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Exploring Community Knowledge and Perceptions of Flooding and Sea-Level Rise in King Salmon, California

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EXPLORING COMMUNITY KNOWLEDGE AND PERCEPTIONS OF FLOODING AND SEA-LEVEL RISE IN KING SALMON, CALIFORNIA

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ABSTRACT

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The coastal community of King Salmon, California could be at the highest risk of relative sea-level rise on the entire U.S. West Coast. In 2019, the community already experiences severe flooding at least annually and may be regularly inundated as early as 2050. Until this study, there had been no documented effort to reach out to the community to show them future sea-level rise projections, understand the context of life in King Salmon, and listen to their reactions and perceptions. This research utilized a mixed methods grounded theory approach integrating semi-structured interviews with King Salmon stakeholders, qualitative data analysis, public workshop observation, GIS analysis, and archival research to understand the community's perceptions of and vulnerability to flooding and sea-level rise, explore their local ecological knowledge, determine their sense of place, and identify their preferred adaptation strategies.

The data demonstrate that King Salmon is a community that has coexisted with flooding for a long time. Many residents reported a perceived increase in flooding over time. Most respondents feel emotionally connected to King Salmon as a place, demonstrating a sense of place. Most community members acknowledged future sea-

level rise, but expressed hope that they could stay in their homes until they died and before more severe future flooding. A majority of the respondents belonged to an aging population group, which may explain this viewpoint. Because most community members indicated a preference to stay and adapt, King Salmon may benefit from looking to other adapting communities worldwide for inspiration. Rolling easements are a potential adaptation strategy that considers the generational component. No matter the adaptation strategy selected, the community must be centered in the discussion. The community of King Salmon faces many challenges, but also presents an opportunity to be a model community for sea-level rise adaptation.

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1.0 INTRODUCTION

King Salmon, a small coastal community on Humboldt Bay in northern California, is likely the most vulnerable to sea-level rise (SLR) on the entire United States (U.S.) west coast (Russell and Griggs 2012b; J. K. Anderson, Laird, and Patton 2017; Laird 2018c; OPC Working Committee 2018). Until now, research in this community has focused on developing SLR projections and vulnerability assessments, but has not included any contact with the community to learn their perceptions of SLR. Historically, government agencies have tended to create top-down climate policy measures that overlook social science contributions, which can create conflict and resistance from communities when implemented (Kythreotis et al. 2019). Incorporating social science methods by listening to and engaging stakeholders affected by adaptation policy creates a pathway for identifying critical social impacts prior to policy implementation. This thesis explores the King Salmon community's local ecological knowledge and perceptions of historical flooding and future SLR, seeks to understand the context of life in King Salmon, and recommends individualized adaptation strategies for this community at risk.

Global SLR is a consequence of anthropogenic climate change (IPCC 2014; 2018). Localized SLR projections vary drastically, and Humboldt County in Northern California is projected to experience the fastest rate of relative SLR on the entire U.S. West Coast. Actual SLR, and likely also community perceptions of SLR, are based on "relative" SLR, which includes vertical land motion caused by local land subsidence due

to tectonic activity. In the Humboldt Bay, vertical land motion is most active in the south (J. K. Anderson 2018). The community of King Salmon is among the lowest-lying and southernmost residential communities on Humboldt Bay and is therefore likely at the highest risk (Laird 2018c).

King Salmon is a small community and former fishing village situated on the Humboldt Bay, approximately 100 miles south of the Oregon border and 270 miles north of San Francisco. Satellite images of King Salmon are displayed in Figure 1 and Figure 2. King Salmon has 190 residential and commercial parcels covering 176 acres (Humboldt County 2018). This community has experienced a tumultuous history of flooding and erosion now compounded by the threat of SLR. In addition to water intruding from the bay, King Salmon also already regularly experiences flooding from rising groundwater with changing tides and storm surges. The community is at a disadvantage because approximately 72% of residents in King Salmon meet the federal definition of economically disadvantaged (U.S. Census Bureau 2017). It is further disenfranchised because it is a small, unincorporated settlement in a rural county and holds little political power. SLR will likely be a threat multiplier in King Salmon, aggravating existing conditions.

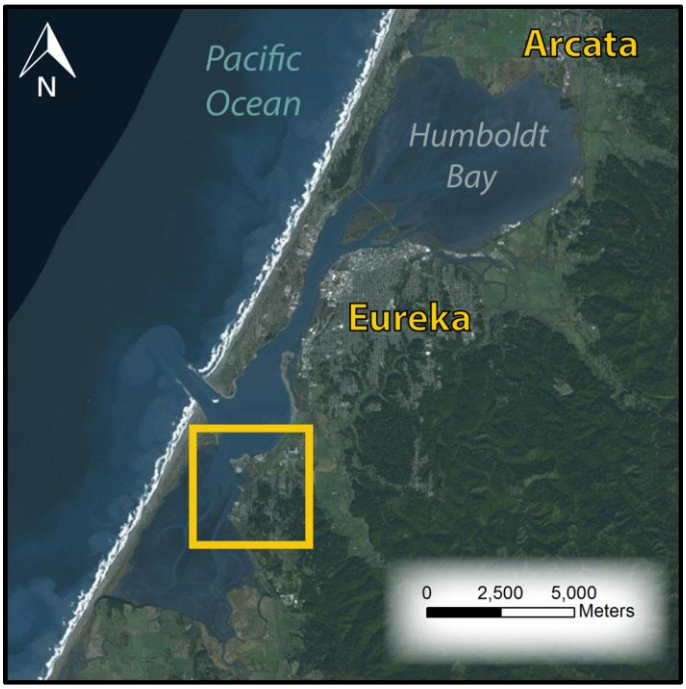


Figure 1: Location of King Salmon, California. Image generated by author.

Figure 2: Community of King Salmon at Mean Monthly Maximum Water (MMMW) at a baseline year of 2000. Image generated by author.

The average elevation in King Salmon in 2019 is approximately 0.9 meters. From 1900 to 1999, the tide gauge nearest King Salmon (the North Spit tide gauge) recorded 4.73 mm per year of SLR (Figure 3) (Russell and Griggs 2012b), the highest value recorded in California and nearly three times the global average of 1.7 mm/year (IPCC 2014). Future projections of SLR in King Salmon are estimated to be at least 33% higher than the global mean of 0.52-0.75 meters (IPCC 2014) by 2100, ranging from 1-2 meters (Russell and Griggs 2012a) to peak forecasts exceeding 3.3 meters (OPC Working Committee 2018). There is a 66% probability that SLR in King Salmon increases 0.2 meters by 2030, 0.3 – 0.5 meters by 2050, and 0.5 – 1.2 meters by 2100 above the 2000 level (OPC Working Committee 2018). Worst case SLR scenarios for King Salmon reach 0.4, 0.9, and 3.3 meters for 2030, 2050, and 2100 (OPC Working Committee 2018). It is possible that the majority of the community, including the only access road, will be significantly impacted by ocean water on a monthly basis by 2050. The people of King Salmon will ultimately need to adapt to rising waters.

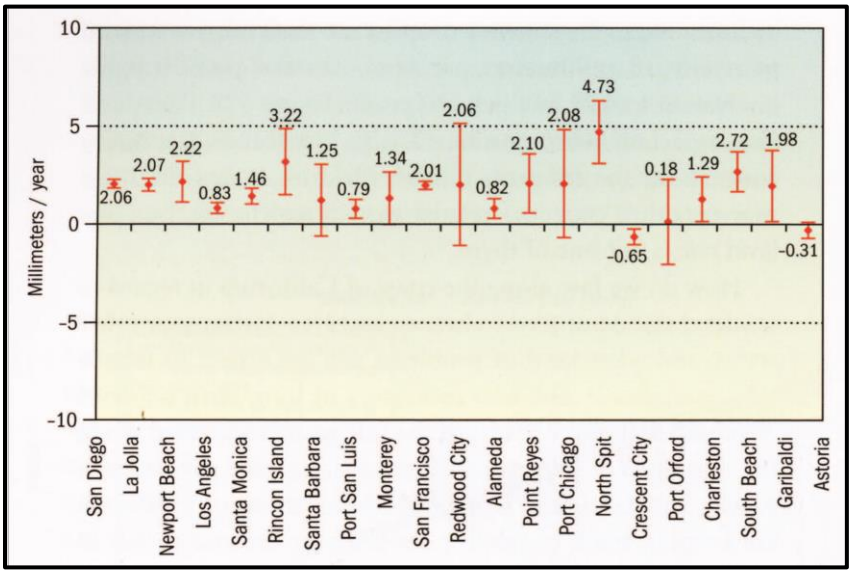


Figure 3: Local sea level rise rates along the coast of California and Oregon from 1990 – 1999, including North Spit in Humboldt County at 4.73 mm/year (Russell and Griggs 2012b).

This research utilized a mixed methods grounded theory approach. I conducted 14 interviews with 17 King Salmon stakeholders, attended and supported one public workshop with community members from King Salmon, performed qualitative analysis, and conducted archival and document review in order to address the following research questions. The primary research question of this study is: How do members of the King Salmon community perceive flooding and sea-level rise and what is their local ecological knowledge of historical and current flooding?

Additional questions of interest include:

1) What is the community's sense of place?

2) How does the community want to adapt to flooding and sea-level rise?

3) Does a belief in anthropogenic climate change have an effect on preferred adaptation responses?

4) How does the community react when they are shown maps projecting future sea- level rise?

2.0 LITERATURE REVIEW

A recent IPCC (2018) special report concludes that even an achievement of net zero anthropogenic emissions today will not stop the future impacts of global climate change. Consequently, alongside emissions mitigation, we need to focus on adapting to climate change's results. The community of King Salmon, along with communities worldwide, needs to plan for rising seas. Each community has its own individual geography, populations, and culture, leading to a substantial variation of appropriate adaptation options. To address SLR in King Salmon, it is important to review the existing literature on adaptation planning efforts.

Numerous studies have recognized the importance of social science in SLR adaptation planning and in using multi-faceted, interdisciplinary approaches when analyzing SLR vulnerability. Agrawal et al. contend that social scientists are "actively reframing and advancing how we think about and analyze climate change" (2012, p. 329). Impacts of potential climate change adaptation policies to individual communities can be identified through a social science lens.

Much of the adaptation implementation and relocation literature and discussion is either post-disaster, involving communities who acknowledge the changes that are occurring and seek respite, or involving abandonment of property with little to no residential development. A notable gap exists in the research with vulnerable coastal communities within a slow-moving, predictable pre-disaster framework. A search of the literature revealed five key subfields covered in the following sections: Adaptive

Capacity, Sense of Place and Adaptation, Socioeconomic Disparities, Adaptation Planning Efforts, and SLR Planning in California.

2.1 Adaptive Capacity

The term "adaptive capacity" grew from systems theory and resilience theory developed by Holling (1973), and is defined as the "adaptability of an affected system, region, or community to cope with the impacts and risks of climate change" (Smit et al. 2001 p. 879). Scholars show that a community's adaptive capacity is strengthened by its collective cohesion (Grothmann and Patt 2005; Adger 2003; Hess, Malilay, and Parkinson 2008). Communities with the ability to adapt to change are said to have strong adaptive capacity. Adaptive capacity in response to SLR is directly related to the community's access to resources and their ability to "act collectively in the face of the threats posed by climate variability and change" (Adger 2003, p. 29). Perception and awareness of risk is a major factor in determining the motivation to adapt (Grothmann and Patt 2005). This suggests that a community unaware of its SLR risk is likely to have weak adaptive capacity and may not be driven to implement adaptation measures. Communities can also have objective adaptive capacity, but be unwilling to adapt (Grothmann and Patt 2005). For example, religious communities in Bangladesh consider natural disasters to be acts of God and believe that adaptation or even temporary evacuation in the face of a disaster is against God's will (Schmuck 2000). Skepticism and ignorance of climate change implications can also lead to reduced adaptive capacity

(Barton 2013). The literature suggests that to build strong adaptive capacity to SLR, a community must be both aware of the threat and willing to adapt. Adaptive capacity becomes essential in the face of vulnerability. The community of King Salmon is particularly vulnerable to SLR, facing the highest risk on the U.S. West Coast (J. K. Anderson, Laird, and Patton 2017), suggesting that measuring and building adaptive capacity in King Salmon is crucial.

2.2 Sense of Place and Adaptation

Adaptation decisions can be influenced by a connection to place or "sense of place", which is commonly cited and defined in the literature as "the meaning attached to a spatial setting by a person or group" (Jorgensen and Stedman 2001, p. 233). Other authors suggest similar definitions including feeling like an "insider" and a desire to remain in their place (Hay 1998) or the important bonding between a person and their place (Low and Altman 1992; Giuliani 2017). Climate change induced SLR and flooding in coastal areas are expected to challenge these existing complex human relationships with place (Hess, Malilay, and Parkinson 2008). In extreme scenarios, there is a potential for place relationships to be permanently disrupted if the physical environment is no longer livable, forcing retreat.

Numerous studies have considered the relationship between climate change adaptation and the concept of sense of place. One study found that coastal New Zealand residents were emotionally attached to their place, making them less likely to be

interested in retreat as an SLR adaptation option (Evans, Milfont, and Lawrence 2014). Coastal residents may be so attached to their place and familiar with past flooding that they do not imagine future increased flooding as a threat (Fincher, Barnett, and Graham 2015). Through in-depth qualitative interviews with Florida fisherman, Stoltz (2018) found that perceptions of SLR adaptation scenarios were more connected to their community relationships than to actual SLR risk. As climate change physically disrupts the global landscape, sense of place can be altered and weakened (Cunsolo Willox et al. 2012). Increased flooding incidents in coastal communities like King Salmon could disconnect the community and weaken residents' sense of place. Sense of place may also affect King Salmon residents' perceptions of SLR and potential adaptation options.

2.3 Socioeconomic Disparities

Previous studies overwhelmingly find that populations with limited access to resources are disproportionately affected by natural disasters. Overall, low-income populations are more likely to live in hazard-prone regions and have less resources to react to and prepare for disasters (Hessel C. Winsemius et al. 2015; Collins et al. 2019; Qiang 2019), increasing the risk that they will be affected by natural disasters. For example, both Hurricane Katrina and Hurricane Harvey were found to disproportionately affect poor and minority populations and have longer term negative impacts on resilience after disasters (Masozera, Bailey, and Kerchner 2007; Nataria, Matthews, and Myers 2014; Collins et al. 2019). However, results are mixed when identifying socioeconomic

disparities in flood-prone areas, because in general, coastal properties are likely to be owned by wealthier populations in the United States (Collins et al. 2019; Qiang 2019). One exception is in the Sacramento Delta, where Burton and Cutter (2008) found disproportionate threats of levee failures and therefore an increased threat of flooding to socially vulnerable populations. King Salmon is another exception, where approximately 72% of residents meet the federal definition of economically disadvantaged (U.S. Census Bureau 2017). Additionally, King Salmon is one of only a few Humboldt County communities providing a supply of the County's stock of affordable housing (Weinreb 2019).

