

PUGET SOUND MARINE AND NEARSHORE GRANT PROGRAM

ANALYSIS OF 2016-2019 REGULATORY EFFECTIVENESS INVESTMENTS

ADDENDUM TO THE PART 1 REPORT

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AUGUST 2019

This project has been funded in part by the United States Environmental Protection Agency under assistance agreement PC 00J90701 to Washington Department of Fish and Wildlife. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

EXECUTIVE SUMMARY

Since 2011, the Puget Sound Marine and Nearshore Grant Program has invested National Estuary Program funds to implement priorities outlined in the [Action Agenda for Puget Sound](#). Habitat restoration and protection has been a major focus of the program.

In 2015, Puget Sound Institute released a report analyzing regulatory effectiveness grants funded by the Grant Program through 2014 (Kinney et al. 2015). **This report is an addendum that summarizes 6 regulatory effectiveness projects completed since 2015 and describes how this body of work has contributed to several regulatory improvements made by WDFW's Habitat Program and Washington's Legislature since 2015.**

The more recent grants built upon previous work relating to **Hydraulic Code and Shoreline Master Program compliance**, and **implementation of Shoreline Management Act "no net loss" requirements**. Results of these new projects provide additional support and more evidence for conclusions made in the 2015 Part 1 report.

Like the compliance investigations described in the 2015 Part 1 report, the newer projects employed different methods to measure a variety of compliance outcomes. During the Grant Program's last years, methods tested for earlier projects were **expanded to new geographic areas**. Plus, an **enforcement element missing from other compliance monitoring efforts funded by the Grant Program was** introduced. Results of this pilot effort demonstrated that construction monitoring by a dedicated civil compliance inspector results in better fish protection.

New Grant Program investments also supported development of shoreline inventories with new technology; a pilot project to use state data to track changes within shoreline regulatory jurisdiction over time; and development of a habitat model to quantify ecological loss associated with individual projects.

As detailed in Section 2, **the Grant Program's regulatory effectiveness investments have had a significant impact and influenced several region-wide policy processes**. These include: Hydraulic Code Rulemaking in 2015; WDFW Habitat Program Improvements to address specific procedural deficiencies identified by Dionne et al. (2015) and Barnhart et al. (2015); the Shoreline Armoring Implementation Strategy (Habitat Strategic Initiative 2018); and bills passed into law during the 2019 session of the Washington State Legislature.

The Grant Program's **investment strategy was deliberate: early grants to increase understanding, later emphasis on formulating and testing solutions, then monitoring results and propagating effective approaches**. The Grant Program and their grantees have demonstrated learning and succeeded in employing adaptive management to accomplish real and lasting change.

CONTENTS

1. Introduction	1
2. Impact of Regulatory Effectiveness Investments	2
3. Compliance with Shoreline Regulations	5
3.1 Findings For Unpermitted Projects	8
3.2 Findings For Permitted Projects.....	9
3.3 Recommendations	12
4. “No Net Loss” Implementation.....	12
4.1 Findings	13
4.2 Recommendations	17
5. References	18

TABLES AND FIGURES

Table 1. Regulatory effectiveness investments (Rounds 5-6)	2
Figure 1. Compliance outcomes measured by Grant Program funded investigations.....	5
Table 2. Summary of compliance data for <i>unpermitted</i> projects.....	6
Table 3. Summary of compliance data for <i>permitted</i> projects.....	7
Figure 2. Example benchmarks for a bulkhead replacement project (from Cook et al. 2019)	11
Figure 3. Parcel-level land cover delineation via LiDAR (from Richardson 2016)	14
Figure 4. Parcel-level change detection via HRCD (from Muller et al. 2016)	15
Figure 5. Modeled Habitat Suitability Index values and Habitat Units for City of Seattle marine shorelines (from Windward Environmental 2016).....	16

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 about 80 projects that implement recovery priorities identified in the [Action Agenda for Puget Sound](#).

Five years into their 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 four analysis reports:

- Part 1 covered 14 regulatory effectiveness and stewardship grants (Kinney et al. 2015);
- Part 2 covered 9 grants related to high-priority threats, and the Puget Sound Pressures Assessment (Kinney et al. 2016a);
- Part 3 covered 20 habitat protection and restoration grants, as well as 6 outreach efforts (Kinney et al. 2016b); and
- A final report synthesizing all 2011-2014 investments (Kinney et al. 2016c).

In 2018, the Grant Program funded PSI to analyze and synthesize results of projects completed since 2016. **Results of the 30 most recent awards are summarized in 3 addendums to the original analysis reports and one new analysis report.**

This addendum covers 6 new grants (Table 1) in the regulatory effectiveness topic area covered in the 2015 Part 1 Report. The more recent grants build upon previous work relating to Hydraulic Code and Shoreline Master Program compliance, and implementation of Shoreline Management Act “no net loss” requirements.

This addendum also describes how this body of work has contributed to regulatory improvements made by WDFW’s Habitat Program and Washington’s Legislature since 2015.

Additional new grants related to other themes included in the 2015 Part 1 Report are included in other PSI deliverables: 12 shoreline armoring science and incentive program awards are covered in a new Part 4 Analysis Report and an eelgrass restoration capital investment is included in the Part 3 Addendum.

