FACT SHEET FOR THE
ZOSTERA JAPONICA MANAGEMENT ON COMMERCIAL CLAM BEDS IN WILLAPA BAY NPDES GENERAL PERMIT

September 17, 2019
Factual Corrections March 2020

SUMMARY

The Washington State Department of Ecology's (Ecology) is proposing minimal changes from the 2017 version of ***Zostera japonica*** Management on ***Commercial Clam Beds*** in Willapa Bay National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge ***General Permit***, which expired on May 2, 2019.

This fact sheet is a companion document to the general permit. It explains the nature of the proposed ***discharge***, Ecology's decisions on limiting ***pollutants*** in the receiving water, and the legal and technical basis for these decisions.

The *Zostera japonica Management on Commercial Clam Beds in Willapa Bay General Permit* (permit) regulates the use of the aquatic ***herbicide*** imazamox and ***marker dyes*** applied to manage *Z. japonica* on commercial clam beds (excluding geoduck culture) in Willapa Bay where imazamox may enter the ***surface waters of the State of Washington***. The permit covers only the chemical management of *Z. japonica*. Project proponents may need other permits if they conduct *Z. japonica* management activities using other methods.

Since the *Headwaters, Inc. v. Talent Irrigation District* Ninth Circuit Court decision, Ecology has maintained that to discharge chemicals to waters of the State, coverage under an NPDES permit is required. Ecology has issued general and individual NPDES permits for ***discharges*** of aquatic ***pesticides*** and other chemicals since 2002. In 2009, the Sixth Circuit Court ruled in *National Cotton Council et al. v. The Environmental Protection Agency (EPA)* that the discharge of pesticides and their residues to waters of the State requires NPDES permit coverage. This decision means that NPDES permitting is required for all aquatic pesticide applications throughout the United States. EPA developed a general NPDES permit for this purpose (effective October 31, 2011). In Washington, the EPA permit covers aquatic pesticide applications on Federal and Tribal Lands.

Ecology may change the proposed terms, limits, and conditions contained in the draft permit based on comments and testimony it receives during a public comment period. The draft permit does not authorize a violation of surface water quality standards or the violation of any other applicable local, state, or federal laws or regulations. Ecology may require any person seeking coverage under this permit to obtain coverage under an ***individual permit*** instead.

Ecology will consider any person who applies imazamox to surface waters of the State without coverage under this general permit, another applicable general permit, an applicable individual permit, or a ***state experimental use permit*** *under the experimental use special condition* to be operating without a discharge permit and subject to potential enforcement action.

Note: The text of this Fact Sheet contains words or phrases, formatted in ***bold and italics*** when first used in the document. Unless the context clearly indicates otherwise, these words or phrases are defined in Appendix A.

Ecology proposes to issue this general permit so that dischargers operating under coverage of this permit will comply with the Federal Clean Water Act (CWA) (33 U.S.C. §1251 et seq.) and with the Washington Water Pollution Control Act, chapter 90.48 Revised Code of Washington (RCW). The ***Permittee*** must notify the public, post signs at treatment sites, monitor, and provide annual pre-treatment and annual treatment reports to Ecology.

TABLE OF CONTENTS

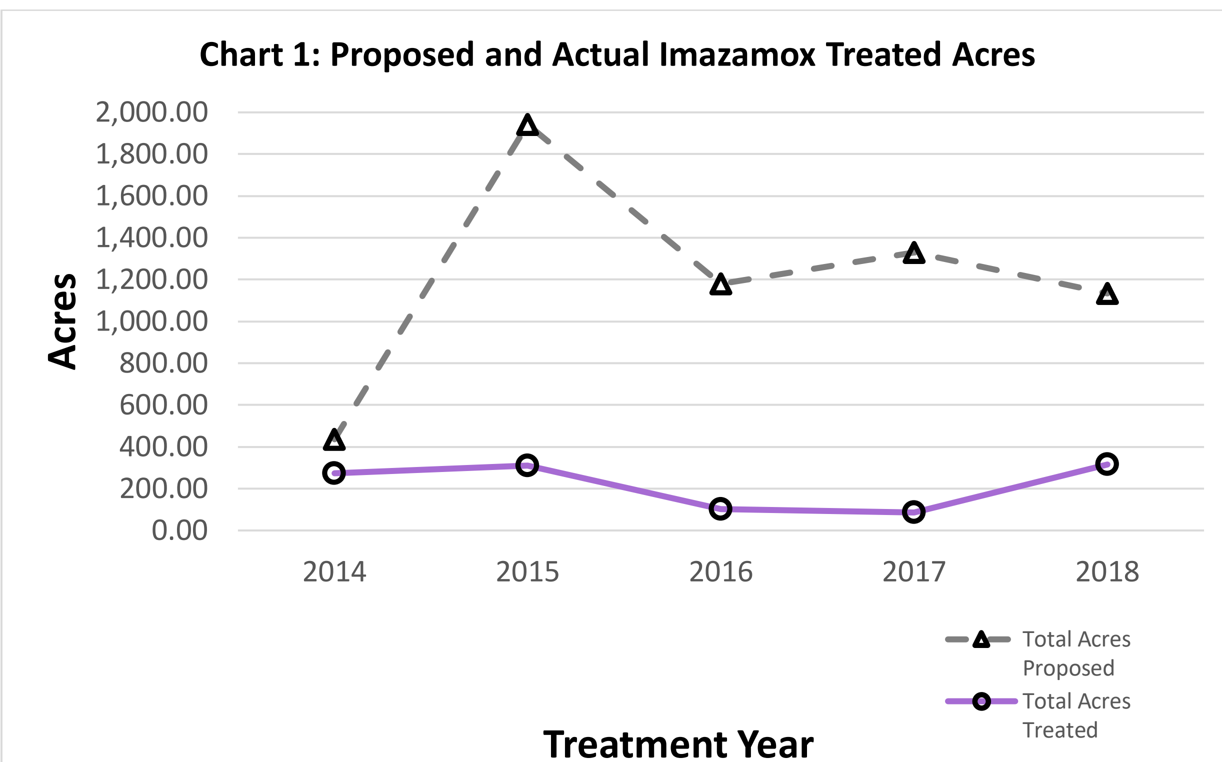
INTRODUCTION

The Washington State Department of Ecology (Ecology) is proposing minimal changes from the 2017 version of *Zostera japonica Management on Commercial Clam Beds in Willapa Bay* National Pollutant Discharge Elimination System (NPDES) and State Waste Discharge General Permit, which expired May 2, 2019. Changes to permit text are noted in each special condition where a change occur in blue underlined text for additions, and red underlined text for deletions. Ecology also updated web links and internal references where needed.

Ecology compiled the results of treatment of commercial clam beds for 2014 to 2018 based upon annual pre-treatment plans and annual treatment reports. The results are contained in Table 1 below, which Chart 1 a visual representation of a comparison by year of the Total Acres Proposed and Total Acres Treated fields in Table 1.

Table 1: Proposed and Actual Imazamox Treated Clam Bed Acres

Year	Number of Permittees	Total Acres Proposed	Total Acres Treated	Percent Proposed Acres Treated
2014	8	436.20	274.37	62.90%
2015	9	1,942.00	310.80	16.00%
2016	9	1,180.80	102.00	8.64%
2017	9	1,330.10	86.00	6.47%
2018	11	1,133.50	315.50	27.83%



This fact sheet is a companion document to the draft *Zostera japonica Management on Commercial Clam Beds in Willapa Bay General Permit* (permit) and provides the legal and technical basis for permit issuance required in chapter 173-226 Washington Administrative Code (WAC). Since 2001, based on *Headwaters v. Talent Irrigation District*, the Washington State Department of Ecology (Ecology) has permitted the discharge of pesticides to waters of the State under National Pollutant Discharge Elimination System (NPDES) permits. In 2009, the Sixth Circuit Court ruled in *National Cotton Council et al. v. The Environmental Protection Agency (EPA)* that the discharge of pesticides and their residues to waters of the State requires NPDES permit coverage. This decision means that NPDES permitting is required for all aquatic pesticide applications throughout the United States.

The draft permit covers the discharge of the aquatic herbicide imazamox and marker dyes to Willapa Bay for the management of *Z. japonica* on commercial clam beds. Ecology may require individual permits where a proposed activity requires additional guidance, or when an individual Permittee requests an individual permit and Ecology agrees to develop and issue one.

This permit helps Ecology:

- Mitigate and condition the aquatic use of the herbicide imazamox.
- Monitor impacts of imazamox treatments on native *Zostera marina* (*Z. marina*) eelgrass beds.
- Ensure that notifications and postings occur.

This fact sheet explains the nature of the proposed discharges, Ecology's decisions on limiting the pollutants in the receiving water, and the legal and technical basis for these decisions. WAC 173-226-130 specifies the required public notice of the draft permit, public hearings, comment periods, and public notice of issuance before Ecology can issue the general permit. This fact sheet, application for coverage, and draft permit are available for review. See Appendix B - Public Involvement - for more detail on public notice procedures.

After the public comment period closes, Ecology will summarize and respond to substantive comments. These comments may cause Ecology to revise some of the permit language and requirements. The summary and response to comments will become part of the file for this permit and parties submitting comments will receive a copy of Ecology's response. Ecology will **not** revise this fact sheet after it publishes the public notice. Appendix C (Response to Comments) will summarize comments and the resultant changes to the permit.

AQUATIC PESTICIDE LEGAL HISTORY

The Federal Clean Water Act (CWA)

The Federal Clean Water Act [CWA, 1972, and later modifications (1977, 1981, and 1987)], established water quality goals for navigable (surface) waters of the United States. One of the mechanisms for achieving the goals of the Clean Water Act is the NPDES system of permits, which the United States Environmental Protection Agency (EPA) administers. The EPA has delegated responsibility for administering the NPDES permit program to the State of Washington. EPA delegated authority to Ecology based on chapter 90.48 RCW that defines Ecology's authority and obligations in administering the NPDES permit program. Ecology does not have authority to issue NPDES permits to federal facilities or to "Indian Country" as defined in 18 USC Sec. 1151.

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)

The following excerpt is from EPA's 2010 NPDES Pesticides General Permit Fact Sheet and explains FIFRA:

> *EPA regulates the sale, distribution, and use of pesticides in the U.S. under the statutory framework of the Federal Insecticide, Fungicide, and Rodenticide Act of 1979, to ensure that when used in conformance with the label, pesticides will not pose unreasonable risks to human health and the environment. All new pesticides must undergo a registration procedure under FIFRA during which EPA assesses a variety of potential human health and environmental effects associated with use of the product. Under FIFRA, EPA is required to consider the effects of pesticides on the environment by determining, among other things, whether a pesticide will perform its intended function without unreasonable adverse effects on the environment, and whether when used in accordance with widespread and commonly recognized practice [the pesticide] will not generally cause unreasonable adverse effects on the environment.* 7 U.S.C. 136a(c)(5).
>
> *In performing this analysis, EPA examines the ingredients of a pesticide, the intended type of application site and directions for use, and supporting scientific studies for human health and environmental effects and exposures. The applicant for registration of the pesticide must provide specific data from tests done according to EPA guidelines.*
>
> *When EPA approves a pesticide for a particular use, the Agency imposes restrictions through labeling requirements governing such use. The restrictions are intended to ensure that the pesticide serves an intended purpose and avoids unreasonable adverse effects. It is illegal under Section 12(a)(2)(G) of FIFRA to use a registered pesticide in a manner inconsistent with it's labeling. EPA has delegated authority to States ~~have primary authority~~ under FIFRA to enforce "use" violations, but both the States and EPA have ample authority to prosecute pesticide misuse when it occurs.*
>
> *After a pesticide has been registered, changes in science, public policy, and pesticide use practices will occur over time. FIFRA, as amended by the Food Quality Protection Act of 1996, mandates a registration review program, under which [EPA] periodically reevaluates pesticides to make sure that as the ability to assess risk evolves and as policies and practices*

change, all registered pesticides continue to meet the statutory standard of no unreasonable adverse effects to human health or the environment. [EPA] is implementing the registration review program pursuant to Section 3(g) of FIFRA and will review each registered pesticide every 15 years to determine whether it continues to meet the FIFRA standard for registration. Information on this program is provided at ~~http://www.epa.gov/oppsrrd1/registration_review/~~ https://www.epa.gov/pesticide-registration/about-pesticide-registration.

FIFRA, as administered by the EPA and the Washington State Department of Agriculture (WSDA), requires that all persons that apply pesticides classified as restricted use be certified according to the provisions of the act, or that they work under the direct supervision of a certified ***applicator***. Commercial and public applicators must demonstrate a practical knowledge of the principles and practices of pest control and safe use of pesticides, which they accomplish by means of a "core" examination. In addition, applicators using or supervising the use of any restricted use pesticides purposefully applied to standing or running water (excluding applicators engaged in public health related activities) must pass an additional exam to demonstrate competency as described in the code of federal regulations as follows:

Aquatic applicators shall demonstrate practical knowledge of the secondary effects which can be caused by improper application rates, incorrect formulations, and faulty application of restricted pesticides used in this category. They shall demonstrate practical knowledge of various water use situations and the potential of downstream effects. Further, they must have practical knowledge concerning potential pesticide effects on plants, fish, birds, beneficial insects, and other organisms which may be present in aquatic environments. Applicants in this category must demonstrate practical knowledge of the principals of limited area application (40 CFR 171.4).

Any person wishing to apply pesticides to waters of the State must obtain an aquatic pesticide applicator license from WSDA or operate under the supervision of an **aquatic *licensed pesticide applicator***. See ~~www.agr.wa.gov/PestFert/LicensingEd/Licensing.htm~~ https://agr.wa.gov/services/licenses-permits-and-certificates/pesticide-license-and-recertification for information on Washington licensing requirements and testing.

Headwaters, Inc. v. Talent Irrigation District

In May 1996, as part of routine vegetation management, the Talent Irrigation District (TID) in southern Oregon applied the pesticide acrolein to a system of irrigation canals. Acrolein-treated water discharged into a fish-bearing creek causing a fish kill. Subsequently, Headwaters, Inc. and Oregon Natural Resources Council filed a Clean Water Act citizen suit against the TID for applying a pesticide into a system of irrigation canals without an NPDES permit.

The Ninth Circuit Court in *Headwaters, Inc. v. Talent Irrigation District* found that the applicator should have obtained coverage under an NPDES permit prior to application of aquatic pesticides to an irrigation canal. The decision addressed residues and other products of aquatic pesticides.

Reversing a district court's opinion, the Ninth Circuit Court held that application of the pesticide in compliance with the FIFRA labeling requirements did not exempt TID from having to obtain an NPDES permit and that the irrigation ditches were "waters of the United States" under the CWA (March 12, 2001).

Based on the TID court decision, Ecology, with advice from the Washington State Office of the Attorney General, determined that all pesticide applications to state surface waters required coverage under NPDES permits. Ecology issued its first NPDES general permits for pesticide applications to Washington's surface waters in 2002. Prior to 2001, Ecology regulated the application of aquatic pesticides to most surface waters by issuing administrative orders (called Short-Term Modifications of Water Quality Standards) to Washington-state licensed applicators. Since the Talent decision, there have been further court challenges about the applicability of NPDES permits to aquatic pesticide application as discussed below in this section of the Fact Sheet.

League of Wilderness Defenders et al. v. Forsgren

In the 1970's the Douglas fir tussock moth defoliated approximately 700,000 acres of Douglas fir in Idaho, Oregon, and Washington. In response to this outbreak, the United States Forest Service (USFS) developed a system to predict tussock moth outbreaks and control them via aerial spraying of insecticides. Based on its warning system, the USFS predicted an outbreak in 2000-2002 and designed a spraying program.

In 2002, the League of Wilderness Defenders et al. filed suit against the USFS for failing to obtain a NPDES permit under the Clean Water Act for the application of insecticides directly above surface waters. The USFS argued that any discharge of insecticides was nonpoint pollution and that the discharges fell under federal exemptions (40 CFR 122.3) for silviculture activities.

The Ninth Circuit Court reversed a district court's opinion upon appeal. It held that aerial spraying (from an aircraft fitted with tanks) directly to, and over, surface water is a point source of pollution and requires an NPDES permit.

Fairhurst v. Hagener

The Montana Department of Fish, Wildlife, and Parks (Department) began a ten-year program to reintroduce threatened native westslope cutthroat trout into Cherry Creek. The Department used antimycin-A, a piscicide, to remove nonnative trout from Cherry Creek over several years, after which they planned to reintroduce native trout.

The Department was sued under the citizen suit provision of the CWA for failing to obtain an NPDES permit before applying antimycin-A to surface waters. During summary judgment, the district court decided in favor of the Department. On appeal, the Ninth Circuit court affirmed the district court's opinion. The Ninth Circuit opined that:

> *A chemical pesticide applied intentionally, in accordance with a FIFRA label, and with no residue or unintended effect is not "waste", and thus not a "pollutant" for the purposes of the Clean Water Act. Because the Department's application of antimycin-A to Cherry Creek was intentional, FIFRA compliant, and without residue or unintended effect, the discharged chemical was not a pollutant and the Department was not required to obtain a NPDES permit*.

Neither the Court nor the EPA offered any guidance regarding which pesticide applications would result in no residue or unintended effect.

Northwest Aquatic Ecosystems v. Ecology, Washington Toxics Coalition

In February 2006, the Pollution Control Hearings Board (PCHB) issued a final order in Case #05-101, *Northwest Aquatic Ecosystems v. Ecology, Washington Toxics Coalition*. This case focused on a number of issues, one of which was whether an NPDES permit is required for the use of federally registered pesticides since the Ninth Circuit Court ruled in *Fairhurst v. Hagener*.

The PCHB ruled on summary judgment that the *Fairhurst* decision does not provide a blanket exemption for the application of aquatic pesticides. Pesticides must meet identified conditions before Ecology can consider it outside the category of a pollutant under the CWA. The pesticide must:

(1) Be applied for a beneficial purpose.

(2) Be applied in compliance with FIFRA.

(3) Produce no pesticide residue.

(4) Produce no unintended effects (Fairhurst, 422 F.3d at 1150).

Northwest Aquatic Ecosystems failed to provide any evidence specifically addressing how the use of the aquatic herbicides diquat and endothall on the proposed sites would meet the four conditions identified in *Fairhurst.* In the absence of such evidence, *Fairhurst* provided no basis for the PCHB to conclude that an NPDES permit is not required for the proposed pesticide applications.

EPA Final Rule

In November 2006, EPA issued a final rule under the CWA entitled *Application of Pesticides to Waters of the United States in Accordance with FIFRA.* This rule replaced a draft interpretive statement EPA issued in 2003 concerning the use of pesticides in or around waters of the United States. The rule stated that any pesticide meant for use in or near water, applied in accordance with the FIFRA label, is not a pollutant under the CWA. Therefore, such applications are not subject to NPDES permitting.

