2020 Drayton Harbor Cooperative Management Plan for European Green Crab

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Northwest Straits Initiative

Washington Department of Fish and Wildlife

Sea Grant Washington

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Glossary

AIS: Aquatic Invasive Species

CPUE: Catch per unit effort (crabs per 100 trap-sets)

EGC: European green crab (*Carcinus maenas*)

GPS: Global Positioning System

MOU: Memorandum of Understanding

NWSC: Northwest Straits Commission

RCW: Revised Code of Washington

WAC: Washington Administrative Code

WDFW: Washington Department of Fish and Wildlife

WSG: Washington Sea Grant

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Executive Summary

The purpose of the 2020 Drayton Harbor Cooperative Management Plan for European Green Crab is to establish and implement a coordinated and collaborative response to a recent discovery of European green crab (EGC) within the Drayton Harbor Action Area. The management plan encompasses tasks that occur from April 2020 to June 2021 with the completion of tasks dependent upon guidelines related to COVID-19 (Office of the Governor, 2020).

EGC can significantly alter aquatic ecosystems by decimating nearshore habitats, displacing native species and causing damage to shellfish industries (Drinkwin et al. 2019). Drayton Harbor, a shallow embayment located near Blaine, WA, is particularly vulnerable to EGC damage as it has extensive eelgrass and salt marsh habitat (Thom et al. 1989) and houses a local shellfish aquaculture industry (Drayton Harbor Oyster Company).

In September and October of 2019, a total of 38 EGC was trapped in two late-season rapid response events in Drayton Harbor yielding a significantly higher catch per unit effort (CPUE) than at other Washington Salish Sea locations through 2018. The dominance of young of the year individuals indicated a recent settlement event, and indicated rapid removal action could be effective.

In response, WDFW and NWSC will co-lead a regional cooperative effort to conduct extensive trapping to both assess the full scope and scale of current EGC invasion, and to reduce population numbers to manageable levels, with WSG providing scientific oversight and advice.

The goals for this plan are:

1. Capacity Building
2. Assessment
3. Risk Reduction & Management
4. Communications

Simultaneous to removing EGC efficiently from Drayton Harbor, the information collected will improve the understanding of the distribution, abundance, reproductive potential, and demographics of EGC in Drayton Harbor. This information will be used to develop adaptive management practices, and inform planning, research, project development, and implementation of future EGC management efforts both in Drayton Harbor and across Washington State.

Background Information & Problem Statement

European Green Crabs (EGC) can significantly alter aquatic ecosystems by decimating nearshore habitats, displacing native species and causing damage to shellfish industries (Drinkwin et al. 2019). The presence of EGC reduces eelgrass bed density (Howard et al. 2019, Malyshev et al. 2011) and leads to competition with juvenile Dungeness crab (*Cancer magister*) and native shore crabs (*Hemigrapsus* spp.) for habitat and food (McDonald et al. 2001; Figlar-Barnes et al. 2002). As bivalve mollusks are a preferred food source for EGC, its establishment within Washington State could have severe impacts on local clam and oyster fisheries (Grosholz et al. 2000; Figlar-Barnes et al. 2002; Susewind 2020). To limit the potential for establishment, EGC is listed as a prohibited level 1 species by Washington State (WAC 220-640-030, RCW 77.135.030). For an in-depth description of EGC biology, ecology, and present status within the Salish Sea refer to the Salish Sea Transboundary Action Plan for Invasive European Green Crab (Drinkwin et al. 2019).

Drayton Harbor, a shallow embayment located near Blaine, WA, provides ideal habitat conditions for EGC establishment. Unfortunately, it is also particularly vulnerable to EGC damage as it has extensive eelgrass and salt marsh habitat (Thom et al. 1989) and houses a local shellfish aquaculture industry (Drayton Harbor Oyster Company).

WSG's Crab Team began monthly monitoring efforts at the mouth of California Creek, a freshwater input into Drayton Harbor, in 2017 (Grason et al. 2018). No evidence of EGC was found until 2019. Below is a timeline of EGC discovery within Drayton Harbor:

- August 17, 2019 – molt of 50mm male EGC discovered by Crab Team volunteers while walking the beach during a Coastal Observation and Seabird Survey Team (COASST) survey midway between California and Dakota Creek.
- August 31, 2019 – molt of 47mm male EGC discovered by Crab Team volunteers during a beach walk by their residence just north of Dakota Creek.
- September 14, 2019 – small molt (<20mm) discovered by WSG Crab Team volunteers during their monthly monitoring at California Creek.

In September and October of 2019, 38 EGC were caught in two late-season rapid response events focused on the eastern shoreline and creeks entering into the harbor. Catch per unit effort (CPUE), which averaged about 8 EGC for every 100 trap sets, was significantly greater than at other Washington Salish Sea locations through 2019, though still just a fraction of the CPUE for the established population in Sooke Harbor, BC (Drinkwin et al. 2019). With the exception of molts, the age-class of captured EGC appears to have been young-of-the-year from recent larval settlements, but already considered mature and potentially reproductive. Due to limited trapping during the assessment, and the cool temperatures, it was believed that the true scope and scale of the infested areas within Drayton Harbor was likely greater than was observable at that time.

Plan Scope

Statement of Purpose

The purpose of this management plan is to:

1. Establish and implement a coordinated and collaborative response within the Drayton Harbor Action Area.
2. Reduce populations of EGC while their numbers are low and most susceptible to control measures.

To do so, WDFW Scientific Technicians and NWSC staff will lead field operations by conducting trapping, training of local partner staff and volunteers, quality control of trapping efforts, collection of biological data, and data management. WSG will support these operations by advising on trapping, training, and management practices, and providing field support as resources allow. Simultaneous to removing EGC efficiently from Drayton Harbor, the information collected will improve the understanding of the distribution, abundance, reproductive potential, and demographics of EGC in Drayton Harbor. This information will be used to develop adaptive management practices, and inform planning, research, project development, and implementation of future EGC management efforts both in Drayton Harbor and across Washington State.

Geographic Scope

The Drayton Harbor Action Area is defined as all waters and associated creeks of Drayton Harbor up to high tide influence and the intertidal waters outside the mouth of Drayton Harbor north to the Canadian border and south to westernmost end of Semiahmoo Park (Figure 1). Drayton Harbor is a small estuarine bay comprised of eelgrass, salt marsh and mudflat habitats (Thom et al. 1989). Two freshwater creeks, California and Dakota, flow into Drayton Harbor and are tidally influenced (Thom et al. 1989).

