

Norwegian University
of Life Sciences

Master's Thesis 2019 30 ECTS

NORAGRIC

Stewarding the Salmosphere:
*Exploring Perceptions of the Values and
Vulnerabilities of the Alaskan Salmon
Enhancement Program*

Julie Susanne Grønsløth Gould
International Environmental Studies, NORAGRIC

The Department of International Environment and Development Studies, Noragric, is the international gateway for the Norwegian University of Life Sciences (NMBU). Established in 1986, Noragric's contribution to international development lies in the interface between research, education (Bachelor, Master and PhD programmes) and assignments.

The Noragric Master theses are the final theses submitted by students in order to fulfill the requirements under the Noragric Master programme "International Environmental Studies", "International Development Studies" and "International Relations".

The findings in this thesis do not necessarily reflect the views of Noragric. Extracts from this publication may only be reproduced after prior consultation with the author and on condition that the source is indicated. For rights of reproduction or translation contact Noragric.

© Julie Gould, December 2019.

Julie.susanne.gronsleth.gould@nmbu.no

Noragric

Department of International Environment and Development Studies P.O. Box 5003

N-1432 Ås

Norway

Tel.: +47 67 23 00 00

Internet: <https://www.nmbu.no/fakultet/landsam/institutt/noragric>

Declaration

I, *Julie Gould*, declare that this thesis is a result of my research investigations and findings. Sources of information other than my own have been acknowledged and a reference list has been appended. This work has not been previously submitted to any other university for award of any type of academic degree.

Signature.....

Date: December 15, 2019

Acknowledgements

I would like to express my deepest appreciation to my *advisers*:

- *Professor Ian Bryceson*, Faculty of Landscape and Society at the Norwegian University of Life Sciences

&

- *Dr. Hannah Harrison*, Department of Geography, Environment and Geomatics at University of Guelph.

Lines of communication were always open whenever I ran into a question about my research or writing. You both consistently allowed this paper to be my own work, but steered me in the right the direction whenever you both thought I needed it.

I would also like to thank the *research participants* who were involved and took part in this research project. Without your passionate participation and insightful input, fieldwork would not have been successfully conducted.

Finally, a huge thank you to my *friends and family* for providing me with support and continuous encouragement throughout these past two years of study and the process of researching and writing this thesis. This accomplishment would not have been possible without you!

Abstract

In response to declining wild stocks and increasing fishing pressures, global hatchery production of all five species of Pacific salmon has increased. Regulations in Alaska state that hatcheries must contribute to common property fisheries while avoiding significant negative impacts on wild stocks. This thesis explores the broader question of how the diverse perceptions and attitudes of key actors, regarding the social and ecological impacts of Alaskan salmon hatcheries, influence stewardship of the resource. Given the variable nature of wild returns and the stable level of hatchery production, there are benefits and concerns of hatchery-wild interactions. Hatcheries are portrayed and debated based on the benefits they provide and the scientific and economic concerns that stakeholders have about them. These risks and benefits are aired in an ongoing public media debate. Research findings revealed that, though individuals hold various views about the merit and acceptability of salmon hatcheries, there is a unanimous desire for further research and prioritization of natural stocks. Findings also suggested that a discussion of trade-offs is necessary to address risks and benefits aired in an ongoing public media debate, and the potential emergence of a social-ecological trap. This investigation contributes to a growing body of research and to a broader understanding of the social dynamics involved in decision-making about hatchery management of Pacific salmon hatcheries in Alaska.

Key Words: *Alaska, Pacific salmon, debate, values, fisheries management*

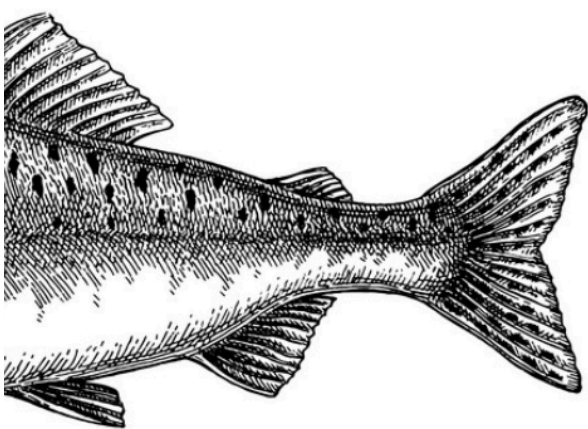


Table of Contents

1 Introduction	1
1.2 <i>Research Question and Objectives</i>	2
1.3 <i>Structure of the paper</i>	2
2 Background and Literature Review	2
2.1 <i>A Brief History of Fisheries & Salmon Enhancement in Alaska</i>	3
2.2 <i>Global Regime Shifts and The Growth of the Fisheries</i>	5
2.3 <i>Hatchery and Wild: Achievements and Criticisms of Hatcheries in Alaska from the Literature</i>	6
3 Resilience and Vulnerability: A Framework for Analysis and Action	6
3.1 <i>Resilience Thinking</i>	6
3.2 <i>Vulnerability and The Pressure and Release (PAR) Model</i>	7
3.3 <i>Social-Ecological Traps</i>	8
4 Methods	9
4.1 <i>A Grounded Approach</i>	10
4.2 <i>Study Area: Alaska: Cook Inlet and Prince William Sound</i>	10
4.3 <i>Data Collection</i>	11
4.3.1 <i>Identifying Key Informants</i>	11
4.3.2 <i>Materials</i>	12
4.3.3 <i>Semi- Structured Interviews</i>	12
4.3.4 <i>Participant Observation</i>	13
4.3.5 <i>Document Analysis</i>	13
4.4 <i>Analytical Approach</i>	14
4.5 <i>Ethical Considerations</i>	15
4.6 <i>Limitations and Future Directions</i>	16
5 Results	16
5.1 <i>The Debate: Attitudes and Perceptions of Hatcheries</i>	17
5.2 <i>Ecological Concerns</i>	17

5.2.1 <i>Competition and Environmental Impact</i>	17
5.2.2 <i>Straying and Genetic Introgression</i>	19
5.3 <i>Science-based Management</i>	20
5.4 <i>Social and Cultural Values</i>	21
5.5 <i>Policy and Regulations</i>	22
5.6 <i>Uncertainty and Change</i>	23
5.7 <i>Why Now?</i>	23
6 Discussion	24
7 Conclusion	30
8 References	31
APPENDIX	36
A. <i>Semi-Structured Interview Guide</i>	36
B. <i>Interview Consent Form</i>	38
C. <i>Egg & Milt Collection</i>	40
D. <i>Otolith Removal</i>	42
E. <i>Pacific Salmon</i>	43

List of Figures

Figure 1 Total salmon eggs collected, juveniles released and adult returns in the Alaska Hatchery Program (Stopha M. 2019).....	4
Figure 2 PAR Model A (adapted from Wisner, B., et al 2004)	8
Figure 3 South Central Alaska (Alaska Department of Fish and Game (s.a)).....	11
Figure 4 Materials Used.....	12
Figure 5 The Coding Process used to analyze data collected during this research project (Saldaña, 2016).....	14
Figure 6 Homer & Kachemak Bay (Google Maps).....	19
Figure 7 PAR Model B (adapted from Wisner, B. et al. 2004).....	29
Figure 8 Cleaning broodstock females before egg-take	40
Figure 9 Eggs collected from 1 female Sockeye salmon.....	40
Figure 10 Collecting eggs from 1 female pink salmon.....	41
Figure 11 Quality control: picking through dead eggs	41
Figure 12 Milt collected from 1 male Sockeye salmon.....	41
Figure 13 Otolith ear bones.....	42
Figure 14 Otolith retrieval.....	42
Figure 15 Pink Salmon congregating before egg take at a hatchery	43
Figure 16 A pair of Sockeye salmon spawning.....	43

List of Acronyms

Alaska Department of Fish and Game.....ADF&G

Division of Fisheries Rehabilitation Enhancement and Development.....FRED

Pressure and Release.....PAR

Private Nonprofit.....PNP

Alaska Department of Environmental Conservation.....DEC

1 Introduction

The growing global demand for sustainable seafood has cast a spotlight on salmon, a desired seafood known for its rich health benefits. Pacific pink salmon (*Oncorhynchus gorbuscha*) populations in Alaska, comprised of both wild and hatchery salmon, continue to play a critical role in supporting commercial, recreational and subsistence and personal use fisheries. Robust commercial salmon harvest, of which up to 1/3 are the result of salmon enhancement (McDowellgroup, 2018), maintain the state's economic foothold in the global seafood market.

Alaska introduced the hatchery system in the 1970's to promote long-term sustainable management after historic lows. Hatcheries are facilities where salmon eggs are fertilized artificially, hatched and reared to a juvenile stage, and released into a river or at sea (depending on rearing state), to supplement naturally-reproducing populations. The fundamental goal of a hatchery is to increase survival during the crucial life-stage bottlenecks (particularly the egg stage) by keeping gametes and juveniles safe from environmental risks (e.g. predators) and imprint the resulting fry on their release locations where they will later return as mature adults (Stopha M., 2013). However, hatcheries have also been a source of contention concerning the long-term success of the species. Ecological concerns (with social ramifications) have prompted an escalating public debate, particularly in light of ongoing scientific research.

Social science research enables researchers to better understand the complexities of the human perspective by identifying key themes of issues. This research project was designed to explore the drivers behind the public debate on salmon enhancement and relationships between hatchery stakeholders. This thesis does not attempt to judge research participants perceptions of the hatchery debate explored in this study, nor to evaluate the pre-existing literature and the concerns it raises about hatchery impacts. Rather, this thesis aims to explore the ongoing issues behind perspectives on the value and ongoing use of hatcheries in the Alaska salmon enhancement program.

1.2 Research Question and Objectives

- How do the diverse perceptions and attitudes of key actors, regarding the social and ecological impacts of Alaskan salmon hatcheries, influence stewardship of the resource?

