The Role of Prioritization in Funding Habitat Restoration Projects for Salmon Recovery in the Puget Sound Basin

Erica V. Bates

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David Fluharty

Jennifer Steger

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Abstract

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Erica V. Bates

Chair of the Supervisory Committee:
Associate Professor David Fluharty
School of Marine and Environmental Affairs

Salmon populations in Washington have suffered severe declines in numbers leading to the listing of many as threatened or endangered under the Endangered Species Act (ESA). Populations in Puget Sound are especially threatened due to degradation and loss of habitat resulting from timber harvest, farming, the effects of urbanization, and increasing human population. A critical component of salmon recovery efforts is the funding of restoration projects carried out by a variety of organizations in the area. The vast quantity of degraded habitat and the limited funding available require prioritization of restoration projects. In Washington, two organizations that have a long history of grants for habitat restoration are the Washington State Salmon Recovery Funding Board (SRFB) and the National Oceanic and Atmospheric Administration Restoration Center (NOAA RC). Over a thirteen year period the SRFB granted over $217 million and the NOAA RC granted nearly $22 million to habitat restoration projects in the Puget Sound recovery region. This research includes the creation of an original database of salmon habitat restoration projects in Puget Sound funded by the SRFB and the NOAA RC between 1999 and 2011. A restoration project type hierarchy was created based on the scientific literature about restoration and prioritization. This hierarchy was compared to the data gathered from the two organizations to determine if funding decisions align with the recommended prioritization of habitat restoration projects. The results show that overall the funding decisions of the SRFB align with the restoration project hierarchy, although there is annual variability that differs from the hierarchy. The NOAA RC shows funding decisions that vary more annually with priorities that often do not align with the restoration project hierarchy.

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CHAPTER 1: Introduction

Many species and populations of salmon in Washington are listed as threatened or endangered under the Endangered Species Act (ESA) and state and federal agencies are therefore required to work towards their recovery. This recovery process often includes the protection and restoration of habitat for the listed species. A key part of the recovery process is the funding of habitat restoration and protection projects. This thesis explores the role of prioritization in funding of salmon habitat restoration projects in the Puget Sound Basin, Washington by analyzing the contributions of the Washington State Salmon Recovery Funding Board (SRFB) and the National Oceanic and Atmospheric Administration (NOAA) Restoration Center to the restoration and prioritization processes through their grant funding programs. These two efforts represent a significant portion of the funding for salmon habitat restoration. The efforts of other private, non-profit, and community-based organizations are acknowledged but not analyzed here.

I first review the status of salmon in Washington and Puget Sound, looking at the health and threats to the local populations as well as their legal status under the Endangered Species Act. I then look at the scientific, peer-reviewed literature to inform a discussion of habitat restoration techniques and methods of prioritization. I discuss the compilation of data on restoration projects in Puget Sound that were funded by the SRFB and the NOAA Restoration Center and compare this data to a restoration project hierarchy that I created to prioritize projects. This data analysis is followed by a discussion of results and recommendations for future prioritization.

Status of Salmon and their Habitat in Puget Sound

Salmon play a critical role in the Puget Sound ecosystem and have been identified as a keystone species based on the disproportionately large role they play in the freshwater ecosystem when compared to their abundance (Willson and Halupka 1995). Salmon are directly tied to maintaining the productivity of the freshwater ecosystem by cycling nutrients from the Pacific Ocean into lakes and streams during and after spawning (Naiman et al. 2002). They are also an integral part of the food web providing a food source for freshwater, terrestrial, and marine wildlife like migrating birds, otters, whales, and bears during all their life stages (Shared Strategy 2007). In addition to their ecological importance, salmon are also a key cultural species in the Pacific Northwest.

Salmon populations throughout Washington State, and especially in the Puget Sound region, have suffered severe declines in numbers. The first species listed under the Endangered Species Act (ESA) was the Snake River sockeye which was listed in 1991. Specific to Puget Sound, the Puget Sound Chinook ESU, the Hood Canal summer chum ESU, and the Coastal-Puget Sound Bull Trout DPS were listed as threatened in 1999, while the Puget Sound Steelhead DPS was listed as threatened in 2007 (NOAA 2012b). The populations of salmon in Washington State are threatened by loss and damage to habitat, dams, overfishing, pollution, and hatcheries, all of which are associated with increasing human populations and the related demands on the ecosystem (RCO 2010a). The populations may also be suffering from changes to their natural habitat due to climate change, fluctuating conditions in the marine environment, and increased predators as well as the cumulative impacts of all these threats (RCO 2010a).

Most important to this research are the habitat factors that are affecting salmon in the Puget Sound Basin. Timber harvest eliminated a key component of a healthy ecosystem by removing trees that would normally fall across waterways and would create pools, reduce water velocity, provide shade, and create spawning and rearing habitats with slow sediment transport (Shared Strategy 2007). The construction of an extensive system of forest and rural roads also led to increased water temperature and sediment load in turn decreasing the quality of the salmon habitat (Lackey et al. 2006). Agriculture has been another significant source of habitat degradation for salmon through decreases in streamside vegetation; pollution from the use of chemical and nutrient fertilizers; diking, draining, and filling wetlands and marshes; and decreased water flow levels due to withdrawal of water for irrigation (Lackey et al. 2006). The general urbanization and population growth in the Puget Sound region has had far-reaching effects on salmon habitat. The Seattle, Bellevue, Everett, and Tacoma metropolitan area has a population of over three million people and the infrastructure of roads, bridges, and utilities has altered and displaced the normal habitat (Shared Strategy 2007). Many streams have lost their complexity and riparian vegetation; natural runoff is altered by structures; pollution has increased, and much of this disruption is centered on important habitat areas including the mouths of rivers and estuarine shorelines (Shared Strategy 2007). Shoreline armoring including bulkheads and retaining walls; and flood control activities like dredging, diking, and filling have interrupted natural processes and caused losses of riparian vegetation, decreased sediment movement, and changes in water velocities (Shared Strategy 2007). Finally, the construction of

dams, blockages for water diversion, and hydroelectric development may block salmon passage or alter streamflow, interrupt sediment transport, elevate temperatures, alter large woody debris recruitment, and alter nutrient supply (Shared Strategy 2007).

The Endangered Species Act

The ESA is critical to discussion of the recovery of Puget Sound salmon species as it is the federal legal framework for the recovery process. The Endangered Species Act of 1973 (16 U.S.C. § 1531-1544) has the purpose of conserving the ecosystems that endangered and threatened species depend on and conserving the endangered and threatened species. An endangered species is defined as "any species which is in danger of extinction throughout all or a significant portion of its range" (16 U.S.C. § 1532(6)). A threatened species is defined as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" (16 U.S.C. § 1532(20)). Two federal agencies share responsibility for implementing the ESA; the U.S. Fish and Wildlife Service (USFWS) and NOAA's National Marine Fisheries Service (NMFS). In general USFWS is responsible for land and freshwater species while NMFS is responsible for marine and anadromous species, which means that salmon species fall under the authority of NMFS because they are anadromous.

Once species has been listed under the ESA as either endangered or threatened the responsible agency is required to designate critical habitat for the species (16 U.S.C. § 1533). Critical habitat is defined by the ESA as "the specific areas within the geographical area occupied by the species, …on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection" (16 U.S.C. § 1532 (5)). The designation of critical habitat is to be based on the best scientific data available, but may also take into consideration the economic impact of such a designation (16 U.S.C. § 1533).

In addition to designating critical habitat, the agency is required to develop and implement a recovery plan for the "conservation and survival of endangered and threatened species" (16 U.S.C. § 1533(f)). The recovery plan is required to incorporate "site-specific management actions", "objective, measurable criteria", and "estimates of the time required and the cost to carry out those measures" in order to achieve the recovery plan's goals for the conservation and recovery of the species (16 U.S.C. § 1533(f)).

The ESA also authorizes the agencies to enter into cooperative agreements with any state that wants to take the lead on conserving and recovering a listed species (16 U.S.C. § 1535(c)). The agency is responsible for assuring that the state program is consistent with the ESA. The agency is also authorized to provide funding to a state to implement its recovery plan (16 U.S.C. § 1535(d)).

Puget Sound Salmon Recovery Region Plan

The Puget Sound Salmon Recovery Plan was developed through the previously noted jurisdictions engaged in collaborative efforts of the Shared Strategy for Puget Sound (Shared Strategy), NOAA, and USFWS, State of Washington, and tribes; and it was adopted by the NMFS in January 2007 (Shared Strategy 2007). The recovery plan has a time frame of 50 years and an estimated cost of 1.42 billion for the first ten years (RCO 2010). Shared Strategy was developed as a voluntary and collaborative process including federal, state, tribal, and local governments; business representatives, forestry interests, agricultural industry, conservation groups, and watershed planning groups that worked together to recover salmon and develop the recovery plan (Shared Strategy 2007).

The Washington Water Resources Act of 1971 (RCW 90.54) divided the state into regions for water resource planning based on watersheds and topography which are called Water Resource Inventory Areas (WRIAs). Many WRIAs were already engaged in watershed-based recovery planning and the plan endorses this strategy with the theory that each watershed is better able to customize its strategy to the unique characteristics of the watershed (Shared Strategy 2007). The recovery plan therefore incorporates the individual plans created by watershed recovery planning groups, aligned with one or more WRIAs, from across Puget Sound. While each of the watersheds has developed its unique strategy for salmon recovery, the regional plan does include a description of the top ten actions needed for salmon that are found throughout the various watersheds. The ten common actions address critical issues in estuaries, floodplain areas, riparian areas, water quantity, water quality/pollution, fish access, Puget Sound shoreline and nearshore marine areas, harvest management, hatchery management, and integration of harvest, hatcheries, and habitat (Shared Strategy 2007).

The recovery plan cites the Puget Sound Technical Recovery Team (PSTRT) as support for advocating protection of existing and functioning habitat before restoration (Shared Strategy

2007). Protection is considered to have a higher level of certainty than restoration and restoration activities may not be able to achieve recovery goals quickly enough or at all without protection of high-quality habitat (Shared Strategy 2012). Protection is necessary at multiple scales to achieve recovery goals, from the individual habitat site to the ecosystem, as well as from rural to urban areas (Shared Strategy 2012). Protection of habitat can be achieved through regulation, incentives, and education through coordinated efforts of governments, property owners, and land managers (Shared Strategy 2012).

Puget Sound Recovery Region

The geographical focus of this study is the Puget Sound Salmon Recovery Region- all the watersheds in the Puget Sound Basin and Puget Sound itself (Figure 1). The recovery regions were formed as a result of the ESA, which requires the development of recovery plans for endangered species. Seven regional organizations were created in Washington to develop recovery plans and they consist of local, state, and federal agencies as well as tribes and other citizens. The Puget Sound Salmon Recovery Region is the largest of the seven in the state and is made up of 12 counties, 19 WRIAs, and 18 federally recognized tribes (SRFB 2011) Table 1. The Puget Sound Basin is the second largest estuary in the United States and has more than 20 major river systems with tributaries (RCO 2010). The Puget Sound Partnership (PSP) was designated as the regional salmon recovery organization in 2008 for all Puget Sound salmon species except Hood Canal summer chum which is considered separately under the Hood Canal Salmon Recovery Region instead (SRFB 2011).

Table 1. Components of the Puget Sound Salmon Recovery Region
Source: RCO 2010a

Counties (All or in part)	WRIAs (All or in part)	Federally Recognized Tribes
Whatcom, Skagit, Island, San Juan, Snohomish, King, Pierce, Thurston, Mason, Kitsap, Jefferson, Clallam	Nooksack (1), San Juan (2), Lower Skagit (3), Upper Skagit (4), Stillaguamish (5), Island (6), Snohomish (7), Cedar/Sammamish (8), Green/Duwamish (9), Puyallup/White (10), Nisqually (11), Chambers/Clover (12), Deschutes (13), Kennedy/Goldsborough (14), Kitsap (15), Skokomish/Dosewallips (16), Quilcene/Snow (17), Elwha/Dungeness (18), and Lyre/Hoko (19)	Elwha Klallam Tribe, Jamestown S'Klallam Tribe, Lummi Nation, Muckleshoot Tribe, Nooksack Indian Tribe, Nisqually Indian Tribe, Port Gamble S'Klallam Tribe, Puyallup Tribe of Indians, Samish Indian Nation, Sauk-Suiattle Indian Tribe, Skokomish Tribe, Snoqualmie Tribes, Squaxin Island Tribe, Stillaguamish Tribe of Indians, Suquamish Tribe, Swinomish Tribe, Tulalip Tribes, Upper Skagit Indian Tribe

The main threats to salmon recovery in the Puget Sound Recovery Region are considered to be degraded floodplain and channel structure; degraded nearshore, marine, and estuarine conditions; riparian degradation and loss of in-river woody material; degraded water quality and temperature; excessive sediment; impaired stream flows; and barriers to fish passage (RCO 2010).

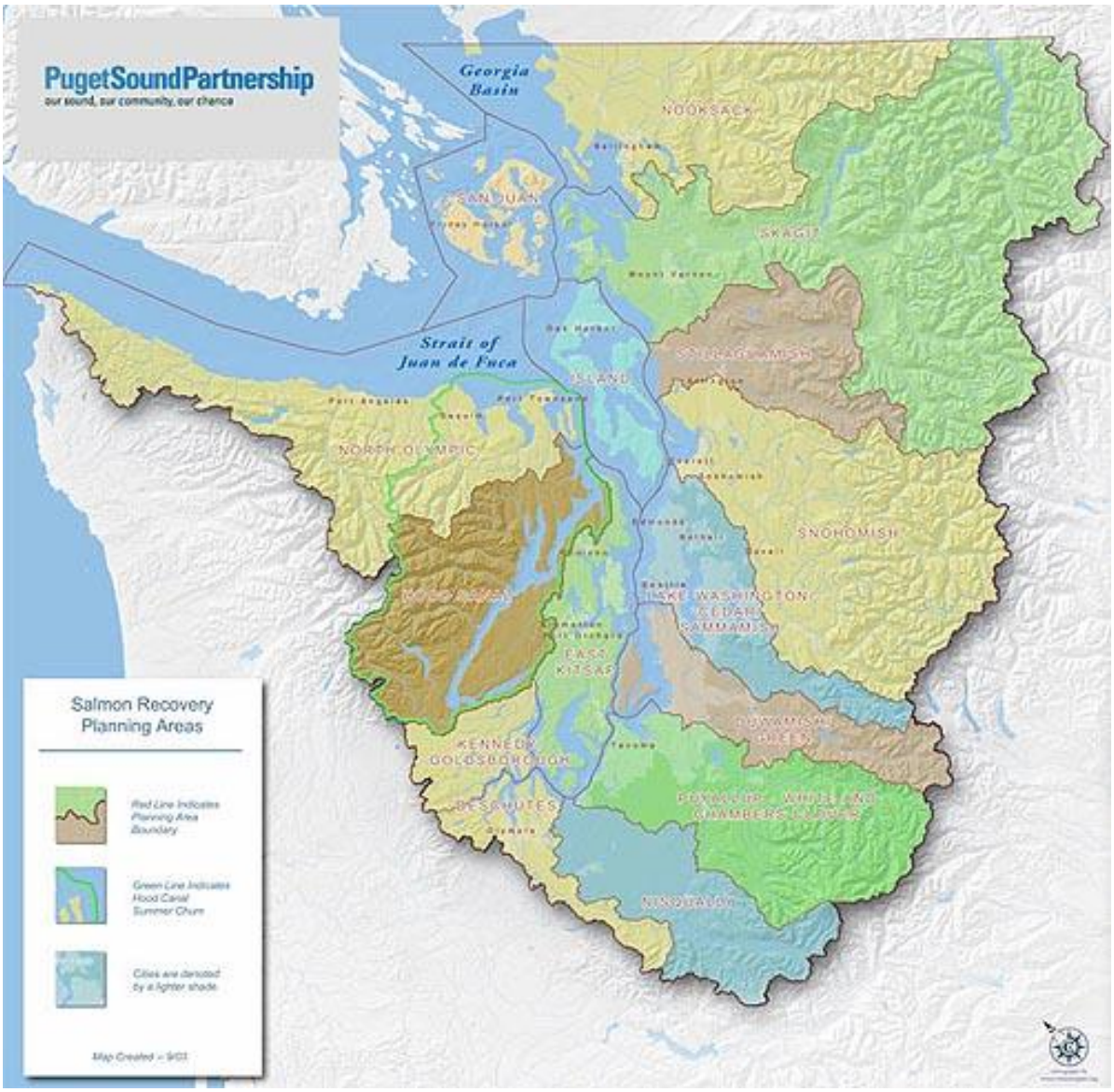

Figure 1. Map of Puget Sound Salmon Recovery Region Watersheds
Source: Puget Sound Partnership 2010

Salmon Recovery Funding Board

The Salmon Recovery Funding Board (SRFB) was created in 1999 by the Washington State Legislature to provide grants funding salmon habitat restoration and protection projects and other activities related to salmon recovery (SRFB 2010). Local communities write recovery plans for the ESA listed salmon species in their WRIA which must then be approved by the federal government. The communities then develop lists of restoration projects and submit them

to the SRFB for technical review (RCO 2010a). The SRFB has two grant programs that it administers; the general salmon recovery grants and the Puget Sound Acquisition and Restoration Fund (RCO 2010a). The funding comes from a mix of federal funds through the Pacific Coastal Salmon Recovery Fund and state funding through the sale of state general obligation bonds (RCO 2010a). Since 1999 when the SFRB was created it has awarded more than $490 million in grants to more than 1,700 projects by 2011 (SRFB 2011).

The SRFB is composed of ten members; five are voting members appointed by the governor and five are non-voting state agency directors from the Washington Department of Fish and Wildlife, the Washington Conservation Commission, the Washington Department of Natural Resources, the Washington Department of Transportation, and the Washington Department of Ecology. The SRFB funding process involves many different levels of organization: there are eight salmon recovery regions in the state which were defined by state and federal agencies; seven regional organizations were formed to develop recovery plans for the regional recovery areas; and lead entities are local groups made up of an administrative body, citizen-based committee, and technical advisory group (SRFB 2012). The purpose of the lead entity is to develop strategies for salmon recovery and to use those in conjunction with the regional plans to develop a sequence of restoration and protection projects. The lead entity technical advisory groups review the projects for scientific validity and the citizen committees use this information and local social, economic, and cultural values to compile ranked project lists to submit to the SRFB (SRFB 2012).

The SRFB awards a percentage of expected funding to the salmon recovery regions as shown in Table 2. The allocation formula was developed in 2006 based on physical and biological factors in the regions including the number of water resource inventory areas, number of salmonid stream habitat, number of listed populations, and Salmon and Steelhead Stock Inventory (SaSI) status (SRFB 2012).

Table 2. SRFB Funding Allocation by Region
Source: SRFB 2012

Salmon Recovery Region	Percentage of Allocation
Lower Columbia River Salmon Recovery Region	15%
Hood Canal Salmon Recovery Region (Hood Canal summer chum)	2.35 %
Middle Columbia River Salmon Recovery Region	9.87%
Northeast Washington Salmon Recovery Region	2 %
Puget Sound Salmon Recovery Region (including Hood Canal Salmon Recovery Region)	42.04%
Snake River Salmon Recovery Region	8.88%
Upper Columbia River Salmon Recovery Region	10.85%
Washington Coastal Salmon Recovery Region	9%

Funding is available through the SRFB to cities, counties, conservation districts, Native American tribes, nonprofit organizations, private landowners, regional fisheries enhancement groups, special purpose districts, and state agencies. A state agency must have a local partner that is independently eligible to apply for a grant. Federal agencies are allowed to partner with eligible applicants and projects may occur on federal lands (SRFB 2012). Funding applicants must work with a local lead entity to submit their proposals. The SRFB Review Panel is then required to visit every project before the final application deadline. The review panel is responsible for evaluating the technical merits of a proposal and identifying any concerns about the benefits to salmon and certainty of success (SRFB 2012). The SRFB prefers that the regions create a prioritized list of projects, but they are required to at least provide a recommendation for funding the lead entity lists (SRFB 2012). Applicants are required to provide a minimum 15 percent match from non-SRFB funds to demonstrate local commitment and support of the project (SRFB 2012). No match is required for certain design-only projects and a greater match of 35 percent is required for fish passage projects and 50 percent for certain sediment reduction projects (SRFB 2012).

Eligible projects must address habitat condition or watershed processes that are important to salmon recovery. A project may also provide secondary benefits like flood control or

education, but this cannot be the primary purpose of the project (SRFB 2012). Types of eligible projects include acquisition of land, access, or other property rights; restoration projects that address in-stream fish passage, in-stream diversion, in-stream and floodplain habitat, riparian habitat, upland habitat, estuarine habitat, and marine nearshore; and planning projects like assessments, designs, inventories, and studies.

NOAA Restoration Center

The NOAA Restoration Center is an additional source of grant funding for salmon habitat restoration activities in Washington (NOAA 2012). The NOAA Restoration Center Northwest Region is responsible for habitat restoration programs in Washington, Oregon, Idaho, and Alaska. The Restoration Center works to support recovery of species listed under the ESA through riparian and estuarine habitat restoration and fish passage projects (NOAA 2012a). The Restoration Center uses a science-based process to restore salmon habitat in Puget Sound in a strategic manner in order to have the biggest impact and the best chance of restoring habitat-forming processes with available funds (NOAA 2012a).

The NOAA Restoration Center has a variety of grant funding programs available for use in salmon habitat restoration. The Community-based Restoration Program is used by NOAA to invest funding and technical expertise in high-priority habitat restoration projects while working with partner organizations to increase the outcome (NOAA 2012). This program also promotes community involvement and local stewardship of projects while providing technical guidance (NOAA 2012). The Open Rivers Initiative is another funding program that is dedicated to providing funding and technical guidance to carry out dam and barrier removal projects to restore local rivers and streams (NOAA 2012). This program was created in 2005 to provide both funding and technical guidance for the community-driven dam and river barrier removal programs (NOAA 2012). The Restoration Partnerships program provides funding for three-year projects for restoration of coastal and marine habitat through collaboration with partners (NOAA 2012). A final source of grant funding for habitat restoration is the Marine Debris Prevention and Removal Funding program. This is another community-based program supporting locally driven projects to benefit coastal habitat, waterways, and wildlife (NOAA 2012).

