time, and by analyzing a large number of molecular markers that represent a greater portion of the genome. In this study, thirty nuclear-encoded microsatellite markers and the dloop mitochondrial gene region were analyzed for white marlin (*Kajikia albida*), a highly migratory, pelagic billfish (family Istiophoridae) distributed throughout temperate and tropical waters of the Atlantic Ocean. The number of microsatellite markers analyzed in this study provides significantly greater genomic coverage than in previous genetic analysis of white marlin population structure. While the null hypothesis of genetic homogeneity could not be rejected, statistically significant pairwise comparisons between samples from some geographic regions suggest spatial heterogeneity. A sampling design that incorporates information on spatio-temporal patterns of abundance to sample naturally separated populations of white marlin would greatly enhance the statistical power necessary to detect genetic differentiation. A clear understanding of white marlin population structure is essential to reduce significant uncertainties associated with the management of this species.

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STUDIES OF TUNA EARLY LIFE HISTORY CONDUCTED AT THE IATTC's ACHOTINES LABORATORY, 2014-2015

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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.

During 2014-2015, several ongoing investigations of yellowfin early life history were continued or completed. Study results were published on a collaborative study, funded by the Pelagic Fisheries Research Program (PFRP) and conducted with scientists of the Secretariat of the Pacific Community (SPC), Macquarie University, Australia and University of Gothenburg, Sweden, investigating the potential effects of ocean acidification (OA) on yellowfin early life stages. The experimental work for the project was conducted at the Achotines Laboratory. Results indicated some potential impacts (*e.g*. decreased survival and growth) of OA on egg and larval stages over a range of acidification scenarios, both near-future and far-future. In a complimentary histological study conducted as part of the same experiments, results indicate significant negative effects of OA on certain larval organ tissues after 5-7 days of feeding, with cellular damage most prominent in the liver, pancreas and kidney.

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 is 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). The project is being funded by the Japan International Cooperation Agency (JICA) and the Japan Science and Technology Agency (JST). Experimental results from 2011-2014 of comparative investigations of growth potential, starvation resistance, and feeding patterns of larvae of both species are reported in this meeting by Stein *et al*. We present summaries here of additional ongoing studies of embryonic and larval development, density effects on larval growth and genetic monitoring, as well as a description of the initial phases of ocean cage culture of juvenile yellowfin in waters near Achotines.

From 2012-2014, a study funded by California Sea Grant was initiated by the IATTC and the Hubbs Sea World Research Institute (HSWRI) to investigate the development of sustainable tuna aquaculture in the U.S. using yellowfin tuna as a model. The project included feasibility studies of air shipment of yellowfin eggs and larvae from Panama to San Diego, as well as rearing studies of yellowfin larvae in both Panama and San Diego. The project was completed in late 2014, and results of these trials will be presented.

Other activities during 2014 included the 12th annual workshop at the Achotines Laboratory on "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.

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STRESS PHYSIOLOGY AND POST-RELEASE MORTALITY RATES OF EIGHT SPECIES OF COASTAL SHARK AFTER LONGLINE CAPTURE

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The National Marine Fisheries Service recently released the Atlantic Highly Migratory Species Management-Based Research Needs and Priorities, with key research needs including establishing post-release mortality rates for commercially caught sharks. Such information is listed as *High Priority*, and very important in creating effective fisheries management plans for sharks targeted or caught as bycatch in commercial gear. For this project, the post-release mortality rates for eight species of shark (*Carcharhinus limbatus* n=59, *C. plumbeus* n=24, *C. brevipinna* n=20, *C. leucas* n=8, *C. acronotus* n=21, *Galeocerdo cuvier* n=40, *Sphyrna lewini* n=3, and *S. mokarran* n=2) were assessed after capture and release on commercial longline gear. Time-on-the-line (TOL), assessed with hook timers, ranged from 9-956 minutes. At-vessel mortality rates ranged from 0% (*G. cuvier* and *C. leucas*) to 100% (*S. mokarron*), showing clear interspecific differences. Acceleration data loggers (ADLs) were used to assess acute post-release mortality, with rates ranging from 0% (*S. lewini*, *G. cuvier*, and *C. leucas*) to 75% (*C. brevipinna*). Depending on the species, significant ($p<0.05$) changes in stress parameters were correlated with TOL, including lactate, potassium, chloride, magnesium, glucose, and pCO_2. The relatively large sample size obtained in this ongoing study highlights the efficacy of using relatively-inexpensive, re-usable ADLs to determine rates of post-release mortality.

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A TALE OF THREE TAILS: CRYPTIC SPECIATION IN A GLOBALLY DISTRIBUTED MARINE FISH OF THE GENUS *Seriola*

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Genetic data are increasingly being applied to re-evaluate past taxonomic hypotheses and better understand the evolutionary patterns and connectivity among regional populations of cosmopolitan species. This is of particular importance for heavily exploited, commercially important species. The phylogenetic structure of the Yellowtail Jack, *Seriola lalandi* Valenciennes, 1833, was investigated using genetic data from 42 individuals collected from California, the Pacific coast of Baja California (Mexico), the Gulf of California (Mexico), New Zealand, Japan, South Africa, and Chile. An analysis using *S. dumerili* as an outgroup and combining the sequences of two mitochondrial genes (CR and COI) and four nuclear genes (RAG2, EHHADH, UBE3A, MLL) was used to determine the level of genetic divergence among samples from different geographic regions. Bayesian and Maximum Likelihood analyses utilizing combined mitochondrial gene (mtDNA) or nuclear gene (nucDNA) data supported the existence of multiple regionally restricted clades with mtDNA analysis identifying four major clades and nucDNA supporting three. Both mtDNA and nucDNA trees were very similar in topology, which was reflected in the combined total evidence phylogram. These clades were highly supported with Bayesian posterior and bootstrap probabilities ranging from 90 to 100 percent for the three major clades that were recovered in both mtDNA and nucDNA trees. These clades represent regionally specific specimens collected from the 1) Northeast Pacific, 2) Northwest Pacific, and 3) Southern Hemisphere. Morphometric analysis (MDS and ANOSIM) of available meristic data on the number of soft dorsal-fin rays, anal-fin rays, and total number of gill rakers separated specimens among the three regions identified by genetic analysis ($P = 0.05$). Based on the phylogenetic structure within this taxonomic unit as evidenced by genetic data and significant meristic differences among these regional lineages, we conclude that three cryptic species currently bear the name Seriola lalandi Valenciennes, 1833. We propose the resurrection of two currently available names based on nomenclatural priority. The Northwest Pacific species name should revert to *Seriola aureovittata* Temminck and Schlegel (1845) (type locality Japan), and the Northeast Pacific species to *Seriola dorsalis* Gill (1863) (type locality Cabo San Lucas, Mexico). *Seriola lalandi* Valenciennes, 1833 (type locality Brazil) should apply only to the species in the Southern Hemisphere.

