Puget Sound/Olympic Peninsula Fisheries Complex
U.S. Fish & Wildlife Service

# Find Your Fish!!
# An Elwha River Recovery Project Learning Experience

Teachers Curriculum Packet:
Fish tracking and an historic fisheries restoration project case study.

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# How to Use this Educational Resource

This document is a resource for teachers and parents who want their students to have an exciting and interactive learning experience using real scientific data. It is adaptable to a wide range of grade levels ($7^{th}$-$12^{th}$) as well as subject coverage. In addition to covering science, there are ample opportunities to expand well beyond the fish migration tracking activity to make it an integrated learning experience. The Curriculum Overview and Curriculum Components sections of this document provide multiple paths for teachers to mold this learning experience to the needs of their students; from the degree of pre and post activities and subject matter integration, to how assignments are delegated (individual vs group work) and assessed (research paper, presentation, etc.).

Some elements of this document, such as the data tables and instructions, will need to be separated out and made available to the students. While these are necessary resources for your students, we strongly encourage guiding them through map entry steps together.

# Curriculum Overview

The Elwha River Recovery Project includes the largest completed dam removals to date. Because of the scale, expense, and significance, it is also one of the most thoroughly studied recovery projects; with a large and diverse group of scientists from the Federal, State, and Tribal agencies as well as universities and conservation organizations.

This historic project is also a unique and comprehensive learning opportunity. While the primary focus of this activity is to track and compare the migrations of various fish species in the Elwha River using real data, it is also an excellent opportunity to learn much more. The subjects that are inherently and potentially integrated into this school project include: biology, field ecology, math, technology, geography, history, government, and Native American studies.

In order to provide important context to the fish tracking activity, we strongly recommend that students conduct research into the area, it's people, and the history of the restoration project. Why did the watershed require such a significant restoration project? What was the problem, why and when did it occur, and how did it impact the people and the environment? How long and what level of effort did it take to implement such a historic restoration project? What are the general goals of the project and what are scientists doing to determine if those goals are being met? It is recommended to keep initial questions broad and vague to raise curiosity and require students to conduct a minimum level of research to determine where the Elwha River is and what exactly required restoration.

It is also important for participating students to orient themselves to the science, technology, math, and geography associated with the fish tracking project. This project focuses on four fish species: Chinook Salmon, Steelhead, Bull Trout, and Pacific Lamprey. Studying up on these species and their life history patterns (habitat, diet, migrations, reproduction, etc.) will enable participants to understand and appreciate the fish they track and to help form hypotheses regarding their migrations.

The technology used to track these fish is called radio telemetry. Researching how this technology works and is used by biologists will be beneficial. The fish locations provided are in the form of latitude and longitude coordinates that were obtained using GPS (Global Positioning System) devices in conjunction with radio telemetry tracking technology. At a minimum, participants should familiarize themselves with how the latitude and longitude system works. A supplemental research topic could also include how GPS technology works. We suggest making broad predictions (hypotheses) prior to plotting the migrations, followed by comparing the migrations of different fish within and among species.

A data table with fish location coordinates and dates along with the instructions for plotting the positions onto Google's "My Maps" (free) are included in this document. Please be sure to complement these resources by walking your students through the map entry steps. Students are to summarize their observations and determine if any of the broad recovery project goals have been achieved. However, please keep in mind these are only a select few fish from multiple radio telemetry fish tracking projects. These radio telemetry projects are among many other aquatic and terrestrial based scientific studies which are assessing the recovery progress. Yet while being a small piece of a larger puzzle, students should still be able to determine whether the fish passage goal has been achieved.

We hope you and your students enjoy this project and gain a better understanding of and appreciation for conservation efforts such as these!

**Suggested Research:** The following components are options that can be assigned as requirements for inclusion into individual research papers or split up and assigned for groups to research and present to the rest of the class. All in all, this curriculum is very flexible, allowing the teacher to mold it to their timeline, student abilities, and other needs.

## **Phase One:** Historical and Watershed Research

**The Problem:** Why is such a large-scale restoration project necessary? Research the watershed and figure out the problem and the history behind it. Who was affected by this problem besides fish and wildlife?

**The Solution:** What types of restoration took place? When did it happen? What type of effort went into getting the restoration project approved? How long did that take?

**Native American Studies:** What tribe(s) resided in the Elwha River watershed? What is their history and how were they impacted by the issue that required restoration? How were they involved in the implementation of the project and study of the results?

**Elwha Watershed:** Describe the watershed. Where is it located? What are the physical characteristics (size, topography, size and length of the main river, etc.)? Describe some of the animals (aquatic and terrestrial) and plants that live within the watershed.

## **Phase Two:** Study Specific Research

**Focus Species:** Research for these four species can be split up or merged into one paper or presentation. What are their life histories? This can include distribution range, size/weight range, lifespan, habitat requirements, water quality requirements, diet, migrations, and population status (Threatened, Endangered, recovering, etc.). How important are these fish to people and/or their ecosystem (what animals and plants depend on them and how)? Have students form a hypothesis regarding their fish migrations. When will the migrations occur and which species will travel the furthest? Will any restoration goals be met (fish passage?)?

- Chinook Salmon, Steelhead, Bull Trout, and Pacific Lamprey.

**Study Method**: What is radio telemetry? How does this technology work? What are the different ways fish are tracked using this technology? How does it compare to other methods of studying and tracking fish?

**Possible Extension:** What is GPS (Global Positioning System) technology? How is it used in conjunction with radio telemetry fish tracking? How does GPS technology work?

**Mapping**: What are latitude and longitude? How are they used to mark and find specific locations on the earth?

**Extension Activities:**

**Practice finding locations given coordinate and coordinates given locations:** Example

**Play the game "Battleship" (in person or online):** Say "latitude" prior to providing the letter and "longitude" prior to providing the number coordinates.

**Fish Tracking Activity:** Have students enter the radio telemetry fish tracking data from the tables into Google's "My Maps", compare migrations, and articulate their findings.

## **Phase One:** Students enter the fish migration data

**Set up a Google "My Map" Account:** Walk students through this process.

> **Note:** Students can share their maps with peers, teachers, and parents. This includes sharing links of your maps for others to see as well as giving access to others with Google accounts to edit and add to their maps. The latter will be key for group work.

**Entering Migration Data:** Provide students with live and written instruction. We recommend students working solo to enter in data for at least two fish per species. For group work, at least one fish per species.

> **Note:** There is a maximum of ten layers per map. You will need to create two maps if you plan on entering all the individual fish.
>
> **Example Map (Bull Trout and Pacific Lamprey migration layers)**

**Optional:** Have students produce distance vs elevation tracking graphs. This will be a useful tool to help you compare the migrations within and between fish species. Complete one graph together as a class.

## **Phase Two:** Students compare fish and record your observations.

**Within the same species:** Do the fish have the same migration routes? How does the migration timing differ at all? Are there any significant timing gaps in the data?

**Between different species:** How do the migration routes AND timing compare?

**Habitat Restoration:** Where did the fish migrate in relation to the two major habitat restoration sites? What is the significance of those movements?

## **Phase Three:** Students draw conclusions and present their findings.

**Paper and/or Presentation:** A critical component of science is communicating the findings.

**Summary:** Students should articulate observations, from general to specific. What did you find to be particularly interesting or surprising? Were the hypotheses supported?

**How do the migrations relate to the goals of the restoration project?** How would the migrations have been limited if there were no restoration? Were any of the goals met?