During this management plan period, the goal is to assess as much intertidal habitat in Drayton Harbor for EGC presence as possible, and remove green crabs in hot spots. Trapping activities are outlined in detail in a separate Trapping Actions and Protocols document.

Figure 1. Map of Drayton Harbor action area. Red lines denote rough action area boundaries.

Briefly, four priority trapping sites for removal and assessment have been identified based on findings in the initial rapid response trapping events: the jetty near Blaine Marina (Jetty Core Site), south of Blaine

Marina near off-shore pillars (Pillars Core Site), the midpoint between Dakota Creek and California Creek (No Name Creek Core Site), and at California Creek (California Creek Core Site) (Figure 2). Additional index sites were added to explore EGC abundance, distribution, and seasonal habitat use across the estuarine gradient in Dakota and California Creeks.

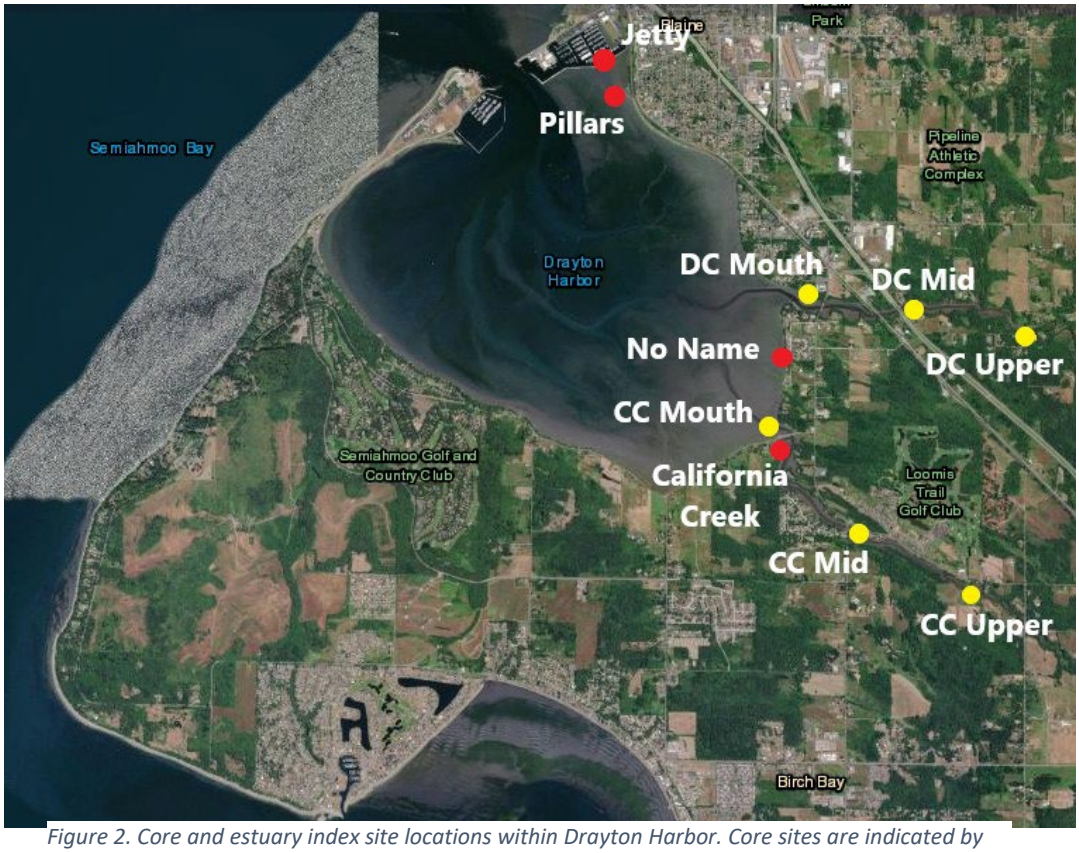

Figure 2. Core and estuary index site locations within Drayton Harbor. Core sites are indicated by red points and Estuary Index sites are indicated by yellow points. DC refers to Dakota Creek and CC refers to California Creek

Timeline

The management plan will encompass tasks that occur from April 2020 to June 2021. If funding allows for the continuation of trapping efforts within Drayton Harbor beyond June 2021, the management plan will be examined and revised as needed.

The projected timeline for the completion of tasks is dependent upon the easing of measures related to COVID-19 (Office of the Governor, 2020) which is inherently impossible to predict. For that reason, in lieu of specific target dates, the timeline will be presented in highest to lowest priority order:

1. Establish partnerships with entities, including tribes, agencies, organizations and others, who request involvement with this management plan and determine their responsibilities through the completion of a Memorandum of Understanding (MOU).
2. Complete preparation of management plan.
3. Contact landowners for permission to access land.
4. Train WDFW technicians and NWSC staff on trapping protocols.

5. Begin implementation of management plan through trapping efforts.
6. Recruit and train partner staff for trapping efforts.
7. Recruit and train volunteers for trapping efforts.
8. Conduct outreach events to educate and engage public.
9. Evaluate findings and collected data to reassess trapping plans and protocols. Adjust if necessary.
10. Review and revise management plan and MOU as necessary.

Plan Leadership and Implementation

WDFW and NWSC will co-lead this cooperative effort to conduct extensive trapping for assessing the full scope and scale of current EGC invasion and reduction of population numbers to manageable levels. EGC experts from WDFW and WSG will provide high-level oversight and coordination, scientific consultation, and planning quality control as needed. As appropriate and feasible, trapping and control activities will be supported by partner staff from local agencies, tribes and organizations, as well as local volunteers, under the training and coordination of WDFW and NWSC.

Goals and Objectives

The goals for this management plan are:

1. *Capacity Building*: To gain support from and develop working relationships with project partners, volunteers, and landowners in order to establish a trapping work force, land access, and equipment needs.
2. *Assessment*: To collect and evaluate data on spatial and temporal patterns of EGC distribution, abundance, and demographic trends, in order to inform adaptive management approach and ensure efficient removal efforts.
3. *Risk Reduction & Management*: To conduct sustained and repeated trapping efforts in order to reduce current populations of EGC to the maximum extent achievable given resources and circumstances.
4. *Communications*: To establish and implement communication between plan leadership (WDFW, NWSC, and WSG) and partner staff, volunteers, and the local Blaine community in order to develop engagement opportunities and support for effective management actions.

