

Salish Sea Transboundary Action Plan for Invasive European Green Crab



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Washington State Environmental Protection Act (SEPA) Review

SEPA provides a medium for citizens of the state to protect their environment. The law (Chapter 43.21C RCW) requires state and local governments within the state to determine whether a proposed action would cause significant harm to project area environmental or cultural resources. A Determination of Non-Significance (DNS) was made, so no environmental impact statement was required. An Environmental Checklist was posted for this document and no comments were received during a two-week public review (see SEPA #19014 https://wdfw.wa.gov/licensing/sepa/sepa_final_docs_2019.html).

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SIGNATORY PAGE

We, the undersigned, recognize European green crab management is essential for the protection of the Salish Sea and that the best way to provide that protection is through implementation of this Action Plan.



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GLOSSARY

Acronyms used in document:

- “AIS” means Aquatic Invasive Species
- “DFO” means the Department of Fisheries and Oceans Canada.
- “EGC” means European green crab.
- “RCW” means Revised Code of Washington
- “SSTAP” means Salish Sea Transboundary Action Plan
- “TEGC” means the Transboundary European Green Crab work group.
- “WAC” means Washington Administrative Code
- “WDFW” means the Washington Department of Fish and Wildlife.
- “WSG” means Washington Sea Grant.

“**Contain**” means to prevent an invasive species from spreading outside a designated infested site.

“**Control**” means to stop or slow the growth in number or size, to prevent the maturation and spread, and/or to reduce the number of a species or the population of a species in an ecosystem (Environmental Law Institute 2004).

“**Detect**” means the verification of an aquatic invasive species' presence as determined by the Washington Department of Fish and Wildlife and Department of Fisheries and Oceans Canada within their respective jurisdictions.

“**Early detection**” means invasive species are detected at earliest point in the invasion process to allow cost effective and environmentally sound decisions to be made to prevent their spread and establishment.

“**Eelgrass**” means perennial submerged marine plants of the genus *Zostera* (esp. *Z. marina*), having grasslike leaves. It is a marine plant of great importance in the Salish Sea and plays important roles in sediment deposition, substrate stabilization, as substrate for epiphytic algae and microinvertebrates, and as nursery grounds for many species of economically important marine vertebrates and macroinvertebrates.

“**Eradicate**” means, to the extent technically and measurably possible, to kill, destroy, remove, or otherwise eliminate an invasive species from a water body or property using physical, chemical, or other methods (Based on Washington State RCW 77.135.010(10) and Canada SOR/2015-121 regulations)

“**Established**” means a population of a species where reproduction is occurring and that population is expected to have a sustained presence.

“**Estuarine**” is a partially enclosed coastal body of brackish water with one or more rivers or streams flowing into it, and with a free connection to the open sea (<https://en.wikipedia.org/wiki/Estuary>). Estuarine areas form a transition zone between river environments and maritime environments. They are subject both to marine influences—such as tides, waves, and the influx of saline water—and to riverine influences—such as flows of fresh water and sediment. The mixing of sea water and fresh water provide high levels of nutrients both in the water column and in sediment, making estuaries among the most productive natural habitats in the world.

“**Infested site**” means a geographic region, water body, facility, or water supply system that carries or contains an invasive species. Designation as an infested site does not require the species to be considered established (Based on Washington State RCW 77.135.010(10) and Canada SOR/2015-121 regulations)

“**Invasive species**” means nonnative species that are not naturally occurring in the Salish Sea for purposes of

breeding, resting, or foraging, and that pose an invasive risk of harming or threatening the Salish Sea's environmental, economic, or human resources. Invasive species include all stages of species development and body parts. They may also include genetically modified or cryptogenic species.

“Manage” means to prevent, control, and/or eradicate the introduction or spread of invasive species.

“Partners” are loosely defined as those entities who participate in response, management, and research at some level. While citizen science volunteers are partners, they are referred to as volunteers in some places in the plan because their training and support involve actions unique to them.

“Rapid response” means expedited management actions, as provided under Washington State RCW 77.135.010(10) and Canada SOR/2015-121 regulations, triggered when invasive species are detected, for the time-sensitive purpose of containing or eradicating the species before it spreads or becomes further established.

“Salish Sea” includes the Strait of Juan de Fuca, the Strait of Georgia, Puget Sound, and all of the connecting channels and adjoining waters, such as Haro Strait, Rosario Strait, Bellingham Bay, Hood Canal, and the waters around and among the San Juan Islands in the U.S. state of Washington and the Gulf Islands in British Columbia, Canada. The western boundary is the entrance to the Strait of Juan de Fuca, defined as a line between Cape Flattery and Carmanah Point. The southern boundary is the southern end of Puget Sound. The northern boundary reaches just beyond the northern end of the Strait of Georgia to include waters that experience the floodstream or tidal surge from the south: Discovery Passage south of Seymour Narrows, Sutil Channel south of Penn Islands, Lewis Channel (between Cortes and West Redonda Island), Waddington Channel (between West Redonda and East Redonda Island), and Pendrell Sound, Desolation Sound, and the southern portion of Homfray Channel (between East Redonda Island and the mainland). These boundaries were based on the 2002 "Georgia Basin–Puget Sound Ecosystem Indicators Report". The total extent of the Salish Sea is about 18,000 square kilometers (6,900 sq mi).

“Site” means a geographic area of connected and similar habitat suitability for a given species where sampling, such as for early detection monitoring, can be expressed as representing the whole geographic area. In more complex, but geographically defined habitat, or where more intensive management is required, a site may be subdivided into sub-sites.

“Stakeholders” are loosely defined as those entities who don't formally participate in response, management, and research (i.e. partners) but nevertheless have a 'stake' in the outcome of EGC management, including, but not limited to shellfish growers, property owners, and those who rely on intact ecosystems.

EXECUTIVE SUMMARY

The purpose of the Salish Sea Transboundary Action Plan for Invasive European Green Crab (Plan) is to establish and implement a coordinated and collaborative response to incursions of European green crab that pose a risk of harming or threatening the environmental, economic, or human resources within the shared waters of the Salish Sea.

European green crab (EGC) is a globally-damaging invasive species that has produced a variety of ecological and economic impacts on temperate coastal shorelines worldwide. Prolific and gregarious, EGC are known to disturb native habitat, displace resident species, and alter natural food webs, when abundant. Additionally, EGC predation has caused significant harm to shellfish industries in some regions.

The EGC is a notorious aquatic invasive species, able to survive a wide range of temperatures and salinities. To reproduce, individual EGC are capable of releasing hundreds of thousands of larvae that can live up to 80 days and travel hundreds of kilometers on ocean currents. It is a generalist feeder, digging in the sediment for bivalves and other prey and has been linked to:

- Massive declines in commercial bivalve crops (reducing softshell clam landings from 15.4 million pounds or 7 million kilos to 2.3 million pounds or 1 million kilos) on the east coast of the U.S., contributing to fishery collapse (Glude 1955);
- Decimation of native clams and shore crabs in at least one California embayment causing alterations of the food web (Grosholz et al. 2000); and
- Substantial reduction (up to 75%) in eelgrass density in Nova Scotia and Newfoundland (Garbary et al. 2014; Matheson et al. 2016).

Potential impacts of an EGC invasion in the Salish Sea include degradation and destruction of eelgrass and estuarine marsh habitats, threats to the harvest of wild Salish Sea shellfish and the shellfish aquaculture industry, threats to the Dungeness crab fishery, threats to salmon recovery (and by extension threats to orca recovery), and a complex array of additional ecological impacts to food webs, all of which negatively impact the human uses and cultural resources of the Salish Sea. Because EGC poses risks to the economy, ecology, and cultural food resources of the Salish Sea, it is classified as a prohibited level 1 species in Washington State and as a control species by the Department of Fisheries and Oceans Canada.

Within the Salish Sea, the range and abundance of EGC is still quite limited, and to date the only established (self-sustaining) population occurs in Sooke Basin, British Columbia. As of October 2018, small numbers of EGC have been found at several other locations in British Columbia and Washington State. Now is our best chance to manage EGC in the Salish Sea to avoid the calamitous results of EGC invasions seen elsewhere around the world. There is no better time to prevent harm than through a successful process of early detection, rapid response and proactive adaptive management.

The current response to early detections of EGC in Washington State waters of the Salish Sea is a success story seldom seen in the world of Aquatic Invasive Species (AIS) management. Rather than playing ‘catch up’, we still appear to be ahead of the curve and are working proactively to understand, identify and prevent incursions of EGC before they take hold and cause the dramatic impacts to the Salish Sea ecology and shellfish industry that have been seen on the East Coast of the United States and elsewhere around the globe. The coordinated, science-based adaptive response involves a team of dedicated partners executing geographically-broad, intensive trapping efforts. These ongoing management actions are designed to keep incursions within manageable size to avoid massive larval spread to other parts of the Salish Sea and *in situ* harm to local ecosystems.

Using lessons learned from successful early detection and rapid responses, this Salish Sea Transboundary

Action Plan for Invasive European Green Crab lays out clear actions to be taken to prevent and/or minimize harm to the environmental, economic, and human resources of the Salish Sea as a whole from an invasion of European green crab.

This action plan focuses on six objectives calling for:

- Collaborative management, including with partners/stakeholders within or immediately adjacent to Salish Sea and regionally;
- Prevention of human-mediated introduction and spread;
- Early detection;
- Rapid response to newly detected incursions;
- Control of infested sites; and
- Strategic research to improve adaptive management.

Washington Department of Fish and Wildlife (WDFW), Department of Fisheries and Oceans Canada (DFO), and Transport Canada are the key regulatory managers of potential human-mediated introduction and spread of EGC through their respective Aquatic Invasive Species programs. Washington Sea Grant's (WSG) Crab Team program, in coordination with WDFW, plays a major role in early detection and rapid response by training and supporting hundreds of volunteers and agency and tribal staff to monitor sites for early detection.

The actions laid out in this plan follow WDFW, DFO, and other partner legal authorities and mandates to implement the response to EGC in their respective jurisdictions. To the extent possible the plan will be implemented in collaboration with affected tribes in Washington State and Canadian Indigenous Groups to the overall benefit of the Salish Sea within the context of available resources. The estimated costs of implementing this plan for future years will be addressed separately.

There is still opportunity to avoid major impacts from EGC in the Salish Sea by continuing decisive and aggressive actions to contain populations and to prevent further introduction and spread of EGC in other parts of the Salish Sea.

INTRODUCTION

The European green crab (EGC) is included on the International Union for Conservation of Nature's (IUCN's) list of 100 of the world's worst alien, invasive species (IUCN, 2018), it is classified as a prohibited level 1 species in Washington State (WAC 220-640-030), and is classified as a species for control in Canada. As an Aquatic Invasive Species (AIS), EGC devastates aquatic ecosystems, displacing native species, degrading and disturbing native habitats (including eelgrass), and altering food webs in a variety of locales worldwide. As a voracious consumer of bivalves, it also has caused significant harm to shellfish industries, particularly on the US East Coast. EGC pose serious risks to the economy and ecology of the Salish Sea (Mach and Chan, 2014).

However, it is possible to manage EGC in the Salish Sea to avoid the calamitous results of EGC invasions seen elsewhere around the world. There is time to act to prevent this harm through a successful process of early detection, rapid assessment, and adaptive response.

There is currently only one documented, established population (self-sustaining) of EGC in the Salish Sea: Sooke Basin in British Columbia. As of October 2018, the EGC has been found at several other Washington State locations, including Dungeness Spit (USFWS Dungeness National Wildlife Refuge), Dungeness Landing River Park, Sequim Bay, Westcott Bay, Padilla Bay, Fidalgo Bay, Lagoon Point, and Kala Point and Scow Bay (collectively labeled as Pt. Townsend; Figure 1). With the exception of Dungeness Spit, only one to six crab have been captured at each location. In British Columbia, the EGC has been collected at Becher Bay, Port Renfrew, and Witty's Lagoon, in addition to Sooke (Figure 1).

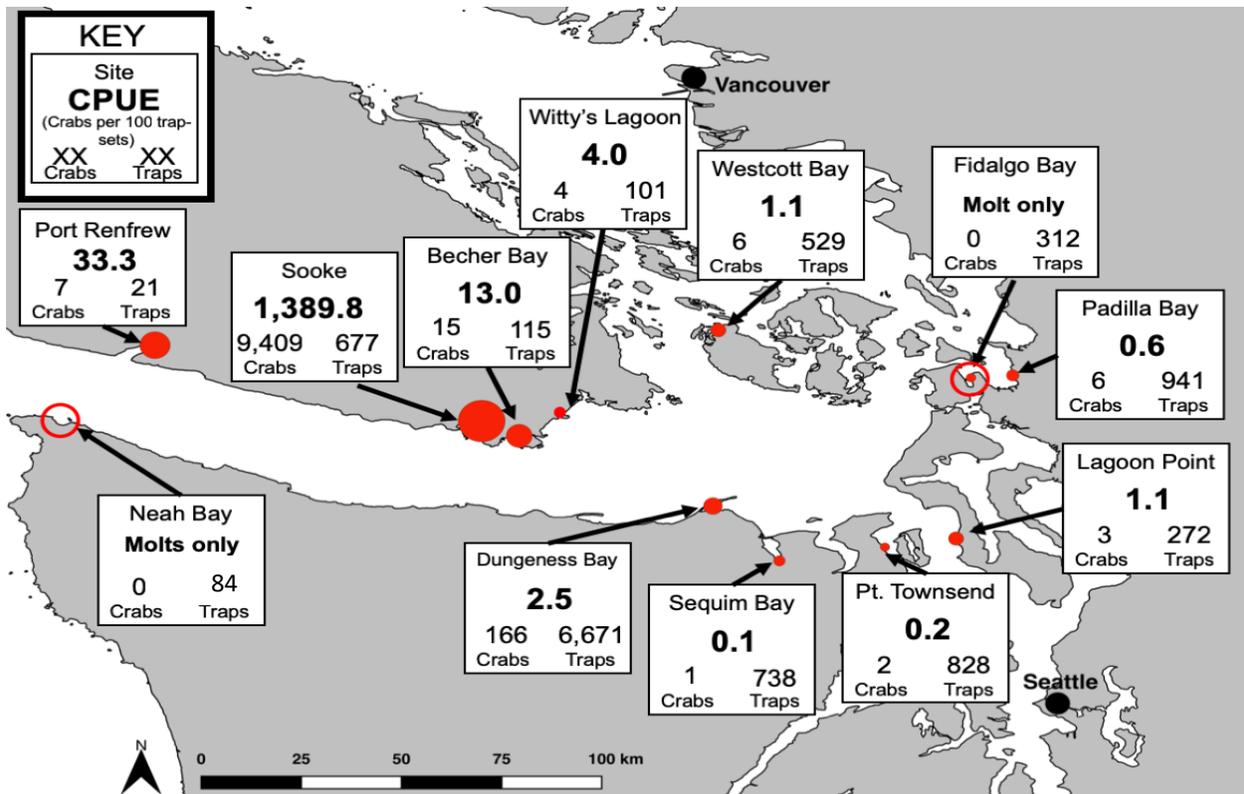


FIGURE 1. Locations of European green crab found in the Salish Sea and trapping efforts associated with those captures. Map of catch per unit effort (CPUE) of European green crab at all detection sites within the Salish Sea. The size of site markers is scaled (logarithmically) with CPUE, which is defined as average number of EGC per 100 trap-days, including all trapping effort recorded since 2012. Because effort varies substantially geographically, actual catch (number of crabs) and effort (trap-days) for each location are reported below CPUE. Map data current as of 10/15/18.

The discovery in 2017 of EGC in Dungeness Spit, part of the U.S. Fish and Wildlife Service's Dungeness National Wildlife Refuge, activated rapid response action that had been piloted and refined the previous year in Westcott Bay and Padilla Bay. This resulted in a coordinated, science-based response involving a team of partners executing multi-day trapping efforts. Current ongoing management actions, involving a cadre of dedicated partners are on track to keep this population within manageable size, avoiding massive larval spread to other parts of the Salish Sea and in situ harm to the ecology of the refuge.

