



# Visualizing ESA-Listed Fish Research On the West Coast

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Rory Spurr



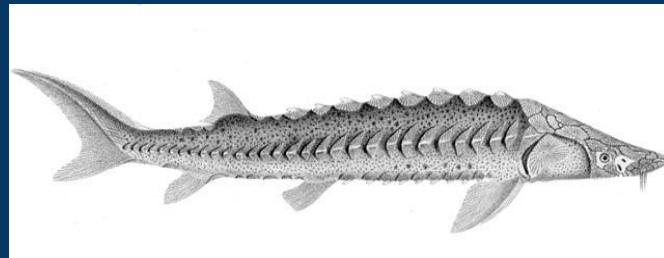
Source: Mark Conlin-VWPics.com

# What is the ESA?

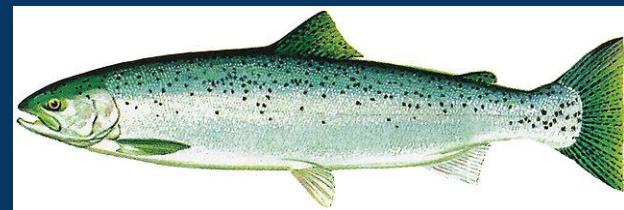
- The Endangered Species Act (ESA) of 1973 protects endangered and threatened species
  - Pacific salmon, steelhead, green sturgeon, eulachon, rockfish



Chinook Salmon (*Oncorhynchus tshawytscha*)



Green Sturgeon (*Acipenser medirostris*)



Steelhead (*Oncorhynchus mykiss*)

Source: Unknown

Source: Muséum d'histoire Naturelle

Source: U.S. Government



**But how do you research these  
ESA-Listed fish if they are  
protected?**

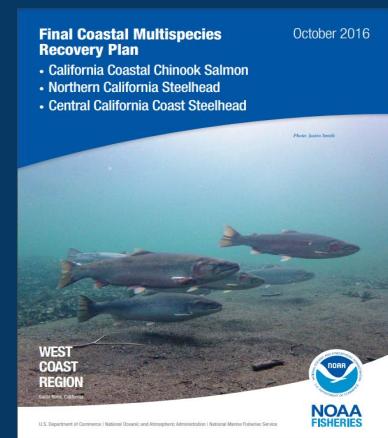
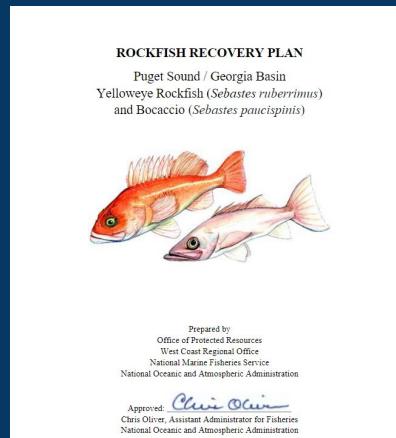
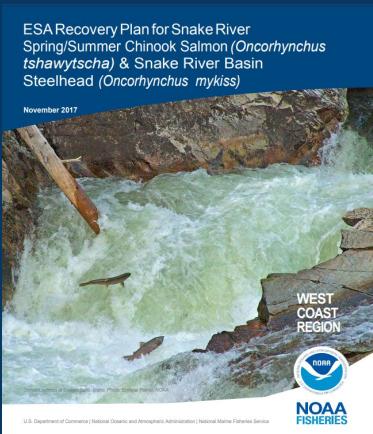
# You ask the Protected Resources Division for a permit!

- Permits team tracks permit requests and resulting data
- Makes yes/no/maybe decisions



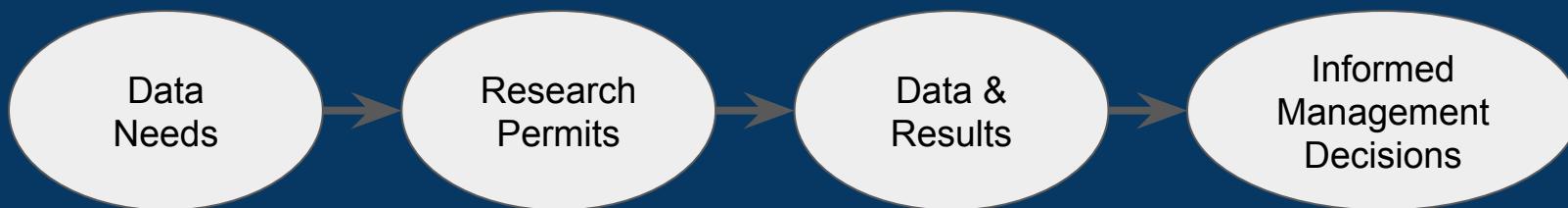
# Why Research ESA-Listed Species?

- To fulfill data needs for listed species
  - Data informs management decisions that protect and conserve listed species



# Why Research ESA-Listed Species?

- To fulfill data needs for listed species
  - Data informs management decisions that protect and conserve listed species
- Permits awarded based on data need and current impact to species



# What is take?

*“to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct” - ESA (16 U.S.C. 1531-1544)*



Hook-and-Line  
Sampling

*Invasive*

vs.

Snorkel Survey

*Non -  
Invasive*



Source: Rich Landers / The Spokesman  
Review via AP

Source: Pacific Southwest Region USFWS



**So what's the problem then?**

## **Problem:**

- No tool existed to easily visualize permitting data**
- Permitting process not accessible to all audiences**

# Objectives

- Support management of ESA-listed species
- Create an accessible visual interface
- Increase transparency about the permitting process
- Educate public about research's role in the management of ESA-listed species
- **So we made an app!**



Source: Paul Jeffrey



plotly

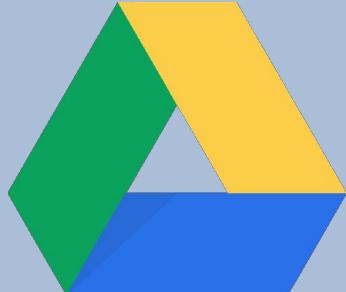
Leaflet A green leaf icon with a thin black stem and a few veins, positioned next to the word "Leaflet".

