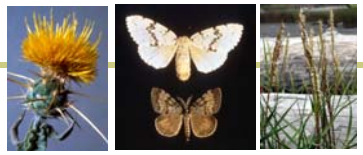
A Baseline Assessment of
Priority Invasive Species in the Puget Sound Basin

A project of the Washington Invasive Species Council

Conducted by Cascadia Consulting Group, Jones & Jones, and Sarah Reichard

February 2011



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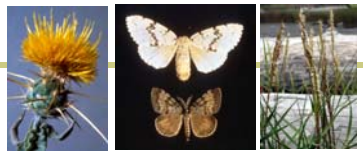
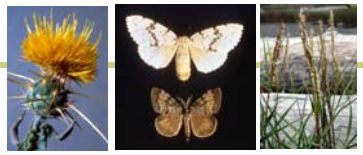
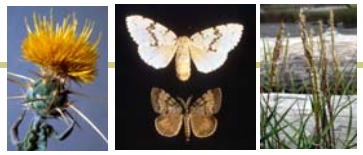


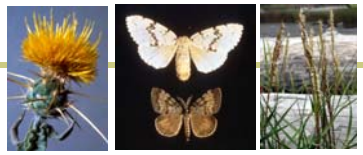


Glossary

Acronyms and abbreviations used in this report.	
APHIS	Animal and Plant Health Inspection Service (USDA)
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ESSB	Engrossed Substitute Senate Bill
CFR	Code of Federal Regulations
GIS	Geographic Information System
NOAA	National Ocean and Atmospheric Administration
NWCB	Noxious Weed Control Board
NWIFC	Northwest Indian Fisheries Commission
RCW	Revised Code of Washington
REEF	Reef Environmental Education Foundation
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
USFWS	U.S. Fish & Wildlife Service
UW	University of Washington
VHS	Viral Hemorrhagic Septicemia
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington State Department of Natural Resources
WSDA	Washington State Department of Agriculture
WSDOT	Washington State Department of Transportation
WSPRC	Washington State Parks and Recreation Commission
WSU	Washington State University



Terms used to describe current knowledge and projections for invasive species	
At-risk resources	Those aspects of the natural and human landscape that are likely to be negatively impacted by an invasive species due to their inherent sensitivity combined with opportunity for the species to invade the area or resource; synonymous with *vulnerable areas or resources* in this report
Impacts	Existing or documented negative impacts to natural and human dimensions of the ecosystem associated with entry or spread of an invasive species
Pathways of introduction	Means by which the species enters Washington or the Puget Sound Basin; the term *entry points* is also used in this report; often termed *vectors* in other work
Pathways of spread	Corridors by which the species moves through the Puget Sound Basin; the term *movement corridors* is also used in this report; often termed *vectors* in other work
Sensitive areas or resources	Those aspects of the natural and human landscape that would be negatively impacted by the presence and/or spread of one of the priority invasive species
Status	Species presence/absence at a specific location at a specific point in time
Threats	Potential negative impacts to natural and human dimensions of the ecosystem associated with entry or spread of an invasive species; often termed *pressures* in other work
Trends	Change in species status over a defined period of time; due to lack of sufficient data to support a formal trend analysis, this report more broadly addresses *changes In species presence over time*
Vulnerable areas or resources	Those aspects of the natural and human landscape that are likely to be negatively impacted by an invasive species due to their inherent sensitivity combined with opportunity for the species to invade the area or resource; synonymous with *at-risk resources* in this report



Terms used in the survey and program analysis to define the suite of possible management activities.	
Control	Treating, pulling, or otherwise removing/killing members of an invasive species population, with the goal of limiting its capability to establish or spread.
Detection	Looking for new populations of an invasive species.
Education/ outreach	Helping others to understand the threats, challenges, and techniques to manage invasive species, among other topics. Audiences may include the general public, land managers, or others.
Enforcement	Ensuring laws governing the transport, control, or eradication of an invasive species are followed.
Eradication	Treating, pulling, or otherwise removing/killing an entire invasive species population with the goal of completely removing the population.
Funding	Providing funds to other organizations or agencies to conduct management activities.
Monitoring	Surveying existing populations, or locations where populations were previously, to assess their status and trends.
Prevention	May include prohibitions against introduction of a species, or education/outreach designed to limit spread.
Policy	Helping to develop local, state, regional, or federal policies governing the management of invasive species.
Research	Conducting research on the characteristics, spread, presence, response to treatment, or other attributes of an invasive species.

Acknowledgements

Data and information providers

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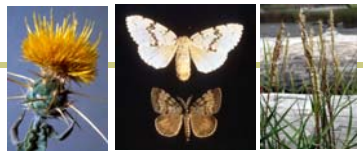

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Work sessions

Terrestrial invasive species work session participants (May 24, 2010): Greg Haubrich (WSDA), Eric LaGasa (WSDA), Karen Ripley (WDNR), and Brad White (WSDA).

Freshwater invasive species work session participants (May 26, 2010): Jeff Adams (Washington Sea Grant), Kathy Hamel (Ecology), Greg Haubrich (WSDA), Rich Johnson (Thurston County NWCB), and Jenifer Parsons (Ecology).