CHAPTER 2: Restoration

Restoration Principles in the Literature

According to Bradshaw (1996), the term restoration has been used with a variety of meanings, but it usually connotes a return to an original state and sometimes to a state that is perfect and healthy. Restoration can be applied on a variety of levels, from a species or community to habitat or an entire ecosystem. Restoration of ecosystems includes an emphasis on fundamental processes while habitat restoration is more focused on the restoration of a place rather than on the processes and functions (Bradshaw 1996). A key concern with restoration is the determination of the final goal. It may be stated as the complete return to the original state, the presence or absence of a species, the number of species, the return of natural processes, or some other goal (Bradshaw 1996). The type of restoration undertaken depends on the goal and the state of the ecosystem, species, or habitat.

While Bradshaw (1996) argues that habitat restoration is limited to restoring physical characteristics of a place, Miller and Hobbs (2007) use of the term includes structural elements, processes, or other factors that benefit target species. They stress those restoration efforts with the goal of improving conditions for a species must be based on the concept that habitat is an area with the combination of resources and environmental conditions necessary for the individuals to carry out life processes (Miller and Hobbs 2007). Miller and Hobbs (2007) also identify a set of important considerations in the habitat restoration process; determining the target species, selecting the key habitat elements for restoration, and assessing the landscape context. These three areas must also be considered in the context of ecological, economic, and social constraints. A basic statement of the constraints is that "ecological constraints define what is possible and financial constraints determine what is realistic, social constraints will determine whether a given habitat restoration project is acceptable" (Miller and Hobbs 2007).

While discussing the restoration of river ecosystems, Beechie et al. (2010), advocate for the use of process-based principles. According to the Beechie et al. (2010), "process-based restoration aims to reestablish normative rates and magnitudes of physical, chemical, and biological processes that create and sustain river and floodplain ecosystems" (p.209). Examples of these include erosion and sediment transport, input of nutrients and thermal energy, storage and routing of water, and nutrient cycling (Beechie et al. 2010). These processes occur on both a

landscape-scale and a reach-scale and both should be considered during the restoration process. By restoring natural processes the actions should require minimal maintenance over time and they can also restore multiple ecosystem components concurrently (Beechie et al. 2010). Beechie et al. (2010) list four principles for river restoration: (1) target the root causes of habitat and ecosystem change, (2) tailor restoration actions to local potential, (3) match the scale of restoration to the scale of physical and biological processes, and (4) be explicit about expected outcomes, including recovery time.

In their report for the Puget Sound Nearshore Partnership, Fresh et al. (2004) also propose basing recovery on reestablishing or improving ecosystem processes. The focus of the report is the nearshore estuarine and marine shoreline areas. The authors recognize that ecosystem processes cross boundaries of air, water, and land and therefore a recovery or restoration plan should incorporate this connectivity between upstream freshwater, terrestrial, shoreline, and marine ecosystems (Fresh et al. 2004). Fresh et al. (2004) also argues that for restoration of Puget Sound to be successful it must be undertaken in a strategic manner with a comprehensive plan, but that there is also great potential value in implementing "early action" projects (Fresh et al. 2004). These early projects could be used to provide information and help develop protocols, test alternatives, evaluate uncertainties, and provide ecological benefits. Overall, the argument is that process-based restoration has the greatest chance to increase valued species or populations or to improve other functions because it addresses the causes of degradation and not the symptoms (Fresh et al. 2004). It also allows the ecosystem to be "naturally productive, self-sustaining (reducing long-term maintenance), and diverse" (Fresh et al. 2004 p. 3).

Salmon Habitat Restoration Projects

There are several types of common salmon habitat restoration activities that occur in the Pacific Northwest and frequently have been documented in the scientific literature. The following is a brief sampling of some of the most common actions. It is not surprising that these also appear in the projects funded by both the NOAA Restoration Center and the SRFB.

The reconnection of isolated habitats can be a crucial restoration action to benefit salmon populations. Floodplains can become isolated due to agriculture, urbanization, flood control, or transportation (Roni et al. 2002). Culverts and other artificial structures can also act as barriers

to salmon passage, blocking their access to rearing areas (Roni et al. 2002). Estuarine habitat may become isolated through the construction of dikes or addition of fill (Roni et al. 2002). All of these causes of isolated habitat can be remedied through restoration actions such as floodplain reconnection, replacement or removal of barriers, and breaching dikes or removing fill.

Road restoration activities are another important category to overcome the effects that roads and bridges can have on salmon habitat. Roads can increase the delivery of fine sediment and change the hydrology of streams (Roni et al. 2002). Restoration activities to remedy this can include the removal of roads and stream crossing structures where possible, the use of local soils for road surfaces, and proper placement of ditches and drainage (Roni et al. 2002). Bridges and other stream-crossing structures can slow or prevent the downstream delivery of sediment, woody debris, or water. Restoration techniques to alleviate these issues include the complete removal of the stream-crossing, or more commonly replacement or retrofitting of the bridge or culvert (Roni et al. 2012a).

Riparian restoration projects are developed to counteract the effects of timber harvest, livestock grazing, and urban development. Restoration projects in the riparian zone may be done to increase shade and decrease water temperatures; reduce erosion or stabilize streambanks; restore forests and increase input of large woody debris and leaf litter; or to improve water quality (Roni et al. 2012a). Many projects will work to improve the condition of riparian vegetation by planting native species and removing invasive species, as well as thinning or removing competing plants (Pollock et al. 2005). Grazing livestock can severely damage fish habitat, but degraded habitats are typically improved by adding fencing or otherwise excluding livestock (Armour et al. 1994). Finally, riparian restoration projects often include the creation or protection of riparian buffers because they can decrease the input of sediments, fertilizers, and pesticides and improve the water quality, water temperature, and bank stability (Roni et al. 2012a).

Instream habitat has been degraded due to removal of boulders and logs, channelization of streams, and the removal of riparian vegetation (Roni et al. 2012a). Much of the restoration activity has centered on the placement of large woody debris and boulders in order to recreate the physical structures of streams. However, research has shown that projects involving large woody debris can promote minor improvements in physical stream conditions in the short-term but improvement in biological conditions have not been observed (Larson et al. 2001). Another

technique is to return a channelized stream to a more natural meander pattern which will increase the amount of habitat and stream length as well as increasing the quality of the habitat (Roni et al. 2012a).

CHAPTER 3: Prioritization

Methods of Prioritizing Restoration Projects

Scientific literature identifies various strategies for prioritization of restoration activities. The focus of the prioritization varies by strategy and may include the types of restoration actions, quality of habitat, populations or stocks of species, or other qualities to determine the prioritization. Selections from the literature are highlighted here to understand different viewpoints of prioritizing restoration projects and funding.

Beechie et al. (2008) provide an overview of river restoration prioritization approaches and suggest that there are six different general approaches that can be used. These approaches are project type, refugia, decision support systems, single-species analysis, multispecies analysis, and cost effectiveness. They specify that the prioritization approach chosen will depend on the amount of information available and each will have different strengths and weaknesses. They identify the first three approaches as "logic" approaches because they are based on simple logic tools rather than on detailed information about the changes in watershed processes and habitats. The first is project type in which "techniques that have a high probability of success, relatively quick response time, and long duration should be implemented before other techniques" (p. 892). The second approach is refugia, which is based on protecting sites in the best condition first and then expanding outward from those areas. This strategy may be most appropriate if at least one species is at high risk of extinction. The third strategy is decision support systems which uses semi-quantitative tools to weigh information and set priorities. Groups can rank and score projects based on common evaluation criteria and compare them based on total scores or component scores. The final three approaches are categorized as "analytical" by the authors because they are based on "analyses of habitat loss or degradation, changes in watershed processes, and importance of specific habitat losses to one or multiple species" (p. 892). Single-species approaches require more detailed information from watershed assessments to identify constraints on the target species. With this information, prioritization can be based on the estimated benefits to the target species. The multiple-species approach focuses on improving watershed processes and restoring habitat conditions for many species. High priority projects improve populations of multiple species or rare species, or may be based on the rarity of a habitat

type or impairment to processes. The final approach is cost effectiveness which ranks projects based on the ability to achieve the most restoration benefit at the least cost (Beechie et al. 2008).

Similar to the project type restoration strategy presented by Beechie et al. (2008) is the hierarchical prioritization strategy discussed by Roni et al. (2002). This approach is specifically based on watershed restoration techniques and the authors advocate for prioritization "based on three elements: (1) principles of watershed processes, (2) protecting existing high-quality habitats, and (3) current knowledge of the effectiveness of specific techniques" (p.1). They also state that the priority should be given to protecting existing high-quality habitat before habitat restoration because protection is easier and more successful than restoration. Beyond the protection of high-quality habitats, restoration actions should be based on a watershed assessment and then occur in a hierarchical manner based on the known effectiveness of the specific techniques. The general restoration focus should also be based on restoring natural processes, which would allow natural habitat types to form, rather than on physical habitat modifications (Roni et al. 2002).

Frissell and Bayles (1996) also advocate for the refugia approach in their article on approaches to ecosystem management. The authors state the need for protected areas as reservoirs of natural biodiversity in areas that are the least damaged. In an area that is already extensively altered the protection of the least-disrupted ecosystems with potential for rapid and cost-efficient restoration would have to be substituted for unaltered ecosystems. The protected areas would also need to have high incidence of the species at risk of serious decline (Frissell and Bayles 1996).

In their article on forest restoration principles, DellaSala et al. (2003) identify three components in their ecological restoration approaches principle. The first component is the protection of areas of high ecological integrity that can serve as core refugia. The second principle is passive restoration through ceasing activities that impede natural recovery processes which can be applied alone or in combination with active restoration techniques. The third principle is active restoration based on reintroducing natural processes or species through direct intervention. The use of active restoration techniques should be based in areas that are at the greatest ecological risk and where no action would carry more risk than the restoration (DellaSala 2003).

Cipollini et al. demonstrate the use of the decision analysis framework to incorporate expert opinion into the prioritization of restoration (2005). They argue that the use of this systematic framework integrates "ecological theory, objective ecological data, and subjective expert opinion to make restoration decisions" (p. 467). The process consists of developing a hierarchy of fundamental objectives, developing measureable attributes for each objective with the experts, modeling expert preferences, and determining priority scores and results in a ranked list of management options. This list indicates what actions should be taken immediately or more intensely based on expert preferences. The use of decision analysis as a consensus-building tool can be especially helpful when there are many people with a variety of backgrounds responsible for making the management decisions (Cipollini et al. 2005).

SRFB Prioritization Strategy

The SRFB's prioritization happens on multiple levels. The first prioritization occurs between the lead entity and the regional organization and may be based on local information such as social, economic, and cultural values (SRFB 2012). The SRFB then reviews all submitted projects for eligibility and finally the SRFB Review Panel evaluates the technical merits of the project (SRFB 2012). The SRFB prefers that each region creates its own prioritized project list and requires at least a recommendation for funding the lead entity list (SRFB 2012). The main prioritization of restoration projects is occurring at the lead entity and regional organization levels of the recovery process. The SRFB does have to follow the regional funding allocation discussed earlier which is also a geographical prioritization strategy based on the number of water resource inventory areas, number of salmonid stream habitat, number of listed populations, and Salmon and Steelhead Stock Inventory (SaSI) status (SRFB 2012)

For the Puget Sound Recovery Region there is no single prioritization strategy outlined. However, indications of the prioritization strategy can be found in the Puget Sound Salmon Recovery Plan because this is the guiding document for the region. Although prioritization and restoration strategies were created in the individual watersheds, the Recovery Plan does address issues that are common to many of the watersheds. The first focus identified by the Recovery Plan is the protection of high-quality salmon habitat in both urban and rural areas (Shared Strategy 2007). This is advocated as the most important action in the short-term in order to increase the chances of achieving the Recovery Plan outcomes. The Recovery Plan then goes on

to state the importance of restoring ecosystem processes as high-value restoration actions (Shared Strategy 2007). The Recovery Plan specifies other areas that are critical to the restoration strategy such as estuarine and marine nearshore, in-stream flow, water quality, forests, and farms (Shared Strategy 2007). However, it does not prioritize these areas or actions for restoration. The individual watersheds are responsible for prioritizing their restoration actions within the larger framework of the Recovery Plan.

NOAA Restoration Center Prioritization Strategy

The NOAA Restoration Center is focused on prioritizing its limited funding on areas with the greatest potential for significant gains for salmon recovery. The primary focus in Washington is Puget Sound. Within the Puget Sound basin, a watershed prioritization process was undertaken three years ago focused on two broad categories; ecosystem components and salmonid population components. The four factors used to define these categories were the status of salmonid stocks, the legal status of all of NOAA's trust resources in a watershed, the watershed condition, and the development pressure in a watershed (J. Steger, personal communication, August 2012). The salmonid stock status was based on Chinook stocks and includes factors of abundance, diversity, spatial structure, and productivity (NMFS 2010). Watersheds that were not influenced by hatcheries were given a higher priority. This process identified the highest priority as Snohomish, Stillaguamish, and Skagit watersheds which are collectively known as the Whidbey Basin. The Nooksack, Dungeness/Elwha, and Skokomish were identified as additional priority watersheds (J. Steger, personal communication, August 2012).

The NOAA Restoration Center uses partnerships to increase total funding to critical recovery actions which can enable projects to go to construction or allow funding to reach further down the list of potential projects. The Restoration Center also uses funding to work in priority watersheds to remove barriers to restoration with technical experts identifying and supporting projects that provide multiple benefits to communities. Additionally, the Restoration Center is focusing on developing and supporting monitoring efforts to increase understanding of the impacts and effectiveness of restoration actions (J. Steger, personal communication, August 2012).

CHAPTER 4: Research Approach

The major focus of this study is to systematically explore the theory of prioritization of restoration projects and compare this to the strategies of the SRFB and NOAA Restoration Center. The stated strategies of the SRFB and NOAA Restoration Center and the scientific theory of prioritization will be measured against actual funding decisions made by each organization. The assumption is that the category of actions taken should show higher levels of funding for high priority watersheds and that the high priority actions will be based on best available science. There has been much discussion of prioritization and this is a way to test the alignment of funding decisions with priority restoration actions.

This analysis was done through creation of an original database of projects funded, project types, and quantity of funds granted. These were compared with a hierarchy I developed from the literature review. Results of the study offer insight into the connection between the scientific theory of prioritization of restoration actions and the reality of the two funding organizations.

Research Questions

The goal of this study is to answer a series of research questions relating to the use of prioritization in the funding decisions made for restoration projects for salmon recovery in Puget Sound, WA.

1. What strategies are recommended in the scientific literature for the prioritization of restoration projects under constraints of limited resources?

    1a. Do the actual grant funding results reflect a recommended prioritization strategy?

2. Does the SRFB follow a specific prioritization strategy when determining how to award funds for salmon habitat restoration projects?

    2a. If so, what is its prioritization strategy?

3. Does the NOAA Restoration Center follow a specific prioritization strategy when determining how to award funds for salmon habitat restoration projects?

2a. If so, what is its prioritization strategy?

4. Are there similarities or differences between the types of projects funded by the SRFB and the NOAA Restoration Center? What comparisons or conclusions can be made?

5. What recommendations can be made for the future use of prioritization strategies in salmon restoration planning in Puget Sound?

Data Collection

A database was created for this study with data from the SRFB and the NOAA Restoration Center. For each project listed for either the SRFB or the NOAA Restoration Center I needed the following information: project name, funding organization, year, project description, and project type. For each project I used the project description to code it by the type of project. The project types are listed in Appendix 1. I created a Microsoft Excel database with entries for each project for both the SRFB and the NOAA Restoration Center.

The SRFB data were compiled using information from the Washington State Recreation and Conservation Office website http://www.rco.wa.gov/grants/eval_results.shtml#srfb. The grant funding results are posted for each year on the website as reports. I downloaded the reports for each year from 1999 to 2011. The amount of information contained in each report varied from year to year so the data treatment varied depending on the year. For 2006 through 2011 all the necessary information were contained in the report. For 1999 through 2005 the reports did not contain all the information required; some were lacking funding information while others were lacking project descriptions. I used the information available in the report and also looked up individual projects in the project search function available on the website at http://www.rco.wa.gov/prism/ProjectSearch.aspx to fill in data gaps.

The data for the NOAA Restoration Center were available online through the Restoration Atlas at http://seahorse2.nmfs.noaa.gov/restoration_atlas/src/html/index.html. This is a public access point to data from the Restoration Center's project tracking database. Each project listing contains a project description, list of partners, funding information, and types of habitat restored. I was able to complete my database fully with the information included in the Restoration Atlas.

In order to analyze the data by type of restoration action or other project type I separated each project into its component parts. The project types were adapted from a general template used by the SRFB to describe projects. I started with the SRFB basic categories and project types and added to it as I came across project actions that were not included within the SRFB's descriptions. Appendix 1 shows the project categories and types as used in the database. Each individual project was determined to have one to five associated project types. I was unable to determine how much of the total funding granted to the overall project was spent on each of the component parts. Therefore I decided to divide the total funds per project equally over the component project types. This method of dividing the funds between project components was chosen because I did not have the data to know what percentage of the total funds went to each project type and this was a standard formula to use for each project. Although it is unlikely that each project component received an equal percentage of the total funds, I believe that the total effect on the data analysis will be negligible as a result of consistent application of this method across all projects.

Restoration Project Hierarchy

As discussed in Chapter 3 on prioritization, there are many possible strategies and the most effective choice depends on the specific situation including the temporal scale, spatial scale, and the quantity and quality of information available. For this thesis it was important to base the analysis on a prioritization strategy that is based on scientific theory and that also best fits the goal of an overall strategy that is applicable to the entire Puget Sound recovery region and both funding organizations studied. I chose to base my prioritization strategy on the project type hierarchy as discussed in Beechie et al. (2008) and Roni et al. (2002, 2003). This approach puts the emphasis on projects that have a high probability of success, relatively quick response times, and a long duration (Beechie et al. 2008). However, this project type prioritization is a more general approach that can be used for any location and does not specifically consider the unique local site-specific or watershed-specific factors that may be relevant (Roni et al. 2012). Roni et al. (2012) recommend this type of prioritization as an initial step that can be followed up with more detailed data collection or multi-criteria decision analysis approach.

While I based my hierarchy on that of Roni et al. (2002), I did make additions and adjustments. The hierarchy established in Roni et al. (2002) is based on an understanding of the

physical and biological effectiveness of restoration methods as evidenced by salmonid response. Their hierarchy begins with protection of high-quality habitat and then moves into restoration actions. The restoration action hierarchy starts with reconnection of isolated habitats which should have a quick biological response, last many decades, and have a high likelihood of success (Beechie et al. 2003). The next focus is on restoring watershed processes beginning with improvements to roads that are impairing these processes. Following that is the restoration of riparian processes. The next and last category for Roni et al. (2002) is restoring habitat, including such actions as placing materials like rocks, gravel, or wood in streams to enhance or restore habitat.

My restoration project hierarchy, Figure 2, follows the advice of Roni et al. (2002) by beginning with the protection of high-quality habitat and then moving into restoration actions. The restoration activity begins with reconnecting isolated habitats, and then moves into restoring processes. The restoration of processes moves from roads, to riparian and instream, to estuarine and marine nearshore. The inclusion of estuarine and marine nearshore processes is not explicitly included in the hierarchy of Roni et al. (2002). They note that little is known about the effectiveness of estuarine restoration, but that reconnecting isolated estuarine habitats is similar to other isolated off-channel habitats and that estuaries are highly important to anadromous fishes (Roni et al. 2002). For these reasons, I have included estuarine and marine nearshore in my hierarchy of restoration projects for reconnection of habitat, restoration of processes, and habitat restoration. The next step in my hierarchy is the habitat restoration category like that of Roni et al. (2002). The final two parts of my hierarchy are not included in the Roni et al. (2002) model but they appear in the data of project funding for the organizations studied. The first is the creation of habitat and supplementation of salmon stocks. Roni et al. (2002) mention that construction of habitats is generally discouraged because the habitats may not have the natural processes necessary for maintenance therefore, this is listed at the end of my hierarchy along with the supplementation of salmon stocks for similar reasons. Another category on my hierarchy is non-restoration projects including project designs, research, assessments, outreach, and education. These are not necessarily the lowest priority but rather are important parts of the restoration and prioritization process. These activities often occur in conjunction with each separate level of the hierarchy and, while they do not represent restoration actions per se, restoration could not proceed without them.

Once I determined the eight broad categories for my restoration project hierarchy, I then related them to the database I created. I did this by assigning each of the 53 different project types present in the database to one of the categories in the hierarchy. I carefully considered each of the project types and used the scientific literature on habitat restoration to determine the best category for each. For much of the data analysis I also combined the three categories related to restoring ecosystem processes; restoration of processes related to roads, restoration of instream and riparian processes, and restoration of estuarine and marine nearshore processes, as one larger category encompassing all process restoration. This was important for comparisons of funding between the project categories.

