Let's Cruise! Data Analysis Questions

Data Link:
http://accessoceans.org/uploads/Ocean%20Climate%20Indicators%20Report%202014_final.pdf

You have been given a data set consisting of sea surface temperature (SST), salinity, and height values for the years 2004-2014 along with the a data set for a particular type of organism. These data sets were collected from buoy and satellite data collected from The Applied California Current Ecosystem Studies (ACCESS), a collaboration effort between 3 science organizations (Cordell Bank NMS, Farallones NMS, and Point Blue Conservation Science) and NOAA.

Chlorophyll and phytoplankton (1 group)
Zooplankton (1-3 possible groups: Copepods, Pteropods, and Euphausiids)
Birds (1-3 possible groups: Cassin's auklet, Common mure, and Brandt's cormorant)
Marine mammals (1 or 2 groups: Blue whales and Humpback whales)

Instructions: Your task as a group of four is to study all of the data sets given to your group to try and determine if there is any correlation between SST readings and abundance of organisms observed during the cruise. In the SST data sets you fill find graphs with the mean recordings represented by black lines. Any anomalies above or below the mean are indicated by red and blue bar graphs. For organismal data, you will find counts represented in bar graphs.

Vocab Terms:
SST
Plankton Net
National Marine Sanctuary
Transect
Anomalies
Upwelling
Downwelling
Spring Transition

1. In what year(s) does your data set have the highest organism counts?
2. In what year(s) does your data set indicate the lowest organisms count?
3. Is/are there any trends that you can observe in your organism count? If so, what is it?
4. Compare the organism count in each year to the salinity measure for each year. Is there any correlation?
5. Compare the organism count in each year to the sea surface temperature measure for each year. Is there any correlation?
6. Compare the organism count in each year to the sea surface height (depth) measure for each year. Is there any correlation?

7. Compare the organism count in each year to the alongshore winds measure for each year. Is there any correlation?
8. Compare the organism count in each year to the upwelling measure for each year. Is there any correlation?
9. Based on the data sets provided, how can changes in oceanic conditions (salinity, temperature) affect marine populations?
10. How can changes in climate conditions affect the overall health of a marine environment?

ACCESS Cruise 5 Ws! (Supplement to the Let's Cruise! Prezi)
http://prezi.com/-phpenw-kiek/?utm_campaign=share&utm_medium=copy&rc=ex0share

What? (This section covers the definition of a cruise ship and the particular cruise that will be used in later data activities, an ACCESS cruise.)

A cruise is a marine research excursion that collects data in order to study and assess the physical, chemical, and geographical conditions of the ocean and, more importantly, to address changes of our oceans that occur over time. Some cruises focus on the biology of an area to assess the health of fisheries and marine habitats, while others focus on hydrographic surveys to help map out the sea floor. The Applied California Current Ecosystem (ACCESS) cruise (http://accessoceans.org/) featured in this lesson focuses on water quality, ocean zoning, climate change, and fisheries in two National Marine Sanctuaries (NMS). NMS are federally designated areas of water established to protect and preserve the biodiversity, ecology, history, and aesthetics of our waters while also setting guidelines for recreational and/or commercial endeavours. NMS are one part of the National Oceanic Atmospheric Administration (NOAA) (http://www.noaa.gov/index.htm), a US government agency that encompasses a wide range of scientific endeavors, including weather mapping, storm tracking, managing fisheries, protecting coastal waters, gathering satellite data; the list is huge. It's vast network of scientists, equipment, and policy makers affect every state in our nation, and much of what we know of the world today in terms of weather, climate, and our oceans can be attributed to NOAA.

The goals associated with the data collected from ACCESS cruises are to inform policymakers about wildlife responses to changes in ocean conditions and to gather public support for marine conservation. ACCESS crusies are a collaboration between three local science organizations: the Farollones Marine Sanctuary Association (http://www.farallones.org/index.php), located in Crissy Field in San Francisco, CA; Cordell Bank National Marine Sancturay (http://cordellbank.noaa.gov/welcome.html), located in Point Reyes, CA; and Point Blue Conservation Science, (http://www.pointblue.org/), located in Petaluma, CA.