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ESTIMATING TUNA GROWTH: MORE DIFFICULT THAN IT APPEARS

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Individual growth is generally considered one of the most well understood processes of fish population dynamics. Unfortunately, our understanding of tuna and billfish growth is generally not adequate enough for contemporary, integrated stock assessments. For example, assessments of tunas and billfish typically do not have the luxury of using age composition or survey data, which serve as the gold standard for information available for conducting stock assessments. Rather, the assessments rely on CPUE-based indices of relative abundance and length composition data. In some cases, tagging data are available, but often times, sample size or sampling design compromises the usefulness of this information in the assessment. To compound the matter, many species are highly productive and the populations experience large natural fluctuations to such an extent that catch levels do not create detectable changes in CPUE time series, which serve as the primary data relied on in the assessment for estimating absolute abundance. Therefore, such assessments rely inherently on length composition data, to some degree, for information regarding stock abundance. Information available in length composition time series on absolute abundance is highly sensitive to the specification of the growth curve, particularly the size of the oldest individuals. A recent workshop organized by the Center for the Advancement of Population Assessment Methodology (CAPAM) on "Growth: theory, estimation, and application in fishery stock assessment models" identified several important issues associated with growth estimation that can potentially impact the quality of results generated from the stock assessment model. We provide a summary of these issues.

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VARIATION OF SAILFISH (*Istiophorus platypterus*) CATCH RATES AND THE INFLUENCE OF SOME ENVIRONMENTAL VARIABLES IN THE MOUTH OF THE GULF OF CALIFORNIA

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Sailfish (*Istiophorus platypterus*) inhabits tropical and subtropical waters of the Atlantic and Indo-Pacific oceans. In Mexico, this species is reserved to sport fishing for exploitation, however it is considered as bycatch species of large-scale fisheries (e.g. tuna purse-seine and longline) operating in coastal waters of Mexico. Despite its importance, there are few studies conducted on the northern limit of its distribution in the Mexican Pacific that analyze the relationship between the environment and catch rates. The aim of this study was to determine the seasonal and inter-annual variations in catch rates (CR) of the species and the effect of some environmental variables on its abundance in three locations in the mouth of the Gulf of California, Mexico. Fishery data was obtained from the monthly logbook recorded by the recreational fleet operating in Mazatlán (MZ) in Sinaloa, Buena Vista (BV) and Cabo San Lucas (CSL) in Baja California Sur, Mexico during 1990-1999. Monthly catch rate (number of sailfish per fishing trip) was computed using catch and effort data. Environmental data was derived from satellite images and oceanographic indexes. Significant differences in CR between locations were observed, Mazatlán showed the highest CR with 0.85 organisms/trip, while Cabo San Lucas had the lowest CR with a value of 0.06. Although no significant differences were found in the CR by year, we observed some variations; MZ had highest values in 1991, BV in 1995 and CSL in 1997, lowest CR where observed in 1994 in MZ, and 1996 in BV and CSL. Seasonal and significant changes were observed in the sailfish CR in three locations, in MZ highest CR values were recorded during spring-summer, BV and CSL had the highest average CR during summer. Fourier analysis determined a cycle of one year of the CR for the three sites. Seasonal variability was significant for all the environmental variables. Cross-correlation analysis determined that CR were significantly correlated with the environmental variables, SSH was correlated to CR with a lag of one month, CHLa and WS were correlated to CR with a maximum lag of four months. Generalized Additive Models were used to explain the effect of environmental and temporal variables on CR of sailfish in three locations. Best-fit models of the recorded CR in MZ and BV, showed that this species displays high seasonality in these areas, in addition we observed highest CR when SST was warmer, Best-fit models explained 55.1 and 26.4% of total deviance in this areas. Similar results were observed in CLS, however MEI index suggest some effects of the large scale El Niño events on the CR of sailfish in this location. In conclusion a strong seasonal pattern was observed for the species in the mouth of Gulf California, which is mostly related with warm temperatures present during spring and summer.

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AGE, GROWTH, AND LENGTH-WEIGHT RELATIONSHIP OF ROOSTERFISH (*Nematistius pectoralis*) IN THE EASTERN PACIFIC OCEAN

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Roosterfish (*Nematistius pectoralis*) is the only species of the genus Nematistius and the family Nematistiidae. It is a coastal pelagic predator of large size which has been shown to occur in the Pacific Ocean from San Clemente in Southern California to San Lorenzo Island in Peru. Despite its ecological and economic importance, very few scientific studies have focused on this species. Growth and life history parameters are fundamental for population modeling, stock assessments, and managing exploited species. In this study we estimated roosterfish growth using incremental analyses of sectioned sagittal otoliths from 200 individuals (5.2-133 cm FL; 0.003-26.0 kg) captured from El Golfo Dulce, Costa Rica and southern Baja California, Mexico between May 2010 and February 2015. Otoliths were embedded in translucent polyester resin and 0.5 mm cross sections were cut and polished with a series of decreasing grit (15 to 0.3 μm) sandpaper. Rings were counted from the nucleus towards the posterior edge of the otolith under100 X magnification. The length-weight relationship was estimated and von Bertalanffy growth equations were developed for each group. Isometric growth was observed for all individuals with no significant differences in the length-weight relationship between sexes or between locations. Ages were estimated from 18d (0.05 years) to 545d (1.5 years), although 26% of samples (57-133 cm) were not legible due to calcification. Individual growth parameters indicate that roosterfish grow at a rapid rate in the first year of life reaching around 60 to 70 cm FL. Future field validation is necessary, however, these data provide initial insight into the growth of this valuable eastern Pacific resource.

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GENOMIC ANALYSIS OF POPULATIONS STRUCTURE OF YELLOWFIN TUNA (*Thunnus albacares*) AT THE GLOBAL SCALE

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Tropical tunas account for the greatest part of world tuna catches but their stock biomass declined ca. 60% from 1954 to 2006, increasing the risk of ecological/economic extinctions. The effort of RFMOs to manage and conserve tropical tunas lies on stock assessments, systematically distorted by insufficient fishery and population biological data. Despite of the relevance of these species, their genetic population structure is not well resolved yet, with several studies leading to discordant evidences. In particular yellowfin tuna, *Thunnus albacares* (YFT) population structure is still poorly understood and they have been considered to be highly mobile and consist of a single panmictic spawning population for the purposes of stock assessment and management in each ocean. However as suggested by some studies in Indian Ocean there may be distinct population structure at a much smaller scale than has generally been considered for highly migratory species. In order to reveal the genetic population structure of yellowfin tuna at the global scale, in this study a streamlined restriction site–associated DNA (RAD) genotyping method based on sequencing the uniform fragments produced by type IIB restriction endonucleases (2b-RAD method) has been used, discovering and genotyping Single-nucleotide polymorphisms (SNPs) across the whole genome of this species. Samples of 600 YFT juveniles (>40 cm FL) were collected from 2 different locations of the western and eastern parts of Atlantic, Pacific and Indian oceans. Their sequences have been analyzed by using the software "STACKS" and several millions of high quality reads per individual and approximately from 1.0 to 2.0 x 10^3 candidate SNP markers selected under conditions of reduced differences between the mean observed and expected heterozygosity and lack of deviations from the Hardy-Weinberg equilibrium have been obtained. Preliminary results indicate high level of genetic differentiation between and within Atlantic and Pacific samples. The novel genomic data generated in the present study, employing the 2bRAD method, can potentially reveal YFT population structure at a level unattainable through classical latter approaches (e.g. allozymes, mtDNA, microsatellites) with significant implication for YFT stock assessment and management. In fact a carelessness of the proper genetic structure might lead to the over-exploitation and depletion of some populations with dramatic consequences for the long-term conservation and sustainable use of YFT stocks.