Programming

*Shiny*

# GitHub

Project Management



Drive

## Visualizing ESA-Listed Fish Research on the West Coast

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Landing  
page for app

Panel allows  
you to toggle  
to different  
screens

## Welcome to the ESA-Listed Fish Research App for West Coast Permits!

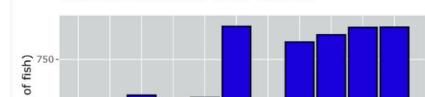
This platform summarizes and displays data collected by the National Marine Fisheries Service (NMFS) on the permits they issue for scientific research that may impact U.S. West Coast salmon, steelhead, eulachon, rockfish, and sturgeon that are listed for protection under the Endangered Species Act (ESA)



The app summarizes how much impact is occurring on ESA-listed fishes in particular areas due to research. Users can choose what data to display to learn about projects on a particular species or in a region of interest, or look at trends over time. It was created to help the National Oceanic and Atmospheric Administration (NOAA) staff see the 'big picture' view of research on the landscape, let researchers learn about each other's work, and make permitting decisions more transparent.

Time Series

Total Fish Authorized To Be Touched



Take Type  
Unused  
Used



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## What is the ESA and how does it affect scientific research?

### What is the ESA?

The Endangered Species Act (ESA) was enacted in 1973 to provide a policy framework for the protection and conservation of threatened and endangered species:

- Endangered species are species that are at risk of extinction throughout all or a significant portion of its range.
- Threatened species are those that are likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

The ESA prohibits 'take', which means to 'harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct' (16 U.S.C. 1531-1544). For more information, click [here](#).

### How does it affect scientific research?

Research on ESA-listed species is important to understand their current extinction risk and threats to recovery. The ESA therefore outlined exceptions to the prohibitions on take where researchers can apply for permits to conduct studies on ESA-listed species:

- Under section 10(a)(1)(A) of the ESA, for studies conducted by any entity that have a bona fide scientific purpose and meet other key [criteria](#), such as limiting harm or justifying the data need; or
- Under section 4(d) of the ESA, for research that may take threatened species being conducted by state agencies or tribes.

Researchers apply for permits through the Authorizations and Permits for Protected Species ([APPS](#)) application, and NMFS personnel view this information and make permitting decisions based on the expected harm the research will do to the species relative to the value of the information that would be collected. For more information on permits and authorizations under section 10(a)(1)(A) and section 4(d), see [here](#).

### Why was this app developed?

Currently NMFS' West Coast Region does not have an easy way to map and visually summarize their research permitting information for internal use, or to share with applicants and co-managers. Therefore, students from the School of Marine and Environmental Affairs (SMEA) at the University of Washington (UW) were contracted with the primary purpose of developing an application that will:

- Support the decision-making process for scientific research permits in NMFS' West Coast Region,
- Provide more transparency to researchers as well as state and tribal government employees about the permitting process, and
- Educate the public about the role of research to inform the management of ESA-listed species.

### References:

1. Endangered Species Act. 16 U.S.C. 1531-1544 (1973).
2. National Marine Fisheries Service (NMFS). (2010). Chapter 2: NMFS Pacific Marine Authorization for Scientific Research Authorizations and Oversight.

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## Terms and Definitions

### Commonly used acronyms

- Department of Fish and Wildlife (DFW): State agencies tasked with the protection and conservation of the state's fish, wildlife, and ecosystems for the benefit of their citizens. One DFW exists for each state in the west coast region.
- Distinct Population Segment (DPS): the smallest division of a taxonomic species permitted to be protected under the U.S. Endangered Species Act.
- Endangered Species Act (ESA): Piece of United States federal legislation that outlines the protection and conservation of the nation's at risk species.
- Evolutionarily significant unit (ESU): a population of organisms that is considered distinct for purposes of conservation.
- Hydrologic Unit Code (HUC): A HUC is a hierarchical land area classification system created by the United States Geological Survey (USGS).
- National Marine Fisheries Service (NMFS): Agency within NOAA responsible for the management, protection and conservation of United States marine resources.
- National Oceanic and Atmospheric Administration (NOAA): Scientific and regulatory agency in the United States that researches weather and atmospheric conditions as well as managing fisheries, marine mammals and endangered species. To learn more about NOAA look [here](#).

### Other key terms

- Dip Net: method of capture where a long handled fishing net (up to five feet in diameter) is dipped into the water to catch unsuspecting fish below.
- Electrofishing: Method of capture where electrical current is used to inhibit or stun fish that can then be captured.
- Metadata: represents data about data, enriches the data with information that makes it easier to find, use and manage.
- Nomenclature: The devising or choosing of names for things, especially in a science or other discipline.
- Take: Defined as any action that harasses, harms, pursues, hunts, shoots, wounds, kills, traps, captures, or collects, or attempts to engage in any such conduct.
- Trap: Various capture methods (screw trap, incline plane trap) that involve the setup of a device that passively catches fish and accumulates them into a live holding tank.
- Trawl: Capture method that involves pulling a large net through the water using one or more boats.
- Seine: a net with floats on top and weights on the bottom that encircles the fish. Can be used from shore (beach seine) or from a boat (purse seine).

### Fish Glossary

Below are the names of the fish species that are included within this app.

#### Salmonids:

- Chinook Salmon (*Oncorhynchus tshawytscha*)
- Coho Salmon (*Oncorhynchus kisutch*)
- Chum Salmon (*Oncorhynchus keta*)
- Sockeye Salmon (*Oncorhynchus nerka*)
- Steelhead (*Oncorhynchus mykiss*)

Find more information regarding salmonids and their listing statuses [here](#).

