

**SEDIMENT IMPACT ZONE (SIZ) APPLICATION FOR DISCHARGE OF
IMIDACLOPRID INTO WILLAPA BAY**

WILLAPA/GRAYS HARBOR OYSTER GROWERS ASSOCIATION

Basic Permit Information

1. Applicant's company name, contact person, address, and telephone number.

Willapa Grays Harbor Oyster Growers Association (WGHOGA)
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2. NPDES permit number.

To Be Determined

3. The exact legal location of the existing or proposed discharge and a map of the discharge location.

The general discharge location for the SIZ will be commercial shellfish beds in Willapa Bay, Washington (Figure 1), between the tidal elevations of -2 ft MLLW to +4 ft MLLW. In any given year, the specific discharge locations will be determined based on shellfish grower plans for their seed beds, grow-out sites, and fattening grounds; the efficacy of prior treatments; and the degree of burrowing shrimp infestation. An Annual Operations Plan (AOP) will be submitted to Ecology every year, prior to commencing treatment with imidacloprid. The AOP will specify the potential shellfish beds to be treated, including legal locations of potential treatment beds; total acreage; type of application (liquid or granular formulation; ground/boat application); legal owner/lessee; and bed identification name.



Figure 1 – Willapa Bay Location Map

4. Annual area to be treated.

Under this SIZ application, and the proposed NPDES permit, WGHOGA is requesting authorization to treat up to 485 acres per year in Willapa Bay (approximately 1.1% of total tideland area exposed at low tide). WGHOGA will decide each year where in Willapa Bay those 485 acres are located.

WGHOGA needs some flexibility in how those acres are allocated, but will commit to maximum levels of treatment, within a given year, of 125 acres, 485 acres, and 30 acres of the North, Central, and Southern portions of the bay, respectively (see Exhibit A for delineation of these zones).¹ Our Exhibit A includes circles, drawn to scale, that identify the area encompassed by these acreage limits. Combining all three areas, WGHOGA is proposing to spray no more than 0.7 percent of the Willapa Bay estuary, annually. Attached are maps for parcel locations where

¹ Although the total of each of these areas is greater than 485 acres, these represent a maximum for each area. So, by way of example, if 125 acres are treated in the north and 15 acres in the south, only 345 acres (485 minus 125 minus 15) could be treated in the central part of the bay.

imidacloprid may be applied in Willapa Bay (Exhibit A) and, in table format, bed information for Willapa Bay plots that would be included in the NPDES permit.

The exact number will vary, depending on shellfish grower plans for their seed beds, grow-out sites, and fattening grounds; the efficacy of prior treatments; and the degree of burrowing shrimp infestation each year. The application rate, maximum annual acreage, treatment schedule, shrimp presence criteria, Best Management Practices, monitoring requirements, and safety precautions would be specified in the permit.

Discharge Characteristics

5. Chemical name and additional chemical information.

For this proposal, imidacloprid (common name and active ingredient) is registered as Protector 2F (21.4%, Nuprid, flowable) and Protector 0.5G (0.5%, Mallet, granular). The MSDS forms for these chemicals are attached as Appendix A. Imidacloprid will be applied at a rate of up to 0.5 lb active ingredient per acre (a.i./acre) for all treatment scenarios.

6. Chemical degradation products.

Imidacloprid is transformed into a series of degradation products in response to hydrolysis, photolysis, oxidation, and biochemical breakdown. From the degradation products identified in aerobic water and sediment studies, a degradation pathway has been proposed as shown on Figure 2. The compounds marked with an asterisk were found only in systems exposed to light. Under anaerobic conditions, imidacloprid-guanidine occurs as a major degradation product.

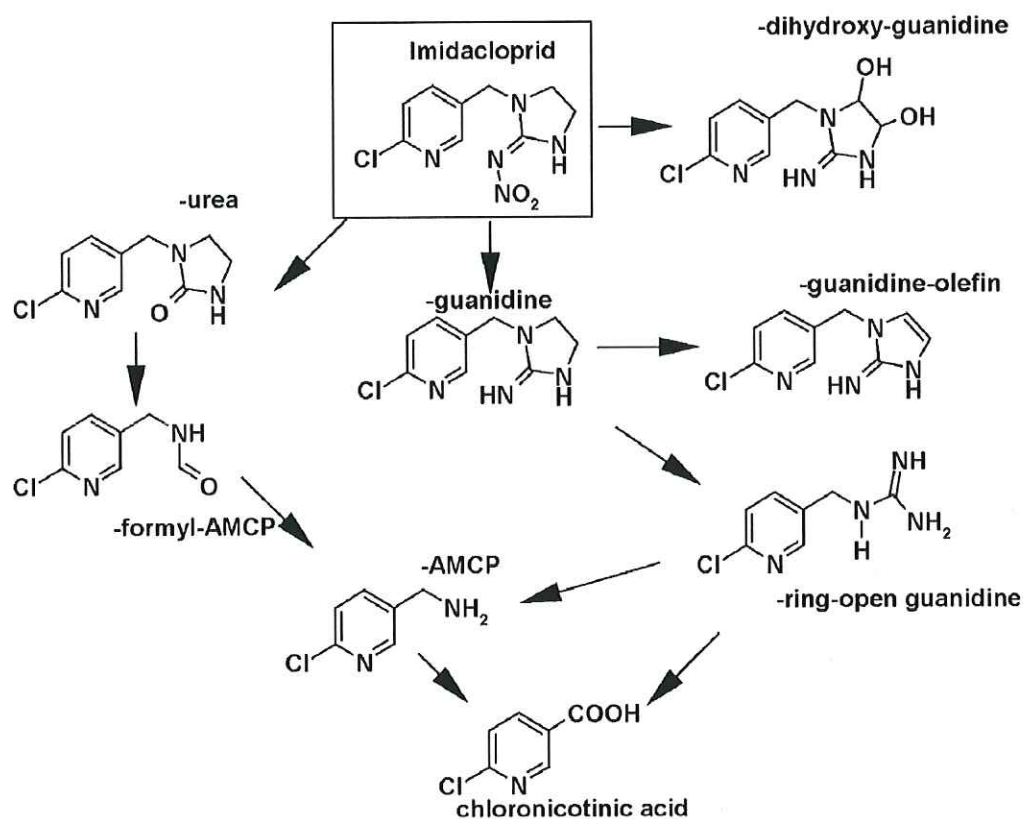


Figure 3 - Proposed Metabolic Pathway for Photo-Transformation in Water of Imidacloprid

The degradation and partitioning behavior of imidacloprid in the dark was studied in three natural systems of water and sediment. Imidacloprid disappears slowly from the water phases of water/sediment systems and is adsorbed into the sediment. Within the sediment, imidacloprid is degraded to imidacloprid-guanidine and other products to a minor extent, including 5-hydroxy imidacloprid. The calculated disappearance half-life (DT50 value) of imidacloprid in the dark has been estimated at between 32 and 142 days. One test using only pond water in the dark resulted in a half-life of 331 days. Under more natural conditions, where sunlight is allowed to reach water-sediment systems, the half-life ranged from 4 to 20 days. The only major (>10%) degradation product in dark aquatic systems was imidacloprid-guanidine; while in illuminated aquatic systems, the guanidine, urea, and 6-chloro nicotinic acid compounds were all formed as major degradation products. The same primary compounds found in the illuminated aquatic systems were also observed in the aqueous photolysis study. The degradation of imidacloprid in anaerobic systems was confirmed in two studies performed in the dark. At 20°C, imidacloprid had a half-life of 36 days, with imidacloprid-guanidine formed as the only major product. Under anaerobic conditions at 5°C, the reaction rate was slower (half-life of 95 days) with the same major degradate observed. Three outdoor pond studies were conducted and offer the opportunity to assess the “real world” dissipation of imidacloprid in aquatic systems. One pond study conducted in Texas and two pond studies conducted in Germany gave evidence of a rapid dissipation. Half-lives for the aqueous phase and the total system were estimated to be 7–10 days and 10–20 days for the two studies conducted in Germany (European Food Safety Authority [EFSA] 2006). Limited toxicity data are available to quantify the toxicity of degradation products or metabolites, as the majority of studies have focused on the parent compound imidacloprid. Several studies conducted on insects found that the 5-hydroxy derivative was 10–27 times less toxic than imidacloprid, while only the olefin derivative, which occurs as a metabolite in treated plants, has toxicity comparable to imidacloprid (Nauen et al. 1998; Suchail et al. 2001; Kagabu et al. 2004; SERA 2005; EFSA 2006; Tomalski et al. 2010). Toxicity studies of the metabolites imidacloprid-urea, 6 chloronicotinic acid, and imidaclopridguanidine concluded none were as acutely toxic as technical grade imidacloprid to the midge (*C. tetans*) or amphipod (*H. azteca*; Bowers 1996a; Bowers and Lam 1998; Rooney and Bowers 1996; Dobbs and Frank 1996;

Tomizawa and Casida 1999). Thus, with the possible exception of olefin imidacloprid, existing studies indicate that degradation products are substantially less toxic than the parent compound. In addition, because these degradation products are, in turn, degraded by environmental factors (e.g., hydrolysis), or are metabolized in most organisms, additional toxicity due to degradation products alone is doubtful. Accordingly, the European Food Safety Authority and USFS have concluded that benchmark values for regulation of imidacloprid would be protective of its metabolites as well (SERA 2005; EFSA 2006).

7. Other effluent chemicals.

The nature of the inert components of imidacloprid is proprietary; therefore, there is little publicly available information regarding these components. The Protector 2F formulation contains glycerine (an EPA List 4A inert ingredient²) while Protector 0.5G contains N-methyl pyrrolidone (an EPA List 3 inert ingredient³). Neither formulation specifies the relative quantity of its identified inert compound.

8. Application methods.

Protector 2F (Nuprid; flowable formulation) would be applied using ground methods and would occur in over exposed tideflats during very low tides. Protector 0.5G (Mallet; granular formulation) would be applied to over shallow standing water. Both formulations may be applied using suitable equipment, such as scows or shallow-draft boats; all-terrain vehicles equipped with a spray boom, backpack reservoirs with hand-held sprayers, and/or belly grinders.

Receiving Water and Sediment Characteristics

9. Navigation charts or other information on bathymetry.

Willapa Bay is a relatively shallow bay and has approximately 45,000 acres exposed at low tide with much of the remaining surface area, except for channels, covered by 1 to 6 feet of water. It consists of three main channels 10 to 20 meters (32.8 to 65.6 feet) deep, surrounded by extensive tidal flats (Banas et al. 2004). The tide is mixed-semidiurnal and tidal levels in the bay vary from 14 to 16 feet (Banas et al. 2004; Banas et al. 2007). In addition, the mean daily tidal range can vary by as much as 50% over the spring-neap cycle. The range from mean higher high water to mean lower low water is approximately 11.5 feet (Banas et al. 2007). During a complete tidal cycle, about 45 to 50% of the water in the bay is exchanged into the Pacific Ocean (Banas and Hickey 2005; NMFS, April 28, 2009); however, the average retention times in the upper third of the estuary are on the order of 3 to 5 weeks (Banas and Hickey 2005). See Banas 2005 for a detailed hydrodynamic model of Willapa Bay.

10. Current velocities and direction near the discharge locations.

Residual currents in Willapa Bay suggest tide- and density-driven circulations. Currents within Willapa Bay appear to be tidally driven, with tidal exchange being very efficient near the mouth, replacing at least 30 % of the tidal prism every tidal cycle. This may be due to strong along-coast currents on the inner shelf of the bay (Banas 2005). See Banas 2005 for a detailed discussion of currents in Willapa Bay. Current velocities are lower around the east side of Long Island and at the north end of the bay, around Cedar River.

11. Tidal dispersivity or other estimates of dispersivity or diffusion in the water column.

Tidal dispersion ranges greatly within Willapa Bay, depending on such factors as season, river flow, and storm events. Tidal diffusivity ranges from 240 m² s⁻¹ at very low flows to 840 m² s⁻¹ at high flows (Banas 2005). Diffusion within Willapa Bay appears to be, on average, tidally driven and is very efficient near the mouth of the estuary. See Banas 2005 for a comprehensive discussion of the hydrography and tidal dispersivity in Willapa Bay.

² EPA List 4A inert ingredients are defined as 'minimal risk inert ingredients'.

³ EPA List 3 inert ingredients are defined as 'inerts of unknown toxicity'

12. General description of sediment characteristics.

Sediment characteristics in Willapa Bay range from sandy sediments to silty, clay-like sediments. Grue and Grassley (2013) found that sediment grain size can range from 79 to 95% sand, 2 to 13% silt, and 0.6 to 8 % clay, depending on the location in the bay. Likewise, total organic carbon content (TOC) concentrations are also variable, ranging from 0.20 to 1.86% throughout the bay. Based on the concentrations reported in Grue and Grassley (2013), higher TOC concentrations and higher silt and clay concentrations appear to be found in areas such as Cedar River where water flow may be lower. Ecology (2007a and 2007b) reported that Willapa Bay sediments tend to be silty, with an average fine sand fraction of 44%, a mean silt fraction of 28%, and a silt-clay content ranging from 0 to 35%. In these studies TOC concentrations in Willapa Bay ranged from less than 0.2% to approximately 1%.

13. Dispersivity or diffusion rate of sediment porewater.

Diffusion rates of sediment porewater in Willapa Bay were not available.

General SIZ Information

14. Results of field trials

Experimental trials using imidacloprid have been conducted since 2007, with the most comprehensive work occurring between 2010 and 2014. Experimental trials aimed at determining efficacy, environmental fate and transport, and the biological effects of imidacloprid were performed in 2011 and 2012, and again in 2014. The 2011 and 2014 field trials are summarized below, and the 2014 field work is more fully detailed in the Final 2014 Field Investigations, Experimental Trials for Imidacloprid Use in Willapa Bay, Hart Crowser, January 8, 2016.

A. 2011 and 2012 Field Trials

The 2011 and 2012 trials were conducted in Willapa Bay, with the study sites chosen to meet the specific criteria of ownership by a WGHOGA member: adequate densities of burrowing shrimp; adequate distance from previous or planned applications of carbaryl on commercial shellfish beds (>0.5 mile); no previous applications of carbaryl to the tested sites within the past 20 years, if ever (personal communication with Dr. Kim Patten, WSU Pacific County Extension Director, May 29, 2014); accessibility; and desirable characteristics of elevation, vegetation, and substrate that are similar to commercial shellfish beds and that were consistent among the study sites. In addition, treatment and control plots had to be adequately separated to prevent cross contamination (>500 meters). These criteria limited the study sites to two locations within Willapa Bay. The first was located off Rosario Beach on the western side of the Bay Center Peninsula on the eastern shore of the Bay (Bay Center) and the second was located east of the main channel of the Cedar River after it enters the northern part of the bay (Cedar River). At Bay Center, both the granular (Mallet) and flowable (Nuprid) formulations of imidacloprid were used, while at Cedar River only Nuprid was used (Booth 2014). A total of 51.38 acres of commercial shellfish beds were treated with imidacloprid, 29.54 acres with Nuprid and 21.84 with Mallet (Patten 2011). The Bay Center site contained sandy sediments common to many of the commercial shellfish beds in Willapa Bay and Grays Harbor. The Cedar River site had higher levels of organic matter in the sediments. Results for the two sets of sites were different for some of the factors being analyzed. Where different, they are presented separately in the sections below.

Megafauna Sampling and Analyses. Effects of imidacloprid on epibenthic megafauna (Dungeness crab and fish) were assessed by counting all affected megafauna species on and within 150 feet of the site. Any species exhibiting signs of tetany (paralysis), or that were dead by any cause, directly or indirectly related to treatment (e.g. bird predation of crabs exhibiting tetany) were considered to be affected. The number of affected Dungeness crab per site ranged from 0 to 19 and the number of affected crab per acre ranged from 0.87 to 3.8, where the treatment site was greater than four acres. There were no affected fish found on the sites following any treatment (Patten 2011).

Efficacy. Efficacy across all sites and treatments ranged from 42 to 96% in burrow reduction, with highest efficacy on sandy sites that had no vegetation and lowest on silty sites and vegetated sites. Studies conducted in 2011 also noted that applications to sites heavily vegetated with eelgrass were problematic, due to the lack of site drainage in these areas. These results indicated that eelgrass may impair efficacy by limiting chemical access to shrimp burrows

and by preventing burrow collapse following treatment, thus allowing affected shrimp to recover once tetany has ceased (Patten 2011).

Sediment Porewater Results. Average imidacloprid concentrations within the sediment porewater ranged from 24 to 154 ppb immediately after treatment. These concentrations decreased to 8 to 20 ppb one day after treatment, and to 0-0.5 ppb at 56 days after treatment.

Epibenthic and Benthic Invertebrate Sampling and Analyses. Epibenthic and benthic invertebrates were sampled at one day before and at 14, 28, and, for Bay Center only, 56 days after treatment. These sampling durations are timed to permit sampling at low tide events following the initial application, and for 14 days, to allow animals killed by imidacloprid to decompose so that they are not confused with live animals taken at the time of collection. Four on-plot stations were sampled in each treatment plot, with 4 or 5 replicate core samples at each station. In general, the impact of imidacloprid was assessed by comparing each of the nine endpoints (absolute abundance, taxonomic richness, and Shannon diversity) were calculated separately for each of three primary taxonomic groups; polychaetes, mollusks, and crustaceans. At each post-treatment interval (14, 28, and sometimes 56 days after treatment), the value of each of the nine endpoints in the treated plot at each study site (Bay Center or Cedar River) was compared to the same endpoints in the respective control plot. A consistent problem in the 2011 trials was that the number of invertebrates on the control and treatment plots were not similar to one another at the time of the imidacloprid application. This makes interpretation of subsequent differences between treated and control sites more difficult (i.e., are differences due to imidacloprid, or to unequal starting conditions?). The problem was especially evident in Cedar River, where some species were as much as 30 times more abundant in the treatment plot than in the control plot at the time of imidacloprid application. In general, before imidacloprid application, the control and treatment plots at the Bay Center sites were similar for about half of the absolute abundance, taxonomic richness, and diversity metrics for crustaceans, polychaetes, and mollusks. Statistical tests for treatment effects of imidacloprid were more definitive for these measures than for metrics that were not similar before treatment. Regardless, the analysis of all of the data from this area consistently failed to find a treatment effect. That is, the invertebrates on the treatment and control sites were similar enough to one another that the data showed no statistical differences after 14 and 28 days; demonstrating that there was either no effect, or no effect with recovery and recolonization. Before the imidacloprid application, invertebrates on the control and treatment plots at the Cedar River site were statistically different for 5 of the 9 endpoints that were examined. Polychaetes and crustaceans, in particular, were far more abundant on the treatment plot than at the control plot. In part, this was likely due to differences in vegetation levels and tidal elevations between the control and treatment plots. The differences between the plots were great enough to make any interpretation of invertebrate numbers after imidacloprid application difficult. Results of the analyses showed a decrease in abundance for most crustacean and polychaete species on the treatment plot, while a general increase was seen in the control plot. These differences were seen at both 14 and 28 days after treatment. While not conclusive, these results are consistent with an interpretation that imidacloprid reduced the number of polychaetes and crustaceans on the treatment plot, and that the decline lasted for at least 28 days following treatment (at least for some species). However, the data also shows that the abundances of some species increased 28 days after treatment. Subtle differences in temperature, tidal elevation, and vegetation accounted for some differences between the treated and control site as well. A treatment effect was not evident for the 3 endpoints for mollusks (abundance, taxonomic richness, and Shannon diversity), or for richness and diversity in polychaetes or crustaceans.

In 2012, experimental trials aimed at determining efficacy, environmental fate and transport, and the biological effects of imidacloprid were performed under an Ecology-approved Sampling and Analysis Plan (Hart Crowser 2012). The scope of these trials was to determine the magnitude, extent and duration of imidacloprid exposure from an application of imidacloprid for the control of burrowing shrimp. This study was also designed to measure one of the degradation products of imidacloprid: imidacloprid-olefin.

The specific components of this study included:

- Measurement of pre- and post-application water column concentrations of imidacloprid and imidacloprid-olefin;
- Measurement of whole sediment imidacloprid and imidacloprid-olefin concentrations;

- Measurement of sediment porewater imidacloprid and imidacloprid-olefin concentrations;
- Evaluation of binding of imidacloprid and imidacloprid-olefin to sediments;
- Measurement of imidacloprid and imidacloprid-olefin concentrations in eelgrass tissues;
- Whole sediment characterization (texture, total organic carbon, dissolved organic carbon);
- Evaluation of the efficacy of imidacloprid in controlling burrowing shrimp; and
- Evaluation of the effects of imidacloprid on benthic invertebrate communities.

The 2012 experimental trials were conducted in Willapa Bay and the study sites were selected with specific criteria in mind. Treatment and control sites were located in two areas of Willapa Bay. The first location was between Sandy Point and Ramsey Point in the east side of the bay, below the south fork of the Palix River (Palix). The second location was south of Leadbetter Point and Grassy Island on the north end of the Long Beach peninsula (Leadbetter). Limited sampling also occurred in one small plot near Cedar River. Treatment occurred in August of 2012. Study site criteria included ownership by a WGHOGA member; adequate densities of burrowing shrimp; adequate distance from previous or planned applications of carbaryl on commercial shellfish beds (>0.5 mile); no previous applications of carbaryl within the past 20 years, if ever (personal communication with Dr. Kim Patten, WSU Pacific County Extension Director, May 29, 2014); accessibility; replication of a commercial-scale application; and desirable characteristics of elevation, vegetation, and substrate that are similar to commercial shellfish beds and that were consistent within the study area. In addition, treatment and control plots had to be adequately separated to prevent cross contamination (>500 meters). All treatment and control plots were 7 to 10 acres in size. Both the granular (Mallet) and flowable (Nuprid) formulations of imidacloprid were used in these trials. The following screening values were used to determine when levels of imidacloprid in various sample types were high enough to potentially result in environmental consequences:

- Surface water – 3.7 ppb (screening value);
- Sediment – 6.7 ppb (laboratory quantitation limit)
- Sediment porewater – 0.6 ppb (screening value); and
- Eelgrass tissue – 10 ppb (laboratory quantitation limit).

The surface water screening value was derived using EPA guidance (USEPA 1985) on water quality criteria and the sediment porewater screening value is a conservative concentration based upon chronic effects No Observed Effects Concentration (NOEC) in 21-day toxicity studies (Ward 1991).

Water Column Sampling and Analyses. Water column samples were collected within each treatment plot, as well as at 60, 120, 240, and 480 meters (m) (197, 394, 787, and 1,575 feet, respectively) from the plot edge on the upslope and downslope side of the plot. Pre- and post-treatment samples were also collected from the control plots. Samples were collected as the first advancing tide moved across the treatment area and onto surrounding areas. When drainage channels were present, samples were taken in the drainage channels at the distances mentioned above. Some drainage channel samples were collected from water draining from the treated area soon after treatment. Nuprid was sprayed on treatment plots that were exposed from an outgoing tide. Mallet was applied to treatment plots having areas with 0.5 to 3 feet of water on them during an outgoing tide. Sample bottles were buried upright in the sediment with the mouth of the bottle 5 cm above the sediment surface. As the tide rose, the sample bottles filled, beginning with the sampling points of lowest elevation. As soon as each individual bottle was filled, the bottle was sealed and removed from the sediment. Samples were collected prior to and approximately 2 hours following application of imidacloprid. Water column samples were analyzed on an iterative basis, meaning that all water samples were collected pre-treatment; those collected on the sample plot and those collected 60 m off the plot were analyzed immediately. When imidacloprid concentrations within water samples collected 60 m from the treated plot were less than the screening value of 3.7 µg/L, samples collected at further distances along the corresponding transects were not analyzed. When concentrations were greater than or equal to 3.7 µg/L, the next sample further along the respective transect was analyzed. This iterative procedure was repeated in a stepwise fashion until either the screening level was not exceeded, or all samples along the respective transects were analyzed. Concentrations of imidacloprid were generally highest in drainage channels associated with Nuprid, with a maximum observed value of 4,200 ppb at 60 m (197 feet), and 120 ppb at 480 m (1,575 feet). Based on the study design, it was expected that the highest concentrations of Nuprid would be found in the drainage channels. In contrast, Mallet concentrations were much lower approximately 2 hours after application. Only 2 of 13 samples were above the quantitation limits

and both were below 1.0 ppb. The results of the water column sampling showed that many offsite locations upslope of the treatment area were found to have at least some concentration of imidacloprid during the first advancing tide that passed over the treated area. Outside of the drainage channels, Nuprid concentrations reached a maximum of 900 ppb, with concentrations as high as 200 ppb at a distance of 480 m (1,575 feet). Mallet concentrations reached 130 ppb at a distance of 60 m (197 feet) and no concentrations above the screening criteria at further distances. The average olefin detection was 1.8% of the corresponding imidacloprid measure. Olefin concentrations ranged from 0.08 to 3.6 ppb.

Sediment and Sediment Porewater Sampling and Analyses. Sediment samples were collected for whole sediment and sediment porewater analysis within each treatment plot and from three transects on the high elevation (direction of tidal flow) side of the treatment plot at 60, 120, 240, and 480 m (197, 394, 787, and 1,575 feet, respectively) from the plot edge. When drainage channels were present, samples were taken in the drainage channels at distances mentioned above. One pre-treatment sample was taken. Samples were also collected on days 1, 14, 27, and 56 after application. Whole sediment and sediment porewater samples were collected using a modified semi-transparent, Nalgene 500 mL HDPE bottle with the bottom removed and a vent hole drilled into the top shoulder of the bottle. All coring devices were new, chemically cleaned at point of manufacture, and not re-used. The sample sizes were 7 cm in diameter by 10 cm in depth. Two sediment cores were collected at each sampling point to ensure sufficient sediment porewater could be extracted from whole sediments. Each sediment core was approximately 750 g, and the sum weight of both cores was approximately 1500 g. From this quantity of sediment, a whole sediment and sediment porewater imidacloprid and olefin analysis could be performed where necessary. When both measures were desired, the sample was first homogenized for about five minutes, and then split into two identical aliquots for the respective analyses. Approximately 400 g of sediment were removed and placed in a disposable, sterile 500-mL Millipore Steritop® 0.22 micron filtration unit. Vacuum was applied and the porewater extracted and collected into individual, clean 125-mL amber glass bottles. Samples were placed on wet ice or refrigerated (< 4 °C) until shipped to the laboratory for analysis. As with the water column samples, sediment porewater samples were analyzed on an iterative basis using a time, distance and a concentration-based process. If imidacloprid concentrations were less than the 0.6 µg/L screening value in sediment porewater samples collected from within the treatment areas, porewater samples collected at later dates were not analyzed. Similarly, if imidacloprid concentrations were less than the practical quantitation limit of 6.7 µg/kg in whole sediment, sediment samples collected at later dates were not analyzed. The maximum concentration of imidacloprid found in sediment porewater on treatment plots one day post-application was 261 ppb. In general, imidacloprid concentrations were greater on the Nuprid-treated beds compared to the Mallet-treated beds. By 14 days post-application, imidacloprid residues in sediments and sediment porewater were reduced by 96.5 % (maximum 9.1 ppb). Concentrations of imidacloprid within porewater samples collected at high elevation transects off the treatment plots largely followed the pattern of the residues within the water column samples. The analyses suggested that 0.5 to 2% of the imidacloprid observed in the inundation water passing a given position will subsequently be observed in the sediment porewater 1 to 3 days post-application (Grue 2012). Analyses of whole sediment samples indicate 89 to 98% of the imidacloprid deposited on the treatment plots had moved off-site in the first 24 hours (see Grue and Grassley 2013 and Hart Crowser 2013 for more details).

Eelgrass Sampling and Analyses. Eelgrass (*Zostera marina* or *Zostera japonica*) samples were collected within and outside of the treatment plots prior to treatment, and 1, 14, and 28 days post-treatment. Detection of imidacloprid at levels above the laboratory quantitation limit (10 ppb) were found only on the first day post-treatment, with a maximum concentration of 120 ppb. Seven out of 20 eelgrass samples had detectable concentrations of imidacloprid on the first day post-treatment.

Sediment Binding Rates. Whole sediment binding rates of imidacloprid were calculated for 51 samples. A binding rate of 50% indicates that half of the total imidacloprid in overlying surface waters would be absorbed into the solid and liquid fractions of the sediment, but does not indicate that the concentration within the solid and liquid fractions are equal (e.g., the solid fraction may have 20% of the imidacloprid, while the liquid fraction has 30%). Initial binding rates ranged from 17.4 to 39.5% at the Palix River and Leadbetter Point treatment plots, while the Cedar River treatment plot had an initial binding rate of 89.8%. Approximately 30 to 90% of the imidacloprid remaining in the sediment one day after treatment is bound to the sediment, rather than present in the pore water. The proportion of imidacloprid bound to the sediment increased through successive sample collections at 14, 28, and 56 days post-treatment, meaning that there was less imidacloprid present in the porewater. Thus, although imidacloprid levels in sediments declined in both sediment and sediment pore water, the declines occurred more readily in the pore water

fraction. Data on sediment binding of imidacloprid indicate that it binds more readily to sediments that are higher in total organic carbon (TOC) (e.g. at the Cedar River treatment plot), and appears to be more persistent, than in sediments with lower concentrations of TOC (Palix River and Leadbetter Point treatment sites). At the Cedar River site, the concentration of imidacloprid bound to sediment decreased from approximately 28% one day after treatment to approximately 10% 56 days after treatment. At the other two sites with lower TOC, imidacloprid concentrations had declined to less than 5% only 28 days after treatment (Grue and Grassley 2013).

Megafauna Sampling and Analyses. Dungeness crab and fish were counted on the day of application, and again 24 hours after treatment. Counts were made at low tide along 3- to 7-m (10- to 23-foot)-wide transects that crossed and extended 50 m (164 feet) on each side of the plots. Species, size, incidence of tetany (temporary paralysis), and cause of death were recorded. The average across all sites and treatments was two affected crab per acre. The highest count was 3.4 affected crab per acre. Bird predation of tetany-affected crab appeared to be the main cause of crab mortality. However, crushing of crab with the ATV during imidacloprid application was also a significant cause of loss. Fish mortality ranged from 0 to 0.1 per acre. These results could have been due to chance (e.g., a dead fish drifted into the sample area on the tide, or to fish crushed by the ATV during imidacloprid application). The results do not indicate that imidacloprid application resulted in more than incidental mortality of any fish species. Birds were observed foraging on and nearby the sites following treatments. No birds exhibiting behaviors consistent with exposure to a pesticide (e.g., confusion, poor balance, tetany) were observed (Patten 2013). In addition, the tidelands outside the treated area were mapped two weeks post-treatment. The presence of dead commensal clam shells (i.e., clams that live with burrowing shrimp) indicated the pattern and range of significant offsite chemical movement. For the most part, these affected areas were confined to a narrow band around treated plots, with an average 15% increase in area beyond what was treated.

Efficacy. Efficacy across all sites ranged from 65 to 84% burrow reduction. Efficacy was reduced at sites with significant eelgrass coverage. Some areas immediately outside the treated areas exhibited some level of burrowing shrimp reduction.

Epibenthic and Benthic Invertebrate Sampling and Analyses. Epibenthic and benthic samples were collected both within and adjacent to the treatment area, using a grid-based sampling approach. Epibenthic and benthic invertebrates were sampled prior to the application of imidacloprid and at 14 and 28 days post-treatment. In general, imidacloprid effects were assessed for nine endpoints (absolute abundance, taxonomic richness, and Shannon diversity for each of three primary taxonomic groups: polychaetes, molluscs, and crustaceans) by comparisons in the treated plots to the same endpoints in the control plots at each post-treatment interval. In general, non-target effects on the epibenthic and benthic invertebrates from imidacloprid were absent to minimal based on the statistical analyses requested by Ecology. Polychaete abundance, richness, or diversity at the treatment sites could not be differentiated from abundance, richness, and diversity at the control site 14 days after treatment (see Hart Crowser 2013 for more details). Molluscs at one treatment site showed post-application declines, which could indicate an effect of imidacloprid; however, other factors may account for incremental changes in abundance, richness and diversity in this taxon and location, particularly as no declines in mollusc abundance, richness and diversity were found at the second site. Imidacloprid application did not affect the richness or diversity of crustaceans, but abundance did show a treatment effect. The composite result from the analysis of invertebrate endpoints is that imidacloprid application exhibited limited effects in both space and time. In most comparisons of data from the treatment and control plots, a treatment effect of imidacloprid could not be demonstrated for the invertebrate endpoints being tested, (see Hart Crowser 2013 and Booth 2013 for more details).