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TEMPORAL EFFECTS OF CLIMATE AND REGIONAL SCALE VARIABILITY ON THE ABUNDANCE OF ALBACORE IN THE EASTERN NORTH PACIFIC OCEAN

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This work examined the juvenile commercial troll fishery of the North Pacific albacore (*Thunnus alalunga*) stock in relation to 10 environmental indices in the North Pacific, within the U.S. coastal fishery grounds from 1961-2008. Frequency analyses (Harr wavelets) were conducted on the catch-per-unit-effort (CPUE) data from the coastal albacore fishery data to determine at which time scales the CPUE should be aggregated. The results from the wavelet lead to a time series analysis at monthly and yearly time scales. Generalized additive models (GAMs) were used and ranked by generalized cross validation (GCV). At the monthly scale, sea surface temperature (SST) was the variable with the strongest (positive) association to albacore CPUE. Such result may be driven by the seasonal migrations of juvenile albacore. At the yearly time scale, the positive SST association breaks down, and the scalar wind cubed (an indicator of mixed layer depth) with a five year lag became the dominant variable with a positive association to CPUE. This index explained 65% of the variability in catch for the entire region. Biologically, it is possible a deeper mixed layer provides favorable habitat for albacore, priming them to have a successful reproductive event when they mature, which results in strong returning juveniles in the next generation. The results from this analysis could help managers and stock assessment scientists in their efforts to integrate environmental factors into the estimate of albacore population size and in forecasting albacore abundance.

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FEEDING ECOLOGY OF COASTAL SHARKS IN THE NORTHWEST GULF OF MEXICO

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The feeding ecology of three coastal shark species consisting of Atlantic Sharpnose (*Rhizoprionodon terraenovae*), Bonnethead (*Sphyrna tiburo*), and Atlantic Blacktip (*Carcharhinus limbatus*) was examined in the northwest Gulf of Mexico (GOM). A total of 601 (305 *R. terraenovae,* 239 *S. tiburo*, and 57 *C. limbatus*) sharks were collected through the recreational fishery offshore Galveston, Texas over 2013 and 2014. Stomach contents were examined for all individuals and quantified for short-term diet information (days) and stable isotopes of carbon ($\delta^{13}C$), nitrogen ($\delta^{15}N$), and sulfur ($\delta^{34}S$) in muscle tissue were analyzed for a subset of samples to examine longer term (weeks to months) feeding patterns. Both *C. limbatus* and *R. terraenovae* stomach contents primarily consisted of teleost fish with % IRIs of 91.16 and 98.95%, respectively. Primary prey categories for R. *terraenovae* included unidentified Teleostei (87.40 %IRI), Panaeidae (3.56 %IRI), and Tuthoidea (2.92 % IRI). Dominant prey in *C. limbatus* consisted of Unidentified Teleostei (88.52 %IRI) and *Micropogonias undulatus* (7.46 %IRI), additional non-teleost fish prey categories including Crustacea and Cephalopoda accounted for 1.15 %IRI. *S. tiburo* had a diet primarily of crustaceans (87.20 % IRI), the top three contributors were unidentified Brachyura (48.91 %IRI), *Callinectes sapidus* (18.06 %IRI), and *C. similis* (3.32 % IRI). Carbon ($\delta^{13}C$), nitrogen ($\delta^{15}N$), and sulfur ($\delta^{34}S$) values revealed similar trends as the stomach contents. Mean $\delta^{13}C$ was significantly enriched for *S. tiburo* (-16.84 ‰) relative to the other two species, which had similar mean $\delta^{13}C$ (*R. terraenovae* -17.07 ‰ and *C. limbatus* -17.06 ‰). Mean $\delta^{15}N$ was significantly enriched for *C. limbatus* (16.64 ‰) and similar between *R. terraenovae* (15.94 ‰) and *S. tiburo* (15.90 ‰). $\delta^{34}S$ was a useful tracer for benthic invertebrate consumption consisting of significantly depleted values for *S. tiburo* (15.45 ‰), relative to *R. terraenovae* (16.01 ‰) and *C. limbatus* (16.30 ‰). Collectively, both stomach contents and stable isotopes support unique feeding strategies of three common shark species that occupy similar habitats in the northwestern GOM.

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BYCATCH MONITORING PROGRAMME OF THE FRENCH BLUEFIN TUNA LONGLINE FLEET

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Pelagic longlines have often been described as a threat to elasmobranchs and endangered sea turtle and seabird populations worldwide. It is important not to generalize across fisheries when considering bycatch issues. The impact of longline fisheries bycatch varies with many factors including season and location of fishing, fishing gear and method, abundance and behavior of potential bycatch species. The SELPAL programme conducted in collaboration with the fishing industry is designed to describe the activity of the fishery, to assess the scale of fishery effects on the various taxa, to study the ecology of the blue shark, one of the most common elasmobranchs species bycaught and to propose mitigation measures to reduce the mortality of sharks, rays and sea birds. This study aims also at exploring spatial population genetic structure of the blue shark (*Prionace glauca*), in the western and Eastern parts of the Mediterranean Sea but also across the other Oceans. The preliminary results are presented.

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SETTING AND ENFORCING TOTAL ALLOWABLE CATCHES COULD LEAD TO REBUILDING OF TUNA AND BILLFISH STOCKS

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Tunas and billfishes are an important source of food and income in both developed and undeveloped countries and some stocks have suffered high exploitation rates for many decades. Tuna and billfish stocks differ widely in their status, and the reasons for these differences are poorly understood. Stock status could reasonably be affected by life history characteristics, intensity and history of exploitation, and the diversity of management actions to which they are subjected. We aimed to find specific factors that drive the current status of stocks and detect management measures that have had a strong effect on population recovery. To describe stock status, we used biomass and fishing mortality estimates relative to their target reference points, i.e. B/B_{MSY} and F/F_{MSY}, from the RAM Legacy Database. The predictors considered were: year of fishery development, market price, maximum sustainable yield (MSY) as a measure of stock scale, generation length, and input and output management measures which included implementation of quotas, seasonal closures, minimum size regulations, and effort limits. We considered biomass levels increasing towards B_{MSY} and fishing mortality decreasing towards F_{MSY} to be a positive sign of rebuilding, and therefore examined stocks that were below B_{MSY} and stocks above F_{MSY} 10 years before the last assessment to analyze the effect of recent management actions. Information was collected for 39 stocks from 7 species of major commercial tunas (Atlantic, Pacific and Southern bluefin, bigeye, albacore, yellowfin and skipjack) and for 6 species of billfishes (swordfish, marlins and spearfishes). On average, these stocks had B/B_{MSY} and F/F_{MSY} near target levels. However, 15% of them had biomass below 0.5 B_{MSY} (the U.S. definition of overfished) and 13% were exploited above 1.5 F_{MSY}. Depletion was generally greater for stocks that had high value, were long lived, were small, and were subject to intense fishing pressure for a long time. In addition, tuna and billfish stocks that were managed with at least one type of input or output control measure are showing improvements, with biomass increasing and fishing mortality decreasing towards target levels. Fisheries management has been effective at responding to overfishing but some stocks remain below B_{MSY}. In particular, the implementation of total allowable catches (TACs) had the greatest positive impact on increasing biomass and decreasing fishing mortality compared to other management measures. TACs were most frequently implemented for these stocks in the Atlantic Ocean. Effective implementation of TACs would seem to be the most effective method to ensure the rebuilt tuna and billfish stocks. Although TACs are not a tool that is easily applied to many fisheries of the world where fleets are large and diverse, some tuna regional fisheries organizations have been successful in implementing them.

