Non-native Species at the Padilla Bay NERR

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INTRODUCTION

There are non-native species present within the Reserve boundaries. Non-native species can be problematic in that they can compete for space or resources native species need to survive. Some plant species, such as *Spartina*, can significantly change the habitat through sediment accretion. As non-native plants often lack the predators (such as insects) or diseases that native plants encounter, the populations can explode or become monotypical stands.

PLANTS

Plankton/Algae

As few freshwater habitats exist within Reserve boundaries, little effort has been given to identifying potential non-native freshwater plankton or algal species and none have been identified. We have not put research effort into identifying possible non-native marine phytoplankton. There is a possibility some exist within the Reserve because of our proximity to shipping and historical ballast release.

Wonham (2001) provides a historical review of marine biological invasions in the Pacific Northwest. The only alga listed in Wonham that overlaps with our species list is *Sargassum muticum*. Giver (1999) looked at the epibiont community associated with *Sargassum muticum* in northern Puget Sound. She compared faunal communities on *S. muticum* and *Laminaria saccharina* (a native brown alga). *Sargassum muticum* is able to support a more abundant and species rich community than *L. saccharina* because of its high degree of morphological complexity. Two non-native epifaunal species found on *S. muticum* (*Harmothoe imbricata*, a scaleworm, and the mussel *Mytilus* sp.) also occurred on *L. saccharina*.

Hayden (1998) studied green macroalgae in Padilla Bay. She stated that "addressing the question of whether the macroalgae in Padilla Bay are native or introduced requires phylogenetic analysis; however, it is premature to undertake this analysis until taxonomic questions are resolved. It is possible that non-native chlorophytic macroalgae occur in Padilla Bay given the active shipping that occurs in the area."

Table 1 contains plants from our species list known to be non-native. Noxious weed classification is also noted and country of origin where known. Brass buttons (*Cotula coronopifolia*) occurs in at least one of our salt marshes (Granger and Burg, 1986). This plant originated in the southern hemisphere and was probably transported as solid ballast to new locations. The first record is unknown (Wonham, 2001).

Spartina alterniflora is native to the Atlantic and Gulf Coasts of the U.S. and was introduced to Padilla Bay in the 1940s as an intentional planting by the Dike Island Gun Club.

Spartina anglica is the fertile cross of *S. alterniflora* and *S. maritima* (a British species). Our infestation comes from the spread of an original planting of either *S. towsendii* or *S. anglica* on (Camano Island) in the 1960s. The first inventory of *S. alterniflora* by the Reserve was conducted in 1987 (Wiggins and Binney, 1987). Another inventory in 1991 documented the spread of *S. alterniflora* in Padilla Bay (Riggs, 1992). Riggs and Bulthuis (1994) documented net aerial primary productivity of *S. alterniflora* in Padilla Bay in 1992-93. NAPP was 1,520 g/m^2/year in this *Spartina* marsh located on Dike Island in south Padilla Bay. This was similar to NAPP for *S. alterniflora* in creek bank and high marsh habitats in Maine (Wiegert and Evans, 1964) and was somewhat higher than NAPP reported for marshes in North Carolina (Wiegert and Evans, 1964; Lomnicki et al., 1968) and Virginia (Reidenbaugh, 1983). Riordan (2000) looked at the extent and potential for further invasion of *Spartina anglica* into Puget Sound salt marshes and mud flats. Ball (2002) placed Sedimentation Elevation Tables (SET) and feldspar marker horizons and did Pb-210 analysis and sediment core analyses to determine rates of shallow subsidence, current and previous marsh accretion rates, and sediment composition within cored marsh sections in an area where *Spartina alterniflora* had been treated for six years. Maricle and Lee (2003) found that mowing, as a treatment method, has little effect on oxygen transport within *S. anglica* and may only function to prevent seed set in mature plants. An NERR Graduate Research Fellow, Eric Hellquist, has looked at *Spartina* colonization of both mudflat and salt marsh at different intertidal elevations. In low intertidal zones (intact and removal plots), seedling mortality was higher among native vegetation than seedlings growing with native vegetation removed. In the low and middle intertidal zones, tiller production was greater in removal plots. Seedlings that persisted in the *Salicornia* zone among native vegetation had fewer tillers, but were taller than seedlings in removal plots. In the high intertidal zone, mortality of seedlings was high, tiller production was low and height was reduced in both treatments (Hellquist, pers. communication).

