

Voices of the Bay Fisheries Education – Balance in the Bay

PowerPoint Notes

Slide 1: Balance in the Bay

We are going to use this presentation to gain more background information about ecosystem-based management and the California market squid fishery.

Slide 2: Fisheries Management

Fisheries management works to sustain the greatest number of boats for the longest period of time while maintaining a healthy fish population. This can be a large challenge!

It is important to account for all factors – biological, regulatory, historical, and economic – when conducting fisheries management. Including all of these factors can help maintain balance within an ecosystem and the communities supported by that ecosystem. This is the way that fisheries management is moving towards, rather than just managing one species at a time.

The ultimate goal of fisheries management is to manage the stock sustainably over the long term, to reduce the potential for overfishing, and to be flexible to environmental and socio-economic changes.

Slide 3: Ecosystem-Based Management

When you take all of these factors into account it is called Ecosystem-Based Management. Takes into account the interaction of ecological, economic, cultural, and regulatory factors impacting the overall health of an ecosystem and the communities dependent on that ecosystem.

For example, some of the specific factors that may impact the health of the marine environment and fish populations include pollution, coastal development, harvest pressure, predator/prey and other ecological interactions, as well as nearby watershed management.

In this example we are going to focus on the California Market Squid.

Slide 4: California Market Squid

Let's meet the Market Squid. Here we provide you with information about the Market Squid to share with your students. More information is available on our website under the Fish & Fishery Fact pages

(<http://sanctuaries.noaa.gov/education/voicesofthebay.html>)

Scientific name: Market squid genus and species name was recently changed from *Loligo opalescens* to *Doryteuthis opalescens*.

Habitat: The Market Squid is a pelagic mollusk. Market squid are harvested near the surface and generally considered pelagic (open ocean), but are actually found over

the continental shelf from the surface to depths of at least 2,600 feet. They prefer the salty ocean and are rarely found in estuaries, bays, or river mouths. They can live in close to shore or as much as 300 km from the shoreline

Diel Migration: During the day Market Squid are often off of the continental shelf at depth, but they come to the surface during the night to forage. Therefore their vertical distribution each day can be from 100-600ms. They often aggregate around light during the night.

Lifespan: Market squid are short lived – their entire lifespan is approximately 4-10 months (often commercially harvested at an average of 6 months old). After reproduction, they die and the entire stock is replaced biannually (twice/year).

Because of high predation on squid, survival rates can be very low.

Growth rate: Fast! Temperature and food availability influence the growth rate and abundance of Market Squid. The population size is dependent upon the previous generation's spawning success and the new generation's survival against environmental conditions and predators.

Maximum size: 1 foot total length, including 8 arms, which are like tentacles but with suckers along most of their length, and 2 feeding tentacles. They weigh between 56 and 84 grams (2-3 ounces).

Reproduction: Market squid are terminal spawners - they spawn at the end of their lifespan, generally around 6 months of age. However, they are also semelparous, meaning they spawn multiple times within a season. Spawning squid concentrate in dense schools in spawning grounds. Males deposit spermatophores into the mantle cavity of females. Eggs are fertilized as they are extruded. Females produce 20 to 30 egg capsules, each capsule containing 50 to 250 eggs. Females attach each egg capsule to the substrate. As spawning continues, mounds of egg capsules covering more than 330 square feet may be formed. Spawning is continuous, and eggs of varying developmental stages may be present at one site. Eggs take several days to a few months to hatch, depending on temperature. Newly hatched squid (paralarvae) resemble miniature adults and are dispersed by currents.

Distinguishing characteristics: Market squid have eight arms and two tentacles that extend from the ends of their bodies around their mouths. They have a mixed, iridescent coloration of milky white and purple. Coloring can change due to behavioral responses or changing environmental conditions, as the chromatophores are exposed when the muscles contract.

Slide 5: Life History

More information about Market Squid.

Spawning season: Year-round. In Monterey Bay, spawning peaks in April but may continue into fall. Off Oregon, squid spawning has been observed from May to July. Off Washington and Canada, spawning begins in late summer.

Spawning grounds: Habitat requirements for spawning are not well understood. Spawning occurs over a wide depth range. Known spawning areas include shallow semi-protected nearshore areas with sandy or muddy bottoms adjacent to submarine canyons, where most fishing occurs. The male transfer a bundle of spermatophores into the female's mantle cavity near the oviduct. Then the female lays the fertilized eggs in elongated cigar-shaped capsules that she attaches to the

seafloor. Each capsule can have up to 300 eggs embedded in the gelatinous mixture inside. Multiple capsules will be laid together by multiple females (it is called an egg mop or cluster). Females will lay between 20-30 capsules in her lifetime. Depending on the water temperature the eggs hatch within 2-5 weeks.

Range: Market squid are found along the Pacific coast from Southeast Alaska to central Baja Mexico. The largest populations are found along the California coast.