B. 2014 Experimental Trials

The 2014 field trials were designed to assess the magnitude, extent, and duration of impacts from imidacloprid that could be associated with commercial use for the control of burrowing shrimp. Whereas the previous studies had focused on smaller plots, the 2014 field trials were designed to assess these potential effects when imidacloprid is applied to larger (>50 acre) plots. Commercial treatment of such plots is most likely only feasible using aerial spraying, which is not intended to be done under WGHOGA's current NPDES application; however, the 2014 field trials nonetheless provide more data to support the conclusion that imidacloprid has very little short or long term impact to non-target species, and does not persist in waters or sediments in Willapa Bay or Grays Harbor.

The 2014 field trials involved two trial plots, both owned by members of WGHOGA with adequate densities of burrowing shrimp, near other beds scheduled for commercial treatment, and with topography and substrate/vegetation composition that could be matched by another untreated plot that could serve as a control. A total of 90 acres were treated by helicopter with Protector 2F at 0.5 lb a.i./ac on July 26, 2014. The control site was of similar elevation, vegetation and substrate, but was located five miles away from the treatment site. The 2014 field trials were intended to assess:

- Whole sediment imidacloprid concentrations after treatment and over time;
- Porewater imidacloprid concentrations after treatment and over time;
- The impact of large scale imidacloprid application on megafauna;
- The efficacy of imidacloprid in controlling burrowing shrimp on larger treatment areas; and
- The impacts of imidacloprid on benthic invertebrate communities.

In general, the 2014 field trials confirmed the results of the prior trials, notably that imidacloprid is not persistent in water or sediments, and that impacts to epibenthic and benthic invertebrate communities are minimal.

Imidacloprid Concentrations in Surface Waters. Overall, the surface water data collected during the 2014 trials indicate a strong pattern of high on-plot and low off-plot concentrations during the first rising tide, supporting prior studies that have concluded there is very little off-plot migration of imidacloprid after treatment. For the Cedar River site, imidacloprid was detected off-plot, but well below the screening level of 3.7 ppb, despite the edge of the plot having concentrations that exceeded the screening level during the first rising tide after treatment.

Imidacloprid Concentrations in Whole Sediments and Pore Water. The 2014 field trials confirmed prior studies that demonstrate a rapid, negative exponential, decline in imidacloprid concentrations in whole sediment and pore water after treatment. All but one sampling site declined to below detection limits in whole sediment by 28 days after treatment, with the one sample only slightly exceeding the conservative (6.7 ppb) screening level established for whole sediment. Sediment porewater demonstrated a similar rapid decline of imidacloprid concentrations, with all sediment porewater samples except one below the screening level of 0.6 ppb by day 28. Once again, the single sample that was above that screening level at day 28 only slightly exceeded that level, with a concentration of 1.2 ppb.

Megafauna Summary. The 2014 trials differed from prior trials and focused on the edges of the plots in surveying effects on crabs, because it was impossible to survey the entire area sprayed. As a result, the monitoring effort focused only on the areas most likely to contain affected crab. These were along the edge of the treated area which was lower and contained more *Z. marina*. This focused monitoring resulted in a higher density of crabs exhibiting tetany and/or dead crabs, when measured per unit area, than previous years where the monitoring was spread out over the entire area. Since no affected crab were noted (but not recorded) in the major portion of the treated area, the overall impact on crab was in proportion with previous year's finding.

Efficacy Summary. The 2014 field trials indicated good results of using imidacloprid to control burrowing shrimp on shellfish beds, particularly in areas with low density of eelgrass. Efficacy was variable, ranging from 27 to 97% in assessments conducted by WGHOGA and WSU.

Effects of Imidacloprid on Epibenthic and Benthic Invertebrates. The 2014 field trials supplement and support two primary conclusions regarding epibenthic and benthic invertebrates:

- Estuarine epibenthic and benthic invertebrates have been similar on control plots as compared to treatment plots;
- Assemblages of benthic and epibenthic invertebrates in Willapa Bay vary considerably in space and time.

No significant difference in epibenthic or benthic assemblages were observed following treatment when comparing treatment plots and control plots. Hart Crowser has concluded that this lack of significant difference between treatment and control may be due to imidacloprid having a limited effect on non-target epibenthic or benthic species,

rapid recolonization following treatment, or some combination of these factors. The lack of impacts on non-target invertebrates is also likely due to the particular life cycle of burrowing shrimp and the tunneling behavior of those shrimp, who cease burrowing maintenance once treated by imidacloprid, resulting in burrow collapse and eventual suffocation. This mechanism of control makes imidacloprid an ideal chemical for control for use on tidelands where oysters or clams are grown in Willapa Bay or Grays Harbor, particularly in comparison to other chemicals that produce direct mortality in a broad cross-section of the invertebrate community.

C. Summary of Efficacy Research

At WGHOGA's request, Dr. Kim Patten wrote a summary of efficacy studies and results from field trials and laboratory experiments over the past 10 years (Exhibit B). His key finding is that in the absence of either flowing water or heavy growth of eelgrass, efficacy of imidacloprid in reducing burrowing shrimp densities is consistently greater than 40%, and averages as much as 80% or more. Where flowing water or heavy eelgrass are present, efficacy can decline below 40% unless site-specific approaches to ensure chemical contact with the sediment-water interface can be enhanced. He recognizes that additional investigative work to optimize efficacy will have to be done in the future given there is no currently permitted way to conduct such trials. But based on his experience he suggests that use of pelletized forms of imidacloprid, reduction in eelgrass densities before treatment, and spot treatments may be effective.

Granular/pellet form: See above and Exhibit B. Dr. Patten's analysis of efficacy includes a variety of studies using the pelletized version of imidacloprid. He found a wide range in efficacy ranging from 40-80 percent under "normal" conditions (see values for formulation 0.5G in Table 1 of Exhibit B) to 30-70 percent under "moderate to thick densities of eelgrass" (Table 2 of Exhibit B). These are generally high levels of efficacy, and help explain why WGHOGA, in the current permit application, expects to use more pelletized versions of imidacloprid. Dr. Patten also offers the opinion that pelletized versions may be more effective in difficult treatment conditions than liquid applications.

Subsurface injectors: Dr. Patten's memo on efficacy includes data from tests using subsurface injectors to control burrowing shrimp (Exhibit B). These tests generally did not find that subsurface injectors provided superior efficacy over other application techniques. They did however, require additional time and equipment to use, and in practice would also require regular maintenance and replacement if used commercially in the future. Accordingly, WGHOGA is not requesting the NPDES and SIZ applications provide for commercial use of subsurface injectors. However, as part of its efforts to improve the efficacy of imidacloprid application via adaptive management, WGHOGA is requesting that the applications permit small scale, experimental use of subsurface injectors.

D. Continued Integrated Pest Management ("IPM") Approach

WGHOGA has participated for a number of years in an IPM program designed to find techniques or treatments that can help control burrowing shrimp, including non-chemical controls. In addition, WGHOGA members have been practicing integrated approaches to shrimp control for decades through such measures as harrowing (raking through shrimp infested ground), rotation and relocation of beds, and compression of sediment using shellfish harvesting equipment. This work has been done through a burrowing shrimp committee that has been working on this issue for decades, and, more recently, an IPM Committee that came about as a result of a 1999 Memorandum of Agreement between the growers and regulatory agencies.

WGHOGA's NPDES and SIZ applications explicitly include a commitment to use IPM approaches to shrimp control. This IPM approach will include both chemical (i.e., imidacloprid) and non-chemical control methods customized for each shellfish plot based on site-specific conditions, and the intended cultural techniques for that plot. Non-chemical approaches can include harrowing, dredging, sediment compaction, addition of gravel and shell to soft sediments, off-bottom culture, and rotation and relocation of beds. Imidacloprid use will also be subject to an IPM approach. First, different application techniques will be used based on site specific conditions. For example, one plot may have areas of hand spraying, and other areas with liquid applications based on the density of eelgrass. Second, WGHOGA expects that adaptive management will, over time, help inform them on how best to use

imidacloprid as a chemical control. For example, treatments in late summer after juvenile shrimp recruitment may turn out to be more effective than early season treatments before such recruitment.

Under the NPDES and SIZ permits, WGHOGA is expected to be required to file a plan with Ecology each year specifying the locations and timing of chemical controls. WGHOGA expects that this annual plan will include maps or drawings for each plot that is to be treated showing the habitat conditions that are present (e.g., patches of eelgrass), and also showing the location of all non-chemical and chemical approaches to shrimp control that will be used on each plot. Such maps and drawings will serve to show WGHOGA's use of IPM approaches to shrimp control in a form that can be effectively reviewed by Ecology.

Although IPM is an explicit commitment by WGHOGA as part of these proposed permits, it is important to recognize that non-chemical controls alone will not be sufficient to control burrowing shrimp; chemical controls are needed. As part of a commitment to integrated pest management (IPM) techniques in WGHOGA's permit, WGHOGA asked Dr. Kim Patten of WSU to compile a summary of past experimental work on non-chemical controls (Exhibit C). His review documents the very wide variety of approaches that have been tried, and the varying levels of success. Of the methods tried, most failed to reduce burrowing shrimp densities. A few methods, like hand spraying individual burrows, did reduce shrimp densities, but required slow, expensive treatments that would not be viable at the scale of commercial shellfish beds. A few others (e.g., physical compression of sediments, high volume water injections) also reduced densities, but in the process appear to have severely reduced or eliminated non-target species of invertebrates as well, likely creating more impacts at the ecosystem level than chemical controls would.

In his conclusion, Dr. Patten states that no non-chemical approach is viable as a stand-alone treatment for burrowing shrimp due to logistics, cost, low efficacy, and/or impacts to non-target species. WGHOGA anticipates technical discussions with Ecology to evaluate whether and which non-chemical controls should be included as part of an IPM strategy approach to controlling burrowing shrimp. Within such an IPM approach, non-chemical methods might be proposed as stand-alone controls in particular locations or conditions, or as adjuncts to imidacloprid applications designed to improve the overall effectiveness of burrowing shrimp control.

15. The locations of spawning areas; nursery areas; waterfowl feeding areas; shellfish harvesting areas; areas used by species of economic importance; tribal fishing grounds or other tribal areas; ecologically unique habitats; water supply intake areas; public recreation areas; areas protected by federal, state, or local laws; or pristine areas (with respect to sediment quality) in the vicinity of the discharge.

Spawning Areas, Nursery Areas, and Areas Used by Species of Economic Importance. Spawning by Pacific herring in Willapa Bay occurs between mid-January and early April, along the inner shoreline of the North Beach peninsula and the west side of Long Island (Stick and Lindquist 2009). There are no documented areas for surf smelt or sand lance spawning in Willapa Bay. The major tributaries that support salmon include the South Fork Willapa River, Trap Creek, Mill Creek, Wilson Creek, Fork Creek, and Ellis Creek. Tributaries to Willapa Bay provide spawning grounds for salmon and trout. These fish migrate through Willapa Bay at various times of the year, and use the bay as a nursery area much of the year (WDF and WDOE 1992). Anadromous salmonid distribution and utilization within Willapa Bay tributaries is described in detail in ENVIRON (2012; Table 2-4). Species include Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), Winter Steelhead (*O. mykiss*), and Fall Chum salmon (*O. keta*). The closest bull trout spawning area is the Quinault core area, more than 50 miles up the coast from the Willapa Bay. Green sturgeon do not spawn in Washington waters. Juvenile lingcod utilize Willapa Bay, and flat fish (e.g. starry flounder and English sole) use the bay as a nursery area (Pacific Fishery Management Council 2012, Appendix G). Juvenile salmonids and English sole feed over lower intertidal and shallow subtidal areas, which may include Pacific oyster beds. Young salmonids and sole feed mostly on small crustaceans, including harpacticoid copepods, cumaceans, and amphipods. In Willapa Bay, river otters may venture into channels on the mudflats in search of fish, and raccoons may forage on the tide flats when these areas are exposed at low tide. Herring, smelt, sand lance, and anchovy feed on phytoplankton and zooplankton in Willapa Bay. See Chapter 3 of the Final Environmental Impact Statement Control of Burrowing shrimp using Imidacloprid on Commercial oyster

and Clam Beds in Willapa Bay and Grays Harbor, Washington (the "2015 EIS"), incorporated here by reference, for more details on spawning areas; nursery areas; waterfowl feeding areas; shellfish harvesting areas and areas used by species of economic importance.

Waterfowl and Shorebird Feeding Areas. Waterfowl tend to feed mostly in the high intertidal mudflats, which are the first areas available as the tides recede, and the last ones covered by incoming tides (USDI/USFWS1997). The peak use of these upper tidal flats is during spring and fall migration. For both waterfowl and shorebirds there is a temporal and spatial separation from areas and timing of treatments with imidacloprid. Waterfowl feed primarily on aquatic plants including eelgrass, salt marsh plant seeds, and invertebrates such as amphipods, worms, and insect larvae. Shorebirds probe the mud with elongated bills and extract the small invertebrates that constitute their food. Amphipods are the most important food for dunlin and western sandpipers wintering in western Washington. Caspian terns take a wide variety of fish while feeding over shallow intertidal areas. The wetlands and waterways of Willapa Bay may be particularly important to raptors, most of which prey on shorebirds (WDF and WDOE 1985). Shorebirds like rhinoceros auklet, common murre, marbled murrelet, pigeon guillemot, and parasitic jaeger use deeper water areas of the bay as feeding sites.

Waterfowl. Identifying which species of waterfowl and shorebirds (here referred to collectively as birds) in Willapa Bay that occur on oyster beds, and therefore could potentially be exposed to imidacloprid, is difficult to predict with any precision. A large number of species of birds may be found on oyster beds at least occasionally, but limited, intermittent use is unlikely to result in significant imidacloprid exposure (i.e., low probability of occurrence combined with low probability that any particular plot will have recently been sprayed). Further, bird use of these estuaries is overwhelmingly seasonal, with most species that overwinter having moved north before the first dates proposed for spraying under WGHOGA's permits. Obviously such birds, even if they occur on oyster beds, would have no risk of imidacloprid exposure. Similarly, birds that eat fish would only be present in the oyster beds during higher tides, when imidacloprid concentrations in water would be dilute. These bird species, and the list is extensive (e.g., loons, cormorants, herons, auks), would probably only be exposed to imidacloprid if they were to eat fish that, in turn, had eaten invertebrates containing imidacloprid. This is an unlikely exposure scenario, and one almost certainly unlikely to result in imidacloprid intake to levels that cause toxicity in birds.

Thus, of the bird species that are found in oyster beds, the group most likely to be exposed to imidacloprid are those that feed on invertebrates on those beds, and are present during the spring-summer months. Such birds are likely to forage largely or exclusively at low tide, when imidacloprid levels on just sprayed beds would be high. This could lead to dermal exposure. And consumption of invertebrates from treated plots could lead to exposure via ingestion pathways. Birds that eat invertebrates from oyster beds fall into four groups: plovers, shorebirds, gulls, and corvids (i.e., American or "common" crow).

A second group of bird species that could be exposed to imidacloprid are waterfowl that eat eelgrass and other vegetation. Although past trials with imidacloprid, conducted under Ecology SAPs, have rarely documented uptake of imidacloprid by eelgrass, some samples have tested positive. And waterfowl could also ingest imidacloprid from sediments or water they take in as they consume vegetation. This group of birds includes a number of species of dabbling ducks (e.g., mallards, widgeon) and geese.

The attached Exhibit D is the list of bird species found in Willapa Bay that was appended to the 2015 EIS. Species in this list that have been highlighted in green meet one of two criteria: 1) they have been observed on oyster beds by the growers, or 2) they are listed as being commonly found in the bay for at least part of the year, and therefore can be assumed to occur on oyster beds. We did not screen this list to exclude species that are rare or not present on the estuaries during the spring-summer months, so our designations of species are conservative. This list excludes species that are rarely observed on the oyster beds and/or the bay. And it excludes bird groups that would not feed in and around the oyster beds (e.g., owls, passerines). Based on the discussion above, WGHOGA would assume that highlighted species of plovers, shorebirds, gulls and American crow are the most likely to be at risk from treatment of oyster beds with imidacloprid. Highlighted waterfowl species that eat vegetation, either as a primary food source (brant) or incidentally (dabbling ducks), and waterfowl that eat invertebrates (e.g., scoters) would also be at higher risk of exposure to imidacloprid.

However, there are a variety of reasons to conclude that no bird species is likely to suffer adverse effects from imidacloprid treatments. Extensive analysis of potential impacts to birds is presented in the 2015 EIS, and is incorporated by reference here. In addition, the attached Exhibit E provides an extensive review of potential imidacloprid toxicity to birds. In evaluating potential effects of imidacloprid on toxicity to birds, a key consideration is that this chemical has very low toxicity to birds, or, put another way, a very great deal of imidacloprid is required to produce sub-lethal or lethal impacts in birds. The application rate proposed by WGHOGA (0.5 lbs a.i./acre) has been shown in repeated field studies to produce water and sediment concentrations that are 1-3 orders of magnitude lower than levels observed to produce toxicity in birds. Hence, WGHOGA continues to believe the 2015 EIS's conclusion that direct toxicity to birds from application of imidacloprid is extremely unlikely.

Exhibit E also expands upon an idea presented in the 2015 EIS that imidacloprid applications, by reducing competition from burrowing shrimp, can increase the diversity of invertebrate prey available to shorebirds, producing a net benefit overall. Key to this analysis is that most shorebirds have short bills, and are therefore dependent on invertebrates species found in or near the sediment surface. These taxa of invertebrates are often reduced or eliminated when shrimp are at high densities.

WGHOGA anticipates additional technical discussions with Ecology staff on the potential impacts and benefits of imidacloprid use on birds.

Tribal Fishing Grounds. The Shoalwater Bay tribe is located in Willapa Bay and has usual and accustomed fishing rights in the area. As such, they are entitled to fish all shoreline areas, including privately owned lands, but must have permits in place to harvest shellfish on privately owned lands.

Water Intake Supply Areas. At the time of this writing, the only known brackish water intake in Willapa Bay is located at the Tokeland Marina. Further inquiries have produced no additional information on the presence of water intake supply areas in Willapa Bay.

Public Shellfish Beds. WGHOGA has attached a maps Willapa Bay (Exhibit F) showing all public shellfish beds, as listed and identified by the Washington Department of Fish and Wildlife (WDFW, <http://wdfw.wa.gov/fishing/shellfish/beaches/>). WDFW information identifies five in or near Willapa Bay. Of the five areas in Willapa Bay, four, all within the estuary, are listed for clams and oysters, while the fifth is the coastal beach area listed for razor clams (Exhibit F).

WGHOGA used GIS to measure the distances from each of these public shellfishing beds to the nearest plot proposed for inclusion in the NPDES and SIZ applications. All distances were measured in the water given that imidacloprid movement off the plots would be via water movements. Those distances are as follows:

- Willapa Bay
- Long Beach: 5.7 miles
- Nahcotta: 0.16 miles
- Long Island Pinnacle Rock: 0.14 miles
- Long Island NW: 0.07 miles
- Nemah: 1.17 miles
- Hawks Point: 0.21 miles

Public areas for razor clam harvest outside Willapa Bay (Long Beach) are unlikely to be exposed to any but the most dilute concentrations of imidacloprid given their distance from treatment plots and their full exposure to the larger body of coastal waters. The other public shellfishing areas range from 1.9 miles to 0.07 miles (approx. 400 feet) from proposed treatment plots. As with past permits for application of carbaryl and imidacloprid, WGHOGA expects the new NPDES permit to include public notification procedures to advise potential users of these areas of the planned location and timing of imidacloprid treatments.

Public Recreation Areas. There are numerous public recreation areas located within Willapa Bay. The Willapa National Wildlife Refuge encompasses four separate areas within Willapa Bay: the southern units (Lewis, Porter Point, and Riekkola); and the Long Island, Leadbetter Point, and Cape Shoalwater units (see Figure 3.2.8-1). The

Refuge allows camping on Long Island, a popular kayaking destination, which has five primitive campgrounds and hiking trails. Because of shallow water depths, large tidal ranges, swift currents, frequent high winds and changeable weather patterns in the bay, recreational boating opportunities are limited. Paddling (kayaking, canoeing) mostly occurs in shallow waters near shorelines. The Willapa Bay Water Trail also provides extensive public recreation opportunities around Willapa Bay. While there are some opportunities to fish deeper channel waters for Dungeness crab and white sturgeon, these activities normally occur closer to a few public boat launch sites. Salmon fishing opportunities occur in the Willapa River at the north end of Willapa Bay. Recreational clamming within the bay is limited to public lands. Waterfowl hunting and wildlife viewing are primarily land-based and occur along the dike and saltmarsh areas of the Refuge's southern units and tidal flats adjacent to the Leadbetter Point unit (U.S. Department of the Interior, U.S. Fish and Wildlife Service 1997).

It is difficult to obtain a comprehensive map of all public recreation areas given the many jurisdictions and types of access. WGHOGA has prepared maps that show the location of state and county parks and reserves, and the boundaries of federal wildlife refuges in Willapa Bay (Exhibit G). WGHOGA welcomes input from Ecology, or during the public comment period for a draft permit, in order to update this map.

Recreational and Commercially Important Species. Information regarding commercially or recreationally important species is provided in the sections above titled "Public Recreation Areas," and "Spawning Areas, Nursery Areas, and Areas Used by Species of Economic Importance." In addition, a detailed evaluation of these species was included in Section 3 of the 2015 EIS, incorporated here by reference.

These discussions indicate that Dungeness crab, various salmonid fish species, green sturgeon, and flatfish, including Pacific halibut, occur in Willapa Bay and could occur in areas that would be treated under this permit. Because the areas to be treated are exposed at low tide, and because they are privately owned, WGHOGA believes that minimal recreational use of the shellfish beds that would be included in the draft permit would occur. In addition, even where species, like Dungeness crab, regularly occur on the subject beds, they are typically juveniles that are not the subject of any recreational or commercial fishery. To the extent Dungeness crab harvest occurs in Willapa Bay, it occurs in deeper channels and near boat launches, separated by significant distances from areas proposed to be treated. Dungeness crab do not generally occur on barren mud or sand like those found in shrimp-impacted areas.

Areas Protected By Federal, State, or Local Laws. In Willapa Bay, these areas include the Willapa Bay National Wildlife Refuge, the Willapa Bay Water Trail, and the Ellsworth Creek Preserve.

Pristine Areas. Chemical concentrations in the sediments of Willapa Bay are not considered pristine. Ecology's 303(d) list ranks Willapa Bay sediments as Category 2 for level of contamination.

16. The legal location of aquatic lands proposed for use as or potentially affected by (or adjacent to) the proposed SIZ.

The legal location of aquatic lands proposed for use as or potentially affected by (or adjacent to) the proposed SIZ will be provided each year in the Annual Operations Plan.

17. The names and addresses of landowners of aquatic lands proposed for use as (or adjacent to) the proposed SIZ.

The names and addresses of WGHOGA members who have participated in the burrowing shrimp Integrated Pest Management program are listed in Table 1. This is the most current list available at this time. Participants may change during any given year and this would be reflected in the appropriate Annual Operations Plan for that year.

Table 1. Current Participants in the Burrowing Shrimp Integrated Pest Management Program.

Company	Contact Person	Address	Phone #
Bay Center Mariculture Co.	Richard Wilson	PO Box 356 Bay Center, WA 98527	360-875-6172
G.A. & Lila L. Wiegardt	Dobby Wiegardt	PO Box 305 Ocean Park, WA 98640	360-665-4966
Heckes Clams, Inc.	John Heckes	PO Box 1657 Ocean Park, WA 98640	360-665-4371
Markham Oyster Inc.	Dave Hollingsworth	20 Old Westport Rd. Aberdeen, WA 98520	360-648-0047
Nisbet Oyster Co. Inc.	David Nisbet	PO Box 338 Bay Center, WA 98527	360-875-6629
Northern Oyster Co.	Brian Sheldon	PO Box 1039 Ocean Park, WA 98640	360-665-2804
Olsen & Son Oyster Co.	Phil Olsen	PO Box 905 South Bend, WA 98586	360-875-5821
Station House Oyster Co.	Jeff Kemmer	P.O. Box 6 Chinook, WA 98614	360-777-8203
Wiegardt & Sons	Ken Wiegardt	PO Box 309 Ocean Park, WA 98640	360-665-4111
Willapa Bay Shellfish	Warren Cowell	PO Box 43 Ocean Park, WA 98640	360-665-4212
Willapa Fish and Oyster Co.	Eric Petit	PO Box 524 South Bend, WA 98586	360- 875-6549
Willapa Resources	Dick Sheldon	P.O. Box 365 Ocean Park, WA 98640	360-244-0203

Table 2 includes a list of all current WGHOGA members. Not all members are currently part of the Burrowing Shrimp Integrated Pest Management Program.

Table 2. Current WGHOGA members.

Company	Address
Bay Center Mariculture	P.O. Box 356 Bay Center, WA 98527
Brady's Oysters, Inc.	3714 Oyster Pl. Rd. Aberdeen, WA 98520
Carol Wiegardt	P.O. Box 336 Nahcotta, WA 98586
Coast Seafood's Co.	P. O. Box 166 South Bend, WA 98586
Ekone Oyster Co.	29 Holtz Rd. South Bend, WA 98586
Heckes Clams Co.	P.O. Box 1657 Ocean Park, WA 98640
Heckes Oyster Co.	P.O. Box 27 Oysterville, WA 98641
Herrold Fish & Oyster Co.	4109 St. Hwy 101 Ilwaco, WA 98624
Long Island Oyster Co.	P.O. Box 1054 Long Beach, WA 98631
Lytle Seafoods Oyster Shack	1 Rock View Ln. Hoquiam, WA 98550
Markham Enterprises	20 Old Westport Rd. Aberdeen, WA 98520
Nisbet Oyster Co.	P.O. Box 338 Bay Center, WA 98527
Northern Oyster Co. Inc.	P.O. Box 1039 Ocean Park, WA 98640
Olsen and Son	P.O. Box 905 South Bend, WA 98586
R&B Oyster Co.	P.O. Box 309 Bay Center, WA 98527
Station House Oyster Co.	P.O. Box 6 Chinook, WA 98614
Stony Point Oyster, Co.	6931 US Hwy 101 South Bend, WA 98586

Taylor Shellfish	P.O. Box 76 Nahcotta, WA 98586
Wiegardt & Son	P.O. Box 309 Ocean Park, WA 98640
Willapa Bay Fish and Oyster	P.O. Box 524 South Bend, WA 98586
Willapa Bay Shellfish	27718 Sandridge Rd. Ocean Park, WA 98640
Willapa Resources	P.O. Box 365 Ocean Park, WA 98640
Dobby Wiegardt	P.O. Box 305 Ocean Park, WA 98640

Appendix B includes two tables of names and addresses. Table B-1 is a list of names and addresses of aquatic landowners with property immediately adjacent to shellfish beds that may be treated with imidacloprid. Table B-2 is a list of names and addresses of landowners with upland property that is adjacent to shellfish beds that may be treated with imidacloprid.

18. Demonstrate that the discharge meets all known, available and reasonable methods of prevention, control and treatment (AKART).

Extensive work has been done on potential alternatives to use of chemical insecticides to control burrowing shrimp. These include various mechanical measures, shellfish culture practices, noninsecticide chemical use, and biological controls. None of these methods, except the use of carbaryl and imidacloprid, has been shown to effectively control burrowing shrimp on commercial shellfish beds in a manner that could reasonably be implemented on the large scale of commercial shellfish grounds in Willapa Bay. Despite this, efforts will continue to find alternatives to chemical control of burrowing shrimp, and an Integrated Pest Management Plan ("IPM") has been developed to serve this purpose. The IPM plan, as discussed in the 2015 EIS, will serve as AKART for this permit. This plan, along with the restrictions in place in the NPDES permit and FIFRA registrations, will help determine appropriate pest management methods, set action thresholds, incorporate principles of IPM, and help reduce pesticide use. These restrictions and best management practices ("BMPs") include limitations such as the frequency with which a shellfish bed may be sprayed, environmental conditions during spraying, human health and safety measures, monitoring requirements, and public notification of spray events. The 2015 EIS outlines the restrictions and BMPs in more detail.

19. Describe best management practices (BMPs) that will be implemented to minimize impacts.

The FIFRA Registrations for Protector 2F and Protector 0.5G include several "Application Instructions" that function as BMPs. These registrations are attached to this SIZ Application and the application instructions contained therein will be the BMPs used to minimize impacts.

20. Describe how the treatment acreage being proposed is the minimum practicable considering environmental effects, technical feasibility, and cost.

Growers use an array of information to decide if and when they should treat a commercial shellfish bed. Before applying for treatment, they consider crop cycles, whether the bed can sustain the crop without loss, whether the bed needs to be treated to sustain the crop for the period of time it will occupy a bed, the life stage and infestation level of burrowing shrimp in the shellfish bed of concern, and other physical and biological conditions at each site. The assessment correlates directly to shrimp density and the activity of the burrowing shrimp that are present. If a few shrimp are causing lots of sediment perturbation, the crop will begin to be lost immediately after planting. If a grower determines that a bed needs to be treated to protect their crop investment, they identify the bed on an application for treatment. Burrowing shrimp populations are cyclic and are currently beginning to greatly increase in numbers. The WGHOGA members participating in this application have conducted a thorough analysis of the needs to treat beds for burrowing shrimp, and have concluded that they need to be able to treat up to 485 acres per year in Willapa Bay, which is less than the 600 acres that could be treated with carbaryl under the prior permit. This acreage should allow them to defer some treatments to subsequent years with the knowledge that the overall allotment should be sufficient to cover varying annual needs throughout the actively-farmed tidelands. Some portion of the actively farmed tidelands would likely never be treated, and portions of some beds included in the estimate of actively farmed tidelands are not useable. For lands that are treated, the treatment timing and frequency will be determined on a site-specific basis depending on shrimp infestation levels, efficacy of imidacloprid treatments, and

physical and biological characteristics of the commercial shellfish beds. Some areas commercially grown with clams have either functioned directly as areas primarily grown for oysters in the past, or have oysters as a secondary crop. With low burrowing shrimp recruitment over the past 10 years or so, it has been possible to farm some of these beds without shrimp control. However, due to the large recent recruitments of burrowing shrimp in Willapa Bay, growers are now also seeing high shrimp densities in areas primarily cultivated with clams. The threshold for treatment in areas commercially grown with clams is reportedly the same as in areas commercially grown with oysters. Growers report that they begin to lose areas primarily or exclusively grown with clams at the same shrimp density as the threshold within areas where oysters are grown; i.e., at 10 adult burrows per square meter (personal communications with WGHOGA members, May 28, 2014, July 30, 2014, and July 31, 2014). Efficacy on areas commercially grown with clams would be monitored and assessed the same as areas commercially grown with oysters, based on burrowing shrimp density following treatment.

21. Propose a SIZ closure plan.

A. Monitoring

WGHOGA agrees with Ecology that the draft NPDES Permit from 2014 provides a good framework for designing an appropriate monitoring program for the proposed use of imidacloprid that is the subject of this current application. As WGHOGA representatives have discussed with Ecology, the monitoring program needs to be tailored to the changes in the proposed use of imidacloprid that is the subject of the current NPDES and SIZ applications. The reduction in total acreage proposed to be treated (from 2,000 annual acres to 500) and the elimination of aerial spraying both result in smaller plot sizes that will be the subject of individual treatments.