> **Note:** The simplified goals of the recovery project as it relates to fish would be successful and consistent fish passage beyond the two historical dam sites as well as population size recovery. The fish data in this assignment is a small sample of more extensive fish tracking projects (more data per fish and more fish tracked). There are many other ongoing studies involving fish, wildlife, plants, and habitat recovery within the Elwha Watershed.

# Protocol for Entering Fish Data into Google's "My Maps"

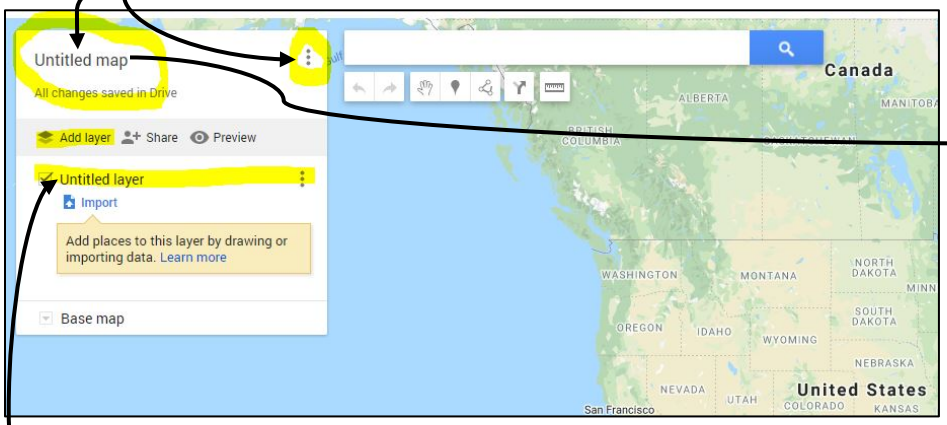
The data (information) we have provided consists of different locations where we have picked up the radio signal of each tagged fish along their migration within the Elwha River Watershed. These fish locations were recorded using both fixed stations (permanent automated antenna & computer systems) and mobile tracking (car, foot, raft and plane).

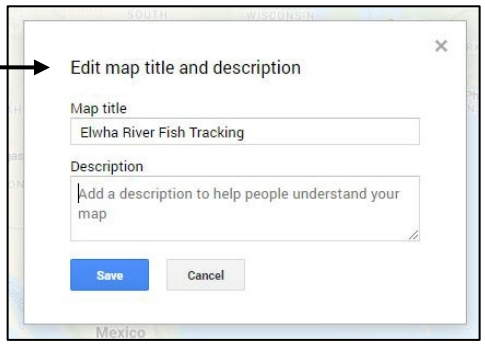
Using Google's "My Maps" program (instead of Google Earth) will allow you to map, save/store, and compare the fish movements. You will enter the locations of each individual fish from the data tables into their own "Layer". Selecting an individual layer will allow you to look at the migration of one fish. You can also click on other fish layers to compare the migrations between different fish of the same species and/or between fish of different species. Keep in mind that you should be comparing the timing of the fish migrations in addition to the distances and locations traveled.

## Plotting your fish using Google "My Maps"

1) **Create a free Google "My Maps" account**

2) **Create a "New Map" and give it an appropriate title (Elwha River…)**
   a) Click on the three vertical dots on the menu, and select "New Map"
   b) Double click on "Untitled map" and give it a title and description



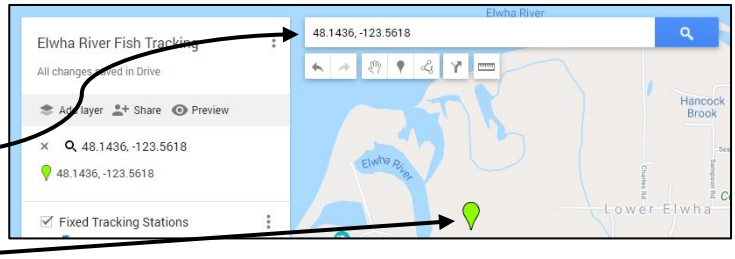




**Layers**: You will be adding in and naming layers within this one map. There will be an individual layer per fish as well as for the radio telemetry fixed stations. You can view layers individually or select multiple layers to compare fish migrations within a species or between species, for example. Your New Map will automatically start with one layer.

3) **Double click on "Untitled Layer" and rename it "Fixed Tracking Stations**". You will need to enter/map these locations (step 4), which were permanent and automatic fish tracking stations. Fish detected within the range of these stations were recorded via computer and periodically downloaded by fisheries biologists.

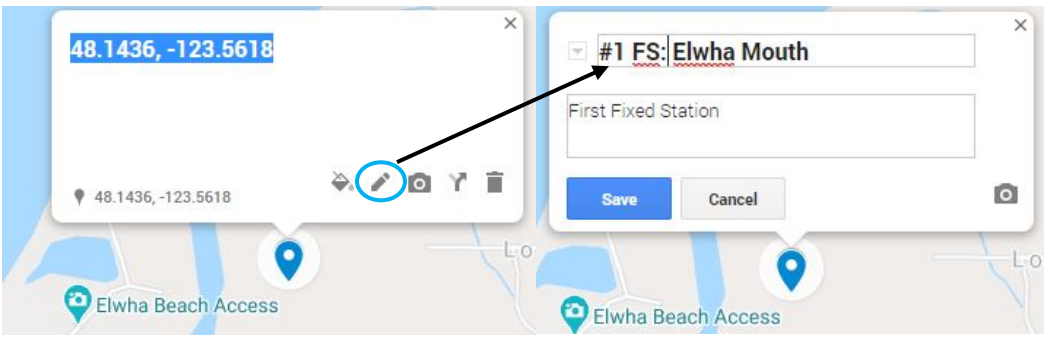
4) **Enter in fixed station locations.**
   a) Copy the latitude-longitude coordinates, paste them into the search box, and click the search icon

| Fixed Site | Site Name | River Miles | Lat-Long Coordinates (Decimal Degrees) |
|---|---|---|---|
| 1 | Elwha Mouth | 0.3 | 48.1436, -123.5618 |
| 2 | Diversion/Elwha Dam | 4.9 | 48.1117, -123.5514 |
| 3 | Johnson's/Little River | 7.7 | 48.0641, -123.5763 |

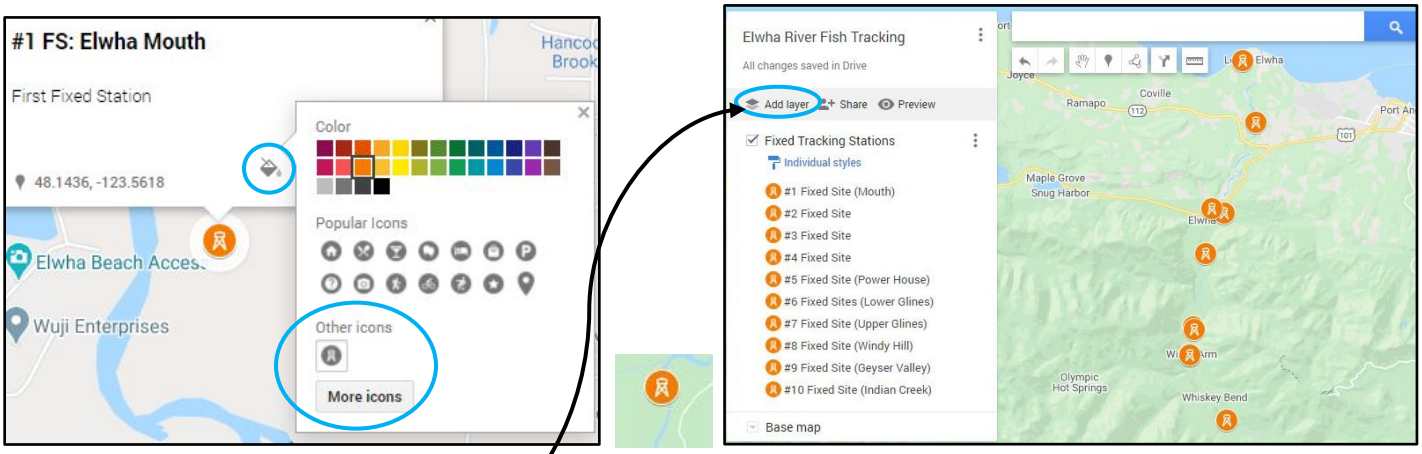



   b) A pin will appear on the map location.
   c) Click on the pin and click "Add to map"

d) Click on the Pin edit option (pencil icon) and change the title to the site name from the data table.



