California Sea Grant Sea Grant
Final Project Progress Report

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Collecting Sea Palms: Planning for Sustainable Use in a Variable Environment

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Project Hypotheses

1. GEOGRAPHIC VARIATION IN PHENOLOGY, GROWTH AND REPRODUCTION (YEAR 1: 2006-2007)

Postelsia palmaeformis (sea palm) spans ~15 degrees of latitude from San Luis Obispo County in California to Vancouver Island, British Columbia. Based on classic biogeography theory we predict ecological performance to be reduced at range limits relative to the center of range, but not necessarily by the same environmental factors. We will use observational methods to examine the following hypotheses:

1. At Postelsia's northern range limit, growth and reproduction is limited by light availability and this results in:
   a. A shorter growing season
      i. Later onset of reproductive maturity
      ii. Earlier senescence and loss of individuals from rocks in the fall
   b. Lower total biomass (standing crop)
   c. Lower reproductive output
   d. Restricted intertidal depth distribution (low end of intertidal distribution is shifted upward)
2. At Postelsia's southern range limit, growth and reproduction is limited by high water and air temperatures and increased desiccation stress during emersion, but light is less limiting and this results in:
   a. A longer growing season
      i. Earlier onset of reproductive maturity
      ii. High mortality during summer
      iii. Possibility of a second generation in the late summer/early fall
   b. Lower total biomass (standing crop)
   c. Lower reproductive output
   d. Restricted intertidal height distribution (upper end of intertidal distribution is shifted downward)
3. At the center of Postesia's range growth and reproduction is maximized resulting in highest ecological performance and this results in:
   a. Intermediate growing season length
   b. Highest reproductive output
   c. Broadest intertidal distribution

2. COLLECTION IMPACT EXPERIMENTS (YEARS 1 and 2: 2006-2008)
Some collectors have suggested that by cutting blades above the meristem early in the season they can derive two successive 'harvests' each year (Kalvass 1994). Presumably this method of take, while not terminal to the individual, delays reproduction as the blades must re-grow before sori can develop along the blades, and potentially reduces reproductive output as energy is diverted to growth. Growth normally plateaus in late spring/early summer when reproduction ensues (Young 1971, Nielsen and Blanchette unpublished data), but experimental evidence suggests growth rates of blades can increase post-clipping (Kalvass 1994). Although re-growth of blades and development of sori may occur, changes in timing of reproduction, or decreases in allocation of energy to growth, may reduce reproductive output or success and result in decreased recruitment in the following year. The impacts may be magnified when blades are cut twice per year. We are conducting two experiments replicated in both the center and southern portion of Postelsia's geographic range:

1. Evaluation of the impact of different clipping regimes on growth and reproduction
2. Evaluation of the impact of clipping on subsequent recruitment
Specific hypotheses:

1. Clipping fronds will reduce the energy available to allocate to reproduction and maintenance. This will result in:
   a. Reduced total biomass (standing crop) of sporophytes
   b. Delayed spore production
   c. Reduced area of sporophyll tissue produced
   d. Reduced spore production
   e. Delayed and/or reduced spore viability
   f. Reduced survivorship of sporophytes
   g. Reduced recruitment of sporophytes
   h. Increased local population extinction probabilities
2. These effects will be more pronounced:
   a. when clipping is done twice per season
   b. at southern range limit due to physiological stress

3. ANALYSIS OF COLLECTING TRENDS IN CDFG TAKE RECORDS (YEARS 2 and 3: 2007-2009)
In the most recent CDFG Annual Status of the Fisheries Report two important recommendations were made to improve documentation of the edible seaweed fishery: 1) have commercial logbooks include wet weight by species and location, and 2) compile and analyze logbooks annually. Recent inquires to CDFG revealed that a voluntary program to compile species and location data was recently initiated (Joann Eres, pers comm.). However, annual take data for edible seaweeds have not been routinely entered and analyzed, and are not currently available. We will to collaborate with CDFG to enter and analyze the available take data to assess trends in take of edible seaweeds over time.

Project Goals and Objectives
Our main goal is to provide the scientific basis for rational management of a growing market for sea palm (*Postelsia palmaeformis*). Although the motivation falls within the sphere of applied science, it provides a terrific opportunity to answer basic questions about variation in the population dynamics of this intertidal kelp across its biogeographic range. The results of this study will represent a substantial contribution to the fields of phycology and intertidal ecology, while simultaneously providing appropriate data for resource managers to use in making regulatory decisions. Investigating how commercial exploitation interacts with varying environmental conditions will also provide a useful model

for other species that are impacted by commercial collecting pressure. A distinct advantage of Postelsia is the relative ease with which life history parameters may be measured while mimicking commercial take. In addition the role of variation in environmental conditions is more easily assessed in an annual, sessile species than in mobile species where juveniles and adults inhabit distant and distinct habitats. There are three components to this study:

1. Documentation of phenology, growth and reproduction across Postelsia's geographic range;
2. Experimental evaluation of the impact of different collecting techniques on growth, reproduction and population persistence in Mendocino County where commercial collection is concentrated and in San Luis Obispo County at Postelsia's southern range limit;
3. Analysis of available records of commercial take of edible seaweeds in collaboration with CDFG.