Objectives and Deliverables:

Goal 1: Capacity Building

Objective 1.1 – Develop working relationships with local private and public landowners.

Task 1.1.1: Establish contact with and obtain land access from private and public landowners.

Task 1.1.2: Engage with the local community about ongoing trapping efforts to facilitate additional shoreline access and volunteer interest.

Task 1.1.3: Develop land access request template to formalize requests

Deliverables 1.1.1 - 1.1.3: Landowner communication log, request template, informational mailings sent to Drayton Harbor residents.

Objective 1.2 – Recruit and engage partners and volunteers to conduct trapping.

Task 1.2.1: Work with other agencies, tribes, and entities who may be able to dedicate staff time to trapping efforts to identify a pool of partner staff who can support removal trapping efforts.

Task 1.2.2: Engage local community volunteers to participate in trapping**.** All volunteers will complete WDFW volunteer forms and WDFW-mandatory training courses.

Task 1.2.3: Train volunteers and partner staff to conduct trapping under supervision of EGC project leaders.

Task 1.2.4: Work with volunteers and partner staff to conduct trapping under supervision of EGC project leaders.

Task 1.2.5: Document all volunteer records and record volunteer and contributed partner staff hours.

Deliverables 1.2.1 - 1.2.5: Record of volunteer and partner staff hours, volunteer and partner staff training documentation and presentations.

Objective 1.3 – Coordinate equipment needs and storage.

Task 1.3.1: Determine the number of traps required to meet trapping needs and what other equipment will be required for successful trapping efforts.

Task 1.3.2: Secure funding and financial support for equipment needs.

Task 1.3.3: Purchase traps and other equipment needed for trapping.

Task 1.3.4: Work with partners to establish where equipment and green crab specimens collected can be held/stored.

Deliverables 1.3.1 - 1.3.4: Equipment storage agreements, equipment purchase records, documentation of financial support from partners.

Goal 2: Assessment

Objective 2.1 – Assess the geographic scope of green crab presence in the Drayton Harbor Action Area

Task 2.1.1: Survey all previously surveyed locations in Drayton Harbor following trapping protocols laid out in Trapping Actions and Protocols.

Task 2.1.2: Expand exploratory trapping in Drayton Harbor Action Area to include shoreline and creek sites not previously surveyed.

Task 2.1.3: Conduct prospecting trapping and experimental trapping in subtidal zones.

Task 2.1.4: Address other questions about crab distribution and capture as they arise, e.g. other habitat types.

Deliverables 2.1.1 - 2.1.4: Section of 2020 Drayton Harbor annual report detailing assessment of Drayton Harbor including any graphs, maps, protocols, and data.

Objective 2.2 - Assess seasonal and temporal patterns and trends in green crab abundance and distribution.

Task 2.2.1: Establish and maintain a standard trapping effort at core removal stations, "hotspots" that will be trapped repeatedly (at least 2 nights every two weeks) and with consistent trap placement across the entire trapping season as described in Trapping Actions and Protocols.

Task 2.2.2: Evaluate seasonal use of estuarine creeks along a tidal gradient by green crabs. Establish and maintain a standard trapping effort at 3 estuary index sites along California and Dakota Creeks that will be trapped repeatedly (at least 1 night every two weeks) and with consistent trap placement across the entire trapping season as described in Trapping Actions and Protocols.

Task 2.2.3: Document WSG Crab Team monthly monitoring at existing California Creek site to support assessment of temporal patterns and trends, including bycatch.

Deliverables 2.2.1 - 2.2.3: Section of 2020 Drayton Harbor annual report detailing temporal and seasonal patterns and trends.

Objective 2.3 – Collect, analyze and interpret data on all trapping efforts to inform management.

Task 2.3.1: Record location (geographic coordinates) and dates of all traps set. Document number of all species present in each trap and collect any other necessary data, as described in Trapping Actions and Protocols.

Task 2.3.2: Collect EGC specimens and meta data as described in Trapping Actions and Protocols, to evaluate demographic trends and processes influencing EGC in Drayton Harbor.

Task 2.3.3: Evaluate spatial CPUE to identify EGC hotspots.

Task 2.3.4: Evaluate seasonal patterns and temporal trends in abundance and distribution, and detect new cohorts of EGC.

Task 2.3.5: Provide EGC specimens to WSG, as the science lead, to utilize for research purposes as appropriate, e.g., genetics, etc.

Deliverables 2.3.1 - 2.3.5: Section of 2020 Drayton Harbor annual report summarizing all data collection, including specimens provided for ongoing studies, analyses, and interpretations.

Goal 3: Risk Reduction and Management

Objective 3.1 – Reduce current EGC population through an adaptive management process primarily based on removal trapping.

Task 3.1.1: Conduct most frequent and extensive trapping at sites identified as hot spots or possible sources as described in Trapping Actions and Protocols.

Task 3.1.2: Conduct additional removal trapping activities at secondary sites (i.e. lower detection rates of EGC) as resources permit, to address all sites where green crabs have been detected within the action area as described in Trapping Actions and Protocols.

Task 3.1.3: Coordinate and lead crews of partner staff and volunteers as appropriate to conduct trapping work.

Deliverables 3.2.1 - 3.2.3: Section of 2020 Drayton Harbor annual report detailing all trapping activities.

Objective 3.2 – Develop recommendations for ongoing management and removal efforts.

Task 3.2.1: Develop annual report for the 2020 trapping season to inform management.

Task 3.2.2: Develop and propose any suggested changes to management plan and trapping protocols for March 2021 – June 2021 based on 2020 findings.

Task 3.2.3: Dependent on available funding, develop and propose changes to management plan for July 2021 – October 2021 based on 2020 findings and ongoing availability of resources.

Deliverables 3.2.1 – 3.2.3: Section of Drayton Harbor 2020 annual report detailing future trapping proposals.

Goal 4: Communications

Objective 4.1 – Increase public awareness and engagement of EGC issue through community outreach to increase local support for management efforts, including volunteer recruitment.

Task 4.1.1: Participate in public outreach events (talks, tabling, etc.). These may be dependent public health recommendations and COVID-19 precautions.

Task 4.1.2: Produce and disseminate appropriate signage and collateral, flyers, rack cards, and pocket IDs.

Task 4.1.3: Create broad public awareness through local news, social media, and other online-based outlets.