Marine invasive species work session participants (May 28, 2010): Jeff Adams (Washington Sea Grant), Rachel Benbrook (People for Puget Sound), Charles Lambert (UW-Friday Harbor), Gretchen Lambert (UW-Friday Harbor), Allen Pleus (WDFW), Chad Phillips (WSDA), and Stephen Phillips (Pacific States Marine Fisheries Commission).

Washington Invasive Species Council

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Cover photos

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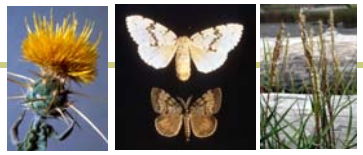


I. Executive Summary

The management of invasive species in Washington State is limited by the fact that existing data and information regarding these species in the state are not centralized, making it difficult to evaluate the current status and potential future impact of these species, and to coordinate management programs. There are a diversity of organizations working on physically controlling and establishing policy for invasive species. Despite some cooperation between these entities, significant gaps exist in communication and coordination across counties, between public and private lands, and between state, federal, tribal, and county lands. As a result, there are disparities in the quality and quantity of data on invasive species, and with few exceptions, neither single species nor multi-species data are gathered in one place accessible to managers or data collectors.

The Washington Invasive Species Council's 2008 strategic plan "Invaders at the Gate" found that these challenges make it difficult to "fully define the scope of the invasive species problem, as well as the state's capacity to measure its progress…to combat them."[1] The Council recommended, as a top priority in the short term, to "compile existing information and conduct a baseline assessment of invasive species information and programs in Washington." This report is a pilot response to this recommendation, focusing on just 15 priority species within the Puget Sound Basin only. This work should begin to inform coordination of a statewide, strategic response to invasive species that uses limited resources effectively and focuses on the greatest ecological need and potential benefit to native ecosystems and the human systems that depend on them.

The Baseline Assessment

The baseline assessment summarizes the status and trends of 15 priority invasive species, as identified by the Washington Invasive Species Council (Council), within the Puget Sound Basin (Basin). The project used available data, published literature, and expert input to assess:

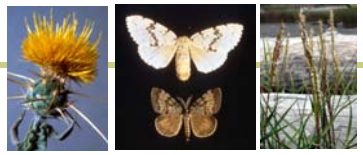
- The status of detection and current presence for each species in the Basin.
- Potential pathways of entry and spread for each species.
- At-risk ecological and human dimensions of the Puget Sound ecosystem.
- Management efforts addressing the 15 priority species.

This report presents spatial summaries of existing invasive species data in the Puget Sound Basin. Due to the limitations in basin-wide data received by the project, the report does not include spatial analyses of species-specific trends, pathways of entry and spread, or impacts to natural resources and human dimensions of the Puget Sound ecosystem.

Additionally, the baseline assessment identifies gaps in three major areas:

- Data collection and information management.
- Knowledge and understanding of species status, pathways, and impacts.
- Management efforts.

[1] Washington Invasive Species Council, 2008. Invaders at the Gate – 2008 Strategic Plan. Page 18.



This gap analysis will support the Council's future decision-making regarding policy recommendations to improve prevention, early detection, and rapid response strategies and actions.

Overarching Findings

Species Presence

Not all of the Council's 15 priority species are currently in the Puget Sound Basin. Some have not yet been introduced, such as *Caulerpa*, while others have been detected but have not yet established (Lymantriid moths) or have been eradicated (hydrilla). Of the species which are currently present in the Basin, some are well-established, such as knapweed, and others are being very effectively controlled, namely, *Spartina* species.

Figure 1 summarizes detection and notes the current status of the 15 species at the county scale. Throughout the report, information is often summarized by county due to the predominance of county-level management efforts for the 15 priority species in the Puget Sound Basin. Of the 11 species that have been detected in the Basin, two are present in all or most of the 13 counties (knapweeds and tunicates), four species are present in five to nine counties (Brazilian elodea, common reed, nutria, *Spartina*), one is present in just two counties (variable-leaf milfoil), and two species have only been detected sporadically in limited locations (Lymantriids, VHS).

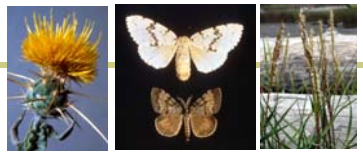
Major pathways – entry points and pathways of spread