In order to explore the research question, this research encompasses the following objectives:

- Investigating how local resource users engage with governing bodies and each other to further understand the interaction between salmon hatchery production and the risks involved
- Exploring and evaluating the perceived benefits, costs, and values of having salmon hatchery programs in the state among resource users
- Drawing upon current perceptions and issues surrounding salmon enhancement production in Alaska from various user groups and research social and ecological feedbacks

1.3 Structure of the paper

The second chapter delves into a literature review that will provide a brief look into the socio-economic and ecological importance of salmon in Alaska. It will give an overview of key terms as well as a brief outline of the history of the state's fisheries and salmon enhancement programs. The third chapter will present a theoretical framework introduced to accommodate and contextualize the findings. The fourth chapter describes the methods used, summarizes how this research has been conducted, how the fieldwork was carried out and analyzed, and recognizes the ethical considerations and limitations of the study. The fifth chapter presents a detailed description of the finding of this research, followed by the sixth chapter, which presents a discussion linking findings together and further analyzing the data. The thesis concludes with a section that highlights the main findings and takeaways from this research.

2 Background and Literature Review

This chapter provides background information of the history of Alaskan fisheries and the hatchery program amidst ecological global regime shifts. I will then introduce positive and negative statements regarding hatcheries and clarify how 'hatchery' and 'wild' are defined in my research.

2.1 A Brief History of Fisheries & Salmon Enhancement in Alaska

Pacific salmon have a unique life history. Born in freshwater, Pacific salmon migrate to the ocean to live their adult years and return to their natal watersheds to spawn and die, providing further nutrient benefit to upstream terrestrial ecosystems (Pacific Salmon Foundation, s.a). With a coastline spanning the Arctic Ocean, the Pacific Ocean, and the Bering Sea, fishery resources are integral to Alaskan's identity and lifestyle. In the mid-1970s, commercial salmon harvests in Alaska reached near historic lows estimating around 25 million in 1972 (Sisk J., 2007).

To counteract diminishing harvests, the state enacted a limited-entry program to control overfishing and embarked on an ambitious salmon enhancement program designed to supplement existing wild stocks. Limited entry established that a fishing permit could be held only by an individual fisherman and not by boats or larger corporations. The established law also allowed for permits to be transferable between fisherman by sale, gift, or inheritance providing equity value and protection from corporate accumulation of salmon fishing privileges (Sisk J., 2007). Salmon fishery managers were able to manage a fishing fleet that was finite rather than expanding continuously. Having developed its hatchery program after others in Europe and the Lower 48, the state benefitted by learning from mistakes made elsewhere. The quote below demonstrates the intent of the salmon enhancement program as it was put into practice.

“It is the intent of this Act to authorize the private ownership of salmon hatcheries by qualified nonprofit corporations for the purpose of contributing, by artificial means, to the rehabilitation of the state's depleted and depressed salmon fishery. The program shall be operated without adversely affecting natural stocks of fish in the state and under a policy of management which allows reasonable segregation of returning hatchery-reared salmon from naturally occurring stocks.” (Stopha M., 2013)

The program implemented genetic oversight of hatchery operations through fish transport permits, pathology guidelines, hatchery site limitations, egg take caps, and locally adapted broodstock development among other measures (Evenson D.F. et al., 2018). The figure below taken from Alaska Department of Fish & Game’s (ADF&G) 2018 annual report is a representation of the hatchery program’s growth from its first data collection numbers of salmon returns in 1977.

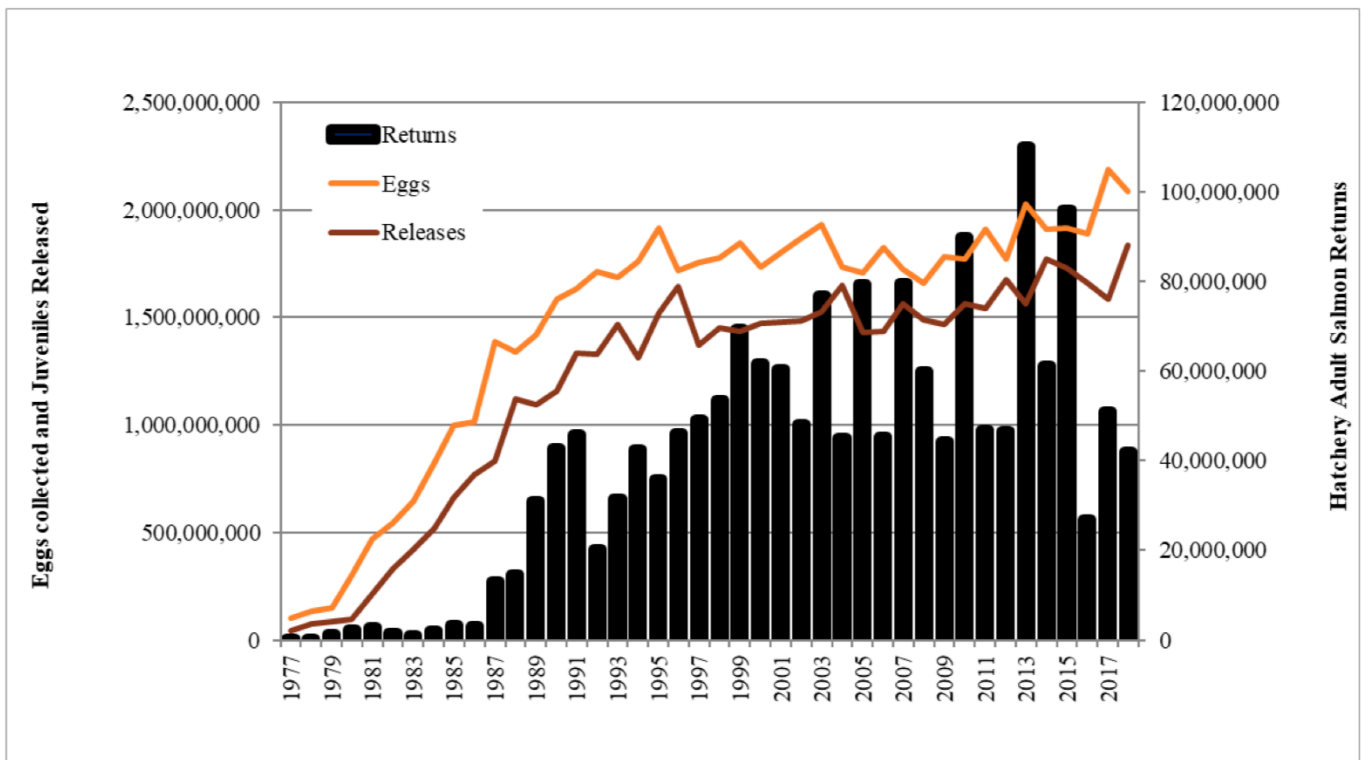


Figure 1 Total salmon eggs collected, juveniles released and adult returns in the Alaska Hatchery Program (Stopha M. 2019)

Currently, twenty-nine salmon hatcheries are operating in the State of Alaska. Twenty-five private non-profit (PNP) corporations, two sport fish hatcheries operated by the state, one research hatchery run by the National Marine Fisheries Service (NOAA), and one production hatchery run by the Metlakatla Indian Community (Stopha M., 2019). PNP hatcheries cater primarily to commercial interests, but also produce salmon for recreational and personal users. Most hatchery production is predominantly pink salmon (*Oncorhynchus gorbuscha*). Because hatchery production is limited by abundant freshwater capacity, space, and cost, pink salmon fry are an ideal economically efficient species. Pink salmon’s shorter life cycles and stronger resistance to disease than other salmon varieties, are the primary salmon export from the State

of Alaska, resulting in millions of dollars in annual economic output (Salmon Hatcheries for Alaska, s.a).

PNP hatcheries fund their operations largely through cost recovery operations and enhancement taxes paid for by commercial fishermen. State and federal grants coupled with tourism activities are also employed to fund production (McDowellgroup, 2018). Alaskan fisheries provide thousands of seasonal and full-time jobs vital for sustaining communities. As an example of hatchery contribution, in a study prepared for eight PNP hatcheries by the McDowell Group in 2018, it was estimated that around 4,700 jobs are sustained through the hatchery system, generating \$218 million in labor income. ADF&G oversees licenses and permits pertaining to commercial, recreational, and subsistence fishing, and because of the magnitude of the fishery, state biologists collect extensive information and statistics for management decisions. The Alaska Board of Fisheries (BOF) which consists of seven members appointed by the governor and approved by the legislator who serve three-year terms, are responsible for considering and adopting regulations to allocate resources between user groups (Alaska Department of Fish and Game, 2019d). Management regimes of both the wild and hatchery stocks fluctuate with elected political cycles, further influencing political pull and partnerships between various actors. As a result, human decisions and environmental feedbacks shift together and because of each other.

2.2 Global Regime Shifts and The Growth of the Fisheries

Favorable ocean conditions, growing enhancement operations, and scientifically managed practices have increased pacific salmon production dramatically over the last 20 years. Evidence of patterns and synchronous changes in the ocean environment have been recognized and discussed as the *Pacific Decadal Oscillation*; a climate index based upon patterns of sea surface temperature (Northwest Fisheries Science Center, s.a). Evidence concludes that in the winter of 1976-77, an eastward shift of the Aleutian low-pressure system and warming surface waters in the Gulf of Alaska defined an onset of a new regime rather than a temporary system shock (Hare, S. R. & Francis R.C., 1994). This regime shift favored salmon production alongside hatchery stocks that were just coming online.

2.3 Hatchery and Wild: Achievements and Criticisms of Hatcheries in Alaska from the Literature

Hatcheries have been a topic of controversy and are not without its critics since their opening in the 1970's. Their perceived benefits have been applauded and disapproved periodically with fluctuating public attitudes and scientific advances, generating ongoing disagreement. There is research documented beyond the North Pacific that suggest hatchery production may adversely affect wild stocks, justifying these widespread concerns among communities, scientists, environmental NGO's, and state managers alike (Chaput G. et al., 2017). Alluding to the North Pacific's carrying capacity, the research also raises questions about whether the ocean can supply enough food to support possible future increases in hatchery fish while still sustaining the productivity of wild salmon. Measures have been taken by managers to minimize risks hatchery fish pose to wild populations by taking actions such as segregating the release of hatchery fish from streams abundant with wild stocks and altering release locations and timing (Evenson D.F. et al., 2018). However, while it is easier to identify risks that hatcheries pose to wild populations, it is difficult to map possible adverse effects and the seriousness of the consequences. These concerns have divided and sparked discussion among the Alaskan community. The hatchery program has undoubtedly played an important role in the state's fisheries for decades growing the economy and influencing the livelihoods and cultural identities of Alaskans while providing a rich nutrient protein source beyond their local waters.

