

PUGET SOUND MARINE AND NEARSHORE GRANT PROGRAM

SYNTHESIS OF 2011-2014 RESULTS AND KEY RECOMMENDATIONS FOR FUTURE RECOVERY EFFORTS

FINAL ANALYSIS REPORT

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CONTENTS

| | |
|--|-----|
| Contents | iii |
| Tables And Figures | iv |
| 1. Introduction | 1 |
| 2. Regulatory Effectiveness..... | 5 |
| 2.1 Compliance and Enforcement | 5 |
| 2.1.1 Key Results | 5 |
| 2.1.2 Recommendations | 8 |
| 2.2 Implementation | 8 |
| 2.2.1 Key Results | 8 |
| 2.2.2 Recommendations | 8 |
| 3. Promoting Armor Removal and “Soft Shore” Protection Techniques | 10 |
| 3.1 Marine Shoreline Design Guidelines..... | 10 |
| 3.1.1 Key Results | 10 |
| 3.1.2 Recommendations | 10 |
| 3.2 Shore Friendly Social Marketing Strategy..... | 11 |
| 3.2.1 Key Results | 11 |
| 3.2.2 Recommendations | 12 |
| 4. Sea Level Rise | 10 |
| 4.1 Key Results..... | 10 |
| 4.2 Recommendations..... | 10 |
| 5. Invasive Species | 11 |
| 5.1 Key Results..... | 11 |
| 5.2 Recommendations..... | 11 |
| 6. Oil Spill Prevention and Response | 12 |
| 6.1 Key Results..... | 12 |
| 6.2 Recommendations..... | 12 |
| 7. Eelgrass | 13 |
| 7.1 Key Results..... | 13 |
| 7.2 Recommendations..... | 13 |
| 8. Habitat Restoration and Protection | 14 |
| 8.1 Key Results..... | 14 |
| 8.2 Recommendations..... | 16 |
| 9. Conclusions and future funding recommendations | 17 |
| 10. Bibliography of Grant Products..... | 18 |
| 11. Other References | 22 |
| Appendix A: Table of Contents for Individual PSI Analysis Reports..... | 23 |
| Part 1 Report: Contents..... | 23 |
| Part 1 Report: Tables | 24 |
| Part 2 Report: Contents..... | 25 |
| Part 2 Report: Tables and Figures..... | 26 |
| Part 3 Report: Contents..... | 27 |
| Part 3 Report: Tables and Figures..... | 28 |
| Appendix B: Summary of 2016 NTA Proposals Related to PSI Recommendations | 29 |

TABLES AND FIGURES

| | |
|---|----|
| Table 1. Grants Reviewed in Part 1 Analysis Report (Kinney et al. 2015)..... | 2 |
| Table 2. Grants Reviewed in Part 2 Analysis Report (Kinney et al. 2016a)..... | 3 |
| Table 3. Grants Reviewed in Part 3 Analysis Report (Kinney et al. 2016b)..... | 4 |
| Table 4. Summary of Existing Puget Sound Shoreline Compliance Data – <i>Unpermitted</i> Construction..... | 6 |
| Table 5. Summary of Existing Puget Sound Shoreline Compliance Data – <i>Permitted</i> Construction | 7 |
| Table 6. Shore Friendly Social Marketing Campaign Framework (Colehour + Cohen et al., 2014b)..... | 9 |
| | |
| Figure 1. Types of Compliance Outcomes Measured | 5 |
| Figure 2. Acquisition and Restoration Project Locations | 15 |

1. INTRODUCTION

The Puget Sound Marine and Nearshore Grant Program (“the Grant Program”) is a partnership between the Washington Department of Fish and Wildlife (WDFW) and the Washington Department of Natural Resources (WDNR). Since 2011, the Grant Program has distributed National Estuary Program funds to support more than 75 projects to implement recovery priorities identified in the [Action Agenda for Puget Sound](#).

Five years into their current 6-year funding cycle, the Grant Program funded the Puget Sound Institute (PSI) to analyze and synthesize the results of their first 4 years of awards. The aim of this grant was to evaluate the results of completed work in order to inform and optimize future work at project, programmatic, and Puget Sound recovery levels.

PSI evaluated and synthesized the reports and deliverables of 50 grants in a series of three Analysis Reports:

- Part 1 covered 14 regulatory effectiveness and stewardship grants (Table 1);
- Part 2 covered 9 grants related to high-priority threats, and the Puget Sound Pressures Assessment (Table 2); and
- Part 3 covered 20 habitat protection and restoration grants, as well as 6 outreach efforts (Table 1).

This report provides an overview of key products, results, and recommendations presented in our 3 previous reports. We have organized key findings into the following categories:

1. Regulatory effectiveness
2. Promoting armor removal and “soft shore” protection techniques
3. Sea level rise planning and adaptation
4. Invasive species
5. Oil spill prevention and response
6. Eelgrass restoration
7. Habitat restoration and protection

These categories correspond broadly to top stressors identified in the Grant Program-funded 2014 Puget Sound Pressures Assessment (McManus et al. 2014), or to strategies for reducing specific stressors. Overall, the Grant Program’s funding strategy aligned well with Pressure Assessment stressor rankings for marine basins (Kinney et al. 2016a). The largest Grant Program investments focused on stressors with the highest potential impact rankings.

Detailed information and analyses related to the individual grants, as well as data from individual grants and additional recommendations, can be found in the Part 1-3 Reports. Not all grants are covered in this summary. The aim of this summary is to capture some of the key over-arching findings and messages that emerged from the synthesis and analysis.

Table 1. Grants Reviewed in Part 1 Analysis Report (Kinney et al. 2015)

| Grant Award | Project Partners | Product Citations |
|--|---|--|
| Marine Shoreline Monitoring and Compliance Pilot Project in WRIA 9 | King County Water and Land Resources | King County (2014) |
| Compliance Assessment | Ecology and WDFW | Talebi and Tyson (2014) |
| Targeted Outreach to Reduce Impacts from Shore Hardening in the PSMA | Northwest Straits Foundation, Coastal Geologic Services, EE Outcomes Consulting, Island and Snohomish Counties and MRCs | Johannessen (2013 a-b) |
| Marine Shoreline Design Guidelines | WDFW, Ecology, Coastal Geologic Services, and Qwg Applied Geology | Johannessen et al. (2014) |
| Nearshore Permitting Effectiveness through T.A.C.T. | Kitsap County, WDFW, and San Juan County | Barnhart et al. (2015) Dionne et al. (2015) Key (2013) |
| Puget Sound Shoreline Master Program Improvement | Futurewise | Futurewise (2014 a-d) |
| Protecting the Strait of Juan de Fuca Nearshore | Coastal Watershed Institute, Clallam County, WDNR, Ecology, and Earth Economics | Flores et al. (2013) Kaminsky et al. (2014) Shaffer et al. (2014) Parks (2015) |
| Puget Sound Feeder Bluffs Mapping | Ecology and Coastal Geologic Services | MacLennan et al. (2013) |
| Support Public Awareness, Outreach and Engagement on SMP Updates | Puget Sound Partnership, WSU Mason County Extension, Heidi Keller Consulting, and Friends of the San Juans | Keller (2012) WSU Mason County Extension (2013) |
| Sea Level Rise and Cumulative Effects Management Tools | Friends of the San Juans, Coastal Geologic Services, and Salish Sea Biological | MacLennan et al. (2013) Whitman and Hawkins (2013) Loring (2013) Whitman et al. (2014) Friends of the San Juans (2014) |
| 20% More Eelgrass by 2020 | WDNR and PNNL | Thom et al. (2014) |
| Ensuring Regulatory Effectiveness in Puget Sound's Most Special Places | Washington Environmental Council | Washington Environmental Council (2013) |
| Protecting Nearshore and Marine Habitat in Mason County | Mason County Community Development | Adkins (2013) |
| Social Marketing Strategy to Reduce Shoreline Armoring | Colehour + Cohen, Social Marketing Services, Futurewise, Coastal Geologic Services, and Applied Research Northwest | Colehour + Cohen et al. (2014 a-e) |

Table 2. Grants Reviewed in Part 2 Analysis Report (Kinney et al. 2016a)

| Grant Award | Project Partners | Product Citations |
|--|---|---|
| Ballast Water Management Assessment | WDFW and UW School of Aquatic and Fishery Sciences | Cordell et al. (2015) |
| Assessment of Biofouling Threats to Puget Sound | Portland State University and Smithsonian Environmental Research Center | Davidson et al. (2014) |
| Toxic Contamination Monitoring in Mussels (Mussel Watch Pilot Expansion) | WDFW | Lanksbury et al. (2012) Lanksbury et al. (2014) |
| Impacts of Outfalls on Eelgrass | WDNR | Gaeckle (2012) Gaeckle (2014) Gaeckle et al. (2015) |
| Assessing Threats from Large Oil Spills (Vessel Traffic Risk Assessment) | Puget Sound Partnership, George Washington University, and Virginia Commonwealth University | Van Dorp and Merrick (2014) |
| Community Engagement for Oil Spill Response and Readiness | Northwest Straits Foundation (NWSF) | NWSF (2015) |
| Swinomish Oil Spill Preparedness Project | Swinomish Indian Tribal Community | Swinomish Tribal Community (2014a-b) |
| Preparing COASST Post-Spill | UW Coastal Observation and Seabird Survey Team (COASST) | COAAST (2014) |
| Geographic Expansion of Seabird Survey and Early On-Scene Training | Seattle Audubon Society | Ross and Joyce (2014) |
| Puget Sound Integrated Risk Assessment | Puget Sound Partnership (PSP) | McManus et al. (2014) Labiosa et al. (2014) |

