Comment on: 'Supplemental Environmental Impact Statement for Control of Burrowing Shrimp Using Imidacloprid on Commercial Oyster and Clam Beds in Willapa Bay and Grays Harbor, Washington – Draft'

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Date: 11/1/2017

Thank you for the opportunity to comment on the Draft SEIS. It is a well prepared document. Below I have supplied comments in eight separate areas for your consideration.

 # 1. USE OF THE TERM 'AERIAL'

1.6.2 Summary of Impacts of and Mitigation Measures:
Alternatives 1, 3 and 4, pages 1-22 to 1-31.

The Draft SEIS, under Alternative 4, consistently uses the word "aerial application" as the application method used under this alternative. This is not correct. Aerial refers to application by air (airplane or helicopter). This is not allowed under Alternative 4. The wording should be replaced with ground-based broadcast boom or hand application for the 2F product, and hand, ground or boat spreader-based application for the 0.5 G product. The uses of "aerial" for Alternative 4 puts the growers in legal jeopardy with the label (See bolded relevant section of the 2F label below).

PROTECTOR 2F LABEL
"RESTRICTIONS: Do not harvest shellfish within thirty days after treatment. All ground must be properly staked and flagged to protect adjacent shellfish and water areas. **For aerial applications, the corners of each plot must be marked so the plot is visible from an altitude of at least 500 ft. Aerial applications must be on beds exposed at low tide.** A single application of imidacloprid per year is allowed. No adjuvants or surfactants are allowed with the use of this product. All applications must occur between April 15 and December 15. **A 100-foot buffer zone must be maintained between the treatment area and the nearest shellfish to be harvested when treatment is by aerial spray;** a 25 foot buffer zone is required if treatment is by hand spray. Do NOT apply when winds are greater than 10 mph or during temperature inversions. **Do not apply aerially during Federal holiday weekends. During aerial applications, all public access areas within one quarter (1/4) mile and all public boat launches within a quarter (1/4) mile radius of any bed scheduled for treatment shall be posted**. Public access areas shall be posted at 500 feet intervals Draft Label at those access areas more than 500 feet wide. Signs shall be a minimum of 8 ½ x 11 inches in size, and be made of a durable weather-resistant, white material. The sign will say "Imidacloprid will be applied for burrowing shrimp control on [date] on commercial shellfish beds. Do not Fish, Crab or Clam within one-quarter mile of the treated area. The location of the treated area will be included on the sign ...."

By the SEIS using the word "aerial" for Alternative 4, it could be legally inferred from the label that the grower would need to comply with all the label requirements stated in the label for aerial application by helicopters, e.g. need 100' buffer, etc.

I don't think it was the intention of the Department of Ecology to use wording in the SEIS that would equate backpacking spraying to aerial application by helicopters; however, in a court of law, such an inference could be made. To avoid costly lawsuits defending the permit, I would suggest adjusting the wording so that there is no confusion in the application terminology and so that it is consistent with the label, and the intent with which it will be used. Consider replacing 'aerial' with 'ground-based broadcast boom' or 'hand application' for the 2F product, and 'hand, ground or boat spreader-based application' for the 0.5 G product, or some other wording that won't legally compromise Ecology and the growers when the NPDES permit is issued.

 # 2. CAUSE OF THE PROBLEM

2.4 History and Background

This section of the SEIS states that the shrimp population dynamics in Willapa Bay and Grays Harbor are poorly studied and not known.

"The factors controlling burrowing shrimp populations are not well known, in part because long-term data on burrowing shrimp numbers in Willapa Bay and Grays Harbor are not available. Several authors (e.g., Stevens 1929, Feldman et al. 2000, Sanford 2012), have hypothesized that human-related impacts may have contributed to changes in Willapa Bay which led to increased burrowing shrimp populations. These potentially include excessive harvest of native Olympia oysters during the 1900s, land use changes in the watersheds (e.g. logging, farming), disturbance associated with current shellfish farming (including chemical and physical efforts to reduce burrowing shrimp), and other human activities. Changes in climate and oceanic conditions may also have altered conditions in ways that are favorable for burrowing shrimp."

