Capstone Management Plan

Visualizing ESA-Listed Fish Research in the West Coast Region

Capstone student team: Alana Santana, Rory Spurr
Capstone mentor team: Diana Dishman (NOAA), Anne Beaudreau (UW SMEA)

1. Capstone Project Description

1.1. Individual goals

Alana Santana

1. **Develop science communication skills**
    a. Science communication is a valuable career skill as it allows for information to be accessible to multiple audiences with different abilities/backgrounds.
    b. I want to make data more accessible to those largely left out of data sharing because of access and education differences so that information can reach a wider audience and be communicated thoroughly.
    c. I will also gain experience communicating the application of environmental policy (in this case, for permitting take of ESA-listed fish for research) for the benefit of researchers, co-managers, and the public.
2. **Develop coding and data wrangling skills**
    a. I want to become a more confident coder who can troubleshoot and proficiently problem solve data hurdles. I hope to gain some experience with spatial analysis and develop an R Shiny app. This will be applicable to future careers and be a valuable skill for future projects.
    b. I intend to gain experience handling large datasets. Prior to this project, I have had limited experience working with large datasets. Determining ways to configure these datasets into usable information is a valuable skill I will use in both my academic and professional career.
    c. I want to work on better data visualization skills to create graphics that are engaging, informational, and accessible by multiple audiences at different educational levels.
    d. I want to be able to develop a Shiny app and provide proper background information for the viewer to understand the purpose of the application and what they can derive from it and is ADA Compliant.
3. **Develop valuable career and partnership skills**
    a. A goal of this project is to gain valuable knowledge and experience in science communication, coding and data wrangling, project management, and partnering/networking with others.

b. I am interested in learning how to work efficiently with team members to produce a product in a timely manner, and to improve my team organization and leadership skills.
c. This project will allow me to become familiar with the different Federal, State, and Tribal entities involved in marine resource management, and the agencies, non-profits, and academic institutions conducting research to help recover ESA-listed fish species.

Rory Spurr

1. **Develop R coding skills**
    a. Through this project, I will increase my proficiency in data visualization. Communicating data in an effective way via figures and graphs is a very important skill in science and in policy. I wish to learn the best practices so that my visualizations are clear and effective.
    b. I will learn how to develop R shiny applications. This platform allows users to interact with data and data visualizations in a way that is more dynamic and engaging than standard reports.
    c. I hope to gain experience to solve my own coding problems. Part of being a good coder is the ability to learn from and solve your own problems and identify and become familiar with new tools. This project will come with many challenges, and I am excited to learn how to best overcome them.
2. **Develop science communication skills**
    a. I want to become more confident in my abilities to communicate technical information, through writing and speaking.
    b. I would like to better understand the barriers that exist in science communication and how to combat them. Scientific information can be hard to understand, especially for people without the relevant skills and background knowledge. Creating easily digestible scientific media can help combat this, although I also recognize it is important to also help people understand how scientific information as well as relevant content and laws are brought together to make decisions.
    c. I will also gain experience communicating the application of environmental policy (in this case, for permitting take of ESA-listed fish for research) for the benefit of researchers, co-managers, and the public.
3. **Develop connections to help explore my career options**
    a. My future career will be as a steward to the environment. I do not know what this looks like specifically, which is why talking to professionals and exploring my options will help me narrow down and focus on careers I want to pursue.
    b. This project will allow me to become familiar with the different Federal, State, and Tribal entities involved in marine resource management, and the agencies, non-profits, and academic institutions conducting research to help recover ESA-listed fish species.

4. **Understand strategies for organizing a team around a project and effective project management**
    a. Time management for complex projects is an important skill no matter what career path I take. I often can feel overwhelmed when faced with big projects, thus learning how to best break them down into manageable pieces and incrementally make progress will be highly beneficial for me.
    b. I wish to learn how best to organize people of diverse backgrounds and skill sets around a project. This will be an important skill in working with any team throughout my career.

