The Science and Management of *Zostera japonica* in Washington: Forum for State Agencies, June 18-19, 2013

ZOSTERA JAPONICA SCIENTIFIC PANEL

Fred Short, DNR

The Forum was held to improve state agency understanding of *Zostera japonica* science and management in Washington State. The scientific panel reviewed and evaluated the science presentations at the Forum, assembled a list of scientific references on *Z. japonica* in relation to its status in Washington State, and determined future research needs and priorities. A fact sheet was developed to address all the Z. japonica issues that emerged from the Forum. The information is categorized and rated regarding its degree of scientific documentation, including peer-reviewed literature, grey literature, and observational information.

The fact sheet summarizes the current state of *Z. japonica* science, one of the primary objectives of the Forum. In summary, the findings of the Science Panel demonstrate that scientific information is extremely limited concerning the ecological or economic effects of *Z. japonica* on the State of Washington's ecosystem resources or commercial activities. In the Panel's assessment of what is known about the ecosystem services provided by *Z. japonica*, the available scientific information documents a large number of positive ecological effects (12 that support natural resources and functions vs. 2 that have negative impacts, and 3 with no impact). The Panel's assessment of the economic effects of *Z. japonica* documents a majority of negative impacts (5 that negatively impact livelihoods and socioeconomic services vs. 1 with a positive effect and 1 with no effect). Considerable further research is needed to understand the ecological and economic effects of *Z. japonica* and the potential consequences of proposed management strategies to either protect or control it.

Panel of scientists:

Dr. Mary O'Connor, U British Columbia

Dr. Brett Dumbauld, Oregon State/US Department of Agriculture

Dr. Debra Shafer, Corps of Engineers, Mississippi

Dr. Renee Takesue, USGS

ZOSTERA JAPONICA SCIENTIFIC PANEL: ISSUES AND RECOMMENDATIONS

The table below lists the *Zostera japonica* (Zj) issues addressed by the panel, shows the panel's evaluations of the weight of evidence based primarily on the presentations at the Forum, and lists published and unpublished literature sources for each issue. The check marks indicate which information in the three weight of evidence categories was presented by the scientific speakers at the Forum and the scientific strength of the evidence presented.

✓ Information for other seagrass species ✓ Information for Zj

Issue	Weight of Evidence (*Increasing weight* →)			Sources
	Observations	Grey Lit	Peer-reviewed, published	
Zj is non-native in WA	✓	✓	✓	**Harrison & Bigley 1982; Harrison 1976; Phillips 1984**; unpublished genetic data
Zj ecology	✓	✓	✓	Harrison1982a, b; Nomme and Harrison 1991; Larned 2003; Lee et al 2005; Kaldy 2006 a,b; Kaldy and Shafer 2012; Ruesink et al.2010
Zj is expanding its distribution in WA (within estuaries and across sites)	✓	✓	✓	Young et al 2008, **Bulthuis 1995;** Dudoit 2006; Ramey et al 2011; **Baldwin and Lovorn 19994a; Britton-Simmons et al. 2010;** Fisher et al.2011, Mach et al. 2010, Shafer et al. 2008, 2011
Zj spreads, reproduces quickly	✓	✓	✓	Ramey et al 2011

The second part of the table has a slightly different format, presenting information on the interaction of Zj with other species, ecological processes, and human activities that are of interest to the State of Washington. The ecosystem services and trend of the effect are also evaluated.

Species/Processes/Activity	Ecosystem Services	Effect	Weight of Evidence (*Increasing weight* →)			Reference
			Observations	Grey Lit	Peer-reviewed, published	
Sediment trapping	Water Quality	Increase	✓		✓	Observations for Zj;
Change in bottom elevation	Accretion	Increase	✓	✓	✓	Bos 2007
Change in sediment texture	Fining	Increase	✓		✓	
Wave/current attenuation	Sediment Stabilization	Increase	✓		✓	Observations for Zj; Stevens and Lacey 2011 (Zm); Tsai
Carbon sequestration	Climate Change Moderation	Increase			✓	Fourqurean et al 2012 " Blue carbon"
Carbon export	Food chain support	Increase			✓	Mateo 2006;
Infaunal abundance, diversity	Species Diversity	Increase			✓	Posey 1988; Ferraro et al 2011