Task 4.1.4: Establish and maintain ArcGIS online dashboard and site hosted by WDFW as hub site for Drayton-specific status and news.

Task 4.1.5: Provide relevant information for local agencies and educational institutions.

Deliverables 4.1.1 - 4.1.5: Documentation of outreach events, workshops, news reports, signage placed, flyers made, stickers, and other relevant media.

Objective 4.2 – Facilitate communication with statewide partners.

Task 4.2.1: Update statewide partners via periodic meetings.

Task 4.2.2: Summarize and present activities and findings to partners statewide to facilitate transfer of knowledge and expertise.

Task 4.2.3: Participate in EGC-related meetings, workshops, conferences, (etc.) as requested and available.

Deliverables 4.2.1-4.2.3: End of season report, presentation and stakeholder meeting/s.

Objective 4.3 – Facilitate communication with Drayton Harbor Taskforce and other local partners.

Task 4.3.1: Summarize and share data with all partners to facilitate transfer of knowledge.

Task 4.3.2: Update Drayton Harbor Taskforce through periodic meetings.

Deliverables 4.3.1-4.3.2: Documentation of meetings and records of data sharing

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Appendix A: Trapping Actions and Protocols

Drayton Harbor European Green Crab Management Plan: Trapping Actions and Protocols

Overview

The project goal is to assess the scale of the current European green crab (hereafter: EGC) invasion in Drayton Harbor, WA and to reduce the population to manageable numbers. Trapping efforts are governed by the collaborative Drayton Harbor green crab management effort and are intended to be adaptive. Protocols outlined here provide a baseline for shared understanding and communication of trapping methods and this document will be updated as needed to reflect any substantive changes in operations. For more information, please refer to the 2020 Drayton Harbor Collaborative Management Plan for European Green Crab and Memorandum of Understanding.

Approach

Baited trapping is currently considered the best way to attract and remove EGC from their intertidal habitats. These protocols primarily rely on the two trap types used broadly in EGC trapping, square Fukui fish traps and Gee-brand minnow traps (Equipment and Standards) deployed from shore during low tides for overnight high-tide soak. Traps may be set on multi-night soaks, but are *always* checked daily to release any native animals, and re-bait if possible. The practicalities may require that bait selection is conducted opportunistically based on availability, though mackerel is preferred if available. The majority of trapping work should be conducted from March through October, with particular emphasis on late spring (May through early June), as these are times of year EGC appear to be most catchable in this region. Winter/off-season trapping may be conducted on an experimental or opportunistic basis to assess seasonal changes in habitat use. Though boat-based deployment of traps may also be investigated for logistical efficiency, or for use in deploying traps sub-tidally, shore trapping on low tide reduces the chance of trap emersion on higher low-tides, which carries a risk of bycatch (terrestrial and aquatic) mortality.

Best Practices

With the twin goals of 1) specifically targeting green crabs and 2) reducing environmental harm, a list of best practices to factor into trap setting and site selection is listed below. This is not an exhaustive list, and these goals must also be balanced with other priorities (e.g. human safety, experimental trapping) guiding efforts.

Targeting EGC:

- Set traps around daytime lower low tide for overnight high tide.
- Set traps near structure (<20m).
- Set traps at least 10m apart for different trap types (20m for same trap type) to avoid trap interference.

- Pin trap securely to substrate using stakes and/or weights. Crabs are reluctant to enter unstable traps.

Reducing habitat/environmental damage:

- Traps should be at least 50% submerged during entire deployment.
- Consider water temperature when timing retrieval to reduce bycatch mortality.
- Release native animals in cool, protected water to aid recovery/survival.
- Avoid areas that will be 100% fresh water at low tide to reduce bycatch mortality.
- Reduce opening size of Fukui traps with zip tie to reduce opportunity for mammals or very large fish to enter.
- Use extra weight and PVC stake in higher-energy or open tide flat areas to reduce potential for trap loss.
- Avoid high flow/scour areas, or steep slopes to reduce potential for trap loss.

Removal/Control Efforts

To remove as many green crabs as possible and control population densities in Drayton Harbor, EGC hotspots will be targeted for the most sustained and substantial trapping efforts to reduce populations to manageable levels. These sites will be addressed through a combination of trapping site strategies, including:

- Core sites – consistent trap number and placement, comprising a minimum effort. These sites were identified at the beginning of the 2020 season based off hotspots discovered during response efforts in 2019.
- Secondary sites – opportunistic trap number and placement building off core and other sites with relatively high EGC observed density, trapped as resources are available to do so. Sites with relatively lower observed abundances of green crabs (e.g. outside the Harbor, Dakota Creek sites) can also be considered secondary sites.

These strategies balance several priorities including: (1) the need for consistent data collection to enable robust evaluation of green crab population dynamics, (2) streamlining logistics to maximize personnel efficiency, and (3) the need for flexible and scalable efforts to adapt to changing resources and new information on green crab abundance and distribution.

Exploratory Efforts

To evaluate trapping strategies and track green crab distribution across Drayton Harbor, a combination of exploratory trapping strategies will be used, including:

- Estuary index sites – three consistently implemented trapping sites extending up each of the two creeks within Drayton Harbor (California and Dakota) to evaluate seasonal influence of salinity on green crab distribution
- Prospecting – trapping at sites not previously trapped, but which comprise reasonably suitable habitat for green crab
- Experimental – trapping at sites/habitat believed to be less suitable for green crab, or using alternate gear types, to validate trapping assumptions and approaches

These approaches will improve efficiency and efficacy of removal trapping activities, i.e. reducing the probability of any other hotspots remaining undetected, and ensuring gear is used to the fullest efficiency of resources. Trapping activities in these sites will occur less frequently than sites targeted for removal trapping (core and secondary), unless new hotspots or approaches are identified. Leads will gain site permission/access and set traps for a minimum of one night and up to three consecutive night soaks. For prospecting and experimental strategies, explicit trapping plans will be developed by management leads (WDFW and WSG), and may be implemented by a combination of leads and technicians.

Site Prioritization and Trapping Protocols

Removal/Control Efforts

Core Sites

Goal: To remove as many EGC from the management area as possible given available resources, best practices, and safety. Core sites are located where previous efforts have resulted in EGC captures and are a focus for consistent trapping effort during the 2020 trapping season. Core sites should be trapped with consistent trap placement for the duration of a season, but could be reassessed and adjusted annually if they no longer fall within the criteria for hotspots.