Using lessons learned from the successful early detection of EGC and rapid response at Dungeness Spit, this Salish Sea Transboundary Action Plan for Invasive European Green Crab lays out clear actions to be taken to prevent and minimize harm to the environmental, economic, and human resources from EGC in the Salish Sea.

SUCCESSFUL EARLY DETECTION AND RAPID RESPONSE

The response to early detections of EGC in the Salish Sea is a success story seldom seen in the world of Aquatic Invasive Species (AIS) Management. Rather than playing 'catch up' we still appear to be ahead of the curve and are working proactively to prevent incursions of EGC before they take hold and cause the dramatic impacts to the Salish Sea ecology and shellfish industry that have been seen on the east coast of the United States and elsewhere around the globe.

The discovery of EGC in Sooke Basin in 2012 galvanized a forward-thinking management strategy in Washington State, capitalizing on an already active and engaged citizen science community to help detect EGC incursions into the Salish Sea as early as possible. In 2015, in partnership with WDFW, Washington Sea Grant launched Crab Team, a citizen science and outreach program to expand the scope of early detection. This strategy paid off when individual EGC were detected by Crab Team volunteers in Westcott Bay (San Juan County), and by outreach staff in Padilla Bay (Skagit County) in 2016. The subsequent rapid response actions, involving large scale trapping efforts (multiple sites/days and hundreds of traps) designed in coordination by WDFW and WSG Crab Team scientists and implemented by partners, set the model for all rapid responses to follow.

Subsequently, the discovery in 2017 of EGC in Dungeness Spit, part of the Washington Maritime Wildlife Refuge resulted in another successfully coordinated, science-based adaptive response involving a team of partners executing multi-day trapping efforts at select sites with habitat suitable for EGC. The current site management activities, including active trapping throughout suitable habitats at Dungeness Spit, mobilization of engaged volunteers, education of refuge visitors, coordination of partners, and systematized data collection, are on track to keep this population within manageable size. This will minimize the chance of massive larval spread to other parts of the Salish Sea, and local harm to the ecology of the refuge.

TRANSBOUNDARY PLAN DEVELOPMENT

The purpose of the Salish Sea Transboundary Action Plan for Invasive European Green Crab (Plan) is to establish and implement a coordinated and collaborative response to incursions of EGC that pose a risk of harming or threatening the environmental, economic, or cultural resources within the shared waters of the Salish Sea. The Salish Sea includes Washington State's Puget Sound, Strait of Juan de Fuca, San Juan Islands; and British Columbia's Gulf Islands and Strait of Georgia. This Plan does not preclude the need to work with British Columbia and Washington State entities with EGC populations in close proximity to the Salish Sea or for development of a comprehensive west coast EGC management strategy.

This Plan was developed through the expertise of members of the Transboundary European Green Crab (TEGC) working group, comprised of representatives from Washington Department of Fish and Wildlife, Department of Fisheries and Oceans Canada, Washington Sea Grant, University of Washington, and the Puget Sound Partnership. The Plan is designed to drive actions to prevent, detect, and control invasions of EGC into the transboundary waters of the Salish Sea. As such, the Plan focuses on strategies and actions to be taken in the next two years (July 2018 through June 2020) and lays out clear performance measures associated with each strategy. To inform decision-makers and funders, estimated costs associated with actions will be provided in a separate document. It is anticipated that the TEGC working group will lead the implementation of the Action Plan, applying adaptive management strategies over its term as new research findings or management tools emerge. The Plan is intended to be a living document and will be updated and revised every two years or as needed.

Strategies and actions identified in this plan were evaluated against the following key considerations:

- Does it address Washington State legislative directive under RCW 77.135.080 and Canadian Aquatic Invasive Species Regulations (SOR/2015-121) to:
 - Protect human safety?
 - Minimize adverse environmental impacts?
 - Minimize adverse economic impacts?
 - Consult/coordinate with appropriate federal, state, tribal, local, and other jurisdictions/interests?
- Is it protective of marine species and habitats?
- Will it drive better management?
- Is it economically cost effective?
- Is it science-based?

While a limited number of agencies and organizations are identified as leads for the actions in this plan, it is well understood that effective management of EGC in the Salish Sea will require collaboration from many different partners (federal, state or provincial agencies, and Washington tribal co-managers) and a variety of stakeholders. In this plan, partners are loosely defined as those entities who participate in response, management, and research at some level. While citizen science volunteers are partners, they are referred to as volunteers in some places in the plan because their training and support involve actions unique to them. Stakeholders are loosely defined as those entities who don't formally participate in response, management, and research (i.e. partners) but nevertheless have a 'stake' in the outcome of EGC management, such as shellfish growers, property owners, and those who rely on intact ecosystems.

STRATEGIC GOALS AND OBJECTIVES

The overall goal of this plan is to prevent and minimize harm to the environmental, economic, and human resources of the Salish Sea from invasive EGC. Objectives are identified in the section below 'Actions for transboundary EGC management.' Strategies designed to achieve these objectives are articulated with specific actions listed to implement each strategy. Performance measures for each strategy are identified.

The six plan Objectives are:

1. Collaboratively manage the response to EGC, including with partners/stakeholders within or immediately adjacent to Salish Sea and regionally.

2. Prevent human-mediated introduction and spread of EGC.
3. Detect EGC presence at earliest invasion stage.
4. Rapidly eradicate or reduce newly detected populations.
5. Control persistent infested site populations to eliminate or minimize environmental, economic, and human resource harm.
6. Conduct research to develop increasingly effective adaptive management strategies.

EUROPEAN GREEN CRAB IN THE SALISH SEA

SUMMARY OF DISTRIBUTION IN THE SALISH SEA

European green crab are native to the western and northern shorelines of Europe. They have spread through various pathways across the globe, establishing on the east coast of the United States more than 200 years ago. EGC became established on the west coast of the United States prior to 1989 in San Francisco Bay (Cohen et al., 1995; Jensen et al., 2002). They have since spread north and south from there (McDonald et al., 2001; Jensen et al., 2002; Gillespie et al., 2007; Behrens Yamada et al., 2015, Gillespie et al. 2015).

In 2012 DFO confirmed the first established Salish Sea EGC population in Sooke Basin on the Strait of Juan de Fuca. Since that time, both DFO and WSG Crab Team have conducted early detection monitoring widely across the Salish Sea at sites identified as most suitable to EGC survival, but covering only about a quarter of all possible sites (Figure 2). DFO Science has trapped opportunistically along the BC shorelines of the Strait of Juan de Fuca, Southern Gulf Islands, and the Strait of Georgia several times since 2012. In 2015, WSG Crab Team launched a citizen science early-detection monitoring network, systematically and repeatedly trapping habitats identified as most suitable to EGC survival (Figure 2).

EGC were first recorded in the Washington portion of the Salish Sea in 2016 when WSG Crab Team volunteers discovered a single crab in Westcott Bay (San Juan County) and outreach staff found one crab in Padilla Bay (Skagit County) (Behrens Yamada et al., 2017; Grason et al., 2018). Subsequent trapping and monitoring in Washington State waters in 2017 and 2018 has documented small numbers of EGC at Dungeness Spit (USFWS Dungeness National Wildlife Refuge), Dungeness Landing River Park and Sequim Bay (Clallam County), Kala Point and Scow Bay (Jefferson County), Westcott Bay (San Juan County), Padilla Bay (Skagit County), and Lagoon Point (Island County) (Figure 1). With the exception of Dungeness Spit, only one to six EGC have been captured at each location.

Since 2016, DFO has conducted several trapping efforts throughout the southern Gulf Islands and along the southern coast of Vancouver Island. Beyond Sooke Basin, EGC were only found in small numbers at Becher Bay in 2017 and Witty's Lagoon in 2018, both just east of Sooke in the Strait of Juan de Fuca. West of Sooke, exploratory trapping detected a small number of EGC in Port Renfrew in 2018. The Sooke Basin population is known to be large, but no abundance estimates are available. No EGC have yet been found in the Gulf Islands or Strait of Georgia.

EGC were introduced in Sooke Basin through accidental human-mediated activities. However, for most other occurrences of EGC in the Salish Sea, the pathway of introduction is believed to be natural larval dispersal from established EGC populations along the outer west coast, and potentially Sooke Basin during optimal ocean conditions (Brasseale et al. 2018). These optimal ocean conditions include storms during relatively warmer winters and unseasonably stormy summers, which can result in flow reversals in the Strait of Juan de Fuca, allowing larvae from the outer coast and Sooke Basin to pass into the Salish Sea. Warm conditions also

accelerate the development of EGC larvae and protect them from fatally cold conditions (Cohen et al., 1995; de Rivera et al. 2007; Behrens Yamada et al., 2017). Nearly all of the EGC in the Salish Sea are estimated to have been from the 2015/2016 or later year classes, corroborating expectations that ocean conditions were favorable during those years (Grason et al., 2018)

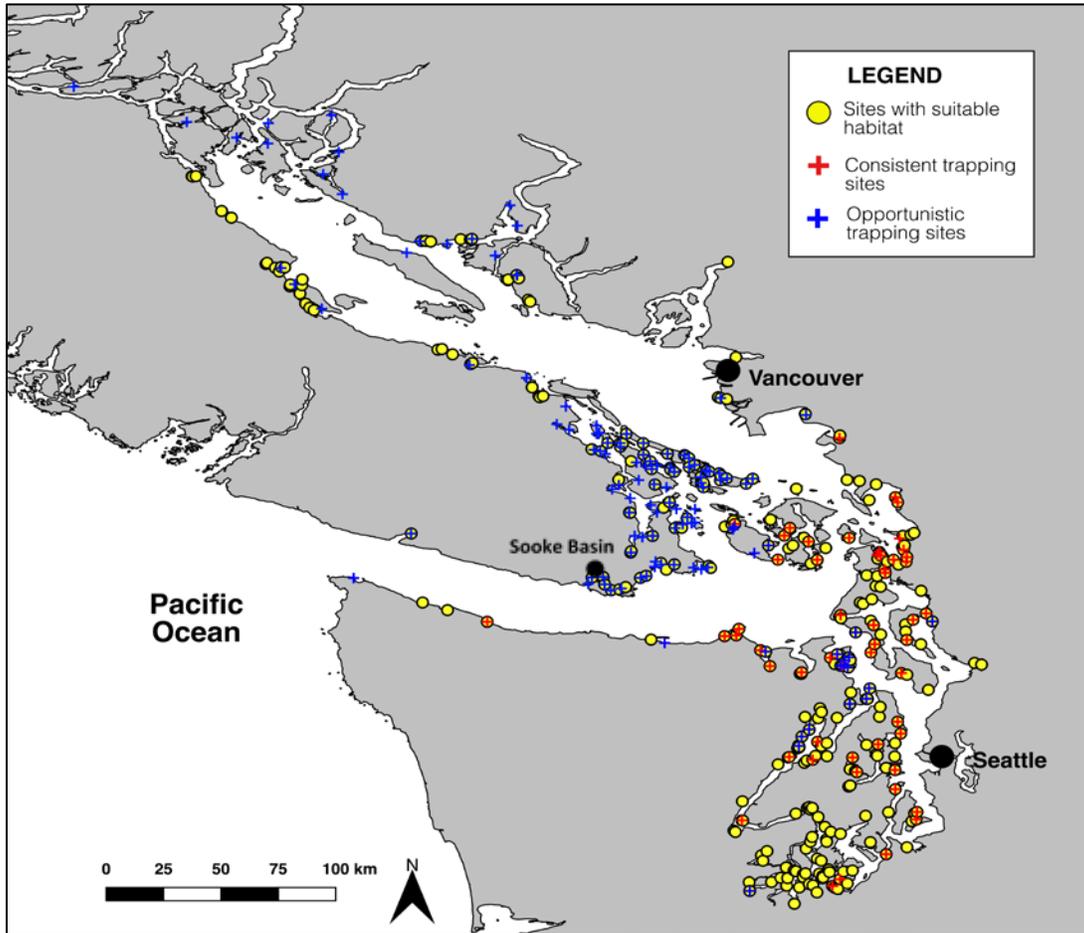


FIGURE 2. Map of European green crab suitable habitat and trapping sites in the Salish Sea. Suitable habitats indicate sites with medium to high suitability for European green crab based on a semi-quantitative algorithm developed by WSG (Grason et al. 2016), but note that assessment of suitable habitat for Canadian shorelines is incomplete. Sites identified as consistent trapping sites indicate WSG Crab Team monitoring sites that are currently trapped each month (April - September) as part of Washington's early detection program. Sites identified as opportunistic trapping sites have had at least one monitoring effort since 2012, but are not regularly trapped. Map data current as of 10/15/18.

Recent limited genetic studies of DNA from the outer West Coast, Sooke Basin, and Dungeness Spit EGC indicate that crabs from Sooke Basin are an isolated population, genetically distinct from EGC at Dungeness Spit and elsewhere on the West Coast. EGC found in other parts of the Salish Sea have not yet been genetically tested for source population. The genetic study did find evidence that Sooke Basin crab larvae are dispersing to the outer coast (Tepolt et al., 2018). More DNA research is needed to build our understanding of potential source populations for the Salish Sea.

BIOLOGY OF EUROPEAN GREEN CRAB

Mature EGC live in intertidal and shallow subtidal habitats (Cohen et al., 1995). In the Salish Sea, it is most likely to be successful in intertidal, marshy habitats where it is safe from predation by larger crabs (Howard, 2018). With a maximum carapace width of about 100mm (~4”), the green crab can grow larger than native Salish Sea shore crabs (*Hemigrapsus* spp.) but is smaller than adults of large native cancrivora species (e.g., red rock, Dungeness, and graceful). The carapace is slightly wider than it is long and is distinct from every other Salish Sea crab species in that it has five prominent marginal teeth (points) to the outside of each eye, along the edge of the carapace (Figure 3). Although commonly referred to as “green” this species often turns quite red as it ages, and can be found with many different colors and patterns, particularly as juveniles (Grason et al., 2016).

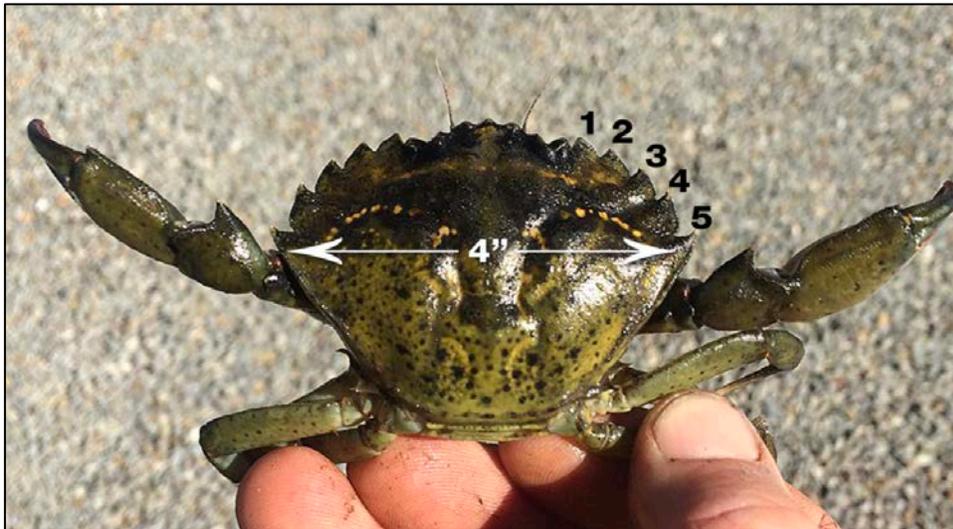


FIGURE 3. Adult European green crab showing most common shell color pattern and five distinct marginal teeth to the outside of each eye. Maximum size is up to about 100mm (4”). Photo courtesy of Jeff Adams/WSG

EGC is a successful invader because it can thrive in a wide variety of temperature and salinity ranges and it eats a wide variety of foods plentiful in the intertidal zone. On the west coast of North America, EGC live from 4-6 years. Female green crab can become reproductively mature during their first year owing to suitable conditions for rapid growth, and can produce up to 200,000 eggs at a time (Cohen et al., 1995; Behrens Yamada et al., 2005). When eggs hatch, the free-swimming zoeae develop over 17–80 days, depending on water temperature, and can travel hundreds of kilometers on ocean currents as they metamorphose into megalopae that eventually settle onto the seafloor (Grason et al., 2016).

