From:	Jim Gibbons
To:	Hamel, Kathy (ECY)
Subject:	Comments for NPDES
Date:	Thursday, March 08, 2012 9:08:39 AM
Attachments:	Kathy Hamel NPDES letter.pdf

Kathy Hamel
Washington State Department of Ecology
P.O. Box 47600
Olympia, AW 98504

Dear Ms. Hamel,

I am writing to express my support for the chemical control of Zostera japonica on commerical shellfish beds and the current NPDES permit for its use that you are considering. Perhaps more importantly, I hope the Department of Eoclogy will begin considering the need to control Zostera Japonica on all tidelands, not just commercial shellfish beds where Zostera Japonica is present.

I base my support on the observations of long time shellfish farmers in Willapa Bay, the area where the infestation is most advanced. My understanding from people I know and respect is that there is no question that the ecology of Willapa Bay is being material changed. I also think there is no question that no one yet can say whether this change is a positive one or a negative one in total while it definitely is having a VERY adverse effect on the shellfish growers in Willapa.

I have attached a letter that has been first sent to you and then forwarded to me. It's not that I don't think you will read the first letter sent to you, I only wish to emphasize the soundness of the arguments presented in Dr. Richard Wilson's letter. I've found Dick Wilson to be one of the best marine scientists I know, particularly as it pertains to the ecosystem in Willapa Bay. I hope you read Dicks' letter carefully and think about his experience, logic and reasoning.

Thank you.

Jim Gibbons, President

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March 6, 2012

Kathy Hamel
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Dear Ms. Hamel,

First I wish to thank you and your department for the chance to offer comments on the requirements for an NPDES permit to control *Zostera japonica* on our shellfish cultivation areas. I hope to present a view that control of *Zostera japonica* is critical for not only the physical disruption of shellfish crops but most important, that eelgrass growths over time modify the sedimentary substrate and change the open productive mudflats critical for estuary productivity into non-transitory sulfide detrital bacterial areas of little benefit except for unique in situ forms such as polychaete worms.

My comments are based on the premise that the primary bases of the estuary food web are small single celled algae called diatoms. I have not heard anyone doubt that diatoms and especially benthic diatoms, if not the most important, certainly are near the top in importance as the basis element to the estuary food web. Diatoms are a diverse group characterized by silica tests (shells) and as plants require a specific habitat that makes available the nutrients, a place of attachment (even if temporary), an open oxygenated intertidal to allow sunlight and current flows to transport. The intertidal mudflats (especially oyster beds) meet these conditions thus dozens of different species spanning a size range of a few microns to large visible individual cells (Fig.1). The single celled diatoms and simple chain forms reproduce by cell division and the mudflat area acts as a large nursery streaming diatoms small zooplankton with the currents. In spring and summer mats often 100 meters long of benthonic diatoms float off the tidal flats and appear much like oil on the surface. Of course, with such a large food source available the various grazer plankton probably decend on or set up residence upon the mud flat. This would not be possible within a thick eelgrass area. As Brook's, 1993, (Changes in Arthropod and Mollusk populations ..... on Oyster Beds in Willapa Bay; for EPA data call in) sampling on oyster beds showed, within the *Amphipoda*, *Ostracoda*, *Decapoda*, *Cumacea* and *Mollusca* an abundance ranging between 20,000 to 80,000 individuals per square meter over and in the mud flat. Thus, this active diatom and micro plankton square meter of mud flat is putting forth with each flush of the tide a huge contribution to the entire estuary. The over growth of *Zostera japonica* can eliminate this production by changing or eliminating the conditions necessary for diatom growth.

I want to emphasize the small size of the taxa these comments are focused on and probably the reason most often overlooked for importance (Fig 1). A tremendous number of plants and animals involved with the basis of the food web measure within the 5 -200 micron size. Many of the primary grazers (like the clam larva) are less than a millimeter in length. These primary consumers thus become the primary prey for others. Single cell algae within the 5 to 100 micron size are food for hundreds of species including clams and oysters. Often I think a habitat value in some studies were based on what macro faunal elements might be present. This does not take into account the transitory habits of those forms to and from the mud flat. What should be examined are those very small forms, which are basic to the process as they are benefiting the entire bay.