1.2. Client's goals

The goals of the client (NOAA Fisheries West Coast Region) are to:

- Create a way to summarize and display publicly available data for scientific research permitting. This will help our staff utilize the best available information to make permitting decisions, and help researchers seeking permits, other resource management partners, and the public better understand research permitting under the ESA, existing research taking place across the landscape, and the role of research in species recovery.
    - Includes developing metadata documentation by capstone team members for future use by others in the public domain
- Develop additional outreach and educational partnerships with UW, cultivating a diverse recruitment pool for NOAA per the Diversity, Equity, and Inclusion goals of the West Coast Region
    - Introduce students to the Region, encourage the next generation to pursue degrees in the marine sciences and careers with the Region
    - Inspire a diversity of students in our communities to pursue degrees in STEM
    - Engage the public in science, technology, engineering, and math issues

1.3. Project goals

The overarching project goals are to:

- Improve communication of the research permitting process under the ESA for researchers, co-managers, and the public. This will be accomplished by creating data products and communication tools that summarize ESA-listed fish research for the NOAA West Coast Region (WCR). Specifically, the team proposes to create an R shiny app designed to meet the needs of multiple audiences / data users, including NOAA staff, outside researchers, and stakeholders. The products created by the capstone team will contribute to longer-term goals of improving transparency in the permitting process, increasing collaboration among researchers in the region, increasing the ability for the public to understand and interact with the complex permitting process, and educating the public about the permitting process and its purpose under the Endangered Species Act (ESA).
- Contribute to the NOAA West Coast Region's permitting process by developing documentation of the WCR Permitting Data for internal use by others interacting with

the dataset. The team will create a data biography to document the pertinent metadata and purpose of the dataset.

- Cultivate collaborative and professional skills and grow the professional networks of all team members through a new partnership between the NOAA West Coast Region and UW SMEA.

1.4. Project description

Background

The Endangered Species Act (ESA) was created in 1973 to provide a policy framework for the protection and conservation of threatened and endangered species (16 U.S.C. 1531-1544). Endangered species are species that are "at risk of extinction throughout all or a significant portion of its range", whereas threatened species are those which are "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" (16 U.S.C. 1531-1544). The ESA protects species that are listed as endangered or threatened from "take", which is defined in section 3 of the ESA; it means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect [a listed species] or attempt to engage in any such conduct" (16 U.S.C. 1531-1544). The ESA outlines these regulations, while also providing some exceptions to the take prohibition. These exceptions specific to scientific research were created on the basis that, to protect threatened and endangered species, research that will inform their conservation or propagation should be allowed to occur for the conservation of that species. The two most notable exceptions to the ESA that are pertinent to this project are under section 10(a)(1)(A) and section 4(d).

These two exceptions to the prohibition of taking of threatened and endangered species outlined in the ESA differ in their scope and purpose. Section 10(a)(1)(A) allows the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) to "issue scientific research permits to enhance the propagation or survival of a species listed as threatened or endangered, provided that there is a bona fide and desirable scientific purpose to the research being conducted" (NMFS 2019). The exceptions under section 4(d) allow NMFS and USFWS to issue research authorizations to conserve species listed as threatened, and mainly provides a streamlined and cooperative process for the state agencies to conduct research and monitoring programs on threatened species (NMFS 2019).

Researchers can apply to conduct scientific research from NMFS under these and other authorities through the Authorizations and Permits for Protected Species (APPS) application (https://apps.nmfs.noaa.gov/index.cfm). APPS allows researchers to provide necessary information describing their research and its importance, and after submitting it through the APPS portal, NMFS decides to grant the authorization or permit or reject the application. NMFS collects and tracks information as to what permits, or authorizations are being issued where, and how much take is authorized for what species and by which methods. Researchers also report the listed species take that occurred during each year of their project through the APPS system. This information is kept in a database where data can be publicly accessed for individual issued permits, although currently there exists no easily digestible central hub to view, interpret, and use this information. Thus, the purpose of this project is to provide a

readily available and informational framework that summarizes this critical information and puts it into context for researchers, NMFS personnel, and other interested parties.