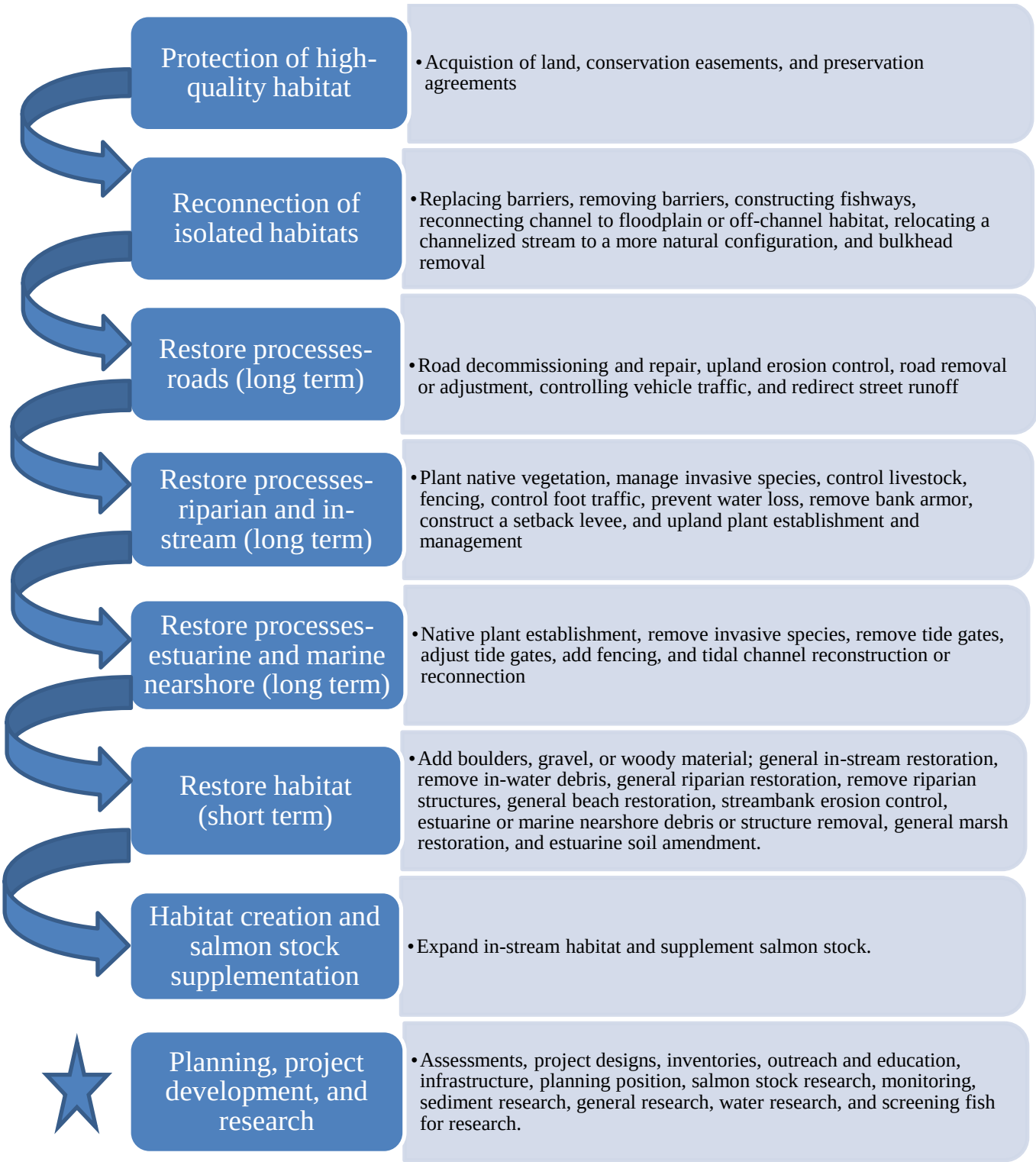

Figure 2. Hierarchy of Restoration Project Types
Adapted from: Roni et al. 2002

Data Analysis

The hierarchy of restoration actions that I developed serves as the basis for my analysis of the database of projects funded by the SRFB and the NOAA Restoration Center. I performed algebraic analyses of the database to answer the research questions about funding granted by project type and prioritization strategies. I was then able to look at similarities and differences between the SRFB and NOAA Restoration Center and also to look at changes in funding decisions over time, project types funded on an annual basis, and funding decisions by lead entity.

CHAPTER 5: Regional Results

The data analysis includes the results of annual total funding for the SRFB and the NOAA Restoration Center, aggregate funding by project type for the entire time period, a breakdown of funding by project type for each year for the SRFB and the NOAA Restoration Center, and results of funding by project type for the SRFB by each lead entity.

Annual Total Funding

The first priority of the analysis was to get an overview of the funds granted in the Puget Sound recovery region by both the SRFB and the NOAA Restoration Center. Figure 3 shows the total funds granted by the SRFB and NOAA Restoration Center during the study period of 1997-2011. The SRFB granted funds totaling $217,388,121 between 1999 and 2011. The year with the lowest funding total was 2000 with $6,279,601. The year with the highest total was 2007 with funding of $39,866,837. The total of SRFB grant funding by year is in Figure 4. The NOAA Restoration Center granted funds totaling $21,873,426 between 1997 and 2011. The year with the lowest funding total was 1997 with $35,000, although there were no funds granted in 1998. The year with the highest total was 2009 with funding of $16,193,037. The total of NOAA Restoration Center grant funding by year is in Figure 5.

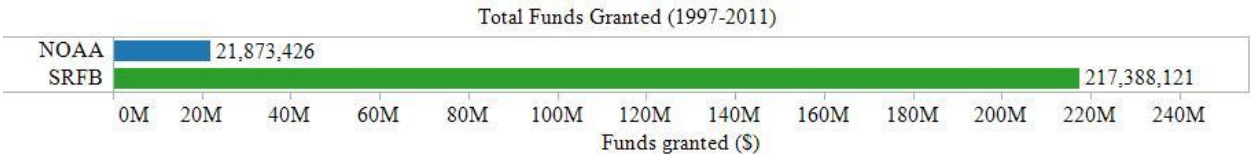

Figure 3. Total funds granted (1997-2011)

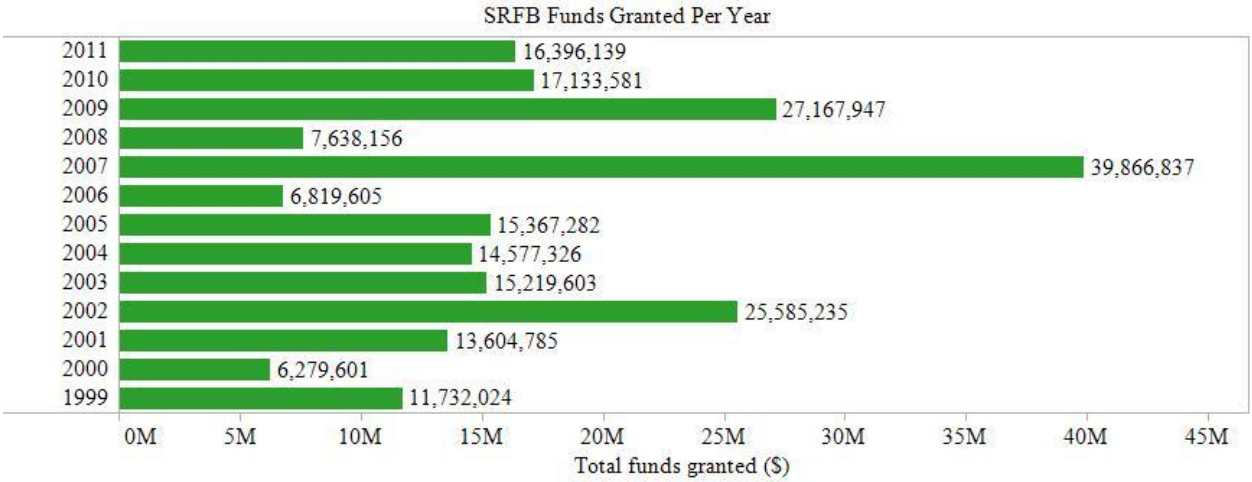

Figure 4. SRFB Funds Granted per Year

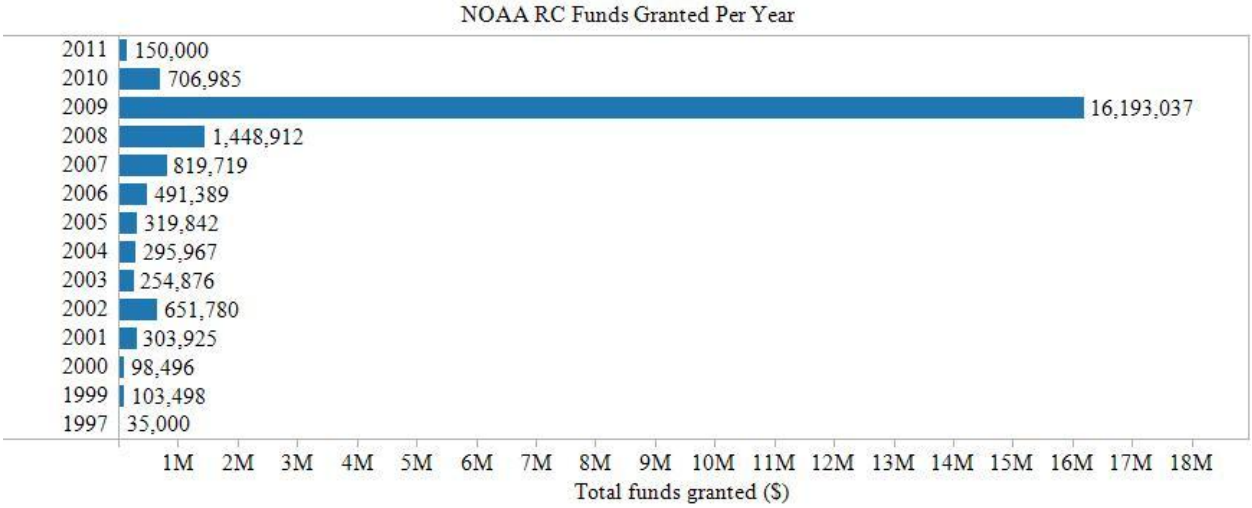

Figure 5. NOAA RC Funds Granted per Year

Total Funding by Project Type

For the entire time period of SRFB funding from 1999 to 2011 the total funding for each project type is shown in Figure 6. The results are somewhat surprising given the ongoing conversation about prioritization being skewed or not done correctly. This total of funding exactly follows the project type hierarchy with the most funding going to habitat protection, second most to reconnection of isolated habitats, next to the combined restoration of processes, followed by habitat restoration, and finally by habitat creation and salmon stock

supplementation. Project creation and research also had funding that ranked just below the combined restoration of processes.

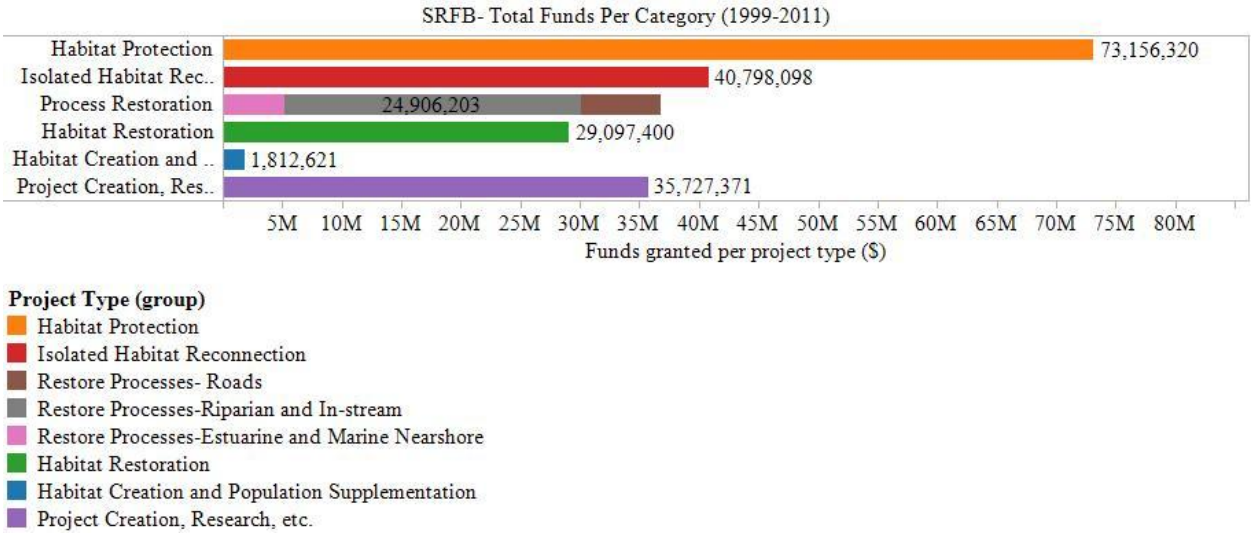

Figure 6. SRFB Total Funds per Category (1999-2011)

The funding granted by the NOAA Restoration Center between 1997 and 2011 is seen in Figure 7 and shows a different pattern of spending with the highest level of funding going to habitat restoration, followed by the combined restoration of processes, next was the reconnection of isolated habitats, and the lowest amount of funding went to project creation and research. The NOAA Restoration Center did not grant any funding to habitat protection or habitat creation and salmon stock supplementation.

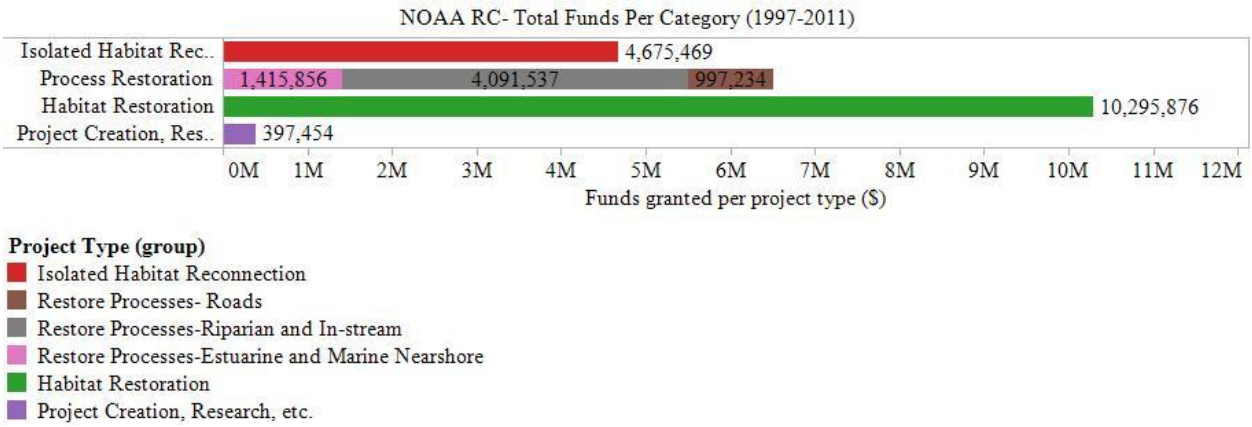

Figure 7. NOAA RC Total Funds per Category (1997-2011)

Annual Funding by Project Type

The next step in the data analysis was to look at the grant funding results on an annual basis to determine if the results observed for the aggregate data are similar year to year, or if there is more variation from the restoration project hierarchy. The annual breakdown for the SRFB is in Figure 8 and NOAA Restoration Center is in Figure 9. Although the total funding for the entire time period showed us that the SRFB aligned with the restoration project hierarchy, Figure 8 displaying the funding decisions by year shows that each year did not align as neatly as the total with the hierarchy of restoration projects. Figure 9 shows that although the totals for the NOAA Restoration Center did not align with restoration project hierarchy, there were years that did align with the hierarchy. Note that the total funding results were greatly affected by the large jump in funding in 2009.

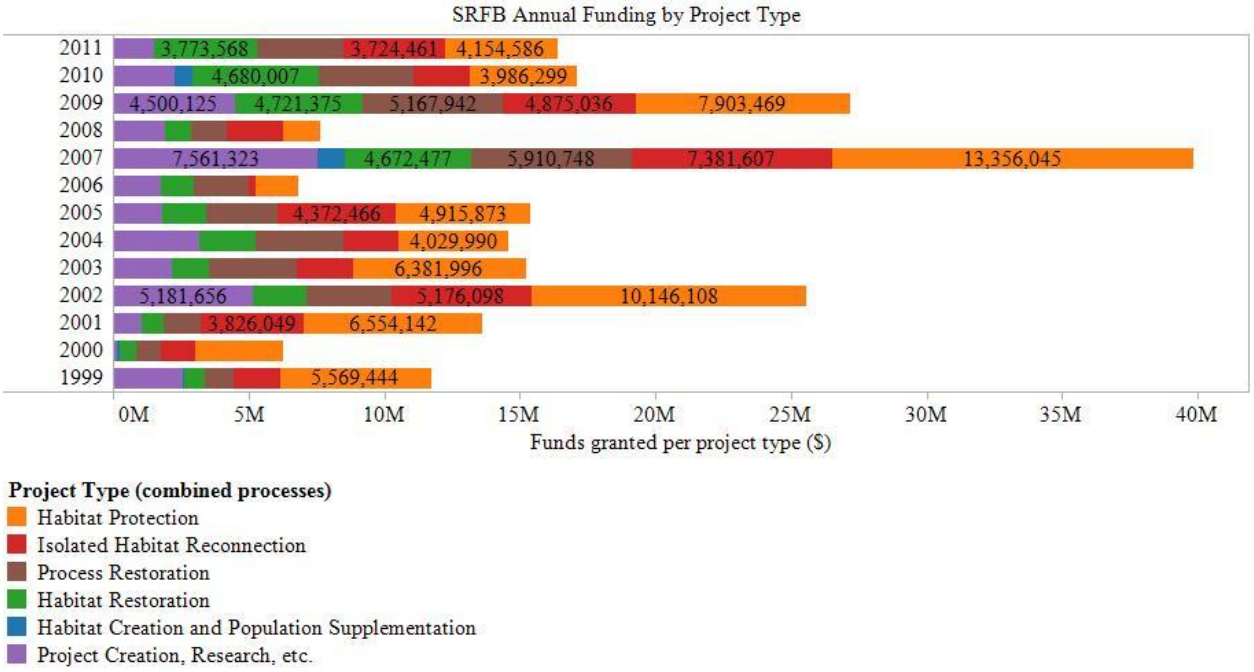

Figure 8. SRFB Annual Funding by Project Type

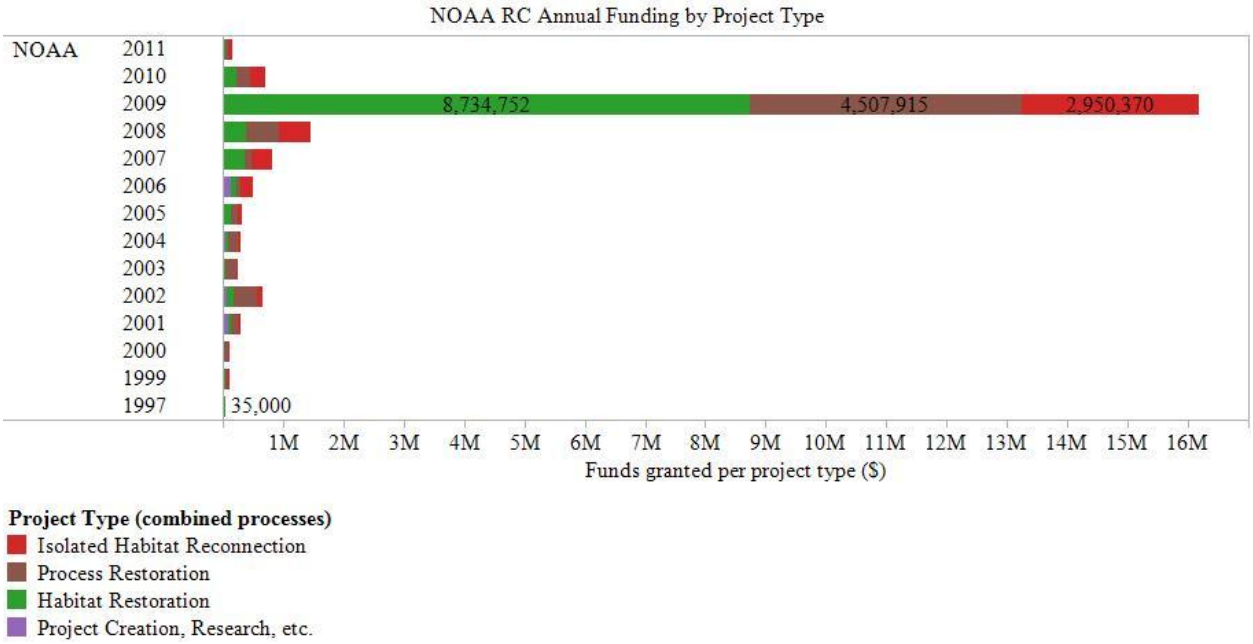

Figure 9. NOAA RC Annual Funding by Project Type

SRFB Annual Funding Results

Figure 8 and Figure 9 show that the variability in funding decisions when the results are examined on a yearly basis. In order to clearly display this variation I sampled the funding results for each year separately to determine if there were any observable funding trends for the SRFB and the NOAA RC.

During 1999, the first year of SRFB funding, the majority of the funding went into habitat protection projects at approximately $5.5 million. The next highest amounts of funding went into project creation and research at approximately $2.6 million, followed by reconnecting isolated habitats at approximately $1.7 million. This first year of salmon habitat restoration funding appears to track well with the project type hierarchy and it's also logical that a large amount of funding would be spent on research and project development at this early point in the funding program. See Figure 10.