After EPA issued the rule, Ecology met with stakeholders to seek input on how it should regulate the use of aquatic pesticides. Ecology also provided the public with a three-week comment period. Stakeholders affiliated with each of the seven affected permits (Mosquito, Noxious Weeds, Aquatic Plant and Algae, Irrigation, Oyster Growers, Fish Management, and Invasive Moth) commented. The consensus of these stakeholders was that Ecology should continue to issue joint NPDES/state waste permits to regulate aquatic pesticide applications.

To apply a pesticide to the water, state law requires the applicator to obtain a short-term modification of the water quality standards from Ecology. Ecology issued site-specific short-term modifications using an administrative order until 2001, when this process was challenged. Currently, the only legal vehicle for implementing a short-term modification is a permit. State law defines only two types of permits for surface water discharges: NPDES (federal) and State Waste Discharge (state). Because of stakeholder consensus and the need for a permit to implement short-term modifications, Ecology decided that Washington would continue to use NPDES permits as the legal vehicle to regulate the use of aquatic pesticides in and around Washington state waters. Ecology believes that these permits provide the best protection of water quality, human health, and the environment.

National Cotton Council et al. v. EPA

In November 2006, EPA issued a final rule under the CWA that determined that pesticides applied in accordance with the FIFRA label are exempt from NPDES permitting requirements. Petitioners filed for review of EPA's final rule in 11 of the 12 federal circuit courts that are able to hear regulatory arguments. The federal courts combined the petitions into one case within the Sixth Circuit Court.

The Sixth Circuit Court made several findings. First, it agreed with the Ninth Circuit (*Fairhurst v. Hagener*) that if an applicator intentionally applies a chemical pesticide to water for a beneficial purpose, and the chemical leaves no waste or residue after performing its intended purpose; the discharge would not require an NPDES permit.

Second, the Court found excess pesticides and residues that make their way into waters during and after any pesticide application constitute wastes under the CWA and must have NPDES permit coverage before discharge occurs.

Finally, the Sixth Court determined that because EPA's final rule exempted discharges that the plain reading of the CWA includes as requiring an NPDES permit, the rule could not stand.

After a later motion, the Sixth Circuit granted EPA a stay on the effective date of this ruling for 24 months to allow the agency time to develop an NPDES permit for aquatic pesticide discharges. EPA issued its general permit on October 31, 2011, for the discharge of pesticides to manage aquatic plants and algae, aquatic animals, mosquitoes and flying insects, and forest canopy pests. In Washington, EPA's general permit covers aquatic pesticide activities conducted on federal facilities, on federal lands when federal entities conduct or authorize the treatment, and on tribal facilities and lands. The state regulates aquatic pesticide application to all other lands/waters.

LEGAL BASIS FOR MANAGING AQUATIC PLANTS IN WASHINGTON

RCW 90.48.445 Aquatic Noxious Weed Control - Water Quality Permits

In 1991, the Washington State Legislature directed Ecology to issue or approve water quality permits for use by federal, state, and local government agencies and licensed applicators for the purpose of using, for aquatic ***noxious weed*** control, herbicides and surfactants registered under state or federal pesticide control laws. Aquatic noxious weed means an aquatic weed on the state noxious weed list adopted under RCW 17.10.080. The legislature also specified that the issuance of these permits was subject only to compliance with federal and state pesticide label requirements, FIFRA requirements, the ***Washington Pesticide Control Act***, the ***Washington Pesticide Application Act***, and the ***State Environmental Policy Act*** (SEPA) (with some exceptions for *Spartina* projects).

The Legislature further stated that Ecology may not use this permit authority to otherwise condition or burden weed control efforts and that permits are effective for five years, unless the ***applicant*** requests a shorter duration.

RCW 17.10 Noxious Weeds – Control Boards

Chapter 17.10 RCW is Washington's primary noxious weed law and it holds landowners responsible for controlling noxious weeds on their property. Its purpose is to "limit economic loss and adverse effects to Washington's agricultural, natural, and human resources due to the presence and spread of noxious weeds on all terrestrial and aquatic areas of the state".

Chapter 16-750 WAC – State Noxious Weed List and Schedule of Monetary Penalties

"Noxious weed" is the traditional, legal term for any "*plant that when established is highly destructive, competitive, or difficult to control by cultural or chemical practices*" (RCW 17.10.010). This rule sets out Washington's Noxious Weed List, which the Washington State Noxious Weed Control Board (WSNWCB) updates each year. It organizes noxious weeds by classification. Class A noxious weeds are non-native species that are limited in distribution in Washington. State law requires that landowners eradicate these weeds. Class B noxious weeds are non-native species that are either absent from, or limited in distribution in some portions of the state, but abundant in other areas. The goal is to contain the Class B weeds where they are already widespread and prevent their spread into new areas. The law requires control and prevention of all reproductive propagules (cuttings, seeds, tubers, etc.) in areas where Class B weeds are designated for control. Class C noxious weeds are non-native plants that are typically already widespread in Washington. Most counties choose to offer advice about control methods or provide education to landowners about Class C weeds. However, counties can choose to require control if the Class C weed poses a threat to agriculture or natural resources.

In January 2013, the WSNWCB listed *Z. japonica* as a Class C noxious weed statewide. The rationale for this change is explained below in an excerpt from the Concise Explanatory Statement (December 11, 2012):

> *"The WSNWCB adopted this proposal to provide support to the shellfish industry and to Pacific County Noxious Weed Control Board, which submitted the proposal. Although Japanese eelgrass has been documented to have some beneficial values, it is still nonetheless a nonnative, invasive estuarine species that has been spreading on the West Coast. It is currently listed as a Class A noxious weed in California, where eradication efforts are underway because of its still-limited populations there. In Washington, its population has recently expanded in Willapa Bay, and it is difficult to control due to prolific seed production and perennial rhizomes. It colonizes the upper tidal zone, converting bare mud flats into heavily vegetated areas. Research indicates that Japanese eelgrass has numerous biotic and abiotic interactions – both beneficial and detrimental – in the intertidal zone, and research is still ongoing. However, it is clear that Japanese eelgrass is having a strong, negative impact to the shellfish industry, particularly in the production of hard-shell clams. Many of the shellfish growers expressed their firsthand observations that Japanese eelgrass is also harmful to the mudflat ecosystems in and around their shellfish farms. Because Japanese eelgrass is a nonnative, invasive species that is an economic concern to shellfish growers, a Class C listing is appropriate. The WSNWCB does not require the control of Class C noxious weeds, although county weed boards have the option of requiring control. The Class C listing allows the WSNWCB to educate the public about the complexities of Japanese eelgrass, including the impacts it's having on the shellfish industry and how it differs from the valuable native eelgrass, Zostera marina."*

ZOSTERA JAPONICA - BIOLOGICAL, ECONOMIC, AND REGULATORY BACKGROUND INFORMATION

Washington's marine/estuarine vascular plants

There are two species of eelgrass found in Washington, a highly valued and protected native eelgrass (*Zostera marina*) and an introduced Asian eelgrass (*Zostera japonica*), that is also valued for habitat. Common names for *Z. japonica* include Japanese eelgrass, dwarf eelgrass, Asian eelgrass, duck grass, and narrow-bladed eelgrass (Mach et al., 2010). Washington's two eelgrass species grow on muddy or mixed sand and mud sediments in protected Washington estuarine waters (Phillips, 1984). Unlike freshwater systems, where there are numerous aquatic vascular species, there are few marine/estuarine vascular species worldwide. Another vascular plant, *Ruppia maritima*, a high intertidal and brackish water annual, is also found in Washington (Mach et al., 2010). Three vascular species in the genus *Phyllospadix* occur in Washington's marine/estuarine waters, although these species typically occur in rocky, exposed waters that are high-energy environments. *Phyllospadix scouleri*, *P. serrulatus*, and *P. torreyii* are commonly referred to as surfgrasses (Phillips, 1984).

Washington's two eelgrass species are seagrasses in the family *Zosteraceae*. Seagrasses are flowering plants found in brackish or marine waters that form highly productive ecosystems. Seagrasses grow in protected coastal waters in both temperate and tropical areas and provide food, shelter, and nursery areas for many fauna. Scientists refer to seagrasses as ecosystem engineers because they partly create their own habitat by slowing down water flow. This increases sedimentation while roots and rhizomes stabilize sediments. As discussed in detail in Phillips (1984), Pacific Northwest seagrasses (both native and exotic) perform the following functions:

- High production and growth: Seagrasses grow rapidly and form highly productive ecosystems.
- Food and feeding pathways: Seagrasses are a direct food source for many organisms as is the detritus produced by decaying seagrass biomass.
- Shelter: Seagrasses serve as nurseries and seagrass beds create homes for various fauna including commercially important Pacific Northwest species such as Pacific herring, striped sea perch, English sole, Dungeness crab, and the young of several salmon species.
- Habitat stabilization: Seagrass leaves slow flow, reducing water velocity and at the same time, the roots and rhizomes bind and stabilize sediments.
- Nutrient effects: Seagrasses provide organic material and aid in sediment/substrate nutrient cycling and release and improve water quality through production of oxygen and adsorption of nutrients.

There are about 50-60 species of seagrasses worldwide, but according to the Global Invasive Species Database; *Z. japonica* is the only documented invasive seagrass. Scientists report that in general seagrass beds are declining worldwide for several reasons including nutrient runoff and sea level rise (Thom et al., 2011).

Life history of *Z. japonica*

For a comprehensive overview of Pacific Northwest eelgrass life history and ecology (both *Z. marina* and *Z. japonica*), see Phillips (1984). Whether *Z. japonica* is annual or perennial depends on latitude, elevation on the intertidal zone, and weather conditions. The *Flora of North America* describes *Z. japonica* as an annual, rarely as a perennial plant. However, the written findings of the WSNWCB indicate that it is an annual to perennial herbaceous plant with creeping, perennial rhizomes (Haynes (2000) as cited in the 2011 WSNWCB written findings). Harrison and Bigley (1982) describe *Z. japonica* as an annual, or a short-lived perennial in British Columbian (B.C.) waters and Harrison (1982a) reported that its location in the intertidal zone determined whether individual *Z. japonica* plants were annual or perennial. Low intertidal populations were partly, or wholly perennial with leafy shoots present year-round. Mid-intertidal plants were annual with only a few leafy shoots overwintering. Phillips (1984) found that plants in more exposed locations tended to be annual and set many seeds. Less exposed plants are perennial and rely more on vegetative reproduction.

In Yaquina Bay, Oregon, *Z. japonica* persists year-round (Larned, 2003; Kaldy, 2006). These authors found that above ground biomass varied seasonally with maximum above ground biomass present in late summer and early fall. Phillips (1984) described *Z. japonica* as a facultative perennial in the Pacific Northwest. Thom (2000) as cited in Dumbauld and Wyllie-Echeverria (2003) noted that *Z. japonica* is predominantly an annual with high seed production in its northern introduced range. However, during warmer years in northern locations and in coastal estuaries it persists as a perennial. In Willapa Bay, *Z. japonica* appears to behave as a short-lived perennial (K. Patten, 2012, personal communication).

Z. japonica's growth habits and life cycle also seem to depend on latitude, tidal elevation, and weather. In his review paper on west coast eelgrass, Phillips (1984) concluded that on the Pacific coast of North America, *Z. japonica* has distinct life-history strategies that depend on latitude, intertidal gradients, water temperatures, salinity, light, grazing, erosion, and wave action.

In southern B.C. waters, Harrison (1982b) determined that *Z. japonica* is an opportunist species that colonizes large areas by seedlings that mature, flower, and set seed within a 6-7 month life cycle. *Z. japonica* overwinters as buried seeds and germinates from the seeds from March to May (Harrison and Bigley, 1982; Harrison, 1982b). It typically flowers in late July and August (Harrison, 1982b), but also reproduces vegetatively through rhizomatous cloning. Maximum above ground biomass occurred in August and September (Harrison, 1982b). Seed set occurs in early autumn with most shoots senescing before November, except in habitats sheltered from storms. In sheltered environments, some short vegetative shoots may overwinter (although those shoots often died the following spring).

Kaldy (2006) describes very different growth and flowering habits of this species in Oregon than occur in southern B.C. He studied the autecology of *Z. japonica* near the southern end of its North American distribution in central Oregon Coast's Yaquina Bay. Unlike in B.C. waters where up to 70% of the shoots flower each year, Kaldy (2006) observed 10% of the shoots flowering in October in 2001 and only 2% of the population flowering in late summer in 2002. In even more southern latitudes (California) plants flower in March, produce seed in April and May, and decay as water temperatures exceed 27º Centigrade (Phillips, 1984).

In a two-year life cycle study of *Z. japonica* in southern B.C., Harrison (1982b) observed that *Z. japonica* is more vigorous (produced more biomass and flowering shoots) in the more submerged locations than in more exposed sites higher on the intertidal zones. He speculated that competition from the more robust-appearing native eelgrass, *Z. marina,* might limit the growth of *Z. japonica* in the lower intertidal and sub tidal zones.

Distribution of *Z. japonica*

Z. japonica is native to Asia, specifically the far east of the Russian Federation, China (Hebei, Liaoning, and Shandong), Japan, Korea, Taiwan, and Vietnam (WSNWCB, 2011). Its native range includes tropical and sub-tropical latitudes, but scientists generally regard *Z. japonica* as a temperate species (Lee, 1997; Shin and Choi, 1998, as cited in Ruesink et al., 2010). In parts of its native range on western Pacific shores, *Z. japonica* is declining, but it is increasing where introduced (Lee, 1997 as cited in Ruesink et al., 2010).

It is believed that *Z. japonica* entered northern Puget Sound in the 1930's along with shipments of Japanese oyster spat, although its presence was not officially documented in the region until 1957. People speculate that shippers used *Z. japonica* as packing material for Japanese oyster stock with eelgrass being disposed into the water and/or that *Z. japonica* seed may have hitchhiked on oyster shipments from Japan to the area. The first documented presence of *Z. japonica* occurred in 1957 from the Washington Coast (Fisher, et al., 2011). In the 1980's, *Z. japonica* rapidly expanded from Willapa Bay to Oregon estuaries, and north and south from Samish Bay into B.C. and throughout Puget Sound (Mach et al., 2010). Scientists do not know if *Z. japonica* established through a single introduction or multiple introductions.

Z. japonica distribution on the west coast of North America now extends from B.C. to Humboldt, California (WSNWCB, 2011). Currently, *Z. japonica* is widespread within Washington waters from areas along the Canadian-USA border, San Juan Straits, north, central, and south Puget Sound, the Hood Canal, and the Washington coast (Willapa Bay and Grays Harbor). Fisher, et al., (2011) lists specific locations within these areas.

In Willapa Bay, Fisher et al. (2011) report *Z. japonica* presence from the mid 1950's. The authors note that populations did not expand until about 1998 when populations "exploded and aggressively carpeted many areas of Willapa Bay." Monitoring conducted by Ruesink et al. (2010) confirmed that substantial increases in eelgrass have occurred on historically unvegetated tide flats, although they reported that this increase in eelgrass was from the upslope expansion of *Z. marina* rather than an increase in *Z. japonica*. The authors reported that *Z. japonica* densities did not change between 2004 and 2007. However, they agree that *Z. japonica* populations have increased in Willapa Bay in the five decades since its introduction.

The Washington State Department of Natural Resources (DNR) has an ongoing Submerged Vegetation Monitoring project that has monitored native eelgrass status and trends in Puget Sound since 2000. DNR also records the presence of *Z. japonica* at the lower edge of its tidal range. DNR identified *Z. japonica* in 68 of 378 sites in the greater Puget Sound (Mach et al., 2010). However, this is likely an underestimate because DNR does not sample all locations within Puget Sound and the study misses shallow water populations (the DNR research vessel cannot enter shallow water). DNR also does not capture anecdotal observations of *Z. japonica*. See Mach et al., (2010) for distribution maps from the DNR eelgrass survey work (see Figure 5 in that report).

Distribution of *Z. japonica* within intertidal zones

Growth patterns of native and *Z. japonica* along the intertidal zones likely result from wave energy and shoreline slope (Mach et al., 2010). With steep topography, there is a disjunct distribution with *Z. japonica* occurring in the high tidal zone, no vegetation in the mid tidal zone, and native eelgrass in the low tidal zone. With flat topography, such as occurs in Willapa Bay, they report that there can be overlapping distribution with *Z. japonica* occurring in the high tidal zone, a mix of Japanese and native eelgrass in the mid tidal zone, and native eelgrass in the low tidal zone. A mosaic distribution sometimes occurs with *Z. japonica* only in the high tidal zone, patches of *Z. japonica* and *Z. marina* in the mid tidal zone, and native eelgrass in the low tidal zone. Mosaic distribution occurs less frequently than the other two distribution patterns. Britton-Simmons et al. (2010) as cited in Mach et al. (2010) noted that there is evidence that the lower edge of *Z. japonica* distribution is not variable and concluded that it is variation in the native eelgrass up-shore tidal limit that causes the patterns of co-occurrence between the two species. In Southern Roberts Bank (southwestern B.C.), Harrison (1982b) determined that *Z. marina* grew in the lower intertidal and upper sub tidal zones (+1 m to -1 m Mean Lower Low Water - MLLW). *Z. japonica* was abundant from +1 m to +3 m, with *Ruppia maritima* common between +2 m to +3 m tidal elevation.

Z. japonica occupies areas in Willapa Bay from MLLW (0 feet elevation) to deeper waters. Fisher et al. (2011) observe, "*Where 20 years ago it [Z. japonica] inhabited areas between approximately between 4' and 7' MLLW, it now grows at the approximate MLLW (0') tidal elevation occupying vast monotypic beds*." These authors also observed that in Willapa Bay, *Z. japonica* appears to colonize intertidal hillocks that are at an elevation that does not initially support native eelgrass. (See Fisher, et al., (2011) for photographs of extensive *Z. japonica* beds in Willapa Bay). However, Harrison and Bigley (1982) reported extensive *Z. japonica* beds earlier in Willapa Bay (pre 1982). They said "*all substrates except those with excessive clay or gravel support dense populations.*" The authors also observed large beds of *Z. japonica* in Gray's Harbor in the early 80’s. Ruesink et al. (2010) reported that as of 1997, *Z. japonica* occupied 7.7% of the Willapa Bay's total area of 35,700 hectares (ha) and native eelgrass occupied 9.6% of the total area. The authors report that about half of Willapa Bay is exposed on extreme low tides.