WGHOGA representatives have had early, but productive discussions with Ecology staff on monitoring requirements for the new permit. These discussions have helped identify monitoring as a significant component of any new NPDES permit, and something that will most probably require multiple technical discussions between WGHOGA representatives and Ecology staff. Thus, rather than propose a draft monitoring plan here, WGHOGA requests that Ecology and WGHOGA representatives continue the technical discussions needed to work out a justifiable and feasible monitoring program that will be incorporated in the new NPDES permit and SIZs.

B. Closure

WGHOGA will put in place a SIZ closure plan to demonstrate that the Willapa Bay SIZ has demonstrated recovery from using imidacloprid to control burrowing shrimp populations in commercial shellfish beds. The regulations outlined in WAC 173-204-415(5) and WAC 173-204-415(6)(b) explain the regulations that allow Ecology to close a SIZ and trigger the SIZ closure plan. The regulations state that Ecology may require closure of the SIZ if the SIZ maintenance standards are being violated, or if Ecology determines that the SIZ is no longer needed in order to meet State Sediment Management Standards. This closure plan will be based on natural recovery and monitoring of the SIZ and will ultimately be similar to the ongoing monitoring required by the proposed NPDES permit. It will include sampling location(s) in Willapa Bay to determine if there have been ongoing effects of imidacloprid on the invertebrate communities. This will entail sampling and analysis of benthic invertebrates, surface water quality sampling, and sediment sampling to determine the level of persistence of imidacloprid in the sediment. Details regarding methods to be used and length of time to monitor will be consistent with the requirements of the NPDES permit.

References

- Banas, N.S., B.M. Hickey, P. MacCready, and J.A. Newton. 2004. Dynamics of Willapa Bay, Washington: A highly unsteady, partially mixed estuary. *Journal of Physical Oceanography* 34:2413–2427.
- Banas, N.S. 2005. Dynamics of Willapa Bay, Washington: links to the coastal ocean, tidal dispersion, and oyster carrying capacity. PhD dissertation, University of Washington, Seattle.
- Banas, N.A., B.M. Hickey, J.A. Newton, and J.L. Ruesink. 2007. Tidal exchange, bivalve grazing, and patterns of primary production in Willapa Bay, Washington, USA. *Marine Ecology Progress Series* 341:123–139.
- Booth, S.R., K. Rassmussen, and A. Suhrbier. 2014. Impact of imidacloprid on epibenthic and benthic invertebrates: 2011 studies to describe the Sediment Impact Zone (SIZ) related to imidacloprid treatments to manage burrowing shrimp.
- Booth, S.R., K. Rassmussen, and A. Suhrbier. 2013. Impact of imidacloprid on epibenthic and benthic invertebrates: 2012 studies to describe the Sediment Impact Zone (SIZ) related to imidacloprid treatments to manage burrowing shrimp.
- Bowers, L. 1996a. Acute Toxicity of (carbon 14)-NTN 33823 to *Chironomus tentans* Under Static Conditions: Lab Project Number: 107316: N3823302. Unpublished study prepared by Bayer Corp. 30 p. MRID 43946602 cited in SERA 2005.
- Bowers, L. and C. Lam. 1998. Acute Toxicity of 6-chloronicotinic acid (a metabolite of Imidacloprid) to *Chironomus tentans* Under Static Renewal Conditions: Lab Project Number: 96-B-123: 108127. Unpublished study prepared by Bayer Corporation. 24 p. MRID 44558901 cited in SERA 2005.
- Carter, H.R. and S.G. Sealy. 1986. Year-round use of coastal lakes by marbled murrelets. *Condor* 88(4):473–477. In: USFWS, March 24, 2009.
- Cialone, M.A. and N.C. Kraus. 2001. Engineering Study of Inlet Entrance Hydrodynamics: Grays Harbor, Washington, UA. *Proceedings of Coastal Dynamics 01*, ASCE, Reston, VA, 413-422.
- Dobbs, M. and J. Frank. 1996. Acute Toxicity of (carbon 14)-NTN 33519 to *Chironomus tentans* Under Static Conditions: Lab Project Number: 107311: N3823301. Unpublished study prepared by Bayer Corp. 35 p. MRID 43946604 cited in SERA 2005.
- ENVIRON International Corporation. 2012. Screening-Level Ecological Risk Assessment of the Proposed Use of the Herbicide Imazamox to Control Invasive Japanese Eelgrass (*Zostera japonica*) in Willapa Bay, Washington. Prepared for Washington State University. Pullman, WA. (<http://www.ecy.wa.gov/programs/wq/pesticides/eelgrassdocs/riskassessmentimazamox110712.pdf>).
- European Food Safety Authority (EFSA). 2006. Draft Assessment Report – Imidacloprid. Initial risk assessment provided by the rapporteur Member State Germany for the existing active substance IMIDACLOPRID of the third stage (part A) of the review programme referred to in Article 8(2) of Council Directive 91/414/EEC Gardner, F. 1981. (Editor) *Washington Coastal Areas of Major Significance*. Washington Department of Ecology.
- Grue, C.E. 2012. Fate, persistence, and potential for non-target impacts associated with the use of imidacloprid to control burrowing shrimp on oyster beds in Willapa Bay and Grays Harbor, Washington – A compilation of reports prepared for the Willapa Grays Harbor Oyster Growers Association. Report submitted to the Willapa Grays Harbor Oyster Growers Association. Washington Cooperative Fish and Wildlife Research Unit, School of Aquatic and Fishery Sciences, University of Washington. Seattle, WA. 92 pp.

Grue, C.E. and J.M. Grassley. 2013. Environmental Fate and Persistence of Imidacloprid Following Experimental Applications to Control Burrowing Shrimp in Willapa Bay, Washington. Washington Cooperative Fish and Wildlife Research Unit, University of Washington. Seattle, WA. 91 pp.

Hart Crowser, Inc. 2012. Sampling and Analysis Plan: Experimental Trials for Imidacloprid Use in Willapa Bay, Washington. Hart Crowser, Inc. Edmonds, WA. 72 pp.

Hart Crowser, Inc. 2013. Draft Field Investigation 2012 Experimental Trials for Imidacloprid Use in Willapa Bay, Washington. Prepared for Willapa Grays Harbor Oyster Growers Association, May 15, 2013. Report No. 12733-02. Hart Crowser Inc. Edmonds, WA. 192 pp.

Hart Crowser, Inc. 2016. Final 2014 Field Investigations Experimental Trials for Imidacloprid Use in Willapa Bay, Willapa Bay, Washington. Prepared for the Willapa Grays Harbor Oyster Growers Association, January 8, 2016, Report No. 12733-02, 42 pp.

Kagabu, S., C. Kato, and K. Nichimura. 2004. Insecticidal and Neuroblocking Activities towards American Cockroach (*Periplaneta Americana* L.) of Imidacloprid Metabolites, 5-hydroxy-, 4,5-dihydroxy- and 4,5-dehydroimidacloprid. *Journal of Pesticide Science*. 29(4):376–379.

National Marine Fisheries Service (NMFS). 2009. Endangered Species Act–Section 7 programmatic consultation, biological and conference opinion, and Magnuson-Stevens Fishery Conservation and Management Act essential fish habitat consultation: Nationwide Permit 48 Washington. Seattle, WA. NMFS Tracking No. 2008/04151.

Nauen R., K. Tietjen, K. Wagner, and A. Elbert. 1998. Efficacy of plant metabolites of imidacloprid against *Myzus persicae* and *Apis gossypii*. *Pesticide Science*. 52:53–57. Pacific Fishery Management Council. 2012. Pacific coast groundfish 5-year review of essential fish habitat. Report to Pacific Fishery Management Council. Phase 1: New information, September 2012. Portland, OR. 416 p.

Patten, K. 2011. Field Assessments of Non-Target Effects of Imidacloprid on Dungeness Crab in Willapa Bay, Washington 2008 to 2011. Final Report to the Willapa and Gray Harbor Oyster Growers Association.

Patten, K. 2013. Efficacy and Non-Target Impacts of Imidacloprid Following Applications to Control Burrowing Shrimp in Willapa Bay, Washington in 2012. Washington State University Long Beach Research and Extension Unit.
<http://longbeach.wsu.edu/shellfish/documents/efficacyandnontargetimpactsofimidaclopridtocontrolburrowingshrimpinwillapabay2012.pdf>

Rooney, D. and L. Bowers 1996. Acute Toxicity of (carbon 14)-NTN 33823 to *Hyalomma azteca* Under Static Conditions: Lab Project Number: 107315: N3823202. Unpublished study prepared by Bayer Corp. 34 p. MRID 43946601 cited in SERA 2005.

SERA, 2005. Imidacloprid – Human Health and Ecological Risk Assessment, Final Report. Prepared for USDA Forest Service by Syracuse Environmental Research Associates, Inc. December 8, 2005. Suchail, S., D. Guez, and L. Belzunces. 2001. Discrepancy between acute and chronic toxicity induced by imidacloprid and its metabolites in *Apis mellifera*. *Environmental Toxicology and Chemistry*. 20(11): 2482–2486.

Tomizawa, M. and J.E. Casida. 1999. Minor structural changes in nicotinoid insecticides confer differential subtype selectivity for mammalian nicotinic acetylcholine receptors. *British Journal of Pharmacology*. 127:115–122.

Tomalski M., W. Leimkuehler, C. Schal, and E. Vargo. 2010. Metabolism of Imidacloprid in Workers of *Reticulitermes flavipes* (Isoptera: Rhinotermitidae). *Annals of the Entomological Society of America*. 103(1):84–95.

U.S. Department of the Interior, U.S. Fish and Wildlife Service (USDI/USFWS). 1997. Environmental Assessment: Control of smooth cordgrass (*Spartina alterniflora*) on Willapa National Wildlife Refuge. Ilwaco, WA.

U.S. Environmental Protection Agency (USEPA). 1985. Guidelines for Deriving Numerical National Water Quality Criteria for the Protection Of Aquatic Organisms and Their Uses. Publication PB85-227049. Office of Research and Development Environmental Research Laboratories - Duluth, Minnesota, Narragansett, Rhode Island and Corvallis, Oregon.

Ward, G. 1991. NTN 33893 Technical: Chronic Toxicity to the Mysid, *Mysidopsis bahia*, Under Flow- Through Test Conditions: Lab Project Number: 9008023G/H: 101347. Unpublished study prepared by Toxikon Environmental Sciences. 87 p. MRID 42055322 cited in SERA 2005.

Washington Department of Ecology (Ecology). 2007a. Condition of Outer Coastal Estuaries of Washington State, 1999. A Statistical Summary. Publication No. 07-03-012.

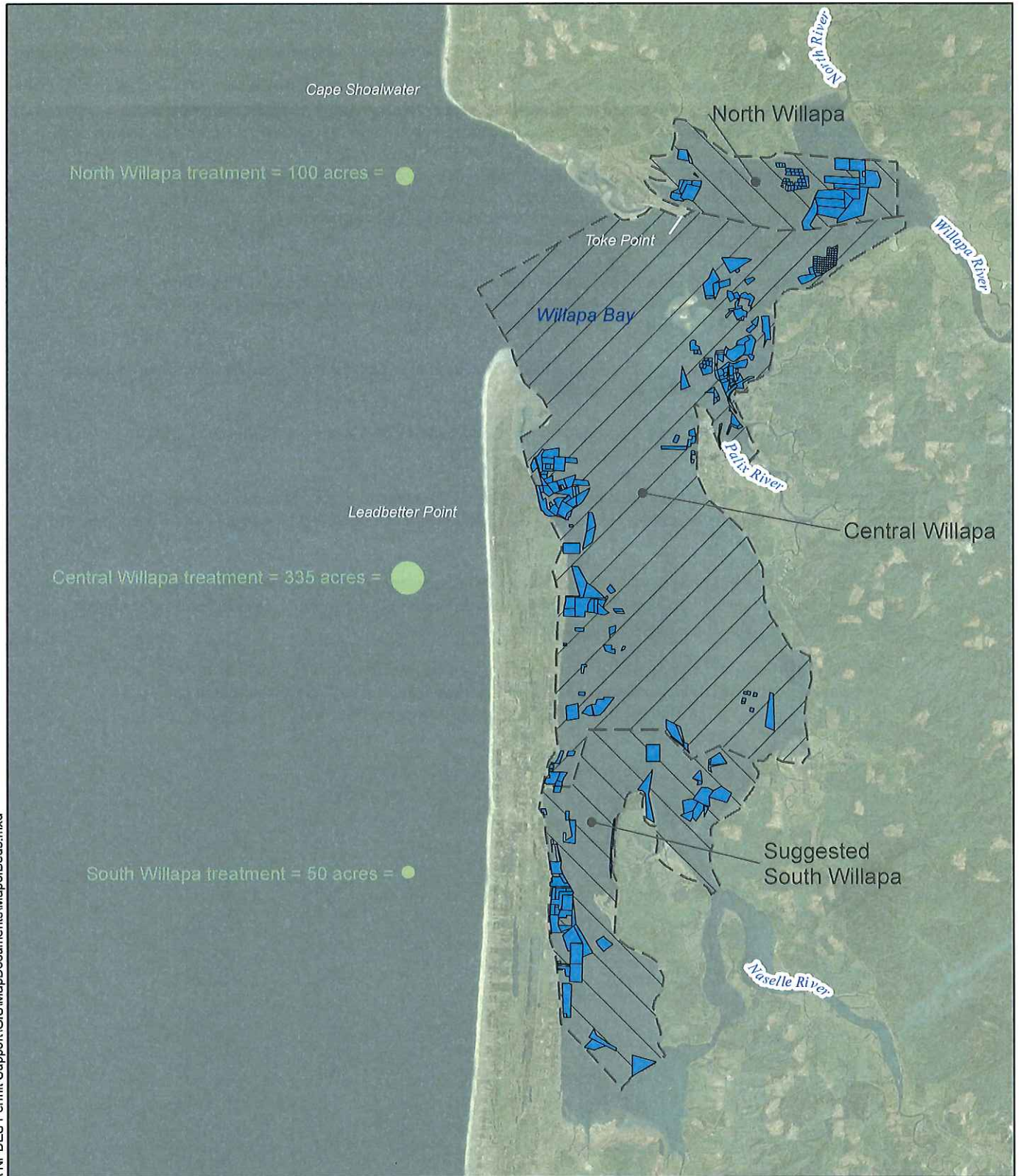
Washington Department of Ecology (Ecology). 2007b. Condition of Coast Waters of Washington State, 2000–2003. A Statistical Summary. Publication No. 07-03-051.

Washington Department of Ecology (Ecology). 2015. Final Environmental Impact Statement Control of Burrowing Shrimp using Imidacloprid on Commercial Oyster and Clam Beds in Willapa Bay and Grays Harbor, Washington. Publication No. 15-10-013.

Washington Department of Fisheries (WDF) and Washington Department of Ecology (WDOE). 1985. Final Environmental Impact Statement: Use of the Insecticide Sevin to Control Ghost and Mud Shrimp in Oyster Beds of Willapa Bay and Grays Harbor. Olympia, WA. June 1985.

Washington Department of Fisheries (WDF) and Washington Department of Ecology (WDOE). 1992. Supplemental Environmental Impact Statement: Use of the Insecticide Carbaryl to Control Ghost and Mud Shrimp in Oyster Beds of Willapa Bay and Grays Harbor. Olympia, WA. March 31, 1992

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ESRI Basemap

Willapa Grays Harbor Oyster Growers Assoc.
Willapa Bay, Pacific County, Washington

Oyster Beds in Willapa Bay

12733-02

8/18/2016



HARTCROWSER

Exhibit

A

Exhibit B

A summary of ten years of research (2006 to 2015) on the efficacy of imidacloprid for management of burrowing shrimp infestations on shellfish grounds

Kim Patten

Washington State University Long Beach Research and Extension Unit

Introduction: There has been an extensive effort to develop alternative controls for burrowing shrimp on shellfish beds. Those efforts resulted in imidacloprid being registered by EPA for burrowing shrimp control. Field efficacy of imidacloprid applied by the shellfish industry, however, has been variable and not consistent. There are several reasons for this variability in efficacy. One is that it is a very difficult pest to control. The other is that the monitoring protocol used by the industry was not designed to provide data on efficacy. Rather it was intended to indicate if the burrowing shrimp density of a bed in the spring was above the economic threshold (> 10 burrows/m²) to warrant spraying with carbaryl in the summer. Monitoring consists of a dozen or so counts made in the spring from a single egress point per site. In comparison to the summer counts, these spring counts are done when there is less burrow activity, more wave action minimizing observable burrows, and less eelgrass coverage to obscure the burrows during counting.

To properly assess efficacy, a large number of burrow counts should be made immediately before treatment and $\sim \frac{1}{2}$ to 1 month after treatment. Comparable methods of measurement should be used at the same or similar locations on the beds. The only data available of this type is that collected by WSU over that past decade. Most of this data is from small research trials conducted under a 1 acre EUP. However, some of the later experiments and conditions were over larger commercial sites. To provide a more comprehensive overview of efficacy, the data from WSU's progress reports from the previous 10 years have been summarized for this report. They were compiled into three tables of varying application conditions. Tables and figures from those original reports are provided in Appendix 1.

Results: A range of efficacy under normal conditions is provided in Table 1. Without eelgrass or water on the site, efficacy of imidacloprid at 0.5 lbs ai/ac ranges from 40 to 80%. Zero control and 100% control were also frequently noted, but those results were outliers. Efficacy varied considerably under any particular sediment type and condition depending on when the product was applied in relationship to the tidal conditions. Imidacloprid, either the 0.5% G or 2F, applied after the sand had dried, generally resulted in poorer efficacy than if the product was applied just as the tide went off the ground. These perfect application conditions are very difficult to replicate with large-scale applications over many beds (traditional aerial applications). Smaller targeted applications would be expected to result in better control.

Efficacy of imidacloprid under more difficult treatment conditions, such as thick eelgrass or on sites that don't go dry, is presented in Tables 2 and 3. Reduced efficacy occurred under these conditions. Results from alternative treatment methods to improve efficacy under these conditions are also presented in Tables 2 and 3. Controlling burrowing shrimp in areas of thick eelgrass or flowing water will be a challenge. The use of several application methods on a single bed might be needed to achieve acceptable control across the entire bed. Table 1 in Appendix 2 provides an example of the type of treatments that would be recommended across several

locations within a bed. Other timings and application methods will need to be more fully vetted, but have not been possible without a NPDES permit. Examples are pretreating sites infested with *Z. japonica* with imazamox 2-3 months prior to treatment with imidacloprid, or hand application of the granular product in 12" to 18" of shallow water in sites covered with thick eelgrass.

Conclusion: Compared to the previous use of carbaryl at 8 lbs ai/ac, achieving good efficacy with broadcast-applied imidacloprid at 0.5 lbs/ac across a range of conditions found on shellfish beds in Willapa Bay requires adaptive management approaches until the optimal method can be identified. An individual bed may require a specific IPM plan that details separate application methods for each of the varying conditions on the bed. Details on a draft recommendation for an IPM treatment plan are provided in Appendix 2. Application of recommendations from this plan will need to be made to larger sites and modified over time.

Table 1. Efficacy of imidacloprid at ≤ 0.5 lbs ai/ac under normal tidal conditions					
Condition	Formulation	Application conditions	Expected range of control (%) found under experimental conditions	Tables referenced in appendix	Figures referenced in appendix
Sand, no or minimal eelgrass	2F	Broadcast, no standing water	60 to 80*	6, 8, 10, 17, 18, 19, 20, 21	1, 11, 19
Sand, no or minimal eelgrass	0.5G	Broadcast, no standing water	40 to 70**	12, 13, 14, 17, 18, 19	6, 8, 11, 13
Silt, no or minimal eelgrass	2F	Broadcast, no standing water	50 to 70*	8, 10, 12, 17, 18, 21	
Silt, no or minimal eelgrass	0.5G	Broadcast, no standing water	40 to 70 **	13, 15, 16	10, 12, 13

* lower if applied to dry beds, higher if applied just as tidal water is going off bed.

** much lower if applied to beds, higher if applied in shallow water just as tidal water is going off bed.

Table 2. Efficacy of imidacloprid at ≤ 0.5 lbs ai/ac in locations that don't fully dewater.					
Condition	Formulation	Application conditions	Expected range of control (%) found under experimental conditions	Tables referenced in appendix	Figures referenced in appendix
Sand	2F	Broadcast, tide out, no standing water	60 to 80*	6, 8, 10, 17, 18, 19, 20, 21	1, 11, 19
Sand	0.5G	Broadcast, tide out, no standing water	40 to 70**	12, 13, 14, 17, 18, 19	6, 8, 11, 13
Sand	2F	Broadcast, tide out, shallow standing water with no outflow	60***		
Sand	2F	Broadcast, tide out or going out, shallow or deep swale with constant flow of water	0****		
Sand	0.5G	Broadcast, tide out, shallow standing water with no outflow	70		19
Sand	0.5G	Broadcast, applied in shallow water 3" to 60" as tide is going out	30 to 80 *****	17, 21	9, 14, 15
Sand	2F	Injected via spikewheel - 4" to 6" depth, shallow or deep swale with constant flow of water	70 to 90	1, 2, 3, 4, 5, 6, 8, 10	2, 3, 4

* lower if applied to dry beds, higher if applied just as tidal water is going off bed.

** much lower if applied to beds, higher if applied in shallow water just as tidal water is going off bed.

*** WSU data from small pools, not large sites. Results have not been provided in any progress report.

**** WSU observations and data not contained in any progress report

***** lower efficacy in deeper water

Table 3. Efficacy of imidacloprid ≤ 0.5 lbs ai/ac under conditions of moderate to thick densities of eelgrass, mainly *Z. japonica*.

Condition	Formulation	Application conditions	Expected range of control (%) found under experimental conditions	Tables referenced	Figures referenced
Sand or silt, thick eelgrass (Zj or Zm)	2F	Broadcast, tide out, no standing water	0 to 70*	6, 17, 18, 19, 21, 22	1, 16, 17, 18, 19
Sand covered with eelgrass (Zj)	2F	Broadcast, tide just going off, 3" to 18" of water.	0 to 40**	19	NA
Sand covered with eelgrass (Zj)	0.5G	Broadcast, tide just going off, 3" to 40" of water.	30 to 70***	12, 17	9, 14
Sand covered with eelgrass (Zj)	2F	Injected via spikewheel - 4" to 6" depth	NA****	6, 7, 8, 9, 10	4
Sand covered with eelgrass (Zj)	2F	Injected by hand - 18"	95****	22	NA
Sand covered with eelgrass (Zj)	2F	Site was pretreated with imazamox to remove Japanese eelgrass prior to treatment. Broadcast, tide out, no standing water	60 to 90	11	18
Sand covered with eelgrass (Zj)	2F	Site was disked after treatment to cut up the eelgrass root zone and incorporate imidacloprid.	30 to 60	NA	16, 17

*Highly variable control. Source of variation is likely the density of eelgrass.

** Sections of these sites were treated in flowing water. The lower efficacy is associated with those locations.

*** Density of eelgrass, depth of water, size of plots are all sources of variation. Not enough large-scale plots on these types of sites to assure confidence in the efficacy range. Lower range of efficacy might be more typical.

**** Only minimal trials of this have been conducted on very small areas.

**** Experiments have not been conducted under these conditions, data not available (NA).

Appendix 1. Efficacy tables and figures from 10 years of progress reports to the Washington State Commission for Pesticide Registration, WDFW and/or USDA.

No effort has been made to standardize format of the data. Prior to 2011, much of the work with the 2F formulation of imidacloprid was done at the 2 lbs ai/ac rate. Those results were left in the data in the Appendix, but are not part of the expected efficacy range presented in Tables 1, 2, & 3.

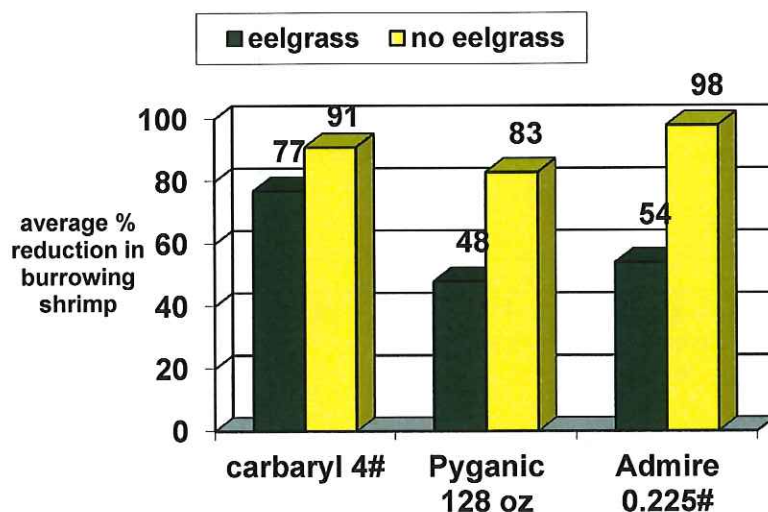


Figure 1 - 2006. Average reduction of burrowing shrimp burrow density over eight experiments with the application of three insecticides to tidal sand flats with and without eelgrass cover.

Table 1. Field screening of pesticides for efficacy on burrowing shrimp using spikewheel injection from a barge in 2006 on sandy sediment.	
Compound	Mean burrow (#/m2 \pm std. err.) count 1 month post treatment
Imidacloprid 0.5 Lbs ai/A	0 \pm 0
Imidacloprid 0.2 Lbs ai/A	0.7 \pm 0.3
Imidacloprid 0.1 Lbs ai/A	6 \pm 2
Carbaryl 3 lbs ai/A	3 \pm 1
Mustard cake 4000 lbs/A	32 \pm 5
Pyganic 128 oz/A	45 \pm 6
Habenero 2 qt/A	61 \pm 3
Mustang 0.01 lbs ai/A	37 \pm 5
Methoprene 1 lb/A	32 \pm 2
Ecozone 20 lbs/A	49 \pm 9
Sulfur 80 lbs/A	51 \pm 3

Table 2 - 2006. The efficacy of various rates of imidacloprid applied across a range of timings and conditions using the Spikewheel applicators on sandy sediment.

Treatment rate	Burrows (mean #/m ² ± std. error) 2 weeks after treatment ¹						
	Site						
	Swwdfw ²	Swms ³	Sw15 ⁴	Sw13 ⁵	Sw12 ⁶	Sw9 ⁷	Sw20 ⁸
Control	8.7±0.7	33.5±2.0	105±4.7	72.4±3.7	9.7±3.5	81±2.0	116±8
Imidacloprid 0.1 lb ai/ac						23±8.0	
Imidacloprid 0.2 lb ai/ac				12.2±2.6		5.7±2.4	
Imidacloprid 0.4 lb ai/ac	1.0±0.2	8.1±1.7	6.5±1.5	2.4±0.7	0.7±0.3	0.25±0.2	2.2±0.9
Imidacloprid 0.8 lb ai/ac		4.2±2.0					
Sevin 3 lb ai/ac					2.7±2.2	14.7±2.0	
Sevin 4 lb ai/ac							31 ±3

¹ Date of counts varied by sites ranging from 1 to 4 weeks after treatment; 2 weeks was the average.

² Spikewheel WDFW applied September 12, 2006, silt

³ Spikewheel MS applied September 12, 2006, silt

⁴ Spikewheel 15 applied August 30, 2006, sand

⁵ Spikewheel 13 applied August 23, 2006, sand

⁶ Spikewheel 12 applied August 8, 2006, sand

⁷ Spikewheel 9 applied July 28, 2006, sand

⁸ Spikewheel 20 applied Oct 20, 2006, sand

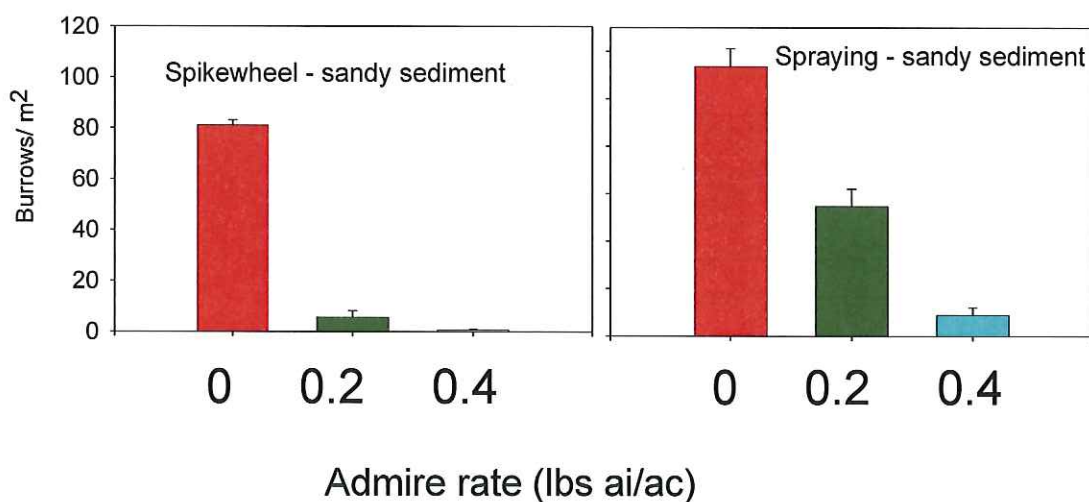


Figure 3 - 2006. Comparative efficacy of low rates of imidacloprid (Admire) for burrowing shrimp control from injection and broadcast spraying in sandy sediment.

Spikewheel in thick Eelgrass beds (both species)

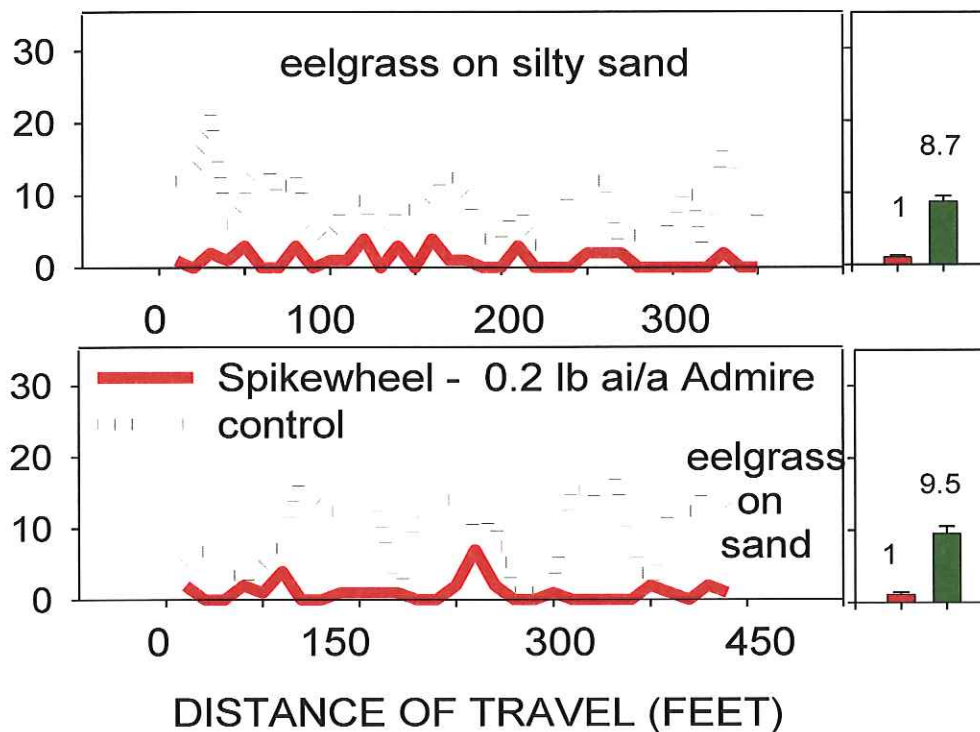


Figure 4 - 2006. Efficacy of imidacloprid (Admire) using a spikewheel injector from a barge on burrowing shrimp control in thick eelgrass beds.