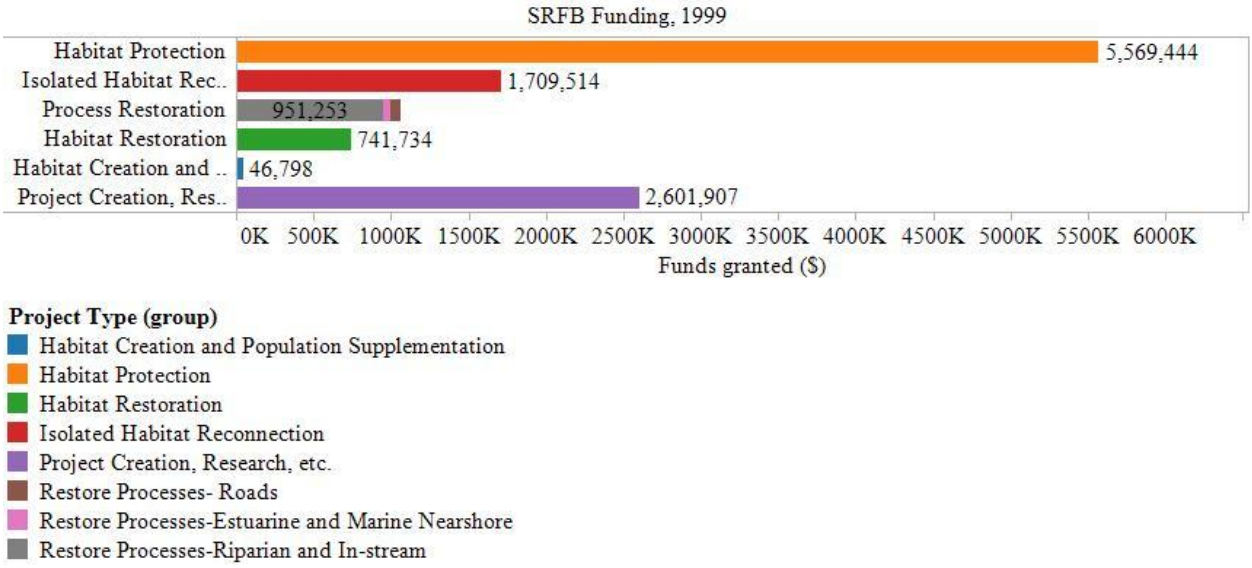

Figure 10. SRFB Funding in 1999

For 2000, the top SRFB funding category again was habitat protection with grants of approximately $3.25 million. The next highest category was isolated habitat reconnection with funds of approximately $1.25 million. All three categories of restoring processes totaled just over $2 million and habitat restoration projects were funded at just over $500,000. This again aligns with the project type hierarchy. See Figure 11.

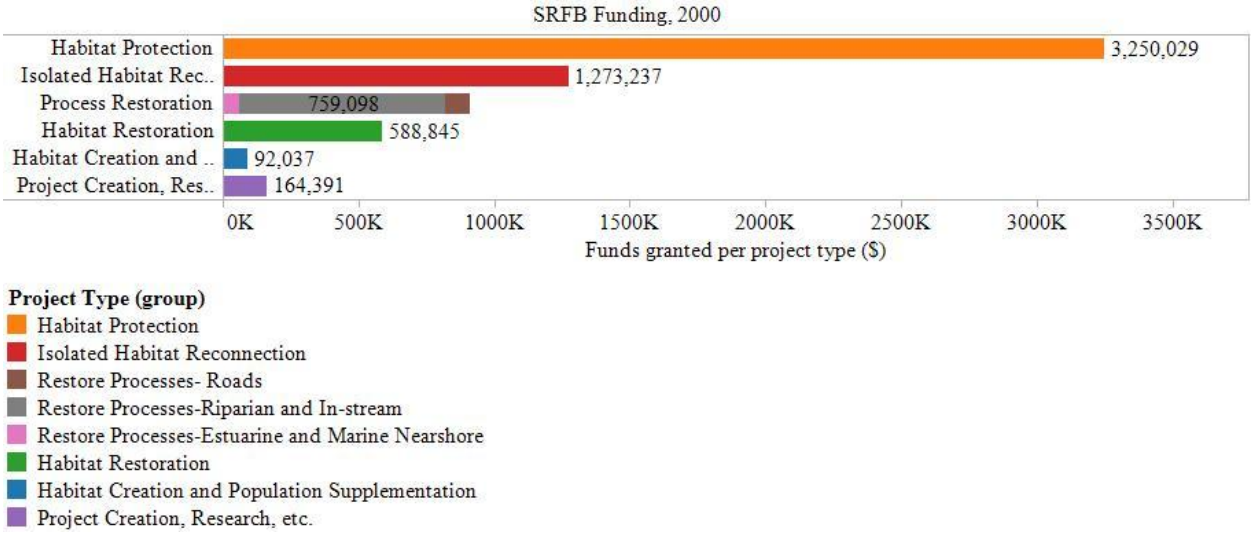

Figure 11. SRFB Funding in 2000

In 2001, the SRFB funded habitat protection with approximately $6.5 million for the top category, followed by reconnection of isolated habitats at almost $3.9 million. Process restoration funding totaled just under $1.5 million while project creation and research funding was just over $1 million. This was another year where the funding aligned with the restoration project hierarchy. See Figure 12.

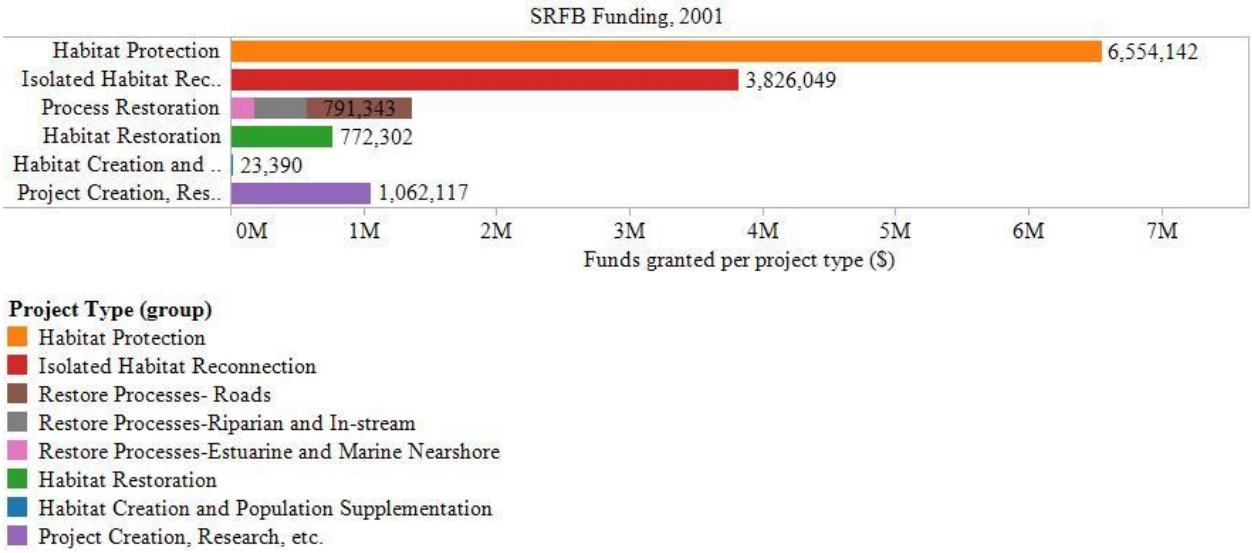

Figure 12. SRFB Funding in 2001

For 2002, the top SRFB funding category continued to be habitat protection with grants of just over $10.1 million. Projects that reconnected isolated habitat and project creation and research each totaled just over $5.1 million. The smallest category was habitat restoration with just under $2 million in funding. See Figure 13.

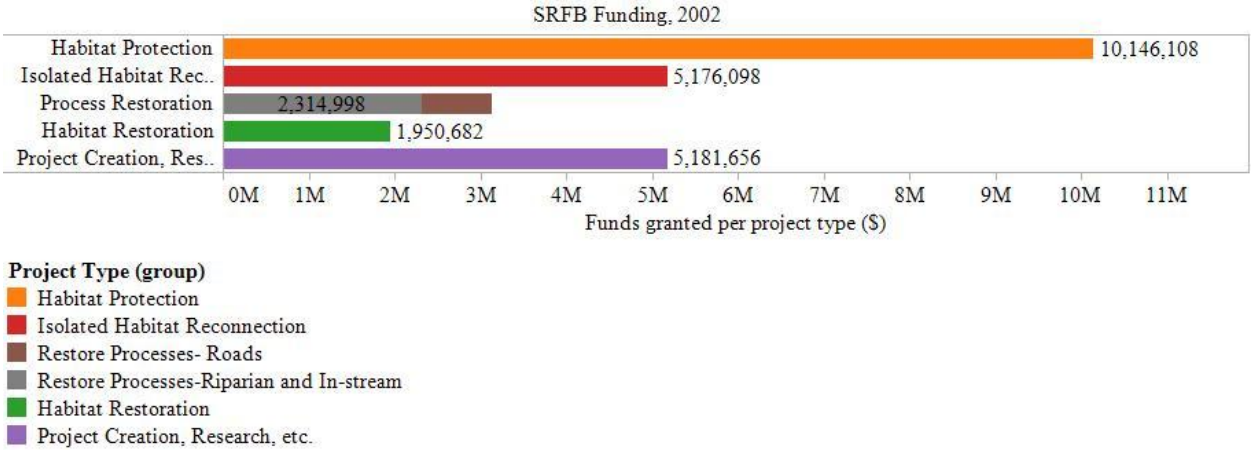

Figure 13. SRFB Funding in 2002

In 2003, the top funding position continued to be habitat protection with grants of approximately $6.4 million and the second most funded was the combined restoration process categories with approximately $3.3 million. Project creation and research and isolated habitat reconnection both came in around $2 million. Habitat restoration was allocated approximately $1.3 million. This was the first year that composite results did not completely follow the hierarchy with process restoration projects receiving greater funds that isolated habitat reconnection projects. See Figure 14.

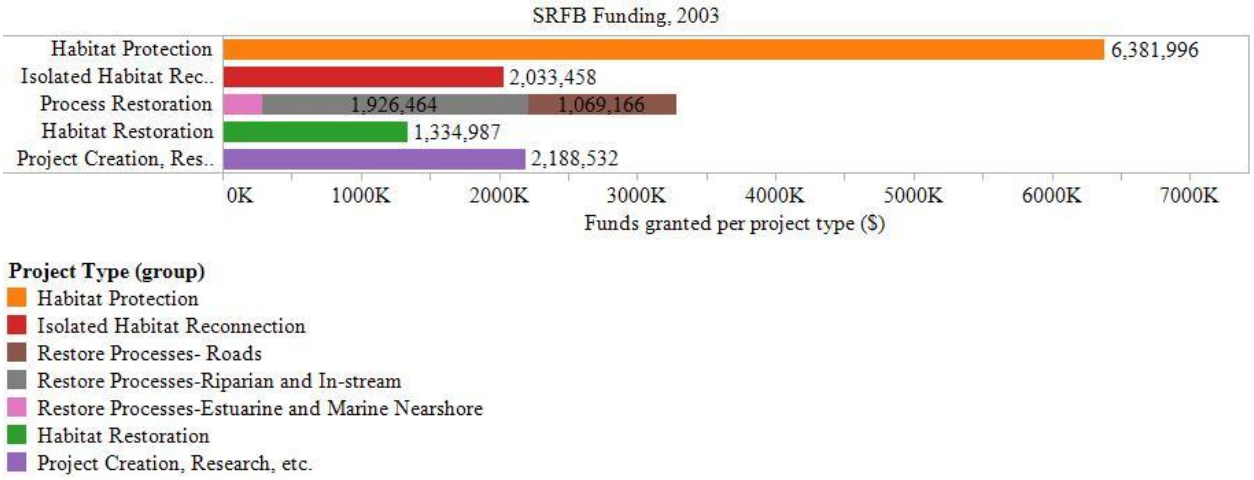

Figure 14. SRFB Funding in 2003

For 2004, the SRFB again awarded the most grant funds to habitat protection with a total of just over $4 million. Process restoration and project creation and research were next with

funding for each of over $3 million. Habitat restoration and reconnection of isolated habitats each received funds of just over $2 million. See Figure 15.

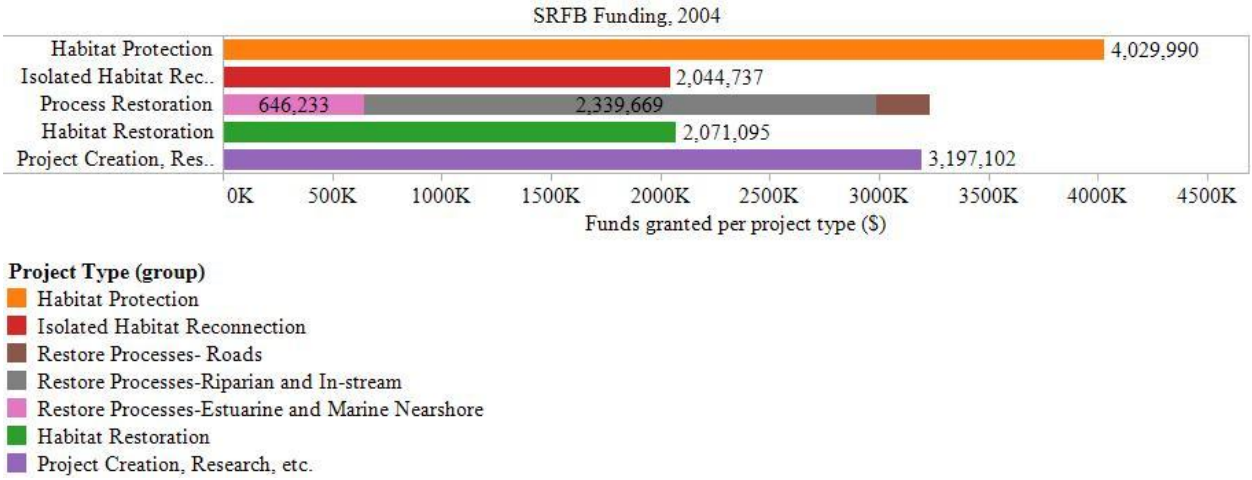

Figure 15. SRFB Funding in 2004

In 2005, almost $5 million was awarded to habitat protection projects, followed by over $4.3 million to reconnection of isolated habitats. Approximately $2.6 million went to projects that restored processes, followed by approximately $1.8 million to project creation or research projects. Habitat restoration projects received just over $1.6 million in funding. This marks a return to alignment with the restoration project hierarchy after a few years of changes in funding. See Figure 16.

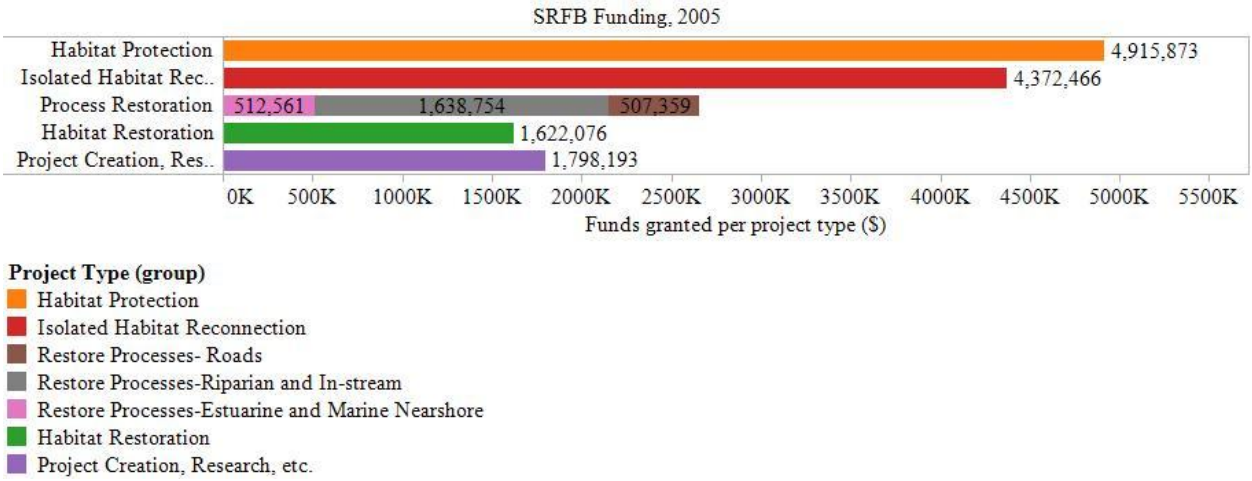

Figure 16. SRFB Funding in 2005

In 2006, for the first time the top funding category was process restoration projects with funding of just over $2 million. Project creation and research was second highest with funding of approximately $1.7 million. Habitat protection projects were funded just below this at just over $1.5 million, followed by habitat restoration projects at just over $1.2 million. The lowest funded project category was the reconnection of isolated habitats with just over $275,000. This was the first year that habitat protection was not the category with the highest funding and that reconnection of isolated habitats received the least funding. See Figure 17.

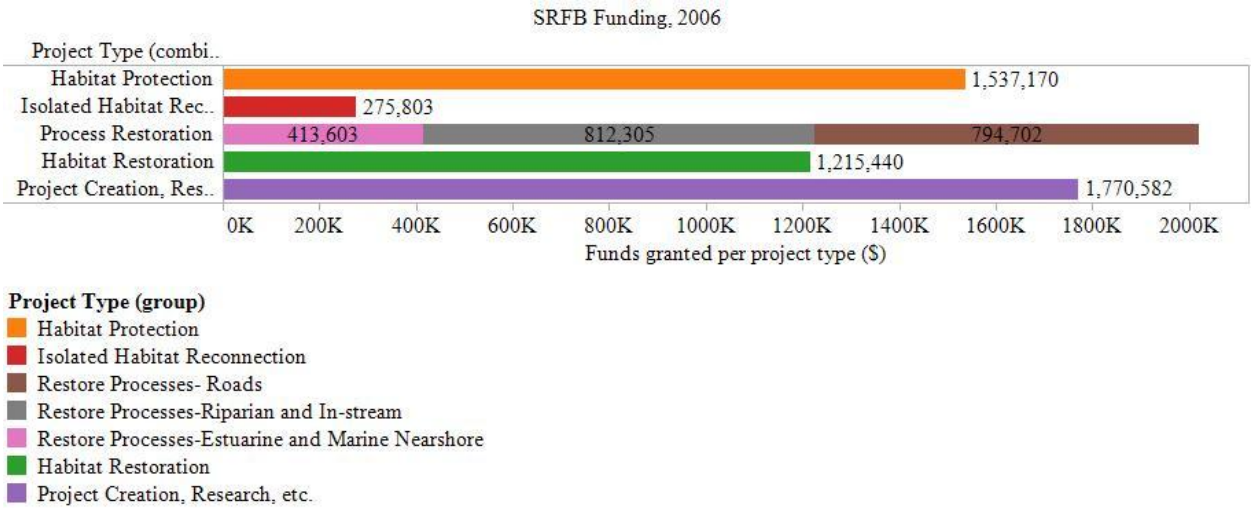

Figure 17. SRFB Funding in 2006

In 2007, the SRFB returned to funding habitat protection projects with the most funds, with over $13.3 million for the year. Project creation and research was the second highest with over $7.5 million and reconnection of isolated habitats was next with almost $7.4 million. Process restoration projects totaled funding of approximately $6 million dollars, followed by habitat restoration with just over $4.6 million. The lowest funding was habitat creation and salmon stock supplementation with just under $1 million in funding. See Figure 18.

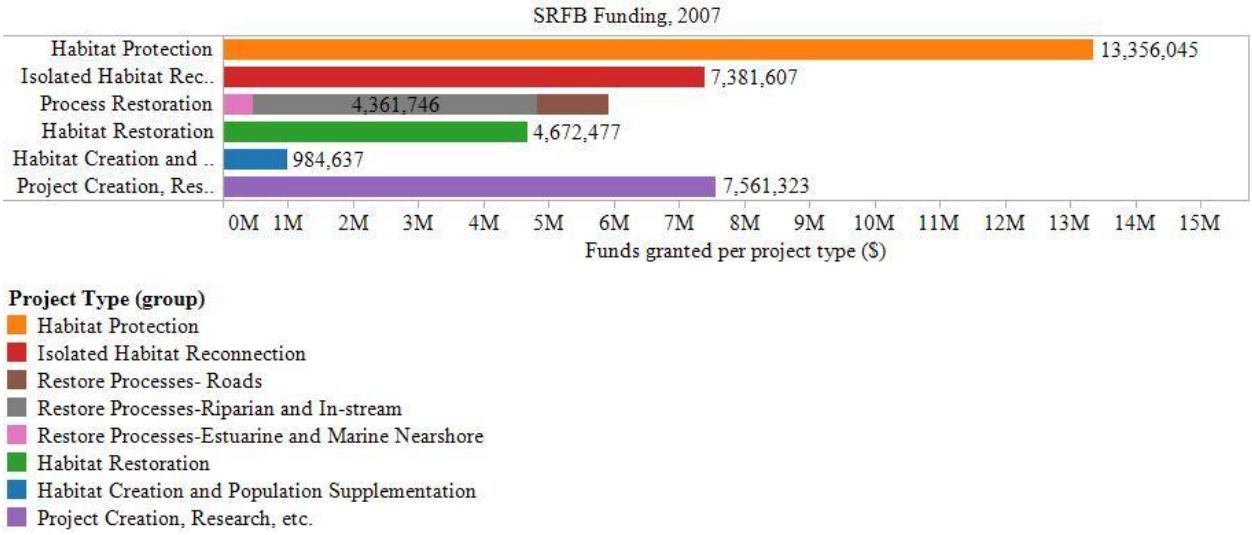

Figure 18. SRFB Funding in 2007

In 2008, the highest funded project category was the reconnection of isolated habitat with just over $2 million in funding. The second highest category was project creation and research with funding just under $2 million. Habitat protection and the restoration of processes both were funded with approximately $1.3 million. The lowest funding level was habitat restoration with just under $1 million. See Figure 19.

