STORIES OF DECLINE: NARRATIVES AND RISK FRAMING OF GLACIER RETREAT AND SALMON IN WASHINGTON, USA

by

JENNA TRAVERS

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Approved: *Dr. Mark Carey*
Primary Thesis Advisor

Climate change is threatening both glaciers and salmon in Washington with extinction, putting the state's economy, culture, and ecosystems at risk. However, the overlapping climate crises are framed and understood differently throughout the state which affects policy and climate action. This study analyzed 115 media sources from four main stakeholder categories to determine a) which narratives of glacier retreat and salmon declines are the most prevalent; b) how perceived risks change among stakeholders and cause narratives to diverge; c) how these narratives are shaped by stakeholder identity, geographic location, knowledge sources, and time; and d) how narratives of overlapping climate emergencies differ from narratives of a single crisis. Key narratives were identified by creating a qualitative codebook that was applied using Dedoose, and the presence of narratives was analyzed across the categories to evaluate trends. The study found that, while a common narrative did exist, stakeholder identity, source of knowledge, time, and especially a source's geographic location were all key factors in shaping narratives. It also found that narratives of overlapping climate emergencies were more likely to diverge than those of a single crisis and could be used to transform pessimistic climate narratives into actionable, hopeful narratives. As

climate change worsens and causes more overlapping crises, understanding how climate narratives are created and shaped will become increasingly important for understanding stakeholder conflicts, effective climate campaigns, and how people view themselves within these crises.

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1. Introduction

1.1. Relevance and Research Questions

Washington is known for its natural beauty and resources: its snow-capped mountains, rushing rivers teeming with salmon, and beautiful coastlines. However, as a result of climate change, many of these natural resources have begun to disappear. Glaciers are retreating, snow is melting earlier in the year, and rivers are drying up, leaving the salmon and communities that rely on their freshwater high and dry. The North Cascades Range in Washington lost more than a third of its glacier coverage since 1984, and 35 glaciers in the Olympic Mountains have disappeared since 1980 (A. G. Fountain et al., 2022; M. S. Pelto, 2008). As glaciers shrink, they provide less cool meltwater for streams and rivers that Washington relies on, which has detrimental impacts on wildlife like Pacific salmon species.

Salmon populations in the state have been declining for many reasons, and climate change and glacier retreat are big contributors to the problem. As of late 2020, 14 salmon populations in Washington were listed under the Endangered Species Act as either threatened or endangered, with five of those populations deemed "in crisis" (Governor's Salmon Recovery Office, 2020). As global atmospheric temperatures continue to rise, glaciers will retreat or disappear altogether and leave rivers that are too hot and dry for salmon to navigate.

Salmon and glaciers are both vital resources for Washington's economy, ecosystems, culture, and recreation. Because these resources span so many sectors of life, different people and stakeholders have very different relationships with them and

perceive and value them differently. In addition to these different relationships, perceptions and values, stakeholders and media sources are framing the risks associated with glacier retreat and salmon loss in different ways. These risks include potential losses of culture, livelihoods, and identity, and they will be different for each community and individual person. People's diverse perceptions and values of glaciers and salmon combine with these various risk framings to form narratives about glacier retreat and salmon declines. While some aspects of narratives are based on facts, the decisions by stakeholders to include or omit certain facts are an important part of the narratives as well. These narratives are woven throughout media sources, government reports, and Indigenous newsletters in Washington, and they are shaped by each stakeholder's identity, sense of place, and source of knowledge, which can lead to divergence. Narratives affect how the public perceives climate issues like glacier retreat and salmon declines and how they will react to conservation and restoration actions. By understanding climate narratives, how they are created, and how they are shaped, we can understand public perceptions of climate and resource issues, watershed conflicts, climate policy reception, and the likelihood of action from individuals and communities.

Additionally, examining climate narrative through a case study of glacier retreat and salmon declines provides an opportunity to examine narratives of overlapping climate emergencies. Overlapping climate emergencies are two or more climate crises (in this case glacier retreat and salmon declines) that not only occur in the same place but are directly linked to each other. As climate change worsens, we expect to see more of these develop, but so far, most research has only focused on single climate

emergencies. Since overlapping emergencies bring in additional stakeholders, they must balance between even more values, perceptions, and conflicts, and the way narratives are shaped may look different from single climate emergencies. Understanding how overlapping climate emergency narratives are shaped and compare to single emergency narratives will allow us to better understand diverging perceptions, conflicts that arise, and support or opposition for climate action and policy.

This study aims to answer how key narratives about overlapping climate issues are developed and shaped, and how they converge with or diverge from each other. To do this, I analyze the overlapping climate issues of glacier retreat and salmon declines in Washington and ask the following questions:

1. What narratives of glacier retreat and salmon declines exist, and among those, which ones are the most common/prevalent across the different stakeholder groups?
2. How do these narratives compare to, expand on, or contradict each other depending on which stakeholder they come from?
3. How are narratives of climate issues shaped by stakeholder identity, geographic location, knowledge sources, and time?
4. How are narratives of overlapping climate emergencies different from narratives of a single emergency, and what might cause these differences?

1.2. Relevant Literature

1.21. Salmon and Glaciers

As Washington salmon populations (*Oncorhynchus* spp.) continue to struggle and decline, researchers, government agencies, and local communities have been working to understand potential causes and solutions (Governor's Salmon Recovery Office, 2020; Grah & Beaulieu, 2013). Studies have shown that population declines are

likely due to several factors, especially habitat degradation, climate change, and watershed barriers like dams and culverts (Governor's Salmon Recovery Office, 2020).

Warming atmospheric temperatures resulting from anthropogenic climate change have caused glaciers in the region to retreat quickly, with some disappearing completely (Grah & Beaulieu, 2013; M. Pelto et al., 2014; M. S. Pelto, 2011; Sitts & Fountain, 2010). The combination of rising temperatures and decreasing meltwater from the glaciers has spelled disaster for many salmon which are cold-water fishes that begin to experience stress and mortality events above 70◦F stream temperatures (Fellman et al., 2015; Governor's Salmon Recovery Office, 2020; Grah & Beaulieu, 2013; Pitman et al., 2020). Glaciers typically help offset rising stream temperatures by providing cold meltwater during the summer spawning months when streams are at their hottest and driest (Fellman et al., 2014, 2015; Pitman et al., 2020). As Washington glaciers shrink, salmon that have relied on these glaciers for centuries for cold water and stream volume will be left at the mercy of rising global temperatures. Studies show that warmer, non-glacier-fed streams have a lower concentration of dissolved oxygen, nutrients, and small invertebrates that salmon need to survive (Hood & Berner, 2009; O'Neel et al., 2015). However, the science is not as simple as just saying "glacier retreat will harm salmon populations that spawn during summer months"—this is a common narrative but one that ignores many of the complex ways glaciers affect salmon.

Glacier retreat will affect different populations of salmon differently depending on their life histories and geographic locations. While much of the research on glacier retreat and salmon focuses on salmon during the adult spawning stage when fully grown salmon return to their natal stream to reproduce and die, studies have also shown glacier

retreat will impact juvenile salmon and eggs (Shanley & Albert, 2014). Glacial floods that occur in the winter and spring when warming temperatures cause ice to melt early have led to large scouring events where eggs or juvenile salmon are flushed from the gravel too early due to a large influx of water (Goode et al., 2013; Shanley et al., 2015). These floods have increased in both occurrence and severity as a result of warming temperatures and glacier retreat (Grah & Beaulieu, 2013).

Different species and populations of salmon will also be affected differently. Salmon that spend more of their life cycle in streams, such as Coho (*O. kisutch*) and Sockeye (*O. nerka*), will be more affected by glacier retreat than Pink (*O. gorbuscha*) and Chum (*O. keta*) salmon that migrate directly to the ocean after emerging from the gravel (Pitman et al., 2020). In more northern regions, such as British Columbia and Alaska, glacier retreat can actually benefit salmon populations. For example, as glaciers retreat the area they once covered can be used as new habitat for salmon populations with one study estimating that glacier retreat will create over 3,000 miles of new habitat by 2100 (Pitman et al., 2021). Northern salmon previously unable to populate streams that were too cold may benefit from slightly warming streams (Farley et al., 2020). While most salmon return home to their natal streams, some salmon stray and can colonize this new habitat quickly.

The impacts of glacier retreat on salmon and communities depend on individual watersheds and stakeholders, meaning that perceptions and narratives of glacier retreat and salmon will vary widely. Studies often call for certain actions or policies without taking into account the way that narratives can affect public perceptions of the issue and risks involved. If these narratives are not considered, there can be strong opposition

from the public even if actions may be beneficial to them in theory. For instance, while many scientists and community members have called for the removal of dams that block salmon runs in the Pacific Northwest already suffering from glacier retreat, there has been some public opposition, not just from hydropower companies, but also from people who are trying to shift to 100% clean energy (Blumm & DeRoy, 2019). Simply looking at this from a salmon value perspective makes it seem like the obvious, environmentally-conscious decision would be to remove the dams, but if alternate narratives and values are considered, it quickly becomes clear why this is such a contentious issue. Similarly, while extensive research has been conducted on how glacier retreat will impact salmon in the Pacific Northwest, these studies have failed to address how the influx of conflicting findings could lead to divergence between science narratives and public narratives, ultimately affecting public perception and action on the issue.

1.22. Climate Narratives

Narrative analysis is a growing field in climate change research because it provides insight into how different stakeholders, values, and types of knowledge can shape and define public perceptions of climate issues. Narratives are important for understanding complex climate issues and how communities and stakeholders will respond to them (Moulton et al., 2021; Scoville-Simonds, 2018). Previous studies have analyzed how narratives can affect public action, policy creation, and perceptions, but few studies have looked at how these narratives are created, shaped, and diverge from each other, especially for overlapping climate change issues such as glacier retreat and salmon declines (Brugger et al., 2013; Moulton et al., 2021; Sherry et al., 2018). As

climate change worsens and more communities experience overlapping climate problems, understanding how narratives of these overlapping issues are created and can shape public perceptions is vital to understanding climate action, conflict, and policy.

Climate issues like glacier retreat and salmon declines affect people with a variety of life experiences, values, and types of knowledge. As a result, people form different narratives that may diverge from other narratives and the scientific consensus (Carey, 2007; Orlove, 2016; Sherry et al., 2018). Studies have shown that personal perceptions of climate issues like ice loss vary depending on geographic location and historical connection with the region (Brugger et al., 2013). Different stakeholders also tend to shape their narratives around their primary concerns within a larger issue which can differ widely, but this has not been deeply examined yet for overlapping climate emergencies like glacier retreat and salmon declines in Washington. While the narratives of ice loss have been studied in the Andes and North Cascades, no studies have looked directly at narratives surrounding salmon declines, especially in the context of glacier loss (Brugger et al., 2013; Carey, 2010; Moulton et al., 2021; Orlove, 2016). Both salmon and glaciers hold economic, cultural, and ecological value, so studying the narratives surrounding this issue can help explain how and why narratives about overlapping climate issues are created and affect public perceptions, actions, and policies.

1.23. Risk Framing of Climate Issues

Another growing research field is science communication, and more studies have been examining how different framings of environmental risk can shape the way people think and act on climate issues. Media representations of environmental issues

have an enormous impact on how the public will perceive, understand, and act on an environmental issue (Fløttum & Gjerstad, 2017; Johns & Jacquet, 2018; Nisbet & Scheufele, 2009). Overlapping emergencies like glacier retreat and salmon declines often have many conflicting narratives, competing interests, and complicated science which science communicators must balance as they shape narratives (McHugh et al., 2021). Previous researchers like Norgaard (2014) have examined overlapping narratives of settler colonialism and fire suppression but have not studied climate emergencies yet. And while the communication of climate emergencies has been studied, these overlapping climate emergencies have not. As climate change worsens and more problems overlap, how science communicators frame the risks will affect the narratives that people construct. Therefore, understanding how communicators are explaining these overlapping issues is vital to understanding narratives, perceptions, and action.

Previous studies have analyzed how science communicators utilize risk framing—a concept of explaining future or potential harms of an environmental issue or crisis (Jacobsen et al., 2021; Stecula & Merkley, 2019). Some researchers like Jacobsen et al. (2021) have studied how stakeholders are conveying conflicting messages about environmental risk, while others have researched how certain phrases such as "climate emergency" or the concept of a "two-degree limit" for global temperature rise have affected public perceptions and narratives of climate change (McHugh et al., 2021; Shaw, 2013). Narratives and tones are important to the way people view environmental risk, with a growing body of research focusing on how tone can affect perceptions and values people hold surrounding an issue (Ettinger et al., 2021; Hinkel et al., 2020; Kelsey, 2016). However, these studies have only analyzed risk framing of single

climate emergencies, rather than overlapping issues, so they cannot adequately predict how perceptions and actions will shift when another layer is added with different concerns, stakeholders, and effects.

1.24. Conclusion

While research has analyzed how glacier retreat will impact salmon populations in Washington, there is no one clear answer. Overlapping climate emergencies pose more difficulties for science communicators since there are more diverse perspectives, stakeholders, and values involved. The effects of glacier retreat on salmon depend on watershed, species, and geographic location, so not all narratives, perceptions, and actions to address the issue will be in sync and some may even conflict. By understanding not only how narratives shape people's perceptions but also how people, stakeholders, and other factors shape narratives, we will be better able to understand where divergent perspectives come from and how to create effective policy for different regions. Currently, very few studies have analyzed the narratives of ice loss and salmon declines separately, and no studies have looked at the two together—or any other dual climate emergencies for that matter. It is important to understand how narratives surrounding these types of issues are shaped and interact in order to understand climate action and policy and inform future science communicators on how to navigate these issues. This study will answer how narratives of overlapping climate issues are shaped to help people understand complex science; how they diverge based on values, geographic location, types of knowledge, and time; and how framings of risk evolve for overlapping climate emergencies in comparison to single climate emergencies.

