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One fish, two fish, red fish… no more fish! Importance of Marine Protected Areas

Synopsis of the Activity:

Visitors will be able to understand the importance of Marine Protected Areas and the effects of overfishing. Through observation of a large poster showing the map of California illustrating the different MPAs, learners will be familiar with local MPA networks and their benefits. If they wish, visitors can participate in our "overfishing" activity using kiddie pools and magnetic poles and fish of the specified local species. Then visitors will have a chance to connect these species to the appropriate trophic levels on the food web poster.

Audience:

The targeted audience would be all of the general public. Age, race, and gender will be irrelevant in terms of the directionality of this activity. The fishing activity might be more interesting to the younger crowd, between the ages of 1 and 10. However, our informational posters, food web design, and talks will target all age groups. This way we will make sure to convey the message to everyone, and not a specific group in particular.

Activity Goals:

Learners will become acquainted with networks of MPA's through methods of inquiry. This process of inquiry will connect conceptual and perceptual knowledge through overfishing simulations. They will participate in a hands-on activity to apply basic knowledge in fisheries

systems designed for all levels. Participants will construct their understanding by connecting previous knowledge with newer ideas that are introduced about overfishing. In addition, learners will become familiar with food web systems.

Concepts:

This presentation will help learners understand the basic concepts of Marine Protected Areas and the effects of overfishing. This will be done stepwise through introducing the following concepts:

- Introduce how fishing one specific species or a certain size group of fish will have trophic cascades which will result in devastating effects on entire ecosystems
- What is a marine food web? How are all of the trophic levels interconnected?
- How can we preserve food webs?
- Identify the positive impacts of creating networks of MPA's locally (local research)
- Introduce Seafood Watch cards

Ocean Literacy Principles Covered:

- Oceans and humans are inextricably interconnected
- The ocean supports a great diversity of life and the ecosystems.

Materials:

- One table with two different tanks filled with "marine life" (modeled using fake organisms)

- Net to place in one of the tanks
- An easel with a poster board of California Marine Protected Areas
- An easel with a white board for food web drawings and design, with the laminated sticky images of local species of marine organisms
- Two kiddie pools on the ground, where children and other visitors can "fish" magnetic laminated purple striped jellyfish, two size groups of cabezon, two size groups of blue rockfish, and yellowfin tuna
- Magnetic fishing poles
- Buckets for fish collection
- Seafood watch cards, to be handed out
- Markers and tape

Preparation and Set-up:

Transport materials to the venue and begin set-up of the tables, poster boards, and kiddie pools an hour early. Study the background information and being acquainted with the material and possible deviations to the presentation.

Blow up kiddie pools and then set them up on the ground with water. Add the laminated magnetic fish to the pools (note to distribute evenly between pools). Place buckets with fishing poles around the pools. This is done to attract people and catch the interest of the visitors.

Set-up a table with the two tanks of fish (also distributing fish evenly between tanks). Place one net in a tank to simulate the unprotected area. This will elicit conversation and engage visitors. The whole area surrounding the table and the kiddie pools will have the two easels with

posters of local MPA's and food webs. Have markers to connect food webs, Seafood Watch cards, and tape available nearby.

Guiding Questions:

Checking for prior knowledge: After welcoming the visitors, we will ask many questions to determine the knowledge base of the audience. We will start by asking general ones and lead to specifics on these topics.

Do you know what an MPA is?

Have you been to any of the beaches along the Central Coast?

Do you go fishing?

How often do you eat seafood?

Do you know where restaurants get their fish?

Do you think there are limitations to how much humans can eat?

To engage them in the activity:

Do you want to play some games with us?

Help us build a food web?

Want to try a little fishing?

How often do you think people go fishing?

Encourage discussion:

Why do you think this (Specific fish) is higher in the food web?

What makes you think so?

What do you notice is changing about this environment (after fishing)?

How do you think fishing affects ecosystems?

Do you think there should be a limit? Why?

Check for understanding:

Do you want to change anything on your designed food pyramid?

Do you think we will run out of fish in the ocean? Any specific types?

What is your say about Marine Protected Areas?

Activity Description:

Introduction:

Invite visitors to come over to investigate fishing station. Start by asking visitors if they have been fishing before. (Follow up with where and what type of fish). Tell learners that today, they will be given the chance to fish for local species and collect them in their own buckets.

Activity Exploration #1:

1. **Free exploration** of the fishing station. Give the visitors a bucket, a fishing pole, and explain how the magnets work for fishing. Then, allow them to freely fish for any species of any size. Respond to questions about the following species present in the kiddie pools: yellowfin tuna, purple striped jellyfish, blue rockfish, and cabezon. As appropriate, ask a few of the following guiding questions to engage discussion:
    - What type of fish do you think this is?
    - Where do you think it came from?

- Do you think people like to eat these?
- What effects do you notice?