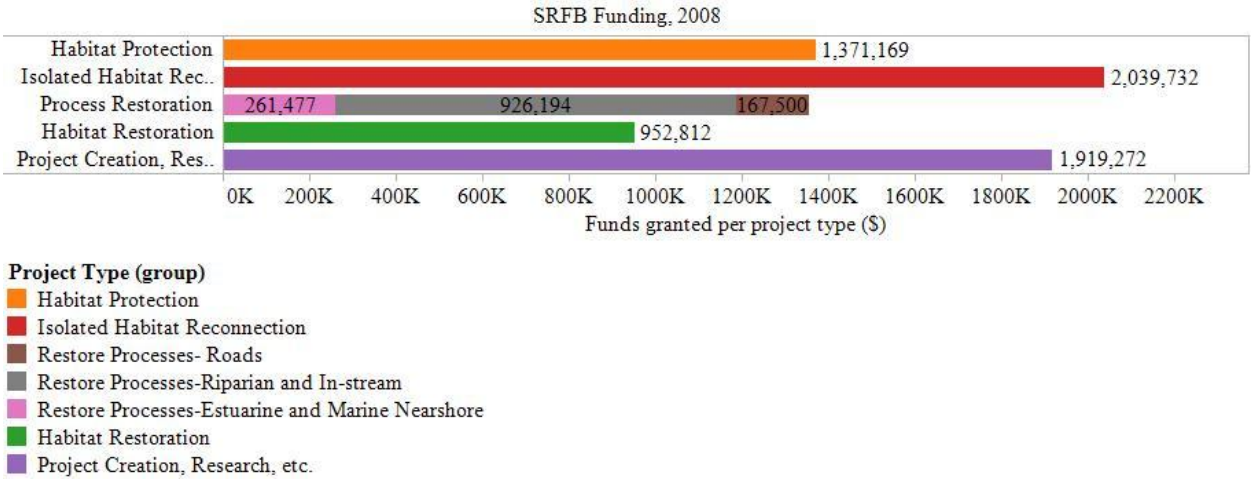

Figure 19. SRFB Funding in 2008

In 2009, the top funding category was habitat protection with grants totaling just under $8 million. Projects focused on restoration of processes received over $5 million. Reconnection of

isolated habitats, project creation and research, and habitat restoration all were funded with over $4.5 million. See Figure 20.

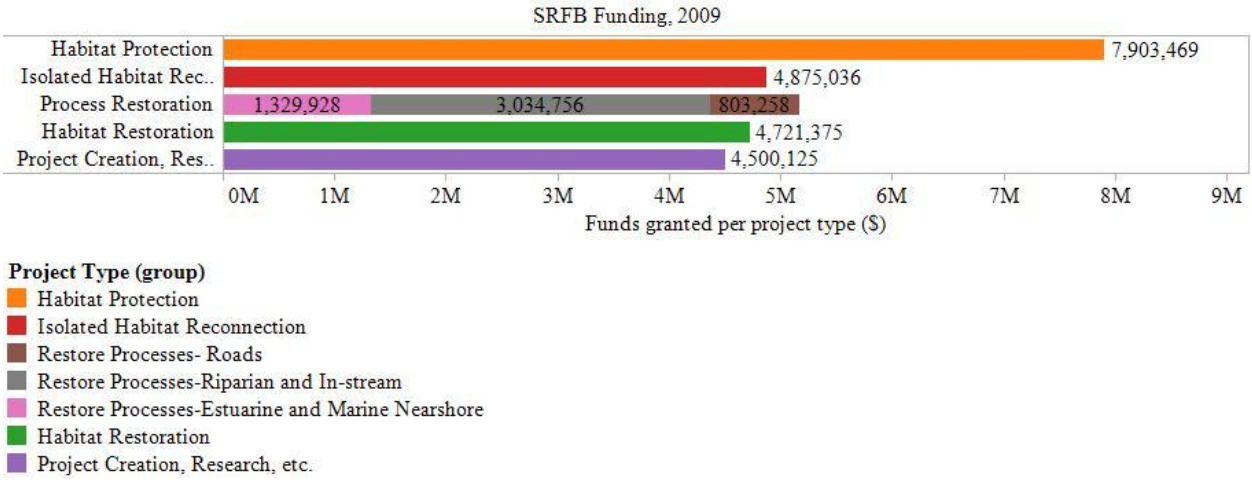

Figure 20. SRFB Funding in 2009

In 2010, the highest funding by the SRFB was in the category of habitat restoration with approximately $4.7 million. Approximately $4 million was granted to habitat protection projects and approximately $3.5 million went to process restoration projects. Project creation and research projects received approximately $2.25 million and habitat restoration received just over $650,000. This was a definite departure from the restoration project hierarchy because one of the categories lowest on the restoration project hierarchy received the most funding. See Figure 21.

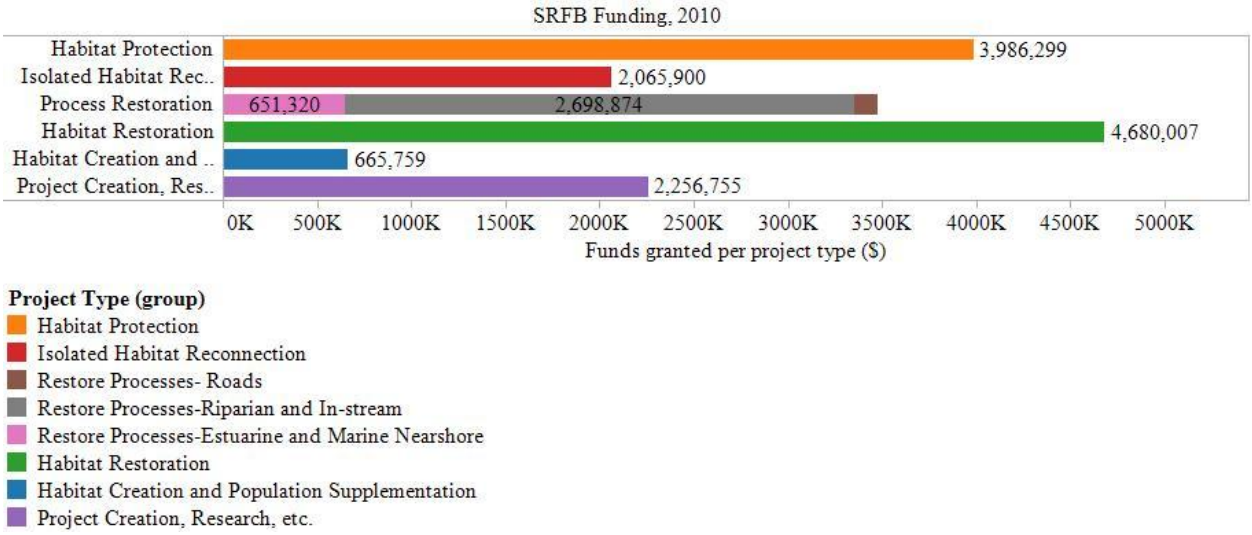

Figure 21. SRFB Funding in 2010

In 2011, the most recent year of funding, the SRFB granted approximately $4.1 million to habitat protection. Reconnection of isolated habitats and habitat restoration projects both received approximately $3.7 million. Process restoration projects received funds of approximately $3.2 million and the lowest funding went to project creation and research with approximately $1.5 million. This is another year where habitat restoration projects were funded very closely to the top. See Figure 22.

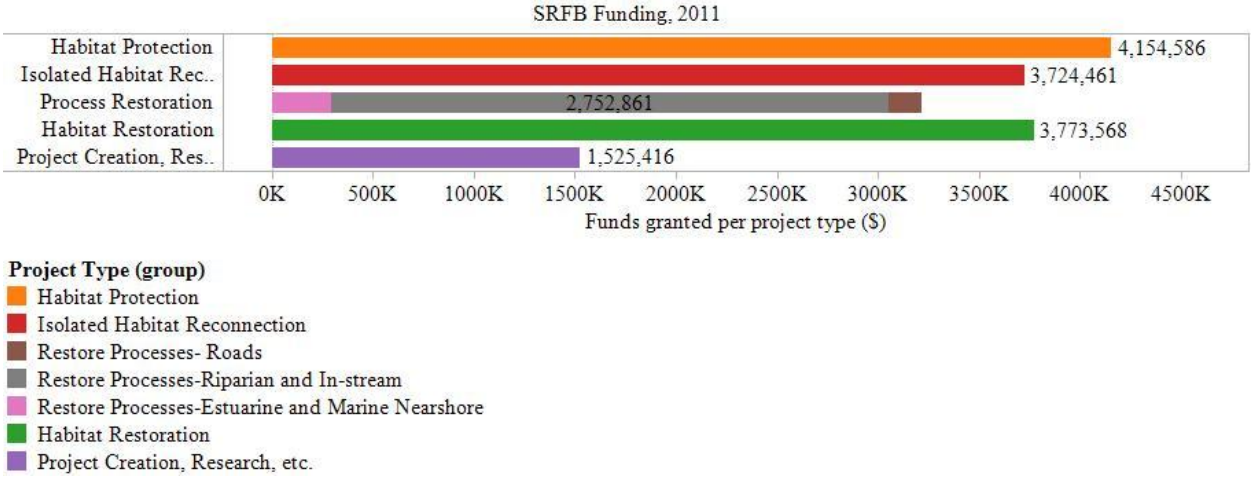

Figure 22. SRFB Funding in 2011

NOAA Restoration Center Annual Funding Results

The results for the NOAA Restoration Center are also shown for each year on an individual basis with funds granted by project type. As seen earlier with the SRFB grant funding results there is annual variation of funding that is not reflected when looking strictly at the aggregate funding totals. The NOAA Restoration Center also shows a broad range in total funding for each year which is seen in the results below.

The first year of funding results for the NOAA Restoration Center are from 1997 with $35,000 granted to a habitat restoration project. See Figure 23. There were no funds granted in 1998.

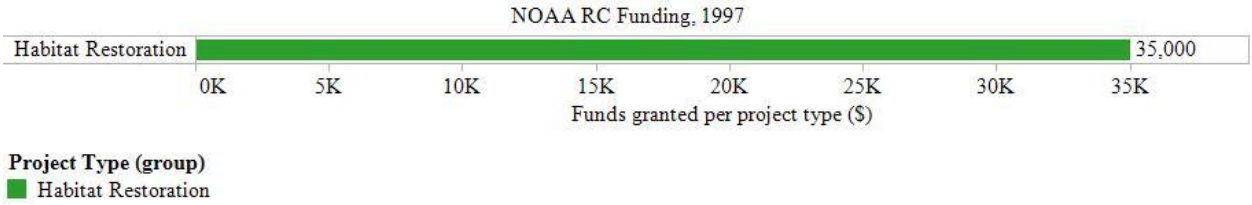

Figure 23. NOAA RC Funding in 1997

In 1999, there was approximately $104,000 total funds granted. The most funding was granted to reconnecting isolated habitat, followed by habitat restoration, and restoration of processes. See Figure 24.

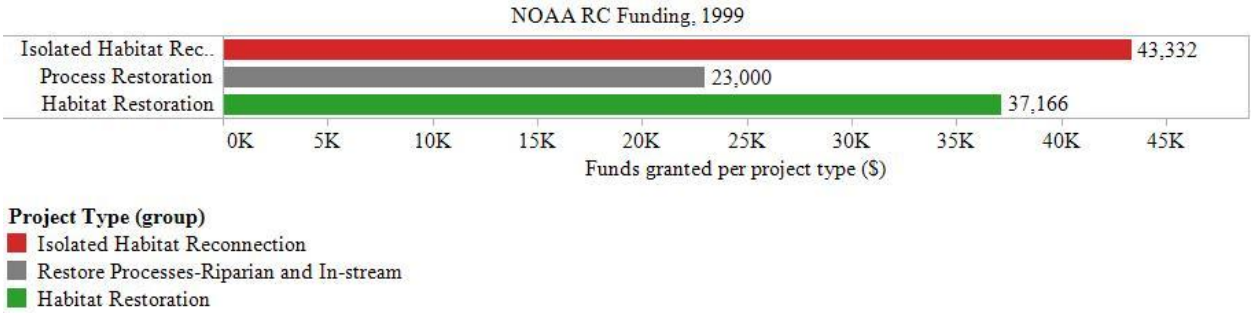

Figure 24. NOAA RC Funding in 1999

In 2000, the NOAA Restoration Center granted just under $100,000 with the most funding going to process restoration, followed by project creation and research, reconnection of isolated habitat, and habitat restoration. See Figure 25.

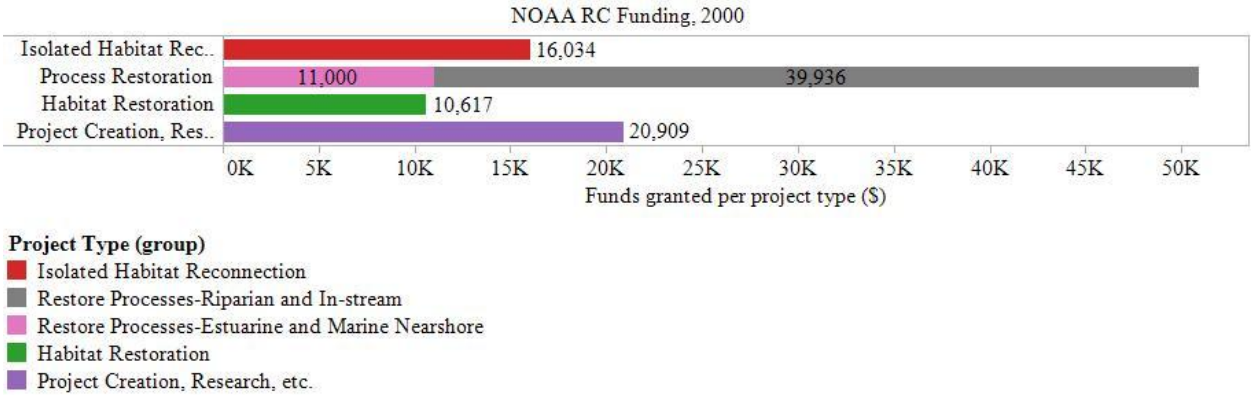

Figure 25. NOAA RC Funding in 2000

In 2001, NOAA Restoration Center granted just over $300,000 in total funds. Process restoration projects received the most funds, project creation and research were second, followed by the reconnection of isolated habitats, and habitat restoration. See Figure 26.

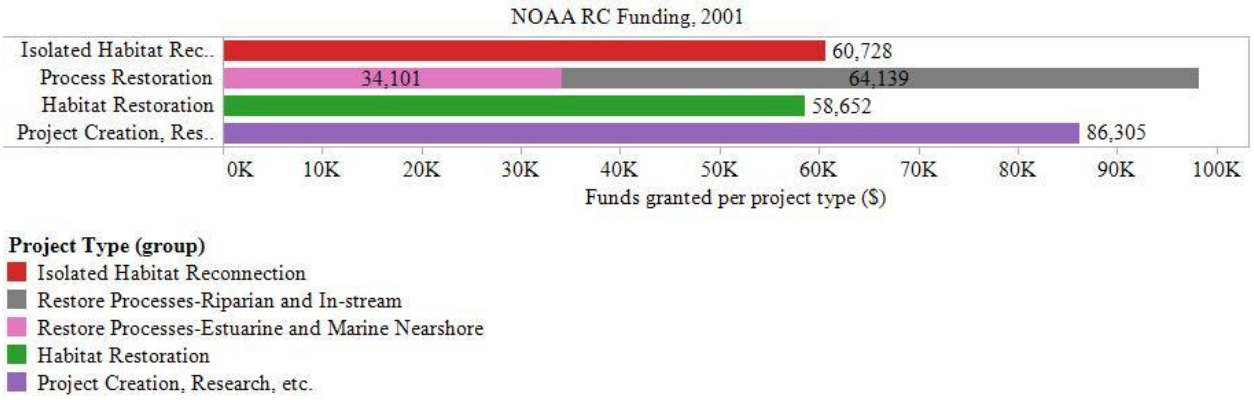

Figure 26. NOAA RC Funding in 2001

In 2002, funds of approximately $650,000 were divided between projects. The most funded projects were again process restoration, then habitat restoration projects, next was reconnection of isolated habitats, and last was project creation and research. See Figure 27.

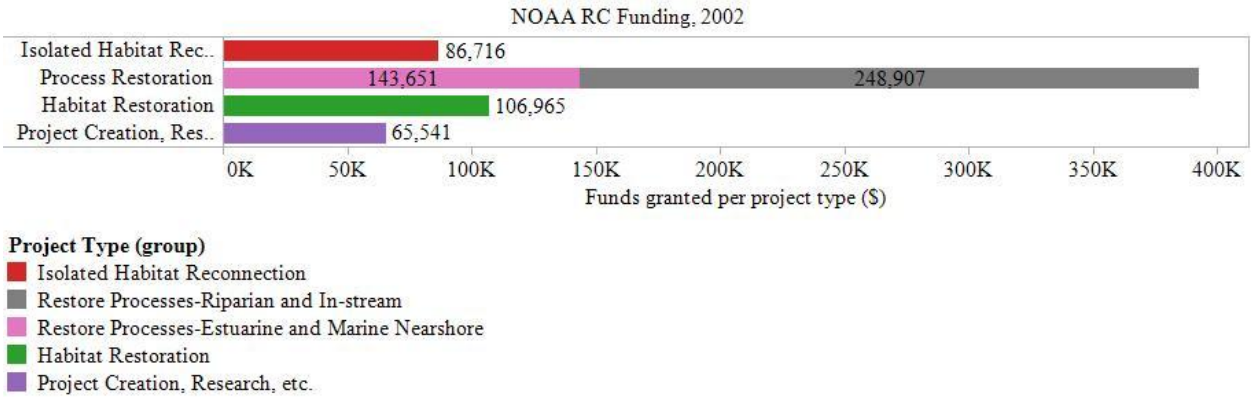

Figure 27. NOAA RC Funding in 2002

For 2003, the NOAA Restoration Center granted approximately $250,000 to projects with the greatest percentage granted to process restoration. Habitat restoration received the next highest amount of funds followed by reconnection of isolated habitats and project creation and research. See Figure 28.

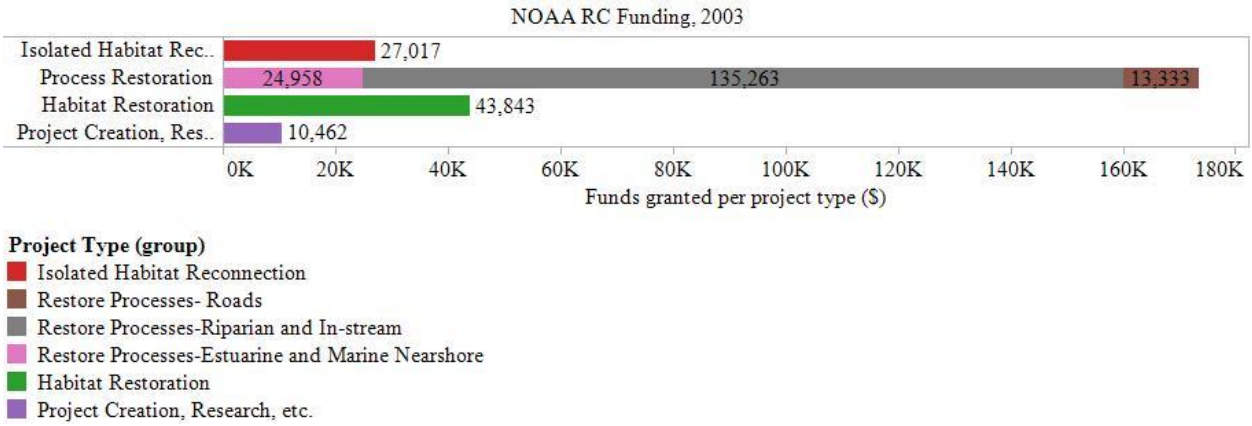

Figure 28. NOAA RC Funding in 2003

In 2004, just under $300,000 was divided between process restoration, habitat restoration, reconnection of isolated habitats, and project creation and research in that order. See Figure 29.

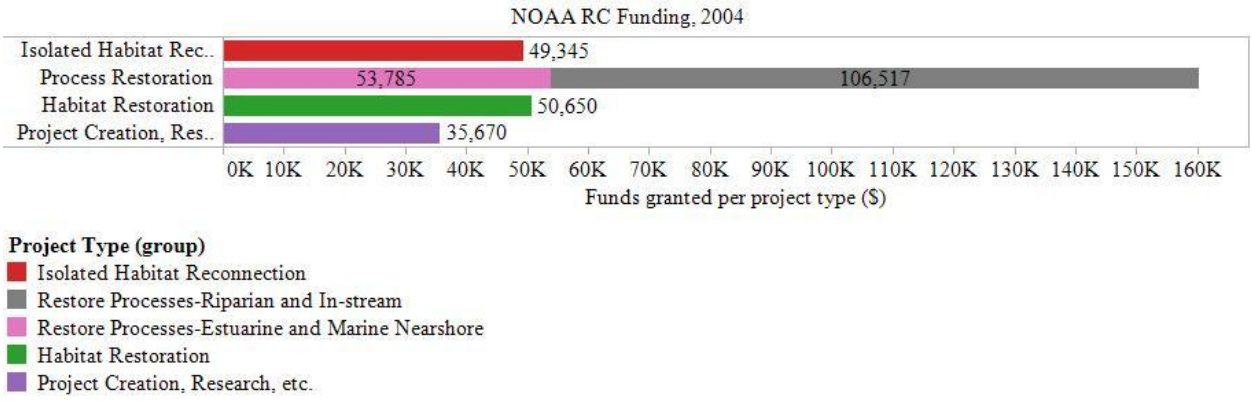

Figure 29. NOAA RC Funding in 2004

In 2005, approximately $320,000 was granted by the Restoration Center with the highest funds granted to habitat restoration projects. The next highest was process restoration projects, followed by reconnection of isolated habitats, and least funding went to project creation and research. See Figure 30.