Comparison of Z. japonica and Z. marina (native)

Baldwin and Lovvorn (1994) concluded that *Z. japonica* has many characteristics of a successful invader; the species is small and heavily invests into reproductive strategies. In Boundary Bay on the Washington/B.C. border, *Z. japonica* seed germinates in the spring in mid-to-low-intertidal areas denuded by storms. In contrast, native eelgrass overwinters as perennial rhizomes and shoots at low intertidal to sub-tidal elevations with limited storm exposure. In B.C., *Z. japonica* produces many seeds, whereas the more robust native eelgrass relies heavily on vegetative resources (rhizomes and shoots) for overwintering. The authors hypothesize that native eelgrass is confined to lower tidal elevations because it appears to have a lower resistance to desiccation than does *Z. japonica* and Harrison (1982) agrees. However, a study comparing the photosynthetic responses of the two species to desiccation did not support their hypothesis (Shafer et al., 2007). Instead, native eelgrass, *Z. marina*, showed greater tolerance for desiccation and recovery than *Z. japonica*, even though *Z. marina* typically grows lower on the intertidal than *Z. japonica*. Shafer et al. (2007) concluded that there is some evidence that the smaller leaves, and more rapid leaf turnover in *Z. japonica*, may account for its ability to grow successfully on a more exposed environment (higher on the intertidal).

People generally differentiate *Z. japonica* from native eelgrass by the length and width of its leaves. *Z. japonica* plants are typically smaller with narrower and shorter leaves than the more robust looking native eelgrass. Native eelgrass leaves can reach lengths of 1.5 m or more, but *Z. japonica* leaves typically only grow to 30 cm in length (Vavrinec et al., 2012). Although the two species look dissimilar most of the time, leaf length and width in both species varies with depth. In intertidal beds, *Z. marina* can be stunted and resemble *Z. japonica* (Harrison and Bigley, 1982). Yang (2011) reported that native eelgrass shoots in sandy, more wave-exposed beds tend to be short and fine, but in protected areas, its shoots are long and wide.

The best way to differentiate between the two species is by their sheaths (Environment Canada, 2002). Native eelgrass has an entire tube-like sheath. When the lower leaves are slowly pulled in opposite directions, the sheath will tear. The sheath of *Z. japonica* consists of two overlapping flaps that do not tear when the lower leaves are pulled apart. However, in Willapa Bay, researchers report that *Z. japonica* is easy to distinguish by morphological characteristics only (K. Patten, 2012, personal communication).

Z. japonica grows much more densely than native eelgrass. In Yaquina Bay, Kaldy (2006) recorded 11,000 shoots m^2 of *Z. japonica* during the summer, with a winter minimum of 1500 shoots m^2. In Willapa Bay, a more northern location, Ruesink (2010) recorded maximum shoot numbers of 3,500 m^2 of *Z. japonica*. In contrast to the very high stem numbers of *Z. japonica*, stem densities of native eelgrass in Yaquina Bay were much lower. In a study of native eelgrass, Kaldy and Lee (2007) observed a minimum of 55 shoots m^2 in April and maximum of 89 shoots m^2 in June 2003. In 2002, they observed a maximum of about 130 shoots m^2. In Willapa Bay, Thom et al. (2011) citied densities of native eelgrass that ranged from 39.5 to 71.3 shoots m^2, but Ruesink, et al. (2006) reported higher native eelgrass densities of 105 to 162 shoots per m^2 in their study of both eelgrass species.

Impacts of *Z. japonica*

Effects on native eelgrass

There is both anecdotal and scientific evidence that the presence of *Z. japonica* can facilitate the migration and establishment of native eelgrass into higher intertidal zones than it normally occupies. Fisher, et al. (2011) noted, “Willapa Bay researchers and oyster growers have observed that the establishment of *Z. japonica* in the middle intertidal range has caused changes in sediment composition and water retention, facilitating the spread of *Z. marina* into shallower waters than it would normally be found”. Ruesink et al. (2010) sampled 14 transects in Willapa Bay at two time periods, four years apart, and found that native eelgrass moved up-shore into areas normally occupied by *Z. japonica*. The authors speculated that this migration to a higher intertidal zone was caused by *Z. japonica* retaining water, thereby physically altering the upper intertidal zone to mimic a lower tidal elevation (i.e., making the habitat more suitable for native eelgrass migration into higher tidal elevations) (excerpted from WSNWCB written findings, Fisher et al., 2011). Tsai et al. (2010) demonstrated that the presence of eelgrass reduced water flow by up to 40% in vegetated test plots in Willapa Bay and concluded that this led to water retention within the plots.

In an evaluation of threats to native eelgrass beds in Washington, Thom et al. (2011) considered *Z. japonica* to be the primary invasive species of concern to native eelgrass populations, but also concluded that *Z. japonica* appeared to have limited impact on native eelgrass beds. Others also thought that it was unlikely that *Z. japonica* would displace native eelgrass beds (Harrison and Bigley, 1982), concluding that native eelgrass populations appear to have the robustness and ability to maintain their niche against *Z. japonica*. However, Thom et al. (2011) also reported that there was some evidence that Washington's *Z. japonica* populations were increasing in cover and distribution. These authors ranked the threat of displacement of native eelgrass from *Z. japonica* to be of a medium but increasing threat. In their paper, they defined medium stressors as having strong, but sub lethal effects, such that additional stressors will likely kill the plant. They also noted that once *Z. japonica* is removed, it appears that native eelgrass can recolonize the area. However, the uncertainty about *Z. japonica* as a stressor is high, which the authors concluded means that the extent of *Z. japonica* effects on native eelgrass are unknown and could be higher than currently thought.

Merrill (1995) conducted a small study in Padilla Bay, Washington to compare the effect of *Z. japonica* on the growth of native eelgrass. He measured the leaf growth and new shoot recruitment of native eelgrass in the presence and absence of *Z. japonica* and found inhibition of both during the latter half of his study in competitive plots. He concluded that the presence of *Z. japonica* could inhibit the establishment of native eelgrass in restoration sites.

Others, such as Mach et al. (2010), believe that because Washington's two eelgrass species occupy different niches in the intertidal zone, there is reduced opportunity for direct competition. They report that in areas where the two species overlap, neither dominates (e.g., the presence of both species did not cause a decrease in the biomass or density of either species).

Bando (2005) reached a different conclusion than Mach et al. (2010) about eelgrass interspecies competition. In her Willapa Bay study, both eelgrass species experienced substantive reductions in above ground biomass in mixed species plots compared to above ground biomass in single species plots (see also Bando, 2006). In the absence of disturbance, native eelgrass outcompeted *Z. japonica*. However, in a disturbed environment, *Z. japonica* responded positively to disturbance, and native eelgrass responded negatively. She recorded a 14-fold decrease in *Z. marina* biomass and an 11-fold increase in *Z. japonica* biomass within disturbed plots and concluded that *Z. japonica* had a massive competitive advantage in disturbed plots. Disturbance also decreased the maximum number of inflorescences per flowering shoots in *Z. marina* (6-fold decrease), but increased flowering shoot production in *Z. japonica* by 19 fold. She concluded that disturbance and interactions with *Z. japonica* are factors in the decline of *Z. marina* in the Pacific Northwest.

However, Mach et al. (2011), noted discrepancies between Bando's descriptions of disturbance effects and her figures (which appeared to show the opposite results to her written descriptions). Mach et al. (2010) also noted that Bando conducted her research at only one site in Willapa Bay and results from this site may not be applicable to other sites. A Korean study of the effects of clam harvesting on *Z. japonica* in its native range supported Bando's results about disturbance. Park et al. (2011) monitored above and below ground biomass of *Z. japonica* pre- (2003) and after a Manila clam harvesting event that removed all above ground biomass in spring 2004. The authors found that reproductive shoot density and reproductive efforts increased the first year after clam harvesting compared to pre-harvesting levels. Further, *Z. japonica* produced reproductive shoots for approximately three times longer after the disturbance than before the disturbance. The below ground biomass was also significantly higher than the biomass prior to the harvest. The authors concluded that disturbance tends to promote more sexual and asexual reproduction in this species.

In her PhD dissertation, Bando (2005) went so far as to call for Washington to rescind its protection of *Z. japonica*. Further, in a peer-reviewed journal, Bando (2006) says, "*The results of this study suggest that the current Washington State policy of conferring blanket protection to any Z. spp. is inconsistent with the goal of protecting native eelgrass. The effective conservation of intertidal Z. marina habitats may require refining this policy to differentiate between native and invasive eelgrass species. Although additional information is needed to determine the relative costs and benefits of controlling Z. japonica, the information at hand suggests that at the very least, the protection of invasive eelgrass should be rescinded in the interest of conserving native intertidal eelgrass habitats.*"

Effects on nutrient cycling
In Yaquina Bay the presence of *Z. japonica* altered nitrogen cycling in the estuary. Larned (2003) hypothesized that this could lead to reductions in nutrient availability. Unvegetated sediments colonized by *Z. japonica* switched from functioning as net sources to net sinks of inorganic nutrients. Nitrate and ammonium fluxes in native eelgrass beds were twice that of *Z. japonica* beds. Scientists believe that nitrogen is the major limiting nutrient in marine waters. However Mach et al. (2010) concluded that there is conflicting evidence of nutrient use by *Z. japonica* that makes it difficult to draw any conclusions about its effect on nitrogen cycling.

Importance to juvenile salmon
Researchers tracked the movement of 17 juvenile hatchery Chinook , implanted with microacoustic tags in an enclosure that encompassed several habitat types in Willapa Bay (Semmens, 2008). Habitat types within the enclosure included native eelgrass, *Z. japonica*, bare ground, oyster beds, and *Spartina*. The fish spent the most time in deeper water over native eelgrass patches, rather than in the other habitats. The author speculated that the salmon preferred native eelgrass to the other habitats because it provided better cover from predators and better foraging opportunities. Native eelgrass was taller with wider stems than *Z. japonica*, providing more structure and grew in deeper water, which may be why the Chinook preferred native eelgrass beds to the *Z. japonica* beds in more shallow water. The authors state "*The apparent similarity in habitat capacity provided by non-native eelgrass and oysters suggests that the common practice of assuming that native and non-native eelgrasses are ecologically equivalent may unduly burden the aquaculture industry during efforts to implement "salmon-friendly" management practices.*" Predators killed all fish within days of release (belted kingfisher, great blue heron, great egret observed in the enclosure, but there were no fish present except for the salmon). All predation events occurred while the fish were over open ground, another reason for assuming that *Z. marina* provides predator protection to small fish.

Shellfish grower concerns
Some Washington shellfish growers, predominantly those farming in Willapa Bay, report that *Z. japonica* is interfering with shellfish production, particularly Manila clam culture. This perception caused growers to collaborate with Washington State University Cooperative Extension to discover new management methods for *Z. japonica* control on shellfish beds. Manila clams (*Ruditapes philippinarum*) represent a growing industry, particularly in Willapa Bay where Ruesink et al. (2006), as cited in Tsai et al. (2010) reports that Manila clam harvests are increasing by 6% each year. At the same time, *Z. japonica* populations have expanded and occupy about 9% of Willapa Bay (Ruesink et al. (2006) as cited in Tsai et al. (2010)). A suitable tidal elevation for Manila clam cultivation is + 0.6 m to + 1.2 m above MLLW. *Z. japonica* has colonized these formerly unvegetated intertidal zones used for Manila clam culture in Washington, interfering with shellfish planting and harvesting, and reducing yields (Fisher et al., 2011). Growers typically harvest clams about 3-5 years after seeding using raking and hand removal

techniques. Dense *Z. japonica* also makes harvesting difficult. A normal aquaculture clam density is about 125 adult clams (>40 mm shell length) per m^2 (Tsai et al., 2010). The density of clams when *Z. japonica* is present varies with eelgrass density and other site conditions, but typically is at least one third less (K. Patten, personal communication, 2012).

In studies conducted in Willapa Bay, the presence of *Z. japonica* reduced both clam condition and the dry weight of the clam meat (Tsai et al., 2010). The authors hypothesized that the negative effects of *Z. japonica* on clam condition may be because of reduced food delivery to clams rearing in eelgrass beds or from poor environmental conditions caused by dense vegetative cover. They observed that clams in the eelgrass plots were closer to the surface than clams in non-vegetated or harrowed research plots, although oxygen levels appeared adequate in all plots. *Z. japonica* affected clam growth and condition, however, the presence of Manila clams did not affect eelgrass growth.

To help document impacts of *Z. japonica* on shellfish beds, the Willapa-Grays Harbor Oyster Growers Association contracted with ENVIRON International Corporation and Washington State University Cooperative Extension (WSU Extension) to prepare a "white paper" *Invasion of Japanese eelgrass, Zostera japonica in the Pacific Northwest: A preliminary analysis of recognized impacts, ecological functions, and risks*. WSU Extension scientist Dr. Kim Patten has been conducting trials of imazamox in Willapa Bay each year since 2007 under WSDA Experimental Use Permits. This "white paper" documents the results from some of his unpublished research trials and summarizes other relevant literature.

Dr. Patten compared the number and weight of Manila clams on imazamox treated beds (no *Z. japonica* present on the beds after treatment). He found that the number and weight of clams was higher at four of the five treated locations and significantly higher at three locations. He saw variable results with soft shell clams, with three of the five sites showing higher abundance in the herbicide treated beds, but two sites showing higher abundance in the beds with *Z. japonica*. In other unpublished information, he reported increased summer length gain and clam weight, and clam quality (meat weight/shell weight) on beds where he removed *Z. japonica* relative to vegetated beds. He reported variable results with clam set. The estimated economic losses in Willapa Bay as reported in the "white paper" were $4,000 per acre per year for loss of Manila clam production.

Because of their growing concern about *Z. japonica* impacts to shellfish farming, some growers initiated a change in the regulatory status of *Z. japonica* in Washington, by submitting proposals to the WSNWCB to list *Z. japonica* as a noxious weed (proposals submitted in 2010 and 2011). Testimony from some commercial shellfish growers at the WSNWCB public hearing in 2011 highlighted their concerns about the negative impacts to shellfish growing areas. A representative from Taylor Shellfish Company testified that a thousand-acre clam bed in Willapa Bay has "turned into a wasteland of mud and muck." Taylor Shellfish Company said that it could no longer farm this clam bed because of *Z. japonica* colonization. Representatives from the Northern Oyster Company and the Willapa-Grays Harbor Oyster Growers Association asserted, "*Japonica is an invasive that is decimating our land. It reduces natural seed setting, degrades meat yield, provides cover for predators, is smothering the beds and trapping sediment resulting in a tremendous loss in crops.*" Shellfish growers Wiegardt and Sons, Inc. testified, "*The infestation of japonica has cost us ten full-time positions.*"

Tim Morris president of the Willapa-Grays Harbor Oyster Growers Association, in a letter that asked Ecology to develop a permit to allow the use of imazamox to manage *Z. japonica*, provided the following reasons why *Z. japonica* impacts aquaculture. *"It [Z. japonica] has carpeted what used to be mostly bare* *sandy bottom tidelands where we have historically cultivated shellfish. …japonica is causing large impacts now and continues to expand its coverage further into the bay…The invasive isn't constrained to only our farms, and is causing the same damages to all state and federally managed tidelands as well.*"

Positive impacts associated with *Z. japonica*

As noted in the description of seagrasses at the start of this section, both *Z. marina* and *Z. japonica* fulfill many of the same food, shelter, and habitat functions. Mach et al. (2010) concludes that it is difficult to assess the effect of *Z. japonica* on community interactions when some species use it for food or habitat, it affects others negatively in density or performance, and some species have no response to *Z. japonica* presence. However, there is scientific literature that discusses positive effects of *Z. japonica* in its introduced range.

Increased species diversity

Species diversity and the abundance of fauna are typically greater in seagrass beds than in unvegetated areas (Phillips, 1984). In Coos Bay Oregon, Posey (1988) reported that species richness was higher within *Z. japonica* patches that he monitored as compared to adjacent unvegetated areas. The densities of several common organisms also changed within eelgrass beds with some common animals showing increases within the patches while other species declined or had no significant correlation with eelgrass cover. The author noted that the increased species richness and other changes found in *Z. japonica* beds are consistent with similar biological effects associated with other seagrasses and concluded that there was a general positive effect of *Z. japonica* colonization on local diversity and animal abundances in Coos Bay.

Epibenthic organisms

Thom et al. (1995) as cited in Mach et al. (2010) showed that populations of invertebrate grazers to be similar on *Z. japonica* as those on *Z. marina*.

Waterfowl food source

Z. japonica can be an important food source for waterfowl at some locations. Because it grows higher on the intertidal zone than native eelgrass, it provides easier feeding access for dabbling ducks. Baldwin and Lovvorn (1994) concluded that in Boundary Bay, *Z. japonica* provides an important feeding habitat for many migratory waterfowl such as brant, American widgeon, and mallard. Some waterfowl species fed preferentially on *Z. japonica* over the native eelgrass at this site. The authors also determined that *Z. japonica* leaves had a higher caloric value than native eelgrass leaves although they did not find any caloric differences between the rhizomes of the two species. Phillips (1984) also noted that Black Brant Geese heavily use *Z. japonica* as a food source. However, Patten in unpublished research in Fisher et al. (2010), reported that there was no appreciable amount of *Z. japonica* in the gullet contents of waterfowl from Willapa Bay. At least one local duck hunter challenges Patten's findings (R. Barkhurst, written testimony to the WSNWCB). Mr. Barkhurst reports that 90% of widgeon taken in his blinds on Willapa Bay have *Z. japonica* in their gullets and other dabbling duck species contained significant amounts. At an informational meeting held in December 2012, Mr. Barkhurst displayed photographs that showed water fowl apparently feeding on *Z. japonica* in Willapa Bay in fall 2012.

Spawning substrate

Z. japonica provides spawning substrate for important forage fish such as herring. Forage fish are small fish that provide a significant food source for larger fish such as salmon. Biologists have observed the usage of middle intertidal beds of *Z. japonica* as egg-deposition substrate by Grays Harbor and Willapa

Bay stocks of Pacific herring during the February-March spawning seasons (Daniel E. Penttila, comment letter to Ecology). In Willapa Bay, biologists found herring eggs on *Z. japonica* beds just inshore of the native *Z. marina* beds in the area north of Oysterville. These herring spawning sites were within short distances of active shellfish aquaculture plots.

Competition with burrowing shrimp
Eelgrasses can reduce numbers of burrowing shrimp (ghost shrimp and mud shrimp), also problem species for shellfish growers (Feldman et al. 2000; Harrison, 1987). The roots and rhizomes of both native and *Z. japonica* appear to inhibit/exclude burrowing organisms. Conversely, burrowing shrimp can reduce the growth of eelgrass. Sediment turnover and water turbidity caused by ghost shrimp reduced the shoot growth of *Z. japonica* compared to areas without shrimp. Burrowing shrimp also impede *Z. japonica* expansion by reducing seedling survival in areas where they are present in Willapa Bay (Dumbauld and Wyllie-Echeverria unpublished manuscript as cited in Feldman et al., 2000). Management of burrowing shrimp may enhance the population of *Z. japonica*.