HARMFUL IMPACTS OF EUROPEAN GREEN CRAB

Ecology

The ecological impacts of an EGC invasion into the Salish Sea could include a complex array of interactions, further stressing an ecosystem already under threat from climate change, pollutants, habitat loss, and loss of biodiversity. Green crab can substantially alter food webs through competition with, and predation on, a wide range of native species, and they can degrade habitats through their role as ecosystem engineers. For instance,

green crab disturb sediments and destroy below-ground tissue of plants while digging for food and burrows. These activities have been associated with decreased stability of saltmarsh banks (Aman and Grimes, 2016) and loss of eelgrass habitat (see below). In one study in California, the densities of native clams and shore crabs declined by 5 to 10 times within a few years of green crab arrival (Grosholz et al., 2000). Such direct impacts are likely to trigger ripple effects throughout the community. Also in California, preferential predation on native clams by EGC was linked to enabling the population explosion of a previously rare invasive clam (Grosholz, 2005). EGC could also impact the health of shorebirds by damaging nesting and feeding habitat, and competing with them for food.

While the full suite of impacts would be wide-ranging, and due to the nature of invasions, which are difficult to anticipate, the most concerning anticipated impacts of EGC could be degradation of eelgrass habitats and predation on wild-capture shellfish harvests. Each of these will be described in detail below.

Eelgrass

In the Salish Sea, eelgrass provides valuable structure, stability and habitat where there would otherwise be relatively bare, unproductive substrate (Thayer and Phillips, 1977; Plummer et al., 2013; Washington Department of Fish and Wildlife, 2018b). It is an important food source, nursery and refuge for birds, fishes, crabs, and many marine invertebrates, and substrate for epiphytic algae, supporting an extended food web from amphipods to orca pods.

EGC have been associated with drastic (up to 75%) reduction in eelgrass (*Zostera marina*) density in Nova Scotia and Newfoundland after invasion. EGC damage eelgrass by disturbing sediments, uprooting eelgrass shoots and grazing directly on the plants (Garbary et al., 2014). EGC have also been implicated in damage to eelgrass beds (Malyshev et al., 2011) and failed efforts to restore eelgrass habitats on the east coast of the United States (Figure 4).

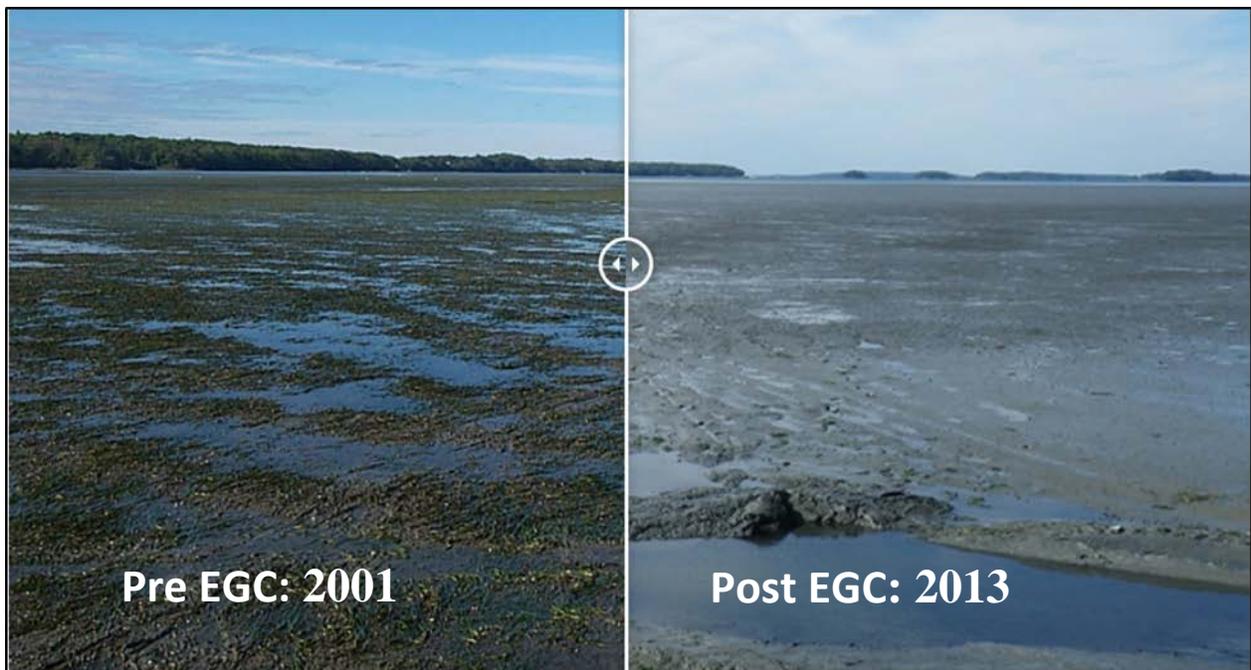


FIGURE 4. Photos of Maquoit Bay, Maine, before and after dense European green crab populations. Photos by Hillary Neckles/U.S. Geological Survey (Grason et al., 2016)

In the Salish Sea, damage to eelgrass could: reduce quality and habitat availability for juvenile salmonids, forage fishes, crabs, and other species; impair carbon-storage capacity of tidelands; increase wave exposure and change tideland shape and reduce available foraging area for shorebirds. Establishment of dense populations of EGC could hinder efforts to achieve the Washington State Puget Sound recovery goal to increase eelgrass area 20% by 2020 (Grason et al., 2016). In addition, establishment of EGC in the Salish Sea could undermine eelgrass restoration efforts funded through DFO's Coastal Restoration Fund and other sources.

Shellfish resources

Harvest of wild shellfish and culture of commercially produced clams, oysters, and mussels are important to the Salish Sea both economically and culturally (Washington Department of Fisheries and Washington Department of Natural Resources, 1981, 1983; Peter-Contesse and Peabody, 2005). Washington Tribes and indigenous groups in British Columbia have harvested wild shellfish for thousands of years. Today, they harvest shellfish commercially, ceremonially, and for subsistence (Pacific Shellfish Institute, 2018). Recreational harvest of wild shellfish stocks has long been a popular activity. In 2011, roughly 347,000 recreational fishing/shellfishing licenses were purchased in Washington State. Likewise, Washington State is the largest producer of hatchery-reared and farmed shellfish in the United States, with estimates that 3,200 jobs are directly or indirectly supported by State shellfish growers, contributing an estimated US\$270 million to the State economy (Washington Shellfish Initiative, 2011). In 2016, the value of shellfish produced in British Columbia's aquaculture industry was C\$23.6 million (Department of Fisheries and Oceans Canada, 2018). The majority of shellfish aquaculture sites in British Columbia are located in the Salish Sea (Department of Fisheries and Oceans Canada, 2017c).

EGC is a major predator of clams, mussels, oysters, and other species in natural settings and in aquaculture (Gillespie et al., 2007). When EGC are abundant, they produce significant impacts to wild harvest and culture of shellfish and this is most pronounced in invaded areas, particularly the western Atlantic, including Maine, Nova Scotia, and other Maritime provinces. The invasion of EGC in New England in the 1950s contributed to the decline of softshell clam landings, from 14.5 million pounds to 2.3 million pounds over 20 years, as EGC populations expanded (Welch, 1968, as cited in Behrens Yamada et al., 2005). In a Nova Scotia study, a single EGC consumed up to 21.8 small softshell clams (*Mya arenaria*) per day and the authors linked local clam declines to an expanding crab population (Floyd and Williams, 2004). These impacts appear to be increasing as EGC become more abundant and widespread.

The shellfish industry within the native range of EGC uses anti-predator netting to mitigate losses, which can be significant for mussels (Dare and Edwards, 1976) and cockles (Masski and Guillou, 1999). Similar measures are in development for softshell clams in New England, where beds of wild shellfish have been decimated (Beal and Kraus, 2002). In Washington State and British Columbia, the shellfish industry has a history of using netting and bags to minimize losses of cultured shellfish due to naturally occurring predators. Thus the sector may be insulated from some EGC impacts. However, harvesters who rely on naturally reproducing and seeded geoduck and Manila and softshell clams, are most at risk (Howard et al., 2018). In Washington State, this includes recreational harvest, as well as tribal commercial and subsistence harvest.

The Dungeness crab fishery in the Salish Sea may also be at risk. In Puget Sound (Washington State), the Dungeness crab fishery is valued at upwards of US\$10 million (Antonelis et al., 2011). Most of the Puget Sound Dungeness crab fishery occurs from Everett northward, in areas near documented incursions of EGC: Padilla Bay and Dungeness Bay, especially produce large commercial quantities of Dungeness crab (Washington Department of Fish and Wildlife, 2018a). The Dungeness crab fishery in British Columbia

averaged C\$46 million from 2013-2015, with about 30% of that coming from crab management areas of the Salish Sea (Department of Fisheries and Oceans Canada, 2017a).

Laboratory experiments have demonstrated that (a) EGC outcompete juvenile Dungeness crab for food and shelter and (b) larger EGC will prey upon smaller Dungeness crab or displace them from refuge, potentially exposing them to other predators (McDonald et al., 2001). Moreover, EGC are known to damage eelgrass beds (Malyshev et al, 2011; Garbary et al., 2014), a key habitat for juvenile Dungeness crab (Thayer and Phillips, 1977; Washington Department of Fisheries and Washington Department of Natural Resources, 1981; Behrens Yamada et al., 2010; ; Washington Department of Fish and Wildlife, 2018b) . Dungeness crab preferentially settle in eelgrass beds, where survival is significantly higher than for bare mud and sand habitat (Fernandez et al., 1993). Thus, eelgrass allows survival of Dungeness crab in early life history, and habitat loss could substantially impact Dungeness crab populations.

Loss of shellfish resources could have important policy implications for Washington State Treaty Tribes. Under the Rafeedie decision of 1994, Washington State is required under Federal Treaties of 1865 to maintain healthy populations of wild shellfish (e.g., clams, mussels, oysters, crab). Judge Rafeedie affirmed that the agreement “reserved an equal share of the sustainable harvest of shellfish for the state’s Treaty Tribes” (Rafeedie 1994; Peter-Contesse and Peabody, 2005). It is assumed that spread and establishment of EGC, and resulting impacts on shellfish resources, will likely affect co-management.

PATHWAYS OF EGC INTRODUCTIONS AND SPREAD IN THE SALISH SEA

HUMAN-MEDIATED INTRODUCTIONS AND SPREAD

Like most AIS, the human-mediated pathways of EGC introduction and spread in the Salish Sea may include shipping, aquaculture practices, recreational and commercial boating, live bait and aquarium/water garden trade, and unauthorized introductions. Many of these pathways, such as aquaculture, are already well regulated to avoid the inadvertent transfer of EGC, but vigilance and review is necessary to make sure there are no potential gaps. The introduction of EGC to Sooke Basin is thought to have resulted from non-aquaculture shellfish transfer from an established population on the west coast of Vancouver Island. Initial introductions of EGC to the west coast in San Francisco are thought to have come from seaweed packing in lobster or bait shipments originating from the east coast of the United States (Cohen et al., 1995; Gillespie et al., 2007; Wonham and Carlton, 2005; Carlton and Cohen, 2003).

Shipping and boating

EGC can be transported as larvae in untreated ballast water by large commercial vessels (Cohen et al., 1995; Carlton and Cohen 2003). Ballast water is currently regulated by Transport Canada in British Columbia and by WDFW in Washington to require that vessels replace ballast water collected at the port of origin with open-ocean water, or treat their ballast water using an approved management system. However, in Canada, ships entering the Salish Sea from ports north of Cape Blanco, Oregon are exempt from these exchange requirements (Transport Canada, 2006) and ballast water management systems are still only used on a fraction of vessels. Similarly, in Washington, a ship may discharge unexchanged ballast water into the Salish Sea if that water originated within the waters of Washington state, the Oregon portions of the Columbia River system, and the internal waters of British Columbia south of latitude 50° N. Unfortunately, these exemptions from ballast water management requirements create a risk that intracoastal vessels could carry EGC larvae from coastal populations of Oregon, Washington, and British Columbia into the Salish Sea, or between infested ports within

the Salish Sea (Dibacco et al., 2012; Cordell et al., 2015).

Biofouling, or the gradual accumulation of organisms such as algae, bacteria, barnacles, and protozoa on ships, boats, and marine equipment or structures, is a known pathway for many AIS but has not been a documented source of introduction or spread of EGC. There is currently little regulatory framework in place to address risks of AIS transport by biofouling. Progress is being made across the region on regulatory strategies for biofouling management for commercial merchant and passenger vessels, but not for recreational boats or marine equipment (Scianni et al., 2017).

Sea-chests, or recesses built into vessel hulls, have been identified as pathways for EGC introduction. A recent study in Canada found that 46% of the commercial vessels' sea-chests investigated harbored non-indigenous species (Frey et al., 2014). The study documented a large number of one AIS (the caprellid amphipod, *Caprella mutica*) in sea-chests of vessels exclusively operating in the west or east coast of Canada. This result furthers the argument for investigating management strategies aimed at preventing EGC spread by intra-coastal vessels as well as management of sea-chest.

Shellfish aquaculture practices

Transportation and shipping of shellfish product and movement of gear can be a pathway of introduction and spread for AIS, including EGC. Though the industry is heavily regulated and in general applies practices that have significantly addressed potential pathways of unintentional movement, introduction and spread of EGC in shellfish product transport and during farming operations is still a risk in the Salish Sea. For example, DFO recently found EGC on samples of three shellfish species which are regularly transferred from the west to the east coast of Vancouver Island for processing (Curtis et al., 2015).

In British Columbia, there are no shellfish processing plants on the west coast of Vancouver Island, and all harvested shellfish must be transferred to the eastern side of the Island or to the lower mainland for processing. Shellfish companies throughout the Salish Sea regularly move shellfish products (including oyster seed, cultch, and shell) and aquaculture equipment (including aquaculture vehicles and vessels) from one water body to another. There are some conditions of license intended to reduce the likelihood of inadvertent movement of EGC, but the efficacy of these conditions is unknown.

In Washington, WDFW requires shellfish import permits to import live shellfish for aquaculture, research, and display purposes (Chapter 77.60 RCW; Chapters 220-340 and 220-370 WAC). Transfer permits are required for the movement of shellfish, shellfish aquaculture products, and aquaculture equipment to prevent the introduction of any marine organism that could adversely affect shellfish. For example, there is evidence that EGC can host and transmit the Oyster Herpes Virus (OsHV-1) and therefore the impacts of introduction to the aquaculture industry could be multiplied (Bookelaar et al. 2018).

Shellfish companies implement best management practices to avoid introduction and spread of AIS, including rinsing equipment and product before moving it. Nevertheless, the effectiveness of these measures, and the degree of rigor with which they are applied, need to be reviewed in collaboration with the industry.

Moreover, there is also a thriving home-based shellfish grower community, which requires targeted education and outreach to prevent the introduction and spread of EGC or other AIS in the Salish Sea.

Trade in live EGC

Introduction and spread of EGC to the Salish Sea from live trade in EGC, from bait trade or otherwise, is considered a lesser risk than ballast water or shellfish aquaculture practices. In Washington, EGC is classified as a prohibited level 1 species, meaning live EGC may not be possessed, purchased, sold, propagated,

transported, or released into state waters (RCW 77.135.040, WAC 220-640-030). In British Columbia, DFO regulates any capture of EGC through the Fisheries General Regulations and the Aquatic Invasive Species Regulations. There is currently no live bait trade in EGC on the west coast of North America. All collecting of EGC during early detection trapping is done in compliance with permits issued by WDFW and DFO.