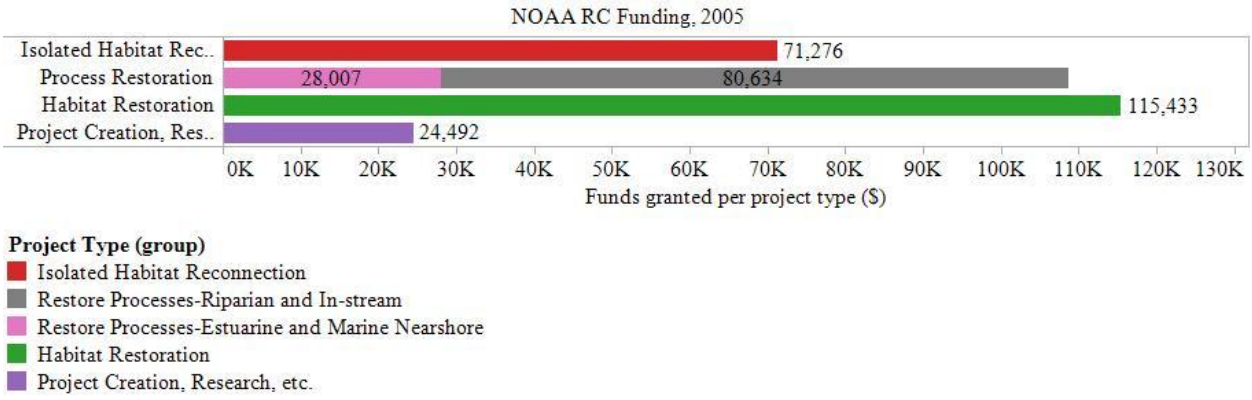

Figure 30. NOAA RC Funding in 2005

For 2006, the Restoration Center granted just less than $500,000. The highest funding went to reconnection of isolated habitats, followed by process restoration, project creation and research, and habitat restoration. See Figure 31.

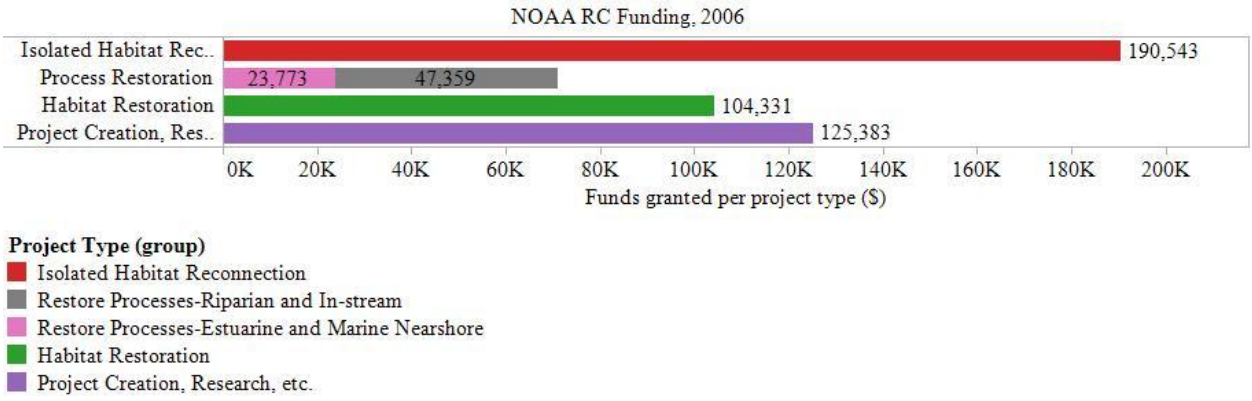

Figure 31. NOAA RC Funding in 2006

In 2007, almost $820,000 was granted and habitat restoration projects and isolated habitat reconnection projects received approximately the same and highest amount of funding. These categories were followed by process restoration and project creation and research. See Figure 32.

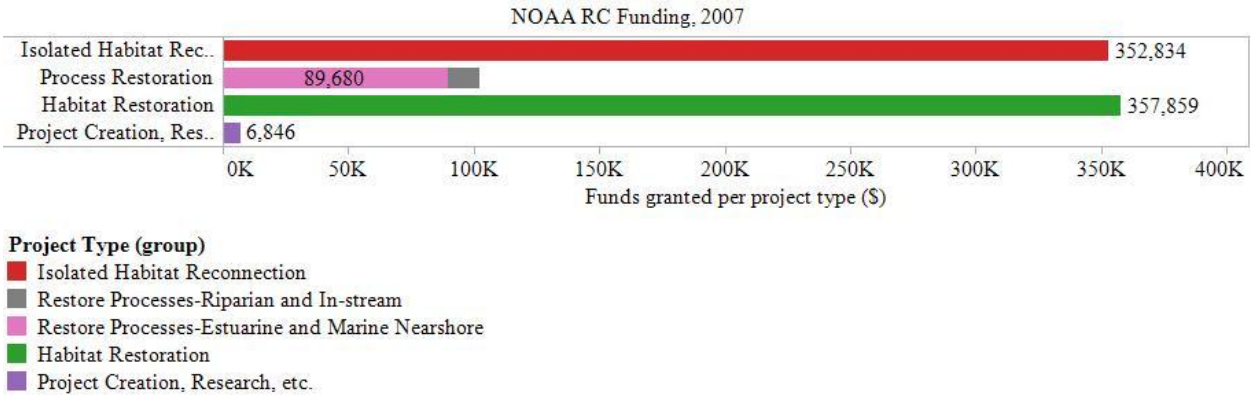

Figure 32. NOAA RC Funding in 2007

For 2008, almost $1.5 million was granted with the highest funding to process restoration projects, followed by reconnection of isolated habitat, and lowest funding to habitat restoration. See Figure 33.

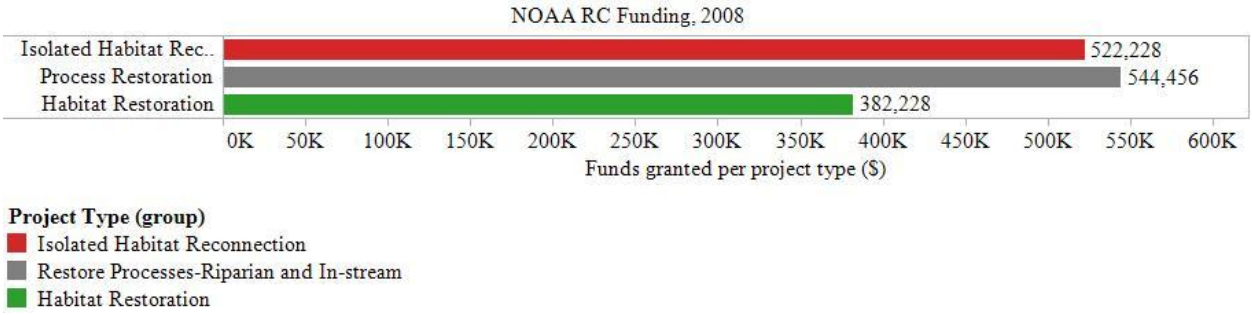

Figure 33. NOAA RC Funding in 2008

In 2009, the funding increased greatly as a result of the American Recovery and Reinvestment Act of 2009 and the NOAA Restoration Center was able to provide grants of almost $16.2 million. Habitat restoration projects received over $8 million in funding, process restoration projects received approximately $4.5 million, and reconnection of isolated habitat receivved almost $3 million. See Figure 34.

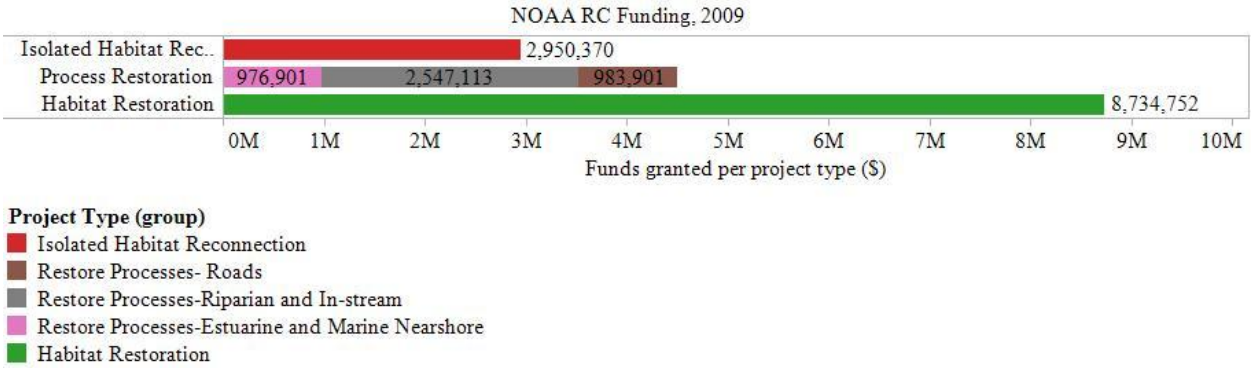

Figure 34. NOAA RC Funding in 2009

In 2010, grant funding dropped down to just over $700,000. Projects for reconnection of isolated habitats received the most funding, followed by process restoration projects, habitat restoration projects, and project creation and research. See Figure 35.

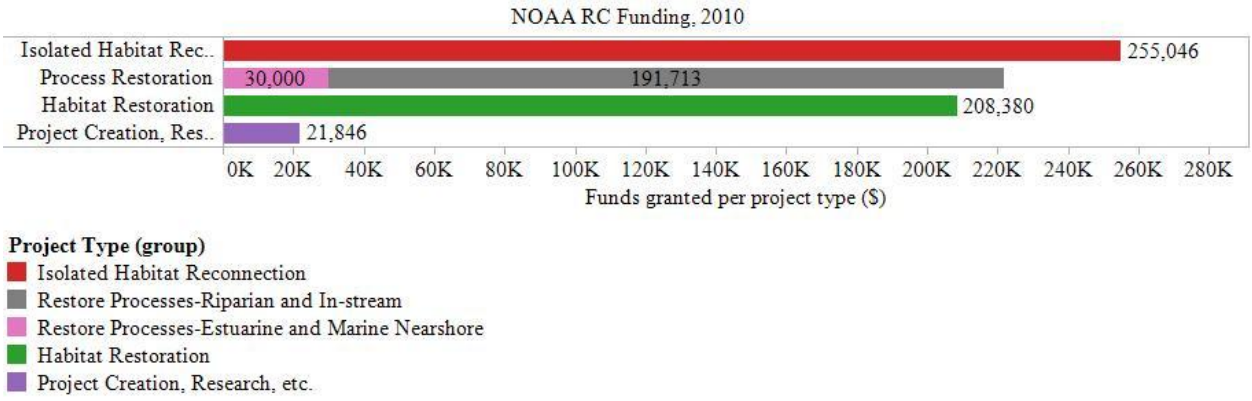

Figure 35. NOAA RC Funding in 2010

In 2011, the most recent year of grant funding, the NOAA Restoration Center provided grants of just $150,000. This funding was divided evenly between reconnection of isolated habitat, restoration of processes, and habitat restoration. See Figure 36.

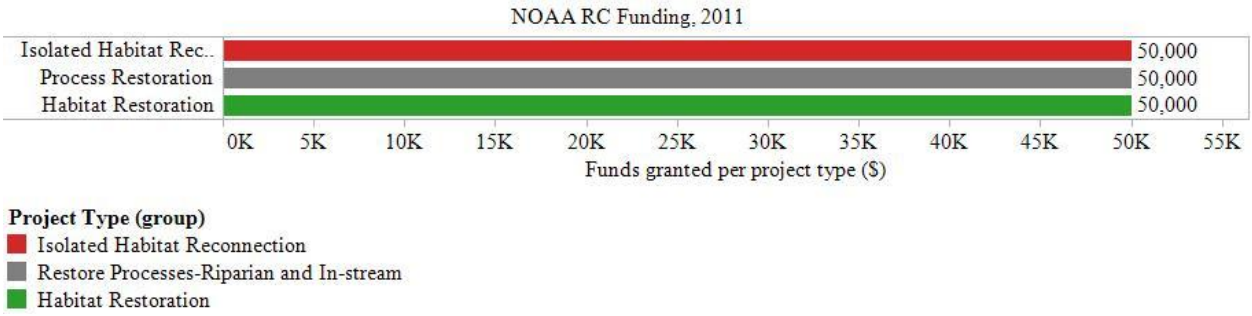

Figure 36. NOAA RC Funding in 2011

The results of the analysis into grant funding decisions for the Puget Sound Recovery Region show that in aggregate for the entire time period the SRFB maintains a close alignment with the restoration project hierarchy. The results for the grant funding time period for the NOAA Restoration Center show more variation from the restoration project hierarchy. However when the anaylsis is performed an annual basis, both funding organizations show deviation from the aggregate results. The results for each organization show that there are years in which the funding decisions align closely with the restoration project hierarchy and other years in which they do not. Overall, the SRFB results show more years in which the funding decisions align with the restoration project hierarchy and fewer years for the NOAA Restoration Center.

CHAPTER 6: Watershed Results

The final analysis performed on the project database was a comparison of the SRFB funding results on the scale of the individual lead entities. This was done to determine if the alignment of the aggregate funding results with the restoration project hierarchy on the regional scale would still be seen on the smaller watershed scale. It is possible that great differences in the types of projects funded occur on the watershed scale, but when they are combined over the entire region it would still reflect the restoration project hierarchy. While the aggregate results for the SRFB align with the restoration project hierarchy this analysis attempts to show whether this trend is seen on a watershed scale.

Projects Funded by Lead Entity

Each of the 14 lead entities was separated out to determine if the funding decisions follow the restoration project hierarchy at the smaller geographic scale, or if that is only seen at the aggregate regional level. The data for the SRFB were separated by lead entity because each lead entity reflects the geographical watershed when it applies for funding within the larger regional recovery area. The NOAA Restoration Center does not structure its funding decisions in this way, therefore only data for the SRFB are used in this analysis. The results for each of the lead entities are discussed below. While some of the lead entities have received funding that reflects the restoration project hierarchy, others deviate from the hierarchy or have patterns of change over time.

The results for the Island County Lead Entity, Figure 37, show a focus on top three categories in the restoration project hierarchy; habitat protection, reconnection of isolated habitats, and process restoration. However, of the eleven years the lead entity received funding, only four include funding for habitat protection projects. Much of the funding for six years goes to project development, research, and other projects in that category. There is very little funding granted to habitat restoration projects and none to habitat creation projects-which matches the low priority given to these categories in the hierarchy.

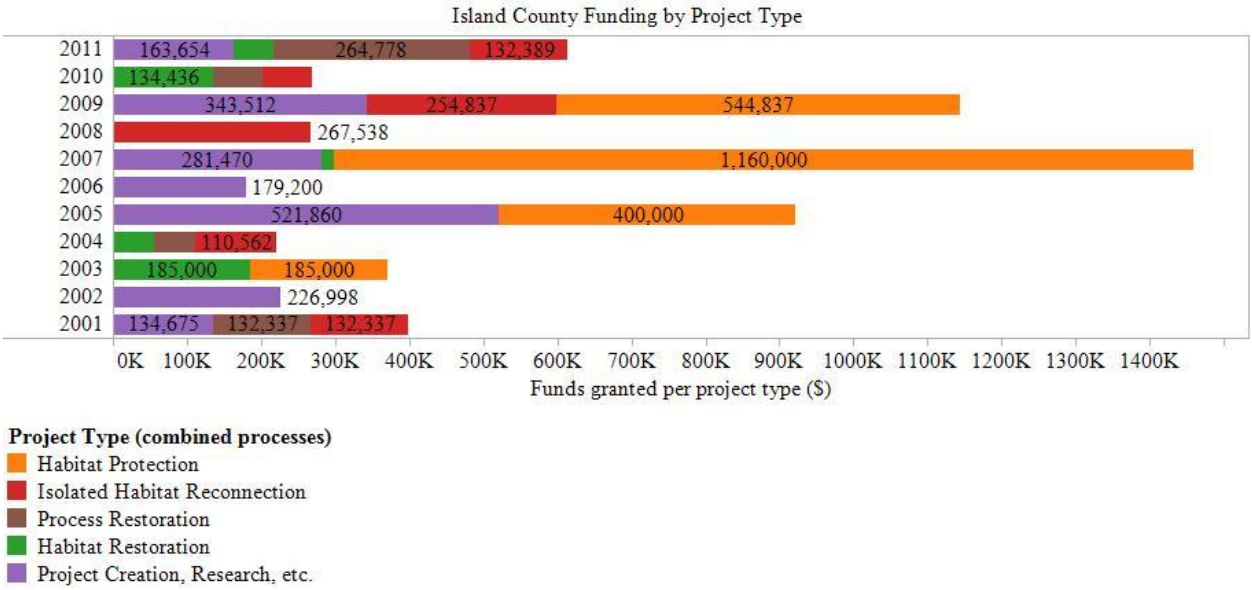

Figure 37. Island County Lead Entity Funding by Project Type

The Mason Conservation District Lead Entity funding results are seen in Figure 38. These results show the two highest funded categories are habitat protection and reconnection of isolated habitats, which matches the two highest categories in the restoration project hierarchy. Very little funding goes to habitat restoration projects and none to habitat creation or salmon stock supplementation projects which also matches the lowest priorities of the restoration project hierarchy.

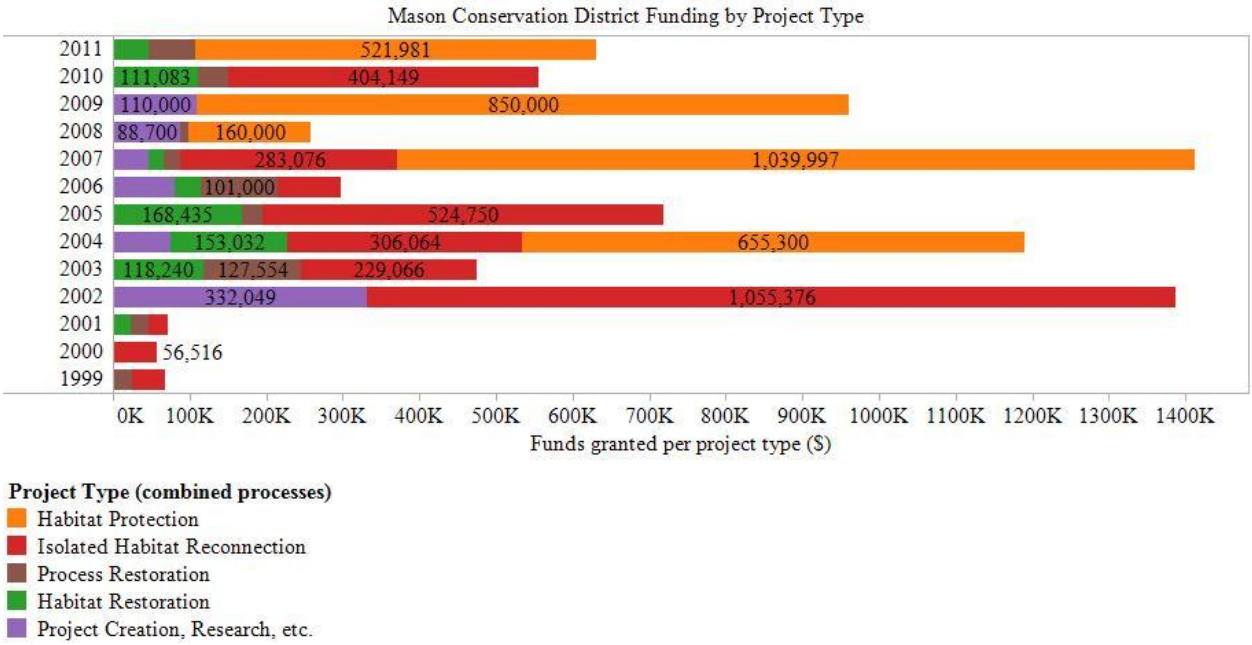

Figure 38. Mason Conservation District Lead Entity Funding by Project Type

Results for the Nisqually River Salmon Recovery Lead Entity are shown in Figure 39. Grant funding for this lead entity again aligns with the major priorities identified in the restoration project hierarchy; habitat protection and reconnection of isolated habitats are funded at the highest levels. There is a medium amount of funding to process restoration projects and the lowest funding was granted to habitat restoration projects and habitat creation or salmon stock supplementation projects.

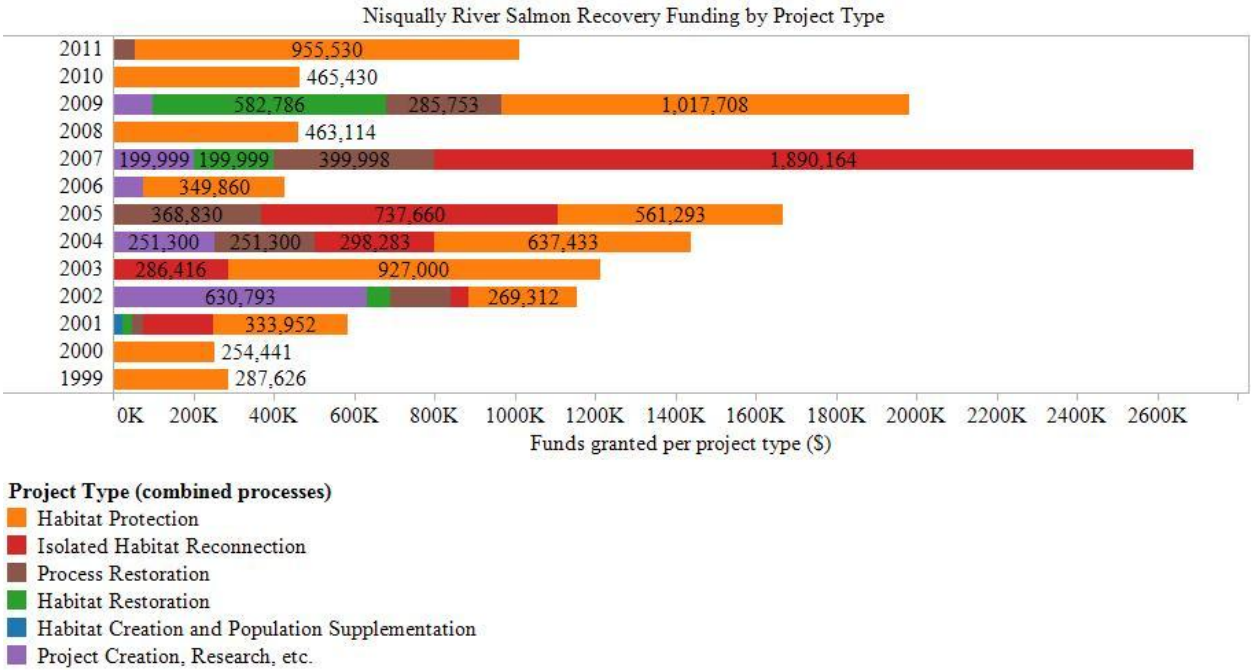

Figure 39. Nisqually River Salmon Recovery Lead Entity Funding by Project Type

The North Olympic Peninsula Lead Entity funding results, Figure 40, show more funding to lower priority project types than other lead entities, while still aligning with the top of the restoration project hierarchy. Habitat protection receives the greatest amount of funding, followed by isolated habitat reconnection but the third highest amount of funding was directed towards habitat restoration projects. This large percentage of funding to a low category on the restoration project hierarchy shows a departure from the aggregate funding results that aligned with the hierarchy.