2.4 Adaptation Planning Efforts

Adaptation refers to avoiding damage by making society more resilient to climate change (Hof et al. 2014). Coastal planning adaptation is generally divided in the literature into three distinct categories: hard stabilization or armoring, soft stabilization, and managed retreat (Dyckman, St. John, and London 2014), or more straightforwardly: protect, accommodate, or retreat (Nicholls 2011). Hard stabilization includes major physical defenses like seawalls, jetties, and revetments (Dyckman, St. John, and London 2014; Pittock 2010). Soft stabilization strategies include beach nourishment, vegetation, and building up sand dunes (Snoussi, Ouchani, and Niazi 2008; Feagin et al. 2010; Heberger et al. 2011). Managed retreat incorporates the physical abandonment of property and relocation, including property buyouts, but also involves zoning regulations

like fixed setbacks (Dyckman, St. John, and London 2014). Coastal communities worldwide will need to choose one, or more likely a combination of these strategies to protect themselves from rising seas. Research indicates that geographically isolated, outlying coastal communities like King Salmon face even more challenges than urban populated regions when preparing for sea-level rise, primarily due to resource allocations but also due to common top-down policy decision-making (Muir, Cooper, and Pétursdóttir 2014).

2.4.1 Hard Stabilization Efforts – "Protect"

Building seawalls to obstruct rising waters is generally considered the most extreme and expensive form of sea-level rise adaptation, satisfying short-term threats, but likely to be environmentally detrimental in the long run (Muir, Cooper, and Pétursdóttir 2014). Beatley et. al (2002) argue that building up structures like levees or seawalls to protect against SLR, storms, and flooding actually creates more hazardous conditions, encouraging development and therefore putting more lives and infrastructure at risk. Even still, many communities worldwide plan to protect themselves from rising waters with seawalls. If the economic value or the critical nature of the property or assets is high, this is an understandably appealing option.

New York plans to spend $10 billion on a plan to protect the city, including a massive seawall (City of New York 2013). After Hurricane Katrina, the U.S. Army Corps spent $14 billion on a series of levees and seawalls to protect New Orleans, but only one year after completing the project, they believe the system may fail within four years

(Department of the Army, U.S. and Army Corps of Engineers 2019). Venice, Italy spent $6.3 billion and sixteen years building a one-mile long seawall that is still unfinished in 2019, and is already deteriorating (Bendix 2018). Plus, that massive and expensive seawall in Venice was unable to protect the city from the second worst flooding event of all time in November 2019, resulting in at least two deaths (Povoledo 2019).

A less extreme form of hard stabilization is strengthening existing structures. This can include installing moisture barriers, building retaining walls around existing properties, or even elevating homes. Sahin et. al. (2013) found this to be a preferred option among coastal residents in Australia, ranked higher than retreating, perhaps because these coastal residents are attached to their place. Improving existing buildings is likely a popular response because it acknowledges SLR while allowing residents to maintain their current living style and not relocate (Sahin et al. 2013). It is important to note that in the same study, the least preferred option was to take no action at all, which may have a financial motive in that no action implies abandoning their residential investment.

Humboldt County currently uses hard stabilization measures to block rising waters in King Salmon and other communities along the Humboldt Bay. Seventy-seven miles of Humboldt Bay's shoreline are artificial, composed of earthen dikes and railroad grade composed in the 1800s to convert the historical bay into agricultural acreage and residential property (Laird 2015). However, these dikes are managed by individual property owners with largely varying states of maintenance (GHD, ESA PWA, and Trinity Associates 2014). There are 26.2 miles of notably vulnerable waterfront structures

that, if breached, could expand the current tidal inundation footprint of Humboldt Bay by 52 percent (Laird 2015).

2.4.2 Soft Stabilization Efforts – "Accommodate"

Accommodation to SLR is easier to execute and less invasive, having less immediate impact on the surrounding environment (Dyckman, St. John, and London 2014). SLR accommodation and managed retreat can be complementary solutions. Accommodation to flooding or coastal erosion has been implemented successfully on a minor scale in several communities in the U.S., including Northfield, VT; Ventura, CA; Warwick, RI; and Pacifica, CA (Coastal Conservancy 2008; Center for Coastal Resources Management 2017; Kershner 2010; Gram 2012). These projects allowed water to reclaim land with either small-scale property buyouts (a form of managed retreat) and/or relocations of non-residential property, like bike paths or parking lots. Though the Netherlands is the master of hard stabilization, they are also embracing rising waters by reframing SLR as a business opportunity and accepting the rising seas (Kimmelman 2017). For example, they build parking garages and parks that act as large reservoirs during high tides (Kimmelman 2017). Nevertheless, a primary strategy of the Netherlands to protect from rising seas is a massive beach renourishment project which has successfully (though temporarily) reversed sand erosion (Stronkhorst et al. 2018). Beach renourishmnent is particularly popular in California, but when waves wash the sand away, it can damage or even destroy ecosystems (Guidi 2018).

Living shorelines are a soft stabilization measure providing erosion control through natural methods such as fiber coir logs, breakwaters, sills, sand, stone and other organic materials (Dyckman, St. John, and London 2014; Heberger et al. 2011). This environmentally sensitive method can be used as a temporary solution to protect a community from SLR while preparing more long-term plans (Dyckman, St. John, and London 2014). Living shorelines are a potential adaptation option that has been introduced in local Humboldt County planning meetings to protect some areas of Humboldt Bay, including King Salmon (County of Humboldt 2018b; 2019).

2.4.3 Managed Retreat Efforts – "Retreat"

Managed retreat may be a controversial adaptation strategy because it involves people eventually leaving their home. There are not yet many examples of large-scale effective relocations within the United States, and most appear to be responses to natural disasters rather than adaptation to SLR. For example, the small town of Valmeyer, Illinois endured multiple severe flooding events when a levee breached and the town was essentially destroyed in 1993 (Knoblach 2005). The entire town relocated successfully to a plot 1.5 miles away and the former mayor of the town credits the community itself for banding together within days of the major flooding event (Knoblach 2005). Another successful retreat materialized in one neighborhood of Staten Island, New York as a response to Hurricane Sandy. Ninety-nine percent of the neighborhood were able to sell their homes to the state of New York at prices exceeding that of their pre-Sandy valuations (Gertz 2015). A few chose to stay, or weren't eligible. However, buyout

policies like these favor property owners and leave renters at a disadvantage. Since buyout policies are typically based on home value, they favor the wealthy with higher home values, establishing further disadvantage for lower income residents who are most at risk of SLR (Marino 2018). Further, the Staten Island example is qualitatively different than Valmeyer in that the community was lost, and wealthier residents received higher payouts based on home value.

Multiple coastal indigenous communities in the U.S. have acknowledged sea-level rise risks and are in different planning stages. In Kivalina, Alaska, a remote barrier island with approximately 400 indigenous residents, climate change has thinned the ice that protected the land from the sea. Currently, no formal relocation plans are in place despite the community's efforts (Marlow and Sancken 2017; Mooney 2015). The coastal Quinault Indian Nation village of Taholah in Washington State conducted a vulnerability assessment incorporating numerous community forums resulting in a relocation plan (EPA, US 2016). The plan includes relocating 650 village members to a site half a mile away 120 feet above sea-level and outside current flood and tsunami zones. A Master Plan was finalized in 2017, but relocation efforts have not yet been initiated. Current federal regulatory framework generally allocates funding only after a disaster has occurred, highlighting "the complexity of self-reliant relocation in predisaster contexts" (Marlow and Sancken 2017, p. 291), which creates complications when planning for SLR retreat in at-risk communities like King Salmon.

One anomaly in SLR retreat efforts is the Biloxi-Chitimacha-Choctaw Indians of Isle de Jean Charles near New Orleans, Louisiana, coined by Smithsonian Magazine as

the first “American climate change refugees” (Beller 2016). In 1955, the island covered approximately 22,000 acres, but today, only 320 acres remain due to a combination of SLR and land subsidence (Usborne 2018). The tribe received $48.3 million in federal funding to relocate eighty remaining residents together as a community to a new site in Louisiana. Groundbreaking on the new site began in late 2018 and the current timeline suggests that the move will be complete by 2022. Beller (2016) proclaims this as the first time an entire community has been relocated in response to SLR in the United States.

The efforts in Staten Island, Valmeyer, Kivalina, and Isle de Jean Charles were all initiated by the communities themselves (Gertz 2015; Knoblach 2005; Marlow and Sancken 2017; Beller 2016), suggesting that implementing a retreat from King Salmon would require internal community motivation and organization.

2.5 SLR Planning in California

It appears that many coastal communities in California facing SLR are still in the planning phases, though some have taken significant action. In 2014, California’s AB-2516 required local municipalities, utilities and relevant state agencies to report the status of their climate change adaptation plans in a public database (State of California 2014). Most of those mandated to report have begun or completed a vulnerability assessment and some have formally introduced adaptation strategies. For example, San Diego published a formal SLR adaptation plan in 2012, identifying vulnerabilities and planning for future engagement, though specific plans were not included (City of San Diego 2012).

San Rafael's Canal neighborhood just north of San Francisco, California is experiencing similar SLR and flooding threats in a comparable geography to King Salmon, though planning efforts are still in progress (Seltenrich 2015). Just like King Salmon, the coastal neighborhood is adjacent to a manmade canal, was developed on infill, and the primary population at risk is low-income (Seltenrich 2015). Also in Marin County, a research team used 360-degree 3D viewers to allow users to virtually see their current coastal environment in different flooding and sea-level rise scenarios and displayed potential responses, like seawalls. The device also allowed users to submit their comments while and after using the devices. They found that users showed increased concern after viewing the 3D images, leading to interest in becoming more involved with the planning process (Moser et al. 2016).

In 1990, the City of Pacifica in San Mateo, CA was an early adopter of SLR adaptation. Until the late 1980's, the city had unsuccessfully used hard armoring to buffer against flooding and erosion from sea-level rise (Kershner 2010). In collaboration with multiple state, federal, and nonprofit partners, they utilized a combination of minor managed retreat and soft stabilization to protect Pacifica State Beach from further erosion (Kershner 2010). Some cities in California have more recently invested heavily in seawalls and offshore breakwaters, including Malibu and Pacific Grove (Guidi 2018), but these options are often not financially feasible for smaller or poorer communities.

Humboldt County has released and funded numerous reports in the process of updating its Humboldt Bay Area Plan to include SLR (Laird 2015; GHD, ESA PWA, and Trinity Associates 2014; County of Humboldt 2018a; Laird 2018a; 2018b). Multiple local

public meetings suggest that the County is interested in feedback from the community, but they appear to intend to implement one generic adaptation plan for the entire County (County of Humboldt 2018b; 2019). Whichever adaptation methods are selected, scholars agree that involving the community in the decision is essential and individual communities have drastically varying needs, rejecting a one-size-fits-all plan (EPA 2014; Arenstam Gibbons and Nicholls 2006; Arnall and Kothari 2015; Chilvers et al. 2014; Graham et al. 2014) .

3.0 METHODS

3.1 Data Collection & Analysis

I used a mixed methods approach to this research, including qualitative semi-structured interviews, public meeting observation, archival document review, and geographic information system (GIS) analysis. I then employed a grounded theory approach to analyze qualitative interview and document data and emergent themes.

3.1.1 Semi-Structured Interviews

The primary method in my research was semi-structured interviews with seventeen residents, property owners, and business owners in King Salmon. Participants were recruited through in-person visits to businesses in the area, mailers to landowners, and snowball sampling. Mailers were designed by the author and ordered using Vistaprint.com (Appendix A).

Participants determined the location of interviews. More than half of the interviews took place in a local King Salmon gathering place and restaurant, Gill's By the Bay. Remaining interviews took place in participant homes, places of work, or other local establishments. One participant was unable to meet in person, so our conversation took place over the phone. Interview lengths varied between thirty minutes and three hours, depending on the engagement and interest of each participant.

I used an interview guide with sample questions and topics to guide each conversation. Questions were divided into four categories. First, I collected background information, like how long the participant had lived in the community and why they chose to move to King Salmon. To understand sense of place and community, I asked questions about their attachment to people and place and what King Salmon as a place meant to them. To understand their local ecological knowledge, I asked questions about historical and current flooding, and how it has affected their lives. Near the end of each interview, I showed participants SLR projection maps designed by Aldaron Laird in early 2018 and recorded responses to these projections. Maps presented to interview participants were actually more optimistic than the science released with the OPC Sea Level Rise Guidance in late 2018 and are included in Appendix B for reference. The full interview guide is included in Appendix C. Interviews were recorded with documented participant consent. Participant research was approved per IRB # 17-148.

It is important to note that the interview respondents in this study volunteered to participate and I did not offer compensation. I did not use randomization for selection. It is possible that a bias exists in this research due to the characteristics of persons available to participate in a non-compensated study and due to self-selection. All parcel owners were invited to participate through targeted mailers, but renters were more difficult to reach. The makeup of the respondents by resident type is displayed in Table 1. There were slightly more men responding than women, with ten men and seven women.

Table 1: Respondents by Resident Type

Resident Type	**Number of Respondents**
Renters	1
Homeowners	11
Recreational Landowners	2
Vacation Home Owners	1
Business owners	2
Total	**17**

Some respondents offered their age during interviews without provocation, but age was not a demographic question I collected during interviews. I estimated the ages of participants by using cues from interview responses and available external sources. I then categorized respondents into three generational categories: Young Generation, Middle Generation, and Advanced Generation displayed in Table 2.

Table 2: Respondents by Generation Type

Generation Type	**Number of Respondents**
Young Generation: Age 30-49	1
Middle Generation: Age 50-64	7
Advanced Generation: Age 65+	9
Total	**17**

3.1.2 Public Meeting Observation

The County of Humboldt's Long Range Planning Division of the Planning and Building Department received a grant from the California Coastal Commission to facilitate public workshops in four coastal communities at high-risk of SLR impacts, including King Salmon. I participated in planning these workshops as a subcontractor of local SLR expert and Environmental Planner Aldaron Laird. I also acted as an observer and note-taker during the actual presentation and recorded the meetings.