LARVAL DISPERSAL

Dispersal of larvae on ocean currents is a significant non-human mediated pathway of AIS introduction and spread, and is believed to be responsible for most arrivals of EGC into the Salish Sea, with the exception of Sooke Basin. Though initial introduction of EGC to San Francisco Bay was likely through ballast water exchange or packaging of seafood product or live bait from the east coast of the United States (Cohen et al., 1995), the gradual spread of EGC north to establish populations in British Columbia, Oregon, and the Washington Coast was facilitated through larval dispersal on ocean currents (Behrens Yamada et al., 2005). EGC can survive up to 80 days drifting on ocean currents, and can travel for hundreds of kilometers before settling. Strong, positive, El Niño-Southern Oscillation (ENSO) conditions favor the survival, transport, and nearshore retention of green crab larvae to the Salish Sea from as far away as central California (Behrens Yamada et al., 2015; Brasseale et al., 2018).

Recent genomics and ocean modeling research initiated by members of the TEGC working group has (a) helped elucidate patterns of larval dispersal and (b) demonstrated that this pathway can occasionally enable EGC larvae from outer coast populations to enter the Salish Sea. Based on genomics, EGC collected at Dungeness Spit in 2017 originated in outer coast populations (Tepolt et al., 2018). Additional ocean modeling work shows that larvae can be washed into the Salish Sea from known source populations on the coast during relatively warm and stormy winters or unseasonably stormy summers (Brasseale et al., 2018). Moreover, due to the current patterns, larvae tend to get swept in along the south side of the Strait of Juan de Fuca (Behrens Yamada et al., 2017; Brasseale et al., 2018).

MANAGEMENT OF EUROPEAN GREEN CRAB

Department of Fisheries and Oceans Canada

In British Columbia, management of EGC falls under the AIS National Core Program, managed by the Ecosystem Management Branch of the DFO. EGC are listed as a control species under the AIS Regulations in the Canadian Fisheries Act. The Science Branch of DFO is also active in informing management of EGC in British Columbia. The Science Branch (a) monitors distribution of EGC along the outer coast and in the Salish Sea, documenting presence/absence and relative abundance, size, and sex to understand different year classes; and (b) maintains this in a database that allows the generation of maps to inform management. Further, DFO has an established AIS rapid response framework to guide development of rapid response plans for specific AIS (Locke et al., 2011).

Transport Canada

Transport Canada is responsible for enforcing regulations associated with vessels greater than 24 meters in length arriving from outside the Canadian Exclusive Economic Zone (EEZ). Therefore, it falls to Transport Canada to enforce ballast water regulations for these vessels. However, as noted above, there are exemption

zones and domestic ballast water currently is not regulated in Canada.

Washington Department of Fish and Wildlife

In Washington, EGC management falls under the AIS Program of WDFW. The WDFW AIS program is responsible for (a) preventing the introduction of new AIS and (b) controlling or eradicating established AIS populations. The requirements of WDFW's Ballast Water Management Program are set forth in Chapter 77.120 RCW and Chapter 220-650 WAC. The State shares regulatory responsibility for ballast water activity with federal agencies (the U.S. Coast Guard [USCG] and U.S. Environmental Protection Agency [EPA]).

As noted in Pathways of EGC Introduction section under shellfish aquaculture practices, the WDFW Shellfish Unit is responsible for minimizing the risk of EGC introduction and spread through their import and transfer permit program under Chapter 77.60 RCW and Chapters 220-340 and 220-370 WAC.

The WDFW Ballast Water Management Program coordinates a Ballast Water Work Group (BWWG) that is comprised of representatives of shipping interests, ports, shellfish growers, fisheries managers, environmental interests, citizens who have knowledge of the issues, and appropriate governmental representatives including the USCG, EPA, and tribal governments. In 2009, the BWWG was reestablished under WAC 220-650-010 to advise WDFW on developing, revising, and implementing chapters RCW 77.120 and WAC 220-650 regarding ballast water and biofouling management (Aquatic Nuisance Species Committee, 2007; Moore et al., 2017).

Washington Sea Grant

Washington Sea Grant (WSG), in cooperation and coordination with WDFW, plays a major role in managing EGC in the Salish Sea (see <https://wsg.washington.edu/crabteam> and https://wdfw.wa.gov/ais/carcinus_maenas). The WSG Crab Team citizen-science program trains hundreds of volunteers to monitor sites for early detection. The program was responsible for the discovery of the first EGC documented in Washington's Salish Sea, and has subsequently succeeded in finding EGC in other locations through systematic early-detection monitoring (Grason et al., 2018). The protocols developed for the program are used throughout the Salish Sea, and WSG program personnel regularly train WDFW, DFO, and partner staff on trapping, identification, and data collection. The WSG website, blogs, and educational programs are instrumental in informing the public and partners about the status of EGC in the Salish Sea, and increasing the capacity of early detection in Washington.

Regional Partners

The Pacific States Marine Fisheries Commission (PSMFC) facilitates regional approaches to AIS management in a variety of ways, including by coordinating the Pacific Ballast Water Group. WDFW and DFO participate in that working group. PSMFC, WDFW, DFO, and WSG also participate on the Western Regional Panel on Aquatic Nuisance Species. Washington and British Columbia are also represented on the Pacific Northwest Economic Region (PNWER) Invasive Species Working Group. The Jamestown S'Klallam Tribe and Makah Tribe have jurisdiction and cultural interests on the Strait of Juan de Fuca in Washington and have been strong partners for early detection monitoring at Sequim Bay, Neah Bay, and Makah Bay and other sites. Other Washington tribes currently contributing to EGC management actions include the Lower Elwha Klallam Tribe, Port Gamble S'Klallam Tribe, Samish Indian Nation, Stillaguamish Tribe of Indians, Swinomish Indian Tribal Community, and Suquamish Tribe.

Site Managers and Key Stakeholders

Management of EGC in the Salish Sea naturally involves private property owners as key stakeholders, as well as federal and state agency partners as managers of sites. Dungeness Spit is part of the National Wildlife

Refuge complex, so management at that site falls to the U.S. Fish and Wildlife Service. Padilla Bay, a federally designated National Estuarine Research Reserve managed by the Washington State Department of Ecology. They and Washington Department of Natural Resources (DNR) also participate in EGC management activities at sites under their respective management jurisdiction.

Addressing Key Considerations

In general, the Plan is designed to meet all key considerations listed on page 12, including protection of natural and cultural resources, management and budget efficiencies, and using a science-based approach. No access is allowed across or into tribal sovereign lands or federal lands without specific permission. In the case of public or private lands, Plan partners will make all reasonable attempts to contact affected Salish Sea shoreline owners/stakeholders for permission to access work sites (see RCW 77.135.170 for Washington State) and to maximize opportunities for Plan actions to be compatible with their needs/operations. This will include developing strategies, as necessary, to protect human safety, minimize any potential adverse environmental impacts, and minimize any potential economic impacts.

Although EGC management activities are expected to be very low impact (access to trapping sites; staking small traps into intertidal areas), there is a chance that Plan partners may make an unexpected discovery or unearthing of cultural artifacts, archaeological features or other evidence of cultural materials and/or skeletal material of human or unknown origin. Objective 1, Strategy 1.6 provides the actions required to alert tribes of potential EGC management actions in their areas and implementation of an Inadvertent Discovery Plan in situations where such discoveries are made.

Common Trapping Equipment and Intertidal Locations

The following pictures provide a general overview of common low-impact EGC trapping equipment and locations that the traps are set using pins to secure them to the intertidal areas. The two primary traps are minnow (silver cylindrical mesh) and “Fukui” (black mesh) folding traps, secured with ¼ inch diameter stainless steel pins (inserted 12-18 inches deep), and placed/checked/retrieved at low tides. *(All photos Allen Pleus, WDFW)*





ACTIONS FOR TRANSBOUNDARY EUROPEAN GREEN CRAB MANAGEMENT

OBJECTIVE 1: COLLABORATIVELY MANAGE THE RESPONSE TO EUROPEAN GREEN CRAB.

STRATEGY 1.1: WASHINGTON DEPARTMENT OF FISH AND WILDLIFE (WDFW) LEADS EGC ADMINISTRATION AND COORDINATION EFFORTS IN WASHINGTON STATE.

Action 1.1.1: WDFW's AIS program allocates or seeks adequate funding for administration and coordination of the Salish Sea Transboundary Action Plan for Invasive European Green Crab (Plan).

Action 1.1.2: WDFW consults/coordinates with tribes in Washington State on the implementation of the Plan.

Action 1.1.3: WDFW maintains participation in the Transboundary EGC (TEGC) working group.

Action 1.1.4: WDFW AIS staff keeps agency leadership and legislature informed about status of Plan implementation and EGC risks in the Salish Sea.

Performance measures:

PM 1.1A: WDFW AIS program allocates dedicated staff time to EGC management.

PM 1.1B: WDFW consults/coordinates with tribes in Washington State on the implementation of the Plan.

PM 1.1C: WDFW AIS coordinator participates in TEGC working group.

STRATEGY 1.2: DEPARTMENT OF FISHERIES AND OCEANS CANADA (DFO) LEADS EGC ADMINISTRATION AND COORDINATION EFFORTS IN BRITISH COLUMBIA.

Action 1.2.1: DFO AIS National Core Program and Science branch allocates or seeks adequate funding for administration and coordination of the Plan.

Action 1.2.2: DFO consults/coordinates with indigenous groups in British Columbia on the implementation of the Plan.

Action 1.2.3: DFO maintains participation in the TEGC working group.

Action 1.2.4: DFO Science and AIS National Core Program staff keeps agency leadership informed about status of the Plan and EGC risks in the Salish Sea.

Performance measures:

PM 1.2A: DFO AIS National Core program and Science branch allocates dedicated staff time to EGC management.

PM 1.2B: DFO consults with indigenous groups regarding coordination on Plan implementation.

PM 1.2C: DFO Science and AIS National Core Program staff participates in TEGC working group.

STRATEGY 1.3: TRANSBOUNDARY EGC WORKING GROUP ENSURES THAT ACTIONS IN WASHINGTON AND BRITISH COLUMBIA ARE COORDINATED AND COMPLEMENTARY.

Action 1.3.1: TEGC working group reviews Plan implementation quarterly.

Action 1.3.2: WDFW leads preparation of a report on implementation of the Plan after two years of implementation.

Action 1.3.3: Partners use Plan Actions to develop individual EGC management workplans.

Action 1.3.4: TEGC coordinates development/collation of standard protocols for EGC monitoring, trapping, data collection, QA/QC, field gear decontamination, and reporting.

Action 1.3.5: WSG coordinates (a) training of partners on protocols and (b) best practices for early detection site selection, trapping techniques, and data collection.

Performance measures:

PM 1.3A: TEGC working group meets at least quarterly, and reviews implementation of the Plan and makes adaptive changes as necessary.

PM 1.3B: Partners are consulted when work plans related to Plan Actions are developed.

PM 1.3C: Biennial report of Plan is reviewed and accepted by TEGC working group.

PM 1.3D: Standard protocols for early detection and site management are implemented by partners working to manage EGC in the Salish Sea.

PM 1.3E: Trainings in established protocols are held for new partners as needed.

STRATEGY 1.4: CAPACITY AND FUNDING ARE ADEQUATE FOR PARTNERS TO EFFECTIVELY MANAGE EGC IN THE SALISH SEA.

Action 1.4.1: WDFW allocates or seeks adequate funding for implementation of collaborative management of the Plan.

Action 1.4.2: DFO allocates or seeks adequate funding for implementation and collaborative management of the Plan.

Action 1.4.3: WSG seeks adequate funding for implementation of Crab Team program Plan Actions.

Performance measures:

PM 1.4A: WDFW AIS program receives sufficient funding to address EGC management.

PM 1.4B: DFO AIS National Core program receives sufficient funding to address EGC management.

PM 1.4C: WSG Crab Team receives sufficient funding to address EGC early detection and management support.

STRATEGY 1.5: ALL DATA AND RESEARCH RESULTS ASSOCIATED WITH EGC IN THE SALISH SEA ARE CONSOLIDATED AND SHARED EFFECTIVELY.

Action 1.5.1: Partners use standard data collection, record-keeping, and QA/QC protocols.

Action 1.5.2: Partners conducting early detection monitoring share information on new detections with TEGC within 48 hours.

Action 1.5.3: TEGC ensures data on Salish Sea EGC is shared to U.S./Canadian regional, national and global AIS databases.

Action 1.5.4: DFO consolidates and standardizes EGC data collected by Science and Management branches.

Action 1.5.5: TEGC supports the development of an accessible regional EGC database.

Performance measures:

PM 1.5A: Information on new EGC detections is made publicly available within one week of detection.

PM 1.5B: Salish Sea EGC database is operational and accessible to partners by June 30, 2020.

PM 1.5C: Salish Sea EGC data is provided to regional and/or national databases as available at least on an annual basis.

STRATEGY 1.6: WDFW AND PLAN PARTNERS WILL WORK CLOSELY WITH AFFECTED TRIBES PRIOR TO ANY WORK.

Action 1.6.1: WDFW will disseminate the Salish Sea Transboundary Action Plan (SSTAP) to all tribes with Usual and Accustomed areas and/or areas of cultural resource interest within the Salish Sea.

Action 1.6.2: WDFW and Partners shall offer support for EGC management or seek permission to access EGC management sites within a tribal government's sovereign lands.

Action 1.6.3: WDFW and Partners shall notify tribes where EGC management sites fall within their Usual and Accustomed areas or as otherwise required for historic and cultural resources protection (see tribal contacts/maps, Appendix A).

Action 1.6.4: WDFW and Partners will implement the Inadvertent Discovery Plan (IDP) in all cases where there is an unexpected discovery or unearthing of cultural artifacts, archaeological features or other evidence of cultural materials and/or skeletal material of human or unknown origin (Appendix B). Contact information by county for tribal, sheriff, and coroner is provided in Appendix C).

Performance measures:

PM 1.6A: Copies of the SSTAP are disseminated to all affected tribes and their IDP contacts.

PM 1.6B: Any inadvertent discoveries were reported to affected tribes, the WDFW archaeologist, and the Department of Archaeology and Historic Preservation, and the jurisdiction's coroner (skeletal remains) as outlined in the IDP.

OBJECTIVE 2: PREVENT HUMAN-MEDIATED INTRODUCTION AND SPREAD OF THE EUROPEAN GREEN CRAB.

STRATEGY 2.1: EDUCATE PARTNERS, MARINE USERS, AND THE PUBLIC ABOUT HOW TO AVOID INTRODUCING EGC.

Action 2.1.1: WDFW, DFO, and WSG provide information on their websites and in outreach materials to other partners, stakeholders, and the public about how to avoid introducing and spreading EGC.

Action 2.1.2: WDFW, DFO, and WSG coordinate with tribes in Washington, indigenous groups in British Columbia, and other partners to provide information on their websites and in outreach materials about how to avoid introduction and spread of EGC.

Performance measures:

PM 2.1A: EGC information on websites of WDFW, DFO (see <http://www.dfo-mpo.gc.ca/species->

especies/profiles-profil/europeangreencrab-crabevert-eng.html), and WSG is current.

PM 2.1B: Public information is available at 10 WA/BC locations/websites frequented by marine user groups in the Salish Sea.

PM 2.1C: WDFW, DFO, and WSG will provide a combined total of at least 10 presentations per year to marine/nearshore user groups.

PM 2.1D: WDFW, DFO, and WSG distribute outreach materials to 10 marine/nearshore user group events per year.

STRATEGY 2.2: PREVENT INTRODUCTION OF EGC FROM AQUACULTURE OPERATIONS.

