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Binational Studies Leading to an Ecosystems-based Management Strategy for Common Thresher Shark in the Southern California Bight (SCB).

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Authors

Graham, Jeffrey B.
Cartamil, Daniel P.

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**California Sea Grant Sea Grant
Final Project Progress Report**

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Preparer Information

Daniel Cartamil
dcartamil@ucsd.edu
858 534 8044

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Binational Studies Leading to an Ecosystems-based Management Strategy
for Common Thresher Shark in the Southern California Bight (SCB).

Jeffrey B. Graham

University of California, San Diego
Scripps Institution of Oceanography
jgraham@ucsd.edu
858 534 8044

Project Hypotheses

Survey of the Mexican SCB Sector Artisanal and Commercial Shark Fisheries
Hypotheses:

- a) Common thresher sharks represent a substantial portion of the catch of artisanal and commercial shark fisheries in the Mexican SCB sector.
- b) Exploitation of common threshers and other elasmobranchs is important to the economy of northern Baja California and, by extension, is directly linked to U.S. fishery management.

Mexican SCB Longlining Survey Hypotheses:

- a) Thresher shark nursery grounds extend south throughout the Mexican sector of the SCB.
- b) Juvenile threshers in Mexican SCB waters will exhibit seasonal patterns of abundance similar to those observed in the California SCB (i.e. higher abundance in early Spring and Summer when pupping is thought to occur).

Tracking and Archival Tagging Hypotheses:

- a) Juvenile thresher sharks utilize distinct inshore areas as nursery grounds and have a strong preference for continental shelf waters.
- b) Within these nursery grounds, juveniles have specific habitat preferences (e.g., substrate composition, algal coverage, topography, etc.).
- c) Juvenile threshers display the same diel movement patterns noted for adults, remaining in the warmer mixed layer by night, and making vertical forays by day. However, we expect that juveniles will inhabit shallower depths and higher temperatures than adults, and also swim at slower speeds.
- d) Juveniles undergo relatively large-scale movements that take them throughout the SCB and further south.

Project Goals and Objectives

This study had two main thrusts. The first was describing the artisanal and commercial shark fisheries of the northwestern coast of Baja California. The objectives were to assess the impacts of these fisheries on shark populations and to link assessments to the sustainable management of threshers and other pelagic sharks in CA SCB waters.

Second, we assessed the essential habitat utilized by juvenile threshers in Mexican waters of the SCB, through a fishery-independent longline survey, acoustic tracking, and archival tagging.

A 1-y extension was granted (see below); specifically, our Year 3 (2009-2010) objectives were to complete archival tagging of juvenile thresher sharks, complete data collection from these archival tag studies, and analyze this data to determine large-scale movement patterns of juvenile threshers in U.S. and Mexican waters.

Briefly describe project methodology

Survey of the Mexican SCB Sector Artisanal and Commercial Shark Fisheries: Collaborating Mexican graduate students from the Sosa Laboratory (CICESE) worked as observers aboard drift gillnet vessels based in Ensenada, collecting data on: a. Catch composition, b. Numbers of each species caught, c. Measurements and maturity data, d) Geographical extent of fishing activity, e) Other biological samples (tissue samples for genetics studies, vertebrae for aging studies, etc.). In addition, fisheries landings records were analyzed for patterns relating to thresher shark life history and exploitation.

Studies on the Artisanal Fishery:

These studies were conducted through monthly surveys that took place at artisanal fishing camps along the Pacific coast of Baja California, to form an assessment of the geographical extent and number of artisanal shark fisheries in the region, and obtain fishery landings and biological data to determine the extent to which thresher sharks and other pelagic species are taken, and the socio-economic importance of these fisheries. Data collection involved similar methodology and protocols as those employed by U. S. drift gillnet observers.

Juvenile thresher shark essential habitat studies:

These studies employed three primary methods. 1) Acoustic telemetry: a depth and temperature-sensing transmitter was attached to the animal, and manual tracking was accomplished aboard a small research vessel. 2) Archival tagging: a data-collecting tag was placed on the animal, which was then released. Data are retrieved when the animal is re-caught by a fisherman, or, in the case of satellite archival tags, when the tag releases from the animal at a pre-determined time and transmits data to a satellite. 3) Longline surveys in Mexican waters: Local artisanal fishermen hired to deploy the longline shark-sampling gear, while the scientific staff assists in operations, and handles the processing of sharks (i.e. data collection and tagging).

