Activity Title: Fishing for Information

Subject: This lesson is applicable to a Biology or AP Environmental Science class.

Grade Level: High School

Average Learning Time: Two to three *45-55* minute class periods for research and data analysis, outside of class time for presentation preparation (homework), one to two periods for presentation/sharing.

Lesson Summary: After selecting and analyzing fisheries data from NOAA, students develop research questions, analyze the data and draw conclusions, which are then represented visually in the form of a poster presentation and shared with the class.

Overall Concept (Big Idea/Essential Question): How can pre-existing, large datasets help scientists to answer questions? What can we learn about an ecosystem by analyzing data?

Specific Concepts: Ecosystems, biodiversity, fisheries management, observing trends, developing testable questions, making inferences and drawing conclusions based on evidence, using mathematical or computational representations to support explanations, communicating scientific evidence.

Focus Questions:

1. What organisms are in the Gulf of Alaska food web?
2. What are the producers and consumers in this food web?
3. Does water temperature (surface and bottom), depth, stratum, location, and/or time of year affect the abundance of organisms at a location?
4. Are there greater numbers of predators or prey?
5. What changes can you observe over time?
6. Can you observe any relationships or trends in the data?
7. What does the current research say about the Gulf of Alaska?
8. How might commercial fisheries be impacted by the information you have discovered?
9. What regulations or legislation exists relevant to the species you have chosen to study?

Objectives/Learning Goals:

The student will examine large fisheries datasets and develop a research question based on the data. The student will analyze the data and create graphical or other mathematical representations of the data and develop a conclusion based on the evidence they have discovered. The student will research the species upon which they are focusing and cite any relevant regulations and/or prior research applicable to the organism(s) of focus. Finally, the student will present this information to the class as a poster presentation, which must include all thirteen of the components as described on the rubric.

Background Information: In order to be successful with this lesson, students must understand how to manipulate/analyze data and use Excel. They must be able to create graphical representations of the data and conduct statistical analyses appropriate for their age/math level.

Common Misconceptions/Preconceptions: Students may think that there has to be a conclusive answer to the scientific question they ask. However, they may not be able to make a connection or draw a conclusion from their investigation. If this is the case, encourage them to develop a

question for further investigation and to identify what kinds of information would be needed to answer this revised or new question.

Materials: Photocopies of database instructions for each student, poster board (optional - students could make PowerPoint or Prezi).

Technical Requirements: Internet access, Microsoft Excel, Microsoft PowerPoint, computers

Teacher Preparation: Practice using RACE Groundfish Survey website to be sure that the files will download when students are conducting their work.

Keywords: forage fish, groundfish, recruitment, gadids, osmerids, nektonic, neritic, zooplankton, walleye pollock, sablefish, Pacific Ocean perch, Pacific cod, Atka mackerel, yellowfin sole

Pre-assessment Strategy/Anticipatory Set:
As an entry task, have students read the NY Times article "Salmon Fishermen Battle Walmart on Certification" http://www.nytimes.com/2013/10/22/business/salmon-fishermen-battle-walmart-on-certification.html?_r=0. Ask students to write why they think fisheries should be regulated, indicate who is responsible for the regulation, and to summarize the current battle between fishermen and Walmart. This is a good segue into a discussion about the research that is conducted that informs the regulatory process and how they can examine this research to see if they can draw any conclusions of their own.

Lesson Procedure: More detailed information is on the student handout following this lesson plan.

1. This project can be conducted by individual students or groups of 3, but I wouldn't recommend larger groups.
2. If students work in groups, have them first decide which data to download based on dates and location. Once the data is downloaded, they can begin looking at what organisms and other information are represented in the data. If they cannot come up with several research questions based on the download, they should start over.
3. Once students have their research questions, they should have them checked by the instructor and get permission to move forward.
4. They can use Excel to manipulate the data and suggest that instead of deleting sections, they just make another workbook page with a refined set of data so they can always go back to the original dataset if they need to.
5. At this point they should start pulling in outside research. On the student worksheet there are some suggested readings and websites as a starting point. Students will be required to show a minimum of THREE primary sources (journal articles) and reference multiple websites (NOAA or other) regarding fisheries management.
6. Students will create poster presentations of their research. The format should be as follows:

   Title, Introduction (including research question), Materials and Methods (could be optional - students might discuss where the data was obtained, etc.), Results (with well labeled charts/graphs - line plots, box plots, scatterplots, regression plots, bar graphs), Conclusions, and Literature Cited (MLA format)
7. Here are a couple of websites that give great advice on poster presentations. These could be modified for your classroom.
   - http://www.cns.cornell.edu/documents/ScientificPosters.pdf
   - http://colinpurrington.com/tips/academic/posterdesign

8. I would conduct the poster session over two class periods so that one group can present their posters, while the non-presenters visit the posters and then they can switch on the second day.
9. As a wrap up, conduct a whole class discussion about the class results and possibilities for further investigation.