Geographic Scale: Four established sites, each consisting of between 10 and 30 traps, according to the scale of the site (Figure 1). Locations of individual traps are marked with semi-permanent stakes (PVC, or survey flags) to enable consistent trap placement.

Temporal Scale: Sites will be trapped at a minimum of twice per month for two consecutive nights each time during the trapping season of March through October. Core sites should be trapped for the entire season, even if capture rates drop off.

Data: Aerial maps of trap locations along with datasheets with prefilled latitude and longitude coordinates are provided to field staff. Because trap placement is consistent, only EGC capture and bycatch data need to be collected.

Secondary Sites

Goal: To remove as many EGC from the management area as possible given available resources, best practices, and safety. Secondary sites may be located either in areas where previous efforts have resulted in relatively lower green crab capture rates than at core sites, or in previously un-trapped areas adjacent to core sites with suitable habitat. Secondary sites will be trapped opportunistically based on property access, habitat, trends in EGC trapping, and resources available.

Geographic Scale: Trapping scale will vary based on location and feasibility. Within sites, field staff will set as many traps as possible during low tide throughout the high-risk site. Leads and field technicians will determine trap placement using "on the fly" decision making based on best practices and habitat. Alternating trap type, and setting traps approximately 20 meters apart is a good baseline strategy, and can be modified for each site depending on habitat. For instance, different trap types may be targeted to microhabitats; placing minnows in the upper intertidal versus Fukui traps in order to target smaller crabs and/or reduce bycatch of native and mammalian species. Field staff may also place traps closer together than the recommended 20 meter separation (minimum 10 meters) dependent on suitable habitat. For example, placing traps 20 meters apart in long simple channels is sufficient, but in complex, branching channels, or patchy habitats, it may be important to place traps around each bend, or targeting microsites (e.g. logs, pools) that offer protection.

Temporal Scale: Trapping frequency will vary based on EGC findings and feasibility.

Data: Because trap placement will be conducted "on the fly" with each secondary site effort, trap placement data, EGC capture, and bycatch data need to be collected.

Exploratory Efforts

Estuary Index Sites

Goal: To evaluate whether seasonal changes in salinity regimes along estuarine gradients created by creek systems influence green crab habitat use in California and Dakota creeks.

Geographic Scale: Three sites per creek (mouth, midway, and upstream) where habitat generally appears suitable for EGC, for a total of six sites (Figure 1). Transects of six traps, alternating between three minnow and three Fukui, will have consistent start and end points using GPS coordinates and landmarks. These locations will be predetermined by leads.

Temporal Scale: Sites will be trapped at a minimum of one night per month during the trapping season of March through October.

Data: Aerial maps of trap locations along with datasheets with prefilled start and end latitude and longitude coordinates are provided to field staff. Because trap placement is consistent, only EGC capture and bycatch data need to be collected.

Prospecting Sites

Goal: To explore previously un-trapped sites within the Drayton Harbor management area that may also offer suitable habitat for green crabs based on previous detections and regional patterns. Prospecting sites will be trapped opportunistically based on property access, habitat, and trends in EGC trappings, and resources available.

Geographic Scale: High risk sites suitable for EGC are determined by science experts via aerial images with some ground truthing (e.g. Grason et al. 2017). Similar to trapping at secondary sites, field staff will set as many traps as possible during low tide throughout the high-risk site. Leads and field technicians will determine trap placement using "on the fly" decision as described in the secondary sites section above.

Temporal Scale: Sites will be trapped at a minimum of one to two nights during the trapping season of March through October. If green crabs are discovered, sites may become secondary sites to increase frequency of trapping and remove as many EGC as possible.

Data: Because trap placement will be conducted "on the fly" with each prospecting site effort, trap placement data, EGC capture, and bycatch data need to be collected.

Experimental Trapping

Goal: To test and validate assumptions about efficiency and efficacy of trapping with respect to habitat use by EGC as well as context dependent trap performance.

Geographic Scale: Using a flexible approach, leads (WSG and WDFW) will plan and prioritize experimental trapping efforts to target sites with habitat believed to be less suitable for EGC than other strategies (e.g., sandy beaches, subtidal tide flats). In addition, experimental trapping may be used to evaluate the performance of alternate gear types (e.g. various

shrimp traps, habitat/burrow traps, pitfall traps, or bait types) across various trapping contexts.

Temporal Scale: Sites will be trapped at a minimum of one to two nights during the trapping season of March through October. If EGC are discovered, sites may become secondary sites to increase frequency of trapping and remove as many EGC as possible and alternate gear may be incorporated into more routine protocols.

Data: Because trap placement will be conducted "on the fly" with each experimental site effort, trap placement data, EGC capture, and bycatch data all need to be collected. In addition, where alternate gear or bait types are being tested, careful notes on gear parameters should be kept to enable post hoc evaluation of efficacy.

