

The Fish, the People, and the Tradeoffs: Social-Ecological Coupling in the Wetfish Fishery of Monterey Bay, California

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November 2015

SUMMARY

Monterey Bay is home to a thriving marine ecosystem and vibrant communities, but also one of the most infamous fishery crashes in U.S. history. Chronicled by many, the anchovy/sardine fishery of the Bay came to a crashing halt due to what we now know was a combination of overharvesting pressure and climatic forcing. This case study focuses on today's wetfish fishery in Monterey Bay, and the complex social-ecological linkages comprising the fishery system. Students will use qualitative and quantitative data to analyze the issue, look carefully at stakeholder viewpoints, and examine S-E linkages in the fishery system. The study consists of a background module and five learning modules. We suggest that the background and modules 1 and 5 are necessary to achieve the SES learning goals. Modules 2 - 4 are optional modules that will enhance case study learning objectives.

CASE STUDY DETAILS

Topical Areas: Coastal Sustainability, Social-Ecological Systems, Ecology, Earth Systems, Fisheries, Conservation Biology, Environmental Studies, Natural Resource Management

Education level: introductory interdisciplinary graduate students / upper level undergraduates

Type/Method: Discussion, interrupted case study, public hearing / problem-based case study

Notes for Instructors

This case study is best completed in an easily moveable room to divide into small groups. PowerPoint presentation, internet, and individual computer capabilities are necessary. Please consider providing the Student Handout document to students in a digital format to save paper.

SES LEARNING GOALS AND CASE STUDY OBJECTIVES

SES Learning Goals (directly from SESYNC learning goals for S-E synthesis):

1. **Understand the structure and behavior of socio-environmental systems**
 - a. Identify the environmental and social components of the system and their interactions
 - b. Identify feedbacks and explain the dynamics of an S-E system
 - c. Use tools and modeling approaches to understand dynamics of an S-E system
4. **Find, analyze, and synthesize existing data, ideas (e.g. frameworks or models), or methods**
 - d. Identify data sources and appropriate tools, evaluate quality of data, and manage data.
 - e. Understand the different kinds of data and research methods used by relevant disciplines in the natural and social sciences.
 - f. Integrate different types of data (interdisciplinary integration)

Case Study Objectives: by studying the Monterey Bay wetfish fishery, students will learn to:

1. Recognize subunits, relationships, and feedbacks within a social-environmental system, and apply a framework to a case.
2. Distill and synthesize various data types, specify data assumptions and limitations, and manipulate and illustrate data to support a clear point.
3. Prepare, present, and defend a stakeholder position, acknowledging importance of stakeholder dialogue and tradeoffs of management alternatives.
4. Communicate effectively across disciplinary boundaries and gain an appreciation of both the difficulty and usefulness of interdisciplinary thinking and decision-making.

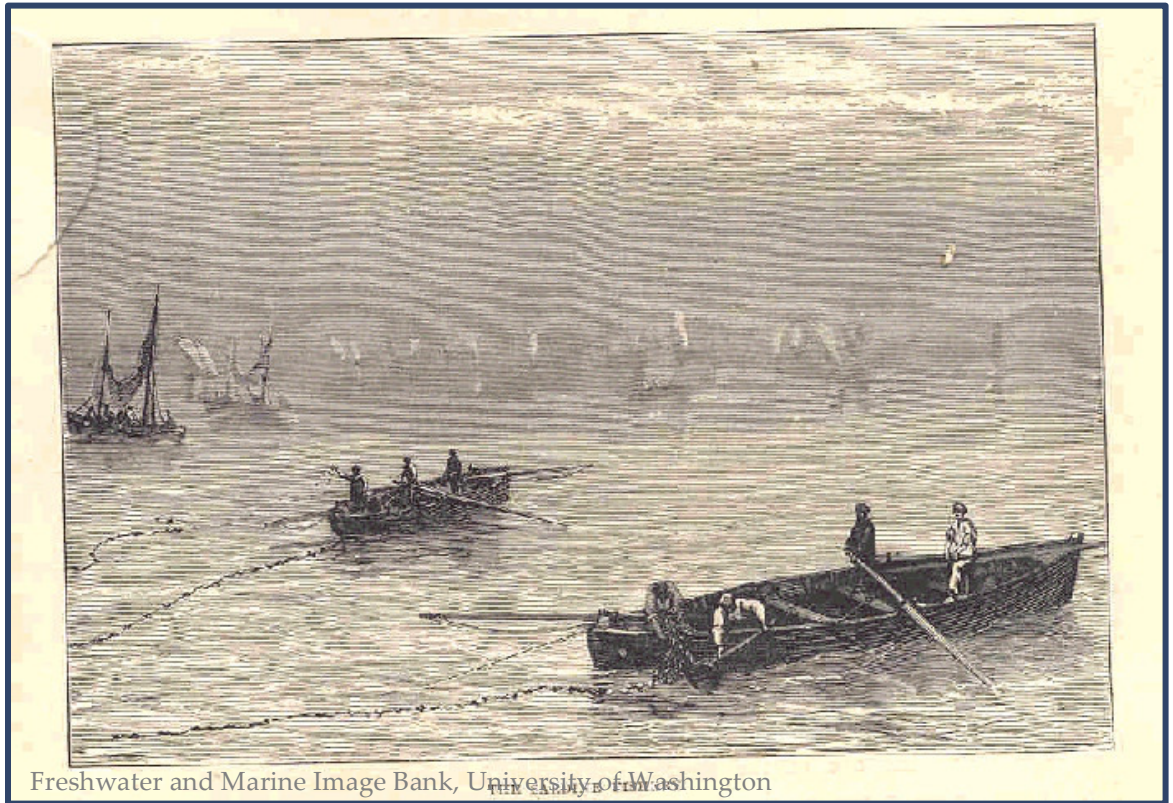
Module	Learning Goal	Learning Objective	Specific Objectives
Case study background	1a	1	1. Understand the historical importance of a natural resource system to a place. 2. Identify stakeholders.
1: SES theory and MB wetfish fishery concept mapping	1a, 1b, 1c	1	1. Understand the utility of an SES framework. 2. Learn the skill of concept mapping.
2: How do we manage a common pool resource system?	1a, 4d	1, 2	1. Identify social and ecological components of a system. 2. Recognize the complexity of data-limitation, fair allocation of resources, and tradeoffs in management decision-making.
3: Decisions, decisions, decisions - voting on squid quota options	1a, 4d	2	1. Synthesize qualitative and quantitative data sources. 2. Appreciate management complexity and the difficulty of consensus.
4: Using qualitative data to make management decisions	4e, 4f	2, 4	1. Understand social implications of fishery management decisions. 2. Explore ways that qualitative data can be used for decision-making.
5: Pacific Fisheries Management Council meeting	1a, 4d, 4f	2, 3, 4	1. Find, manipulate and illustrate data. 2. Present data concisely.

Table 1. Case study modules listed with their corresponding learning goals, broad learning objectives and specific objectives.

OUTLINE OF CASE STUDY MODULES

Module	In-class time	Assignment	Activity
Case study background	15 minutes	Background readings; stakeholder identification	None
1: SES theory and MB wetfish fishery concept mapping	2 hours	Concept map	Class discussion; lecture; in-class concept mapping
2: How do we manage a common pool resource system?	2 hours	Reflection writing	Interrupted case study in fisheries management decision-making
3: Decisions, decisions, decisions	1.5 hours	5 written questions	Class decision-making and considering stakeholders
4: Using qualitative data to make management decisions	30 minutes	Background reading and discussion preparation	None
5: Pacific Fisheries Management Council meeting	3 hrs over two class periods	Day 1: Prepare meeting materials; reflective writing Day 2: 6 written questions	Mock fisheries management council meeting

Table 2. Case study modules listed with their corresponding assignments and activities.



Freshwater and Marine Image Bank, University of Washington

CASE STUDY BACKGROUND

Module Overview

The case study background module introduces students to the California wetfish fishery and the social-ecological relationships surrounding the fishery system. The background reading and work is a jumping off point for the following five modules that rely on information in the readings. This pre-module requires students to spend several hours of out-of-classroom time to complete the readings below and complete the stakeholder identification exercise. During the first module (see page 11), the instructor will lead a discussion on the readings, and will guide students as they review stakeholder lists.

Estimated class time needed: 15 minutes to explain the case study and background reading assignment

Class Plan and Activities

Student Handout

Students should be given the Student Handout at the very beginning of this case study. However, while the handout is available as one document, we recommend giving the students the handout in sections, only presenting the students with each single module's student portion at a time. This is because information in later modules may hamper the creative process desired in earlier modules. Note that some modules in the Student Handout may have a portion that should be given WITHIN the module (e.g. Module 2) or AFTER the module (e.g. Module 3). Student Handouts can be printed at once and the instructor can hand out the sections according to which modules the instructor decides to implement and when.

Historical perspective readings

Students will read the following documents and come to class with three questions for a group discussion.