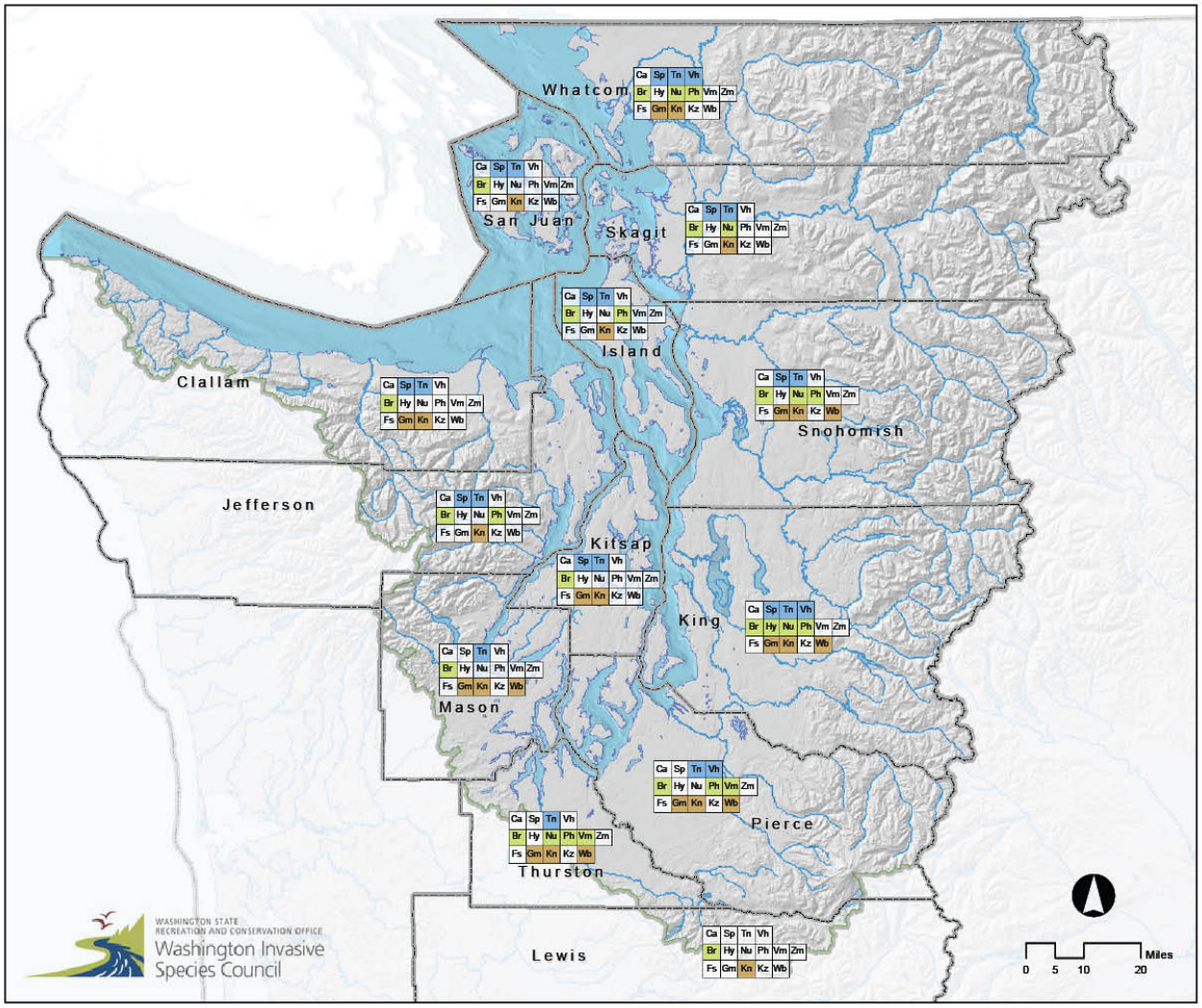
Invasive species may enter and spread through the Puget Sound Basin via a number of different pathways. Major pathways include intentional releases of the species from aquaria or from classrooms (where they were introduced via biological supply houses) or as live bait. Species may also be intentionally planted as garden ornamentals or introduced for their commercial value (e.g., as food, or for fur). Invasive species can hitch rides on boats (e.g., on hulls or in ballast water and sea chests), other water-based equipment, vehicles, livestock, walkers, or firewood. Pathways specific to each species are discussed in the species summaries in this report.

Impacts

Invasive species pose a threat to both ecological and human systems, through means such as:

- **Altering the physical processes of their environment.** *Spartina* clones trap sediment and alter the basic hydrology of their environment.
- **Outcompeting or preying on native plants and animals.** Invasive tunicates outcompete native species for food and space and may siphon out other species' gametes.
- **Impacting resource-based industries.** Successful establishment of wood-boring insects or Lymantriids would likely lead to quarantines on wood products.
- **Interfering with infrastructure.** Zebra and quagga mussels have clogged piping and mechanical systems of industrial plants, utilities, locks, and dams in other regions.
- **Reducing recreational value.** Thick growth of Brazilian elodea puts a damper on recreational boating, swimming, and other activities in multiple lakes in the Puget Sound basin.





Species Detection* at the County Level

Puget Sound Basin

Ca	Sp	Tn	Vh			Marine
Br	Hy	Nu	Ph	Vm	Zm	Freshwater
Fs	Gm	Kn	Kz	Wb		Terrestrial

Marine Species Detected

- Ca: Caulerpa
- Sp: Spartina
- Tn: Tunicates
- Vh: VHS Type IVa (Type IVb not yet detected in PSB)

Freshwater Species Detected

- Br: Brazilian elodea
- Hy: Hydrilla (Eradicated in King County)
- Nu Nutria
- Ph: Common reed
- Vm: Variable leaf milfoil
- Zm: Zebra, quagga mussels

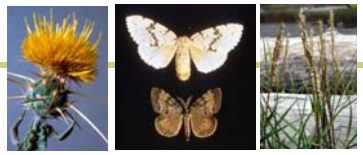
Terrestrial Species Detected

- Fs Feral swine
- Gm: Lymantriid moths (Detected but not established)
- Kn: Knapweeds
- Kz: Kudzu
- Wb: Wood - boring beetles (Detected but not established)

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

* Includes all available detection data across species (1974-present)

Figure 1. Detections reported for each of the 15 priority species, by Puget Sound Basin county.