Table 3 - 2007. Effect of wheel spacing on the efficacy of spikewheel-injected imidacloprid for burrowing shrimp control on May 24, 2007.

Treatment	Wheel spacing	Burrows/m ²	
		6/4/07 11 dat	6/27/07 33 dat
Control		47.1±1.6	47.1±1.6
Imidacloprid 2F 0.082 lb ai/a	2 wheels/6'	10.8±2.2	27.8±2.9
Imidacloprid 2F 0.165 lb ai/a	2 wheels/6'	3.1±0.6	18.0±1.7
Imidacloprid 2F 0.33 lb ai/a	2 wheels/6'	2.7±0.8	13.5±1.2
Imidacloprid 2F 0.125 lb ai/a	4 wheels/6'	4.3±1.2	11.9±1.0
Imidacloprid 2F 0.5 lb ai/a	4 wheels/6'	0.1±0.1	4.7±0.8
Mean of 10 1-m ² counts ± standard error (ss3 2007)			

Table 4 - 2007. Effect of wheel spacing on the efficacy of spikewheel-injected imidacloprid for burrowing shrimp control on August 14, 2007.

				Burrows/m ²
Treatment			Wheels per 6 foot swath	9/27/2 (30 DAT)
Imidacloprid 2F	0.37	1b ai/a	4	2.9
Imidacloprid 2F	0.5	1b ai/a	6	3.7
Control				30
Treatment Prob(F)				0.0005

Mean of 10 - 1 m² counts ± standard error (ss11b 2007)

Table 5- 2007. Efficacy of spikewheel-injected imidacloprid on June 21 2007 for burrowing shrimp control on bare sand in large plots.

			Burrows/m ²					
			6/26/2007		7/11/2007		9/8/2007	
Treatment			5 DAT		12 DAT		79 DAT	
Imidacloprid 2F	0.25	1b ai/a	25.6	±11.2	5.1	±1.8	18.5	±3.4
Imidacloprid 2F	0.5	1b ai/a	18.4	±7.2	2.5	±0.8	7.4	±1.9
Control			100	±0	43.5	±5.6	69.7	±4

Table 6 – 2007. Efficacy comparison of broadcast and spikewheel-injected imidacloprid applied on July 17, 2007 and August 14, 2007 to control burrowing shrimp on beds covered by thick Japanese eelgrass.

				Burrows/m ²			
				9/13/2007		9/13/2007	
Treatment				Site 1 42 DAT		Site 2 28 DAT	
Imidacloprid 2F	0.5	1b ai/a	broadcast	3.6	±1.3	23.5	±2.4
Imidacloprid 2F	0.5	1b ai/a	injection	15.6	±2.1	25.6	±3.6
Control				26.4	±3.8	34.2	±3.1
LSD (P=.05)				16.52		20.54	
Treatment Prob(F)				0.1203		0.2829	

Mean of 10 1 m² counts ± standard error (ss10ab &b)

Table 7 - 2007. Effect of sediment type on the efficacy of spikewheel injecting and broadcasting imidacloprid 2F on soft mud and shell-based sediment on July 11 2007.

Treatment				Burrows/m ²			
				9/11/2007			
				93 dat			
				Mud		Shell	
Control				28.7	±2.6	2	±0.8
Imidacloprid 2F	0.25	1b ai/a	injected	20.0	±3.1	0	±0
Imidacloprid 2F	0.5	1b ai/a	injected	16.4	±3.4	1.1	±0.7
Imidacloprid 2F	0.25	1b ai/a	broadcast	12.6	±1.5	0.8	±0.2
Imidacloprid 2F	0.5	1b ai/a	broadcast	2.0	±1.3	1.0	±0.5

Mean of 10 1 m² counts ± standard error (ss8 07)

Table 8 - 2008. Comparison of application methods on the efficacy of 0.5 lbs ai/ac imidacloprid for reducing burrow density from spikewheel injection and broadcast spraying*

Sediment condition/timing	Burrows in control (#/m ²)	% Reduction in burrows		
		Treatment		
		Spikewheel - ATV	Spikewheel - Boat	Spray
Sand - April	24	16		62
Sand - May	24	72		62
Sand - July	24	83		96
Sand - September	24	25		95
Silt- June	79		0	49
Sand - June	18		0	96
Eelgrass & sand - August	11	48	74	37
Eelgrass & sand - August	28		0	9

*Each row represents a different experiment. Data are average counts across all replications

Table 9 - 2008. Effect of timing on the efficacy of 0.5 lbs ai/ac imidacloprid from spikewheel injection *for reducing burrow density on thick eelgrass plots.

Treatment- sediment	Burrows in control (#/m ²)	% reduction in burrows	
		July	August
		83	
Spikewheel - eelgrass	12	87	
Spikewheel - eelgrass	13		17
Spikewheel - eelgrass	29		72
Spikewheel - eelgrass	11		0
Spikewheel - eelgrass	28		0

*Each row represents a different experiment. Data are average counts across all replications

Table 10 -2008. Effect of timing on the efficacy of 0.5 lbs ai/ac imidacloprid for reducing burrow density from broadcast spraying and spikewheel injection.*

Treatment- sediment	Burrows in control (#/m ²)	% reduction in burrows					
		Time of treatment					
		April	May	June	July	August	Sept.
Spray - bare sand	25	52	52		84		92
Spray - bare sand	50		0				
Spray - bare silt	30			0			
Spray - bare sand	48						82
Spray - bare sand	47						95
Spray - bare sand	52						69
Spray - bare sand	20			95			
Spray - bare sand	76						92
Spray - bare silt	15					87	
Spray - bare silt	15						93
Spray - bare silt	72						61
Spikewheel - bare sand	25	20	72		84		20
Spikewheel - bare sand	8	63					
Spikewheel - bare sand	46		93				
Spikewheel - bare sand	20		75				
Spikewheel - bare silt	30			0			
Spikewheel - bare silt	15					0	
Spikewheel - bare silt	30						77

*Each row represents a different experiment. Data are average counts across all replications

Table 11- 2008. Effect of eelgrass control with imazamox on the efficacy of 0.5 lbs ai/ac imidacloprid for reducing burrow density from broadcast spraying the 2F formulation.*			
Treatment	Burrows in control (#/m ²)	% reduction in burrows	
		Eelgrass treated with imazamox	Untreated eelgrass
Eelgrass treated 5/21; Shrimp treated 6/25	52	73	36
Eelgrass treated 5/21; Shrimp treated 9/16	57	95	42
*Each row represents a different experiment. Data are average counts across all replications			

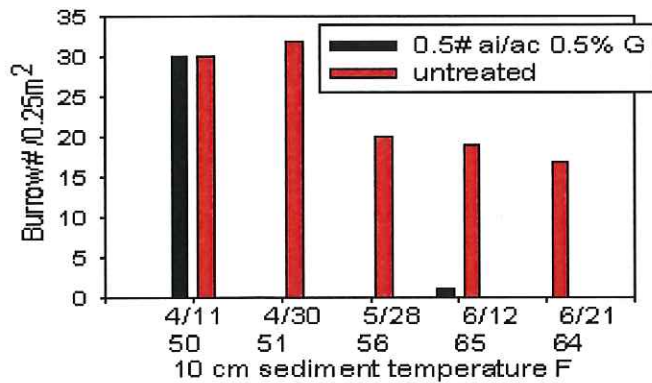


Figure 6 - 2009. Application timing/sediment temperature effect on efficacy in 2009; granular imidacloprid applied to bare sand.

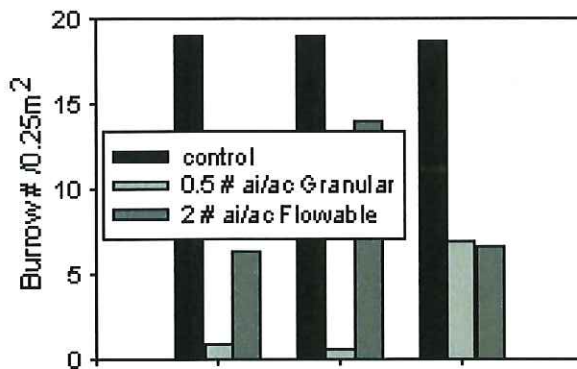


Figure 7 - 2009. Formulation comparisons at three sites where product was applied in 3" to 12" of outgoing tidal water on bare sand in 2009.

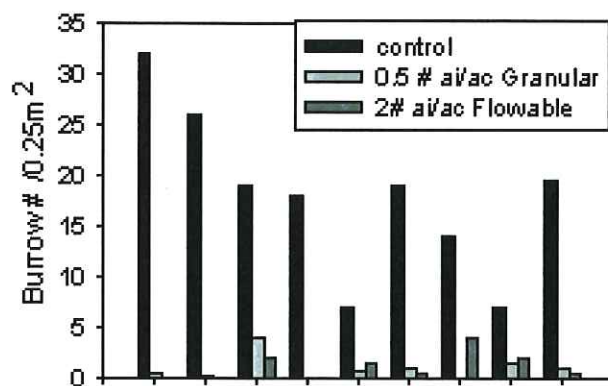


Figure 8 - 2009. Formulation comparisons at nine sites in 2009 on bare, fairly dry tidal flats.

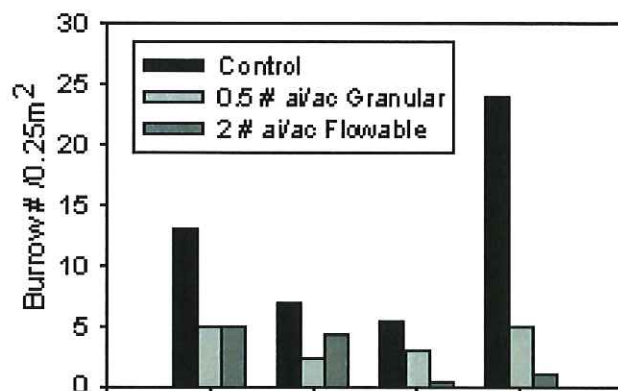


Figure 9 - 2009. Formulation comparisons at four sites in 2009 with thick Japanese eelgrass.

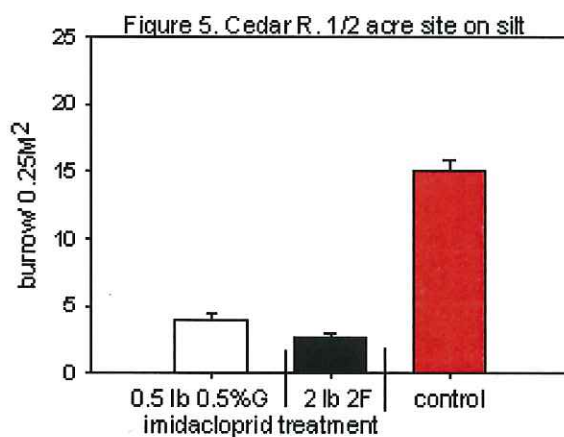


Figure 10 - 2009. Formulation comparisons at Cedar River on site – ½ acre plots in 2009.

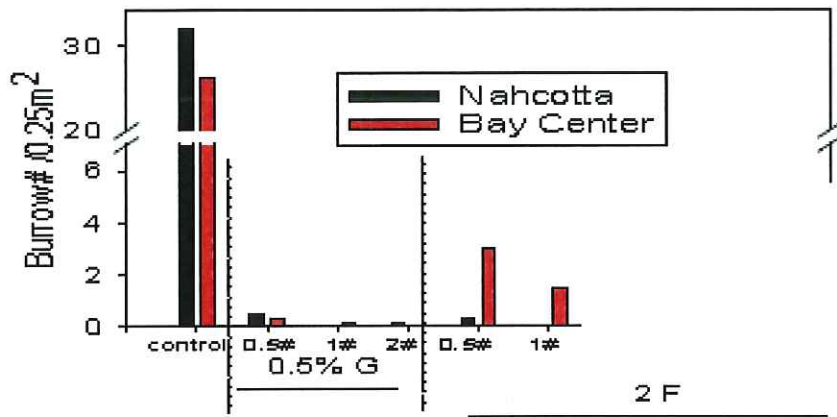


Figure 11 - 2009. Imidacloprid formulation comparisons for efficacy in May 2009 at Nahcotta and Bay Center on sand.

Table 12 - 2010. Effect of sediment type on efficacy		
	Range in % control (# of viable treatments resulting in <8 burrows/m ²)	
Sediment	Mallet (0.5 lb ai/ac)	Nuprid (2 lb ai/ac)
Bare sand	64 to 100% (8 of 13 treatments adequate)	74-100% (7 of 8 treatments adequate)
Silt	75-85% (4 of 7 treatments adequate)	97-100% (8 of 9 treatments adequate)
Silty Sand	54-86% (3 of 7 treatments adequate)	84-99% (6 of 6 treatments adequate)
Eelgrass/sand	59-90% (3 of 5 treatments adequate)	72-97% (3 of 3 treatments adequate)
*Only standard application protocol considered: June to August, minus tide with water just off		

Table 13 – 2010. Effect of sediment type and time of application on efficacy of imidacloprid for control of burrowing shrimp at Leadbetter, Willapa Bay 2010

Leadbetter - silt			Leadbetter - wet sand with water flowing off		
Month of treatments	Burrows/m ²		Month of treatments	Burrows/m ²	
	Mallet (0.5 lb ai/ac)	Nuprid (2 lb ai/ac)		Mallet (0.5 lb ai/ac)	Nuprid (2 lb ai/ac)
April	4	0	April	6	3
May	1	0	May	12	2
July	4	0	July	8	0
August	20	8	August	20	5
* Untreated site had 16 burrows/m ²			* Untreated site had 40 burrows/m ²		

Leadbetter- dry sand			Leadbetter - wet silt sand with water flowing off		
Month of treatments	Burrows/m ²		Month of treatments	Burrows/m ²	
	Mallet (0.5 lb ai/ac)	Nuprid (2 lb ai/ac)		Mallet (0.5 lb ai/ac)	Nuprid (2 lb ai/ac)
April	4	0	April	10	0
May	6	0	May	10	2
July	2	1	July	4	0
August	4	0	August	20	0
* Untreated site had 16 burrows/m ²			* Untreated site had 64 burrows/m ²		

Table 14- 2010. Effect of timing of imidacloprid (0.5 % G Mallet @ 0.5 lb ai/ac) on efficacy on sand sediment in Nahcotta

Month of treatment	Burrows/m ²	
	Bare sand	Eelgrass over sand
May	12	17
June	8	11
Untreated site had 32 burrows/m ²		

Table 15. - 2010. Effect of timing of imidacloprid (0.5 % G Mallet @ 0.5 lb ai/ac and Nuprid @ 2 lbs ai/ac) on efficacy on silt sediment at Bay Center.

Month of treatment	Burrows/m ²	
	Mallet (0.5 lb ai/ac)	Nuprid (2 lb ai/ac)
May	14	1
June	10	1
*untreated site had 50 burrows/m ²		

Table 16- 2010. Effect of timing of imidacloprid (0.5% G Mallet @ 0.5 ai/ac and Nuprid @ 2 lbs ai/ac) on efficacy on silt sediment at Cedar River		
	Burrows/m ²	
Month of treatment	Mallet (0.5 lb ai/ac)	Nuprid (2 lb ai/ac)
April	72	1
May	4	0
August	8	2
Untreated site had 72 burrows/m ²		

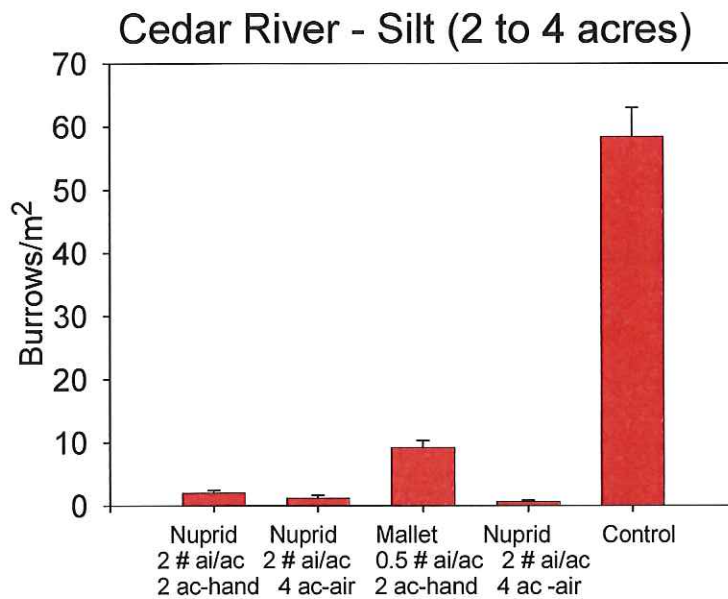


Figure 12 - 2010. Efficacy of different imidacloprid formulations on medium size plots on silt at Cedar River.

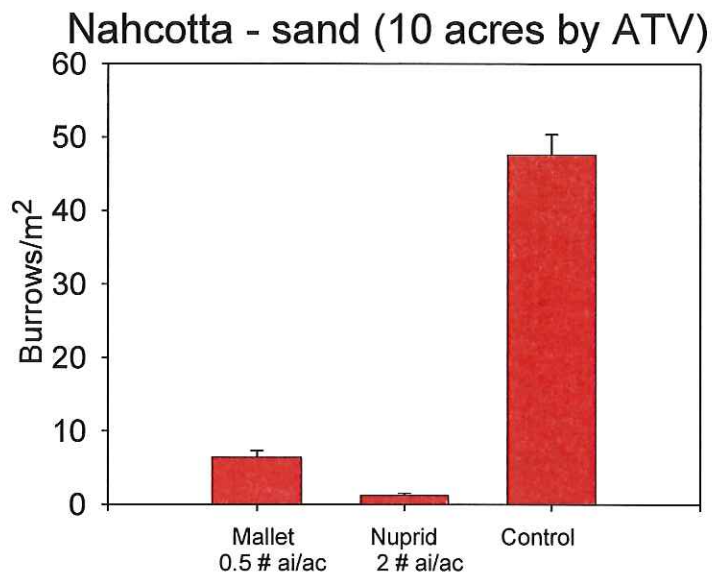


Figure 13 - 2010. Efficacy of different imidacloprid formulations on ten-acre plots on sand at Nahcotta.

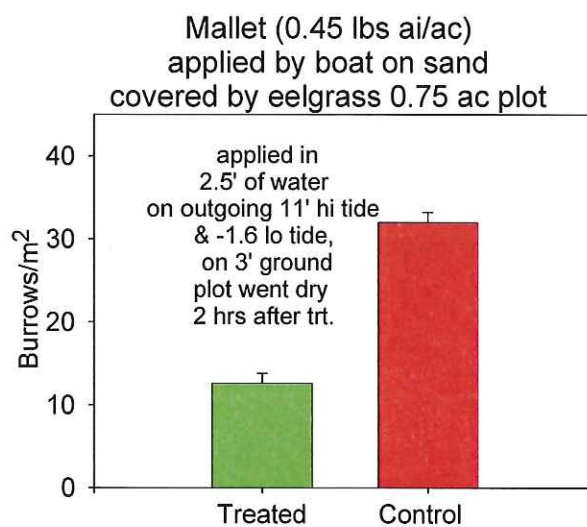


Figure 14 - 2010. Efficacy of granular imidacloprid applied from a boat during an outgoing tide.

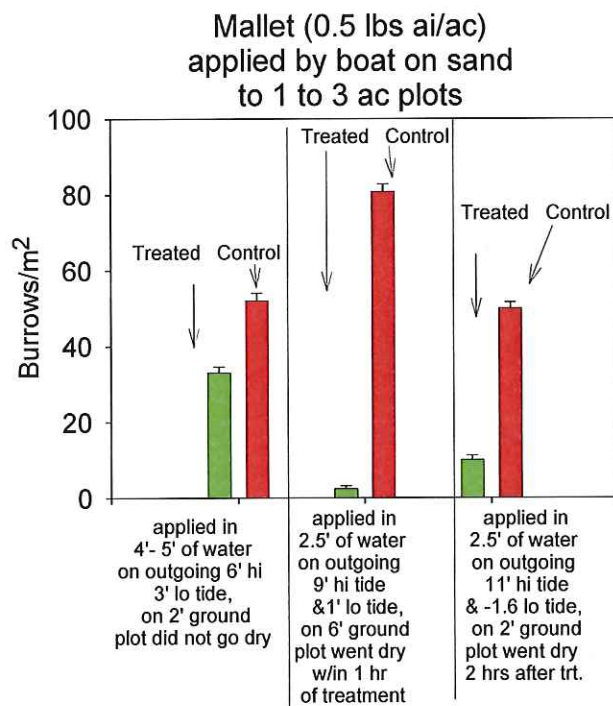


Figure 15 – 2010. Efficacy of granular imidacloprid applied from a boat during different tidal conditions.

Table 17- 2011. Efficacy of imidacloprid at 0.5 lbs ai/ac for burrowing shrimp control in 2011

Exp #	Material	Bed Type ^a	App. Method	Acres treated	Treat-ment date	Pre-treatment density ^b (#/0.25m ²)	Post-treatment density (#/0.25m ²)	% reduction (control)
1	Mallet	Sn Zj	ATV	1	5/17/11	4.9	1.4	70
2	Nuprid	Sn Zj	ATV	1	5/18/11	6.9	1.5	78
3	Mallet	Sn Zj	ATV	1.7	5/17/11	5.7	3.3	50
4	Nuprid	Sn Zj	ATV	1.7	5/18/11	7	1.6	74
5	Nuprid	Sn Zj	Hand	0.5	5/18/11	4.3	0.8	81
6	Mallet	Sn Zj	Hand	0.3	5/17/11	7.8	2.2	70
7	Mallet	Sn Zj	Boat	0.3	6/3/11	6.1	2.5	60
8	Mallet	Sn Zj	Hand	0.12	9/14/11	4.5	1.1	75
8	Nuprid	Sn Zj	Hand	0.12	9/14/11	4.5	2.6	42
9	Mallet	Si	Hand	0.12	5/20/11	8.4	1.8	78
9	Nuprid	Si	Hand	0.12	5/20/11	8.4	1.2	85
10	Mallet	Si	Boat	0.3	6/3/11	8.4	1.12	86
11	Mallet	Si	Hand	0.3	5/20/11	9.6	3.1	67
11	Nuprid	Si	Hand	0.3	5/20/11	9.6	1	90
12	Nuprid	Sn	Aerial	10.3	7/3/11	11.1	0.5	96
13	Mallet	Sn	Hand	2.2	6/2/11	5.2	0.9	82
14	Mallet	Sn	Aerial	10.2	7/15/11	5.4	0.57	89
15	Nuprid	Sn	ATV	10.2	7/15/11	5.2	1.2	77
16	Mallet	Si	Boat	1.4	6/6/11	6.4	2.5	61
17	Mallet	Si	Boat	4.2	8/30/11	6.7	3.5	48
18	Nuprid	Si Zm	Hand	5	8/30/11	4.9	1.9	61

^a Sn= sandy, Si=silty, Zj *Zostera japonica*, Zm *Zostera marina*, * Efficacy-E, Imidacloprid-I, Crab- C

^b Pretreatment counts were not always available, in which case counts from adjacent control sites were used to obtain efficacy (% control).

^c Affected crab were any crab present across the entire treated area or within 100' around the entire plot that were exhibiting signs of tetany or were dead. Data were collected 24 hours after treatment.

Table 18 - 2012. Treatment sites and efficacy of imidacloprid at 0.5 lbs ai/ac in 2012					
Size (ac)	Date	Location	Sediment	Formulation	% Control
4.8	7/2	Nahcotta	Sand w/ eelgrass	Nuprid	75
2.3	7/2	Nahcotta	Sand w/ eelgrass	Nuprid	66
5.8	7/2	Nahcotta	Sand w/ eelgrass	Nuprid	54
2.9	7/2	Nahcotta	Sand w/ eelgrass	Nuprid	53
8.9	8/2	Bay Center	Sand w/ eelgrass	Mallet	87
8.9	8/2	Bay Center	Sand w/ eelgrass	Nuprid	80
5	8/15	Leadbetter	Sand	Mallet	33
7.5	8/15	Leadbetter	Sand	Nuprid	82
1	8/17	Cedar R.	Silt	Nuprid	61

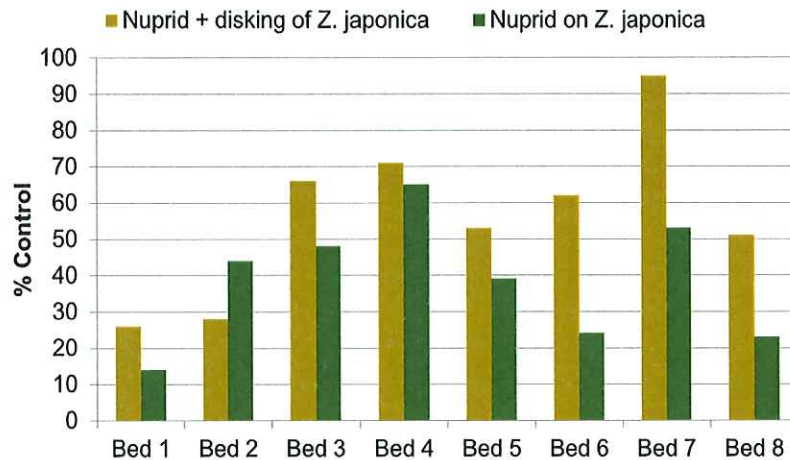


Figure 16 - 2012. Effect of post-treatment disking (1 day after treatment) on the efficacy of imidacloprid at 0.5 lbs ai/ac in 2012 applied via broadcast to sediment infested with burrowing shrimp and Japanese eelgrass.

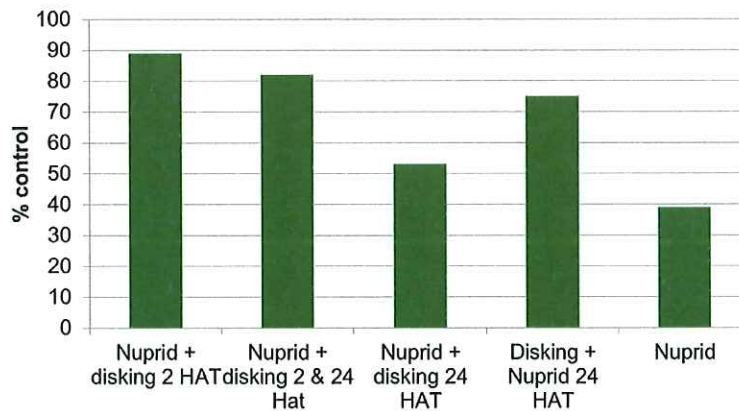


Figure 17-2012. Effect of disking time on the efficacy of imidacloprid at 0.5 lbs ai/ac in 2012 applied via broadcast to sediment infested with burrowing shrimp and Japanese eelgrass.

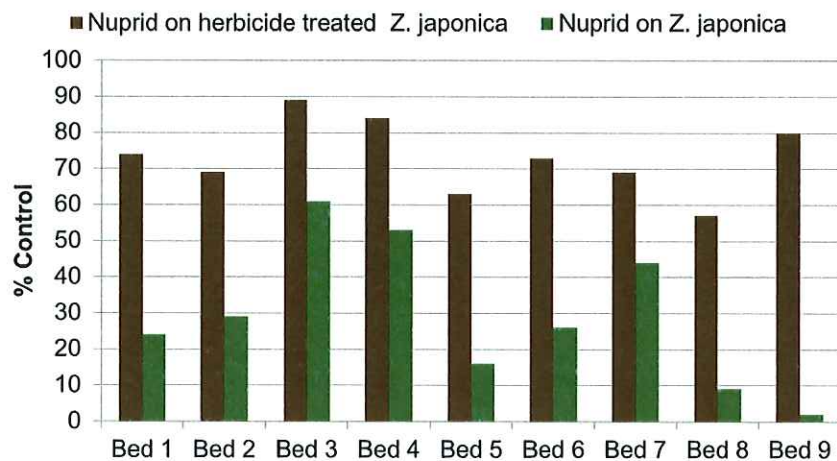


Figure 18-2012. Effect of pre-treatment control of Japanese eelgrass with imazamox on the efficacy of imidacloprid at 0.5 lbs ai/ac in 2012 applied via broadcast to beds with and without *Z. japonica* control.

Table 19- 2013. On-site treatment efficacy at SAP plots

Stake #	Palix River sites						Leadbetter sites					
	Mallet, sparse <i>Z. japonica</i>			Nuprid thick <i>Z. japonica</i>			Mallet, bare sand			Nuprid, bare sand		
	burrows/1/4 m ²		% reduction	burrows/1/4 m ²		% reduction	burrows/1/4 m ²		% reduction	burrows/1/4 m ²		% reduction
	1 DBT	14 DAT		1 DBT	14 DAT		1 DBT	14 DAT		1 DBT	14 DAT	
1	13	0	100	15	5	67	6	0	100	3	0	100
2	19	0	100	11	4	64			0	3	0	100
3	11	0	100	16	1	94	14	0	100	5	0	100
4	14	0	80	9	3	67	18	0	100	5	1	80
5	13	0	100	4		100	20	0	100	2	0	100
6	9	3	100	15	7	53	18	3	83	5	0	100
7	13	2	100	3	1	67	18	2	89	2	0	100
8	10	0	0	10	8	20	13	1	92	1	2	0
9	11	1	100	32	7	78	11	0	100	3	0	100
10	9	2	0	22	9	59	9	1	89	2	2	0
11	9	3	100	12	4	67	4	2	50	2	0	100
12	8	2	63	9	0	100	9	0	100	8	3	63
13	14	1	100	12	0	100	9	0	100	3	0	100
14	14	1	50	15	0	100	6	0	100	2	1	50
15	5		100	11	10	9	8	0	100	1	0	100
16	16	0	100	12	2	83	15	0	100	2	0	100
17	20		100	14	9	36	10	1	90	1	0	100
18	16	0	0	10	0	100	8	0	100	1	2	0
19	18	2	83	5	4	20			0	6	1	83
20	20	0	100	11	4	64	14	0	100	2	0	100
21	21	9	67	12	4	67	9	0	100	3	1	67
22	9	0	25	20	6	70	11	0	100	4	3	25
23	9	0	100	11	3	73	17	0	100	11	0	100
24	6	0	100	10	6	40	15	0	100	11	0	100
25	6	0	64	12	1	92	11		0	11	4	64
26	7	7	100	7	1	86	11		0	3	0	100
27	14	0	33	13	4	69	11	0	100	3	2	33
28	10	0	83	14	0	100	10	0	100	6	1	83
29	12	4	60	15	6	60	12	0	100	5	2	60
30	10	6	100	7	2	71	12	2	83	2	0	100
31	9	1	71	15	10	33	11	5	55	7	2	71
32	12	1	100	12	8	33	11	2	82	4	0	100
33	13	0	80	16	3	81	4	0	100	5	1	80
34	11	0	60	16	5	69	15	0	100	5	2	60
35	8	0	100	13	8	38	11	0	100	10	0	100
36	10	1	88	7	8	0	15	0	100	8	1	88
Mean			78±5			65±5			84±5			78±5

Table 20 – 2014. Effect of Nuprid at 0.5 lbs ai/ac on young recruits on bare sand in fall 2014.

Site	# burrows/0.054 m ²		% control	Treatment F value
	Control	Treated		
1	21.2 ±1.2	9.8 ±1.3	54	39
2	20.3 ±1.1	0.1 ±0.1	100	358
3	6.1 ±1	2.6 ±0.7	57	7
4	8.7 ±1.5	3.2 ±0.7	63	11
5	11.5 ±0.8	4.8 ±0.9	58	35
6	8.0 ±0.6	2.7 ±0.5	66	45
Total	12.4 ±0.8	3.9 ±0.4	76	96
Treated 10/15/13, assessed 10/31/13; F values were all significant at the 0.001% level. Assessment of just juvenile shrimp was not possible as there was a wide range of shrimp sizes (3 to 15 mm carapace). The density of small burrows was counted instead. The burrow density values reflect control of all sizes of shrimp.				