Table 1. Regulatory effectiveness investments (Rounds 5-6)

Awards	Grantees	Product Citations
Marine and Nearshore Compliance Improvement Project	Island County	Island County 2017a-d
WRIA 9 Shoreline Monitoring & Compliance Phase 2	King County	King County 2019
Hydraulic Code Compliance Assurance Program Pilot	WDFW	Faulkner et al. 2018 Cook et al. 2019
Monitoring Ecological Function with Remote Sensing along Bainbridge Island Shoreline	City of Bainbridge Island	Schulze 2015 Richardson 2016
HRCD-based SMP Effectiveness and Compliance Monitoring	Thurston County	Thurston County 2017a Thurston County 2017b
Marine Habitat Evaluation Procedures	City of Seattle	Luxon et al. 2016 Luxon 2016 Windward Environmental 2016

2. IMPACT OF REGULATORY EFFECTIVENESS INVESTMENTS

Between 2011 and 2014, the Grant Program funded several investigations aimed at improving the effectiveness shoreline regulations. These investments explored regulatory program outcomes related to shoreline armoring. Results highlighted the importance of compliance monitoring and enforcement, as well as opportunities to improve implementation through changes to permit program project review and tracking procedures.

As detailed below, **these regulatory effectiveness investments have had a significant impact.** Before delving into results of the most recent grants, we will summarize how previous findings and recommendations have influenced regulatory programs since 2015 to provide context for interpreting the newer results.

The single most impactful regulatory effectiveness investment has been **Nearshore Permitting Effectiveness through T.A.C.T grant**.¹ This joint project by WDFW, Kitsap County, and San Juan County was funded in 2012. Barnhart et al. (2015) assessed 5 years of Shoreline Master Program (SMP) permits and Hydraulic Project Approvals (HPAs) permit records for marine bulkhead projects to identify procedural deficiencies and potential corrective actions. Dionne et al. (2015) conducted field investigations of shoreline sites identified during the troubleshooting phase to determine if regulatory conditions were implemented and if they were effective at protecting habitat.

¹ Acronym for Troubleshooting, Action planning, Course correction, Tracking and monitoring

T.A.C.T. project findings guided subsequent Grant Program investments, resulted in procedural improvements at three² local jurisdictions, and **influenced the following region-wide policy processes and changes:**

- 2015 Hydraulic Code Rulemaking – [WAC 220-660-370\(6\)\(a\)](#) was added to allow WDFW to require establishment of a permanent benchmark before a project proponent begins work on a marine bank protection project. This change was a direct result of T.A.C.T. project findings. Benchmarks help WDFW ensure structures are built within the approved footprint and elevation.
 - Dionne et al. (2015) intended to compare as-built bulkhead alignment/footings with those specified in permit documents to estimate project compliance with permit requirements. **This is important because toe elevation is the key factor for minimizing the impact of a bank stabilization structure.** The lower in beach elevation a bulkhead is located on a beach, the more likely it is to negatively affect a variety of ecosystem functions (Dethier et al. 2016). **State regulations generally prohibit or limit shoreline stabilization activities below the ordinary high water mark (OHWM).**
 - However, Dionne et al. (2015) was unable to evaluate compliance in many cases because more than half the of permits lacked a stable point against which new/repared bulkheads could be referenced. Beach profiles are often re-graded during construction or impacted by subsequent tidal and wave action. Where permits referenced a qualitative elevation—OHWM, top of bank, or old armoring—that could have been altered during construction, it was not possible to determine if the bulkhead was built according to plans or lower on the beach.
 - The new provision enables accurate compliance monitoring of critical HPA alignment requirements. Effective use of this new regulatory tool by Cook et al. (2019) is described in Section 3.2 of this report.
- **2016 Habitat Program Improvements** – WDFW developed and implemented several changes for the HPA decision process to address specific procedural deficiencies that were identified during the T.A.C.T. project. These include:
 - New fields for parcel number, GPS coordinates, length (existing/new), waterward extent (referencing a stable structure), and height in Aquatic Protection Permitting System (APPS) tracking software.
 - An electronic project and site review form that provides Habitat Biologists (staff that review applications and issue HPAs) with a structured method for documenting existing habitat conditions, species at risk of impact from proposed activities, existing habitat functions, project impacts, and mitigation analysis. The electronic form is prepopulated with common parameters to assist with project

² Original grantees Kitsap County and San Juan County plus Island County, who received a 2015 grant to conduct a similar permit troubleshooting review and course correction.

determinations. A detailed user guide was prepared to support application of this tool by Habitat Biologists.

- Standard operating procedures for marine bulkhead replacement that provide Habitat Biologists with standardized guidelines for processing applications, data resources, common mitigation requirements, and several rules of thumb.
- **2018 Shoreline Armoring Implementation Strategy** – This regional recovery plan included a regulatory strategy that was informed by and drew heavily from the regulatory effectiveness investments. Strategy near-term priorities relating to compliance and effectiveness monitoring and enforcement specifically referenced King County’s compliance monitoring, the T.A.C.T. project, and the Hood Canal pilot as examples (Habitat Strategic Initiative 2018). **Development of this Implementation Strategy also demonstrated the value of a synthesis step to maximize the utility of prior investments in recovery planning.** The 2015 Part 1 report provided a relatively concise summary of more than 15 individual deliverables from 6 regulatory effectiveness projects. Without the availability of a distilled version of key findings and recommendations, it is unlikely that this extensive body of gray literature would have informed the strategy and companion program analysis (Kinney 2018) to the same extent.
- **2019 Session of the Washington State Legislature** – Statutory changes consistent with regulatory effectiveness project findings and Shoreline Armoring Implementation Strategy recommendations became law in July 2019:
 - [Second Substitute House Bill 1579](#) increased the civil penalty for Hydraulic Code violations (up to \$10,000 per violation from \$100 per day) and provided WDFW with stop-work authority for Hydraulic Code violations.
 - Funding for 2 additional Fish and Wildlife Officers to focus on HPA-related work was added to WDFW’s operating budget.³

The Grant Program’s **investment strategy was deliberate: early grants to increase understanding, later emphasis on formulating and testing solutions, then monitoring results and propagating effective approaches.** The Grant Program and their grantees have demonstrated learning and succeeded in employing adaptive management to accomplish real and lasting change.