Who? (This section covers the agencies involved in the cruise and the positions aboard a cruise ship.)

As mentioned in the "What?" section, ACCESS cruises are a collaboration between three local conservation organizations, two NMS in NOAA and Point Blue Conservation Science. Funding for the cruises is provided by both NOAA and Point Blue.

While NOAA is an all-encompassing agency, the three local organizations in this lesson plan are responsible for collecting the data that is ultimately reported back to NOAA. The Farallones Marine Sanctuary Association is a non-profit organization dedicated to protecting the 3,295 miles of coastal and open waters that encompass the Gulf of the Farallones National Marine Sanctuary (GFNMS). The Cordell Bank National Marine Sanctuary (CBNMS) is an entirely offshore NMS that covers 1,286 miles. Both NMS are important habitats for many marine life,

including sea birds and mammals, and both NMS are dedicated to educating the public about the importance of preserving these national treasures. Point Blue Conservation Science, which compiled the data collected aboard the ship and used in this lesson plan, is an organization dedicated to conservation of birds, other wildlife, and ecosystems both on land and at sea. Once aboard a research vessel, there are many different jobs to be filled, depending on the type and size of research vessel. For the ACCESS cruise, the vessel used is the R/V Fulmar (http://www.sanctuarysimon.org/regional_sections/fulmar/), a 67-foot twin-hull catamaran specfically designed to naviagte the waters off Central California. The people on an ACCESS cruise include:

Captain/Chief Officer in Charge: The captain is the person in charge of the vessel, making sure it is ready to head out to sea every day and is in safe operating condition. The captain is in charge of navigating the ship, staying abreast of weather conditions, watching out for potential hazards along the route (including collisions with animals), and has the final say in whether a cruise will continue or return to dock due to changing weather conditions. The captain also helps with data collection, such as operating the winch or maneuvering the boat into position for optimal data retrieval.

The Mate: The mate is second in command and can operate the boat and all the equipment aboard the ship just as the captain. In addition to safely operating the boat, the mate also helps with data collection.

Principal Investigator: The principal investigator is responsible for the type of data being collected aboard the ship, ensures the collection procedures are being conducted properly, and helps in data collection. Because this a collaborative effort between three Bay Area organizations, there are three principal investigators on an ACCESS cruise. This position is also known as the chief scientist aboard other NOAA cruises.

Associate Scientists: Along with the chief scientists, several scientists aboard the help collect the data aboard the ship. Often times they will work in shifts to reduce fatigue and ensure accurate data collection routines.

Cruise Leader: The cruise leader is in charge of the logistics of the trip: who's on board, emergency contacts, what transects we will monitor, the ports we will visit, and a host of other responsibilities once we actually leave land.

Graduate Students/Volunteers: The ACCESS cruise has had many graduate students that help to collect the data aboard the ship because it directly helps with their studies. Volunteers from the GFNMS, CBNMS, and Point Blue also accompany the crew to help with data collection on the back deck, marine bird and mammal counts, and ship duties such as packing and unpacking (called MOB and DEMOB for mobilize and demobilize) and cooking.

Teacher at Sea: A teacher aboard the ship who learns about the day-to-day operation of a research vessel in order to help gather data and inform generations of students about the importance of research and data collection.

Where? (This section covers the exact locations of the ACCESS cruise.)

ACCESS cruises focus on the NMS off the central coast of California. There are three NMS that encompass an ACCESS cruise: the Cordell Bank NMS at the northern end, the Gulf of the Farallones NMS in the middle, and Monterey Bay NMS covering the southern end. These three, interlocking NMS cover an area that stretches from about 60 miles northwest of San Francisco to about 120 miles south of Monterey Bay, near San Simeon, CA, and they are part of a vast 12,000 square mile sanctuary that covers areas from Washington State down to Southern California. (For detailed maps of all west coast sanctuaries, visit http://sanctuaries.noaa.gov/about/westcoast.html).