Table 21 - 2014. Summary of efficacy data from commercial sprays of imidacloprid at 0.5 lbs/ai/ac in 2014 monitored by WSU*

Site	Sediment/vegetation type	# burrow/ 0.25 m ²			% control
		Before inside	After inside	After outside	
SAP site, liquid	Bare sand		6.28	28.9	80
	Sand w/ thick Zj		21.3	29.1	27
A 40, liquid	Sand, bare		1.6	22.7	93
	Sand, medium Zm		0.9	9.11	90
	Silty sand, bare		4.2	16.5	68
	Sandy silt, bare		1.7	61.0	97
	Silty sand, w/ thick Zm		6.0	15.3	61
	Silty sand, w/ medium Zm		2.0	7.2	72
A 101, liquid	Silt, bare	43	13.0		69
	Silt, mixed bare w/ Zm	21.7	7.1		81
B 197, liquid	Sand, bare		5.3	27.8	81
	Sand, medium to thick Zm		3.2	8.1	61
B111, granular in 5' water	silty sand	13.7	8.4		39

*Data were only collected where burrowing shrimp density was high enough to provide efficacy data. Zj – *Zostera japonica*; Zm – *Zostera marina*.

Burrowing Shrimp control - 2015 small research trials

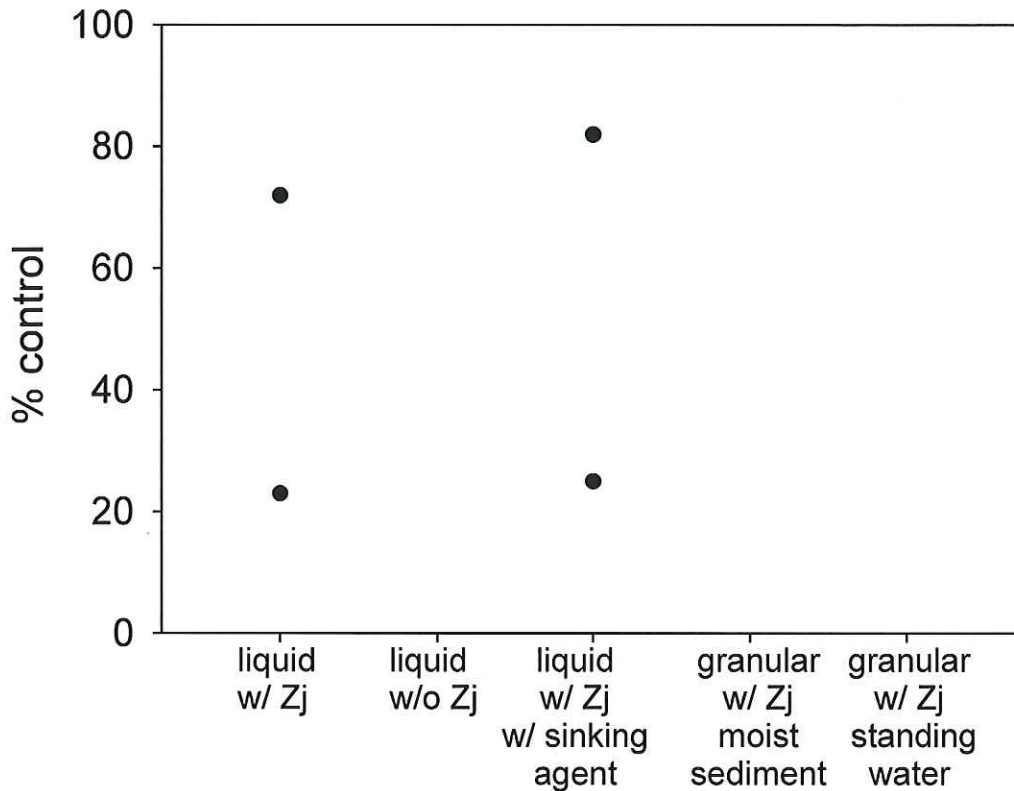


Figure 19 - 2015. Box and whisker plots of comparative control of adult ghost shrimp with imidacloprid 2F at 0.5 lbs ai/ac in early May 2015 under different treatment conditions. Experiments were conducted prior to the NPDES cancellation. The first and third quartiles are at the ends of the box, the median is indicated with a vertical line in the interior of the box, and the maximum and minimum are at the ends of the whiskers.

Table 22 – 2015. Efficacy of imidacloprid 2F hand injected at 18” depth to control burrowing shrimp in small preliminary trials in May 2015, prior to the NPDES cancellation, in areas of thick <i>Z. japonica</i> .	
Treatment	% control
Imidacloprid 2F 0.5 lbs ai/ac broadcast spray	0
Imidacloprid 2F 0.5 lbs ai/ac injected	88
Imidacloprid 2F 0.25 lbs ai/ac injected	77
Imidacloprid 2F 0.125 lbs ai/ac injected	75

Appendix 2. Draft IPM recommendations for chemical control of burrowing shrimp using imidacloprid.

Background: Burrowing shrimp are located 1-3 feet below the surface of the sediment. This makes it difficult to get enough active ingredient to the target area to achieve efficacy. Consequently, burrowing shrimp control with imidacloprid can be inconsistent. Obtaining good control will be highly dependent on the site conditions during the application time, and how those conditions help or hinder the concentration of imidacloprid reaching the subsurface shrimp. Adjustments in timing, formulation and/or application method should be used to obtain higher levels of efficacy under different conditions.

Treatment Recommendations: Table 1 provides expected efficacy under various conditions. This table should be used as an IPM guide to select how to treat a site. For example, a uniform thinly vegetated site would only have the liquid formulation applied just as the water is pulling off the site. A non-uniform site could require using the liquid formulation over most of the site, but also include granular formations in the low spots, and subsurface injection on parts that are thickly vegetated.

Table 1. Draft treatment recommendations for the use of imidacloprid for control of burrowing shrimp under different conditions.		
Conditions	Recommendations	Expected control (%)
Sand or silt, bare to thin eelgrass cover, relatively flat bed that dewater uniformly	Apply imidacloprid 2F immediately after water goes off site. A large bed should be treated progressively as each section dewater.	70 to 90
Sand or silt, bare to thick eelgrass cover, shallow swales within bed that never fully dewater and are constantly draining.	Apply imidacloprid 0.5 G by hand at low tide to areas of bed that don't dewater.	60 to 80
Sand or silt, bare to thick eelgrass cover, basin-shaped dredged beds that never dewater at low tide.	Uniformly broadcast imidacloprid 0.5 G across bed during very low tides (<6-12" of water if possible).	60 to 80
Sand or silt, moderate to thick eelgrass cover, relatively flat bed that dewater uniformly	Option 1- If the eelgrass is <i>Z. japonica</i> , remove with imazamox in early May. If possible <i>Z. japonica</i> should be controlled one year prior to burrowing shrimp control. In July to August, apply imidacloprid 2F immediately after water goes off site.	50 to 80
	Option 2 - Uniformly broadcast imidacloprid 0.5 G across bed in 10" to 18" of water as the tide is pulling off the site.	30 to 70
	Option 3 - Subsurface (18") injection by hand of imidacloprid 2F*	85 to 95

Research recommendations: The major problem in achieving good consistent efficacy appears to be the inability of the current treatment protocols to move imidacloprid into the subsurface target zone where the burrowing shrimp are. Research in methods to improve efficacy has been prevented in recent years owing to a lack of NPDES, and the requirement to focus on data collection for the Sample Analysis Plan (SAP). Several other application methods may be more successful in targeting the pest, but have not been researched on treatment sites large enough to provide reliable efficacy data. The following are several protocols that should be vetted as potential methods to improve efficacy under the more challenging conditions.

Situation: Sites where thick eelgrass vegetation prevents imidacloprid, either the 2F or 0.5 G, from reaching the subsurface target zone when applied during low tide.

Possible solutions:

- *Subsurface injection by hand:*
 - Test the lowest use-rate that efficacy can be obtained with. Our current data is limited and suggests 0.125 lbs ai/ac may suffice.
 - Other parameters to test - the ideal injection spacing, and depth and volume of injection.
- *Broadcast applications of imidacloprid 2F in water:*
 - Test hand broadcast applications of imidacloprid in a 10' to 15' wide band of shallow water (3" to 6" deep) parallel to shore just as the bed dewateres during an out-going tide. The treatment pattern would progress outward as the bed continues to dewater. This protocol would theoretically let imidacloprid penetrate below the canopy in the water column and be sucked into the sediment as the bed goes dry.
 - Other parameters to test - the width and length of the treatment band, ideal water depth during application and the treatment application volume.
- *Hand broadcast (belly grind) imidacloprid in water*
 - Test hand-broadcast applications of imidacloprid 0.5 G in 15 to 20' wide-band of water (12 to 18" deep) parallel to shore just as the bed dewateres during an out-going tide. The treatment pattern would progress outward as the bed continues to dewater. This protocol would theoretical let imidacloprid pellets penetrate through the eelgrass canopy below the bed dewatered. Smaller replicated plot work indicated that this could be successful, but it has not been assessed on a commercial scale.
 - Other parameters to test - the width and length of the treatment band, and ideal water depth during application.
- *Pre-treatment of the site with imazamox to remove invasive eelgrass.*
 - Test at the commercial scale if removal of *Z. japonica* in April with imazamox improves the efficacy of a summer-applied imidacloprid 2F. This protocol has been tested in small replication plots and found to improve efficacy, but not on larger sites.
 - Other parameters to test – the timing of the imazamox treatment relative to the imidacloprid treatment.

Situation: Basin-shaped dredged beds that don't dewater, or slowly dewater and are covered in vegetation. These sites are common in Willapa and we have almost no efficacy data for imidacloprid 2F or 0.5 G. Normally imidacloprid applied during outgoing tides drains off the site long before it can reach the subsurface sediment.

Possible solutions:

- *Subsurface injection by hand:*
 - Test the lowest use-rate that efficacy can be obtained with. Our current data is limited and suggests 0.125 lbs ai/ac may suffice.
 - Other parameters to test - the ideal injection spacing, and depth and volume of injection.

Exhibit C

A review of the past decade of research on non-chemical methods to control burrowing shrimp

Kim Patten, WSU Long Beach Research and Extension Unit

Biological control

- *Crab* – Dungeness Crab and Red Rock Crab were assessed for their potential to control adult burrowing shrimp. Adult crabs were placed in fenced enclosures in areas with high ghost shrimp burrow counts. Studies were conducted in both the winter and summer. Predation was observed over a 2 to 7 day period. There was a 5 to 25% reduction in burrow counts. Total burrow counts, however, were still extremely high ($>100/\text{m}^2$) even after 7 days of enclosure. These results indicated that predation on adult burrowing shrimp was insufficient to provide any practical control.
- *Green Sturgeon* - Sturgeon were assessed for their ability to reduce adult burrowing shrimp density. Comparisons in burrow density inside and outside of areas staked to exclude green sturgeon were compared. Differences were noted, but not enough to warrant consideration for biological control. Densities of burrowing shrimp immediately within a sturgeon feeding pit and outside the feeding pit were compared. Some reduction was noted, but there were still adult shrimp remaining within the feeding pit. Comparative surveys of the densities of sturgeon feeding pits were made between commercial shellfish beds and open tideflats. There was minimal use of shellfish beds by green sturgeon compared to adjacent non-shellfish tideflats.
- *Parasitic isopods* – A bopyrid isopod parasite, *Orthione griffenis*, introduced in the 1980s from Asia, caused the collapse of west coast mud shrimp (*Upogebia pugettensis*) populations. Another isopod parasite has been noted on ghost shrimp but has had no effect on its populations.

Mechanical and cultural control

- *Suction harvesting method*: Several suction head devices were designed and hooked up to water pumps. The premise was to create enough suction to selectively evacuate shrimp from their burrows, without removing sediment. The best design (shown in the figure below) was fashioned from 33 gallon plastic barrels cut longitudinally and attached to a sharp-edged plywood platform. We were able to apply enough suction to collapse the barrels, and could selectively pull large volumes of water out of burrows, but few shrimp were removed from their burrows. We concluded that suction is not a feasible method for shrimp control. Not only was it destructive to the benthic environment, but it failed to remove a significant number of adult shrimp.
- *Subsurface air bubble harvester*: The premise of an air bubble harvester is to put enough air below the shrimp to force them up out of their burrows into the water column, where they are then trapped in a net or other harvest device. Two devices were



constructed (see picture below). One used compressed air at 10.7 CFM @ 125 psi applied through our six-wheel spikewheel unit. The other used 185.5 CFM @ 100 psi applied through a large shank system constructed by an Oysterman, Leonard Bennett. The first system was tested using WSU's spikewheel barge; the second system was tested using a commercial shellfish barge (see photo below). Based on data from underwater cameras, there was no evidence that any shrimp were raised from the substrate. Burrow counts post-treatment were temporarily reduced 39% with the high volume air bubble method (60 vs. 98 burrows/m²), but this level is still well above what is required for a successful control.



- Surface cover: Thin quick drying cement layers were set over infested areas. Although these layers set quickly, they were not effective in reducing shrimp (see photo). Plastic traps were placed over areas infested with burrowing shrimp for 1, 3 and 10 days. Although the areas under the traps went anoxic, the shrimp populations were not significantly reduced. A previous effort to use a thick cover of oyster shells was also concluded to be ineffective.



- Heat: Surface areas of sediment were heated with a propane torch for 2 minutes/m². The sediment temperatures at 10 cm and 20 cm depths



did not change sufficiently to affect burrowing shrimp. There was no effect on adult shrimp below the heated area.

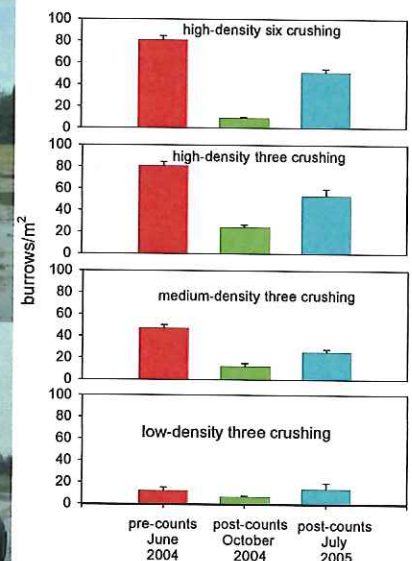
- Electrofishing: Similar equipment to that used for electrofishing was assessed for burrowing shrimp control. Experiments were done in the lab by USDA. Burrowing shrimp retreated deeper into their burrows following the introduction of electric current. The treatment was not effective in removing shrimp from their burrows or killing them.

- High pressure low-volume water injection. A shanking system was designed to inject water at 1500 PSI and be dragged through the sediment (see photo). Penetration of the water jet into the sediment was not deep enough to reach shrimp. The system did not reduce shrimp densities.



- Low pressure – high volume water injection. Taylor Shellfish designed a tow sled that injected water at ~ 10,000 gpm into the sediment. This large injection sled was very difficult to tow in a straight line and the barge was not able to maintain the plotted course of direction. An assessment of post-treatment efficacy indicated good shrimp control in the affected areas, but the entire sediment profile, vegetation and invertebrate population were also destroyed. Overall this method was not practical to implement and extremely destructive to the habitat.

- Crushing: Several amphibious platforms were assessed for compaction of sediment and killing shrimp. A four-wheeled Rolligon and a tracked unit (see photos) were repeatedly driven over affected ground and population changes of shrimp were monitored over time. Crushing reduced the number of burrows/m² in the year of treatment, but one year after treatment burrow density rebounded well above the 10 burrows/m² considered to be the economic threshold (See adjacent graph).



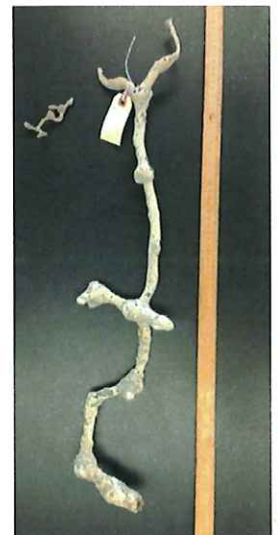
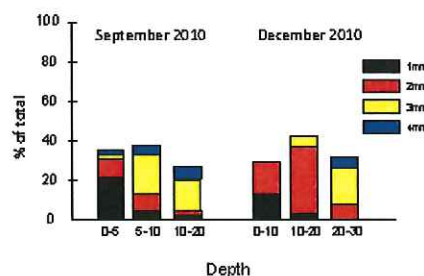
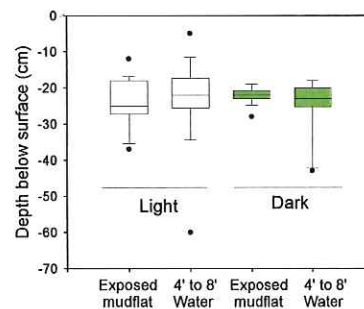
- **Disking and shanking:** Shallow disks and deep shanks were pulled through infected ground with either a Rolligon or ATV to control shrimp (see pictures). Neither method was effective in reducing shrimp populations. Neither method could penetrate deep enough to affect shrimp, and both methods were destructive to eelgrass, surface sediment and oysters that were present. New efforts are focused on shallow in-water harrowing as a method to reduce the populations of new recruits as they settle. Results are pending.



- **Cultural methods:** There has not been any recent controlled scientific research on cultural methods. However, long-lines, floating racks and flip bag cultural methods are commonly used by growers to prevent oysters sinking in affected ground. These methods are feasible in areas of production that are protected from violent storm action, and where shrimp populations are not too high to prevent effective anchoring. These conditions are not very common, so these methods are really only feasible for growers with large acres to select from. Shellfish production in Willapa is 95% ground culture and 5% off-bottom. The majority of growers don't have viable options for switching their farms to off-bottom culture.

- **Behavioral weak links.** Assessments were made to find weak links in the biology of the pest that could help focus the mechanical control effort. Burrowing shrimp were pit-tagged, as well as filmed under the surface in their burrows to determine if there was a time when they came closer to the surface. Shrimp maintained a fairly constant depth within their burrows, 25-30 cm, regardless of the conditions. Adult burrow depth, 60 to 100 cm, is deep enough to preclude most types of mechanical control (see figure on excised burrow). The depths of new recruits were sampled as a function of time and size. New recruits were often found at depths too deep to

MEDIUM DEPTH OF GHOST SHRIMP
BASED ON UNDERWATER VIDEO IMAGES



facilitate easy physical control.

- Trapping: Scents were tested for their attractiveness to burrowing shrimp. Several were found to be effective. Scent lures were then used in crawfish traps on the sediment surface to trap adult burrowing shrimp. Although a few large male shrimp were trapped, the traps had no impact on density of shrimp in the immediate area.
- Water injection. The traditional method to harvest shrimp is by pumping water into the sediment along a bank of drainage channel. Shrimp will float out. This method is destructive to the sediment, and is only effective on channel banks and not flat shellfish ground. A method was devised to extract shrimp from small areas on flat ground by pumping water into an 8" diameter aluminum pipe sunk 1 meter deep into the sediment (see figures). It was effective for sampling but not practical for treating large areas.
- Sound Waves. Sound waves of different frequencies were assessed to determine if shrimp were sensitive to a particular Hz. No frequencies within the normal range were found to be effective. Infrasound and ultrasound could have some potential, but have yet to be fully assessed.



Summary:

Research over the past decade has examined options for nonchemical control. The table in the appendix lists most of those projects and PI's. No suitable biological control method has yet been found to suppress the population of ghost shrimp. None of the mechanical methods assessed provided viable options for management of burrowing shrimp populations. They all failed to permanently reduce shrimp populations below the economic threshold (10 burrows/m²). Most of the methods tested were also very destructive to the habitat, as well as to any shellfish that would be present at the time of treatment. At present the only commercial production of oysters in shrimp infested ground in Willapa Bay and Grays Harbor is in the small areas of the bays that are protected from exposure to major winter storms and have low enough shrimp densities to provide for secure anchoring for off-bottom culture. None of these production methods, however, are viable for large-scale production across the major growing regions in these estuaries.

Major research projects between 2005 and 2016 to develop alternative controls for burrowing shrimp management*		
Project/ year(s)	PIs	Summary of findings, and significance to IPM
Monitoring and general IPM		
Mapping the distribution of burrowing shrimp and their interaction with oyster aquaculture in Willapa Bay: 2006 to 2010	Dumbauld, USDA; Wecker, UW	Shrimp populations of Willapa Bay were mapped. This is useful to trend future patterns of recruit and population shifts.
Monitoring larval stages of burrowing shrimp and associated water quality variables in Willapa Bay: 2007 to 2009	Bollens, WSU Vancouver	Diurnal and tidal patterns of larvae movement in the water column were found. Could potentially help monitoring for new recruitment in the future.
Using molecular genetics to identify source populations of ghost shrimp in Willapa Bay and Grays Harbor Estuaries: 2005 to 2007	Parr, San Jose State	Not successful in identifying recruit source populations.
Rearing of juvenile burrowing shrimp from eggs: 2006	Dumbauld, USDA-ARS and UW	Not successful enough to provide samples for research.
Biological control		
Macrofauna predators (crab) as biocontrol for burrowing shrimp: 2006 to 2007	Patten, WSU	Few adult burrowing shrimp were consumed by crab under natural conditions in the wild.
Macrofauna (green sturgeon) as biocontrol for burrowing shrimp: 2006 to 2007	Trimble, UW; Patten, WSU	Green sturgeon feed on significant amounts of adult burrowing shrimp. The use of this listed species is problematic for a biocontrol agent.
Lug worm as biocontrol of burrowing shrimp: 2006	Booth, PSI	No effects on burrowing shrimp populations were found.
Identification of predators as potential biological control agents of burrowing shrimp in Willapa Bay: 2007 to 2009	Bollens, WSU Vancouver	Numerous species were found which consumed burrowing shrimp larvae. No one predator dominated enough to be a significant management tool.
Augmenting the bopyrid isopod parasite <i>Ione cornuta</i> for the biological control of its ghost shrimp host <i>Neotrypaea californiensis</i> : 2006 to 2010	Chapman, OSU	This isopod had only a minor effect on ghost shrimp. It would not be useful to manage populations.
Mechanical control		
Examination of operational parameters for electrofishing equipment to be used to control burrowing shrimp in oyster culture, a feasibility study: 2008	Dumbauld USDA-ARS	Not effective; shrimp moved deeper into their holes rather than out of their holes.
Burrowing shrimp control using sound waves: 2006, 2015	Patten, WSU; Dumbauld, USDA-ARS	Irritation noted at some high frequencies in the lab. Use in field could be problematic. Potential management tool, but use of sound wave technology has serious implications for endangered species (whales, seals etc.)

Water sled as alternative control for burrowing shrimp management : 2006 to 2008	Johnson, Taylor Resources	Partial control provided by water jet sled, but impacts to the sediment were too significant to be a valid control method.
High pressure water jets for burrowing shrimp control: 2006	Patten, WSU	Water jet penetration not deep enough for efficacy.
Harvest & harrowing systems for control of newly recruited burrowing shrimp: 2006, 2015, 2016	Patten, WSU	In-water sediment disturbance to dislodge newly recruited shrimp followed by netting. Results to date have not been effective. New efforts are continuing. Method would not be useful for management of adult shrimp.
Mechanical compaction for control of burrowing shrimp: 2004 to 2007	Patten, WSU	Compaction of shrimp-affected tideflats suppressed population for short term, but populations were back to pre-existing densities in the year after treatment.
Sediment mechanical modification for control of burrowing shrimp: 2005 to 2008, 2015 to 2016	Liou, U of Idaho; Patten, WSU	Sediments in the bay are not suitable for achieving enough compaction to kill shrimp. Applying a thin layer of cement did not control shrimp.
Chemical control		
Screening of alternative chemicals for burrowing shrimp control: 2004 to 2008	Patten, WSU	Organic insecticides, GRAS compounds, salts, and dozens of other chemicals were assessed for their potential efficacy. None were effective enough to warrant registration. Only imidacloprid showed promise.
Evaluation of subsurface chemical delivery systems for management of burrowing shrimp populations: 2006 to 2010	Patten & Durfey, WSU	Partial success using shanking and spikewheel technology to improve efficacy of more benign chemistries, but this methodology was too problematic to be practical.

*This list represents only some of the major work done during this time period.

Exhibit D

Appendix A

Bird Checklists of the United States: Willapa National Wildlife Refuge (USFWS 1991)

The U.S. Geological Survey (USGS), Northern Prairie Wildlife Research Center¹ maintains Bird Checklists of the United States that are grouped by geographic area. The checklist area for Willapa National Wildlife Refuge and the Columbia River Estuary includes: Willapa Bay and adjacent habitats west of Highway 101 and south of Highway 105, plus the Long Beach Peninsula; the Columbia River from Puget Island to the Pacific Ocean; and the Julia Butler Hansen Refuge for the Columbia whitetailed deer. The list of bird species reproduced below has been extracted from that source for only those sightings in Willapa Bay, the Long Beach Peninsula and the Columbia River, west on the Astoria-Megler Bridge.

Seasons

Spring	March through May
Summer	June through August
Fall	September through November
Winter	December through February

Relative Abundance

a – abundant	Species that are very numerous
c – common	Species that are nearly certain to be seen
u – uncommon	Species that are present but not certain to be seen
o – occasional	Species that are seen several time/year or locally
r – rare	Species seen at intervals of 2 to 5 years
*	Known to nest within the checklist area

Common Names

Seasonal Observations

	Spring	Summer	Fall	Winter
LOONS				
Red-throated loon	c	-	c	c
Pacific loon	c	r	c	u
Common loon	c	r	c	u
GREBES				
Pied-billed grebe*	u	u	u	u
Horned grebe	c	r	c	c
Red-necked grebe	r	-	o	o
Western grebe	a	u	a	a

¹ The Northern Prairie Wildlife Research Center (NPWRC) is one of 18 science and technology centers within the USGS Biological Resources Discipline (BRD). The NPWRC is administratively positioned in the Central Region of the United States, and geographically located in the northern Great Plains. The main campus is in Jamestown, North Dakota. The mission of NPWRC is to provide the scientific information needed to conserve and manage the national's biological resources, with an emphasis on the species and ecosystems of the nation's interior.

Common Names**Seasonal Observations**

	Spring	Summer	Fall	Winter
FULMARS, PETRELS AND SHEARWATERS				
Northern fulmar	-	r	r	u
Pink-footed shearwater	-	-	r	-
Sooty shearwater	u	c	a	-
Short-tailed shearwater	-	-	-	o
Fork-tailed storm petrel	-	-	r	-
Leach's storm petrel*	-	-	r	-
PELICANS AND CORMORANTS				
Brown pelican	o	c	c	-
Double-crested cormorant*	c	c	c	c
Brandt's cormorant*	c	c	c	c
BITTERNS, HERONS AND EGRETS				
American bittern*	o	u	u	o
Great blue heron*	c	c	c	c
Great egret	o	-	o	-
Cattle egret	-	-	r	-
Green heron	r	r	r	-
WATERFOWL				
Tundra swan	-	-	u	u
Trumpeter swan	-	-	u	u
Greater white-fronted goose	o	-	o	o
Snow goose	o	-	o	o
Ross' goose	r	-	-	-
Emperor goose	r	-	o	r
Brant	a	o	c	c
Canada goose*	a	c	a	a
Wood duck*	u	u	u	-
Green-winged teal	c	r	c	c
Mallard*	c	c	c	c
Northern pintail	u	r	a	c
Blue-winged teal	u	r	u	-
Cinnamon teal*	u	u	u	-
Northern shoveler	u	r	u	o
Gadwall	u	r	u	u
Eurasian wigeon	-	-	o	o
American wigeon	c	r	a	c
Canvasback	u	-	u	u
Ring-necked duck	u	-	u	u
Tufted duck	-	-	-	r
Greater scaup	u	-	u	u
Lesser scaup	c	-	c	c
Harlequin duck	r	-	r	r
Oldsquaw	o	-	r	o
Black scoter	u	-	u	u

Common Names**Seasonal Observations**

	Spring	Summer	Fall	Winter
Surf scoter	c	o	c	c
White-winged scoter	c	o	c	c
Common goldeneye	u	-	u	c
Barrow's goldeneye	r	-	-	r
Bufflehead	c	-	c	c
Hooded merganser*	u	o	u	u
Common merganser*	c	u	u	u
Red-breasted merganser	c	r	c	c
Ruddy duck	o	-	u	u
VULTURES				
Turkey vulture	u	u	u	r
OSPREY, KITES, EAGLES AND HAWKS				
Osprey*	u	u	u	r
White-tailed kite	o	u	o	o
Bald eagle*	u	u	u	u
Northern harrier*	c	c	c	c
Sharp-shinned hawk	u	r	u	u
Cooper's hawk	u	r	u	u
Northern goshawk	r	-	r	r
Red-tailed hawk*	c	c	c	c
Rough-legged hawk	u	-	u	u
FALCONS				
American kestrel	u	r	u	u
Merlin	u	-	u	u
Peregrine falcon	u	-	u	u
Gyr falcon	-	-	r	r
GALLINACEOUS BIRDS				
Ring-necked pheasant*	u	u	u	u
Blue grouse*	u	u	u	r
Ruffed grouse*	u	u	u	u
Wild turkey	r	r	r	r
Northern bobwhite*	u	u	o	o
RAILS				
Virginia rail*	u	u	u	r
Sora	r	-	r	-
American coot	u	-	u	c
PLOVERS				
Black-bellied plover	c	u	a	c
American golden plover	r	r	u	r
Snowy Plover*	u	u	u	r
Semipalmated plover	c	c	c	r

Common Names**Seasonal Observations**

	Spring	Summer	Fall	Winter
Killdeer*	u	u	c	u
OYSTERCATCHERS				
American oystercatcher*	u	u	u	-
SHOREBIRDS				
Greater yellowlegs	c	u	c	c
Lesser yellowlegs	-	-	r	-
Willet	r	-	o	o
Wandering tattler	u	o	u	-
Spotted sandpiper	u	o	u	-
Whimbrel	c	o	c	-
Long-billed curlew	u	-	u	o
Bar-tailed godwit	-	-	o	-
Marbled godwit	u	o	u	r
Ruddy turnstone	c	o	c	r
Black turnstone	u	u	u	u
Surfbird	c	r	c	r
Red knot	c	-	u	-
Sanderling	a	c	a	c
Semipalmated sandpiper	o	r	-	-
Western sandpiper	a	a	a	c
Least sandpiper	c	c	a	u
Pectoral sandpiper	-	-	c	-
Sharp-tailed sandpiper	r	-	u	-
Dunlin	a	u	a	a
Stilt sandpiper	-	-	r	-
Ruff	-	-	r	-
Short-billed dowitcher	a	a	c	-
Long-billed dowitcher	u	r	c	u
SNIPE				
Common snipe	c	r	c	u
PHALAROPES				
Wilson's phalarope	-	-	r	-
Red-necked phalarope	u	o	u	-
Red phalarope	r	r	o	-
JAEGER				
Parasitic jaeger	r	r	u	-
GULLS AND TERNS				
Bonaparte's gull	c	u	c	r
Heermann's gull	o	c	c	-
Mew gull	c	r	c	c
Ring-billed gull	c	u	c	u