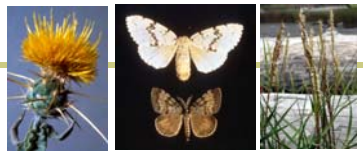


Management efforts

Organizations at multiple levels are involved in preventing and managing the spread of invasive species in the Puget Sound Basin. **County-level** agencies have primary responsibility for ensuring that private landowners control invasive plants on their properties. **State-level** agencies lead coordinated management efforts for the majority of the priority species, and also conduct education, surveys, monitoring, and control and eradication activities. **Federal agencies** may set legal frameworks for invasive species management, fund management activities, or conduct detection and control activities on their own lands. **Tribes** conduct management activities on reservation lands and associated resource lands. Other organizations managing the Council's priority species include non-governmental organizations, universities, cities, and inter-regional agencies. We classified management efforts into ten different categories, with control efforts being reported most frequently and enforcement efforts reported least frequently. Table 1 summarizes management efforts by organizational level for the 15 priority species.

Table 1. Programs addressing priority species in the Puget Sound Basin. * "Other" includes city, private, NGO, research, inter-regional, and tribal organizations.

Species	Detection (# of counties)	Organizations* with programs targeting priority species				Most common program types
		County	State	Federal	Other	
Brazilian elodea	yes (9)	10	7	2	8	Detection, education/outreach, control and monitoring
Caulerpa	no		1	3		Education/outreach, prevention, policy
Common reed	yes (7)	10	6	1	4	Detection, education/outreach, eradication, control, monitoring, prevention
Feral swine	no	-	-	-	-	-
Hydrilla	yes, eradicated	8	4	3	1	Education/outreach, detection, prevention
Knapweeds	yes (13)	13	4	5	4	Control, detection, education/outreach, monitoring
Kudzu	no	5	4	1	2	Detection, education/outreach, prevention
Lymantriid moths	yes, not established	-	1	1	-	Detection, funding
Nutria	yes (5)	-	1	3	4	Control, education/outreach, prevention
Spartina	yes (8)	10	7	3	7	Detection, education/outreach, prevention
Tunicates	yes (12)	1	1	2	5	Education/outreach, prevention, policy
Variable-leaf milfoil	yes (2)	8	3	2	1	Education/outreach, detection, prevention
VHS	yes, sporadically	-	1	2	1	Detection, research
Wood-boring beetles	yes, eradicated	-	2	-	-	Detection, education/outreach
Zebra, quagga mussels	no	-	2	2	4	Education/outreach, detection



Conclusions

Although significant work on invasives is underway, this study noted three overarching categories of gaps, namely **data collection and information management**; **knowledge and understanding of species status, pathways, and impacts**; and the **extent and focus of efforts**. These over-arching gaps, summarized below, frame and underlay the species-specific gaps presented within the body of the report.

Priority gaps

Data collection and information management gaps

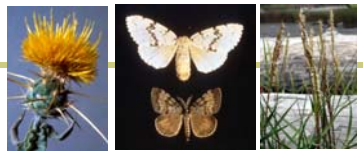
Gaps in data collection and management can limit our ability to draw conclusions about species presence and trends, which in turn affect management decisions.

- Data collection methods are not standardized across all organizations assessing a given species. As a result, there is wide variability in the quality of data compiled for the majority of the priority species. For example, tunicate data submitted to the project ranged from GIS shapefiles of transects surveyed by state agency divers on a biannual basis, to occasionally reported sightings from recreational divers trained to identify invasive tunicates, to observations made by scientists at docks and marinas.
- Data collection efforts are much more extensive, well-funded, and long-term for some of the Council's priority species than for others, resulting in wide variability in the quantity and quality of data collected between the priority species. For example, King, Thurston, and Whatcom counties shared data indicating numerous locations of knapweed presence in those counties (see Map 6.1). The fact that these counties appear to have more knapweed than neighboring counties may be due in part to King, Thurston, and Whatcom counties' data collection and management efforts for knapweed, rather than only due to actual differences in knapweed populations on the landscape.
- Citizen-science programs exist for a very small number of the priority species, even though these programs can produce large quantities of high quality data when effective protocols for data collection and reporting are implemented. For example, People for Puget Sound trains volunteers to conduct *Spartina* surveys from their kayaks; these data are particularly needed because the remaining *Spartina clones* are often isolated and hard to reach by foot.

Knowledge and understanding of species status, pathways, and impacts

Gaps in our knowledge and understanding of species status, pathways, and impacts make it difficult to target management efforts to most effectively prevent, control, and eradicate species.