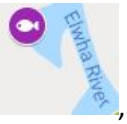

i) Customize the pin to best represent a fixed station. A suggested icon can be seen in the images below. Use the same pin symbol and color for **all** fixed sites




**2) Add in fish data:**

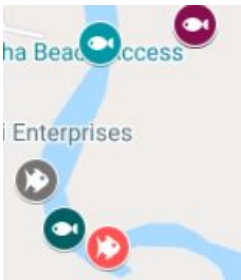
a) **Create a new layer per individual fish**. Each data table within the species page is an individual fish.

i) Title with the fish name, number and year. Use a unique **symbol** for each fish **species**.

**Examples**: Chinook , Steelhead  , Bull Trout , Pacific Lamprey

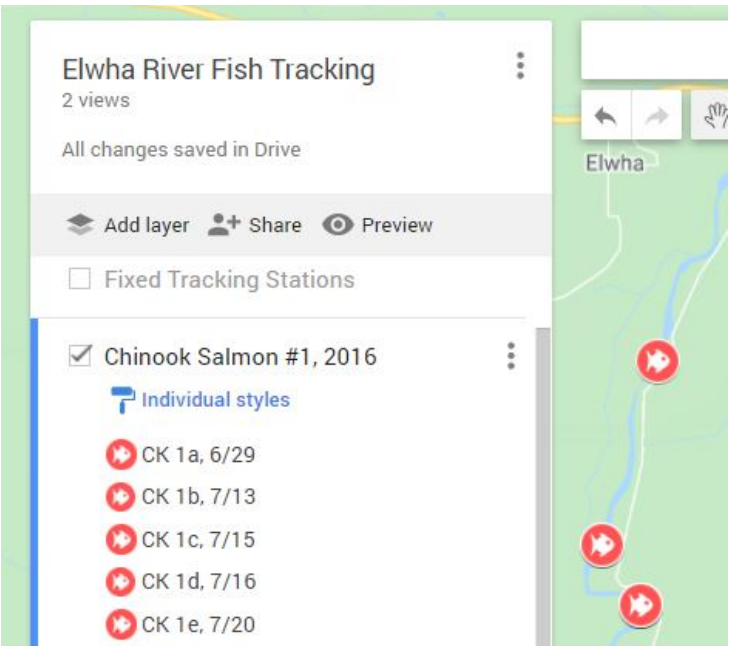
ii) Select one **color** per individual fish. For example: All Pacific Lamprey will have the same symbol type (e.g. snake), but each individual fish will have their own map layer with their own unique color. This will allow you to compare migrations between fish of the same species (Bull Trout 1 = red vs Bull Trout 2 = blue).

**Example**: In this section of the map below, you can see two different Chinook Salmon (grey and orange) and three different Steelhead. Note that the layers of each of these fish have all been selected in order to view them together on the map.



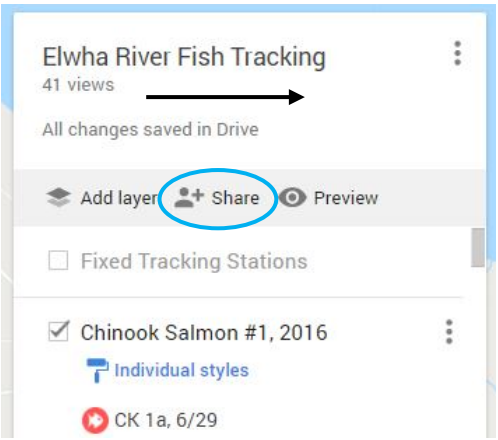
iii) **Labeling location points:** Each spreadsheet includes a map label code per fish that starts with a species abbreviation and the fish number. Use those in each location point label title. You can also include a letter after the number to indicate the order. Bull Trout #1 for the first three dates could be labeled as BT 1a, BT 1b, BT 1c respectively, for example. Also include the date in the location point title or notes.

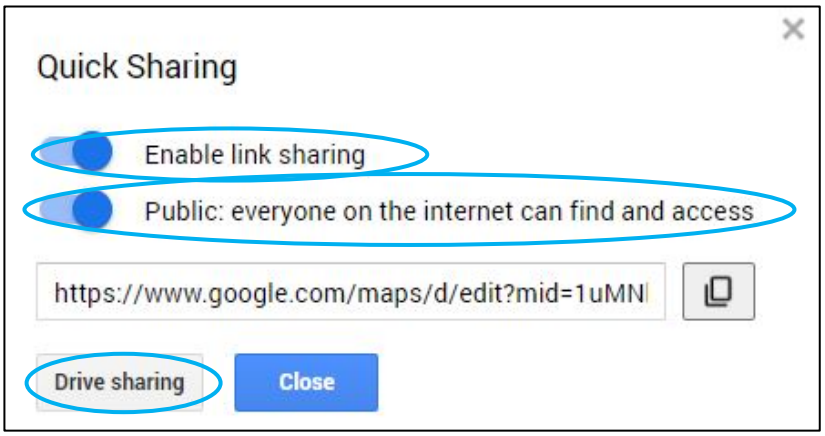
**Example**: Here we can see: the overall map title; the layers section with layer and location point labeling; and a portion of the map where we can see some of the locations of that fish in the layer. Notice that the "Fixed Tracking Stations" layer was not selected, so both the point list in the left-hand table and the locations on the map remain hidden until you check off that label.