Describe progress and accomplishments toward meeting goals and objectives

Survey of the Mexican SCB Sector Artisanal and Commercial Shark Fisheries: Our surveys of the artisanal fishery were completed in December 2008. We have collected data from every artisanal camp on the Pacific coast of Baja California. In addition, monthly surveys from the representative artisanal camp at Laguna Manuela has allowed us to characterize these fisheries in terms of seasonality, species impacted, effort, and economic importance. This study formed part of the doctoral dissertation of trainee Cartamil, and is now being prepared for journal submission.

The observer program of Ensenada's drift gillnet fishery has also yielded important data, allowing us to quantify commercial fishing effort for thresher sharks in Mexican waters over the past decade. Through collaboration with fishery personnel, we were allowed to board most incoming vessels prior to unloading to collect data, and in many cases have sent observers aboard vessels

for multi-day trips to collect data. This study is complete and forms the basis of a masters thesis for Miguel Olvera, a Mexican graduate students in Oscar Sosa's laboratory. We received new funding (Save our Seas Foundation) for thresher shark population genetics studies utilizing the tissue samples collected aboard drift gillnet vessels; this work is in progress.

Juvenile thresher shark essential habitat studies:

1) Acoustic telemetry: Eight juvenile thresher sharks were tracked for periods of up to 75 hours, yielding important data on the fine-scale habitat utilization and nursery biology of this species. A peer-reviewed article is in press.

2) Archival tagging: Four archival tags were deployed in a preliminary study in 2007. In September 2008 we deployed seven additional tags by participating in a NOAA shark-tagging cruise. These tags were programmed to transmit their data in March, 2009. However, problems with the tags forced us to apply for a 1-y extension. During this time, an additional 17 pop-off satellite archival tags were deployed. 15 of these have successfully transmitted their archived data, providing the largest dataset available for juvenile threshers; these data are currently being analyzed.

3) Longline surveys: see Project Modifications below.

Birch Aquarium Outreach: We held our `Teacher Workshop' at Birch Aquarium in April 2008, where elementary teachers from southern California gathered to learn about biology and conservation issues affecting sharks in the SCB, as well as the implementation of teaching methods that address these issues. The Graham Laboratory also participated in `Shark Week' in 2008 and 2009, hosting a station at the Aquarium to educate the public about shark biology and shark studies at Scripps Institution of Oceanography, as well as providing lectures to the public on shark biology and conservation.

Project modifications

Archival Tagging of Juvenile Threshers: After deploying our archival tags in October, 2008, we received news from the manufacturer that the tags were incorrectly programmed, as were tags we had deployed in 2007. The manufacturer (Microwave Telemetry Inc.) replaced the malfunctioning tags, and 17 new tags were deployed in Fall 2009. These tags have all functioned well, and the data from these tags has provided unprecedented insight into the habitat, distribution, and behavior of juvenile threshers.

Longline Survey: As reported last year, Mexican fisheries authorities placed unexpected restrictions on our longline sampling gear configuration. Our original plan was to use two anchored, 1.6 km longlines with 50 hooks each. However, we were only permitted to use one un-anchored line with 12 hooks, thus severely curtailing the efficacy of our sampling program, while the cost and effort expenditure would remain essentially the same. Despite our attempts to reconcile the situation, we had no choice but to cut this portion of the project.

Project outcomes

First data compilation of commercial thresher shark catch rates in Mexican waters. Complete database of all artisanal fishing camps along the northwestern coast of Baja California, and detailed two-year data sets from two major fishing camps (Erendira and Laguna Manuela), based on monthly sampling. Acoustic tracking data (up to 75 h each) from eight juvenile thresher sharks in their nursery grounds in the SCB. Archival data sets from 17 satellite-tagged juvenile threshers in the SCB and Mexican waters.