Table 3. Grants Reviewed in Part 3 Analysis Report (Kinney et al. 2016b)

| Grant Award | Project Partners | PRISM Project |
|---|--|----------------------------------|
| Puget Sound Derelict Net Removal and Pilot Response | Northwest Straits Foundation | n/a |
| Pt. Heyer property acquisition | King County | Project #11-1282 |
| Barnum Point property acquisition | The Nature Conservancy | Project #11-1651 |
| Dabob Bay property acquisition | Northwest Watershed Institute and the Nature Conservancy | Project #11-1657 |
| Southeast Lummi property acquisition | Lummi Island Heritage Trust | Project #14-1870 |
| Waterman property acquisition | Whidbey Camano Land Trust | Project #14-1917 |
| Lyre River property acquisition | North Olympic Land Trust | Project #14-1998 |
| Maury Island property acquisition | King County | Project #14-2226 |
| Skokomish restoration | Mason Conservation District and Skokomish Tribe | Project #11-1361 |
| Port Susan restoration | The Nature Conservancy | Project #11-1650 |
| Milltown Island restoration | Skagit River System Cooperative | Project #11-1669 |
| Woodard Bay restoration | WDNR | Project #10-1116 |
| Beard's Cove restoration | Great Peninsula Conservancy | Project #14-1326 |
| Brown Island restoration | Friends of the San Juans | Project #13-1177 |
| Seahurst Park restoration | City of Burien | Project #09-1415 |
| Meadowbrook (3 Crabs) restoration | North Olympic Salmon Coalition | Project #11-1343 |
| Howarth Park restoration | Snohomish County | Project #13-1106 |
| Bowman Bay restoration | Northwest Straits Foundation | Project #13-1235 |
| Fort Townsend restoration | Northwest Straits Foundation | Project #13-1234 |
| Titlow Beach Park restoration | South Puget Sound Salmon Enhancement Group | Project #15-1447 |
| Brown Island outreach | Friends of the San Juans | n/a |
| Seahurst Park outreach | Environmental Science Center | n/a |
| Meadowbrook (3 Crabs) outreach | North Olympic Salmon Coalition | Project #15-1329 |
| Bowman Bay outreach | Northwest Straits Foundation | Project #15-1367 |
| Fort Townsend outreach | Northwest Straits Foundation | n/a |
| Howarth Park outreach | Snohomish County Parks | Project #15-1422 |

2. REGULATORY EFFECTIVENESS

2.1 COMPLIANCE AND ENFORCEMENT

2.1.1 KEY RESULTS

- There is evidence that shoreline construction is often occurring in the absence of or out of compliance with permits (King County 2014; Friends of the San Juans 2014; Dionne et al. 2015; Barnhart et al. 2015; Futurewise 2014a). Inadequate compliance programs undermine the effectiveness of local SMPs. Compliance monitoring conducted in two Puget Sound counties and one city found that, on average, about half of shoreline modifications did not have required permits. Where permits were obtained, requirements were sometimes violated in nontrivial ways. On-site evaluations of permitted shoreline armoring projects in two counties found that some structures were built longer or closer to the water than was specified in permit documentation.
- Most local jurisdictions do not have dedicated enforcement staff and are not tracking Shoreline Master Program (SMP) compliance (Talebi and Tyson 2014; Futurewise 2014a; Johannessen 2013a). Agency resources are focused on development or review of regulations and guidelines, while compliance monitoring and enforcement are not prioritized.
- The wide range of compliance rates reported reflects the variation in outcomes measured (Figure 1) and data collection methods employed (Table 4 and Table 5). The highest quality data on *unpermitted* construction derived from surveys using field-based methods (boat surveys and site visits). Efforts that relied on remote methods (aerial photo interpretation) for baseline data appeared to identify fewer armoring projects.

Figure 1. Types of Compliance Outcomes Measured

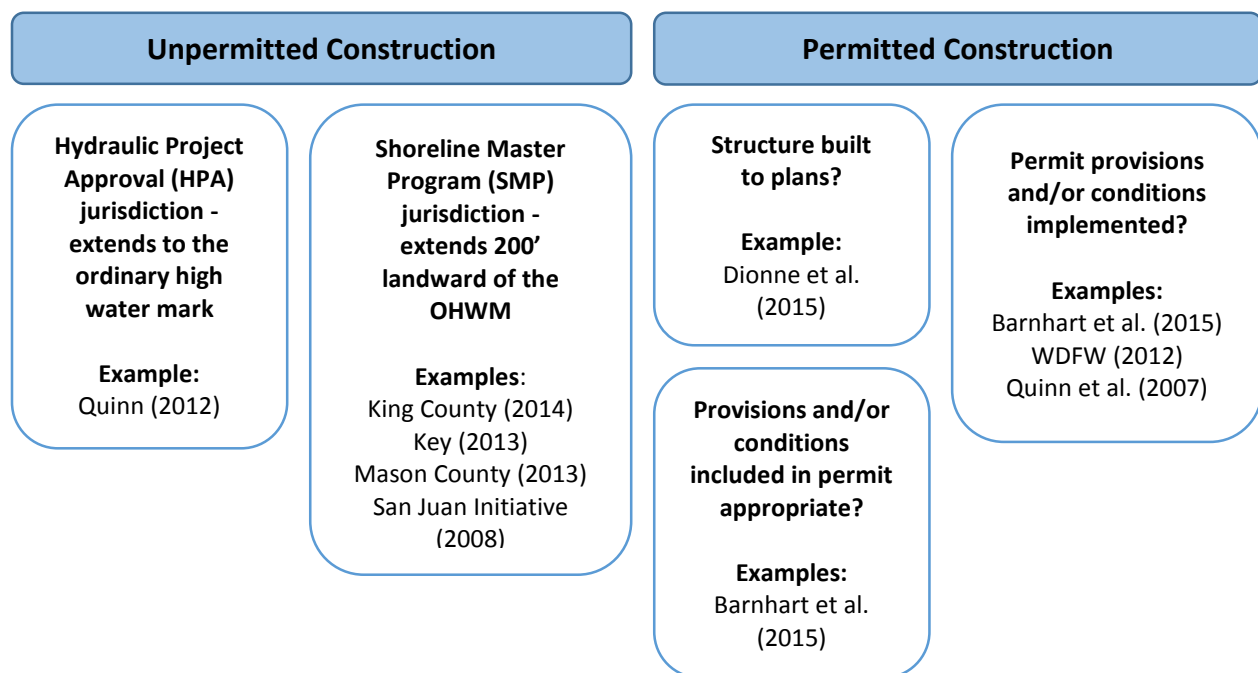


Table 4. Summary of Existing Puget Sound Shoreline Compliance Data – *Unpermitted Construction*

| Source | Outcome(s) Measured | Method(s) to Determine Baseline | Time Period | Area | Data | Compliance Rate |
|---------------------------------|--|---|-----------------|--|--|-----------------|
| King County (2014) * | changes in shoreline condition cross- checked against permit records (includes 200' landward of OHWM) | boat-based surveys and aerial photographs | 2004-2013 | 92 miles of shoreline in King County (6 jurisdictions) | <ul style="list-style-type: none"> • 145 distinct changes in shoreline condition, including 7 new armoring and 66 armoring repairs • 46 changes permitted | 32% |
| Mason County (2013) * | unpermitted improvements | aerial photographs | 2001-2011 | 10.5 miles of shoreline in Mason County | <ul style="list-style-type: none"> • 42 new overwater structures • 2 new shoreline armoring | 87% |
| Quinn (2012) | changes in beach structures cross- checked against HPA permit records | aerial photographs | 2006-2012 | 55 miles of shoreline along Bainbridge Island | <ul style="list-style-type: none"> • 82 shoreline changes • 64 HPAs issued | 80% |
| Quinn (2012) and Key (2013) * | changes in in beach structures cross- checked against HPA and SMP permit records | aerial photographs | 2006-2012 | 34 miles of shoreline in San Juan County | <ul style="list-style-type: none"> • 32 shoreline changes • 10 projects with both HPAs and SMP permits • 6 projects had only HPA or only SMP permits • 16 projects with no permits • 63% of the parcels with no permits on record involved armoring | 50% |
| Friends of the San Juans (2010) | baseline inventory of shoreline structures | boat-based surveys | April-July 2009 | 408 miles of shoreline in San Juan County | <ul style="list-style-type: none"> • 710 armored beaches • 472 docks | not applicable |
| San Juan Initiative (2008) | shoreline modifications from MacLennan and Johannessen (2008) cross-checked against SMP permit records | boat-based surveys and aerial photographs | 1977-2006 | 34 miles of shoreline in San Juan County | <ul style="list-style-type: none"> • >200 parcels • 9 SMP permits • 12 HPAs | <10% |

* funded by the Grant Program

Table 5. Summary of Existing Puget Sound Shoreline Compliance Data – *Permitted Construction*

| Source | Outcome(s) Measured | Data Collection Method | Time Period | Area Evaluated | Number and Type of Data Points | Compliance Rate |
|----------------------------|--|---|--------------------------|---|--|--------------------------------|
| Barnhart et al. (2015) * | number of shoreline armoring projects that complied with SMP permit conditions | review of permit records | 2007-2012 | unincorporated Kitsap County | <ul style="list-style-type: none"> • 60 bulkhead permits evaluated • 32 had at least 1 condition • 9 documented instances where conditions not met | 72% |
| Dionne et al. (2015) * | as-built dimensions and position of shoreline stabilization structures compared to corresponding measurements specified in issued HPAs | field measurements and review of permit records | permits issued 2006-2014 | unincorporated Kitsap County and 34 miles of shoreline in San Juan County | <ul style="list-style-type: none"> • 45 shoreline stabilization structures measured • Compliance was difficult or impossible to measure for several projects because of information missing from the permit record: 6% had no clear statement of structure length and 55% lacked a fixed reference point. 26% longer than permitted • 26% taller than permitted • 21% further waterward than permitted | |
| WDFW (2012) | number of projects that complied with mitigation provisions included in HPAs | site visits | 2010-2011 | 12 counties | <ul style="list-style-type: none"> • 95 marine bank protection HPAs • 66 marine overwater structure HPAs | 91% |
| Quinn et al. (2007) | number of projects that complied with mitigation provisions included in HPAs | site visits | 2005-2006 | 6 counties | <ul style="list-style-type: none"> • 14 marine bank protection HPAs | 73% |
| Whitman (2007) | temporal and spatial assessment of shoreline permit activity | geo-database development and queries | 1972-2005 | 408 miles of shoreline in San Juan County | <ul style="list-style-type: none"> • 2,607 permits total • 372 violation permits | 40-100% depending on provision |
| San Juan Initiative (2008) | number of projects that complied with permit conditions | not provided | 2006 | 34 miles of shoreline in San Juan County | <ul style="list-style-type: none"> • 9 SMP permits • 12 HPAs | 86% |
| | | | | | | <50% |

* funded by the Grant Program

2.1.2 RECOMMENDATIONS

- Prioritize compliance monitoring and enforcement activities. Reliable and consistent data on SMP and Hydraulic Code regulatory compliance need to be collected and acted upon. Rigorous baseline inventories of shoreline structures at the parcel scale are useful for identifying violations and tracking overall compliance rates.
- Coordinate enforcement efforts among departments or agencies to increase identification of unpermitted and non-compliant structures, as well as the efficiency of subsequent enforcement actions (Futurewise 2014a-b; Barnhart et al. 2015). Prioritize inspections before, during, and after construction of new and repair/replacement marine shoreline stabilization projects (Dionne et al. 2015; Barnhart et al. 2015).
- Encourage compliance by implementing penalties or other adverse consequences sufficient to deter non-compliance (Futurewise 2014a).
- Improve local program capacity by increasing access to technical experts in state agencies; training on legal/procedural requirements for enforcement actions; and providing resources to effectively manage permit data (Futurewise 2014a; Barnhart et al. 2015).