Action 2.2.1: WDFW and DFO consult/collaborate with shellfish growers association forums and local shellfish growers to ensure growers understand pathways of EGC introduction.

Action 2.2.2: DFO enforces regulations related to moving product from west to east Vancouver Island.

Action 2.2.3: WDFW enforces aquaculture transport regulations in Washington.

Action 2.2.4: WDFW and DFO investigate compliance with and adequacy of current shellfish industry best management practices to prevent spread of EGC.

Performance measures:

PM 2.2A: Pacific Coast Shellfish Growers Association (PCSGA) and British Columbia Shellfish Growers Association (BCSGA) include information about prevention of introduction and spread of EGC in materials for growers.

PM 2.2B: All aquaculture transport complies with regulations designed to prevent introduction and spread of EGC in the Salish Sea.

STRATEGY 2.3: PREVENT INTRODUCTION OF EGC FROM BALLAST WATER.

Action 2.3.1: WDFW requests Transport Canada review the risks of foreign and domestic intracoastally unexchanged vessels.

Action 2.3.2: WDFW requests Transport Canada enforce current ballast water regulations.

Action 2.3.3: WDFW reviews risk of intracoastally unexchanged vessels.

Action 2.3.4: WDFW enforces current ballast water regulations.

Performance measures:

PM 2.3A: Risks of introduction and spread of EGC from the intracoastal vessel pathway are identified.

PM 2.3B: Ballast water is managed to prevent introduction and spread of EGC.

STRATEGY 2.4: PREVENT INTRODUCTION OF EGC FROM BIOFOULING, RECREATIONAL BOATING, BAIT TRADE, RESEARCH AND EDUCATION, AND LIVE TRADE.

Action 2.4.1: WDFW enforces restrictions on live EGC trade.

Action 2.4.2: DFO enforces regulations and licensing related to AIS.

Action 2.4.3: WDFW enforces regulations related to vessel biofouling.

Action 2.4.4: WDFW evaluates risk of mussel transfer practices of WDFW Mussel Monitoring Survey program.

Action 2.4.5: WDFW and DFO investigate the adequacy of current authorities to prevent introduction and spread of EGC along known pathways.

Performance measures:

PM 2.4A: Risks of introduction and spread of EGC from live trade, biofouling, WDFW Mussel Monitoring Survey program and other known pathways are identified.

PM 2.4B: Recommendations are provided on how to prevent introduction and spread of EGC by vessel biofouling.

PM 2.4C: Recommendations are provided on how to prevent the introduction and spread of EGC from other pathways.

OBJECTIVE 3: DETECT EUROPEAN GREEN CRAB PRESENCE AT EARLIEST INVASION STAGE.

STRATEGY 3.1: IDENTIFY AND CATEGORIZE POTENTIAL SITES OF EGC INVASIONS.

Action 3.1.1: WSG continues to use existing habitat suitability assessments to select early detection monitoring sites in Washington.

Action 3.1.2: DFO develops habitat suitability maps for BC using same protocols as WSG.

Performance measures:

PM 3.1A: WSG habitat suitability maps are evaluated against EGC detection data in Washington State.

PM 3.1B: DFO habitat suitability maps are evaluated against EGC detection data in BC.

STRATEGY 3.2: TRAIN AND SUPPORT VOLUNTEERS AND PARTNERS TO MONITOR FOR EGC.

Action 3.2.1: DFO pilots volunteer EGC monitoring with an existing citizen group, or with interested indigenous groups.

Action 3.2.2: DFO expands recruitment and support of volunteers and partners to monitor for EGC.

Action 3.2.3: WSG and DFO train volunteers and partners on established monitoring protocols.

Action 3.2.4: WSG and DFO support active volunteers and partners with communication and data reporting.

Performance measures:

PM 3.2A: 100 or more volunteers are trained for monitoring EGC in Washington using standard protocols.

PM 3.2B: 20 or more volunteers are trained (intent to eventually reach 100 volunteers) for monitoring EGC in British Columbia using standard protocols.

PM 3.2C: Work with tribes, Pacific Shellfish Growers Association, and other Salish Sea shellfish growers to develop an ad hoc EGC monitoring network.

PM 3.2D: All monitors are trained to minimize adverse environmental impacts (e.g. bycatch mortality of native species; shoreline habitat degradation, etc.).

STRATEGY 3.3: MONITOR 160+ SITES REGULARLY FOR INVASIONS OF EGC

Action 3.3.1: DFO, WDFW, and WSG develop a Salish Sea monitoring plan for high and moderate sites identified in habitat suitability maps.

Action 3.3.2: DFO, WDFW, and WSG monitor highly-suitable sites monthly during months of April through September using established protocols.

Action 3.3.3: DFO, WDFW, WSG, and partners monitor additional moderate- to high- risk sites at least once annually.

Performance measures:

PM 3.3A: 50 Washington State moderate to high suitability sites are monitored monthly for EGC from April through September.

PM 3.3B: 10 British Columbia moderate to high suitability sites (intent to eventually reach 50 sites) are monitored monthly for EGC between April and September.

PM 3.3C: 50 additional Washington State moderate to high suitability sites are monitored at least once per year.

PM 3.3C: 50 additional British Columbia moderate to high suitability sites are monitored at least once per year.

PM 3.3D: Adverse environmental impacts from monitoring actions are minimized (e.g. bycatch mortality of native species; shoreline habitat degradation, etc.).

STRATEGY 3.4: ENCOURAGE AND FACILITATE PUBLIC REPORTING OF EGC SIGHTINGS

Action 3.4.1: Ensure DFO AIS reporting system is functional, and develop education/outreach to public for use.

Action 3.4.2: WSG, WDFW, and DFO include reporting information in all EGC outreach and presentations.

Action 3.4.3: Ensure WSG reporting information is up-to-date on their website.

Action 3.4.4: Ensure “WA Invasives” Smartphone App EGC reporting is functional, and EGC reports are forwarded to the appropriate groups.

Action 3.4.5: Verify/enhance BC general invasive species reporting App for EGC, and reports are directed to the appropriate agency(s).

Performance measures:

PM 3.4A: Online and digital reporting systems are in place, functional, and used by the public.

PM 3.4B: All Washington reports of EGC are provided to WDFW and WSG.

PM 3.4C: All British Columbia reports of EGC are provided to DFO.

OBJECTIVE 4: RAPIDLY ERADICATE OR REDUCE NEWLY DETECTED POPULATIONS.

STRATEGY 4.1: RAPIDLY RESPOND TO DETECTION OF EGC AT NEW LOCATIONS.

Action 4.1.1: WDFW, DFO, and partners assess threat level (species densities and geographic scope of infestation) for all detections at new locations.

Action 4.1.2: WDFW and DFO activate formal Incident Command Structure, rapid-response process for all newly detected sites reaching thresholds to be developed under Action 4.2.

Performance measures:

PM 4.1A: All detections of EGC at new locations are investigated and EGC populations are controlled or eradicated.

PM 4.1B: Adverse environmental impacts from response actions are minimized (e.g. bycatch mortality of native species; shoreline habitat degradation, etc.).

STRATEGY 4.2: DEVELOP A FORMAL INCIDENT COMMAND STRUCTURE TO RESPOND TO SIGNIFICANT DETECTIONS OF EGC IN THE SALISH SEA.

Action 4.2.1: WDFW and DFO define thresholds for activation of a formal Incident Command Structure.

Action 4.2.2: Develop Incident Command Structure consistent with DFO response process to include: site specific benchmarks for success, defined partner roles, methods, and reporting.

Action 4.2.3: WDFW and DFO obtain partner commitments to implement rapid response actions.

Performance measure:

PM 4.2A: Incident Command Structure is formalized and agreed to with partners.

OBJECTIVE 5: CONTROL PERSISTENT INFESTED SITE POPULATIONS TO ELIMINATE OR MINIMIZE ENVIRONMENTAL, ECONOMIC, AND HUMAN RESOURCE HARM.

STRATEGY 5.1: DEVELOP PROCESS TO MANAGE INFESTED SITES

Action 5.1.1: WDFW and DFO develop Infested Site Management Plan process, including: site specific benchmarks of success; menu of available management actions; menu of available mitigation measures to minimize harm; defined partner roles, data collection and reporting.

Action 5.1.2: WDFW and DFO develop an infested site management plan for the EGC population in Sooke Basin.

Action 5.1.3: WDFW and DFO develop an infested site management plan for the EGC population in Dungeness Spit.

Action 5.1.4: WDFW and DFO develop infested site management plans for all new sites if/when meeting threshold criteria.

Action 5.1.5: Obtain partner commitments to implement infested site management plans.

Performance measures:

PM 5.1A: Infested Site Management Plan process is formalized and agreed to with partners.

PM 5.1B: Infested Site Management Plans are developed and initiated for Sooke Basin and Dungeness Spit.

PM 5.1C: Infested Site Management Plans are developed and implemented for any other sites meeting threshold criteria.

OBJECTIVE 6: CONDUCT RESEARCH TO DEVELOP INCREASINGLY EFFECTIVE MANAGEMENT STRATEGIES.

STRATEGY 6.1: ENSURE THAT RESEARCH RESOURCES ARE FOCUSED ON THE HIGHEST PRIORITY RESEARCH GAPS TO IMPROVE PREVENTION AND MANAGEMENT OF EGC IN THE SALISH SEA.

Action 6.1.1: TEGC working group develops a ranked list of needed research annually to coincide with funding cycles to improve prevention, detection, and management of EGC in the Salish Sea. This research does not have to occur within the Salish Sea if compatible and more practical alternatives are available, such as in Makah Bay.

Performance measure:

PM 6.1A: Ranked list of EGC research priorities is produced.

STRATEGY 6.2: RESEARCH EGC GENETICS AND ENVIRONMENTAL DNA (eDNA) APPLICATIONS

Action 6.2.1: Continue to collect tissue samples from EGC at Salish Sea sites and conduct genetic analyses.

Action 6.2.2: Investigate utility of sampling eDNA to detect presence of EGC.

Performance measures:

PM 6.2A: Population analysis is updated to refine understanding of population connectivity.

PM 6.2B: Utility of eDNA analysis to detect EGC presence is understood.

REFERENCES

- Antonelis, K., Huppert, D., Velasquez, D., June, J., 2011. Dungeness crab mortality due to lost traps and a cost – benefit analysis of trap removal in Washington State waters of the Salish Sea. *North Am. J. Fish. Manag.* 37–41. doi:10.1080/02755947.2011.590113
- Aquatic Nuisance Species Committee, 2007. Washington State Aquatic Nuisance Species Committee Report to the 2008 Legislature. Prepared by P. Meacham and A. Pleus, Washington Department of Fish and Wildlife.
- Beal, B.F., Kraus, M.G., 2002. Interactive effects of initial size, stocking density, and type of predator deterrent netting on survival and growth of cultured juveniles of the soft-shell clam, *Mya arenaria* L., in eastern Maine. *Aquaculture*, 208(1-2), 81–111.
- Behrens Yamada, S., Dumbauld, B.R., Kalin, A., Hunt, C.E., Figlar-barnes, R., Randall, A., 2005. Growth and persistence of a recent invader *Carcinus maenas* in estuaries of the northeastern Pacific. *Biol. Invasions* 7, 309–321.
- Behrens Yamada, S., Mathias Davidson, T., Fisher, S., 2010. Claw morphology and feeding rates of introduced European green crabs (*Carcinus maenas* L, 1758) and native Dungeness crabs (*Cancer magister* Dana, 1852). *J. Shellfish Res.* 29, 471–477.
- Behrens Yamada, S., Peterson, W.T., M., K.P., 2015. Biological and physical ocean indicators predict the success of an invasive crab, *Carcinus maenas*, in the northern California Current. *Mar. Ecol. Prog. Ser.* 537, 175–189.
- Behrens Yamada, S., Thomson, R.E., Gillespie, G.E., Norgard, T.C., 2017. Lifting Barriers to Range Expansion: the European Green Crab *Carcinus maenas* (Linnaeus, 1758) Enters the Salish Sea. *J. Shellfish Res.* 36, 201–208.
- Bookelaar, B.E., A.O Reilly, S.A. Lynch, and S.C. Culloty. 2018. Role of the intertidal predatory shore crab *Carcinus maenas* in transmission dynamics of ostreid herpesvirus-1 microvariant. *Diseases of aquatic organisms*, 130(3), pp.221-233.
- Brasseale, E., Adams, J., Grason, E.W., MacCready, P., McDonald, P.S., 2018. Larval transport modeling evidence of European Green Crab source populations, Presentation, Salish Sea Ecosystem Conference 2018, Seattle WA.
- Carlton, J.T., Cohen, A.N., 2003. Episodic global dispersal in shallow water marine organisms: the case history of the European shore crabs *Carcinus maenas* and *C. aestuarii*. *J. Biogeog.* 30(12), 1809–1820.
- Cohen, A.N., Carlton, J.T., Fountain, M.C., 1995. Introduction, dispersal and potential impacts of the green crab *Carcinus maenas* in San Francisco Bay, California. *Marine Biology* 122(2), 225-237.
- Cordell, J., Kalata, O., Pleus, A., Newsom, A., Strieck, K., Gertsen, G., 2015. Effectiveness of Ballast Water Exchange in Protecting Puget Sound from Invasive Species. Washington Department of Fish and Wildlife Contract 12-1212 Final Report. 55p. Available online: <https://wdfw.wa.gov/publications/01710/wdfw01710.pdf>.
- Curtis, L.J.F., Matkin, H., Curtis, D.L., Thompson, M., Choi, F., Callow, P., Gillespie, G.E., Therriault, T.W., and Pearce, C.M. Evaluating transfers of harvested shellfish products, from the west to the east coast of Vancouver Island, as a potential vector for European Green Crab (*Carcinus maenas*) and other non-indigenous invertebrate species. Canadian Science Advisory Secretariat Research Document 2015/014: 74 pp.
- Dare, P.J., Edwards, D.B., 1976. Experiments on the survival, growth and yield of relaid seed mussels (*Mytilus edulis*) in the Menai Straits, North Wales. *J. Cons. Int. Explor. Mer.* 37, 16–28.
- de Rivera, C.E., Hitchcock, N.G., Teck, S.J., Steves, B.P., Hines, A.H., Ruiz, G.M., 2007. Larval development rates predicts range expansion of an introduced crab. *Mar. Biol.* 150(6), 1275-1288.