Capstone project purpose

The overarching goal of this project is to work towards better science communication by providing a synthesis of NOAA data that is accessible by multiple audiences, including researchers and the public. To achieve this goal, we will create an R shiny app that summarizes the impacts of research on ESA-listed fish in the West Coast Region (WCR) and educates the public about the permitting process. The app will synthesize publicly available NOAA research permitting data in a way that can allow viewers to visualize various active research permits across the region. Those doing research will also be able to see which other active permits are operating in their research area to facilitate project collaboration. We plan to summarize these active permits by species, region, watershed, and any other boundaries that would be relevant to ESA-listed fish management. Also, in this app, we will include information on the kinds of research permits you can apply for and the application and issuance process. Additionally, the app will also include information on the purpose of the ESA, the listings of regionally relevant species on the ESA, and the relation of the ESA to scientific research permitting. The purpose of this is to provide more transparency behind these permits, the procedures, and overall decision-making while highlighting the importance of this process in aiding recovery efforts.

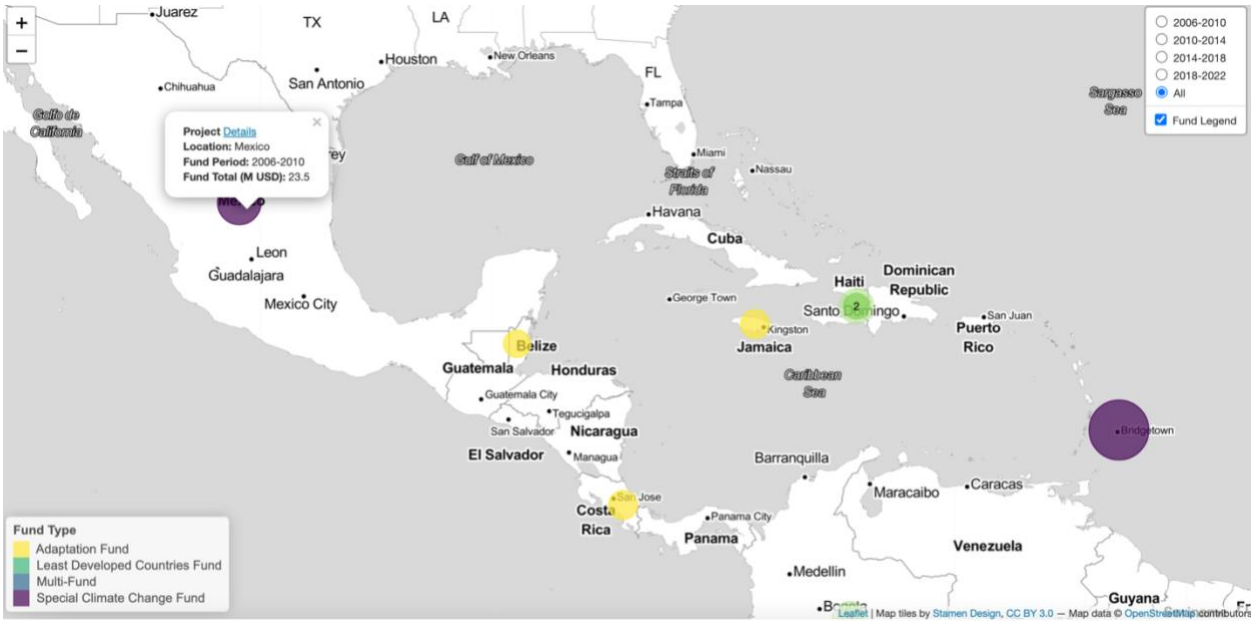

Fig. 1 Example deliverable.

Creating a helpful data biography and metadata to be used by others accessing this publicly available NOAA permitting data is another goal of this project. A data biography and metadata are handy tools as they help ensure the quality of the dataset and provide means for easier access and preservation of the data. A data biography allows the individual to familiarize themselves with the data by understanding who collected it, where it was collected, how it was

collected, and importantly, why it was collected (Krause, 2019). Metadata is also helpful for this dataset as it ensures that we will be able to find data, use data, and preserve and re-use data for future use. Additionally, metadata is critical for interpreting and applying data (Michener, 2018). By providing a data biography and metadata for this dataset, the goal is to make it easier for those viewing the dataset to understand the various aspects and purposes of the data and whether this dataset is relevant to their needs.