³ Requested Compliance Inspector position(s) were not funded. However, the Fish and Wildlife Commission subsequently approved inclusion of 8 Compliance Inspector positions in WDFW’s supplemental budget request for 2020-21. This request will go to the Legislature for consideration during the 2020 Legislative session (R. Thurston, WDFW, pers. comm.).

3. COMPLIANCE WITH SHORELINE REGULATIONS

Like the compliance investigations described in the 2015 Part 1 report, these newer projects employed different methods to measure a variety of compliance outcomes (Figure 1). During the Grant Program's last years, methods tested for earlier projects were **expanded to new geographic areas**. Plus, **two new compliance monitoring techniques were piloted by WDFW** for their Hydraulic Code compliance assurance project: site visits by a Compliance Inspector during construction of permitted projects and boat emphasis patrols by a Fish and Wildlife Enforcement Officer to search for unpermitted construction in progress. **Visiting permitted projects during active construction was a central recommendation** from the T.A.C.T. project discussed in the Part 1 report.

Tables 2 and 3 provide a wrap-up summary of results from all the compliance investigations funded by the Grant Program since 2011. A discussion of key findings from the 3 recent projects listed below and how they relate to the previous efforts follows that summary:

- Marine and Nearshore Compliance Improvement Project (Island County 2017a-d)
- WRIA 9 Shoreline Monitoring & Compliance Phase 2 (King County 2019)
- Hydraulic Code Compliance Assurance Program Pilot (Faulkner et al. 2018, Cook et al. 2019)