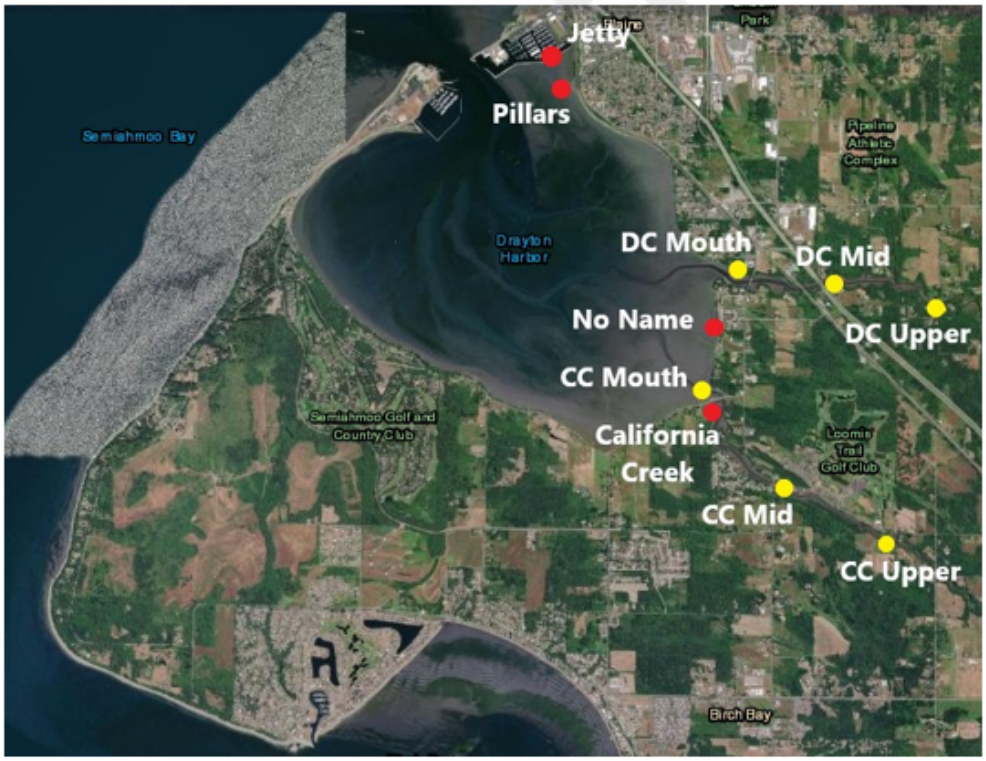


Figure 1. A map of the Drayton Harbor Action Area. Red markers indicate core sites and yellow markers indicate estuary index sites. DC refers to Dakota Creek and CC refers to California Creek.

Equipment and Standards

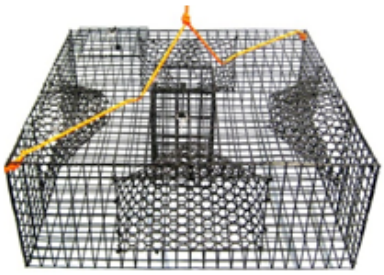
Trap Types

Fukui traps have large openings and the mesh is 1/2" (12 mm). In unmodified traps, the opening is 16" (0.4 meters) and can stretch several inches tall allowing for large fish or mammals to enter. To limit the possibility of larger animals entering the trap, zip-ties are used to fasten together the top to bottom panels of the opening at the middle, reducing the width by half. These traps are used for all EGC trapping efforts.

Gee-brand minnow traps with galvanized steel mesh size ¼" (6 mm). WDFW modifies these traps to enlarge the opening to approximately 2 inches in diameter. The larger-than-standard opening allows for smaller EGC to enter while is still small enough to prevent mammals or larger fish from entering. These traps are used for all EGC trapping efforts.

Russel shrimp traps will be used primarily for experimental trapping but could be used during prospecting, e.g., in deeper habitats.
Photo courtesy of Makah (left: Makah-constructed trap, right: WDFW- constructed trap).

Promar-brand 4-way shrimp traps will be used primarily for experimental trapping but could be used during prospecting as well, e.g., in deeper habitats. Bait may or may not be enclosed in an additional jar or container within the bait locker in the trap itself.



Data Standards

Data collected vary by trapping site and approach as described in Site Prioritization and Trapping Actions section. Effort and EGC data are required at minimum regardless of type of effort, and bycatch data (to the level of number of species or taxon) should also be collected except in extenuating circumstances which will be determined by leads. Samples of all data sheets are provided.

Effort

Information on trap type, location (geographic coordinates), and date are collected for all trap sets. For sites where trap location is consistent (core and estuary index), effort data can be streamlined with pre-filled data sheets. In either case, a version of the Trap Deployment Datasheet can be used.

Trap Catch

All animals captured in traps are recorded on the Trap Catch data sheet, including EGC. Catch, as number of individuals of each species or taxon is recorded in the field or with photo documentation. Taxonomic resolution will generally follow the WSG Crab Team guides (WSG Crab Team, 2020) In general, four-letter species codes, drawn from the first two letters of the genus and first two letters of the species name are used (e.g. CAMA for EGC comes from *Carcinus maenas* while Dungeness crab is listed as MEMA, for *Metacarinus magister)*. In very rare cases (low personnel availability and urgent trap retrieval), leads may elect to omit Trap Catch from data collection, in which case number of EGC in a given trap, along with EGC metadata and Effort, will be the only pieces of information recorded. This should be a case of last resort.

EGC

For each individual EGC captured, the minimum metadata recorded include trap effort (date, location, type), crab condition (live, dead, or molt), sex, size (as measured to the outside of the 5th anterio-lateral spine of the carapace, Figure 2), limb damage, shell condition (using ventral color and presence of shell epibionts as a proxy for molt stage estimation), and whether females are gravid. A photo of the ventral and dorsal side of each EGC captured along with the trap ID should be taken. Crabs will be assigned unique ID numbers.

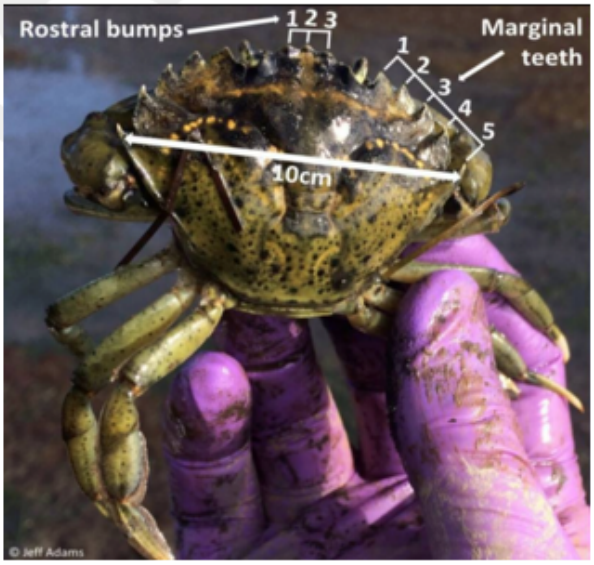


Figure 2. Example of EGC and where size of the carapace width is measured. Maximum size of EGC is roughly 10 cm.

Sample Data sheets

Trap Deployment Datasheet

For core sites, the coordinates, trap ID, and trap type will be pre-filled. For estuary index sites, the start and end coordinates, trap ID and trap type will be pre-filled. Blank datasheets will be available for all other trap deployments. Trap number refers to the attached WDFW tag number found on individual traps. Columns for "Checked Day 1/2" offer a way track which traps have been checked on intermediated days of multi-day deployments. This example has two columns since two-night deployment is most common, but additional columns could be used for longer deployments.

