

# UC San Diego

## Research Final Reports

### Title

Assessing changes in life history traits and reproductive function of CA sheephead across its range: historical comparisons and the effects of fishing

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

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Assessing changes in life history traits and reproductive function of CA sheephead across its range: historical comparisons and the effects of fishing

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**Project Hypotheses**

The specific predictions can be summarized as:

- P1: Life history parameters will vary across the range of this species and spatial differences in life histories will be determined by population density, sex ratios, environmental factors, and fishing pressure.
- P2: Fish collected in this study will be smaller and younger than fish collected from previous times (historical collections from 1970-1980) and the effects will be greatest at sites where fishing is intense (i.e. southern California vs. Baja California).
- P3: Fish collected in this study will change sex from female to male at a younger age and smaller size than previous times, especially at sites where fishing is intense (as predicted by size advantage model).
- P4: As a result of P3 (females mature younger and smaller), operational sex ratios will increase (also predicted by size advantage model).
- P5: Stricter harvest limits may have initiated recovery in heavily exploited populations and may result in increases in lengths, the timing of maturation, and the timing of sex change.
- P6: Individual growth rates will differ both spatially (sites across the species range) and temporally (historical vs. 1998 vs. this study) and variance will be more related to site location (e.g. water temperature and food availability) than type or amount of fishing.
- P7: Ultrasound techniques will provide a cost effective, non-destructive, and reliable tool to assess sex, fecundity, and reproductive state in these important fish.
- P8: Radioimmunoassays of estradiol and testosterone will verify the utility of visual assessments of sexual state and provide a non-destructive means to survey reproductive function during the breeding season.

P9: Potential reproductive output will be less in this study than that of past studies at sites where fishing pressure is intense.

### **Project Goals and Objectives**

The overall goal of this project is to a) address many of the data deficiencies identified during the recent stock assessment of California sheephead in order to allow managers to reduce uncertainties in the assessment and better aid resource management of this key component of the nearshore ecosystem, and b) provide a unique test of specific predictions from life history theory on the effects of size- and sex-selective harvesting on a temperate sex-changing fishery species

### **Briefly describe project methodology**

Our basic approach in this study is to undertake a comprehensive and current examination of spatial variation in age, growth, density and reproductive function. We propose to gather the following data from collections and surveys at sites throughout southern California and Baja, Mexico: (1) Individual sex specific age and growth, (2) Population size structure (via collections and visual surveys), (3) age and size at maturity and sex change, (4) Reproductive output and potential during the spawning season (4) Population density and (5) Paired morphological and hormonal assessments of sex. Ancillary data will include: (1) Estimates of the type and amount of fishing at collection sites, (2) Water temperature throughout the range and over time and (3) Environmental indices (e.g. Southern Oscillation Index (SOI), Pacific decadal oscillation (PDO) and Bakun upwelling index). Specifically, we will collect morphometric measurements, ultrasound measures of sex and fecundity, blood, spines, and tissue from a large number of CA sheephead at sites spanning their range, and gonadal tissue for histology from a smaller sample at a subset of sites. With these collections we will conduct histological assays, blood chemistry assays (CSULB), age and growth studies, and provide samples to collaborators for genetics and stable isotopes.