#### Other species:

[Home](#)[» Welcome](#)[» How it works](#)[» Background and Purpose](#)[» Glossary](#)[» Uses and Limitations](#) [Authorized Take Map](#) [Time Series Plots](#) [About Us](#)

## Uses and Limitations

### Things to know about this app

Users of this app should be aware of the following limitations and assumptions regarding the raw data and data summaries:

Note: These data are provisional, and are subject to change at any time. Additionally, this app is specifically for ESA-listed fish species in the [west coast region](#) under NOAA jurisdiction. Therefore, ESA-listed fish species under the jurisdiction of the U.S. Fish and Wildlife Service or other federal and international organizations are not represented here.

For the purpose of this project, some fields and data entries were modified to simplify analyses and provide consistency across the nomenclature. These include:

- Adjusting HUC 8 codes to encompass redrawn boundaries; see [metadata](#) for details
- Renaming and classifying waterbodies in the 'WaterbodyName' field to allow for consistent nomenclature and inform users about the type of waterbodies (saltwater or freshwater) these species exist in. Renaming practices were performed using best available data provided by the 'LocationDescription' field.
- Reclassifying 'Lifestage' and 'Production' fields to reduce the number of unique entries. For example:
  - 'Smolt' was replaced by 'Juvenile'
  - 'Listed Hatchery, Clipped and Intact' was replaced by 'Listed Hatchery'

### Limitations and Omissions

Some data limitations were beyond the developers' control. These include:

- Unreported take from projects for which exit reports were not completed by permittees.
- The input of incorrect HUC 8 codes by researchers applying for permits (for example: the '9999999' HUC codes seen in the reactive data table)

For the purpose of this project, the following were omitted:

- Unlisted hatchery fish.
- Non-invasive take actions (e.g., snorkel surveys, dead tissue samples)
- Unknown take actions.
- Permits that are expired or were never issued
- Research happening across a large geographic scope (whole states or coasts) were omitted from the map, but are included in time series.
- Tribal 4d permits omitted for data privacy reasons.

### Metadata

For further information regarding the data source, data attributes, R packages used, and general metadata for this project, please visit the metadata folder of our Github [here](#).

# Interactive Map Component

## Build Your Map

### Choose a Life Stage

- Adult
- Juvenile

### Choose an Origin

- Natural
- Hatchery

### Choose Data to Display

- Total Take
- Lethal Take

### Choose an ESU/DPS to View

Puget Sound Chinook salmon

[Update Map and Table](#)

## Authorized Take Map



# Interactive Map Component

Build Your Map

Choose a Life Stage

- Adult
- Juvenile

Choose an Origin

- Natural
- Hatchery

Choose Data to Display

- Total Take
- Lethal Take

Choose an ESU/DPS to View

- Puget Sound Chinook salmon
- Puget Sound/Georgia Basin DPS yelloweye rockfish
- Hood Canal summer-run chum salmon
- Ozette Lake sockeye salmon
- Upper Columbia River spring-run Chinook salmon
- Upper Columbia River spring-run NEP Chinook salmon
- Upper Columbia River steelhead

for the HUC 8, including specific authorized take values

Select criteria to filter data

Authorized Take Map

+

-

Total Take (# of fish)

- 20
- 40
- 60
- 80
- 100

Leaflet | Map tiles by Stamen Design, CC BY 3.0 — Map data © OpenStreetMap contributors

thal take depending on what data is selected to display), for each Hydrologic Unit Code 8 (HUC 8). The black  
se species may be encountered. Individual HUC 8's may be clicked on inside the map to reveal more information