2. Background

2.1. Washington, USA

2.11. Regional Description

Both glaciers and salmon provide immense economic, ecological, and cultural value to the state of Washington, and as climate change threatens both of them, policymakers and leaders have to balance diverging narratives, conflicting stakeholder interests, and fair resource allocation. Washington State is the most glaciated state in the continental United States, so it relies on glacial meltwater in the summer to feed its rivers and provide water for agriculture, hydropower, and salmon populations (Bush, 2021). Many of the things Washington is known for rely on glacial meltwater. Washington produces more cherries, apples, pears, and raspberries than any other state, and it is the largest generator of hydroelectric power (Sandison, 2022; U.S. Energy Information Administration, 2022). In addition, its estuaries, rivers, and tributaries sustain many populations of the five Pacific salmon species found in the United States, but many of these populations have been declining in the face of warming rivers, habitat degradation, and overfishing (Governor's Salmon Recovery Office, 2020; Washington Department of Fish and Wildlife, 2020). Salmon are vital to the ecosystems, economy, Indigenous culture, and recreational pursuits of the state, so they connect a broad number of interests and stakeholders. Glaciers generally help offset some of the in-stream stressors salmon face such as low streamflows and high stream temperatures (Governor's Salmon Recovery Office, 2020; Pitman et al., 2020). However, as these glaciers shrink, Washington stands to lose not only the ice it relies on for its economy,

recreational practices, and energy source but also the salmon runs that depend on these frozen reservoirs (Governor's Salmon Recovery Office, 2020). Both glacier retreat and salmon declines are climate emergencies in their own right, but the overlap between them has led to a much wider range of stakeholders becoming involved both inside and outside Washington. This creates a perfect space to analyze how narratives of climate emergencies are shaped by stakeholder identity, location, knowledge source, and time and also compare how narratives shift for overlapping climate emergencies compared to individual ones.

2.12. Glaciers in Washington

Glaciers act as water reservoirs for several major Washington industries, including agriculture, hydropower, recreation, and fisheries. Most Washington rivers are sourced from rainwater, snowpack melt, or glacier runoff, and while all three of these sources are important contributors of water, glaciers tend to be more consistent than the other sources and contribute to rivers when the other two sources fail (M. Pelto, 2022b). Rainwater contribution to streams is generally low in summer months during the dry season, and snowpack contribution during the summer has decreased in recent years due to rising atmospheric temperatures that lead to both the reduced volume of snowpack in the mountains and earlier melt in the year (M. Pelto, 2022b; US Geological Survey, 2022). As a result, glaciers are necessary for offsetting the lower contributions of rainwater and snowpack in the hot, dry summer months. Glacier melt is higher during warm, dry summers when they are needed and is lower during cool, wet summers when they are not; this cycle creates a natural reservoir system (M. Pelto, 2022b). However, as glaciers have shrunk and some disappeared altogether, glaciers in Washington have

been offsetting low stream volumes less and less (M. Pelto, 2022a; Ryan, 2021a). As glaciers shrink, stakeholders will have to decide how to allocate limited water resources among several important sectors of Washington life (Washington Department of Health, 2022).

Glaciers are important scenic and recreational resources for the state of Washington. Glaciers attract visitors to numerous state and national parks which fuels the tourism industry in the region (Morton, 2014). For instance, the North Cascades National Park website alone lists 78 different providers of tours, guided trips, and services for tourists to explore the glaciers there, and typical tours start at around $400 per person (National Park Service, 2022). Glacier retreat will actually likely benefit the tourism industry in the short term as people participate in "last-chance tourism" and try to see the glaciers before they retreat (Islam, 2019). However, that bump in revenue may not last long after glaciers shrink so much they become inaccessible or disappear altogether. In addition to tourist interests, mountaineering is a popular sport in Washington, and gear, classes, and guided tours all provide revenue to local Washington businesses (Northwest Alpine Guides, 2022). As glaciers retreat, they will no longer be able to provide the same scenic and recreational value to Washingtonians and tourists.

In addition to subsidizing the tourism industry, glacier meltwater feeds streams that Washington's agriculture industry relies on to irrigate their crops. Streams and rivers provide a majority of Washington's irrigation water, so the loss of glaciers will likely lead to less water for crops and ultimately harm Washington's economy and farmworkers (Environmental Protection Agency, 2017). However, not all crops or

farms will be affected in the same way. While the Washington Department of Ecology predicts that Washington's production of apples and cherries could decline by $23 million by the end of the current decade, other crops that are harvested in the spring and early summer like peas will not face similarly drastic water conditions since rainwater and snowpack contribution in earlier months will help provide for these crops (Environmental Protection Agency, 2017; Washington Department of Ecology, 2022). Most of Washington's key crops are harvested in mid-to-late summer though, meaning glacier retreat and low streamflows could spell disaster for the industry (Washington State Department of Agriculture, 2022). In addition, when flows are low, large farms and those with senior water rights could be prioritized for irrigation water which will cause smaller farms and those with junior water rights to suffer according to the Washington Department of Ecology (2022). Policymakers and river managers will have to decide how to divide up water between crops and farms, likely leading to intense conflicts between different stakeholders and farm owners. As glaciers retreat, they will provide less water for the agriculture industry which will likely lead to job shortages and supply shortages for many of the fruits and vegetables that Washington produces (Washington Department of Ecology, 2022).

Washington State also consistently leads the nation in renewable energy generation, mostly due to its hydropower production (Chevalier, 2018; U.S. Energy Information Administration, 2022). Washington already generates about 75% of its electricity from renewable sources, and clean energy advocates and state policymakers are pushing to increase renewable energy even further (Specht, 2019). The legislature passed SB 5116 in 2019 which committed Washington to 100% clean electricity by

2045. Washington generates the most hydroelectric power out of any state, but due to droughts, the state has produced less energy in recent years (U.S. Energy Information Administration, 2022). Meltwater from glaciers subsidizes low summertime streamflows for hydropower production, but as glaciers recede, they produce less and less water to offset droughts (M. Pelto, 2022b; U.S. Energy Information Administration, 2022). Glacier retreat will reduce hydropower output during the melt season which will likely decrease production by between nine to 11 percent in the 2020s (Environmental Protection Agency, 2017). This is significant as Washington tries to work toward 100% renewable energy since they may need to rely more heavily on fossil fuels if hydropower production declines (Specht, 2019; Washington Department of Ecology, 2022). This will put additional stress on river system resource managers who are already trying to divide up water resources between agriculture, municipal sources, and ecosystem functions.

Finally, salmon populations in Washington also rely on glaciers to subsidize low streamflows with cool runoff during hot summer months (Governor's Salmon Recovery Office, 2020). Many salmon populations, including Chinook (*O. tshawytscha*) and Coho, migrate upstream and spawn in late summer when streamflows are at their lowest and water temperatures at their highest (Pitman et al., 2020). Salmon are a cold-water species, so streams above 70°F can be lethal to them (Governor's Salmon Recovery Office, 2020). As atmospheric temperatures increase due to climate change, stream temperatures have risen with them; warm stream temperatures threaten salmon populations and have led to mass die-offs in some cases (Flatt, 2021; Kempe, 2021). Glaciers offset the warm river temperatures in the late summer months and subsidize

low streamflows which makes it possible for salmon to migrate upstream and spawn (M. Pelto, 2022c). For example, the North Cascades glaciers in northwest Washington release approximately 230 billion gallons of water each year between June and September which aids salmon runs that would otherwise struggle in rivers like the Nooksack, Stehekin, and Skagit (M. Pelto, 2022c). Salmon are a vital ecological, economic, and cultural resource to Washington State, and as glaciers retreat, populations will find it more and more difficult to migrate upstream and survive (Governor's Salmon Recovery Office, 2020).

As glaciers continue to shrink and produce less meltwater, water resource managers will have to decide how to allocate limited water resources between the competing interests laid out in this section, namely tourism, agriculture, renewable energy, and fisheries. Stakeholders in each of these sectors have framed the risks of glacier retreat in different ways and affected people's perceptions and understandings of the issue.

2.13. Salmon in Washington

Retreating glaciers will impact many aspects of life in Washington, but one key aspect that brings together one of the broadest groups of stakeholders is salmon. Salmon in Washington rely on cool glacial meltwater in the hot summer months to survive, and people rely on salmon for everything from recreation to cultural ceremonies to income. This section will describe the ecological, economic, and tribal importance of salmon, as well as what their loss would mean for people in Washington State.

As an ecological resource, salmon provide food for other animals and nutrients for the streams in which they spawn and die. Salmon are a keystone species which

means they have a disproportionately large effect on marine, estuarine, and riparian ecosystems due to the vast number of species that rely on them for food and nutrients (Rahr, 2022; Science World, 2022). In the Pacific Northwest, salmon are an important staple of the diets of at least 137 species, including killer whales, sea lions, eagles, and grizzly bears (Cederholm et al., 2000; Rahr, 2022). If populations of salmon continue to decline, there will be a ripple effect across the food web which will harm already endangered species like sea otters (*Enhydra lutris*) and Southern Resident killer whales (*Orcinus orca*) (Bugas, 2020; Mapes, 2019). In addition to providing food for macrofauna, salmon bring nutrients from the ocean when they migrate upstream to spawn, and after they die, their decaying carcasses release these nutrients that sustain trees, freshwater plants, microbes, and small insects (Barnard, 2006). Decaying salmon increase levels of nitrogen, phosphorus, and other nutrients which support stream and river ecosystems. For example, trees on the banks of streams with salmon runs have been found to grow more quickly than those near non-salmon streams (Post, 2008). Insects that feed on salmon carcasses eventually become food for juvenile salmon emerging from the gravel and start the cycle again (Cederholm et al., 2000). The ecological role of salmon both for macrofauna and stream ecosystems in Washington cannot be overstated, and further declines in salmon could lead to the extinction of some species and collapse of food webs on which Washington relies (Dukes Seafood and Chowder, 2018).

Declines in salmon populations will also devastate the commercial fishing, seafood processing, and tourism industries in Washington that rely heavily on salmon for revenue and jobs. Commercial and recreational fishing in Washington supports an

estimated 16,000 jobs and provides $540 million in personal income (Governor's Salmon Recovery Office, 2020). Recreational fishers spend an estimated $1.5 billion annually on fishing equipment and trip-related costs in Washington which supports many rural families and businesses (Governor's Salmon Recovery Office, 2020). In Puget Sound alone, salmon fishing has an average economic impact of $100 million per year, and the steep decline in salmon populations has hurt the industry severely (Dukes Seafood and Chowder, 2017). In addition to the economic loss from fishing, salmon also provide food for whales, a huge attraction for the state. Each year, nearly one million visitors go on whale-watching tours in Washington and British Columbia, and San Juan County alone has 17 whale-watching businesses that bring in $127 million annually (Dukes Seafood and Chowder, 2017). Salmon are vital to many economic and recreational industries, and the loss of populations in Washington would put local businesses and the job market at risk.

Finally, in addition to the ecological and economic importance of salmon, they are also a key part of the traditional foods, economy, and identity of many Washington tribes. In the 1850s, the US coerced many Indigenous tribes in Washington to sign treaties, including the 1855 Treaty of Port Elliott, signed by many Puget Sound tribes including the Duwamish, Skagit, Samish, Snohomish, and Nooksack, among others (Duwamish Tribe, 2018; Pailthorp, 2021). These treaties secured the rights that tribes already had (but that the US government were threatening to take away) to fish and hunt in the "usual and accustomed areas" in return for ceding their lands to the federal government (Pailthorp, 2021). Access to these cultural resources, including salmon, is vital to Washington tribes, and several court cases, such as *U.S. v. Washington* (known

as the Boldt Decision), have been fought over the State of Washington's failure to provide equitable access of salmon harvests to Indigenous tribes (Nooksack Indian Tribe, 2022; Whisner, 2022). Many Indigenous tribes in Washington rely on salmon for sustenance and their economy as well as cultural practices and identity. Coast Salish tribes, including the Muckleshoot Tribe and the Lummi Nation, refer to themselves as "salmon people" who "stand to lose more than anyone else" as salmon populations decline (Kim, 2021; Peeples, 2016). The Nooksack Tribe has said that salmon are their heritage and that "without those fish, we don't exist" (Ryan, 2021c; Salmon Need Water, 2022). These tribes are place-based and cannot just relocate to different watersheds if the salmon populations they have been managing and harvesting since time immemorial go extinct (Grah & Beaulieu, 2013). As a result, it is vital that salmon populations in Washington are restored and protected, especially as glaciers melt and create poor river conditions for salmon.

Washington State relies on salmon populations for their intrinsic ecological, economic, and cultural value, and the loss of salmon would be devastating to the region. Since salmon are vital to so many groups, there are many stakeholders and perceptions both of their importance and the risks involved with their decline. Many of these stakeholders overlap with those focused on glaciers and glacier retreat in Washington, and the most prominent stakeholders for both glaciers and salmon populations will be discussed in the following section.

2.2. Prominent Groups Analyzed

Since both glacier retreat and resulting salmon declines will threaten many industries, ecosystems, and people in Washington, these issues are frequently discussed

by stakeholders and communicated to the public which shapes narratives, perceptions, and actions in Washington. The most prominent stakeholders in both of these emergencies that are actively communicating with the public are government entities, news media outlets, environmental nonprofits, and Indigenous tribes and tribal organizations. These four groups are some of the most vocal on the issue and also the most likely to interact with the public. Academic sources were not included due to the low amount of direct interaction with the public, as research is usually communicated indirectly by other sources like news media outlets. Similarly, industry leaders were left out either due to their lack of involvement in one of the emergencies or due to their lack of direct role in shaping narratives (many utilize government entities, news media outlets, and environmental nonprofits to influence perceptions).