3 Resilience and Vulnerability: A Framework for Analysis and Action

As interlinked concepts, vulnerability and resilience offer insights into the complexity of human and natural system relationships. The framework sets out the key factors that contribute to people's vulnerability: exposure to hazards and stresses; fragile livelihoods; future uncertainty; and weak governance. It provides detailed explanations of the linkages between these factors, as well as ideas to strengthen resilience.

3.1 Resilience Thinking

The resilience perspective acknowledges that ecosystems continually adapt to disturbances on a variety of scales, yet levels of resilience hinder on whether the ecosystem can reorganize, renew, and persist following disturbance without shifting to a different regime (Berkes F. & Folke C., 1998). As resilience increases, the degree of damage for a given hazard decreases.

This thesis applies resilience thinking in this context to address the complex and adaptive integrated systems of Alaskans connection to salmon hatcheries amidst ongoing research that may or may not subscribe to legislative language as it is currently written. Because ecosystems have limits in their capacities to reorganize and repair themselves following disturbance, human intervention must work within the adaptive capacities of salmon management to avoid placing the ecosystem services at risk. The precautionary approach method ensures cautious foresight to reduce and/or avoid risk to the resource, environment, and people considering the existing uncertainties and potential consequences (UNESCO, 2005).

3.2 Vulnerability and The Pressure and Release (PAR) Model

Vulnerability in this context refers to the situational characteristics of Alaskan coastal communities that influence their capacity to anticipate, cope with, resist and recover from the impact of a hazard (in this case an unfolding process) (Proag V., 2014). Vulnerabilities involve a combination of factors that determine the degree to which livelihood's, properties and/or other assets are put at risk. Vulnerability is considered in three levels: root causes, dynamic pressures and unsafe conditions. A disaster (in this case a potential disaster), sits at the intersection of two opposing forces: the process generating vulnerability, and the exposure to hazard(s). Disaster occurs as a result of potential hazards acting in combination with vulnerabilities. Increasing pressure can come from either side of the model, but vulnerability has to be reduced to relieve the pressure. The PAR model is a flexible tool and can be changed and updated for fluctuating conditions and site-specific geographic locations. The time dimension is difficult to account for as effects can resonate elsewhere or years into the future such as the effect of climate change and hatchery/wild interactions. The PAR model (figure 2) displays how a potential disaster may occur in relation to broader patterns of society, and how analyzing unsafe conditions may provide a more insightful way to build policies to mitigate hazards. Vulnerabilities are rooted in social processes and underlying causes whilst disasters are a complex mix of natural hazards and human action.

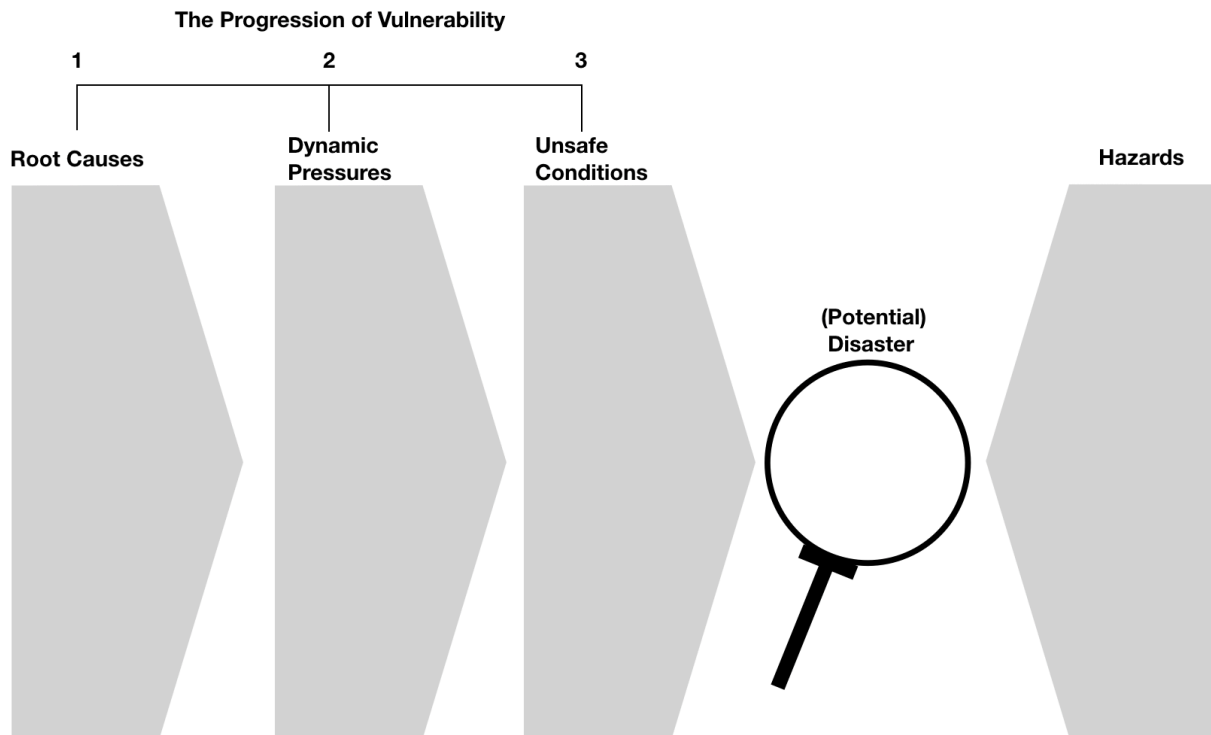


Figure 2 PAR Model A (adapted from Wisner, B., et al 2004)

3.3 Social-Ecological Traps

A social-ecological trap as described by the Stockholm Resilience Center is ‘a situation where social and ecological feedbacks mutually reinforce each other and maintain or push a social-ecological system towards an undesirable state’ (Stockholmresilience, s.a). Social-ecological traps highlight and explore connections between people and their natural systems from the perspective of viewing societies as a part of nature. The trap metaphor has been useful in this study to contextualize the causal relationship of environmental and livelihood feedback loops where the two systems evolve and shift together and because of each other as a process. Evidence of this metaphor includes time and history dimensions and is later examined in the discussion section. Social–ecological traps are a path-dependent processes that may insinuate a condition from which people (almost) cannot escape; however, this study conceptualizes social ecological traps as a process of entrapment that may be stopped or reversed through steps such as policy intervention and not an outcome (Boonstra, W. & De Boer, F., 2013). Below are four key findings of Social-Ecological trap literature that will be later discussed in this research context in section 6 where results of the study are inked to vulnerability and resilience thinking:

- *Social-ecological traps can be driven by economic opportunities and aggravated by masking effects.*
- *Identifying key actor groups can be critical to understand social-ecological traps.*
- *Lag-effects can reinforce social-ecological traps.*
- *Ecosystem illiteracy and strong identity can push people into social-ecological traps.*

(Stockholm Resilience, s.a)

4 Methods

This qualitative case study was based upon multiple sources of data to inductively identify patterns and build theory (Burney & Hussain, 2008). First, this section describes the grounded approach, a method used to approach the study and build research questions and theory (Glaser, B. G. & Strauss, A., 1967). Then, sampling techniques and data collection procedures are presented including the use of document analysis, semi-structured interviews, and participant observation. It also summarizes the materials used, analytical procedures, and validity and the reliability of the collected data. Lastly, the ethical considerations and limitations of the research are explained.

The field work and majority of the data collection used to inform this study was conducted by and engaging in joint learning and data collection. In addition, the study drew upon the expertise of other researchers who had significant experience in the case study area. Specifically, I worked with and conducted joint fieldwork with Dr. Hannah Harrison, a post-doctoral researcher at the University of Guelph and co-supervisor to this thesis work. We worked in tandem to identify primary research questions, design the study approach, identify interview participants and relevant documents for analysis. The fieldwork and data collection for this study took place between July and September 2019.

Local actors have shown a keen interest in hatchery effects since the emergence of the program which was expressed by an interview participant, however recently the discussion has turned more public. As a result, the scope of this research focuses primarily on recent actions, but also references the changes observed by participants since the birth of the salmon enhancement program in the early 1970's. This thesis does not aim to draw sweeping conclusions to be

applied elsewhere, as it has become strikingly clear through my research that attitudes and perceptions vary greatly based on case study context. Qualitative methods are best suited to rich description rather than generalization between cases. Instead, I aim to discuss my specific findings and reflections on how actors involved engage with each other, their support base, and the general public.

4.1 A Grounded Approach

As a team, we approached research with a broad query into the social dimension of Alaska's salmon hatcheries, and went on to collect relevant information about the topic through the previously described data collection methods. Glaser and Strauss (1998), originators of grounded theory, proposed that researchers should engage in simultaneous data collection and analysis through an inductive approach. The method stresses the importance of allowing theoretical ideas to emerge out of the data as collected. Repeated ideas, concepts or elements that become apparent were tagged with *open codes* and sorted through *memos*. Data was further grouped and reviewed into categories then developed into overarching theories. Coding and analytically memoing continually brought me back to the text and data and in turn formed the analysis necessary to develop novel findings to discuss (Corbin, J., & Strauss, A., 1990; Glaser B. G., 1998; Glaser, B. G. & Strauss, A., 1967). Charmaz, a student of Glaser and Strauss, developed the constructivist grounded theory, which advocates that the researchers include raw data in their memos and continue to as memos become more complex and analytical. This approach helps to keep the participant's voice present (Charmaz, K. & Belgrave, L., 2015).

4.2 Study Area: Alaska: Cook Inlet and Prince William Sound

Fieldwork was conducted throughout south central Alaska on the Kenai peninsula and further east in Prince William Sound. This study area was selected because the marine environments in these areas comprise of a wide variety of habitats with geographical variations in topography. In addition, these are important recreational areas for many locals and tourists, and also have a high species richness that supports stocks targeted by both commercial and recreational fisherfolk.

As already mentioned, Dr. Hannah Harrison, my research partner, is an Alaskan local with extensive knowledge and familiarity within the realm of salmon issues. She has strong ties to the local and statewide community which made this study area an ideal place to partake in research.