TRAP DEPLOYMENT DATASHEET	LOCATION (MANGEMENT AREA[1]/WATERBODY/SITE): CORE - JETTY								PAGE _1_ of _1_
	PERSONNEL:								ENTERED IN DATABASE: ☐
DEPLOYMENT START/END TIME:	NOTES:								
RETRIEVAL START/END TIME:									EGC: YES / NO
WEATHER:									
DATE DEPLOYED	**DATE RETRIEVED**	**TRAP ID**	**TRAP TYPE[2]**	**TRAP #**	**LATITUDE**	**LONGITUDE**	**CHECKED DAY 1**	**CHECKED DAY 2**	**NOTES**
		C.J.01	F		48.991602	-122.756026			
		C.J.02	M		48.991751	-122.755718			
		C.J.03	F		48.991778	-122.755589			
		C.J.04	M		48.991873	-122.755336			
		C.J.05	F		48.991982	-122.755065			
		C.J.06	M		48.992058	-122.754921			
		C.J.07	F		48.992146	-122.754670			
		C.J.08	M		48.992273	-122.754437			
		C.J.09	F		48.992351	-122.754208			
		C.J.10	M		48.992435	-122.754035			
		C.J.11	F		48.992522	-122.753881			
		C.J.12	M		48.992641	-122.753520			
									13 ENTRIES PER SHEET

[1]Management Area: Western or Eastern Strait of Juan de Fuca, North, Central, or South Puget Sound, San Juan Islands, Hood Canal, Outer Coast, Willapa Bay, Grays Harbor

[2]Trap Type: M = Minnow, F = Fukui, R = Russel, P = Fitfell, SB = Shell Bags, H = Hand

Trapping Effort Datasheet

For core and estuary index sites the Trap ID and Trap Type will be pre-filled because location of these traps is consistent and marked by semi-permanent site stakes. Blank datasheets will be available for all other trapping deployments. Trap number refers to the attached WDFW tag number found on individual traps. Species will be recorded using four letter codes (see Trap Catch above).

TRAPPING EFFORT DATASHEET	LOCATION (MANGEMENT AREA[1]/WATERBODY/SITE): CORE - JETTY								PAGE _1_ of _1_	
	PERSONNEL:								ENTERED IN DATABASE: ☐	
DATE:		NOTES:								
START/END TIME:									EGC: YES / NO	
WEATHER:										
TRAP ID	**TRAP TYPE[2]**	**TRAP #**	**CAMA**	**HEOR**	**LEAR**					
C.J.01	F									
C.J.02	M									
C.J.03	F									
C.J.04	M									
C.J.05	F									
C.J.06	M									
C.J.07	F									
C.J.08	M									
C.J.09	F									
C.J.10	M									
C.J.11	F									
C.J.12	M									
										15 ENTRIES PER SHEET

[1]Management Area: Western or Eastern Strait of Juan de Fuca, North, Central, or South Puget Sound, San Juan Islands, Hood Canal, Outer Coast, Willapa Bay, Grays Harbor

[2]Trap Type: M = Minnow, F = Fukui, R = Russel, P = Pitfall, SB = Shell Bags, H = Hand

European green crab capture datasheet

EGC # is the assigned unique ID number. Location/Site refers to the site in general, whether it is a core site, estuary index site or prospecting. If it is a core or index site then the name of the site is added here as well. Trap ID refers to the consistently placed traps from core and index sites. Trap number refers to the attached WDFW tag number found on individual traps. For details on EGC data, see EGC section above.

EUROPEAN GREEN CRAB (EGC) DATASHEET												PAGE __ of ___
EGC #	DATE	LOCATION/SITE	TRAP ID	TRAP TYPE[1]	TRAP #	SEX	SIZE (MM)	COLOR	LIMB STATUS[2]		EGGS	BARNACLES
1	MM/DD/YY	CORE - JETTY	CJ.01	M	613	(M) / F / UNK	87.4	LG	L1,2 Lr4	R3 Rd2	YES / (NO)	(YES) / NO
COMMENTS: EGC was very soft, found near a large down tree, with tons of large barnacles and no bycatch.												DATABASE: [X]
						M / F / UNK					YES / NO	YES / NO
COMMENTS:												DATABASE: ☐
						M / F / UNK					YES / NO	YES / NO
COMMENTS:												DATABASE: ☐
						M / F / UNK					YES / NO	YES / NO
COMMENTS:												DATABASE: ☐
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						M / F / UNK					YES / NO	YES / NO
COMMENTS:												DATABASE: ☐
						M / F / UNK					YES / NO	YES / NO
COMMENTS:												DATABASE: ☐

[1] Trap Type: M = Minnow, F = Fukui, R = Russel, P = Pitfall, SB = Shell Bags, H = Hand

[2] Limb Status: L = left, Lr = left rejuvenating, Ld = left damaged; R = right, Rr = right rejuvenating, Rd = right damaged

10 entries/page

European green crab ID tags

Each individual EGC captured will have a specimen tag that documents the crab metadata also recorded on the EGC capture datasheet. The tag will travel with the crab specimen until the specimen is destroyed.

EGC #: _____ **COLLECTION DATE:** ____/____/____
LOCATION/SITE: ___________________________
TRAP TYPE: _____ **TRAP #:** _____ **MOLT:** Y / N
SEX: M / F / UNK **SIZE:** _____mm **EGGS:** Y / N / NA
COLOR (UNDERSIDE): __________ **BARNACLES:** Y / N
MISSING LIMBS: L 1 2 3 4 5 R 1 2 3 4 5
REJUVENATING: _________ **DAMAGED:** _________

Geographic data collection

Geographic coordinates are collected in decimal degrees using WGS 84 with at least 5 decimal precision. Coordinates may be collected in the field via approved phone app or GPS receiver. Additionally, it is sufficient to collect coordinates (or correct field-collected coordinates) post-sampling, by pinning or adjusting location on a map with satellite imagery (e.g. Google Maps/Earth, or ArcOnline). Below are example coordinates in decimal degrees from core sites.