While the purpose of the SEIS is not to provide a complete review of population dynamics of burrowing shrimp in SW coastal WA, it should at least reflect recent population trends reported by Dumbauld and others. There were major recruitment events in 1989, 1993 and 1994, followed by 17 years of little to no recruitment that continued until 2012. The past several years have all had consistent solid recruitment (see WSU 2017 data presented in the economic section below). The important aspect of this to consider is that, since ghost shrimp are long-lived as adults (>10 years), any major recruitment event will refresh the adult population. Consequently the upsurge in recent recruits will pose a significant long-term pest threat level not seen in the past 2 decades. This is germane as it relates to the economic section below.

The SEIS also speculates that overall shrimp population in the bay could be associated with historic and current shellfish harvesting and farming. This is a significant overreach. There is also no mention of over-fishing, or the damming of the Columbia River and its impact on fresh water purges of the bays. Both of these variables are mentioned frequently as causative in historic population trends, but are not mentioned in the SEIS.

 # 3. POTENTIAL IMPACT OF THE PROBLEM BASED ON 2017 RECRUITMENT DATA.

Section 2.6 Economics.

This section of the SEIS details estimated economic damage to the industry if chemical control is not an option. It states $50 million in cumulative losses by 2022. These estimates were made by the industry prior to knowing the population dynamics of shrimp on their beds over the next 5 years. That population is based on the number of recruits that have survived and grown into adults that can cause damage. WSU Long Beach and USDA have done extensive population monitoring for the past several years to try to understand what those populations will be in the future.

The need to control burrowing shrimp is based on the population of adult shrimp that is responsible for bioturbation. The standard economic threshold for treatment has been 10 burrows/m^2. This is an adult shrimp population of ~ 6 to 7 adults/m^2. An adult population of burrowing shrimp at any one time is based on natural mortality and recruitment rate of juvenile shrimp. Adults can live >10 years. Prior to

2014 there were many years with very low recruitment of new juvenile shrimp. This meant that the need to control burrowing shrimp in Willapa Bay was moderate and limited to sites with residual populations of adult shrimp. WSU sampling of recruitment populations over the last 4 years, however, has indicated that there have been significant new populations of juvenile shrimp settling across most of the tideflats in the bay. This has been especially noticeable on shellfish beds near the mouth of the bay. For example, on one bed we have been monitoring (bed A40), there were 140, 340 and 50 new recruits/m^2 in 2015, 2016 and 2017 respectively. Mean population of ghost shrimp by recruit age class for three growing areas in Willapa Bay, based on extensive sampling in September 2017, is provided in Table 1. These data indicate that recruitment numbers were slightly down for 2017 for the northern part of the bay but up for the southern part of the bay. The data also indicate that there was a decent survival rate of previous years' recruits. The sub-adult population of ghost shrimp is very high in all these regions and represents a very real threat to the future of the shellfish industry in Willapa Bay for 2018 to 2022. If these recruitment trends continue, it is likely that the economic impact stated in the SEIS could be a low estimate (Section 2-6, page 60). Furthermore, based on samples collected 10/31/17, there appeared to be continued episodes of significant recruitment during October 2017 (see footnote in Table 1).

Table 1. Mean density of ghost shrimp by age class in three shellfish growing regions in Willapa Bay based on sampling done in late September 2017*

	Ghost shrimp density (#/m/^{2}) **				
Location	2014 recruits	2015 recruits	2016 recruits	2017 recruits	Total population of sub-adult shrimp***
Tokeland/Cedar River area	112	88	137	35	372
Stackpole area	16	28	54	50	148
Nahcotta Flats & Middle Is. Sands	41	16	21	104****	182