Figure 3 South Central Alaska (Alaska Department of Fish and Game (s.a)).

4.3 Data Collection

The data collection consisted primarily of semi-structured interviews and direct and indirect participant observation. These approaches were supplemented with the collection and analysis of public documents including materials from official governmental websites and news articles as well as secondary source academic research. These documents were chosen to provide reputable background information and provide context for embarking on field work. The elected methods were selected to achieve an in-depth and comprehensive understanding of perspectives held by stakeholders within the case study.

4.3.1 Identifying Key Informants

Participants were identified by combining two methods: purposive and snowball sampling techniques. The research team used purposive sampling to select an appropriate group of interview and research participants. Potential participants were identified using public comments submitted to the Board of Fish Hatchery Committee meeting on March 8, 2019 (Alaska Department of Fish and Game, 2019a, Alaska Department of Fish and Game, 2019b) The comments offered an indicative record of individuals and organizations with an active involvement and interest within the community, thus creating a strategic sample to achieve

highly relevant data. Once those initial participants were identified, at the end of each interview we set time aside to ask for further suggested contacts. This enabled an expansion of the participant pool using snowball sampling (Bryman, 2015, p. 415).

We included a diverse range of participants to solicit a wide range of perspectives and opinions in an attempt to make the research findings more representative of the target population. Participants were labeled as key informants (Marshall, 1996) as a result of their personal skills or familiarity with the topic. Represented among the 28 interviewees are local and state government employees (8), non-profits (9), researchers (3), educators (2), conservationists (2), and fisherfolk (4), all of whom are local residents. Many informants exemplified more than one category.

4.3.2 Materials

- Informed Consent Interview Forms
- Notebook
- Recorder
- Camera

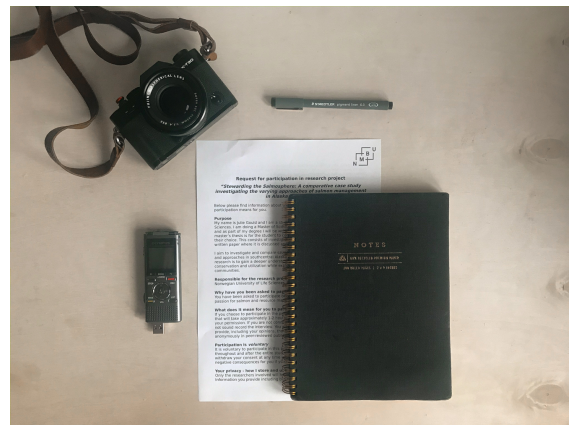


Figure 4 Materials Used

4.3.3 Semi- Structured Interviews

One-on-one, semi-structured interviews with 28 sampled participants were used to gather a collection of in-depth perspectives representative of participants reflections. On four occasions more than one respondent was interviewed simultaneously at the request of the interviewees. Interviews were conducted using a previously-prepared interview guide that provided an outline, yet the flexibility to adapt based on the responses of participants (Appendix A). The guide was designed so the interviews would be conversational and the interviewee could feel comfortable to share stories, anecdotes, experiences, ideas, and perceptions. Interviews were semi-structured but were flexible in allowing participants to direct the line of inquiry toward topics they found personally relevant to the research questions. We sought clarity and encouraged participants to elaborate on complex points by asking follow-up and clarifying questions. (Bryman, 2015, p. 473-475). Interviews were conducted primarily in person at the

participants place of work, public location, or other location of the participants choice. Due to logistical constraints, some interviews were held over the phone or over the internet video platform *Zoom*. Interviews typically lasted between 60 - 90 minutes and were recorded on audio recording devices with the explicit permission of the interview participant. Following each interview, the research team debriefed and took note of what was expressed, how new information fit into the larger picture of the case, and new directions of inquiry to pursue in later interviews.

4.3.4 Participant Observation

Participant observation was an active tool I utilized to expand and provide a more nuanced understanding that could only derive from personal experience. It assisted to form the physical, social, cultural, and economic contexts in which the study participants live (Guides.library.duke, 2019). In just over two weeks I visited local areas of interest engaging in conversations with participants. I incorporated suggestions of individuals to speak with, online resources to use, and local activities to attend. A field note journal helped organize notes of daily accomplishments and personal reflections to formulate a more detailed account of time spent. Observing and participating in community activities provided a deeper understanding of the breadth and complexities involved when speaking about salmon and hatchery issues.

4.3.5 Document Analysis

Public documents including reports, public comments, peer reviewed academic articles, museum informational materials and exhibits, various conservation organizations promotional and informative print materials, social media pages containing organizational opinion and propaganda, and newspaper articles informed data analysis. The time frame of the relevant articles was limited from 1970-2019. Articles were identified using a mixture of key word searches (e.g. 'salmon enhancement,' 'conflict,' 'perceptions,' and 'hatchery,') and opportunistically collected articles with direct relevance to current day events surrounding the research questions (Bolton, 2018, Naish et al., 2007, Miller K.A., 2000). I relied on peer-reviewed academic articles and identified several key authors within the academic field to familiarize myself with the study area and past research while using new articles as a supplemental tool. Official documents provided by these organizations helpfully illustrated what the organizations deemed appropriate and valuable for the public to know in order to achieve their goals and garner support.

4.4 Analytical Approach

Thematic analysis identified patterns appearing from participants answers (Berg, B. L. & Lune, H., 2012). All interviews with the 28 research participants were transcribed using *Express Scribe* software and uploaded into *NVivo*, a qualitative data analysis software that provides a platform to code themes within text to interpret and organize. Once sections of interviews were coded, they were sorted into broader thematic categories that further developed into concepts and theoretical explanations. The figure below presents a visual aid of thematic analysis. Analysis was a continual process adding codes as themes became apparent.

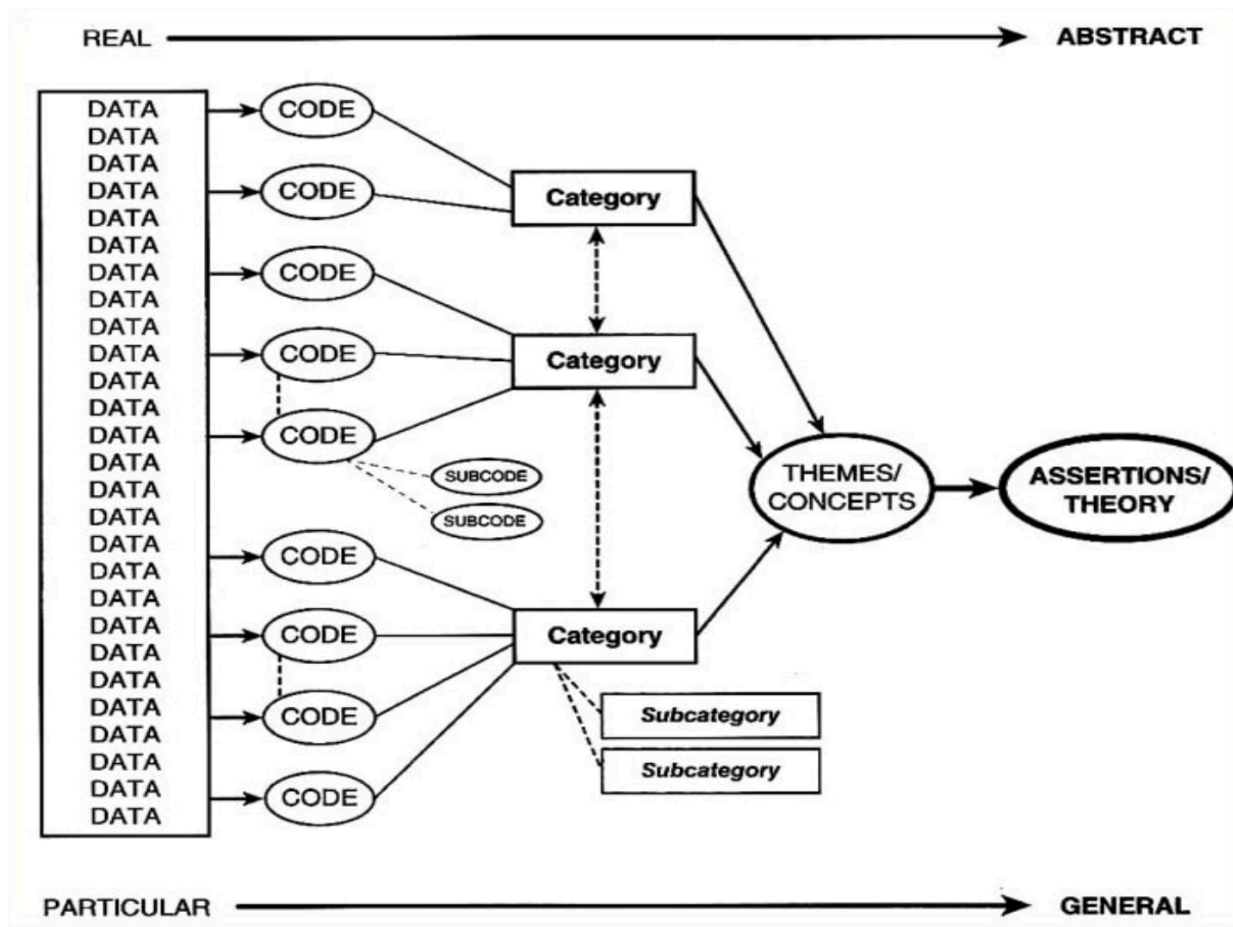


Figure 5 The Coding Process used to analyze data collected during this research project (Saldaña, 2016)

Multiple data collection methods promoted validity and reliability of conclusions drawn, an important step to ensure the findings are credible and trustworthy (Brink H., 1993). These clusters of data reinforced each other and worked to fill in gaps of research to connect ideas. As a research team, we continually combed through shared data and discussed concepts. As

mentioned in the semi-structured interview section, we debriefed periodically to discuss and expand upon themes mentioned and drawing connections.

4.5 Ethical Considerations

Ethical concerns while conducting a study must be considered to protect informants and to ensure the integrity of the research. Diener and Crandall (1978) break down ethical principles into four areas; do no harm to participants, always give informed consent, rights to privacy, and overt research. In order to ensure privacy and no harm to participants, the identities and records of individuals are not identifiable in this thesis. I have purposely omitted dates of interviews following quotes throughout the results section to further ensure anonymity stating only the year conducted. Recordings, field notes and interview transcripts were stored securely to prevent people and places from being identified by anyone else.