Regulatory Status of *Z. japonica*

Washington State Department of Fish and Wildlife
The Washington State Department of Fish and Wildlife (WDFW) Priority Habitat and Species designation is the agency's primary means of transferring fish and wildlife information from its resource experts to those local and state entities that can protect habitat through their regulatory actions. Although the Priority Habitat and Species program is not a WDFW regulatory program, other agencies use the WDFW information to set conditions and mitigations in their regulatory programs to protect these habitats and species. As an example of how agencies use this information, Ecology's NPDES Aquatic Plant and Algae Management Permit uses Priority Habitat and Species data to help protect these species and habitat from aquatic herbicide applications and potential habitat loss in lakes and rivers.

Until 2011, WDFW listed all species of *Zostera* on its Priority Species and Habitat list. In 2011, WDFW changed the listing from *Zostera* spp. to *Z. marina* (P. Anderson, WDFW Director, Personal Communication to Representative Brian Blake, House Chair, Agricultural and Natural Resources Committee, Feb. 2011). WDFW continues to list native eelgrass as a Priority Habitat and Species. However, under its Hydraulic Project Approval Program, WDFW does not have any regulatory authority to protect Z. marina with respect to private sector cultured aquatic products (Attorney General Office Opinion citing RCW 77.115.010 (2)).

Ecology – SEA Program
Ecology's Shorelands and Environmental Assistance Program (SEA Program) is involved with eelgrass primarily in three ways: 1) Research at Padilla Bay, 2) Shoreline Master Programs, and 3) Water quality certifications and shoreline permits. Padilla Bay is a national estuary research area with extensive reaches of both Z. japonica and Z. marina. The SEA Program administers the Shoreline Master Program required by the Shoreline Management Act. Local government shoreline programs must designate existing eelgrass beds as critical saltwater habitat [WAC 173-26-221(2)(c)(iii)] and fish and wildlife habitat conservation areas [WAC 365-190-130(1)(d)]. Ecology currently interprets "eelgrass" to mean Z. marina only. Invasive, noxious and non-native species such as Z. japonica are to be treated differently from other species in a shoreline program [WAC 173-26-020(36) and WAC 173-26-221(5)]. SEA currently

conducts water quality certifications for new geoduck projects under the US Army Corps Nationwide Permit 48. SEA also reviews certain shoreline development permits administered by local governments.

Puget Sound Partnership

Puget Sound Partnership has a goal of increasing eelgrass populations in Puget Sound by 20% by 2020. The agency did not distinguish between *Z. marina* and *Z. japonica* in its goal statement.

Washington State Noxious Weed Control Board (WSNWCB)

In January 2012, in response to a noxious weed-listing request from Pacific Coast Shellfish Growers, Northern Oyster Company, and Willabay, Inc., the WSNWCB listed *Z. japonica* as a Class C noxious weed on commercially managed shellfish beds only (WAC 16-750-015). In January 2013 in response to a request from Pacific County Noxious Weed Control Board the WSNWCB listed *Z. japonica* as a Class C noxious weed everywhere. Under a Class C listing, there is no requirement for landowner control, unless a county noxious weed control board decides to "select" the plant for control on its county noxious weed list (RCW 17.10.090). In 2013, no counties "selected" *Z. japonica* for control.

Western States

The regulatory status of *Z. japonica* as a Class C noxious weed in Washington contrasts with its more aggressive regulatory status in California. *Z. japonica* is an A rated weed in California. A-rated noxious weeds are prohibited from entry into California, for sale within the state, and are subject to eradication. Since the early 2000's, there has been an ongoing eradication program for *Z. japonica* in California (Muir, 2011; Williams 2007). However, there is substantially less *Z. japonica* present in California than in Washington. Eradication is theoretically feasible in California, whereas eradication is less likely to occur in Washington where *Z. japonica* is already widespread in coastal estuaries and in Puget Sound.

Oregon does not list *Z. japonica* as a noxious weed. However, information on the internet indicates that some government agencies recognize *Z. japonica* as non-native and invasive in Oregon (Nugent 2005, ODFW).

Williams (2007), in a paper about seagrass status and concerns, observed that *Z. japonica* poses a management conundrum in Washington. *Z. japonica* populations add new habitat, increase primary productivity, and biodiversity in estuaries, but populations are expanding and we do not know what all the impacts may be. Certainly, shellfish growers are seeing negative impacts on hard-shell clam production from *Z. japonica* and this triggered their decision to propose listing this species as a noxious weed in Washington.

In an ecological analysis of Washington seagrasses, Pawlak and Olson (1995) observed that when state agencies treat all eelgrass species the same, it assumes that the habitat created by the non-native eelgrass is of equal or greater value than the habitat that it replaces and that *Z. japonica* does not pose a direct or indirect threat to native species or other habitat. They concluded that although the research available did not suggest that *Z. japonica* would be an ecosystem threat, that there were unknowns, particularly as related to the vegetation of previously bare flats by *Z. japonica*.

Summary

Z. japonica is non-native and expanding its introduced range along the west coast of North America. Two of the three affected western states currently list it as a noxious weed. *Z. japonica* represents a management conundrum. Unlike many invasive weeds, it has positive attributes. Scientist opinions are mixed as to whether positive benefits outweigh the negative impacts of Z. japonica colonization.

Shellfish growers are seeing impacts to clam culture, mostly in Willapa Bay and need to remove it from their beds to make farming clams economically feasible.

Willapa Bay Information (from Feldman et al. (2000))

Willapa Bay is Washington's largest outer coast estuary. Willapa Bay is 260 km (31,970 ha - 77,517 acres) at mean high water. Less than 15% of the estuary is deeper than 7 m with half of the surface area exposed at low tide. There are 17,200 ha (42,502 acres) of intertidal area in Willapa Bay with 10,533 ha (26,028 acres) privately owned or leased for commercial aquaculture. In Willapa Bay approximately 20,000 acres of tidelands are designated for oyster culture and 6,000 acres are designated for clam culture.

References and Additional Information Sources for Z. japonica

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IMAZAMOX

Background

A number of shellfish growers have proposed application of the EPA-registered aquatic herbicide imazamox to control *Z. japonica* on commercial clam beds. These growers selected imazamox as the herbicide of choice after research trials conducted by Washington State University Extension, under WSDA Experimental Use Permits showed the herbicide to be effective on dewatered *Z. japonica* plants with minimal impacts to nearby native eelgrass beds. Currently, imazamox has a marine/estuarine label from the EPA, one of only three aquatic herbicides with this use designation. EPA also considers imazamox to be a reduced risk herbicide. To support the use of imazamox to manage *Z. japonica* in the marine/estuarine environment, Washington State University contracted with ENVIRON International Corporation of Seattle to develop a risk assessment for imazamox. The risk assessment, *Screening-Level Ecological Risk Assessment of the Proposed Use of the Herbicide Imazamox to Control Invasive Japanese Eelgrass (Zostera japonica) in Willapa Bay, Washington State, is* available at: https://fortress.wa.gov/ecy/publications/SummaryPages/1410050.html

As SEPA lead agency., Ecology has made the determination that the issuance of this permit could have significant adverse environmental impact and determined that an Environmental Impact Statement (EIS) was required. At Ecology's request, shellfish growers prepared a draft EIS for the use of imazamox to manage *Z. japonica* on shellfish beds. The EIS analyzes alternatives for *Z. japonica* management including a no action alternative, chemical management, and an ***integrated pest management*** approach. The document is the SEPA documentation for the issuance of this permit. Ecology made the draft EIS document available on its website at: https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Aquatic-pesticide-permits/Zostera-japonica-eelgrass-management.

Information about environmental and human health impacts of imazamox in a freshwater environment is available in Ecology's *Environmental Impact Statement for Penoxsulam, Imazamox, Bispyribac-sodium, Flumioxazin, and Carfentrazone-ethyl: Addendum to the Final Supplemental Environmental Impact Statement for Freshwater Aquatic Plant Management*. This document is available at https://fortress.wa.gov/ecy/publications/SummaryPages/0010040Addendum1.html. Although this document refers to imazamox use in freshwater systems, toxicity, and other information about the herbicide in the document is relevant to its uses in a marine environment.

The risk assessment and the *Z. japonica* EIS provide a comprehensive overview of imazamox and its use in a marine/estuarine environment. Ecology provides a short summary of imazamox below, but refers the reader to the above documents for a more thorough evaluation of imazamox toxicities and effects. For more information about imazamox, also see the documents listed in the following reference section. Growers do not propose to use adjuvants, so Ecology does not discuss the toxicity of adjuvants in this summary.

The shellfish industry has research trial data that indicates that it can exploit dissimilar environmental niches to remove invasive *Z. japonica* with minimal disruption to native eelgrass populations. The permit will allow them to treat beds of *Z. japonica* during low tides as the plants are exposed. Native eelgrass beds typically lie in deeper waters. In Willapa Bay, Dumbauld and Wyllie-Echeverria (2003) as cited in Bando (2006) found that *Z. japonica* typically occupies tidal elevations of +1 m to +3 m relative to MLLW, and *Z. marina* occupies elevations of -1 m to +3 m MLLW. Bando (2005) notes that the intertidal mudflats above + 1.8 m MLLW were historically unvegetated. Ruesink et al. (2010) found that *Z. marina* occurred up to + 0.6 m MLLW and in depressions at still higher elevations. They report an upper limit of *Z. japonica* at +1.5 m MLLW in Willapa Bay (where they ended their survey transects). They also did not observe an abundance of *Z. japonica* under dense *Z. marina*. In two of their sampling sites, they observed species overlap between 0.2 and 0.6 MLLW, but not at a third site within the Bay.

Registration status of imazamox

EPA granted a conditional registration for imazamox in 1997 and an unconditional registration Section 3 label in 2001. In 2003, imazamox received an exemption for tolerance designation from the EPA. The exemption waives all food residue tolerance requirements for potential food or feed uses of imazamox, including fish, shellfish, crustaceans, and irrigated crops. Imazamox is the first and only organic pesticide to receive a tolerance exemption. This means that EPA determined that the total quantity of imazamox in or on food presents no hazard to public health. The EPA considers imazamox to be a reduced risk pesticide with both terrestrial and aquatic uses.

EPA registered an aquatic-labeled formulation of imazamox called Clearcast® for estuarine and marine sites, ponds, lakes, reservoirs, wetlands, marshes, swamps, ditches, canals, streams, rivers, and other slow-moving or quiescent bodies of water. Applicators may also apply imazamox during drawdown conditions (sites exposed by low tides). Under this permit, shellfish growers propose to apply imazamox to *Z. japonica* as a foliar application to the plants when the tide exposes the plant bed. They do not need to add any adjuvants to the spray mix for effective treatment.

The aquatic formulation, Clearcast® consists of 12.1% imazamox ammonium salt and 87.9% other ingredients. It contains one-pound imazamox acid equivalent per gallon of product. The registrant BASF considers the identities of the other ingredients (formerly referred to as inerts) proprietary information. However, the Material Safety Data Sheet (MSDS) for Clearcast® does not specify any toxic or specially regulated ingredients. This indicates that none of the other ingredients present in Clearcast® (at a concentration of 1% or more) is classified as hazardous. MSDSs must list hazardous chemicals that are found in a product in quantities of 1% or greater or 0.1% or greater if the chemical is a carcinogen (www.ehso.com/msds_regulations.php).

In March 2012, Ecology asked the registrant for and obtained a list of the other ingredients in Clearcast® although the registrant has requested that Ecology not disclose these ingredients to the public since they are company proprietary information. Ecology asked a human health toxicologist and an environmental toxicologist to review these other ingredients and advise it of any human health or environmental concerns with the other ingredients at expected environmental concentrations. Neither toxicologist expressed concern with the other ingredients, although the human health toxicologist indicated that one of the ingredients could potentially cause eye irritation, but to applicators only. However, the label does not require applicators to wear eye protection when handling the concentrate. This indicates that EPA does not consider Clearcast® to present a danger to eyes (although the label recommends rinsing the eye for 20 minutes should an applicator get Clearcast® into his or her eye). Note: It is very unusual for a chemical company to disclose other ingredients in a pesticide formulation (as opposed to the ***active ingredient***) at the request of a state agency.

Mode of action of imazamox

Imazamox belongs to a chemical family called imidazolinones (imazapyr used for *Spartina* management in Washington is a member of that herbicide family). Imazamox is a systemic herbicide that works by inhibiting a biochemical pathway specific to plants. It is an acetolactate synthase (ALS) inhibitor herbicide. ALS is a plant enzyme that regulates the production of three essential amino acids in plants (valine, leucine, and isoleucine). ALS inhibitors slowly starve plants of these amino acids and kill the plant by halting protein synthesis which then leads to inhibition of DNA synthesis. Animals do not use this biochemical pathway. This may be the reason why imazamox is practically non-toxic to most tested animals. Scientists consider Clearcast® to be a selective herbicide; generally, dicots are less sensitive than monocots (*Z. japonica* is a monocot). Imazamox is rapidly absorbed into the foliage of the treated plant and translocated throughout the plant via phloem and xylem tissues. The herbicide concentrates in the actively growing portions of roots and shoots.

Toxicity

EPA categorizes the acute toxicity of pesticides from "practically non-toxic" to "very highly toxic" for aquatic organisms (based on LC_{50}[1] values), terrestrial mammals (based on LD_{50}[2] values), avian species (based on LC_{50} values), and non-target insects (based on LD_{50} values for honey bees).

Fish and aquatic invertebrates

EPA classified imazamox as practically non-toxic to freshwater and estuarine fish and invertebrates. At the highest concentrations tested there were no observed adverse effects for most animal species tested. Therefore, the LC_{50} or LD_{50} values are all greater than the highest tested concentrations/doses. The tested concentrations/doses are substantially higher than expected environmental concentrations of the active ingredient.

Study	Organism	Results	EPA Toxicity Category
Fish 96 hour LC_{50}	Bluegill	>119 mg a.i./L	Practically non-toxic
Fish 96 hour LC_{50}	Rainbow Trout	>122 mg a.i./L	Practically non-toxic
Invertebrate 48 hour EC_{50}	*Daphnia magna*	>122 mg a.i./L	Practically non-toxic

There are no chronic data available for aquatic animals so EPA was unable to evaluate chronic risk. However, Ecology does not anticipate any significant chronic exposures of imazamox to estuarine animals in Willapa Bay due to large tidal exchanges that will dilute the herbicide. The European Commission noted two longer-term studies of imazamox for rainbow trout and a 21-day study for *Daphnia magna*. They reported a 28-day NOEC[3] of 122 mg/L and a 96-day NOEC of 11.9 mg/L for rainbow trout and a 21-day NOAEC[4] for *D. magna* of 137 mg/L. Tested concentrations with no chronic effects are well above any expected estuarine concentrations of imazamox.

Birds

There were no adverse effects or mortalities reported for avians at the highest dose tested. The avian reproductive study showed no adverse reproductive effects at 2000 ppm. EPA concluded that there are no adverse effects to birds from the labeled use of imazamox.

[1] The concentration that results in the death of 50% of the test organisms.
[2] The dose (amount fed or administered) that results in the death of 50% of the test organisms.
[3] No observed effect concentration.
[4] No observed adverse effect concentration.

Mammals

EPA required chronic and subchronic studies for mammals, but did not find overt toxicity or tissue pathology at doses up to about 1600 mg/kg/bw/day. The author of an independent risk assessment of imazamox prepared for the US Forest Service concluded that “ while adverse effects on plants may be anticipated, there is no basis for asserting that applications of imazamox will pose any substantial risk to humans or other species of animals. For humans and mammalian wildlife, confidence in the risk assessment is high.”

The ability for imazamox to bioaccumulate is low. There was no reproductive or developmental toxicity observed at highest doses tested. Mutagenicity tests were negative and there were no effects on organs associated with endocrine function. EPA did not require neurotoxicity studies because there was no evidence of neurotoxic effects observed in acute, subchronic, developmental, reproduction, or chronic studies. EPA classified imazamox as “not likely to be a human carcinogen.”

Plants

Imazamox is an herbicide; accordingly, imazamox is toxic to aquatic and terrestrial plants.

Algae

The EC_{50} for alga was greater than the highest concentration tested (40 ppb) during the registration process. EPA did not require further algae testing so EPA did not predict whether imazamox would affect algae at higher imazamox water concentrations. However, subsequent to the registration process, scientists conducted further testing on imazamox and algae (discussed in effects section).

Effects

EPA integrates exposure and toxicity effects data to evaluate the likelihood of adverse ecological effects on non-target species. The agency comes up with a value called a Level of Concern (LOC) that indicates when a pesticide's labeled use has the potential to cause adverse effects on non-target organisms.

Animals

In its aquatic risk assessment, EPA did not anticipate that the use of imazamox for aquatic weed control would exceed the agency's acute LOC for avian, mammalian, fish, and aquatic invertebrate listed species. EPA did not rule out chronic risk for aquatic fish and invertebrates since there are no EPA reviewed and approved chronic toxicity data on fish and invertebrates. However, based on the large tidal fluxes in Willapa Bay (dilution of herbicide), and the low sorption potential of imazamox (should not bind to sediment), it would be highly unlikely that fish and invertebrates would experience chronic exposure to imazamox from treatments in Willapa Bay.

Plants

EPA predicts that aquatic plant control with imazamox will adversely impact nearby aquatic vascular plants. Ecology's greatest concern with the use of imazamox for the management of *Z. japonica* is inadvertent treatment of adjacent native eelgrass beds (mitigations discussed further in the monitoring section of the Fact Sheet). Unintended removal or sub lethal impacts to native eelgrass beds could lead to secondary effects including changes in food availability and habitat quality for animals.

Patten (2003) as cited in Entrix (2003) showed that eelgrass could rapidly regrow after herbicide treatment. He observed that imazapyr-treated eelgrass beds returned to their pre-treated state less than one year after treatment. Regardless of whether native eelgrass can recover quickly from herbicide treatment, Ecology expects its permit to protect native eelgrass beds from inadvertent treatment from imazamox use on nearby treated clam beds.

The scenario for managing *Z. japonica* is to spray plants with imazamox with at least one hour of dry time before tidal inundation. Nearby native eelgrass beds should be underwater at the time of treatment. There may also be native eelgrass on the beds, but mostly in lower elevation swales or channels that applicators would avoid spraying since clams do not grow in these areas and the permit limits spraying directly into them. *Z. japonica* would have a minimum of one hour to take up the herbicide, some herbicide would bind to the sediment, and some would degrade before the flood tide washed herbicide residues off the bed.