Another important goal of this project is to cultivate collaborative and professional skills and develop valuable career skills. Through partnering with NOAA and using NOAA data to create this R shiny app, we plan to cultivate relationships between the University of Washington (UW) and the NOAA WCR office. We will also grow the professional networks for all team members through this partnership. Furthermore, this project aims to allow the team members to gain valuable coding and data wrangling experience. By the end of the project, all team members will be competent coders and data wranglers who can problem solve/troubleshoot data challenges and develop solutions. As the project's product provides a public-facing R shiny app, all team members will also gain experience in data visualization in a manner accessible in multiple formats and by various audiences.

1.5. Your assigned portion of the project

Task	**Lead on Task (* indicates task lead)**
Capstone Management Plan	All
Background Reading/Literature Review	All
● ESA	● Alana
● NOAA permitting	● Rory
● WCR stocks and research	● All
Data Biography and Metadata	Alana*, Rory
● Research relevant background information on the NOAA permitting dataset	● Rory
● Draft data biography and metadata document	● Alana
● Revise following team feedback; Make it accessible for multiple parties and audiences	● Alana
Conceptualizing the Project	Rory*, Alana

● Become familiar with applications/look at examples (R Shiny)	● All
● Draft/brainstorm data visualization ideas	● Rory
● Draft/brainstorm writing pieces	● Alana
● Layout of app	● All
● Integration of data viz and writing	● All
Prototyping	All
● Perform QC on the dataset	● Alana
● Subset dataset with relevant data for R Shiny app	● Rory
● Compile data into R Shiny app and configure the data in an accessible format (figures, tables, infographics)	● All
● Write educational/explanatory pieces for R shiny app	● All
Editing/Finalizing	All
● Peer review/critique	● Mentor team and NOAA staff
● Revisions	● All
Communicating the product and its use to interested parties	All

- Skills you have to complete these tasks
    - Intermediate R coding (RS: Data Viz, loops, functions, tidyR (very limited); AS: mapping, tidyR, data analysis)
    - Writing (RS, AS)
    - Attention to detail (AS, RS)
    - Problem solving (AS, RS)
- Skills still needed to complete these tasks
    - Rmarkdown format and syntax, and associated R shiny (RS, AS)
    - Knowledge of ESA permitting (RS, AS)
- Working with spatial data in R (RS, AS)

- Proposed courses to gain these skills
    - R trainings through NOAA
    - Intro GIS (SEFS 520, S. Trush)
    - Spatial R class (SMEA 586, S. Jardine)
    - SMEA 550 B: Data Exploration and Synthesis for Environmental Policy (Instructor: A. Beaudreau)

1.6. Potential hurdles

- Developing bespoke code
    - With creating a new app or interface, challenges are bound to come up as we need to learn new packages and syntax to efficiently produce the desired product when starting from scratch. To reduce the burden of this effort we will rely on the use of packages and supporting materials provided by our UW coursework and UW and NOAA mentors. To eliminate bugs from our coding, we plan to use online resources as well as our mentors and each other for coding help and to QA the products we produce.
    - We have compiled R resources in a shared Google drive folder.
- Creating the app we want without putting too much stress on a relatively small team
    - The team will divide work evenly and to leverage our individual skills/talents. Team members will communicate their time commitments and what support they need from mentors and each other, so that work can be allocated equitably and team members' needs are met.
    - It will also be important to identify minimum goals to meet project needs as well as “value added” goals that can be implemented when minimum project goals are met.
- Confusion/ambiguity about the research permitting process; understanding the best approach for incorporating information about the permitting process as part of data display.
    - Can confer with people outside the project, to see if our explanations are clear enough for someone unfamiliar with the project to understand.
- Workload
    - As there are only two participants in this project, it will be important to scope the project so that it is feasible for a team of two. We addressed this by designing the project so that the work for each part of the project is divided equally and plays on each other's strengths.
    - Additionally, managing capstone work with coursework will require strong organizational skills.
- Lack of data description intended for external data users
    - This means that the team will need to create their own metadata record, with assistance from Diana Dishman and NOAA colleagues. A benefit to the team is that they will be able to generate a deeper understanding of the data by creating their own data biography.
- Time constraints
    - As both Rory and Alana intend to graduate Winter 2023, we will need to have a

clear plan and make substantive progress during year 1 of the MMA program (AY 2021-22).

- To mitigate this, we will stick strictly to the project management plan and try to ensure we do not miss any deadlines or get behind so that all deliverables are finished on time. Additionally, partial funding support from NOAA will allow Rory and Alana to commit dedicated time to the project during summer 2022.