2.21. Government Entities

Washington government entities include federal, state, and local agencies, legislatures, and policymakers. Most of the federal communication about glacier retreat and salmon declines comes from agencies such as the US Geological Survey which has dozens of projects and studies researching glacier recession in the region, such as their Glaciers and Climate Project (US Geological Survey, 2015). Another prominent federal agency involved in these emergencies is the National Oceanic and Atmospheric Administration (NOAA) which tracks, studies, and manages Pacific salmon fisheries in the US alongside state and community partners. The NOAA Restoration Center partners with NOAA Fisheries to conduct and fund restoration projects all over Washington for salmon populations, and NOAA Fisheries regularly publishes articles on their news site about new studies, projects, and findings related to Pacific salmon and glacier retreat

(NOAA Fisheries, 2021, 2022a, 2022b). Since both ice loss and salmon declines are issues localized to the West Coast, federal policymakers tend to talk about the emergencies in more general terms or as asides in a discussion of climate change, but Washington's federal legislators, including Senators Patty Murray and Maria Cantwell and Representative Pramila Jayapal, have been vocal about how climate change is affecting salmon and glaciers and have worked to secure funding for salmon in multiple infrastructure bills (Jayapal, 2022; Murray, 2017, p. 201, 2021). Additionally, US Secretary of the Interior Deb Haaland (*Laguna Pueblo*) has visited multiple Washington tribes and discussed how melting glaciers affect salmon and the salmon people that rely on them (Mapes, 2021).

At the state government level, agencies like the Governor's Salmon Recovery Office (GSRO), Washington Department of Ecology (WDE), and Washington Department of Natural Resources (WDNR) are key sources of information and narratives about glacier retreat and salmon. The GSRO was created by the state legislature in 1997 to coordinate a statewide recovery strategy for salmon populations that were in crisis, and they release a "State of Salmon" overview report every two years that explains the current status of all Washington salmon populations, current threats, and updates on how restoration projects are progressing (Governor's Salmon Recovery Office, 2020). The WDE and WDNR both research glacier retreat and salmon, and they publish their findings both as academic research papers and also as blog posts and media articles to reach a more public audience (Clifford, 2022; Washington Department of Natural Resources, 2022). They also fund local restoration and research projects. Washington state policymakers are some of the most vocal on the

overlapping issues, such as Governor Jay Inslee who staked his campaign on salmon recovery and State Representative Debra Lekanoff (*Tlingit*), the only Indigenous member of the Washington State Legislature, who has proposed and sponsored several bills that would work to protect and recover salmon populations (Amos-Landgraf, 2021; Inslee, 2021).

Finally, at a local level, the most prominent stakeholders are watershed councils, climate committees, and public works or public utility departments. Watershed councils are generally formed by local governments and conduct research and restoration projects on rivers. Most watershed councils in Washington are very vocal about salmon, while those on glaciated rivers like the Skagit and Nooksack tend to be more vocal about both salmon and glaciers. Climate committees are generally in charge of advising local governments on climate action, such as the Climate Impacts Advisory Committee in Whatcom County which advises the Whatcom County Council and works to develop resolutions and include public voices in decision making (Climate Impacts Advisory Committee, 2021). Public works departments and public utility districts tend to focus more on water supply, municipal uses, and irrigation, so their media tends to follow glaciers and water availability more than salmon. Typically, these local sources are focused on a specific issue or section, so their narratives and information are more pointed and less broad than the state and federal government sources.

2.22. News Media Outlets

Media coverage of glacier retreat and salmon declines comes from sources both inside and outside of the state. Outside sources mostly include large national sources such as National Public Radio, the New York Times, and National Geographic. These

outlets tend to focus on overarching themes of glacier retreat and salmon declines, especially in relation to climate change (Ahearn, 2014; H. Fountain, 2019; Randall, 2021). Other outside sources include smaller state sources from nearby states like Oregon Public Broadcasting (OPB). OPB talks about glacier retreat and salmon declines in both Oregon and Washington, especially for shared rivers or salmon populations (Ryan, 2021b).

Within the state of Washington, much of the coverage of glacier retreat and salmon comes from larger newspapers like the Seattle Times and the Olympian, especially when they are covering new policy or government action on the issues (Bush, 2021; Ryan, 2022). The Seattle Times' proximity to Puget Sound and several vital salmon rivers leads to a lot of coverage on these topics, especially since Seattle has a lot of environmental activists and nonprofits working on these issues. Smaller newspapers, especially ones near glaciated watersheds with salmon like the Peninsula Daily News (based in Port Angeles) and the Salish Current (based in Bellingham), also frequently cover glaciers and salmon (Cauvel, 2021; Peninsula Daily News, 2013). These newspapers tend to focus more on community impacts and action rather than state-wide or national impacts of glacier retreat and salmon.

2.23. Environmental Nonprofits

The environmental nonprofits that shape narratives of glacier retreat and salmon declines through information dissemination tend to either be small nonprofits focused on water resources or large national and international climate organizations. Large nonprofits include the Nature Conservancy, the Sierra Club, and the World Wildlife Fund. All three of these nonprofits have very broad goals and interests; the Nature

Conservancy focuses on conservation and biodiversity, the Sierra Club works on grassroots environmental policy and preserving natural areas, and the World Wildlife Fund is an NGO that is dedicated to conserving endangered species. These large organizations can reach more people due to their size and outreach, but glacier retreat and salmon declines tend to just be one minor part of their work, rather than the main focus. The main exception to this trend for this study was the Wild Salmon Center, an international nonprofit that is specifically focused on protecting and restoring Pacific salmon. While they are technically international, they solely work in the North Pacific researching Pacific salmon, so their work is still relatively localized and focused on one specific area, similar to the smaller environmental nonprofits based in Washington and focused on watersheds (Rahr, 2022).

The small, local environmental nonprofit category includes groups like Save our Wild Salmon, a group based in Seattle that works to restore wild salmon and steelhead to Pacific Northwest rivers, and the North Cascades Conservation Council, another Seattle-based group that works to protect and preserve the North Cascades' scenic, recreational, educational, and wilderness values. These smaller nonprofits are generally much more focused on one specific issue, and though they reach a smaller audience, their place within communities likely gives them more credibility and a lot of influence on narratives and perceptions of the issues.

2.24. Indigenous Tribes and Tribal Organizations

The final stakeholder group identified for the overlapping issues of glacier retreat and salmon declines was Indigenous tribes and tribal organizations. As discussed in section 2.13, salmon populations are vital to the identities, economies, and traditional

foods of many Indigenous tribes in Washington, and tribes have been extremely vocal about salmon declines and active in salmon restoration projects. For example, the Nooksack Indian Tribe has been monitoring water quality, streamflows, and salmon populations in the three forks of Nooksack River (two of which are glaciated) for over a decade and has worked with the Lummi Tribe to restore habitat for salmon in the river (Cauvel, 2021; Ryan, 2021a). The Sauk-Suiattle Tribe has installed logjams on the Sauk River to create cold water refuges for salmon and has spoken about how warming streams will harm salmon (Northwest Treaty Tribes, 2021). In contrast to other stakeholders, many Indigenous stakeholders can bring in historical knowledge since time immemorial and also have a legal right to salmon due to the treaties which can shift perceptions of the issues and actions to fix them.

In addition to sources from individual Indigenous tribes in Washington, there are several Indigenous coalitions, organizations, and media outlets that also work to communicate these issues to the public. The Northwest Indian Fisheries Commission (NWIFC) is a natural resources management support organization for the 20 treaty tribes in western Washington, created following *US v. Washington* which confirmed tribes had treaty-reserved fishing rights and established tribes as co-managers of natural resources in Washington. Northwest Treaty Tribes (NWTT) is the communications arm of the NWIFC that writes about tribal natural resources news with frequent guest authors from different tribes. Indian Country Today is a nonprofit Indigenous news enterprise that covers tribes and Native people throughout the Americas.

2.3. Conclusion

The state of Washington is heavily dependent on salmon and the glaciers that sustain them. Narratives of these two overlapping climate issues affect public perceptions, actions, and policies surrounding the issues, so understanding how stakeholders frame these issues and shape narratives surrounding them is key to understanding conflicting viewpoints from the public and how these issues are framed together.

3. Methods

3.1 Research Questions

1. What narratives of glacier retreat and salmon declines exist, and among those, which ones are the most common/prevalent across the different stakeholder groups?
2. How do these narratives compare to, expand on, or contradict each other depending on which stakeholder they come from?
3. How are narratives of climate issues shaped by stakeholder identity, geographic location, knowledge sources, and time?
4. How are narratives of overlapping climate emergencies different from narratives of a single emergency, and what might cause these differences?

3.2 Data Sources

I found sources for this study using search engines and the search functions on the websites of the aforementioned prominent stakeholder groups to simulate how the general public is likely to find these articles. All 115 sources mentioned both glaciers and salmon, and most (83.5% or 96 sources) focused on either glacier retreat, salmon, or both. Sources that did not specifically focus on one of these generally focused on more broad topics such as climate change or riparian ecosystems. A majority of the data sources I found (53.9% or 62 sources) were articles, but I used other media such as blog posts, webpages, educational videos, and short reports as well. All sources were published after 2000, with 94.7% published in the past decade (2011-2021).

Of the 138 sources initially collected, I kept 115 for analysis. I discarded sources if they failed to mention glaciers and salmon; if salmon, glaciers, or some related topic (e.g. climate change) were not the primary focus; if they were inaccessible to the public (100-page reports, dense academic papers, password-protected webpages); or if they did

not focus at least in part on Washington (interstate and international rivers and salmon stocks shared by Washington were included).

3.21. Stakeholder Sources

The study analyzed approximately even numbers of sources from the four stakeholder groups, with 25 government sources, 31 news media sources, 31 Indigenous tribes and tribal organization sources, and 28 environmental nonprofit sources. For this study, stakeholders are defined as the producers/publishers of the information or source. Some sources, such as watershed councils, were difficult to separate between these categories. For instance, many watershed councils are established by government bodies and inform government decisions but are labeled as environmental organizations. However, as their role was closer to that of an advisory board than a water restoration nonprofit, I chose to include these as government entities.

I split government sources into federal, state, and local sources, and most of these came from direct stakeholders in either salmon, glaciers, or both (Table 1). I found news media sources by identifying the top ten most-read Washington State newspapers based on public relations reports and websites, and I used the search functions of those news media outlets to find articles, op-eds, and interviews related to salmon and glaciers, as shown in Table 1 (Agility PR Solutions, 2021). In addition, I inputted certain key phrases (such as “glacier retreat and salmon” or “salmon declining Washington glaciers”) into search engines to find popular news articles that likely reached people in Washington despite being from outside sources. Sources from environmental nonprofits were found by searching for the nonprofits in Washington, navigating to their websites, and searching for keywords and phrases, similar to the

other stakeholders (Earth Focus Group, 2022). For Indigenous tribes and tribal organization sources, I consulted the websites of the 29 federally recognized and five non-federally recognized nations and tribes of Washington, in addition to a few Indigenous or Indigenous-led coalitions and news organizations (Table 1). I only included data sources made publicly available by Indigenous authors and sources, rather than outsiders' publications about Indigenous peoples to avoid potentially intrusive and inaccurate data that may come from outside sources about these groups. Information reserved for tribe members and Indigenous peoples was not used for this study.

Stakeholder	*Sources Used*
Government	***Federal:*** *Environmental Protection Agency; National Oceanic and Atmospheric Administration; National Parks Service; US Geological Survey* ***State:*** *Washington Department of Ecology; Washington Department of Natural Resources; Washington Governor's Office; Washington Recreation and Conservation Office* ***Local:*** *King County; Nooksack Salmon Enhancement Association; Pierce County; Seattle City Light; Skagit Watershed Council; Whatcom County Public Utility District*
News Media Outlets	***Washington Media:*** *Go Skagit; Herald Net; Peninsula Daily News; Salish Current; The Bellingham Herald; The Columbian; The Olympian; The Seattle Times; The Spokesman-Review* ***Out-of-State Media*** *GlacierHub; National Geographic; National Public Radio; Oregon Public Broadcasting; Public Broadcasting Service; The Guardian; The New York Times; The Washington Post*
Environmental Nonprofits	***National/International Nonprofits*** *American Geophysical Union; The Nature Conservancy; Natural Resources Defense Council; Sierra Club; The Outdoor Society; Wild Salmon Center; World Wildlife Fund* ***Washington Nonprofits*** *InStream Conservation; Land Trust Alliance; North Cascades Conservation Council; No Water No Life; Save Our Wild Salmon*
Indigenous Tribes and Tribal Organizations	***Indigenous Tribes*** *Nooksack Indian Tribe; Nisqually Indian Tribe; Lummi Nation; Port Gamble S'Klallam Tribe; Puyallup Tribe; Quinault Indian Nation; Samish Indian Nation; Sauk-Suiattle Indian Tribe; Squaxin Island Tribe; Stillaguamish Tribe of Indians; Swinomish Indian Tribal Community* ***Tribal Organizations*** *Northwest Treaty Tribes; Northwest Indian Fisheries Commission*

Table 1: Stakeholder Sources

This table includes all 56 sources from which media were taken, divided into their four stakeholder groups.