Figure 1. Compliance outcomes measured by Grant Program funded investigations

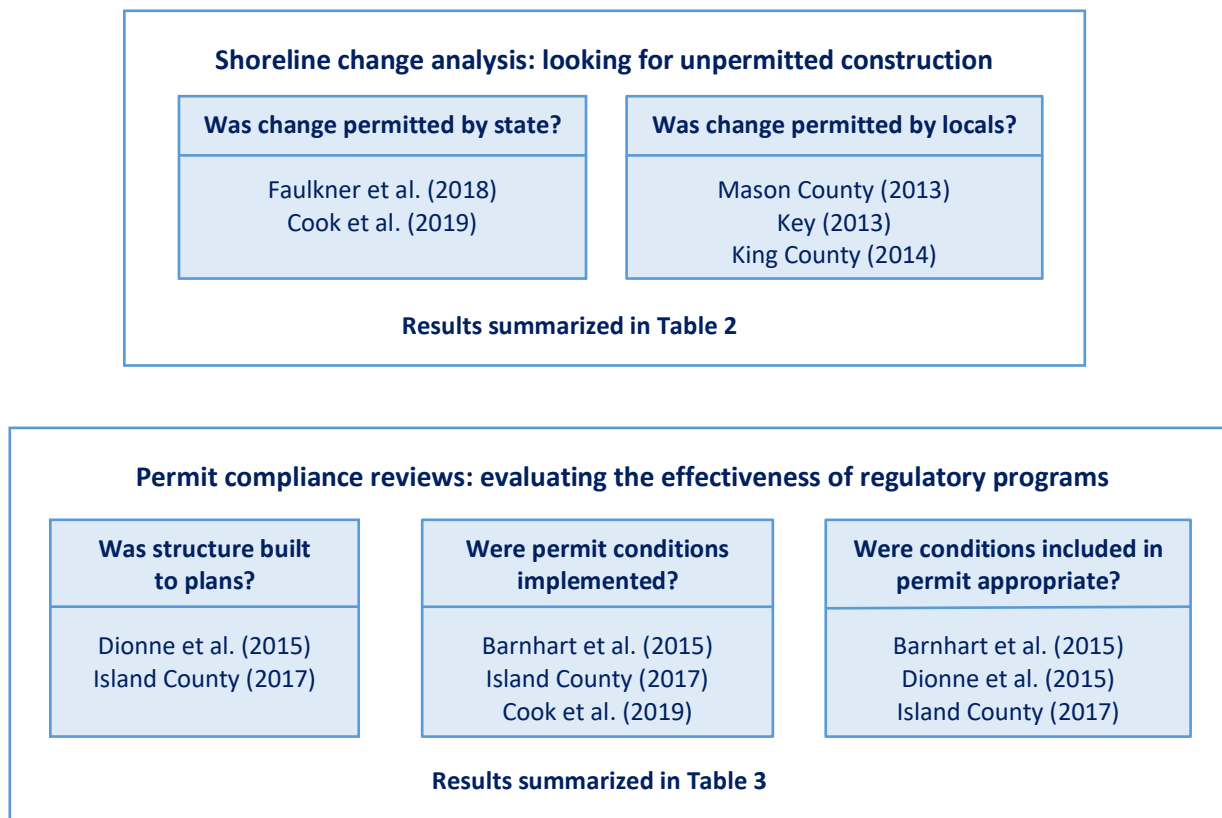


Table 2. Summary of compliance data for *unpermitted* projects

Source	Outcome(s) Measured	Methods	Time Period	Geographic Coverage	Results	Compliance Rate
Mason County (2013)	unpermitted improvements within SMP jurisdiction	aerial photographs for baseline and change	2001-2011	10.5 miles of shoreline in Mason County	<ul style="list-style-type: none"> • 205 new structures observed (2 new armoring, 42 new overwater structures) • 26 built without local permits 	87%
Key (2013)	changes in beach structures cross-checked against HPA and SMP permit records	baseline and change from Quinn (2012)	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%
King County (2014)	changes within SMP jurisdiction cross-checked against permit records	boat-based surveys for baseline and change	2004-2013	92 miles of shoreline in King County	<ul style="list-style-type: none"> • 145 changes observed (7 new armoring, 66 armoring repairs, 7 new overwater structures, 15 vegetation clearings) • 46 changes had SMP permits 	32%
King County (2019)	changes within SMP jurisdiction cross-checked against permit records	boat-based surveys for baseline and change	2013-2018	92 miles of shoreline in King County	<ul style="list-style-type: none"> • 284 changes observed (9 new armoring, 125 armoring repairs, 6 new overwater structures, 68 vegetation clearings) • 118 changes had SMP permits • 177 changes were <i>likely to need</i> an HPA (as determined by King County not WDFW) • 53 of those had an HPA 	42% SMP 30% HPA
Faulkner et al. (2018)	changes within HPA jurisdiction cross-checked against permit records	aerial photographs for baseline, boat surveys and aerial photographs for change	2006-2018	91 miles of shoreline in Mason County	<ul style="list-style-type: none"> • 388 changes detected (new structures only) • 122 permits matched to changes • 266 changes not linked to a permit • >200 permits lacked detailed location data 	insufficient location data in many HPA records
Cook et al. (2019)	HPA violations in progress	boat emphasis patrols with Fish & Wildlife Officer and Compliance Inspector	2018	685 miles of shoreline in Hood Canal and mid-to-south Puget Sound	<ul style="list-style-type: none"> • 65 possible violations observed • Staff made contact with 11 people • Voluntary compliance achieved for 6 projects • 6 cases referred to local prosecutors' offices 	n/a

Table 3. Summary of compliance data for *permitted* projects

Source	Outcome(s) Measured	Methods	Time Period	Geographic Coverage	Results	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	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 	64-79% where permit data was sufficient to determine
Island County (2017)	compliance with site plans and permit conditions	site visits and review of permit records	2010-2014	Island County	<ul style="list-style-type: none"> • 30 permits selected randomly • 20 projects implemented in substantial compliance with site plans • 5 noncompliant projects were bulkheads • Lack of benchmarks made bulkhead placement relative to OHWM difficult to determine for some other projects 	70%
Cook et al. (2019)	compliance with HPA provisions and plans/specifications	site visits during construction	7/2017-2/2019	Mason County	<ul style="list-style-type: none"> • 175 inspections of 98 permitted projects • 76 inspected projects had one or more instances of noncompliance with HPA provisions that required corrective action • 40% of instances of noncompliance involved construction issues and 11% differences from construction plans; remaining 47% were administrative issues 	22% before request for correction then 100% after corrections

3.1 FINDINGS FOR UNPERMITTED PROJECTS

Results of a second phase of compliance monitoring for WRIA 9 marine shorelines are documented King County (2019). Changes in shoreline conditions in the 5 years since the end of the previous grant (King County 2014) were assessed to discern trends over time and to determine if outreach efforts prior to the second phase improved compliance rates.

As shown in Table 2, compliance rates improved only slightly during the second phase. King County (2019) concluded that newspaper articles/editorials, presentations to community groups, and a landowner workshop were not effective in significantly improving compliance rates.

King County’s boat-based survey methods were expanded to a new geographic area—Mason County—for Faulkner et al. (2018). WDFW’s lead survey biologist and compliance inspector spent fourteen hours shadowing King County staff during their 2018 survey of Vashon Island. This allowed WDFW staff to practice methods and tools before conducting a baseline survey along 91 miles of Hood Canal. The resulting data provide a strong baseline for follow-up compliance monitoring via boat surveys.

Faulkner et al. (2018) also conducted a change analysis using 2006 Department of Ecology aerial photographs for a baseline. Two methods were used to detect changes: 2016 aerial photographs and the 2018 boat surveys. HPA records dating back to 2001 were then reviewed to determine permit status of all changes detected.

- Results provided in Table 2 indicate that only 31% of the changes detected were linked with HPA permits.
- However, **more than 200 HPAs lacked project location information specific enough (latitude/longitude) to be linked with a detected change** so an accurate estimate of compliance was not possible. As noted in Section 1, WDFW added a new field for GPS coordinates to APPS tracking software in 2016. This improvement will ensure that future analyses have location data necessary to match changes with permits.

An interesting element of the Faulkner et al. (2018) study was inclusion of a quantitative comparison of change detection methods. They calculated the number of staff hours required to identify changes via photo and field methods. Results indicated that **more staff time was expended to inventory and characterize each change via aerial photographs compared to boat surveys**. In addition, the boat method detected 14 more changes, allows for greater survey repeatability (i.e., not limited by Ecology flight frequency), supports more detailed examination of shoreline condition (e.g., materials used), and allowed for greater coverage of the survey area (82 miles versus 75 miles inaccessible).