*Data are means from replicated coring over multiple locations within each region.
**Recruit age is approximate, based on carapace length: 2014 recruit ~ 7.65 mm to 12.5; 2015 recruit ~ 6.6 to 7.6 mm; 2016 recruit 4.5 to 6.5 mm; 2017 recruit <4.5 mm.
*** Total population of non-adult shrimp is the sum density of all shrimp <12.5 cm carapace sampled in September 2017.
**** Four sites off the Nahcotta Flats were resampled in 10/31/17 to assess if there was on-going recruitment occurring during the fall. At those sites, the mean density of 2017 recruits was 244 ± 21, n=13 with 95% of them having a carapace <2mm. Three locations that were sampled 10/7/17 were resampled on 10/31/17. The was a >60% increase in new recruit density during that time period (94/m^2 to 230/m^2).

4. 2017 DATA ON MECHANICAL CONTROL

2.8.5.1 Mechanical Control Methods

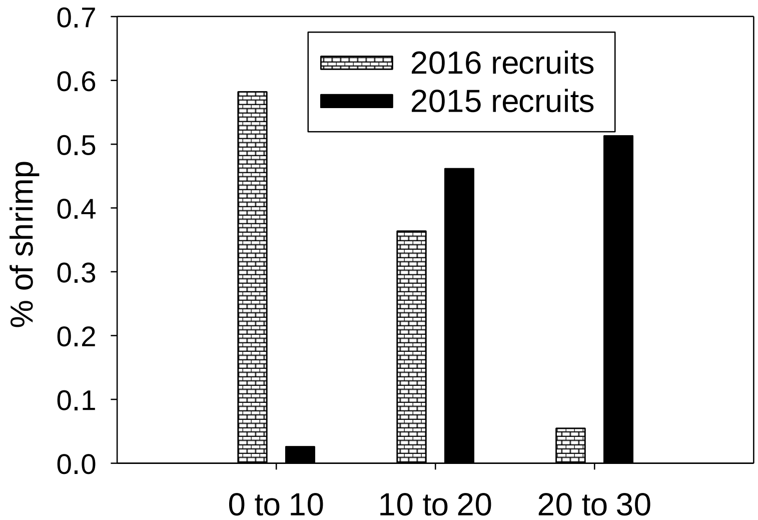
This section evaluates mechanical control options for the industry and suggests that they have limited options. At the time of its writing, however, there was no hard data on harrowing or dredging. Mechanical harrowing or dredging has been suggested by the public and others as a method to control young burrowing shrimp that are near the surface. It has been claimed that harrowing from a barge dislodges or destroys young- shallow- tender recruits and could, if practiced aggressively, be used by the industry as an alternative to chemical control. Prior attempts to gather data on efficacy of this method have been hampered due to the lack of juvenile shrimp populations in adequate density to conduct research.   In recent years, populations of recruits have been high enough to allow that research to be conducted. WSU Long Beach conducted two studies in 2017 to assess efficacy of harrowing and clean-up dredging (see Studies 1 and 2 below). These studies indicate that these efforts slightly reduced the population of new/young shrimp compared to untreated sites, but those reductions were not statistically significant and did not reduce the populations to levels that would be consider of practical value.

<u>Study 1: Deep harrowing</u>
Site: Bed A40 Cedar River, sandy sediment, Goose Point Oyster bed, recruit population May 2017 ~200/ m^2 range.
Experiment design: Randomized complete block, 0.5 by 1.5 m plot size, 3 replications.
Treatments: Untreated control and hand harrowing. An aquatic weed rake with a set of six -25 cm long x 2.5 mm wide tines was pulled by hand through the treated plots down to the 20 cm depth in the sediment, 3 times in each direction. This was done in 0.3 to 0.5 m of water during an incoming tide. New recruits were noted as swimming off the disturbed treated plots.
Assessment: Sixteen days post-treatment the plots were cored (2 cores/plot, 10 cm diameter by 40 cm depth), and recruits collected by sieving (2 mm mesh) and measured to the nearest 0.01 mm carapace size. Data were analyzed by ANOVA for the total number (between 2 and 6 mm carapace, and within each mm size bracket of carapace). Data were also collected on recruit density and size by depth (0 to 10 cm, 10 to 20 cm, and 20 to 30 cm) within the plots.
Results: There were no differences in shrimp densities due to treatment for all size brackets (Table 2). There was a slight trend for harrowing to numerically reduce the density of recruits, but these differences were not close to being statistically different or of practical relevancy.   A significant portion (>40%) of new 2016 recruits were deeper than 10 cm and >95% of the 2015 recruits were deeper than 10 cm (Figure 1). Surface dredging or harrowing from a barge is unlikely to get much deeper than 10 cm.
Summary: Deep harrowing, far in excess of the depth that would be achieved by barge harrowing, provided no relevant control of new recruits.