The public workshop targeting the at-risk communities of King Salmon and nearby Fields Landing took place in August 2018. County staff intended to convey vulnerability information and include stakeholders in developing adaptation strategies. To encourage local participation, County staff selected the workshop venue close to the communities. All parcel owners in King Salmon and Fields Landing received an invitation. I designed flyers to recruit for the workshop (Appendix D), distributed flyers within the communities, and drafted a press release published by local news outlets. During my interviews, I encouraged King Salmon stakeholders to attend the workshop. County staff also reached out to the communities online through social media. More than sixty people attended the workshop. I did not collect any demographic information on workshop attendees. During the question and answer period, some attendees identified themselves as King Salmon residents, Fields Landing residents, local elected officials, and utility representatives from Pacific Gas and Electric (PG&E) or Humboldt Community Services District.

In preparation for the workshop, I designed oversized posters using Aldaron Laird's maps, showing localized tidal inundation areas during king tides, and with 1.6, 3.3, and 4.9 feet (0.5, 1.0 and 1.5 meters) of SLR. Posters were displayed prominently along the walls of the venue (Figure 4). I took notes on participant reactions and responses to the scientific presentation and the conversations about future planning.

Figure 4: Photo of August 7, 2018 public meeting. Photo by author.

3.1.3 Archival Research

I examined archival documents at the Humboldt Room at Humboldt State University and the Humboldt County Historical Society in Eureka, California. The information in the Historical Context section of this report was primarily gathered from these visits. Documents included newspaper articles dating back as early as 1949, reports from the Army Corps of Engineers, journals, and books. These documents related to King

Salmon's historical context were reviewed, analyzed, and photographed to better understand the planning decisions that led to the current threat of flooding and SLR inundation.

3.1.4 Qualitative Data Analysis

I transcribed the digital recordings from interviews and the public meeting first using an online transcription service with voice recognition. Then, I listened to each recording with the draft transcription in writing and implemented necessary edits to the transcripts. I analyzed all transcriptions from the interviews and public meeting along with the archival data and identified emergent patterns and trends in the data. As patterns began to develop, I categorized related quotes and archival data into separate documents. The process was iterative; I repeatedly returned to the transcripts and archival documents to review for supporting data as themes emerged. Key themes included experience with flooding, perceptions of and reactions to flooding, current and future adaptation responses, climate change beliefs, and generational differences.

3.1.5 GIS Analysis

To conceptualize future scenarios of SLR, I created projection maps for the King Salmon community. My analysis used the method developed by Flick et al. (2013) to adjust Mean Monthly Maximum Water (MMMW), or more simply, the average highest tide for the month, for the local North Spit tide gauge station. Per this method, to accommodate for the 18.61 year lunar node tide cycle, I established a 19 year period from

1991 – 2009, with the baseline year (2000) in the center. I collected monthly high sea-level values from NOAA's website from 1991 to 2009 and averaged the values to determine the MMMW of 6.935 meters. Projected SLR values were captured from the most recent localized data (OPC Working Committee 2018) relative to the baseline year 2000. I obtained the datum relationship of 4.357 meters for the North American Vertical Datum of 1988 (NAVD88) relative to the Station Datum at the North Spit tide gauge station from NOAA's website. Then, I adjusted the start-year centered 19-year epoch MMMW value to the appropriate datum (NAVD88) by subtracting the two, per the method introduced by Flick et al. (2013) (Table 3).

Table 3. Start year adjustment to local geodetic datum (North Spit tide gauge, meters), baseline year 2000

Start year epoch MMMW (1991-2009) (Station Datum)	6.935 m
NAVD88 Conversion	4.537 m
Start year epoch MMMW (NAVD88)	**2.398 m**

MMMW values relative to NAVD88 were computed by adding the start year epoch value to the projected values from the Ocean Protection Council (2018) (Table 4), per the method developed by Flick et al. (2013). The Ocean Protection Council's

projections were released in late 2018, so it is likely that this is the first time they have been used to conceptualize sea-level rise maps for the Humboldt Bay.

Table 4. Future year elevations relative to local geodetic datum (North Spit tide gauge, meters), Medium-High Risk Aversion

Year	**Projected SLR relative to Year 2000**	**NAVD88 (MMMW)**
2000	0.000	2.398
2030	0.305	2.703
2040	0.488	2.886
2050	0.701	3.099
2100	1.920 – 2.316	4.318 – 4.714

The Representative Concentration Pathways (RCP's) modeled are emissions scenarios adopted by the Intergovernmental Panel on Climate Change (IPCC). RCP 2.6 most closely correlates with the Paris Agreement and assumes that global carbon dioxide emissions decline by 70% by 2050, to zero by 2080 and then below zero (IPCC 2014). RCP 8.5 is referred to as a "business as usual" scenario (OPC Working Committee 2018) where there are limited efforts to reduce global emissions. RCP H++ was coined by the Ocean Protection Council to model an extreme emissions scenario in addition to rapid Antarctic ice sheet loss. RCP H++ is not included in the IPCC report. Though unlikely, it is important to review the anticipated worst-case scenario. Per the Ocean Protection Council (2018) report, the low emissions scenario (RCP 2.6) is no longer achievable for

years 2030-2050, as we have already reached the point of no return. RCP 2.6 is possible for 2100, so this scenario is mapped as a low emissions scenario, along with the RCP 8.5 (high emissions) and H++ (extreme) scenarios.

I collected the 2009-2011 CA Coastal Conservancy Coastal Lidar Project: Digital Elevation Model (DEM) from the National Oceanic and Atmospheric Administration (NOAA) website. A DEM is essentially a map containing data on vertical elevations. This DEM has a 1 meter resolution with a 5 centimeter confirmed vertical accuracy and a 50 centimeter assumed horizontal accuracy. This high resolution is required to precisely map SLR projections. Some maps are included in the follow Study Site section. Additional maps are included in Appendix E and a flowchart visualizing my methods is displayed in Appendix F.

3.2 Study Site

3.2.1 Historical Context

In order to understand the challenges that King Salmon faces today, it is important to understand its history. The Wiyot Indian tribe has occupied the area which is now known as Humboldt Bay since time immemorial. On April 14, 1850, German explorers aboard the Laura Virginia navigated the treacherous entrance of the bay, and violently claimed the Wiyot Indian village of Djorokegochkok, declaring it “Humboldt City”. They named its highest peak “Buhne Point” (Figure 5) after crewmember Hans Buhne (Shepherd 2011). Only one year later, Humboldt City was essentially abandoned,

reportedly due to poor proximity to the Klamath gold mines (Turner 1993). Nearly a century later, Humboldt City would become known as the community of King Salmon.

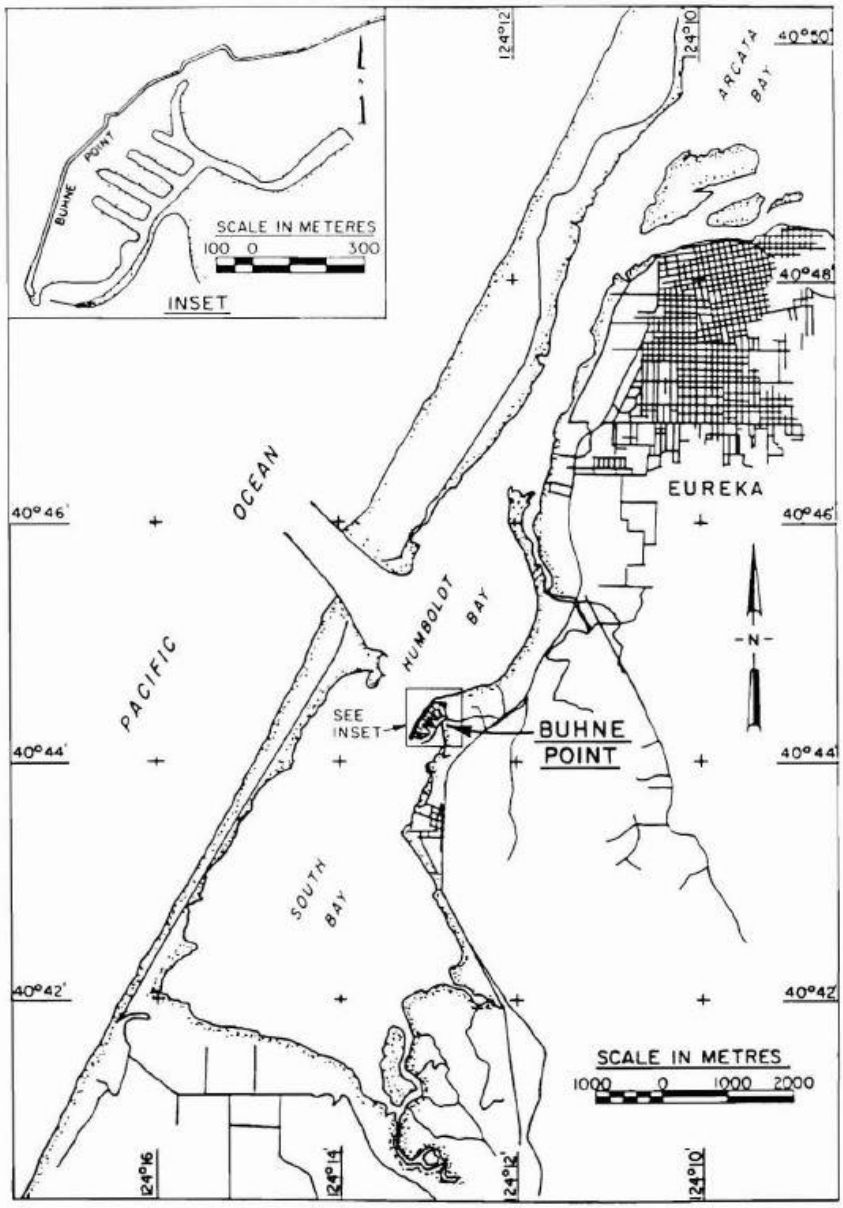


Figure 5: Historical map of Humboldt Bay and Buhne Point, date unknown (Bottin 1990).

Though Buhne Point was abandoned in 1851, settlers began occupying the region in increasing numbers and developing industries that relied on traversing the entrance to Humboldt Bay. In 1899, the U.S. Army Corps completed construction on two jetties to keep the Humboldt Bay open for ship transport. By 1907, both jetties were deemed useless when the powerful ocean waves washed them away below the lowest mean water levels (Tuttle 1982). By 1925, the north and south jetties were reconstructed with hardier materials in an attempt to combat the natural ocean forces. Helen Rowe, a long-time observer of the area recognized that wave patterns were altered following this reconstruction, causing waves to break further south at Buhne Point (Tuttle 1982). Ms. Rowe's observations were confirmed by technical surveys that showed the Buhne Point area eroded 1,400 feet between 1854 and 1955, 1,000 feet of which was after the jetties were reconstructed in 1926 (Tuttle 1982). The area was quickly losing landmass and experiencing flooding (Figure 6), and the causal factor appeared to be the reconstruction of the jetties.

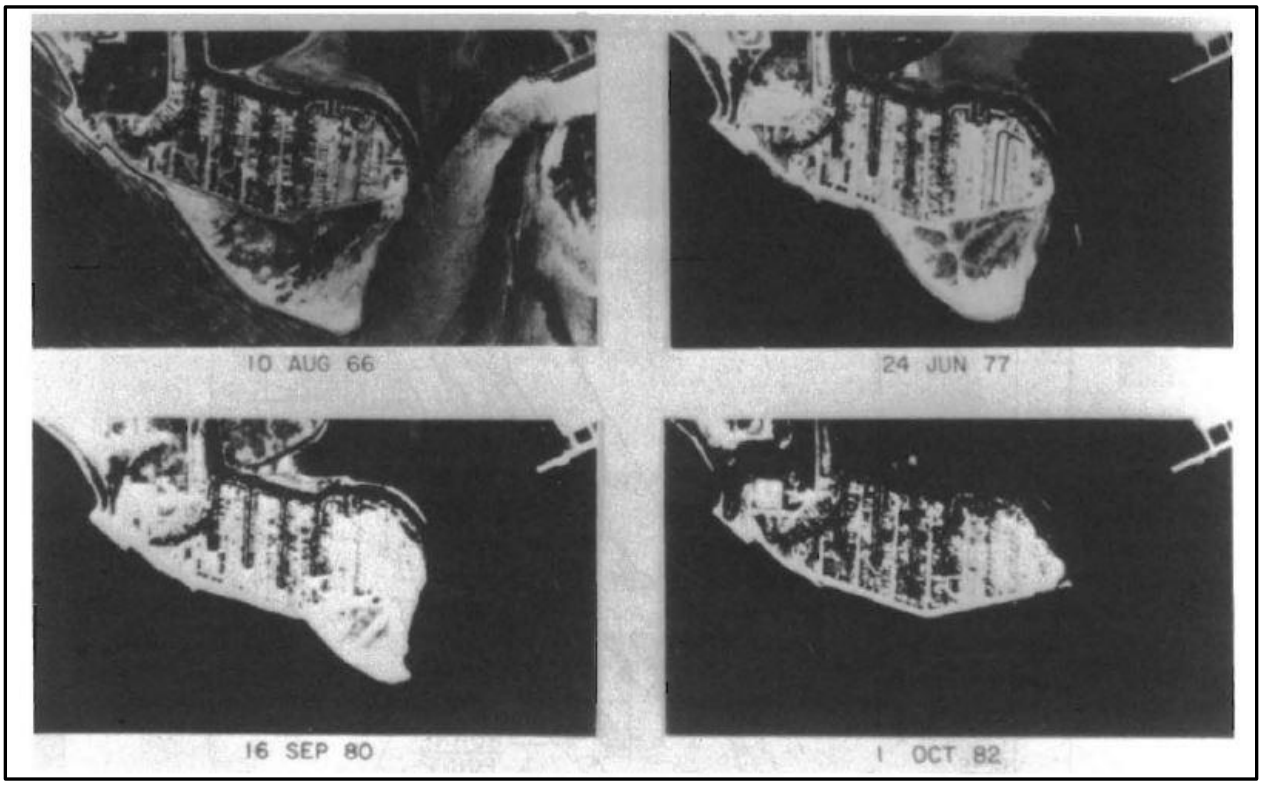


Figure 6: Historical erosion of King Salmon and Buhne Point (Bottin 1990).