Within the three NMS of the ACCESS cruises, there are certain areas that a cruise focuses on to gather data, which are called transects. A transect is a fixed path that a research vessel will traverse and make pre-determined stops in order to collect data samples. On page 6 of the attached Point Blue *Ocean Climate Indicators status report for 2013*, you will find a color map of the Central California NMS that are studied during an ACCESS cruise. On this map you will find highlighted lines of latitude with number ranging from 1-10 or N0-N10; these parallel lines indicate the transects studied for this cruise.

The length of transects is determined by the shelf break, the area where the continental shelf begins to slope down to the seafloor. (There are two different types of transect: nearshore, N0-N10, and offshore, 1-10.) The shelf break is an area of significance because this is where upwelling and downwelling occur, affecting the biological activity around these areas. Also, because it's close to shore, throughout the year you can have varied amounts of freshwater runoff what mixes with the ocean, so there is plenty of change, and activity, that occurs along the shelf break.
Another factor to consider when creating transects is the amount of time it takes to get there and return to shore, and the amount of gas it the boat uses to get there and back. Sometimes a transect can not be finished because of changing sea conditions, so the length of the trip has to be cut short in order to safely return to shore.

The total area covered by an ACCESS cruise is a bit tricky. The cruise covers all of the CDNMS (529 miles), all of the GFNMS (1,279 miles, and the northern part of the MBNMS (4,601 miles). Added all up this equals 5,409 miles, but remember, only the northernmost part of the MBNMS is covered. The space between each transect is about 10km, and they are placed along key features in the NMS such as the Farallone Islands and Cordell Bank.

Why/How? (This section covers the purpose of the ACCESS cruise and the type of data that is collected on the cruise.)

The purpose of any cruise is to gather data to gain a better understanding of our oceans. The ACCESS cruise's mission is to collect data in order to inform policy makers about decisions regarding local NMS and to influence the public into joining conservation efforts of our NMS. The type of data collected on an ACCESS cruise, and used in the lesson plan, includes:

CTD Data: CTD stands for conductivity (salinity), temperature, and depth, and a CTD device is an instrument used to collect data readings for each; the significance of CTD data is explained here:

Conductivity: Conductivity is a measurement of how much electricity can flow through water, and it's directly related to the amount of salt in the water. Hence, by taking conductivity readings of the ocean, we can tell the salinity. Salinity is very important to the health of an ocean and its inhabitants because many organisms are sensitive to the changes in ocean salinity. High-salinity waters can indicate nutrient-rich waters due to upwelling.

Temperature: Temperature data is collected as well because as upwelling increases, cold, nutrient-rich water will rise to the surface, creating an environment capable of supporting life.

Depth: Depth, or sea surface height, is also a good indicator of optimal feeding conditions. When winds blow southward along the coast, upwelling will occur because the winds will eventually push the water offshore, lowering the sea level height.

CTDs are launched from the back deck of a stopped boat along predetermined points on the transects. A winch will lower the CTD down to about a depth just above the seafloor, which is determined by echo-sounders aboard the ship that inform the scientist of the exact depth at each location. Once we reach a location and determine the depth, we are ready to launch the CTD.

Extreme caution has to be taken when launching anything from the back deck of the boat because of changing sea conditions, slippery water, and human queasiness! There are three metal ropes attached along the back of the deck that must be taken down to allow the winch access to the water. Once the ropes are down and the CTD is securely attached to the winch (tightened down with a wrench), the CTD can be launched from the back of the boat...very carefully. The CTD has to be pushed out far enough so that it doesn't swing back and hit the boat, but you also have to be careful not to push too hard or you'll send yourself overboard along with the CTD.

Once the CTD is launched, it's lowered to the predetermined depth and, once it reaches that depth, it's immediately brought back up. Instruments within the CTD collect the data and store it for later use once the cruise is over and the data can be retrieved.