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NOVEL METHODS FOR ABUNDANCE ESTIMATES AND THEIR USE IN STOCK ASSESMENT MODELS AND MANAGEMENT PROCEDURES

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Gene-tagging is a mark-recapture method that can provide fishery independent estimates of absolute abundance for use in stock assessment models and management procedures. Monitoring programs can be expensive, but costs of genetic techniques are dropping and there is enhanced repeatability through automation. As part of the current CCSBT scientific research program, we are conducting a design study as the first stage to demonstrating the feasibility of a gene-tagging program for an abundance estimate of juvenile southern bluefin tuna that can be integrated in an operational stock assessment.

An index of juvenile recruitment from a scientific aerial survey is currently used in the SBT stock assessment and in the management procedure used to set TACs. Initial design and costs analysis indicates that an absolute abundance estimate would cost less than, and could potentially replace, the relative abundance estimate from the scientific aerial survey. A key advantage of gene-tagging is that it provides data that are not affected by the reporting rate problems that lead to the cessation of the CCSBT conventional tagging program in 2006. Use of gene-tagging data in stock assessment models, and potential use in the SBT management procedure, will be discussed.

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USING GENETIC AND GENOMIC TOOLS TO PIECE TOGETHER THE POPULATION DYNAMICS AND THE EARLY-LIFE DEVELOPMENT OF THE COASTAL PELAGIC SPECIES, *Seriola dorsalis*.

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Seriola species (*S. dorsalis, S. dumerili, S. lalandi, S. rivoliana, S. quinqueradiata*), collectively known as amberjacks, are fish of particular interest to the growing aquaculture industry due to their high value, forming a billion dollar plus component of the sashimi industry. Of these species, the native California *Seriola dorsalis*, is considered a prime candidate for aquaculture development in southern California. Larval rearing methods for this and other *Seriola* species are still unreliable, resulting in highly variable survival and physical malformation rates that reduce the market value of cultured fish. While genetic resources have been used to improve aquaculture practices for several marine species, few have been developed for *S. dorsalis*. We are working to develop genetic resources for *S. dorsalis* to help improve aquaculture techniques, and to gain a better understanding of the early life-stages of this species. In a collaborative effort between the SWFSC and Genome Informatics Facility at Iowa State University, we have created a de novo draft assembly of the genome for *Seriola dorsalis.* DNA sequencing was conducted using the Illumina HiSeq 2500, resulting in approximately 1.2 billion raw reads, for estimated 160X coverage of the 685Mb genome. CEGMA analysis indicated that the MaSurCA assembly contained 93% of the Core Eukaryotic genes. Transcriptome analyses were also conducted to characterize physiological system development and examine growth heterogeneity. Gene expression was measured in three replicates of pooled larval samples at 2, 7, and 17 days post hatch. Sixty million reads, on average, were obtained per replicate. Genes of related function were sorted into clusters; those found at high frequency in the differential gene expression set were identified. These genomic and transcriptomic tools are valuable for examining regions (genes) of interest (e.g., sex identification), looking for candidates for marker selection and development (e.g., thermal and disease resistance), identifying vulnerable developmental stages, and exploring the timing of developmental milestones during these early stages (e.g., sensory and digestive stages). This presentation will summarize highlights from these projects, and discuss results of these analyses, to date.

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UTILIZATION OF OTOLITH CHEMISTRY TO EXAMINE SWORDFISH (*Xiphias gladius*) CONNECTIVITY THROUGHOUT THE NORTH PACIFIC OCEAN

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Swordfish population structure in the North Pacific is poorly understood with a number of alternative hypotheses. To examine population structure, the connectivity of swordfish (*Xiphias gladius*) throughout the North Pacific Ocean was examined by investigating trace element concentrations in otoliths. Objectives were twofold; first, to use otolith core chemistry of juvenile swordfish as a proxy of nursery origin to evaluate nursery-specific signatures. Next, to analyze otolith bulk chemistry (as a proxy for lifetime signature) of sub-adults and adults collected in three important feeding grounds where targeted fisheries exist. A total of 217 sagittal otoliths from juvenile swordfish (< 80 cm eye-to-fork-length, EFL) were opportunistically collected from 1997 - 2008 by fishery observers and field researchers to evaluate elemental signatures among seven nurseries throughout the Pacific Ocean. Nurseries were named by region of collection and included coastal Ecuador, the central Equatorial Pacific, French Polynesia, the Hawaiian Islands, coastal Japan, the central North Pacific Ocean west of Hawaii, and the western North Pacific Ocean. Trace element concentrations of calcium (Ca), magnesium (Mg), aluminum (Al), silicon (Si), manganese (Mn), zinc (Zn), strontium (Sr86 and Sr88), barium (Ba), and lead (Pb) of swordfish otolith cores were quantified using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS). Resulting elemental concentrations were used to evaluate the utility of otolith chemistry methodology in identifying unique nursery-specific signatures throughout the North Pacific Ocean. Multivariate analysis of variance (MANOVA) results support significantly different trace element concentrations among nurseries and analysis of variance (ANOVA) also indicates significant differences in individual element concentrations among nurseries. To investigate otolith bulk chemistry of sub-adults and adults, trace elements and stable isotopes of carbon ($\delta^{13}C$) and oxygen ($\delta^{18}O$) were analyzed from individuals collected among three important feeding grounds (Hawaii n=17, California n=24, and Mexico n=12). Overall cross-validated classification success from quadratic discriminant function analysis (QDFA) resulted in 91% with highest classification success in Hawaii (94%), followed by Mexico (92%), and California (88%). Sub-adult and adult swordfish otoliths from these same three feeding grounds are currently being analyzed for otolith core chemistry in order to identify nursery origin. Results from this study will greatly inform researchers and fisheries management agencies on connectivity of the Pacific swordfish population in the North Pacific.

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SPATIO-TEMPORAL DISTRIBUTION OF WHALE SHARKS (*Rhincodon typus*) CAUGHT BY THE TUNA PURSE-SEINE FISHERY IN THE EASTERN PACIFIC OCEAN

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Whale sharks (*Rhincodon typus*) are a component of the bycatch of the tuna purse seine fishery in the eastern Pacific Ocean (EPO). The majority are caught in unassociated sets. Compared with boney fishes, they have a small litter size, long reproductive cycle, late maturity, etc., which makes them particularly susceptible to over-exploitation, and they are currently listed as a CITES protected species. The temporal and the spatial distribution of whale sharks were analyzed over a 10 year period (1995-2014), and its interaction with some oceanographic variables was explored. Aggregations of whale sharks were concentrated in areas with high indices of biological productivity, with sea surface temperature ranging from 24 to 25°C.

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BALANCING GROWTH AND WATER QUALITY IN CAPTIVE BLUEFIN (*THUNNUS ORIENTALIS*) AND YELLOWFIN TUNA (*THUNNUS ALABACARES*)

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Maintaining water quality while maximizing the growth of captive fish presents an often contradicting set of considerations for effective husbandry. This is especially true when housing large, endothermic pelagic species like Bluefin tuna (*Thunnus orientalis*) and Yellowfin tuna (*Thunnus albacares*) in captivity. In a system with limited quantities of oceanic make-up water and filtering capacity, balancing the needs for optimal growth with the deleterious effects of increasing ammonia loads on pH and oxygen availability requires careful monitoring to minimize stress. Here we present an in-depth look at the effects of increasing feeding to achieve heightened growth rates for 16 bluefin and yellowfin tuna on critical water quality parameters.