At the beginning of each interview I requested the informed consent of the participant(s) and explained their rights (Appendix B). Participants were given the opportunity to ask questions and seek clarification on the conditions of their participation in the study. I explained the purpose of the research and their personal role in it clearly to each individual. They were notified that they were allowed to speak ‘off the record’ and if they preferred they could also withdraw from the study at any time without the need to state a reason or negative consequences. I further went on to inform them how I would use the information collected. A copy of the signed informed consent was left with each participant after their interview which included the contact information of the research team for future reference.

The research project is registered with the Norwegian Social Science Data Services (NSD), which provides strict guidelines and a review process for submitted proposals. The identities of all participants were anonymized in the early stages of fieldwork, including notebooks and my personal computer. Upon completion and approval of the thesis, I will ensure that all data is responsibly disposed of. Following the publication of this thesis, I intend to share and convey my results to each research participant to maintain those relationships and avoid contributing to exploitative or extractive research practices.

4.6 Limitations and Future Directions

Collecting and analyzing data provided novel insights, however, as with all research, there were methodological and logistical limitations to the study. While a variety of methods of data collection and analysis were employed, time constraints and locality were limiting. The timing of fieldwork interviews coincided with the height of the fishing season. This caused scheduling conflicts and limited availability of some interviewees. Interview participants were spread out around the large remote state proving difficult for in-person interviews. As a team we had to place reasonable limitations on travel. It would have been ideal to speak with every participant personally to make note of the social nuances one can gather only through observation. It may be difficult to build rapport and develop a sense of who a participant is without participating or observing activities. Additional time and more interviews may have been helpful as well to further analyze data in greater depth and gather more literature adding additional perspectives and complexity.

Being from outside Alaska, I did not possess a local insight and knowledge base. Through reading literature before travelling and engaging in participant observation on the ground, my knowledge expanded. However, I relied heavily on research and second-hand knowledge. Due to some polarizing opinions of the hatchery programs, it was necessary to acknowledge my intrinsic biases and hone in on reflexivity, reflecting on how my personal experiences and perceptions influence my thoughts and actions (Bryman, 2015, p. 388). While I aimed to be unbiased, I acknowledge it is impossible to fully step outside of one's own preconceptions, but I did my best to accurately reflect participants reflections while considering the sources of information as I was analyzing data. For this reason, I intentionally spoke with individuals from various user groups spanning various positions in an attempt to expand the representation.

5 Results

In this chapter, findings from research and fieldwork are presented. Data analysis showed a complex, multifaceted debate based on the value, importance, and concerns surrounding the Alaskan salmon enhancement program. An overview of the ongoing debate and elaboration of participants' ecological concerns will first be presented before a discussion of key findings, such as the significance of science-based management and value sets. This chapter also discusses the regulatory language put in place by the State of Alaska to advise management decisions and respondents concerns of uncertainty of future ecological and political

proceedings. The results presented are integral to understanding effects that resonate beyond the marine ecosystem and into communities.

5.1 The Debate: Attitudes and Perceptions of Hatcheries

Within Alaskan salmon stakeholder communities, there is currently a debate about the ongoing use of hatcheries to enhance Alaska's wild salmon runs. Specifically, the debate revolves around key aspects of hatchery efficacy and the potential threats hatchery-reared salmon may pose to natural populations. The debate has taken place in such as in opinion pieces, print and digital media, Board of Fish meetings and social media campaigns amongst others. The debate can be characterized around four primary issues: ecological concerns, the significance of science-based management, social and cultural values surrounding hatchery salmon and their associated fisheries, and the regulations and policy that outline the state's intent for the hatchery program. Stakeholders attitudes and perceptions on hatcheries and salmon enhancement are also important aspects of the debate, as while most participants agreed that hatcheries play a key role in supporting commercial salmon fisheries (an economic pillar of the state), opinions fell across a spectrum when assessing trade-offs and what risk hatcheries and stocking may pose amidst broader ecological uncertainty.

5.2 Ecological Concerns

5.2.1 Competition and Environmental Impact

Research participants frequently raised ecological concerns about hatcheries, ranging from competition and environmental impact to straying and genetic introgression. For example, the volume of fry released annually raised concerns amongst hatchery critics of competition between hatchery fish and other wildlife with whom their diet overlaps such as resident seabird populations. These criticisms were often linked to scientific literature that has shown a possible effect between plankton and pink salmon population densities in the marine environment. Similar studies and local observations by study participants have shown possible links between seabird starvation and other salmon species returning at lower average weights during years of large pink salmon returns. Other study participants pointed out that whales such as humpbacks (*Megaptera novaeangliae*) are not uncommon around hatchery release sites where they are believed to be feeding on released juveniles. Their presence impacts the economics of the area's fisheries as the released fry will not be later harvested by the fishermen/women. However, their

presence may also enhance the marine ecosystem for larger desirable predators that support ecotourism in coastal communities. More broadly, interview participants raised concerns about limited marine food supply, climatic changes, and natural variations all working in tandem with pressure from enhanced salmon populations to create potentially unhealthy competition for resources between hatchery fish and other marine life. Some participants alluded to the uncertainty of the ocean's carrying capacity for different species of salmon and the potential to through stocking reach an ecological tipping point, though no study participant believed that there is yet a clear idea of where (or when) that tipping point may be.

The Tutka Bay hatchery, located in Kachemak State park and a critical habitat area, was an important example of hatchery-environmental interactions for many stakeholders. The hatchery is located in a shallow lagoon where dissolved oxygen is refreshed only by a small freshwater stream and tidal exchange. Local residents and hatchery critics in this study expressed concern about the relationship between low oxygen levels and fish carcass disposal that may have resonating effects for other organisms. After broodstock are harvested for eggs and milt at the hatchery facility, fish carcasses are documented and disposed of. Permission to continue the Tutka Bay Hatchery's disposal method in the lagoon was denied on behalf of the Department of Natural Resources. Despite a challenging location for a hatchery, efforts have been made on behalf of Cook Inlet Aquaculture Association (CIAA), the overarching association that runs Tutka Bay hatchery among others in the area, to communicate their perceived value of area stocking and rebuild relationships with the surrounding community more effectively.



Figure 6 Homer & Kachemak Bay (Google Maps)

5.2.2 Straying and Genetic Introgression

The impact of hatchery fish on the genetic integrity and diversity of wild fish populations, particularly in the large quantities that are being released each year into Alaskan waterways, (approximately 1.8 billion (Stopha M., 2019)), was of significant concern to some stakeholders. Genetic interaction between hatchery and wild fish occurs when hatchery-origin fish are not harvested and spawn with their wild counterparts. Though straying is a natural mechanism by which salmon maintain genetic variability between subpopulations, the reported stray rate percentage, varying from 4-15% (Evensen D.F., et al., 2018) (particularly for pink salmon) and sheer volume of hatchery-produced fish in comparison to existing wild populations was a significant concern for some study participants. These concerns escalated for some stakeholders when in 2017, pink salmon congregated in large numbers throughout Kachemak Bay, an area on the Kenai peninsula (Figure 6) that had not historically supported large pink

salmon returns. Pink salmon were seen piling up in ditches and small, seasonal streams that offered no chance of reproductive or rearing environments. As one participant described:

“There were hundreds of pink salmon flopping around dying in that spot. It was not a positive experience to see those fish there, no one has ever seen pink salmon in beluga slough, [it] doesn't mean that they weren't there. It just didn't feel right. It was weird. That summer was like 'where the hell are these fish coming from?’” (Participant 4, 2019)

ADF&G officials sampled carcass otolith markings, thermal band marks imprinted on ear bones by changing the water temperatures during hatchery incubation, and found that a high proportion of the fish were primarily hatchery strays from Prince William Sound. The cause of this ‘migration’ remains unknown and while variation in odd and even years are expected, this event was considered abnormal by ADF&G personnel and locals alike.

In response to concerns regarding straying and possible genetic impacts, the Alaska Department of Fish & Game launched a hatchery-wild salmon interaction study in 2011 to scientifically investigate the potential genetic, fitness, and interaction concerns. They expect to conclude the study in 2023, yet it may take several more years before the full report is reviewed and accessible. Due to funding protocols, preliminary results from the study were obligatorily released in the summer of 2019. The preliminary findings focused on small samples based on two streams. They revealed that hatchery parentage fish bear lower reproductive success than their wild counterparts (see Lescak A. et al., 2019). There are mixed opinions about how scientific knowledge and preliminary results of the ADF&G study were released to the public and how those early releases may sway public opinion about the potential presence and impacts of straying. Some interview participants expressed that they felt the results were too premature to draw any significant conclusions and had preferred that the results only be released upon completion of the study. For others, the findings added fuel to their concerns about hatchery-wild salmon interactions.

5.3 Science-based Management

The value of science-based management linked to the prioritization of wild stock maintenance over hatchery salmon production was a key theme that arose in most interviews. Participants across stakeholder groups emphasized the value of data-driven management decisions and

frequently linked the sustainability of hatchery runs and concerns about wild-hatchery interactions by pointing to ADF&G studies and reports. When discussing scientific and social critiques and concerns about Alaska's hatchery production, some participants linked their potential opinion to scientific outcomes saying that they 'would wait until further scientific reports come out' before reaching a decision to support or condemn hatchery production. As one participant described:

"I guess I would want to know what the science is. That does concern me. I think there needs to be a push in that direction, let's try to find out what's going on." (Participant 18, 2019)

Other participants criticized the notion of waiting for evidence, citing concerns about the slow production of empirical data related to hatchery outcomes and possible conflicts of interest between producers of scientific knowledge and the economic drivers behind the hatchery fish. One participant expressed discontent with the lack of ongoing long-term research, saying:

"This should be people's careers, not a project of 50 they complete in 25 years of fisheries biology." (Participant 15, 2019)

Limited funds coupled with shifting political regimes and research priorities remain a challenge long term data collection.

5.4 Social and Cultural Values

Most stakeholders identified that hatcheries provide numerous positive social effects, such as cultural identity, providing opportunities and facilities for research and education, and economically sustaining some coastal community's existence. Participants expressed appreciation for commercial fisheries management that have supported their lifestyle.