- "Schmalz, David. 2014. The modest little fish - and Monterey icon - contains grand teachings on how to manage fish populations. Monterey County Weekly. Link: http://www.montereycountyweekly.com/archives/2014/0102/the-modest-little-fish-and-monterey-icon-contains-grand-teachings/article_d68733a2-727e-11e3-95cc-0019bb30f31a.html
- U.S. West coast sardine season halted to stave off overfishing. 2015. The Wall Street Journal. Link: <http://www.wsj.com/articles/u-s-west-coast-sardine-season-halted-to-stave-off-overfishing-1429149949>
- Cesare, Chris. 2014. Sardine ban looms as fishermen weigh disaster funds. Santa Cruz Sentinel. Link: <http://www.santacruzsentinel.com/environment-and-nature/20150309/sardine-ban-looms-as-fishermen-weigh-disaster-funds>
- Ueber, Edward and MacCall, Alec. The rise and fall of the California sardine empire. Link: <https://swfsc.noaa.gov/publications/CR/1992/92104.PDF>

Students will be directed to keep the following questions in mind while reading and come to class with responses (written or otherwise).

1. What is the problem? Are there both social and ecological components to the problem?
2. Whose (i.e. which stakeholders) voices are heard in the articles? Whose are not heard?
3. How confident are you with these sources of information? Why? What knowledge gaps remain?
4. What lens are you seeing the wetfish fishery issue through? Consider your disciplinary background, prior knowledge and experience. Try to see the issue through other lenses.

Social-ecological theory readings

Students will read the following documents and come to class with three questions for a group discussion.

- Gordon, Scott H. 1954. The economic theory of a common-property resource: the fishery. *The Journal of Political Economy* 62 (2): 124-142.
Link: <http://www.econ.ucsb.edu/~tedb/Courses/Ec100C/Readings/ScottGordonFisheries.pdf>
- Ostrom, Elinor. 2009. A general framework for analyzing sustainability of social-ecological systems. *Science* 325 (419).
Link: <http://vw.slis.indiana.edu/talks-fall09/Lin.pdf>
- Binder, C.R., Hinkel, J., Bots, P.W.G., Paul-Wostl, C. 2013. Comparison of frameworks for analyzing social-ecological systems. *Ecology and Society* 18 (4): 26.
Link: <http://www.ecologyandsociety.org/vol18/iss4/art26/>

Students will be directed to keep the following questions in mind while reading and come to class with responses (written or otherwise).

1. In your words, what is a social-ecological (or social-environmental) system?
2. Why do we use frameworks to describe complex social-ecological systems? Do you think this is helpful?

Supplementary Materials

Students should be made aware of the following materials, but are not required to read them.

- Aguilera, S.E. 2015. Managing small-scale commercial fisheries for adaptive capacity: insights from dynamics social-ecological drivers of change in Monterey Bay. *PloS ONE*. 10(3): e0118992. DOI: 10.1371/journal.pone.0118992
Link: <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0118992>
- Coastal Pelagic Species Fishery Management Plan. September 2011. Pacific Fishery Management Council. Link: http://www.pcouncil.org/wp-content/uploads/CPS_FMP_as_Amended_thru_A13_current.pdf

- Radovich, John. 1982. The collapse of the California sardine fishery: What have we learned? CalCOFI Report, Vol. 23.
Link: http://www.calcofi.org/publications/calcofireports/v23/Vol_23_Radovich.pdf
- Kittinger, J.N. et al. 2013. Emerging frontiers in social-ecological systems research for sustainability of small-scale fisheries. Current Opinion in Environmental Sustainability 5: 352-357.
Link:
http://www.centerforoceansolutions.org/sites/default/files/Kittinger_etal_2013_Cosust.pdf
- Hinkel, J., Cox, M.E., Schluter, M., Binder, C.R., Falk, T. 2015. A diagnostic procedure for applying the social-ecological systems framework in diverse cases. Ecology & Society 20: 32.
Link: <http://www.ecologyandsociety.org/vol20/iss1/art32/>
- Palumbi, Stephen and Sotka, Carolyn. The Death and Life of Monterey Bay: A Story of Revival. 2010. Island Press.
No available link, this is a book which is recommended if the library has it.
Amazon link: <http://www.amazon.com/The-Death-Life-Monterey-Bay/dp/1610911903>

Stakeholder Identification Exercise

In this exercise, students will develop a draft stakeholder list for the case study, with stakeholders organized into Ostrom's framework (Fig.1). This should solidify ideas from the Ostrom paper above and provide a place for students to synthesize information gleaned from the historical perspective readings. Be sure to guide students to think through the second-level variables in Ostrom 2009 that fall under first-level core subsystems. Students should select 2-3 second-level variables under each subsystem to describe for this exercise (see example in Fig. 2).

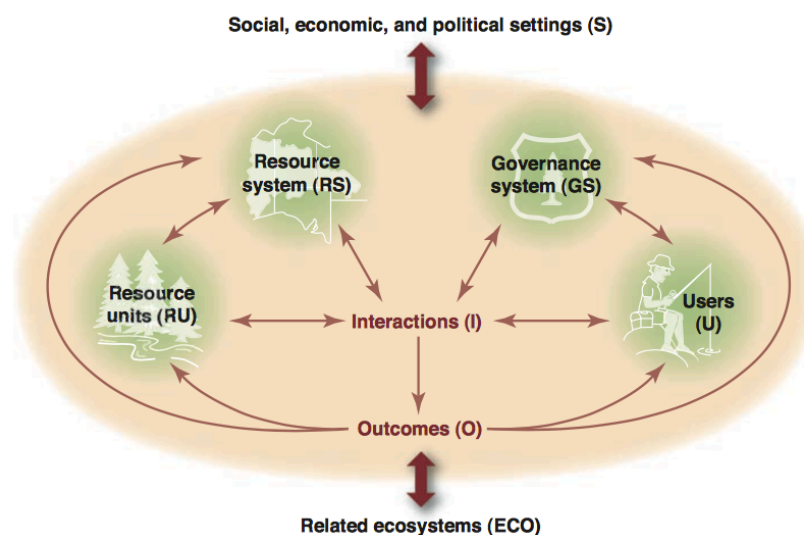


Figure 1. The core subsystems in a framework for analyzing social-ecological systems (directly from Ostrom 2009).

Monterey Bay wetfish fishery in Ostrom's SES framework

*The following are examples of first- and second-level Ostrom variables with descriptions of wetfish social-ecological system attributes. This is **not** a comprehensive list, but is meant to serve as a guiding example.*

Resource System (RS): marine ecosystem, Coastal Pelagic Species fishery

RS2: clear fisheries regulation system boundaries, fuzzy ecological system boundaries

RS4: wetfish seine fishing vessels, squid fishing light boats, wetfish processing facilities

RS7: climate dynamics of the system are predictable in the short-term with some degree of error, however long-time (several year) predictions are not accurate.

Resource Units (RU): Pacific Sardine, Northern Anchovy and Market Squid

RU1: sardine, anchovies and squid are mobile marine organisms. Their location and habitat use is largely dependent on water temperature and other oceanographic variables, and prey dynamics.

RU3: Many decades of fisheries and ecosystem data have yielded a strong pattern of abundant sardines in warmer years and abundant anchovies in cooler years. Squid also prefer cooler years, but are available in a different season than anchovy.

RU4: the wetfish fishery is one of the most significant California fisheries. In 2012, sardine, anchovy and squid accounted for 77% of total statewide commercial fishery catch, and 30% of statewide commercial fishery value (CDFW).

Governance System (GS)

GS1: NOAA National Marine Fisheries Service, California Department of Fish and Wildlife, Pacific Fisheries Management Council

GS2: fishermen/processors organizations, Oceana and other environmental NGOs, academic institutions with scientists studying any aspect of wetfish ecology or dynamics

Users (U): commercial fishermen, recreational fishermen, processors, recreational users of Monterey Bay, fish consumers (human and non-human), scientists and resource managers

U4: There are three major fishery landings ports in Monterey Bay: Santa Cruz, Moss Landing and Monterey, though resource users are not limited to these locations.

Interactions (I) → Outcomes (O)

I4: Major conflict between groups aiming to protect wetfish populations for the consumption of marine mammals and groups aiming to exploit wetfish populations for human use.

O2: Ecological performance can be measured using traditional fisheries metrics such as catch per unit effort or total stock biomass. It could also be measured using metrics of whole ecosystem health or biodiversity of the system.

Related ecosystems (ECO)

ECO1: The wetfish fishery is intimately tied to climate and sea temperature oscillations in the Pacific Ocean. El Nino Southern Oscillation and Pacific Decadal Oscillation dynamics strongly influence the abundance of the three focal wetfish species.

Figure 2. An example of wetfish fishery system attributes arranged into first- and second-level variables in Ostrom's framework. First- and second-level SES variables are taken from Table 1 in: Ostrom, Elinor. 2009. A general framework for analyzing sustainability of social-ecological systems. Science 325: 419-422.