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PURSE-SEINE CATCH DISTRIBUTIONS AND MOVEMENTS OF BIGEYE TUNA, RELEVANT TO THEIR CONSERVATION IN THE IATTC CONVENTION AREA

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During the twenty-one year period 1994-2014, since commencement in the IATTC convention area of the purse-seine fishery on tuna aggregations associated with drifting fish-aggregating devices, the estimated average annual purse-seine catch of bigeye tuna has been about 61,000 mt, and has ranged from 35,000 in 1994 to 95,000 in 2000. About 65% of that catch occurred in the equatorial region between 5°N and 5°S, from the coast to 150°W. Bigeye tagging data with plastic dart and archival tags has demonstrated a strong fidelity to this highly productive zone, apparently due to the dynamic equatorial current system with horizontal and vertical structure, resulting in high concentrations of prey including squids and meso-pelagic fish. Purse-seine and longline catch distributions as well as movements of bigeye, based on tagging data, across the equatorial Pacific will be presented and discussed.

The IATTC has adopted conservation and management measures (CMMs) to reduce fishing mortality on both yellowfin and bigeye tuna. Since 2009 the CMMs included a two month closure to most purse seine fishing vessels, along with a 1 month closure of a bigeye "hot-spot" area in the equatorial zone, and quotas on longline catches of bigeye. The history of CMMs proposed by the IATTC staff and those adopted pertaining to bigeye conservation, will be presented along with information regarding their apparent effectiveness. Consideration of a large spatial/temporal closure to purse-seine fishing in the IATTC convention area to reduce fishing mortality on bigeye, taking into account the impact such a measure may have on the skipjack catch, will also be presented.

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SYNOPSIS OF MIXING LEVELS OF ATLANTIC BLUEFIN TUNA ESTIMATED FROM OTOLITH STABLE ISOTOPE COMPOSITION ANALYSIS, 2005-2014

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Over the past ten years, several international groups have estimated stock mixing levels for Atlantic bluefin tuna captured throughout the Gulf of Mexico, Atlantic Ocean, and Mediterranean Sea, estimated from otolith stable isotope analysis. Mixing levels for important management regions are summarized from recent SCRS reports and publications for the period 2005-2014. The estimated Gulf of Mexico population contribution was 100% for both the recreational category (~ 70 to160 cm curved fork length; N=247) and the commercial category (> 180 cm; N=74) based on otolith stable isotope composition of $\delta^{18}O$ and $\delta^{13}C$. This level of stock contribution was similar for a previous sample (collected 1996-2002) of Gulf of Maine adults but substantially different than a previous sample from the recreational fishery collected 1996-2000, which showed a substantial contribution (~50%) by the Mediterranean population. In contrast to stock mixing levels estimated for the period 1990-2002, there is diminished contributions by Mediterranean population to US mid-Atlantic aggregations of juveniles (≤160 cm CFL), but evidence of increased contributions by this population to Canadian fisheries, likely the result of increased selection on smaller sized fish. A large gap in our current understanding on mixing and western stock sustainability is lack of information for Gulf of Maine commercial category bluefin tuna. A large number of otoliths have been have been sampled from this fishery during the last 5 years (N>2000), which merits priority in otolith stable isotope composition analysis. Mixing levels in the US Mid-Atlantic, Canadian Maritimes, and North Central Atlantic show non-stationary dynamic, meriting additional sampling and analysis in the coming years.

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EXPLORING ALTERNATIVE FISHERY OPTIONS FOR U.S. WEST COAST SWORDFISH

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West coast swordfish fisheries have declined by over 90% in the last 30 years despite reports of healthy stocks and robust markets. Fishery decline has been primarily attributed to bycatch mitigation measures that have severely impacted the California drift gillnet fishery as well a marked decline in traditional harpoon operations. In an attempt to develop an additional, low impact method for harvesting swordfish off the U.S. west coast, this work has focused on the development and field trials of deep-set buoy gear (DSBG), a vertical hook and line method that targets swordfish deep (250-400m) during the day. Field studies incorporated depth distribution data from target and non-target species to develop and test DSBG and other similar configurations for swordfish and other marketable species. Field testing with research and cooperative fisher vessels was performed during 130 8-h DSBG sets from 2011 to 2014. Each set consisted of 10 to 30 hooks per deployment and catch rates ranged from 0.6 to 1.75 swordfish/day. The trials revealed high selectivity for swordfish and other secondary target species, with marketable catch comprising 94% of the total landings. Due to active tending and strike detection, all non-marketable species captured (6%), were released alive during the trials, further suggesting the low-impact nature of DSBG activities. Concurrent market development studies have identified a high price-point for DSBG swordfish, one that is comparable to traditional harpoon-caught product and nearly double that of the CA DGN fishery. Heightened market value is primarily attributed to (1) product quality, (2) reduced domestic landings and (3) the selective nature of the DSBG techniques. DSBG is currently being proposed for exempted fishery permit status off the California coast in 2015 and alternative deep-set configurations will continue to be tested and developed to enhance gear efficiency.

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MOVEMENTS OF THE SWORDFISH *Xiphias gladius* WITHIN THE PACIFIC LEATHERBACK CONSERVATION AREA

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This study reports on the vertical and horizontal movements of swordfish tagged within the Pacific Leatherback Conservation Area (PLCA), a >500,000 km^2 area located off the U.S. West Coast. The PLCA was historically a productive fishing ground for the CA drift gillnet fishery targeting swordfish; however, the area has been seasonally restricted to drift gillnet gear since 2001 as a conservation measure to minimize leatherback sea turtle bycatch. To better understand swordfish fine-scale movements within the PLCA and to assess potential differences in the vertical distribution of target and non-target species, this study outfitted swordfish with satellite-based archival tags scheduled for both short (2-20 d) and longer-term (150 d) deployments. All tags were deployed on basking swordfish using traditional harpoon methods during the fall of 2012 and 2013, proximal (<100 km) to the Davidson seamount (35 41N/ 122 45W). To examine fine-scale depth distribution, transmitters that popped off closer to shore (< 200 nm; n=7) were recovered using a signal direction finder. Depth and temperature data from eleven swordfish (~90 to 150 kg) were collected resulting in 250 days of data from the PLCA region. All PLCA swordfish exhibited surface-oriented nocturnal movements, with individuals spending 99% of the night above the average thermocline depth (38 m); average night depth was 8.3 ± 1.6 m. Daytime depth distribution was greater and more variable (mean depth 107.1 ± 21.2 m) with fish displaying three predominant movement patterns: (1) predominant basking activity near the surface (> 3 m of the surface) accounted for 16.7% of the daytime records; (2) a mixed-layer distribution between 3 m and the thermocline accounted for 26.8% of the daytime records; and (3) prolonged dives well below the thermocline accounted for 56.5% of the daytime records. Daytime basking rate and thermocline depth were positively correlated in seven tracks, with several individuals exhibiting extensive basking activity in waters with a relatively shallow thermocline depth (i.e. <35 m). The relevance of swordfish vertical distributions in relation to leatherback sea turtle movements are discussed with respect to the potential development of alternative fishery options within the PLCA.