Interesting facts:

- Market squid swim backwards by pumping water through valves and a tube near their head.
- Market squid are members of the mollusk family known as cephalopods, which means “foot-on-head.”
- Like most squid species, market squid have an ink sac, which serves as a defense mechanism. Squid expel ink to confuse predators.
- Squid are attracted to lights. This is called phototaxis, which is the response of a plant or organism to light, either toward the light (positive phototaxis) or away from it (negative phototaxis).

Slide 6: Squid Food Web

Beyond squid being predators in the food chain (as shown here eating anchovies and krill), they are also a common forage species for many species in the marine ecosystem.

Preferred food: Market squid eat small crustaceans (euphausids, copepods, krill) and small fish (anchovy). They also eat other small squid, gastropods, polychaete worms.

Predators: Few organisms eat squid eggs, although bat stars and sea urchins have been observed doing so. Like other coastal pelagic species such as anchovy and sardine, market squid are an important prey to a long list of fish, birds, and mammals including threatened, endangered, and depleted species. Some important predators of squid include king and Coho salmon, lingcod, rockfish, harbor seals, California sea lion, sea otters, elephant seal, Dall's porpoise, sooty shearwater, Brandt's cormorant, rhinoceros auklet, and common murre.

Predators of Eggs: Bat stars and urchins prey on the egg capsules.

Slide 7: Squid Fishing: Gear

Today purse seines, fish pumps, and light boats are all used in the commercial market squid fishery.

Purse seine: a large net used to encircle a school of squid or fish (typically 200-400m long and < 50m deep).

Light boat: a smaller boat equipped with high-powered lights that attract squid to the surface. You must have a light boat permit to operate a light boat; there are restrictions on the strength (< 30,000 watts) and angle of the light shields (to decrease the horizontal light scatter) on a light boat.

Slide 8: Squid Fishing: How it Works

Fishing occurs in shallow (50-150 ft) water over sandy substrate, sometimes with rocky outcrops. The squid aggregate in semi-protected bays to spawn, and this is when the fishermen catch the squid.

To catch the squid...

1. A skiff (small boat) is released from the purse seine boat with one end of the net.
2. The purse seine boat "sets" the net around a school of squid.
3. The end of the net attached to the skiff is connected with the purse seine boat to close the circle.
4. Fishermen purse the bottom of the net to tighten up the catch bringing the concentrated squid close to the boat. The squid are then pumped from the net into the hold with a fish pump.

The volume of squid caught is dependent upon the squid coming into shallow waters to spawn and the demand for and price paid by the international market. These two factors affect the amount of effort fishermen exert to catch the squid and thus the overall volume caught. As the size of squid populations around the world has decreased, the international demand for Market Squid has increased.

In 2008, 7% of the total landings were bycatch (comprised of 34 species). Common bycatch in the squid fishery is other coastal pelagic species, other benthic species, and Market Squid egg capsules.

Slide 9: Squid Fishing: At Night

Squid are attracted to light, a behavior called *positive phototaxis*. So most squid fishing is done at night using high-powered lights to attract schooling squid to the water's surface.

Slide 10: Squid Fishing Season

Because fishing occurs on the aggregation of adults spawning, fishing is only allowed from Sunday at noon to Friday at noon, to allow for a few days of spawning without fishing. However, light boats can be on the water at any time.

During a good fishing year (like 2010 and 2011), squid are typically caught in Monterey Bay from April through November. The market squid fishery is active in northern California and southern California at different times of the year. The northern fishery season (North of Point Conception, but mainly in Monterey Bay) traditionally occurs from April through November, while the southern fishery (mostly in the Channel Islands vicinity) begins in October and generally lasts through March (source: NOAA SWFSC).

Slide 11: Economic Importance

What happened to the Monterey Bay squid catch in 1998-1999? 1997 was an El Niño year. In an El Niño year, water temperatures increase, causing squid to move away from their traditional spawning grounds, which adversely affects squid populations in the following years. This is an example of a natural challenge that may require regulatory action in response.

Typical landings (catch): The California squid fishery accounts for most of the Pacific coast landings. Minor amounts of market squid are landed in Oregon, Washington, and Canada. A growing international market for squid and declining squid production in other parts of the world resulted in an increased demand for California market squid. As a result, commercial landings of market squid more than quadrupled from 1980 to 1997. However, landings experience large annual fluctuations due to a variety of factors. Between 2005-2008, squid were mostly caught in southern California, not Monterey Bay. However, although not yet depicted on the graph, squid were being landed in Monterey Bay in 2009.

Size of Fishery: In 2000, there were 243 purse seine boats, and 53 light boats by 2009 there were only 83 purse seine boats (of which only 70 made commercial landings and 50 made 90% of the catch) and 63 light boats.

2009 was the largest season by volume and the largest volume and value fishery in California (> 92,000 tons and the ex-vessel value was \$56.5 million), because there were favorable environmental conditions.

Slide 12: Squid Products

40-65% of the squid landed in California is exported to 36 countries. Over 70% of the exports go to China. The next largest markets for exporting squid are Vietnam, Greece, Spain, and United Kingdom.