Impacts of project

Fisheries resources such as thresher shark are commonly managed from the limited point of view of the domestic fishery. However, many large pelagic species have ranges that span international borders. As such, management must take into account mortality introduced through the activities of all fisheries operating on a stock to effectively ensure sustainable harvest levels. The present study bridges this gap by providing data on the magnitude of commercial harvest of threshers in Mexican waters. In addition, we describe, for the first time, the smaller-scale, but geographically extensive, artisanal fishery for threshers and other elasmobranchs along the Pacific coast of Baja California. Concurrent studies of thresher shark movement patterns have shed light on the essential habitat used by the juvenile life-history stage of this species, and serve to identify potential threats from fisheries, as well as habitat-based management options. The primary impact of these studies, then, is that they will form the basis for an assessment of the combined effects of US and Mexican fisheries on exploited elasmobranch stocks, and represent the first step towards a binational management plan. Thus, our research will contribute to the sustainability of these fisheries, and the economic welfare of U.S. and Mexican fishermen who depend upon them. Finally, we believe that public education is a key element of shark conservation. Through our outreach efforts involving the Birch Aquarium, we are informing a wide public audience about shark conservation issues relevant to the SCB.

Benefits, commercialization and application of project results

Craig Heberer, NOAA Fisheries Biologist. craig.heberer@noaa.gov. 760-966-1956. Used results of juvenile thresher shark tracking data for modification of recreational catch limits for thresher sharks in California waters. February 25, 2010: Data from this study presented to the Pacific Fishery Management Council.

Data on juvenile thresher habitat utilization were supplied to the California Department of Fish and Game for consideration in design of marine reserves (South Coast Regional Marine Life Protection Act).

Leonardo Castillo; Instituto Nacional de la Pesca (INAPESCA) Fisheries Biologist. ptiburon@yahoo.com.mx. (646) 174-6135. Leonardo has been collaborating with us on data collection from artisanal fisheries; project data will be used in annual INAPESCA assessment of artisanal fishery effort on the Pacific coast of Baja California.

Economic benefits generated by discovery

The California commercial drift gillnet fishery for thresher sharks is of major economic importance in California waters, with a current annual value of approximately \$36 million and involving close to 100 commercial vessels. Thresher shark also support a commercial fishery in Mexican waters, and form an important component of the artisanal fishery for sharks and rays on the Pacific coast of Baja California. Data gathered in this study can contribute to an integrative binational stock assessment that contributes to the long-term sustainability (and therefore economic viability) of the thresher shark fishery, both in the U.S. and Mexico.

Issue-based forecast capabilities

Forecast capabilities have not yet been developed. However, as the population of northern Baja California increases, we expect that our artisanal fishery data

will be important in forecasting the socio-economic and ecological effects of increased fishing effort, as well as the impacts of new fishing regulations.

Publications

Conference papers, proceedings, symposia

Title: Genetic analysis of thresher shark nurseries in the Southern California Bight

Authors: Dovi Kacev, Daniel Cartamil, Rebecca Lewison, Andrew Bohonak, Oscar Sosa-Nishizaki

Date: July 2008

Conference Title: Annual Meeting of the American Elasmobranch Society

Location: Montreal, Canada

Title: Movement Patterns and nursery habitat of juvenile thresher sharks, *Alopias vulpinus*

Authors: Daniel Cartamil, Nick Wegner, Jeffrey Graham

Date: July 2008

Conference Title: Annual Meeting of the American Elasmobranch Society

Location: Montreal, Canada

Title: Distribution and fisheries for thresher sharks in the US and Mexico

Authors: Daniel Cartamil, Omar Santana, Miguel Olvera, Dovi Kacev, Suzanne Kohin, Oscar Sosa-Nishizaki, Jeffrey Graham

Date: May 17, 2010

Conference Title: Tuna Conference

Location: Arrowhead, CA

Title: Thresher shark fisheries in Mexican waters

Authors: Daniel Cartamil, Omar Santana, Miguel Olvera, Dovi Kacev, Suzanne Kohin, Oscar Sosa-Nishizaki, Jeffrey Graham

Date: July 10, 2010

Conference Title: Annual Meeting of the American Elasmobranch Society

Location: Providence, RI

Peer-reviewed journal articles or book chapters

Title: Movement patterns and nursery habitat of juvenile thresher sharks, *Alopias vulpinus*

Authors: Daniel Cartamil, Nick Wegner, Dovi Kacev, Noah Ben-aderet, Suzanne Kohin, Jeffrey Graham

Date: In press

Journal Name: Marine Ecology Progress Series

Title: Diel movement patterns and habitat preferences of subadult and adult thresher shark *Alopias vulpinus* in the Southern California Bight

Authors: D. Cartamil, N. Wegner, S. Aalbers, C. Sepulveda, A. Baquero, J.B. Graham.