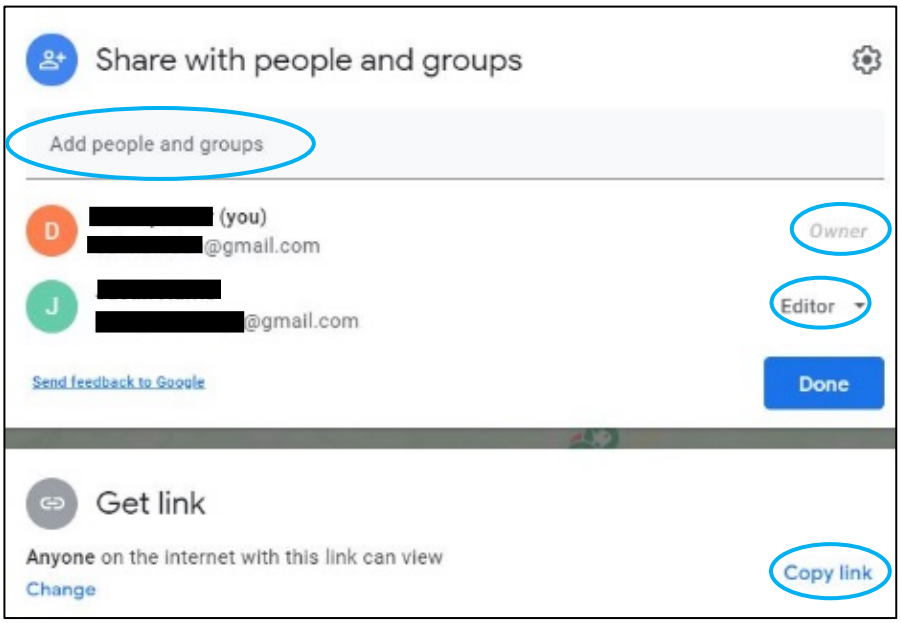

**3) Share Your Map**: At a minimum, you'll want to share a link to your map so your teacher can view your progress and grade your work when completed. A Google account is not necessary to view a link to your map if you make it public. If you project involves group work, you'll want to share the map and editing permission with your team.

a) Click the "Share" button under your map title. Make sure the "Enable link sharing" and "Public:" options are selected (blue circle to the right). Then select "Drive sharing."



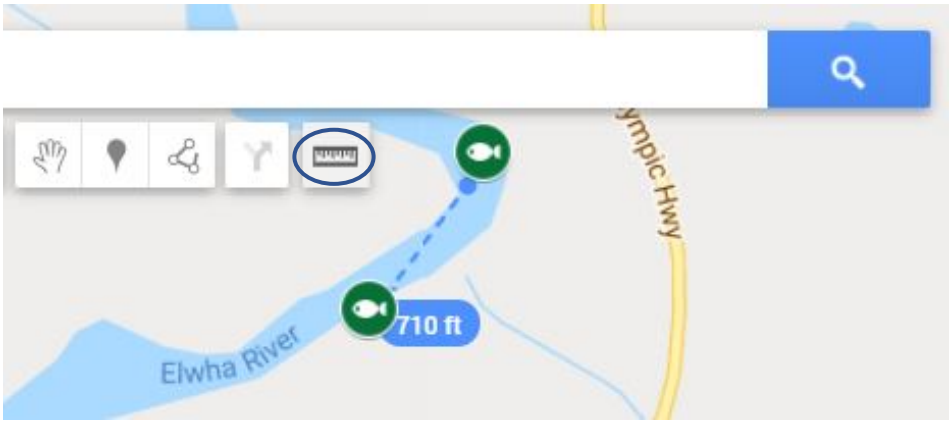
b) Send email invitations to collaborators. One person per group should initiate this step. Select the "Copy link" button for sharing your map with those whom you want to share your map with without editing powers.




4) **Compare migrations**: Select different combinations of layers to compare migrations within and between species. Record your observations. Be sure to pay attention to migration timing as well. As such, having the dates included on the point titles is helpful for quick viewing and comparisons.

5) **Record your observations:** Take note of any interesting movements. Pay special attention to the time of year when you observed the most movements within and among species. Which fish/species traveled the furthest and least? Try to include some numbers (quantitative data) in your comparisons along with your descriptions (qualitative).

a) There is a measuring tool on "My Maps" located just under the search bar.




b) There are also directions for producing graphs that compare elevation gains to distance traveled (pages 18-20) following the data tables. Producing at least one per species will be helpful visuals for analysis and reporting.

6) **Conclusions**: What did you learn? How did your findings compare to your research? Did your findings support or reject your hypothesis? Were any restoration goals achieved? Why is or isn't this a useful study?

**Note**: Do keep in mind the sample size (number of tagged/tracked fish) we have provided is small. The tracking studies we obtained these data from included several more fish per species and more data (locations) per fish. There are other studies that focus more on population estimates (juvenile and adults), habitat changes, etc.

# Telemetry Fixed Station Site Locations

The signal from radio tags (tranmitters) are detected using a antenna and reciever. Fish locations are determined using recievers during mobile tracking (via foot, car, raft, or plane) and at permanent fixed locations, where computers logs tag information when they are detected. The following are the locations of the fixed sites used for the fish tracking studies.

| Site Name | River Miles | Lat-Long Coordinates |
|---|---|---|
| Elwha Mouth | 0.3 | 48.1436, -123.5618 |
| Elwha Dam | 4.9 | 48.1117, -123.5514 |
| Little River | 7.7 | 48.0641, -123.5763 |
| Power House | 13.2 | 48.0052, -123.6005 |
| Lower Glines | 13.3 | 48.0036, -123.5993 |
| Upper Glines | 13.5 | 47.9904, -123.6029 |
| Windy Arm | 14.4 | 47.9905, -123.6028 |
| Indian Creek | 12.6 | 48.0664, -123.5857 |
| Geyser Valley | 17.6 | 47.9562, -123.5739 |

# Steelhead Radio Telemetry Data (1)

| Fish information | |
|---|---|
| **Map Label** | STH 1 |
| **Species** | Steelhead |
| **Length (mm)** | 651 |
| **Capture Method** | Drift Netting |
| **Code** | 61 |
| **Frequency** | 148.43 |

| Date | Lat-Long Coordinates |
|---|---|
| 06/22/17 | 47.9932, -123.6033 |
| 06/23/17 | 48.0034, -123.5993 |
| 06/24/17 | 48.0054, -123.6003 |
| 06/26/17 | 48.0183, -123.5941 |
| 07/05/17 | 48.0777, -123.5722 |
| 07/07/17 | 48.0640, -123.5773 |
| 07/11/17 | 48.0769, -123.5717 |
| 07/26/17 | 48.0730, -123.5752 |
| 07/30/17 | 48.0053, -123.6002 |
| 07/31/17 | 47.9907, -123.6042 |
| 08/03/17 | 48.0769, -123.5717 |
| 09/13/17 | 47.8394, -123.4699 |
| 10/11/17 | 47.9122, -123.4967 |
| 11/17/17 | 47.8394, -123.4699 |

| Fish information | |
|---|---|
| **Map Label** | STH 2 |
| **Species** | Steelhead |
| **Length (mm)** | 506 |
| **Capture Method** | Drift Netting |
| **Code** | 40 |
| **Frequency** | 148.43 |

| Date | Lat-Long Coordinates |
|---|---|
| 04/05/17 | 48.1402, -123.5651 |
| 04/12/17 | 48.1345, -123.5551 |
| 04/18/17 | 48.1108, -123.5503 |
| 04/23/17 | 48.0853, -123.5620 |
| 04/25/17 | 48.0833, -123.5646 |
| 04/30/17 | 48.0051, -123.6002 |
| 05/07/17 | 48.0033, -123.5993 |
| 05/12/17 | 48.0180, -123.5939 |
| 05/17/17 | 48.0052, -123.6002 |
| 05/24/17 | 48.0155, -123.5946 |
| 05/26/17 | 48.0052, -123.6002 |
| 06/07/17 | 48.0159, -123.5950 |
| 06/28/17 | 48.0642, -123.5773 |
| 07/04/17 | 48.1116, -123.5515 |
| 07/05/17 | 48.1186, -123.5544 |
| 07/06/17 | 48.1437, -123.5638 |
| 10/11/17 | 48.1303, -123.5536 |