Common Names	Seasonal Observations			
	Spring	Summer	Fall	Winter
California gull	c	u	a	u
Herring gull	-	-	-	r
Thayer's gull	-	-	-	r
Western gull*	c	c	c	c
Glaucous-winged gull*	c	c	c	c
Black-legged kittiwake	u	r	u	u
Sabine's gull	r	r	r	-
Caspian tern*	c	c	c	-
Common tern	u	r	u	-
Arctic tern	r	-	r	-
SEABIRDS				
Common murre	u	c	c	u
Pigeon guillemot*	c	c	u	r
Marbled murrelet*	u	u	u	u
Ancient murrelet	-	-	r	r
Cassin's auklet	-	-	r	r
Rhinoceros auklet	o	u	o	o
Tufted puffin	o	u	o	o
Horned puffin	-	-	-	o
DOVES				
Rock dove*	u	u	u	u
Band-tailed pigeon*	c	c	c	-
Mourning dove	r	r	r	-
OWLS				
Barn owl*	u	u	u	u
Western scree owl*	u	u	u	u
Great horned owl*	u	u	u	u
Snowy owl	-	-	-	r
Northern pygmy owl*	u	u	u	u
Burrowing owl	r	-	r	r
Barred owl*	u	u	u	u
Long-eared owl	r	-	r	r
Short-eared owl	u	o	u	u
Northern saw-whet owl*	u	u	u	u
GOATSUCKERS				
Common nighthawk*	r	u	u	-
SWIFTS				
Vaux's swift*	c	c	c	-
HUMMINGBIRDS				
Anna's hummingbird	-	-	-	r
Rufous hummingbird*	a	a	o	r

Common Names	Seasonal Observations			
	Spring	Summer	Fall	Winter
KINGFISHERS				
Belted kingfisher*	u	u	u	o
WOODPECKERS				
Red-breasted sapsucker	u	-	u	u
Downy woodpecker*	u	u	u	u
Hairy woodpecker*	u	u	u	u
Northern flicker*	c	c	c	c
Pileated woodpecker*	u	u	u	u
FLYCATCHERS				
Olive-sided flycatcher*	c	c	o	-
Western wood-pewee*	u	u	o	-
Willow flycatcher*	u	u	o	-
Pacific-slope flycatcher*	c	c	u	-
LARKS				
Horned lark*	u	u	u	o
SWALLOWS				
Tree swallow*	c	c	u	o
Violet-green swallow*	c	c	u	o
Northern rough-winged swallow*	u	u	o	-
Cliff swallow*	c	c	o	-
Barn swallow*	c	a	o	-
JAYS, MAGPIES AND CROWS				
Gray jay	o	o	o	o
Stellar's jay*	u	u	c	u
American crow*	c	c	c	c
Common raven*	u	u	u	u
CHICKADEES AND TITMICE				
Black-capped chickadee*	c	c	c	c
Chestnut-backed chickadee*	c	c	c	c
BUSHTITS				
Bushtit*	o	r	o	o
NUTHATCHES				
Red-breasted nuthatch	u	r	u	u
CREEPERS				
Brown creeper*	u	u	u	u

Common Names**Seasonal Observations**

	Spring	Summer	Fall	Winter
WRENS				
Bewick's wren*	u	u	u	u
Winter wren*	c	c	c	c
Marsh wren*	c	c	c	c
KINGLETS, BLUEBIRDS AND THRUSHES				
Golden-crowned kinglet*	c	c	c	c
Ruby-crowned kinglet*	c	r	c	u
Western bluebird	r	-	r	-
Mountain bluebird	r	-	r	-
Townsend's solitaire	o	r	r	-
Swainson's thrush*	c	c	u	-
Hermit thrush	u	-	u	u
American robin*	c	c	c	c
Varied thrush*	c	u	c	c
WAGTAILS AND PIPITS				
American pipit	-	-	o	-
WAXWINGS				
Cedar waxwing*	u	c	u	r
SHRIKES				
Northern shrike	o	-	u	u
STARLINGS AND MYNAS				
European starling*	c	c	c	c
VIREOS				
Solitary vireo*	r	-	r	-
Hutton's vireo*	u	u	u	u
Warbling vireo*	u	u	o	-
Orange-crowned warbler*	c	c	u	-
Yellow warbler*	u	u	r	-
Yellow-rumped warbler*	c	u	u	c
Black-throated gray warbler	c	c	u	-
Townsend warbler	c	-	u	u
Hermit warbler	r	r	-	-
Palm warbler	-	-	r	r
MacGillivray's warbler	r	r	-	-
Common yellowthroat*	c	c	u	-
Wilson's warbler	c	c	u	-
TANAGERS				
Western tanager*	u	u	o	-

Common Names	Seasonal Observations			
	Spring	Summer	Fall	Winter
GROSBEAKS AND BUNTINGS				
Black-headed grosbeak*	u	u	r	-
TOWHEES AND SPARROWS				
Rufous-sided towhee*	u	u	c	c
Chipping sparrow	r	-	r	-
Savannah sparrow*	c	c	u	-
Fox sparrow	u	-	u	u
Song sparrow*	c	c	c	c
Lincoln's sparrow	r	-	r	-
White-throated sparrow	o	o	-	-
Golden-crowned sparrow	c	-	c	c
White-crowned sparrow*	c	c	c	u
Dark-eyed junco*	c	c	c	c
Lapland longspur	r	-	c	r
Snow bunting	-	-	o	o
BLACKBIRDS, MEADOWLARKS, ORIOLES				
Red-winged blackbird*	c	c	c	c
Western meadowlark*	u	u	u	u
Yellow-headed blackbird	r	-	-	-
Brewer's blackbird*	c	c	u	u
Brown-headed cowbird*	c	c	u	r
FINCHES				
Purple finch*	c	c	u	u
House finch*	c	c	c	c
Red crossbill*	u	c	u	u
Common redpoll	-	-	-	r
Pine siskin*	c	o	c	c
American goldfinch*	u	c	c	r
WEAVER FINCHES				
House sparrow*	c	c	c	c

Appendix A, continued

Birds of Willapa Bay and Grays Harbor (WDF and WDOE, June 1985).

Explanation of Symbols

Breeding: * - (after species name) Known to breed regularly within Willapa Bay or Grays Harbor.

References: - Wahl, R. and R. Paulson. 1981. A Guide to Bird Finding in Washington. Whatcom Museum Press, Bellingham, WA.
 - Willapa Bay National Wildlife Refuge Checklist and Widrig, R. 1980. The Birds and Plants of Long Beach Peninsula.

Habitats: SW - open salt water
 SS - sandy shore
 FW - fresh water (including marsh and shore)

Abundance: (in columns under Habitats and Seasons)

A - abundant
 C - common; often seen or heard in appropriate habitats
 U - uncommon; usually present but not seen or heard on every visit to appropriate habitats
 R - rare; present in appropriate habitats only in small numbers and seldom seen or heard

Seasons: S - Spring F - Fall
 S - Summer W - Winter

	Habitats			Seasons			
	SW	SS	FW	S	S	F	W
CATHARTIDAE							
Common Loon	C				C	C	C
Arctic Loon	C				C	C	C
Red-throated Loon	C				C	C	C
PODICIPEDIDAE							
Red-necked Grebe	C				C	C	C
Horned Grebe	C				C	C	C
Western Grebe	C				C	C	C
Pied-billed Grebe	C				C	C	C
PROCELLARIIDAE							
Sooty shearwater	C				C	C	C
PELICANIDAE							
Brown Pelican	C				C	C	C
PHALACROCORACIDAE							
Double-crested Cormorant	C				C	C	C
Brandt's Cormorant	C				C	C	C
Pelagic Cormorant	C				C	C	C
ARDEIDAE							
Great Blue Heron	C				C	C	C
Great Common Egret	C				C	C	C
American Bittern	C				C	C	C

	Habitats			Seasons			
	SW	SS	FW	S	S	F	W
ANATIDAE							
Whistling Swan	C				C	C	C
Trumpeter Swan	C				C	C	C
Canada Goose	C				C	C	C
White-fronted Goose	C				C	C	C
Brant	C				C	C	C
Snow Goose	C				C	C	C
Mallard	C				C	C	C
Gadwall	C				C	C	C
Pintail	C				C	C	C
Green-winged Teal	C				C	C	C
Cinnamon Teal	C				C	C	C
European Widgeon	C				C	C	C
American Widgeon	C				C	C	C
Shoveler	C				C	C	C
Redhead	C				C	C	C
Ring-necked Duck	C				C	C	C
Canvasback	C				C	C	C
Greater Scaup	C				C	C	C
Lesser Scaup	C				C	C	C
Common Goldeneye	C				C	C	C
Barrow's Goldeneye	C				C	C	C
Bufflehead	C				C	C	C
Oldsquaw	C				C	C	C
White-winged Scoter	C				C	C	C
Surf Scoter	C				C	C	C
Common Scoter	C				C	C	C
Ruddy Duck	C				C	C	C
Hooded Merganser	C				C	C	C
Common Merganser	C				C	C	C
Red-breasted Merganser	C				C	C	C
ACCIPITRIDAE							
Sharp-shinned Hawk	C				C	C	C
Cooper's Hawk	C				C	C	C
Red-tailed Hawk	C				C	C	C
Bald Eagle	C				C	C	C
Marsh Hawk	C				C	C	C
FALCONIDAE							
Osprey	C				C	C	C
FALCONIDAE							
Peregrine Falcon	C				C	C	C
Merlin Pigeon Hawk	C				C	C	C
American Kestrel	C				C	C	C
GRUVIDAE							
Sandhill Crane	C				C	C	C

	Habitats		Seasons				
	SW	SS	FW	S	S	F	W
FALINAE							
Virginia Rail				U	U	U	U
American Coot				U	R	U	U
HAEMATOPODINAE							
Black Oystercatcher	C	C					
CHARADRIINAE							
Semipalmated Plover				C	C	C	C
Sooty Plover				U	U	U	U
Killdeer				U	U	U	U
American Golden Plover				U	U	U	U
Black-bellied Plover				U	U	U	U
Surf-bird				U	U	U	U
Ruddy Turnstone				U	U	U	U
Black Turnstone				U	U	U	U
SCOLOPACINAE							
Common Snipe				C	C	C	C
Long-billed Curlew				U	U	U	U
Whimbrel				C	C	C	C
Spotted Sandpiper				U	U	U	U
Wandering Tattler				U	U	U	U
Willet				U	U	U	U
Greater Yellowlegs				U	U	U	U
Lesser Yellowlegs				U	U	U	U
Red Knot				U	U	U	U
Sharp-tailed Sandpiper				U	U	U	U
Pectoral Sandpiper				U	U	U	U
Baird's Sandpiper				U	U	U	U
Dunlin				U	U	U	U
Short-billed Dowitcher				U	U	U	U
Long-billed Dowitcher				U	U	U	U
Western Sandpiper				U	U	U	U
Buff-breasted Sandpiper				U	U	U	U
Marbled Godwit				U	U	U	U
Sanderling				U	U	U	U
Least Sandpiper				U	U	U	U
PHALAROPODINAE							
Red Phalarope				U	U	U	U
Wilson's Phalarope				U	U	U	U
Northern Phalarope				U	U	U	U
STERCORARIINAE							
Parasitic Jaeger				U	U	U	U

	Habitats		Seasons				
	SW	SS	FW	S	S	F	W
LARINAE							
Glaucous Gull	R	R	R	U	U	U	U
Glaucous-winged Gull	C	C	C	U	U	U	U
Western Gull	C	C	C	U	U	U	U
Herring Gull	C	C	C	U	U	U	U
Thayer's Gull	C	C	C	U	U	U	U
California Gull	C	C	C	U	U	U	U
Ring-billed Gull	C	C	C	U	U	U	U
New Gull	C	C	C	U	U	U	U
Bonaparte's Gull	C	C	C	U	U	U	U
Heermann's Gull	C	C	C	U	U	U	U
Black-legged Kittiwake	C	C	C	U	U	U	U
Common Tern	C	C	C	U	U	U	U
Arctic Tern	C	C	C	U	U	U	U
Caspian Tern	C	C	C	U	U	U	U
ALCIDAE							
Common Murre	C	C	C	U	U	U	U
Pigeon Guillemot	C	C	C	U	U	U	U
Marbled Murrelet	C	C	C	U	U	U	U
Rhinoceros Auklet	C	C	C	U	U	U	U
STRIGIDAE							
Great Horned Owl	C	C	C	U	U	U	U
Short-eared Owl	C	C	C	U	U	U	U
ALCEDININAE							
Belted Kingfisher	C	C	C	U	U	U	U
CORVIDAE							
Common Raven	C	C	C	U	U	U	U
Crow - Common and Northwestern	C	C	C	U	U	U	U

Exhibit E: Potential Effects of Imidacloprid Treatments on Birds

The SEPA (State Environmental Policy Act) EIS (Environmental Impact Statement) discussed the birds of Willapa Bay and Grays Harbor in some detail, and specifically examined potential impacts of imidacloprid spraying. The potential for negative impacts was deemed low for a variety of reasons:

- The very low toxicity of imidacloprid to birds. The EIS reviewed studies showing that concentrations of imidacloprid below 150 milligrams per kilogram (mg/kg) are generally non-toxic to birds (Gervais et al. 2010), and that no direct or indirect effect of imidacloprid application had been found on bird species in Willapa Bay or Grays Harbor (McGaughey et al. 2013).
- Seasonal timing that would limit potential exposure. Many birds are present in Willapa Bay and Grays Harbor during a specific time of the year. Birds present as overwintering species, or that pass through in spring migrations (April-May) are likely to have a lower potential for exposure to imidacloprid than species that are year-round residents, or that tend to use these estuaries in the summer. The EIS notes that the majority of birds that use these estuaries are migrating through. Anecdotally, WGHOGA growers have observed that seagulls and American crows are often the only species of birds present on beds that have recently been treated with imidacloprid, perhaps due, in part, to their tolerance of the human presence and disturbance immediately before and after treatment (WGHOGA pers. comm.).
- Habitat use patterns that would limit potential exposure. Many birds use only deeper water habitats (e.g., marbled murrelets), barrier beaches (e.g., snowy plovers), salt marshes, or upland vegetation where the potential for imidacloprid exposure is minimal. Many other shorebirds and waterfowl concentrate their use in the shallowest portions of Willapa Bay and Grays Harbor for the simple reason that these areas have a longer exposure during low tides than do deeper areas. Many of these species use areas where imidacloprid may be sprayed, but a majority of their feeding and habitat use would be outside such areas, limiting exposure.
- Rapid dilution and breakdown of imidacloprid after application. A number of studies are cited to show imidacloprid dilution to non-toxic levels on the first tide following application, and an exponential decline in sediments over 14-28 days. The transitory nature of imidacloprid in the estuaries reduces potential exposure to birds.

The EIS also evaluated potential benefits of imidacloprid applications. The EIS reviewed a number of studies that documented that high densities of burrowing shrimp were associated with lower or much lower numbers of other invertebrate species than areas with low shrimp densities (Chapter 3.1, section titled *Interaction of Burrowing Shrimp with Other Mudflat Organisms*). To the extent shrimp reduce the ability of other invertebrate species to colonize and grow, it reduces prey for bird species that consume these animals.

One example is the amphipod *Corophium*, a relatively large and abundant (up to 40,000/m²) species that is available as an infaunal organism near the surface of the sediment during low tide. Birds as small as sandpipers, with bill lengths of 75-100 mm, are able to find and consume this prey. Qualitative studies have confirmed that areas with high *Corophium* abundance are attractive to shorebirds in Willapa Bay, and conversely, that areas with low abundance often have few shorebirds (Dr. Richard Wilson, pers. comm.)

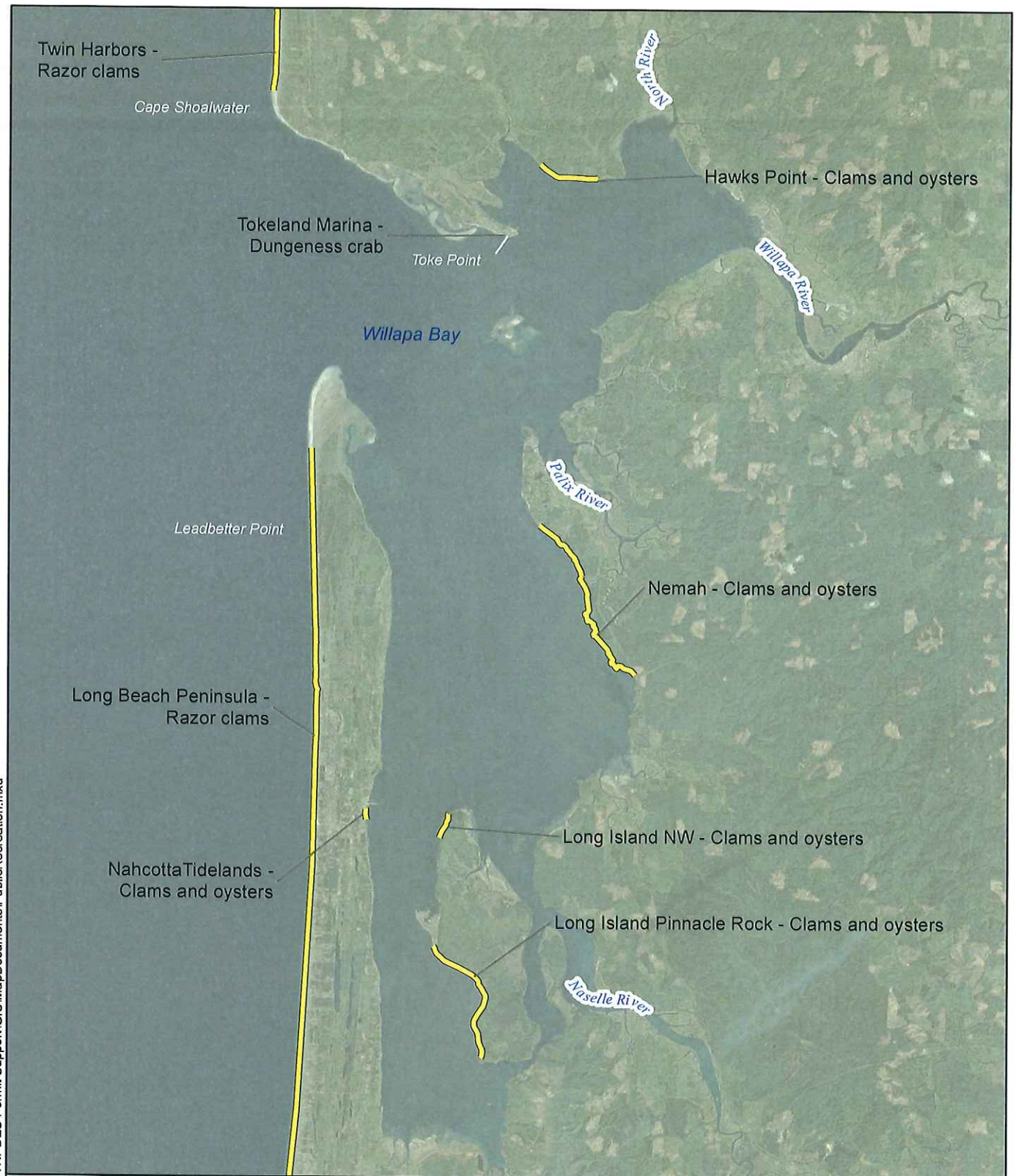
The EIS also examined the effects of high shrimp densities on vegetation. It cited literature showing high shrimp densities have been found to reduce or eliminate the presence of eelgrass (see EIS Chapter 3.1, section titled *Interactions of Burrowing Shrimp and Eelgrass*). Waterfowl that feed on eelgrass (e.g., black brant) are therefore also likely to experience negative impacts in areas where burrowing shrimp densities are high.

Dr. Richard Wilson, of Bay Center Mariculture, has studied sediments from the surface of Willapa Bay in areas with high and low densities of burrowing shrimp. Using high resolution microphotographs, he has examined sediments for the presence of food organisms that could be used to support epibenthic and infaunal invertebrates. In low shrimp settings he has found the surface sediment particles are intermixed with a biofilm of diatoms and other plankton (see microphotographs at <https://www.flickr.com/photos/76798465@N00/28665041926/in/album-72157671681119915/>). By contrast, many sediments with high shrimp densities lack this biofilm, and are dominated by inorganic particles (see microphotographs at <https://www.flickr.com/photos/76798465@N00/28665039106/in/album-72157671681119915/>). When sediments from the two types of areas are compared, the biggest difference is that high shrimp locations are dominated by sand sized particles, and generally have very low levels of silt and clay. Based on this difference, Dr. Wilson believes that the small sediment components of silt and clay are important to help stabilize the sediments, and without them the resulting unstable fine sands prevent the development of a diatom biofilm. Regardless of whether this hypothesis is correct, his work points out a real difference in food resources to invertebrates that likely helps to explain why high shrimp densities are often associated with decreases in other invertebrate species. And, as noted above, reduced invertebrate resources represent a negative impact to many shorebird and waterfowl.

Stakeholders raised concerns about potential impacts to birds during the public review of the EIS, and in subsequent correspondence with Ecology (e.g., Audubon Washington letter of July 7, 2016). Although some of these comments questioned whether spraying could impact birds by reducing the availability of burrowing shrimp as prey, the small percentage of Willapa Bay and Grays Harbor that would be sprayed (a maximum of 0.7 percent and 0.02% respectively, of the area of these estuaries) ensures that if any bird species do feed on burrowing shrimp they would have extensive, untreated acreage for foraging. Another raised concern was that birds may forage on treated areas, and therefore be exposed to imidacloprid, either directly through water and sediment contact, or through ingestion of imidacloprid-containing prey. An important mitigating factor to this potential exposure pathway is the very short period in which imidacloprid remains in the environment. Repeated field trials reviewed in the EIS have documented that water concentrations of imidacloprid fall below biologically toxic levels with the first incoming tide, and sediment concentrations show an approximately negative exponential decline in imidacloprid concentrations, with residues below biologically toxic levels in 14-56 days. Similarly, epibenthic invertebrates, which are a primary food source for many shorebirds (e.g., sanderling, *Calidris alba*), are similarly dispersed with the tides, making any ingestion-based pathway to exposure highly unlikely. Species that forage for invertebrates in the sediment may ingest prey containing imidacloprid. Such exposures should be short-term, as prey killed by imidacloprid rapidly deteriorate into an indigestible state following treatment. Also, the very low toxicity of imidacloprid is expected to prevent the occurrence of negative impacts in birds even if they do forage on invertebrates containing imidacloprid.

Imidacloprid has been sprayed experimentally in Willapa Bay over a number of years. Carbaryl, a much more toxic pesticide, has been sprayed in both Willapa Bay and Grays Harbor for over 50 years. These sprayings offer an empirical test of whether shorebirds are at risk of acute or sub-lethal effects of imidacloprid spraying. No impacts to birds have been noted (e.g., mortality, disoriented behavior, etc.) from treatment of shellfish beds with either imidacloprid or carbaryl. In addition, as noted in the Audubon Washington letter, Willapa Bay and Grays Harbor “support a diverse array of birds and marine wildlife, including exceptional numbers of migratory shorebirds” and offer “a vital wintering area for waterfowl and shorebirds.” This outstanding diversity and support of shorebird populations has occurred over five decades of carbaryl spraying to control burrowing shrimp with no apparent negative impacts, strong evidence that limited spraying of the less toxic imidacloprid proposed in the permit will not harm birds in these estuaries.

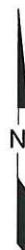
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0 2 4 8 Miles

 Public recreational shellfish beaches

Data source: WA DOH, ESRI Basemap



Willapa Grays Harbor Oyster Growers Assoc.
Willapa Bay, Pacific County, Washington

Willapa Bay Recreational Shellfish Beaches

12795-001

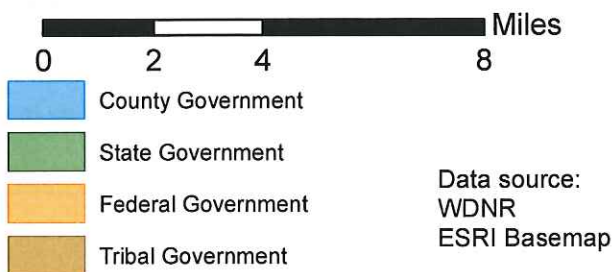
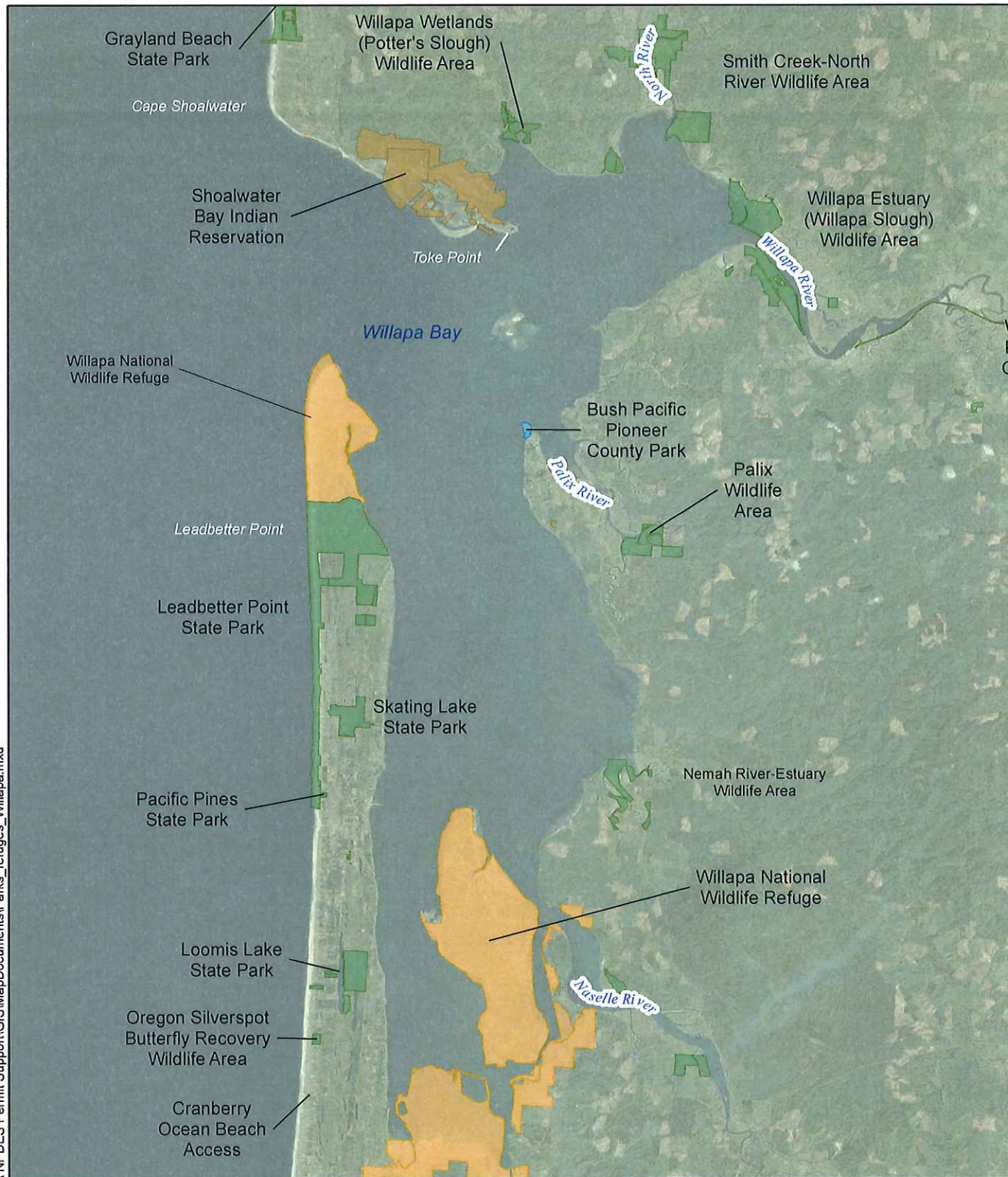
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HARTCROWSER

Exhibit

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Willapa Grays Harbor Oyster Growers Assoc.
Willapa Bay, Pacific County, Washington

Willapa Bay Public Parks and Wildlife Areas

12795-001

8/24/2016

HARTCROWSER

Exhibit
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APPENDIX A

**SEDIMENT IMPACT ZONE (SIZ) APPLICATION FOR DISCHARGE OF
IMIDACLOPRID INTO WILLAPA BAY
WILLAPA/GRAYS HARBOR OYSTER GROWERS ASSOCIATION**



For Chemical Emergency, Spill, Leak, Fire, Exposure, or Accident,
Call CHEMTREC Day or Night: 1-800-424-9300.
For Medical Emergencies Only, Call 1-877-325-1840.

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Nuprid™ 2F Insecticide
Synonyms: Insecticide: Imidacloprid; 1-[(6-chloro-3-pyridinyl)methyl]-N-nitro-2-imidazolidinimine
EPA Reg. No.: 228-484
Company Name: Nufarm Americas Inc.
150 Harvester Drive, Suite 200
Burr Ridge, IL 60527
Date of Issue: April 17, 2007
Sections Revised: 2, 11 and 14
Supersedes: July 7, 2006

2. HAZARDS IDENTIFICATION

Emergency Overview:

Appearance and Odor: White aqueous suspension with a sweet odor.

Warning Statements: Keep out of reach of children. CAUTION. Harmful if absorbed through skin. Harmful if inhaled. Avoid contact with skin, eyes or clothing. Avoid breathing spray mist.

Potential Health Effects:

Likely Routes of Exposure: Inhalation, eye and skin contact.

Eye Contact: Minimally irritating based on toxicity studies.

Skin Contact: Mildly toxic and non-irritating irritating based on toxicity studies.

Ingestion: No more than slightly toxic if ingested based on toxicity studies.

Inhalation: Low inhalation toxicity. Inhalation of glycerin mists may cause irritation of respiratory tract.

Medical Conditions Aggravated by Exposure: None known.

See Section 11: TOXICOLOGICAL INFORMATION for more information.

Potential Environmental Effects:

This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds.

This product is toxic to wildlife and highly toxic to aquatic invertebrates.

See Section 12: ECOLOGICAL INFORMATION for more information.

3. COMPOSITION / INFORMATION ON INGREDIENTS

COMPONENT	CAS NO.	% BY WEIGHT
Imidacloprid	138261-41-3	21.4
Inert Ingredients Including Glycerin	56-81-5	78.6

4. FIRST AID MEASURES

If Swallowed: Call a poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by the poison control center or doctor. Do not give anything by mouth to an unconscious person.

If Inhaled: Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible. Call a poison control center or doctor for further treatment advice.

If on Skin: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15 to 20 minutes. Call a poison control center or doctor for treatment advice.

If in Eyes: Hold eye open and rinse slowly and gently with water for 15 to 20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.

Note to Physician: No specific antidote is available. Treat the patient symptomatically.

5. FIRE FIGHTING MEASURES

Flash Point: >210°F (>98.9°C) Pensky-Martens

Autoignition Temperature: Not determined

Flammability Limits: Not determined

Extinguishing Media: Water, carbon dioxide, dry chemical or foam.

Special Fire Fighting Procedures: Firefighters should wear NIOSH/MSHA approved self-contained breathing apparatus and full fire-fighting turn out gear. Dike area to prevent runoff and contamination of water sources. Dispose of fire control water later.

Unusual Fire and Explosion Hazards: If water is used to fight fire, contain runoff, using dikes to prevent contamination of water supplies. Dispose of fire control water later.

Hazardous Decomposition Materials (Under Fire Conditions): May produce gases such as hydrogen chloride, hydrogen cyanide, and oxides of carbon and nitrogen.

National Fire Protection Association (NFPA) Hazard Rating:

Rating for this product: Health: 1 Flammability: 1 Reactivity: 1

Hazards Scale: 0 = Minimal 1 = Slight 2 = Moderate 3 = Serious 4 = Severe

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions: Wear appropriate protective gear for the situation. See Personal Protection information in Section 8.

Environmental Precautions: Prevent material from entering public sewer systems or any waterways. Do not flush to drain. Large spills to soil or similar surfaces may necessitate removal of topsoil. The affected area should be removed and placed in an appropriate container for disposal.

Methods for Containment: Dike spill using absorbent or impervious materials such as earth, sand or clay. Collect and contain contaminated absorbent and dike material for disposal.