Our control efforts started in 1991 with research on the potential effects of applications of Rodeo® to *Spartina alterniflora*, native salt marsh vegetation, eelgrass and eelgrass epiphytes (Bulthuis and Scott, 1993; Bulthuis and Shaw, 1993; Bulthuis and Hartman, 1994). An experimental wiper application of Rodeo®, in *Spartina alterniflora* in 1994 in two habitats on Dike Island (exposed and protected) showed no significant difference in stem densities between controls and treatments in either habitat (Riggs and Bulthuis, 1995). We started active control of *Spartina alterniflora* in 1994 with wiper applications of Rodeo®/LI700®, to the outlying clones. We modified that in 1995 by mowing a month prior to applying Rodeo®/LI700®. We also conducted a study in *Spartina anglica* using six different treatment methods (mow only, mow/cover, mow/glyphosate 10 qts/ac, mow/glyphosate 20 qts/ac, glyphosate 10 qts/ac, glyphosate 20 qts/ac) and found a significant reduction in live stem

densities with four of the six treatments (mow/cover, glyphosate 20 qts/ac, mow/glyphosate 10 qts/ac, mow/glyphosate 20 qts/ac) (Riggs and Bulthuis, 1996). We were still using wipers in 1996, which was the first year we actively controlled *Spartina anglica*. Employing Integrated Weed Management principles, we hand-pulled seedlings, dug small clumps (<1 foot diameter) and used herbicide (Rodeo®/LI700®, wipers) on any clones >1 foot in diameter.

The acreage of *Spartina* in Padilla Bay peaked in 1997 at around 17.5 acres. 1997 was our first year of active control on the largest *Spartina alterniflora* infestation, which was on Dike Island. We mowed six acres on the west end of Dike Island a month prior to using a backpack sprayer application of Rodeo®/R11®. In 1998, we mowed all of Dike Island a month prior to spraying with backpack and boat-mounted sprayers.

Every year the entire shoreline of Padilla Bay is surveyed to locate infestations or re-growth. There is no growth of *S. alterniflora* at the outlying clones and the areas have re-vegetated naturally with *Salicornia virginica*. We continue to see infestation at the Swinomish Spit because there are still seed sources outside the Reserve. Some infestation remains in Telegraph Slough and we monitor the property just north of Sullivan Minor as there continue to be new plants at that site. We treat any remaining *S. alterniflora* on Dike Island (none in 2011). We plan to continue annual monitoring and control.

Bulthuis (1991) mapped the occurrence of *Zostera marina* (native) and *Zostera japonica* (non-native) based on 1989 aerial photographs. *Zostera japonica* originated on the north Pacific coast of Asia (Wonham, 2001) and was introduced into this region through commercial oyster culture some time between the 1930s and 1950s. Merrill (1995) looked at the effect of *Z. japonica* on the growth of *Z. marina* in their shared transitional boundary.