Site	Coordinates
Jetty Core	48.99205, -122.75492
Pillars Core	48.98876, -122.75495
No Name Creek Core	48.96822, -122.73331
California Creek Core	48.96083, -122.73395

References

Grason EW, PS McDonald, J Adams, K Litle, JK Apple, A Pleus (2018) **Citizen science program detects range expansion of the globally invasive European green crab in Washington State (USA).** *Management of Biological Invasions*. Vol 9 (1): 39-47. DOI: https://doi.org/10.3391/mbi.2018.9.1.04

WSG Crab Team (2020) Full Species List. wsg.washington.edu/crabteam/get-involved/toolbox Accessed on 7/7/20

Appendix B: Memorandum of Understanding (Copy)

Appendix C: Letter to the Governor (Copy)

State of Washington
DEPARTMENT OF FISH AND WILDLIFE
Mailing Address: P.O. Box 43200, Olympia, WA 98504-3200 • (360) 902-2200 • TDD (360) 902-2207
Main Office Location: Natural Resources Building, 1111 Washington Street SE, Olympia, WA

February 18, 2020

The Honorable Jay Inslee
Governor
P.O. Box 40002
Olympia, WA 98504-0002

Dear Governor Inslee:

The recent significant detection of European green crab in Drayton Harbor and Lummi Bay, and the wide gap in assessment of this species' presence and populations throughout the Salish Sea and coastal areas, poses imminent danger to Washington State's environment, economy and well-being. It is our best professional judgement, in consultation with a broad spectrum of partners and co-managers, that these detections are the "tip of the iceberg" of much larger populations in those areas. Emergency measures are necessary to provide the best chances of successfully controlling the green crab at current low population levels. However, sufficient resources are not available to support a swift response and I am asking for your assistance to address this problem.

European green crab are voracious predators and habitat modifiers as documented in their world-wide invasion history. In Washington State, those impacts include predation on shellfish and juvenile Dungeness crab, and destruction of critical habitat such as eelgrass beds and estuary marshes, which destruction could significantly impact juvenile Dungeness crab recruitment, shorebird food supply, salmon recovery, orca recovery and ultimately affect overall Puget Sound recovery efforts. Of equal importance, these resources are part of the cultural identity of the tribes and the citizens of Washington State. More detailed information on European green crab risks and an assessment of the imminent danger are provided in Exhibit 1. In recognition of these threats, the Washington Department of Fish and Wildlife (Department) co-signed the Salish Sea Transboundary Action Plan (Plan) in early 2019 (Exhibit 2) with the Department of Fisheries and Oceans Canada, the Puget Sound Partnership, and Washington Sea Grant. All actions proposed in this request fall within the scope of this Plan.

Therefore, under RCW 77.135.090, I request that you consider adopting findings and issuing an order for emergency measures under RCW 43.06.010(14) to allow the Washington Department of Fish and Wildlife (Department) to implement the following emergency provisions:

1) Direct the Puget Sound Partnership to establish and facilitate a task force to oversee short-term emergency and guide long-term European green crab management in the Salish Sea;

2) Support an emergency gap funding request of **$220,886** to implement highest priority emergency management actions between March 1 and June 30, 2020, to initiate the task force, allow immediate population assessment actions at Drayton Harbor and Lummi Bay, and prepare for implementation of full actions pending a requested 2020 legislative appropriation.
3) Support an emergency funding request to the 2020 Legislature of **$725,161** to implement emergency actions by a broad coalition for control of European green crab populations where they pose imminent danger of becoming established, and to conduct detection surveys to assess the full scope and scale of risk to the state;
4) Direct the Washington Coast Marine Advisory Council to coordinate and lead the development a coastal management plan; and
5) Direct the Washington State Departments of Agriculture, Natural Resources, and Parks to identify European green crab management as a high priority on their respective state-owned aquatic lands and to facilitate implementing the emergency measures described herein.

The basis of this combined **$946,047** emergency funding request is the Department finding that there exists an imminent danger of infestation from European green crab (*Carcinus maenas*), classified as a prohibited level 1 species (highest risk) under RCW 77.135.030, that seriously threatens the environment, economy and well-being of the State of Washington. Under RCW 77.135.090, such a finding requires the Department to request the Governor to order emergency measures under RCW 43.06.010(14), which provides specific authorization for the Governor to order emergency measures for preventing or abating the prohibited species. Copies of relevant statutes are provided in Exhibit 3.

The problems created by green crab extend far beyond the jurisdiction and mandate of the Washington Department of Fish and Wildlife. As such, an effective response will require cooperation among local, state, federal, and tribal governments, Canada, non-governmental organizations, and private industry. Among these entities there is a great capacity for in-kind resources, but they cannot be effectively utilized without additional funding to support the coordination, training, experienced field leadership, and data management required for this scale of response. Proposed expenditures for the emergency funding are provided in Exhibit 4 and an evaluation of the effect of the requested emergency measures on environmental, economic, human health and well-being factors can be found in Exhibit 5

Extensive searching has found no other potential funding sources that can offer us the ability to respond in a timely, effective manner, and waiting until the 2021 Legislative Session would likely allow the green crab populations to expand beyond our ability to stop their becoming established in the Salish Sea – as once they are established, costs for control and mitigation and loss of commercial and recreational resources could dramatically increase into the tens, if not hundreds of millions of dollars.

Given the imminent danger of the European green crab's threat to the state's marine environment, marine-based economy, and the cultural well-being of Washington State, it is imperative that the Department lead a cooperative approach to apply all possible means in the

effort to prevent their establishment. The potential costs of inaction are unacceptably high. The longer we delay implementing emergency response actions, the greater the risk that those actions will be ineffective against the growing crab populations. The longer the delay, the more costly response actions will be to achieve—if even possible—the same level of results as earlier intervention. The longer the delay, the greater the risk of significant and potentially irreparable harm to economic and cultural resources.

I assure you that all funds entrusted to the Department, partners and co-managers will be used wisely and that our actions will serve to strengthen public confidence in this agency and state government. I know funds available to you for emergencies are extremely limited. In carefully evaluating this situation, I am convinced there are no other available funding sources capable of providing the swift action required to adequately address this imminent danger.

Please do not hesitate to contact me or Amy Windrope, Deputy Director, at (360) 902-2720, if you have questions or wish further information.

Sincerely,

Kelly Susewind
Director

cc: Fish and Wildlife Commission
Allen Pleus, Aquatic Invasive Species Unit Manager

Enclosures:

Exhibit 1. Detailed findings and conclusions for determining European green crab meet an imminent danger threshold.
Exhibit 2. Salish Sea Transboundary Action Plan for European Green Crab.
Exhibit 3. RCW 77.135.090 Emergency measures and 43.06.010(14) Governor's General powers and duties.
Exhibit 4. Proposed Emergency Actions and Budget to Address Imminent Danger Risks.
Exhibit 5. Evaluation of the effect of the requested emergency measures on environmental, economic, human health and well-being factors.
Exhibit 6. Draft Governor's Proclamation for European green crab emergency measures