Fig. 1. Microscope photo image from a seawater sample over an oyster growing intertidal area. Visible scale present is 1mm marked off in 10 micron units. The width of the image is ~ 1.2 mm. There are probably at least 20 species of diatoms (count them) and in the center one big (~200 micron) clam larvae. Note also the dark organic decay particles, which could become part of a permanent deposit if caught up within a thick Z. japonica habitat.

Since *Z. japonica* is the focus of this NPDES discussion the remarks for the most part will focus on this species. This sea grass happens to favor the higher intertidal which seem also a favorite for the diatom community. This grass has spread through other brackish areas on other continents and mention will be made of work on *Zostera noltii* (= *Z. japonica*). Both species of eelgrass however, impact shellfish culture so these comments are not meant to totally exclude the lower tidal and larger *Z. marina.* The main thrust here is that the encroachment of *Z. japonica* over the open tidal mud flats changes the benthic substrate and thus the fauna and flora associated with it. It modifies the role of the natural sedimentary aggradation and degradation vital for storage and release of nutrients for the entire diatom assemblage and those dependent upon it in the microbenthic community. The invasive eelgrass *Z. japonica*, forms meadows over time and can develop an organic rich substrate which leads to an increased sulfide environment with a bacterial component replacing the diatom rich benthic of the open tidal areas. As the eelgrass meadow thickens and organic material accumulates over time the faunal component change from one rich in both mobile and in situ crustacea (in the roles of prey, grazers, and predator) to the detrital bacterial consumers such as polychaete worms. The very food web is severely disrupted. In short, what has changed is the loss for the tidal area of the prey species (diatoms and crustacea) the very base of the food web important to other areas of the estuary. The covering of the open silt, sand, clay, organic flats rich in nutrients by eelgrass which eliminates the diatom production takes away a vital component of the overall estuary production. Not much different than would diking off or putting up a bulkhead around a section of the high intertidal.

These assertions are a basis of the research efforts by scientists in various countries such as in Do, et al., ('Sea grass colonization: Knock-on effects on the zoobenthic community, populations and individual health'. http://adsabs.harvard.edu/abs/2011ECSS...95..458T . Their testing showed that the increased organic matter deposition in sea grass could create unsuitable habitat for buried bivalves with hypoxic conditions and enhanced sulfide concentrations at the sediment surface. Rosenberg, et al., also reported this 1991. "Hypoxic tolerance of marine benthic fauna", Mar. Ecol. Prog. Ser. v79 pp127-131.

The most important premise to this assertion is that the single celled benthic diatom fauna is key to the zooplanktonic and macro estuary residents. Composed largely of crustacea but containing the larvae of many forms such bivalves, etc. That this interactive, often mobile, interaction of food web elements is dependent upon the open or oxygenated mudflats containing nutrients. The mudflat (heterogeneous deposit of sand, silt, clay mineral, organics, etc.) holds the collection of minerals and nutrients, many of which are a product of the weathering of the sedimentary and igneous rocks. The Willapa watershed drains by means of many small creeks and streams into the bay to add the upland nutrients. This normally occurs during the rainy periods and this mudflat encapsulation not only keeps the valuable compounds, trace elements, nutrients, etc., from leaving the bay but also holds them until the seasonal diatom growth period is fully in need for them. Of note is one important component of the weathering process, anhydrous sodium silicate, and the usable form of SiO_2 essential to form the tests of diatoms.

Dozens of single celled diatom species can be present within a drop of seawater or on a square millimeter of the surface area of an attachment place. The small grazer crustaceans are primary consumers but then again so are bivalves such as clams and oysters. It all happens from that mudflat origin which can be modified or eliminated by an infestation of eelgrass. A few turions are not a problem until they become the dominant element and provide the stabilizing root structures and density to block light at key times of the year, restrict currents and harbor a bacterial feast for worms on an elevated sulfide organic rich sediment. Thus by the sedimentary changes the general floral and faunal composition once containing beneficial forms such as diatoms, crustaceans and bivalves can revert to an organic bacterial environment incompatible to the basic estuary food web organisms. For a sulfide build up to occur many factors must be included thus it is important to study the entire history of a habitat.