Z. japonica inhibited the leaf growth and shoot recruitment of *Z. marina* in August. This suggests competitive interaction between the species. Pawlak (1994) discusses the management considerations of *Z. japonica*. He states "Neither WDNR nor WDFW see an immediate negative effect from the spread of *Z. japonica*" and may view "*Z. japonica* as a 'no cost' opportunity to provide additional fish habitat and improve feeding grounds for migratory waterfowl." *Zostera japonica* was added to the noxious weed list in 2012 as a Class C weed but only has that designation in commercial shellfish beds. Thom (1987) found that *Z. japonica* formed a band at upper elevations, and mixed with *Z. marina* at about 0.3m to 0.6m MLLW. Annual net primary productivity for the system was 351 gC/m^2. Epiphytic algae, *Z. japonica* and *Z. marina* were responsible for 50, 2 and 48% of this production, respectively. Some field truthing of *Z. japonica* and *Z. marina* (turions/m^2, biomass,length of blade, blades/turion, blade area, leaf area index) are reported by Webber, et al (1987). Lepla (1991) compared invertebrate communities living in *Zostera marina* and *Z. japonica*. He found more taxa in the aerial portions of *Z. marina* vs. *Z. japonica* (7/5). He found more taxa in *Z. japonica* rhizomes vs. *Z. marina* (12/7). The rhizome communities of both *Zostera* species had higher species richness

and evenness than did the communities living on the leaves. Hourdequin (1994) found that *Z. marina* grew significantly faster in experiments where it was isolated from *Z. japonica*.

We have made an active effort to control Canada thistle (*Cirsium arvense*, Class C noxious weed), Bull Thistle (*Cirsium vulgare,* Class C noxious weed), English Holly (*Ilex aquifolium*), and Bay Laurel (*Laurus nobilis*) on Reserve property. The last three are used as residential plantings and the seeds are spread by birds or small mammals.

ANIMALS

We have some shallow depressions in the upland that are seasonally filled with freshwater. They are a maximum of six inches deep. We have not focused on these habitats so do not know what pond species might be present and if any of those are non-native.

There are invasive plankton on the outer coast of Washington, but they do not seem to be able to survive in Puget Sound and the inner waterway (pers. comm. with Jeff Cordell, 2/03). Only one species of sponge, *Halichondria panicea*, has been identified to date in the bay (Kight, 1998) and it is a native species. The invasive worms in Table 1 were identified by cross-referencing our species listing with Wonham (2001) and are: *Heteromastus filiformis, Polydora cornuta* (=*ligni*), *Pseudopolydora kempi*, and *Strebliospio benedicti*. They probably were all introduced with oyster culture.

We do not have invasive crabs yet, but European green crabs (*Carcinus maenas*) are moving up the outer coast (Willapa Bay and Grays Harbor) and have been found on Vancouver Island (Yamada, 2001). We have been using Washington State Department of Fish and Wildlife protocol (minnow traps or folding fish traps) to monitor for green crab since 2001. Chinese mitten crab (*Eriocheir sinensis*) also has the potential to invade in Puget Sound though none have been reported here yet.

Japanese littlenecks and Japanese oysters have been intentionally introduced for commercial culture (*Venerupis phillipinarum* and *Crassostrea gigas*). Soft-shell clams (*Mya arenaria*) were accidentally introduced with oyster culture. Education staff at the Reserve first noticed *Nuttallia obscurata* at the Bay View State Park beach around 1999. It is a relatively recent invader that may have been introduced via ballast water to English Bay, British Columbia (Barkas, 2002). Barkas studied the distribution of *N. obscurata*, competition with *Protothaca staminea* and *Venerupis philippinarum* , and habitat characteristics. She found *Nutallia* at the mouth of Hood Canal, in Discovery Bay, at Holmes Harbor on Whidbey, on San Juan Island and in Chuckanut Bay.In the competition experiment, she found extremely high mortality of *N. obscurata* in the habitat range primarily occupied by *P. staminea*. She also found *N. obscurata* preferred coarse-grained sediments.