"We shoot ourselves in the foot if we screw up the biology and we lose the fishery...socially, economically, culturally. You can look over the bluff right now and see a bunch of college students and family and kids [fishing], learning the work ethic and working together to accomplish a goal and it's a pretty unique way of life. If the biology slips and we screw things up, that goes away." (Participant 18, 2019)

Fishermen interviewed expressed interest in keeping the salmon economy healthy, signifying that the salmon resource itself needed to be kept healthy and robust. Many fishermen further articulated that they would be the first to express concern if they saw negative environmental

impacts due to hatchery fish. As a result of criticisms to ecological concerns, some hatcheries have made efforts to reach out to the public through educational activities, social media, and publications to educate the public on their efforts and raise awareness that some popular personal use fisheries, such as the China Poot dipnet fishery in Kachemak Bay, are the result of stocking efforts. When discussing value hatcheries provide beyond pure economic gain, several participants expressed that there are not adequate metrics to fully embody the spectrum of values. Some stakeholders find hatcheries to clash against other important socio-cultural values, such as scenic areas. When discussing net pens in Tutka bay, one participant critiqued such pens by commenting that they ruined the scenic quality of the area as a well traversed recreational area located in a state park. As Kachemak Bay is a destination for tourists and locals alike, the value set on the pristine scenic area is high.

Another participant disagreed, stating,

“95% of [testimony] at least is about the way the individuals value the experience of fishing. And the Board of Fisheries takes all the time that they take because they try to embody some of that in regulation....and it’s far from perfect and it ends up being overly complicated...every effort is being made to include value-based decisions.”
(Participant 12, 2019)

5.5 Policy and Regulations

Current policies and regulatory language were crafted to address and minimize potential issues with hatchery-wild interactions and supplement wild stock productivity. Language embedded within the Alaska Salmon Hatchery and Enhancement Regulations Section 5 AAC 40.170 (2) states that regional planning teams review applications to determine if proposed hatcheries are compatible with the criteria of protecting naturally occurring stocks from *any adverse effects*. However, it is unclear how *adverse* is defined and what threshold of impact would be considered too significant and/or adverse for intervention. For this reason, some participants expressed discontent with policy implementation stating that:

“If hatchery production is hurting wild fish, then you’re out of line with your statutes. You’re not following the law...either follow the rules or update them so they make more sense.” (Participant 27, 2019)

As research seeks to understand hatchery wild interactions, ecological concerns aired such as hatchery stray rates and genetic introgression have brought policy and legislative language under critique. Further regulations state that hatcheries must contribute to common property fisheries (5 AAC 40.860(3)) while avoiding significant negative impacts to wild stocks (5 AAC 40.860(4)). If there are seemingly adverse impacts uncovered from ongoing recent studies, no policy or regulations are currently put in place to influence action as expressed in an interview:

“Having a broad palette of ‘if this, then these are things we would consider.’ If folks can lay their cards on the table and get out in front of it [research findings] before we get to see what the data means and then decide whether it means anything or not. Tie[ing] the research to the policy decisions beforehand would be ideal.” (Participant 8, 2019)

5.6 Uncertainty and Change

Despite policies perceived to be written with good intentions, uncertainty and nervousness around management and shifting power dynamics were expressed by all participants. Climate change was a key issue discussed in nearly every interview, with one participant articulating:

“Unfortunately, new research [ADF&G hatchery-wild study] is coming at a really inopportune time because everything in our lives is being overwhelmed by the changes in the climate. I question how stable any of our research is going to be as long as we're on this trajectory with the climate.” (Participant 2, 2019)

2019 was an unusually warm summer, setting the record for the hottest July documented in the state and stressing salmon, with mass mortalities as stream temperatures rose. Climate change, coastal urban and industrial development, invasive species, and habitat degradation all have impacts on marine ecosystems yielding complex and difficult-to-predict results. This complexity makes it difficult to attribute changes in wild salmon to a specific cause, natural or enhancement related further complicating research studies that aim to look at particular effects.

5.7 Why Now?

When speaking about the increased attention the debate has received and the cyclical nature of its popularity, Participant 2 (2019) relayed, *“I’ve been doing this my whole career and those [pro/anti- hatchery] camps have always been there.”* News articles, social media platforms,

opinion pieces, and public comments have exemplified the growing community's involvement around the use of hatcheries and critiques on decision making, raising the question 'why has this debate seemingly recently gained momentum?' Media content revealed that hatcheries are depicted and debated based on benefits they provide the community and their scientific and economic concerns. Outlets shared among the community seek to garner support and express industry views such as the newly formed platform *Salmon Hatcheries for Alaska* and popular opinion writers in Alaska's traditional print and online media. Comments submitted to the Board of Fish by the general public have fallen across the spectrum both in support and opposition to hatcheries, while various non-profits have also stepped inside the debate. Though people have strong opinions and want to participate in the conversation about hatcheries, it can be difficult due to a lack of clear information and the spread of misinformation. One participant stated their frustrations:

"People want to be involved but I understand its enormously time consuming. I mean the state has a lot of information available that is not easy to find, and is buried in papers." (Participant 5, 2019)

As external pressures such as climate change come to the forefront, timely research and policy discussions were expressed as essential to continuing successful fisheries management.

6 Discussion

An integrated perspective viewing humans as a part of nature is important for both science and successful management. Societies today depend on resources and services provided by the environment. The following section discusses the significance of research findings in relation to trade-offs, a recommended necessary step to strengthen resilience and reduce the vulnerabilities of both the ecosystems and communities. Research conclusions also further suggest the potential presence of a social-ecological trap, a concept linking social processes and ecosystem dynamics. The pressure and release model (PAR) will be presented to help understand the intersection between socio-economic pressures, the progression of vulnerability, and recommended action to enhance resilience.

6.1 Trade-Offs: A measure to strengthen resilience and reduce vulnerability

The Alaskan salmon enhancement program is intended to enhance wild stocks, provide increased harvest opportunities, and support economic development in coastal communities. Between natural fluctuations, experienced and anticipated climate change impacts, and shifting political regimes, uncertainty is certain. Referring to the concepts of vulnerability and resilience presented by Miller, F., et al. (2010), the results from this research suggest that addressing tradeoffs is essential to strengthen resilience of both communities and the wider ecosystem. Dialogues between stakeholders considering trade-offs should investigate whether one course of action is more justifiable over another, evaluating advantages and disadvantages to determine what are ‘acceptable’ outcomes. This may prove difficult as stakeholders may not share similar views on what is considered ‘acceptable’ or disagree on the path to achieve shared desirable outcomes. Some tradeoffs may include a reduction in the resilience of wild salmon or landscape changes because of potential effects with hatchery fish. Another tradeoff may include ecological effects such as competition between hatchery and wild salmon or other species. Participants themselves acknowledged the concept of tradeoffs; they recognized the ecological concerns raised in the debate tied to hatcheries, but simultaneously acknowledged the economic benefits hatchery runs provide. A place-based evaluation approach when assessing trade-offs is necessary. One participant explained this necessity by providing an example: there is a unanimous desire of stakeholders to prioritize and not interfere with wild runs, however, if habitat is available and criteria for stocking is in line with Alaska policy, would impacting (or possibly replacing) a small wild run for a strong hatchery run (which would have positive economic impacts) be a sufficient trade off?

The international release of 5.1 billion hatchery salmon fry annually from the US, Canada, Japan, Russia, and Korea would introduce significant pressures and unknown complexities into the ecosystems of the North Pacific and respective in-shore systems. Legislative history demonstrates attempts to limit hatchery-wild impacts through measures discussed in the ‘*ecological concerns*’ section. However, current management does not adequately address hatchery risks and potential subsequent action in the case that unacceptable ‘adverse’ effects are found from ongoing studies. Without hatcheries, the commercial salmon fishing industry could not exist at present levels. Participant 8 (2019) stated: “*The number one priority is to share the burden of conservation.*” In interviews, stakeholders expressed their trust in ADF&G’s transparency and prioritization of wild runs, awarding permits only after

concentrated examination by the department. If findings emergent from ongoing research suggest that adverse effects are happening, however ‘adverse’ may be defined, this research suggests that the Alaskan community is unprepared to deal with ramifications that urge hatcheries to ramp down production, or in an extreme case, shut down altogether, increasing vulnerability of communities and the ecosystem at large. Due to historical significance, financial investments, and positive economic outcomes hatcheries have supplied for the state, closure may be unlikely and a social ecological trap may be forming. Acknowledging that increased production potentially affects other species, including wild salmon, is imperative in discussion between stakeholders and policy makers.

6.2 Social-Ecological Traps: Feedbacks & Interactions

Livelihoods, cultural values, and economic power are aspects within the social-ecological system that underwrite complex statewide and global dependency on Alaskan hatchery produced salmon. After conducting a few interviews, a recurring theme of communities’ dependence and relationship with the current hatchery production volume became apparent. We discussed the relationship in the context of social-ecological traps with participants after the majority had alluded to it. When asked, participants recognized and some had agreed that the process of social ecological traps could be happening. Figure 1 shows the growth of the fishery, exemplifying a great shift in the ecological baseline from the 1970’s, the inception of the hatchery program, to today. The debate questioning hatcheries and their perceived problems has gained momentum from few influential voices that have encouraged a wider discussion concerning management. Communities have shifted baselines along with the ecosystem, growing with and because of each other. The exponential expansion of the fishery coupled with fluctuating abundance in salmon return years, has resonating social impacts readily noticed by research participants and throughout communities. As salmon release numbers and stocking programs have grown (now leveling off in the past few years), social influences have ramped up along with it. One participant stated:

“On a good fishing year versus a bad fishing year you can see it go through the whole economy. You can see [people] have houses built or they don’t have houses built. They buy a new truck or they don’t buy new trucks. It totally affects me as a parent. If I have to struggle and make money [during the winter], I can’t help out volunteering at the school [or] whatever it is.” (Participant 5, 2019)

Fishermen dependent on where they were fishing, alluded to linking their financial decisions with hatcheries in mind. Many coastal communities have invested heavily in their fishing fleets, and individuals have taken out substantial loans. Some participants were concerned that there was a dependence that had been built around returning hatchery fish. In certain areas, suggestions arose that fleets were overcapitalized and debt was extensive among fishermen and women from continual investment pressure to keep up or improve catch capacities. When faced with the hypothetical question of hatchery closure, participants stated that it had the potential to be a disaster, stagnating the economy for no longer being able to support ongoing operations and livelihood's for crew members and the wider community. Alaskans strong cultural identity and the fisheries economic success make it difficult to ramp production down as Participant 8 states:

“I would rather disappoint everybody in a way they can accept than have somebody that sees particular pain. That’s the challenge. Nobody wants their neighbors to hurt, so hopefully we can find good solutions.” (2019)

Social-ecological traps are difficult to escape and incremental change is not sufficient. Climate change may aggravate the trap as its effect's manifests in unknown ways and often lag. The multimillion-dollar industry is tied to the global market and individual and family's livelihoods. Navigating away from this potential social-ecological trap will necessitate a discussion of trade-offs, cooperation, and a governance structure that can maintain ecological functions at multiple scales and incorporate stakeholders cultural, economic, and societal values.