Assessment and Evaluation: The final product, the poster presentation, will be the final assessment piece and will be graded on a rubric. Along the way, students will have checkpoints for a grade based on their initial question development and research. Students should be able to show that they can find and analyze NOAA data, they should be able to identify and explain at least one relevant regulation (US or international) that applies to the harvesting of marine food resources or helps manage marine organisms, and they should be able to share what they have learned from at least one relevant primary source (they should have read three).

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Standards

Next Generation Science Standards (2013):

Cross Cutting Standards - Cause and Effect:

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

High School: Interdependent Relationships in Ecosystems

- HS-LS2-1 Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
- HS-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
- HS-LS2-6 Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

Ocean Literacy Principles:

- 5. The ocean supports a great diversity of life and ecosystems. (5 d,e,f)
- 6. The ocean and humans are inextricably connected. (6 b,d,e,g)
- 7. The ocean is largely unexplored (7 b,d,e,f)

AP Environmental Science Course Outline:

- II. The Living World A. Ecosystem Structure, B. Energy Flow, C. Ecosystem Diversity, D. Natural Ecosystem Change
- IV. Land and Water Use F. Fishing (fishing techniques, overfishing, aquaculture, relevant laws and treaties), G. Global Economics (globalization, tragedy of the commons)

Washington State Science Standards:

- 9-12 INQA Question - Scientists *generate* and *evaluate questions* to *investigate* the *natural world*.
- 9-12 INQB Investigate - Scientific progress requires the use of various methods appropriate for answering different kinds of research *questions*, a thoughtful plan for gathering data needed to answer the *question*, and care in collecting, *analyzing*, and displaying the data.
- 9-12 INQC Explain - C*onclusions* must be logical, based on e*vidence*, and consistent with prior *established* knowledge.

- 9-12 INQD Communicate Clearly - The methods and procedures that scientists use to obtain *evidence* must be clearly reported to enhance opportunities for further *investigation*.
- 9-12 INQE Model - The essence of scientific *investigation* involves the development of a *theory* or conceptual *model* that can *generate* testable predictions.
- 9-12 INQF Communicate - *Science* is a human endeavor that involves logical reasoning and creativity and entails the testing, revision, and occasional discarding of theories as new *evidence* comes to light.
- 9-11 LS2B Living *organisms* have the capacity to produce very large *populations*. *Population density* is the number of individuals of a particular *population* living in a given amount of space.
- 9-11 LS2C *Population growth* is limited by the availability of matter and *energy* found in resources, the size of the *environment*, and the presence of competing and/or predatory *organisms*.
- 9-11 LS2D Scientists represent *ecosystems* in the *natural world* using mathematical *models*.
- 9-11 LS2E Interrelationships of organisms may generate ecosystems that are stable for hundreds or thousands of years. Biodiversity refers to the different kinds of organisms in specific ecosystems or on the planet as a whole.

Common Core Connections:

ELA/Literacy:

- RST.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
- RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
- RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
- WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.
- WHST.9-12.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
- WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Mathematics:

- MP.2 Reason abstractly and quantitatively.
- MP.4 Model with mathematics.
- HSN.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
- HSN.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.
- HSN.Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
- HSS-ID.A.1 Represent data with plots on the real number line.
  HSS-IC.A.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
- HSS-IC.B.6 Evaluate reports based on data.

Fishing for Information:
Analyzing NOAA Fisheries Data

Cod end of a trawl net full of groundfish. Photo credit: NOAA Fisheries

Introduction:

Excerpt below is from:
http://www.afsc.noaa.gov/RACE/groundfish/

"The Groundfish Assessment Program is responsible for planning, executing, analyzing, and reporting results from surveys to establish time series estimates for the distribution and abundance of Alaska groundfish resources in the Gulf of Alaska, Bering Sea, and Aleutian Islands. The program also investigates biological processes and interactions with the environment to estimate growth, mortality, and recruitment to improve the precision and accuracy of forecasting stock dynamics. Impacts of bottom trawls on the seafloor and the description of bottom type are also being studied in the Bering Sea and Aleutian Islands."