Assessment and Rubric

1. Instructor checks that each student comes to the first class period (see module 1) with 6 discussion questions about the reading (3 focused on the historical perspective readings and 3 focused on the SES theory readings).
2. During Module 1, the group will discuss the case study stakeholder list organized into Ostrom's framework and revise until the class and instructor are happy with the result.



Module 1: Social-environmental system
theory and Monterey Bay wetfish fishery
concept mapping

Module Overview

This module includes a discussion, lecture, and concept mapping using a jigsaw classroom. The students will further explore what they know about the California wetfish fishery, and reflect on things they don't know. Students will be introduced to concept mapping and develop a comprehensive concept map for the wetfish fishery SES.

Estimated class time needed: 2 hours

Class Plan and Activities

Readings Discussion (~15 minutes)

This module begins with a class discussion on the case study and theory readings assigned prior to this module. Students should be given the student handout explaining the case and including the “hook” before the discussion class period. All students should have 6 questions taken from the readings to contribute to the discussion. With a small class, discussions can be done as one group, with a larger class, instructors can split students up as they see fit. Instructors can use the following table to ensure that the class knows some of the very basic (but very important) characteristics of the wetfish fishery.

	Monterey Bay Fishery		
	Market Squid	Northern Anchovy	Pacific Sardine
Primary management authority	State	Federal	Federal
FMP implementation	2005	1978	2000
Limited entry implementation	1998	2000	2000
Limited entry permit type	Squid	CPS Finfish	CPS Finfish
Number of permits, 2013*	76	61	61
Number of resident vessels	~10	~10	~10
Number of resident seafood buyers in area	4	4	4
Primary gear	Round haul net	Round haul net	Round haul net
Peak season	Spring/Summer	Fall	Fall
Preferred oceanographic regime	Cooler	Cooler	Warmer
Spawning habitat	Nearshore	Nearshore	Offshore
Primary market destination	China	Domestic US	Japan/Australia
Average ex-vessel price, 1974-2012 (\$/lb)	0.245	0.062	0.148

Table 1. Key features of the commercial fisheries that comprise the interconnected Monterey Bay wetfish fisheries system (directly from Aguilera *et al* 2015). *Available permits does not indicate the number of vessels with landings as some permitted vessels may not participate in a given year. The number of market squid permits applies only to round haul (seine) vessels; light boat and brail vessel permits are issued separately.

Stakeholder List Discussion (~15 minutes)

Students (either in small groups or as a large group) will share stakeholder lists and discuss how those stakeholders fit into Ostrom's framework. The instructor should project a list of the Ostrom first- and second-level variables for students to work with.

Social-Ecological Theory Lecture (~30 minutes)

Depending on the instructor's expertise, he/she may want to give a lecture on social-ecological theory, may want to consider a guest speaker or may want to assign a reading of choice (suggestion: a chapter from Elinor Ostrom's "Governing the Commons" or a chapter from Donella Meadow's "Thinking in Systems"). We find it useful to start a lecture describing what a "wicked problem" is, then delving into S-E systems thinking and how that might help to solve these problems.

Subunit and Master Concept Mapping (~45 minutes)

During this activity, students will use knowledge gained from the readings and lecture, and the stakeholder list that the class developed to create a concept map of the Monterey Bay Wetfish Fishery SE system (see Fig. 3 for an example concept map). Instructors should follow the steps below to complete this activity.

1. Present 3 examples of concept maps to the class for consideration. Emphasize that there is no one correct way to create a concept map and that students should do what makes sense to them. Feel free to search for concept map examples online to show the class. This is a good resource on how and why to construct concept maps:
<http://cmap.ihmc.us/docs/theory-of-concept-maps>
2. Introduce your concept mapping tool of choice. We suggest [CMAP](#), [MentalModeler](#), or [Draw IO](#) as free online tools that students can access.
3. MAPPING OPTION 1:
 - a. Split students into four groups and assign an Ostrom subunit (i.e. Resource system, Resource units, Governance system, or Users) to each group. Allow each group to complete a concept map of that subunit and (if time allows) present these to the class.
 - b. Now take one student from each subunit to create a second set of groups (see descriptions of a jigsaw classroom for details). Each new group (that contains an "expert" from each subunit) will combine the subunits to a Master Concept Map for the case study.
4. MAPPING OPTION 2: Do collaborative mapping as an entire class. Start with suggestions for several nodes on the map and have each student add to the map. Instructors (or a student volunteer) should be mapping in real time, and the map should be projected to the class. The activity should conclude with a Master Concept Map for the case study.

Activity Modifications

- If the class is time limited, instructors can choose to skip the subunit mapping and go directly to the master map activity.
- Instructors that are familiar with the DPSIR framework can present this prior to concept mapping to allow students to better develop directional interactions between map nodes.

Assessment and Rubric

1. Instructor checks that each student comes to class with 6 discussion questions about the reading (3 focused on the historical perspective readings and 3 focused on the SES theory readings).
2. Students came to class with a draft stakeholder list organized into Ostrom's framework, participate in the group discussion of the stakeholder list, and actively contribute to the revision process.
3. At end of class period, all students will write 3 sticky notes: 1) Something new or interesting from today, 2) something I still have questions about, 3) something I understand well. This formative assessment can assist the instructor in gauging teaching effectiveness and ensure that remaining questions are addressed before the next module is started.
4. Instructors should review concept maps during class or have them emailed after class for review. Nodes from each of the Ostrom subunits should be included. Any interactions or nodes that are missing should be discussed before the next module is started (see Fig. 3).
5. (OPTIONAL) Assign a short reflective written piece on the usefulness of systems thinking and the SES framework in their own research. The instructor could pull brief excerpts (anonymous) from the reflections and present these during the next class period to prompt a discussion.

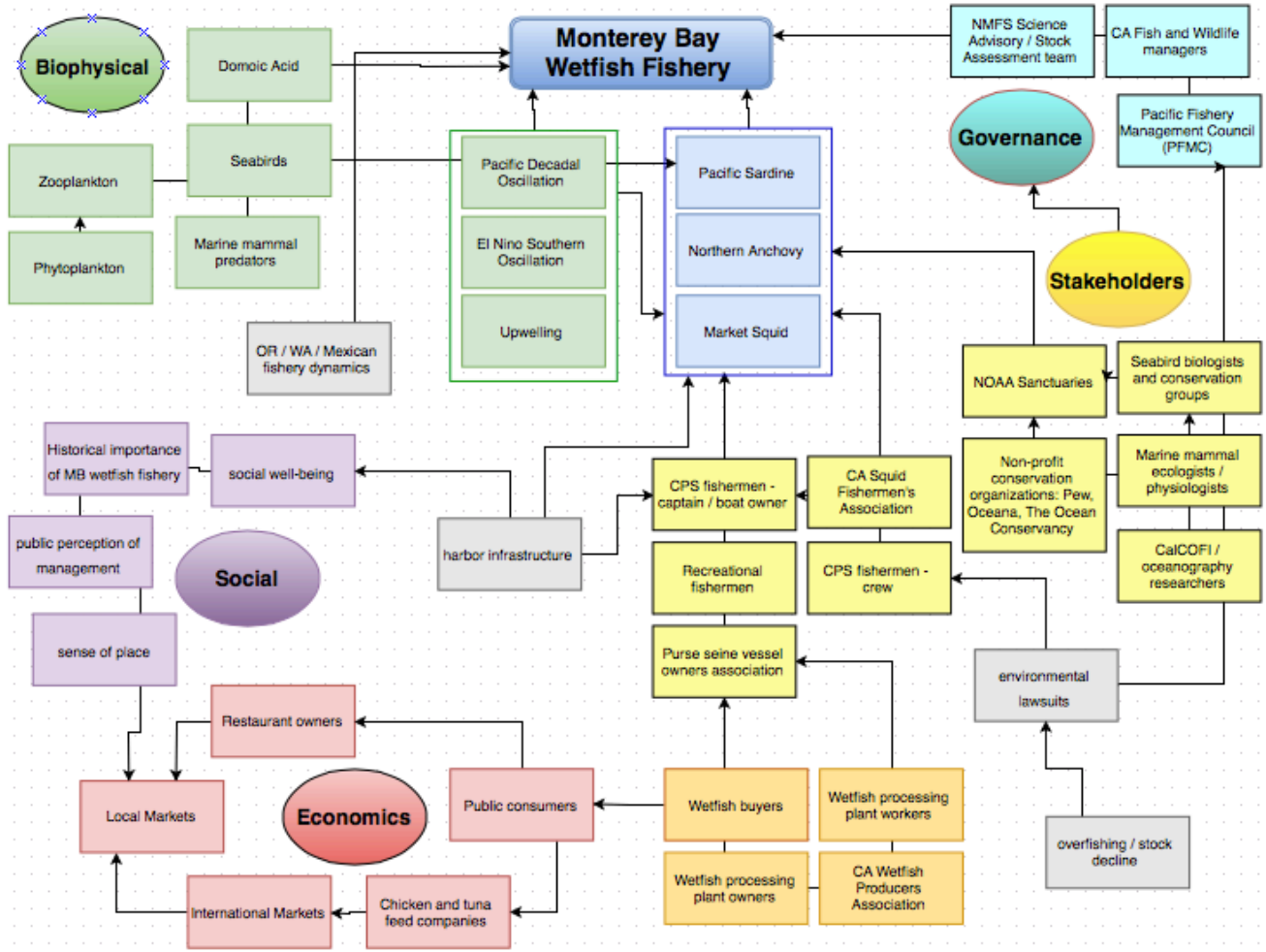


Figure 3. An example concept map (created with Draw IO) for the Monterey Bay wetfish fishery with many stakeholders listed for class reference. Note that not all connections are drawn and that there are many other concept maps that could be created to describe the system!