- Compiled data for a given species may inaccurately indicate greater presence in one area than another, due to differences in funding of data collection efforts, as highlighted above, or due to variability in the amount of existing data shared with the project.
- A lack of standardized, comprehensive data sets limits our ability to complete more detailed spatial and temporal analyses of species status, trends, pathways, and impacts.

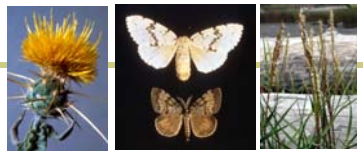


- In certain regions and for certain species, there is limited data-sharing and communication between organizations collecting data for the same species. This lessens the likelihood of potential partners developing collaborative approaches for data collection and management that will support improved understanding of species presence, behavior, and impacts in the Basin.
- There are too few research programs targeted at understanding points of entry and pathways of spread in the Puget Sound Basin for the priority species.
- There are too few research programs focused on understanding potential impacts of the priority species to ecological and human dimensions, particularly in the Puget Sound Basin. Invasive species impacts to agricultural and forestry resources are fairly well understood, but areas needing further study include impacts to recreational resources, human health, and other resource-based economic sectors (e.g., aquaculture, fishing).
- There are too few research programs underway to better understand the effects of a shifting climate upon the ability of these species to invade and spread.
- A lack of agency, professional, and academic knowledge and understanding at the species level translates to gaps in societal understanding. The general public is relatively unaware of the existence of these species, their potential impacts to ecological and socio-economic resources, and the role they themselves can play in preventing and detecting invasive species.

Management efforts

Gaps in management efforts and programs range from a lack of uniform management coverage for all 15 species throughout Puget Sound Basin to variable levels of management coordination among entities managing the same species within the Basin.

- To date, invasive species management efforts primarily address 12 of the 15 priority species. This study found that there is a lack of funding and associated programs to manage invasive mammals (feral swine and nutria), and the alga *Caulerpa.*
- Funding levels for county noxious weed control boards is typically insufficient to cover those organizations' plant control mandates. For example, in 2008, the Kitsap County Noxious Weed Control Board forecast a budget shortfall of $37,000 for 2010. This shortfall has significantly affected staff resources to carry out management objectives.
- There are variable levels of coordination between neighboring county weed boards. Noxious weed boards in Jefferson and Clallam county partner to collaborate with state and federal agencies on invasive plant management. Other counties appeared less aware of their neighbors' activities.
- There are variable levels of management coordination between federal, state, local, and tribal entities across the Basin. This represents a missed opportunity to enhance efforts already being conducted by individual entities. An example that could be replicated for other species is the Washington State Department of Agriculture's *Spartina* program. WSDA has effectively coordinated



with about 25 local, state, federal, tribal, and non-profit entities to successfully move towards eradication of *Spartina*.

- There are variable levels of coordination with other states and Canadian provinces. Although there has been extensive regional collaboration to prevent the spread of zebra and quagga mussels, little to no regional coordination was reported for most of the priority species.
- Too few programs target pathways of introduction and spread. Most management efforts focus on species control or eradication, or on general outreach and education.
- Most invasive species programs are not evaluated for effectiveness and, as a result, there is a corresponding lack of understanding regarding which programs are or are not working and why.

Opportunities

There are numerous opportunities to improve management of the 15 priority invasive species within the Puget Sound Basin. Primary study findings presented below are included as representative examples of opportunities to enhance the efficiency and functionality of existing approaches to invasive species management over time.

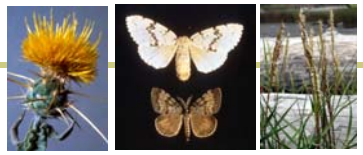
Improvement of Data Collection and Management

- Create ongoing opportunities for invasive species data sharing throughout the Basin. Though the data solicitation phase of this project yielded much data and information pertaining to the 15 priority species, there are likely data that were not obtained. To ensure and improve the utility of this effort moving forward, develop a protocol for continued data and information submission to the Washington Invasive Species Council.
- Provide standardized data collection and reporting methods for use by the various organizations involved with each species.
- Increase engagement of citizens in data collection to supplement formal research and management efforts and broaden regional understanding of the spatial extent and impact of these species to ecological and socio-economic resources. At a minimum, an online site where the public can report and spatially locate sightings of invasive species could significantly enhance formal detection efforts conducted by public agencies and NGOs.

Alignment with Related and Parallel Efforts

Ensuring the alignment of parallel efforts currently underway within the Council's partner organizations will enhance the efforts of the Council as well as its partner agencies. In particular, the following regional programs have goals and objectives that overlap with those of this baseline assessment.

- The Puget Sound Partnership.
- Puget Sound Nearshore Ecosystem Restoration Project (PSNERP).
- NOAA Northwest Fisheries Science Center (NWFSC) Integrated Ecosystem Assessment (IEA).