Cook et al. (2019) introduced an **enforcement element that was missing from other compliance monitoring efforts funded by the Grant Program.**⁴ All the other studies summarized in Tables 2 and 3 were intended to characterize compliance rates, not identify violations as a basis for enforcement action.

- This grant to WDFW funded a new Compliance Inspector position and additional capacity for a Fish and Wildlife Officer to **seek out unpermitted hydraulic projects and follow-up on identified violations.**
- As a result of these efforts, 6 projects were brought into voluntary compliance and 6 cases (3 for the same project) were referred to local prosecutors' offices.
- **Since this pilot effort wrapped up, Fish and Wildlife Enforcement Officers have additional enforcement tools at their disposal.** As noted in Section 1, WDFW was granted authority to issue stop-work orders and the civil penalty for Hydraulic Code violations was increased (up to \$10,000 per violation from \$100 per day) during the 2019 legislative session.

3.2 FINDINGS FOR PERMITTED PROJECTS

T.A.C.T. project methods and findings inspired Island County to conduct a similar review of SMP permits. The grantee evaluated a random sample of 30 SMP permits issued between 2010-2014. Results from Island County (2017a-b) are summarized in Table 3. **Common areas of non-compliance were implementation of required mitigation and lack of consistency between shoreline permits and building permits.**

The County had difficulty determining if bulkheads were constructed in the alignment specified in permits. This was similar to the findings of Dionne et al. (2015), who could not ensure some bulkheads projects occurred above OHWM (a common permit condition) after-the-fact since construction and the bulkhead itself can change the OHWM.

Island County's office audit results were unique among the Grant Program's regulatory effectiveness investments because they linked staff experience with permit quality. The County noted variability in compliance rates over the study period: the percentage of projects that complied with permit requirements was near 90% in 2011 and 2012, but only 50% in 2010, 2013, and 2014. Island County (2017b) attributes this drop to an **"extreme employee turnover rate"** around 2012 - 2014: "Many Planners left the County, resulting in unfilled vacancies, unmanageable workloads, new hires with minimal experience, and a lack of training for new staff. This is likely directly correlated to the trend of non-compliance during this time period and the cause of **planner mistakes, poorly written conditions, and approvals out of compliance with regulations.**"

⁴ King County (2019) noted that letters were sent to landowners, and some code enforcement cases were initiated with a few now closed, but this was not an objective of the grant.

As part of the same grant, Island County also increased the number of **pre-application site assessments** offered to applicants for shoreline permits. These assessments provide County staff an opportunity to influence early design decisions and inform project proponents about natural/regulatory constraints. The importance of pre-application assistance was a key finding of the Futurewise **Improving the Implementation of the Shoreline Management Act** grant discussed in the 2015 Part 1 report.

WDFW developed the **Hydraulic Code Compliance Assurance Program Pilot** project based on the findings of earlier regulatory effectiveness projects. Multiple grantees found that there are **few mechanisms to follow through and ensure permit requirements and conditions are implemented** (Talebi and Tyson 2014, Futurewise 2014a, Dionne et al. 2015, Barnhart et al. 2105). Field evaluations of permitted shoreline armoring projects for the T.A.C.T. project found that some **bulkheads were built longer or closer to the water than was specified in permit documentation** (Dionne et al. 2015). Barnhart et al. (2015) concluded that **effective implementation of regulations for marine shoreline stabilization projects requires inspections before, during, and after construction**

As part of the pilot program, a full-time Compliance Inspector was hired to conduct **site visits to permitted marine shoreline construction sites in Mason County to ensure HPA provisions were implemented**. The Compliance Inspector monitored project progress and provided technical assistance; determined the compliance status of each project relative to permit conditions; and assisted permittees to voluntarily come into compliance with permit provisions by providing corrections advice, timelines, and certainty of re-inspection. If necessary, the inspector would have been able to gather evidence to support criminal prosecution.