Cooper (1997) tested whether *Batallaria zonalis* (aka *B. cumingi, multiformis, aterrima* and *attramentaria*) in *Zostera japonica* prefer sites with high eelgrass coverage vs. sites without and found they seek sites with eelgrass cover. They did not appear to obtain nutrition from the eelgrass, but rather from diatoms. Most of the snails were also infested with parasitic flukes. O'Connor et al. (2001) used an exclusion cage experiment to test for the impacts of B. attramentaria on sediment cholorphyll *a* concentration, sediment particle size, percent cover of eelgrass and macrofaunal densities. There was no significant change in the variables listed but apparent patterns suggested there are complex interactions between the variables and *B. attramentaria. Crepidula convexa, C. fornicata* and *Urosalpinx cinerea* originate in the western Atlantic and were introduced with oyster culture. *Nassarius fraterculus'* origin is the western Pacific and was introduced with oyster culture (Wonham, 2001). The amphipod *Ampithoe valida* probably came with oyster culture but is known to have other avenues for introduction as well (ballast water, ship fouling) (Wonham, 2001).

Atlantic salmon (*Salmo salar*) are farmed in Puget Sound and are a possible threat but -- to date -- have not been recorded in Padilla Bay.

Terrestrial non-native animals include the Virginia opossum (*Didelphis virginiana*), Eastern cottontail (*Sylvilagus floridanus*) and Norway rat (*Rattus norvegicus*.

REFERENCES

Ball, D. 2002. The effects of *Spartina alterniflora* eradication on localized sediment dynamics in Padilla Bay, Washington. Final report to the Padilla Bay National Estuarine Research Reserve, Mount Vernon, Washington.

Barkas, J. 2002. Assessment of the range, habitat and potnetial impact of an exotic bivalve (*Nuttallia obscurata*) on Puget Sound resident burrowing bivalves. Master's Thesis. Western Washington University, Bellingham, Washington.

Bulthuis, D.A. 1991. Distribution of habitats and summer standing crop of seagrasses and macroalgae in Padilla Bay, Washington. Padilla Bay National Estuarine Research Reserve Technical Report No. 2. Mount Vernon, Washington.

Bulthuis, D.A. and M.J. Hartman. 1994. Effects of application of glyphosate during summer on epiphytes of the eelgrasses *Zostera marina* and *Zostera japonica* in Padilla Bay, Washington. Padilla Bay National Estuarine Research Reserve Technical Report No. 9. Mount Vernon, Washington.

Bulthuis, D.A. and B.A. Scott. 1993. Effects of application of glyphosate on cordgrass, *Spartina alterniflora*, and adjacent native salt marsh vegetation in Padilla Bay, Washington. Padilla Bay National Estuarine Research Reserve Technical Report No. 7. Mount Vernon, Washington.

Bulthuis, D.A. and T.C. Shaw. 1993. Effects of application of glyphosate on the eelgrasses *Zostera marina* and *Zostera japonica* in Padilla Bay, Washington. Padilla Bay National Estuarine Research Reserve Technical Report No. 8. Mount Vernon, Washington.

Cooper, C. 1997. Factors affecting the abundance of the introduced snail, *Batillaria zonalis*, at Padilla Bay, Washington. Student report, Friday Harbor Laboratories, University of Washington, Friday Harbor, Washington.

Giver, K.J. 1999. Effects of the invasive seaweed *Sargassum muticum* on native marine communities in northern Puget Sound, Washington. Master of Science Thesis, Western Washington University, Bellingham, Washington.

Granger, T. and M. Burg. 1986. Plant communities of a salt marsh in Padilla Bay, Washington. Padilla Bay National Estuarine Research Reserve Reprint Series No. 4. Mount Vernon, Washington.

Hayden, H.S. and J.R. Waaland. 1998. Green tide algae of the Padilla Bay estuary, Washington. Padilla Bay National Estuarine Research Reserve Technical Report No. 20. Mount Vernon, Washington.

Hourdequin, M. 1994. Interaction between two species of seagrass in Padilla Bay: evidence for competition between *Zostera marina* and the exotic *Zostera japonica.* Student report, Friday Harbor Laboratories, University of Washington, Friday Harbor, Washington.

Kight, J.B. 1998. Species richness, preferred substratum assemblage and identification to the nearest taxonomic level of Phylum Porifera residing in the

intertidal zones of Padilla Bay National Estuarine Reserve, Washington. Student report, Skagit Valley College, Mount Vernon, Washington.