2.2 IMPLEMENTATION

2.2.1 KEY RESULTS

- Improving SMP permitting processes can strengthen protection of nearshore and marine resources without requiring changes to laws or regulations.
- Local shoreline management staff surveyed had concerns about their programs' capacity to process permits quickly and with adequate conditions and provisions, as well as with their access to technical expertise (Talebi and Tyson 2014).
- SMP implementers benefit from collaboration with WDFW Area Habitat Biologists during project review, but coordination is limited by staffing levels and workload demands (Barnhart et al. 2015).
- SMP program fee structures can result in restrictions on staff time that limit activities which could minimize impacts, such as pre-application assistance, research on protected species and habitats in the project area, and pre-construction inspections (Barnhart et al. 2015; Futurewise 2014a; Johannessen 2013b). This is especially true for exempted development. Between 2007 and 2012, an average of 80% of the shoreline armoring permits issued by Kitsap and San Juan Counties were processed as exemptions (Barnhart et al. 2015).
- Barnhart et al. (2015) found that staff conducting field inspections often had no training on locating the ordinary high water mark (OHWM). This is problematic where regulatory programs focus on minimizing negative impacts of marine shoreline development by limiting activities below OHWM.

2.2.2 RECOMMENDATIONS

- Provide financial resources and/or technical support to local jurisdictions for creating or updating electronic SMP data management systems to better support project review and enforcement.
- Develop standardized SMP review and inspection forms, procedures, tools, and definitions to improve the permit process and subsequent monitoring/tracking (Barnhart et al. 2015). Addition of

tracking metrics to permit records can assist with both compliance monitoring and implementation of “no net loss” requirements.

- Implement procedural improvements for permit review to ensure that SMP exemptions for shoreline protection projects are conditioned in a manner protective of priority habitats. Barnhart et al. (2015) identified several considerations for improving consistency in applying permit conditions.
- Develop an interagency mitigation manual to set standard mitigation requirements for shoreline erosion protection. A region-wide mitigation manual could encourage consistency across the multiple jurisdictions and agencies responsible for regulating shoreline development; result in more efficient and predictable permit review; and result in more avoidance, minimization, and compensatory measures incorporated into regulatory approvals (Futurewise 2014c). A mitigation manual could also provide jurisdictions with easy-to-apply conditions for projects processed as exemptions.

3. PROMOTING ARMOR REMOVAL AND “SOFT SHORE” PROTECTION TECHNIQUES

3.1 MARINE SHORELINE DESIGN GUIDELINES

3.1.1 KEY RESULTS

- The Marine Shoreline Design Guidelines (Johannessen et al. 2014), also known as MSDG, provides:
 1. A comprehensive framework for site assessment and alternatives analysis that can be applied to evaluate the need for shore protection and inform selection of appropriate erosion management techniques with deliberate consideration of physical processes and ecological impacts.
 2. Detailed descriptions and standardized design guidance for 5 engineered shore protection options: beach nourishment, large wood, reslope-revegetation, bulkhead removal, and hard armor. Information on application, effects, design considerations, costs, and monitoring/maintenance requirements is included.
- The MSDG is a key tool that can be used to determine where alternatives to traditional armoring are a feasible option for erosion control, to encourage techniques for minimizing impacts of existing structures undergoing repair, and to identify candidate sites for bulkhead setbacks or removal.
- The MSDG approach to determining the level of protection necessary at a site is based upon a cumulative risk model that integrates information on the causes and potential magnitude of erosion with risks to infrastructure. The type and proximity of structures are critical to qualifying risk at a site, with the magnitude of the risk directly corresponding to setback distance. The risk model helps distinguish actual need from perceived need. Considered along with other site characteristics, the risk score defines which design techniques are optimal for erosion control.
- Dionne et al. (2015) applied the risk model and decision tree to compare design recommendations generated by the MSDG with as-built conditions for 85 erosion control structures constructed 2006-2014. They found that 68% of the projects were more risk averse than the MSDG recommendation (e.g., hard armor instead of beach nourishment or LWD placement).
- Educational programs and focused outreach based upon the MSDG approach may help change widespread perceptions regarding the effectiveness and necessity of bulkheads for shore protection.

3.1.2 RECOMMENDATIONS

- Build regional capacity for specialized technical support on geological and engineering issues associated with shoreline projects. Develop a training program covering technical application of MSDG site assessment and design selection tools for engineers, consultants, and contractors.
- Develop additional training resources for SMP implementers covering the MSDG and alternative shoreline stabilization techniques. Investigate ways to expand participation in existing training opportunities for SMP implementers, for example by using webinars to reduce costs associated with travel/lodging.

3.2 SHORE FRIENDLY SOCIAL MARKETING STRATEGY

3.2.1 KEY RESULTS

- Residential parcels should be the focus of efforts to reverse current shoreline armoring trends:
 1. Residential parcels comprise almost 1,400 miles—roughly 57%—of the shoreline of Puget Sound and the southern Strait of Juan de Fuca (Colehour + Cohen et al. 2014c).
 2. 71% of the 1,200 HPAs issued for new and replacement marine shoreline stabilization structures between 2005 and 2012 were single family residential (Dionne et al. 2015).
 3. 48% of Puget Sound’s residential parcels are currently armored (Colehour + Cohen et al. 2014c).
- A significant number of hard armor structures that have been in place for decades are losing their structural integrity (Johannessen et al. 2014). Many of these bulkheads were installed prior to implementation of the SMA, when structures were commonly built in intertidal areas.
 1. Between 2007 and 2012 in Kitsap and San Juan Counties, 74% of issued permits were for repair or replacement of existing structures (Barnhart et al. 2015).
 2. In King County, 95% of observed changes in shoreline armoring between 2004 and 2013 were repairs (King County 2014).
- Structures approaching the end of their life span—many in areas where coastal erosion is not a pending threat to buildings, roads, or other infrastructure—present a major restoration opportunity. Bulkhead removal, setbacks, and/or incorporation of soft shore techniques can reverse some of the damage inflicted by erosion control structures in Puget Sound (Johannessen et al. 2014).
- Colehour + Cohen et al. (2014c) developed a Puget Sound parcel database to categorize properties by armor status, erosion potential, and presence/absence of homes. The project partners used this information to identify target behaviors, barriers, and motivations for each of these parcel groups, then developed social marketing incentive tools and messaging strategies to encourage preferred armoring behaviors (see Table 6).
- Landowners do not understand how armor impacts the health of Puget Sound and many see armor as a desirable, or even crucial, element in protecting shoreline properties (Colehour + Cohen et al. 2014d-e; Keller 2012).
- Working with landowners on a voluntary basis can address both the existing impacts of armoring and the future demand for it. Financial incentives, technical design assistance, and streamlining of permit processes can encourage landowners to consider alterations to existing structures and/or installation of alternative shore protection techniques.
- Direct and focused landowner engagement is key to changing landowner perceptions and behavior related to armoring (Colehour + Cohen et al. 2014d-e; Keller 2012; Futurewise 2014d; Shaffer et al. 2014; Johannessen 2013b). Participation of trusted community members resulted in positive responses from property owners. Technical assistance is best offered in a non-regulatory context.
- There is high demand for site visits where landowners can receive site-specific management recommendations from local experts in a non-regulatory context (Johannessen 2013b; Shaffer et al. 2014). Bluff landowners are particularly interested in information about upland management practices.

- The “Shore Friendly” social marketing framework was developed to motivate residential shoreline landowners to voluntarily choose alternatives to hard armor. It provides a coordinated set of audience-tested messages and incentive tools with great potential to change landowner perceptions and behavior regarding the effectiveness and necessity of bulkheads for shore protection.
- The cost of armor removal is a barrier that must be overcome in order for a social marketing effort around armor removal to succeed. Currently, there are not adequate financial incentives in place to overcome the cost barrier (Colehour + Cohen et al. 2014b).

3.2.2 RECOMMENDATIONS

- Expand current and develop additional incentive programs to encourage armor removal and/or soft shore techniques. Financial incentives, streamlined permitting, and technical assistance programs should be prioritized.
- Enhance the Puget Sound Conservation District’s regional capacity for nearshore technical assistance to landowners through training in Shore Friendly and MSDG resources.

Table 6. Shore Friendly Social Marketing Campaign Framework (Colehour + Cohen et al., 2014b)

| Audience | Desired Behavior(s) | Barriers | Motivations | Potential Incentive Tools |
|--|---|---|---|---|
| Category 1 52% of parcels | leave shore unarmored | concern with erosion and storms, waves, or tides might change shoreline | <ul style="list-style-type: none"> • being confident their property would be protected or enhanced • enjoying the natural look • providing healthy habitat for fish and wildlife | <ul style="list-style-type: none"> • free erosion assessment • Shore Friendly ambassador (single point of contact for questions, referrals, assistance) • certified contractor program • workshops • new homeowner packets and visits • stewardship recognition and awards • communication response after erosion events |
| Category 2 46% of parcels | remove all or a portion of armor replace armor with soft shore protection, if needed | concern with erosion | <ul style="list-style-type: none"> • being confident their property would be protected or enhanced | <ul style="list-style-type: none"> • free erosion assessment • free technical assistance • Shore Friendly ambassador • certified contractor program • workshops • new homeowner packets and visits • stewardship recognition and awards |
| | | expense of removing armor | <ul style="list-style-type: none"> • tax break • loan or grant | <ul style="list-style-type: none"> • property tax breaks • grants • loans • group rates for neighborhoods • free technical assistance • free or discounted permits |
| | | complicated nature of regulatory and permitting process to remove armor | <ul style="list-style-type: none"> • streamlined permitting process | <ul style="list-style-type: none"> • special Shore Friendly permits • free technical assistance • certified contractor program • expedited permitting • free or discounted permits • Shore Friendly ambassador • ShoreFriendly.org |

Armor removal and soft shore alternatives are generally less feasible for the remaining 1% of parcels due to high erosion potential.