3.3 Analysis

To identify different narratives and framings of glacier retreat and salmon declines in Washington, I used coding and analysis processes common in narrative analysis and risk framing studies (Jacobsen et al., 2021; Moulton et al., 2021). First, I

read through each source and took notes on themes, narratives, and topics, identifying over 600 total narratives and themes (many of which were similar/identical) throughout the 115 sources. I then combined and condensed similar/identical narratives into 20 key narratives with a total of 24 sub-narratives that fell within the larger overarching narratives. These made up the 44 codes I would use in my analysis (Table 2). I verified that this codebook of 20 parent codes and 24 child codes encompassed all of the themes by returning to my coding notes and ensuring each theme, narrative, and topic fit within at least one code. Using Dedoose, a web-based qualitative software program, I marked each occurrence in all 115 sources, which allowed me to use quantitative analysis to quickly identify the most common narratives of glacier retreat and salmon declines in Washington (*Dedoose*, 2021).

Category	*Narrative*	*Sub-narrative*
Importance of Glaciers	*1. Glaciers are important (non-salmon related)* *2. Glaciers are important (salmon-related)*	*- Agriculture; Drinking water; Hydropower; Scenic/recreational* *- Cold water; Stream volume*
Importance of Salmon	*3. Salmon are important/loss will be felt culturally* *4. Salmon are important/loss will be felt ecologically* *5. Salmon are important/loss will be felt economically* *6. Salmon are important/loss will be felt recreationally* *7. Salmon are important/loss will be felt tribally*	*- Macrofauna, Stream Nutrients* *- Commercial fishing/seafood industry; Tourism* *- Identity/history/place; Economy; Traditional foods/health*
Salmon Declines and Glacier Retreat	*8. Glacier retreat is benefitting/will benefit salmon* *9. Glacier retreat is having/will have mixed results for salmon* *10. Glacier retreat is harming/will harm salmon* *11. Glaciers are retreating quickly in the Pacific Northwest* *12. Glacier retreat will impact water availability and life in Washington* *13. Salmon populations are declining, in crisis, or threatened* *14. Glaciers and salmon connect many sectors; competing interests*	*- Increased habitat; Regulating temperatures in cold watersheds* *- Depends on species; Depends on location; Depends on watershed type* *- As adults (streamflow); As adults (temperature); As juveniles (scouring/food/temperature)* *- Climate change; Overfishing; Dams*
Solutions, Strategies, and Future Action	*15. Need to be doing more to address the issue* *16. There is something being done* *17. There is something the audience can do* *18. Collaboration is important to address this issue* *19. Communication is important to address this issue* *20. Education is important to address this issue*	

Table 2: Codebook of Glacier Retreat and Salmon Narratives

This table includes the 20 narratives and 24 sub-narratives used to code sources for this project. They are divided into four categories: importance of glaciers; importance of salmon; salmon declines and glacier retreat; and solutions, strategies, and future action.

In addition to identifying common narratives, this study seeks to understand how narratives originate, are shaped, and diverge, as well as how overlapping climate emergencies compare with single crises. To analyze this, I used the descriptor function in Dedoose to sort sources based on attributes including stakeholder identity, geographic location, source of knowledge, medium, focus, and time (Table 3). From there, I could analyze how different descriptors correlated with certain narratives and identify potential causes of these correlations that might explain how narratives are shaped. I could also compare the narratives and risk framings of sources that focused on overlapping climate emergencies versus just one. All this data entry was categorical, with the descriptors and options shown in Table 3.

Descriptor	*Options*
Stakeholder Identity	*Government, Environmental Nonprofits, Media, Indigenous Group*
Government Type*	*Federal, State, Local*
Geographic Location	*Within Washington, Outside Washington*
Source of Knowledge**	*Research, Government, Indigenous/Tribal, Personal Experience/Opinions*
Medium	*Academic Paper, Article, Artwork, Blog Post, Interview, Newsletter, Op-Ed, Report, Story, Story Map, Video Educational Material, Webpage, Written Educational Material*
Focus	*Glaciers, Salmon, Glaciers and Salmon*
Year***	*Before 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021*
Month***	*January, February, March, April, May, June, July, August, September, October, November, December*

Table 3: Quantitative Analysis Descriptors

This table shows the descriptors and options used to run quantitative analysis in Dedoose.
*Only applicable to government sources
**Primary and Secondary Cited Sources were chosen, sources that did not cite other sources were not included in this descriptor
***based on when the source was published; sources without dates such as website pages were not included in this descriptor

To analyze the prevalence of narratives overall and in certain categories, I looked for the presence of each narrative/code in each source or category, using the Dedoose Code Count Table analysis option. By using presence as a marker, I could remove some potential error that could have occurred in how the codes were marked. For instance, the format of some sources allowed lines of text to be highlighted and coded while other sources did not have text that could be highlighted and instead had to be marked by

drawing a rectangle around the region of text (Figure 1). This led to different summed areas of coded regions, which could have weighted the prevalence differently. By using presence as a metric instead, it negated this potential error.

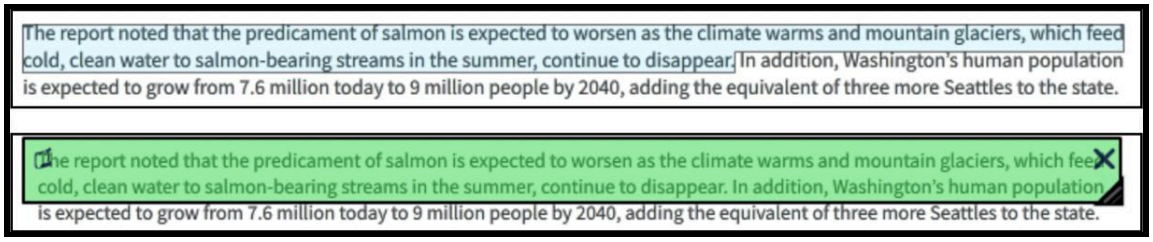

Figure 1: Showing Error Risks in Dedoose

Two images from a Washington Recreation and Conservation Office source show how highlighting text (top) versus using rectangles (bottom) affects the total area highlighted.

4. Results and Discussion

4.1. A Common Story of Glacier Retreat and Salmon Declines

The first section of the results and discussion will examine what common narratives exist, how an overarching narrative is formed from small pieces, and how these narratives compare to, expand on, or diverge from each other.

4.11. Glacier Retreat will Harm Salmon and Put Communities at Risk

The collective way that stakeholders frame the risks and solutions associated with glacier retreat and salmon declines forms narratives of the issues—stories that link together what is happening, the risks involved, and what we can do to fix it. These narratives in turn affect public perceptions of the issues and climate action at both a local and non-local level. Understanding which narratives exist and which are the most prevalent is therefore important in understanding public perceptions of the issues, responses to policy, and action (Fløttum & Gjerstad, 2017). This study identified prevalent narratives across the four categories outlined in the methods as demonstrated in Figure 2, a word cloud of all 44 narratives and sub-narratives. This word cloud provides a visual representation of the narrative prevalence throughout the 115 sources.

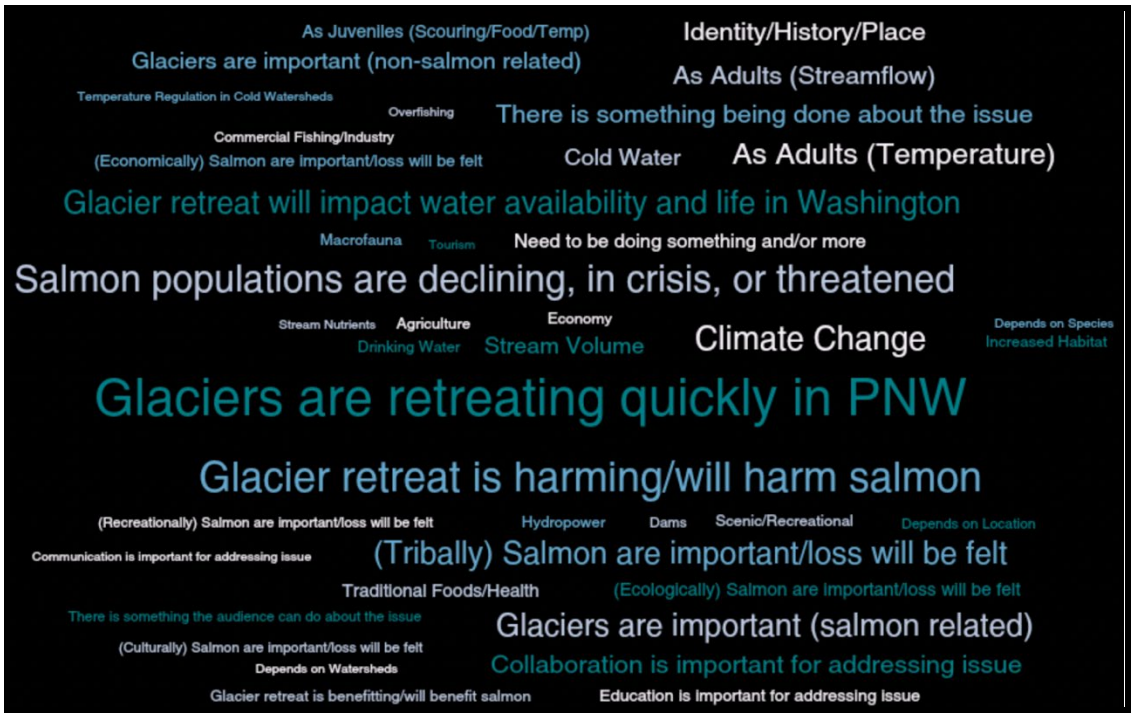

Figure 2. Narrative Word Cloud

This figure shows the prevalence of all 44 narratives and sub-narratives identified for this study. Text size is proportional to prevalence, with the more popular narratives appearing larger in the cloud.

As shown in Table 3, narratives of glacier retreat and salmon declines fell into four different categories: importance of glaciers; importance of salmon; salmon declines and glacier retreat; and solutions, strategies, and future action. Within each of these categories, certain narratives were more prevalent than others, and these narratives can be put together to form an overarching narrative, or story, of glacier retreat and salmon declines in Washington.

For the glacier importance category (Table 2), sources primarily highlighted the importance of glaciers for water availability for a number of sectors: agriculture, hydropower, fisheries, and drinking water. Sources framed the risk of glacier retreat as something that would cause both present and future water scarcity in summer months

when it is needed the most which will affect both human and salmon needs. They predicted conflicts between the agriculture, hydropower, municipal, and fishing industries as water becomes a contested interest. This framing of glacier importance has been common across multiple other studies, including Moulton et al. (2021) and Gagné et al. (2014). Narratives of dwindling water supply and future conflict are common themes of glacier retreat across the world (Carey, 2007; Klare, 2020), due to the way the risk of losing glaciers is framed. By highlighting the risks retreating glaciers pose to water supply, sources in this study also influenced narratives of why glaciers are important.

Meanwhile, for the salmon importance narratives (Table 2), sources often focused on the tribal and economic importance of salmon. For tribal value, sources tended to focus on how salmon are vital to the traditional foods and health, tribal economy and customs, and sense of identity and place of many tribes, such as the Nooksack Indian Tribe and Sauk-Suiattle Indian Tribe. In terms of economic value, sources discussed the role salmon play in both the seafood and tourism industries, and they explained the potential lost revenue and impacts on jobs and small businesses. Some sources also mentioned the importance of salmon to ecosystems and food webs, especially in relation to the Southern Resident killer whales in the Puget Sound—an endangered population that relies on Chinook salmon as a staple of their diet.

By highlighting what communities stood to lose from salmon declines, sources created narratives of the tribal, economic, and ecological importance of these populations. While significantly fewer studies have looked at narratives and risk framing of salmon or fisheries declines, one study found that cultural and economic

narratives of salmon importance were common in the Skagit watershed in Washington State and that diverging narratives and perceptions led to conflict over salmon management and restoration practices (Breslow, 2014a). The findings of this thesis support Breslow's findings and elaborate on them by including smaller sub-narratives within these categories and expanding the study to more stakeholders rather than just Indigenous groups and farmers.

Within the third category (glacier retreat and salmon declines), sources highlighted that glaciers were retreating quickly and that salmon were declining or threatened in Washington, both of which have been identified by other studies (Breslow, 2014a, 2014b; Gagné et al., 2014; Jackson, 2015). However, by looking at this as an overlapping climate problem, another key narrative emerged: glacier retreat will directly harm salmon populations. Sources focused on how shrinking glaciers will lead to low streamflows and high water temperatures, threatening salmon populations. Since previous studies analyzing risk framing and narratives of glaciers and salmon individually have not looked at this as an overlapping climate issue (Breslow, 2014a; Gagné et al., 2014), they have not identified this narrative despite it being common in discussions of both glaciers and salmon.

Within the final "future action, solutions, and strategies" category, sources primarily focused on current action and the importance of collaboration for projects of restoration. Collaboration was mentioned more than twice as often as education and six times as often as public communication in terms of which strategies were prioritized for future action. Sources often justified the necessity of collaboration by focusing on how rivers span many communities, sectors, and groups of people. Many groups called for

more to be done and explained what they were currently doing and how the audience could get involved. For example, an article about the Swinomish Tribe's climate action described the work the tribe was doing and provided a list of ways the community could get involved and reduce their carbon footprint (Neumeyer, 2010). Most of these narratives are common in other climate narratives studies, but there was a surprising lack of "doom-and-gloom" style narratives, with groups instead focusing on what could be still done (Hinkel et al., 2020).

Piecing together the most prevalent narratives from each of these categories allows us to see the overarching story of glaciers and salmon:

> Glaciers are important for sustaining salmon populations, many of which are threatened with extinction. Glaciers are retreating quickly in Washington, leading to a water shortage which will exacerbate the problems salmon are facing with climate change. Something needs to be done to save the salmon and protect the communities that rely on them for economic and cultural purposes. Collaboration between different stakeholders will be important for effectively addressing declines.