Date: In press

Journal Name: Marine and Freshwater Research

Issue/Page Numbers:

Title: An archival tagging study of common thresher shark (*Alopias vulpinus*) in the Southern California Bight

Authors: Daniel Cartamil, Nick Wegner, Scott Aalbers, Chugey Sepulveda, Jeffrey Graham

Date: To be submitted May, 2010

Journal Name: Marine Ecology Progress Series
Issue/Page Numbers:

Title: Artisanal shark fisheries of the Pacific coast of Baja California
Authors: Daniel Cartamil, Omar Santana, Miguel Olvera, Dovi Kacev, Oscar Sosa, Jeffrey Graham
Date: In preparation, to be submitted March, 2010
Journal Name: Fisheries
Issue/Page Numbers:

Title: The Mexican drift gillnet fishery for common thresher shark, 1999-2009
Authors: Miguel Olvera, Omar Santana, Daniel Cartamil, Jeffrey Graham, Oscar Sosa-Nishizaki
Date: In preparation, to be submitted Summer, 2010
Journal Name: Ciencias Marinas
Issue/Page Numbers:

Electronic publications (
Title: Southern California Bight Elasmobranch Consortium website
(www.sharkbight.com)
Authors: J.B. Graham, D. Cartamil
In particular, see <http://www.sharkbight.com/science/index.php>

Theses, dissertations

Title: Movement patterns and fisheries biology of the thresher shark, *Alopias vulpinus*, in the Southern California Bight.
Authors: Cartamil, D.
Schools: Scripps Institution of Oceanography (UCSD)
Date: October, 2009.

Title: Species composition of elasmobranchs captured by the artisanal fishery in Bahia Sebastian Vizcaino, Baja California, Mexico.
Authors: Omar Santana
School: Centro de Investigacion y de Educacion Superior de Ensenada
Date: October 2008

Title: Biological analysis of the drift gillnet fishery of Baja California, 1999-2008
Authors: Miguel Olvera
School: Centro de Investigacion y de Educacion Superior de Ensenada
Date: March 2009

Media coverage

San Diego News 8, KFMB
City: San Diego
State: CA
Date of publication/broadcast: Dec. 10, 2008
Headline or topic: "Scientists Monitor Fisheries In Mexico To Protect Ecosystems"
<http://www.cbs8.com/Global/story.asp?s=9500132>

Workshops/presentations

1) Birch Aquarium at Scripps - La Jolla, CA, 12 April, 2008. Audience: K-12 educators. # attendees: ~40. Content: A teacher education workshop focused on shark biology and conservation in the SCB.

2) Third Annual Shark Conservation Conference - La Paz, Mexico, 20-22 March, 2009. Audience: conservationists, fishermen. # Attendees: 200. Content: This conference is designed to disseminate scientific results to artisanal shark fishermen in Baja California, who have been instrumental in the collection of the data. The object of the conference is to promote sustainable fisheries in Mexico, as well as foster strong working relationships between fishermen and scientists.

Dissemination of results

October 29, 2008. Seminar at Scripps Institution of Oceanography by project Associated Researcher Dr. Oscar Sosa, entitled "Elasmobranch fisheries in northwestern Mexico: how far can we go?"

December 10, 2008. Dr. Oscar Sosa and SG trainee Daniel Cartamil are featured on San Diego news channel 8. Transcript and video at <http://www.cbs8.com/Global/story.asp?s=9500132>

Students

Daniel P. Cartamil

University of California, San Diego

Scripps Institution of Oceanography

Degree program enrolled in: Ph.D.

Theses/dissertation title: Movement patterns and fisheries biology of the thresher shark, *Alopias vulpinus*, in the Southern California Bight.

Supported by Sea Grant funds? yes no

Start date 02/01/2007

End date 02/01/2009

Omar Santana

Centro de Investigacion Cientifica y de Educacion Superior de Ensenada (CICESE)
Oceanography

Degree program enrolled in: M.S.

Theses/dissertation title: An alternative method for analyzing fisheries catch composition at the Laguna Manuela, artisanal camp, Baja California.