4. SEA LEVEL RISE

4.1 KEY RESULTS

- Modeling and GIS tools can identify vulnerable infrastructure and habitats and support adaptation planning.
- MacLennan et al. (2013) identified almost 20 miles of public and private roads and 1,200 shoreline structures—primarily residential—that are vulnerable to future inundation and erosion hazards in San Juan County.
- Beach-spawning forage fish may be particularly vulnerable to sea level rise. Based on vertical egg distribution data from San Juan County, a rise in sea level of 1 foot would inundate 33% of surf smelt eggs, and a 2-foot rise would inundate 79% of eggs (Whitman et al. 2014).
- Intact sediment supply is a critical element of beach resilience to sea level rise (Johannessen et al. 2014).
- Projecting changes in shoreline position supports prioritization of infrastructure protection and relocation measures, as well as identification of long-term restoration and conservation targets. Relocation and/or redesign of public shoreline road infrastructure is a significant opportunity for habitat restoration and enhancement, as well as change adaptation.

4.2 RECOMMENDATIONS

- Fund additional sea level rise vulnerability evaluations to support local government efforts to incorporate climate change forecasts into local plans, regulations, and policies.
- Consider climate resiliency—of both communities (e.g., decrease public infrastructure like roads along the shoreline) and vulnerable habitats (e.g. forage fish spawning beaches)—as a decision criterion for restoration projects.

5. INVASIVE SPECIES

5.1 KEY RESULTS

- At least 74 marine and estuarine non-indigenous species (NIS) occur in Puget Sound (Davidson et al. 2014). The lack of data on impacts of marine and estuarine NIS established in the region hampers analyses of risks associated with these species.
- Records of marine and estuarine NIS introduction and spread in Puget Sound have increased over time (Davidson et al. 2014). Vessel biofouling and ballast water are currently the most significant vectors.
- Ballast water exchange regulations have reduced, but not eliminated, the discharge of NIS zooplankton into Puget Sound (Cordell et al. 2015). Total estimated coastal zooplankton discharged into Puget Sound declined dramatically after 2008; this increase in ballast water management compliance coincides with WDFW's focus on ship inspections, sampling, and review of ballasting records during this time period.
- Cordell et al. (2015) developed prioritization criteria to identify high-risk vessels for inspections and other management actions. Tankers from California are particularly high-risk, and exempt from federal regulations requiring ballast treatment system installation. Ballast water from the Columbia River is also categorized high-risk, but exchange is not required before entering Puget Sound under current regulations.
- The vessel biofouling vector is not currently managed in Washington, but development of a biofouling program is underway. High-risk commercial vessels can be identified through the age of their anti-fouling coating (i.e., hull maintenance schedule) and length of recent lay-ups. Biofouling risk is compounded by a lack of effective in-water cleaning systems that prevent release of both invasive species and pollutants (Davidson et al. 2014).
- Implementation of ballast water management criteria and development of a biofouling program is hindered by a lack of staff resources. Funding for WDFW's Aquatic Invasive Species and Ballast Water programs has declined in recent years, resulting in deferral of several high-priority activities.

5.2 RECOMMENDATIONS

- Support WDFW Aquatic Invasive Species and Ballast Water programs so that they can implement the risk criteria developed as part of previously-funded work; resolve policy issues involving changes to the state's Common Water Zone; and work with Ecology to examine tradeoffs between invasive species and toxins management measures.
- Conduct zooplankton monitoring and research to establish a baseline for detecting future invasions. The Asian copepod *Oithona davisae* is of particular concern. The PSEMP Forage Fish and Food Webs Workgroup could provide a venue to foster collaboration between NIS investigators and other researchers (e.g., Long Live the Kings' zooplankton monitoring program).

6. OIL SPILL PREVENTION AND RESPONSE

6.1 KEY RESULTS

- A Vessel Traffic Risk Assessment (VTRA) by Van Dorp and Merrick (2014) found that operation of three proposed maritime terminal developments—the Gateway bulk carrier terminal, the Trans-Mountain/Kinder Morgan pipeline expansion, and Delta Port terminal expansions—would increase the probability of an oil spill in US/Canadian trans-boundary waters. However, most of the POTENTIAL increased risk could be mitigated using a well-designed portfolio of management measures such as speed limits, one-way traffic regimes, and a rescue tug. Some of these interventions should be considered for implementation even if none of the terminal developments are constructed.
- Restoration sites and other high-value habitats may not be included in the six Geographic Response Plans that are used to guide coordinated spill response in Puget Sound. These plans can be strengthened with input from Tribes, local jurisdictions, and community organizations. Having access and other logistical issues worked out before a spill should significantly improve the performance of defensive measures intended to protect habitat (Swinomish Indian Tribal Community 2014a).
- Community volunteers can be engaged in some elements of spill response, but regular investment in recurring training sessions is required (NWSF 2015; COASST 2014; Ross and Joyce 2014). Keeping organizations and individuals engaged in maintaining volunteer response capabilities may prove to be challenging given the mismatch between the frequency of required trainings and the frequency of spill events.

6.2 RECOMMENDATIONS

- Use VTRA results to inform maritime vessel traffic management schemes, as well as future investments in community preparedness programs and regional response planning.
- Support community preparedness programs, but consider encouraging alternative training strategies for volunteer activities. Certifying organization staff to deliver HAZWOPER training to their volunteers and/or moving to a “just-in-time” model could help reduce costs and volunteer attrition.
- Update Geographic Response Plans (GRPs) with: specific locations where oil is likely to accumulate; access points and staging areas for responders; and high quality habitats where defensive measures can be prescribed. Tribes, local jurisdictions, and community organizations could contribute valuable knowledge to significantly increase the level of detail provided in current GRPs

7. EELGRASS

7.1 KEY RESULTS

- Protection and enhancement measures are needed to achieve recovery targets for eelgrass. Numerical biomass and habitat suitability models developed by Thom et al. (2014) found significant acreage with physical conditions suitable for eelgrass but with no eelgrass present, indicating stressors need to be managed. Survey input from technical experts and shoreline managers suggests locals can play a key role in managing stressors because of the site-specific nature of direct impacts like mooring buoys, overwater structures, and recreational shellfish harvest. Rigorous pre-planting site evaluations did not guarantee restoration success, so protection is vital.
- It is difficult to demonstrate a cause and effect relationship between outfall effluent and eelgrass decline in Puget Sound. However, concentrations of copper, lead, and zinc in eelgrass tissue collected from Puget Sound by (Gaeckle 2014) were within ranges where adverse effects have been observed elsewhere.

7.2 RECOMMENDATIONS

- Identify and mitigate site-specific activities that disturb eelgrass. Educate harbor masters, waterfront homeowners with mooring buoys, and park managers about boating impacts to eelgrass and how to minimize them.
- Evaluate and abate water quality stressors in areas where the Thom et al. (2014) model indicates they are suitable for eelgrass but eelgrass is absent or sparse.
- Conduct field investigations to identify relationships between stressors and eelgrass response.

8. HABITAT RESTORATION AND PROTECTION

8.1 KEY RESULTS

The Grant Program funded 20 restoration and acquisition projects through 2014. Locations of the 12 restoration sites, 7 property acquisitions, and derelict net removal sites that received Grant Program funding during Rounds 1-4 are shown in Figure 2. Individual projects are listed in Table 3 and described in the Part 3 Analysis Report (Kinney et al. 2016b).

Measurable results of these capital investments include:

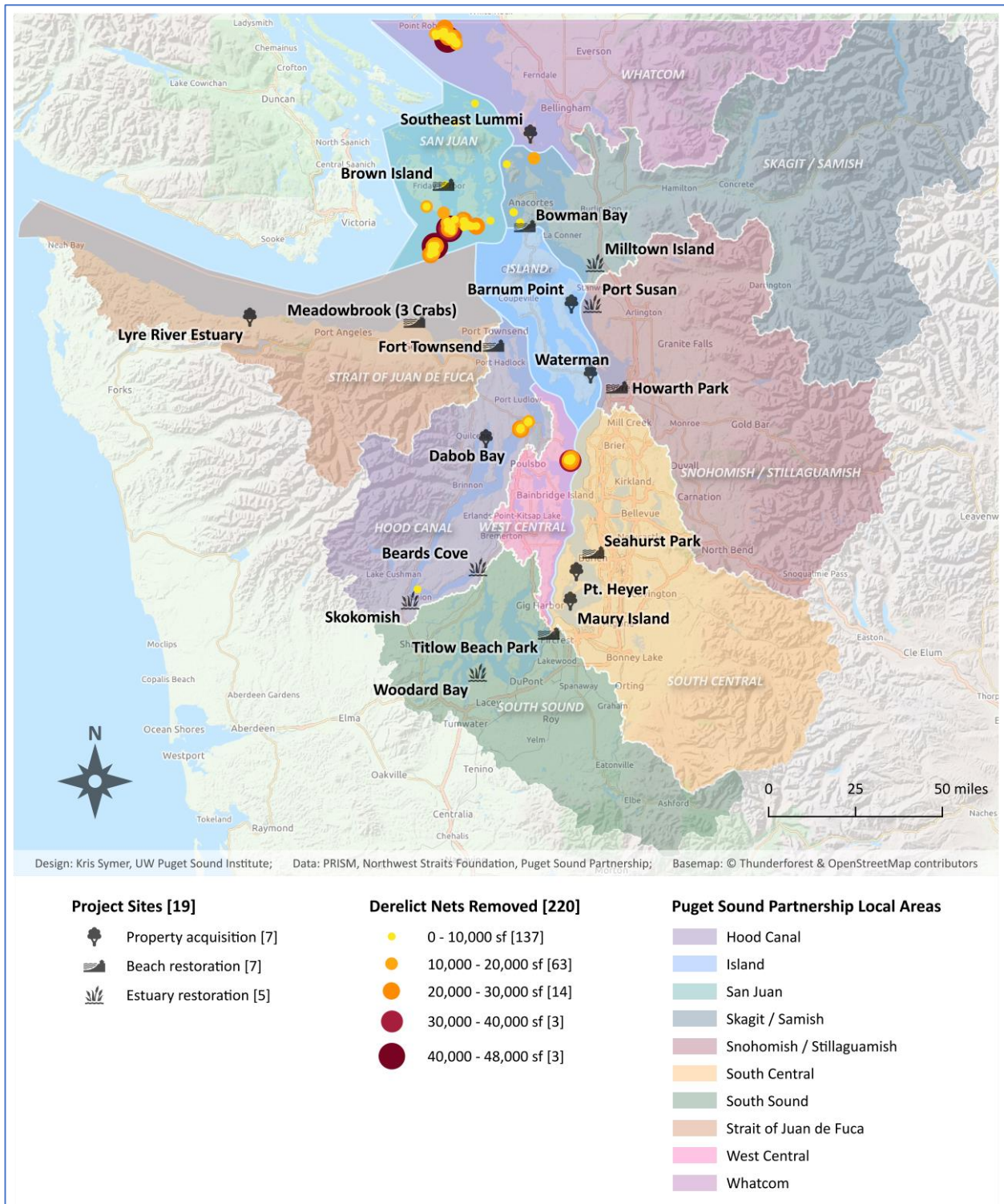
- 423 acres of restored and/or enhanced tidal hydrology at 3 major river deltas;
- 0.92 mile (4,801 linear feet) of shoreline armor removed;
- 373 acres of shoreline habitat and 2.85 miles (13,582 feet) of shoreline permanently protected;¹
- 57 acres of restored and/or enhanced tidal hydrology in 2 small estuaries;
- 600 toxic creosote pilings removed; and
- 48 acres of subtidal rocky reef habitat uncovered by removal of 220 derelict fishing nets.