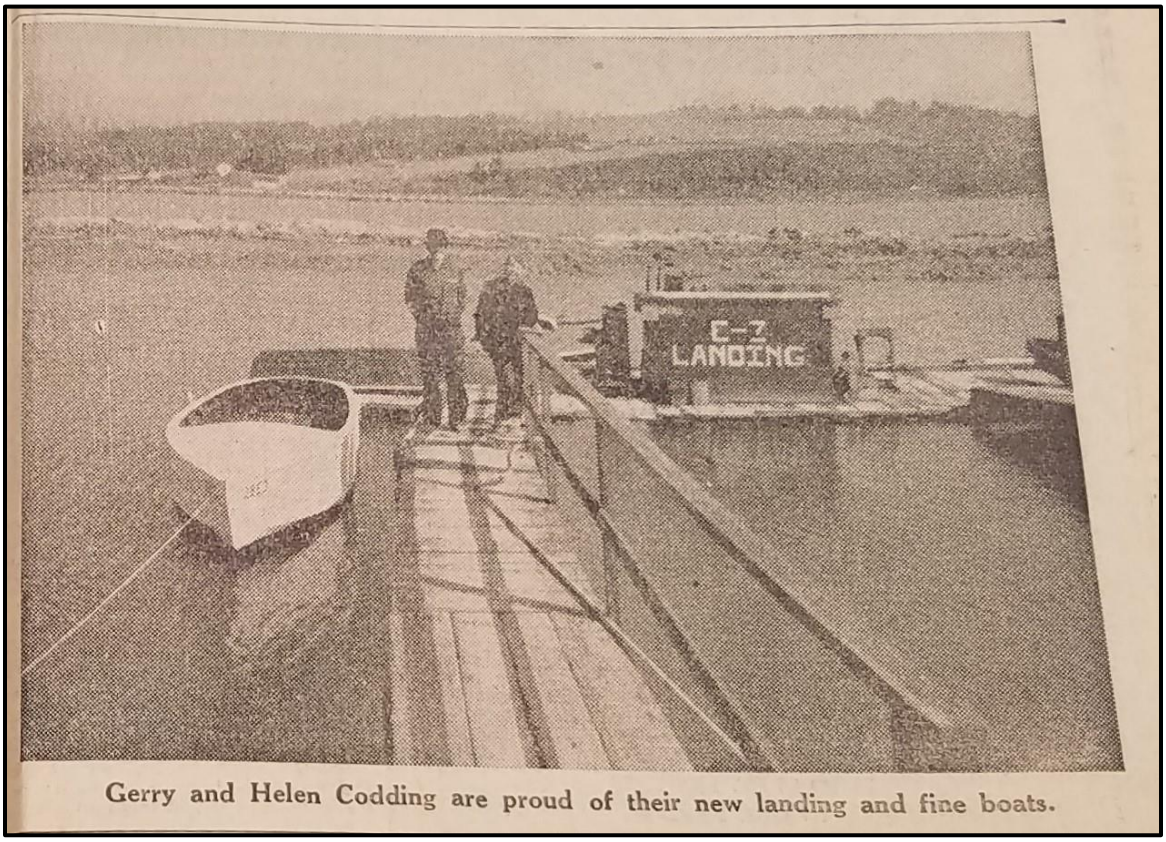
The U.S. Army Corps of Engineers recognized the erosion and flooding, but chose not to act, deeming proposals as “cost-prohibitive”, “not yet economical”, or concluding that the value of land to be protected did not warrant protection (Tuttle 1982). Reports were published in 1933, 1936, 1950, 1956, and 1979 by the Army Corps with the repetitive stance that although the area was in jeopardy, no action should take place.

Despite Buhne Spit’s erosion, the King Salmon Resort was established in 1949. The local newspaper reporting on its construction recognized the erosion, while praising Humboldt Shipbuilders for obstructing the wave action with a manufactured beach (Schwarzkopf 1949). Channels were scooped out of filled salt marsh (Figure 7) to turn

the previous dredge spoil dumpsite into an aspiring “fishing resort known all over the world” (Genzoli Unknown Date). Developers anticipated the resort to be an upscale fisherman’s community and nearly every parcel had access to its own boat dock (D. Anderson 1995).

Figure 7: King Salmon pre-development, 1948 (Herbert and Root 2012).

By 1953, fishermen had docked their boats there (Figure 8) and people began to move in (Figure 9), though it appears that the community never became the fishing tourism haven expected by the original developers. I was not able to identify any archival documents discussing the development of the community between 1953 and 1977 when flooding and erosion were reintroduced as a headline.



Gerry and Helen Codding are proud of their new landing and fine boats.

Figure 8: Brand new King Salmon landing owners (Schwarzkopf 1949).

Figure 9: King Salmon under construction, 1953. Photo discovered in Humboldt Room at Humboldt State University.

By 1958, Pacific Gas and Electric (PG&E) completed construction on Units 1 and 2, two steam-generated power plants in King Salmon (Figure 10). In 1963, PG&E completed construction of Unit 3, “the first commercially viable, privately-funded nuclear power plant in the world” (Herbert and Root 2012, p. 28). The nuclear plant ceased operations in 1976, but spent nuclear fuel is still stored on site and decommissioning is in progress to date in late 2019.

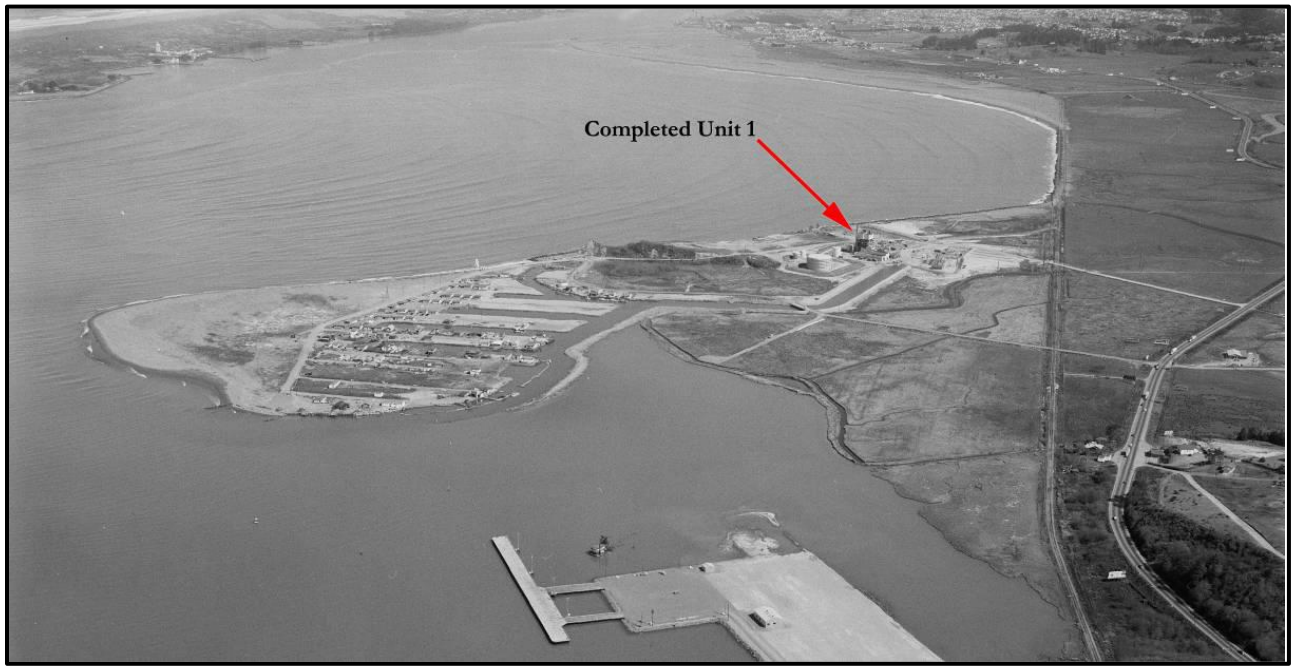


Figure 10: King Salmon, following the completion of Unit 1 of 2 steam generating power facilities, 1955 (Herbert and Root 2012).

As the King Salmon area continued to flood and erode, in the late 1970s and early 1980s, a "Save King Salmon" movement emerged. A spokeswoman of the movement, Edith Higgins said at a town meeting in 1978, "We've been trying to get the waterfront here fixed for 23 years. We used to have about a 57-acre beach out there. Now it's about 12 acres… We always get the same answers – 'Sorry, we can't do anything.' Well, if something isn't done soon there won't be a King Salmon. We get studies, we get sympathy, and we get 'well maybes', but we don't get the rocks fixed (Unknown 1978a)." In 1982, the major street that protected sewer and water resources in King Salmon (Buhne Drive) was reportedly at risk of frequent inundation (Holmblad 1982a).

Despite the County of Humboldt spending $228,500 (in 1982 dollars) between 1968 and 1982, King Salmon continued to erode into the bay (Holmblad 1982b).

In 1979, the property at King Salmon, including the PG&E power plant, was estimated to have a value of $6 million. A project to address the erosion in King Salmon materialized, initially estimated at around $1.2 million (Tuttle 1982). Nine million dollars (primarily from the U.S. Army Corps) and six years later, a rock jetty was completed to defend from the raging waves.

The primary delay in the project's completion was Humboldt Bay's encroaching waters that had eroded the bluffs for centuries. For example, in 1984, the project was ceased when a contractor hired to complete his portion of the project declared that the waves were too rough for his heavy-duty equipment: "I've never seen a bay that can tear up like this one in my life" (Holmblad 1984).

After the project was completed (Figure 11), a 1986 U.S. Army Corps journal indicated that the same methods would be repeated in future erosion and flooding control ventures (Bottin 1986). The Times-Standard lauded the project as "a model of interagency cooperation and good environmental planning", citing multiple national and statewide prestigious awards (D. Anderson 1995).

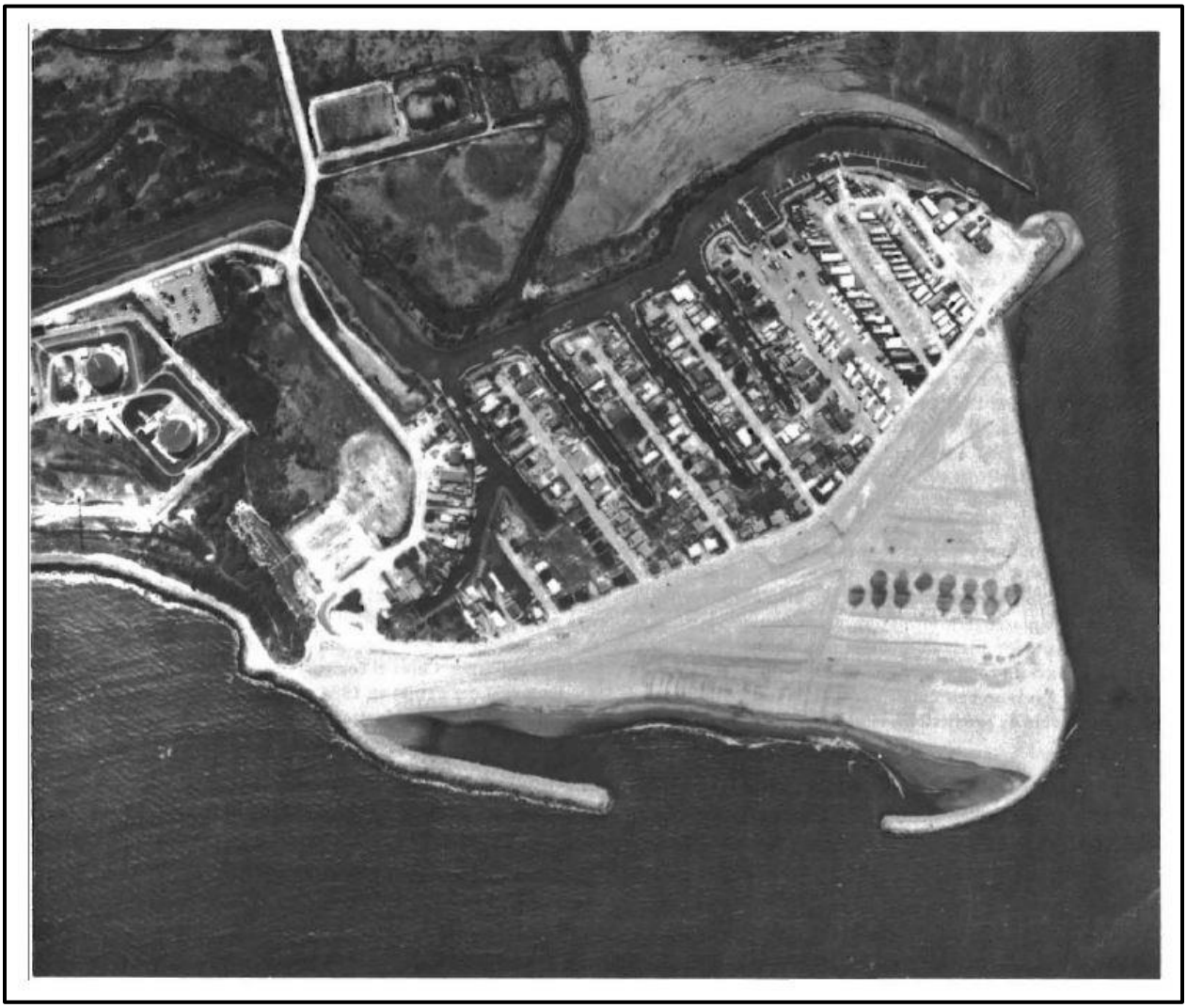


Figure 11: Completed project at King Salmon and Buhne Point, 1985 (Bottin 1990).

The U.S. Army Corps repairs did not effectively hold back the bay. In 1995, Harbor District Executive Director Jack Alderson said that King Salmon is “exactly the sort of project the California Coastal Act was intended to prevent, but when it was built, there was no Coastal Commission” (D. Anderson 1995). Numerous floods were recorded in the 2000s and beyond (Figure 12). Meteorologist Troy Nicolini of the National

Weather Service reported that the source of the flooding was not the rain: “They are being flooded by the ocean, period (Faulk 2005).” It is likely that modern laws would have never permitted King Salmon’s development, specifically on filled salt marsh in an area known to be experiencing high rates of erosion.

Figure 12: Flooding in King Salmon (Times Standard, 2005).