### **Describe progress and accomplishments toward meeting goals and objectives**

To date, we have collected samples of sheephead from seven of the Channel Islands, including: Santa Rosa, Santa Cruz, Anacapa, Santa Barbara, San Nicolas, Catalina, and San Clemente, in addition to two sites along the mainland coast: Palos Verdes and Point Loma. We collected samples from multiple sites on each island and processed approximately 50 fish from each island for: size, weight, sex, gonads, color morphology, dorsal spines, blood, tissue, gut contents, and ultrasound measurements of gonads. At this point, we have completed the aging of all samples (~450 fish) using thin sections of dorsal spines. As part of the Isaac's Undergraduate Fellowship we completed the gut content analysis on all fish from our collections. We have examined spatial differences in size structure, and the timing of maturation and sex change as well as growth rates, and compared these to historical samples at a number of locations. We have analyzed spatial differences in diet both through gut content analysis and stable isotopes of muscle tissues and conducted stable isotope analyses of prey items found in the guts of sheephead. The large spatial differences in trophic ecology we detected have strong influences on growth rates and life histories of this species. In terms of the reproductive function work, as part of a Sea Grant traineeship, we have assayed estradiol and 11-ketotestosterone levels of males, females, and transitionals to compare with histological preparations of gonads. In addition, we have examined the efficacy of field-based ultrasound techniques to non-invasively image gonads in situ. While not a specific objective of this

grant, data from our collections have been used to estimate egg output for different populations.

### **Project modifications**

During the summer of 2008 our research goals were to sample sheephead from 4 populations in Baja California, Mexico from which we had historical data, to assess changes in these populations through time. Unfortunately, our plans were cut short on the drive down because we suffered a severe automobile accident that required 2 students to be medically evacuated from Mexico. There was not enough time or funding to return to Mexico and complete the work that field season.

Although not an initial part of the project plan, we collected muscle tissue samples of sheephead to potentially use for stable isotope analyses of feeding ecology. Preliminary analyses showed strong spatial separation of isotopic signatures among populations. After receiving a no-cost extension and change in objectives, we used to the foreign travel funding for further stable isotope investigations of sheephead and their primary prey items. We are working to use Bayesian stable isotope mixing models to estimate the contribution to the diet of various prey items to different sheephead populations.

A number of interesting research topics have been developed following the collection of sheephead samples throughout southern California. We have used muscle tissue samples to investigate spatial, size, and sex-specific differences in condition through lipid content analyses at UCSB. In addition, muscle tissue samples have been sent to the lab of Bryan Rourke (CSULB) to examine spatial and sex-specific differences in myosin isoforms of sheephead, focusing on differences in fishes undergoing sexual transformation from females to males. A graduate student at UCSB (Loren Merrill) is currently using blood plasma samples to examine spatial and sex-specific differences in bacterial-killing ability and immune function. We have also sent samples of dorsal spines from both our 2007-2008 Sea Grant collections and our historic 1998 collections to Seth Newsome at the Carnegie Institute for stable isotope analysis to examine temporal and ontogenetic variation in trophic ecology. The stable isotope samples have been run on all dorsal spines and we are in the process of analyzing data. We have also worked with two graduate students at UCSB (Jono Wilson and Tal Ben-Horin) to incorporate spatial variation in sheephead demography into age-based fisheries models. Results suggested that more localized management of sheephead tuned to local demographic parameters may improve population persistence and fisheries yields. We are currently beginning to prepare a manuscript of this work for publication.

### **Project outcomes**

Data collected to date include: Sex-specific sizes, ages and growth rates of sheephead from 9 populations, gut contents of 30 different prey items, age and size at maturity and sex change, gonad and liver weights, lipid content, egg production, gonad histology, blood hormone concentrations, and bacterial killing ability of blood plasma. These data are stored in local databases. Gonad tissue and blood samples (for endocrine assays) are stored at CSULB Muscle tissue, gut contents, and dorsal spines are stored at UCSB Physical oceanographic data is being collected as an ongoing part of PISCO and can be accessed from the PISCO dataserer.

### **Benefits, commercialization and application of project results**

The California Department of Fish and Game is considering re-doing the stock assessment of CA sheephead and our data will be vital for those efforts. We held a 1-day workshop at UCSB between researchers studying sheephead and representatives from the CA Dept. Fish and Game in January 2009 at Sea Grant has contacted CDFG managers to discuss how this research will be used to help manage the sheephead fishery in the future. Contacts at CDFG include Tom Barnes and Deb Wilson-Vandenberg

**Economic benefits generated by discovery**

None at this point

**Issue-based forecast capabilities**

We do not know as yet whether the findings from our study will allow for predictive responses of the sheephead populations in northern Baja and southern California attributed to factors such as pollution and climate change. However, it may be possible to compare our results from sex hormone and reproductive function with fish collected in the future from areas along the coastline in close proximity to municipal outfalls. It is possible that estrogenic or androgenic compounds could also influence patterns in maturation and sex change in this species; however, this was not the original intent of this study.