Table 2. The efficacy of deep harrowing on the population density of young burrowing shrimp in May 2017.

	# burrowing shrimp by size class/m^2				
Treatment	2-3 mm	3-4 mm	4-5 mm	5-6mm	total 2-6 mm
Untreated control	62	68	68	5	203
20 cm deep harrowing	26	62	26	10	124
F test value	1.8	0.0	2.0	0.5	2.1
Probability of significance	0.3	0.9	0.2	0.5	0.2

Figure 1. Distribution of recruits by sediment depth (cm) on bed A40



Study 2: Barge dredging

Site: Bed A55 Cedar River, sandy/silty sediment Taylor bed, recruit population moderately high (May 2017 ~100 to 200/m^2 range).

Experimental design: Whole bed, pseudo-replicate, comparison of inside and outside a 20- acre bed that was dredged during winter 2016.

Treatment: The bed was dredged to remove transplanted oysters between 10/24/2016 and 12/15/2016. There were twelve 3-hour dredging sessions. The total cost to dredge the sites was estimated by the grower to be $24,000.

Assessment: Three transects (replications) that ran inside and outside the dredged bed were compared. Transects were sampled (4- 10 cm diameter cores 30 cm deep) for recruit density at 17 m and 33 m inside and outside the bed. Data were pooled (inside vs. outside along each transect (replication n=3)) to compared density of 2015 and 2016 recruits. Recruit density was analyzed by one-sample Wilcoxon signed rank test for non-parametric data; a Mann-Whitney Rank Sum Test for the data did not pass the Shapiro-Wilk normality test.

Results: There were no differences in shrimp densities due to treatment for all recruit ages (Table 3). There was a slight trend for dredging to numerically reduce the density of recruits, but these differences were not close to being statistically different or of practical relevancy. In addition, the study was neither truly randomized nor replicated. The dredged bed had a residual shell base and was siltier sediment than the comparison zones immediately outside the bed. The difference in treatment could have been due to site rather than dredging.

Summary: Cleanup dredging to remove transplant oysters left behind did not statistically reduce recruit densities. The nonsignificant difference between treatments could have been site difference. Regardless, the recruit density in the dredged beds was still too high to be of practical control value.

Table 3. The efficacy of cleanup dredging on the population density of young burrowing shrimp in May 2017.

Treatment	# burrowing shrimp by size class/m²		
	2016	2015	2015+2016
Untreated control	129	75	163
20 cm deep harrowing	204	34	279
Probability of significance	0.24	0.15	0.10

 # 5. THE NEED FOR BETTER DATA RELATING TO SPATIAL & TEMPORAL EXPOSURE OF IMIDACLOPRID IN WATER.

3.0 Affected Environment, Potential Impacts, and Mitigation Measures

The draft SEIS uses water exposure data developed during commercial-size applications in Willapa Bay. That is a good data set that provides expected maximum exposure concentration for a risk assessment immediately following an application. This assessment is fine for species that are exposed in that first 5-10 cm of tidal inundation. However, it is not realistic for fauna, such as fish or Dungeness crab megalopae. These fauna would be exposed to the concentration of imidacloprid that is found in the actual water column, not the wetting front. Unfortunately, we have very little data on what those values are because the former SAPs and NPDES required data only from the first 10 cm of the wetting front. We have no idea about the extent of dilution of imidacloprid over time in the water column. While it is important to have a conservative approach to risk assessment, it is equally important to use realistic exposure data. This point may want to be addressed in the SEIS, and/or considered later when developing the SAP and NPDES for monitoring.