Algae

EPA was not certain whether the maximum in-water label concentration of 500 ppb would adversely affect aquatic unicellular algae since the maximum concentration tested on algae during the registration process was 40 ppb. However, subsequent to the EPA process, federal aquatic scientists Netherland et al. (2009) assessed imazamox for efficacy against eight species of green and blue-green algae at imazamox concentrations of 100, 200, and 500 ppb a.i. in a two-week exposure laboratory experiment. The authors did not observe a response to the different rates of imazamox or any species selectivity. They did not recommend further testing of imazamox for potential as an algaecide because it did not demonstrate any algaecidal activity (unlike some of the other ALS inhibitor chemicals that they tested).

Exposure to imazamox during research trials conducted on Willapa Bay did not indicate any effects on algae in treated beds (K. Patten, 2012, personal communication). Dr. Patten also indicated that unlike eelgrass, which is rooted, macro algae are transient on shellfish beds. Ecology believes that effects on algae from treatment of *Z. japonica* with imazamox are unlikely to occur.

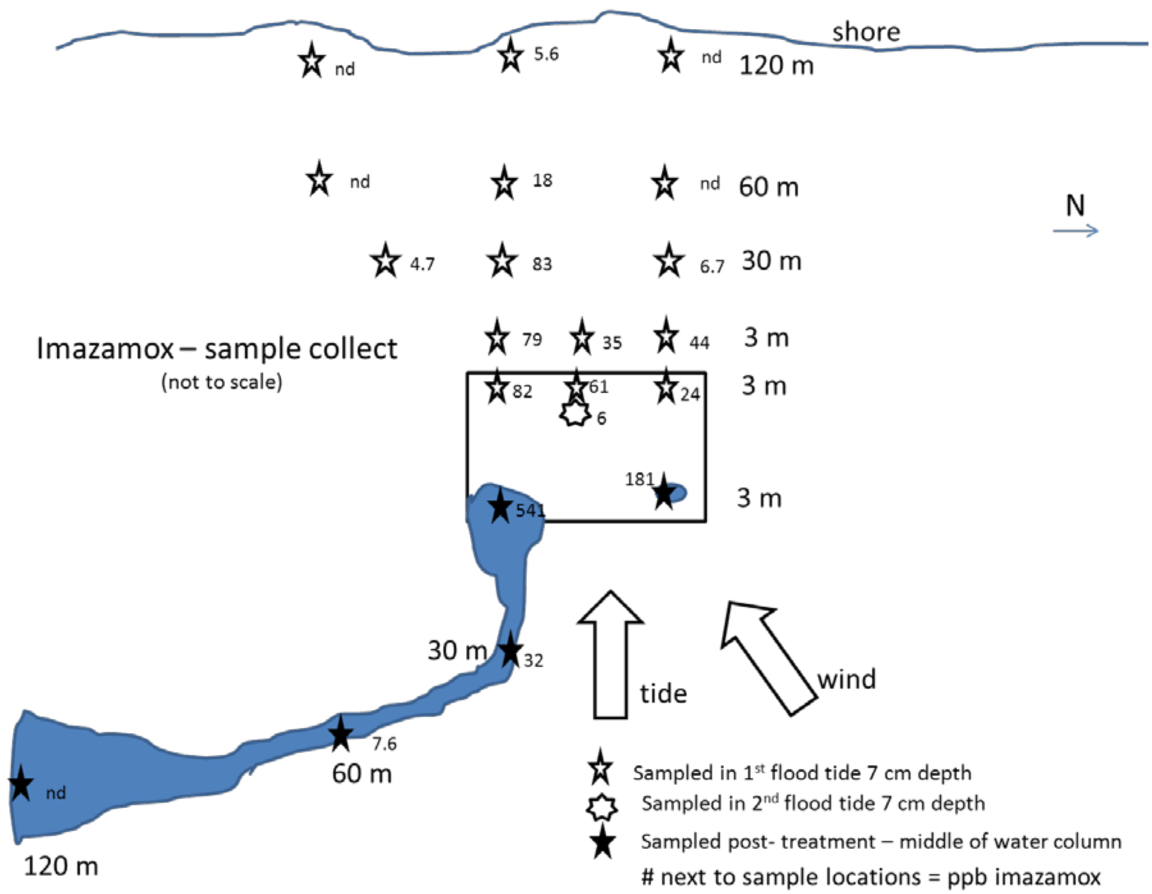
Persistence

In aquatic environments, photolytic degradation and dilution are the primary sources of the dissipation of imazamox in water, but the key degradation pathway is photolysis (breaks down by light). Imazamox degrades rapidly in light (half-life of 6.8 hours) and degradation proceeds via microbial action to carbon dioxide. The proposed application method (applied to dewatered plants) should lead to rapid breakdown of the herbicide since this method maximizes light exposure. Imazamox is also very water-soluble (4,424 mg/L) and adheres poorly to all soil types. The kd is 0.05 to 2.7 mL/g. Willapa Bay sediments have low organic carbon content and sorption is typically less in these low organic sediments. The organic sorption koc is 5-143 mL/g for imazamox. See also the sediment section.

Water

There is a large tidal range in Willapa Bay (tides may exceed 3 m) so Ecology expects rapid dilution of imazamox once the flood tide submerges the sprayed bed. Tidal flux provides a consistent and predictable rinsing effect that will solubilize applied herbicide residues and move them off site. In Willapa Bay, there are generally two high and two low tides within 24 hours (Entrix, 2003). The average difference between the high and low tide ranges from 8.1 to 10.3 feet, with an average volume of water between mean high tide and mean low tide of 4.8×10^8 cubic yards and an average tidal flow discharge of 25,000 cubic yards per second. With at least an hour of dry time, plants would have taken up some of the herbicide and some breakdown by photolysis will occur. Ecology expects the flood tide to wash over the sprayed plants with remaining herbicide residues most concentrated in the leading edge.

Patten and Haldeman (2012) characterized imazamox concentrations after an application in Willapa Bay conducted under an experimental use permit (WSEUP No. 12003). They treated a sandy sediment site with 16 ounces per acre rate of Clearcast® 20 minutes before low tide (-2.6 feet) using a backpack sprayer. They described the site as dry except for a tidal drainage swale and several isolated pools. Following treatment, they collected water samples within tidal pools and swales within the treated site, in the tidal swale draining the site during ebb tide, and on the shore side of the plot during flood tide. To assure that the off-site sample locations or times of sampling occurred where and when concentrations were highest, they added a blue dye to the water in the outgoing drainage swale immediately after treatment and to the leading edge of the incoming tidal water as it moved across the site. Sampling times at each collection site during the ebb tide corresponded to times when the peak of the dye was most concentrated for that location. The results are summarized in the figure below taken from the report. **Results are reported in ppb.**



On-site concentrations of imazamox were higher, but quickly diluted as the tide moved over the treated site. Imazamox moved offsite in both the ebb and flood direction. Note: the Clearcast® label allows irrigation to occur with treated freshwater when the water concentration of imazamox is ≤ 50 ppb. That means that the manufacturer does not expect any toxicity to plants at an irrigation water concentration of 50 ppb or less.

The imazamox concentrations detected in this trial should not pose any risk to animal species since the LC_{50} of the most sensitive aquatic animal is >100 ppm (orders of magnitude higher than the exposure from a *Z. japonica* treatment where concentrations were ppb).

Scientists have also collected water concentration information for imidicloprid, a chemical proposed for use on the estuary for burrowing shrimp management. Imidicloprid, although an insecticide, shares similar sorption and solubility characteristics with imazamox and thus should behave similarly to imazamox as the tide inundates treated areas. Felsot and Ruppert (2002) treated small plots with imidicloprid (6.1 m x 6.1 m). They collected water and sediment directly in the treated plots or at various distances along a transect from the plots. They collected water samples on the flood tide in 2 cm of water (initial samples, and 14, and 28 days after treatment). They also collected sediments during low tides when the sediment was exposed.

Typically imidicloprid was detected in first tidal flush water after application (concentrations peaked 10 minutes post-flow), but was not detected in samples collected 30- and 40-minutes after the ***first flush tide***. They did not detect imidicloprid in water samples collected 15 and 152 m from the plot the day after application. The authors attributed the rapid dissipation of imidicloprid to dilution and concluded that 99% of the applied chemical dissipated from the small plots within 24 hours. At a distance of 152 m along a transect from the plot in the direction of tidal flow, imidicloprid levels peaked within ten minutes after the tidal waters reached that location, but within 30 minutes, no residues were detected. Nor were any residues detected for a month following the treatment when sampling finished.

As part of the imidicloprid registration process, researchers are conducting ongoing and additional treatment trials. Unpublished results indicate similar tidal dissipation/dilution of imidicloprid as described above when imidicloprid is applied to much larger treatment plots (Derek Rockett, unpublished data).

Patten (2002) as cited in Entrix (2003) found that imazapyr, a liquid herbicide used for *Spartina* management in Willapa Bay, diluted beyond detection within approximately 40 hours or less – four to five tidal exchanges after herbicide application. Like imazamox, applicators apply imazapyr directly to *Spartina* plants on low tides. This research gives further weight to the premise that imazamox should dissipate quickly due to tidal dilution.

Sediment

In terrestrial applications, imazamox degrades slowly when applied to upland soils (half-lives varied from 15 to 130 days in field sites in North America). In sediment, imazamox half-lives were similar (15 – 130 days). Because imazamox is highly water soluble, it is not expected to bind with organic materials in the sediment. However, Ecology expects the half-life of imazamox in estuarine sediment to be less than observed in lake sediments due to tidal exchange and dilution. In its risk assessment, EPA concluded that even if imazamox does persist in the sediments, it is unlikely to present any risk to fish, invertebrates, birds, or mammals.

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REGULATORY INFORMATION

Regulatory Pollution Reduction Requirements

Federal and state regulations require that effluent limits in an NPDES permit must be either technology- or-water-quality-based.

- Technology-based limitations are based upon the methods available to treat specific pollutants. Technology-based limits are set by EPA and published as a regulation or Ecology develops the limit on a case-by-case basis (40 CFR 125.3, and chapter 173-226-070 WAC).
- Water quality-based limits are calculated so that the effluent will comply with the Surface Water Quality Standards (chapter 173-201A WAC), Groundwater Standards (chapter 173-200 WAC), Sediment Quality Standards (chapter 173-204 WAC) or the National Toxics Rule (40 CFR 131.36).
- Ecology must apply the more stringent of these limits to each parameter of concern. These limits are described below.

Technology-Based Water Quality Protection Requirements

Sections 301, 302, 306, and 307 of the CWA establish discharge standards, prohibitions, and limits based on pollution control technologies. These technology-based limits are *best practical control technology* (BPT), *best available technology economically achievable* (BAT), and *best conventional pollutant control technology economically achievable* (BCT). Permit writers may also determine compliance with BPT/BAT/BCT using their *best professional judgment* (BPJ). EPA has stated that for pesticide application to water (in its aquatic pesticide NPDES general permit issued October, 2011) that technology-based requirements are Best Management Practices (BMPs); not numeric limits.

Washington has similar technology-based limits that are described as ***All Known, Available, and Reasonable methods of control, prevention, and Treatment*** **(*AKART*)** methods. State law refers to AKART under RCW's 90.48.010, 90.48.520, 90.52.040, and 90.54.020. The federal technology-based limits and AKART are similar but not equivalent. Ecology may establish AKART:

- For an industrial category or in an individual permit on a case-by-case basis.
- That is more stringent than federal regulations.
- That includes BMP's such as prevention and control methods (e.g., waste minimization, waste/source reduction, or reduction in total contaminant releases to the environment).

Ecology and EPA concur that AKART may be equivalent to best professional judgment (BPJ) determinations.

Historically, EPA has regulated the pesticide application industry under FIFRA. EPA developed label use requirements to regulate the use of pesticides. EPA also requires the pesticide manufacturer to register each pesticide, provide evidence that the pesticide will work as promised, and minimize unacceptable environmental harm.

The Pesticide Management Division of the Washington State Department of Agriculture (WSDA) ensures that applicators use pesticides legally and safely in Washington. WSDA registers pesticides for use in

Washington (in addition to EPA registration); licenses pesticide applicators, dealers and consultants; investigates complaints such as label violations; maintains a registry of pesticide sensitive individuals; and administers a waste pesticide collection program. These duties are performed under the authority of the Washington Pesticide Control Act (chapter 15.58 RCW), the Washington Pesticide Application Act (chapter 17.21 RCW), the General Pesticide Rules (chapter16-228 WAC), the Worker Protection Standard (chapter 16-233 WAC) and a number of pesticide and/or county specific regulations (https://agr.wa.gov/washington-agriculture/laws-and-rules/pesticides).

The standards for environmental protection are different between the CWA and FIFRA. In compliance with the *National Cotton Council, et al. v. EPA* court decision, all aquatic pesticide applications in the United States occur under NPDES permits (as of October 31, 2011). EPA-delegated states, such as Washington, developed their own state NPDES permits for these activities. EPA developed a general aquatic pesticide NPDES permit for the non-delegated states and federal and tribal lands not delegated under state permitting authority. In Washington, all aquatic pesticide activities taking place on tribal lands must follow EPA permitting guidelines. All federal agency actions taken by federal agencies on federal lands must occur under the EPA permit. Aquatic pesticide applications occurring on federal lands where the federal agency is not the decision maker or applicator may occur under state NPDES permits instead of the EPA permit (by agreement between EPA and Ecology).

After the *Headwaters Inc. v. Talent Irrigation District* decision (2001), Ecology regulated aquatic pesticide application under NPDES permits. Ecology issued its first aquatic pesticide permits in 2002. Since 2002, Ecology has revised and reissued several of its aquatic pesticide permits. It is Ecology's intent that issuing this permit will authorize *Z. japonica* management using the aquatic herbicide imazamox in a manner that complies with federal and state requirements.

All wastewater discharge permits issued by Ecology must incorporate requirements to implement reasonable prevention, treatment, and control of pollutants. Ecology acknowledges that applicators could treat the pollutants addressed in this permit only with great difficulty due to the diffuse nature and low concentrations that exist after the pesticides have become waste. The *Headwater, Inc. v. Talent* ruling established that aquatic pesticides become waste in the water after the pesticide has performed its intended action and the target organisms are controlled or if excess pesticide is present during treatment.

Integrated Pest Management (IPM)

EPA regards IPM as meeting technology-based-effluent-limits for aquatic pesticide application (see the EPA general permit). EPA's permit requires that all applicants required to file a ***Notice of Intent (NOI)*** under its general permit develop and implement *Pesticide Discharge Management Plans* that include comprehensive IPM practices. EPA also requires any state-issued aquatic pesticide NPDES permits to be at least as stringent as its permit. Therefore, Ecology's permit requires that applicants develop ***Discharge Management Plans*** (*DMP's*) for the use of imazamox to manage *Z. japonica* on commercial clam beds. Appendix C of the draft permit sets out the minimum standards and guidelines for plan development. Because the EIS prepared for the issuance of this permit covers many of the elements required in the DMP, Ecology will allow substitution of the EIS for some of the DMP plan elements, where appropriate.

Experimental Use Permits

Entities operating under WSDA-issued ***experimental use permits*** (WSEUP) need coverage under this permit. WSDA requires WSEUP for all research experiments involving pesticides that are not federally registered or for uses not allowed on the pesticide label. WSDA experimental use permits limit the area that a Permittee can test to one acre or less. WSDA grants experimental use permits for gathering data in support of registration under FIFRA Section (3) or Section 24(c).

When a researcher conducts a test on more than one surface acre of water (per pest), he or she must operate under a federal experimental use permit as well as a state experimental use permit. Any person may apply to the EPA for a federal experimental use permit for pesticides. These permits are usually valid for only one year. Persons holding a federal experimental use permit must also apply for and obtain a state experimental use permit before initiating any shipment of the pesticide to Washington. Ecology requires coverage under the appropriate aquatic pesticide permit for persons operating under a federal experimental use permit. This permit will limit experimental use activities to one acre or less regardless of whether the Permittee has a state or a federal EUP.

Water Quality-Based Requirements

Surface Water Quality-Based Effluent Limits

The Washington State Surface Water Quality Standards (chapter 173-201A WAC) were designed to protect existing water quality and preserve the ***beneficial uses*** of Washington's surface waters. Waste discharge permits must include conditions that ensure the discharge will meet established surface water quality standards (WAC 173-201A-510). Water quality-based effluent limits may be based on an individual waste load allocation or on a waste load allocation developed during a basin-wide total maximum daily loading study (TMDL).

Ecology conditions NPDES and waste discharge permits in such a manner that authorized discharges meet water quality standards. The characteristic beneficial uses of surface waters include, but are not limited to, the following: domestic, industrial and agricultural water supply; stock watering; the spawning, rearing, migration and harvesting of fish; the spawning, rearing and harvesting of shellfish; wildlife habitat; recreation (primary contact, sport fishing, boating, and aesthetic enjoyment of nature); commerce; aesthetics and navigation.

Numeric Criteria for the Protection of Aquatic Life and Recreation

Numeric water quality criteria are published in the Water Quality Standards for Surface Waters (chapter 173-201A WAC). They specify the levels of pollutants allowed in receiving water to protect aquatic life and recreation in and on the water. Ecology uses numeric criteria along with chemical and physical data for the wastewater and receiving water to derive effluent limits in the discharge permit. When surface water quality-based limits are more stringent or potentially more stringent than technology-based limits, the discharge must meet the water quality-based limits.

The EPA has published 91 numeric water quality criteria for the protection of human health that are applicable to dischargers in Washington State (40 CFR 131.36). EPA designed these criteria to protect humans from exposure to pollutants linked to cancer and other diseases, based on consuming fish and shellfish and drinking contaminated surface waters. The Water Quality Standards also include radionuclide criteria to protect humans from the effects of radioactive substances.

Narrative Criteria

Narrative water quality criteria (e.g. WAC 173-201A-240(1); 2006) limit the toxic, radioactive, or other deleterious material concentrations that may be discharged to levels below those which have the potential to:

- Adversely affect designated water uses.
- Cause acute or chronic toxicity to biota.
- Impair aesthetic values
- Adversely affect human heath

Narrative criteria are statements that describe the desired water quality goal, such as waters being "free from" pollutants such as oil and scum, color and odor, and other substances that can harm people and fish. Ecology uses these criteria for pollutants for which numeric criteria are difficult to specify, such as those that offend the senses (e.g., color and odor). Narrative criteria protect the specific designated uses of all freshwaters (WAC 173-201-A-200; 2006) and of all marine waters (WAC 173-201A-210; 2006) in the State of Washington.