Acquisition of intact bluff-backed beaches and armor removal projects received the bulk of capital funds. Beaches were a program priority because they tended to be underfunded, relative to other critical habitats like estuaries, by other state and federal funding sources.

Our Part 3 Analysis Report provides an evaluation of project costs relative to the area restored. We observed a very large range of calculated cost-per-acre values, with beach projects being significantly more expensive compared to estuary projects. It cost nearly \$8 million to remove a little under 1 mile of armoring. Further analysis revealed that this variation is a consequence of non-equivalent reporting of area restored for these two types of projects. The result is an understatement of the benefits of beach projects relative to estuary projects, which has implications for both program performance evaluations and proposal ranking/selection. This effect may extend to other project types with relatively high calculated costs per acre (e.g., toxics removal).

¹ Some of these output numbers suggest more precision than likely exists. In several cases the shoreline length metrics were recorded in miles protected or restored, which is not an optimal scale for smaller sites.

Figure 2. Acquisition and Restoration Project Locations



8.2 RECOMMENDATIONS

- Improve reporting metrics for beach projects by focusing on feet—not miles or acres—of armor removed. Even more useful would be including data on feeder bluff length and type.
- While reviewing and ranking armor removal proposals, strive to maximize project outcomes by focusing on sediment supply and transport (as the key habitat-forming process for Puget Sound beaches) rather than outputs like length of armor removed. The scale of a project relative to the size of its drift cell and the proportion of the drift cell with functional sediment dynamics are important evaluation criteria in this context. Keep in mind that the 2016 ranked list of armor removal Near Term Actions (NTAs)² was a result of proposals and a scoring process that lacked this level of specificity.
- Given the extent of new armoring that is continuing to be built, regulatory and incentive-based approaches are crucial for progress towards the [Shoreline Armoring indicator target](#). Opportunities for armor removal on public lands have largely been exhausted, so a focus on private properties is necessary.
- Use findings and products of ongoing technical investigations as decision support tools to identify areas where beach restoration and Shore Friendly incentive investments would have the most impact.
- Support monitoring of project performance relative to intended physical and biological outcomes. In the near-term, emphasize investment in monitoring beach geomorphology after armor removal projects because this information is most crucial for optimizing selection of future projects.

² NTAs are new programs, projects, investigations, or other actions intended to advance priority recovery sub-strategies. They are the core of the Implementation Plan component of the [2016 Action Agenda Update](#). Information on the fall 2015 solicitation, subsequent review process, and ranked lists of NTAs can be found on the Puget Sound Partnership's [2016 Near Term Action Proposals website](#).

9. CONCLUSIONS AND FUTURE FUNDING RECOMMENDATIONS

In Appendix B, we connect 2016 NTA proposals to specific recommendations made in this report and identify gaps that could be filled via future proposal solicitations. This summary demonstrates the value of a synthesis step to maximize the utility of prior investments in recovery and integrate past learning into future decisions. This work will support the development of the Shoreline Armoring Implementation Strategy, by providing technical and programmatic information related to the best available science around shoreline armoring, as well as setting the policy and human context.

A small number of innovative projects stand out, among all those we reviewed, as particularly suitable for translation to other jurisdictions. The following efforts formulated and tested solutions for priority stressors:

- Nearshore Permitting Effectiveness through T.A.C.T. (Barnhart et al. 2015 and Dionne et al. 2015)
- Marine Shoreline Monitoring and Compliance Pilot Project in WRIA 9 (King County 2014)
- Targeted Outreach to Reduce Impacts from Shore Hardening in the PSMA (Johannessen 2013 a-b)
- Shore Friendly Social Marketing Strategy (Colehour + Cohen et al. 2014 a-e)
- Sea Level Rise Vulnerability Assessment for San Juan County (MacLennan et al. 2013)
- Development of a Sediment Budget in Clallam County using Boat-based LiDAR (Kaminsky et al. 2014)
- Swinomish Oil Spill Preparedness Project (Swinomish Tribal Community 2014 a-b)

This project required synthesis of dozens of reports and final deliverables from recipients of NEP funding. Based on this review, we make the following recommendations for deliverables and requirements for future NEP funding recipients:

- Grantees should be required to produce a 1-page summary of their findings for communication to a broad audience.
- Grantees should provide a list of project deliverables to accompany their submission.
- Grantees should provide project metadata (where the project occurred, how much it cost, how much area was impacted, etc.) to the Puget Sound Project Atlas and, for the northern Puget Sound counties, any raw data and spatial location to SoundIQ, maintained by the Northwest Straits Commission.

10. BIBLIOGRAPHY OF GRANT PRODUCTS

- Adkins, B. 2013. Final Report for Grant 10-1744 (Protecting Nearshore and Marine Habitat in Mason County). Deliverable to the Marine and Nearshore Grant Program.
- Barnhart, K., S. Key, and P.E. Dionne. 2015. *Shoreline Permitting Effectiveness through T.A.C.T. Final Report*. Kitsap County, San Juan County, and Washington Department of Fish and Wildlife.
- COAAST. 2014. Final Report: Preparing COASST Post Spill, WDFW Contract #12-1938. Deliverable to the Washington Department of Fish and Wildlife, and Department of Natural Resources.
- Colehour + Cohen, Applied Research Northwest, Social Marketing Services, Futurewise, and Coastal Geologic Services. 2014a. [*Shore Friendly Final Report*](#). Prepared for the Washington Department of Fish and Wildlife and the Washington Department of Natural Resources.
- Colehour + Cohen, Applied Research Northwest, Social Marketing Services, Futurewise, and Coastal Geologic Services. 2014b. [*Social Marketing Approach and Campaign Tools for the Reduction of Puget Sound Shoreline Armor*](#). Prepared for the Washington Department of Fish and Wildlife and the Washington Department of Natural Resources.
- Colehour + Cohen, Applied Research Northwest, Social Marketing Services, Futurewise, and Coastal Geologic Services. 2014c. Coastal Geologic Services. 2014. [*Puget Sound Shoreline Parcel Segmentation Report*](#). Prepared by Coastal Geologic Services for Colehour + Cohen, the Washington Department of Fish and Wildlife and the Washington Department of Natural Resources.
- Colehour + Cohen, Applied Research Northwest, Social Marketing Services, Futurewise, and Coastal Geologic Services. 2014d. [*Survey of Shoreline Property Owners Report*](#). Prepared by Applied Research Northwest for Colehour + Cohen, the Washington Department of Fish and Wildlife and the Washington Department of Natural Resources.
- Colehour + Cohen, Applied Research Northwest, Social Marketing Services, Futurewise, and Coastal Geologic Services. 2014e. *Shoreline Armor Focus Group Findings*. Prepared by Applied Research Northwest for Colehour + Cohen, the Washington Department of Fish and Wildlife and the Washington Department of Natural Resources.
- Cordell, J., O. Kalata, A. Pleus, A. Newsom, K. Strieck, and G. Gersten. 2015. Effectiveness of Ballast Water Exchange in Protecting Puget Sound from Invasive Species: Results from WDFW/UW Ballast Water Sampling, 2001-2014. Report to the Washington Department of Fish and Wildlife and Washington Department of Natural Resources.
- Davidson, I. C. Zabin, and G. Ruiz. 2014. An Assessment of Biofouling Introductions to the Puget Sound Region of Washington State. Report to the Washington Department of Fish and Wildlife and Washington Department of Natural Resources.
- Dionne, P.E., H. Faulkner, W. Dezan, K. Barnhart, S. Key, and T. Quinn. 2015. *Tracking and Monitoring of Marine Shoreline Stabilization Permits Final Report*. Habitat Program, Washington Department of Fish and Wildlife, Olympia, WA.