**Tools, technologies and information services developed**

Collaborators at UC Santa Cruz (Dr. Giacomo Bernardi) and NCEAS (Dr. Kim Selkoe) are currently using fin clips from our collections to develop genetic markers for analyses of population genetic structure.

**Publications**

**Conference papers, proceedings, symposia**

Title: Selective harvesting alters life histories of a temperate sex-changing fish: historical comparisons and current status of California sheephead.

Authors: Hamilton S, Caselle J, Love M, Schroeder D, Loke K, Young K, Lowe C

Date: 11/07

Conference Title: Western Society of Naturalists

Location: Ventura, CA

Title: Size-selective harvesting alters the life history of California sheephead across its biogeographic range

Authors: Caselle and Hamilton

Date: 9/07

Conference Title: American Fisheries Society

Location: San Francisco, CA

Title: Reproductive Parameters of California Sheephead Across the Channels Islands

Authors: Loke, Caselle, Hamilton, Lowe, and Young

Date: 7/08

Conference Title: American Society of Ichthyologists and Herpetologists

Location: Montreal, Canada

Title: How do patterns of abundance, size structure and biomass differ between fished and unfished waters in the Channel Islands? Results from SCUBA surveys  
Authors: Caselle J, Hamilton S, Malone D, Kushner D, Carr M  
Date: 02/08  
Conference Title: California Islands Symposia: special session on first 5 years of monitoring the Channel Islands marine reserves  
Location: Ventura, CA

Title: Spatial differences in trophic ecology and life histories of California sheephead have fisheries management implications  
Authors: Hamilton S, Caselle J, Egloff T, Kondo K, Loke K, Lowe C  
Date: 11/08  
Conference Title: Western Society of Naturalists  
Location: Vancouver, B.C., Canada

**Peer-reviewed journal articles or book chapters**

Title: Geographic variation in density, demography, and life history traits of a harvested temperate sex-changing reef fish  
Authors: Hamilton SL, Caselle JE, Schroeder DM, Love MS, Standish JD, Rosales-Casian JA, Sosa-Nishizaki O  
Date: In review  
Journal Name: Canadian Journal of Fisheries and Aquatic Science  
Issue/Page Numbers:

Title: Extensive geographic and ontogenetic variation characterizes the trophic ecology of California sheephead (*Semicossyphus pulcher*) in southern California  
Authors: Hamilton SL, Caselle JE, Lantz C, Egloff T, Loke K, Lowe C  
Date: in preparation  
Journal Name: Target journal - Marine Ecology Progress Series  
Issue/Page Numbers:

Title: Size-limits tuned to local variation in demographic parameters both protect populations and enhance yield of California sheephead  
Authors: Hamilton SL, Wilson J, Ben-horin T, Loke K, Lowe C, Caselle JE  
Date: in preparation  
Journal Name: Target journal - Ecological Applications  
Issue/Page Numbers:

**Theses, dissertations**

Title: Analyses of the reproductive potential of the protogynous teleost, California sheephead (*Semicossyphus pulcher*) at the Channel Islands in relation to size-selective fishing pressure  
Authors: Kerri Loke  
Schools: California State University Long Beach  
Date: Fall 2007 to present - research ongoing

**Newsletters, periodicals**

Title: PISCO: Coastal Connections (an annual publication of the Partnership for Interdisciplinary Studies of Coastal Oceans) - Article Title: "Fish Data Give Managers New Insights"  
Date: 2007, Vol. 6