Lepla, K. 1991. Marine invertebrate communities associated with *Zostera marina* and *Zostera japonica* from Padilla Bay, Washington. Student report,

Maricle, B. R. and R.W. Lee. 2003. The effect of mowing on oxygen transport in *Spartina anglica* (Poaceae). Padilla Bay National Estuarine Research Reserve Technical Report No. xx. Mount Vernon, Washington.

Merrill, G.G. 1995. The effect of *Zostera japonica* on the growth of *Zostera marina* in their shared transitional boundary. Padilla Bay National Estuarine Research Reserve Technical Report No. 12. Mount Vernon, Washington.

O'Connor, M., M. Wonham, C. Harley. 2001. Quantifying the impacts of an invader: the Asian mud snail Batillaria attramentaria on the mud flats of Padilla Bay, Washington. Padilla Bay National Estuarine Research Reserve, Technical Report No. 25. Mount Vernon, Washington.

Pawlak, B.T. 1994. Analysis of the policies and management practices of Washington State agencies as they pertain to the seagrasses, *Zostera marina* and *Zostera japonica*. Padilla Bay National Estuarine Research Reserve Reprint Series No. 20. Mount Vernon, Washington.

Riggs, S.R. 1992. Distribution of *Spartina alterniflora* in Padilla Bay, Washington, in 1991. Padilla Bay National Estuarine Research Reserve Technical Report No. 3. Mount Vernon, Washington.

Riggs, S.R. and D.A. Bulthuis. 1994. Estimated net aerial primary productivity and monitoring of selected characteristics of *Spartina alterniflora* in Padilla Bay, Washington, April 1992-May 1993. Padilla Bay National Estuarine Research Reserve Technical Report No. 11. Mount Vernon, Washington.

Riggs, S.R. and D.A. Bulthuis. 1996. Experimental control of *Spartina anglica* in Padilla Bay, Washington. Unpublished draft. Padilla Bay National Estuarine Research Reserve, Mount Vernon, Washington.

Riordan, T.J. Jr. 2000. Assessing the extent and potential for further invasion of Spartina anglica into Puget Sound salt marshes and mud flats. Student report, Department of Zoology, University of Washington, Seattle, Washington.

Thom, R.M. 1988. Benthic primary production in the eelgrass meadow at the Padilla Bay National Estuarine Research Reserve, Washington. Padilla Bay National Estuarine Research Reserve Reprint Series No. 10. Mount Vernon, Washington.

Webber, H.H., T.F. Mumford, Jr, and J. Eby. 1987. Remote sensing inventory of the seagrass meadow of the Padilla Bay National Estuarine Research Reserve: areal extent and estimation of biomass. Padilla Bay National Estuarine Research Reserve Reprint Series No. 6. Mount Vernon, Washington.

Wiggins, J. and E. Binney. 1987. A baseline study of the distribution of *Spartina alterniflora* in Padilla Bay. Padilla Bay National Estuarine Research Reserve Reprint Series No. 7. Mount Vernon, Washington.

Wonham, M.J. 2001. Ecology and management of marine biological invasions: distribution and environmental constraints in *Mytilus galloprovincialis*. Ph.D. dissertation, Department of Zoology, University of Washington, Seattle, Washington.

Yamada, S.B. 2001. Global invader: the European green crab. Oregon State University, Corvallis, Oregon.

Table 1. Non-native species at the Padilla Bay National Estuarine Research Reserve.