# Interactive Map Component

## Build Your Map

### Choose a Life Stage

- Adult
- Juvenile

### Choose an Origin

- Natural
- Hatchery

### Choose Data to Display

- Total Take
- Lethal Take

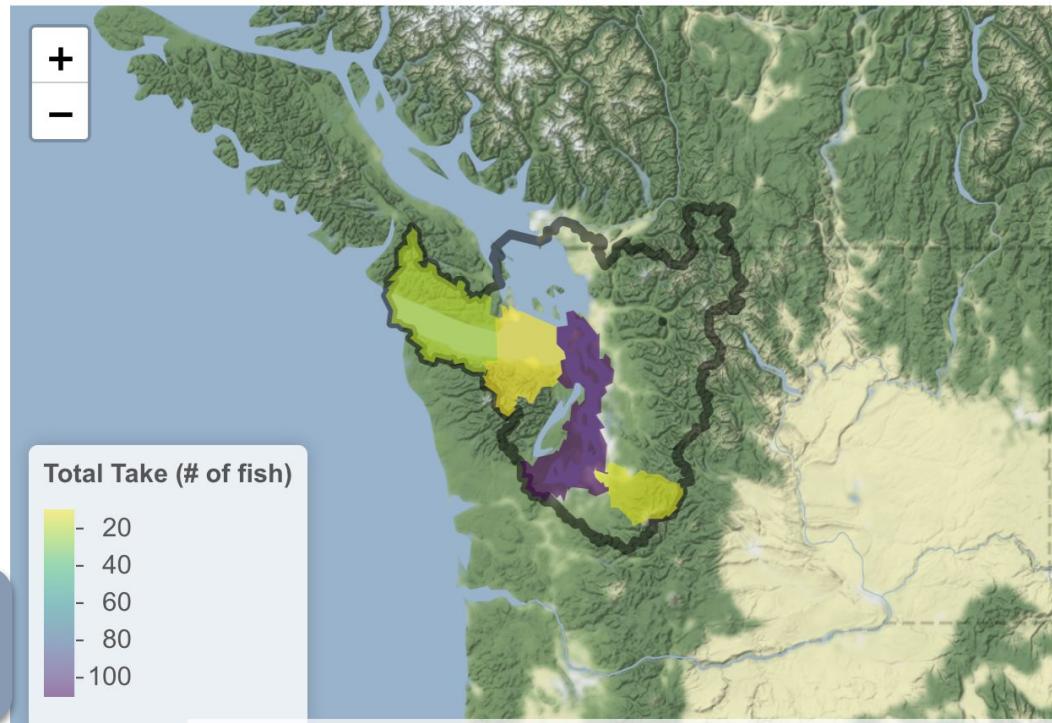
### Choose an ESU/DPS to View

Upper Willamette River steelhead ▾

Update Map and Table

Hit update  
button to  
filter data

## Authorized Take Map



# Interactive Map Component

## Build Your Map

### Choose a Life Stage

- Adult
- Juvenile

### Choose an Origin

- Natural
- Hatchery

### Choose Data to Display

- Total Take
- Lethal Take

### Choose an ESU/DPS to View

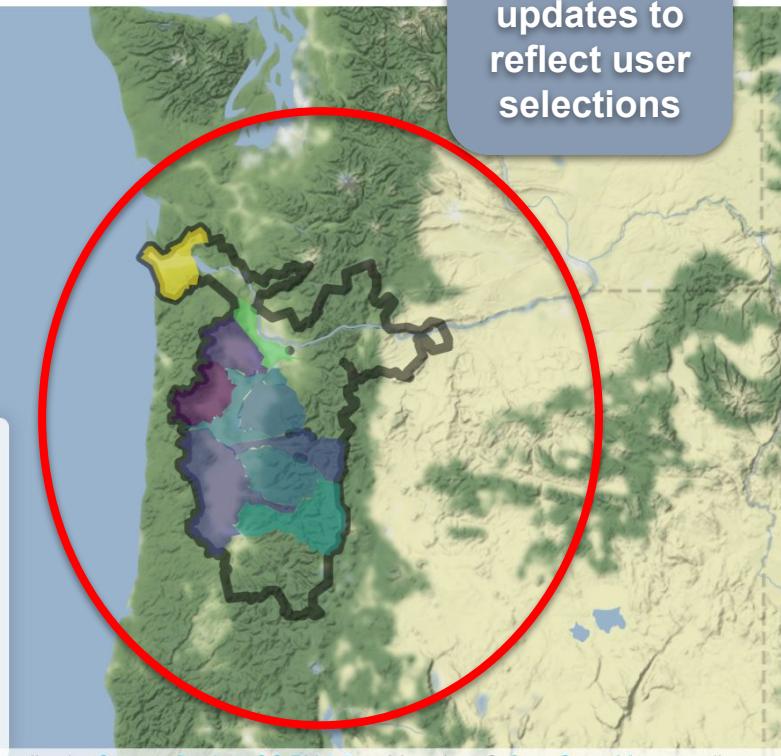
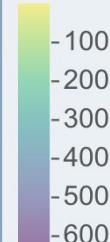
Upper Willamette River steelhead ▾

[Update Map and Table](#)

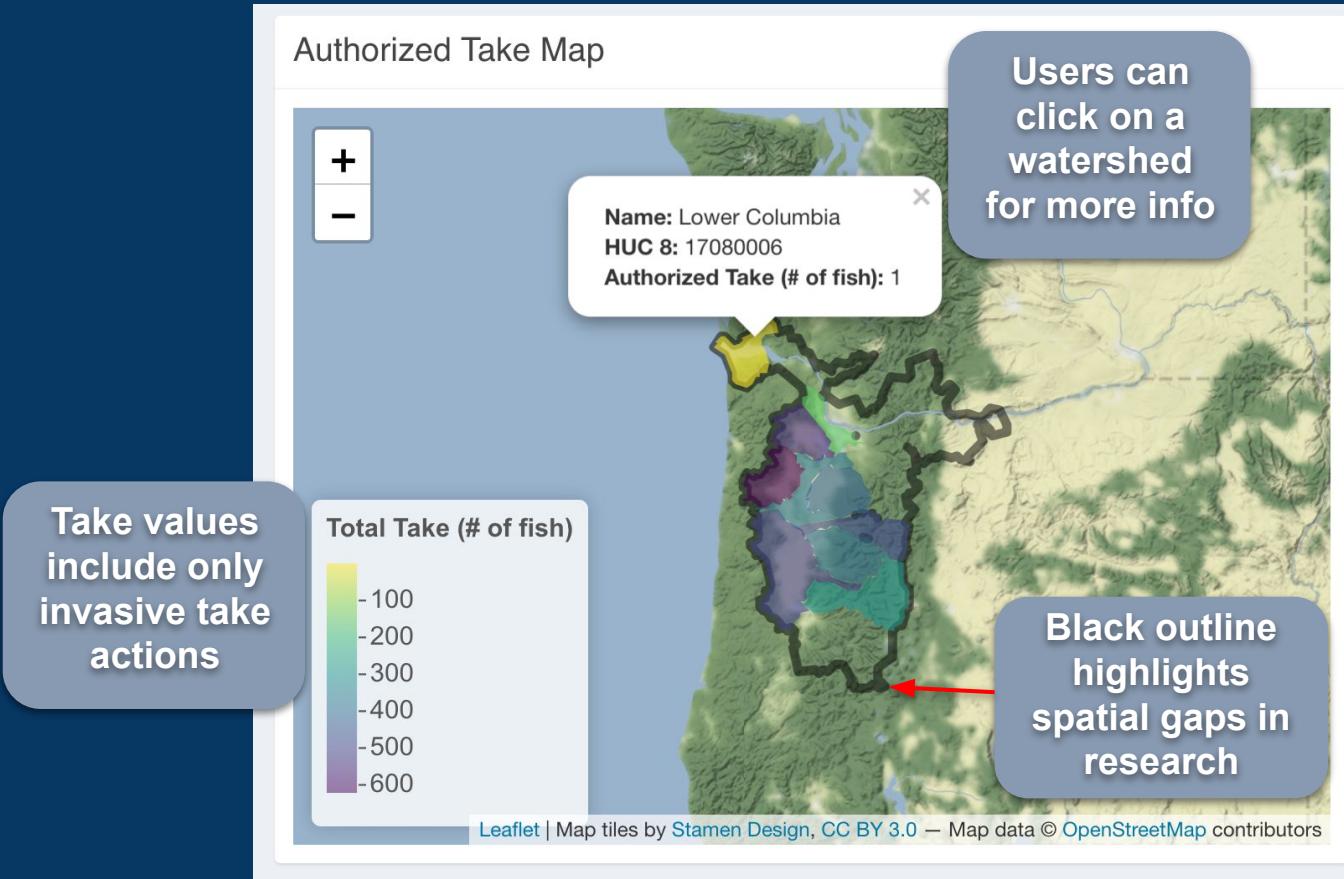
## Authorized Take Map



### Total Take (# of fish)



# Interactive Map Component



Located directly below map and controls

# Interactive Map Component

Reactive Data Table

Displays data by individual permit

Show 10 entries

Search:

	Permit Code	Permit Type	Organization	HUC 8	Location	Water Type	Take Action	Gear Type	Total Take	Lethal Take
1	1410-13M	NMFS 10a1A Salmon	NMFS Northwest Fisheries ...	99999999	Pacific Ocean off Oregon ...	SW	Intentional (Directed) Mo...	Trawl, Nordic Surface	7	7
2	16122-3R	NMFS 10a1A Salmon	Confederated Tribes of th...	17020006	Okanogan	FW	Capture/Handle/Release An...	Trap, Screw	600	12
3	16122-3R	NMFS 10a1A Salmon	Confederated Tribes of th...	17020006	Okanogan	FW	Capture/Handle/Release An...	Trap, Screw	600	12
4	22369-2M	NMFS 10a1A Salmon	NMFS Northwest Fisheries ...	99999999	Pacific Ocean	SW	Capture/Mark, Tag, Sample...	Hook and line/angler/rod ...	4	0

# Interactive Map Component

Reactive Data Table

Show 10 entries

Search function allows further filtering

Search: Electrofishing

Permit Code	Permit Type	Organization	HUC 8	Location	Water Type	Take Action	Gear Type	Total Take	Lethal Take	
7	22865	NMFS 10a1A Salmon	U.S. Forest Service	999999999	Naches, Yakima, Wenatchee...	FW	Capture/Handle/Release An...	Electrofishing, Backpack	200	4
11	1386-10R	NMFS 10a1A Salmon	Washington Department of ...	999999999	Streams and tributaries t...	FW	Capture/Handle/Release An...	Electrofishing, Boat	10	1
13	15207-4R	NMFS 10a1A Salmon	Amnis Opes Institute, LLC	999999999	Upper Columbia River basi...	FW	Capture/Handle/Release An...	Electrofishing, Boat	50	2
14	1598-5R	NMFS 10a1A Salmon	Washington Department of ...	999999999	All waterbodies adjacent ...	FW	Capture/Handle/Release An...	Electrofishing, Backpack	20	1
15	16069-4R	NMFS 10a1A Salmon	City of Portland	17090012	Lower Willamette	FW	Capture/Mark, Tag, Sample...	Electrofishing, Boat	20	1

# Time Series Component

**Build Your Plot**

**Choose a Life Stage**

- Adult
- Juvenile

**Choose an Origin**

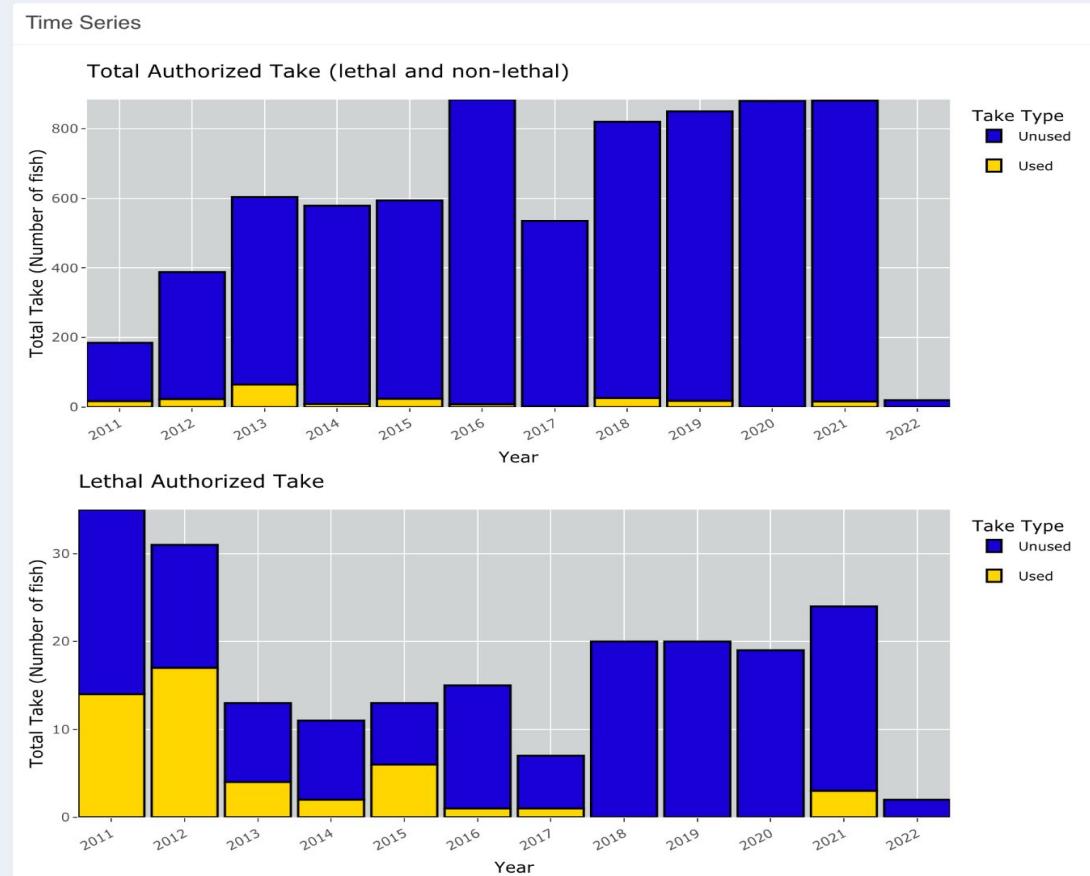
- Natural
- Hatchery

**Choose an ESU/DPS to View**

Puget Sound Chinook salmon

Puget Sound Chinook salmon  
Puget Sound steelhead  
Puget Sound/Georgia Basin DPS bocaccio  
Puget Sound/Georgia Basin DPS yelloweye rockfish  
Hood Canal summer-run chum salmon  
Ozette Lake sockeye salmon  
Upper Columbia River spring-run Chinook salmon  
Upper Columbia River spring-run NEP Chinook salmon