3.2.2 King Salmon Today

Today, King Salmon is a small, unincorporated coastal community with 190 residential and commercial parcels encompassing 176 acres (Humboldt County 2018). The street names are still reminiscent of the intended fishing resort, including Cod Street, Perch Street, Crab Street, Sole Street, and Herring Street. Approximately 72% of residents meet the federal definition of economically distressed (U.S. Census Bureau

2017). The community is composed of mostly small residential homes, two trailer and RV parks, one restaurant (Gill's By the Bay), one small convenience store, a public beach, and the region's largest privately-owned power generating station (PG&E's natural gas power plant). The previous nuclear power plant is still being decommissioned today and nuclear rods are stored on site. Humboldt County's Public Works Department is responsible for maintaining the streets and storm water drains. Humboldt Community Services District is responsible for water and sewage services. PG&E provides electricity and natural gas. PG&E is responsible for maintaining a seawall and the Humboldt Bay Harbor, Recreation, and Conservation District is responsible for the jetties constructed in the 1970s and 1980s.

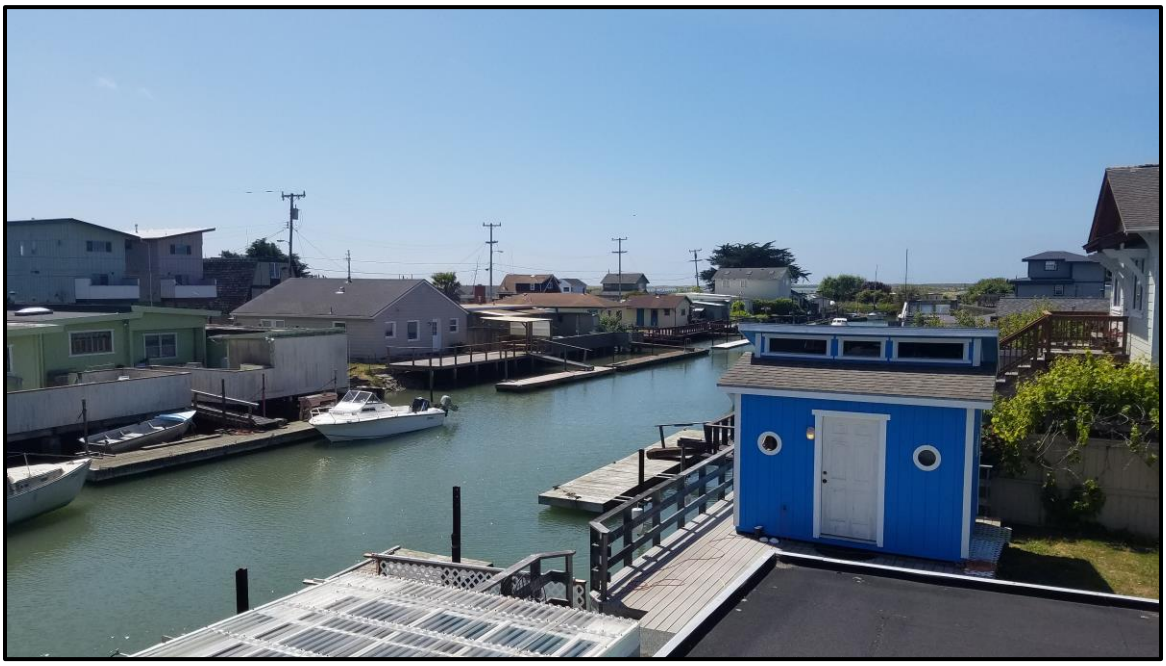


Figure 13: Homes on a canal in King Salmon, June 15, 2018. Photo by author.

Relative sea-level is rising more quickly in Humboldt County than anywhere else on the U.S. West Coast, and within Humboldt County, King Salmon is the lowest lying community and at the highest risk. With water almost completely encircling the community, subsidence due to tectonic activity, and SLR, it is not surprising that there is regular flooding in King Salmon, particularly during the annual high tides, also known as king tides (Figure 14, Figure 15). In addition to water intruding from the bay, King Salmon regularly experiences flooding from rising groundwater. This community has endured a tumultuous history of flooding and erosion now compounded by the threat of SLR. The people of King Salmon will ultimately need to adapt to rising waters.

Figure 14: Cars flooded by king tides on Perch Street in King Salmon, January 20, 2019. Photo by author.

Figure 15: Canal overtopped in King Salmon during king tides, January 20, 2019. Photo by author.

3.2.3 Future SLR Projections

The Ocean Protection Council's 2018 Sea Level Rise Guidance policy document provides the latest science on California SLR projections, including specific localized estimates using the North Spit tide gauge in Humboldt Bay. As part of this research, I generated a series of maps to help visualize potential future scenarios for King Salmon. Figure 16 shows essentially the best-case scenario under the Medium-High Risk Aversion for the mean monthly maximum water (MMMW) in King Salmon in 2100 with 1.9 meters of SLR. According to the OPC guidance document, planners should use the Medium-High Risk aversion scenario when implementing adaptation strategies for "vulnerable projects or populations that will experience medium to high consequences as

a result of underestimating sea-level rise", including coastal development (OPC Working Committee 2018 p. 25). This scenario, RCP 2.6 assumes that global carbon dioxide emissions decline by 70% by 2050, to zero by 2080 and then below zero, closely correlating with the Paris Agreement (IPCC 2014). Notice that nearly all residential and commercial parcels are inundated and the only point of entry into the community, King Salmon Road, is partially inundated.

Figure 16: King Salmon, projected MMMW, Year 2100 – Med-High Risk Aversion, RCP 2.6 (1.920 meters). Image generated by author.

The RCP 8.5 scenario is considered “business as usual”, where there are limited efforts to reduce global emissions. Following are maps depicting SLR projections using the Medium-High risk aversion scenarios for MMMW in 2030 (Figure 17), the highest

annual tide in 2030 also known as a king tide (Figure 18), and MMMW in 2100 (Figure 19). Note that a majority of parcels are inundated on a monthly basis and nearly all parcels are inundated on an annual basis as early as year 2030, only a decade from now. By 2100, on at least a monthly basis, all of King Salmon's residential and commercial parcels and the only access road to enter King Salmon are completely inundated. Also, the PG&E power plant is inundated at least monthly, as is major interstate Highway 101. It appears that at some point between 2030 and 2100, King Salmon may become uninhabitable without major adaptation implementation.

Figure 17: King Salmon, projected MMMW, Year 2030 – Medium-High Risk Aversion, RCP 8.5 (0.305 meters). Image generated by author.

Figure 18: King Salmon, projected king tide, Year 2030 – Medium-High Risk Aversion, RCP 8.5 (approximately 0.6 meters). Image generated by author.

Figure 19: King Salmon, projected MMMW, Year 2100 – Medium-High Risk Aversion, RCP 8.5 (2.3 meters). Image generated by author.

4.0 RESULTS

In the following sections, interview participants are labeled using “P” for participant followed by an assigned numerical indicator. Attendees of the Communities at Risk (CAR) public meeting are not individually identified.

4.1 Coexisting with Floodwaters

Flooding in King Salmon is not a new phenomenon. Archival data shows that this community has a long, recorded history of flood experiences over the past century. The U.S. Army Corps published four reports between 1936 and 1979 recognizing an escalation of erosion and flooding in the area (Tuttle 1982). Numerous newspaper articles report severe flooding events (Unknown 1978b; Holmblad 1982a; 1982b; 1982c; Bird 2003; Faulk 2005). Despite the seawall and jetty construction in the 1980s, King Salmon still floods today. All 17 participants interviewed and many public meeting attendees reported experiences with flooding within King Salmon. This is a community that coexists with floodwaters.

4.1.1 Flooding Experiences

In personal interviews and at the CAR public meeting, many community members shared dramatic stories of flooding on their own property. One experienced a severe flooding event on the first day after he moved into his new home (Figure 20):

> I moved here in 2002, Thanksgiving Day actually. And a funny thing happened the following morning. I have, my bed is up on the second floor, and I have a window facing out on the street and I woke up and I look out the window and there's water flowing out from under the house into the street. The first night I was there. I thought what has happened? I thought the water main broke or something in the house, huh? And I go running downstairs and there's, in the back where the channel is, there's a little curb wall that a deck is built and the deck overhangs the channel and there was a hole eroded under that little curved wall and the water was just flowing into the backyard (P8 2018).

Figure 20: Flooding in King Salmon, 2002. Photo provided by interview participant.

This respondent's story suggested that he was unaware of the flood risk when he moved into the home, or at the very least, surprised by its magnitude. It is also interesting that he described the incident as a "funny thing", casually recollecting quite an extraordinary

story. Another resident described “2-3 inches of water in our house… we had to have had 20-24 inches of water in our yard” (P2 2018). He described in detail how water began seeping up through his hardwood floorboards in their library room, not rushing through the front door as he expected. They discovered later that their library room was two inches lower in elevation than the rest of their house. That minor elevation difference of two inches was enough to cause thousands of dollars in damage. His wife did mention that the flooding made her “uncomfortable”, but the overall sentiment was still relatively nonchalant. Two other residents talked about floodwaters damaging their vehicles (P13, P8 2018). One reported that his insurance company deemed his car totaled after ocean water entered the brakes and floorboards, even with the car elevated on cinderblocks (P13 2018). These remarkable stories of flooding reveal the challenging experiences King Salmon residents regularly face. Responses indicate that flooding has become a casual, almost mundane part of life in King Salmon.

Interviews revealed that localized flooding within the small community varied drastically. The localized differences in flood reports appear to be due to minor elevation differences that could become less relevant with future SLR. Some respondents did not necessarily experience flooding damaging their own personal property, but described seeing their neighbors’ homes flooded (P3, P5, P6, P13 2018). For example, one homeowner explained that even on one short street, water levels can fluctuate considerably: “I've walked down the street and its two feet deeper waters, over the top of my boots” (P5 2018). Another pointed out localized flooding on a different street. Their particular home rarely floods, but “the first 4 or 5 houses on the left side as you're going

down Crab [Street] are always flooding" (P3 2018). This localized flooding may introduce a social justice concern. King Salmon is a major part of Humboldt County's supply of low-income housing according to Humboldt County Planning Director John Ford (Weinreb 2019). But interviews, personal observations, and projection maps suggest that the most severe flooding in King Salmon is in and near the two trailer parks, likely the poorest areas in the already low-income community (Figure 21).

Figure 21: Trailer park in King Salmon during flooding event in 2002. Photo provided by interview participant.

4.1.2 Historical Flooding

Participants interviewed lived in King Salmon for an average of 24 years. One resident interviewed moved in as a child in 1955, shortly after the original King Salmon Resort was developed. Some respondents lived in the community in the 1970s and 1980s before the seawall and jetty were constructed. They recalled the ocean waves breaking over Buhne Drive (the main road in King Salmon) prior to the seawall and jetty construction (P4, P9, P15 2018). One homeowner described, “you would have to wait for the waves to pass and hurry to pass before the next wave would come. The waves came up all the way to the road” (P15). This local ecological knowledge corresponds to archival newspaper articles (Unknown 1977; Holmblad 1982b; 1982a) and photos (Figure 22).

Figure 22: Truck driving on Buhne Drive in King Salmon, pummeled by ocean waves (Unknown 1977).

Many respondents perceived that flooding conditions have worsened over time in frequency and intensity (P4, P10, P13, P14 2018). For example, one person reported, “it used to happen like once or twice a year. Now, I would say about 12 to 14 times a year that the street floods” (P13 2018). Two interview respondents did not believe that flooding had worsened over time (P9, P12 2018), though one of these respondents had only lived in King Salmon for five years. A recurring recollection was that the worst floods took place in 2003 and 2005, which aligns with archival records. One resident who had lived in King Salmon since his childhood explained when trying to recollect

historical floods, “when you're a kid, you don't really remember that clearly” (P4 2018). The age at which a resident first moved to King Salmon, and the length of residency of each interview respondent may have affected their perceptions of how flood conditions have changed over time.

4.1.3 Casual Approach

Many residents described flooding events in a nonchalant manner. The two most extraordinary flooding stories mentioned earlier in this section were described with a casual tone. Multiple respondents joked about boating down the streets. For example, one resident explained, “well last time there was some gal, had an inflatable raft, pumped that up, got in a bathing suit with a little umbrella and a drink and she's floating around there” (P5 2018). However, he dismissed it as a partial dramatization, continuing, “of course the newspaper gravitates toward that”. Another resident described friends who didn’t understand the regularity of flooding in King Salmon:

> “And it's made national TV, you know, like I'll get a friend's call saying ‘God, are you okay, are you okay?’ I go, ‘Yeah, its only tidal! It will come down. It's just gorgeous. It'll be gone in 15 minutes!’…I mean, if you're not used to it, it could be scary” (P6 2018).

In a similar fashion, a local newspaper quoted a King Salmon resident saying, “our street is a river again”, with a corresponding photo of that resident floating down her street during a 2017 high tide (Goff 2017; Figure 23). Another respondent explained, “The joke was you could get a pole and go out there with your rubber boots on and you could snag great lawn furniture going by” (P2 2018). These stories and news articles demonstrate

that some King Salmon residents turn flooding events into recreational activities and can appear to have a lighthearted and casual response to flooding events. This may be connected to the unique nature of these floods. In contrast with unexpected flash flooding or major disasters in other areas, these recurring floods can usually be predicted with the tides.

Figure 23: A woman floating down Cod Street in King Salmon during a high tide. Photo from Lost Coast Outpost (Goff 2017).

Similarly, the popular “Gill’s by the Bay” restaurant in King Salmon displayed a poster on the wall with the establishment nearly surrounded by water and the cheeky caption “Gill’s IN the Bay” (Figure 24). The poster was designed and donated by a customer after one of many flood events in King Salmon. This is another example of the light-hearted, casual response to flooding in the community.