Methods for Cleanup and Disposal: Pump any free liquid into an appropriate closed container. Wash entire spill area with soap and water. Absorb and place into container for disposal. Decontaminate tools and equipment following cleanup. See Section 13: DISPOSAL CONSIDERATIONS for more information.

Other Information: Large spills may be reportable to the National Response Center (800-424-8802) and to state and/or local agencies.

7. HANDLING AND STORAGE

Handling:

Avoid contact with skin, eyes or clothing. Avoid breathing spray mist. Users should wash hands before eating, drinking, chewing gum, using tobacco or using the toilet. Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing. Remove Personal Protective Equipment

MATERIAL SAFETY DATA SHEET**Nuprid 2F Insecticide**

(PPE) immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

Storage:

Store in a cool, dry place and in such a manner as to prevent cross contamination with other pesticides, fertilizers, food and feed. Store in original container and out of the reach of children, preferably in a locked storage area. Handle and open container in a manner as to prevent spillage. Do not contaminate water, food or feed by storage or disposal.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION**Engineering Controls:**

Where engineering controls are indicated by specific use conditions or a potential for excessive exposure, use local exhaust ventilation at the point of generation.

Personal Protective Equipment:

Eye/Face Protection: To avoid contact with eyes, wear chemical goggles or shielded safety glasses. An emergency eyewash or water supply should be readily accessible to the work area.

Skin Protection: To avoid contact with skin, wear long pants, long-sleeved shirt, socks, shoes and chemical-resistant gloves made of any waterproof material. An emergency shower or water supply should be readily accessible to the work area.

Respiratory Protection: Not normally required. If vapors or mists exceed acceptable levels, wear NIOSH approved air-purifying respirator with cartridges/canisters approved for use against pesticides.

General Hygiene Considerations: Personal hygiene is an important work practice exposure control measure and the following general measures should be taken when working with or handling this material: 1) do not store, use and/or consume foods, beverages, tobacco products, or cosmetics in areas where this material is stored; 2) wash hands and face carefully before eating, drinking, using tobacco, applying cosmetics or using the toilet.

Exposure Guidelines:

Component	OSHA		ACGIH		Unit
	TWA	STEL	TWA	STEL	
Imidacloprid	NE	NE	NE	NE	NE
Glycerin Mist	15 (T) 5 (R)	NE	10	NE	mg/m ³

T = Total Dust
R = Respirable Fraction

NE = Not Established

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance and Odor: White aqueous suspension with a sweet odor.

Boiling Point: Not determined

Solubility in Water: Dispersible

Density: 9.35 pounds/gallon

Specific Gravity: 1.121 @ 20°C

Evaporation Rate: Not determined

Vapor Density: Not determined

Freezing Point: Not determined

Vapor Pressure: Not determined

pH: 6 – 7 (1% solution)

Viscosity: 634.6 mPa s @ 20°C

Note: Physical data are typical values, but may vary from sample to sample. A typical value should not be construed as a guaranteed analysis or as a specification.

10. STABILITY AND REACTIVITY

Chemical Stability: This material is stable under normal handling and storage conditions.

Conditions to Avoid: Excessive heat. For imidacloprid, strong exothermal reaction above 200°C.

Incompatible Materials: Not known

Hazardous Decomposition Products: Under fire conditions, may produce gases such as hydrogen chloride, hydrogen cyanide, and oxides of carbon and nitrogen.

Hazardous Reactions: Hazardous polymerization will not occur.

11. TOXICOLOGICAL INFORMATION**Toxicological Data:**

Except as noted, data from laboratory studies conducted on this product:

Oral: Rat LD₅₀: >2,000 mg/kg (female)

Dermal: Rat LD₅₀: >2,000 mg/kg

Inhalation: Rat 4-hr LC₅₀: >5.33 mg/l (similar product)

Eye Irritation: Rabbit: Minimally irritating

Skin Irritation: Rabbit: Non-irritating

Skin Sensitization: Not a contact sensitizer in guinea pigs following repeated skin exposure.

Subchronic (Target Organ) Effects: Repeated overexposure to imidacloprid may effect heart, thyroid, blood chemistry, and liver.

Carcinogenicity / Chronic Health Effects: Prolonged overexposure to imidacloprid can cause effects to the thyroid. Imidacloprid did not cause cancer in laboratory animal studies. The U.S. EPA has given imidacloprid a Group E classification (evidence of non-carcinogenicity in humans).

Reproductive Toxicity: In a two-generation reproduction study in rats, imidacloprid produced reduced mean body weights and body weight gains. No other reproductive effects were observed.

Developmental Toxicity: Rat and rabbit studies on imidacloprid resulted in skeletal abnormalities, increased resorptions (rabbits) and reduced body weight gains at doses that were also toxic to mother animals.

Genotoxicity: The imidacloprid mutagenicity studies, taken collectively, demonstrate that imidacloprid is not genotoxic or mutagenic.

Assessment Carcinogenicity: None listed with ACGIH, IARC, NTP or OSHA.

See Section 2: HAZARDS IDENTIFICATION for more information.

12. ECOLOGICAL INFORMATION**Ecotoxicity:**

Data on Imidacloprid Technical:

96-hour LC ₅₀ Rainbow Trout:	211 mg/l	Japanese Quail Oral LD ₅₀ :	31 mg/kg
48-hour EC ₅₀ Daphnia:	85 mg/l	Bobwhite Quail Oral LD ₅₀ :	152 mg/kg
96-hour LC ₅₀ Mysid:	0.038 ppm	House Sparrow Oral LD ₅₀ :	41 mg/kg
48-hour Honey Bee Contact LD ₅₀ :	0.078 µg/bee	48-hour Honey Bee Oral LD ₅₀ :	0.0039 µg/bee

Environmental Fate:

Hydrolysis half-life of imidacloprid is greater than 30 days at pH 7 and 25°C. The aqueous photolysis half-life is less than 3 hours. The soil surface photolysis of imidacloprid has a half-life of 39 days, and in soil, the half-life ranged from 26 to 229 days.

13. DISPOSAL CONSIDERATIONS**Waste Disposal Method:**

Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

Container Handling and Disposal:

Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill or by incineration, or, if allowed by State and local authorities, by burning. If burned, stay out of smoke.

14. TRANSPORTATION INFORMATION

Follow the precautions indicated in Section 7: HANDLING AND STORAGE of this MSDS.

DOT

Non Regulated – See 49 CFR 173.132(b)(3)

IMDG

Non Regulated – See IMDG 2.6.2.1.3

IATA

Non Regulated – See IATA 3.6.1.5.3

15. REGULATORY INFORMATION**U.S. Federal Regulations:**

TSCA Inventory: This product is exempted from TSCA because it is solely for FIFRA regulated use.

SARA Hazard Notification/Reporting:

Hazard Categories Under Criteria of SARA Title III Rules (40 CFR Part 370): Immediate

Section 313 Toxic Chemical(s): None

Reportable Quantity (RQ) under U.S. CERCLA: None

RCRA Waste Code: None

State Information:

Other state regulations may apply. Check individual state requirements.

California Proposition 65: Not Listed.

16. OTHER INFORMATION

This Material Safety Data Sheet (MSDS) serves different purposes than and DOES NOT REPLACE OR MODIFY THE EPA-ACCEPTED PRODUCT LABELING (attached to and accompanying the product container). This MSDS provides important health, safety and environmental information for employers, employees, emergency responders and others handling large quantities of the product in activities generally other than product use, while the labeling provides that information specifically for product use in the ordinary course.

Use, storage and disposal of pesticide products are regulated by the EPA under the authority of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) through the product labeling, and all necessary and appropriate precautionary, use, storage, and disposal information is set forth on that labeling. It is a violation of Federal law to use a pesticide product in any manner not prescribed on the EPA-accepted label.

Although the information and recommendations set forth herein (hereinafter "Information") are presented in good faith and believed to be correct as of the date hereof, Nufarm Americas Inc. makes no representations as to the completeness or accuracy thereof. Information is supplied upon the condition that the persons receiving same will make their own determination as to its suitability for their purposes prior to use. In no event will Nufarm Americas Inc. be responsible for damages of any nature whatsoever resulting from the use of or reliance upon Information. NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OF ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO INFORMATION OR THE PRODUCT TO WHICH INFORMATION REFERS.

Nuprid is a trademark of Nufarm Americas Inc.

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Mallet® 0.5G Insecticide
EPA Reg. No.: 228-501
Synonyms: Imidacloprid; 1-[(6-chloro-3-pyridinyl)methyl]-N-nitro-2-imidazolidinimine
Product Type: Insecticide

Company Name: Nufarm Americas Inc.
150 Harvester Drive, Suite 200
Burr Ridge, IL 60527

Telephone Numbers: For Chemical Emergency, Spill, Leak, Fire, Exposure, or Accident,
Call CHEMTREC Day or Night: 1-800-424-9300
For Medical Emergencies Only, Call 1-877-325-1840

Date of Issue: May 17, 2012 **Supersedes:** February 23, 2007
Sections Revised: 3, 4, 7, 8, 11, 12, 13, 14, 15

2. HAZARDS IDENTIFICATION**Emergency Overview:**

Appearance and Odor: Brown colored granules with slight odor.

Warning Statements: Keep out of reach of children. CAUTION. Causes moderate eye irritation. Avoid contact with eyes or clothing.

Potential Health Effects:

Likely Routes of Exposure: Inhalation, skin and eye contact.

Eye Contact: Moderately irritating based on toxicity studies. Dusts may cause irritation.

Skin Contact: Slightly toxic and minimally irritating based on toxicity studies.

Ingestion: Slightly toxic if ingested based on toxicity studies.

Inhalation: Low inhalation toxicity.

Medical Conditions Aggravated by Exposure: Inhalation of product may aggravate existing chronic respiratory problems such as asthma, emphysema or bronchitis. Skin contact may aggravate existing skin disease.

See Section 11: TOXICOLOGICAL INFORMATION for more information.

Potential Environmental Effects:

This product is highly toxic to aquatic invertebrates.

See Section 12: ECOLOGICAL INFORMATION for more information.

3. COMPOSITION / INFORMATION ON INGREDIENTS

COMPONENT	CAS NO.	% BY WEIGHT
Imidacloprid	138261-41-3	0.5
Other Ingredients including N-methyl pyrrolidone	872-50-4	99.5

4. FIRST AID MEASURES

If on Skin or Clothing: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15 to 20 minutes. Call a poison control center or doctor for treatment advice.

If in Eyes: Hold eye open and rinse slowly and gently with water for 15 to 20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.

If Swallowed: Call a poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by the poison control center or doctor. Do not give anything by mouth to an unconscious person.

If Inhaled: Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible. Call a poison control center or doctor for further treatment advice.

Note to Physician: No specific antidote is available. Treat the patient symptomatically.

5. FIRE FIGHTING MEASURES

Flash Point: Not applicable

Autoignition Temperature: Not applicable **Flammability Limits:** Not applicable

Extinguishing Media: Use extinguishing media suitable for surrounding materials. Dry chemical, carbon dioxide, foam, water spray or fog.

Special Fire Fighting Procedures: Firefighters should wear NIOSH/MSHA approved self-contained breathing apparatus and full fire-fighting turn out gear. Dike area to prevent runoff and contamination of water sources. Dispose of fire control water later.

Unusual Fire and Explosion Hazards: If water is used to fight fire, contain runoff, using dikes to prevent contamination of water supplies. Dispose of fire control water later

Hazardous Decomposition Materials (Under Fire Conditions): May produce gases such as oxides of carbon and nitrogen.

National Fire Protection Association (NFPA) Hazard Rating:

Rating for this product: Health: 1 Flammability: 1 Reactivity: 0

Hazards Scale: 0 = Minimal 1 = Slight 2 = Moderate 3 = Serious 4 = Severe

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions: Wear appropriate protective gear for the situation. See Personal Protection information in Section 8.

Environmental Precautions: Prevent material from entering public sewer systems or any waterways. Do not flush to drain. Large spills to soil or similar surfaces may necessitate removal of topsoil. The affected area should be removed and placed in an appropriate container for disposal.

Methods for Containment: Dike spill using absorbent or impervious materials such as earth, sand or clay. Collect and contain contaminated absorbent and dike material for disposal.

Methods for Cleanup and Disposal: Wash entire spill area with a detergent slurry, absorb and sweep into container for disposal. Decontaminate tools and equipment following cleanup. See Section 13: DISPOSAL CONSIDERATIONS for more information.

Other Information: Large spills may be reportable to the National Response Center (800-424-8802) and to state and/or local agencies.



7. HANDLING AND STORAGE

Handling:

Avoid contact with eyes or clothing. Users should wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet. Remove clothing/Personal Protective Equipment (PPE) if pesticide gets inside. Then wash thoroughly and put on clean clothing. Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

Storage:

Store in a cool, dry place and in such a manner as to prevent cross-contamination with other pesticides, fertilizers, food and feed. Store in original container and out of reach of children, preferably in a locked storage area. Do not contaminate water, food or feed by storage or disposal.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering Controls:

Where engineering controls are indicated by specific use conditions or a potential for excessive exposure, use local exhaust ventilation at the point of generation.

Personal Protective Equipment:

Eye/Face Protection: To avoid contact with eyes, wear chemical goggles or shielded safety glasses. An emergency eyewash or water supply should be readily accessible to the work area.

Skin Protection: To avoid contact with skin, wear long pants, long-sleeved shirt, shoes plus socks, and chemical-resistant gloves made of waterproof material such as barrier laminate, butyl rubber, nitrile rubber, neoprene rubber, natural rubber, polyethylene, polyvinylchloride (PVC) or viton. An emergency shower or water supply should be readily accessible to the work area.

Respiratory Protection: Not normally required. If vapors or mists exceed acceptable levels, wear NIOSH approved air-purifying respirator with cartridges/canisters approved for use against pesticides.

General Hygiene Considerations: Personal hygiene is an important work practice exposure control measure and the following general measures should be taken when working with or handling this material: 1) do not store, use and/or consume foods, beverages, tobacco products, or cosmetics in areas where this material is stored; 2) wash hands and face carefully before eating, drinking, using tobacco, applying cosmetics or using the toilet.

Exposure Guidelines:

Component	OSHA		ACGIH		Unit
	TWA	STEL	TWA	STEL	
Imidacloprid	NE	NE	NE	NE	

NE = Not Established

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance and Odor: Brown colored granules with slight odor.

Boiling Point:	Not applicable	Solubility in Water:	Relatively insoluble
Density:	46 pounds/cubic foot	Specific Gravity:	Not applicable
Evaporation Rate:	Not applicable	Vapor Density:	Not applicable
Freezing Point:	Not applicable	Vapor Pressure:	Not applicable
pH:	6.4	Viscosity:	Not applicable

Note: Physical data are typical values, but may vary from sample to sample. A typical value should not be construed as a guaranteed analysis or as a specification.

10. STABILITY AND REACTIVITY

Chemical Stability: This material is stable under normal handling and storage conditions.

Conditions to Avoid: Excessive heat. Do not store near heat or flame.

Incompatible Materials: Strong oxidizing agents: bases and acids.

Hazardous Decomposition Products: Under fire conditions may produce gases such as oxides of carbon and nitrogen.

Hazardous Reactions: Hazardous polymerization will not occur.

11. TOXICOLOGICAL INFORMATION

Toxicological Data:

Data from laboratory studies conducted on a similar, but not identical, formulation:

Oral: Rat LD₅₀: > 5,000 mg/kg (female)

Dermal: Rat LD₅₀: > 5,000 mg/kg

Inhalation: Rat 4-hr LC₅₀: >2.06 mg/l

Eye Irritation: Rabbit: Moderately irritating

Skin Irritation: Rabbit: Minimally irritating

Skin Sensitization: Not a contact sensitizer in guinea pigs following repeated skin exposure.

Subchronic (Target Organ) Effects: Repeated overexposure to imidacloprid, may affect heart, thyroid, blood chemistry, and liver. Repeated overexposure to N-Methyl 2-pyrrolidinone (NMP) may cause effects to eyes, skin, respiratory system, central nervous system, liver and kidneys. The solvent component of this product is reported to cause irritation to the eyes and skin and may contribute to the irritation potential reported for this product.

Carcinogenicity / Chronic Health Effects: Prolonged overexposure to imidacloprid can cause effects to the thyroid. Imidacloprid did not cause cancer in laboratory animal studies. The U.S. EPA has given imidacloprid a Group E classification (evidence of non-carcinogenicity in humans). No increase in tumors was seen in rats via dietary or inhalation exposure to NMP for two years; however, an increase in liver tumors was noted in mice receiving high dietary doses over a similar period. Liver tumors are not uncommon when non-genotoxic chemicals such as NMP are tested in the mouse bioassay.

Reproductive Toxicity: In a two-generation reproduction study in rats, imidacloprid produced reduced mean body weights and body weight gains. No other reproductive effects were observed. NMP may adversely affect reproduction in rats after ingestion, although fertility is unaltered.

Developmental Toxicity: Rat and rabbit studies on imidacloprid resulted in skeletal abnormalities, increased resorptions (rabbits) and reduced body weight gains at doses that were also toxic to mother animals. Fetal developmental effects were observed following ingestion, inhalation and dermal exposures to NMP in pregnant animals, and occurred both in the presence and absence of maternal toxicity.

Genotoxicity: The imidacloprid mutagenicity studies, taken collectively, demonstrate that imidacloprid is not genotoxic or mutagenic. Neither *in vitro* nor *in vivo* tests on NMP demonstrated mutagenic effects.

Assessment Carcinogenicity: None listed with ACGIH, IARC, NTP or OSHA.

See Section 2: HAZARDS IDENTIFICATION for more information.

12. ECOLOGICAL INFORMATION

Ecotoxicity:

Data on Imidacloprid Technical:

Data on Imidacloprid Technical:

96-hour LC ₅₀ Rainbow Trout:	211 mg/l	Japanese Quail Oral LD ₅₀ :	31 mg/kg
48-hour EC ₅₀ Daphnia:	85 mg/l	Bobwhite Quail Oral LD ₅₀ :	152 mg/kg
96-hour LC ₅₀ Mysid:	0.038 ppm	House Sparrow Oral LD ₅₀ :	41 mg/kg
96-hour LC ₅₀ Bluegill:	>105 mg/l	Bobwhite Quail 8-day Dietary LC ₅₀ :	1535 ppm
48-hour Honey Bee Contact LD ₅₀ :	0.078 µg/bee	Mallard Duck 8-day Dietary LC ₅₀ :	>4797 ppm
48-hour Honey Bee Oral LD ₅₀ :	0.0039 µg/bee		

Environmental Fate:

Hydrolysis half-life of imidacloprid is greater than 30 days at pH 7 and 25°C. The aqueous photolysis half-life is less than 3 hours. The soil surface photolysis of imidacloprid has a half-life of 39 days, and in soil, the half-life ranged from 26 to 229 days.

13. DISPOSAL CONSIDERATIONS**Waste Disposal Method:**

Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility. Improper disposal of excess pesticide is a violation of Federal law.

Container Handling and Disposal:

Nonrefillable bags: Nonrefillable container. Do not reuse or refill this container. Completely empty bag into application equipment, then offer for recycling if available, or dispose of empty bag in a sanitary landfill or by incineration. Do not burn unless allowed by state and local ordinance. If burned stay out of smoke.

14. TRANSPORTATION INFORMATION

Follow the precautions indicated in Section 7: HANDLING AND STORAGE of this MSDS.

DOT

Not regulated by DOT unless shipped by water. See IMO / IMDG description.

IMDG

UN3077, Environmentally hazardous substance, solid, n.o.s.,
(Imidacloprid), 9, III, Marine Pollutant

IATA

UN3077, Environmentally hazardous substance, solid, n.o.s.,
(Imidacloprid), 9, III, Marine Pollutant

15. REGULATORY INFORMATION**U.S. Federal Regulations:**

TSCA Inventory: This product is exempted from TSCA because it is solely for FIFRA regulated use.

SARA Hazard Notification/Reporting:

Hazard Categories Under Criteria of SARA Title III Rules (40 CFR Part 370): Immediate

Section 313 Toxic Chemical(s):

N-Methyl-2-pyrrolidinone (CAS No 872-50-4), < 2% by weight in product

Reportable Quantity (RQ) under U.S. CERCLA: None

RCRA Waste Code: None

State Information:

Other state regulations may apply. Check individual state requirements.

California Proposition 65: WARNING. This product contains chemicals known to the State of California to cause cancer or birth defects or other reproductive harm

16. OTHER INFORMATION

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Mallet is a registered trademark of Nufarm Americas Inc.

APPENDIX B

**SEDIMENT IMPACT ZONE (SIZ) APPLICATION FOR DISCHARGE OF
IMIDACLOPRID INTO WILLAPA BAY
WILLAPA/GRAYS HARBOR OYSTER GROWERS ASSOCIATION**

Table B-1. Names and address of aquatic landowners with property adjacent to shellfish beds.

CURRENT OWNER	MAILING ADDRESS	
ADAIR, ROBERT Q	58 MILL RANCH ROAD	NASELLE, WA 98638
AHLSTROM, TIMOTHY & KATHRYN	P O BOX 375	BAY CENTER, WA 98527
ALBERTSON, MARK JEFFREY	5949 S SCHOONER PL	BOISE, ID 83716-9091
ALLRED, SHALOM C ET AL	95 S 100 W	TOOELE, UT 84074
ANDERSON, JOHN W & MARTHA K & SARAH J	0819 SW PENNOYER ST	PORTLAND, OR 97239-4401
ARISS, GREGORY D	7 SUNRISE COURT	MONTESANO, WA 98563
AVILA, JOHNNY R & KIMBERLY S	3939 14TH COURT NE	OLYMPIA, WA 98506
B & B PROPERTIES FAMILY LTD PART	1357 GRUHN ROAD	RAYMOND, WA 98577-9684
B & R OYSTERS LLC	P O BOX 309	BAY CENTER, WA 98527
BAILEY, BARBARA P	P O BOX 217	OCEAN PARK, WA 98640
BAY CENTER MARICULTURE CO	P O BOX 356	BAY CENTER, WA 98527
BEEBE, FRANK R ET AL	12208 GREENWOOD AVE N	SEATTLE, WA 98133
BENDIKSEN, E H CO INC	12351 LAKE CITY WAY NE STE 103	SEATTLE, WA 98125-5437
BENNETT, MARK F & CHAMBERS, CRISTEN	3334 NE DAVIS STREET	PORTLAND, OR 97232
BERNARD, KEVIN & ELEANOR	2732 NE BRAZEE CT	PORTLAND, OR 97212
BETCHER, IRENE L	2210 NE 284TH AVENUE	CAMAS, WA 98607
BOND, DENNIS & MARY/TRUSTEES	P O BOX 101	MANCHESTER, WA 98353
BROOKS, J X	45146 NW DAVID HILL RD	FOREST GROVE, OR 97116-7529
CASCADE LAND CONSERVANCY	901 5TH AVENUE STE 2200	SEATTLE, WA 98164
CASWELL, ROBERT W & MARILYN V	25204 SANDRIDGE ROAD	OCEAN PARK, WA 98640
CASWELL, EDWIN W JR TRUSTEE	10855 SW BUTNER ROAD	PORTLAND, OR 97225
CHRISTENSON, MARGARET J/TRUSTEE	PO BOX 539	OCEAN PARK, WA 98640
CLARK, VICKIE W & BROOKS, KENN	P O BOX 225	TOKELAND, WA 98590
COAST SEAFOODS COMPANY	14711 NE 29TH PLACE #111	BELLEVUE, WA 98007
COOK, FRED W & PATRICIA E	8242 SW SAND RIDGE RD	TERRABONNE, OR 97760-9270

COOPER, PAULA & PRESTON, BUCK	P O BOX 94	OCEAN PARK, WA	98640
COUSINS, TERRY	6200 GLENWOOD RD SW	PORT ORCHARD, WA	98367-7012
COWELL, WARREN EUGENE	PO BOX 43	OCEAN PARK, WA	98640
CRUMET, LARRY & MOLLY	S 2625 GARFIELD RD	SPOKANE, WA	99203
DANIELSON, RUTH	PO BOX 2137	PISMO BEACH, CA	93448
DAVIS, MICHAEL B/TRUSTEE	507 TAHOS RD	ORINDA, CA	94563
DAVIS, JOCELYN U/TRUSTEE	26404 SANDRIDGE RD	OCEAN PARK, WA	98640
DOWNER, CYNTHIA K	30510 SANDRIDGE RD	OCEAN PARK, WA	98640
DRISCOLL, DANIEL ALAN	P O BOX 6	OYSTERVILLE, WA	98641
DRISCOLL, VIRGINIA ANN	P O BOX 862	ILWACO, WA	98624
EIDEN, JOHN M ET AL	P O BOX 594	WHITE SALMON, WA	98672
EITREIM, ERIC C	5511 52ND AVENUE SOUTH	SEATTLE, WA	98118
ESCANO, GLORIA G	3204 SOUTH KENYON STREET	SEATTLE, WA	98118
ESVELDT, GEORGE & BETTY	7554 26TH AVE NW	SEATTLE, WA	98117-4423
EVANS, RANDALL C & JENEEN A	13 TORPPA ROAD	NASELLE, WA	98638-8544
FOSSE, DORWIN N & DELORES	P O BOX 560	SOUTH BEND, WA	98586
FOSTER, EILEEN	25 OLD BEACON RD	MONTESANO, WA	98563
FRANKS, MIKE	7980 STATE HIGHWAY 97A	WENATCHEE, WA	98801
FRESHLEY, CHRISTOPHER J & GLORIA	3944 SW 36TH PLACE	PORTLAND, OR	97221
GABRYCH, EUGENE	2006 OLD HIGHWAY 395	FALLBROOK, CA	92028
GIBSON FAMILY REVOCABLE LIVING T	P O BOX 733	OCEAN PARK, WA	98640
GLENN, FRANK O III & CAROL L	3204 113TH LANE	LONG BEACH, WA	98631
GOLLINGS, KENNETH & RITA	30304 SANDRIDGE RD	OCEAN PARK, WA	98640-5105
GOODELL, STANLEY A ET UX	P O BOX 594	OYSTERVILLE, WA	98641
GRASSY ISLAND CLAM FARMS LLC	P O BOX 1039	OCEAN PARK, WA	98640
GRAVES, DONALD A & JO ANN TRUST	635 SNEAD DRIVE N	KEIZER, OR	97303
GREINER, ALAN	P O BOX 89	NAHCOTTA, WA	98637

GRIFFIN, BARRY A ET AL	55 ELIOT ST APT 44	JAMAICA PLAIN, MA	02130-2762
HANCOCK, MRS BILL	2644 W LAKE SAMM PKWY SE	BELLEVUE, WA	98004
HANNA, LAWRENCE ET UX	2645 LILLY RD NE	OLYMPIA, WA	98506
HANSELMAN, LUCY/TRUST	PO BOX 68	UKIAH, OR	97880-0068
HARBOR ROCK INC	P O BOX 246	SOUTH BEND, WA	98586
HAWTHORNE, DAVID R	P O BOX 421	TOKELAND, WA	98590
HAYWARD PROPERTIES LLC	1223 SPRING STREET #901	SEATTLE, WA	98104
HECKES, JOHN P	P O BOX 1657	OCEAN PARK, WA	98640
HECKES, PETER & JOHN	P O BOX 27	OYSTERVILLE, WA	98641
HENDERSON, PATRICIA	P O BOX 206	GLENEDEN BEACH, OR	97388
HERROLD, JOHN & ROY	4109 STATE ROUTE 101	ILWACO, WA	98624
HILL, ARNOLD P & DOROTHY	BOX 1428	SOUTH BEND, WA	98586
HOOD, CAREY D	P O BOX 64	NAHCOTTA, WA	98637
J L LEDGETT LOGGING CO INC	BOX 400	KALAMA, WA	98625
JAMBOR, NICK H & JOANNE S	29 HOLTZ ROAD	SOUTH BEND, WA	98586
JENSEN, ERIC S	905 N BALDWIN STREET	PORTLAND, OR	97217
JOHNSON, THOMAS & WATERS, ERIC	P O BOX 19072	PORTLAND, OR	97280
KAUFFMAN, BRUCE E & MARY J	P O BOX 353	OCEAN PARK, WA	98640
KELLY, JOHN	1151 GOULD ROAD	GRAYLAND, WA	98547
KEMMER, JAMES L	P O BOX 1054	LONG BEACH, WA	98631
KEMMER, JAMES J & ANDREA	P O BOX 6	CHINOOK, WA	98614
KEMMER, LARRY L	110 STRINGTOWN ROAD	ILWACO, WA	98624
KEMMER, ROBERT BRIAN JR	P O BOX 33	OCEAN PARK, WA	98640-0033
KISFISH INC	P O BOX 376	BAY CENTER, WA	98527
KRUEGER, GARY	712 SE 7TH AVE	PORTLAND, OR	97214-2226
LAGERGREN, ELLEN & KELLER, RANDY & RUS	122 COWAN STREET	ABERDEEN, WA	98520
LAMPMAN, WILLIAM G	29304 JOY LANE	OCEAN PARK, WA	98640

LANTER, ROBERT G	172 MOCKINGBIRD	BURKEVILLE, TX	75932-2240
LEDGETT, J L LOGGINS CO INC	P O BOX 400	KALAMA, WA	98625
LEIGH, ELLEN	P O BOX 1505	BATTLE GROUND, WA	98604-1505
LESTER, JOHN HAMILTON & LINDA	P O BOX 62	NAHCOTTA, WA	98637
LYNN POINT HOMEOWNERS ASSOC	P O BOX 447	BAY CENTER, WA	98527
MANSFIELD, CAROL ANN	6021 FAUNTLEROY WAY SW UNIT #A	SEATTLE, WA	98136-3605
MASINGALE, GARY D	7295 E JUANITA AVE	MESA, AZ	85209-4117
MAYFIELD, JULIE TRUSTEE	11519 NE 29TH ST	VANCOUVER, WA	98682-8729
MAYKO, MARK J & PATRICIA	7432 SW MILES PL	PORTLAND, OR	97219-3087
MAYNER, WILLIAM F & ERNIE D	25010 SANDRIDGE ROAD	OCEAN PARK, WA	98640
MC DONALD, ABBY L TRUSTEE	35570 BARNUM ROAD	SANDY, OR	97055
MOBY DICK CORPORATION	P O BOX 82	NAHCOTTA, WA	98637
NAIDITCH, ROBERT L	5 NORTH HWY 101 #279	WARRENTON, OR	97146
NAKONECHNY, LYLE	PO BOX 500	OCEAN PARK, WA	98640
NELSON, GEORGE W II	3508 299TH LANE	OCEAN PARK, WA	98640-4904
NISBET, DAVID H & MAUREENE E	P O BOX 338	BAY CENTER, WA	98527
NIVEN, WILLIAM J ET UX/TRUSTEES	215 HAMES ROAD	WATSONVILLE, CA	95076
O'CONNOR, BRIAN & RENEE	24608 SANDRIDGE RD	OCEAN PARK, WA	98640
OGILVIE, ROBERT & RODNEY & RICH	4202 TRESIZE ROAD	RAYMOND, WA	98577
O'LEARY, DAVID F	4017 24TH PL S	SEATTLE, WA	98108
OLSEN & SON OYSTER COMPANY INC	P O BOX 905	SOUTH BEND, WA	98586
PACIFIC COUNTY	300 MEMORIAL DRIVE	SOUTH BEND, WA	98586
PATTEN, KIM DAVID & ANDREA G	18306 SANDRIDGE ROAD	LONG BEACH, WA	98631
PEA, ANNA KATHLEEN	P O BOX 798	SOUTH BEND, WA	98586
PENNY, MARIETTA F	218 O STREET SW	QUINCY, WA	98848-1691
PETIT, NORRIS A & MAUREEN A	P O BOX 811	SOUTH BEND, WA	98586
PETIT, ERIC W	P O BOX 524	SOUTH BEND, WA	98586