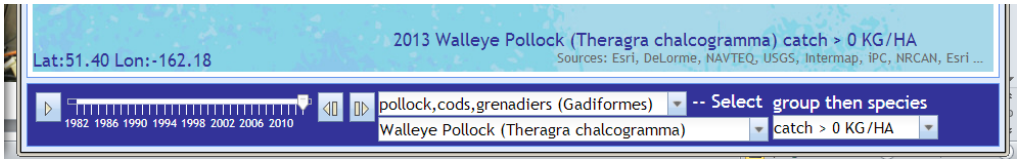
In this lesson, you will have the opportunity to put yourself in the shoes (er...rubber boots) of a NOAA fisheries scientist and analyze data that has been compiled as the result of several fisheries research cruises. The datasets range from 1982 to the present and data can be obtained for the Aleutian Islands, Bering Sea Slope, Eastern Bering Sea Shelf, Northern Bering Sea Shelf, and the Gulf of Alaska. During this project, you will develop your own research questions and conduct an analysis of the data. You will then present your research and conclusions to the class during a poster presentation. Your analysis will be accompanied by a review of relevant primary sources and fisheries regulations.

From top to bottom: Age 2+ walleye pollock, age 1 walleye pollock, age zero walleye pollock caught on the R/V Oscar Dyson September 2013. Photo credit: John Eiler, NOAA

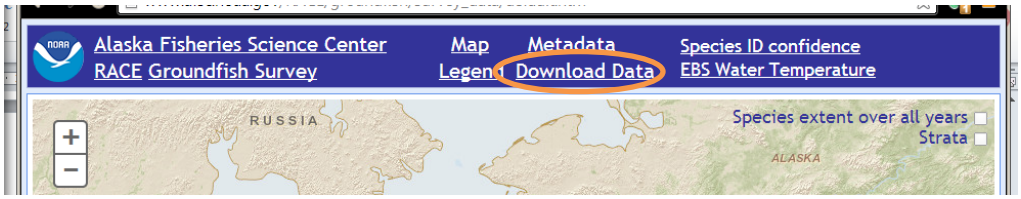
Step One - Retrieving Data:

1. Go to the Alaska Fisheries Science Center RACE Groundfish Survey website: http://www.afsc.noaa.gov/RACE/groundfish/survey_data/default.htm

2. At the bottom, make sure "Pollock, cods, grenadiers (Gadiformes) is selected and select "Walleye Pollock" as shown below. Don't change the catch dropdown menu. Your selections should appear as in the image below.