Photo credit: Marcel Holyoak



Module 2: How do we manage a common pool resource system?

Module Overview

This optional module serves as an opportunity for students to engage in fisheries policy decision-making at a detailed level using the interrupted case study teaching method. The aim is to have students gradually consider the many factors that a natural resource manager would have to examine, and for students to weigh the tradeoffs as a manager would, according to the information available to them. The instructor will begin with a quick overview of the activity and structure of the class period. If the instructor has no or little background in fisheries or in the PFMC Sardine management plan, reading the Coastal Pelagic Species Fishery Management Plan (link provided on page 7) will be helpful for leading the discussions for this module.

Estimated class time needed: 2 hours

Class Plan and Activities

The class period will be divided into 5 steps. The instructor will introduce the question or task for each step, students will engage in small-group discussions and team research, and the class will then convene for each group will present their ideas (1-2 minutes each) and discuss. Before the class continues to the next step, the instructor will present to the class how actual fishery managers thought about the question, and what real-world decision was made.

Students will break into small groups (3-5 students each) with access to at least one computer with internet. The information and resources for each step are included in the Student Handout. However, it is important to only hand out each step one at a time (available on different pages of the handout). Students can also search for sources, and use them to support class presentation points after each small-group breakout discussion. Using all of the resources is not mandatory. It is recommended to encourage students to use the previous background readings during this module.

Suggested Module Timetable

Introduction To Class Period Structure: 5 minutes

Step 1: 15 minutes

Step 2: 20 minutes

Step 3: 20 minutes

Step 4: 25 minutes

Step 5: 20 minutes

Reflection Assignment and Wrap Up: 15 minutes

Total Class Time: 2 hours

Note that these are suggested time blocks, but can vary. This module can be lengthened by giving students more time to prepare each step's presentation. Cutting off each group's end-of-step presentation after 2 minutes is key to keeping on track. A longer class period can allow for longer group presentations.

Activity Details

The instructor will announce that the class will begin with Step 1. The students should be instructed to look at each Student Handout section once that step has begun, and can use materials from previous steps in future steps. Readings are not mandatory, but available to assist students in researching the step's question.

STEP 1.

The Problem: Need to manage fishery or risk collapse. (~15 minutes)

The objective of this step is to bring student's awareness to why fisheries must be managed. This will be the quickest step, but sets the scene for the importance of the mission at hand.

The resources for this section includes:

- a) Ueber, E., MacCall, A. The rise and fall of the California sardine empire. Ch. 3. 31-48.
Link: <https://swfsc.noaa.gov/publications/CR/1992/92104.PDF>
- b) Historical Archives (Provided in Student Handout)

The instructor will ask the question (*suggestion*: use the "Module Step Questions" PowerPoint in the instructor's materials): "What happened in this case? What is the problem?"

Each group will stand and summarize (in 1-2 minutes) what they believe the problem is.

Following presentations, the instructor will discuss answers that fishery managers consider most important. This includes, but is not limited to, a fishery collapsed, the environment/ecosystem was decimated, the economy suffered, the community suffered. If an answer is provided by a group that does not fit the situation, do not discount it, but explain why we are focused on these particular situations. Note that one of the primary drivers for managing the fisheries in California, other than the realization that something bad had happened here in the sardine fishery, is the Magnuson-Stevens Fishery Conservation and Management Act, which has 4 primary objectives: prevent overfishing, rebuild overfished stocks, increase long-term economic and social benefits, and ensure a safe and sustainable supply of seafood.

STEP 2:

How should we manage the sardine fishery? (~20 minutes)

The objective of this step is to allow the students the opportunity to brainstorm management options, and to become aware of the challenging task of choosing how to manage a resource.

The instructor should pose the question to students as, "Now that we know there is a problem in this fishery, how do we fix it? How should we manage the sardine fishery? Be as detailed as possible in your response and explain why you decided how to fix the system."

There is no right or wrong answer to what students come up with. Students are given the chance to read about various strategies from other fishery management plans. We recommend advising students to divide readings among the group and report back to each other to maximize time.

The resources for this section (available but not mandatory) include:

- a) MSY, Maximum Sustainable Yield. Pew. April 2012. 4pp.
Link:
http://www.pewtrusts.org/~media/assets/2015/03/turning_the_tide_msy_explained.pdf
- b) Newell, R., Sanchirico, J., and Kerr, S. Fishing Quota Markets. 53 pp.
Link: <http://www.rff.org/files/sharepoint/WorkImages/Download/RFF-Event-fishing-quota.pdf>
- c) A fishery manager's guidebook. Management measures and their application. FAO. Fisheries Technical Paper 424.
Link: <http://www.fao.org/docrep/015/i0053e/i0053e.pdf>
- d) Coastal Pelagic Species Operational Definitions of Terms (Pages 10-12)
Link:
http://www.westcoast.fisheries.noaa.gov/publications/fishery_management/cps_program/cps_fmp_as_amended_thru_a13_current.pdf
- e) Magnuson Stevens Act
Link:
http://www.nmfs.noaa.gov/msa2005/docs/MSA_amended_msa%20_20070112_FINAL.pdf
- f) Gutierrez, N.L., Hilborn, R., and Defeo, O. (2011) Leadership, social capital and incentives promote successful fisheries. *Nature* 470: 386–389.
Link: <http://www.monitoringmatters.org/articles/Gutierrez.pdf>
- g) World Ocean View, Chapter 6, Exploiting a living resource: Fisheries. 2010.
Link: http://worldoceanreview.com/wp-content/downloads/wor1/WOR1_english.pdf

Each group will present a 2-3 minute management strategy that they would apply to this case. Students can be as detailed as they wish, but a general management strategy and logical reasoning behind their decision is essential. If any group presents “Do nothing” or “Close the fishery”, engage the students in a conversation about why choosing to protect only ecosystems or only the economy would be problematic. Also remind students that the Magnuson-Stevens Act aims to encourage economic and social benefits, while protecting the environment. Encourage the class to develop a compromise from various stakeholder perspectives. Following presentations, the instructor will inform the class that actual sardine managers decided to first manage the fishery through a quota system, and later a limited entry program.

STEP 3:

Determining the quota (~20 minutes)

The objective of this step is for students to discuss how a quota is determined, and the social and ecological implications for a given quota.

The instructor will ask the question: “What should the sardine quota be? How should managers determine what the quota is? What factors are important in determining a quota?”

The resources for this section includes:

- a) Sardine, anchovy, and squid landings and ex vessel revenue

Found at:

<https://www.wildlife.ca.gov/Fishing/Commercial/Landings#26004335-2000>

Hint: Look at Table 18 PUB for the Monterey Area

Other source: http://pacfin.psmfc.org/pacfin_pub/all_species_pub/woc_r308.php

- b) Caddy, J.F., Mahon, R. 1995. Reference points for fisheries management. FAO Fisheries Technical Paper 347.

Link: <http://www.fao.org/docrep/003/v8400e/v8400e00.HTM>

- c) Review of some California Fisheries for 1983. CalCOFI Reports Vol. 25, 1984.

Link: http://www.calcofi.org/publications/calcofireports/v25/Vol_25_Fisheries_Review.pdf

Students should present their ideas (1-2 minutes), but this step may require more full-class discussion time than the previous two steps. The instructor should list the factors that students identified on a white board, then list factors that were not identified but could have been discussed. Such factors can include: highest historical catch, population/stock size, recruitment rate, natural death rate, how many active fishermen/number of permits, accuracy of stock assessments, proportion left for foraging (e.g. marine mammal considerations), increases in technology and fishing efficiency, market demand.

For the full class discussion, the instructor can pose the question: “How do we measure the population and how do we keep track of the quota?” The discussion should focus on ways of measuring and difficulties of data collection. At the end of this full class discussion, the instructor should show three videos: NOAA Sardine Trawling Survey Video (<https://www.youtube.com/watch?v=ebzhXzwwgf60>), NOAA Sardine Acoustics Survey Video (https://www.youtube.com/watch?v=Ls6_fQDfO-A), and if time/interest, NOAA Sampling Eggs at Sea (<https://www.youtube.com/watch?v=6VuRQOu6efA>). These videos detail how data is collected (trawling surveys & acoustic surveys) and discuss assumptions of such methods. If no AV capabilities are available, the instructor can summarize the video, or skip this.