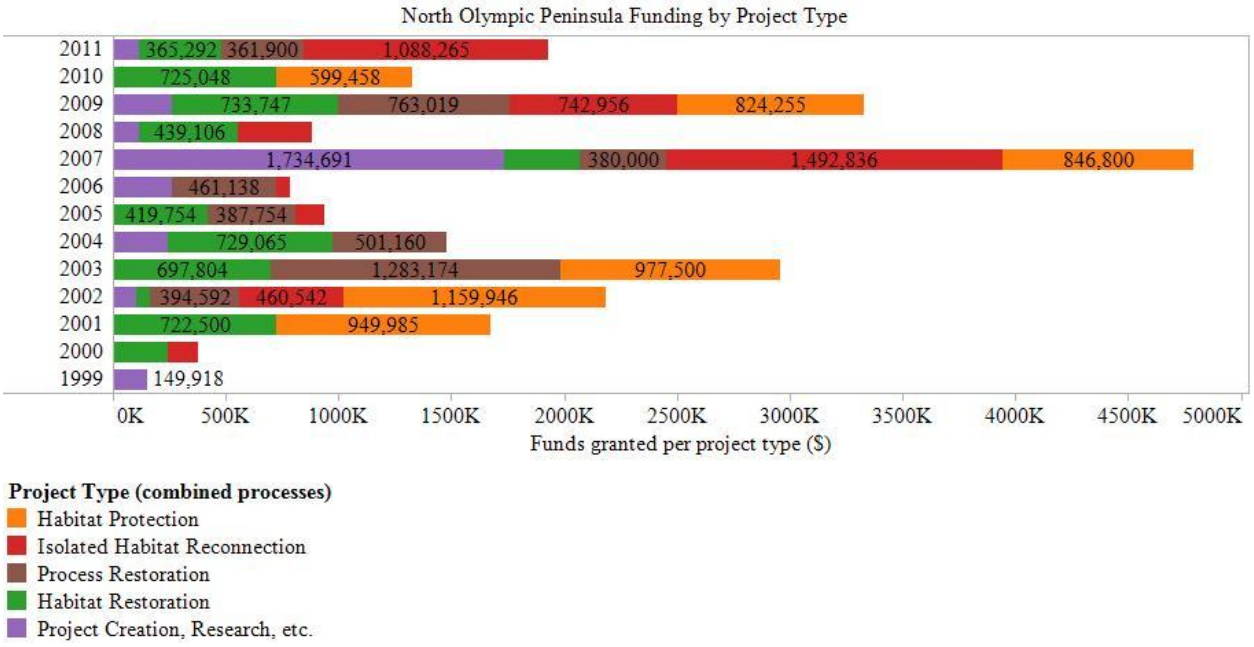

Figure 40. North Olympic Peninsula Lead Entity Funding by Project Type

The Pierce County Lead Entity funding results, Figure 41, track well with the restoration project hierarchy. Top grant funding went to habitat protection, isolated habitat reconnection, and process restoration. Less funding went to habitat restoration projects, with no funding granted for these projects between 1999 and 2005 followed by an increase in funding between 2006 and 2011. This suggests a possible transition from high priority project availability in the earlier years leading into lower priority projects in more recent years. This could be a result of less need for the high priority project categories, or perhaps the most attainable projects in the those categories were completed in the earlier years and those that are still necessary may face implementation challenges that prevent them from being funded.

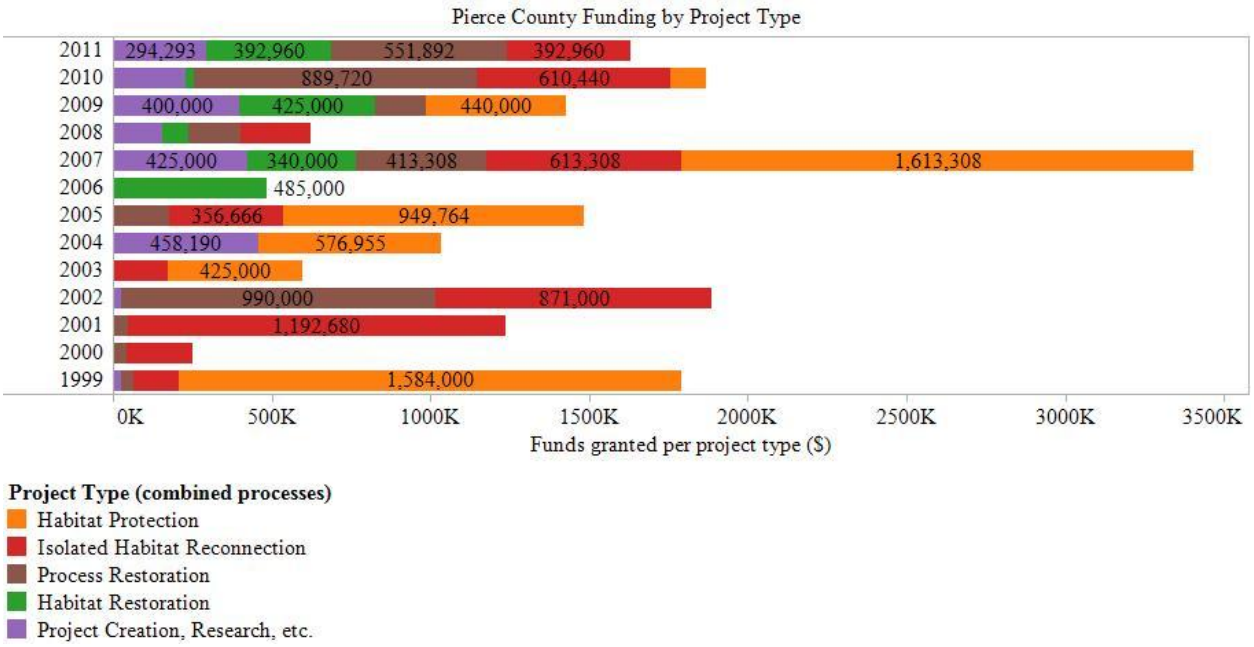

Figure 41. Pierce County Lead Entity Funding by Project Type

The San Juan County Community Development Lead Entity funding results, Figure 42, show that the majority of funding received was dedicated to projects within the project creation or research category. The next highest category funded was habitat restoration projects. This is not aligned with the restoration project hierarchy, and quite different compared to the results of many of the other lead entities. This may reflect the relatively poor habitat and historical spawning distribution on the arid and small San Juan Islands. It is possible that this indicates that there are few restoration opportunities in the San Juan Islands and that it should be considered a lower priority for the recovery region.

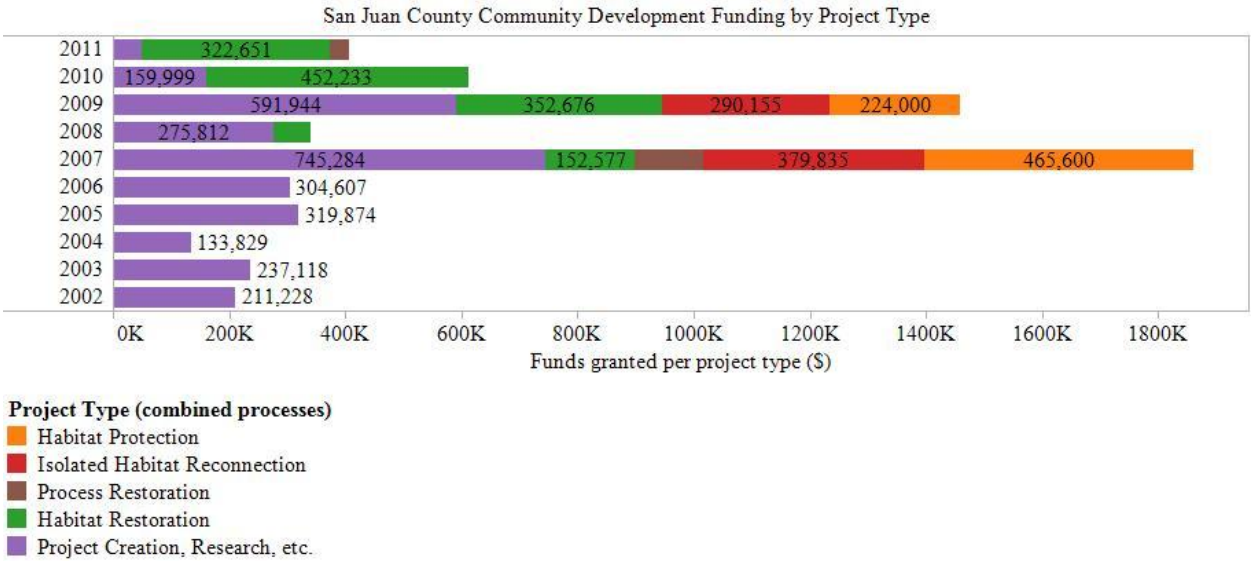

Figure 42. San Juan County Community Development Lead Entity Funding by Project Type

The Skagit Watershed Council Lead Entity funding results, Figure 43, reflects priorities of the restoration project hierarchy. The three highest funded categories are also the top three priorities on the hierarchy; habitat protection, isolated habitat reconnection, and process restoration projects. This is the largest salmon river in the Puget Sound basin and it seems logical that greater investments here with this adherence to the restoration project hierarchy could produce larger, long-term gains for salmon recovery.

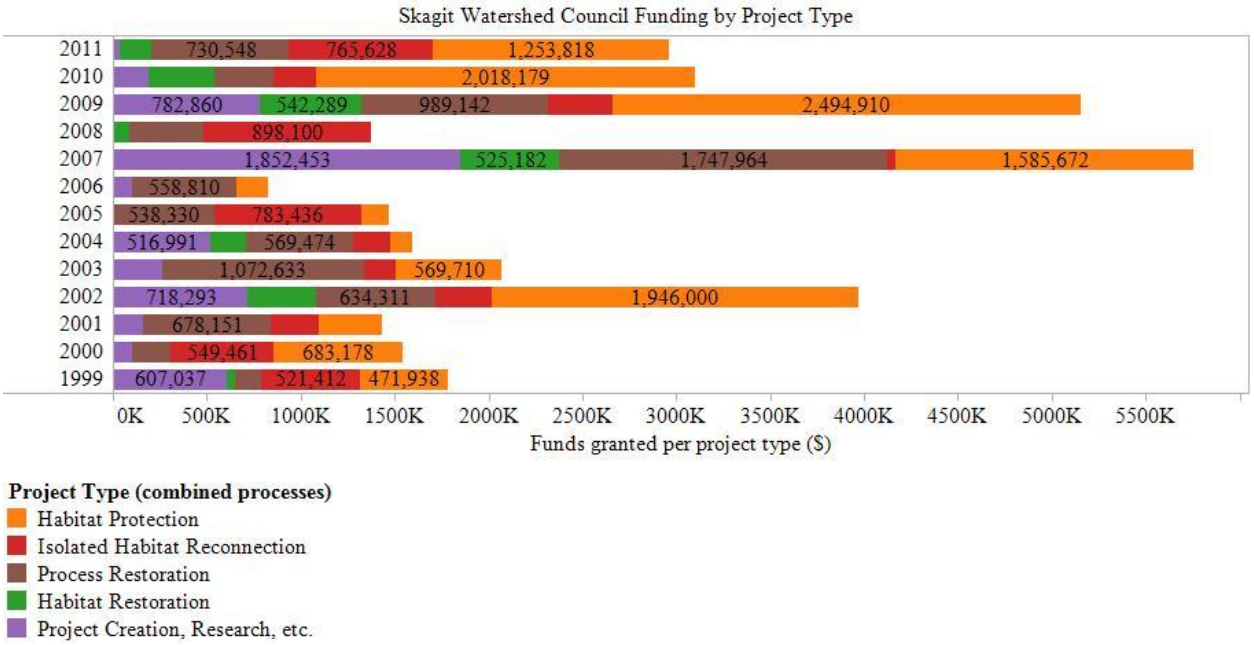

Figure 43. Skagit Watershed Council Lead Entity Funding by Project Type

The Snohomish County Lead Entity funding results, in Figure 44, show a progression of project types. The majority of funding went to habitat protection projects between 1999 and 2002. Following that the funding was granted to a wider variety of projects including process restoration and isolated habitat reconnection projects. The least funding was granted to habitat restoration projects and habitat creation or salmon stock supplementation projects. Overall, the funding does follow the restoration project hierarchy with annual variation.

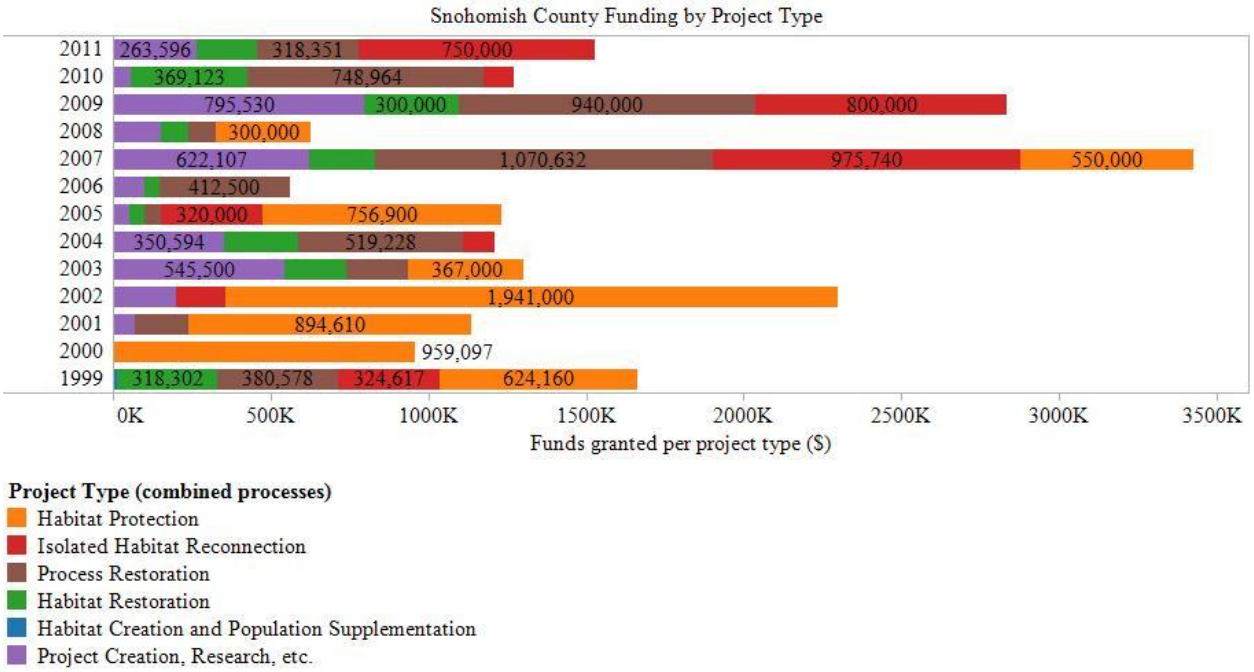

Figure 44. Snohomish County Lead Entity Funding by Project Type

The Stillaguamish Lead Entity funding results, Figure 45, do not reflect the focus on habitat protection that many of the other lead entities have. While there are habitat protection projects funded in six years, it is the highest funded category in only one of those years. The highest funded category overall is isolated habitat reconnection, but on an annual basis the funding varies quite a bit. There are two years in which habitat restoration projects received the most funding and two years each with funding to habitat creation or salmon stock supplementation projects of over $600,000.

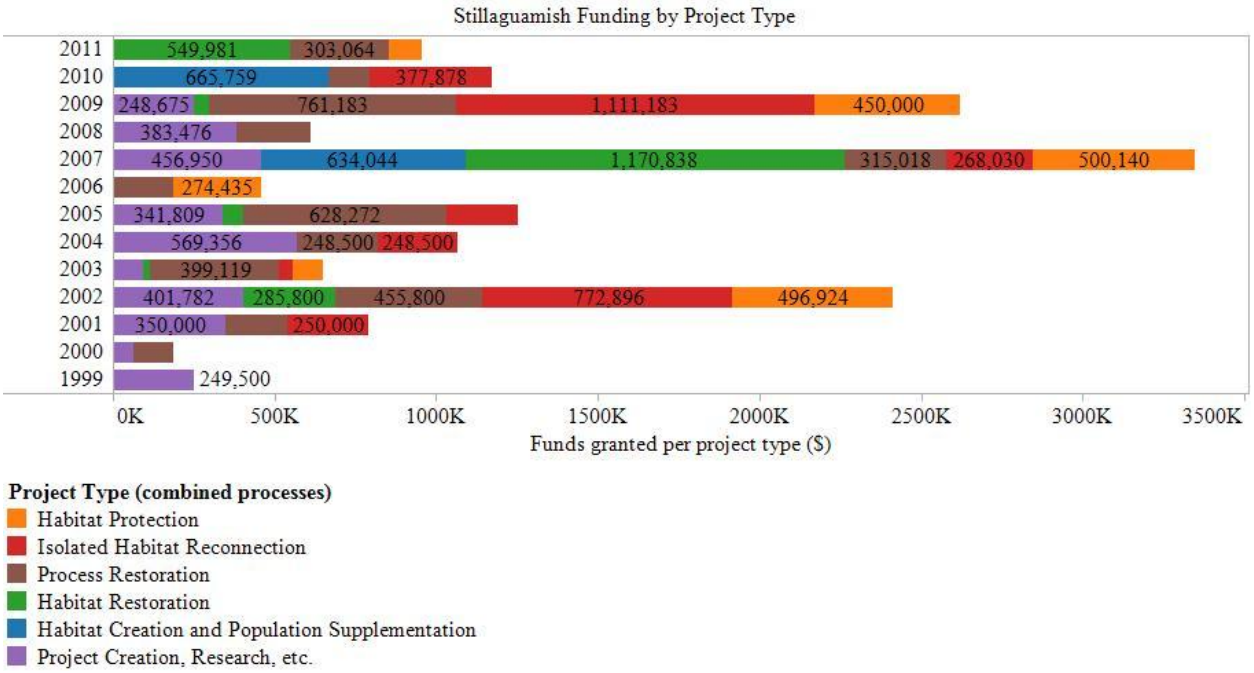

Figure 45. Stillaguamish Lead Entity Funding by Project Type

The Thurston County Conservation District Lead Entity funding results, Figure 46, track well with the restoration project hierarchy. There are three years with small funding amounts granted to habitat restoration restoration projects. The rest of the funding was granted to habitat protection, isolated habitat reconnection, process restoration, and project creation or research projects.

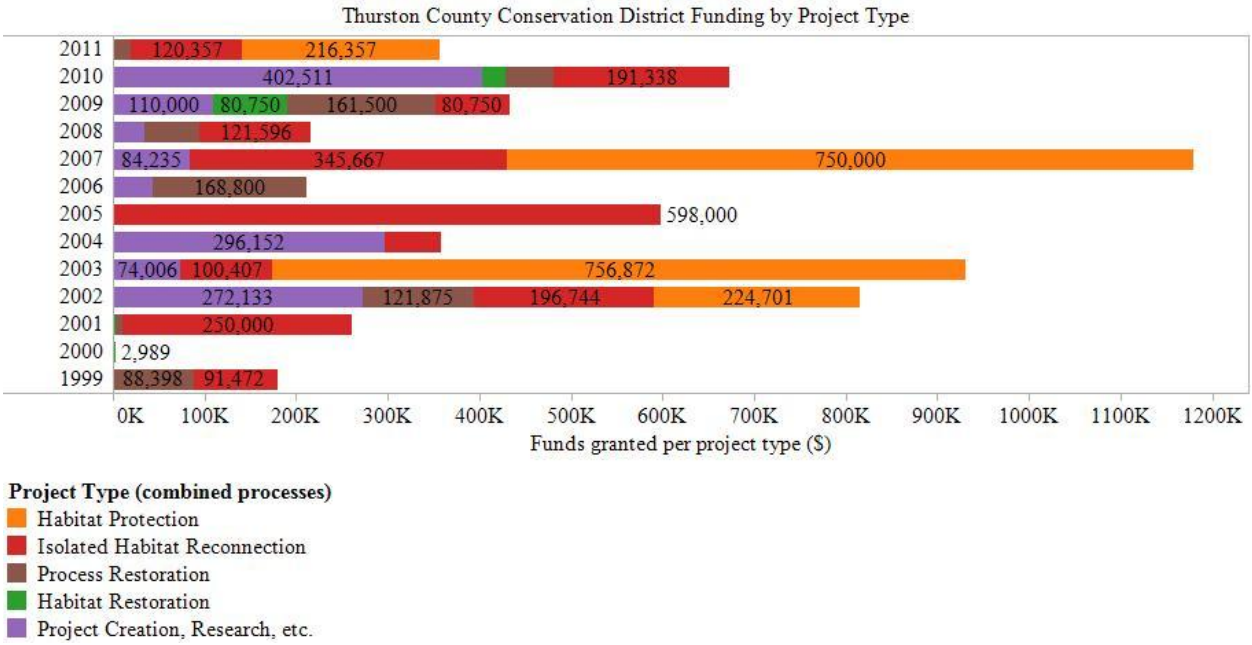

Figure 46. Thurston County Conservation District Lead Entity Funding by Project Type

The West Sound Watersheds Lead Entity funding results, Figure 47, show that the majority of funding was granted to isolated habitat reconnection projects. The category with the next highest funding was habitat protection projects. This is the reverse of the top categories in the restoration project hierarchy. Overall, the funding results do track well with the hierarchy, very little funding was granted to either habitat restoration projects or habitat creation and salmon stock supplementation projects.