6.3 PAR: Using the pressure and release model to understand vulnerability

Trade-offs and social-ecological traps are both key components exhibited in the PAR model (Figure 7). The PAR model lays a series of steps that come together to produce what is described as the ‘progression of vulnerability.’ High reliance on the fishery economy and growth-oriented development ideologies have shifted ecological baselines into unsafe conditions (such as a social-ecological trap). This PAR model suggests that if research results from studies that force policy change to significantly change hatchery releases or lead to political upheaval, dramatic shifts in livelihood's and ecosystem dynamics may occur. Root causes and dynamic pressures are reasonably well understood, though addressing them is

highly political. Proposal 22 (Alaska Department of Fish and Game, 2019c), submitted to the BOF for the December 2019 meeting expresses the need for the BOF to establish a cap or limit on the percentage of returning fish that a hatchery may harvest for cost recovery. The proposal reasons that a limit is necessary to eliminate unintended consequences of hatcheries over producing pink salmon to fulfill their revenue targets and overall statutory goal of hatcheries. Pressures such as potential negative hatchery-wild interactions and climate change, can increase hazard risk and decrease resilience.

Successful preventative measures require political mobilization at the state level. It's often easier to mobilize action following the aftermath of a disaster when awareness is high and political payoff is significant for enacting change. However, with delayed effects from climate change and uncertain futures, mobilization is difficult and political processes long. Effects of climate change may have complex and evolving repercussions to intensify vulnerabilities.

The PAR model provides a broad view of vulnerability and a framework for looking at relationships between vulnerability and potential disasters. A limitation however, is that it is a tool for explaining vulnerability but not for measuring it. Stakeholders have diverse perceptions and attitudes regarding the social and ecological impacts of Alaskan salmon hatcheries. Those attitudes and perceptions shaped by values and concerns are further complicated by issues not yet adequately addressed such as trade-offs. The involvement of key actors in the ongoing debate has mobilized action such as the recently launched studies.

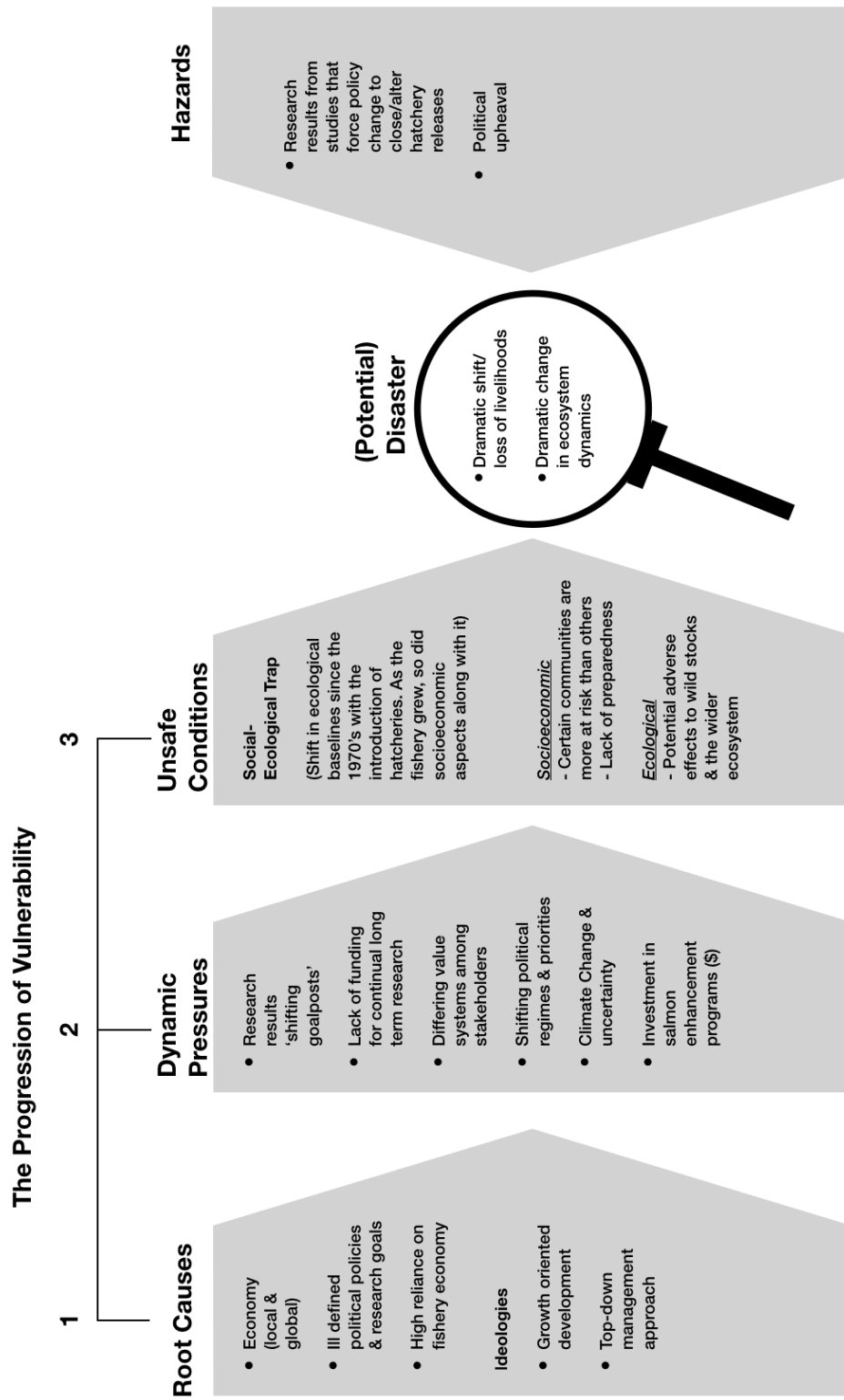


Figure 7 PAR Model B (adapted from Wisner, B. et al. 2004)

7 Conclusion

Salmon are a cultural icon, ecological pillar and economic driver. Hatchery programs provide value to communities well beyond the economic components. Presently, there seems to be a search for an analytical solution to a value-based problem. This study examined how stakeholders interact and perceive the Alaskan Salmon Enhancement program, and did not analyze successes or failures or judge actions. Research findings suggested that a discussion of trade-offs is necessary to address risks and benefits aired in an ongoing public media debate. The PAR model was utilized to frame a progression of vulnerability to a possible social-ecological trap. Further research could be undertaken to expand on these complex issues as addressing them involves a delicate negotiation of relevant ongoing scientific research and stakeholder values.

8 References

- Alaska Department of Fish and Game (s.a). *Southcentral - Sport Fishing Information, Alaska Department of Fish and Game*. Available at:
<https://www.adfg.alaska.gov/index.cfm?adfg=SportByAreaSouthcentral.main>
(accessed: 3.12. 2019).
- Alaska Department of Fish and Game (2019a) *Public Comments Submitted* Available at:
<http://www.adfg.alaska.gov/static/regulations/regprocess/fisheriesboard/pdfs/2018-2019/hc/pcs1-60.pdf> (accessed: 5.07.2019).
- Alaska Department of Fish and Game (2019b) *Public Comments Submitted* Available at:
<http://www.adfg.alaska.gov/static/regulations/regprocess/fisheriesboard/pdfs/2018-2019/hc/pcs61-122.pdf> (accessed: 5.07.2019).
- Alaska Department of Fish and Game (2019c) *Proposal 22 submitted* Available at:
<http://www.adfg.alaska.gov/static/regulations/regprocess/fisheriesboard/pdfs/2019-2020/proposals/22.pdf> (accessed: 1.12.2019).
- Alaska Department of Fish and Game (2019d) *Welcome to the Alaska Board of Fisheries* Available at: <http://www.adfg.alaska.gov/index.cfm?adfg=fisheriesboard.main> (accessed: 21.11.2019).
- Berg, B. L. & Lune, H. (ed.). (2012). *Qualitative Research Methods for the Social Sciences*. 8th ed. Boston: Pearson
- Berkes, F., & Folke, C. (1998) *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience*. Cambridge Univ Press, New York.
- Brink, H. (1993) Validity and reliability in qualitative research. *Curationis*, 16(2).doi:10.4102/curationis.v16i2.1396

Bryman, A. (2015) *Social Research Methods* - 5th Edition. 5th ed. Oxford: OXFORD University Press

Bolton, A. (2018) *Hatchery debate wages on as research continues* - *Alaska Public Media*. *Alaska Public Media*. Available at: <https://www.alaskapublic.org/2018/07/12/hatchery-debate-wages-on-as-research-continues/> (accessed: 28.11. 2019).

Boonstra, W. & De Boer, F. (2013). The Historical Dynamics of Social–Ecological Traps. *AMBIO*, 43(3), pp.260-274. doi:10.1007/s13280-013-0419-1

Burney & Hussain (2008) *Inductive and Deductive Research Approach*. doi:10.13140/RG.2.2.31603.58406

Chaput, G., Knight, P., Russell, I., Sivertsen, A., Hutchinson, P. & Forero Segovia, S. L. (2017) Understanding the risks and benefits of hatchery and stocking activities to wild Atlantic salmon populations. *Report of a Theme-based Special Session of the Council of NASCO*. NASCO Council document CNL (17)61. 116pp

Charmaz, K. & Belgrave, L. (2015). Grounded Theory. *The Blackwell Encyclopedia of Sociology*. doi:10.1002/9781405165518.wbeosg070.pub2

Corbin, J., & Strauss, A. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative sociology*, 13(1), 3–21. doi:10.1007/BF00988593

Diener, E., & Crandall, R. (1978) *Ethics in social and behavioral research*. Chicago: University of Chicago Press.