# Steelhead Radio Telemetry Data (2)

| Fish information | |
|---|---|
| **Map Label** | STH 3 |
| **Species** | Steelhead |
| **Length (mm)** | 695 |
| **Capture Method** | Drift Netting |
| **Code** | 34 |
| **Frequency** | 148.43 |

| Date | Lat-Long Coordinates |
|---|---|
| 04/12/16 | 48.0834, -123.5643 |
| 04/13/16 | 48.0854, -123.5621 |
| 04/19/16 | 48.0200, -123.5956 |
| 05/03/16 | 48.0111, -123.5909 |
| 05/04/16 | 48.0054, -123.6003 |
| 05/13/16 | 48.0164, -123.5944 |
| 05/13/16 | 48.0050, -123.6000 |
| 05/17/16 | 48.0191, -123.5917 |
| 05/23/16 | 48.0601, -123.5803 |
| 05/24/16 | 48.0842, -123.5626 |
| 05/28/16 | 48.1118, -123.5516 |

| Fish information | |
|---|---|
| **Map Label** | STH 4 |
| **Species** | Steelhead |
| **Length (mm)** | 695 |
| **Capture Method** | Drift Netting |
| **Code** | 25 |
| **Frequency** | 148.43 |

| Date | Lat-Long Coordinates |
|---|---|
| 08/04/15 | 48.0037, -123.5992 |
| 08/04/15 | 48.0052, -123.6003 |
| 08/06/15 | 48.0159, -123.5946 |
| 08/27/15 | 48.0207, -123.5965 |
| 08/31/15 | 48.1117, -123.5514 |
| 09/01/15 | 48.1433, -123.5642 |

| Fish information (optional fish) | |
|---|---|
| **Map Label** | STH 5 |
| **Species** | Steelhead |
| **Length (mm)** | 655 |
| **Capture Method** | Drift Netting |
| **Code** | 97 |
| **Frequency** | 150.8 |

| Date | Lat-Long Coordinates |
|---|---|
| 04/06/15 | 48.0051, -123.5998 |
| 04/07/15 | 48.0038, -123.5992 |
| 04/08/15 | 48.0051, -123.6002 |
| 04/21/15 | 48.0079, -123.5983 |
| 04/22/15 | 48.0051, -123.6002 |
| 04/30/15 | 48.0773, -123.5722 |
| 05/05/15 | 48.1117, -123.5514 |
| 05/09/15 | 48.1430, -123.5640 |

# Bull Trout Radio Telemetry Data (1)

| Fish information | |
|---|---|
| **Map Label** | BT 1 |
| **Species** | Bull Trout |
| **Length (mm)** | 530 |
| **Weight (kg)** | 1.78 |
| **Capture Method** | Drift Netting |
| **Code** | 35 |
| **Frequency** | 151.720 |

| Date Contacted | Lat-Long Coordinates |
|---|---|
| 07/12/16 | 48.0051, -123.6002 |
| 07/13/16 | 48.0181, -123.5940 |
| 07/20/16 | 48.0310, -123.5903 |
| 07/25/16 | 48.0177, -123.5939 |
| 07/26/16 | 48.0054, -123.6003 |
| 07/27/16 | 47.9918, -123.6039 |
| 08/16/16 | 47.8442, -123.4669 |
| 09/16/16 | 47.8080, -123.4540 |
| 10/19/16 | 47.8397, -123.4676 |
| 12/15/16 | 47.8394, -123.4699 |
| 01/09/17 | 47.9906, -123.6043 |
| 03/30/17 | 47.9909, -123.6041 |
| 03/31/17 | 48.0052, -123.5999 |
| 04/08/17 | 48.1117, -123.5514 |
| 05/10/17 | 48.1394, -123.5599 |
| 06/14/17 | 48.1436, -123.5639 |
| 08/03/17 | 48.1438, -123.5639 |
| 08/04/17 | 48.1108, -123.5503 |
| 08/05/17 | 48.0853, -123.5621 |
| 08/07/17 | 48.0027, -123.5995 |
| 08/09/17 | 47.9578, -123.5750 |
| 09/13/17 | 47.8092, -123.4552 |
| 11/17/17 | 47.8093, -123.4553 |
| 11/28/17 | 47.9580, -123.5750 |
| 11/30/17 | 47.9907, -123.6041 |

| Fish information | |
|---|---|
| **Map Label** | BT 2 |
| **Species** | Bull Trout |
| **Length (mm)** | 485 |
| **Weight (kg)** | 1.58 |
| **Capture Method** | Drift Netting |
| **Code** | 25 |
| **Frequency** | 151.720 |

| Date Contacted | Lat-Long Coordinates |
|---|---|
| 06/10/16 | 48.1236, -123.5556 |
| 06/21/16 | 48.1295, -123.5572 |
| 06/28/16 | 48.1107, -123.5498 |
| 06/29/16 | 48.0856, -123.5623 |
| 07/13/16 | 48.0078, -123.5988 |
| 07/17/16 | 47.9918, -123.6039 |
| 07/21/16 | 47.9658, -123.5852 |
| 08/08/16 | 47.9644, -123.5815 |
| 08/31/16 | 47.9903, -123.6049 |
| 09/16/16 | 47.9826, -123.5989 |
| 09/18/16 | 47.9911, -123.6040 |
| 10/04/16 | 48.0164, -123.5944 |
| 10/07/16 | 48.0853, -123.5625 |
| 10/10/16 | 48.1116, -123.5519 |
| 11/14/16 | 48.1179, -123.5547 |
| 12/28/16 | 48.1195, -123.5539 |
| 06/06/17 | 48.1347, -123.5556 |
| 07/08/17 | 48.1117, -123.5514 |
| 07/09/17 | 48.0855, -123.5619 |
| 07/11/17 | 48.01604 -123.5947 |
| 07/12/17 | 48.0055, -123.6000 |
| 07/24/17 | 47.9582, -123.5751 |
| 09/13/17 | 47.8395, -123.4697 |

# Bull Trout Radio Telemetry Data (2)

| Fish information | |
|---|---|
| **Map Label** | BT 3 |
| **Species** | Bull Trout |
| **Length (mm)** | 495 |
| **Weight (kg)** | 1.81 |
| **Capture Method** | Drift Netting |
| **Code** | 190 |
| **Frequency** | 151.480 |

| Date Contacted | Lat-Long Coordinates |
|---|---|
| 06/18/14 | 48.1347, -123.5556 |
| 07/06/14 | 48.1117, -123.5514 |
| 07/09/14 | 48.0853, -123.5621 |
| 07/14/14 | 48.0053, -123.6002 |
| 08/02/14 | 48.0855, -123.5624 |
| 08/04/14 | 48.0987, -123.5582 |
| 08/05/14 | 48.1108, -123.5503 |
| 08/14/14 | 48.0855, -123.5621 |
| 08/25/14 | 48.0310, -123.5901 |
| 08/26/14 | 48.0036, -123.5992 |
| 08/27/14 | 48.0111, -123.5906 |
| 09/04/14 | 48.0162, -123.5946 |
| 09/11/14 | 48.0660, -123.5784 |
| 09/13/14 | 48.0039, -123.5993 |
| 09/23/14 | 47.9633, -123.5802 |
| 12/18/14 | 47.9530, -123.5723 |
| 02/17/15 | 47.9531, -123.5725 |

| Fish information | |
|---|---|
| **Map Label** | BT 4 |
| **Species** | Bull Trout |
| **Length (mm)** | 480 |
| **Weight (kg)** | |
| **Capture Method** | Drift Netting |
| **Code** | 167 |
| **Frequency** | 151.480 |

| Date Contacted | Lat-Long Coordinates |
|---|---|
| 05/07/14 | 48.1120, -123.5528 |
| 05/12/14 | 48.1088, -123.5513 |
| 06/05/14 | 48.1436, -123.5618 |
| 06/26/14 | 48.1466, -123.5633 |
| 07/10/14 | 48.1434, -123.5641 |
| 07/17/14 | 48.1477, -123.5668 |
| 07/17/14 | 48.1437, -123.5639 |
| 07/24/14 | 48.1164, -123.5539 |
| 07/25/14 | 48.0853, -123.5621 |
| 07/27/14 | 48.0036, -123.5992 |
| 08/05/14 | 47.9906, -123.6042 |
| 09/03/14 | 47.9587, -123.5754 |
| 09/23/14 | 47.9587, -123.5756 |