#6. A MAJOR IMPACT FACTOR NOT CONSIDERED FOR THE 'NO ACTION ALTERNATIVE'

The SEIS does a good job detailing the potential impacts of the four alternatives. One consideration that was not addressed with the No Action Alternative (#1) is that if this alternative is selected then there will be no future NPDES. Without an NPDES, there is no possibility for anyone to obtain an Experimental Use Permit (EUP) for future research. "A Washington State Experimental Use Permit is required for all experiments involving pesticides that are not registered, and for all experiments involving uses not allowed by the pesticide label". Coverage under a NPDES permit is required whenever an experimental pesticide is going to be applied to an aquatic environment. One of the conditions of the previous NPDES was to allow for new research to be conducted on alternative chemical control on a limited scale (<1 acre). Based on conversations with WSDA and Dept. of Ecology, there are no exceptions to this rule, regardless of how small the plot is or how environmentally benign the treatment may be. Since a pesticide is defined by EPA as "Any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest," then virtually all future burrowing shrimp control options would be considered pesticides and prohibited from being evaluated. By definition the following could be considered pesticides: subsurface injection with fresh water, ultra-sound and electro-shocking. These three methods have been tested in the lab with some marginal suppression of burrowing shrimp, but now could not be tested in the field. Any new chemistries with selective control in the lab and with the potential for minimal non-target impact, that might be found in the future, would also not be able to be evaluated in the field.

If Dept. of Ecology does not choose Alternative Four, the No Action Alternative is the default. One of the unintended consequences of the No Action Alternative would be to virtually eliminate any future research on burrowing shrimp control, other than mechanical control. Mechanical control has been well vetted over the past 70 years, and has been found to have very limited potential. In addition, due to potential impacts to eelgrass, it is unlikely it would even be allowed under the new restrictive Nationwide Permit imposed by the Army Corps of Engineers. Under the current burrowing shrimp recruitment conditions, and with few options for research on new control methods, the long-term consequences to the shellfish industry in Willapa Bay under the No Action Alternative would be grim.

I realize that there is serious opposition to Alternative Four by many stakeholders. These stakeholders insist that the No Action Alternative is the only sane choice and the industry should find other methods to control burrowing shrimp. Unfortunately, the No Action Alternative slams the door on the industry's ability to find alternative control methods, other than mechanical/cultural methods. The extensive research over 70 years has yet to even hint that there are any good mechanical methods to manage adult shrimp populations and the industry can not all convert to off-bottom culture.

In summary, a major research effort will be needed to find and test other options for control. However, it is impossible to make a valid inference on efficacy without field testing. You can't field test without an EUP. You can't get an EUP without an NPDES. Since you can not get an NPDES under the No Action Alternative, you virtually eliminate the ability to conduct research on alternative controls. Unfortunately the unintended consequences of the No Action Alternative will mean no future control for burrowing shrimp will likely ever be developed. To that end, the shellfish industry in Willapa Bay will go through a major decline over the next several decades.

#7. IMPACT ON BENTHIC INVERTEBRATES

Information on the potential impacts of imidacloprid on benthic invertebrates is presented in the 2015 FEIS (Chapter 3, Section 3.2.5, pages 3-48 through 3-49). Some new additional analysis is included in this SEIS. PSI and WSU recently reassessed the data sets obtained under previous SAP studies in Willapa Bay using Principal Response Curve Analysis (PRC). PRC analysis is a multivariate ordination technique that was derived from Redundancy Analysis, primarily to simplify assessment of pesticide treatments on abundances of aquatic invertebrates in mesocosms and has since become fairly standard for such experimental systems. We are in the process of submitting this analysis for publication to either Nature or Coastal Shelf and Estuary Science.