Evenson, D. F., C. Habicht, M. Stopha, A. R. Munro, T. R. Meyers, and W. D. Templin. 2018. Salmon hatcheries in

Alaska – A review of the implementation of plans, permits, and policies designed to provide protection for wild stocks. *Alaska Department of Fish and Game*, Special Publication No. 18-12, Anchorage

- Glaser, B. G. (1998) *Doing Grounded Theory: Issues and Discussion*. Mill Valley: Sociology Press.
- Glaser, B. G. & Strauss, A. (1967) *The Discovery of Grounded Theory; Strategies for Qualitative Research*. New York, NY: Aldine De Gruyter.
- Guides.library.duke (2019) *Qualitative Research Methods: A Data Collector's Field Guide*. Available at: https://guides.library.duke.edu/ld.php?content_id=11691400 (accessed: 12.07.2019)
- Hare, S. R., & R. C. Francis. (1994) Climate change and salmon production in the northeast Pacific Ocean, *Canadian Special Publication Fisheries and Aquatic Science*. 121 p. 357-372
- Lescak EA, Shedd KR, Dann TH. (2019). North Pacific Research Board Final Report: Relative productivity of hatchery pink salmon in a natural stream. *NPRB Project 1619 Final report*. 46 pp. Available at: http://146.63.61.200/static/fishing/PDFs/hatcheries/research/2016_nprb_final_report.pdf (accessed: 12.08.2019)
- Marshall, M. N. (1996) *The key informant technique*. *Family Practice*, 13(1), 92–97
- Mcdowellgroup (2018) *Economic Impacts of Alaska's Salmon Hatcheries*. [online] Available at: <https://www.mcdowellgroup.net/wp-content/uploads/2018/10/economic-impact-of-alaskas-salmon-hatcheries.pdf> (accessed: 15.07.2019)
- Miller, K.A. (2000). Pacific Salmon Fisheries: Climate, Information and Adaptation in a Conflict-Ridden Context. *Societal Adaptation to Climate Variability and Change*, pp.37-61. doi:10.1007/978-94-017-3010-5_4
- Naish, K., Taylor, J., Levin, P., Quinn, T., Winton, J., Huppert, D. and Hilborn, R. (2007). An Evaluation of the Effects of Conservation and Fishery Enhancement Hatcheries on Wild Populations of Salmon. *Advances in Marine Biology*, pp.61-194. doi: 10.1016/S0065-2881(07)53002-6

- Northwest Fisheries Science Center. (s.a) *Pacific Decadal Oscillation (PDO) - Northwest Fisheries Science Center*. [online] Available at:
<https://www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/ca-pdo.cfm> (accessed: 8.10.2019)
- Pacific Salmon Foundation (s.a) *Species & Lifecycle* [online] Available at:
<https://www.psf.ca/learn/species-lifecycle> (accessed 12.11.2019)
- Proag, V. (2014). The Concept of Vulnerability and Resilience. *Procedia Economics and Finance*, 18, pp.369-376. doi:10.1016/S2212-5671(14)00952-6
- Saldaña, J. (2016) *The coding manual for qualitative researchers*. Thousand Oaks, CA: Sage.
- Salmon Hatcheries for Alaska. (s.a). *Hatchery FAQ's — Salmon Hatcheries for Alaska*. [online] Available at: <https://www.salmonhatcheriesforak.org/hatchery-faqs> (accessed 05.11. 2019)
- Stopha, M. (2013) Recent trends in Alaska salmon value and implications for hatchery production. *Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 5J13-09*, Anchorage. [online] Available at:
<http://www.adfg.alaska.gov/FedAidPDFs/RIR.5J.2013.09.pdf> (accessed 15.07.2019)
- Stopha, M. (2019) Alaska salmon fisheries enhancement annual report 2018. *Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 5J19-01*, Juneau. [online] Available at:
<http://www.adfg.alaska.gov/FedAidPDFs/RIR.5J.2019.01.pdf> (accessed 15.07.2019)
- Sisk, J. (2007). The Southeastern Alaska Salmon Industry: Historical Overview and Current Status. *Conservationgateway* [online] Available at:
https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/alaska/seak/era/cfm/Documents/9.5_SalmonIndustry.pdf z (accessed 01.12. 2019)

Stockholmresilience (s.a). Insight #5 Social-ecological traps. *Stockholm Resilience Centre*.
[online] Available at: <https://www.stockholmresilience.org/research/insights/2016-11-16-insight-5-social-ecological-traps.html> (accessed 28.08. 2019)

UNESCO (2005) The Precautionary Principle: World Commission on the Ethics of Scientific Knowledge and Technology. COMEST [online] Available at:
<https://unesdoc.unesco.org/ark:/48223/pf0000139> [Accessed December 10, 2019]

Wisner, B., Blaikie, P.M., Cannon, T., Davis, I. (2004) *At Risk: Natural Hazards, people's Vulnerability and Disasters*, second ed. Routledge, London.

APPENDIX

A. Semi-Structured Interview Guide

Semi-Structured Interview Guide:

The introduction in every interview with the various stakeholder groups was the same, however, the depth and topics of the interviews differed between the different stakeholders.

Introduction:

- Introduce myself & the research project
- Go through consent forms
 - (right to withdraw, all data will be anonymized/confidential)
- Ask for permission to audio record interview

Questions:

Fishermen/Fisherwomen (topics)

- Full name + title
- Background on how they came into the industry/position
- Views on current/past fisheries management
- Climate change
- Changes observed over career

Organizations (topics)

- Full name + title
- Overview of projects
- Goals of organization
- Views on current/past fisheries management
- Organizations support base
- Methods of communication
- Climate change
- Changes observed over career

Hatcheries (topics)

- Full name + title
- Overview of projects
- Goals of organization
- What they do and what they work with
- How does production work

- Achievements & challenges
- Communication platforms
- Views on current/past management
- Climate change
- Changes observed over career
- Self-assess own approach
 - a. Do you regard it as the most promising solution in terms of managing salmon as a resource?
 - b. Do you see any flaws in your current approach? What are they?
 - c. How would those flaws be fixed?

Governmental Entities (topics)

- Full name + title
- Overview of projects
- Goals of organization
- Views on current/past fisheries management
- Organizations support base – structure of power
- Methods of communication
- Climate change
- Changes observed over career

Wrap Up:

- Thank you for your time
- Snowball sampling – ask for recommendations of other people that might be beneficial to speak with

Day After:

- Send thank you / follow up e-mail

B. Interview Consent Form

Request for participation in research project

“Stewarding the Salmosphere: A comparative case study investigating the varying approaches of salmon management in Alaska & Norway” *

Below please find information about the goals of this research project and what participation means for you.

Purpose

My name is Julie Gould and I am a student at the Norwegian University of Life Sciences. I am doing a Master of Science in International Environmental Studies, and as part of my degree I will be writing a master’s thesis. The purpose of a master’s thesis is for the student to conduct an independent study of a topic of their choice. This consists of investigating a research question(s) and producing a written paper where it is discussed and answered.

I aim to investigate and compare salmon management and conservation issues and approaches in southcentral Alaska and northern Norway. The goal of this research is to gain a deeper understanding of the various approaches to salmon conservation and utilization while exploring their impacts on coastal communities.

Responsible for the research project

Norwegian University of Life Sciences, Student: Julie Gould

Why have you been asked to participate?

You have been asked to participate because of your expertise, experience, and passion for salmon and resource management.

What does it mean for you to participate?

If you choose to participate in the project, you will be consenting to an interview that will take approximately 1-2 hours. The interview may be sound recorded with your permission. If you are not comfortable and do not want to be recorded, I will not sound record the interview. You also acknowledge that any information you provide, including your opinions, thoughts, and experiences, may be used anonymously in peer-reviewed publications in the future.

Participation is *voluntary*

It is voluntary to participate in this project. You will remain anonymous throughout and after the entire study. If you choose to participate, you can withdraw your consent at any time without giving any reason. It will not have any negative consequences for you if you to withdraw prior to submission.

Your privacy - how we store and use your information

Only the researchers involved will have access to personal information. Information you provide including but not limited to audio, written materials, photographs, etc. will be coded and kept securely to ensure full anonymity. Any identifying information used in this study will be anonymized prior to publication. Information about participants will not be used in a

* After midway evaluation during fieldwork and consultation with my supervisors, we agreed upon focusing the thesis solely on Alaska

way that is identifying to the participant unless explicit, written permission is granted by the participant.

What happens to your information when we finish the research project?

The research project is scheduled to finish on the 15th of Dec 2019. After this the personal information about each participant and all sound files from interviews will be deleted.

Where can I find out more?

If you have questions about the study or wish to avail yourself of your rights, please contact: Norwegian University of Life Sciences. Julie Gould (julie.susanne.gronsleth.gould@nmbu.no)

Your help and participation is greatly appreciated!

Kind regards,
Julie Gould

Declaration of consent

I have received and understood information about the project « *Stewarding the Salmosphere: A comparative case study investigating the varying approaches of salmon management in Alaska & Norway* » and have had the opportunity to ask questions. I agree to:

To participate in interview

(Printed name of participant, date)

(Signed by participant, date)

C. Egg & Milt Collection



Figure 8 Cleaning broodstock females before egg-take



Figure 9 Eggs collected from 1 female Sockeye salmon



Figure 12 Milt collected from 1 male Sockeye salmon



Figure 10 Collecting eggs from 1 female pink salmon



Figure 11 Quality control: picking through dead eggs

D. Otolith Removal



Figure 13 Otolith ear bones



Figure 14 Otolith removal

E. Pacific Salmon



Figure 15 Pink Salmon congregating before egg take at a hatchery



Figure 16 A pair of Sockeye salmon spawning



Norges miljø- og biovitenskapelige universitet
Noregs miljø- og biovitenskapelige universitet
Norwegian University of Life Sciences

Postboks 5003
NO-1432 Ås
Norway