Plankton Tows: Plankton tows and nets are devices used to collect plankton from the ocean at varying depths and locations along a transect. They basically consist of very fine nets that allow water to flow through but plankton to be trapped. As water and plankton flow through the net, the plankton pile up on the bottom of the net where they fall into a collecting bottle.

The plankton net and CTDs are sometimes deployed at the same points along a transect. If the transect point involves a plankton tow, this will occur first, as it requires the boat to move in order to collect the plankton. Once the boat stops and the net is collected, the CTD is deployed.

Because plankton are at the base of the marine food web, changes in the type and abundance can have significant effects on marine ecosystems. The amount of nutrients in the water, which is directly tied to the temperature and salinity of the water, is a good indication of the state of health of the plankton community.

Plankton tows are launched much the same way as CTDs: very carefully! There are two type of plankton collecting devices on an ACCESS cruise: a plankton net and a Tucker Trawl.

Plankton nets on an ACCESS cruise are deployed from the back deck using a winch. The net is dragged behind the boat at slow speed while the net is lowered at a rate of 2 m/s until a depth of 100 meters, and then it is pulled back up. (You can ask your students how long this takes.)

Lifting the plankton net out of the ocean can be very difficult because the net is soaked with water, and water is heavy. As you pull the net up to the boat, it is best to allow as much water as possible to drain because the less you have to haul up the better. Once aboard the ship, the whole net is sprayed down with salt water from a hose to allow as much plankton in the net to reach the bottom to the collection bottle. Once it's sufficiently washed and rinse off, the bottle is removed from the net and its contents are placed in a strainer.

Once in the strainer, a water bottle with long, thin nozzle is used to wash off the contents of the bottle; it's then transferred to a different bottle and stored until the contents can be examined and analyzed.

A Tucker Trawl is another version of a plankton net with a few key changes because it's used to take krill samples, which are found with an echosounder. With a Tucker trawl, there are 3 different nets, each being deployed at different depths, and as it's lowered into the water, a weight is attached to a metal wire from the boat. This weight is sent shooting down the wire until it hits a trigger at the net, causing it to open at different depths.

Marine Bird Counts: Marine birds are top-level consumers in the marine food web. Some birds, such as the California Gull, breed in the region, while others such as the black-footed albatross, cross thousands of miles to feed on in the highly-productive waters in Central and Northern California. Bird counts are important indicators of marine ecosystem health because if there is sufficient supply of plankton, then smaller fish such as sardines can feed on the plankton. These smaller fish are then consumed by sea birds. While a variety of sea bird sighting are counted and documented during an ACCESS cruise, the data provided narrows the numbers down to three: Cassin's Auklet, Common Murre, and Brandt's Cormorant.

Marine Mammal Counts: As with sea birds, marine mammals are at the top of the food web in marine ecosystems. California Sea breed in the Channel Islands, Northern Fur seal breed on Farallon islands, and harbor seals breed on the coast, but they all take advantage of the food-

rich water off our coast. Some organisms, such as humpback whales, travel great distances to take advantage of productive oceans off the Central and Northern California coasts. The Central California NMS also act as navigation routes for many whales. High marine mammal counts are indicators of productive waters because of the availability of prey for these top-level consumers.

Marine bird and mammal counts are collected from the flybridge of the vessel, where there is enough room for four elevated seats and two bench seats. When a marine bird is spotted, there are a series of codes that the watcher calls out to the person recording the sightings on the laptop. For example, when on the top deck you might here this: Common Murre 2, zone 1, flying, 160. This means that there are two Common Murre birds within 100 meters of the boat, and they are flying toward 160 degrees (in a 360-degree circle).

When a marine mammal is sighted, there are even more codes. For example, you may hear this: Mammal, by eye, bearing 270, reticle 7, observer 9, side 1, traveling, immature, sex unknown, 2-2-2.