The instructor should then show the students that the managers choose to conduct annual assessments and adapt the quota according to a harvest guideline, overfishing rate, and cutoff. In the instructor’s materials is a list of historical quotas. Provide this to the students at the beginning of your explanation. The harvest guideline (HG) is a specified numerical harvest objective (a range or a point estimate) that may be specified as an annual catch target that is not a quota. Attainment of an HG does not require complete closure of a fishery. HGs are used for the domestic fishery because bycatch of one CPS is common when fishing for another, and curtailing the harvest of one species may limit the harvest of another and prevent achieving target harvest levels. The harvest guideline provides an estimate for the managers to then decide what the seasonal commercial fishery quota should be. This quota is then allocated in three seasons: July 1 to September 14, September 15 to December 31, and January 1 to June 30. The seasonal quota may be adjusted according to new information.

STEP 4:

What variables go into a harvest guideline and a cutoff? How do you decide what these numbers should be? (~25 minutes)

The objective of step 4 is to further investigate the diversity of metrics that can be incorporated into a fishery plan. The instructor should encourage students to think from an interdisciplinary lens, and to consider social and ecological factors.

The question for students in this step is: “What variables or factors should go into a harvest guideline? What variables or factors should go into a cutoff? How should managers decide what these numbers should be? If you have time, what do you think the numbers should be?”

The resources for this section include:

- a) Historical quota allocations (provided in Student Handout)
- b) “Fishery Managers Scale Back Sardine Harvest” by Terry Dillman, Dec 1 2013 in *Fishermen’s News* Link: <http://www.fishermensnews.com/story/2013/12/01/features/fishery-managers-scale-back-sardine-harvest/225.html>
- c) Dowling, NA et al. (2015) Guidelines for developing formal harvest strategies for data-poor species and fisheries. *Fisheries Research* 171: 130-140.
Link:
https://www.researchgate.net/publication/282936482_Guidelines_for_developing_formal_harvest_strategies_for_data-poor_species_and_fisheries

The students should present a list of which variables they would add into a harvest guideline and a cutoff, and what they think the limits should be in 2-3 minutes.

The instructor will then summarize what students presented, then give an explanation of how this fishery is actually managed. Depending on how students answered, this may be more of an overview than a lesson. The instructor will show the harvest guideline equation, show the options to harvest guideline and cutoffs before decisions were made, and describe the various components that were integrated into the sardine management plan (e.g. what is biomass? what is fraction? what is distribution?). Information for guiding this overview/lesson is provided as a PowerPoint.

STEP 5:

Should any of the current model variables be changed? (~20 minutes)

Step 5 requires forward thinking and creative answers by students since it is assessing the current situation and does not have an “answer” based on what scientists and managers have done. The objective is to allow students the opportunity to critically determine if the current course of action is the best course, according to their newly gained knowledge. Encourage students to use all materials from this module and previous ones to gather information and assess the situation.

The question for the students in this step is: “Knowing the history of this fishery, and how managers decided to manage the fishery, would you change any aspect? Would you remove or add any variables? Change any structural aspect to the management plan? If so, what would you

change, why, and what would the new management look like? If not, why are you satisfied with the current management system?"

The resources for this section include:

- a. Assessment of the Pacific Sardine Resource in 2015 for USA Management in 2015-16
Link: http://www.pcouncil.org/wp-content/uploads/2015/03/G1a_ExecSumSardine_Assessment_Print_APR2015BB.pdf
- b. Draft Report of the Pacific Sardine Harvest Parameters Workshop
Link: http://www.pcouncil.org/wp-content/uploads/I1b_ATT1_SARDINE_WKSHP_RPT_APR2013BB.pdf
- c. Oceana's "The Modern Day Pacific Sardine Collapse: How to Stop Overfishing and Prevent a Future Crisis" April 8 2015
Link: <http://usa.oceana.org/predators-prey/modern-day-pacific-sardine-collapse-how-stop-overfishing-and-prevent-future-crisis>
- d. Sardine population growing significantly. Monterey Herald. Diane Pleschner-Steele, 2012
Link: <http://www.montereyherald.com/general-news/20120610/diane-pleschner-steele-sardine-population-growing-significantly>
- e. Abraham, K. 2015 Feds vote to close sardine fishery ASAP. Monterey County Weekly.
http://www.montereycountyweekly.com/blogs/news_blog/feds-vote-to-close-sardine-fishery-asap/article_e4fcf67e-e460-11e4-8842-af67d385fc88.html
Coastal Pelagic Species Fishery Management Plan and Amendments
Link: <http://www.pcouncil.org/coastal-pelagic-species/fishery-management-plan-and-amendments/>
- f. Sardine Public Comment
 - i. http://www.pcouncil.org/wp-content/uploads/2015/03/B1b_OpenPubComment3_OceanaSardine_APR2015BB.pdf
 - ii. Pages 25-32 found at:
ftp://ftp.pcouncil.org/pub/Briefing%20Books/ADVANCE_BB_BY_SECTION/September_2014/C_Coastal_Pelagic_Species_Management_Sept2014.pdf
- g. Council Votes to Close 2015-2016 Pacific Sardine Fishery. PFMC.
Link: <http://www.pcouncil.org/2015/04/36387/council-votes-to-close-2015-2016-pacific-sardine-fishery/>
- h. Fimrite, P. 2015. Sardine population collapses, prompting ban on commercial fishing. SF Gate.
Link: <http://www.sfgate.com/bayarea/article/Sardine-population-collapses-prompts-ban-on-6197380.php>

Students will present their answer (2-3 minutes), but this step does not require the instructor to follow up with a "real world" answer. The instructor can inform the class that managers have considered integrating more environmental variables and changing the sea surface temperature (SST) source to be from the Scripps pier to the CalCOFI transects, but are looking at other ways to incorporate SST.

Assignment (~10 minutes)

The last 10 minutes of class will be dedicated to a reflection based on the prompt below. The instructor should tell students that there is no right or wrong answer, but to be thorough in their reasoning.

In 10 minutes, address each of the following questions. Be sure to answer each of the 5 questions and elaborate on your ideas. You will be graded on this assignment for your level of thought and detailed accounts.

1. What surprised you in this activity?
2. What did not surprise you?
3. What did you learn?
4. What did you find confusing?
5. What do you still have questions about?

Conclusions (~5 minutes)

Once the reflections are turned in to the instructor, a final hopeful take-away message can be expressed to the class. There are many factors to take into consideration in a management plan, but such allocations are still contentious even though the wetfish fishery is considered relatively successful.

List of Materials for Instructor to Prepare

1. PowerPoint presentation with each new slide containing the questions for students in each step (provided for you), or a list of each question in order for the instructor to write each on a chalk or whiteboard at the front of the room.
2. Materials to present to students at end of step discussions.
 - a. Sardine Management Equation PowerPoint
 - b. NOAA videos (NOAA Sardine Trawling Survey Video (<https://www.youtube.com/watch?v=ebzhXzwgf60>), NOAA Sardine Acoustics Survey Video (https://www.youtube.com/watch?v=Ls6_fQDfO-A), NOAA Sampling Eggs at Sea (<https://www.youtube.com/watch?v=6VuRQOu6efA>)) (requires visual/audio capabilities, but videos are optional)
 - c. Options to harvest guideline and cutoffs before decisions were made (provided in PowerPoint)
3. Student Handout Module 2 Assignment
4. Printed Student Handouts, divided into each step to hand out one at a time. Resources for the activity are broken down as follows:

Activity Step	Resources
Step 1	<p>Ueber, E., MacCall, A. The rise and fall of the California sardine empire. Ch. 3. 31-48.</p> <p>Historical Archives</p>
Step 2	<p>MSY, Maximum Sustainable Yield. Pew. April 2012. 4pp.</p> <p>Newell, R., Sanchirico, J., and Kerr, S. Fishing Quota Markets. 53 pp.</p> <p>A fishery manager’s guidebook. Management measures and their application. FAO. Fisheries Technical Paper 424.</p> <p>Coastal Pelagic Species Operational Definitions of Terms</p> <p>Magnuson Stevens Act</p> <p>Gutierrez, N.L., Hilborn, R., and Defeo, O. (2011) Leadership, social capital and incentives promote successful fisheries. Nature 470: 386–389.</p> <p>World Ocean View, Chapter 6, Exploiting a living resource: Fisheries. 2010.</p>
Step 3	<p>Sardine, anchovy, and squid landings and ex vessel revenue</p> <p>Caddy, J.F., Mahon, R. 1995. Reference points for fisheries management. FAO Fisheries Technical Paper 347.</p> <p>Review of some California Fisheries for 1983. CalCOFI Reports Vol. 25, 1984.</p>
Step 4	<p>Historical quota allocations</p> <p>“Fishery Managers Scale Back Sardine Harvest” by Terry Dillman, Dec 1 2013 in Fishermen’s News</p> <p>Dowling, NA et al. (2015) Guidelines for developing formal harvest strategies for data-poor species and fisheries. Fisheries Research 171: 130-140.</p>
Step 5	<p>Assessment of Pacific Sardine Resource in 2015 for Management in 2015-16</p> <p>Draft Report of the Pacific Sardine Harvest Parameters Workshop</p> <p>Oceana’s “The Modern Day Pacific Sardine Collapse: How to Stop Overfishing and Prevent a Future Crisis” April 8 2015</p> <p>Sardine population growing significantly. Diane Pleschner-Steele, 2012</p> <p>Abraham, K. 2-15 Feds vote to close sardine fishery ASAP. Monterey County.</p> <p>Coastal Pelagic Species Fishery Management Plan</p> <p>Sardine Public Comment.</p> <p>Council Votes to Close 2015-2016 Pacific Sardine Fishery</p> <p>Fimrite, P. 2015. Sardine population collapses, prompting ban on commercial fishing. SF Gate.</p>