# Chinook Salmon Radio Telemetry Data (1)

| Fish Information | |
|---|---|
| **Map Label** | CK 1 |
| **Species** | Chinook Salmon |
| **Sex** | Female |
| **Capture Method** | Drift Netting |
| **Length (mm)** | 875 |
| **Code** | 146 (16-054) |
| **Frequency** | 151.480 |
| | |
| **Date** | **Lat-Long Coordinates** |
| 06/29/16 | 48.1399, -123.5640 |
| 07/13/16 | 48.1106, -123.5498 |
| 07/16/16 | 48.0857, -123.5634 |
| 07/20/16 | 48.0099, -123.5903 |
| 07/21/16 | 48.0052, -123.6002 |
| 07/25/16 | 47.9918, -123.6038 |
| 07/26/16 | 48.0036, -123.5988 |
| 08/05/16 | 47.9918, -123.6039 |
| 08/24/16 | 48.0037, -123.5992 |
| 09/01/16 | 47.9918, -123.6038 |
| 09/07/16 | 48.0310, -123.5902 |
| 09/16/16 | 48.0311, -123.5903 |
| 09/16/16 | 48.0474, -123.5891 |
| 09/27/16 | 48.0350, -123.5944 |
| 10/06/16 | 48.0309, -123.5900 |

| Fish Information | |
|---|---|
| **Map Label** | CK 2 |
| **Species** | Chinook Salmon |
| **Sex** | Female |
| **Length (mm)** | 690 |
| **Capture Method** | Drift Netting |
| **Code** | 49 |
| **Frequency** | 151.480 |
| | |
| **Date** | **Lat-Long Coordinates** |
| 07/23/14 | 48.1338, -123.5540 |
| 07/24/14 | 48.1325, -123.5519 |
| 07/27/14 | 48.1110, -123.5501 |
| 07/28/14 | 48.0942, -123.5590 |
| 08/07/14 | 48.0942, -123.5592 |
| 08/13/14 | 48.0907, -123.5641 |
| 09/02/14 | 48.0853, -123.5621 |
| 09/04/14 | 48.0176, -123.5938 |
| 09/06/14 | 48.0035, -123.5992 |
| 09/11/14 | 48.0172, -123.5940 |
| 10/09/14 | 48.0172, -123.5939 |

# Chinook Salmon Radio Telemetry Data (2)

| Fish Information | |
|---|---|
| **Map Label** | CK 3 |
| **Species** | Chinook Salmon |
| **Sex** | Female |
| **Length (mm)** | 711 |
| **Capture Method** | Drift Netting |
| **Code** | 33 |
| **Frequency** | 150.500 |

| Date | Lat-Long Coordinates |
|---|---|
| 07/09/14 | 48.1347, -123.5556 |
| 07/14/14 | 48.1008, -123.5581 |
| 07/17/14 | 48.1108, -123.5502 |
| 07/18/14 | 48.0853, -123.5622 |
| 07/21/14 | 48.0310, -123.5903 |
| 08/01/14 | 48.0036, -123.5992 |
| 08/04/14 | 48.0120, -123.5920 |
| 08/25/14 | 48.0099, -123.5902 |
| 09/04/14 | 48.0660, -123.5783 |
| 09/12/14 | 48.0036, -123.5992 |
| 09/18/14 | 48.0111, -123.5905 |
| 09/30/14 | 48.0150, -123.5942 |
| 10/07/14 | 48.0099, -123.5901 |
| 10/09/14 | 48.0134, -123.5928 |

| Fish Information | |
|---|---|
| **Map Label** | CK 4 |
| **Species** | Chinook Salmon |
| **Sex** | Male |
| **Length (mm)** | 760 |
| **Capture Method** | Drift Netting |
| **Code** | 168 (17-051) |
| **Frequency** | 151.100 |

| Date | Lat-Long Coordinates |
|---|---|
| 07/06/17 | 48.1436, -123.5638 |
| 07/07/17 | 48.1410, -123.5656 |
| 07/17/17 | 48.0990, -123.5580 |
| 07/25/17 | 48.1117, -123.5515 |
| 07/26/17 | 48.0990, -123.5584 |
| 07/27/17 | 48.1116, -123.5513 |
| 07/31/17 | 48.0982, -123.5578 |
| 08/01/17 | 48.0852, -123.5621 |
| 08/07/17 | 48.0786, -123.5728 |
| 08/14/17 | 48.0632, -123.5771 |
| 08/23/17 | 48.0638, -123.5777 |
| 10/11/17 | 48.0162, -123.5946 |
| 10/26/17 | 48.0146, -123.5940 |

# Pacific Lamprey Radio Telemetry Data (1)

| Fish information | |
|---|---|
| **Map Label** | PL 1 |
| **Species** | Pacific Lamprey |
| **Length (mm)** | 570 |
| **Girth (mm):** | 95 |
| **Weight (kg)** | 0.326 |
| **Code** | 45/ Fish 33 |
| **Frequency** | 151.340 13 |

| Date | Lat-Long Coordinates |
|---|---|
| 06/14/18 | 48.1324, -123.5520 |
| 06/15/18 | 48.1256, -123.5564 |
| 06/16/18 | 48.1212, -123.5543 |
| 06/18/18 | 48.1203, -123.5541 |
| 07/09/18 | 48.1114, -123.5517 |
| 07/16/18 | 48.1008, -123.5578 |
| 07/27/18 | 48.0943, -123.5569 |
| 08/08/18 | 48.0602, -123.5817 |
| 08/10/18 | 48.0419, -123.5911 |
| 09/28/18 | 47.9831, -123.6005 |

| Fish information | |
|---|---|
| **Map Label** | PL 2 |
| **Species** | Pacific Lamprey |
| **Length (mm)** | 584 |
| **Girth (mm):** | 95 |
| **Weight (kg)** | 0.290 |
| **Code** | 16 |
| **Frequency** | 151.34 30/4 |

| Date | Lat-Long Coordinates |
|---|---|
| 04/13/18 | 48.1319, -123.5516 |
| 04/18/18 | 48.1222, -123.5542 |
| 05/17/18 | 48.1117, -123.5516 |
| 05/21/18 | 48.1125, -123.5539 |
| 05/23/18 | 48.1116, -123.5519 |
| 07/16/18 | 48.1186, -123.5531 |
| 07/17/18 | 48.1114, -123.5517 |
| 07/30/18 | 48.0944, -123.5564 |
| 08/06/18 | 48.0660, -123.5894 |
| 08/10/18 | 48.0648, -123.5972 |
| 08/14/18 | 48.0652, -123.5936 |