- Flores, L., J. Harrison-Cox, S. Wilson, and D. Batker. 2013. [Nature's Value in Clallam County: The Economic Benefits of Feeder Bluffs and 12 Other Ecosystems](#). Earth Economics. Tacoma, WA.
- Friends of the San Juans. 2014. *Healthy Beaches for People and Fish: Protecting Shorelines from the Impacts of Armoring Today and Rising Seas Tomorrow*. Final Report to WDFW and the U.S. EPA. Friday Harbor, Washington.
- Futurewise. 2014a. *Practical Guide: Cost-Effective Compliance with Shoreline Regulations*. Prepared by D. Patterson, H. Trim, and T. Trohimovich.
- Futurewise. 2014b. *Practical Guide: Interagency Coordination in Implementing Shoreline Regulations*. Prepared by D. Patterson, H. Trim, and T. Trohimovich.
- Futurewise. 2014c. *Practical Guide: Shoreline Permitting and Mitigation to Achieve No Net Loss*. Prepared by D. Patterson, H. Trim, and T. Trohimovich.
- Futurewise. 2014d. *Practical Guide: Incentives to Help Meet Priority Shoreline Restoration and Protection Objectives*. Prepared by Dean Patterson, Heather Trim, and Tim Trohimovich.
- Gaeckle, J. 2012. Effects of Outfalls and Effluent on Eelgrass (*Zostera marina* L.): A Literature Review. Washington Department of Natural Resources, Nearshore Habitat Program. Olympia, WA.
- Gaeckle, J. 2014. [The Assessment of Nutrient, Metal, and Organic Contaminant Concentrations in Eelgrass \(*Zostera marina* L\) in Puget Sound, WA \(USA\): A Project Overview](#). Presentation at the 2014 Salish Sea Ecosystem Conference.
- Gaeckle, J., L. Ferrier, and K. Sherman. 2015. Spatial Evaluation of the Proximity of Outfalls and Eelgrass (*Zostera marina* L.) in Greater Puget Sound. Washington Department of Natural Resources, Nearshore Habitat Program. Olympia, WA.
- Johannessen, J., A. MacLennan, A. Blue, J. Waggoner, S. Williams, W. Gerstel, R. Barnard, R. Carman, and H. Shipman. 2014. *Marine Shoreline Design Guidelines*. Washington Department of Fish and Wildlife, Olympia, Washington.
- Johannessen, T. 2013a. *Targeted Outreach to Reduce Impacts from Shore Armor in the Port Susan Marine Stewardship Area: County Planner Needs Assessment and Workshop Summary Report*. Prepared for the Northwest Straits Foundation by EE Outcomes Consulting.
- Johannessen, T. 2013b. *Targeted Outreach to Reduce Impacts from Shore Armor in the Port Susan Marine Stewardship Area: Program Assessment Summary Report*. Prepared for the Northwest Straits Foundation by EE Outcomes Consulting.
- Kaminsky, G.M., H.M. Baron, A. Hacking, D. McCandless, and D.S. Parks. 2014. *Mapping and Monitoring Bluff Erosion with Boat-based LIDAR and the Development of a Sediment Budget and Erosion Model for the Elwha and Dungeness Littoral Cells, Clallam County, Washington*. Washington State Department of Ecology Coastal Monitoring and Analysis Program, and Washington State Department of Natural Resources

- Keller, H. 2012. *Exploration of Shoreline Property Owner Knowledge and Awareness of Shoreline Management and Habitat Issues*. Report to WSU Mason County Extension.
- Key, S. 2013. *T.A.C.T. Troubleshooting Report, Attachment A: Results of an Analysis of the San Juan Initiative's Measures of Success*. San Juan County Department of Community Development, Friday Harbor, WA. Deliverable to the Marine and Nearshore Grant Program.
- King County. 2014. *The WRIA 9 Marine Shoreline Monitoring and Compliance Pilot Project*. Prepared by Kollin Higgins, Water and Land Resources Division.
- Kinney, A., T. Francis, and J. Rice. 2015. [Analysis of Effective Regulation and Stewardship Findings: A Review of Puget Sound Marine and Nearshore Grant Program Results, Part 1](#). Puget Sound Institute. Tacoma, WA.
- Kinney, A., T. Francis, and J. Rice. 2016a. [Analysis of Invasive Species, Toxics, Oil Spill, and Integrated Risk Assessment Findings: A Review of Puget Sound Marine and Nearshore Grant Program Results, Part 2](#). Puget Sound Institute. Tacoma, WA.
- Kinney, A., T. Francis, and J. Rice. 2016b. Analysis of Strategic Capital Investments for Habitat Restoration and Protection: A Review of Puget Sound Marine and Nearshore Grant Program Results, Part 3. Puget Sound Institute. Tacoma, WA.
- Labiosa, W., W. Landis, T. Quinn, R. Johnston, K. Currens, S. Redmond, and R. Anderson. 2014. Puget Sound Pressures Assessment Methodology. Puget Sound Partnership Technical Report 2014-02. Tacoma, WA.
- Lanksbury, J.A., J.E. West, and L.A. Niewolny. 2012. [Quality Assurance Project Plan: Mussel Watch Pilot Expansion Project](#). Prepared for the Washington State Department of Ecology.
- Lanksbury, J.A., L.A. Niewolny, A.J. Carey, and J.E. West. 2014. Toxic Contaminants in Puget Sound's Nearshore Biota: A Large-Scale Synoptic Survey Using Transplanted Mussels (*Mytilus trossulus*). WDFW Report Number FPT 14-08.
- Loring, K. 2013. Addressing Sea Level Rise and Cumulative Ecological Impacts in San Juan County Washington Through Improved Implementation and Effective Amendment of Local, State, and Federal Laws. Friends of the San Juans. Friday Harbor, Washington.
- MacLennan, A.J., J.W. Johannessen, S.A. Williams, W.J. Gerstel, J.F. Waggoner, and A. Bailey. 2013. *Feeder Bluff Mapping of Puget Sound*. Prepared by Coastal Geologic Services for the Washington Department of Ecology and the Washington Department of Fish and Wildlife. Bellingham, Washington.
- MacLennan, A., J. Waggoner, and J. Johannessen. 2013. *Sea Level Rise Vulnerability Assessment for San Juan County, Washington*. Prepared by Coastal Geologic Services for the Friends of the San Juans.
- McManus, E., K. Jenni, M. Clancy, K. Ghalambor, I. Logan, S. Redman, B. Labiosa, K. Currens, T. Quinn, W. Landid, K. Stiles, J. Burke. 2014. The 2014 Puget Sound Pressures Assessment. Puget Sound Partnership Publication #2014-04. Tacoma, WA.

- Northwest Straits Foundation. 2015a. Community Engagement for Oil Spill Response and Readiness: Final Report for Project #12-9040. Deliverable to the Marine and Nearshore Grant Program.
- Parks, D. S. (2015). Bluff recession in the Elwha and Dungeness littoral cells, Washington, USA. *Environmental & Engineering Geoscience*. 21(2): 129-146.
- Ross, T. and J. Joyce. 2014. Geographic Expansion of the Puget Sound Seabird Survey and Volunteer Training for Early On-Scene Reconnaissance Final Project Report. Deliverable to the Marine and Nearshore Grant Program.
- Shaffer, A., N. Harris, and D. Parks. 2014. *Protecting the Strait of Juan de Fuca Nearshore through Shoreline Master Program Improvements, Bluff Development Buffers and Building Setbacks, Ecosystem Services Valuation, and Community Stewardship: Field Metrics Final Report*. Coastal Watershed Institute and Washington Department of Natural Resources
- Swinomish Tribal Community. 2014a. Final Report for Grant #12-1937, Swinomish Marine Oil Spill Response. Deliverable to the Marine and Nearshore Grant Program.
- Swinomish Tribal Community. 2014b. Swinomish Marine Oil Spill Preparedness Project Standard Operating Procedures. Deliverable to the Marine and Nearshore Grant Program.
- Talebi, B. and J. Tyson. 2014. *Puget Sound Marine and Nearshore Grant Program Compliance Assessment Project*. Washington Department of Ecology and Washington Department of Fish and Wildlife.
- Thom, R.M., J.L. Gecko, K.E. Buenau, A.B. Borde, J. Vavrinec, L. Aston, and D.L. Woodruff. 2014. *Eelgrass (Zostera marina L.) Restoration in Puget Sound: Development and Testing of Tools for Optimizing Site Selection*. Pacific Northwest National Laboratory.
- Van Dorp, J.R. and J. Merrick. 2014. Preventing Oil Spills from Large Ships and Barges in Northern Puget Sound & Strait of Juan de Fuca: VTRA 2010 Final Report. Prepared for the Puget Sound Partnership.
- Washington Environmental Council. 2013. Final Narrative Report for Grant 12-1103 (Ensuring Regulatory Effectiveness in Puget Sound's Most Special Places). Deliverable to the Marine and Nearshore Grant Program.
- Whitman, T. and S. Hawkins. 2014. *The Impacts of Shoreline Armoring on Beach Spawning Forage Fish Habitat in San Juan County*. Friends of the San Juans. Friday Harbor, WA.
- Whitman, T., D. Penttila, K. Krueger, P. Dionne, K. Pierce, Jr. and T. Quinn. 2014. *Tidal Elevation of Surf Smelt Spawn Habitat Study for San Juan County, Washington*. Friends of the San Juans, Salish Sea Biological, and WDFW. Friday Harbor, WA.
- WSU Mason County Extension. 2013. *Shoreline Master Plan Targeted Awareness Grant Final Report*. Deliverable to the Marine and Nearshore Grant Program.

11. OTHER REFERENCES

- Friends of the San Juans. 2010. *Shoreline Modification Inventory for San Juan County, Washington*. Friday Harbor, WA
- MacLennan, A. and J. Johannessen. 2008. *San Juan Initiative Protection Assessment Nearshore Case Study Area Characterization*. Prepared for the San Juan Initiative and Puget Sound Partnership through the Surfrider Foundation. Coastal Geologic Services, Bellingham, WA.
- San Juan Initiative. 2008. *Protecting Our Places for Nature and People*. Publication No. PSP08-17.
- Quinn, T., S. Kalinowski, R. Bicknell, C. Olds, M. Schirato, D. Price, C. Byrnes, D. Kloempkin, and R. Barnard. 2007. *A Pilot Study of Hydraulic Permit Compliance, Implementation, and Effectiveness in Region 6*. Washington Department of Fish and Wildlife. Olympia, WA.
- Quinn, T. 2012. *A Pilot Study to Estimate Levels of Unpermitted Construction Along Marine Shorelines in Puget Sound*. Washington Department of Fish and Wildlife. Olympia, WA.
- Washington Department of Fish and Wildlife. 2012. *Hydraulic Project Approval Compliance Monitoring Progress Report*. Habitat Program, Protection Division.
- Whitman, T. 2007. *Analysis of Shoreline Permit Activity in San Juan County, Washington 1972-2005*. Friends of the San Juans. Friday Harbor, WA.