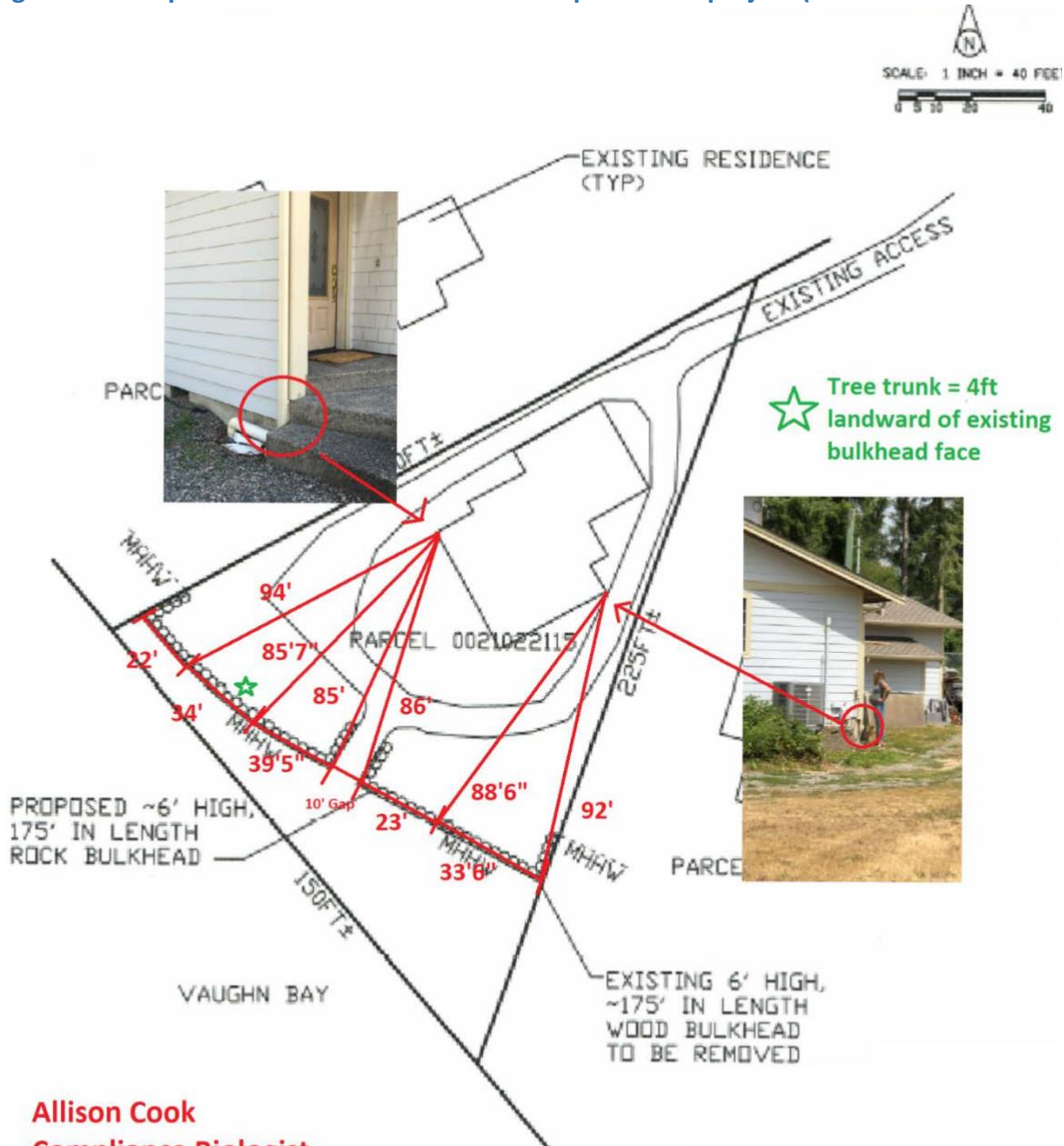
Over the course of 19 months, Cook et al. (2019) conducted **175 inspections of 98 permitted marine projects**. 78% of inspected projects (n=76) had one or more instances of noncompliance with HPA provisions that required corrective action. **100% of permittees complied voluntarily when the inspector requested a correction.**

Shoreline armoring projects were a large number of the projects inspected and had a relatively large number of instances of noncompliance. In several cases, **HPAs lacked or had insufficient benchmarks**. As described in Section 2, benchmarks are a stable reference point important for ensuring structures are built within the approved footprint and elevation. The inspector was able to provide field assistance for benchmarks prior to the start of construction of 18 armoring projects. However, 16 other projects were not able to be measured of structure placement accuracy after the structure was completed because of insufficient or absent benchmarks. Cook et al. (2019) concluded that **Habitat Biologists, local governments, and project proponents would benefit from training about establishing adequate benchmarks.**

Cook et al. (2019) found that the single stable reference point recommended by Dionne et al. (2015) and mentioned in [WAC 220-660-370\(6\)\(a\)](#) was not always sufficient to ensure structures were built in the permitted alignment. Cook et al. (2019) recommends **updating the Hydraulic Code benchmark provision to include at least 5 benchmarks per project, or every 20 feet,**

spread evenly over the length of armoring. An example is provided in Figure 2. This frequency improves the likelihood that structure compliance with approved plans and specifications can be assessed.

Figure 2. Example benchmarks for a bulkhead replacement project (from Cook et al. 2019)



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Compliance Biologist
7/10/2018
HPA 15274

3.3 RECOMMENDATIONS

These new projects provide additional support and more evidence for conclusions made in the 2015 Part 1 report, and our original recommendations still apply. The following suggestions are for consideration by the Habitat Strategic Initiative (successor of the Grant Program) as they consider future investments to continue moving this work forward.

- 1) Consider funding other local jurisdictions to review SMP permit records, identify process deficiencies, and take corrective actions.
- 2) Encourage regional partners to mobilize in support of WDFW's request for additional Compliance Inspector staff. The pilot program demonstrated that construction monitoring by a dedicated Civil Compliance inspector results in better fish protection. If funding is not approved by the Legislature, consider supporting new positions with grant funding.
- 3) Cook et al. (2019) recommended development of technical assistance materials on construction best management practices. A flyer detailing types of construction materials to use, when to use them, and where to get them, could improve permittee compliance with construction provisions. This suggestion should be considered as part of the Shoreline Armoring Implementation Strategy's technical training strategy

4. "NO NET LOSS" IMPLEMENTATION

The Shoreline Management Act requires local jurisdictions to prepare Shoreline Master Programs (SMPs) that ensure that **permitted development does not result in a net loss of ecological functions over time**.⁵ This standard was designed to halt deterioration of shoreline ecological functions resulting from new development. The baseline for no net loss occurs when an updated⁶ SMP is implemented. The baseline condition is documented in a shoreline inventory and characterization developed during the comprehensive update process.