Antidegradation Analysis and Antidegradation Plan

The following narrative represents Ecology's antidegradation analysis and antidegradation plan for the *Z. japonica* Management on Commercial Clam Beds in Willapa Bay General Permit. The purpose of Washington's Antidegradation Policy (WAC 173-201A-300-330; 2006) is to:

- Restore and maintain the highest possible quality of the surface waters of Washington.
- Describe situations under which water quality may be lowered from its current condition.
- Apply to human activities that are likely to have an impact on the water quality of surface water.
- Ensure that all human activities likely to contribute to a lowering of water quality, at a minimum, apply AKART.
- Apply three Tiers of protection (described below) for surface waters of the State.

Tier I ensures existing and designated uses are maintained and protected and applies to all waters and all sources of pollution. Tier II ensures that dischargers do not degrade waters of a higher quality than the criteria assigned unless such lowering of water quality is necessary and in the overriding public interest. Tier II applies only to a specific list of polluting activities. Tier III prevents the degradation of waters formally listed as "outstanding resource waters" and applies to all sources of pollution.

WAC 173-201A-320(6) describes how Ecology implements Tier I and II antidegradation in general permits. All Permittees covered under the general permit must comply with the provisions of Tier 1. Ecology determined that the permit does not cover discharges to Tier III waters.

Under state law, the use of herbicides is in the public interest.

> *"Many commercially available herbicides have been demonstrated to be effective in controlling nuisance and noxious aquatic weeds and algae and do not pose a risk to the environment or public health. The purpose of this act is to allow the use of commercially available herbicides that*

have been approved by the environmental protection agency and the department of agriculture and subject to rigorous evaluation by the department of ecology through an environmental impact statement for the aquatic plant management program". (RCW 90.48.447)

See also the Biological Background Section for information about how *Z. japonica* affects shellfish aquaculture activities.

The water quality standards at WAC 173-201A-320(6) describe how Ecology should conduct an antidegradation Tier II analysis when it issues NPDES general permits. This section of the rule requires Ecology to:

Use the information collected, from implementation of the permit, to revise the permit or program requirements.

- Ecology developed the proposed permit based on written and oral feedback from potential Permittees, parties potentially affected by the proposed permit, internal agency staff, natural resource scientists from other government agencies, and academia. Ecology will further revise the draft permit based on a formal public comment period and testimony received at public hearings.
- Ecology may modify or revoke the permit if monitoring data show significant adverse impacts to Z*. marina* beds off of the treatment site, through the continued use of imazamox. In addition, the permit requires immediate reporting of any adverse impacts from treatment to fauna or humans. Ecology investigates these reports and determines if the treatment caused or contributed to the problem.
- Ecology requested a buffer validation study as part of the 2014 version of the permit and requires visual monitoring (special condition S.5 of the permit) to answer the following questions:
    - What is the concentration and degradation of imazamox in sediment within the treated sites?
    - What are the effects of imazamox treatment on native eelgrass plants growing on properties adjacent to treated commercial clam beds?

The buffer validations study was completed and a final report submitted to Ecology in 2015. Based on the study report, Ecology modified the 2014 version of the permit in 2017 to remove further buffer study and continue with visual monitoring of buffers on treated commercial clam beds. This decision was based on the study results showing no significant impact (>20% change in cover or stem density) to off-site *Z. marina* in worst-case scenario treatments.

Review and refine management and control programs in cycles not to exceed five years or the period of permit reissuance.

- This is the second issuance of this permit. It expires (date five years from effective date). Permit issuance includes a public involvement process as described below.
- Ecology spent several years prior to the 2014 permit issuance soliciting input from users and affected parties, writing and revising permit conditions, reviewing relevant data and literature, and collaborating with natural resource scientists before soliciting public comment on the permit

and accompanying documents and finalizing the permit. In addition, Ecology required the potential applicants to develop an EIS to support the use of imazamox to treat *Z. japonica* in a marine/estuarine environment.

- Where treatment occurs up to the edge of the 10m buffer, visual monitoring is still required (special condition S5) and must be reported to Ecology. If there is a change that show the buffer is no longer working, Ecology may consider alternative options for protecting off-site *Z. marina*, which would take place during the next reissuance process or through a major modification of the permit.

Include a plan that describes how Ecology will obtain and use information to ensure full compliance with water quality standards. Ecology must develop and document the plan in advance of permit or program approval.

- The information in the Fact Sheet and in the antidegradation section of this Fact Sheet constitute Ecology's antidegradation plan for the *Zostera japonica Management on Commercial Clam Beds in Willapa Bay General Permit*. This is despite language in Ecology's guidance document implementing Tier II antidegradation requirements that indicates such a plan may not be required. Ecology *Supplementary Guidance Implementing the Tier II Antidegradation Rules,* dated September 2011 (https://fortress.wa.gov/ecy/publications/SummaryPages/1110073.html). A Tier II analysis is not required in association with activities regulated under a short-term modification (WAC 173-201A-410) such as what would occur with construction and maintenance activities or the periodic use of herbicides to control noxious aquatic weeds.
- Imazamox and marker dyes are not chemicals of concern.
- Willapa bay is not a ***303(d)-Listed water body*** because of imazamox or marker dyes. The Permittee will not apply imazamox directly to the water but will apply it to *Z. japonica* beds exposed by low tides. As the rising tide covers the treated vegetation, some herbicide will enter the water from the sprayed foliage. Based on monitoring data, Ecology anticipates that the concentration of the herbicide in the water off the treated beds will be under the in-water label rate for imazamox. The permit requires monitoring of nearby *Z. marina* beds.
- Ecology will review monitoring information and reports, and if non-target impacts to *Z. marina* beds, located off the commercial clam bed property, are unacceptable or other adverse impacts become apparent, may modify the permit or terminate permit coverage.
- Ecology required Permittees to develop a DMP for this activity.

Short-Term Water Quality Modification Provisions

The short-term water quality modification provision of the draft permit allows the authorized discharges to cause a temporary diminishment of some designated beneficial uses while it alters the water body to remove the state-listed noxious weed *Z. japonica* from commercial clam beds in Willapa Bay. The conditions of this permit constitute the requirements of a short-term water quality modification.

A short-term exceedance only applies to short lived (hours or days) impairments, but short-term exceedances may occur periodically throughout the five-year permit term. Short-term exceedances may also extend over the five-year life span of the permit (long-term exceedance) provided the Permittee satisfies the requirements of WAC 173-201A-410.

Washington's Water Quality Standards include 91 numeric health-based criteria that Ecology must consider when writing NPDES permits. The EPA established these criteria in 1992 in its National Toxics Rule (40 CFR 121.36). Ecology has determined that the Permittee's discharge does not contain chemicals of concern based on existing data or knowledge.

Sediment Quality Standards

The sediment standards (chapter 173-204 WAC) protect aquatic biota and human health. To comply with these standards, Ecology evaluates the potential for a discharge to cause a violation of marine sediment quality criteria (WAC 173-204-400). WAC 173-204-415(2) states, in summary, that a sediment impact zone (SIZ) is to be required by Ecology if a discharge causes a violations or substantial potential to violate marine sediment quality criteria (WAC 173-204-320 – marine sediment quality standards).

EPA concluded that imazamox will not bind to sediments (low binding potential), or persist within sediments. Imazamox has a low sorption potential, meaning it is very soluble in water and should not bind to sediments (EPA, 2008)(Ecology, 2014). Sediment monitoring data obtained during the 2014 to 2019 permit cycle indicate that sediment imazamox concentrations ranged from less than 0.50 ppb (non-detect) to 3.2 ppb wet weight 48 hours post treatment. These environmental concentrations are well below the 50 ppb environmental concentration where impacts to non-target native plants that are located outside of commercial clam beds would be expected. EPA reported that ALS/ASHS inhibitors have an average aerobic (terrestrial) soil half-life of 2 weeks (imazamox listed as 28-30 days), indicating that some soil microbes will work to breakdown herbicides in addition to photolysis. Aqueous photolysis (breakdown in the presence of light) is reported to be a major breakdown pathway with a half-life of 6.8 hours (EPA, 1997)(EPA, 2008)(Ecology 2014). Due to these factors EPA concluded imazamox unlikely to present a risk to fish, invertebrates, birds, or mammals.

Additionally the imazamox mode of action is an acetolactate synthase (ALS)/acetohydroxyacid synthase (ASHS) inhibitor preventing synthesis of branched chain amino acids. This chemical pathway is not present in animals. Therefore, EPA categorized the toxicity of imazamox as practically non-toxic to animals. The final EIS (2014) for imazamox concluded that the exposure risk to invertebrates, birds, fish, reptiles, amphibians, mammals, and humans from use of imazamox on commercial clam beds would be transient and due to the lack of ALS/ASHS pathway, of minimal risk.

Based on EPA's conclusions, the 2014 EIS, and permit data, it is unlikely that use of imazamox under permit will cause or contribute to a violation of marine sediment quality criteria or have acute or chronic impacts to non-target animal or plant species in Willapa Bay.

Water Quality Program staff also consulted with Toxics Cleanup Program (TCP) staff to determine if further investigation on marine sediment impacts from imazamox use on commercial clam beds is appropriate. TCP staff concluded that imazamox use on commercial clam beds will not cause or contribute to a violation of marine sediment quality criteria based on acute or chronic impacts to non-target plant or animal species in Willapa Bay, therefore a SIZ is not required.

TCP staff did note one area of uncertainty, - the effects on marine sediment benthic bacteria on commercial clam beds. Due to this noted uncertainty, Ecology performed a search for information about the potential effects of imazamox on marine sediment bacteria. Ecology could locate no information directly on the subject of imazamox effects on marine sediment bacteria. A broader search for the effect of ALS/ASHS inhibitor herbicides (e.g. imidazolinones, sulfonylureas; not just imazamox) on microorganisms resulted in some information pertaining to terrestrial (e.g. agricultural, forestry) or laboratory environments. These environments differ significantly from the marine environment where tidal drain/flood cycles (dilution, reduced time on sediment before dilution) as well as photolysis will greatly influence imazamox dissipation and most likely mitigate effects on marine sediment bacteria. A summary of reviewed journal articles is presented here to illustrate the range of literature.

- Imazethapyr (an imidazolinone herbicide similar to imazamox) reported to be degraded by a strain of soil bacterium. Also reported some studies documented other bacteria strains capable of degrading imidazolinone herbicides. (Huang et al, 2009)

- ASHS inhibitor based herbicides reported to inhibit growth of some bacterial strains. (Gedi & Yoon, 2012)

- A greenhouse experiment with several herbicides including imazamox/imazethapyr noted reduced soil microbial biomass (microbial C) after herbicide use. None of the experiments reduced species diversity compared to control. Follow up field experiments had did not find effects on soil microbial diversity or biomass. (Lupwayi et al, 2003)

- Carbon and nitrogen mineralization in soil has a microbial component. Mediterranean soils were exposed to imazamox to determine if the herbicide affected mineralization rates. In some circumstances, presence of imazamox did not affect mineralization. In others, mineralization was significantly lower. Results indicate that imazamox use reduced action by bacteria involved in mineralization. (Kizildag et al, 2014)

- Researchers noted differences in ALS inhibition between plants and bacteria; however, more research is necessary to determine the reason for these differences. (Durner et al, 1990)

- Sulfonylurea based AHAS inhibiting herbicides have bacteriostatic effects on some bacteria. However, some strains presented spontaneous mutations resistant to AHAS inhibition. (Kriesberg et al, 2013)

- Microcosm field study carried out at the edge of agricultural fields and exposed to insecticides and herbicides when applied to the field. Individual insecticides reduced microbial diversity and biomass, but herbicides did not. Mixtures of insecticides and herbicides also lead to a reduced microbial community and changes in its structure. It is unknown if this effect was due to synergy or concentration, however the primary driver appeared to be the insecticides. (Muturi et al, 2017)

- Researchers in oak forest regeneration noted a decrease in some soil bacteria after treatment with imazamox, however other bacteria were stimulated by the application of herbicides. (Vasic, 2019)

- Summarizing Gandioni et al, 1998, and Zohar et al., 2003, McCourt and Duggleby note that while sulfonylureas (an ALS/ASHA inhibitor) showed some bacteriostatic effects related to *M.*

tuberculosis and *M. avium*, imidazolinones (e.g. imazamox) showed little to no inhibitory activity. (McCourt & Duggleby, 2006)

- Many strains of rhizobacteria in pure culture were tolerant of imidazolinone and other herbicide use even at high concentrations, but there was great variability in bacteria species response. Some taxa were more sensitive than others. Repeated herbicide use could shift populations towards more tolerant species. Field trials resulted in tolerant strains to achieve higher populations densities on root structure versus non-tolerant strains. (Forlani et al, 1995)

- Researchers attempted to isolate a bacterial strain for potential use as a mitigation tool for imazamox residues in crop fields. Strain IB5 of *Acinetobacter baumannii* was identified as a promising bacteria. This strain utilizes imazamox as a carbon source and was able to degrade up to 98.91% of imazamox residue. Other strains degraded between 9.36 and 57.33%. (Lui et al, 2016)

Based on the limited information available, the fact that the information is related to terrestrial and/or laboratory environments, extrapolation to effects on bacteria in a marine sediment environment is challenging. Literature is unclear on actual effects, with some bacteria species being affected by one ALS/ASHS inhibiting herbicide, but not another. Some bacteria species appear to be affected negatively, other positively. No information directly addressed rebound of bacteria population diversity or density, though some literature noted inhibition in growth, and shifts in population. Additionally, some bacteria are known to breakdown pesticides (Nayak et al, 2018)(Lui et al, 2016). Bacteria have generation times (growth and cell fission) ranging from minutes to hours, depending on species and environmental characteristics (e.g. temperature, nutrient sources) (Brock, 1970)(Rheinheimer, 1985). It is unclear if short-term grown inhibition or shifts in bacteria population could occur in the marine sediment environment or how fast populations may rebound.

Current information does not appear to support a reasonable potential for unacceptable impacts to marine sediment bacteria. The permit limits the number of imazamox applications to a commercial clam bed to one time per year in Willapa Bay. Literature indicates short chemical half-life, short bacteria generation periods, uncertainty if bacteria will actually be effected by imazamox, and the likelihood that some bacteria will contribute to the breakdown of imazamox. Therefore, at this time, the information does not support the requirement for a SIZ.

Literature reviewed for information on interaction between imazamox and bacteria:

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- Kreisberg, J., Ong, N., Krishna, A., Joseph, T., Wang, J., et al. (2013). *Growth Inhibition of Pathogenic Bacteria by Sulfonylurea Herbicides*. Antimicrobial Agents and Chemotherapy, 57(3), 1513-1517. [Category 1]
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- Zohar, Y., Einav, M., Chipman, D. M., Barak, Z. (2003). *Acetohydroxyacid/synthase from Mycobacterium avium and its inhibition by sulfonylureas and imidazolinones*. Biochimica et Biophysica Acta - Proteins and Proteomics, 1649, 97-105. [Category 1]

Groundwater Quality Standards

The Groundwater Quality Standards, (chapter 173-200 WAC), protect beneficial uses of ground water. Permits issued by Ecology must not allow violations of those standards. This permit does not allow the use of any pesticides expected to contaminate groundwater. In the event there are additional concerns, Ecology can issue orders requiring groundwater monitoring for imazamox under this permit.

SEPA Compliance

This is a reissuance of an existing general permit. Ecology is not proposing any changes that reduce the stringency of existing state rules for imazamox use on commercial clam beds in Willapa Bay. In such cases where change is not proposed, the permit is exempt from SEPA review based upon RCW 43.21C.0383 that states in the applicable clause:

> "*The following waste discharge permit actions are not subject to the requirements of RCW 43.21C.030(2)(c): (1) For existing discharges, the issuance, reissuance, or modification of a waste discharge permit that contains conditions no less stringent than federal effluent limitations and state rules; . . .*"

RCW 43.21C.030(2)(c), summarized, requires that any state agency include a SEPA review of an actions taken. The proposed permit is at least as stringent as the version of the permit which expires May 2019.

Ecology is proposing a procedural change in how it handles the project level SEPA determination for each permit coverage.

A programmatic SEPA review of the proposed action through development of an environmental impact statement (EIS) was previously conducted. Ecology adopted the EIS through a Determination of Significance with Adoption of Existing Environmental Documents and Addendum for activities covered by the 2014 and 2017 versions of the permit. The programmatic SEPA review assesses all of the herbicides (imazamox) allowed for use under the permit and applies to all sites potentially covered by this permit. The type of activities conducted under permit have not changed since 2014. Ecology is not proposing to expand the geographical area to which this permit applies (Willapa Bay only).

Ecology will rely upon the programmatic SEPA determination to issue permit coverage rather than issuing a SEPA determination for each separate coverage. In a change from the 2014 Permit modified in 2017, applicants no longer fill out a separate SEPA checklist. Instead, the NOI provides site-specific project information to supplement Ecology's programmatic EIS.

SEIS: https://fortress.wa.gov/ecy/publications/SummaryPages/1410050.html

Endangered and Sensitive Species

EPA has implemented an Endangered Species Protection Program (ESPP) to identify all pesticides that may cause adverse impacts on threatened/endangered species and to implement measures that will mitigate these impacts. When the ESPP identifies an adverse impact, it requires use restrictions to protect these species at the county level. EPA will specify these use restrictions on the product label or by distributing a county-specific Endangered Species Protection Bulletin. Bulletins are enforceable under FIFRA. General Condition G9 of the *Z. japonica* Permit requires the Permittee to comply with all applicable federal regulations. See https://www.epa.gov/endangered-species/about-endangered-species-protection-program for more information. However, in its aquatic risk assessment for imazamox, EPA only identified a level of concern for endangered plants. There are no endangered plants on the Willapa tide flats where shellfish growers propose to use imazamox. However because *Z. marina* is a WDFW priority species, Ecology will endeavor to protect *Z. marina* beds, located off of treated sites, and require monitoring for impacts to this species. The goal for *Z. marina* is no net loss, off commercial clam bed properties, in Willapa Bay due to activities conducted under this permit.

The U.S. Fish and Wildlife Service and National Marine Fisheries Service are involved in EPA's processes to protect listed species and designated critical habitat in several ways: by consulting with EPA on specific endangered species concerns; by issuing Biological Opinions on certain species; or other ways, as necessary. For details on how EPA evaluates the potential risks from pesticides to listed species and consults with the Services, see their risk assessment process web page at https://www.epa.gov/endangered-species/assessing-pesticides-under-endangered-species-act.

The southern distinct population segment of green sturgeon is an ESA threatened species found along the western coast of the USA, Canada, and Mexico. The term "threatened species" is defined as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." Green sturgeons are present in Willapa Bay, but do not spawn in Washington waters. According to a NOAA website, the principal factor in the decline of the green sturgeon on the west coast is reduction of the spawning area to a limited section of the Sacramento River. Scientists believe that green sturgeon mainly eat benthic invertebrates.