This project combines observational, experimental and modeling approaches to achieve the project's objectives. We are observing population demography across the species geographic range in concert with physical measurements of environmental conditions to address questions related to latitudinal variation in phenology. We are using field experiments to assess hypotheses related to the impact collection frequency and timing on individual-level responses as well as to assess the potential impacts to recruitment success at the population level. We are using a modeling approach to ascertaining the potential impact of different commercial collection strategies on population viability or persistence. We are also collaborating with CDFG to enter and analyze log-book records from the edible seaweed fishery to assess temporal trends in the magnitude, diversity and spatial extent of commercial take.

Briefly describe project methodology

We have completed demographic monitoring of sea palm (*Postelsia palmaeformis*) across its geographic range and collected data on environmental conditions. The analyses done to date support the predictions that central range populations have the highest biomass and reproductive output relative to edge population to the north and south. The field experiments to assess the impacts of the frequency and timing of different commercial collection strategies on individual level responses have also been completed. The results have been described in Sarah Ann Thompson's MS thesis (2007, Sonoma State University). The thesis was revised and submitted for formal publication in a peer-reviewed scientific journal and we are in the final stage of revision in response to reviewer comments in anticipation of a submission to Marine Ecology Progress Series. We found that frond trimming had a negative effect on frond area, as expected, but also on reproductive output. Fronds trimmed early in the season (May/June) were able to regrow and eventually produce viable spores, albeit at somewhat reduced rates. However, spore production was sharply reduced when fronds were taken either twice or just once late in the season (August). After the onset of sporogenesis fronds did not readily regrow. Frond trimming effects were similar between sites but varied in magnitude. The recruitment impact field experiments were initiated during the spring of 2007, and then monitored and repeated in 2008 and 2009; we plan a final monitoring for summer 2010, thus this experiment is still in progress. Results through the 2009 field season will be reported in second MS thesis by Heather Knoll with an anticipated completion date of December 2009. Initial results suggest there is a significant interaction between population size and the frequency of commercial collecting whereby smaller populations that are harvested multiple times per year are more likely to experience reduced recruitment and even extinction in some cases relative to

larger populations that are harvested only once or not at all. We also collaborated with Laura Rogers-Bennett (CDFG) to locate, enter and analyze the log book records for intertidal seaweed "landings". These data have been entered and summary data indicating trends in the total take of edible intertidal seaweeds as well as the take of Postelsia per se have been included in the manuscript we are about to submit to Marine Ecology Progress Series (indicated above). Results of this analysis shows that landings of Postelsia consistently made up ~ 45% of the total landings of the edible seaweed fishery between 2002-2007 (the years for which species specific data are available from CDFG). In addition the total landings of edible seaweed has increased over 400% over the ten years for which data are available (1997-2007) from an average of 3.4 tons per year between 1997-2003 to an average of 14.6 tons per year between 2004-2007, with a high of 17.7 tons reported in 2004.

Project modifications
N/A

Project outcomes
To date, data have been collected on: 1) population demography of four populations of *Postelsia palmaeformis* (sea palm) spanning its biogeographic range; and 2) impacts of field experiments assessing the effects of frequency and timing in Postelsia growth, reproduction and survivorship. Results have been shared at 4 scientific meetings, through CA Sea Grant web page, and one manuscript is being revised for re-submission to Marine Ecology Progress Series.

Impacts of project
We have gained significant demographic and phenological information on the population biology of an annual intertidal kelp across its biogeographic range, and contributed strong experimental evidence of the impacts of current commercial collection techniques that provide specific guidance for natural resource managers to develop a sustainable management plan to regulate the sea palm 'fishery'. Our first Sea Grant Trainee Sarah Ann Thompson has completed her MS thesis (2007, Sonoma State University) and submitted a manuscript based on her thesis to a major scientific journal for review and revisions in response to reviewer comments are almost completed and we anticipate resubmitting the manuscript very soon. She is currently employed as a database manager for the Farallon Institute for Advanced Ecosystem Studies. We also involved 7 undergraduates in various aspects of the field and laboratory work associated with this project (three undergraduates worked as paid research assistants and others as volunteers or for academic credit as Biology 'Special Studies' students). Two of our undergraduate research assistants have since graduated from SSU, one joined the project as our second Sea Grant Trainee and is close to completing her MS degree, the other is currently teaching high school biology and completing his secondary education teaching credential at Dominican University. The third continues to work in the Nielsen lab as a student research assistant on another project.