A key finding of previous regulatory effectiveness grants was that implementation of SMP "no net loss" requirements is a challenge owing to the difficulty of quantifying and tracking net changes (Futurewise 2014b, Barnhart et al. 2015).

The Grant Program supported **development of shoreline inventories with new technology; a pilot project to use state data to track changes within SMP jurisdiction over time; and development of a habitat model to quantify ecological loss associated with individual projects**. Findings and recommendations presented in this section are based on the following grants:

⁵ [WAC 173-26-186\(8\)](#)

⁶ Major updates to the Shoreline Management Act's implementing regulations occurred in 2003. The revised statute included a requirement and schedule for local jurisdictions to comprehensively update their SMPs, most of which were originally written between 1974 and 1978.

- HRCD-based SMP Effectiveness and Compliance Monitoring in Thurston County (Thurston County 2017a, Thurston County 2017b)
- Monitoring Ecological Function with Remote Sensing along Bainbridge Island Shoreline (Schulze 2015, Richardson 2016)
- City of Seattle Marine Habitat Evaluation Procedures (Luxon et al. 2016, Luxon 2016, Windward Environmental 2016)

The Island County Marine and Nearshore Compliance Improvement Project grant discussed in Section 3.2 allowed the County to acquire updated technology to improve enforcement efforts and document a January 2016 baseline for the “no net loss” mandate in their newly adopted Shoreline Master Program. Details were not provided in grantee deliverables, so this project is not discussed further.

4.1 FINDINGS

The **City of Bainbridge Island** used grant funding to establish their SMP baseline shoreline inventory by acquiring and processing LiDAR data. Aerial LiDAR data was collected for the entire island, verified through field visits for accuracy, and compiled into a map layer. The LiDAR images create a three-dimensional representation of the island. The **0.2m resolution** (0.5 accuracy) enabled mapping of detailed land-cover types along the shoreline. With this dataset, **land cover within individual parcels can be delineated with exceptional detail** (Figure 3). Data from future follow-up flights future will be compared against this baseline to help planners estimate net loss of ecological function.

Thurston County used data and methods from WDFW’s **High Resolution Change Detection (HRCD)**⁷ project to analyze change in land cover (**loss of canopy cover and gain of impervious surface**) within the County’s SMP jurisdiction. An example is provided in Figure 4. WDFW provided Thurston County with the HRCD data and a protocol manual with a detailed methodology for analyzing the data. Thurston County used these to count a total number of change events and total acreage of land cover change along marine shorelines for three time periods. The County’s analysis revealed a total **205 small-scale change events** covering a total of 37.05 acres in the Marine SMP area across three time periods from 2006 to 2013. Much of this change is from canopy loss associated with restoration activity in the Nisqually Wildlife refuge. Subtracting this area yielded a final **change of 11.52 acres**. These results were highly similar to results produced by WDFW over the same area.

⁷ WDFW launched the HRDC project on 2009. **HRCD is a method to detect small-scale changes utilizing high resolution satellite imagery data (to 1-meter resolution)** collected by the US Department of Agriculture for the National Agriculture Imagery Program.

Figure 3. Parcel-level land cover delineation via LiDAR (from Richardson 2016)