**Media Coverage**

Easy Reader (<http://www.easyreadernews.com/>)  
City: Los Angeles Peninsula

State: California  
Date of publication/broadcast: 10/8/2009  
Headline or topic: Sex change in sheephead and overfishing of males

*Santa Barbara Independent*

City: Santa Barbara  
State: CA  
Date of publication/broadcast: 5/13/2009  
Headline or topic: California Sheephead Populations Dwindling

California Sea Grant

City: San Diego  
State: CA  
Date of publication/broadcast: 4/21/2009  
Headline or topic: Sportfishing hammering large male sheephead

**Workshops**

Title: "Evaluating the performance of the Channel Islands marine reserves: California's first network." Departmental seminar Bodega Bay Marine Lab.  
Date: Feb 2010

Title: "The ecology, harvest, and conservation of California sheephead... and other kelp forest fishes". Scripps Institution of Oceanography. Invited seminar for the Interdisciplinary Master's Program  
Date: July 2009

Title: "Reproductive ecology of California sheephead across the Channel Islands of California"  
45 minute presentation to approximately 40 recreational fishermen at a meeting of the Los Angeles Rod and Reel Club in Sherman Oaks, CA.  
July 27, 2009

Title: "Current status of California sheephead research for fisheries management". One-day workshop held with resource managers from the California Department of Fish and Game at UCSB. 4 separate talks were given with data collected in this project.  
Date: January 2009

**Dissemination of results**

Lectures in UCSB coursework: EEMB 106 Biology of Fishes, Fall 2007-2010  
Lectures in CSU Catalina Marine Biology Semester: Marine Ichthyology, Fall 2007-2010

Lecures in CSULB coursework: BIOL 444 Reproductive Biology Spring 2009

**Students**

Kerri Loke

CSULB

Biological Sciences

Degree program enrolled in: Master's of Science

Theses/dissertation title: Analyses of the reproductive potential of the protogynous teleost, California sheephead (*Semicossyphus pulcher*) at the Channel Islands in relation to size-selective fishing pressure

Supported by Sea Grant funds?  yes  no

Start date: 06/01/2007

End date: 12/31/2009

Tiana Egloff

UCSB

College of Creative Studies

Degree program enrolled in: Bachelor of Arts

Theses/dissertation title: n/a

Supported by Sea Grant funds?  yes  no

Start date: 09/01/2007

End date: 12/31/2008

Greer McMichael

CSULB

Biological Sciences

Degree program enrolled in: Bachelor of Arts

Theses/dissertation title: n/a

Supported by Sea Grant funds?  yes  no

Start date: 06/01/2007

End date: 06/01/2008

**How many students/volunteers were involved in the project?** 25

**Cooperating organizations****Federal**

Channel Islands National Park Service - contract with Jenn Caselle, salary support for technicians

Channel Islands National Marine Sanctuary - ship time provided aboard the R/V Shearwater for sheephead collections

**Local and state**

California Department of Fish and Game - vessel support for sheephead collections aboard the R/V *Garibaldi*

**International implications**

Yes, we collaborated with a Mexican researcher (Oscar Sosa-Nishizaki, CICESE, University of Ensenada) to collect sheephead in Baja California, Mexico. The implications of this work are that the range of sheephead crosses the borders of the U.S. and Mexico and this species may need to be managed bi-nationally.

**Awards**

Student: Kerri Loke (trainee)

Award: Graduate Research Award

Organization: Southern California Tuna Club Marine Biology Education Foundation

Date: May, 2007.



Student: Kerri Loke (trainee)  
Award: Graduate Research Award  
Organization: Los Angeles Rod & Reel Club Marine Biology Scholarship  
Date: Nov, 2008.

Issac's undergraduate fellowships to Tiana Egloff and Greer McMichael

**Keywords**

California sheephead, sex change, fishery, population dynamics, biogeography, reproductive function