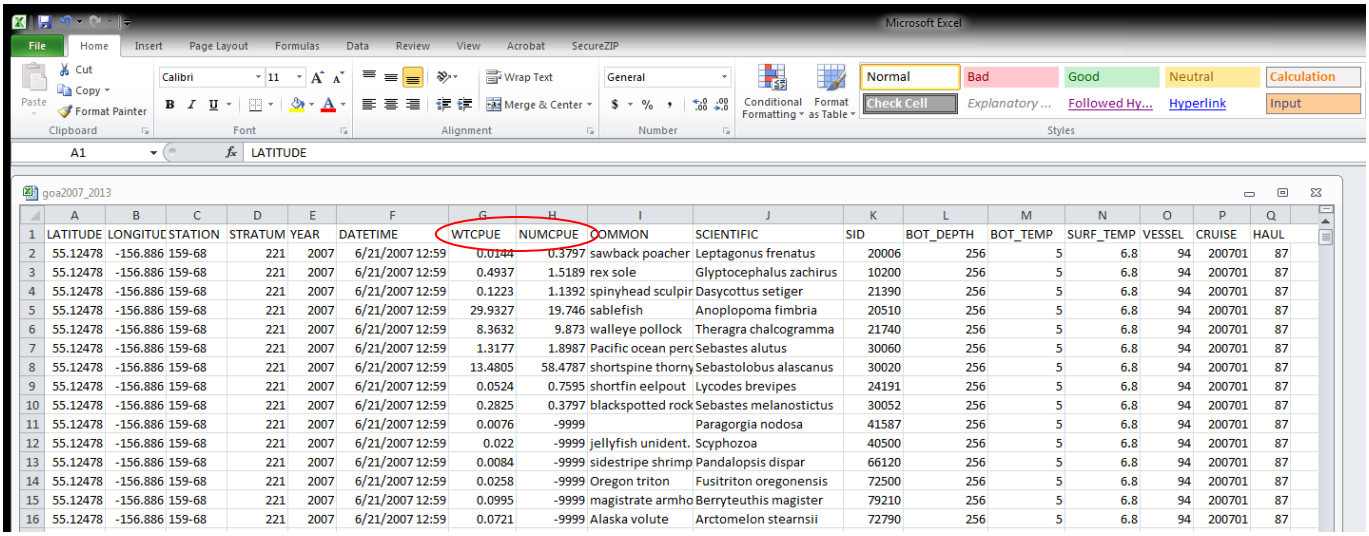


3. At the top of the screen, select "Download Data"



4. Choose the location (Aleutian Islands, Bering Sea Slope, Eastern Bering Sea Shelf, Northern Bering Sea Shelf, or Gulf of Alaska) and the range of years that you want to research. For this example, I have selected "Gulf of Alaska" years 2007-2013.

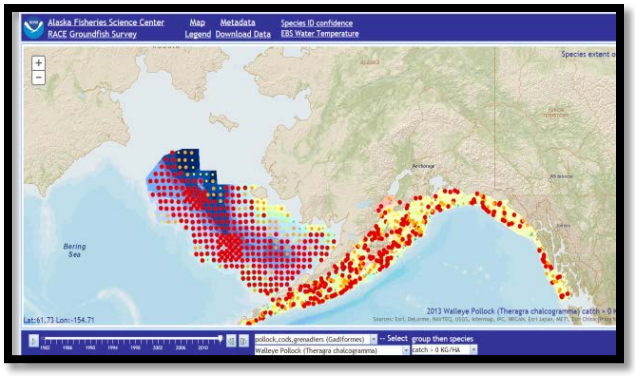
5. When you click on the years, the data will be download and will appear as a zip file in the lower right hand corner of your screen. Click to open the downloaded file. An Excel spreadsheet will be generated. Save this file to a USB drive so you don't have to be on a computer with an internet connection to do this work once you have the file.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	LATITUDE	LONGITUD	STATION	STRATUM	YEAR	DATETIME	WTCPUE	NUMCPUE	COMMON	SCIENTIFIC	SID	BOT_DEPTH	BOT_TEMP	SURF_TEMP	VESSEL	CRUISE	HAUL
2	55.12478	-156.886	159-68	221	2007	6/21/2007 12:59	0.0144	0.3797	sawback poacher	Leptagonus frenatus	20006	256	5	6.8	94	200701	87
3	55.12478	-156.886	159-68	221	2007	6/21/2007 12:59	0.4937	1.5189	rex sole	Glyptocephalus zachirus	10200	256	5	6.8	94	200701	87
4	55.12478	-156.886	159-68	221	2007	6/21/2007 12:59	0.1223	1.1392	spinyhead sculpir	Dasycottus setiger	21390	256	5	6.8	94	200701	87
5	55.12478	-156.886	159-68	221	2007	6/21/2007 12:59	29.9327	19.746	sablefish	Anoplopoma fimbria	20510	256	5	6.8	94	200701	87
6	55.12478	-156.886	159-68	221	2007	6/21/2007 12:59	8.3632	9.873	walleye pollock	Theragra chalcogramma	21740	256	5	6.8	94	200701	87
7	55.12478	-156.886	159-68	221	2007	6/21/2007 12:59	1.3177	1.8987	Pacific ocean perc	Sebastes alutus	30060	256	5	6.8	94	200701	87
8	55.12478	-156.886	159-68	221	2007	6/21/2007 12:59	13.4805	58.4787	shortspine thorny	Sebastolobus alascanus	30020	256	5	6.8	94	200701	87
9	55.12478	-156.886	159-68	221	2007	6/21/2007 12:59	0.0524	0.7595	shortfin eelpout	Lycodes brevipes	24191	256	5	6.8	94	200701	87
10	55.12478	-156.886	159-68	221	2007	6/21/2007 12:59	0.2825	0.3797	blackspotted rock	Sebastes melanostictus	30052	256	5	6.8	94	200701	87
11	55.12478	-156.886	159-68	221	2007	6/21/2007 12:59	0.0076	-9999		Paragorgia nodosa	41587	256	5	6.8	94	200701	87
12	55.12478	-156.886	159-68	221	2007	6/21/2007 12:59	0.022	-9999	jellyfish unident.	Scyphozoa	40500	256	5	6.8	94	200701	87
13	55.12478	-156.886	159-68	221	2007	6/21/2007 12:59	0.0084	-9999	sidestripe shrimp	Pandalopsis dispar	66120	256	5	6.8	94	200701	87
14	55.12478	-156.886	159-68	221	2007	6/21/2007 12:59	0.0258	-9999	Oregon triton	Fusitriton oregonensis	72500	256	5	6.8	94	200701	87
15	55.12478	-156.886	159-68	221	2007	6/21/2007 12:59	0.0995	-9999	magistrate armho	Berryteuthis magister	79210	256	5	6.8	94	200701	87
16	55.12478	-156.886	159-68	221	2007	6/21/2007 12:59	0.0721	-9999	Alaska volute	Arctomelon stearnsii	72790	256	5	6.8	94	200701	87