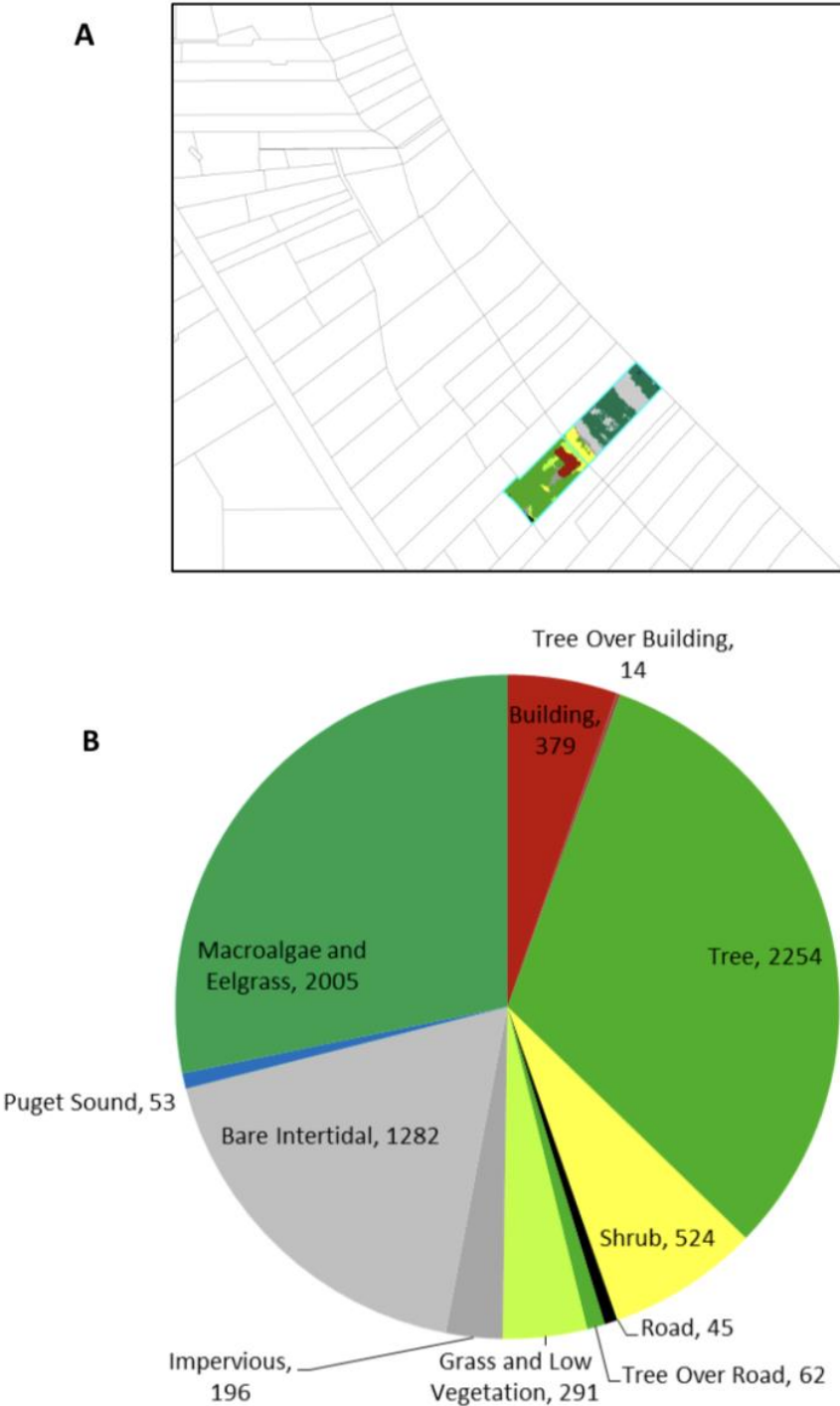


Figure 4. Parcel-level change detection via HRCD (from Muller et al. 2016)



Further work is required at the county level to identify if changes are happening without permits and for estimating measures of ecological function associated with detected changes, but HRCD analysis as a whole offers a cost-effective method of aiding no net loss of ecological function goals. **By successfully testing this protocol, Thurston County demonstrated how HRCD analysis can aid SMP monitoring efforts in other jurisdictions.** Since the data and analysis method is standardized, rates of change can be compared across jurisdictions to determine which jurisdictions have the most change and overall effectiveness of regional SMPs.

The **City of Seattle** developed a **Habitat Evaluation Procedures program** to **quantitatively assess both impacts of marine shoreline development on ecological functions and the amount of mitigation required to compensate for those impacts.** The grantee developed a **Habitat Suitability Index model** in collaboration with an expert panel with University of Washington fishery scientists and representatives from NOAA Fisheries, King County, and City of Seattle. The model calculates a habitat suitability index for **juvenile Chinook salmon** based on 7 habitat attributes: water depth, bed slope, overhead cover, substrate composition, riparian vegetation, aquatic macrophytes, and shoreline armoring. The expert panel scored and combined habitat attributes for 27 shoreline reaches to calculate **Habitat Units** –a quantitative measure of ecological functions. Results are summarized in Figure 5.

The City used the cost of 9 completed restoration projects to estimate mitigation costs per HU. The fee per HU in the Duwamish River was set to \$290 and the fee per HU in Puget Sound was set to \$390. These estimates were then used to establish fees for purchase of mitigation credits through an in-lieu fee mitigation program. **Two new sections** detailing how this Habitat Evaluation Procedure Program will implement mitigation requirements outlined in Seattle’s Shoreline Master Program were **added to the Seattle Municipal Code** (23.60.027 and 23.60.028) during the grant period.

Figure 5. Modeled Habitat Suitability Index values and Habitat Units for City of Seattle marine shorelines (from Windward Environmental 2016)



Use of the City's Habitat Evaluation Procedures Program is expected to **enhance the quality of mitigation projects** in response to development, **increase predictability and transparency** in permitting processes, and enable greater **flexibility in meeting mitigation requirements**. Since the model considers several attributes that contribute to ecological function, it is better suited for demonstrating no net loss of ecological function compared to methods that track land cover changes.

4.2 RECOMMENDATIONS

These new projects provide tested innovative tools to accomplish recommendations made in the 2015 Part 1 report. These methods could be expanded to other local jurisdictions in support of SMP implementation. The following suggestions are for consideration by the Habitat Strategic Initiative as they consider future investments to continue moving this work forward:

- 1) Consider supporting the HRCD program or academic researchers to collect additional LiDAR data and develop computational techniques for change analysis with 3-D data (e.g., Qin et al. 2016, Reif and Theel 2016, Luo et al. 2018, Tran et al. 2018).
 - Compared to the data used for HRCD for land cover mapping, LiDAR data provides higher accuracy/resolution (0.2/0.5m versus 1m) and adds capacity to construct a 3D digital elevation model to track elevation changes. The detailed data layers developed by City of Bainbridge Island provide a comprehensive view of baseline conditions and could enable detection of small-scale changes not identified with HRCD. For example, HRCD misses bulkheads, docks, and vertical structures.
 - New technologies to capture, geo-reference, and render images are developing quickly as costs are falling. This could lead to less labor-intensive techniques for collecting and processing information about built shoreline features (Kinney et al. 2015).
- 2) Consider engaging a broader range of technical experts to develop a regional habitat suitability model that incorporates geomorphic factors—such as disruption sediment supply—more to quantify project impacts and mitigation requirements.
 - In addition to improving no net loss implementation, habitat suitability modeling could greatly improve development of mitigation requirements. More mitigation options for shoreline armoring projects was a priority for many participants in the Shoreline Armoring Implementation Strategy development process (Kinney 2018).

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