# Pacific Lamprey Radio Telemetry Data (2)

| Fish information | |
|---|---|
| **Map Label** | PL 3 |
| **Species** | Pacific Lamprey |
| **Length (mm)** | 555 |
| **Girth (mm):** | 100 |
| **Weight (kg)** | 0.294 |
| **Code** | 48/Fish 30 |
| **Frequency** | 151.340 13 |

| Date | Lat-Long Coordinates |
|---|---|
| 06/14/18 | 48.1326, -123.5509 |
| 06/15/18 | 48.1218, -123.5546 |
| 06/21/18 | 48.0942, -123.5567 |
| 06/26/18 | 48.0950, -123.5559 |
| 07/02/18 | 48.0942, -123.5568 |
| 08/14/18 | 47.9992, -123.6015 |
| 11/16/18 | 47.9987, -123.6015 |
| 01/04/19 | 48.0077, -123.5966 |

| Fish information | |
|---|---|
| **Map Label** | PL 4 |
| **Species** | Pacific Lamprey |
| **Length (mm)** | 570 |
| **Girth (mm):** | 105 |
| **Weight (kg)** | 0.317 |
| **Code** | 47/ Fish 40 |
| **Frequency** | 151.340 13 |

| Date | Lat-Long Coordinates |
|---|---|
| 06/14/18 | 48.1328, -123.5520 |
| 06/21/18 | 48.1164, -123.5515 |
| 06/26/18 | 48.1183, -123.5528 |
| 06/28/18 | 48.1134, -123.5542 |
| 06/29/18 | 48.1205, -123.5541 |
| 07/02/18 | 48.1110, -123.5504 |
| 7/9 - 11/28/18 | 48.0942, -123.5566 |
| 12/2/18 - 5/1/19 | 48.1054, -123.5517 |

| Fish information | |
|---|---|
| **Map Label** | PL 5 |
| **Species** | Pacific Lamprey |
| **Length (mm)** | 560 |
| **Girth (mm):** | 105 |
| **Weight (kg)** | 0.325 |
| **Code** | 49/Fish #28 |
| **Frequency** | 151.340 13 |

| Date | Lat-Long Coordinates |
|---|---|
| 06/14/18 | 48.1324, -123.5518 |
| 06/18/18 | 48.1210, -123.5545 |
| 06/21/18 | 48.1183, -123.5528 |
| 06/22/18 | 48.1165, -123.5515 |
| 07/09/18 | 48.1220, -123.5545 |
| 07/11/18 | 48.1205, -123.5542 |
| 07/16/18 | 48.1159, -123.5519 |
| 07/17/18 | 48.1214, -123.5546 |
| 07/27/18 | 48.0942, -123.5567 |
| 07/30/18 | 48.1216, -123.5546 |
| 09/10/18 | 48.1184, -123.5540 |

**Note:** **This lamprey and radio tag were eaten by an otter (found in otter scat).**

# Distance and Elevation Tracking Instructions

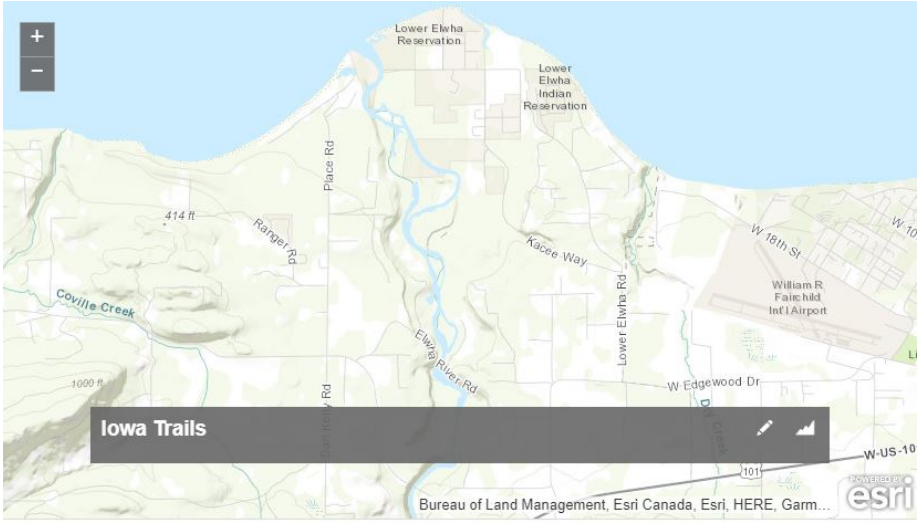
**Overview**: This activity is a recommended extension to incorporate into your investigation of the fish migrations. The graphs produced through this program will be another valuable tool for comparing migrations of fish within and between species.

1. Click on the following link. It will automatically take you to in area in Iowa

   https://www.arcgis.com/apps/Profile/index.html

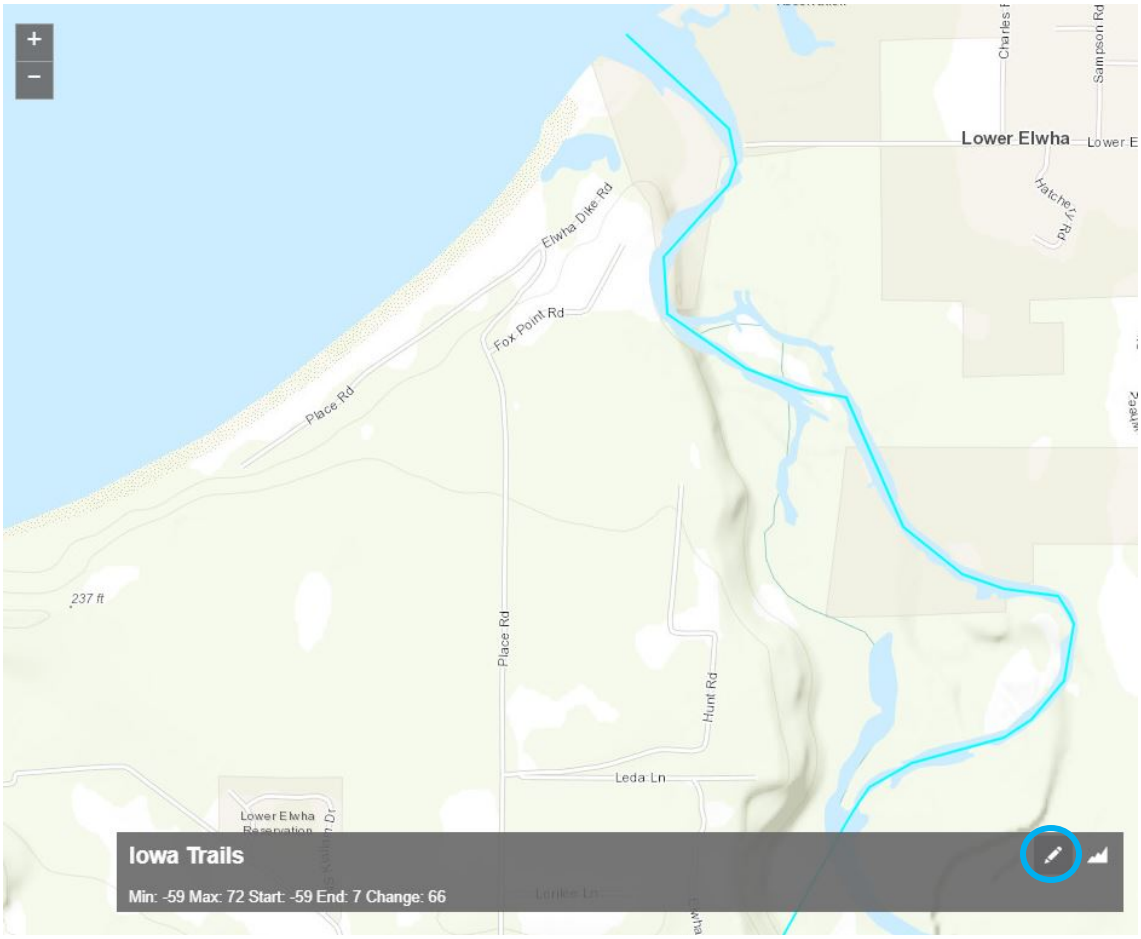
2. Click on the minus button until you zoom out to the map of the US map.
   a. It'll take around 11 clicks.