6. Most of the columns are self explanatory, with the exception of "WTCPUE," which represents kilograms per hectare and "NUMCPUE," which represents number per hectare. You can hide column K as we will not use it in our analysis.

7. Notes on Station and Haul
    - **Station**: a location on a map where the sample was taken. You can go back to the http://www.afsc.noaa.gov/RACE/groundfish/survey_data/default.htm website and find the station where the organisms were collected on the map.



    - **Haul**: the number of that particular haul. For example, all organisms labeled haul 87 were collected in the same net/trawl.

Step Two - Making Discoveries:

1. The information you have downloaded includes:
    - Latitude and longitude (you could use this later to make a map of your sites)
    - Station ID
    - Stratum
    - Year/Date/Time
    - Kilogram/hectare
    - Number/hectare
    - Scientific and Common Names
    - Bottom Depth
    - Bottom Temperature
    - Vessel # and Cruise #
    - Haul #

2. You have already made some choices based on location and year(s). Now look over the data you have retrieved and brainstorm questions. Write the questions in your lab notebook.

3. Consider the following focus questions to help guide you:
    a) What organisms are in the Gulf of Alaska food web?
    b) What are the producers and consumers in this food web?
    c) Does water temperature (surface and bottom), depth, stratum, location, and/or time of year affect the abundance of organisms at a location?
    d) Are there greater numbers of predators or prey?
    e) What changes can you observe over time?
    f) Can you observe any relationships or trends in the data?
    g) What does the current research say about the Gulf of Alaska?
    h) How might commercial fisheries be impacted by the information you have discovered?
    i) What regulations or legislation exists relevant to the species you have chosen to study?

4. Discuss what makes a good research question. As a team, go through each of your questions and determine which question is most "researchable" (i.e. not too broad, can be examined using the available data, etc.).

5. Once everyone has agreed on the best research question, **ask the teacher for approval before continuing**.

6. Use Microsoft Excel to analyze the data. Instead of deleting sections, I recommend that you make another workbook page with a refined set of data so you can always go back to the original dataset without having to download it again.

7. Once you have refined your dataset, start pulling in outside research. There are some suggested readings and websites following this set of instructions to be used as a starting point. You will be required to show a minimum of THREE primary sources (journal articles) and reference a minimum of THREE websites (NOAA or other) regarding fisheries management on your poster.

8. If you find that your research question doesn't allow you to develop an adequate analysis or if in light of new information you would like to change your question, you may revise your question with teacher approval.

9. Your group will create a poster presentation to summarize your research. The format should be as follows:
    - Title
    - Introduction
    - Materials and Methods (discuss where the data was obtained and how you analyzed it, consider creating a map of the stations where you used data, etc.)
    - Results (with well labeled charts/graphs - line plots, box plots, scatterplots, regression plots, bar graphs)
    - Conclusions and suggestions for further investigation
    - Literature Cited (MLA format)

10. Your group will be evaluated on the projects checkpoints and final poster presentation.

11. As a wrap up, we will conduct a group discussion about the class results and possibilities for further investigation.