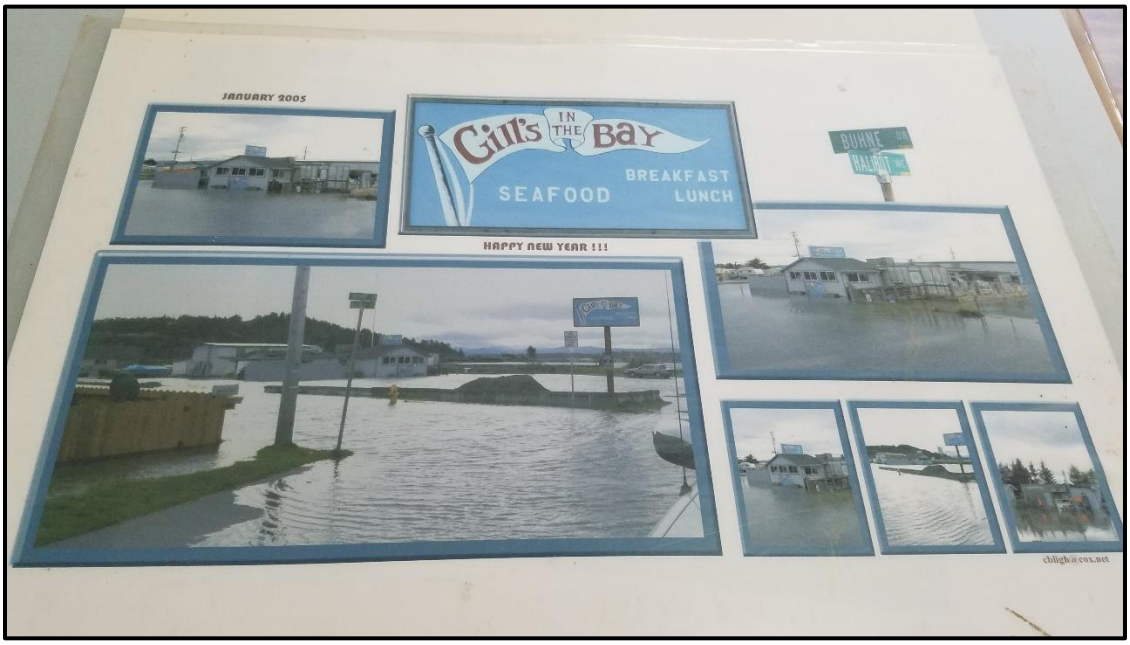


Figure 24: Photograph of poster at Gill's By the Bay during a king tide, with the caption "Gill's IN THE Bay". Poster designed by unknown customer; photograph of poster by author.

4.1.4 Existing Adaptation Methods

To coexist with the floodwaters, the community is already implementing adaptation strategies to protect their homes and belongings. All interview respondents revealed storing important items on cinderblocks, pallets or similar raised structures (Figure 25). Sandbags were also a frequently mentioned necessity. "It's a good thing I got lots of storage for sandbags," said one resident (P7 2018). Sandbags were not only used on personal property, but also to prevent flooding of critical utilities and infrastructure (Figure 26). Moisture barriers (typically plastic or foil sheets placed in walls, ceilings, and floors to protect structures from water damage) and sump pumps were also popular adaptation strategies (P7, P2 2018). One person even routinely parked his car on cinder

blocks in preparation for high tides or storms (P13 2018). Two respondents mentioned using hard stabilization techniques to protect their homes, including physically raising their entire home (P10, P13 2018) or installing a concrete seawall around a personal property (P2 2018). These adaptation strategies suggest that many King Salmon residents are willing to tolerate the floodwaters and invest to protect their property and possessions. Most of the community will likely be unable to afford raising existing structures on their own, but many are willing and able to purchase sandbags, pallets, and cinderblocks. Respondents described protecting themselves with a tone of pride. The community appears to have accepted the floodwaters as its partner, albeit a disruptive one, and seems willing to do what it takes to stand their ground.

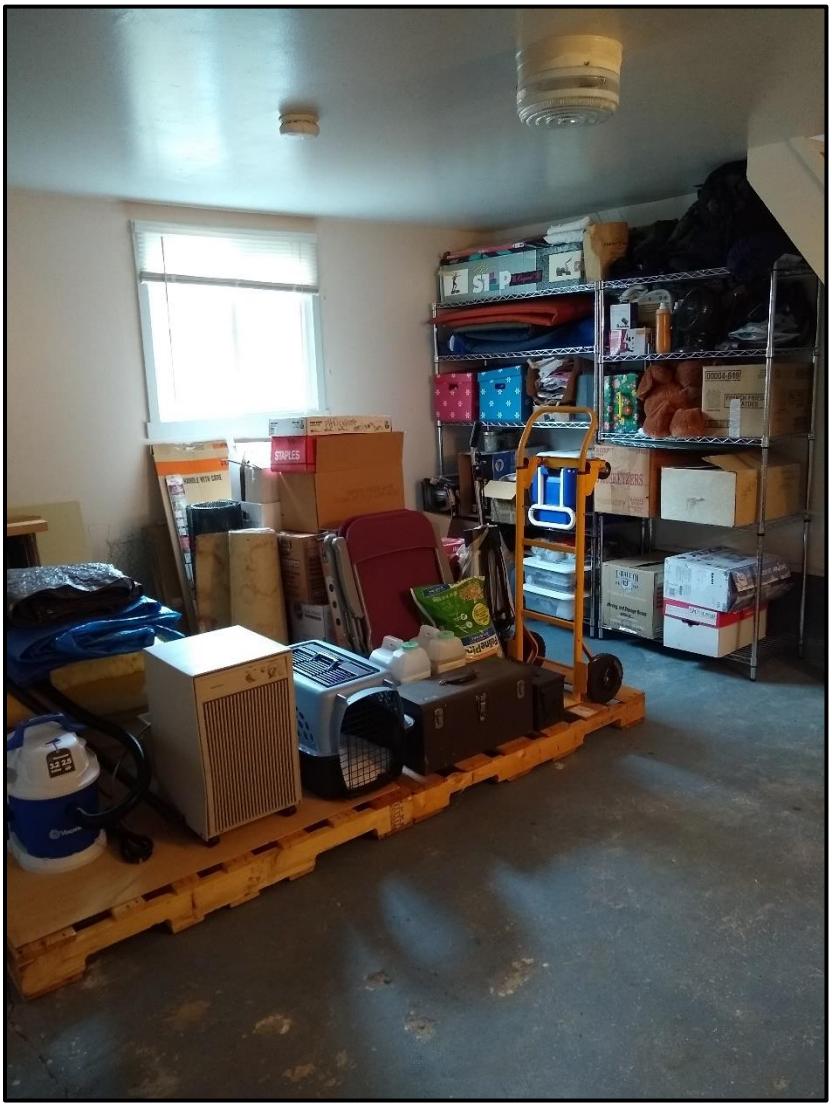


Figure 25: Pallets protecting a King Salmon resident's belongings from floodwaters. Photo by interview participant.

Figure 26: Sandbags on King Salmon Drive to protect stormwater infrastructure (Laird 2018).

The community has learned to adjust their daily routines around their constantly changing environment. One recurring theme was that residents learned lessons from strange or unexpected flooding experiences and acclimated in response. For example, one family described sewage coming up from their bathtub drain during a king tide. Now, when high tides are projected, they plug up the bathtub drain and pile sandbags on top. Another resident learned what can happen when it floods on trash day:

> I've had to haul my [trash] cans all the way up to Buhne Drive and put them up there so they don't float away because, yeah one time of walking around the neighborhood apologizing to all the neighbors for all the trash everywhere is all it took for me (P13 2018).

Most residents reportedly monitor tide tables to plan their activities in order to safely cohabit with the floodwaters. One resident installed a sonic tide gauge to alert him via text message when the canal's water reaches likely flood levels (P13 2018; Figure 27). He also schedules appointments around the tides to ensure he can exit his home to travel, but expressed concern that an ambulance would be unable to reach his aging parents in the case of an emergency. This introduces a health hazard particularly for older residents unable to navigate floodwaters. Others described minor inconveniences due to flooding and how they adapt. For example, one resident tried to dig a hole for a fence pole during a high tide, and the pole was bobbing up and down in the hole (P9 2018). He simply waited for the water to recede to complete his project. Some residents have waders on hand in case they need to navigate the floodwaters:

> Like sometimes if I do have someplace I have to go during the flooding, I've got hip waders. I'll just park the car over there, take the waders over there, you know, throw them in a plastic bag put on my shoes and go (P13 2018).

These unique experiences drive the community's adaptation. These comments and actions are further evidence of a community willingly working around the schedules of floodwaters.

Figure 27: Sonic tide gauge installed by King Salmon resident. Photo by author.

4.1.5 Frustrations with Local Government

Data suggest that some community members believe current flooding is exacerbated by poor maintenance by the County of Humboldt, or the Humboldt Community Services District that maintains the sewer and water systems in King Salmon. One interview respondent removes barnacles and sticks from backed-up public drains on his street to prevent floods, though he thinks this responsibility should fall on the County (P13 2018). Two residents mentioned saltwater corroding the pavement on their streets, creating deep puddles when it rains or floods (P6, P13 2018). Many workshop attendees criticized government maintenance. One attendee explained of a particular local road:

> That intersection floods because there is a four-foot deep three-foot wide drainage ditch that the County, when they put it in, said they were going to clean [it] out every year. That was back in the 80s and it has never been cleaned out... the water has got no place to go, it has to come up (CAR Workshop 2018).

This comment received strong verbal agreement from the crowd, with another attendee bringing up a flood gate that "for all the fifty years I have lived there, [it] has never worked" (CAR Workshop 2018). When a County representative told the group they were writing down complaints and would take them into consideration, a woman audibly scoffed and said they had been "asking for this for fifteen years". A man echoed "longer than that!" (CAR Workshop 2018). These complaints are not new; at a public meeting in 1978, King Salmon resident Maggie Smith asked the County, "Why can't we get some preventative work done here? Will we have to wait until a disaster occurs to get some help?" (Unknown 1978b). Most of the fixes requested by interview participants and workshop attendees were perceived to be relatively minor and inexpensive, and the community was frustrated that their requests had been ignored.

4.2 Sense of Place and Community

While browsing the Humboldt State University library and the Humboldt County Historical Association archives, I became fascinated by the history of the community banding together to demand that the jetty be built. For example, in the late 1970s and early 1980s, a "Save King Salmon" movement emerged, complete with popular bumper stickers (Holmblad 1982c). Edith Higgins, a King Salmon resident, organized a community meeting in 1978 to communicate flooding concerns to the local government. I

was curious to find out if this sense of community still existed today, and if residents felt a connection to their community, or a sense of place. “Sense of place” is commonly cited and defined in the literature as “the meaning attached to a spatial setting by a person or group” (Jorgensen and Stedman 2001, p. 233). Other authors suggest similar definitions including feeling like an “insider” and a desire to remain in their place (Hay 1998) or the important bonding between a person and their place (Low and Altman 1992; Giuliani 2017).

4.2.1 Connection to Place

Interestingly, even though all respondents interviewed reported adverse flooding experiences, they generally appeared to have a strong and positive connection to their physical surroundings and their homes, and a desire to stay, if possible. Although a few lived there by necessity, most moved there purposefully to be near the water. All respondents enjoyed recreational activities that only a waterfront community can provide, like kayaking, sailing, fishing, crabbing, or simply walking their dogs on the beach.

Many became passionate when discussing their feelings of attachment to King Salmon. One resident affectionately called King Salmon “an oasis”, declaring, “This is my place, I belong here” (P1 2018). Another explained, “It's important that I live here. I don't plan on ever going anywhere. I think this is my retirement place forever. Well, until it's underwater” (P14 2018). Another described in detail her emotion-based decision when purchasing her home:

> I am a PhD in environmental science, right? And I'm like, okay I should totally like be paying attention to what I'm doing. I saw the house and I was like, I don't care and my agent is going, 'well, you have to have flood insurance.' I'm like, I don't care, you know, it was honestly, the emotional part totally took over. I was like no, this is this is what I need for my soul… I said well, so if I am taken away by tsunami, at least I will have had my dream home. Seriously. I would have had my dream home. Even if it's only for five months (P7 2018).

Similarly, another resident explained, "When I bought this house many years ago, one of my kids are going 'Mom!' and my friends are going 'Really?', but I just felt like it was worth it just to be here, you know, just to hang out" (P6 2018). These emotional responses demonstrate an intense connection between residents and King Salmon as a place.

Residents also indicated that King Salmon was one of the few places on the California coast where they could actually afford to purchase property. For example, one homeowner said, "Living here, yeah, it makes economic sense for me" (P13 2018).

One theme discovered was that some residents moved to King Salmon because it reminded them of a place they previously lived, leading to a nostalgia of place. Living by the sea, or living in a small coastal community was reportedly a primary part of their identity. For example, one resident expressed:

> I found this neighborhood and its like, oh my God, this is Carlsbad. This is what it used to look like, little shanties on the water. I love it… that's what I grew up with in Carlsbad, it feels like it is literally in my veins. I've always felt like I had saltwater veins! I've lived in magnificent places, I've lived in Paris, the best city in the entire world, but it's not by the ocean. There's something different about the air that seems to be integral to my very physical survival" (P7 2018).

Others reminisced similarly about King Salmon reminding them of other coastal communities they had lived in, including Staten Island, Seattle, San Diego, Vancouver,

and Santa Cruz (P5, P6, P7 2018). Some respondents noted that King Salmon was one of the few places on the California coast left that they could actually afford (P7, P13 2018). This suggests that some residents' attachment to place could be more of an attachment to waterfront living, and perhaps not a specific attachment to King Salmon.

4.2.2 Connection to People

Respondents repeatedly described King Salmon as a quaint community where "everybody knows everybody" (P3, P5, P14 2018). One resident described the "dock to dock" conversations, with people regularly chatting across the canals (P7 2018). The same resident expressed a feeling of "friendship and cordiality…'if you love this place like I love this place then I love you', you know, it seems to be the King Salmon way of, you know, doing things" (P7 2018). One resident exclaimed, "We never go without fresh fish because our friends just bring it to our door!" (P6 2018). Another described, "Our little street here, we watch out for each other and there's several people that we're especially concerned about because they are having a health issue or something, so we watch out for each other" (P5 2018). King Salmon seems to be a community where people take care of each other.

King Salmon residents appear to look out for each other when it comes to flooding too, with more established residents cautioning new community members about flood threats. One resident distributes a monthly newsletter to warn neighbors of potential flooding dates (P13 2018, Appendix G). A property manager explained that he educates his new tenants often: "I've had tenants call me that are new… and say 'Hey, do you

know you're flooding over here? Is there a pipe broken?' I say no, that's the ocean" (P14 2018). One respondent recalled staff from a local business wearing waders during an extreme flood event and carrying customers through the floodwaters to their cars (P16 2018). These comments and stories point to a sense of community and a connection between the people of King Salmon.