APPENDIX A: TABLE OF CONTENTS FOR INDIVIDUAL PSI ANALYSIS REPORTS

PART 1 REPORT: CONTENTS

| | |
|--|----|
| Key results | 2 |
| 1. Background | 6 |
| 2. Improving and Strengthening Regulations | 8 |
| 2.1 Enforcement | 8 |
| 2.2 Implementation | 13 |
| 2.3 Exemptions | 16 |
| 2.4 Recommendations | 17 |
| 3. Promoting Armoring Removal | 19 |
| 3.1 Marine Shoreline Design Guidelines | 20 |
| 3.2 Shoreline Landowner Audience Research and Outreach | 23 |
| 3.3 The Role of Incentives | 25 |
| 3.4 Bringing It All Together: Shore Friendly | 26 |
| 3.5 Recommendations | 30 |
| 4. Supporting Local Governments | 32 |
| 4.1 Identifying Staff Needs | 32 |
| 4.2 Sea Level Rise Vulnerability Assessment | 34 |
| 4.3 Ecosystem Services Valuation | 35 |
| 4.4 Recommendations | 36 |
| 5. Protecting Priority Habitats and Processes | 38 |
| 5.1 Feeder Bluffs | 38 |
| 5.2 Forage Fish Spawning Beaches | 40 |
| 5.3 Recommendations | 41 |
| 6. Implementing Priority Restoration | 42 |
| 6.1 Eelgrass | 43 |
| 6.3 Recommendations | 44 |
| 7. Summary | 45 |
| 7.1 Recommendations for the Grant Program | 45 |
| 7.2 Recommendations for the 2016/2017 Action Agenda for Puget Sound | 46 |
| 8. Acronyms and Abbreviations | 47 |
| 9. References | 48 |
| 9.1 Major Grant Program Products | 48 |
| 9.2 Other Literature Cited | 51 |
| Appendix A. Effective Regulation and Stewardship Investment Area Grants | 53 |
| Appendix B. Effective Regulation and Stewardship Investments Advancing Priorities Identified in the 2011-2013 Biennial Science Work Plan | 56 |

PART 1 REPORT: TABLES

| | |
|--|----|
| Table 1. Effective Regulation and Stewardship Grants (Rounds 1-4) | 7 |
| Table 2. Summary of Existing Puget Sound Shoreline Compliance Data Unpermitted Construction | 11 |
| Table 3. Summary of Existing Puget Sound Shoreline Compliance Data Permitted Construction..... | 12 |
| Table 4. Shore Friendly Social Marketing Campaign Framework | 27 |

PART 2 REPORT: CONTENTS

| | |
|--|-----|
| Key Results and Recommendations | iii |
| Invasive Species Prevention and Response | iii |
| Toxics in Nearshore Biota | iii |
| Oil Spill Prevention and Response | iii |
| Puget Sound Pressures Assessment | iv |
| Contents | v |
| Tables and Figures | vi |
| 1. Background | 1 |
| 2. Invasive Species Prevention and Response | 3 |
| 2.1 Findings | 3 |
| 2.1.1 Ballast Water Vector | 4 |
| 2.1.2 Vessel Biofouling Vector | 7 |
| 2.2 Implications | 11 |
| 2.3 Recommendations | 11 |
| 3. Toxics in Nearshore Biota | 12 |
| 3.1 Findings | 13 |
| 3.1.1 Toxic Contamination in Mussels | 13 |
| 3.1.2 Effects of Outfalls on Eelgrass | 18 |
| 3.2 Implications | 20 |
| 3.3 Recommendations | 21 |
| 4. Oil Spill Prevention | 21 |
| 4.1 Findings | 22 |
| 4.2 Implications | 25 |
| 4.3 Recommendations | 25 |
| 5. Oil Spill Response | 26 |
| 5.1 Outcomes | 27 |
| 5.1.1 Swinomish Oil Spill Preparedness | 27 |
| 5.1.2 Volunteer Response Training and Data Collection Programs | 27 |
| 5.1.3 Local Government and Community Engagement Workshops | 30 |
| 5.2 Implications | 31 |
| 5.3 Recommendations | 31 |
| 6. Puget Sound Pressures Assessment | 32 |
| 6.1 Findings | 37 |
| 6.2 Implications | 45 |
| 6.3 Recommendations | 45 |
| 7. Summary of Recommendations and Related Near Term Actions | 46 |
| 8. Acronyms and Abbreviations | 49 |
| 9. References | 50 |
| 9.1 Major Grant Program Products | 50 |
| 9.2 Other Literature Cited | 51 |
| Appendix A: High Priority Threats and Cross Cutting Issues Grants | 53 |
| Appendix B: High Priority Threats and Cross Cutting Issues Investments | 55 |

PART 2 REPORT: TABLES AND FIGURES

| | |
|--|----|
| Table 1: High Priority Threats and Cross Cutting Issues Grants (Rounds 1-4) | 2 |
| Table 2: Comparison of Puget Sound Mussel Monitoring Efforts..... | 15 |
| Table 3: Mussel Contaminant Concentration Results from Lanksbury et al. (2014) | 17 |
| Table 4: Relationships between Proxies for Urbanization and Contaminant Concentrations | 18 |
| Table 5: Relationships between Proxies for Urbanization and Biological Endpoints | 18 |
| Table 6: Comparison of Leaf Metal Concentrations in Eelgrass (<i>Zostera marina</i>) | 20 |
| Table 7: VTRA Results – Changes Associated with 1,250 Additional Arrivals | 24 |
| Table 8: Overview of Stressor Assessments Intended to Support Prioritization Efforts | 34 |
| Table 9: PSPA Stressors | 35 |
| Table 10: PSPA Endpoints by Domain | 36 |
| Table 11: Grant Program Investment Levels Compared to Stressor Potential Impact Rankings | 43 |
| Table 12: High Priority Threats and Cross Cutting Issues Grants..... | 53 |
| Table 13: Advancing Priorities Identified in the 2011-2013 Biennial Science Work Plan..... | 55 |
| Figure 1: Number of First Records for NIS in Puget Sound | 4 |
| Figure 2: Coastal Zooplankton Density in Exchanged and Unexchanged Ballast from Trans-Pacific Sources (Figure 12 from Cordell et al. 2015) | 5 |
| Figure 3: Coastal Zooplankton Density in Exchanged and Unexchanged Ballast from West Coast Sources (Figure 12 from Cordell et al. 2015) | 6 |
| Figure 4: Estimated Total Coastal and NIS Zooplankton Propagules Discharged into Puget Sound for Two Main Ship Types (Figure 15 from Cordell et al. 2015)..... | 6 |
| Figure 5: Role of Vessel Biofouling in NIS Initial Introduction (Figure 1.4 from Davidson et al. 2014) | 8 |
| Figure 6: Role of Vessel Biofouling in NIS Spread (Figures 1.5 from Davidson et al. 2014)..... | 8 |
| Figure 7: Mussel Monitoring Sites in Puget Sound | 16 |
| Figure 8: VTRA Results – Waterway Zone Contributions to Total Potential Oil Loss..... | 24 |
| Figure 9: Stressors Ranked by IV Stressor Index Values (Figure 7 in McManus et al. 2014) | 38 |
| Figure 10: Endpoints Ranked by IV Endpoint Index Values (Figure 8 in McManus et al. 2014) | 39 |
| Figure 11: Ranked Potential Impact of Stressors in Marine Basins (Figure 10 in McManus et al. 2014) ... | 40 |
| Figure 12: Comparison of IV and PI Index Rankings in Marine Basins (Figure 15 in McManus et al. 2014) | 41 |
| Figure 13: Relationship between PI Results and IV Index Scores (Figure 13 in McManus et al. 2014) | 42 |

PART 3 REPORT: CONTENTS

| | |
|---|-----|
| Key Results | iii |
| Project Outcomes | iii |
| Recommendations | iv |
| Contents | v |
| Tables and Figures | vi |
| 1. Background | 1 |
| 2. Protection Awards | 4 |
| 2.1 Investment Strategy | 4 |
| 2.2 Results | 5 |
| 2.3 Recommendations | 7 |
| 3. Derelict Net Removal | 8 |
| 3.1 Investment Strategy | 8 |
| 3.2 Results | 8 |
| 3.2.1 Legacy Net Removal | 8 |
| 3.2.2 Pilot Reporting, Response, and Retrieval Program | 9 |
| 4. Estuary Restoration Projects | 10 |
| 4.1 Investment Strategy | 10 |
| 4.2 Results | 10 |
| 4.3 Recommendations | 11 |
| 5. Beach Restoration Projects | 13 |
| 5.1 Investment Strategy | 13 |
| 5.2 Results | 13 |
| 5.3 Recommendations | 14 |
| 6. Building Knowledge and Awareness of Restoration Benefits | 16 |
| 6.1 Investment Strategy | 16 |
| 6.2 Results | 16 |
| 7. Investment Performance | 18 |
| 7.1 Measurable Results in the Near-term | 18 |
| 7.2 Consistency with Stated Habitat Protection and Restoration Priorities | 18 |
| 7.2.1 Estuaries Indicator Targets | 19 |
| 7.2.2 Shoreline Armoring Indicator Targets | 19 |
| 7.3 Leverages Additional Funding | 20 |
| 7.4 Sustainable Project Benefits | 20 |
| 7.5 Supports Draft State Climate Change Adaptation Strategies | 21 |
| 8. Project Costs and Outputs/Outcomes | 22 |
| 9. Recommendations | 24 |
| 10. Acronyms and Abbreviations | 26 |
| 11. References | 27 |
| Appendix A: Project Data from PRISM Database | 29 |

PART 3 REPORT: TABLES AND FIGURES

| | |
|--|----|
| Table 1: Strategic Capital Investments (Rounds 1-4) | 3 |
| Table 2: Protection Awards | 6 |
| Table 3: Estuary Restoration Projects | 12 |
| Table 4: Beach Restoration Projects | 15 |
| Table 5: Beach Restoration Outreach Awards | 17 |
| Table 6: Property Acquisitions | 29 |
| Table 7: Estuary and Marine Projects | 30 |
| Table 8: Armor Removal Projects..... | 31 |
| | |
| Figure 1: Acquisition and Restoration Project Locations | 2 |
| Figure 2: Capital Investments by Category | 3 |
| Figure 3: Total Acres Protected by Habitat Type | 5 |
| Figure 4: Acquisition Cost Per Acre | 7 |
| Figure 5: Armor Removal Cost Per Linear Foot of Shoreline | 14 |
| Figure 6: NEP Contributions as Proportion of Project Costs | 21 |
| Figure 7: Restoration Cost Per Acre as Reported in PRISM | 22 |
| Figure 8: Outputs and Outcomes for Process-Based Restoration | 23 |