Select criteria to filter data



# Time Series Component

Build Your Plot

Choose a Life Stage

- Adult
- Juvenile

Choose an Origin

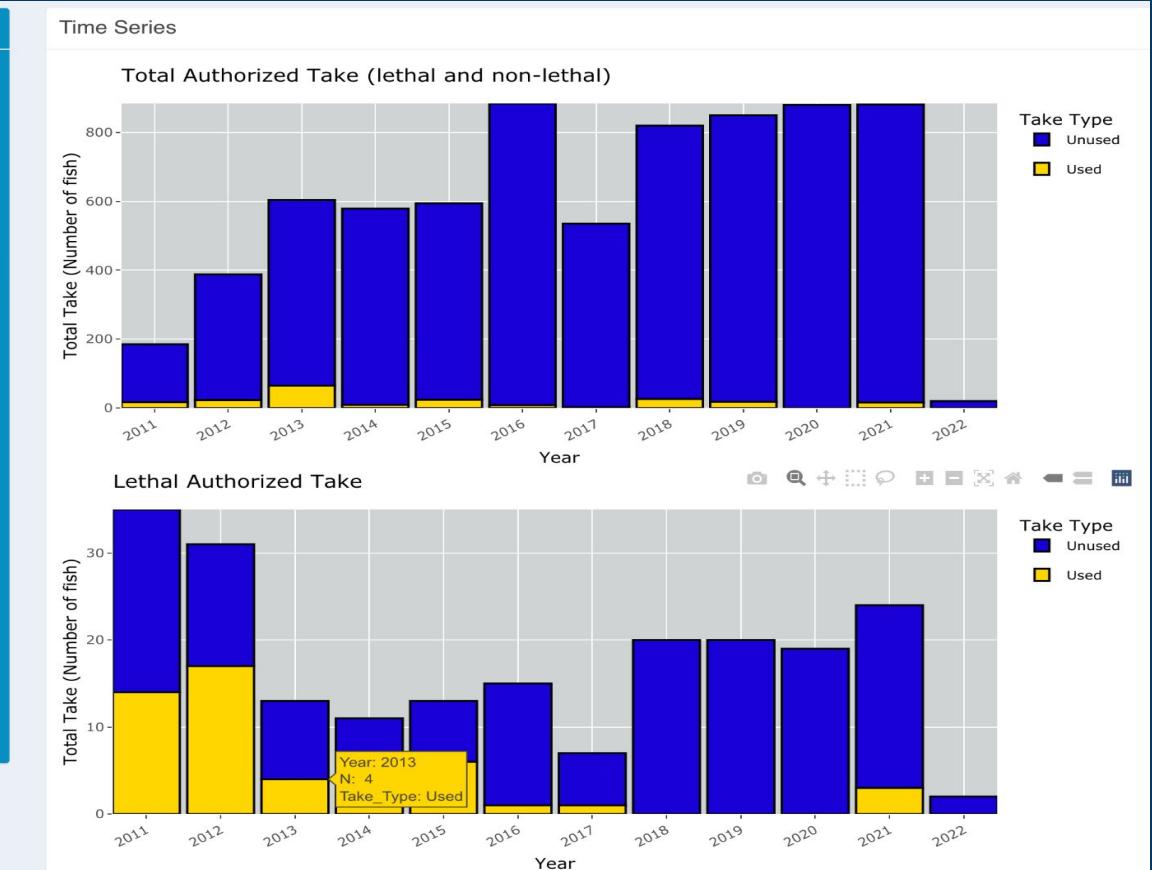
- Natural
- Hatchery

Choose an ESU/DPS to View

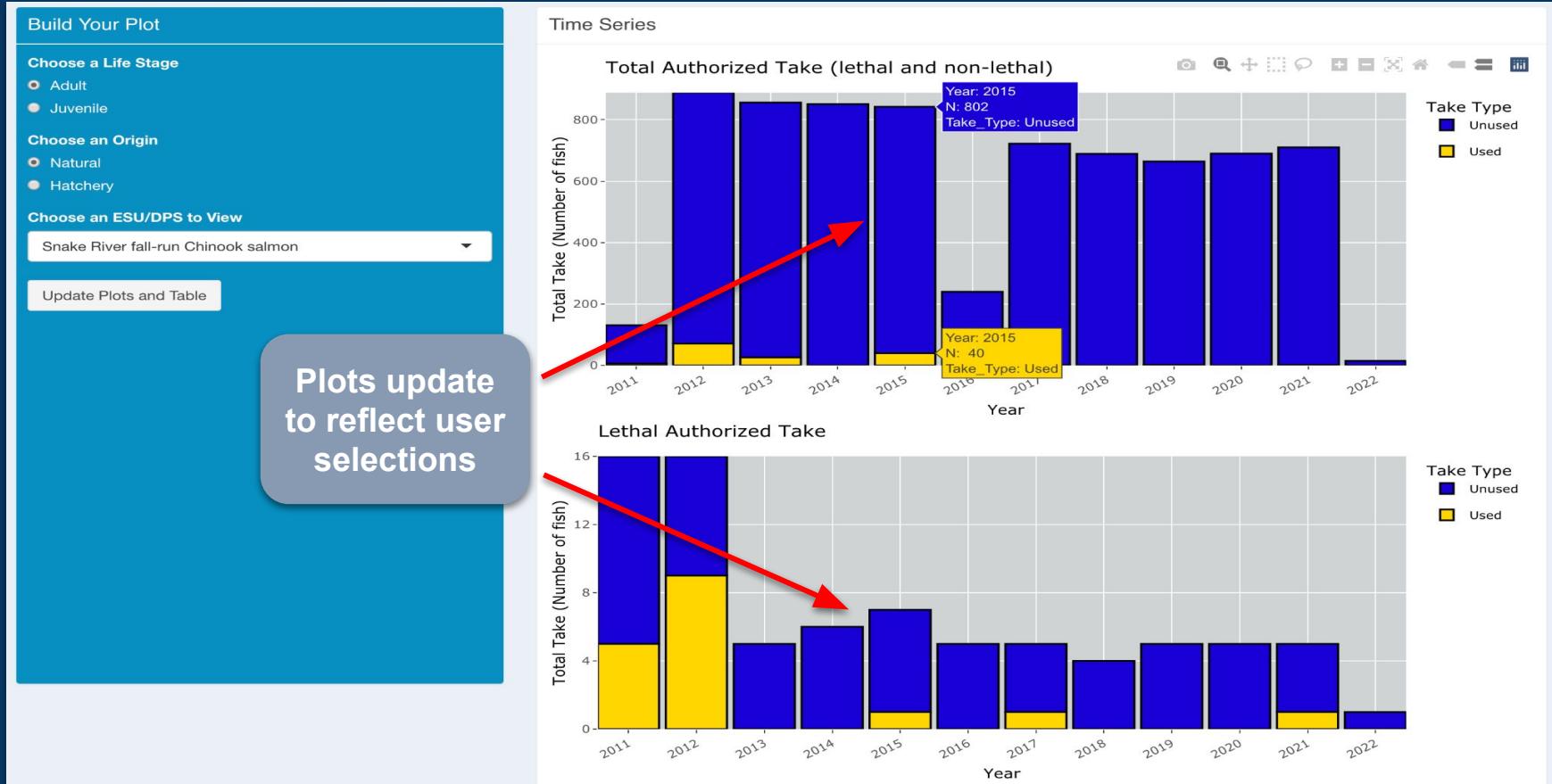
Puget Sound Chinook salmon

**Update Plots and Table**

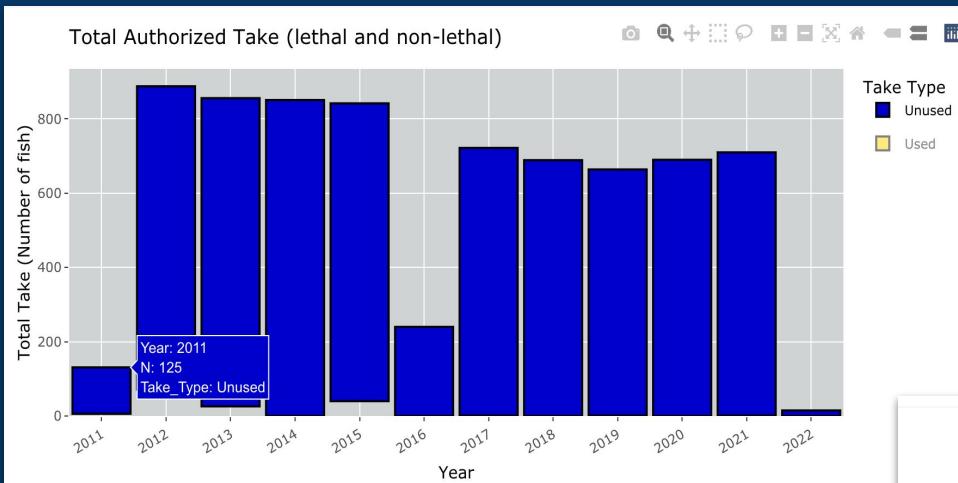
Hit button to update plots



# Time Series Component

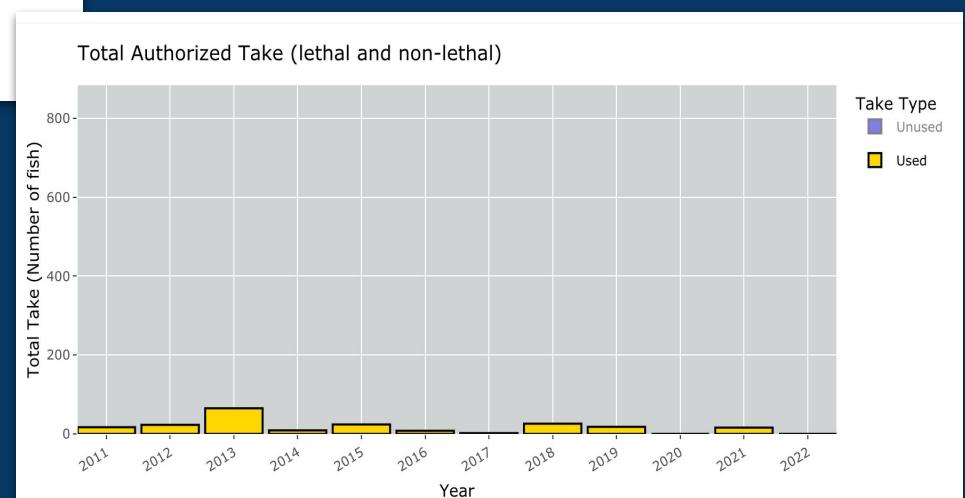


# Time Series Component



The Plotly package can:

- Isolate variables
- Zoom in and out
- Export plots



Can assist with:

- Compare and contrast years
- Visualize trends
- Inform decision making

# Time Series Component

User inputs simultaneously updates table

Search function allows further filtering

Reactive Data Table

Show 10 entries

Note: Permits issued under the ESA 4(d) authority specific to Tribal Resource Management are not individually listed in the table because they are not considered public, but those data are included in the totals displayed in the map above.