- Department of Fisheries and Oceans Canada, 2017a. Pacific Region Integrated Fisheries Management Plan Crab by Trap, January 1, 2017 to March 31, 2018.
- Department of Fisheries and Oceans Canada, 2017b. Keeping the Green Crab at Bay - A Proactive Approach, Department of Fisheries and Oceans Canada webpage, accessed 6/29/18 [WWW Document]. URL <http://www.dfo-mpo.gc.ca/science/publications/article/2014/02-14-14-eng.html>
- Department of Fisheries and Oceans Canada, 2017c. 2016 Aquaculture Maps. Department of Fisheries and Oceans Canada webpage, accessed 6/29/18 [WWW Document]. URL <http://www.dfo-mpo.gc.ca/aquaculture/bc-cb/maps-cartes-eng.html#sites>.
- Department of Fisheries and Oceans Canada, 2018. Aquaculture Production Quantities and Values. Department of Fisheries and Oceans Canada webpage, accessed 6/29/18 [WWW Document]. URL <http://www.dfo-mpo.gc.ca/stats/aqua/aqua16-eng.htm>.
- Dibacco, C., Humphrey, D.B., Nasmith, L.E., Levings, C.D., 2012. Ballast water transport of non-indigenous zooplankton to Canadian ports. *ICES J. Mar. Sci.* 69, 483–491.
- Fernandez, M., Iribarne, O., Armstrong, D.A., 1993. Habitat selection by young-of-the-year Dungeness crab *Cancer magister* and predation risk in intertidal habitats. *Mar. Ecol. Prog. Ser.* 92, 171.
- Floyd, T., Williams, J., 2004. Impact of green crab (*Carcinus maenas* L.) predation on a population of soft-shell clams (*Mya arenaria* L.) in the Southern Gulf of St. Lawrence. *J. Shellfish Res.* 23(3), 457–463.
- Frey, M., Frey, M.A., Simard, N., Robichaud, D.D., Martin, J.L., Therriault, T.W., 2014. Fouling around: vessel sea-chests as a vector for the introduction and spread of aquatic invasive species. doi:10.3391/mbi.2014.5.1.02
- Garbary, D.J., Miller, A.G., Williams, J., Seymour, N.R., 2014. Drastic decline of an extensive eelgrass bed in Nova Scotia due to the activity of the invasive green crab (*Carcinus maenas*). *Mar. Biol.* 161, 3–15.
- Gillespie, G.E., Norgard, T.C., Anderson, E.D., Haggarty, D.R., and Phillips, A.C. 2015. Distribution and biological characteristics of European Green Crab, *Carcinus maenas*, in British Columbia, 2006 - 2013. *Can. Tech. Rep. Fish. Aquat. Sci.* 3120: viii + 88 p.
- Gillespie, G.E., Phillips, A.C., Paltzat, D.L., Therriault, T.W., 2007. Status of the European green crab, *Carcinus maenas*, in British Columbia - 2006. *Can. Tech. Rep. Fish. Aquat. Sci.* 2700: vii + 39 p.
- Glude, J.B., 1955. The effects of temperature and predators on the abundance of the soft-shell clam, *Mya Arenaria*, in New England, *Transactions of the American Fisheries Society*, 84:1, 13-26.
- Grason, E.W., McDonald, P.S., Litle, K., Martin, K., Adams, J., 2018. European Green Crab in the Salish Sea: Same Region, Different Invasion?, presentation, Salish Sea Ecosystem Conference 2018, Seattle WA.
- Grason, E.W., Litle, K., McDonald, P.S., Dalton, P.D., 2016. European green crab early detection and monitoring. Washington Sea Grant, Final Report WSG-TR 16-07.
- Grason, E.W., McDonald, P.S., Adams, J., Litle, K., Apple, J.K., Pleus, A., 2018. Citizen science program detects range expansion of the globally invasive European green crab in Washington State (USA). *Manag. Biol. Inv.* 9, 39–47.
- Grosholz, E.D., Ruiz, G.M., Dean, C.A., Shirley, K.A., Maron, J.L., Connors, P.G., 2000. The impacts of a nonindigenous marine predator in a California bay. *Ecology* 81(5), 1206–1224.
- Howard, B.R., 2018. Impacts of the European Green Crab, presentation, Salish Sea Ecosystem Conference 2018, Seattle WA.
- Howard, B.R., Barrios-O'Neill, D., Alexander, M.E., Dick, J.T., Therriault, T.W., Robinson, T.B., Côté, I.M., 2018. Functional responses of a cosmopolitan invader demonstrate intraspecific variability in consumer-resource dynamics. *PeerJ* [online] 6, e5634 (<https://peerj.com/articles/5634>).

- IUCN, 2018. Global Invasive Species Database Species profile: *Carcinus maenas*. Downloaded from <http://www.iucngisd.org/gisd/species.php?sc=114> on 29-06-2018.
- Jensen, G.C., McDonald, P.S., Armstrong, D.A., 2002. East meets west: competitive interactions between green crab *Carcinus maenas*, and native and introduced shore crab *Hemigrapsus* spp. Marine Ecology Progress Series, 225, 251-262.
- Locke, A., Mandrak, N.E., Therriault, T.W., 2011. A Canadian Rapid Response Framework for Aquatic Invasive Species. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/114. vi + 30 p.
- Mach, M.E., Chan, K.M.A., 2014. Trading green backs for green crabs: evaluating the commercial shellfish harvest at risk to European green crab invasion. F1000Research [online], 2, 66 (<https://f1000research.com/articles/2-66/v3>).
- Malyshev, A., Quijón, P.A., 2011. Disruption of essential habitat by a coastal invader: new evidence of the effects of green crabs on eelgrass beds. ICES J. Mar. Sci. 68(9), 1852–1856.
- Masski, H., Guillou J., 1999, The role of biotic interactions in the juvenile mortality of the cockle (*Cerastoderma edule* L.): Field observations and experiment. J. Shellfish Res. 18, 575–578.
- Matheson, K., McKenzie, C. H., Gregory, R. S., Robichaud, D. A., Bradbury, I. R., Snelgrove, P. V. R., Rose, G. A., 2016. Linking eelgrass decline and impacts on associated fish communities to European green crab *Carcinus maenas* invasion. Marine Ecology Progress Series, 548, 31-45.
- McDonald, P.S., Jensen, G.C., Armstrong, D.A. 2001. The competitive and predatory impacts of the nonindigenous crab *Carcinus maenas* (L.) on early benthic phase Dungeness crab *Cancer magister* (Dana). J. Exp. Mar. Biol. Ecol., 258(1), 39–54
- Moore, Z., Pleus, A., Lane, H., Reynolds, 2017. Washington Department of Fish and Wildlife Six-Year Strategic Plan, Ballast Water Management, Document No. 16050.01.
- Pacific Shellfish Institute, 2018. Pacific Shellfish Institute, Where We Work [WWW Document]. URL <http://www.pacshell.org/washington.asp>
- Peter-Contesse, T., Peabody, B., 2005. Reestablishing Olympia oyster populations in Puget Sound, Washington. Washington Sea Grant Program, WSG-AS 05-04, Seattle, WA. 9 pp. ([https://www.extension.org/sites/default/files/Reestablishing Olympia Oyster Populations in Puget Sound, WA.pdf](https://www.extension.org/sites/default/files/Reestablishing%20Olympia%20Oyster%20Populations%20in%20Puget%20Sound,%20WA.pdf)).
- Plummer, M.L., 2013. The role of eelgrass in marine community interactions and ecosystem services: results from ecosystem-scale food web models. Ecosystems 16(2), 237–251.
- Scianni, C., Falkner, M., Debryckere, L., 2017. Biofouling in the U.S . Pacific States and British Columbia, White Paper Prepared for the Coastal Committee of the Western Regional Panel on Aquatic Nuisance Species.
- Tepolt, C., Grason, E.W., McDonald, P.S., Adams, J., 2018. Population genomics of green crabs in the Salish Sea and other west coast populations, presentation, Salish Sea Ecosystem Conference 2018, Seattle WA.
- Thayer, G.W., Phillips, R.C., 1977. Importance of eelgrass beds in Puget Sound. Marine Fisheries Review 39(11): 18-22.
- Transport Canada, 2006. Ballast water control and management regulations, 2006 Canadian Shipping Act, Section 657.1, SOR/2006-129.
- Washington Department of Fisheries, Washington Department of Natural Resources. 1981. Management plan for the Puget Sound commercial subtidal hardshell clam fishery. Olympia, WA. 70 pp. & app. (<https://www.gpo.gov/fdsys/pkg/CZIC-sh373-2-u5-m36-1981/html/CZIC-sh373-2-u5-m36-1981.htm>).
- Washington Department of Fisheries, Washington Department of Natural Resources. 1983. The commercial harvest of geoduck clams (brochure). Olympia, WA. 8 pp. (cf. <https://wdfw.wa.gov/fishing/commercial/geoduck>).

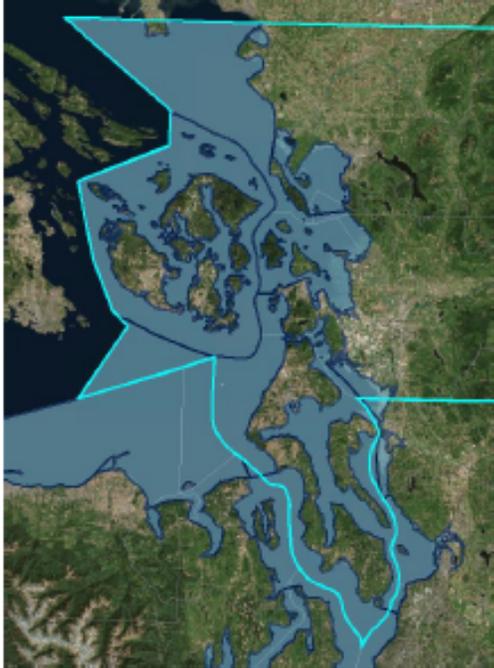
- Washington Department of Fish and Wildlife, 2018a. Fishing & Shellfishing, Washington Department of Fish and Wildlife website, accessed June 29, 2018 [WWW Document]. URL <https://wdfw.wa.gov/fishing/commercial/crab/pugetsound/history.html>
- Washington Department of Fish and Wildlife. 2018b. Priority Habitats and Species List. Updated ed., Olympia, WA. 287 pp. (<https://wdfw.wa.gov/conservation/phs/list>).
- Washington Shellfish Initiative. 2011. White Paper. Washington Governor Jay Inslee's Website, accessed October 10, 2018 [WWW Document]. URL https://www.governor.wa.gov/sites/default/files/documents/WSI_WhitePaper2001.pdf
- Wonham, M.J., Carlton, J.T., 2005. Trends in marine biological invasions at local and regional scales: the Northeast Pacific Ocean as a model system. *Biol. Inv.* 7(3), 369–392.

APPENDIX A: SSTAP TRIBAL CULTURAL AREA MAPS & CONTACTS

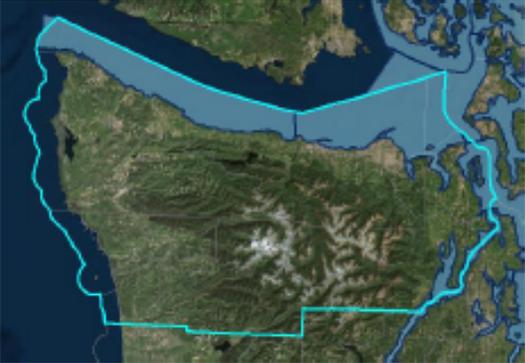
Jamestown S'Klallam Tribe
David Brownell Archival Historian
- Cultural Resources Specialist (360) 681-4638



Lummi Indian Nation
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(360) 389-0078



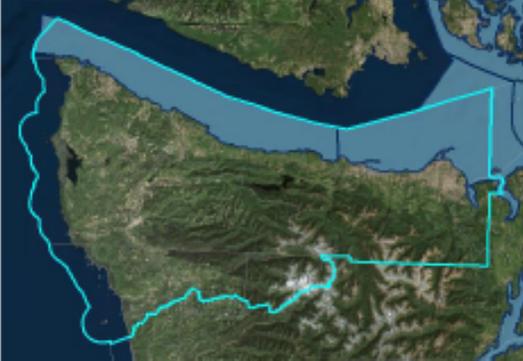
Lower Elwah Klallam Tribe
Bill White Tribal Archeologist
(360) 452-8471 x163



Port Gamble Sklallam Tribe
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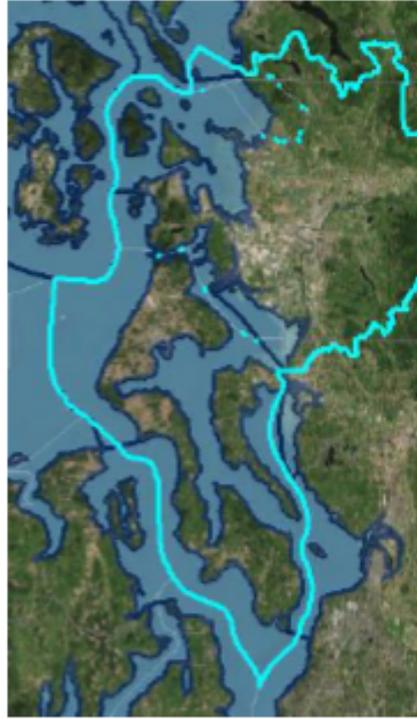
Makah Indian Tribe
Janine Ledford Tribal Historic Preservation Officer
(360) 645-2711



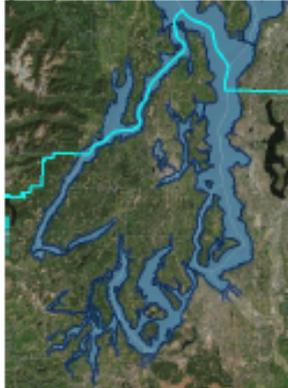
Nooksack Indian Tribe
George Swanaset, Jr. Cultural Resources Director
(360) 305-9126



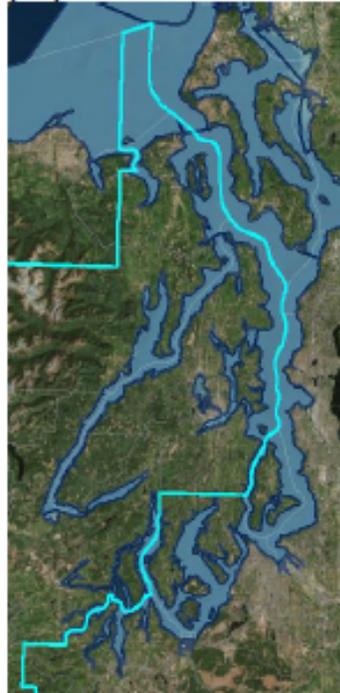
Skagit River System Coop
Mike Olis TFW Field Biologist (360) 708-2809



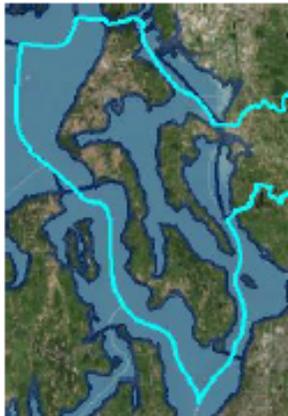
Squaxin Island Tribe
Rhonda Foster Cultural Resources Director
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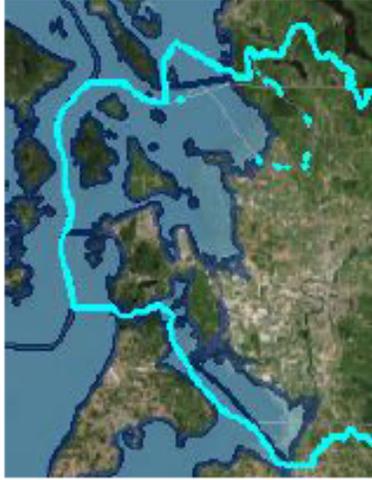
Skokomish Tribal Nation
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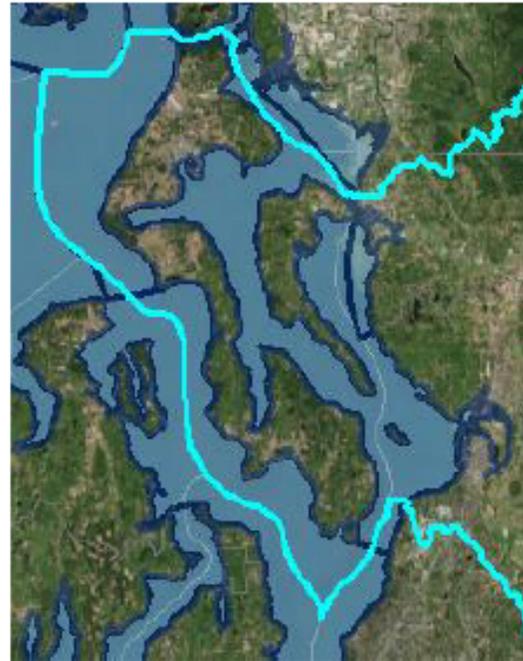
Stillaguamish Tribe of Indians
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Upper Skagit Indian Tribe
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APPENDIX B: SSTAP INADVERTENT DISCOVERY PLAN

WASHINGTON STATE DEPARTMENT OF FISH & WILDLIFE INADVERTENT DISCOVERY PLAN FOR CULTURAL RESOURCES FOR SALISH SEA TRANSBOUNDARY ACTION PLAN (SSTAP) FOR INVASIVE EUROPEAN GREEN CRAB PROJECT IN MULTIPLE COUNTIES, WASHINGTON

The Inadvertent Discovery Plan is intended to provide clear guidance related to the management of an unexpected discovery or unearthing of cultural artifacts, archaeological features or other evidence of cultural materials and/or of skeletal material of human or unknown origin during WDFW projects not governed by a DAHP-issued excavation permit, or by a Monitoring or Site Protection Plan for a specific area or activity.