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HISTORICAL EFFECTS OF FISHING ON AGE STRUCTURE AND STOCK MIXING IN NORTHWEST ATLANTIC BLUEFIN TUNA FISHERIES

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Over the past 40 years, Northwest Atlantic bluefin tuna have experienced high rates of exploitation, fisheries targeting the largest size classes of the population, and an unknown degree of Mediterranean-stock contribution despite management assumptions of no mixing between stocks. Evaluating the effects of fishing on historical demographics of this population requires an interdisciplinary approach that can simultaneously evaluate changes in abundance, age structure, and degree of mixing between Gulf of Mexico-origin and Mediterranean-origin stocks. Historical comparisons of age-structure, size-at-age, and stock mixing were conducted using archived otoliths from two National Marine Fisheries Service sampling efforts to investigate demographic changes between a period prior to (1974-1978; N=359) and after high exploitation (1996-2000; N=146). Comparisons of age structure indicated strong age truncation had occurred: ages for the historical and more recent samples ranged from 1-33 and 1-20 years, respectively, while size distribution between samples remained similar (50-310 and 50-270 cm CFL). Individuals in the historical sample were comprised of 56% 11+ year olds, while only 5% of the more recent sample was included in this age category. No apparent differences in size-at-age were detected between the two samples. Otolith stable isotope analysis of the archived samples indicated a substantially higher contribution of Mediterranean origin fish in the 1990s, consistent with published research. Integrated methods have shown that historical high rates of size-selective fishing has caused (1) age truncation and a population largely comprised of recruit spawners; (2) diminished recruitments; and (3) increased levels of subsidy by Mediterranean origin bluefin tuna to North American fisheries in the 1990s. The demographics of bluefin tuna are assessed utilizing samples of mixed stock origin. In order to put the pieces together, an adaptive and integrative assessment framework that considers the dynamic nature of stock productivity, trans-oceanic migrations, and fishing selectivity is required.

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THE GREAT WHITE SHARK (*Carcharodon carcharias*) IN MEXICAN WATERS: ITS USE, MANAGEMENT AND CONSERVATION

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All of the ontogenetic stages of the white shark (*Carcharodon carcharias*) are present in waters of northwestern Mexico. Adults and sub-adults aggregate around Guadalupe Island, mainly during the June to December period, where they are use as an attraction for touristic cage-diving operations. Young of the year and juveniles distribute in coastal waters off the west coast of Baja California peninsula where they can be incidentally caught by local fishing operations, largely from the bottom gillnet artisanal fishery. Some adults, generally females, enter the Gulf of California as well as juveniles and semi adults, where incidental catches by the local artisanal fishery have been reported. Since 2002 several regulations have been developed for the management and conservation of this species in Mexico, including the establishment of a recent fishing ban for targeting and landing great white shark in February 2014. In order to putt the pieces of information together, in late 2013 a protection program for the species was developed. Since then, actions have been taken for improving the knowledge of the species in Mexican waters. During the talk a summary of the basis for the development and the main goals of the protection program will be presented, including recent results. Also, the lack of information and the need for further regulations will be pointed out.

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AN UPDATE ON COMPARATIVE STUDIES OF GROWTH AND FEEDING DYNAMICS OF YELLOWFIN (*Thunnus albacares*) AND PACIFIC BLUEFIN (*Thunnus orientalis*) LARVAE

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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 growth studies of yellowfin and Pacific bluefin larvae have been conducted at both facilities. In this paper, we present a review of the results from experiments conducted between 2011 and 2013, which include comparisons of growth potential of larvae under variable food conditions, species-specific abilities of larvae to recover from 1- to 2-day delays in optimal food levels at first feeding, and starvation rates of larvae of both species. Additionally, new areas of comparative study initiated during the 2014 experimental season will also be discussed. The 2014 experiments include a comparison of the ability of each species to feed exclusively on large prey items at first-feeding, as well as a species-specific comparison of food selectivity patterns at the onset of piscivory during the late-flexion larval stage.

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THERMAL EFFECTS ON AEROBIC MUSCLE FUNCTION IN A DEEP-DIVING TELEOST AND SHARK

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For fishes using water as the respiratory medium, thermal equilibration at the gills, and convective heat transfer via blood, can greatly affect muscle function, particularly at low temperatures. However, several large, active, pelagic fishes are able to move rapidly and repeatedly throughout the water column exposing them to marked changes in ambient temperature . The vertical movement patterns of swordfish (*Xiphias gladius*) and bigeye thresher sharks (*Alopias supercilious)* show their ability to undergo long duration dives from the surface (18-20ºC) to well beneath the thermocline (5-10ºC). Bigeye thresher sharks, unlike the closely related common thresher shark (*A. vulpinus*), are not capable of regional endothermy, and the temperature of the aerobic swimming muscles reflects changes in ambient temperature. By contrast, swordfish have medially positioned aerobic swimming muscles and a suite of vascular specializations that may act as counter-current heat exchangers. Although the presence of regional endothermy in swordfish remains unresolved, quantification of thermal effects on the contraction of the swimming muscles can help elucidate if swordfish swimming muscles have evolved a narrow thermal operating range, as in other known regionally endothermic fishes (i.e., tunas, lamnid sharks), or if they exhibit a broad thermal tolerance, as predicted for bigeye thresher sharks.

This study investigated the thermal effects on power production and contractile kinetics in aerobic, swimming muscles isolated from swordfish and bigeye thresher sharks. Cyclical contractions were optimized at 8, 16, and 24ºC by altering cycle frequency, stimulus duration, and stimulus phase. For swordfish, optimized power output increased with temperature; the difference was more than 10 fold between 8 and 24ºC, and more than double between 16 and 24ºC. Cycle frequency generating peak power was greatest at 24ºC (0.9 – 1.0 Hz), but similar at the lower temperatures increasing from ~0.25 to 0.5Hz between 8 and 16ºC. While temperature also appeared to increase with optimized power in bigeye thresher sharks, unlike swordfish, optimum cycle frequency was slow (0.27Hz) at 8ºC with similar values at both 16 and 24ºC (0.4-0.5 Hz). The more pronounced thermal effects on swordfish aerobic muscle function, as compared to bigeye thresher sharks, was further supported by faster rates of force development (100%) and relaxation (50%) during 500ms isometric contractions at the highest temperatures. The increased thermal sensitivity exhibited by aerobic muscle of swordfish relative to bigeye thresher sharks, coupled with previous findings for common thresher and lamnid sharks, suggests a possible relationship between thermal sensitivity and regional endothermy. The understanding of how regional endothermy or a large thermal tolerance may affect the vertical and horizontal distributions of large pelagic fishes, like swordfish and bigeye thresher sharks, is integral in providing fishery managers with a more accurate method of predicting where these fish may be found and how they may be affected by potential climate (oceanographic) changes.