Squid are fishes for human consumption (e.g., calamari) and to be used as bait for recreational and commercial fisheries.

The final types of products are frozen, fresh, and canned.

Slide 13: Squid Fishing History

Squid fishing began in the mid-1800s by Chinese immigrants. They used small skiffs and lit torches that attracted the squid to the surface. They would then deploy purse seines to capture the squid. Most of their catch was dried and shipped to China, although a small amount was consumed locally.

Italian immigrants introduced the lampara (or round haul) net into the fishery in 1905 and out-competed the Chinese, who then focused on the processing and exporting side of the business.

Although light boats were used in the southern fishery, they were not allowed in the Monterey Bay between 1959-1988 because the fishermen banned their use.

Historically, the origins of the fishery were in Monterey Bay, however since the southern fishery began south of Santa Barbara in 1961 the southern California portion now dominates the fishery.

Until the 1970s, small brail nets were used to lift the squid out of the main lampara net and into the vessel, a couple hundred pounds at a time. Now, a centrifugal pump is

lowered into the netted school of squid. Water and squid are then pumped through a separator and into the hold of the vessel.

The late 1970s began the shift to purse seine nets and fish pumps, which is how nearly all squid are landed today. Light boats are used alongside purse seiners to attract squid to the surface at night.

Slide 14: Squid Fishery Management: Players

Scientists study squid and provide fishery managers data on biology, ecology, and population abundance. Money from the squid permits goes to the scientists to conduct research and to determine the biological assessments of the resource. They use this information to develop recommendations for the conservation and management of the Market Squid. Because we do not know specifically the age, size, and sex distribution of the squid and because the fishery targets the spawning adults, the fishery tests the squid mantle size and the number of eggs estimated to have already been spawned.

Pacific Fishery Management Council develops a squid fishery management plan.

California Department of Fish and Game (CDFG) and the California Fish and Game Commission manage and enforce squid fishing regulations in California. State provisions include a seasonal catch limitation, seasonal length and closures, monitoring programs, and a permit system.

Slide 15: Squid Fishery Management: How it Works

Market squid were included in the Pacific Fishery Management Council's (PFMC) Coastal Pelagic Species Fishery Management Plan (FMP) in 1999. The market squid resource is a "monitored" species, meaning that landings and available abundance are monitored for management purposes.

Maximum sustainable yield is calculated for market squid using egg escapement (the proportion of squid allowed to spawn prior to capture...this is estimated from the mantle thickness or gonad mass vs. the mantle length).

Currently the management is:

- Limited entry fishery – Since 1998 need a permit for the purse seine boat, light boat, and the brail boat (which brings the squid on board)
- The permits can be traded or transferred between people, meaning the only way to get into the fishery is to buy someone's permit
- Need to provide information about where fishing in a logbook to CDFG, this provides information about where the fleet is and how much they are catching
- Total Allowable Catch per year = 107,048 metric tons, this was reached in 2010 for the first time which meant the fishery was closed
- No fishing around Farallon Islands (because of birds), the light from light boats was correlated with next abandonment and increases in chick predation for the breeding seabird colonies on the Farallon Islands so you cannot fish for squid there anymore.

Slide 16: Squid Fishing Challenge

Now that we have learned a bit more about fisheries management and Market Squid you can see how the fishermen, Regulatory Agency Representatives, and Marine Scientists all work together to sustain a fishery. We also saw this through the first simulation.

As we learned, nature also plays an important role, often creating challenges that require a specific human action or response. We will account for these sources of variability in future fishing seasons. An Ecosystem-based Challenge Cards will be drawn to simulate natural and man-made challenges.

But first we need to go over our sustainability strategies to maintain a “balance in the bay” that we came up with at the end of the previous simulation. Do we want to make any changes to our strategy now that we know this information?

Slide 17: Community-wide Objective

As a reminder, the overall objective for the community (class) is to sustain the greatest number of fishing boats for the longest period of time while also maintaining a healthy squid population season to season.

Slide 18: Fishermen

Just like before the challenge will be to gather as many squid (paperclips) as you can, using your left hand only, during the fishing season (1 minute).

Slide 19: Fishermen – Calculations

- 1.Count your catch.
- 2.Calculate your seasonal earnings, while taking into account the Ecosystem-based Challenge Card.
- 3.As a fishing fleet, decide if you would like to purchase additional boats.

Slide 19: Regulatory Agency Representatives

- 1.Announce the beginning and end of each season.
- 2.Ensure fishing fleets are following regulations and fair fishing practices.
- 3.Randomly choose 1 fleet per season and count their catch to ensure accurate reporting of catch.

Slide 20: Marine Scientists

- 1.Draw an Ecosystem-based Challenge Card. The class must adhere to the card directions.
- 2.Record data on the Community Fishery Summary Sheet for all fleets to view.
- 3.Calculate the number of paperclips to return to the fishing grounds for the next season.

Slide 21: Acknowledgements