PORT OF PENINSULA	3311 275TH STREET	OCEAN PARK, WA	98640
PRESTON, BUCKLEY CHARLES & PAULA JEAN	P O BOX 94	OCEAN PARK, WA	98640
PUBLIC UTILITY DISTRICT #2	P O BOX 472	RAYMOND, WA	98577
RANTANEN, RITVA H	VANCOUVER BC	CANADA V6J 4V1	
READ, CARL ET UX	1400 NE 18TH AVENUE	BATTLE GROUND, WA	98604
REX LAND CO.	PO BOX 569	REDMOND, WA	98073
RHOADES, CARLTON L	35 SO BROADWAY #1	TACOMA, WA	98402-4100
ROBERT, SALLY A	108 BELVEDERE DRIVE	MILL VALLEY, CA	94941-2420
ROTH, STEPHEN A & JEAN	13363 SW IRON MOUNTAIN BLVD	PORTLAND, OR	97219
RUSSELL, ERIC	34671 N US HIGHWAY 101	LILLWAUP, WA	98555-9760
SADLER, ERNEST J & ANN T	18716 SANDRIDGE ROAD	LONG BEACH, WA	98631
SCHREIBER, CORY & PAMELA	1640 SE 59TH AVENUE	PORTLAND, OR	97215
SETON, JOHN	4315 SW WESTDALE	PORTLAND, OR	97221
SETON, WALDEMAR III ET AL	47202 EL AGADIR	PALM DESERT, CA	92260-5806
SHELDON, RICHARD N & RUTH ET AL	BOX 365	OCEAN PARK, WA	98640
SHELDON, BRIAN & MARILYN	P O BOX 1039	OCEAN PARK, WA	98640-1039
SHIELS, WILLIAM E	15020 BEAR CREEK RD NE	WOODINVILLE, WA	98072
SHOALWATER BAY INDIAN TRIBE	P O BOX 130	TOKELAND, WA	98590
SHOTWELL, STEVEN & ANDREA	190 N NEMAH RD E	SOUTH BEND, WA	98586
SHOTWELL, SUSAN & CROSSON, RON	2310 LASHI STREET SE	OLYMPIA, WA	98513
SMITH, ROBERT E & PATRICIA A TRUSTEES	1888 WILT ROAD	FALLBROOK, CA	92028
SOULE, ERNEST L & YVONNA K	24208 SANDRIDGE ROAD	OCEAN PARK, WA	98640
STATE OF WASHINGTON	P O BOX 42650	OLYMPIA, WA	98504
STATE OF WASHINGTON	P O BOX 1709	VANCOUVER, WA	98668
STATE OF WASHINGTON/DNR	P O BOX 47000	OLYMPIA, WA	98504
STATE OF WASHINGTON/FISH & WILDLIFE	600 CAPITOL WAY N-F11	OLYMPIA, WA	98501-1091
STEVENS, NYEL L & SYDNEY M	P O BOX 2	OYSTERVILLE, WA	98641

STONY POINT OYSTER COMPANY LLC	7500 US HWY 101	SOUTH BEND, WA	98586
STUART, CHARLES H & JEFFREY D	2651 TANDY TURN	EUGENE, OR	97401
SWALLOW, JOSEPH G & SHARON M	27863 S MERIDIAN ROAD	AURORA, OR	97002
SWANTEK, CHRIS	201 SOUTH ADAMS	HOQUIAM, WA	98550
SZYMANKE, MILDRED B TRUSTEE	5548 N AGAAVE DR	TUCSON, AZ	85704
TAYLOR, MICHAEL W & KELLE L TRUSTEES	4412 SE 185TH CT	VANCOUVER, WA	98683
TAYLOR RESOURCES INC	130 SE LYNCH RD	SHELTON, WA	98584
UNDERWOOD, CONNIE	1502 266TH PL	OCEAN PARK, WA	98640
U.S.A. FISH & WILDLIFE DIVISION	911 NE 11TH AVE	PORTLAND, OR	97232
VENDURE LIMITED PARTNERSHIP	240 JEROME STREET	SILVERTON, OR	97381
WAAGE, SHERYL ANN	9953 SE 32ND ST	MILWAUKIE, OR	97222
WACHSMUTH, CHESTER N JR & CAROL	3380 SE 9TH AVENUE	PORTLAND, OR	97202
WEST, PETER	7311 SE YAMHILL STREET	PORTLAND, OR	97215
WESTERN OYSTER CO	1828 4TH ST	KIRKLAND, WA	98033
WESTLUND, EVONNA & TRAPP, DIANNA & MEY	701 SOUTH ANDRESEN ROAD	VANCOUVER, WA	98661
WIEGARDT, FREDERIC W & CHIKAKO T	P O BOX 366	OCEAN PARK, WA	98640
WIEGARDT, CAROLE	P O BOX 1	NAHCOTTA, WA	98637
WIEGARDT, KENICHI T	P O BOX 1356	OCEAN PARK, WA	98640
WIEGARDT, GUSTAVE A JR & LILA L	P O BOX 305	OCEAN PARK, WA	98640
WILLIAMS, ROBERT D & DEIDRE H	PO BOX 68	NAHCOTTA, WA	98637
WILSON, CHARLES GARY TRUSTEE	P O BOX 4	NAHCOTTA, WA	98637
WOOD, ROBERT R	P O BOX 1313	VANCOUVER, WA	98666
WOOLLEY, BEVERLY L	100 SE 47TH ST	PORTLAND, OR	97215
YOUNG, DONALD B & CAROL L	P O BOX 47	NAHCOTTA, WA	98637

Table B-2. Names and addresses of landowners with upland property adjacent to shellfish beds.

CURRENT OWNER	MAILING ADDRESS
Albert and Jocelyn Bangi	8747 Colony Lane NW, Olympia, WA 98589
Bradley and Geraldine Harden	7601 US Hwy 101, South Bend, WA 98586
Charles W Lyons	777 Willapa First St., Raymond, WA 98577-9499
Dag Weiser and Jessica Frame	1426 Hecker Pass Road, Watsonville, WA 98520
Einar and Turid Opedal	18414 70th St Ct., Longbranch, WA 98351-9690
Forterra	901 5th Ave Ste 2200, Seattle, WA 98164
Fred and Nichola Goodin	PO Box 865, South Bend, WA 98586
Frederick and Janice Kulczycki	136 Wilson Lane, South Bend, WA 98586
Fruit Growers Supply Co.	PO Box 10352, Van Nuys, CA 91410-0352
Hancock Forest Management Inc	17700 SE Mill Plain Blvd #180, Vancouver, WA 98063-9777
Harbor Harbor Inc.	PO Box 246, South Bend, WA 98586
Irene Betcher	2210 NE 248th Ave, Cama, WA 98607
James and Carolyn Hopkins	PO Box 1512, Ocean Park, WA 98640
James Green	PO Box 415, Neskowin, OR 97149
John Stephens and Stephen McCormic	PO Box 93, Nahcotta, WA 98637
Joni Korpenfelt	6195 N Knowles Ave, Portland, OR 97217
Joseph and Janine Strauel	3609 SW 388th Pl, Federal Way, WA 98023
Kate Rae	23804 NE 182nd Ave, Battle Ground, WA 98604
Laurine Wiegardt	87870 Highway 202, Astoria, OR 97103
Lowell Bridges	112 North G Street, Aberdeen, WA 98577
Michael and Karen Wilsey	647 9th Court, Fox Island, WA 98333-9669
Pacific County	300 Memorial Drive, South Bend, WA 98586
Phillip and Clara Hawks	PO Box 412, Bay Center, WA 98527
Robert and Annette Seaman	2976 Westgate Ave, San Jose, CA 95125-9690
Robert Klein	1804 Nelson Rd., Raymond, WA 98577
Robert Kycek	4840 Grand Fir Lane NW, Olympia, WA 98502
Ronald Barclay	PO Box 1109, Long Beach, WA 98631

Rose Ranch LLC	9847 US Hwy 101, South Bend, WA 98586
Sally Gillies	7500 US Hwy 101, South Bend, WA 98586
Scott and Susan Doten	4125 Madrona Way North, Tacoma, WA 98407
Senja Edwards	7484 US Highway 101, South Bend, WA 98586
Stanley and Nancy Goodell	PO Box 594, Oysterville, WA 98641
Stephen and Karen Clarke	PO Box 1640, Long Beach, WA 98631
Theresa McCasland Trustee	7575 S Elkhorn Mtn, Littleton, CO 80127-3822
Timothy and Melinda Leahey	14918 Sandridge Road, Long Beach, WA 98631
Wendy Jane Horn	1312 Boone St. SE, Lacey, WA 98503
William and Beverly Rupp	PO Box 1130, Ocean Park, WA 98640

APPENDIX C

**SEDIMENT IMPACT ZONE (SIZ) APPLICATION FOR DISCHARGE OF
IMIDACLOPRID INTO WILLAPA BAY
WILLAPA/GRAYS HARBOR OYSTER GROWERS ASSOCIATION**



U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Chemical Safety and Pollution Prevention
Registration Division (7505C)
1200 Pennsylvania Ave., N.W.
Washington, D.C. 20460

EPA Reg. Number:

88867-1

Date of Issuance:

JUN 06 2013

NOTICE OF PESTICIDE:

☒ Registration
☐ Reregistration

(under FIFRA, as amended)

Term of Issuance:

Conditional

Name of Pesticide Product:

Protector 0.5G

Name and Address of Registrant (include ZIP Code):

Willapa-Grays Harbor Oyster Growers Association
P.O. Box 3, Ocean Park, WA 98640

Note: Changes in labeling differing in substance from that accepted in connection with this registration must be submitted to and accepted by the Registration Division prior to use of the label in commerce. In any correspondence on this product always refer to the above EPA registration number.

On the basis of information furnished by the registrant, the above named pesticide is hereby registered under the Federal Insecticide, Fungicide and Rodenticide Act.

Registration is in no way to be construed as an endorsement or recommendation of this product by the Agency. In order to protect health and the environment, the Administrator, on his motion, may at any time suspend or cancel the registration of a pesticide in accordance with the Act. The acceptance of any name in connection with the registration of a product under this Act is not to be construed as giving the registrant a right to exclusive use of the name or to its use if it has been covered by others.

This product is conditionally registered in accordance with FIFRA section 3(c)(7)(a). You must:

1. Submit and/or cite all data required for registration/registration review of your product when the Agency requires all registrants of similar products to submit such data.
2. Submit or cite any data which have previously been required for imidacloprid.
3. Make the following label change before you release the product for shipment:
 - Revise the EPA Registration Number to read, "EPA Reg. No 88867-1."

Signature of Approving Official:

John Hebert, Product Manager 07
Insecticide-Rodenticide Branch, Registration Division (7505P)

Date:

JUN 06 2013

Page 2

EPA Reg. No. 88867-1

4. Note that monitoring data reporting is required under the National Pollutant Discharge Elimination System (NPDES) permit. We request that you submit this information to the Registration Division, Office of Pesticide Programs, as well.

5. Submit one copy of the revised final printed label for the record before you release the product for shipment.

If these conditions are not complied with, the registration will be subject to cancellation in accordance with FIFRA section 6(e). Your release for shipment of the product constitutes acceptance of these conditions. A stamped copy of the label is enclosed for your records. Please also note that the CSF currently on file for this product is the basic CSF, dated 2/21/12.

If you have any questions, please contact Dr. Jennifer Urbanski at 703-347-0156 or urbanski.jennifer@epa.gov.

John Hebert
Product Manager 07
Insecticide-Rodenticide Branch
Registration Division (7505P)

Enclosure

ACCEPTED

JUN 06 2013

Under the Federal Insecticide, Fungicide,
and Rodenticide Act, as amended, for the
pesticide registered under:

GROUP 4A INSECTICIDE

EPA Reg. No: 88867-1

PROTECTOR 0.5G

FOR USE ONLY IN WILLAPA BAY/ GRAYS HARBOR, WASHINGTON,
TO CONTROL BURROWING SHRIMP IN COMMERCIAL SHELLFISH
BEDS

ACTIVE INGREDIENT:

Imidacloprid: 1-[(6-Chloro-3-pyridiny) methyl]-N-nitro-2-imidazolidinimine.....0.5%
OTHER INGREDIENTS:.....99.5%
TOTAL:.....100.0%

KEEP OUT OF REACH OF CHILDREN
CAUTION-CAUCION

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle.
(If you do not understand the label, find someone to explain it to you in detail.)

EPA Reg. No.

EPA Establishment No.

FIRST AID	
If in eyes:	<ul style="list-style-type: none"> • Hold eye open and rise slowly and gently with water for 15-20 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice
<p>Have the product container or label with you when calling poison control center or doctor or going for treatment. You may also 1-800-222-1222 for emergency medical treatment information.</p> <p>NOTE TO PHYSICIAN</p> <p>No specific antidote is available. Treat the patient symptomatically</p>	

PRECAUTIONARY STATEMENTS HAZARDS TO HUMANS AND DOMESTIC ANIMALS

CAUTION: Causes moderate eye irritation. Avoid contact with eyes or clothing. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum or using tobacco.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Applicators and other handlers must wear:

- Long-sleeved shirt and long pants
- Chemical-resistant gloves made of any waterproof material such as barrier laminate, butyl rubber, nitrile rubber, neoprene rubber, natural rubber, polyethylene, polyvinylchloride (PVC) or viton
- Shoes and socks
- Protective eyewear
- Dust mask

Follow manufacturer's instructions for cleaning/maintaining PPE. If instructions for washables do not exist, use detergent and hot water. Keep and wash PPE separately from other laundry.

ENGINEERING CONTROLS STATEMENTS

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240 (d)(4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.

USER SAFETY RECOMMENDATIONS

Users Must:

- Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing.

ENVIRONMENTAL HAZARDS

Do not contaminate water when disposing of equipment wash waters. This product is toxic to wildlife and highly toxic to aquatic invertebrates.

DIRECTIONS FOR USE

It is a violation of the Federal law to use this product in a manner inconsistent with its labeling. A copy of this label must be in the possession of the user at the time the product is applied.

READ THIS LABEL: Read the entire label and follow all use directions and precautions.

For use only to control burrowing shrimp in intertidal commercial shellfish beds [of Washington State's Willapa Bay and Grays Harbor]

MIXING INSTRUCTIONS:

Do NOT formulate this product into other end-use products.

APPLICATION INSTRUCTIONS:

To control burrowing shrimp in intertidal commercial shellfish beds [of Washington State's Willapa Bay and Grays Harbor], apply at a maximum rate of 0.5 lb a.i. imidacloprid/acre per year.

Apply this product uniformly over the area being treated using drop-type or rotary-type spreaders. Do not use spreaders that would apply the material in narrow, concentrated bands. All spreader equipment must be calibrated at the time of application to achieve desired application rate.

Use one of the following properly calibrated application equipment:

- Conventional granular pesticide applicators ("belly grinders").
- Helicopters equipped with boom $\frac{3}{4}$ as long as rotor diameter.
- Ground based vehicles equipped with spinners or drop spreaders.

RESTRICTIONS:

- Do not harvest shellfish within 30 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 500ft.
- A single application of imidacloprid at up to 0.5 ai per acre per year is allowed.
- No adjuvants or surfactants are allowed with the use of this product.
- Aerial applications must be on beds exposed at low tide. Applications from a floating platform or boat may be applied to beds under water using a calibrated granular applicator.
- 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 within 30 days when treatment is by aerial spray; a 25 foot buffer zone is required if treatment is by hand spray if nearest shellfish bed is to be harvested within 30 days.
- 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 quarter (1/4) mile radius of any bed scheduled for treatment shall be posted. Public access areas shall be posted at 500 foot intervals at those access areas more than 500 feet wide. Signs shall be a minimum of 8 1/2 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 shell fish 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.

Draft Label

The sign will include lettering shall be in bold black type with the word "WARNING" or "CAUTION" at least one-fourth (1/4) of an inch high. Signs shall be posted so they are secure from the normal effects of weather and water currents, but cause no damage to private property. Signs shall be posted at least 2 days prior to treatment and shall remain for at least 30 days after treatment.

This product is registered by the Willapa-Grays Harbor Oyster Growers Association, P.O. Box 3, Ocean Park, WA 98640

DRIFT MANAGEMENT:

The interaction of many equipment and weather related factors determine the potential for product drift. Average wind speed at the time of application is not to exceed 10 mph to minimize drift to adjacent shellfish and water areas when applied by air. Drift potential increases at wind speeds of less than 3 mph (due to inversion potential) or more than 10 mph. However, many factors including height of granular spreader above the tideflat and equipment specifications determine drift potential at any given wind speed. Do NOT apply when winds are greater than 10 mph or during temperature inversions. Make applications at the lowest possible height (helicopter, ground or barge) that is safe to operate and reduces exposure of the granules to wind. When applications are made crosswind, the swath will be displaced downwind. Therefore, on the up and downwind edges of the treatment area, the applicator must compensate for this displacement by adjusting the path of the application equipment upwind. Swath adjustment distance should increase with increasing drift potential.

Mixing and Loading Requirements

The use of a properly designed and maintained containment pad for mixing and loading of any pesticide into application equipment is recommended. If containment pad is not used, maintain a minimum distance of 25 feet between mixing and loading areas and potential surface to groundwater conduits such as field sumps, uncased well heads, sinkholes, or field drains.

STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage or disposal.

Pesticide Disposal: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

Pesticide Storage: Store in a cool, dry place in such a manner as to prevent cross contamination with other pesticides, fertilizers, food, and feed. Store in original container and out of the reach of children, preferably in a locked storage area.

Handle and open container in a manner as to prevent spillage. If material is spilled for any reason or cause, carefully contain any spilled material to prevent non-target contamination. Do not walk through spilled material and dispose of as directed for pesticides above. Refer to Precautionary Statements on label for hazards associated with handle of this material. In spill or leak incidents, keep unauthorized people away. For chemical spill, leak, fire, or exposure, you may contact CHEMTREC at 800-424-9300.

Container Disposal: Non-Refillable: Do not reuse or refill this container. Completely empty bag into application equipment. Dispose of empty bag in a sanitary landfill, by incineration, or if allowed by state and local authorities, by burning. If burned, stay out of smoke.



U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Chemical Safety and Pollution Prevention
Registration Division (7505C)
1200 Pennsylvania Ave., N.W.
Washington, D.C. 20460

EPA Reg. Number:

88867-2

Date of Issuance:

JUN 06 2013

NOTICE OF PESTICIDE:

☒ Registration
☐ Reregistration

(under FIFRA, as amended)

Term of Issuance:

Conditional

Name of Pesticide Product:

Protector 2F

Name and Address of Registrant (include ZIP Code):

Willapa-Grays Harbor Oyster Growers Association
P.O. Box 3, Ocean Park, WA 98640

Note: Changes in labeling differing in substance from that accepted in connection with this registration must be submitted to and accepted by the Registration Division prior to use of the label in commerce. In any correspondence on this product always refer to the above EPA registration number.

On the basis of information furnished by the registrant, the above named pesticide is hereby registered under the Federal Insecticide, Fungicide and Rodenticide Act.

Registration is in no way to be construed as an endorsement or recommendation of this product by the Agency. In order to protect health and the environment, the Administrator, on his motion, may at any time suspend or cancel the registration of a pesticide in accordance with the Act. The acceptance of any name in connection with the registration of a product under this Act is not to be construed as giving the registrant a right to exclusive use of the name or to its use if it has been covered by others.

This product is conditionally registered in accordance with FIFRA section 3(c)(7)(a). You must:

1. Submit and/or cite all data required for registration/registration review of your product when the Agency requires all registrants of similar products to submit such data.
2. Submit or cite any data which have previously been required for imidacloprid.
3. Make the following label change before you release the product for shipment:
 - Revise the EPA Registration Number to read, "EPA Reg. No 88867-2."

Signature of Approving Official:

John Hebert, Product Manager 07
Insecticide/Rodenticide Branch, Registration Division (7505P)

Date:

JUN 06 2013

Page 2

EPA Reg. No. 88867-2

4. Note that monitoring data reporting is required under the National Pollutant Discharge Elimination System (NPDES) permit. We request that you submit this information to the Registration Division, Office of Pesticide Programs, as well.

5. Submit one copy of the revised final printed label for the record before you release the product for shipment.

If these conditions are not complied with, the registration will be subject to cancellation in accordance with FIFRA section 6(e). Your release for shipment of the product constitutes acceptance of these conditions. A stamped copy of the label is enclosed for your records. Please also note that the CSF currently on file for this product is the basic CSF, dated 2/21/12.

If you have any questions, please contact Dr. Jennifer Urbanski at 703-347-0156 or urbanski.jennifer@epa.gov.

John Hebert
Product Manager 07
Insecticide-Rodenticide Branch
Registration Division (7505P)

Enclosure

GROUP 4A INSECTICIDE

PROTECTOR 2F

FOR USE ONLY IN WILLAPA BAY/ GRAYS HARBOR, WASHINGTON,
TO CONTROL BURROWING SHRIMP IN COMMERCIAL SHELLFISH
BEDS

ACTIVE INGREDIENT:

Imidacloprid: 1-[(6-Chloro-3-pyridiny)methyl]-N-nitro-2-imidazolidinimine..... 21.4%

OTHER INGREDIENTS:..... 78.6%

TOTAL:.....100.0%

Contains 2 pounds of imidacloprid per gallon.

KEEP OUT OF REACH OF CHILDREN CAUTION-CAUCION

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle.
(If you do not understand the label, find someone to explain it to you in detail.)

EPA Reg. No.

EPA Establishment No.

SHAKE WELL BEFORE USING

ACCEPTED
JUN 06 2013

Under the Federal Insecticide, Fungicide,
and Rodenticide Act, as amended, for the
pesticide registered under:

EPA. Reg. No: 88867-2

FIRST AID	
If swallowed:	<ul style="list-style-type: none"> • Call a poison control center or doctor immediately for treatment advice. • Have person sip a glass of water if able to swallow. • Do not induce vomiting unless told to do so by the poison control center or doctor. • Do not give anything by mouth to an unconscious person.
If inhaled	<ul style="list-style-type: none"> • Move person to fresh air • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible
If on skin or clothing:	<ul style="list-style-type: none"> • Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
<p>Have the product container or label with you when calling a poison control center or doctor or going for treatment. You may also contact 1-800-222-1222 for emergency medical treatment information</p> <p>NOTE TO PHYSICIAN</p> <p>No specific antidote is available. Treat the patient symptomatically.</p>	

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

CAUTION

Harmful if swallowed. Harmful if inhaled. Harmful if absorbed through skin. Avoid contact with skin, eyes, or clothing. Avoid breathing spray mist

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Applicators and other handlers must wear:

- Long-sleeved shirt and long pants
- Chemical-resistant gloves made of any waterproof material such as barrier laminate, butyl rubber, nitrile rubber, neoprene rubber, natural rubber, polyethylene, polyvinylchloride (PVC) or viton
- Shoes and socks
- Protective eyewear

Follow Manufacturer's instructions for cleaning/maintaining PPE. If instructions for washables do not exist, use detergent and hot water. Keep and wash PPE separately from other laundry.

ENGINEERING CONTROLS STATEMENTS

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240 (d)(4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.

USER SAFETY RECOMMENDATIONS

Users Must:

- Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing immediately if pesticide gets inside. Wash contaminated area thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing.

ENVIRONMENTAL HAZARDS

Do not contaminate water when disposing of equipment washwaters. This product is highly toxic to bees exposed to direct treatment or residues on blooming crops and weeds. Do not allow this product to drift to blooming crops or weeds are visiting the treatment area. This product is toxic to wildlife and highly toxic to aquatic invertebrates.

DIRECTIONS FOR USE

It is a violation of the Federal law to use this product in a manner inconsistent with its labeling. A copy of this label must be in the possession of the user at the time the product is applied.

READ THIS LABEL: Read the entire label and follow all use directions and precautions.

For use only to control burrowing shrimp in intertidal commercial shellfish beds of Washington State's Willapa Bay and Grays Harbor.

MIXING INSTRUCTIONS:

To prepare the application mixture, add a portion of the required amount of water to the spray tank, begin agitation, and add the Protector 2F. Complete filling tank with the balance of water needed. Be sure to maintain agitation during both mixing and application.

Do NOT formulate this product into other end-use products.

APPLICATION INSTRUCTIONS:

To control burrowing shrimp in intertidal commercial shellfish beds [of Washington State's Willapa Bay and Grays Harbor], apply at a maximum rate of 0.5 lb a.i. imidacloprid /acre per year using the following properly calibrated application equipment:

- Helicopters equipped with boom $\frac{3}{4}$ as long as rotor diameter equipped with Accuflo or similar nozzles
- Backpack sprayer.
- Ground based vehicle with boom.

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 500ft.
- 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 aerially during Federal holiday weekends. During aerial applications, all public access areas within one-quarter ($\frac{1}{4}$) mile and all public boat launches within a quarter ($\frac{1}{4}$) mile radius of any bed scheduled for treatment shall be posted. Public access areas shall be posted at 500 foot intervals at those access areas more than 500 feet wide. Signs shall be a minimum of 8 $\frac{1}{2}$ 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 shell fish 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.

- The sign will include lettering shall be in bold black type with the word "WARNING" or "CAUTION" at least one-fourth (1/4) of an inch high. Signs shall be posted so they are secure from the normal effects of weather and water currents, but cause no damage to private property. Signs shall be posted at least 2 days prior to treatment and shall remain for at least 30 days after treatment.

SPRAY DRIFT MANAGEMENT:

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment-and-weather-related factors determines the potential for spray drift. The applicator and the entity authorizing spraying are responsible for considering all these factors when making decisions.

To minimize spray drift, the applicator should be familiar with and take into account the following drift reduction advisory information. Additional information may be available from state enforcement agencies or the Cooperative Extension on the application of the product.

The best drift management strategy and most effective way to reduce drift potential are to apply large droplets that provide sufficient coverage and control. Applying larger droplets reduces drift potential, but will not prevent drift if applications are made improperly, or under unfavorable environmental conditions (see WIND, TEMPERATURE AND HUMIDITY, and TEMPERATURE INVERSIONS).

CONTROLLING DROPLET SIZE

- Volume – Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with higher rated flows produce larger droplets.
- Pressure – Do not exceed the nozzle manufacturer's recommended pressures. For many nozzle types, lower pressure produces larger droplets. When higher flow rates are needed, use higher flow rate nozzles instead of increasing pressure.
- Number of Nozzles – Use the minimum number of nozzles that provide uniform coverage.
- Nozzle Orientation – Orienting nozzles so that the spray is released parallel to the airstream produces larger droplets than other orientations and is recommended practice. Significant deflection from the horizontal will reduce droplet size and increase drift potential.
- Nozzle Type – Use a nozzle type that is designed for the intended application. With most nozzle types, narrow spray angles produce larger droplets. Consider using low-drift nozzles. Solid stream nozzles oriented straight back produce the largest droplets and the lowest drift. Do not use nozzles producing a mist droplet spray.

APPLICATION HEIGHT

Making applications at the lowest possible height (helicopter, ground driven spray boom) that is safe and practical reduces exposure of droplets to evaporation and wind.
ground) upwind. Swath adjustment distance should increase with increasing drift potential (higher wind, smaller droplets, etc.).

WIND

Drift potential is lowest between wind speeds of 3-10 mph. However, many factors, including droplet size and equipment type, determine drift potential at any given speed. Application should be avoided below 3 mph due to variable wind direction and high inversion potential. NOTE: Local terrain can influence wind patterns. Every applicator should be familiar with local wind patterns and how they affect spray drift.

TEMPERATURE INVERSIONS

Drift potential is high during a temperature inversion. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud, which can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing.

AERIAL APPLICATION METHODS AND EQUIPMENT HELICOPTERS ONLY

Water Volume: Use 2 or more gallons of water per acre. The actual minimum spray volume per acre is determined by the spray equipment used. Use adequate spray volume to provide accurate and uniform distribution of spray particles over the treated area and to avoid spray drift.

Managing spray drift from aerial applications: Applicators must follow these requirements to avoid off-target drift movement: 1) boom length – the distance of the outmost nozzles on the boom must not exceed $\frac{1}{4}$ the length of the rotor, 2) nozzle orientation – nozzles must always point backward parallel with the air stream and never be pointed downwards more than 45 degrees, and 3) application height – without compromising helicopter safety, applications should be made at a height of 10 feet or less above the crop canopy or tallest plants. Applicators must follow the most restrictive use cautions to avoid drift hazards, including those found in this labeling as well as applicable state and local regulations and ordinances.

GROUND APPLICATION (BROADCAST)

Water Volume: Use 5 or more gallons of water per acre. The actual minimum spray volume per acre is determined by the spray equipment used. Use adequate spray volume to provide accurate and uniform distribution of spray particles over the treated area and to avoid spray drift.

Spray tank should have constant agitation to assure adequate mixing of product.

AERIAL APPLICATIONS

All precautions should be taken to minimize or eliminate spray drift. Helicopters can be used to apply PROTECTOR 2F; however, DO NOT make applications by helicopter unless appropriate buffer zones can be maintained to prevent spray drift out of the target area, or when spray drift as a result of helicopter application can be tolerated. Aerial equipment designed to minimize spray drift, such as a helicopter

equipped designed to minimize spray drift, such as a helicopter equipped with a Microfoil™ boom, Thru-Valve™ boom or raindrop nozzles, must be used and calibrated. Except when applying with a Microfoil boom, a drift control agent may be added at the recommended label rate. To avoid drift, applications should not be made during inversion conditions, when winds are gusty or any other conditions which allow drift. Side trimming is not recommended with PROTECTOR 2F unless death of treated tree can be tolerated.

GROUND APPLICATIONS

Low Volume

Use equipment calibrated to deliver 5 to 20 gallons of spray solution per acre.

For low volume, selected proper nozzles to avoid over-application. Proper application is critical to ensure desirable results.

Restrictions During Temperature Inversions

Because the potential for spray drift is high during temperature inversions, do NOT make air applications during temperature inversions.

Mixing and Loading Requirements

The use of a properly designed and maintained containment pad for mixing and loading of any pesticide into application equipment is recommended. If containment pad is not used, maintain a minimum distance of 25 feet between mixing and loading areas and potential surface to groundwater conduits such as field sumps, uncased well heads, sinkholes, or field drains.

container. Do not reuse or refill this container. Offer for recycling if available. Triple rinse or pressure rinse container (or equivalent) promptly after emptying.

Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank. Fill the container 1/4 full with water. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least one complete revolution, for 30 seconds. Stand the container on its end and tip it back and forth several times. Turn the container over onto its other end and tip it back and forth several times. Empty the rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Repeat this procedure two more times.

Pressure rinse as follows: Empty the remaining contents into application equipment or a mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank or collect rinsate for later use or disposal. Insert pressure rinsing nozzle in the side of the container, and rinse at about 40 psi for at least 30 seconds. Drain for 10 seconds after the flow begins to drip.

This product is registered by the Willapa-Grays Harbor Oyster Growers Association, P.O. Box 3, Ocean Park, WA 98640

STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage or disposal.

Pesticide Storage: Store in a cool, dry place and in such a manner as to prevent cross contamination with other pesticides, fertilizers, food, and feed. Store in original container and out of reach of children, preferably in a locked storage area. Handle and open container in a manner as to prevent spillage. If the container is leaking or material spilled for any reason or cause, carefully dam up spilled material to prevent runoff. Refer to Precautionary Statements on label for hazards associated with the handling of this material. Do not walk through spilled material. Absorb spilled material with absorbing type compounds and dispose of as directed for pesticides below. In spill or leak incidents, keep unauthorized people away.

Pesticide Disposal: Wastes resulting from the use of this product may be disposed of at an approved waste disposal facility.

CONTAINER DISPOSAL [HANDLING]:

For containers smaller than 5 gallons: Nonrefillable container: Do not reuse or refill this container. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container 1/4 full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other procedures approved by State and local authorities. Plastic containers are also disposable by incineration, or, if allowed by State and local authorities, by burning. If burned, stay out of smoke.

Nonrefillable Containers Larger than 5 Gallons: Nonrefillable