I asked each participant if they knew of any community organizations in King Salmon, similar to the "Save King Salmon" movement of the 1970s discovered in archival research. All interview respondents reported that they were unaware of any formal organizations. One resident responded that she believed that it would be difficult to organize the community, explaining, "as far as this community, it's kind of like full of independent people. They're not real followers. It's hard to get a group to, you know in my experience to agree on anything much" (P6 2018). Another resident was more hopeful explaining, "I think I'm banking on the community loving the place enough that we will work together enough to save enough of it" (P7 2018). There appear to be varied opinions within the community regarding whether they can organize together. There may be avenues for the community to improve in terms of civic engagement, community organizing, and leadership.

Some residents believed that the sense of community had diminished in recent years and acknowledged some negative interactions among community members. One resident reminisced about the fishing community:

> But the people over time now, you know, it's changed… It's not the fishing community that it once was. Back in the early 70s, there were community parties like Fourth of July festivals at Johnny's Marina and over time this has become like

> more of a low-rent district than sport fishermen that used to own the places (P12 2018).

An issue with crime was mentioned by a few residents. One participant actually left the community due to perceptions of high crime. He explained, “We had this joke where we had this million-dollar view out of our kitchen and bedroom window. We had this 35 cent view across the street because it was awful and we were always calling the police. That's one of the reasons we moved out” (P10 2018). This resident later moved back to King Salmon, describing that he still felt a connection to the community even during the gap when he was away.

4.3 Future Adaptation Responses

In each interview, I asked respondents how they think their community should respond to future SLR and flooding. County government officials asked attendees of the CAR public meeting the same question. The following sections review responses to these questions.

4.3.1 Protect or Accommodate

Most respondents indicated that they would probably prefer to stay and adapt to SLR, but they were not exactly sure how to achieve this. For example, one interview respondent said, “I really like living here, I want to stay and enjoy it ‘til I'm dead” (P8 2018). Many expressed interest in hard stabilization, particularly strengthening or protecting their existing residential structures, in order to stay. For example, one resident

explained, “I might need to move which I'd hate but ideally, I'd like to raise the house and stay, but I don't know if that's possible” (P8 2018). Another interview respondent indicated that she might need to build up her existing retaining wall, “which might obstruct my view of the canal a little… there are things I might have to do that make it less attractive or more inconvenient, but it's worth it to be here” (P7 2018). This response reinforces the sense of place perceived by many in the community.

Numerous interview respondents and public meeting attendees suggested we look toward other communities for inspiration. Holland, New York City, Venice, Rotterdam, and Charleston were all mentioned as potential models for adaptation (P6, P7, P13 2018; CAR Workshop 2018). Specific suggestions included building gated holding areas for floodwaters, moving out of first stories, and lifting homes up on stilts. At the public meeting, residents expressed bewilderment that they were being asked to come up with ideas on the spot, while so many examples in other communities had not already been considered by local government officials.

4.3.2 Retreat

A few residents suggested relocating the community or showed an interest in relocating on their own. For example, one person asked, “Can’t the school and homes and structures be moved? What’s the point of building a barrier if groundwater will flood the area anyway?” (CAR Workshop 2018). Also during the public workshop, one attendee admitted that the educational presentation displaying future SLR projections may have changed her mind about relocating: “I for one have not really thought about it much. I

don't have a plan in my head. Yes, I'd like to keep my house. But now maybe it might be nice to sell it in a few years and move" (CAR Workshop 2018).

Many residents were not interested in abandoning their homes and relocating, but some presumed it would be an eventual necessity. For example, one resident explained, "I might have to move and I'm just keeping my fingers crossed. I don't want to move… I don't know how many years I have to go or how hot how soon it's going to be... I'm assuming at some point, everybody's gonna have to move out of here" (P8 2018). At the public meeting, a potential bias against retreat was introduced by Humboldt County Building Director John Ford. He started the public comment section soliciting adaptation ideas by saying, "It is self-evident really to us, you want to live in your homes, you don't want to the increase the cost of living there, I mean everyone wants to maintain their properties" (CAR Workshop 2018).

A few respondents brought up the idea of buyouts, a form of managed retreat. For example, one resident explained, "…If it became a real bad place for people to live, if it was completely condemned… just give people enough money to start again somewhere else" (P5 2018). Some specified interest in staying in their home until they passed, and buyouts were thought of as a supplement for their heirs, not a solution for now (P8 2018). Most of the residents interviewed belonged to the Advanced Generation group (65 years or older), which may explain this view.

4.3.3 Funding Concerns

Residents repeatedly expressed concerns for funding future SLR adaptation. Most indicated that they could not afford to adapt on their own with their limited economic resources. For example, one person stated, “I would say finances are the biggest prohibitive factor” (P13 2018). One resident questioned if his home would even be worth saving:

> I mean the value of this this property, I think it's around the upper 100s [thousands of dollars]. So now I mean, you know, for us it wouldn't make sense to put, you know, probably what might be a hundred thousand of jacking it up, and you know, putting it up say maybe six or eight more feet to where it's absolutely safe (P13 2018).

Another resident expressed concern that publicly announcing SLR projections would decrease the value of his home, and even if he sells it at its present value, he would not be able to afford another coastal property (CAR Workshop 2018).

Others thought the government should be responsible for funding future adaptation to protect their properties, particularly with the nearby PG&E power plant and nuclear waste at risk of inundation. One resident actually mentioned feeling more comfortable with her home purchase in a known vulnerable area because the power plant would need to be protected for the greater Humboldt County community (P7 2018). This was also a major concern introduced by workshop attendees. Allison Talbott of PG&E was in attendance and explained that there did not appear to be political will to move the fuel rods anytime soon, although it is the federal government’s responsibility to do so (CAR Workshop 2018).

4.3.4 Climate Change Beliefs

Nearly all interview participants, of all ages, said that they believed in climate change. Two respondents stated that the sea level might be rising, but they did not think it is anthropogenic. For example, one community member said, “It might be rising. I don't think it's man-made” (P15 2018), while another explained “I don't think as man we can do too much about it” (P12 2018). One resident did not believe the sea is rising at all, one resident was unsure, and another did not reply to the question. The five community members who did not explicitly say they believed in anthropogenic climate change belonged to all three age groups, though three of the five belonged to the Advanced Generation group. There did not appear to be a connection between age group and belief in anthropogenic climate change. Table 5 displays the breakdown of respondents by their expressed climate change belief.

Table 5: Responses to belief in climate change

Belief in Climate Change	**Count**
Yes	12
Yes, but not anthropogenic	2
Not sure	1
No	1
Did not answer	1

4.3.5 Generational Differences

All interview respondents were shown potential SLR inundation maps. Their initial responses are recorded below in Table 6. A recurring finding was that many residents accepted the current risks of living in an area vulnerable to SLR, flooding, and potential tsunamis, but hoped that they would not live long enough to have to deal with more severe risks in the future. In fact, ten of the seventeen interview respondents expressed this sentiment. All ten belonged to the Advanced Generation group (65 years or older). Comments included: “Well I won't be here” (P15 2018), “I'm not going to be here to be able to do anything” (P17 2018), and “most of us in this room will be dead” (CAR Workshop 2018).

Table 6: Initial Responses to SLR Projection Maps

Response	**Generation Group**
“Oh, yeah, that's probably true… I'll tell my kid if she inherits the house, sell quick.”	Advanced
“Well, let's see. How long can we tread water?”	Advanced
“Yeah, I can see us being underwater…but then you know you go out towards Eureka and all that's going to be underwater. CR is going to be underwater. You know, there's a lot of places going to be underwater besides King Salmon.”	Advanced
“Well, I think overall, we're not as concerned with some of these so-called problems as we were 10 or 15 years ago. We're not going to be around that much longer.”	Advanced
“I don't think it's going to happen in our lifetime and it might but I doubt it… I'd like to believe that we leave things in good order for the future too."	Advanced

Response	Generation Group
“Oh absolutely, I do believe that.” [the SLR projections]	Middle
“It's totally believable. And like I said, I'm just hoping it doesn't happen until after my daughter sells it.”	Advanced
“I don't know whether they're correct or not, but I do think that the sea level is going to rise and maybe is right now. Slowly but surely like you said there's different estimates on how quickly it's going to happen, but I think it will. Yeah, the more we go through this more I'm thinking about packing bags!”	Advanced
“Alright, I'll be dead so I'm not worried.”	Advanced
“I mean, I believe it. I don't know when it's going to happen. And I don't know what I'm going to do about it…I'm spoiled, I feel like I'm gambling though. But I'll have a good time while I'm here, that's my thought.”	Advanced
“I see that as I appreciate the bright mind of that guy. But there's no scientific evidence that I can see living here 37 years that indicates that is going to happen.”	Middle
“Oh, I could definitely see that happening. In fact, I would give a 25 to 50 percent chance that maybe it will be twice as bad as that.”	Middle
“It's actually kind of depressing. I believe anything can happen, anything's possible, but there has to be a way to rectify all that too. I mean, there's got to be a way that they could raise the levees or do something to stop that. Yeah, maybe an expensive undertaking but there's got to be a way they can do it.”	Middle
“Well. I won't be here. What are you gonna do? If it happens, It happens. You can't force the tide back. So it's kind of a moot point. If it's going to happen, it's going to happen…it might be rising. I don't think it's man-made. Yeah, weather is what it is, can't predict it, you know.”	Advanced
“Well, you know, I'm not going to be here to be able to do anything.”	Advanced

Many agreed that retreating from the area was a probable future necessity, though they hoped that the sea would hold back during their lifetimes. One interview respondent expressed his sympathy for future generations:

> Well, we knew this was happening, but we reckoned that we would be by that time not living there and too old or dead. But I mean, I feel sorry for your generation. Sorry for you with everything else as well. I know, I don't know what you know, I'm a child of the 60s. We lived through the Cold War, we lived through it all, but you've got a whole different set of things you're going to have to live through. So hey, I wish you the best, I really do, keep your chin up… I don't want to live in denial but there's a level to, a level I can take, too much information, I can't worry about that, so your generation, you need to worry about that (P10 2018).

His comments suggest that he accepts that King Salmon will need to adapt to rising seas, but there is sadness and regret expressed in his statement for what the next generation will have to face.

One interview respondent expressed specific expectations for his heirs:

> So my hope is that I'll grow old and die before that happens. My daughter will inherit it [his home] and hopefully there will still be a market for it and she can sell it, because she doesn't want it, and she can get some money out of it, and say 'whew we made it!' before the tsunami or before the icebergs melt, but I don't know maybe, maybe it's going to happen sooner than that… I'm just hoping it doesn't happen until after my daughter sells it (P8 2018).

An attendee at the CAR public meeting expressed a similar sentiment, explaining that she was aware when she purchased her home in King Salmon that she would likely be unable to pass it on to her children. A home is typically the asset of most value passed onto the next generation. Eliminating this inheritance creates a loss of intergenerational wealth in a community already struggling below the poverty line, again highlighting a social justice concern.

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 Key Findings

Qualitative interviews, public meeting responses, and archival data collected in this research demonstrate that King Salmon is a community that historically and currently coexists with constantly changing water levels. Many community members reported perceiving that flooding had increased in intensity and frequency over time. All interview respondents revealed employing some type of adaptation strategy to protect their properties and possessions, suggesting that King Salmon residents are willing to endure floodwaters and stand their ground. The community has learned to adapt to the flooding for now, though they are discouraged by a perception of being abandoned by their local government. Most community members feel emotionally connected to King Salmon as a place, demonstrating a sense of place. A majority of respondents reported feeling connected to the people of King Salmon too, though some believed that community cohesion had weakened in recent years. Belief in anthropogenic climate change did not appear to have an effect on preferred adaptation responses. Respondents largely demonstrated a preference for staying and adapting to sea-level rise, which may be associated with an aging population. Overall, it appears that the community accepts that flooding is simply a consequence of living by the water. One resident summarized the sentiment well:

> I always say, you know, when you try to choose the water, the river, or the ocean as your partner, you have to accept the fact that you might get your feet wet once in a while. It's worth it though (P6 2018).

A notable finding was a connection between age and preferred adaptation method. The Advanced Generation group composed of respondents aged 65 and older generally expressed a preference for staying, alluding to their impending death as the reason to not retreat. Stoltz similarly found a statistically significant correlation between Florida coastal fishermen's desire to stay and adapt to SLR and their age; respondents over 60 were least likely to select retreat as an option (2018). Future research could further investigate individual variables in communities and behavioral correlates. For example, future investigators may consider how attitudes vary with age with other research designs.

Perception and awareness of risk is a major factor in determining the motivation to adapt (Grothmann and Patt 2005). This research demonstrates that King Salmon residents are very aware of their flooding and future SLR risk, which could suggest a strong adaptive capacity. But even though residents are aware of their risk, the tidal and predictable nature of current and past floods, along with the tendency for residents to be more advanced in age, have formed a community not very concerned, and maybe even apathetic, about future SLR.

One issue multiple respondents discussed was difficulties with local government maintaining existing infrastructure to prevent floods. This systemic failure to treat pre-disaster issues with urgency is not specific to Humboldt County, but is exacerbated by the difficulty that King Salmon is a small, rural, unincorporated settlement in a large county

with no clear community leadership. Marlow and Sancken similarly underlined the difficulties of enacting policies or obtaining funding in predisaster contexts (2017). Similarly, Rose et al. examined 5,500 FEMA mitigation grants in the U.S. and concluded that the benefit-to-cost ratio of flood mitigation is 5:1 (2007). Other studies have found disaster risk reduction to be largely undervalued and that it can vary greatly with the specific situation. In Mozambique, for example, post-disaster aid exceeded 203 times an unfulfilled pre-disaster mitigation request (La Trobe and Venton 2003; Shreve and Kelman 2014). Many scholars agree that maintaining existing flood prevention infrastructure and implementing pre-disaster adaptation planning is not only humane, but also economically responsible. Adapting to sea-level rise will be expensive, but doing nothing will cost exponentially more. Future research could be focused on building adaptive capacity in communities to push for disaster support, and in governments' ability to work effectively with communities.

5.2 Recommendations

Based on the most current SLR projections (OPC Working Committee 2018), permanent coastal development may not be not economically or ecologically practical in King Salmon. However, this research suggests that most current residents would prefer to stay in their homes until the end of their lives. So how can planners balance the community's preferences to protect their homes and the reality that their homes will eventually be under water?