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ECOLOGICAL RISK ASSESSMENT OF LARGE MIGRATORY SPECIES IN THE WESTERN AND CENTRAL PACIFIC OCEAN

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Productivity and susceptibility analysis (PSA) was used to assess the ecological risk of large migratory species in the western and central Pacific Ocean (WCPO), including albacore, bigeye tuna, yellowfin tuna, Pacific bluefin tuna, longtail tuna, skipjack tuna, swordfish, striped marlin, blue marlin, black marlin, sailfish, common dolphin fish and wahoo. Information from tuna longline, purse seine and pole and line fisheries was also used in the analysis. The risk for swordfish, striped marlin, and albacore was assessed by putative stock boundaries (northern and southern) in the WCPO. The productivity index represents the capacity of the stock to recover and was estimated based on biological parameters of the species, including von Bertalanffy growth coefficient, natural mortality (M), maximum age, trophic level, average age at maturity and annual fecundity. Six attributes for susceptibility were calculated including (1) areal overlap of fish distribution and fisheries, (2) vertical overlap (i.e., fish depth distribution and fisheries), (3) ratio of fishing mortality (F) to M, (4) fish price, (5) schooling behavior and (6) annual catch trends that represented factors to measure the potential impact of fishing on stocks. Vulnerability for each stock was calculated based on the ranking of the productivity and susceptibility attributes, which was then used to evaluate the ecological risk of the species. Results showed that the ecological risk for Pacific bluefin tuna, black marlin, bigeye tuna and the northern stock of striped marlin were high, suggesting a critical need for detailed monitoring that would, in turn, allow for stock assessments, with special reference for black marlin that to date, has not been assessed. For species identified with medium risk (such as the southern stock of swordfish, blue marlin, both stocks of albacore, longtail tuna, sailfish, the southern stock of striped marlin and yellowfin tuna), data for stock assessments should be collected continuously. The fishery using resources with lower risk (such as the northern stock of swordfish, wahoo, skipjack tuna and common dolphin fish), should be monitored closely. As indicated by removing one variable each time in the sensitivity analysis, the impacts of schooling behavior and ratio of F to M were highly significant in the model, but were relatively minor for trophic level and fish price. The data quality analysis indentified gaps in knowledge and suggests that further studies are warranted for Pacific bluefin tuna, longtail tuna, common dolphin fish and wahoo to obtain biological parameters, and that fishery information and data should also be collected for longtail tuna.

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PUTTING THE RFMO REPORTING PIECES TOGETHER: INTEGRATING HMS DATA FROM MULTIPLE FISHERIES GUIDED BY VALUE STREAM MAPPING

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Each year, staff from the Southwest Fisheries Science Center (SWFSC), the Pacific Islands Fisheries Science Center (PIFSC), the West Coast Regional Office (WCR), and the Pacific Islands Regional Office (PIRO) work collaboratively to report on Pacific HMS fisheries data to the Regional Fisheries Management Organizations (RFMOs). With 15 different fisheries to summarize data, our goal is to standardize business rules and summary procedures and create a centralized data warehouse to hold these data. To reach this goal, we implemented a powerful tool called Value Stream Mapping (VSM). The VSM is a pictorial representation of the current state of a process (i.e. flowchart on steroids) enhanced by measurable attributes in each step. These measurable attributes provide information on which steps in the process cause the most problems, where there may be duplicative effort, and/or unnecessary waiting times between steps. To properly create a VSM, participation is required from all investment sectors (upper level managers to technical experts) and all participants have to be present in the same room. Participants routinely experience breakthrough realizations ('A-Ha' moments). The results of the current-state VSM are then used to create the future (ideal) state VSM by streamlining the process.

Our VSM team has met face-to-face three times in the past three years and 'virtually' numerous times in between. In the first meeting, we created a VSM for the entire process each office goes through to get the data summarized for the annual submission to the WCPFC. In the second meeting, we further reviewed the process and created a VSM for the annual submissions to the IATTC and ISC. In our third meeting in January 2015, we focused on one fishery, the U.S. purse-seine fishery that operates out of American Samoa under the South Pacific Tuna Treaty (SPTT), and created two separate VSMs; one for the data collection portion, and a second for the data processing portion. SPTT data have been managed by SWFSC since 1988, but will be transferred to PIFSC in 2015. Using VSM to guide the transfer of this large data set encapsulates current state business practices with many of the measurable attributes and provides a roadmap for future improvements. Examples of the SPTT VSMs will be highlighted and discussed, along with summaries of SPTT data.

The VSM workshops were inspired and funded by the NOAA Quality Management Professional Speciality Group (QM PSG) of the Fisheries Information System (FIS).

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IDENTIFICATION OF BULL SHARK NURSERY AREAS USING VERTEBRAL CHEMISTRY

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The status of large coastal sharks in the Gulf of Mexico is largely unknown, though many are thought to be in decline, likely as the result of anthropogenic activities such as overfishing or habitat loss/degradation. Estuaries and embayments along the Gulf coast are thought to provide nursery habitat for neonates and juveniles of several species of elasmobranchs (e.g. Bull Sharks), but questions as to how young sharks utilize bays and estuaries remain central to the management of these habitats. Before strategies can be implemented that effectively address interactions between human activities and populations of sharks susceptible to these activities, basic questions regarding the frequency and duration of use of these estuarine habitats, as well as the degree of connectivity among discrete estuaries or bays, must be addressed. In this study, we determine the utility of vertebral chemistry to discriminate young-of-the-year sharks from putative nurseries along the Texas coast. Here we quantify trace element and stable isotope concentrations of vertebral tissue from 20 Bull Sharks collected from four distinct bay systems along the Texas coast from Spring 2013 to Fall 2014. Discriminant analyses are used to determine the classification accuracy of sharks from each bay system using chemical signatures in the vertebrae based on 13 elements and two stable isotopes ($\delta^{13}C$ and $\delta^{18}O$). Additionally, we examine the effect of year, size, and vertebra position within the vertebral column on chemical signatures. Here we present the results of these analyses and discuss future lines of research and alternative approaches in characterizing the use of Bull Shark nursery habitat along the Texas coast.

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EXPLORING MOVEMENT AND BEHAVIOR OF SOUTHERN BLUEFIN TUNA CAUGHT AND RELEASED AT COASTAL AREAS AROUND SOUTHEAST AUSTRALIA

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Southern Bluefin Tuna are an iconic large pelagic species that demands one of the highest prices for seafood per kilogram on international markets. The high demand for this species led to significant commercial overfishing in the past. More recently international management efforts have led to a slow but recovering trend in southern Bluefin tuna stocks. Australia currently holds the largest quota share of southern Bluefin tuna with the species found in relative abundance off the western, southern and southeastern coastline of the continent. At certain times of the year schools of fish migrate along the coast of Australia within range of recreational fishing boats. This presentation explores the movement and vertical behavior of 49 Southern Bluefin Tuna that were tagged with PAT tags as part of a project investigating post-release survival from recreational fishing. Tagged fish ranged in size from 10 – 100 kg and were caught in coastal waters around southeast Australia where they are most commonly interacting with recreational fishers. Southern Bluefin Tuna spend only a limited amount of time in these nearshore areas with clear seasonal trends in the timing of their availability to recreational fishers. The transitory behavior in these nearshore areas is also reflected in the relative absence of commercial fishing, which more commonly takes place much further out to sea where large schools of fish can be targeted. Tagged fish showed a high degree of migratory behavior with tags detaching over a range of 2,500 nm from Western Australia to the east coast of New Zealand with the direction and magnitude of the distance travelled dependent on the month and location of when and where the fish were tagged.

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SUSTAINABLE SWIMMING SPEED AND METABOLIC RATE AS INDICATORS OF FITNESS IN AQUACULTURE-RAISED CALIFORNIA YELLOWTAIL, *SERIOLA DORSALIS*

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In order to assess the health and fitness of juvenile aquaculture-reared California yellowtail, *Seriola dorsalis*, maximum sustainable swimming speed (U_{crit}) and oxygen consumption (M_{O_2}) were determined in comparison to wild-caught individuals using a variable speed swim tunnel respirometer. Wild-caught yellowtail were capable of swimming over one body length per second faster than aquaculture reared fish (6.72 ± 0.72 FL/s vs. 5.30 ± 0.89 FL/s). In addition, extrapolation of oxygen consumption over a range of swimming speeds revealed that the standard metabolic rate of wild-caught yellowtail (5.51 ± 1.33 mgO_2 min^{-1} kg^{-1} at 18°C) was approximately 30% lower than that of aquaculture-reared fish (7.75 ± 1.48 mgO_2 min^{-1} kg^{-1}). Both slower swimming speeds and higher oxygen requirements indicate the reduced fitness of yellowtail reared in captivity. We hypothesize that rearing young juveniles under constant flow regimes to force continuous swimming may increase their health and fitness. An increase in the fitness of aquaculture-reared yellowtail (and associated reduction in metabolic demand), could substantially decrease rearing costs.