II. Introduction

Purpose of Assessment

In 2008, the Washington Invasive Species Council released its strategic plan for preventing the introduction and spread of harmful invasive species. The first of this plan's priority recommendations is to conduct a baseline assessment of the status and trends of priority invasive species; the pathways by which species are transported; the resources, industries, and economies most at risk; and public and private efforts to prevent, control, or eradicate these species. The ultimate goal is to identify gaps in knowledge and management efforts to inform policy recommendations to fill those gaps. This assessment focuses on 15 species, selected by the Council, and is limited to the Puget Sound Basin, as defined by the Puget Sound Partnership.

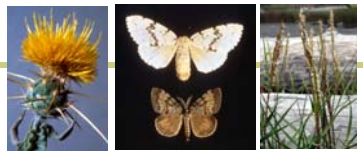
The Challenge of Managing Invasive Species

Invasive, non-native species pose a direct threat to native species and their habitats and adversely impact ecological and human dimensions of ecosystems, by competing with or feeding on native species, reducing the resilience of ecosystems, altering local habitats and ecological and biophysical processes, affecting flood patterns, and introducing diseases. Managing for invasive species within the Puget Sound Basin is complex due to the number and types of pathways through which species are introduced and travel. These pathways include the importation of seeds, plants, fruits and vegetables, and wood materials; ballast water discharges from ships; commercial and recreational boat hulls; travelers' clothes and shoes, cars, and airplanes; and people who release exotic pets and plants into the wild. A diverse array of agencies and organizations work to prevent the introduction and spread of invasive species, physically control or eradicate them, monitor their distribution, and understand their characteristics.

The Washington Invasive Species Council (Council), administered by the Recreation and Conservation Office, was established by the state legislature to improve coordination and collaboration of efforts among local, state, and federal agencies; tribes; non-governmental organizations; and other stakeholders to better protect Washington from the harmful effects of invasive species.

The Need for this Baseline Assessment

At this time, existing data and information regarding invasive species in Washington State are not centralized, making it difficult to evaluate the current status and potential future impact of these species and to coordinate management programs. There are a diversity of groups and entities working on establishing policy for and physically controlling invasive species, at the county, state, and federal level, as well as among tribes, non-profit organizations, and citizen groups. While there is some cooperation between these entities, they do have significant differences in management approaches. Furthermore, there exist significant gaps in communication and coordination across counties, between public and private lands, and between state, federal, tribal, and county lands.



Agencies collecting data on invasive species range from University of Washington scientists who study a single species or group of species for many years, to county noxious weed control boards that are charged with managing noxious weeds and keep some records of their eradication and control efforts. Some species are very well-documented, such as plants classified as Class A Noxious Weeds (eradication is required by law). The presence of others, such as the nutria, is sparsely recorded and often only in anecdotes. In sum, there are many disparities in the quality and quantity of these data, and with few exceptions, neither single species nor multi-species data are gathered in a single place accessible to managers or data collectors.

Brazilian elodea on San Juan Island – lack of data centralization.

In reviewing compiled data sets, project team members noticed that the UW Burke Herbarium had record of Brazilian elodea on San Juan Island; this had not been reported by Ecology, which surveys public access lakes for Brazilian elodea, or by the San Juan County Noxious Weed Control Board, whose staff had surveyed in that particular area. Staff asked "Is there another list that we have missed that would augment our data from plants that we have observed? Is there a central site or person to which we should be sending these observations?"

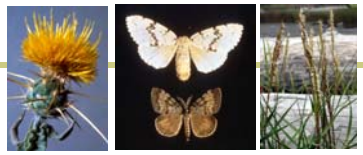
In its 2008 strategic plan "Invaders at the Gate," the Council recognized that without fully understanding the pieces of current invasive species management, it would be difficult to "fully define the scope of the invasive species problem, as well as the state's capacity to measure its progress…to combat them."[2] Thus the Council recommended, as a top priority in the short term, to "compile existing information and conduct a baseline assessment of invasive species information and programs in Washington." The purpose of the assessment is to gain an understanding of what information exists for these species; what we know about the species' location, rate of spread, and pathways of entry and transport; and what programs are in place to address them. This baseline assessment serves as an initial step towards coordinating a statewide, strategic response to the threat of invasive species, in a manner that uses limited resources effectively and that focuses on the greatest ecological need and potential benefit to native ecosystems and the human systems that depend on them.

The funding for this project, from the Environmental Protection Agency (EPA), specified a focus on the Puget Sound Basin. A broader assessment could be conducted statewide, contingent on available funding. In August 2009, the Council contracted with Cascadia Consulting Group and Jones & Jones, with technical advice from Dr. Sarah Reichard at the University of Washington ("the project team"), to conduct this baseline assessment.

The Species

The Council selected 15 species or species groups as priorities for this baseline assessment. Council members, who have a diverse range of natural resource specialties, used best professional judgment to identify species with a range of impacts to Washington's environment, economy, and human health. They identified species which are currently actively managed, and those for which management activities are more limited. These species include plants, mammals, invertebrates, algae, and viruses, and they represent terrestrial, freshwater and marine ecosystems. Some of the priority species are widespread in the Puget Sound Basin, others have been observed in a small

[2] Washington Invasive Species Council, 2008. Invaders at the Gate – 2008 Strategic Plan. Page 18.



number of locations, while still others have not yet been introduced to the region but are considered significant threats by invasive species managers and scientists.