Year	Report ID	Permit Code	Permit Type	Gear Type	Authorized Take	Reported Take	Unused Take	Authorized Mortality	Reported Mortality	Unused Mortality
287	2021	15889	1386-9R	NMFS 10a1A Salmon	Electrofishing, Boat	10	1	9	1	0
9	2012	10362	1345-7R	NMFS 10a1A Salmon	Electrofishing, Boat	2	0	2	0	0
12	2012	10840	1386-6R	NMFS 10a1A Salmon	Electrofishing, Boat	10	0	10	1	0
16	2012	10154	1601-3R	NMFS 10a1A Salmon	Electrofishing, Backpack	2	0	2	0	0
23	2012	10057	16751	NMFS 10a1A Salmon	Electrofishing, Backpack	18	0	18	0	0
24	2012	10159	16798	NMFS 10a1A Salmon	Electrofishing, Backpack	2	0	2	0	0
25	2012	10693	16838	NMFS 10a1A Salmon	Electrofishing, Boat	5	0	5	0	0
35	2013	10363	1345-7R	NMFS 10a1A Salmon	Electrofishing, Boat	2	0	2	0	0
38	2013	10841	1386-6R	NMFS 10a1A Salmon	Electrofishing, Boat	10	0	10	1	0
42	2013	10155	1601-3R	NMFS 10a1A Salmon	Electrofishing, Backpack	2	0	2	0	0

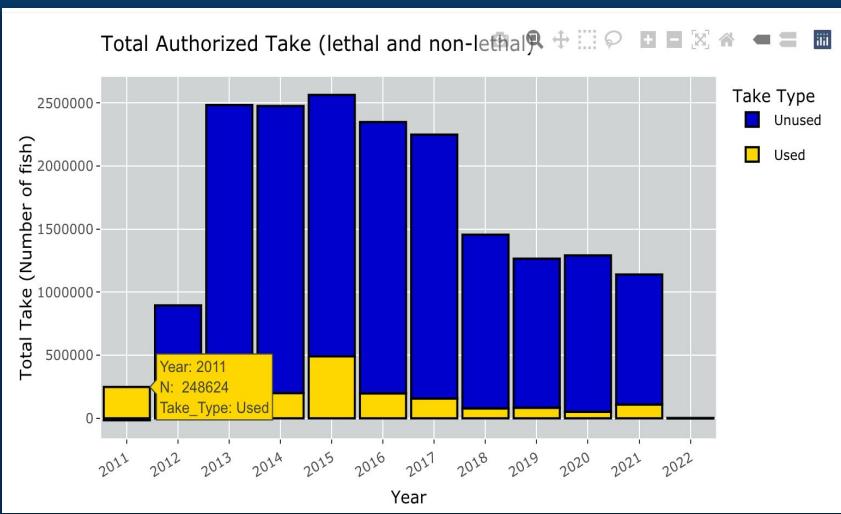
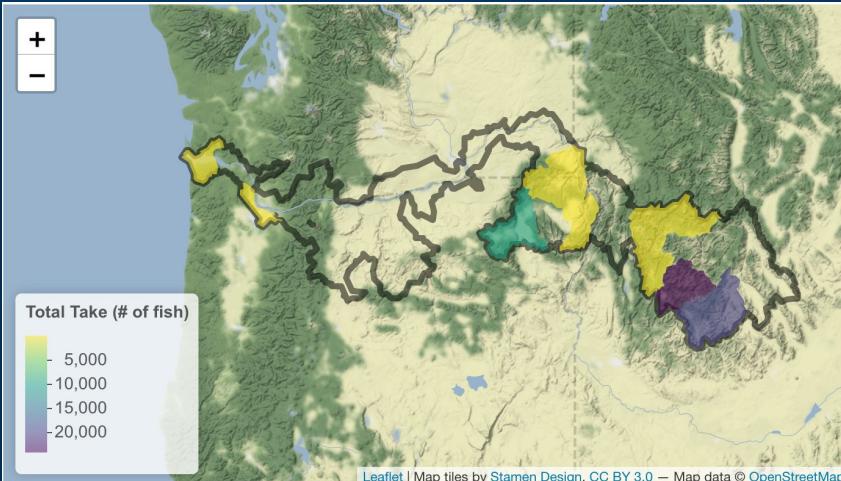
Showing 1 to 10 of 51 entries (filtered from 317 total entries)

Previous 1 2 3 4 5 6 Next

Search: Electrofishing

# Metadata and Documentation

- Data documentation of APPS data through data biography
- Coding documentation and commentary for reproducibility
- Assumptions, limitations, omissions
- Documented app text for further editing on NOAA's side



# Example Uses

- Identify research areas that are not being utilized
- Increase collaboration amongst organizations to reduce impact on species
- Generate novel questions and facilitate conversation on how to reduce impact to ESA-listed species



# What we learned

A screenshot of a GitHub project board with four columns: Backlog, To do, In Progress, and Completed. Each column contains several items represented as cards.

- Backlog:**
  - Final HUC corrections #79 opened by DianaDishman-NOAA Editing/Cleanup
  - Are there any specific rules regarding indigenous rights surrounding ESA permits and authorizations? #61 opened by rory-spurr question
  - Generate ideas for more pages/tabs to app #16 opened by rory-spurr Planning
- To do:**
  - Data bio update and add methods #56 opened by annebeau documentation
  - Catch up on NOAA github/R trainings #6 opened by rory-spurr Training/Learning
- In Progress:**
  - Create infographic on permitting process #15 opened by rory-spurr Educational Section of App
  - Integrate Anne's and Diana's edits into app regarding information section. #81 opened by asantan8 Editing/Cleanup
- Completed:**
  - Hatchery data not working in time series and map #83 opened by asantan8 bug
  - Load and check display of CapProjShinyDashP #80 opened by asantan8 enhancement
  - Timeseries blank space problem #82 opened by asantan8 help wanted question

## Project Management

- Design and Editing
- Documentation
- Divide and Conquer

## Coding

- Interactivity
- Debugging
- Data Wrangling

# Acknowledgements

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- Diana Dishman
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- Those who provided feedback regarding layout, design, and content of the app

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# Questions?



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Github: rory-spurr



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Github: asantan8