This plan is to be implemented without exception whenever such discoveries occur, and applies to WDFW staff, contractors, subcontractors, volunteers, and others who may be involved with projects initiated by WDFW, or occurring on WDFW-managed land. This plan does not supersede or satisfy requirements for Monitoring, Site Protection, or other plans developed to address concerns at known archaeological and historic sites.

PRE-FIELD ACTIONS

Prior to ground disturbance, the WDFW project or program manager (PM) will notify work crews/machine operators that they are obligated to cease work in the immediate area and notify supervisory personnel upon discovery of any bones or objects of human manufacture, particularly suspected Native American artifacts. This action will be repeated prior to commencement of work in new locations, after significant changes in field staff, and if work is re-started after a hiatus. Field supervisors will be made aware of their responsibilities for interim protection and notification as detailed below.

FIELD ACTIONS

Specific Procedures for the Inadvertent Discovery of Archaeological Resources

In the event that cultural resources (not including human remains) are encountered during project implementation, the following actions will be taken:

1. All work within the discovery area and a surrounding buffer adequate and sufficient to prevent further disturbance will cease. The field supervisor will notify the PM immediately.
2. The PM will immediately contact WDFW archaeologist or archaeological monitor. If an archaeological monitor is present, he/she will notify the WDFW archaeologist.
3. If the WDFW archaeologist determines that potentially significant archaeological materials or historic sites are present, the PM will be advised of interim protective measures. Work may resume outside the buffer, unless the WDFW archaeologist directs otherwise.

4. The WDFW archaeologist will initiate Tribal and DAHP consultation regarding evaluation of the find's significance, potential for effects caused by the project, and subsequent treatment plans or Memoranda of Agreement (MOA).
5. Wherever possible, the preferred treatment of significant archaeological resources and historic sites will be in situ preservation. If a treatment plan requires that such resources be excavated or removed, an agreement must first be reached between WDFW and the consulting parties.

Specific Procedures for the Inadvertent Discovery of Human Remains

Inadvertent finds of what appear to be human remains introduce cultural concerns and legal requirements that initiate a different response than cultural resources. Human remains must be treated with utmost respect. Four presumptions regarding identification guide the treatment of possible human remains:

- Unidentified bones will be considered human until there is evidence that they are not.
- Human remains will be considered non-forensic until and unless the county coroner has determined them to be forensic.
- Non-forensic human remains will be treated as Native American until and unless the DAHP physical anthropologist, in consultation with interested Tribes, has determined that they are not.
- Only the coroner and physical anthropologist may handle human remains until a burial treatment plan developed with the WDFW and consulting parties has been established. Examination and recording beyond that required to make the legally required determination is not authorized except through a burial treatment plan developed by WDFW and the consulting parties.

If human remains are found within the project area, the following actions will be taken, consistent with Washington State RCWs 68.50.645, 27.44.055, and 68.60.055:

1. If ground disturbing activities encounter human skeletal remains during the course of construction, then all activity will cease that may cause further disturbance to those remains.
2. The area of the find will be secured and protected from further disturbance. The project supervisor will cover the remains with a tarp or other fabric when available, notify workers that the area is off limits, and will maintain a watch to ensure that the area is not disturbed. The remains will be treated respectfully at all times. News of the discovery is not to be communicated beyond the people who need to know.
3. The finding of human skeletal remains will be reported to the county medical examiner/coroner, local law enforcement, and the WDFW archaeologist in the most expeditious manner possible. The remains will not be touched, moved, or further disturbed.
4. The county medical examiner/coroner will assume jurisdiction over the human skeletal remains and make a determination of whether those remains are forensic or non-forensic. If the county medical examiner/coroner determines the remains are non-forensic, then they will report that finding to DAHP, which will then take jurisdiction

over the remains. The DAHP will notify any appropriate cemeteries and all affected tribes of the find.

5. WDFW archaeologist will serve as WDFW's lead for Tribal and DAHP consultation process should the remains be determined non-forensic.
6. The State Physical Anthropologist will make a determination of whether the remains are Indian or Non-Indian and report that finding to any appropriate cemeteries and the affected tribes by certified letter within two business days of examination.
7. Interim protective measures will be maintained until the required determinations have been made and a burial treatment plan has been finalized. The WDFW will develop the plan in cooperation with all consulting parties and lineal descendants (if any). Parties defined in the burial treatment plan will implement its provisions.
8. Under no conditions are WDFW staff or other project personnel to make the location or contents of inadvertent human remains finds public, unless specifically authorized to do so in the burial treatment plan.

Contacts:

Washington Department of Fish and Wildlife

Katherine M. Kelly, Department Archaeologist 360-902-2573 or 360-951-0941

If the archaeologist cannot be reached, contact Paul Dahmer, Wildlife Area Access Manager at 360-902-2480

Allen Pleus, WDFW Project Manager 360-902-2724

Jesse Schultz, WDFW Assistant Project Manager 360-902-2184

Tribal Cultural/Archaeological

Appendix A provides the names of tribal cultural/archaeological resource staff wishing to be contacted correlates to the geographic areas represented on maps.

Washington State Department of Archaeology and Historic Preservation

Allyson Brooks, State Historic Preservation Officer 360-586-3066

Stephanie Kramer, Assistant State Archaeologist 360-586-3083

Guy Tasa, State Physical Anthropologist 360-586-3534

Tribal Natural Resources & County

Appendix C provides the names of tribal natural resources, county sheriff, and county coroner staff by county.

Definitions:

Archaeological Features are physical alterations in the natural environment such as pits or house foundations.

Archaeological materials are the physical remains of human cultural behavior, including artifacts and features left on the landscape.

Artifacts are the physical objects of a culture, including tools with evidence of intentional modification (such as flaked stone blades) as well as those objects such as fire-cracked rock that reflect human activity.

Burial statutes include the 2008 Washington State legislation that established current practices for inadvertent burial treatment through additions and amendments to the code, including 27.44 RCW (Indian Graves and Records, as amended), 27.53 (Archaeological Sites and Resources, as amended), as well as chapters 27.34, 43.334, 68.60, and 68.60 RCW.

Consulting parties are those which have a legal right to comment on determinations of significance and NRHP eligibility, project effects on cultural resources, and human remains. This may vary according to projects, but typically includes DAHP and Tribes whose Ceded Lands or Usual and Accustomed areas include the project area.

Coroner refers to the office of the local county coroner or medical examiner, and is responsible for confirming that the remains are human and determining whether they are forensic (dead less than 50 years, and therefore a law enforcement matter) or non-forensic (more than 50 years, and therefore subject to burial statutes).

Cultural Deposits are layers or features of sediment containing cultural materials.

Cultural Resources include archaeological resources and historic sites.

Historic sites are locations 50 years old or older, where native or non-native events and activities have taken place since the arrival of Euro-Americans, and which are considered by DAHP to be historic site types.

Human remains are any physical remains that are known to be human, or could be human but have not yet been positively identified.

Physical anthropologist in this case refers to the professional physical anthropologist employed at DAHP, who determines whether human remains are Native American (if possible), and is the individual responsible for handling human remains.

APPENDIX C: SSTAP
INADVERTENT DISCOVERY
PLAN CONTACTS BY COUNTY

Clallam County

JAMESTOWN S'KLALLAM TRIBE

1033 Old Blyn Highway, Sequim, WA 98382
Lead Representative: Ron Allen, Tribal Council
Chairman, 360-683-1109
Primary Contact: Gideon Cauffmann, Cultural
Resources, 360-681-4638

LOWER ELWHA KLALLAM TRIBE

2851 Lower Elwha Road, Port Angeles, WA
98363
Lead Representative: Francis G Charles, Chair,
360-452-8471 ext 106
Primary Contact: William S. White, Cultural
Resources, 360-452-8471 ext 163

MAKAH TRIBE

PO Box 115. Neah Bay, WA 98357
Lead Representative: John Ides, Sr., Chair,
360-645-3288
Primary Contact: Janine Bowechop, THPO, 360-
645-2711

PORT GAMBLE S'KLALLAM

31912 Little Boston Road NE, Kingston, WA
98346
Lead Representative: Jeromy Sullivan, Chair, 360-
297-2646
Primary Contact: Marie Hebert, Cultural
Resources Director, 360-297-2646 ext 241
Josh Wisniewski, THPO, 360.633.1899

QUILEUTE TRIBE

PO Box 279, La Push, WA 98350
Lead Representative: Tony Foster, Chair, 360-374-
6163
Primary Contact: Deanna Hobson, Cultural
Resources, 360-374-9651

SKOKOMISH TRIBE

N. 80 Tribal Center Road, Shelton, WA 98584
Lead Representative: Charles Miller, Chair, 360-
426-4232
Primary Contact: Kris Miller, THPO, 360-426-
4232 ext. 215

CLALLAM COUNTY SHERIFF'S OFFICE

223 E 4th Street, Port Angeles, WA 98362
Lead Representative: Bill Benedict, Sheriff, 360-
417-2459

**CLALLAM COUNTY CORONER'S
OFFICE**

223 East Fourth Street, Suite 11, Port Angeles,
WA 98362-3015
Lead Representative: Deborah S. Kelly,
Prosecuting Attorney/Coroner, 360-417-2297

Island County

JAMESTOWN S'KLALLAM TRIBE

1033 Old Blyn Highway, Sequim, WA 98382
Lead Representative: Ron Allen, Tribal Council
Chairman, 360-683-1109
Primary Contact: Gideon Cauffmann, Cultural
Resources, 360-681-4638

LOWER ELWHA KLALLAM TRIBE

2851 Lower Elwha Road, Port Angeles, WA
98363
Lead Representative: Francis G Charles, Chair,
360-452-8471 ext 106
Primary Contact: William S. White, Cultural
Resources, 360-452-8471 ext 163

PORT GAMBLE S'KLALLAM

31912 Little Boston Road NE, Kingston, WA
98346
Lead Representative: Jeromy Sullivan, Chair, 360-
297-2646
Primary Contact: Marie Hebert, Cultural
Resources Director, 360-297-2646 ext 241
Josh Wisniewski, THPO, 360.633.1899

SNOHOMISH TRIBE

11014-19th Ave SE, Suite 8, Everett, WA 98208-
5121
Lead Representative: Michael didahalqid Evans,
Chair, 425-744-1855

SNOQUALMOO TRIBE

2613 Pacific Street, Bellingham, WA 98226
Lead Representative: Earny Sandstrom, Chair,
360-671-1387

ISLAND COUNTY SHERIFF'S OFFICE

6th Street NE, Coupeville, WA 98239
 Lead Representative: Mark C. Brown, Sheriff, 360-678-4422 (North Whidbey Island)
 Lead Representative: Mark C. Brown, Sheriff, 360-321-5113 x7310 South Whidbey Island
 Lead Representative: Mark C. Brown, Sheriff, 360-629-4523 x7310 Camano Island

ISLAND COUNTY CORONER'S OFFICE

1 NE 7th Street, Coupeville, WA 98239-5000
 Lead Representative: Robert Bishop, Coroner, 360-679-7358

Jefferson County**HOH TRIBE**

P.O. Box 2196; 2464 Lower Hoh Rd, Forks, WA 98331
 Lead Representative: Maria Lopez, Chair, 360-374-3271
 Primary Contact: Dob Boyce, Cultural Resources, 360-374-6090

JAMESTOWN S'KLALLAM TRIBE

1033 Old Blyn Highway, Sequim, WA 98382
 Lead Representative: Ron Allen, Tribal Council Chairman, 360-683-1109
 Primary Contact: Gideon Cauffmann, Cultural Resources, 360-681-4638

LOWER ELWHA KLALLAM TRIBE

2851 Lower Elwha Road, Port Angeles, WA 98363
 Lead Representative: Francis G Charles, Chair, 360-452-8471 ext 106
 Primary Contact: William S. White, Cultural Resources, 360-452-8471 ext 163

PORT GAMBLE S'KLALLAM

31912 Little Boston Road NE, Kingston, WA 98346
 Lead Representative: Jeromy Sullivan, Chair, 360-297-2646
 Primary Contact: Marie Hebert, Cultural Resources Director, 360-297-2646 ext 241
 Josh Wisniewski, THPO, 360.633.1899

QUINAULT NATION

PO Box 189, Taholah, WA 98587

Lead Representative: Fawn Sharp, Chair, 360-276-8211

Primary Contact: Justine James, Cultural Resources, 360-276-8211 ext: 520

SKOKOMISH TRIBE

N. 80 Tribal Center Road, Shelton, WA 98584
 Lead Representative: Charles Miller, Chair, 360-426-4232
 Primary Contact: Kris Miller, THPO, 360-426-4232 ext. 215

SNOHOMISH TRIBE

11014-19th Ave SE, Suite 8, Everett, WA 98208-5121
 Lead Representative: Michael didahalqid Evans, Chair, 425-744-1855

JEFFERSON COUNTY SHERIFF'S OFFICE

79 Elkins Road, Port Hadlock, WA 98339
 Lead Representative: Tony Hernandez, Sheriff, 360-385-3831

JEFFERSON COUNTY CORONER'S OFFICE

PO Box 122, Port Townsend, WA 98368
 Lead Representative: Scott W. Rosekrans, Prosecuting Attorney/Coroner, 360-385-9180

King County

DUWAMISH TRIBE (not federally recognized)
 4705 West Marginal Way SW, Seattle, WA 98106
 Lead Representative: Cecile A. Hanson, Chair, 206-431-1582

MUCKLESHOOT TRIBE

39015 172nd Avenue SE, Auburn, WA 98092
 Lead Representative: Virginia Cross, Chair, 253-939-3311 ext 3194
 Primary Contact: Laura Murphy, Tribal Archaeologist, 253-939-3311

SNOQUALMIE TRIBE

PO Box 969, Snoqualmie, WA 98065
 Lead Representative: Carolyn Lubenau, Chair, 425-888-6551
 Primary Contact: Steve Mullen-Moses, Cultural Resources, 425-888-6551

KING COUNTY SHERIFF'S OFFICE

King County Courthouse, 516 Third Ave, Room W-150, Seattle, WA 98104
Lead Representative: John Urquhart, Sheriff, 206-296-4155

KING COUNTY MEDICAL EXAMINER'S OFFICE

Harborview Medical Center, 325 9th Avenue, Box 359792, Seattle, WA 98104-2499
Lead Representative: Richard Harruff, Medical Officer, 206-731-3232

Kitsap County

DUWAMISH TRIBE (not federally recognized)
4705 West Marginal Way SW, Seattle, WA 98106
Lead Representative: Cecile A. Hanson, Chair, 206-431-1582

JAMESTOWN S'KLALLAM TRIBE

1033 Old Blyn Highway, Sequim, WA 98382
Lead Representative: Ron Allen, Tribal Council Chairman, 360-683-1109
Primary Contact: Gideon Cauffmann, Cultural Resources, 360-681-4638

LOWER ELWHA KLALLAM TRIBE

2851 Lower Elwha Road, Port Angeles, WA 98363
Lead Representative: Francis G Charles, Chair, 360-452-8471 ext 106
Primary Contact: William S. White, Cultural Resources, 360-452-8471 ext 163

MUCKLESHOOT TRIBE

39015 172nd Avenue SE, Auburn, WA 98092
Lead Representative: Virginia Cross, Chair, 253-939-3311 ext 3194
Primary Contact: Laura Murphy, Tribal Archaeologist, 253-939-3311