Common name	Scientific name
Terrestrial & Wetland Plants	
Common horsetail	*Equisetum arvense*
Giant horsetail	*Equisetum telmateia*
Spreading wood fern	*Dryopteris austriaca*
California hazelnut	*Corylus cornuta*
Stinging nettle	*Urtica dioica*
Sheep sorrel	*Rumex acetosella*
Curly dock	*Rumex crispus*
Lambsquarters	*Chenopodium album*
Field chickweed	*Cerastium arvense*
Pink	*Dianthus armeria*
Celery-leaved buttercup	*Ranunculus sceleratus*
Field mustard	*Brassica campestris*
Shepherd's purse	*Capsella bursa-pastoris*
Peppergrass	*Lepidium virginicum var. menziesii*
Honesty	*Lunaria annua*
Erect cinquefoil	*Potentilla recta*
Himalayan blackberry	*Rubus discolor*
Evergreen blackberry	*Rubus laciniatus*
Scot's broom	*Cystisus scoparius*
Beach pea	*Lathyrus japonicus*
Yellow clover	*Trifolium dubium*
White clover	*Trifolium repens*
Bird vetch	*Vicia cracca*
Crane's bill	*Erodium cicutarium*
Cut leaf geranium	*Geranium dissectum*
Stork's bill	*Geranium molle*
Russian olive tree	*Elaeagnus angustifolia*
Enchanter's nightshade	*Circaea alpina*
Fireweed	*Epilobium angustifolium*
Mare's tail	*Hippuris vulgaris*
Ivy	*Hedera helix*
Queen Anne's lace	*Daucus carota*
Saltwort	*Glaux maritima*
Climbing nightshade	*Solanum dulcamara*
Foxglove	*Digitalis purpurea*
Parentucellia	*Parentucellia viscosa*
English or buckhorn plantain	*Plantago lanceolata*
Seaside plantain	*Plantago maritima*
Fragrant bedstraw	*Galium aparine*
Red elderberry	*Sambucus racemosa var. arborescens*
Canada thistle	*Cirsium arvense*
Bull thistle	*Cirsium vulgare*
Brass buttons	*Cotula coronopifolia*

Smooth hawksbeard	*Crepis capillaris*
Smooth cat's ear	*Hypochaeris glabra*
Hairy cat's ear	*Hypochaeris radicata*
Wall lettuce	*Lactuca muralis*
Prickly lettuce	*Lactuca serriola*
Nipplewort	*Lapsana communis*
Wood groundsel	*Senecio sylvaticus*
Old-man-in-the-spring	*Senecio vulgaris*
Common tansy	*Tanacetum vulgare*
Common dandelion	*Taraxacum officinale*
Quack grass	*Agropyron repens*
Bentgrass	*Agrostis alba*
Cheat grass	*Bromus tectorum*
Orchard grass	*Dactylis glomerata*
Velvet grass/Yorkshire fog	*Holcus lanatus*
Mediterranean barley	*Hordeum geniculatum*
English ryegrass	*Lolium perenne*
Reed canarygrass	*Phalaris arundinaceae*
Smooth cordgrass	*Spartina alterniflora*
Common cordgrass	*Spartina anglica*
Six-weeks fescue	*Vulpia bromoides*
Rat-tail fescue	*Vulpia myuros*
Narrow-leaved cattail	*Typha latifolia*
Estuarine Plants	
Japanese eelgrass	*Zostera japonica*
Sargassum	*Sargassum muticum*
Mammals	
Virginia opossum	*Didelphis virginiana*
Eastern cottontail	*Sylvilagus floridanus*
Norway rat	*Rattus norvegicus*
Invertebrates	
Common slipper shell	*Crepidula fornicata*
Eastern drill	*Urosalpinx cinerea*
Basket shell	*Nassarius fraterculus*
Turret shell	*Batillaria attramentaria*
Mouse-ear marshsnail	*Phytia (Ovatella) myosotis*
Japanese oyster	*Crassostrea gigas*
Eastern soft-shell clam	*Mya arenaria*
Robust mysella	*Mysella tumida*
Purple varnish clam	*Nuttallia obscurata*
Japanese littleneck clam	*Venerupis phillipinarum*
Striped barnacle	*Balanus amphitrite amphitrite*
Amphipod	*Ampithoe valida*
Polychaete worm	*Spirorbis sp.*
Polydora mudworm	*Polydora ligni*
Spionid worm	*Pseudopolydora kempi*

Compiled: 2/5/12