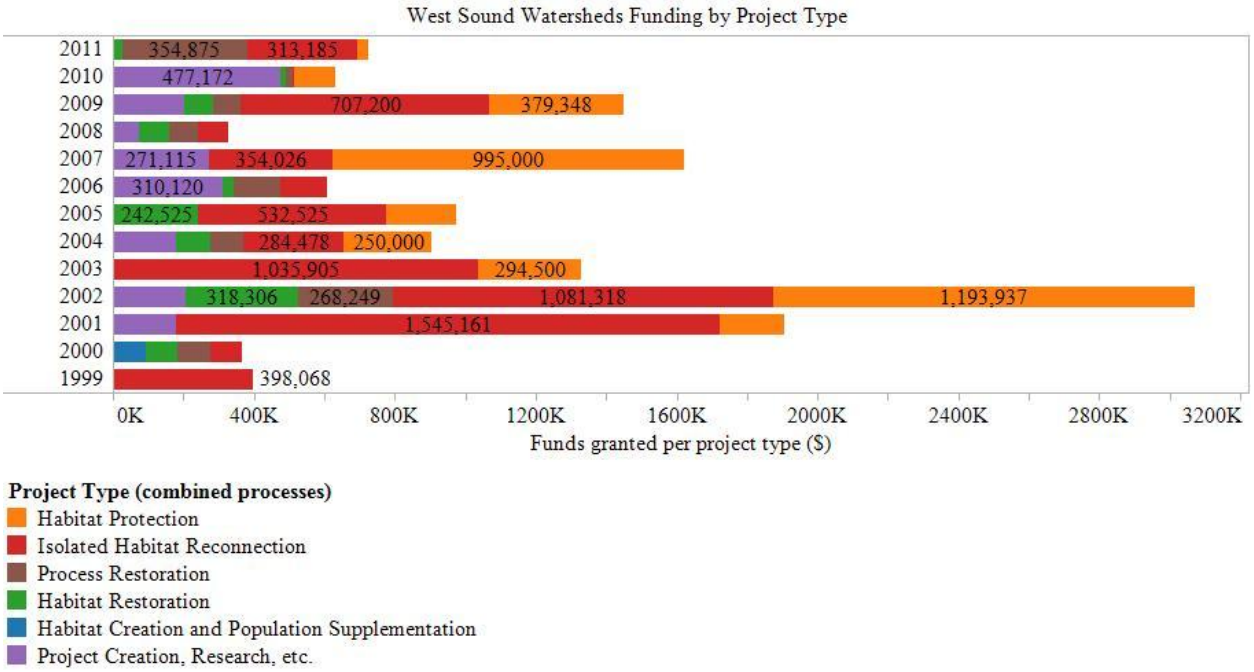

Figure 47. West Sound Watersheds Lead Entity Funding by Project Type

The WRIA 1 (Lummi) Lead Entity funding results, Figure 48, indicate that the highest level of funding was granted to habitat restoration projects. This does not align with the restoration project hierarchy in which habitat restoration projects are one of the lowest priority categories. The second highest funded category is habitat protection projects which is the top priority in the hierarchy.

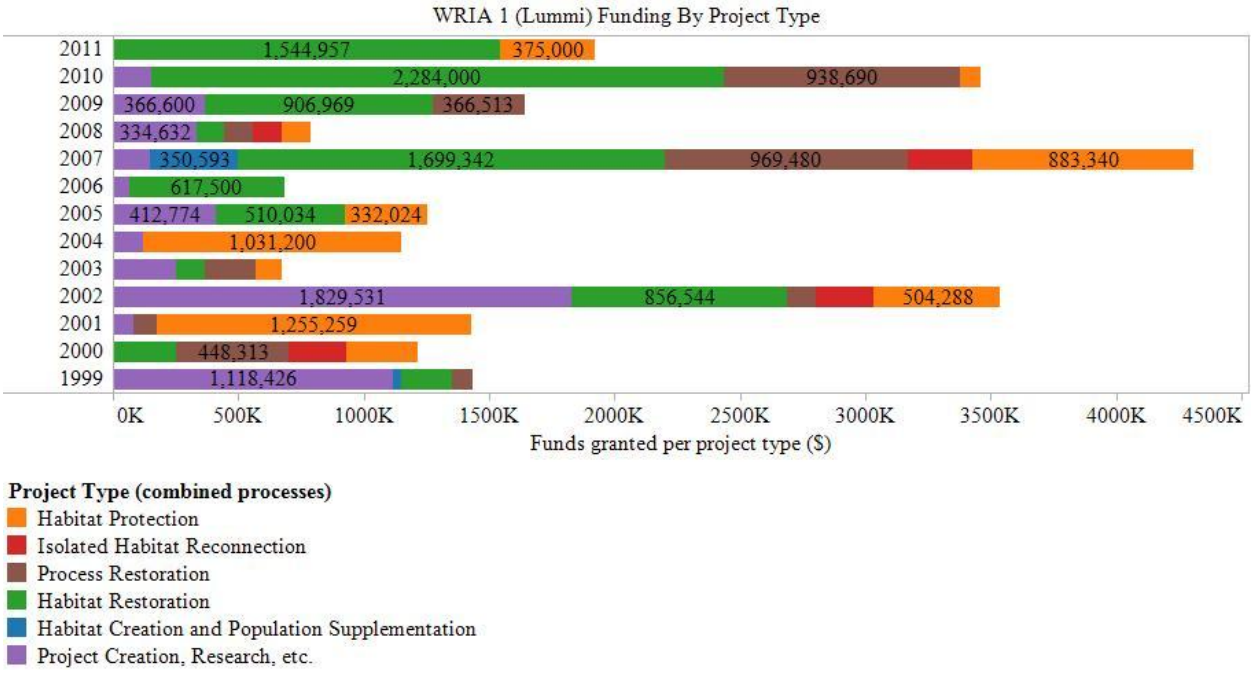

Figure 48. WRIA 1 (Lummi) Lead Entity Funding by Project Type

The WRIA 8 (King County) Lead Entity funding results, Figure 49, show that the vast majority of funding was granted to habitat protection over the entire funding period. There is only one year in which it is not the top funded category, but rather is the second highest funded. This clearly reflects the priority of the restoration project hierarchy. What the results do not show is how much habitat was protected through these projects. It is possible that higher property values in the area mean that the cost per area acquired is quite high.

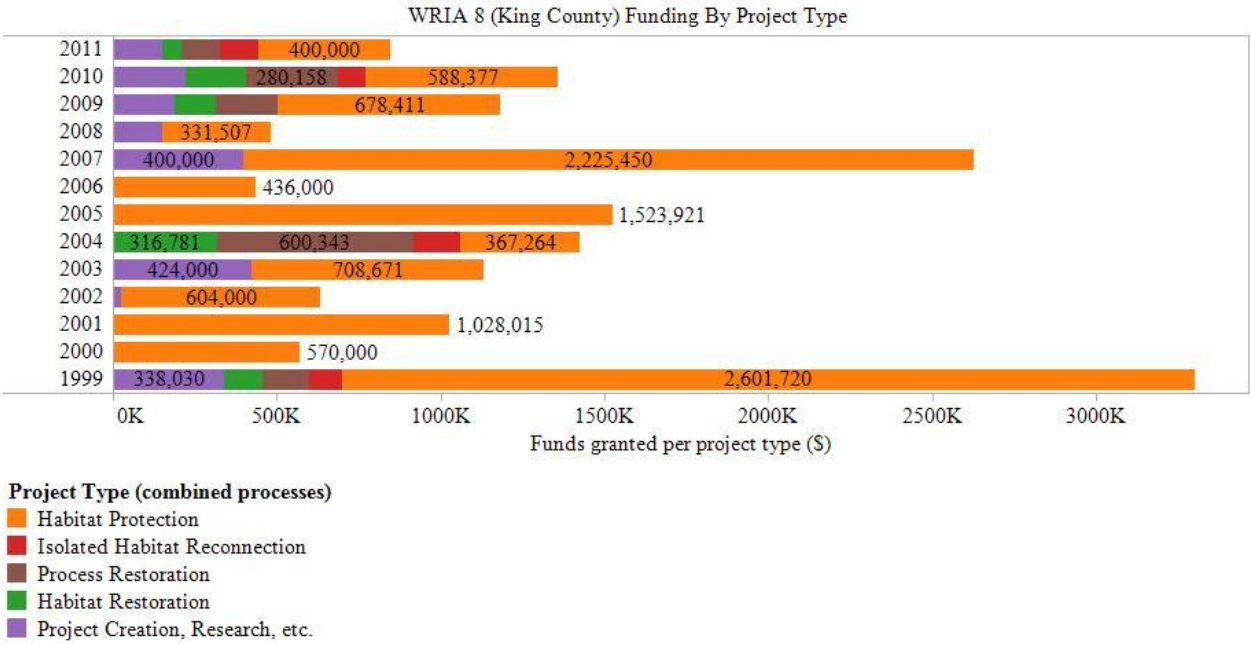

Figure 49. WRIA 8 (King County) Lead Entity Funding by Project Type

The WRIA 9 (King County) Lead Entity funding results, Figure 50, also reflect the high priority placed on habitat protection with the most funding granted to those projects overall. Five of the first six years of funding have the most funding dedicated to habitat protection, but after that there is more variation in funding with an increase in grants to isolated habitat reconnection, process restoration, and project creation or research projects.

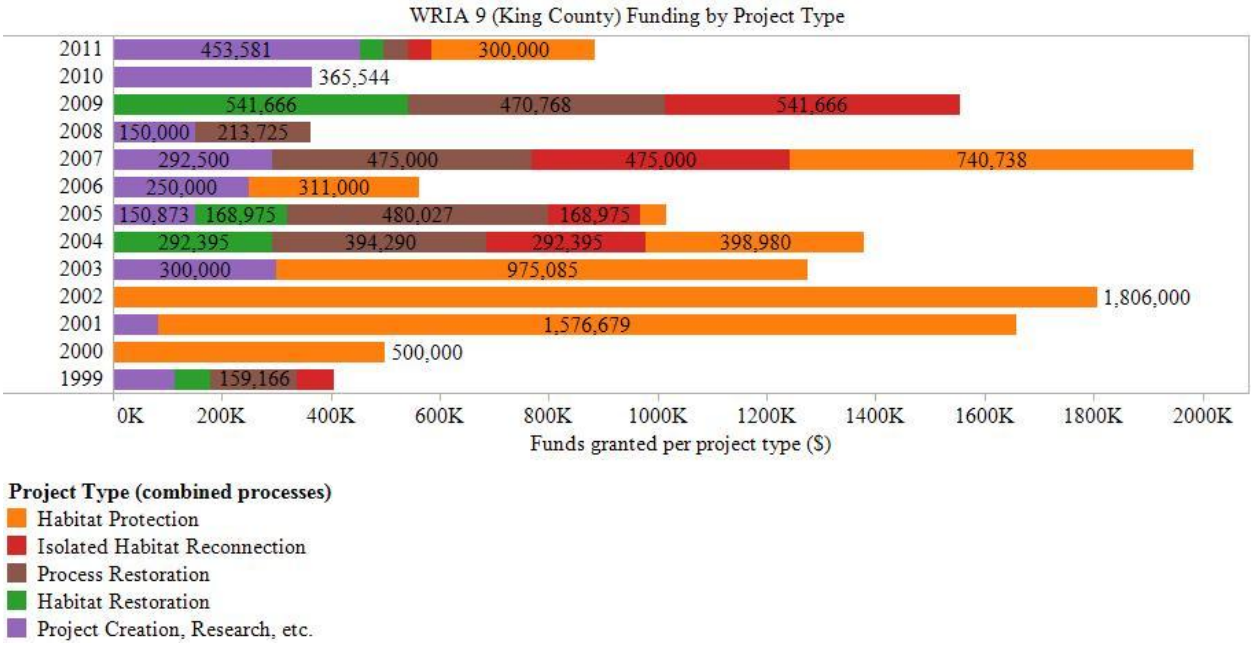

Figure 50. WRIA 9 (King County) Lead Entity Funding by Project Type

The results of the data analysis on the basis of the fourteen lead entities show that there is quite a bit of variety between lead entities and on an annual basis. While project funding for some of the lead entities aligns with the restoration project hierarchy others deviate quite a bit from the hierarchy. In addition, the results show that in some of the watersheds there is a major shift over time of the types of projects funded. While it is beyond the scope of the research for this thesis to fully explain the divergences from the restoration project hierarchy for each watershed and each year, it is enlightening to understand that there are differences between the regional and watershed results. This is certainly an area for further research to determine if salmon recovery goals are being achieved as efficiently as possible on a sub-regional basis or if the SRFB's regional funding strategy is obscuring the need for further prioritization.

CHAPTER 7: Conclusions

The results of this research are informative of the use of prioritization in salmon habitat restoration funding in the Puget Sound Basin. The ongoing discussion, sometimes accusatory and acrimonious, surrounding the funding of restoration projects led to a hypothesis that results of this research would show considerable deviation from the restoration project hierarchy developed for this study based on projections by the scientific community. The results, however, show a much greater alignment with the restoration project hierarchy than was hypothesized.

The SRFB data track thirteen years of funding decisions, from the very beginning of the program to the most recent year of grant funding. When looking at the funding totaled over this entire time period the funding per project category completely aligns with the restoration project hierarchy developed for this research. The most funding went to protection of habitat, next was the reconnection of isolated habitat, this was followed by the combined categories dealing with the restoration of ecosystem processes. The next category was habitat restoration and the last was the creation of habitat and the supplementation of salmon stocks. A separate category was the project creation and research category which actually ranked just below the combined process restoration category in total funding. This category was ranked separately because project creation, design, research, studies, and other components are part of each of the other restoration project categories. When the data were queried on an annual basis the results show more variation from the restoration project hierarchy. Most years maintained priority funding to habitat protection projects, but in more recent years habitat restoration projects began to receive more funding although this is a lower priority category. The final analysis of the SRFB data was a comparison of the annual funding results at the lead entity level. The analysis showed that although many of the lead entity funding results align fairly well with the restoration project hierarchy, there are some lead entities that do not. Many of the lead entity results also displayed a shift between years in the types of projects funded.

The NOAA Restoration Center data contains information on funding decisions over a fifteen year time period, including one year with no funding granted. The results show a much greater deviation from the restoration project hierarchy than those of the SRFB. There is no funding for habitat protection projects over the entire time period as this is not something the NOAA Restoration Center can fund. There were also many years where the process restoration category was funded at higher rates than the reconnection of isolated habitats. In more recent

years the habitat restoration category received a high amount of funding although this is a somewhat lower priority category on the hierarchy. This was especially evident in 2009 when the NOAA Restoration Center was able to grant funds of over $16 million due to the American Recovery and Reinvestment Act.

Comparison of the SRFB and the NOAA Restoration Center

The analysis of the data shows that there are definite differences in the project funding decisions made by the SRFB and the NOAA Restoration Center. The NOAA Restoration Center grant funding results varied more from the restoration project hierarchy than the SRFB results. The differences between grant funding results for the SRFB and the NOAA Restoration Center can be explained by multiple factors.

One obvious difference between the two funding organizations is the difference in funding priority for habitat protection projects. Although this is the top priority on the restoration project hierarchy developed for this thesis, the NOAA Restoration Center does not grant funds towards purchasing property or conservation easements. Therefore, this category was not represented at all in the NOAA Restoration Center grant funding results but it is the highest funded project category for the SRFB.

The availability of funding is another major difference between the SRFB and the NOAA Restoration Center. Over the entire study period the SRFB was able to grants funds of nearly ten times the amount the NOAA Restoration Center was able to grant. The NOAA Restoration Center had one more year of funding than the SRFB and granted $21,873,426 while the SRFB granted $217,388,121. This difference in available funding can affect the types of projects selected for funding. Some of the higher priority project types can also be more expensive to undertake, such as purchasing property for habitat protection, removing or replacing barriers to habitat connection, and restoring processes. Habitat restoration projects can often be smaller or more manageable and may therefore be attractive to limited funding.

The funding process that each of the organizations uses can also have a significant impact on the types of projects selected for funding. The SRFB is constrained by the funding allocation formula and is required to give a certain percentage of the total funds to each of the salmon recovery regions. Rather than being able to prioritize projects across the entire state or perhaps by priority watersheds in the Puget Sound basin the SRFB must fund a certain amount

determined by formula within each recovery region. This has the potential to limit funding to higher priority projects and increase funding to projects that are lower on the restoration project hierarchy due strictly to their location in a certain recovery region. The NOAA Restoration Center has more flexibility in the determining how to allocate its funds. Therefore, although the funds that the NOAA Restoration Center has available are more limited overall than that of the SRFB, it is able to apply these funds where the need is the greatest. The NOAA Restoration Center is also able to fund projects in a way that addresses gaps in SRFB funding due to its restrictions. In order to select projects for funding the NOAA Restoration Center is given access to the prioritized lists of projects submitted for grant funding to the SRFB and is then able to select projects that will likely not receive funding from the SRFB or need additional funding to be most effective (J. Steger, personal communication, August 2012). This cooperation between the SRFB and the NOAA Restoration Center allows for the implementation of higher priority projects that may not otherwise be achieved. The combined synergistic effect of these two programs matches well with the restoration project hierarchy indicated by the scientific community.

Opportunities for Future Research

The research and analysis performed in this thesis is informative on the status of restoration project funding in relation to a scientifically-based restoration project hierarchy for the Puget Sound Basin. The parameters of this research allowed for analysis of the funding results for two critical funding organizations in the Puget Sound Basin on the aggregate level, annual basis, and by lead entity. There are many opportunities for future research in this field to build upon the base of information established in this research. One direction of future research is to explore the funding decisions made for the other recovery regions to identify how well they conform to a restoration project hierarchy. The Puget Sound Salmon Recovery Region is one of eight in Washington and it would be useful to know if the other recovery regions also align with the restoration project hierarchy. It is possible that there is variety in the other regions and that there may be effects from the fact that the Puget Sound recovery region receives the highest percentage of the total funds. In addition to looking at all the recovery regions there is also the need to examine the results on a watershed basis as done in the research for the Puget Sound basin. The thesis research also only looked at two funding organizations, the SRFB and the

NOAA Restoration Center, and while these are the largest sources of funds for salmon habitat restoration projects in Washington, there are many other public and private organizations that also provide funds for projects. The framework developed in this research could be applied on a broader scale to other funding organizations such as non-governmental organizations to see if their funding decisions align with the restoration project hierarchy.

Overall while the results of this research are enlightening about the role of prioritization and the status of salmon habitat restoration projects in the Puget Sound Basin it is still just one piece of the larger picture. This research and the restoration project hierarchy are based on the scientific literature but the nature of habitat restoration and salmon life cycles mean that it may take decades to observe the results of the efforts. In the meantime, the additional challenges of urban sprawl and development, climate change, and balancing wild and hatchery stocks continue to build against the recovery efforts. This requires a significant amount of trust in the science that the activities and projects being undertaken are in the best interest of the salmon populations and the people of the Puget Sound basin.

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Appendix 1. Database Categorization Key

	Project Type	Project Type Code
In-Stream Passage (ISP)	Replacing Barriers	**REPB**
	Removing Barriers	**REMB**
	Constructing Fishways	**COFI**
In-Stream Diversion (ISD)	Screening Fish from water conveyance system	**SFWS**
In-Stream Habitat (ISH)	Adding boulders, gravel, woody material	**ABGW**
	Relocating a channelized stream to more natural configuration	**RECS**
	Reconnecting channel to floodplain or off-channel habitat	**RECFO**
	Removing bank armor	**REBA**
	Streambank erosion control	**STEC**
	Redirect runoff	**RERU**
	Expand Habitat	**EXHA**
	General Restoration	**GERE**
	Remove In-Water Debris	**RIWD**
	Prevent Water Loss	**PRWL**
Riparian Habitat (RH)	Planting native vegetation	**PLNV**
	Managing invasive species	**MINS**
	Controlling livestock	**COLI**
	Controlling foot traffic	**COFT**
	Controlling vehicle traffic/Roads	**COVT**
	Fencing	**FENC**
	Riparian Restoration	**RIRE**
	Construct setback levee	**COSL**
	Remove Structures	**REST**
Upland Habitat (UH)	Upland erosion control	**UPEC**
	Upland plant establishment and management	**UPPEM**
	Road decommissioning/Repair	**RODE**
Estuarine and Marine Nearshore (EMN)	Beach Restoration	**BERE**
	Bulkhead Removal	**BURE**
	Dike modification or removal	**DIMR**
	Native plant establishment	**NAPE**
	Tidal channel reconstruction	**TICR**
	Debris or structure removal	**DERE**
	Remove Road/Adjust Road	**RERO**
	Marsh Restoration	**MARE**
	Add fencing	**ADFE**
	Soil Amendment	**SOAM**
	Remove tide gates	**RETG**
	Add tide gates	**ADTG**
	Remove Invasive Species	**REIN**
Acquisitions (ACQ)	Acquisition of land	**ACQ**
	conservation easement/preservation agreement	**COEA**
Non-capital Projects (NCP)	Assessments	**ASSE**
	Project Designs (may include permits)	**PRDE**
	Inventories	**INVE**
	Outreach and Education	**OUED**
	Infrastructure	**INFR**
	Planning position	**PLPO**
Research (RES)	Salmon stock research	**SSR**
	Monitoring	**MONI**
	Sediment	**SEDI**
	Broad research	**BRRE**
	Water research (type, flow, etc.)	**WARE**
Population (POP)	Supplement salmon stock	**SUSS**