PORT GAMBLE S'KLALLAM

31912 Little Boston Road NE, Kingston, WA 98346
Lead Representative: Jeromy Sullivan, Chair, 360-297-2646
Primary Contact: Marie Hebert, Cultural Resources Director, 360-297-2646 ext 241
Josh Wisniewski, THPO, 360.633.1899

SKOKOMISH TRIBE

N. 80 Tribal Center Road, Shelton, WA 98584
Lead Representative: Charles Miller, Chair, 360-426-4232
Primary Contact: Kris Miller, THPO, 360-426-4232 ext. 215

SUQUAMISH TRIBE

PO Box 498, Suquamish, WA 98392-0498
Lead Representative: Leonard Forsman, Chair, 360-598-3311
Primary Contact: Dennis E. Lewarch, THPO, 360-394-8529

KITSAP COUNTY SHERIFF'S OFFICE

614 Division St, MS-37, Port Orchard WA 98366
Lead Representative: Steve Boyer, Sheriff, 360-337-7101

KITSAP COUNTY CORONER'S OFFICE

5010 Linden Street MS-17, Bremerton, WA 98312
Lead Representative: Greg Sandstrom, Coroner, 360-337-7077

Mason County**SKOKOMISH TRIBE**

N. 80 Tribal Center Road, Shelton, WA 98584
Lead Representative: Charles Miller, Chair, 360-426-4232
Primary Contact: Kris Miller, THPO, 360-426-4232 ext. 215

SQUAXIN ISLAND TRIBE

10 SE Squaxin Lane, Shelton, WA 98584
Lead Representative: David Lopeman, Chair, 360-426-9781
Primary Contact: Rhonda Foster, THPO, 360-432-3850

MASON COUNTY SHERIFF'S OFFICE

322 N 3rd Street, Shelton, WA 98584
Lead Representative: Casey Salisbury, Sheriff, 360-427-9670 ext. 313 South County
Lead Representative: Casey Salisbury, Sheriff, 360-275-4467 X313 North County Lead Representative: Casey Salisbury, Sheriff, 360-482-5269 ext. 313 West County

MASON COUNTY CORONER'S OFFICE

414 North 5th Street, Shelton, WA 98584
Lead Representative: Wes Stockwell, Coroner,
360-427-9670 ext. 752

Pierce County

MUCKLESHOOT TRIBE

39015 172nd Avenue SE, Auburn, WA 98092
Lead Representative: Virginia Cross, Chair, 253-
939-3311 ext 3194
Primary Contact: Laura Murphy, Tribal
Archaeologist, 253-939-3311

NISQUALLY TRIBE

4820 She-Nah-Num Drive SE, Olympia, WA
98513
Lead Representative: Cynthia Iyall, Tribal
Chairperson, 360-456-5221
Primary Contact: Jacqueline (Jackie) Wall, THPO,
360-456-5221 Ext. 2180
Annette Bullchild, THPO, 360-456-5221 Ext.
1106

PUYALLUP TRIBE

3009 E Portland Ave, Tacoma, WA 98404
Lead Representative: Herman Dillon Sr., Chair,
253-573-7800
Primary Contact: Brandon Reynon, Cultural
Resources, 253-573-7986

SQUAXIN ISLAND TRIBE

10 SE Squaxin Lane, Shelton, WA 98584
Lead Representative: David Lopeman, Chair, 360-
426-9781
Primary Contact: Rhonda Foster, THPO, 360-
432-3850

STEILACOOM TRIBE PO Box 88419,
Steilacoom, WA 98388 Lead Representative:
Danny K. Marshall, Chair. 253-584-6308

PIERCE COUNTY SHERIFF'S OFFICE

County-City Building, 930 Tacoma Avenue S.,
Tacoma, WA 98402
Lead Representative: Paul A. Pastor, Sheriff, 253-
798-7530

PIERCE COUNTY MEDICAL EXAMINER'S OFFICE

3619 Pacific Avenue, Tacoma, WA 98418-7929

Lead Representative: Thomas B. Clark III,
Medical Examiner, 253-798-6494

San Juan County

LUMMI NATION

2616 Kwina Road, Bellingham, WA 98226
Lead Representative: Tim Ballew II, Chair, 360-
384-1489
Primary Contact: Lena Tso, THPO, 360-384-2298

SAMISH NATION

PO Box 217; 2918 Commercial Ave, Anacortes,
WA 98221
Lead Representative: Tom Wooten, Chair, 360-
293-6404
Primary Contact: Jacquelyn Ferry, Cultural
Resources, 360-293-6404 ext. 215

SAN JUAN COUNTY SHERIFF'S OFFICE

96 Second Street, Friday Harbor, WA 98250
Lead Representative: Roy Nou, Sheriff, 360-378-
4151

SAN JUAN COUNTY CORONER'S OFFICE

350 Court Street, Friday Harbor, WA 98250
Lead Representative: Randall K. Gaylord,
Prosecuting Attorney/Coroner, 360-378-4101

Skagit County

SAMISH NATION

PO Box 217; 2918 Commercial Ave, Anacortes,
WA 98221
Lead Representative: Tom Wooten, Chair, 360-
293-6404
Primary Contact: Jacquelyn Ferry, Cultural
Resources, 360-293-6404 ext. 215

SAUK-SUIATTLE TRIBE

5318 Chief Brown Lane, Darrington, WA 98241
Lead Representative: Norma A. Joseph, Chair,
360-436-0131
Primary Contact: Norma Joseph, Cultural
Resources, 360-436-0347

SWINOMISH TRIBE

11404 Moorage Way, LaConner, WA 98257
Lead Representative: Brian Cladoosby, Chair, 360-
466-3163

Primary Contact: Larry W Campbell, THPO, 360-466-7352

UPPER SKAGIT TRIBE

25944 Community Plaza, Sedro Woolley, WA 98284

Lead Representative: Jennifer Washington, Chair, 360-854-7000

Primary Contact: Scott Schuyler, Cultural Resources, 360-854-7009

SKAGIT COUNTY SHERIFF'S OFFICE

600 S. 3rd Street, Mount Vernon, WA 98273

Lead Representative: Will Reichardt, Sheriff, 360-336-9450

SKAGIT COUNTY CORONER'S OFFICE

124 West Gates Street, Mount Vernon, WA 98273

Lead Representative: Daniel Dempsey, Coroner, 360-336-9431

Snohomish County

SAUK-SUIATTLE TRIBE

5318 Chief Brown Lane, Darrington 98241

Lead Representative: Norma A. Joseph, Chair, 360-436- 1124

njoseph@sauk-suiattle.com

Primary Contact: Benjamin Joseph, Cultural Resources, 436.0333 BJoseph@sauk-suiattle.com

SNOHOMISH TRIBE

11014 19th Ave SE, Suite 8, Everett, WA 98208-5121

Lead Representative: Michael didahalqid Evans, Chair, 425-744-1855

chair@snohomishtribe.com

SNOQUALMIE NATION

8130 Railroad Ave, Ste 103

P O Box 969, Snoqualmie 98065

Lead Representative: Carolyn Lubenau, Chair, 425-888-6551

carolyn@snoqualmietribe.us

Primary Contact: Steve Mullen-Moses, Cultural Resources, 425-888-6551

Steve@snoqualmietribe.us

SNOQUALMOO TRIBE (not federally recognized)

2613 Pacific Street, Bellingham, WA 98226

Lead Representative: Earngy Sandstrom, Chair, 360-671-1387

STILLAGUAMISH TRIBE

3310 Smokey Point Drive, Arlington, WA 98223-0297

Lead Representative: Shawn Yanity, Chair, 360-652-7362

syanity@stillaguamish.com

Primary Contact: Kerry Lyste, Cultural Resources, 360-657-3687 ext 14

KLyste@stillaguamish.com

John Miller, Cultural Resources, 360-652-7362

TULALIP TRIBES

6406 Marine Drive, Tulalip, WA 98271

Lead Representative: Melvin R. Sheldon, Jr., Chair, 360- 651-4500

melsheldon@tulaliptribes-nsn.gov

Primary Contact: Richard Young, Cultural Resources, 360- 239-0182

ryoung@tulaliptribes-nsn.gov

Hibulb Cultural Center & Natural History Preserve

6410 23rd Avenue, N.E.

Tulalip, WA 98271

SNOHOMISH COUNTY SHERIFF'S OFFICE

3000 Rockefeller Avenue, Everett, WA 98201

Lead Representative: Ty Trenary, Sheriff, 425-388-3393

SNOHOMISH COUNTY MEDICAL EXAMINER'S OFFICE

9509 29th Avenue West, Everett, WA 98204

Lead Representative: Norman Thiersch, Medical Examiner, 425-438-6200

Thurston County

CHEHALIS CONFEDERATED TRIBES

420 Howanut Road; PO Box 536, Oakville, WA 98568

Lead Representative: David Burnett, Chair, 360-273-5911

Primary Contact: Richard Bellon, Cultural Resources, 360-273-5911 ext 1304

KIKIALLUS INDIAN NATION

2103 Harrison Ave NW, #143, Olympia, WA
98502
Lead Representative: Kurt Weinreich,
Administrator, 360-956-3742

NISQUALLY TRIBE

4820 She-Nah-Num Drive SE, Olympia, WA
98513
Lead Representative: Cynthia Iyall, Tribal
Chairperson, 360-456-5221
Primary Contact: Jacqueline (Jackie) Wall, THPO,
360-456-5221 Ext. 2180 Annette Bullchild,
THPO, 360-456-5221 Ext. 1106

SQUAXIN ISLAND TRIBE

10 SE Squaxin Lane, Shelton, WA 98584
Lead Representative: David Lopeman, Chair, 360-
426-9781
Primary Contact: Rhonda Foster, THPO, 360-
432-3850

**THURSTON COUNTY SHERIFF'S
OFFICE**

2000 Lakeridge Drive SW, Olympia, WA 98502
Lead Representative: John Snaza, Sheriff, 360-
754-3800

**THURSTON COUNTY CORONER'S
OFFICE**

2925 37th Avenue S.W., Tumwater, WA 98512
Lead Representative: Gary Warnock, Coroner,
360-586-2091

Whatcom County

LUMMI NATION

2616 Kwina Road, Bellingham, WA 98226
Lead Representative: Tim Ballew II, Chair, 360-
384-1489
Primary Contact: Lena Tso, THPO, 360-384-2298

MARIETTA BAND OF NOOKSACK TRIBE

1827 Marine Drive, Bellingham, WA 98226
Lead Representative: Robert Davis, Jr., Chair, 360-
752-0563

NOOKSACK TRIBE

4979 Mount Baker Hwy, Suite F, Deming, WA
98244
Lead Representative: Bob Kelly, Chair, 360-592-
5164

Primary Contact: George Swanaset, Jr., THPO,
360-592-0162

WHATCOM COUNTY SHERIFF'S OFFICE

311 Grand Ave, Bellingham WA 98225
Lead Representative: Bill Elfo, Sheriff, 360-676-
6650

**WHATCOM COUNTY MEDICAL
EXAMINER'S OFFICE**

1500 North State Street, Bellingham, WA 98225
Lead Representative: Gary Goldfogel, Medical
Examiner, 360-738-4557



Fisheries and Oceans
Canada

Pêches et Océans
Canada

Fish and Fish Habitat
Protection Program

Programme de protection du poisson
et de l'habitat du poisson

Director

Directeur

UNCLASSIFIED

2019-505-00019
EKME #: 4041977

MEMORANDUM FOR THE REGIONAL DIRECTOR, ECOSYSTEMS MANAGEMENT
BRANCH

**SALISH SEA EUROPEAN GREEN CRAB TRANSBOUNDARY ACTION PLAN
(FOR DECISION)**

SUMMARY

The purpose of this note is to seek approval of the attached *Salish Sea Transboundary Action Plan for Invasive European Green Crab* (the Action Plan) (Attachment 2).

The Aquatic Invasive Species (AIS) Program and the Science Branch in the Pacific Region have been working with Washington Department of Fish and Wildlife, Washington Sea Grant and Puget Sound Partnership to develop an action plan to counteract the spread/invasion of European Green Crab (EGC) into the Salish Sea.

The Action Plan has already been approved and signed by the Director, Washington Department of Fish and Wildlife and now requires approval and signature by Fisheries and Oceans Canada (DFO) to support implementation.

The Action Plan has been reviewed approved by the Regional Director, Science Branch and is now being forwarded to the Regional Director, Ecosystems Management Branch (EMB) for final approval and signature given the lead role of the AIS Program in coordinating the Department's efforts on AIS-related initiatives.

No final date for approval has been set, but approval is requested as soon as possible to provide for implementation in the 2019 field season.

BACKGROUND

EGC were first introduced into the Salish Sea in 2012 through a shellfish transfer resulting in the establishment of a self-sustaining population within Sooke Basin. This population is believed to be isolated despite subsequent detection of EGC around the Victoria area and along Washington's Juan de Fuca Strait coastline, as these other occurrences are believed to be the result of abnormal current patterns associated with warm ocean currents present in 2014. Each of these new detections has been subjected to management action which seems to have been successful, but if unmanaged, EGC has the potential to spread throughout the Salish Sea, and have lasting ecological and economic impacts to Canada and the United States.

The AIS Program and Science Branch in the Pacific Region have been working with Washington Department of Fish and Wildlife, Washington Sea Grant and Puget Sound Partnership to develop the *Salish Sea Transboundary Action Plan for Invasive European Green Crab* (the Action Plan) to counteract the spread/invasion of EGC into the Salish Sea.

The Action Plan outlines a pathway for effective and efficient management of EGC to prevent their establishment in the Salish Sea and identifies 63 specific actions within a framework of 18 strategies that address 6 overarching objectives. In addition, 47 performance measures are identified to ensure the actions taken are meeting objectives.

STRATEGIC CONSIDERATIONS

The Department's implementation of the Action Plan will be a shared responsibility between the AIS Program and Science Branch. Specific roles and responsibilities for implementation of the Action Plan have been discussed, agreed to, and will be formalized in a DFO internal agreement document.

The AIS Program has incorporated implementation of the Action Plan into the 2019-20 budget and work plan, and no additional funds will be required to implement the AIS Program's responsibilities within the Action Plan.

Signing onto the Action Plan provides formal recognition that DFO agrees that EGC poses a threat to the ecology of the Salish Sea and that management action should be taken. This recognition will aid US partners in acquiring funding for Action Plan implementation.

SCIENCE ADVICE

DFO Science began developing the Action Plan (Attachment 2) with Washington Department of Fish and Wildlife, Washington Sea Grant and Puget Sound Partnership in early 2016. The subsequently launched DFO AIS Program - having a mandate for coordination, management and response to AIS issues - also contributed, but the Action Plan was co-authored, reviewed and approved by Science Branch. It contains best, current science advice and is consistent with AIS management and response frameworks including collaborative management, prevention, early detection, rapid response, control and strategic research to improve adaptive management.

.../3

ADVICE AND RECOMMENDATIONS TO REGIONAL DIRECTOR, ECOSYSTEMS MANAGEMENT BRANCH

Following approval and sign-off by the Regional Director, Ecosystems Management Branch the Action Plan will be sent to the other signatories for confirmation of DFO's endorsement. The signatories will use the signed Action Plan to leverage funding required for implementation.

The AIS Program and Science Branch will formalize DFO internal roles and responsibilities pertaining to the Action Plan and implement as appropriate.

Approval is requested as soon as possible to provide for implementation in the 2019 field season.

 JUL 29 2019

Brad Fanos
Director
Fish and Fish Habitat Protection Program
Ecosystems Management Branch

- I concur with the recommendations
- I do not concur with the recommendations

 JUL 29 2019
Cheryl Webb
Regional Director
Ecosystems Management Branch

Attachment(s): (2)

- 1) Backgrounder – Salish Sea EGC Transboundary Action Plan (EKME #4041985)
- 2) Salish Sea EGC Transboundary Action Plan – For Signature (EKME #4041988)