"Willapa Bay, along with the Columbia River and Grays Harbor, is one of the estuaries where green sturgeon concentrate in summer. Generally, green sturgeon are more abundant than white sturgeon here (Emmett et al. 1991). Catches have declined from 3,000-4,000 fish per year in the 1960's to few or none in recent years. Much of this is probably due to reduced size limits and seasonal and area closures https://www.westcoast.fisheries.noaa.gov/publications/status_reviews/other_species/green_sturgeon/greensturgeon.pdf.

It was also noted in the 2015 NOAA 5-Year Review of green sturgeon that this species has difficulty feeding in *Z. japonica* beds, with the lowest density of feeding pits in the highest *Z. japonica* stem density areas.
https://www.westcoast.fisheries.noaa.gov/publications/protected_species/other/green_sturgeon/8.25.2015_southern_dps_green_sturgeon_5_year_review_2015.pdf

The issuance of this permit does not have a federal nexus that would trigger formal ESA consultation with the federal services. National Marine Fisheries Service (NMFS) staff said in a communication to Ecology, "*As the permit is issued solely by the state, there is no formal nexus, and therefore NMFS will not be issuing a legal opinion on the permit. We have offered, and will assist, in providing technical input to Ecology as it relates to this permit and any potential interactions it has with our trust species, but lacking a formal federal nexus, our role will be in providing technical assistance and feedback only.*"

Because imazamox is practically non-toxic to fish, will be applied to dewatered plants, and unpublished research shows that green sturgeon typically do not feed in areas of *Z. japonica* (Fisher et al.), it seems unlikely that the application of imazamox would pose a risk to adult green sturgeon present in Willapa Bay.

WAC173-226-140 requires that Ecology submit all draft general NPDES permits for federal agency review and recommendations. Federal agencies include the EPA, the US Army Corps of Engineers, the US Fish and Wildlife Service, the National Marine Fisheries Service, and any other federal agency upon their request. Ecology also solicited input from federal resource agency scientists when drafting this permit.

Responsibility to Comply with Other Requirements

Ecology has established, and will enforce, limits and conditions in the permit for the discharge of aquatic herbicides registered for use by the EPA and the WSDA. EPA and WSDA will enforce the use, storage, and disposal requirements expressed on pesticide labels. The Permittee must comply with the pesticide label requirements (FIFRA) and all of the conditions of this general permit. The permit does not supersede or preempt federal or state label requirements or any other applicable laws and regulations.

SPECIAL CONDITIONS

S1. PERMIT COVERAGE

This permit is a reissuance of the permit was issued April 2, 2014, modified April 5, 2017, and that expires May 2, 2019.

Activities Covered under This Permit

Dischargers (aquatic licensed applicators) together with the project sponsors (the individual or entity that makes the decision to ***treat***) that participate in *Z. japonica* control activities that result in a discharge of pollutants to waters of the State must obtain coverage under a permit as required by Washington laws and regulations (RCW's 90.48.080, 90.48.160, 90.48.260 and chapter 173-201A WAC). The aquatic herbicide imazamox and herbicides that may be used under a EUP, are a potential pollutant, and therefore require a discharge permit before application to Washington State surface waters. This permit regulates the use of imazamox and marker dyes for the management of the state-listed noxious weed *Z. japonica* on commercial clam beds in Willapa Bay. Ecology has excluded geoduck clam culture from coverage under this permit. Additionally, this permit regulates the use of other herbicides used under a state or federal EUP for the management of the state-listed noxious weed *Z. japonica* on commercial clam beds in Willapa Bay.

Geographic Area Covered

The permit covers the treatment of Z. japonica with imazamox on commercial clam beds in Willapa Bay. RCW 90.48.020, WAC 173-201A-020, and WAC 173-226-030 give Ecology the regulatory authority over surface waters. Ecology does not have jurisdiction over federal or tribal lands and EPA has not delegated regulatory authority to Ecology to issue NPDES permits on federal and "Indian Country" as defined in 18 USC Sec. 1151.[5]

S2. PERMIT ADMINISTRATION

Who May Obtain Permit Coverage

A definition of "Permittee" is not provided in chapter 90.48 RCW, chapters 173-216, 173-220, or 173-226 WAC, nor is one provided in 40 CFR 122 (EPA NPDES Permit Program) or State NPDES Permit Programs. Based upon the usage of Permittee in federal and Washington State law, Ecology understands the term "Permittee" to mean the person or entity that discharges or controls the discharge of pollutants to waters of the State (surface or ground) and holds permit coverage allowing that specific discharge.

For this permit, Ecology has established that the Permittee is the aquatic licensed applicator. The permittee must have a project sponsor for each permit coverage (although in some cases the applicator and the sponsor may be the same individual). A sponsor is typically any commercial shellfish farmer holding a current business license that conducts *Z. japonica* management on its commercial clam beds in Willapa Bay. A state agency may treat its commercial clam beds under this permit if the agency specifically requests to treat under the permit. However, this permit does not allow treatment on state-

[5] Entities conducting herbicide treatment on federal lands can operate under state-issued NPDES permits where the decision maker is not a federal entity and the federal entity is the not the applicator (e.g., irrigation districts operating on Bureau of Reclamation lands can operate under the state Irrigation District Permit).

owned lands where clams are not being commercially grown for sale (e.g., lands managed for public harvest of clams). A state-licensed applicator or an applicator under the direct supervision of a state-licensed applicator must conduct the actual herbicide application.

This permit does not limit treatment on commercial clam bed lands leased from DNR. However, the Permittee is responsible for ensuring that they are not violating any aspect of their lease agreement with DNR by controlling *Z. japonica* under this permit.

WDFW manages a shellfish reserve in Willapa bay where rights to harvest the available shellfish are sometimes auctioned off. It is Ecology's opinion that the shellfish reserve managed by WDFW does not constitute a commercial clam bed per the requirement of this permit.

How to Obtain Coverage

Applicants must submit a complete application for permit coverage to Ecology a minimum of 60 days before applying imazamox.

A new permit applicant must submit a complete application to Ecology including a NOI. An official who has signature authority (WAC 173-226-200) for the entity applying for permit coverage must sign all documents. Ecology must receive the complete application for permit coverage on or before the publication date of the public notice the permit applicant posted in a newspaper of general circulation (WAC 173-226-130). Ecology considers a newspaper of general circulation as the major newspaper publication for a region. A public notice template with require language is included on the NOI. Applicants must use the template language for their public notices.

Ecology will allow two or more applicants to issue a single public notice so long as the notice contains the contact information and the treatment location(s) for each applicant.

When Ecology receives a new applicant's complete application before public notice it can review the application and communicate necessary changes on application documents. Communication (prior to publishing public notice) about document changes can save the applicant money by identifying any necessary changes (and the possible need to redo public notice) before the applicant publishes and sends out the public notice.

The public has the opportunity to comment on the permit application and the proposed coverage during the 30 days after publication of the second public notice (public comment period). Ecology will consider comments about the applicability of the permit to the proposed activity received during this period. If Ecology receives no substantive comments, it may issue permit coverage on the 38th day following receipt of a complete application. Third parties have the right to appeal coverage decisions.

Ecology is considering modifying the language in number 5 to direct permit applicants to use the public notice template on the NOI where it is easier to find than a template that is an appendix to the permit:

> 5. Use the Public Notice Template provided on the NOI for this permit ~~For New Applicants provided in Appendix B of this permit~~. The applicant may add additional information to the template as long as the required information remains as stated on the template.

How to Terminate Permit Coverage
Ecology plans to issue the permit for a period of up to five years, starting on the effective date of the permit (WAC 173-226-330). Coverage will last from the date of coverage to the date of permit expiration, which may be up to five years, unless the Permittee terminates coverage by submitting a notice of termination or unless Ecology terminates the permit early. If the Permittee does not terminate coverage, the Permittee will continue to incur an annual permit fee, even if it does not treat.

S3. DISCHARGE LIMITS

Compliance with Standards
See also the section "Technology-Based Water Quality Protection Requirements" for a discussion about AKART. Ecology also believes that implementing the applicant's DMP, following all permit conditions, and the FIFRA label will meet AKART for this permit. Ecology based the DMP planning requirements on:

- A similar planning requirement in EPA's NPDES Pesticides General Permit application. In its fact sheet, EPA considers Integrated Pest Management (IPM) to meet technology-based standards.
- Integrated Pest Management Law (chapter 17.15 RCW).
- Washington's Water Quality Standards (WAC 173-201A-110).
- Similar planning requirements in the Aquatic Plant and Algae Management NPDES permit that allows the herbicide treatment of in-water noxious weeds in freshwater lakes and rivers.

Temporary Exceedance of Water Quality Standards
In 2006, Ecology updated the Water Quality Standards for Surface Waters of the State of Washington (chapter 173-201A WAC). The standards allow a temporary exceedance of water quality standards for up to five years (the term of a general permit) provided the Permittee has followed certain guidelines. WAC 173-201A-410(2) requires that for Ecology to extend the exceedance for up to five years, and not limit it to hours or days, the Permittee must develop and implement an IPM plan. The Permittee must develop the plan following the Administrative Procedures Act for public involvement (chapter 34.05 RCW) and must complete a State Environmental Policy Act (chapter 43.21C RCW and chapter 197-11 WAC) review of the proposed activity. Permittees who do not meet these requirements must ensure that the short-term exceedance of water quality standards is limited to only hours or days. Ecology may also request updated plans and addendums to existing plans. However, Ecology believes that any activities conducted under this permit are unlikely to exceed the Water Quality Standards for more than hours or days since tidal exchange will rapidly dilute the herbicide within this period.

Application Requirements
Under state laws administered by WSDA, all aquatic herbicides are restricted use (WAC 16-228-1231). Only Washington-aquatic licensed applicators or applicators under direct supervision of an aquatic licensed applicator may apply pesticides to water. The permit requires that all applicators use appropriate application methods, have training in application techniques, and that trained personnel calibrate the application equipment to ensure appropriate label treatment rates.

Impaired Water bodies
Ecology periodically reviews water quality data to determine if water bodies meet criteria. Section 303(d) of the CWA requires that waters not meeting criteria undergo an evaluation of the cause and amount of the contaminant. Ecology publishes Total Maximum Daily Load (TMDL) reports, which may establish limits on the amounts of pollutants contributors may discharge.

Willapa Bay is on the 303(d) list for several parameters; however, Ecology believes that further impairment to Willapa Bay is unlikely through activities permitted under this permit. Treatment will have no effect on most of the listed parameters, such as legacy chemicals. Imazamox treatment is unlikely to impair parameters such as dissolved oxygen or nutrients. Noxious weeds dying from treatment on the tide flats should not cause low oxygen conditions or substantial nutrient nitrogen release in Willapa Bay with its dynamic tidal systems and substantial dilution potential.

Sensitive, Threatened, or Endangered Plants and Priority Habitats and Species

Currently, no state law protects ***sensitive, threatened, or endangered plant*** species (rare plants) in Washington. However, many federal and state land-management agencies have policies to protect rare plants. In 1982, the state legislature recognized the need for a systematic and objective approach to protect those features of natural ecosystems most at risk and created the Natural Heritage Program within the Department of Natural Resources to assume this task (RCW 79.70.060). In addition, local jurisdictions may provide protection for rare species and high quality ecosystems through ordinances, regulations, and permitting requirements. This permit does not authorize Permittees to cause permanent harm to rare plant populations and priority species. It requires the Permittee to take care to minimize harm to native plant species while treating noxious weeds.

There are sensitive habitats (high salt marsh) in Willapa Bay. However, Ecology does not believe that vascular plants, other than *Z. marina* would be exposed to concentrations of imazamox high enough and for long enough to cause impacts from treatments under this permit because clams typically grow in tidal flats at lower elevations than salt marsh vegetation. WDFW lists *Z. marina* as a priority species and habitat, although it is not a rare or threatened species in Washington. However, *Z. marina* is highly valued for its ecological benefits (see the *Z. japonica* section of this fact sheet). For example, the Puget Sound Partnership has set a goal to increase the amount of eelgrass (did not specify which species) in Puget Sound by 20 percent by 2020.

Ecology believes that the plant most at risk from treatment of *Z. japonica* on commercial clam beds in Willapa Bay is *Z. marina*. Permittees, and Ecology through the issuance of the permit, must ensure that treatment of *Z. japonica* with imazamox does not cause permanent harm to *Z. marina* populations in Willapa Bay. The goal is no net loss of *Z. marina*, off commercial clam bed properties, in Willapa Bay due to permit activities. Buffer and application requirements set out in the permit will mitigate impacts and the compliance monitoring requirements will provide feedback to Ecology for ongoing assessment that the treatment buffers are working.

Discharge Management Plans

Integrated pest management is AKART for this permit. DMP's are plans to help applicants determine appropriate pest management methods, set ***action thresholds***, incorporate principles of IPM, and help reduce pesticide use. EPA requires the development of a DMP in its NPDES permit for aquatic pesticide application and state permits must not be less stringent than federal permits. Because Ecology required an Environmental Impact Statement as the SEPA documentation for the issuance of this permit, Ecology will allow elements of this EIS to substitute for applicable DMP elements. DMP's also sets out lines of responsibility by identifying responsible parties and applicators and provides up-to-date contact information.

S4. PRODUCT USE

Prohibited Discharges
RCW 90.48.080 states that: "*It shall be unlawful for any person to throw, drain, run, or otherwise discharge into any of the waters of this state, or to cause, permit or suffer to be thrown, run, drained, allowed to seep, or otherwise discharged into such waters any organic or inorganic matter that shall cause or tend to cause pollution of such waters according to the determination of the department."*

Ecology prohibits treatment that causes oxygen depletion to the point of stress or lethality to aquatic biota from plant die-off, unintended impacts to water quality or biota, or the mortality of aquatic vertebrates. After evaluating toxicity data, the EPA risk assessment, and other relevant documents, Ecology believes that imazamox treatments allowed under this permit would be highly unlikely to cause any of the above impacts to aquatic biota from treatment of *Z. japonica* on tide flats in Willapa Bay. Imazamox is practically non-toxic to both vertebrates and invertebrates and the EPA level of concern was for adverse impacts to rare plant species and not animals.

Authorized Discharges
This permit allows the use of the liquid, aquatic-labeled formulation of the herbicide imazamox and marker dyes on commercial clam beds in Willapa Bay. Ecology authorizes these discharges in accordance with WAC 173-201A-410 and chapter 90.48 RCW. EPA regulates imazamox under FIFRA and under its general Aquatic Pesticide Permit on federal and tribal lands in Washington.

Permittees must comply with the herbicide label requirements and all applicable permit conditions. **Coverage under this general permit does not supersede or preempt federal or state pesticide product label requirements or any other applicable laws and regulations**. It is the responsibility of the Permittee to determine if there are other applicable requirements pertaining to this activity and to comply with these requirements. General Condition G9 reminds the Permittee of this fact. The permit does not convey any property rights of any sort, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights. Permittees treating under this permit must obtain proper permissions to access and treat on private land (see RCW 17.10.160 right of entry).

Active Ingredient: The permit allows for and conditions the use of the aquatic herbicide imazamox, a federally registered active ingredient (Clearcast® specimen label - http://cru66.cahe.wsu.edu/~picol/pdf/WA/50970.pdf). The FIFRA label allows the use of imazamox in the marine/estuarine environment. Imazamox has undergone review by Ecology and WSDA prior to approval (see https://fortress.wa.gov/ecy/publications/SummaryPages/1410050.html). In addition, Washington State University contracted with ENVIRON International Corporation to prepare a document called *Screening-Level Ecological Risk Assessment of the Proposed Use of the Herbicide Imazamox to Control Invasive Japanese Eelgrass (Zostera japonica) in Willapa Bay, Washington State*. Ecology has made this document available on its website at: https://ecology.wa.gov/Regulations-Permits/Permits-certifications/Aquatic-pesticide-permits/Zostera-japonica-eelgrass-management.
Ecology determined that, if used according to the EPA label and in compliance with the conditions of this general permit, imazamox would not violate water quality standards. By approving the active ingredient rather than trademarked product, Ecology does not plan to conduct additional review for each new trade name of imazamox marketed. However, this permit allows only the liquid formulation of imazamox to be used.

Marker Dyes: The permit allows the use of marker dyes. Marker dyes are typically food grade dyes and do not have any herbicidal activity by themselves. EPA does not label or regulate marker dyes as pesticides. Applicators use marker dyes to distinguish treated areas from untreated areas when applying herbicide. Marker dyes help keep applicators from over applying herbicides and facilitate reduced pesticide use.

Experimental Use

EPA regulates federal EUP's under section 5(f) of FIFRA and WSDA regulates both state and federal EUP's under RCW 15.58.405(3). Entities operating under a state EUP need coverage under this permit because discharge of pollutants to waters of the State requires an NPDES permit. Additionally, entities operating under a federal EUP must obtain permit coverage. Federal EUP's typically allow treatment of up to several hundred acres. The permit allows entities operating under a federal EUP to use chemicals/products not listed in the permit so long as their use is solely for research and monitoring. Entities operating under a federal EUP must also obtain and operate under a state EUP.

Application Restrictions

Ecology conditions the permit to limit impacts. Growers initially expected that Ecology would allow the treatment of *Z. japonica*, a Class C noxious weed, under the Aquatic Noxious Weed Management General Permit. Instead, Ecology declined to cover that activity under that permit. In a letter to Ecology dated August 4, 2011, the President of the Willapa-Grays Harbor Oyster Growers Association formally requested that Ecology develop a permit that would allow treatment of *Z. japonica* with imazamox on commercial shellfish beds statewide. In response to the letter, Ecology made a preliminary determination to develop a general permit for that activity (WAC 173-226-130). Ecology provided public notice of its preliminary determination in the Washington State Register (WSR 12-03-097) and on its website (WAC 173-226-060).

In response to subsequent public comments and concerns from natural resource scientists and others about possible impacts to *Z. marina* populations, Ecology narrowed the scope of this permit to affected commercial clam beds in Willapa Bay and decided to proceed with permit development. Ecology understands that Manila clam culture in Willapa Bay has been the most affected activity and location at this time. The agency solicited further public comment on the revised proposal from October 3 to November 2, 2012.

Ecology limited the active ingredient to the liquid formulation of the aquatic herbicide imazamox and marker dyes. Research trials show that imazamox is effective on controlling *Z. japonica* without the use of adjuvants. Many adjuvants are more toxic than the active ingredient and can increase the toxicity of the formulation. In this case, the only toxicity to consider is from the active ingredient itself (see also the imazamox section of this Fact Sheet).