This overarching story focused more on the importance of salmon than glaciers to communities and what can be done to restore salmon populations. This disparity was likely due to both psychological distance and achievable action. As Leviston et al. (2014) found, retreating glaciers are often used as iconic representations of climate change, but they create a psychological, moral distance between the general public and the environment. Many people first and foremost feel a moral responsibility to act when other humans are affected, followed by other animals (especially charismatic macrofauna), and finally for non-living environmental objects like glaciers (Leviston et al., 2014). This was evident even in the typical risk framing by sources in this study: "glacier retreat will decrease water supply which will harm human industries, like

fishing, agriculture, and hydropower." This contrasted with the risk framing of salmon loss which is that "the loss of salmon will directly harm cultural and economic practices." The framing of salmon loss was much more directly linked to humans without the extra step which emphasizes the importance of salmon over glaciers.

The second reason for the disparity between narratives of salmon and glacier importance was a sense of helplessness associated with glacier retreat. Because there is a delay in atmospheric warming from carbon emissions, even if all emissions completely stopped today, atmospheric temperatures would continue to rise about one more degree Fahrenheit and cause many Washington glaciers to shrink considerably or disappear (Rood, 2014). As a result, it is very easy for narratives of glacier retreat to fall into doom-and-gloom categories. On the other hand, salmon declines are reversible if action is taken, and salmon populations have proven their resilience in coming back after habitat restoration, barrier removal projects, and climate policy (Honea et al., 2009). For instance, one of the sources used in this study, the 2020 Washington State of the Salmon report highlighted how a collaborative stream restoration between the Yakama Nation and Chelan and Grant Counties helped salmon recover (Governor's Salmon Recovery Office, 2020). By framing the overlapping issues of glacier retreat and salmon more as an issue for salmon, stakeholders can bypass both the psychological distance and feeling of helplessness that comes with glacier retreat. This moves narratives away from "doom-and-gloom" and into empowerment, as discussed by Hinkel et al. (2020).

A majority of sources that talked about future strategies for addressing salmon declines and glacier retreat focused on collaboration with different stakeholders. Many

of the restoration projects mentioned for salmon are collaborative projects, such as the Entiat River side-channel habitat restoration in Chelan County, which brought together the Yakama Nation and local public utility districts (Governor's Salmon Recovery Office, 2020). The prevalence of collaborative projects is important not only because there are so many different stakeholders involved but also because it shows that those involved in these climate change issues are moving away from the knowledge deficit model commonly used in climate change sources in the past (Thomas et al., 2019). Science communication studies such as Thomas et al. (2019) have shown that the knowledge deficit model—when experts assume people do not care about climate change because they do not understand it and think educating them will fix that—is generally ineffective for science communicators to use and based on faulty assumptions. Co-production and collaboration models—where community knowledge is valued and incorporated just as much as scientific knowledge—are much more effective for addressing climate issues (Bremer & Meisch, 2017; Lemos & Morehouse, 2005). The presence of these models throughout sources demonstrates that these models are likely becoming more popular within climate change work, which supports findings from other studies, including (Bremer et al., 2019).

The overarching story seems simple: glaciers are retreating which hurts salmon and will harm communities, so we need to do something about it. However, this oversimplified version does not take into account diverging or less common narratives that are still vital in shaping perceptions and action on glacier retreat and salmon declines. The following sections will explore what these narratives are, where they

come from, and how they are vital to understanding perceptions and action on climate change despite being less prevalent.

4.12. Exceptions and Different Framings

Despite the prevalence of certain narratives, the issue of glacier retreat and salmon declines cannot be summarized in one sentence. This section will focus on presenting the alternate narratives that emerged throughout the sources that still play an important role in how people understand the story of glacier retreat and salmon declines.

One of the key spots of divergence in the story of glacier retreat and salmon declines is how glacier retreat will impact salmon populations. While a majority of sources stated that glacier retreat will harm salmon populations, some sources said it will have mixed results or benefit certain populations, either by exposing new stream habitat as glaciers shrink or by no longer contributing cold water to rivers that are too cold for salmon populations currently (DeNies, 2020; H. Fountain, 2019). These alternate narratives could change the policy landscape of glacier retreat and salmon: if glacier retreat will harm salmon, then restoration of streams and mitigation is important, but if glacier retreat will benefit salmon by creating new habitat, then we need to focus on protecting habitat that does not exist yet from future development. Even within the narrative that glacier retreat will harm salmon, there are further contradictions and intricacies. Most sources focused on the ways that glacier retreat would negatively impact spawning adult salmon in streams as a result of rising temperatures and lower streamflows (Figure 2). However, other sources talked about the impacts of glacier retreat on juvenile salmon, such as glacial floods scouring streambeds and washing

away eggs or affecting food sources (Walker, 2015). This adds another layer to how to best protect and restore salmon populations: where should the work start and which life stage is the most vulnerable? Different narratives of the issue will shape how people perceive the risks involved and which policies are fought for and enacted to help salmon populations.

Another common area of variance was the narratives of importance. While almost all 115 sources mentioned the importance of glaciers and salmon in some way, the actual reasons varied significantly. For glaciers, many sources identified glaciers as valuable for producing cold meltwater for salmon populations, while other sources mentioned non-salmon reasons. Glaciers also provide water resources for drinking water, agriculture, and hydropower, all of which were brought up as values. However, the scenic and recreational value of glaciers—the only value assigned to them that was not based on the water they produce for other sectors—was mentioned significantly less than the other sources and often by outsider groups (Figure 2). In regards to salmon, two key narratives identified throughout sources are the importance of salmon for Washington's economy and the Indigenous peoples in the region. However, other sources also highlighted the ecological role salmon play in food webs and stream ecosystems, and a few sources also mentioned the recreational value of salmon. The ways salmon populations are restored—and which populations are prioritized—will vary depending on the framing of their importance, so understanding the differences and who is discussing which narrative the most is important to understanding policy decisions and perceptions of who is at risk.

Finally, the structure of the narratives themselves also differs, as shown in Table 2 in the Methods section. Conflicting narratives focused on different aspects of the story of glacier retreat and salmon. For instance, when sources talk about the negative impacts of glacier retreat on salmon, they discuss the life histories and stages of salmon (e.g. glacier retreat will harm juvenile salmon). However, when sources talk about the benefits or mixed effects, they tend to focus more on the characteristics of populations as a whole, such as where they live, what species they are, and the kind of watershed they live in. Similarly, narratives about the importance of glaciers primarily focused on the value glaciers provide as a water resource rather than their own intrinsic value, with the exception of the scenic/recreational argument. The different framings of these narratives help explain why the narratives diverge so much: perceptions of the harms of glacier retreat or importance of salmon and glaciers change for different people, and all of these narratives form the collective story of glacier retreat and salmon declines.

Based on this study and other research, we know that climate change narratives diverge from each other. In the case of glacier retreat and salmon, the way sources framed the risk (or benefits) of glacier retreat changed the narratives and caused them to diverge. However, there is still very little research on why narratives diverge and how narratives are created and shaped. The following section will look into how both the prevalent and alternate narratives may have been created and shaped by stakeholder identity, geographic location, knowledge sources, and time.

4.2. Shaping Narratives

While very few studies have looked into how climate narratives are shaped, there are some proposed reasons. Some studies, like Briley et al. (2015)and Jacobsen et

al. (2021), attribute narrative creation and shifts at least in part to stakeholders and overarching groups. Other studies have suggested narratives may be attributed to the type of knowledge or temporal aspects (Alexander et al., 2011; Coulter et al., 2019; Risbey, 2008). This thesis will expand on previous research to compare the impacts of four potential ways that narratives were shaped: stakeholder identity, geographic location, knowledge sources, and time. By understanding how narratives are created and shaped, we can better understand how the public is influenced by their perceptions and actions on climate issues.

4.21. Stakeholder Identity

One potential shaper of narratives that previous studies have identified is stakeholder identity (Blaxekjær & Nielsen, 2015; Jacobsen et al., 2021). This study analyzed how narratives of glacier retreat and salmon declines shifted across four key stakeholders in the state to understand how stakeholder identity can shape narratives: government, news media outlets, environmental nonprofits, and Indigenous tribes and tribal organizations.

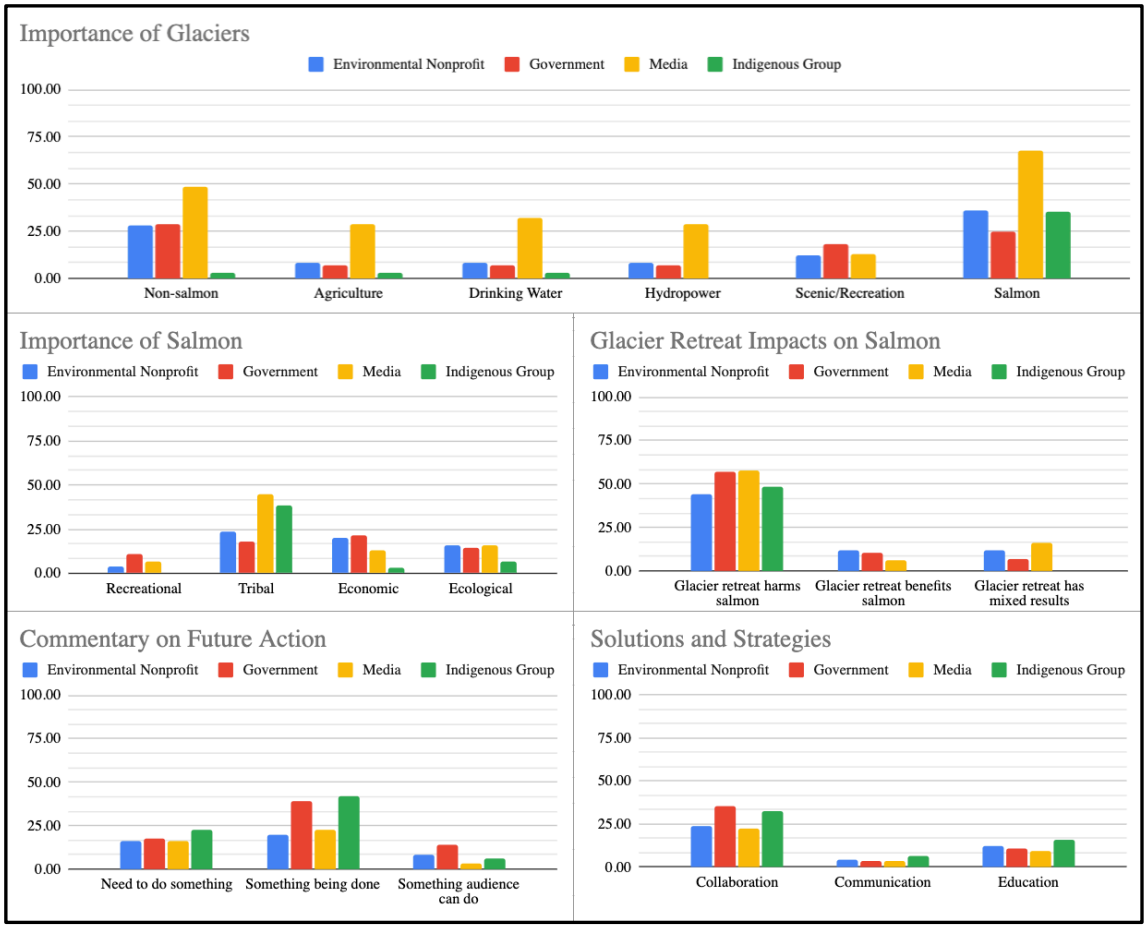

Figure 3. Stakeholder Narratives

This figure shows narrative prevalence in sources as a percent of the total number of sources in each stakeholder category—environmental nonprofits (blue), government (red), media (yellow), and Indigenous groups (green). The figure includes defining narratives from each of the four categories: Importance of Glaciers (top), Importance of Salmon (middle left), Glacier Retreat Impacts on Salmon (middle right), and Commentary on Future Action/Solutions and Strategies (bottom left and right).

4.211. Government

Government sources—including agency press releases, reports, legislative updates, and blog posts—often reinforced the overarching story but also included some alternate supplementary narratives. Government sources highlighted the economic and recreational importance of salmon more than other stakeholders (Figure 3), and they

emphasized the importance of glaciers for both salmon and non-salmon purposes. As shown in Figure 3, they were also the most likely of all the stakeholders to discuss the scenic/recreational value of glaciers and the most likely to discuss the potential harms of glacier retreat to juvenile salmon—though this narrative was still less common than harms to adult salmon. In terms of future action, government sources emphasized the importance of collaboration more than any other stakeholder and also were one of the top groups to explain what was currently being done.

Stakeholders that are trying to reach a larger, more diverse audience tend to use more medium types to reach different people. Government sources used seven different types of media, primarily articles, webpages, and blog posts. Using so many different types of sources demonstrates an effort to reach larger audiences, although they use fewer media than other sources.