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NATURAL TRACERS REVEAL POPULATION STRUCTURE OF ALBACORE (*Thunnus alalunga*) IN THE EASTERN NORTH PACIFIC OCEAN

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Chemical signatures in otoliths and muscle tissue of albacore (*Thunnus alalunga*) from two regions of the North Pacific Ocean were characterized to examine population structure. Regions included northern (offshore northwestern United States and Canada, > 40°N) and southern (offshore southwestern United States and Mexico, < 40°N) areas where albacore have demonstrated region-specific differences in movement and size at age. Juvenile (ages 1-4 years) albacore were collected from each region through recreational and commercial fisheries over a five-year period (2009-2013). Three different otolith chemistry assays were performed including whole otoliths (proxy for lifetime signature), otolith edge (recent signature), and otolith core (nursery signature). Whole otolith $\delta^{13}C$ and $\delta^{18}O$ showed similar $\delta^{13}C$ and enriched $\delta^{18}O$ (~ 0.5‰) values for juvenile albacore collected in the southern region; classification success to the two regions ranged from 78-91% during each year (similar age-classes). Otolith edge $\delta^{13}C$ and $\delta^{18}O$ showed similar results as whole otoliths, but no regional differences were found for otolith core chemistry. Incorporation of trace element concentrations from whole otoliths improved discrimination between regions to 90-100% classification success during each year of the study with significantly higher Ba:Ca, Mg:Ca, and Mn:Ca in albacore otoliths from the northern region. Albacore from the southern region also displayed enriched muscle $\delta^{13}C$ (~1.21‰) and $\delta^{15}N$ (~0.85‰) values relative to fish of the same size range from the northern region. Discrimination success between the two regions across all years using muscle $\delta^{13}C$ and $\delta^{15}N$ was 91%. Ultimately, results from this study suggest regional separation of albacore in the eastern North Pacific warranting region-specific vital rates in future modeling efforts.

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FRENCH BLUEFIN TUNA FISHERIES IN THE MEDITERRANEAN SEA: LESSONS FROM THE PAST

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The French artisanal Bluefin tuna (*Thunnus thynnus*) fisheries in the Mediterranean Sea have changed over the past decade following the mandatory measures imposed by the Regional Fisheries Management Organizations (ICCAT and GFCM) and the environmental non-governmental organizations. While two main gears were used (rod and reel and large-scale pelagic driftnet) in the Gulf of Lions, the French fisheries components have deeply changed with a shift to longline as main gear. Fishers are businessmen but also interested in participating in cooperative research aimed at improving the sustainability of their fishery. The bycatch issue is well known to stakeholders and the fishing industry which accept that the problem needed to be addressed. Therefore they decided to finance a research program to assess these issues and to propose mitigation measures. This presentation briefly recall the history and the place of the fishery for French Bluefin tuna, the evolution of regulatory measures, the consequences in terms of fisheries management, and the expected results of the program to improve the selectivity of the longline fishery.

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EFFECTS OF ENVIRONMENTAL FACTORS ON THE SPATIO-TEMPORAL DISTRIBUTION OF DOLPHINFISH CATCH RATES OFF CABO SAN LUCAS, BAJA CALIFORNIA SUR, MEXICO

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The dolphinfish (*Coryphaena hippurus*) is an epipelagic fish that inhabits tropical and subtropical oceans around the world. Although by law in Mexico the species is reserved for recreational fishing within 50 nmi from shore, dolphinfish are captured incidentally by purse seiners, longliners and small artisanal fleet that operate along the Mexican Pacific coast. The effect of environmental variables on the spatio-temporal distribution of dolphinfish catch rates (CR) in Los Cabos, B.C.S. was assessed by means of general additive models (GAMs), using georeferenced information of the CR recorded by the main recreational fleets that operated in the region from 2008 to 2011. The study examined the effect of sea surface temperature (SST), chlorophyll-*a* concentration (Chl-*a*), sea surface height (SSH) and the wind speed (WS), obtained from satellite images. Seasonal and interannual variability of the CR was significant, with maxima during spring-autumn and in 2009. There was a significant correlation between the CR and all environmental variables except WS. The spatial analysis identified three quadrants along the west coast with high catches; one in the Golden Gate and two near the shore. The best-fit model explained 37.5% of the deviance, which included spatial variables (latitude, longitude), time (month) and environmental (SST). The final model shows a spatial preference to the west, as well as an environmental preference for temperatures of 26°C and a greater abundance of the species during September in the Los Cabos region.

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ESTIMATING BYCATCH OF THE CHINESE LONGLINE FISHERY USING OBSERVER DATA

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The Pelagic longline is one of the common fishing gears targeting tunas and billfishes in the open oceans. Bycatch in the pelagic longline fishery can have potential impacts on community structure and ecosystem stability. In this study based on Chinese pelagic longline scientific observer data from 20 trips in the tropical Pacific Ocean from 2010-2013, we investigated the spatial-seasonal patterns of catch rates for bycatch species and species group (e.g., sharks). We then evaluated potential correlations in catch rates of target and bycatch species. Due to the long duration of haulback time (e.g., about 20 hours) in Chinese longline fishery operations, observers on board usually observed only 50-70% of the deployed hooks for each set. Therefore, we also tested if this period of observations was sufficient to estimate bycatch rates for the entire set. Spatial interpolation method was applied to estimate catch rates in non-observed spatial grids, in order to estimate the bycatch of the whole fleet. This study provides useful information on understanding of the spatial-temporal distribution pattern of pelagic species, and aid to estimate the catch rates for bycatch species.

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OTOLITH MORPHOLOGY OF FOUR MACKEREL SPECIES (Scomberomorus spp.) IN AUSTRALIA: SPECIES DIFFERENTIATION AND PREDICTION FOR FISHERIES MONITORING AND ASSESSMENT

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Four species of large mackerels (Scomberomorus spp.) co-occur in the waters off northern Australia. These species are important to commercial and recreational fisheries, with state fisheries agencies responsible for their monitoring, assessment and management. The monitoring program of Fisheries Queensland (FQ) routinely collects and ages hundreds of mackerel specimens each year. However, a proportion of these specimens are discarded due to difficulties with accurate species identification of incomplete specimens (e.g. partial fish skeletons). This study examined the efficacy of using otolith morphometrics to differentiate and predict among the four mackerel in Australia. Otoliths were examined from 555 specimens, with seven otolith measurements and five shape indices recorded. Multivariate modelling, including linear discriminant analysis and support vector machines, successfully differentiated among the four species based on otolith morphometrics. The shape index ellipticity and the otolith measurement feret length had the highest contribution to among-species differentiation. Leave-one-out and five-fold cross validation determined a predictive accuracy of at least 96% for both models. This suggests that otolith morphology may be a useful tool for FQ to identify specimens that would have otherwise been discarded. This predictive tool has the potential to improve the accuracy of fish ageing, the estimates based on these ages (i.e. mortality) and the overall management of these species in Australia.

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