The Permittee may not apply other pesticides to commercial clam beds during the four days before and after application of imazamox. The purpose of this limitation is to avoid synergistic or additive effects from imazamox and the discharge of pesticides to control burrowing shrimp. An application has been submitted to Ecology for an NPDES permit to be developed that would condition the use of imidacloprid to treat burrowing shrimp (ghost shrimp and mud shrimp) on commercial clam and oyster beds in Willapa Bay and Grays Harbor.

Permittees must apply herbicide only when the action threshold, as identified in their DMP, is met. Applicators must only treat plants when there is at least an hour of dry time before tidal inundation. This allows adequate time for plants to take up the herbicide before the incoming tide washes herbicide residues off the plants. Ecology limited the application period to daylight hours during April 15 through June 30 and only one application per season per treated area. The application window occurs after the herring-spawning season in Willapa Bay, but is an optimal time for germination and rapid growth of *Z. japonica*. The application window is also within the work windows set by WDFW for their regulatory Hydraulic Project Approval Program to protect fish life. To avoid potential overlap with pesticide applications to control burrowing shrimp, this permit will not allow discharge of other pesticides to commercial clam beds on the four days before and after imazamox application. Limiting the treatment to one application per season, helps reduce the amount of herbicide applied per area and may reduce the potential for *Z. japonica* to become resistant to imazamox.

To help control non-target impacts to nearby organisms through any spray drift that may occur through treatment activities, Ecology prohibited the aerial application of imazamox and limited ground broadcast applications to times when the wind speed is 10 miles per hour or less.

To help limit impacts to non-target *Z. marina* populations off the commercial clam bed property, Ecology imposed a 10-meter buffer along property boundaries that are part of the treatment site. Ecology imposed the buffers along property boundaries because information and photographs from test trial plots of imazamox showed occasional damage to adjacent *Z. marina* plants seaward from these treated trial sites, particularly in drainages. Direct application of imazamox into any drainage that contains *Z. marina* and is moving water off the treatment site is not allowed.

Since *Z. japonica* beds typically lie at higher tidal elevations than do *Z. marina* plants, incoming tides will tend to submerge *Z. marina* before inundating treated *Z. japonica* beds. This will help dilute and lower imazamox water concentrations around nearby downslope *Z. marina* beds and imposing a 10m buffer around the property line should protect these plants from imazamox damage.

Studies of many aquatic plant species and many aquatic herbicides have demonstrated a relationship between exposure (time exposed to a chemical), water herbicide concentration, and plant response. With short duration exposures, even high herbicide concentrations may not cause impacts to normally sensitive species. The leading edge of the incoming tide during a 2012 study carried imazamox concentrations as high as 83 ppb, but the duration of the exposure was short (based on dilution data from imidacloprid and imazamox experiments in Willapa Bay). While concentration/time studies have not been done for imazamox and *Z. marina*, the Clearcast® label allows treated water to be used for irrigation purposes when imazamox concentrations are less than or equal to 50 ppb. This indicates that the manufacturer did not perceive any liability risk from allowing imazamox treated water at this concentration or lower to be used to irrigate terrestrial plants. Given the large tidal ranges in Willapa Bay, Ecology expects that contact of *Z. marina* with concentrations greater than 50 ppb will be transitory, particularly with the imposition of 10 meter buffers. However, to check for any sub-lethal impacts of herbicide exposure, Ecology requires documentation of unusual plant growth or appearance of *Z. marina* in its study requirements.

To further limit impacts to *Z. marina* growing in drainages on a commercial clam bed, Ecology does not allow any direct application into these waters if there is *Z. marina* present.

Treated acreages are likely not completely contiguous, but rather consist of commercial clam beds from different areas within the estuary. Treatment can occur over a two and a half month time period so effects should be staggered. Growers expect that the acreage treated each year will decline as beds are treated and go into clam-growing production.

ANNUAL PUBLIC NOTICE AND SHORELINE POSTING

Notification and Posting Requirements
The requirement of public posting in the proposed permit is consistent with posting and notification requirements in other aquatic pesticide permits. Ecology considered input from interested parties and Permittees when developing posting and notification requirements in its aquatic pesticide permits. Ecology based these requirements on its BPJ and the publics' right-to-know.

The intent of notification is to make people aware of those activities taking place that have the possibility of affecting them. The public has the right to know about possible chemical applications so they can make informed decisions about limiting their exposure. Under this permit, treatment will typically occur on privately owned tidelands used for commercial clam farming at a time when *Z. japonica* beds are exposed by the low tide. It is unlikely that public exposure to treated plants on these private tidelands would occur. Even if there were exposure, concentrations of imazamox carried on the leading edge of the flood tide should be under the maximum in-water label rate used when treating freshwater lakes. In freshwater applications, people may swim and fish in waters treated with imazamox immediately after application. There is a drinking water tolerance of 50 ppb for humans and 500 ppb for livestock, but because it is brackish, Willapa Bay water is not potable. Regardless of the lack of use restrictions associated with the use of imazamox, Ecology requires Permittees to post all corners of the treatment site and will publish all Permittees annual pre-treatment plans 30-days prior to the first application of the season on the *Z. japonica* Management on Commercial Clam Beds in Willapa Bay website. Individuals wishing to prevent any contact with treated water or beds could avoid the area. Because imazamox has minimal human health risks, there are no water use restrictions in Willapa Bay, including consumption of food items such as fish and shellfish. This means that humans can consume shellfish from treated beds the day of treatment, if they wanted to. Based on low toxicities to mammals and lack of use restrictions combined with low potential for exposure, Ecology does not perceive any human health risks from the use of imazamox to treat *Z. japonica* in Willapa Bay.

SPILL PREVENTION AND CONTROL

WAC 173-226-070 allows Ecology to place permit conditions to prevent or control pollutant discharges from runoff, spillage or leaks, sludge or waste disposal, or materials handling or storage. It also allows Ecology to require the use of BMPs that includes schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of the waters of the State. BMPs also include treatment requirements, operating procedures, and practices to control runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage. The Permittee must be prepared to mitigate for any potential spills and, in the event of a spill, perform the necessary cleanup, and notify the appropriate Ecology regional office (see RCW 90.48.080, and WAC 173-226-070).

S5. MONITORING

RCW 90.48.260 gives Ecology the authority to establish inspection, monitoring, entry, and reporting requirements. WAC 173-220-210 gives Ecology the authority to require monitoring of treated waters to determine the effects of discharges on surface waters of the State.

With the exception of certain parameters (pH, temperature, alkalinity), Ecology requires that all monitoring data be analyzed and prepared by a laboratory registered or accredited for the active ingredient under the provisions of chapter 173-50 WAC, *Accreditation of Environmental Laboratories*.

Monitoring

Permittees must record the amount of pesticide active ingredient they use at each site, and the amount of acreage treated to Ecology in an annual report. Measurement of the distance that herbicidal effects are seen going into the buffer as well as photographs will be required in the annual report. The number of measurements and photographs taken will be dependent on the acreage treated (permit special condition S5.A). These measurements will help to provide verification that the 10m property line buffer is effectively protecting off-site *Z. marina* from imazamox applications on commercial clam beds.

S6. Records

Ecology based this permit condition on its authority to specify any appropriate reporting and recordkeeping requirements to prevent and control waste discharges (WAC 173-226-090). Applicators must keep all records and documents required by this permit for five years. If there is any unresolved litigation regarding the discharge of pollutants by the Permittee, they must extend the period of record retention through the course of the litigation (WAC 173-226-090).

S7. REPORTING

Special condition S7 of the permit contains specific conditions based on Ecology's authority to specify any appropriate reporting and recordkeeping requirements to prevent and control waste discharges (WAC 173-226-090).

Annual Pre-Treatment Plan

The pre-treatment plan includes maps and acreages proposed for treatment during the upcoming season. While the 2014 version of this permit intended for the pre-treatment report to be submitted even if no treatment was planned, it did not explicitly require the submittal. Ecology has clarified in this version that submitting a pretreatment report is required even if no treatment is planned for the season. This helps Ecology respond to public concern about the use of herbicides and understanding where treatment may be taking place.

Annual Report

Permittees meet part of their reporting requirements through annual treatment reporting. Permittees must submit their signed annual reports to Ecology by December 31 of each year.

The annual post-treatment report summarizes the amount of imazamox (in pounds of active ingredient) used during the course of each treatment season per coverage and locations where imazamox was used. All monitoring results are included in the annual report.

Noncompliance Notification

WAC 173-226-080 (1) (d) states that a discharge of any pollutant more frequently or at a level in excess of that authorized is a permit violation. Ecology requires that if a Permittee violates permit conditions, they must take steps to stop the activity, minimize any violations, and report those violations to Ecology. For pesticide applications authorized in the permit, applicators must report violations to the Aquatic Pesticide Permit Manager and the Regional Spills Hotline (ERTS Hotline) within 24 hours. This allows Ecology to determine if more action is necessary to mitigate the permit violation.

In addition to state requirements under WAC 173-226-180, 40 CFR § 122.41(l)(6) specifies when and how a Permittee must report noncompliance with their permit that may endanger human health or the environment. Ecology requires that if a Permittee violates permit conditions, it must take steps to stop the activity, minimize any violations, and report those violations to Ecology.

Both the 24-hour report and the five day written report must both contain the information specified in 40 CFR § 122.41(l)(6) which is included as permit requirements.

Failure to report noncompliance is a violation of the state permit and may constitute grounds for enforcement actions or termination of the permit coverage

GENERAL CONDITIONS

Ecology bases the General Conditions on state and federal law and regulations.

DUTY TO REAPPLY

All NPDES permits require Permittees to reapply for coverage 180 days prior to the expiration date of the general permit in accordance with 40 CFR 122.21 (d), 40 CFR 122.41(b), and WAC 183-226-220(2).

PERMIT ISSUANCE PROCEDURES

Permit Modifications

Ecology may modify this permit to impose new or modified numerical limits, if necessary to meet Water Quality Standards for Surface Waters, Sediment Quality Standards, or Water Quality Standards for Ground Waters. Ecology would base any modifications on new information obtained from sources such as inspections, imazamox monitoring, or Ecology-approved reports. Ecology may also modify this permit because of new or amended state or federal regulations. Ecology may terminate the permit if monitoring shows significant adverse impacts to non-target species from *Z. japonica* treatments using imazamox.

Recommendation for Permit Issuance

The general permit meets all statutory requirements for authorizing a wastewater discharge, including those limitations and conditions believed necessary to control toxics, protect human health, aquatic life, and the beneficial uses of waters of the State of Washington. Ecology proposes to issue this general permit for five (5) years.

APPENDIX A: DEFINITIONS

All definitions listed below are for use in the context of this permit only.

303(d) List: Means the list of water bodies in Washington State that do not meet the current water quality standards set in Chapter 173-201A WAC.

Action threshold: The density or number of individuals in a pest population that trigger management activities.

Active ingredient: The ingredient(s) in a pesticide product that provides the pesticidal effects.

All known, available, and reasonable methods of prevention, control, and treatment (*AKART*): A technology-based approach to limiting pollutants from discharges. Described in chapters 90.48 and 90.54 RCW and chapters 173-201A, 173-204, 173-216 and 173-
220 WAC.

Applicant: The aquatic licensed pesticide applicator and sponsor applying for permit coverage.

Aquatic License: Means as defined in WAC 16-228-1545(3)(u).

Beneficial uses: As defined in WAC 173-201A-200.

Commercial clam beds: Marine or estuarine areas where clams (excluding geoduck and oysters) are raised and harvested for commercial sale under a current Washington State business license.

Direct Supervision: Means as defined in RCW 17.21.020(13).

Discharge: The addition of any pollutant to a water of the state.

Discharge Management Plan: A plan that documents intended pest management strategies based on action thresholds using the principles of *integrated pest management*.

Experimental Use Permit: Federal and state permits that allow the use of unregistered pesticides in the context of research and development for registration of the pesticide under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Section 3, or for registration of a new use of a currently registered pesticide under FIFRA Section 3.

The Washington State Department of Agriculture would issue experimental use permits for aquatic applications limited to a maximum of 1.0 acre in size.

The U.S. Environmental Protection Agency would issue experimental use permits for aquatic applications that may exceed 1.0 acre in size.

Federal Insecticide, Fungicide, and Rodenticide Act (*FIFRA*): A set of EPA regulations that establishes uniform pesticide product labeling, use restrictions, and review of new pesticides.

General Permit: A permit that covers multiple discharges of a point source category within a designated geographical area, in lieu of individual permits being issued to each discharger.

Herbicide: Any substance or mixture of substances intended to prevent, destroy, repel, or mitigate any weed or other higher plant (see chapter 17.21.020 RCW).

Individual permit: A discharge permit specific to a single point source or facility.

Integrated Pest Management: RCW 17.15.010 defines integrated pest management to mean a coordinated decision-making and action process that uses the most appropriate pest control methods and strategy in an environmentally and economically sound manner.

Marker dyes: Colorants sprayed onto the targeted weed along with the herbicide to mark the areas already treated.

Notice of Intent (*NOI*): The application form that Ecology specifies the applicant must use to apply for permit coverage.

Noxious weed: means a plant that when established is highly destructive, competitive, or difficult to control by cultural or chemical practices. RCW 17.10.010

Permittee: An aquatic licensed pesticide applicator with coverage under this permit.

Pesticide: Means as defined in RCW's 15.58.030(31) and 17.21.020(36)

Pesticide Applicator: An individual licensed by Washington Department of Agriculture under chapters 17.21 RCW and 16-228 WAC to apply pesticides.

Pollutant: Means any substance discharged that would alter the chemical, physical, thermal, biological, or radiological integrity of the waters of the State or would be likely to create and nuisance or renders such waters harmful, detrimental, or injurious to the public health, safety, or welfare, or to any legitimate beneficial use, or to any animal life, either terrestrial or aquatic. Pollutants include, but are not limited to the following: dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, pH, temperature, total suspended solids, turbidity, color, biological oxygen demand, total dissolved solids, toxicity, odor, and industrial, municipal, and agricultural waste.

Sensitive, threatened, or endangered:

> *Sensitive*: Any species that is vulnerable or declining and could become endangered or threatened in the state without active management or removal of threats.

Threatened: Any species likely to become endangered in Washington within the foreseeable future if factors contributing to its population decline or habitat degradation or loss continue.

Endangered: Any species in danger of becoming extinct or extirpated from Washington within the foreseeable future if factors contributing to its decline continue. Populations of these species are at critically low levels or their habitats have been degraded or depleted to a significant degree.

Sponsor: An individual entity in the business of commercial production and sale of clams who has the legal authority to make the decision to apply herbicide to its owned or leased clam beds.

State Environmental Policy Act (SEPA): Chapter 43.21C RCW and Chapter 197-11 WAC.

State experimental use permit: A permit issued by WSDA that allows the use of pesticides that are not registered or labeled for a particular use pattern for the purposes of research and development.,

Surface waters of the State of Washington: Means all waters within the geographic boundaries of the state of Washington defined as "waters of the United States" in 40 CFR 122.2, and all waters defined as "waters of the State" in RCW 90.48.020 excluding underground waters. These include lakes, rivers, ponds, streams, inland waters, wetlands, and all other fresh or brackish waters and water courses within the jurisdiction of the state of Washington, plus drainages to those surface waters.

Treat: To apply a pesticide to a pest population.

Washington Pesticide Application Act: Chapter 17.21 RCW.

Washington Pesticide Control Act: Chapter 15.58 RCW.

Zostera japonica: A seagrass species in the family Zosteraceae listed as a Class C noxious weed in Washington.

In the absence of other definitions set forth herein, the definitions set forth in 40 CFR Part 403.3 or in chapter 90.48 RCW apply.

APPENDIX B: PUBLIC INVOLVEMENT INFORMATION

Ecology proposes to reissue the *Zostera japonica Management on Commercial Clam Beds in Willapa Bay General Permit* (*Z. japonica* permit). The permit was last modified on April 5, 2017, and expired on May 2, 2019. The proposed (draft) permit will replace the current (expired) permit).

The draft permit, fact sheet, and permit application form, are available for review and public comment from **September 18, 2019 until 11:59 p.m. on November 4, 2019**. Ecology will host informational workshops and public hearings on the draft permit.

Copies of the Draft Permit and Fact Sheet:
You may download copies of the draft *Z. japonica* permit, fact sheet, and permit application from the web page: https://ecology.wa.gov/zjaponicapermit. Or you may request copies from: Jon Jennings at jonathan.jennings@ecy.wa.gov, or (360) 407-6283.

Submitting Written and Oral Comments
Ecology will accept written and oral comments on the draft *Z. japonica* permit, factsheet, and permit application form. Comments should reference specific permit conditions when possible. Comments may address the following:

- Technical issues
- Accuracy and completeness of information
- Adequacy of environmental protection and permit conditions
- Any other concern that would result from the issuance of this permit.

Ecology prefers comments be submitted via the e-Comment form located at:
http://ws.ecology.commentinput.com/?id=gAE9x

Written comments must be postmarked or received via email no later than
November 4, 2019 at 11:59 p.m.

Submit written, hard copy comments to:

Department of Ecology
Water Quality Program
Attn: Jon Jennings
PO Box 47696
Olympia, WA 98504-7696

Interested parties may also provide oral comments by testifying at the public hearings. Written and oral comments receive the same consideration.

Workshop and Public Hearing
Ecology will hold two workshops and public hearings on the draft *Z. japonica* permit. At the workshop, Ecology will explain the draft permit and answer questions. The hearing will provide the opportunity for the public to provide formal oral testimony and submit written comments on the draft permit. The public hearing will begin immediately following each workshop and will conclude when testimony is complete. The workshops and hearings will held on these dates/times:

October 21, 2019 starting at 1:00 PM
Webinar
Join the webinar at:
https://watech.webex.com/watech/onstage/g.php?MTID=e4a06c196920a5bc8be9b7762dcb8b9e6

October 22, 2019 starting at 1:00 PM
Willapa Harbor Community Center
916 W First Street
South Bend, WA 98586

Issuing the Final Permit
Ecology will make a determination whether to issue the final permit after it receives and considers all public comments. Ecology expects to make a decision on issuing the new general permit in Spring 2020. It will be effective one month after the issuance date.

For further information, contact the Aquatic Pesticide Permit Specialist (currently Jon Jennings) at jonathan.jennings@ecy.wa.gov, or (360) 407-6283, or by writing to Ecology at the Olympia PO Box address listed above.

APPENDIX C: RESPONSE TO COMMENTS

Will be added after the public comment period closes (September 18, 2019 until 11:59 pm on November 4, 2019).

Look for the Response to Comments document on the *Zostera japonica Management on Commercial Clam Beds in Willapa Bay General Permit* web page: https://ecology.wa.gov/zjaponicapermit