This faunal change seems to be illustrated by a study from sampling specific habitats in Grays Harbor by Ferraro and Cole, 2011. (Ecological periodic tables for benthic macro faunal usage of estuarine habitats in the US Pacific Northwest. Estuarine Coastal and Shelf Science 94: 36-47., 2011). For example, within the *Zostera japonica* habitat sediment, the ten most abundant forms, representing 83% of all forms, were the polychaete annelids and most are tube forming (in situ forms). The lesser current and organics thus raise the H_2S level replacing the once exposed mud flat surface. Even as winter approaches and the eelgrass stems and blades in most patches break off the tough root structures remain and help hold over the newly established organic deposits and the faunal elements new to the mud flat. The worms have been established and a new fauna not contributing to the water column or adjacent areas as before takes over. This seems to be representative of a more organic rich elevated sulfide environment created by the Japanese eelgrass. In contrast, was the high percent of amphipods on the well-oxygenated Willapa oyster bed habitat sampled extensively during the summer by the Ken Brooks' study for EPA. Here he found *Corophium* (a key food item for young fish, e.g. salmon) and *Leptochelia savignyi* I seem to recall made up ~90% of the 50 plus species of all crustacea and mollusca present. These are known diatom grazers that would not be present if not for the diatoms of a particular size and were very sparse around the heavy growth of eelgrass in the Grays Harbor report. By examination of the macro fauna one can get a good idea of the suitability of the habitat for overall production. To show variation in this faunal switch, in France, it is a small bacterial consuming gastropod, *Hydrobia ulvae*, which replaces *Corophium* as the diatom selection is reduced and eliminated in a Z. *noltii habitat*, T. Fenchel, et al., 2008. (MARINE BIOLOGY Volume 30, Number 2, 119-128, DOI: 10.1007/BF00391586)

There also has to be competition between the diatoms and eelgrass for those nutrients within the benthic sediments. I am not sure which but most plants have many in common. Another study concluded the eelgrass vegetation limits hydrodynamics and alters suspension filtration efficiency by filter feeders (Coen and Heck, 1991). When sea grass was already present and recruitment rate was high, the number of recruits was significantly lower in sea grass bed, possibly due to predation (assume by worms) that is higher in the sea grass for small prey such as juvenile cockles (Edgar, 1999). Mean shell length (cockles in Do, et al.) was always smaller in seagrass (eelgrass, *Zostera noltii = Z. japonica*). Just removing the diatom flora from the sedimentary interface would account for slow growth. These bivalve impacts of slow growth and greater mortality in summer times are what we observe on our oyster growing areas

One of the most direct examples, which can be understood by most, is the benthic diatom (in partially open mud flat areas) being grazed on by amphipods such as *Corophium* a key food item in the northwest for young salmon. Of course, the multitude of diatom types and sizes which can inhabit an area of mud flat (with some attachment objects like shell or some grass) are key to bivalves also ... as they release and float to other areas.

I do firmly agree with the other negative impacts beside the disruption of the food web as listed by others. There is the expected disruption of current, tidal and wave action and its ability to transport sediment and nutrients. Sunlight hitting the mud flat is a plant necessity and the warmth of the mud flat would be reduced or eliminated in the eelgrass habitat. However, the dark warmth of the organics in the grass habitat would be supportive of greater bacterial action and decomposition. As a long time member, including a board position at one time, of the Audubon society, I have observed the sad disruption to the feeding of migrating shore birds.

However, both migratory and wintering shorebirds use our oyster beds to feed around the year, but do not even seem to land on the eelgrass areas. Note: Over 10,000 Dunlin observed from Bay Center on the Christmas Bird Count after the Spartina was removed, which illustrates the abundance and compatibility among the user groups.