Species/Processes/Activity	Ecosystem Service	Effect	Observations	Grey Lit	Peer-reviewed, published	Reference
Mesograzer abundance	Species Diversity	Increase			✓	Thom 1995
Zostera marina (Zm) habitat (mechanism: moisture–high intertidal)	Community Diversity and Structure	Increase	✓			Observations
Spawning habitat for herring	Fisheries Habitat Utilization	Increase	✓			Observations; D. Pentilla ODFW pers. com.
Settlement of juvenile Dungeness crabs	Fisheries Habitat Utilization	Increase	✓	✓		Observations; Dinnel et al 1986
Clam, oyster production	Livelihood/socio-economic	Increase, decrease (species-specific)			✓	Tu Do 2011 (*Zostera noltii*)
Waterfowl foraging habitat	Food chain support	Increase			✓	**Baldwin and Lovorn 1994b;** Ganter 2000; Ward et al 2005; Wilson and Atkinson 1995
Green sturgeon feeding habitat	Fisheries Habitat Utilization; Food chain support	Decrease	✓			Observations by K. Patten
Cost of clam harvest	Livelihood/socio-economics	Increase	✓			Park et al. 2011; Observations by K. Patten
Clam production, condition and growth	Livelihood/socio-economic	Decrease	✓		✓	Observations by K. Patten; Tsai et al. 2010
Juvenile clam survival	Livelihood/socio-economic	Decrease	✓		✓	Ruesink et al 2013 in review

Species/Processes/Activity	Ecosystem Service	Effect	Observations	Grey Lit	Peer-reviewed, published	Reference
Burrowing shrimp abundance	Habitat Structure	Decrease			✓	Harrison 1987; Berkenbusch et al 2007; **Dumbauld and Wyllie-Echeverria 2003**
Bird habitat use	Food chain support	None		✓		Lamberson et al 2011
Juvenile salmon habitat utilization	Fisheries Habitat Utilization	None		✓	✓	Semmens et al 2008; Simenstad and Wissmar 1985
Clam recruitment	Livelihood/socio-economic	None			✓	Tsai et al. 2010
Effect of Zj on Zm (light)	Shading	None	✓	✓	✓	Hannam 2013; Bando 2006; Hahn 2003

Research needs for *Zostera japonica* in Washington State: recommendations of Science Panel

Plant-related

1. Publication of Zj genetics research, including Zj from Asia and North America.
2. The factors influencing Zj distribution within estuaries and geographically in the Pacific Northwest.
3. Zj occurrence and locations in WA. Need to analyze and publish existing data on historic *Zostera japonica* distributions, and also to continue collecting new data for comparison to future distribution in WA.
4. Factors determining upper and lower limits of Zj zonation.
5. Zj studies from fringing seagrass areas and small flats. The majority of studies to date have been in large shallow embayments (e.g., Padilla Bay and Willapa Bay).
6. Mechanism and rate of Zj recolonization after disturbance. (How long are seeds viable?)

Shellfish-related

7. Zj interactions with shellfish production: A) to differentiate between Zj effects vs. predation by birds and/or polychaetes on clam recruitment; B) to determine the effect of Zj sediment trapping and increased sedimentation on shellfish production; and C) to determine the effect of *Spartina* removal on sedimentation rates in Zj.
8. Shellfish harvest methods in Asia and the potential for coexistence of Zj and shellfish aquaculture.
9. Economic cost-benefit analyses of Zj control (test both action and no-action alternatives).
10. Ecological cost-benefit analyses of Zj control (test both action and no-action alternatives).
11. Peer-reviewed published studies on effects of Zj control on non-target organisms, including native eelgrass, and microphytobenthos.
12. Possible scale effects on the ecosystem of management actions to chemically control Zj.

Ecosystem Services

13. Potential Zj mitigation of ocean acidification by buffering pH.
14. Effect of Zj on sediment chemistry and nutrient cycling.
15. Interaction of Zj and native species of concern, including salmon, forage fishes, sturgeon, crabs, waterfowl, wading birds, shorebirds.
16. Comparisons of change in ecosystem services between Zj and unvegetated habitat (e.g., baseline of change, habitat replacement).
17. Effect of Zj shoot density on ecosystem services.

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