2. **Guided Simulation** to fish out a specific size. Direct visitors to fish out all of the big species of fish, leaving all of the juveniles in the population. Be patient, let them explore and describe what is happening. Ask them the following guiding questions:
    - What do you notice about the remaining fish?
    - Do you think these fish will be able to reproduce?
    - Why do you think people may fish out the larger rather than the smaller fish?
    - What else do you think is happening?
3. **Guided Simulation** to fish out a specific species. Direct visitors to fish out all of the cabezon, leaving all of the other fish available in the population. Be patient, let them explore and describe what is happening. Ask them the following guiding questions:
    - What do you notice about the remaining fish?
    - Do you think this will have any ecosystem effects?
    - Will these be positive or negative?
    - What else do you think is happening?
    - What does this tell you about commercial fisheries?
4. **Further exploration of fishing** with the two tanks. Ask visitors to notice what is going on in each of the two tanks, using a net to fish out all of the fish species from one of the tanks. Ask visitors to see if they understand the difference between the two tanks. Make sure to indicate that one tank represents an area with little fishing while the other represents and area that can be largely fished from. Ask the following guiding questions:
    - Which tank represents an ecologically friendly area?

- Which would you rather see along our coastline?

Activity Exploration #2:

1. **Introduce Food Webs** to visitors after completing the first activity. Ask visitors if they know which of the following marine organisms eat what? Ask the following guiding questions:
    - Do you know what a food web is?
    - Do you want to help me build one?
    - Do you know what trophic levels are?
    - Do you know what trophic level cascades are?
    - Do you know what producers/consumers are?

    Explain what the previous terms mean if students do not know. Refer to definitions in the vocabulary section.
2. **Build Food Webs** using cards with pictures of humans, white sharks, tuna, cabezon, abalone, and plankton as the organisms. Ask visitors the following set of guiding questions to help build the food webs:
    - Which organism do you think produces food for other organisms on the poster board?
    - Which do you think eats these? (Keep asking the until the entire food web is set up)
    - Can you help me connect all of the species that eat each other using a sharpie?
    - What do you think would happen if we took out one trophic level? Would this result in a trophic cascade?

- Do you know what "shifting baselines" is? (If students are unfamiliar, explain term)

3. **Introduce Marine Protected Areas** to visitors. Direct learners to the poster of the map of the Central Coast of California, pointing out the local marine protected areas. Ask the following guiding questions:

- Do you know what these colored spots are on the map?
- Do you know what marine protected areas are?
- What do you think are the benefits of having these?
- Are there any downsides to having these?

Connect overfishing to marine protected areas and introduce local research by Royden Nakamura and Dean Wendt at Cal Poly. Hand out Seafood Watch cards to interested visitors.

Handle visitors dropping in and out at different times by having facilitators actively engaged in activities. One instructor will facilitate the kiddie pool activity, where the other will either help with oncoming visitors or can help the first instructor. If visitors start to use the materials in a way that was not initially intended, facilitators should use this as an opportunity to engage them in the activity and ask them questions that direct them to the overall concept.

Teaching Strategies:

There are several important steps in the learning cycle that should be emphasized by facilitators. First, invite students over to the activity with the use of visuals (posters/pictures) and the kiddie pools to grab their interest. Once the visitors are successfully hooked, facilitators

should allow students to explore. Exploration is a large part in this whole activity. Visitors should explore the idea of overfishing and come up with possible effects of this process. During the fishing activity, facilitators will encourage inquiry by asking guiding questions.

Concept invention can also be part of this, where visitors can build their own food web through simulation activities. They will be able to question and manipulate the food web activity, and then go through creating and connecting new and old information to build concepts about fishing and marine food webs. Finally, connect what they learned about overfishing and the food web to explain the benefits of marine protected.

Vocabulary:

Marine Protected Areas: An area of the marine or coastal environment that is afforded some degree of legal protection for natural and/or cultural resources.

Food web: It is the feeding relationships among species in an ecological community (of who eats whom).

Ecosystems: It is the biological environment that includes living and non-living factors (biotic and abiotic), and their interaction.

Trophic cascades: The effect of predators on the food web, and on the lower trophic levels. This causes a change in abundance or behavior of the lower levels.

Fisheries management: Using science to find a way to protect fish and keep species alive, with minimal effect on the food web.

Collaborative Fisheries Effort: designed to monitor the effectiveness of 29 MPA's since September 21st 2007 along the Central Coast

Consumer: obtain nutrients from other organisms (heterotroph)

Producer: produce organic compounds from inorganic compounds (autotroph)

Top Down Control: structure of ecosystem based on predation and competition for resources

Science Content Background Additional Resources:

One of the most successful ways of conserving biodiversity, managing marine resources, protecting endangered species, and enhancing fisheries is through developing Marine Protected Areas (MPAs). The California Collaborative Fisheries Research Program defines MPA networks as areas of coastal and marine environments that aim to conserve marine resources and biodiversity, where a balance is set between no-take zones and areas that are manipulated. Further, this program mentions that some degree of legal protection is afforded to MPA's, specifically from the effects of anthropogenic forces like pollution, overfishing, and development.