In short, every acre of eelgrass which can be opened up by control to allow diatoms and the array of grazers should add to the overall productivity of the bay - albeit temporarily. The sediments can again lose the organic layer when exposed to wave, tidal and current energy when the eelgrass is removed. The crustacea move in often being the grazers and prey both. The food web should reestablish with the sea grass removal. Eelgrass will return but shellfish farming can offer even the rotational nature and the chance to contribute to the entire bay for a period of time. We see this daily ... and Willapa, for over 100 years, reflects the productivity from this type of crop rotation.

Figure 2. Oyster bed with oysters about a year from harvest. Check out the macro algae and eelgrass as part of a thriving diatom – micro – macro assemblage. Imagine diatoms attached to all with the open mud area supplying nutrients. Within a year these oysters and bed will be cleaned off and the cycle repeated with the planting of more seed on oyster shells. It takes time for the process of renewal and optimal abundance and habitat formation but it does not allow the area to become unproductive by becoming a meadow of eelgrass. This particular piece of oyster ground has been farmed for over 100 years and is just as productive and beneficial to the entire estuary as the day it started. If eelgrass were allowed to grow here it would probably be non productive to the bay as a whole and a bacterial sulfide area.

It is important that the resource agencies soon recognize the destructive nature of this invasive, *Zostera japonica*. It will have a negative impact to the public lands and fisheries. At a minimum they should assist in the process of removal from public shellfish areas even though they may not want to cooperate with private oyster lands. At least support our efforts when (and if) they realize it benefits natural resources they have charge of. Currently only the shellfish farmer is trying to do battle with this destructive plant. Eelgrass will gradually shut down intertidal production important to the crustacea and Mollusca and follow right up the food chain to such important forms such as crab and fish. Study must be preformed by those responsible. An assessment cannot be from a causal stroll across the intertidal in April but must be scientifically analyzed over various seasons. The majority of changes are chemical or involve the very small in the plant and animal groups and just counting how may fish or worms are present does not represent the major change which can take place at the microscopic level. The development of an eelgrass meadow with *Z. japonica* will impact the food web for the entire estuary just as would diking off or building a bulkhead across the upper intertidal. We need to stop worship of the eelgrass and realize when agencies promote its growth they are actually helping to destroy the productive capacity for the entire bay or estuary. We have experienced the warning signs in the shellfish growing areas as the eelgrass takes over. These deleterious effects, especially within the diatoms, will reach to many important forms outside the shellfish growing areas.

As a final comment, I hope the requirements of the NPDES permit, assuming it becomes necessary, reflect the seriousness of this invasive grass and not end up adding a great deal of difficulty or expense to the control process. That the requirements are on the premise that the shellfish growers are in fact taking the lead in pointing out the seriousness of this invasive and spending time and money doing the work that the resource managers most likely will have to consider soon to help the entire bay. At this stage it the resource agencies would do well to learn about the deleterious impacts *of Z. japonica* and work with the growers in the battle. Hopefully, if the permit is necessary it will reflect this type of cooperation.

Respectively,

Richard L. Wilson, Ph.D, President

PS Note: I realize the majority of reports show sea grasses like Z. japonica as supportive of higher numbers of fish and macro invertebrates. However, I think this begs the question why? Does it mean or imply that the entire food cycle is present? Is the grass just for cover to prey on those planktonic forms, which blunder into or get trapped in the tangle of grass? I did not see studies, which reported the diatom-primary foragers prevalent within the eelgrass. The sampling studies in Grays Harbor show this not the case. Does the advantage of the grass cover and abundance of say larger nektonic predators like fish really depend upon how productive the surrounding open areas are in supplying diatoms and the associated micro invertebrates to develop that portion of the food web they can utilize? Would not the gradual take over by an invasive eelgrass over certain tidal levels cause the decline of those same species, for which it provided cover and habitat as it gradually phased out the conditions and source of the primary production? Needs to be studied!