1.7. Project objectives

The following steps reflect the near-term and longer-term work plan for the project team.

1. Short-Term
    a. Capstone Management Plan
        i. Complete each section of rough draft by 3/14.
        ii. Receive feedback from mentors by 3/28.
        iii. Complete revisions and submit Final Draft by 4/8.
    b. Data Biography and Metadata
        i. Research relevant background information on the NOAA permitting dataset.
        ii. Compile research into Data Biography and Metadata sheet/document.
        iii. Make it accessible for multiple parties and audiences.
    c. Conceptualizing the Project
        i. Become familiar with applications (R Shiny).
        ii. Become familiar with the permitting process.
        iii. Research relevant background information on the permitting process and the ESA to include in the informational aspect of the app.
        iv. Research relevant templates/data visualization techniques.
        v. Perform QC on the dataset.
        vi. Perform exploratory data analysis to test different approaches for visualization.
2. Long-Term
    a. Prototyping
        i. Finalize data visualizations (i.e., number and types of figures, tables, infographics).
        ii. Design the app layout.
        iii. R Shiny app construction and testing.
        iv. Write educational/explanatory pieces for R shiny app.
    b. Editing/Finalizing
        i. Feedback from the mentor team and NOAA staff will be sought at each stage of the project.
    c. Communicating the product and its use to interested parties
        i. Presentations to NOAA staff

2. Proposed Timeline

The capstone team will continue to meet approximately weekly with the mentor team to provide updates and seek feedback on their work.

Category	Task	Wi 2022	Sp 2022	Su 2022	Au 2022	Wi 2023
Capstone Management Plan	First Draft	Mar 16				
	Feedback/Comments	Mar 28				
	Submit to SMEA		Apr 8			
Conceptualization	Metadata description / Data biography		X			
	Work sessions with Diana on dataset details and coding		X			
	Data QC		X			
	Exploratory analysis / visualization		X	X		
	Research on permitting process and project examples		X	X		
	Research R Shiny app examples		X	X		
Prototyping	Finalize data visualizations			X	X	
	Design app layout		X	X	X	
	Construct R Shiny app		X	X	X	
	Write permit stories / accompanying text				X	
Finalizing & Communicating Results	Test app and receive feedback from NOAA staff		X	X	X	X
	Incorporate revisions and			X	X	X

	finalize app					
	Present project					X

See Appendix for schedule of coursework.

4. References

Krause, H. (2020). An introduction to the data biography. We All Count. Retrieved March 9, 2022, from https://weallcount.com/2019/01/21/an-introduction-to-the-data-biography/

Michener, W.K. (2018). Chapter 2: Project Data Management Planning. pp. 13-26. In: Recknagel F, Michener WK (Eds.) Ecological Informatics. 3rd Ed. Springer.

Endangered Species Act. 16 U.S.C. 1531-1544 (1973).

National Marine Fisheries Service (NMFS). (2019). Chapter 3: NMFS Pacific Marine/Anadromous

Fish and Invertebrates Scientific Research Authorizations and Oregon Scientific Take Permits. National Marine Fisheries Service. 1315 East-West Highway Silver Spring, MD 20910.

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Appendix. Schedule of Coursework

Alana Santana: Planned Class Matrix

Autumn 2021			
Course Name	Title	Credits	Instructor
SMEA 500	Introduction to human dimensions of global change	3	Klinger
SMEA 521	Climate Change Governance	3	Dolsak
SMEA 584	Statistics for Marine Policy	3	Jardine
SMEA 539	U.S. Fisheries Management	3	Beaudreau
SMEA 560	Coding in R	3	Kelly
SMEA 600	Advising	1	Kelly
Total		16	

Winter 2022			
Course Name	Title	Credits	Instructor
SMEA 550B	Data Exploration and Synthesis	3	Beaudreau
SMEA 515	U.S. Coastal and	3	Kelly
SMEA 536	Applied	3	Jardine
SMEA 591	Marine Science in	3	Aceves-
SMEA 600	Advising	1	Beaudreau
Total		13	