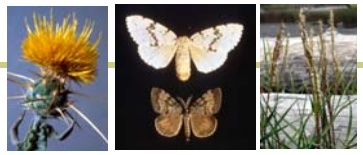
The 15 priority species are as follows:

1) Brazilian elodea (*Egeria densa)*
2) Caulerpa (*Caulerpa taxifolia*)
3) Common reed (*Phragmites australis*)
4) Feral swine (*Sus scrofa*)
5) Hydrilla (*Hydrilla verticillata*)
6) Knapweeds (*Centaurea* species)
7) Kudzu (*Pueraria montana* var. *lobata*)
8) Lymantriid moths (initially focused on Asian, European gypsy moths)
9) Nutria (*Myocastor coypus*)
10) Spartina (*Spartina alterniflora*, *S. anglica*, *S. patens*, *S. denisflora*)
11) Tunicates (*Didemnum vexillum*, *Styela clava*, *Ciona savignyi*)
12) Variable-leaf milfoil (*Myriophyllum heterophyllum*)
13) VHS (Viral Hemorrhagic Septicemia Virus), Type IVa (Type IVb was later added)
14) Wood-boring beetles (Cerambycidae, Buprestidae, Scolytidae, Siricidae families)
15) Zebra, quagga mussels (*Dreissena polymorpha*, *D. rostriformis bugensis*)

What this Assessment and Report Does and Does Not Do

This baseline assessment report presents information to support the Council's decision making regarding management, funding, and outreach priorities. A primary feature of the report is its maps, which summarize available data on the distribution of those species present or formerly present in the Puget Sound Basin, as well as, in a few cases, data from survey efforts targeted at species that are not currently present. The report summarizes in narrative form, with support from the maps, how these species are or have been introduced to this region, how they move through the Puget Sound Basin, and specific resources affected by their presence and spread. In addition, the report summarizes management programs that are currently in place at the local, state, and federal levels to prevent introduction, detect invasions, and manage the spread of these species.

This report synthesizes and summarizes all data and information obtained by the project team for the 15 priority species. As described in Section III, we administered a broad-ranging survey to the Council's contacts to solicit data and information, followed by extensive one-on-one outreach via phone and email to survey respondents and a selection of non-responders. We also conducted internet and literature reviews to identify additional data sources. Although we managed to collect the overwhelming majority of data files reported to the project, we acknowledge that there are



likely data on these 15 species in the Puget Sound Basin that we were unable to obtain—either due to a lack of response from potential data providers or an inability to obtain the files within the timeframe of the project. To ensure and improve the utility of this effort moving forward, readers are encouraged to submit data and information not included here to the Washington Invasive Species Council.

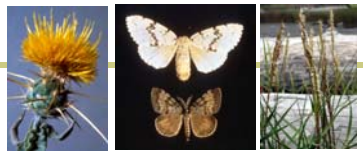
The mapped spatial summaries only include data provided to the team in formats that could be readily incorporated in or adapted to GIS-based spatial summaries. Additional data provided to the team are discussed in the narrative. The project team did not create new data or modify existing data for the purposes of this assessment project. However, wherever possible, we converted spatially explicit datasets (e.g., spreadsheets with street addresses or GPS points) into GIS shapefiles for inclusion in species-specific spatial summaries (see Section III).

While this report does present spatial summaries of existing data in the Puget Sound Basin, the report does not include spatial analyses of species-specific trends, pathways of entry and spread, or impacts to natural resources and human dimensions of the Puget Sound ecosystem. In most cases, sufficient data do not exist to support basin-wide spatial analyses and in limited cases where sufficient basin-wide data do exist, discrepancies in data format, quality and quantity of attribute information, and extent of coverage as provided by different data providers precluded the use of many datasets in basin-wide spatial analyses. Overarching and species-specific gaps in availability of spatial data are addressed in the Gap Summaries sections of the report.

Report Structure

The report is organized as follows:

- **Section III** briefly describes the methods used in the baseline analysis. Further detail on initial outreach, data review and subsequent outreach, development of a project database, and the development of data and management analyses may be found in Appendix A0.4.
- **Section IV** summarizes the current state of knowledge and management efforts for the 15 priority species overall, with overarching themes and statistics related to
    - Current status of the 15 species in the Basin.
    - Major pathways of entry and movement within the Basin across all 15 species.
    - Major at-risk resources within the Basin across all 15 species.
    - Trends in management efforts addressing the 15 priority species.
- **Section V** includes individual summaries for each species, including:
    - Overviews of species status, summarized in maps and narrative, with a discussion of available data on species presence and absence.
    - Discussions of major pathways (entry points and movement corridors), summarized in narrative form supported with maps of major pathways.



- Discussions of major impacts and at-risk resources (ecological and human dimensions), summarized in narrative form supported with maps of at-risk resources.
- Discussions of management efforts, summarized in maps and narrative.
- An assessment of gaps in knowledge and management efforts.

- **Section VI** lists appendices, which include outputs from the project database and basin-wide and county-specific maps for each species for which data were available. Appendices are provided as separate documents.