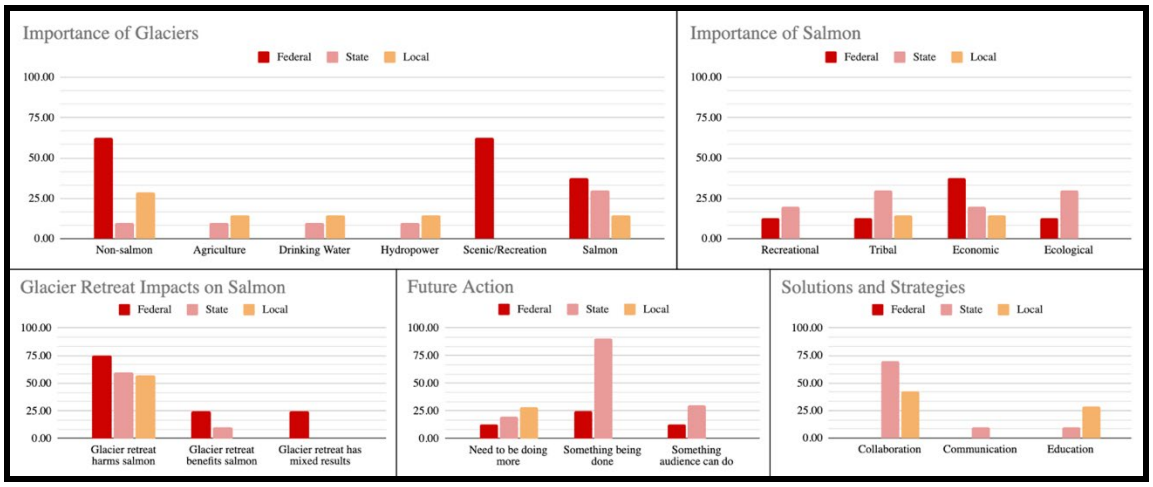

Figure 4. Types of Government Narratives

This figure shows narrative prevalence in sources as a percent of the total number of sources in each government sector category—federal (dark red), state (pink), and local (orange). The figure includes defining narratives from each of the four categories: Importance of Glaciers (top left), Importance of Salmon (top right), Glacier Retreat Impacts on Salmon (bottom left), and Commentary on Future Action/Solutions and Strategies (bottom middle and right).

This study also analyzed government sources at a smaller scale since there were clear divides between federal, state, and local government sources. Federal sources were more likely to mention the potential benefits of glacier retreat for salmon than state and local sources, but they still primarily stated that glacier retreat would harm salmon. They tended to emphasize the economic importance of salmon and the scenic/recreational importance of glaciers, making them the only group in the entire study to talk more about the scenic/recreational value of glaciers over the importance of glaciers for salmon (Figure 4). Importantly, federal sources rarely mentioned future action and did not mention strategies to solve the problem (collaboration, communication, education) at all (Figure 4). State sources on the other hand emphasized the importance of collaboration in 70% of their sources and explained the current action

they were taking in 90% of their media (Figure 4). State sources emphasized the tribal and ecological importance of salmon and focused on the importance of glaciers for salmon more than any other sector. Both state and local government sources highlighted that glacier retreat would primarily harm salmon, with local government not mentioning the potential benefits or the mixed results at all. Local government focused on the tribal and economic importance of salmon and the non-salmon importance of glaciers, though agriculture, drinking water, hydropower, and salmon were all mentioned equally in relation to why glaciers are valuable (Figure 4). Local government sources emphasized the importance of collaboration as well as education to help solve the problem. All three types of government took very different approaches and formed different narratives, most obvious in the differences between federal government and state/local government.

Overall, government sources were most likely to emphasize the economic importance of salmon and focus on sectors other than salmon in terms of glacier value. This is likely because government priorities span these sectors, and the study used sources gathered from municipal and agricultural agencies as well as fisheries agencies. There were striking differences between federal and state/local governments, especially regarding the value of glaciers and conversations about future action. Federal sources were more likely to talk about the scenic and recreational uses of glaciers, likely because their target audience is the national public that might only associate glaciers with the images they see on the news. Local and state sources tended to focus on the importance of glaciers to Washington and local communities (for salmon, agriculture, hydropower, and drinking water) since that was their target audience. State and local

sources also emphasized strategies and solutions more than federal sources, likely because most of the climate action and restoration for this problem is currently happening at a state and local level (Bedsworth & Hanak, 2013).

4.212. News Media Outlets

Media sources tended to use stories rather than science or research to explain glacier retreat and salmon declines, utilizing personal experiences and opinions to back up their narratives. As a result, media sources emphasized the tribal and ecological importance of salmon more than other stakeholders, focusing especially on macrofauna like the southern resident killer whales when talking about the ecological roles salmon play since there is a deep emotional connection between many Washingtonians and these mammals. Media articles were the most likely to emphasize the importance of glaciers across all sectors except for scenic/recreational purposes. 67.7% of sources said glaciers were important for salmon (Figure 3), and 48.5% said they were important for other sectors—nearly double the number of sources from other individual stakeholders. Media sources were the most likely to claim glacier retreat would harm salmon (58.1% of articles), especially due to warming streams, but they were also the most likely to emphasize the potential mixed effects of glacier retreat on salmon (Figure 3). Media sources were the least likely to include narratives of future actions or solutions and strategies across all categories, despite including the narratives that glaciers are retreating quickly in 90.3% of their articles and that salmon are declining due to climate change in 48.4% of their articles (Figure 3).

Media sources only used three kinds of media: articles, op-eds, and interviews. However, this makes sense because those tend to be the primary types of media used in

newspapers and online news sites. While this does not necessarily target a diverse audience (such as people who get their news from YouTube), media sources likely reached the largest audience out of all the stakeholders, simply because communicating to the public is what they do and they have the name recognition that other stakeholders may not have so they do not need to do as much outreach. People tend to rely on media sources to get science news rather than getting it directly from the source or an aligned source like government agencies.

While media sources were lumped together as one group in this study, they came from a number of different news organizations that range in political lean, target demographic, and locality (Table 1). This leads to varied narratives, but clear trends were still present. Media sources were the clear frontrunners for explaining the importance of glaciers in almost every narrative, and they were also the most likely to talk about how glacier retreat would impact salmon. They tended to utilize personal stories to tell the science in more accessible ways to the public which is useful in helping the public understand complex science. However, many of the media sources included doom-and-gloom narratives (glaciers are retreating quickly, salmon are declining, glacier retreat will harm salmon), and they were the least likely of the stakeholders to mention potential future action, solutions, and strategies. This can quickly lead to an overwhelmed audience who feels helpless in the face of climate change, as demonstrated in previous studies (Hinkel et al., 2020; Johns & Jacquet, 2018).

4.213. Environmental Nonprofits

Environmental nonprofits, laid out in Table 1, highlighted the ecological, economic, and tribal importance of salmon. They also focused on the role of glaciers for salmon populations more than non-salmon uses but did talk about the value of glaciers in terms of water availability. Out of all the stakeholders, they were the most likely to discuss the potential benefits of glacier retreat for salmon populations, but still overwhelmingly emphasized the harms (Figure 3). They were also the most likely to highlight that glaciers are retreating quickly (92%) and that salmon are declining (60%). They emphasized some future strategies more than media sources but at a much lower rate than government and Indigenous sources.

Environmental nonprofits used nine different types of media—the most of any group—consisting mostly of articles, blog posts, webpages, and educational material. They used videos, art, and a variety of other media to reach a varied audience, and they were the only group to use art as a medium for science communication. Environmental nonprofits typically have a dedicated following but have to do significant outreach to reach past this core group, so it makes sense that they would use more diverse media types than media sources (Jacobson et al., 2015).

Similar to all of the stakeholder identities, environmental nonprofits vary in their goals, leading to diverging narratives. However, they tended to emphasize the narrative that salmon are declining and that glacier retreat is not helping. The sources that mentioned the potential benefits of glacier retreat for salmon populations tended to be the international environmental nonprofits talking about more northern populations of salmon in British Columbia. These geographic differences will be discussed further in

Section 4.22. Environmental nonprofits were also less likely to call for more action than other studies have suggested, so much of their media seemed to be aimed at getting people to join their cause by painting a drastic picture of this rather than offering ways to help, utilizing doom-and-gloom messaging (Hinkel et al., 2020).

4.214. Indigenous Tribes and Tribal Organizations

Finally, Indigenous sources—sources from Indigenous tribes, organizations, and peoples—tended to combine science with personal experience and traditional knowledge to communicate the impacts of glacier retreat on salmon and the ways that climate change is already impacting their communities. They focused on the importance of salmon for Washington tribes, such as the Nooksack Indian Tribe and Swinomish Tribe, and they tended to equally prioritize tribal economy, connections to identity and place, and traditional foods and health within that category. The importance of salmon to the Indigenous economy and traditional foods were often left out of other stakeholder narratives even for those that did mention the importance of salmon to tribes. Most coverage of Indigenous salmon importance from non-tribal sources was very surface-level, so it did not go past "salmon are important for the identity of Indigenous tribes" while tribal sources focused on traditional foods, tribal economy, *and* identity. Indigenous sources primarily focused on the importance of glaciers for salmon rather than other sectors, and they did not discuss the potential benefits or mixed effects of glacier retreat for salmon at all (Figure 3). They focused on how glacier retreat would harm salmon at all stages of their life histories, especially due to rising stream temperatures. In terms of future strategies, they emphasized the importance of doing something and were also the most likely of the stakeholder groups to explain what they

were already doing. They also called for more collaboration and education as strategies moving forward. As many Indigenous tribes had much of their land stolen and were forced onto reservations, collaboration with landowners in their ancestral homeland is now a necessity to save salmon and the ecosystems they rely on (Gilles, 2016).

Indigenous sources used eight different types of media, including articles, webpages, educational videos, and reports. Their sources tended to include personal experience and science combined with tribal knowledge, and they targeted a wide audience through their use of many media.

Indigenous groups emphasized the importance of salmon and the negative effects glacier retreat will have on salmon populations. They were the only group not to mention the potential benefits of glacier retreat out of all the stakeholders, likely because all of the Indigenous sources came from local tribes and coalitions focused only on Washington watersheds (more on the importance of geographic location to shaping narratives is covered in the Section 4.22). Salmon are a vital part of multiple aspects of life for many Indigenous tribes in the region, so many of their sources focused on salmon, how climate change and glacier retreat were contributing to the declines, and what can be done to restore these populations, especially those of culturally significant value (Grah & Beaulieu, 2013). Indigenous sources were also the most likely to talk about many of the future actions, solutions, and strategies, such as what is currently being done, in contrast to media and environmental nonprofits that explain glaciers are melting and salmon are dying but give very few solutions.

4.215. Conclusion

While previous studies have identified the importance of stakeholder identity in risk framing and creating/shaping narratives, broad stakeholder identity did not play a large role in narratives of glacier retreat and salmon declines. Studies that have identified the role stakeholders play in perceptions of climate issues and policies are usually looking at individual stakeholders rather than stakeholder groups. However, policy and climate talks generally lump stakeholders together into larger groups and industries, but these groups are not always good indicators of trends and beliefs of the individuals. While there were some trends for each of the groups, a closer examination of government stakeholders demonstrated that stakeholders within those groups may frame risks very differently, which leads to different narratives. In the same way that federal, state, and local governments have diverse priorities and methods of addressing a climate issue, news media sources and environmental nonprofits have different revenue sources, goals, and political leanings that affect the way they frame glacier retreat and salmon declines. For instance, a mountaineering nonprofit and a salmon nonprofit will not address this issue in the same way, despite both of them being environmental nonprofits. Similarly, Indigenous tribes have different histories, traditional foods, and relationships to the watersheds they live on. Glacier retreat will affect Spring Chinook (vital to the Nooksack Indian Tribe's cultural practices and subsistence) differently than Kokanee salmon (the cultural salmon of the Spokane Tribe).

4.22. Geographic Location

While stakeholder identity had a moderate effect on narratives and framings of glacier retreat and salmon declines, differences in narratives based on geographic location (in-state or out-of-state) were much more apparent, especially for future action and how glacier retreat affects salmon.

Figure 5. Geographic Location Narratives

This figure shows narrative prevalence in sources as a percent of the total number of sources in each geographic category—inside Washington (aqua) and outside Washington (green). The figure includes defining narratives from each of the four categories: Importance of Glaciers (top), Importance of Salmon (middle left), Glacier Retreat Impacts on Salmon (middle right), and Commentary on Future Action/Solutions and Strategies (bottom left and right).

While both in-state and out-of-state sources agree that salmon and glaciers are important in Washington, they focus on different sectors when discussing that importance. In-state sources are more likely to mention the tribal importance of salmon, while out-of-state sources are more than twice as likely to mention the economic importance of salmon. Both sources include ecological and recreational importance as

part of their narratives but to a smaller extent than their main importance narrative (Figure 5). Outside sources emphasize the importance of glaciers for salmon in a majority (51.2%) of their media but also recognized the scenic and recreational benefits of glaciers in almost one-fifth of their media (Figure 5). In-state sources, on the other hand, barely mention the scenic and recreational uses for glaciers but do prioritize other non-salmon uses for glaciers in their framing of the issue (Figure 5). In-state sources focus on the importance of glaciers for salmon and hydropower, and these narratives appear in similar numbers in their sources. The priorities of in-state and out-of-state sources likely affect how glaciers and salmon are valued in these sources, shaping the perceptions of their audience and the policy decisions that go with it.

For narratives of how glacier retreat would impact salmon populations, sources from within Washington almost solely say that glacier retreat will harm salmon, with just one source (2.7% of in-state sources) claiming there might be some benefits or mixed results (Figure 5). Outside sources also primarily say that glacier retreat will harm salmon (61%), but approximately one-fifth (19.5%) of their media say that glacier retreat will have both good and bad results for salmon and 14.6% of their media say that glacier retreat will benefit salmon (Figure 5). While these narratives seem contradictory, they are addressing the complex relationship between glacier retreat and salmon populations in the Pacific Northwest. As glaciers retreat, streams will get warmer which is bad for salmon in mid-range latitudes like Washington or for salmon who spend a lot of time in rivers like Coho salmon. However, for salmon in more northern latitudes, which out-of-state sources are more likely to be including in their narrative, glacier retreat may benefit salmon by creating new habitat and regulating temperatures. The

difference between in-state sources overwhelmingly saying glacier retreat will harm salmon while out-of-state sources being much more variable is one of the biggest differences between groups in this study. It also ties into the stakeholders; stakeholders that tend to be more local (like Indigenous groups) also tend to say that glacier retreat will harm salmon, while national and international stakeholders (like the federal government and international nonprofits) say it will benefit salmon or have mixed effects.