The Ocean Conservancy claims that overfishing is a major threat to marine biodiversity, ecosystem structures, and food web dynamics (2012). Overfishing is the act of taking out large predatory consumer species that are reproductively mature. Moreover, smaller consumer species that are reproductively immature will remain virtually untouched in this environment. Ecosystem integrity is highly dependent upon the presence of predatory fish with top-down control. When large reproductively mature fish are removed from a population, there will be a lag in the time that it takes to produce new individuals within this species. This results in trophic level cascades and shifting baselines within ecosystems where the next consumer assumes the role of the large, overfished species. Furthermore, the effect of "fishing down the marine food web" will occur when organisms further down on the food web begin to be fished once the large predatory fish

stocks are replete (Stewart, 2009). The cycle of overfishing continues where top consumers may continue to be fished to extinction. These trophic level cascades ultimately affect food web dynamics, where certain organisms fail to regain their status in a given population (Jackson *et al.* 2001). Past fisheries practices have proven to be unsustainable, thus action needs to be taken to replenish fish stocks for future generations. In order to maintain biodiversity and restore ecosystems to their previous stocks, it is necessary that the management of marine resources through scientific-integrated policy decisions occurs (Tanner and Chavez 2009).

MPA networks were designed and implemented to reverse the damaging effects of overfishing. California's Marine Life Protection Act was created in 1999, which was the first state law that required the establishment of a network of MPA's. In 1935 the first MPA was the Fort Jefferson National Monument in Florida, but the idea of preservations and MPA guidelines did not together till the late 60s (Gubbay 1995). In 1982, The World Congress on National Parks gave the order to incorporate Marine Protected Areas in the worldwide network of protected areas (Gubbay 1995). California's Marine Life Protection Act was created in 1999, which was the first state law that actually required the establishment of a network of MPA's. The California Collaborative Fisheries Research Program was created to monitor the effectiveness of 29 MPA's since September 21, 2007 along the Central Coast of California. Since the start of this program, many research institutions have made an effort to study the effectiveness of MPA's, including California Polytechnic State University in San Luis Obispo (C. C. F. R. P., 2011).

Positive outcomes from Marine Protected Areas have been shown in several studies. A survey of over a series of 100 international MPAs showed that there was a 446% average increase in biomass of animals and plants, 166% average increase in number of plants or animals, 1,000% increase in biomass and populations density of heavily fished species, 28%

average increase in body size of animals, and 21% average increase in species density (Lester et al. 2009). In other words, the marine protected areas increase the number of animals present, and add to the sizes of already existing species; the latter will then reproduce better and more often. Another important aspect proved in the same research showed positive effects at all the different latitudes, which contradicts the perception that MPAs are more effective in tropical areas only. Marine protected areas are very important, and should be implemented in more locations. Educating the public about the importance of overfishing, how the organisms survive via food webs and the importance of MPAs is essential to help maintain our ecosystem.

Additional Resources:

Books about fishing, local fish information pamphlets, and even seafood watch cards are all important and helpful for visitors wanting to learn more.

References:

Gubbay, Susan. 1995. Marine Protected Areas: Principles and Techniques for Management. *London: Chapman & Hall*, v. 1, p. 1-12.

Jackson, J.B.C., M. X. Kirby, W. H. Berger, K. A. Bjorndal, L. W. Botsford, B. J. Bourque, R. H. Bradbury, R. Cooke, J. Erlandson, J. A. Estes, T. P. Hughes, S. Kidwell, C. B. Lange, H. S. Lenihan, J. M. Pandolfi, C. H. Peterson, R. S. Steneck, M. J. Tegner, and R. R. Warner, 2001, Historical overfishing and the recent collapse of coastal ecosystems, *Science,* v. 293, p. 629-637.

Lester, S.E., B.S. Halpern, K. Grorud-Colvert, J. Lubchenco, B.I. Ruttenberg, S.D. Gaines, S. Airamé, and R.R.Warner. 2009. Biological effects within no-take marine reserves: a global synthesis. *Mar Ecol Prog Ser*, v. 384, p. 33-46.

"Marine Protected Areas: preserving Yosemites of the sea". *Ocean Conservancy Start a Sea of Change*, 2012. Web. 13 Feb 2012. <http://www.oceanconservancy.org/our-work/marine-protected-areas/>

Robert Stewart. "Marine Fisheries Food Webs". *Oceanography in the 21st Century- An Online Textbook,* 3 Aug. 2009. Web. 13 Feb. 2012.

Stewart, R. Marine fisheries food webs, *Oceanography in the 21st Century- An Online Textbook.* 2009. Web. 13 Feb. 2012. <http://oceanworld.tamu.edu/resources/oceanography-book/marinefoodwebs.htm>

Tanner, C. and Chavez, F., 2006, State of the Central California marine ecosystem. *MBARI* 2006. Web 13 Feb, 2012. <http://www.mbari.org/education/internship/06interns/papers/CTanner.pdf>

"The California Collaborative Fisheries Research Program". *Fisheries and Conservation Lab at MLML,* 2011. Web. 13 Feb. 2012. <http://seagrant.mlml.calstate.edu/research/ccfrp/>