APPENDIX B: SUMMARY OF 2016 NTA PROPOSALS RELATED TO PSI RECOMMENDATIONS

| Recommendation | 2016 NTA Proposal | Owner | Rank |
|---|---|---|------|
| ASSESS COMPLIANCE AND IMPROVE ENFORCEMENT OF EXISTING REGULATIONS | | | |
| Develop standardized compliance monitoring protocols, including baseline inventories of shoreline structures. | GAP <i>WRIA 9 Pilot is a model that could be expanded to other jurisdictions</i> | | |
| Identify unpermitted and non-compliant shoreline structures. | 0116 WRIA 9 marine shoreline monitoring and compliance | King County Natural Resources and Parks | 6 |
| | 0377 Hydraulic Code compliance assurance program | WDFW | 115 |
| Direct resources to enforcement programs: inspections before, during, and after construction; staff salaries; training on legal and procedural requirements for enforcement actions; and access to technical experts in state agencies. | GAP | | |
| STRENGTHEN IMPLEMENTATION OF EXISTING REGULATIONS | | | |
| Create or update electronic SMP and HPA data management systems to better support project review and enforcement. | 0280 Regional local regulatory compliance tracking systems pilot | Jefferson County Public Health | 103 |
| | 0049 Online application and database management tools for HPAs | WDFW | 204 |
| Develop standardized SMP review and inspection forms, procedures, tools, and definitions to improve permit review and subsequent monitoring/tracking. | GAP <i>T.A.C.T. is a model that could be expanded to other jurisdictions</i> | | |
| Develop tools and training to support local implementation of “demonstration of need” and “no net loss” SMP provisions. Encourage use of the MSDG alternatives evaluation framework to support mitigation sequencing for shoreline protection projects. | 0350 Improving implementation of shoreline modification regulations | WDFW | 66 |
| | 0272 Guidance manual for no net loss of ecological functions in critical areas | WDFW | 77 |
| | 0354 Habitat evaluation procedures | Seattle DCI | 139 |
| | 0314 No net loss evaluation framework | The Watershed Company | 178 |

| Recommendation | 2016 NTA Proposal | | Owner | Rank |
|---|-------------------|---|--|------|
| Compile data on how local jurisdictions review and conditions projects exempt from substantial development permit procedural requirements. Examine if/how permit fee structures limit staff hours dedicated to review of exempt projects. | GAP | <i>Will be included in the Base Program Analysis for Shoreline Armoring</i> | <i>UW Puget Sound Institute</i> | |
| Collect and map data on priority habitats and species for use by shoreline planners during permit review and conditioning. | 0165 | Eelgrass and forage fish mapping in Snohomish County | Snohomish MRC | 139 |
| | 0392 | Critical forage fish habitat identification and protection | WDFW | 169 |
| | 0079 | Forage fish survey and baseline habitat map for Commencement Bay | Citizens for a Healthy Bay | 189 |
| | 0060 | West Sound eelgrass monitoring program | Suquamish Tribe | 194 |
| PROMOTE ARMOR REMOVAL AND “SOFT SHORE” PROTECTION TECHNIQUES | | | | |
| Develop a training program covering technical applications of MSDG site assessment and design selection tools for engineers, consultants, and contractors. | 0380 | MSDG engineering technical assistance, training, and outreach | WDFW | 115 |
| Enhance regional capacity for Puget Sound Conservation Districts to provide nearshore technical assistance to landowners. | 0172 | Expand Conservation District Shore Friendly programs across Puget Sound | Mason Conservation District | 37 |
| | 0268 | Expand Conservation District shoreline technical assistance in Puget Sound | Puget Sound Conservation District Caucus | 48 |
| Support technical assistance and other incentive programs that promote desired armoring behaviors on private property. | 0001 | Shoreline armoring reduction project | NWSF | 4 |
| | 0139 | Permanent marine shoreline protection in San Juan County | Friends of the San Juans | 31 |
| | 0327 | Marine shoreline technical assistance and project identification | King Conservation District | 37 |
| | 0145 | Shoreline stewardship technical assistance program | San Juan Islands Conservation District | 54 |

| Recommendation | 2016 NTA Proposal | Owner | Rank |
|---|---|---------------------------------|------|
| | 0197 Discovery Bay landowner outreach | Jefferson MRC | 54 |
| | 0171 Port Susan armor reduction | Snohomish MRC | 66 |
| | 0236 Shore Friendly incentives in King, Snohomish, and Pierce Counties | Futurewise | 93 |
| | 0104 Hood Canal shoreline outreach and technical assistance | WSU | 121 |
| | 0196 West Central nearshore restoration prioritization and armor removal | Kitsap County | 126 |
| | 1219 Green Shores for Homes implementation | Washington Sea Grant | 126 |
| PROTECT AND RESTORE HABITAT-FORMING PROCESSES | | | |
| Support efforts that provide data for prioritization of project proposals on a landscape scale. | 0398 Strategic mapping of priority drift cells for protection and restoration | Ecology | 8 |
| | 0123 Beach strategies for nearshore restoration and protection | Coastal Geologic Services | 121 |
| | 0393 Hood Canal nearshore inventory, assessment, and prioritization | Hood Canal Coordinating Council | 178 |
| PROTECT, ENHANCE, AND RESTORE EELGRASS BEDS | | | |
| Identify and mitigate site-specific activities that disturb eelgrass. Educate harbor masters, waterfront homeowners with mooring buoys, and park managers about boating impacts to eelgrass and how to minimize them. | GAP | | |
| Evaluate and abate water quality stressors in areas the PNNL model indicates are suitable for eelgrass but eelgrass is absent or sparse. | 0357 Implement eelgrass recovery strategy in Quartermaster Harbor focus area | WDNR | 93 |
| | 0363 Coordinated approach to support effectiveness monitoring | Ecology | 200 |
| Conduct field investigations to identify relationships between stressors and eelgrass response. | GAP | | |

| Recommendation | 2016 NTA Proposal | | Owner | Rank |
|---|-------------------|--|--------------------------|------|
| INVEST IN MONITORING AND ADAPTIVE MANAGEMENT | | | | |
| Continue HPA effectiveness monitoring field surveys to evaluate the extent to which mitigation provisions result in desired outcomes. | 0132 | Improve effectiveness of state Hydraulic Code rules | WDFW | 174 |
| Encourage use of standardized protocols for monitoring beach response to construction. Compile existing information and monitoring reports (physical and biological) for alternative shore protection and beach restoration projects. | 0119 | Shoreline Monitoring Toolbox protocol implementation and data management | Washington Sea Grant | 115 |
| | 0221 | A queryable spatial data service for habitat restoration projects | WDFW | 198 |
| Monitor project performance relative to intended physical (immediate and intermediate) and biological (end) outcomes to validate hypotheses at the center of the process-based model of restoration. | 0328 | Monitor the effectiveness of shoreline restoration | UW Puget Sound Institute | 44 |
| | 0324 | Monitoring biological endpoints of eelgrass restoration | UW Puget Sound Institute | 58 |
| INVEST IN SEA LEVEL RISE VULNERABILITY ASSESSMENT AND ADAPTATION | | | | |
| Conduct sea-level rise vulnerability assessments to identify infrastructure and habitats at risk from inundation and/or erosion hazards. Support local government efforts to incorporate climate change forecasts into local plan, regulations, and policies. | 0089 | Community-scale sea level rise and coastal hazard assessment | UW Climate Impacts Group | 2 |
| | 0140 | Advancing sea level rise adaptation in San Juan County | Friends of the San Juans | 48 |
| | 0190 | Climate change vulnerability assessment and adaptation plan | Kitsap County | 93 |
| | 0293 | Puget Sound integrated coastal inundation modeling and mapping | USGS | 103 |
| INVEST IN OIL SPILL PREVENTION AND RESPONSE | | | | |
| Use VTRA results to inform future investments in community preparedness programs and regional response planning. | 0400 | Higher volume port area evaluation | Makah Tribal Council | 8 |
| | 0219 | Vessel Traffic Risk Assessment update | Ecology | 11 |

| Recommendation | 2016 NTA Proposal | Owner | Rank |
|--|--|------------------------------|-------------------|
| | 0362 Trans-boundary vessel safety summit | Makah Tribal Council | 22 |
| Continue to support community preparedness programs, but consider encouraging alternative training strategies for volunteer activities. Certifying organization staff to deliver HAZWOPER training to their volunteers and/or moving to a “just-in-time” model could help reduce costs and volunteer attrition. | 0322 Evaluate the status of marine birds at greatest risk from oil spills | Seattle Audubon Society | 48 |
| | 0138 Oil spill trainings to increase preparedness of local communities | Clallam MRC | 66 |
| Update Geographic Response Plans (GRPs) with: specific locations where oil is likely to accumulate; access points and staging areas for responders; and high quality habitats where defensive measures can be prescribed. Tribes, local jurisdictions, and community organizations could contribute valuable knowledge to significantly increase the level of detail provided in current GRPs. | 0239 Shoreline segmentation: citizens improving oil spill response data | Northwest Straits Commission | 66 |
| INVEST IN INVASIVE SPECIES PREVENTION, DETECTION, AND RESPONSE | | | |
| Continue to support WDFW Aquatic Invasive Species and Ballast Water programs so that they can: (1) implement the risk criteria developed as part of previously-funded work; (2) resolve policy issues involving changes to the state’s Common Water Zone; and (3) work with Ecology to examine tradeoffs between invasive species and toxins management measures. | 0030 Assessing changes in marine water quality related to antifouling paints | Ecology | 58 |
| | 0301 Copper-free boat paint implementation | Ecology | 7 (Stormwater) |
| Conduct zooplankton monitoring and research to establish a baseline for detecting future invasions. The Asian copepod <i>Oithona davisae</i> is of particular concern. The PSEMP Forage Fish and Food Webs Workgroup could provide a venue to foster collaboration between NIS investigators and other researchers. | 0367 Puget Sound-wide zooplankton monitoring program | Long Live the Kings | 66 |

| Recommendation | 2016 NTA Proposal | | Owner | Rank |
|---|-------------------|---|----------------------|--------------------|
| UTILIZE PSSA FINDINGS TO GUIDE FUTURE INVESTMENT DECISIONS | | | | |
| Consider placing additional emphasis on stressors expected to become more impactful under projected climate change scenarios, such as changing ocean conditions and sea level rise. | 0405 | Ocean acidification hotspots and sources of shellfish resilience | WDNR | 66 |
| | 0366 | Encourage BMPs and behaviors that address nutrient-driven ocean acidification | Washington Sea Grant | 93 (Stormwater) |
| | 0408 | Add acidification parameters to Ecology monitoring network | Ecology | 132 |
| | 0063 | Samish Bay and Padilla Bay oxygen, acidification, and bacterial submodels | Ecology | 189 |