The final way that in-state and out-of-state sources differed significantly was in their future action and solutions/strategies sections. In-state sources are nearly twice as likely to call for more to be done, explain what is currently being done, and offer ways the audience can participate in restoring watersheds (Figure 5). In-state groups also emphasize the importance of collaboration more than twice as much as out-of-state groups, but both groups also state that education and communication are important—though less than collaboration—for addressing the problem. The disparity between out-of-state sources being more likely to talk about how glacier retreat affects salmon but also less likely to discuss future action is important for understanding the motivations of these two groups and how they can shape the narratives they tell.

One of the key differences between in-state and out-of-state sources is the audiences they aim to reach. While Washington locals are part of the audience of out-of-state sources like national media outlets, federal government agencies, and international environmental nonprofits, their audience is much broader, targeting people all across the U.S. and the world. As a result, the narratives told by out-of-state sources are meant to entice people who do not think about glaciers and salmon regularly or may

never have interacted with either one. They do this by focusing on things that those people can understand: glaciers are beautiful but retreating (as we frequently see in climate change reports), salmon are important for the economy that people rely on for jobs, and glacier retreat is going to affect salmon. Since their audience includes residents of more northern latitudes, narratives about the effects of glacier retreat on salmon include benefits and mixed results rather than just harm. Explaining that glaciers are important for water supply for agriculture and drinking water is harder to do for an outside audience than proclaiming that we are losing beautiful landmarks that decorate our national parks. Sources tend to focus less on future action and more on educating people about the topic because most of those people would be unable to help anyway.

In-state sources on the other hand are generally aimed at Washington audiences. Other people in surrounding areas or around the world might read their media, but their target audiences are the communities of Washington that are either being directly or indirectly affected by this problem. While many Washingtonians can see glaciers decorating their mountains throughout the year, glaciers tie much more directly into their lives through the water availability issue. Glacier meltwater irrigates their crops, provides their drinking water, sustains their salmon, and powers their houses. Glaciers and the water they produce are woven into their lives rather than just being a photo in a climate change report or a tourist destination. The same is true for salmon, which is why in-state sources are more likely to talk about the tribal and ecological value of salmon in their communities. When examining how glacier retreat will impact salmon populations, in-state sources focus on the harm because that is what Washington communities are experiencing and will continue to experience. However, rather than

solely focusing on doom-and-gloom narratives, in-state sources also provide a route for future action, including explaining what is already being done, how the audience can help, and what strategies will be the most helpful. The focus of in-state sources on collaboration is especially important as they call for more stakeholders to get involved and focus on building partnerships and coalitions of tribes, government agencies, environmental nonprofits, and community members.

The differences between in-state and out-of-state sources were some of the most striking and show how geographic location can shift and shape narratives. This has led to a disparity between insider and outsider perceptions of glacier retreat and salmon declines, which will also lead to a vast difference in outside climate action and policy. While other research has looked at how different geographic regions will be affected by common problems like ice loss, this thesis is the first to examine how narratives about one region depend on the geographic location of the source. Previous studies, like Brugger et al. (2013), have examined how narratives change in different regions experiencing the same problem (in that instance, how emotions and understandings of glacier retreat changed in the Alps, Andes, and North Cascades). However, this thesis solely examines narratives of Washington glacier retreat and salmon but through the lens of both in-state and out-of-state sources. The geographic location of the source was a significant predictor of narrative prevalence and shaped narratives of importance, risk, and future action.

4.23. Knowledge Source

Another aspect that can affect how narratives are shaped is the types of knowledge that these sources use and cite in their media. There are four main types of

knowledge utilized by the 115 different sources in this study: research, government, tribal, and personal experience/opinions. Studies that cited research conducted by tribes or the government were marked as “government” or “tribal” as a primary source of knowledge and “research” as a secondary source.

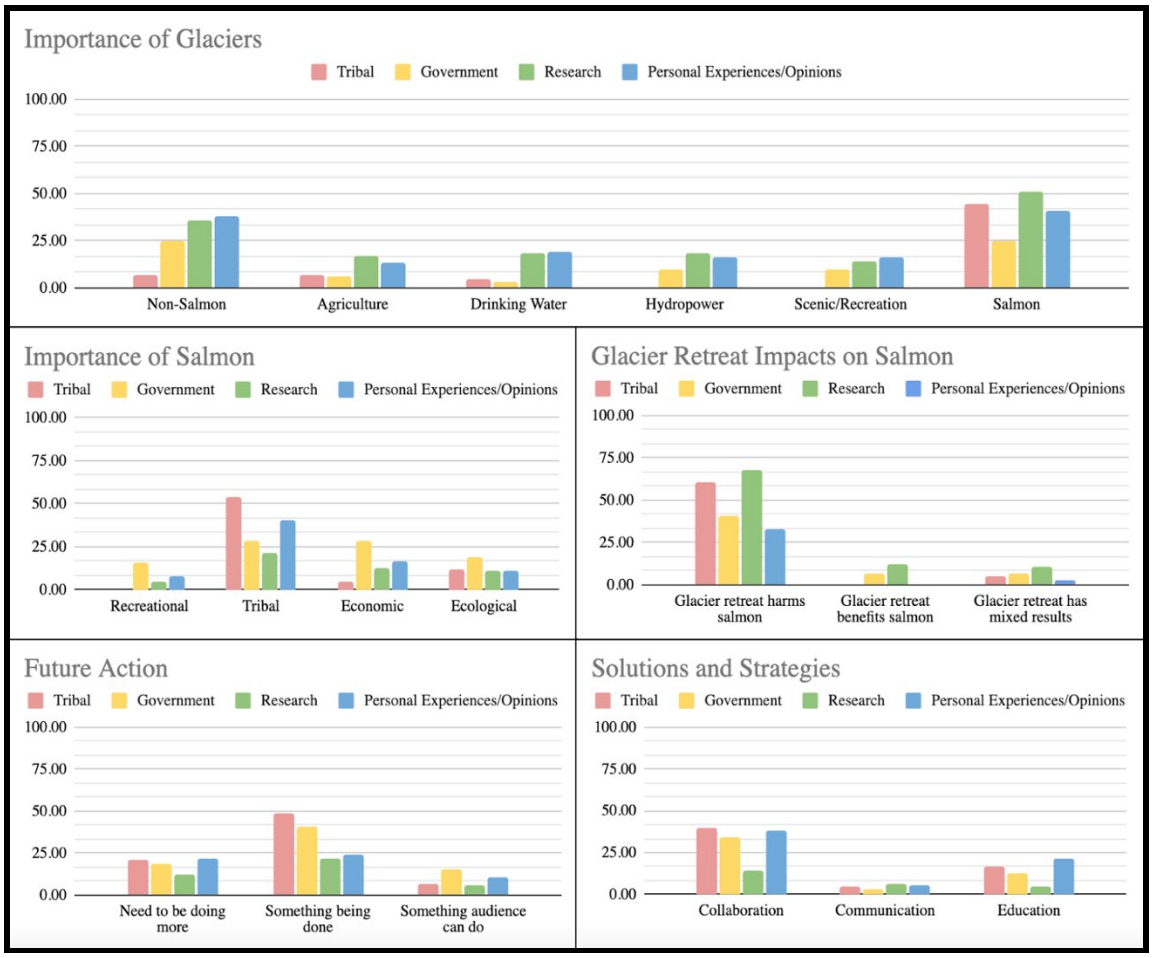

Figure 6. Knowledge Source Narratives

This figure shows narrative prevalence in sources as a percent of the total number of sources in each knowledge type category—tribal knowledge (pink), government knowledge (yellow), research (green), and personal experience/opinions (blue). The figure includes defining narratives from each of the four categories: Importance of Glaciers (top), Importance of Salmon (middle left), Glacier Retreat Impacts on Salmon (middle right), and Commentary on Future Action/Solutions and Strategies (bottom left and right).

Sources that relied on research or academia as one of their top two sources of information are more likely to talk about how glaciers affected salmon in all ways (harms, benefits, and mixed) (Figure 6). Notably, only sources that relied on either research or government as one of their two types of knowledge claim that glacier retreat

could benefit salmon. Sources that cited research also highlighted the importance of glaciers for salmon, hydropower, and drinking water more than other types of knowledge (Figure 6). They tended to mention the importance of salmon less than other types of knowledge, but mostly focused on tribal importance when they did talk about it. Finally, they were the least likely to talk about solutions, strategies, and future action for almost every marker, except promoting communication as a useful strategy for addressing the problem.

Sources that relied on government information or reports as one of their top two types of knowledge tended to discuss the impacts of glacier retreat on salmon less than most other sources but did still favor the narrative that glacier retreat will harm salmon rather than benefit them (Figure 6). However, they were the only other information source aside from research that mentioned that glacier retreat could benefit salmon. These sources highlighted the tribal and economic importance of salmon and were also the most likely group to talk about the recreational importance of salmon (Figure 6). They were the least likely to talk about glacier importance in almost any category (except "non-salmon" in the general sense), but they did strongly focus on future action, promoting collaboration and education as strategies and highlighting the work currently being done. These sources were also the most likely to suggest ways the audience could get involved.

Sources that rely on tribal information, including traditional ecological knowledge, stories, and tribal reports, mention the negative impacts of glacier retreat in 60% of their media—more than any other source aside from research (Figure 6). They emphasize the importance of salmon for tribes more than any other group and

highlighted the importance of glaciers for salmon in a majority of their articles. They were the most likely to call for collaboration as a future strategy and the most likely to explain what was being done to help salmon (almost 50% of their articles explained a current practice being used). They were tied with media that cited personal experience/opinions for calling for more to be done.

Finally, sources that cited personal experience and opinions were the least likely to talk about how glacier retreat affects salmon, but the most likely to talk about the non-salmon importance of glaciers. They focused mostly on the tribal and economic importance of salmon and focused strongly on collaboration and education as future strategies. They were the most likely to state that more needs to be done and second to explain what the audience could do to help.

While the type of knowledge affected and shaped narratives, the trends were not as clear as geographic location. Research-sourced media tended to focus mostly on the effects of glacier retreat on salmon and the importance of both glaciers and salmon in comparison to future action. Government-source media was similar to research but had more future action narratives, likely because the government (especially the state government in Washington) is actively working to restore salmon populations. Tribal knowledge emphasized the tribal importance of salmon but also future action, the importance of glaciers for salmon, and how glacier retreat will harm salmon. Finally, sources that cited personal experience/opinion emphasized the importance of glaciers and salmon as well as future action but talked less about the impacts of glacier retreat on salmon. These findings support previous studies that have suggested that different forms of knowledge can affect climate narratives (Alexander et al., 2011).

4.24. Temporal

The final aspect analyzed in the role of shaping narratives was time, specifically looking at both year and month.

Sources for this study ranged from the early 2000s to 2021, with the majority of sources (63.5%) published between 2015 and 2021. Many narratives have actually stayed constant over the past two decades such as narratives that glaciers are retreating quickly and that glacier retreat will harm salmon. There were two spikes in sources talking about glacier retreat and salmon: one in 2015 and one in 2021.

The spike in 2015 is likely due to the Paris Climate Summit, which occurred in mid-December of that year. Many articles wrote about Washington tribes going to the summit to discuss how glacier retreat and climate change were harming their salmon. Other articles from that year focused on several new studies that came out tying glacier retreat to salmon declines in the Salish Sea. Meanwhile, the spike in 2021 focused on the extreme heat waves in July that struck the Pacific Northwest and killed over a hundred people in Washington. These heat waves led to significant mass loss of glacial ice and a die-off of thousands of salmon in streams that warmed too much. While many narratives have remained relatively constant, both years had spikes in saying glacier retreat would harm salmon, discussing the importance of salmon and glaciers, and calling for more action or explaining what was being done to remedy the problem.

On a month timescale, coverage of glacier retreat and salmon declines usually spikes between July and December, lining up with warming temperatures and times of glacial melt. August has the most coverage, and sources during the month focus mostly on the importance of glaciers and salmon, the quick retreat of glaciers, and how glacier

retreat is harming salmon. In December, there is a strong focus on the narratives that glaciers are retreating and salmon are declining, likely in response to annual reports released during the month, such as the State of Salmon report.

Overall, while time is not the biggest predictor of how narratives change or are shaped, certain events can reframe risk and have a big impact on climate change. Previous research supports this, with Haigh and Griffiths (2012) finding that climate change events on a local level (such as the heat waves Washington experienced) can surprise communities and act as catalysts for climate action and discourse. Larger events like the Paris Climate Agreement have been found to encourage discussions of climate change at a local level, especially local action (Burch, 2016). Both surprise climate events such as the severe 2021 heatwaves and large climate change movements like the Paris Climate Agreement led to an influx of coverage on how climate change is impacting Washington which led to coverage of glacier retreat and salmon. Things like annual reports, fishing seasons, and research paper releases affect when these issues are covered and what stories are told as a result. Because fishing seasons do not occur during the winter, there is significantly less coverage of the problem than when flood and scouring could harm juvenile salmon. Catalyst events like heatwaves, the Paris Climate Agreement, and mass die-offs can shape how narratives are told temporally, but this study did not find significant evidence of evolving narratives.

Previous researchers such as Creutzig (2016) have studied how narratives evolved over time. While that was not evident in this study, many of the data sources were collected very recently with few sources prior to the most recent decade. As a

result, the data was better suited to look at catalyst events rather than evolving narratives.