What does all this mean? Take a look at the strip transect picture in the prezi, which has the meanings for all of the codes.

On certain reticle binoculars, there are 14 tick marks in a vertical column that the observer can see when looking through the lens; the top tick mark is 0 and the bottom is 14. When looking for marine mammals, you can estimate where they are located by these tick marks, called reticules. Reticule 0 is the horizon, and reticule 14 is the boat. If you have a mammal sighting at reticule 7, that means the mammal is roughly somewhere in the middle between the horizon and the boat, which is quite a distance. It takes a lot of practice to accurately estimate distance this way, especially on a rocking boat, but the ACCESS crew is well versed in this task.

The rest of the codes are pretty self-explanatory until you reach the counts, which gives your best estimate for number of organisms. A count of 2-2-2- means your best estimate of number of organisms is 2, the high number of organisms is 2, and the low count is 2; when you hear a call like this, the observer is certain that the number of organisms is 2 because there is no fluctuation. If you heard a count of 2-3-2, the observer saw at least 2 organisms but it could have been 3.

How did this data make a difference? How is it used to influence policy makers and the public?

The data collected by ACCESS cruises helps influence policy makers and the public by providing strong evidence that changing climate conditions affect the health of a variety of marine organisms and, thus, the health of marine ecosystems.

Evidence that shows deteriorating ecosystems can be tied to changing climate conditions can positively influence policy makers in government to implement strategies of change. Possible

strategies to discuss with you class include: reducing greenhouse gas emissions, establishing conservation as a national priority, limiting or eliminating the use of fossil fuels, increasing the use of renewable resources, establishing and maintaining fishing limits; the list goes on.

Conservation of the ecosystems within NMS is also of vital local economic importance. Topics to bring up with your class include how many people are dependant on our oceans for food, how the tourism industry attracts hundreds of thousands of people to the beauty our local waterways, and how the medical industry has many uses for marine life. While there are areas of NMS that are no-take sections, the benefits of having these areas certainly enriches the productivity of surrounding locations. These studies also help to illuminate the beauty and wonder of the biodiversity held within our nation's NMS, and having a beautiful, highly-diverse place to live is a certainly a benefit that many can enjoy.

When? (This section covers when the cruises occur and what to expect as a crewmember aboard the ship.)

ACCESS cruises have been running since 2004, and the goal is to run the cruise three times a year, weather permitting. The times of the year the cruise runs is determined by oceanographic seasons: spring transition, upwelling, and relaxation.

Spring transition is the time of the year when winter downwelling begins to change to spring upwelling, bringing with it a time of increased productivity; this time period usually occurs around Feb-March, although it can be as late as June. During the summer months offshore winds continue to cause upwelling along the coast, providing a steady supply of food throughout the marine food web. During the relaxation period in late summer/fall, winds die down, upwelling slows or stops, and warmer, nutrient-poor water surface returns with a drop in productivity.

As for what to expect as a crew member aboard the ship, no day is a typical day, and because each cruise occurs during different times of the year, weather conditions out at sea can change drastically. What can start off as a sunny day with relaxed winds on shore can turn into a foggy, cold, choppy sea that sends the vessel bobbing from side to side while the captain tries to maintain control; It's not unheard of for the boat to turn around during adverse weather conditions.

Clothing should be worn in layers (typical of the Bay Area), but you will always want to bring clothes that can get wet. While you will generally wear rain pants/wet bib and waterproof boots while working on the back deck of the boat, there's always the chance of wind-driven water blowing water at you no matter where you are on the boat. Besides water-proof clothes, you will always wear a hard hat and a life preserver while on the back deck in case someone falls off.

When you are working on the flybridge, you are not required to wear waterproof clothes or a life preserver, but you definitely want to wear lots of layers and perhaps a warm beverage; winds do not let down at that level and you will quickly find yourself shivering if you're not properly

dressed. Also, keep in mind that the fly bridge sits higher than the rest of the boat, which can make you more aware of the up/down motions of the boat and make you queazy.