Assessment and Rubric

1. Small group discussions: instructor will float among small-group discussions and be available for questions. Each student should be engaged and actively participating in their group.
2. Full class discussions: students are either actively participating or actively listening.
3. Module 2 assignment: at the end of class, students will complete and hand in a reflection on the day's activity. Instructor can use the following rubric to evaluate responses:
 - Did the student turn in the assignment? 1 points
 - Did the student answer each of the 5 questions? 1 point
 - Did the student's responses reflect or exceed the level of discussion during class? 3 points
 - Did the student provide accurate information? 2 point
 - Did the student provide relevant information to the case study? 3 points

10 points total

Photo credit: Stacy Aguilera



The transfer of market squid from vessel to truck on Monterey Bay commercial wharf

Module 3: Decisions, decisions, decisions - voting on squid quota options

Module Overview

This optional module aims to stimulate higher level thinking of the students by allowing students to become knowledgeable about one aspect of a fishery management decision that they then teach to their peers. Here students are expected to take multiple stakeholders into consideration, weigh various pros and cons of management decisions, determine the 'winners' and the 'losers', and understand the assumptions and implications of a real-life management ruling. This module takes an in-depth look into a decision the Market Squid managers had to make while the Market Squid Fishery Management Plan was being created in 2005. It was agreed that the squid fishery should have a quota or catch limit, but what that quota should be and if it should be flexible, was highly debated. Students should be broken into 7 small groups (number per group depends on class size) for the activities detailed below.

Estimated class time needed: 1.5 hours

Class Plan and Activities

First, each group will be assigned to 1 of the 7 quota options, which include:

A.1 Statewide seasonal catch limit of 80,000 tons

- *Option A.1: Establish a statewide seasonal catch limitation of 80,000 tons. This seasonal catch limitation is based on the seasonal catch limitation using the 3-year recent average catch from the 1999-2000 to 2001-2002 seasons with the assumption that the stock is below BMSY (average spawning biomass) and above MSST (minimum stock size threshold). This approach uses a multiplier of 0.67. Under this option, a maximum statewide seasonal catch limitation of 80,000 tons would be implemented.*

A.2 Statewide seasonal catch of 118,000 tons

- *Option A.2 (proposed action): Establish a statewide seasonal catch limitation of 118,000 tons. This seasonal catch limitation is based on the recent average catch and the assumption that the stock is above the BMSY. This approach uses a multiplier of 1.0. Under Option A.2, a maximum seasonal catch limitation of 118,000 would be implemented.*

A.3 Regional seasonal catch limit based on multi-year averages

- *Option A.3: Establish regional seasonal catch limitations based on either a multi-year recent average catch for each region with the assumption that the stock is above BMSY. The regions would be north and south of Point Conception.*

A.4 Statewide seasonal catch limit based on environmental conditions

- *Option A.4: Establish a statewide seasonal catch limitation based on environmental conditions as recommended by the SRSC: a seasonal harvest of 115,000 tons in a non-El Niño period and a landings cap of 11,000 tons during an El Niño period.*

A.5 *Statewide seasonal catch of 125,000 tons (status quo)*

- *Option A.5 (status quo): Establish a statewide seasonal catch limitation of 125,000 tons, a value in close proximity to the highest catch on record.*

A.6 *No seasonal catch limitation**

- *Option A.6: Do not set a seasonal catch limitation. The SFAC did not support any landings limit. Most fishers and processors opposed the landings limit. There was speculation that the likelihood of repeating a catch of 125,000 tons in a season is unlikely given the implementation of weekend closures. Landings for the 2001-2002 season were 123,411, which was 98.7 percent of the limit.*

A.7 *Establish a seasonal catch limitation of between 24,000 -125,000 tons*

- *Option A.7: Establish a seasonal catch limitation of between 24,000 to 125,000 tons (as directed by the Commission, 1 August 2003). The maximum value (125,000 tons) represents the current interim regulation, while the minimum value represents a 6 year average of seasonal landings from the 1997-1998 to 2002-2003 seasons and the assumption that the stock is below the MSST. The primary purpose of this option is to give the Commission greater flexibility in determining a seasonal catch limitation with a level of protection they are comfortable with.*

The students are tasked with answering 7 questions pertaining to their respective quota option. The seven questions are as follows:

- 1) Who are the 'winners' of this option?
- 2) Who are the 'losers' of this option?
- 3) What are other indirect benefits of this option?
- 4) What are other associated opportunity costs?
- 5) What are the limitations and assumptions of this option?
- 6) What data exists that can help inform why this option should be voted for?
- 7) What data would be helpful to inform about this option, but does not exist?

Each group will write out their answers on a large piece of paper. Students will be given a list of materials they can use to answer the questions, but are welcomed to find sources on their own. Using all of the resources is not mandatory.

The instructor will give the students the student handout that includes the "Options for Establishing a Seasonal Catch Limitation". Explain that while the Market Squid Fishery Management Plan was being created, there was a public comment period, and these 7 options were all proposed. Only one of them was actually implemented, but they were all seriously considered. Inform the students that at the end of the class period, they will have an opportunity to defend their option to the class, and then they will be voting on which option they would implement if they were a fishery manager. An important piece of information for the students is to only consider data through 2005 (since the decision was made in that year). At the end of the class period, the option chosen by managers will be revealed.

Suggested Module Timetable

Introduction To Class Period Structure and Case: 10 minutes

Group research to answer 7 questions: 30 minutes

Class Walk Around *or* Jigsaw: 20 minutes

Voting Activity: 5 minutes

Wrap Up of Actual Option Implemented: 10 minutes

Writing Assignment: 15 minutes

Total Class Time: 1.5 hours

Note that these are suggested time blocks, and can vary. This module can be lengthened by giving students more time to answer each question or by allowing longer group statements.

Class Decision Making / Jigsaw Activity

Students are given 30 minutes to complete their answers. While there are no right or wrong answers, answers should be thorough, logical, and have a reasonable explanation. Once all answers are written, students are given 20 minutes to walk around the room and see how each group answered. If there are more than 14 students in the class (i.e. more than 2 students per group), a jigsaw structure can be used, where one student from each option forms a group (making groups of 7 students). In these 7-student groups, each student reports on their option. This “each one teach one” activity aims to actively involve each student.

Once each student has seen the seven responses, reconvene the class. Allow each student group the opportunity (2-4 minutes) to explain why their option should be implemented and why the class should vote for their option. Once each group has completed their final statements, start the voting. Students should close their eyes/put their head down so as to not be persuaded by their classmates. Tally which option received the most votes, then inform the students that Option A.2 was actually implemented.

If interested, the instructor can share the Department’s responses to public comments on why option A.2 was implemented (these can be found in the Market Squid FMP under the public comment sections and are included in the teaching resources of this case study).

Assignment

In a few pages, answer the following questions regarding the squid quota options activity.

1. What outside-class assumptions and experiences influenced how you thought about the various options?
2. What data and information was helpful in making you decide on an option?
3. Which values did you compare and contrast and did you rank any values higher than others? If so, what was your reasoning?
4. From this activity, what can you say are some of the largest challenges a fishery manager faces?
5. Which of Ostrom’s variables play a role in this decision? Pick at least 5 variables, describe what they are, and describe what they look like in this system and/or the role they play (Ostrom 2009).