4.25. Conclusion

A variety of factors shape narratives and perceptions about climate issues such as glacier retreat and salmon declines, including stakeholder identity, geographic location, type of knowledge, and time. Of these, geographic location seemed to be the most definitive for showing how narratives are shaped and diverge, followed by stakeholder identity and knowledge type. Glacier retreat impacts salmon populations in different ways, especially depending on species and latitude. This along with the increased likelihood of local groups to be working on the restoration and protection of watersheds means that most of the diverging narratives come from outside of Washington.

Stakeholder identity was a moderate predictor of narratives, but utilizing large overarching groups can ignore the important distinctions between individual stakeholders that are much more apparent at closer levels of analysis. Similarly, types of knowledge are useful for understanding where narratives might originate from, but most sources use a variety of knowledge types, leading to difficult-to-track trends. A temporal lens for looking at narrative creation and shaping is useful if certain key events are being analyzed alongside narratives, but less useful for determining how narratives change over time, especially with such a small dataset.

This study found that geographic location is one of the most likely factors in shaping narratives and creating diverging narratives. The audiences of different stakeholders depend on their location and impact how they frame these issues, resulting

in different public perceptions of the same issue. Previous studies have analyzed how geographic location can affect narratives of similar events in different locations (such as ice loss in the North Cascades and Andes), but no other sources have looked at how geographic location of sources affects framing and narrative shaping about climate issues in one location (Brugger et al., 2013). One potential reason for this is that people who do not regularly interact with or encounter salmon and glaciers (i.e. the audience of out-of-state sources) have a psychological distance (Leviston et al., 2014). As a result, the ways narratives are framed have to be different to reach these audiences—such as focusing on things they can picture (scenic glaciers and recreational fishing) rather than things that are vital to the communities on the ground (water supply, subsistence, livelihoods).

Previous studies including McHugh et al. (2021) have called for research to examine how overlapping climate emergencies such as glacier retreat and salmon declines are framed and communicated to the public. The following section will analyze narratives of glacier retreat and salmon declines as framings and narratives of both single and overlapping climate emergencies.

4.3. Framing Overlapping Climate Emergencies

Many previous studies have looked at risk framing and climate narratives for single climate emergencies such as ice loss, wildfires, and biodiversity loss (Jacobson et al., 2015; Joshi, 2022; Moulton et al., 2021). However, as climate change worsens, individual climate problems will not exist in a vacuum and will overlap with other problems (McHugh et al., 2021).

This adds more stakeholders to already complicated problems, so understanding how overlapping climate emergencies are being communicated in an early case will help us both understand how narratives of overlapping emergencies are formed, how they differ from single emergencies, and how overlapping narratives can be used to re-frame climate change.

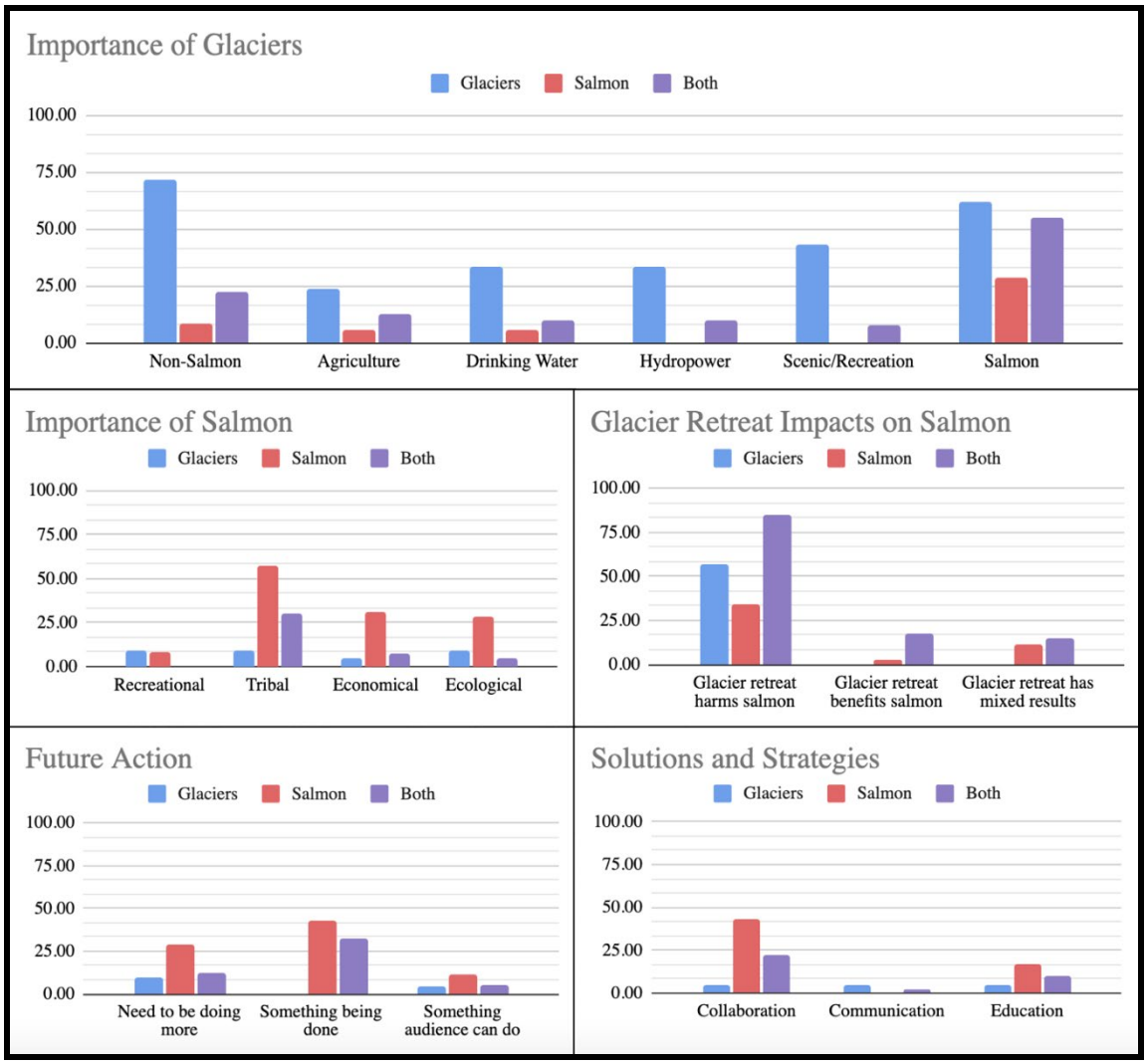

Figure 7. Narratives of Overlapping and Single Emergencies

This figure shows narrative prevalence in sources as a percent of the total number of sources in each focus category—glacier-focused (blue), salmon-focused (red), and both (purple). The figure includes defining narratives from each of the four categories: Importance of Glaciers (top), Importance of Salmon (middle left), Glacier Retreat Impacts on Salmon (middle right), and Commentary on Future Action/Solutions and Strategies (bottom left and right).

For sources that just focused on glaciers, there was a heavy emphasis on the importance of glaciers for Washington communities. 71.4% of sources highlighted the non-salmon value of glaciers, focusing on the importance of glaciers for scenic/recreational

purposes, hydropower, and drinking water (Figure 7). 61.9% highlighted the importance of glaciers to salmon populations, focusing slightly more on cold water contributions over stream volume. Glacier-primary sources predictably talked less about the importance of salmon, but interestingly they mentioned the recreational importance of salmon approximately the same amount as salmon-primary sources (Figure 7). Glacier sources were more likely than salmon articles to focus on the negative impacts of glacier retreat on salmon but did not mention the potential benefits or mixed results. They were also much less likely to comment on future action, and no articles centered on glaciers mentioned something currently being done.

For salmon-focused articles, glaciers were mentioned significantly less and primarily only in relation to salmon. 28.6% of salmon-focused sources included glacier importance in terms of salmon, while only 8.6% mentioned non-salmon importance. Predictably, salmon-focused sources went into much greater detail about the importance of salmon to Washington life, focusing especially on the tribal, economic, and ecological value of salmon populations. Approximately one-third of salmon-focused sources (34.3%) discussed that glacier retreat will harm salmon, but a couple of sources also mentioned the potential benefits and mixed results. Salmon-focused articles were much more future- and action-oriented and were the most likely to include all future action, solutions, and strategies narratives except for calling for communication as a strategy.

Sources from both single emergency-focused categories were very limited in scope. Each focused on the importance of their individual natural resource for Washington with some crossover narratives that paled in comparison to their main

narratives. One striking difference is the lack of future-focused narratives in the glacier-focused sources. 95.2% of glacier-focused sources emphasize that glaciers are retreating quickly which will affect all of the sectors shown in Figure 7. However, fewer than one in ten sources call for more to be done and no sources mention current action. The different solutions and strategies are each mentioned in one glacier-focused source (4.76%), emphasizing that there is no way forward and no way to respond to this. Since we know that even if we stopped emitting carbon instantly, glaciers would continue to shrink, this sort of doom-and-gloom narrative makes sense, but that does not mean it is accurate. Salmon-focused sources include future-focused narratives because the sources still believe there is something that can be done. However, by combining these individual emergencies into one narrative, we can change how the risks of glaciers are framed.

Sources that are focused on both glaciers and salmon generally land somewhere in the middle for the relevant narratives. They include the importance of both salmon and glaciers more than the opposite sources but less than the main source (with the exception of the recreational and ecological value of salmon). However, 85% of overlapping sources claim glacier retreat will harm salmon, showing the spot of overlap. Notably, despite including glacier retreat as one of the climate problems to address, these sources still have future-focused narratives with almost one-third of sources discussing action currently being done to solve the problem. These sources also prioritize collaboration and education once again as midpoints between glacier-focused and salmon-focused sources.

This study found that overlapping narratives can change the perceptions of climate emergencies from hopeless to actionable. Narratives of glacier-focused sources talk about how important glaciers are and how fast they are retreating but provide no future direction or ways to try to prevent all of the sectors that rely on glaciers from falling apart. Glaciers are going to continue to retreat and shrink even if all emissions stop immediately, so this problem feels hopeless. However, glacier retreat will impact many sectors of Washington life, and those impacts can be mitigated if we act now. By combining these two emergencies, the hopeless narrative of glacier retreat is turned into an actionable narrative that people can address. Narratives of overlapping climate change issues can shift doom-and-gloom narratives into ones of hope, reframing the risk that we are facing from climate change. This is vital for changing public perceptions and inspiring action on climate change while there is still time to act.

5. Conclusion

Understanding how risk framing creates and shapes climate narratives is vital to better understanding public perceptions, support for policies, conflict over climate issues, and climate action. This study analyzed climate narratives and risk framing through the case study of glacier retreat and salmon declines in Washington and identified 44 narratives and sub-narratives of these issues. I found that while an overarching story of glacier retreat and salmon declines existed, there were several diverging and less common narratives that were still important in shaping public perceptions and policy decisions. Previous studies suggested potential factors that shaped narratives and caused them to diverge such as stakeholder identity, type of knowledge, and evolution of time. I found that, for the case study of glacier retreat and salmon declines, stakeholder identity and the type of knowledge had moderate effects on narrative shaping and that temporal catalysts could cause spikes in certain narratives. However, I also found that a source's geographic location was the most important factor in shaping narratives and creating diverging narratives. Even when sources are discussing the same climate issues in the same location, their geographic location respective to the issue affects how they portray the issue. These narratives are important for shaping public perceptions and policies, so these differences could explain why we see differences in outsider vs. insider perceptions and federal vs. state/local policies on climate (Bedsworth & Hanak, 2013). State policies—like Washington's commitment to 100% clean energy and bills requiring buffers on streams—have been much more aggressive in addressing salmon declines and carbon emissions than national policies,

which have mostly consisted of funding culvert removals (Abrantes, 2021; Dunagan, 2022).

The second key finding of this study was that overlapping narratives of climate emergencies can be used to transform narratives from doom-and-gloom to hopeful narratives that inspire climate action. Some climate emergencies, such as glacier retreat and ocean acidification, will continue to worsen due to atmospheric temperatures lagging behind carbon emissions even if drastic climate action is taken. Certain climate issues are more psychologically distant due to the subject or relationships people have with these resources. As a result, narratives of these often fall into the "doom-and-gloom" narratives that leave people feeling pessimistic and hopeless in the face of climate change. This can lead to perceptions that there is nothing we can do to prevent climate change and that the severe impacts of global warming are inevitable. These perceptions often lead to inaction and reduce active support for policies and climate action (Stecula & Merkley, 2019). This leads legislators to prioritize these issues less which is what we have seen at a national level where there is a physical and psychological distance between most legislators and the climate issues impacting Washingtonians.

However, if an "inevitable" climate issue overlaps with a more-solvable issue like salmon declines—which could be reversed with proper habitat restoration, barrier removal, and climate policies—the overlapping narratives can transform from "doom-and-gloom" to a narrative of doable action and hope. Narratives of hope are more likely to inspire climate action but can also minimize the severe impacts of climate change (Ettinger et al., 2021; Kelsey, 2016). This study shows that overlapping climate

emergency narratives like glacier retreat and salmon declines employ both narratives of doom-and-gloom (glaciers are retreating and salmon are declining) with narratives of action (stakeholders are working to solve these problems and the audience can get involved). This allows stakeholders to utilize the benefits of both and inspire action rather than hopelessness.

Future research should examine and compare other overlapping climate emergencies to see if similar trends emerge. This research will become increasingly important as climate change worsens and overlapping climate emergencies become more common. Studies should also examine how these narratives empower or marginalize different groups, what the effects of proposed solutions and future action would be, and the potential future that narratives of glacier retreat and salmon have not addressed in Washington. These studies would help increase our understanding of how narratives of overlapping climate issues affect people, perceptions, and climate action throughout the world.

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