Spring 2022			
Course Nam	Title	Credits	Instructor
SMEA 586	Intro to Spatial data Manipulation	3	Jardine
SMEA 510	Topics in Marine Ecology	3	Levin
SMEA 519	Marine Policy Analysis	3	Aceves-
SMEA 650	Capstone	2	Beaudreau
SMEA 550A	Speaker Series	1	Beaudreau
Total		12	

Autumn 2022			
Course Name	Title	Credits	Instructor
SMEA 550 B	INDIGENOUS SOVEREIGNTY AND ENVIRONMENTAL JUSTICE	3	Griffin
SMEA 650	Capstone	3	Beaudreau
Elective	Elective	3	TBA
Elective	Elective	3	TBA
Total		12	

Winter 2023			
Course Name	Title	Credits	Instructor
Elective	Elective	3	TBA
SMEA 650	Capstone	3	Beaudreau
Elective	Elective	5	TBA
Total		11	

Spring 2023			
Course Nam	Title	Credits	Instructor
Total		0	

Total Program Credits	64
Required Credits	59
Credits Needed	-5

Core Requirement	Class taken/planned to take	Quarter
SMEA 550	SMEA 550	Autumn 2021
EJJ	SMEA 572	Autumn 2022
Law	SMEA 515	Winter 2022
Policy Analysis	SMEA 519	Spring 2022
Economics	SMEA 536	Winter 2022
Policy Process	SMEA 521	Autumn 2021
Marine Science	SMEA 591	Winter 2022
Research Methods	SMEA 584	Fall 2021
Advising	SMEA 600 (x2)	Fall/Winter 2022
Capstone	SMEA 650	Spri22/Aut22/Wi23

Legend
Not Completed
Completed

Legend
Core Requirement
Elective

Rory Spurr: Planned Class Matrix

Autumn 2021				Winter 2022				Spring 2022				Legend
Course Name	Title	Credits	Instructor	Course Name	Title	Credits	Instructor	Course Name	Title	Credits	Instructor	Core Requirement
SMEA 500	Introduction to human dimensions of global change	3	Klinger	SMEA 550B	Data Exploration	3	Beaudreau	SMEA 586	Intro to Spatial data Manipulation	3	Jardine	Elective
SMEA 584	Statistics for Marine Policy	3	Jardine	SEFS 520	Intro to GIS	5	Trush	SMEA 510	Topics in Marine Ecology	3	Levin	
SMEA 539	U.S. Fisheries Management	3	Beaudreau	OCEAN 450	Climatic Extremes	4	Sachs	SMEA 519	Marine Policy Analysis	3	Aceves-Bueno	
ATM S 587	Fundamentals of Climate Change	3	Frierson	SMEA 600	Advising	1	Beaudreau	SMEA 650	Capstone	1	Beaudreau	
SMEA 600	Advising	1	Jardine									
Total		13		Total		13		Total		10		

Autumn 2022				Winter 2023				Spring 2023			
Course Name	Title	Credits	Instructor	Course Name	Title	Credits	Instructor	Course Name	Title	Credits	Instructor
SMEA 521	Climate Change Governance	3	Dolsak	SMEA 515	U.S. Coastal and Ocean Law	3	Kelly				
SMEA 572	Environmental Justice and Polictical Ecology Field Course: Indigenous Perspectives, Coalitions, and Activism	5	Christie	SMEA 536	Applied Microeconomics for Marine Affairs	3	Jardine				
SMEA 650	Capstone	5	Beaudreau	SMEA 550A	Seminar Series	1	Beaudreau				
				SMEA 650	Capstone	3	Beaudreau				
Total		13		Total		10		Total		0	

Total Program Credits	59
Required Credits	59
Credits Needed	0

Core Requirement	Class taken/planned to take	Quarter planned/completed
SMEA 550	SMEA 550	Autumn 2021
EJJ	SMEA 572	Autumn 2022
Law	SMEA 515	Winter 2023
Policy Analysis	SMEA 519	Spring 2022
Economics	SMEA 536	Winter 2023
Policy Process	SMEA 521	Autumn 2022
Marine Science	OCEAN 450	Winter 2022
Research Methods	SMEA 584	Fall 2021
Advising	SMEA 600 (x2)	Fall/Winter 2022

Legend
Not Completed
Completed