Resources Available to Students:

- Squid landings (until 2005) (provided in Student Handout)
- CPUE (catch per unit effort) (until 2005) (provided in Student Handout)
- Number of squid processors (until 2005) (provided in Student Handout)
- Number of squid permitted vessels (until 2005) (provided in Student Handout)
- Market price of squid (until 2005) (provided in Student Handout)
- Amount of California squid exports (until 2005) (provided in Student Handout)
- Value of California squid exports (until 2005) (provided in Student Handout)
- PDO Index, source: JISAO, University of Washington
Link: <http://research.jisao.washington.edu/pdo/PDO.latest>
- Pacific Decadal Oscillation Explanation, source: JISAO, University of Washington
Link: <http://research.jisao.washington.edu/pdo/>
- MEI (ENSO) Index, source: ESRL, NOAA
Link: <http://www.esrl.noaa.gov/psd/enso/mei/table.html>
- Earth System Research Laboratory MEI Explanation
Link: <http://www.esrl.noaa.gov/psd/enso/mei/>
- Pomeroy, C., M. Hunter, and M. Los Huertos. (2002) Socio-Economic Profile of the California Wetfish Industry. In California's "Wetfish" Industry: Its Importance Past, Present and Future, D.B. Pleschner, ed. Santa Barbara, CA: California Seafood Council. 46 pp.
Link: https://caseagrant.ucsd.edu/sites/default/files/67570_0.pdf
- Rogers-Bennett, L (2003) Environmental Variability and its impact on invertebrate fisheries. CalCOFI Report Vol. 45, 63-64.
Link: http://calcofi.org/publications/calcofireports/v45/Vol_45_Symposium.pdf
- Sweetnam, D (ed.) (2005) Review of Some California Fisheries for 2004: Coastal Pelagic Finfish, Market Squid, Sea urchin, lobster, spot and ridgeback prawn, groundfish, highly migratory species, ocean salmon, nearshore live-fish, pacific herring, and recreational. CalCOFI Report Vol. 46, 10-31.
Link: http://www.calcofi.org/publications/calcofireports/v46/Vol_46_Fisheries_Review.pdf
- Schultz, K. (1984) Area fishermen file for relief after El Nino empties pockets. MPH. (provided in Student Handout)
- Pomeroy, C., and M. Fitz Simmons. (2001) Socio-Economic Organization of the California Market Squid Fishery: Assessment for Optimal Resource Management. California Sea Grant Project R/MA-39. 10 pp.
Link:
http://www.psmfc.org/efin/docs/otherpublications/Pomeroy_&_FitzSimmons_2001.pdf
- Vojkovich, M. (1998). The California Fishery for Market Squid (*Loligo opalescens*). CalCOFI Report Vol 39, 55-60.
Link: http://www.calcofi.org/publications/calcofireports/v39/Vol_39_Vojkovich.pdf
- Sullivan, W. (1988) New Theory on El Nino's Origin. The New York Times.
Link: <http://www.nytimes.com/1988/11/29/science/theory-ties-earthquakes-in-pacific-to-el-nino.html>
- Talking Squid, 1988, Herald. (provided in Student Handout)
- Scutro, A. (2003) Squid Reeled In. The Weekly (provided in Student Handout)

- Weber, T., Dworkin, P. (1985) Monterey Bay's Empty Squid Nets. The San Francisco Chronicle. (provided in Student Handout)
- Bowe, M (1962) The Catch Has Changed - Fishermen Still Fish. Mercury. (provided in Student Handout)
- Monterey Bay Facing Squid Shortage (1973). MPH. (provided in Student Handout)
- Papineau, A. (1985) Squid: it's time we took this mollusc seriously. The Carmel Pine Cone. (provided in Student Handout)

List of Materials for Instructor to Prepare

1. Student Handout for Module 3
2. Student Handout for Module 3 Assignment
3. Student Handout for Post-Module 3

Assessment and Rubric

1. Small Group Activity: During class period, instructor will ensure each of the seven questions are comprehensively addressed and answers are logical.
2. Voting Activity: Instructor will ensure that each student participates in voting activity.
3. Module 3 assignment: for the voting reflection, each student will turn in a written piece which addresses each question and provides thorough and reasonable answers. Answers can be graded using this rubric:
 - Did the student answer each question? 1 point
 - Did the responses reflect class discussion material and level? 3 points
 - Were the data and specific information used credible and attributed to the correct sources? 1 point
 - Were the management challenges described within reason? 1 point
 - Were more than one management challenge described? 1 point
 - Were Ostrom's variable explanations accurate according to Ostromonian literature? 3 points

10 points total



Module 4: Using qualitative data to make
management decisions: allocating squid
fishery permits

Module Overview

This optional module aims to introduce students to qualitative data analysis, especially data in the form of public comments and stakeholder opinions. The context for this module is an actual decision that fisheries managers made regarding who was eligible for market squid fishery permits. This module is largely done by students outside of class, though an in-class discussion is included. Content from this module will be used in a section of Module 5.

Estimated class time needed: 30 minutes

Class Plan and Activities

Students will review (scanning or reading portions of the document is acceptable) the Public Comment to the Market Squid FMP prior to class and select three comments that they find particularly interesting. For example, students might look for seemingly valid or outrageous comments, two comments that seem contradictory, comments that do or do not fit their preconceived notions about the stakeholder that submitted the comment, or comments that otherwise might spark discussion or be important to consider during a decision-making process. (Public Comment Link: <https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=33599&inline=true>). The only preparation is distributing the student handout to the students prior to class.

Students should consider the following questions to further prepare for the class discussion. The instructor can also use these questions to structure the discussion.

1. Do any of the stakeholders seem more credible than others? Why? Think critically about how your background and experiences might influence this opinion.
2. Do you empathize with a group of stakeholders more than the others? Why do you think this is?
3. Do you feel that public comment is an effective way to communicate with policy makers?
4. Does this new form of information (public comments) change your opinion of the wetfish fishery management issue in any way? Why or why not?
5. Can you find common ground among stakeholders? Do you think is a starting point for compromise in a decision-making process?

Assessment

In module 4, students will be evaluated only on preparation for the discussion and active class participation. Instructors should prepare and ask probing questions during the discussion to determine whether students are thinking critically about the case study, linking concepts learned in other modules, and engaging in discussion that highlights the complexity of the S-E system. Instructors should make it clear that they don't know all the answers to the questions posed either!



Photo credit: Rainer Zenz

Module 5: Pacific Fisheries Management Council meeting

Module Overview

This two-day module applies the problem-based case study method to a mock council meeting, where one day is dedicated to preparing for the meeting, and the next day is dedicated to the actual meeting. This module was designed to encourage students to fully understand the context and reasoning behind one stakeholder's perspective, to acknowledge the viewpoints of various stakeholders, and to recognize the complexity of common pool resource system negotiations.

Estimated class time needed: 3 hours over 2 class periods

Day 1: Class Plan and Activities

The instructor will begin by dividing students into various stakeholder groups. Groups should consist of 3-6 students, but this will depend on the class size. Each group will sit in a different section of the class (allow time for students to rearrange seating locations) and will be assigned a Stakeholder. Students can find the details of their stakeholder in the Student Handout, which should be given at the beginning of the class period. The class should be informed of the other stakeholders that will be present at the Council meeting. The stakeholders groups are:

Group 1: Permitted CPS (and Squid) fishermen

Group 2: Wetfish Producers Association

Group 3: NMFS stock assessment scientist

Group 4: Oceana staff

Group 5: Pew scientist

Optional additional groups (if larger class size):

Group 6: University Ecologists

Group 7: Sea Grant social scientists

Group 8: Monterey Bay City Council

Group 9: Monterey Bay National Marine Sanctuaries Office

Group 10: Cannery Row Wharf Restaurant Owner

Once students are sitting with their respective stakeholder group, the instructor will introduce her or himself as the Pacific Fishery Management Council Executive Director and explain that the next class period will be a Council Meeting. At this meeting, each stakeholder group will have no more than 10 minutes to present their data and defend their position to the Council on several issues.

The format of the meeting will be:

- 10 minutes / group for initial presentations and viewpoints
- 5 minutes / group for responses to initial presentations (or 3 minutes)
- 5 minutes / group for a final rebuttal and closing argument (or 3 minutes)

Inform students that once the 10 or 5-minute mark has passed, they will be immediately cut off and the Council will hear from the next stakeholder. The stakeholder groups have this current class period to research, develop arguments, collect evidence and materials, and prepare for the Council presentation.

The instructor will ensure that students have access to a paper or digital copy of “Council Meeting Instructions for Students”, found in the case study materials. This document details the council decisions that will be researched and voted on as part of this module. Students will have the majority of the class period to research and prepare their presentations for the mock Council meeting. Inform students they should access reading materials from previous modules. If all modules were not conducted for this group of students, give them access to the Student Handouts from the other modules for access to additional resources.

Suggested Module Timetable

Introduction to case & council meeting structure: 10 minutes

Assignment of Groups and Reshuffling Class: 5 minutes

Small-Group Research and Presentation Preparation: 60 minutes

Writing Assignment: 15 minutes

Total Class Time: 1.5 hours

Note that these are suggested time blocks, and can vary. The written response can be completed out of class.

Assignment

15 minutes before class ends, have the students complete a short written response addressing the following questions:

- a) What data sources, information, and tools do you want/need prior to the hearing?
- b) What do we know about the dynamics of the wetfish fishery S-E System?
- c) What are the knowledge gaps?
- d) What are the factors to consider when reviewing data, sources, and preparing your argument?