One of the major points of this analysis is to highlight the fact that the default response of estuarine epibenthic and benthic invertebrates to imidacloprid is neutral, rather than negative. In fact only 6 PRCs out of 60 showed a significant negative effect. The large majority of PRCs showed no significant effect from imidacloprid application, a neutral treatment effect, or ostensibly a "positive" treatment effect.

I've attached the current draft of that paper. Below is the title and abstract

Response of Estuarine Benthic Invertebrates to Large Scale Field Applications of Imidacloprid.
Steven R. Booth[1], Kim Patten[2] and Leslie New[3]. Pacific Shellfish Institute[1], Olympia, WA 98501, Washington State University Long Beach Extension Unit[2], Long Beach WA 98631, Washington State University Vancouver[3] WA 98686

A total of 60 analyses were conducted to examine the response of 6 taxonomic assemblages (polychaetes, non-juvenile polychaetes only, mollusks, non-juvenile mollusks only, and crustaceans, and all invertebrates combined). The response was significant ($p < 0.05$) among 51 of the analyses, but interpretation was often confounded by significant differences between treated and control assemblages before treatment. In general, the response of the treated assemblages relative to the control assemblage usually did not change much over time, indicating a minimal treatment effect on the assemblage as a whole. Only 6 PRCs of 60 showed a significant negative effect from imidacloprid application. Five of the 6 PRCs represented mollusks, which represented < 2% of all organisms sampled among all sites and years. Crustaceans were negatively affected in one of 8 studies. Polychaetes, both with and without juveniles, were never negatively affected. The large majority of PRCs showed no significant effect from imidacloprid application, a neutral treatment effect, or ostensibly a “positive” treatment effect. The overall minimal response was likely due to exposure to low concentrations of imidacloprid for limited times, physiological tolerance to imidacloprid for some species, and multiple life history strategies to rebound from natural disturbance and adaptation to a highly variable environment. These strategies include high mobility and dispersal behaviors, high intrinsic rates of reproduction, and rapid development. The highly variable environment was reflected in the response as variation among years, sites, replicates, and perhaps haphazard movements of individuals, particularly juvenile bivalves.

#8. EFFECTS OF BURROWING SHRIMP ON CLAMS

1.7 Areas of Controversy and Uncertainty, and Issues to be Resolved

“Research on the effects of burrowing shrimp on commercial shellfish beds has been done where oysters are the primary crop. Field research data are lacking regarding how burrowing shrimp affect clams, and the threshold for damage to clam beds.”

The SEIS is correct in stating that there have been no studies showing the direct impact of burrowing shrimp on commercial clam production. We have attempted to collect economic threshold data several times, but have not been successful. The main reason for this failure is due to the fact that we could not maintain gravel on the surface long enough to conduct an experiment. Gravel is much denser than oysters, and rapidly sinks in areas infested with burrowing shrimp. If you don’t have gravel, you don’t have clams. We have also attempted to place mature clams on sites with different densities of burrowing shrimp and assess thresholds, but because clams are very mobile, we have never been able to find them at the conclusion of the study. In addition, the average harvest cycle for commercial clams in Willapa Bay is 3 to 4 years. Because population dynamics of burrowing shrimp are not steady, determining accurate economic thresholds for burrowing shrimp over that 3 to 4 year duration is exceedingly difficult. It would be reasonably easy to design an experiment that examines the sinking rate of gravel as a function of burrowing shrimp density. From that, a threshold for treating burrowing shrimp could be developed. However, I would be uncertain as to what timeframe should be used to determine the threshold for sinking (6, 12 or 36 months), especially when shrimp populations are not constant.

The point I want to make is that what seems like a simple data request – "shrimp treatment threshold for clam production" – is exceedingly difficult to obtain. We don't even have an accurate method for quantifying burrowing shrimp density, other than excavating and sifting sediment down to a meter in depth. Because the total acreage for treatment is very limited (500 acres), I think it would be realistic to set the threshold similar to what has worked for oysters (10 burrows/m^2), and let the industry decide where their treatment priority areas are based on the economic impact it will have to their farms.

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