Supported by Sea Grant funds? yes no

Miguel Olvera

Centro de Investigacion Cientifica y de Educacion Superior de Ensenada (CICESE)
Oceanography

Degree program enrolled in; M.S.

Theses/dissertation title: Analysis of the drift gillnet fishery for thresher sharks at Ensenada, Mexico

Supported by Sea Grant funds? yes no

How many students/volunteers were involved in the project? 10

Cooperating organizations

Federal

National Marine Fisheries Service (Southwest Fisheries Science Center, La Jolla, CA). Provided assistance by allowing our research team to utilize their annual juvenile shark survey as a platform for thresher shark tagging operations. SWFSC has also provided a research vessel for use in shark tagging operations, as well as specialized tracking equipment. SWFCS also provided CA fishery catch data for analysis and inclusion in our juvenile thresher shark acoustic tracking article. Local and state organizations

Nongovernmental

Birch Aquarium, La Jolla, CA. Education experts at the Birch Aquarium provided materials, organizational assistance, and activities for our Teacher Shark Education Symposium, funded by CA Sea Grant.

Instituto Nacional de la Pesca, Ensenada Mexico. This Mexican fisheries organization provided two technicians (paid by the INP) to assist with data collection from artisanal elasmobranch fisheries. In addition, the INP has also provided valuable fisheries statistics for our analyses.

Corrina del Mar, drift gillnet vessel based in Ensenada, Mexico. The captain and crew of the "Corrina" have voluntarily allowed our observers aboard their vessel for multiple fishing trips, providing food and board during these trips, and access to all specimens. In addition, they have provided access to a long-term database of drift gillnet catch records.

Academic Institutions

Centro de Investigacion Cientifica y de Educacion Superior de Ensenada (CICESE). CICESE has supported this project by providing sampling equipment, and occasional use of a four-wheel drive vehicle for artisanal camp surveys in Baja California. Graduate student volunteers from CICESE have also been instrumental in data collection from artisanal camps.

International implications

Federal and state fishery managers charged with ensuring the sustainability of thresher shark and other fisheries within California waters operate largely without information about the population status and fisheries exploitation of these same species within the Mexican portion of their geographical range. Our goal with this project was to establish a binational research collaboration to augment the fishery management efforts of both countries by removing the data void for the Mexican sector of the SCB, thus aiding in the formation of an ecosystems based management program for pelagic fisheries spanning the U.S. and Mexican regions of the Southern California Bight.

Awards

Tinker Foundation. \$120,000 awarded to J. Graham and associated researchers, Spring 2007. "Artisanal Shark Fisheries of Western Baja California: Shifting an imperiled resource towards sustainability". This award essentially allows us to extend our surveys of artisanal elasmobranch fisheries into Baja California Sur, thus providing a more comprehensive view of the impact artisanal fisheries have on elasmobranch populations in Mexican waters.

Save Our Seas Foundation. \$96,425 awarded to J. Graham and associated researchers, Summer 2008. "Binational education and research designed to increase public awareness about the need for shark conservation and the ecological threats posed by excessive shark fishing". This award provides funds for a genetics study of thresher shark population connectivity in the eastern Pacific. In addition, previous SG trainee Cartamil will receive post-doctoral salary to continue SCBEC activities through the Graham laboratory at SIO. Funding is also provided for shark-tagging studies in Mexico.

Keywords

Thresher shark, elasmobranch, artisanal fishery, ecosystem management, acoustic telemetry, archival satellite tagging, nursery grounds, movement patterns, observer program.

Notes

Omar Santana and Miguel Olvera, listed above under "Students", are graduate students from CICESE in the laboratory of Dr. Oscar Sosa-Nishizaki, (Associated Researcher for this project). Although not supported as Sea Grant trainees, both have been instrumental in the success of the research described above, and both have received masters degrees based upon research completed as part of this Sea Grant funded study. Omar and Miguel have been working closely with trainee Dan Cartamil in the collection and analysis of data in Mexico, and have traveled on numerous occasions to Scripps Institution of Oceanography to assist with collection of data in the U.S. sector of the SCB. The international exchange of students for research is an important component of the project that will foster a culture of collaboration and plant the seeds for future binational collaboration on issues important to the region.

In-press and in-preparation peer-reviewed journal articles stemming from this award will be sent to Sea Grant upon publication.