Readings Available to Students (not mandatory, but helpful for discussion)

- Pleschner, DB (2015) Another View: Sardine population isn't crashing. The Sacramento Bee
Link: <http://www.sacbee.com/opinion/op-ed/soapbox/article19165350.html>
- Abraham, K. (2013) Oceana Takes Small Win, Bigger Loss in Forage Fish Lawsuit. Monterey County Now.
Link: http://www.montereycountyweekly.com/blogs/animal_blog/oceana-takes-small-win-bigger-loss-in-forage-fish-lawsuit/article_737dda56-ade6-54ee-b457-4536a44a6933.html
- Market Price of Sardine in the Monterey, Santa Cruz, and Moss Landing Ports 1975-2012 (provided in Student Handout)
- Amount of Sardine Exported From the State of California 1975-2012 (provided in Student Handout)

- Value of Sardine Exported From the State of California 1975-2012 (provided in Student Handout)
- Ex-vessel value for Sardine Fishery (1980-2012) (provided in Student Handout)
- Court Rules in Favor of Fishing Families and Local Seafood Processors Throughout California (2013) TPG Online Daily
Link: <http://www.tpgonlinedaily.com/court-rules-in-favor-of-fishing-families-and-local-seafood-processors-throughout-california/>
- Pew (2013) The state of the science: Forage fish in the California current. Scientific Report. 20 pp.
Link:
http://www.pewtrusts.org/~media/legacy/uploadedfiles/peg/publications/other_resource/the20state20of20the20science2020forage20fish20in20the20california20currentpdf.pdf
- City of Monterey Fishing Community Sustainability Plan (2013) Lisa Wise Consulting, INC. 85 pp.
Link: http://www.smharbor.com/harbordistrict/packets/03182015_8a1.pdf

Day 1: List of Materials for Instructor to Prepare

1. Stakeholder group assignments
2. Student Handout
3. Student Handout: Assignment

Day 1: Assessment and Rubric

1. Council Preparation: The instructor should walk around the room and check to see if each student is actively engaged in the small-group discussion.
2. Assignment #7: The short written response will be thorough, correctly use S-E System terms, and provide credible data and information.

Module 5 Rubric (day 1):

- Did the student answer each question? 1 point
 - Were data and other information credible and correctly cited? 2 points
 - Did the description of S-E System dynamics contain all Ostrom subunits? 2 points
 - Are responses logical and provide credible reasoning? 1 point
- 5 points total*

Day 2: Class Plan and Activities

This class period is dedicated to the mock Council meeting. The instructor should begin class wearing the “Pacific Fishery Management Council Executive Director” hat, instead of class instructor. One suggestion is to come to class dressed in formal business attire wearing a fake name-tag that says executive director.

Each stakeholder group will be called one by one to the “podium” (if no podium is available, place a desk or table at the front). Each stakeholder group will present their initial statements in 10 minutes. Stakeholders can present as a group or select a representative from their group to present their positions. Once every stakeholder has presented, the class will have the opportunity to break into small groups again and in 5 minutes, groups will prepare a response which they will then one at a time present to the class (each response is a maximum 5 minutes). After this first set of rebuttals, if any stakeholder wishes, they may take a maximum of 5 minutes for last responses and a final attempt to convince the Council to vote in their favor. Inform students you will cut them off at 10/5-minute mark and they must stop speaking at that moment. The Council will vote on each of the issues at the end of the meeting, and stakeholders can address any or all of them in their presentations.

Once the final rebuttals have been given, the instructor will announce that the Council needs a few minutes to vote on the issues. The Council should vote according to the best arguments, not what was actually decided upon by the true Council, then share the decisions with the class. The instructor should take a minute to explain that during real Council meetings, most stakeholders get about 3 minutes total to defend their points, and sometimes add a letter. Before finishing class with the final assignment, give the class 5 minutes to fill out the small-group assessment cards (in Student Handout), rating each group member on their contributions.

Suggested Module Timetable

Reminder of council meeting structure: 5 minutes

First Set of Stakeholder Presentations: ~60 minutes

First Set of Rebuttals: ~25 minutes

Rebuttals and Concluding Remarks: ~20 minutes

Council Vote: 5 minutes

Small-Group Assessment: 5 minutes

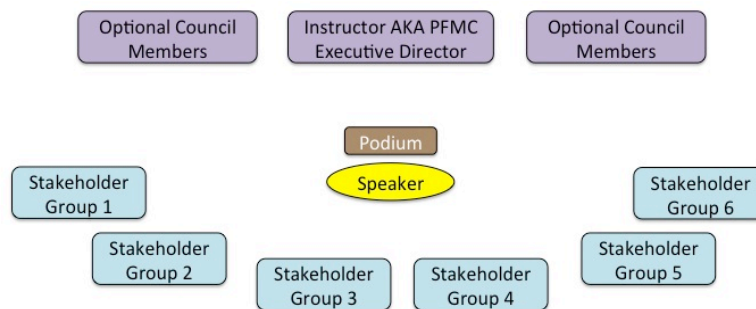
Total Class Time: 2 hours

If there are many stakeholder groups, consider shortening the time each group presents to the Council. The written response can be completed in or out of class.

Council Meeting Seating Arrangement Example

Before this class period begins, ask other instructors or students outside class if they would like to be Council members during this mock meeting. These Council members would listen to each stakeholder group, then vote on each issue at the end of the presentations. If other members are

unavailable, the instructor can vote. If a podium is available to the instructor, place it in the middle of the room. If not, use a table or instruct students were to stand when speaking to the Council. Only the students at the podium are allowed to speak.



Assignment

At the end of the class period, the instructor will introduce the following final assignment. If there are 20 minutes left at the end of class, students can complete and turn this in before leaving class.

Final assignment: Congratulations on defending your position to the Pacific Fisheries Management Council. While the Council may or may not have voted in your favor, your participation in a public hearing plays an important role in how we manage our natural resources. In a few pages, please respond to each of the following questions:

1. What was your stakeholder, what were their primary interests, what were their positions on the issues being voted upon, and why did they hold this position?
2. Pick one other stakeholder that was present during the Council meeting, and discuss the same points (what were their primary interests, what were their positions on the issues being voted upon, and why did they hold this position?).
3. What are the various scales of this system?
4. How might components of the S-E system interact differently in the future? In a different region? Under a different management system?
5. From your reading and research, is the goal of this management aligned with the value systems of any or all stakeholders that participated? Was this a component of the meeting discussion? If so, how? If not, why do you think that is? Properly cite your sources.
6. Do you think a different decision would have been reached if any of the stakeholders (representing components of the S-E System) were not present?

Day 2: List of Materials for Instructor to Prepare

- “Executive Director” name tag
- A timekeeper (e.g. watch) (to cut off students who go past the 10 or 5 minute mark)
- Student Handout: Small-Group Evaluations
- Student Handout: Assignment

Day 2: Assessment and Rubric

1. Mock Council Meeting: Instructor ensures that each student is present and engaged in their small-group activities. The mock meeting should have a professional demeanor and students should use data and legitimate sources to defend their positions.
2. Assignment #8: The written assignment should be complete, and reflect higher level thinking. Answers should be thorough, logical, and reflect the class activity.
3. Student Small Group Evaluations: Student ratings of each other's contribution levels will be taken into consideration, and students will be graded according to results.

Module 5 Rubric (day 2):

Council Meeting Presentations

- Was the student actively engaged in the mock Council meeting (not necessarily the one presenting, but was present, listening, and when appropriate, supporting other team members)? 5 points
 - Did each group provide data, credible information, and logical reasoning during their presentation? 5 points
 - Was the presentation delivered in a professional and succinct manner? 5 points
- 15 points total*

Written Assignment

- Q1) Did the description of their stakeholder's position include logical reasoning as to why that stakeholder holds a certain position? 1 point
 - Q2) Was the description of the other stakeholder's position accurate and reflect that group's presentation? 2 points
 - Q3) Did the student identify local (participants), national (managers), and global (market) levels? 2 points
 - Q4) Did the student use all of the S-E System subunits, and use each correctly according to the literature and lecture material? 2 points
 - Q5) Are the responses supported by credible information from credible sources? 2 points
 - Q6) Question is answered and a logical reasoning is provided. 1 point
- 10 points total*

Small Group Evaluations

- For each student, their score is the average of what each student in their group rated them (e.g. a 4, 3, 5, and 5 would total a score of 4.25).
- 5 points total*

Note from the Authors

We are very interested in making ongoing revisions based on student and instructor feedback. Please contact us if you have questions about the module, if you're interested in using the module in your classroom or if you have taught this module and are willing to give feedback.

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Acknowledgements

The authors would like to thank the National Socio-Environmental Synthesis Center (SESYNC) for the opportunity to attend the 2015 short course on teaching socio-environmental synthesis. We would also like to acknowledge other members of the course that contributed both their time in the review of the module, and their creative teaching ideas during the short course.

This work was supported by the National Socio-Environmental Synthesis Center (SESYNC) under funding received from the National Science Foundation DBI-1052875.

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