Many respondents suggested looking to other coastal communities worldwide for inspiration. It is not impossible to live at an elevation below sea-level. The Netherlands is a particularly successful model to examine using a combination of protection and accommodation techniques. The country is low-lying with some areas up to twenty feet below sea-level. They have chosen to accommodate tidal flooding in innovative ways like constructing urban water plazas and underground parking garages to hold floodwaters and even building floating homes (Dircke and Molenaar 2010; Kimmelman 2017). They also are working on a system of dikes to protect their community that rise and lower according to the tides (Dircke and Molenaar 2010), though the system has had some criticism. Many other examples of sea-level rise accommodation exist worldwide.

However, most of these accommodation techniques are paired with hardening strategies, which can create conflict between property owners and the public, as structural hardening ultimately leads to loss of beaches and ecosystems (Kousky 2014). Plus, King Salmon is unusual in that flooding regularly originates from rising groundwater, which means a seawall protecting the entire community likely would not be a viable option. The aging population in King Salmon opens the door to adaptation options with a generational component. For example, rolling easements are a type of managed retreat in the form of long-range buyouts. They can be part of a multifaceted policy approach to allow property owners to accept compensation for agreeing not to implement hard stabilization methods on their property, like elevating structures or building retaining walls. There is a mutual and formal understanding that the home will likely be permanently inundated at some point, and that at some predetermined time the property

would be forfeited and the property owner would relocate. It is important to note that allowing elevation of structures and other hard stabilization measures creates a "safe development paradox" (Burby 2006, p.171), which puts more lives at risk, further emboldens development in hazardous area, and creates higher financial losses (King 2004).

There are many possible ways to structure a rolling easement policy. Compensation could be dispersed at the time of the agreement, on a payment schedule, or even as a payment to heirs at the time of the current residents' death. Under the public trust doctrine, structures that become seaward of the mean high tide line due to rising seas are subject to the authority of the California State Lands Commission, and owners could be charged rent or structures could even be destroyed (Center for Ocean Solutions 2017). In other words, these homeowners in King Salmon could lose their properties anyway as the sea rises, and rolling easements could protect them from some of the attendant financial losses. Rolling easements can be particularly effective in rural, less developed areas like King Salmon where buying out properties is less expensive than in urban areas. Further, there is an ecological benefit of reclaiming coastal lands for wetland migration (Mclaughlin 2011). The age cohort in King Salmon creates an opportunity to consider rolling easements or other similar partnerships between agencies and the public that allow residents to stay in their home for a limited time.

Other coastal communities in California are in a higher income bracket and have access to more resources than the economically disadvantaged community of King Salmon. For example, San Francisco was able to tax parcels to raise funding for a sea-

level rise adaptation plan (Kousky 2014). Previous studies have found that low-income populations are generally more likely to live in hazard-prone regions and have less resources to react to and prepare for disasters (Hessel C. Winsemius et al. 2015; Collins et al. 2019; Qiang 2019). Even within the tiny community of King Salmon, the threat of flooding is unevenly experienced due to microgeographies in which wealthier groups' homes are at slightly higher elevations. Sea-level rise is or has the potential to be a threat multiplier in King Salmon, exacerbating existing poverty conditions.

King Salmon may also be at a disadvantage because it is unincorporated, creating a fragmented allocation of resource management responsibilities. As a result, the planning effort will need to include collaboration of many key stakeholders. These include but are not limited to the County of Humboldt, Humboldt Community Services District, California Department of Transportation, and PG&E. King Salmon is not alone in this struggle against rising seas. The state of California will need to identify a funding mechanism to pay for implementing individual adaptation plans in many California coastal communities. Federal funding will need to be considered too. For example, FEMA provides funding for hazard mitigation to state, local, and tribal governments through a Pre-Disaster Mitigation Grant Program. Though climate change and SLR are not explicitly identified as eligible hazards for this particular program, flooding is, so Humboldt County may qualify for this or similar funding to implement SLR adaptation plans. The fact that King Salmon has been identified as the most vulnerable settlement on the U.S. West Coast may actually be advantageous to the community, in that the risks are evident and planning can begin now.

The County of Humboldt can do much more to improve their community engagement. Until the workshop observed in this study, the County had no engagement with the community, and the follow-up from that workshop is unclear. Simply hosting one public workshop is a far cry from developing a meaningful community-connected planning process. The County should be responsible for developing a mechanism to engage the community regularly, like a community advisory group. Also, the community of King Salmon could do more to self-organize around impending SLR. The most successful managed retreat effort to date in Isle de Jean Charles included the community centrally involved in the SLR planning process. The people of King Salmon know their community better than anyone else, so it is critical that they are at the center of all planning conversations. This means planning more public meetings, engaging the community, and building their adaptive capacity. This research demonstrates the importance of assessing individual community perceptions of adaptation strategies through qualitative research to customize adaptation plans. We have an opportunity to turn King Salmon into a model community for SLR adaptation, but considerable work is needed in building capacity, community involvement and coordination.

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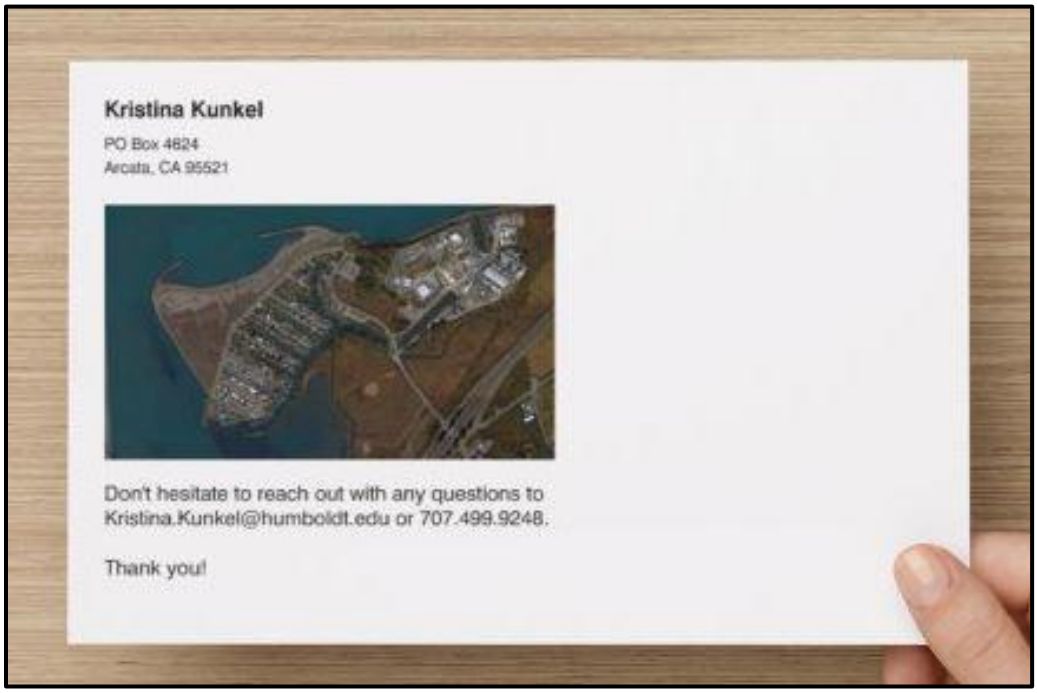
Appendix A: Flyer for interview recruitment



Appendix B: Maps shown to interview participants

KING SALMON, DAILY + 3.3 FT (182+/YEAR, ~2071)

KING SALMON, MONTHLY + 3.3 FT (8+/YEAR, ~2071)

King Salmon Ave inundated

KING SALMON, MONTHLY + 4.9FT (8+/YEAR, ~2100)

PG&E facilities inundated

Appendix C: Interview guide for semi-structured interviews

1. Background:
   - How long have you lived in this community?
   - Do you rent or own your property?
   - Why did you move to King Salmon?
   - Where else did you live before moving here? How many other places?

2. Sense of Place/Community
   - What activities do you enjoy in King Salmon?
   - What does King Salmon – as a place – mean to you?
   - Do you feel an attachment to the people in this community? To this place?
   - What is appealing about living in King Salmon? What don't you like about living here?
   - Are you involved with any community groups or organizations in King Salmon?
   - What would you miss most if you left King Salmon?

3. Flooding & Water – Historic and Present:
   - Has flooding affected your property or activities? How?
   - How do feel the level and amount of flooding has changed over time?
   - How do you use the water here?
   - Is it important to you that you live near the water?

4. SLR and Potential Response:
   - Have you ever considered moving out of the area? Why/why not?
   - What would moving out of King Salmon mean for you?
   - What are your feelings about/vision for the future of King Salmon?
   - If given the choice, would you prefer to move collaboratively with your community?
   - What do you think your government should be doing to support you?
   - Some reports project that water levels will continue to increase in this area and flooding will be more common. (Show maps.) Are you concerned about the impacts of sea-level rise in King Salmon?
   - Would you be interested in participating in community planning conversations?
   - Is there anyone else you suggest I speak to?

Appendix D: Flyer for workshop recruitment

KING SALMON & FIELDS LANDING: COMMUNITIES AT RISK

Strategic Sea Level Rise Adaptation Planning
Public Workshop

3.3 feet sea level rise in King Salmon & Fields Landing, high projection for 2070

Tuesday, August 7, 2018
6:00 PM - 8:00 PM

Humboldt County Ag Center
5630 South Broadway
Eureka, CA 95501

WHO SHOULD ATTEND?

King Salmon & Fields Landing property owners, residents, business owners, recreationists, & interested public

Refreshments will be provided.

Join us for a free workshop to learn how sea level rise may impact King Salmon & Fields Landing.

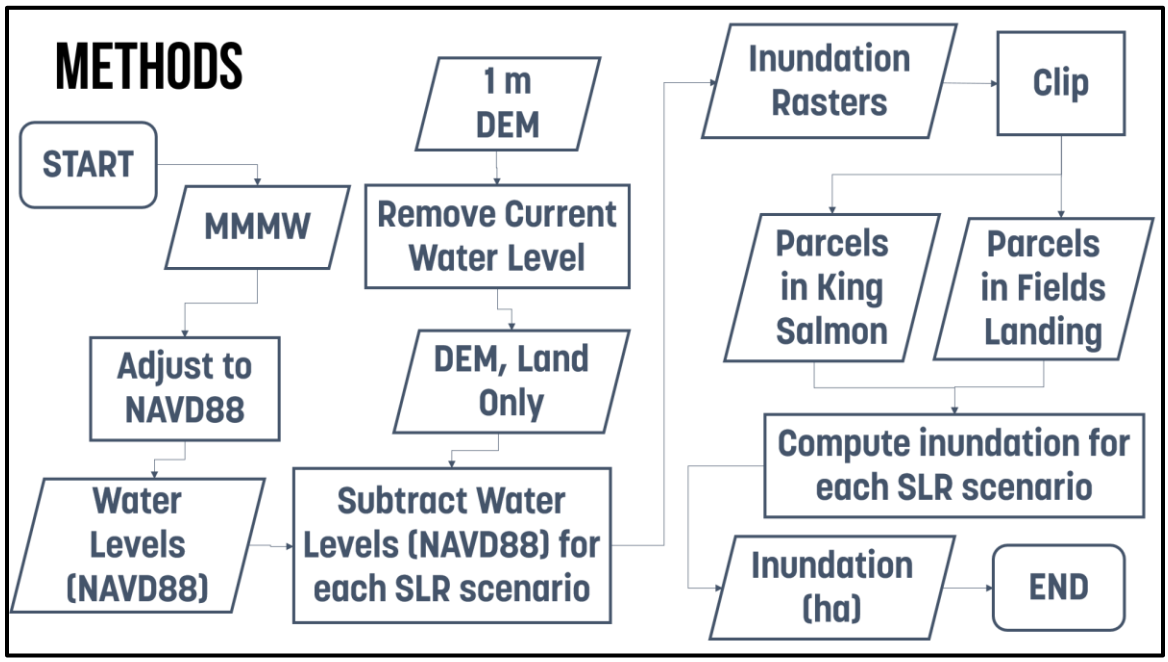
Learn how sea level rise could affect your future, ask questions, and provide input on how these communities could adapt to sea level rise.

Facilitated by Sea Level Rise Planner
Aldaron Laird, Trinity Associates

CONTACT US WITH QUESTIONS:
Aldaron Laird - 707.845.6877 - riverplanner@gmail.com
Lisa Shikany - 707.268.3780 - LShikany@co.humboldt.ca.us
Michael Richardson - 707.268.3273 - MRichardson@co.humboldt.ca.us

CALIFORNIA COASTAL COMMISSION

Appendix E: Flowchart depicting methods for generating maps



Appendix F: Monthly newsletter distributed to King Salmon residents

JUNE 2018 PERCH ST POTENTIAL FLOODING DATES

THESE PREDICTIONS ARE BASED ON AMATURE OBSERVATIONS AND NO GAURENTEE IS MADE AS TO THEIR ACCURACY. NO LIABILITY WILL BE ACCEPTED FOR DAMAGES RESULTING FROM THEIR USE.

THESE PREDICTIONS DO NOT ACCOUNT FOR STORM SURGE WHICH CAN BE AS HIGH AS 1.0 FT EXTRA. (IT IS UNUSUAL FOR THIS SURGE TO BE MORE THAN 0.6 FT) STORM SURGES ARE IMPOSSIBLE TO PREDICT, BUT LARGE SURGES CAN HAPPEN WHEN THERE IS A STRONG ON-SHORE WIND, LOW BAROMETRIC PRESSURE OR LARGE STORMS ANYWHERE IN THE PACIFIC OCEAN NORTH OF THE EQUATOR.

WHEN THE TOTAL WATER LEVEL (TIDE + SURGE) REACHES 8.2 FT, SEVERE STREET FLOODING WILL HAPPEN.

MINOR STREET FLOODING MAY HAPPEN ANY TIME THE TOTAL WATER LEVEL IS ABOVE 7.2 FT AND THE STREET DRAIN CHECK VALVE LEAKS (THIS A FAIRLY RARE EVENT HAPPENING ONCE EVERY YEAR OR TWO)

JUNE 2018

NOTE: PEAKS IN JUNE 2018 OCCUR AT NIGHT

MON JUNE 11	**11:04 PM PDT / 8.1 ft**
TUE JUNE 12	**11:47 PM PDT / 8.4 ft**
THU JUNE 14	**12:33 AM PDT / 8.6 ft**
FRI JUNE 15	**1:20 AM PDT / 8.6 ft**
SAT JUNE 16	**2:11 AM PDT / 8.4 ft**
SUN JUNE 17	**3:05 AM PDT / 7.9 ft**