Background reading:

Salmon Fishermen Battle Walmart on Certification
http://www.nytimes.com/2013/10/22/business/salmon-fishermen-battle-walmart-on-certification.html?_r=0

General Fisheries Information: A Good Catch
http://www.education.noaa.gov/Marine_Life/A_Good_Catch_NMFS.pdf

Alaska Fisheries Science Center Education Website:
http://www.afsc.noaa.gov/Education/oceanlife/fish/oceanlifefish.htm

NOAA Fisheries

http://www.nmfs.noaa.gov/
http://www.nmfs.noaa.gov/regulations.htm

NOAA Alaska Fish Background Information

- Atka Mackerel http://www.afsc.noaa.gov/Education/factsheets/10_AtkaM_fs.pdf
- Sablefish http://www.afsc.noaa.gov/Education/factsheets/10_Sablefish_fs.pdf
- Walleye Pollock http://www.afsc.noaa.gov/Education/factsheets/10_Wpoll_FS.pdf
- Pacific Cod http://www.afsc.noaa.gov/Education/factsheets/10_Pcod_fs.pdf
- Pacific Ocean Perch http://www.afsc.noaa.gov/Education/factsheets/10_POP_fs.pdf
- Yellowfin Sole http://www.afsc.noaa.gov/Education/factsheets/10_Yellowfin_fs.pdf

Inter-research Science Center

Anderson and Piatt. 1999 Community reorganization in the Gulf of Alaska following ocean climate regime shift. Marine Ecology Progress Series. 189: 117-123. http://www.int-res.com/articles/meps/189/m189p117.pdf

The North Pacific Research Board Website

http://publication.nprb.org/list.jsf

Possible Readings from NPRB (you are not limited to these):

- Brodeur, RD, Decker, MB, Ciannelli, L, Purcell, JE, Bond, NA, Stabeno, PJ, Acuna, E, and Hunt, GL 2008. Rise and fall of jellyfish in the eastern Bering Sea in relation to climate regime shifts. Progress in Oceanography 77: 103-111.
- Buchheister, A., Wilson, M.T., Foy, R.J., and Beauchamp, D.A. 2005. Seasonal and Geographic Variation in Condition of Juvenile Walleye Pollock in the Western Gulf of Alaska. Transactions of the American Fisheries Society 135: 897-907.
- Logerwell, Elizabeth A., Duffy-Anderson, Janet, Wilson, Matthew, and McKelvey, Denise 2010. The influence of pelagic habitat selection and interspecific competition on productivity of juvenile walleye pollock (Theragra chalcogramma) and capelin (Mallotus villosus) in the Gulf of Alaska. Fisheries Oceanography 19: 262-278.
- Mazur, M.M., Wilson, M.T., Dougherty, A.B., Buchheister, A., and Beauchamp, D.A. 2006. Temperature and prey quality effects on growth of juvenile walleye pollock Theragra chalcogramma: A spatially-explicit bioenergetics approach. Journal of Fish Biology 70: 816-836.
- Wilson, Matthew T. 2009. Ecology of small neritic fishes in the western Gulf of Alaska. I. Geographic distribution in relation to prey density and the physical environment. Marine Ecology Progress Series 392: 223-237.

Other NOAA Fisheries Data Online

Ecosystems and Fisheries-Oceanography Coordinated Investigations Links to Data and Metadata http://www.ecofoci.noaa.gov/efoci_data.shtml

Group Names:_____**Period:**_____

Fishing for Information Rubric and Tracking Sheet

Score	Completed*	Criteria
PREPARATION		
		Initial research question has been approved.
		Data has been downloaded.
POSTER COMPONENTS		
		The **title** is specific, original, and scientific.
		The **introduction** indicates the research question and describes the project in a succinct way.
		The **methods** section explains how you analyzed the data.
		The **methods** section includes a **map** of the location from which the data was obtained.
		The **results** section includes well labeled charts, tables, and graphs as appropriate. Consider using line plots, box plots, scatterplots, regression plots, bar graphs to display your data.
		The **conclusion** is based on evidence and mathematical or computational representations are used to support explanations.
		The **conclusion** provides suggestions for further investigation and explains the information needed for this investigation.
		Poster includes a **literature cited** section. A minimum of **three** journal articles are cited and minimum of **three** websites are cited in MLA format.
POSTER QUALITY		
		Poster layout is easy to follow (good flow) and images, graphs, and tables help the viewer understand the presentation.
		The poster construction is neat and the text is large enough for the viewer to read.
		Poster has been proofread and is typed. Text is concise and informative.
TOTAL POINTS		
	Teacher notes:	

* **Highlight the boxes in the completed column in yellow if you have completed the step.**