3. Zoom in to the Elwha River
   a. Double click onto the Seattle, WA area (about 5 times) until the Port Angeles label appears to the west on the Olympic Peninsula.
   b. Center the map to Port Angeles (arrow keys or clicking and holding mouse) and double click (or use + button) until the Elwha River appears just to the west.
   c. Re-center the map to the Elwha River with the outlet is in view and the river is clearly distinguishable from the land (you'll be tracing the river)

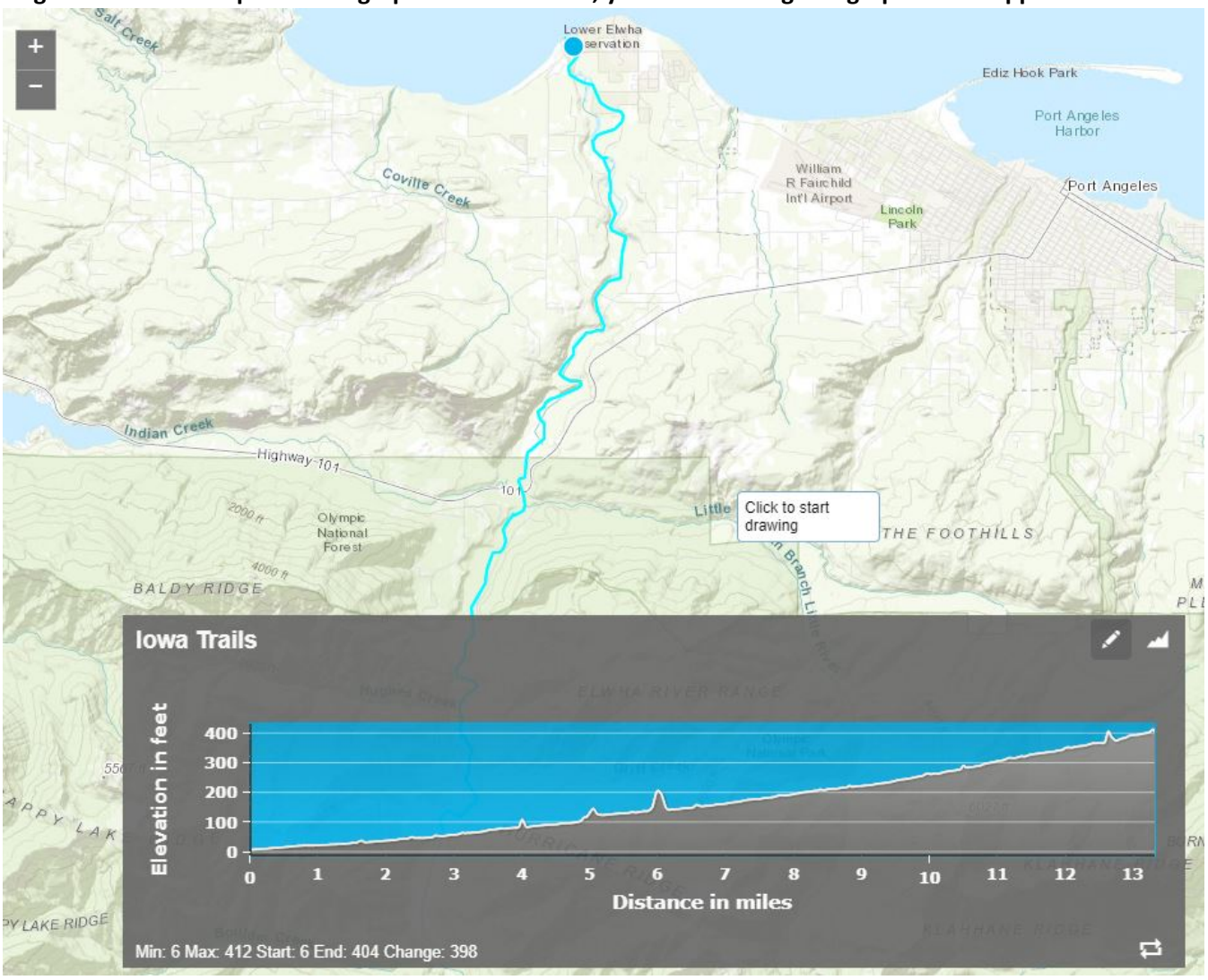



4. Separately open your Google "My Map" Elwha River Project map and select a single fish layer
    a. Find a recognizable landmark at end of its migration. Or the upper most point for those fish that return back down river.

5. Select the pencil icon, click your mouse once on the river outlet and move the mouse upriver. A blue line should appear as you extend your mouse.
    a. These lines are straight, so to follow the bends in the river, you must single click the mouse to set points and angles.
    b. You will need to use the arrow keys to reposition the map as you move up and down river.
        i. **Note**: There are a few fish that have up AND down river migrations. Simply trace the river up and back down again.



6. Double click on the last migration point. The computer program will generate an Elevation vs Distance graph for you. Be sure to take a screen shot (snipping tool if PC) of the graph. Do that right away. **If you even make a single click on the map after the graph has been made, your river tracing and graph will disappear.**




7. Review the graphs and compare within and between species to look for any pattern's and/or noteworthy differences.

8. Potentially integrate some/all of these graphs into a report and/or group presentation with your other findings.

## Additional Teacher Resources:

### Web Sites:

**Lower Elwha Klallam Tribe:** Elwha River Restoration (Goals & Objectives)

**Olympic National Park**: Elwha Recovery

**U.S. Geological Survey:** Elwha River Restoration Project

### Videos:

**National Park Service:** Elwha River Restoration; Restoration of the Elwha Begins; The River Emerges; Undammed; Wonders unveiled

**Radio Telemetry:** How it works, how it is used, and why it is useful.

**Trout Unlimited:** Elwha Summer Steelhead Recovery Documentary

**Science News:** A River Unleashed

**Quest:** A River Returns

**EarthFix:** Undamming the Elwha, the documentary

**Nautilus:** How the Elwha River was saved

### Media Coverage:

**Seattle Times:** Elwha: Roaring back to life; At Elwha River, forests, fish and flowers where there were dams and lakes.

**National Geographic:** World's largest dam removal unleashes U.S. River after century of electric production

**Science News:** Dam demolition lets the Elwha River run free

**Nature:** Dam removals: rivers on the run

**Peninsula Daily News:** VIDEO: Scientists optimistic about return of Chinook to Elwha River; Leader of revegetation effort revels in growth on the Elwha River; Fish recolonizing areas upriver of former dam sites on Elwha River.

**University of Washington:** How the Elwha dam removals changed the river's mouth.

**The Revelator:** The Elwha's Living Laboratory

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This educational resource would not be available without the support of biologists from both the Olympic National Park and the Natural Resources division of the Lower Elwha-Klallam Tribe. They were responsible for tagging and tracking the fish as well as selecting and sharing the fish migration data.

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