Benefits, commercialization and application of project results
CDFG/MLPA; Provided information including initial results from this project, and personal knowledge of commercial seaweed collecting sites (to supplement CDFG logbook data) in response to a request from Rebecca Studebaker (CDFG/MLPA staff biologist). The information was requested to help evaluate protests by commercial seaweed harvesters to the CA Fish and Game Commission that they were overlooked stakeholders with respect to the proposed placement of North Central Coast marine protected areas.

Economic benefits generated by discovery
To be determined

Issue-based forecast capabilities
We have gained insight into likely outcomes of different commercial collection strategies on growth, reproduction, survivorship and population persistence of sea palms (*Postelsia palmaeformis*).

Tools, technologies and information services developed
N/A

Publications
Conference papers, proceedings, symposia
Title: Deficits in biological knowledge and literacy impede management and protection of the Sea Palm, *Postelsia palmaeformis*
Authors: Nielsen, K.J., S.A. Thompson and C.A. Blanchette
Date: August 2006
Conference Title: International Temperate Reef Symposium
Location: Santa Barbara, CA

Title: Effects of commercial collection on growth and reproductive output of *Postelsia palmaeformis*
Authors: Thompson, S.A., K.J. Nielsen, C.A. Blanchette, B. Brockbank and H.R. Knoll
Date: August 2007
Conference Title: Ecological Society of America
Location: San Jose, CA

Title: Balancing conservation with commercial use: experiments to guide sustainable exploitation of *Postelsia palmaeformis*
Authors: Thompson, S.A., K.J. Nielsen, C.A. Blanchette, B. Brockbank and H.R. Knoll
Date: November 2007
Conference Title: Western Society of Naturalists
Location: Ventura, CA

Title: Save the seaweeds: Applying ecological insights to avoid “boom and bust” commercial exploitation of wild populations
Authors: Nielsen, K.J., S.A. Thompson, C.A. Blanchette and H. Knoll.
Date: January 2009
Conference Title: International Temperate Reef Symposium
Location: Adelaide, Australia

Peer-reviewed journal articles or book chapters
Title: Balancing conservation with commercial use: an experiment to guide sustainable exploitation of an ecologically vulnerable kelp
Authors: Thompson, S.A., K.J. Nielsen and C.A. Blanchette
Date: In revision
Journal Name: *Marine Ecology Progress Series*
Issue/Page Numbers:
Issue/Page Numbers:

Electronic publications
Title: Regulations Needed to Protect Sea Palms in Mendocino (http://www-csgc.ucsd.edu/NEWSROOM/NEWSRELEASES/Seapalms-Mendocino.html)
Authors: Christina S. Johnson
Date: 2/12/2008

Media coverage
Name of publication/radio station, etc: Mendocino Public Radio (KZYX and Z)
City: Philo
State: CA
Date of publication/broadcast: June 17, 2009.
Headline or topic: Radio interview by Christina Aanistad, Evening Local News, segment on conflict between north coast seaweed harvesters and the Marine Life Protection Act.

Dissemination of results
May 1, 2008, Op-Ed, Nielsen, K.J., Don't let sea palms go the way of salmon, The Mendocino Beacon, Mendocino, CA
October 2008, Provided information including initial results from this project, and personal knowledge of commercial seaweed collecting sites (to supplement CDFG logbook data) to the CDFG/MLPA in response to a request from Rebecca Studebaker (CDFG/MLPA staff biologist). The information was requested to help evaluate protests by commercial seaweed harvesters to the CA Fish and Game Commission that they were overlooked stakeholders with respect to the proposed placement of North Central Coast marine protected areas.
October 21, 2008, Letter to CA Fish and Game Commissioner, scientific comment regarding the potential impact of commercial take of marine algae within proposed Marine Protected Areas under consideration for designation on the North Central Coast region of the MLPA process.

Students
Sarah A. Thompson
Sonoma State University
Department of Biology
Degree program enrolled in: M.S.
Theses/dissertation title: BALANCING CONSERVATION WITH COMMERCIAL USE: AN EXPERIMENT TO GUIDE SUSTAINABLE EXPLOITATION OF AN ECOLOGICALLY VULNERABLE KELP
Supported by Sea Grant funds? [X] yes [] no
Start date: 2/1/2006
End date: 8/31/2007

Heather Knoll
Sonoma State University
Department of Biology
Degree program enrolled in: M.S.
Theses/dissertation title: Postelsia in the face of human exploitation: mechanisms of population persistence
Supported by Sea Grant funds? [X] yes [] no
Start date: 9/1/2007
End date: 09/15/2009

How many students/volunteers were involved in the project? 6

Cooperating organizations

Local and state

Laura Rogers-Bennett, CDFG: Assisted with analysis of commercial collecting permit logbooks for edible seaweed. Data are required from collectors regarding amount and location of take, but have not been transcribed nor quantified to date. Laura Rogers- Bennett provided assistance with locating records and data entry.

Keywords

Postelsia palmaeformis, sea palm, conservation, harvest, sustainable management, kelp, intertidal, Laminariales