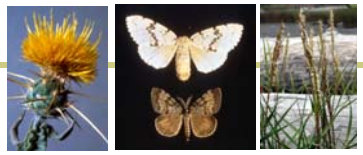
Note that the body of the report includes all basin-scale maps. The Appendices contain species-specific county-scale maps for all counties for which we received status data for that species.

Related and Parallel Efforts

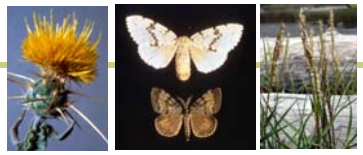
The mission of the Washington Invasive Species Council is to coordinate and provide planning and policy direction to those involved in the management of invasive species in the state. In keeping with the Council's high-level coordination role, we sought to ensure that this baseline assessment is consistent with parallel broad ecosystem efforts. In particular, concurrent efforts include

- **The Puget Sound Partnership.** This baseline assessment addresses several priorities of the Partnership's Action Agenda, which informed EPA's funding of this work. These priorities include prevention of and rapid response to the introduction of invasive species, implementation of key recommendations for the Puget Sound region as identified in the Invasive Species Council Strategic Plan, development of a Puget Sound baseline and database of invasive species to guide control efforts, and working together in coordination to ensure that activities and funding are focused on the most urgent and important problems facing the region.
- **Puget Sound Nearshore Ecosystem Restoration Project (PSNERP).** The purpose of PSNERP is "to identify significant ecosystem problems in Washington State's Puget Sound basin, evaluate potential solutions, and restore and preserve critical nearshore habitat."[3] Initiated in 2001 and recently folded under the umbrella of the Partnership, PSNERP is comprised of a partnership between the U.S. Army Corps of Engineers, state, local, and federal government organizations, tribes, industries, and environmental organizations working collaboratively to protect and restore the nearshore. Included in the scope of their work is identification of threats posed by invasive species as well as identification and implementation of solutions to minimize the impact of invasives in the nearshore.
- **NOAA Northwest Fisheries Science Center (NWFSC) Integrated Ecosystem Assessment (IEA).** NOAA NWFSC is currently developing an IEA for the Puget Sound Basin that will provide a synthesis and quantitative analysis of natural and socio-economic factors related to ecosystem health and ecosystem management goals in the Basin. Included in the IEA is identification of key stressors

[3] http://www.pugetsoundnearshore.org/



(e.g.,invasive species) affecting the ecosystem, indicators of ecosystem health and management effectiveness, and gaps in knowledge and data associated with key stressors and their management.



III. Methods

This section briefly summarizes the methods used to compile, review, sort, and analyze data and management information on the 15 priority species, in support of the analyses presented in Sections IV and V. More detail on our methodology may be found in Appendix A0.3.

Data Compilation

We administered an online survey in November 2009 to an initial distribution list of 196 individuals and organizations provided by Council staff. The survey posed four questions for each species:

- Are you involved in programs or activities targeted at this species?
- If so, what types of programs (ten program types provided to chose from)?
- Do you have data for this species?
- If so, what type of data and how much is available to share with the project?

We initially received responses from about 80 organizations, and followed up with these respondents to collect more detailed information on available data and relevant programs, and to obtain data files themselves. We also contacted a subset of individuals who had not responded to the survey as well as individuals and organizations not initially surveyed, following guidance from Council members and staff as well as initial contacts. This information gathering was ongoing throughout the course of the project, with a small number of data files and program information received through the fall of 2010. For a complete list of organizations participating in and contacted throughout the duration of the project, see Appendix A0.2.

Database Development

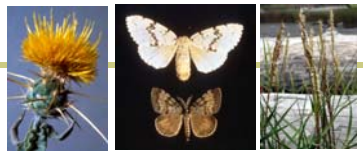
The project team constructed an Access-based relational database to house, track, update, and report on baseline assessment information. This database includes:

- A catalogue of **organizations and individuals** contacted, cross-referenced to information reported and provided.
- A catalogue of all **data files** received and processed.
- Summaries of known **programs** targeted at the 15 priority species, including associated contacts.
- A library of all **references** identified and consulted throughout the span of the project.

This database has been turned over to the Council at the completion of this project, to function as an updatable repository for invasive species information.

Metadata Quality Review

We assessed the completeness and quality of metadata (e.g., dates, locations, methods, names of collectors) for each data file received and for all program information provided to the project. We developed a set of critical metadata that provided important information about data files and



program information, and used these critical metadata categories to direct further outreach in an attempt to fully complete the data and program records. This subsequent outreach improved our records but gaps remained which we were unable to address. In almost all of these situations we were still able to use the data file or program information in the species summaries, but these gaps limited our ability to draw conclusions. Appendix A0.3 includes a complete description of the metadata review and summaries of data and project information meeting the metadata criteria.

Data Summaries, Management Summaries, Gap Analysis

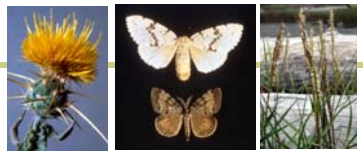
The spatial summaries, management summaries, and gap analyses presented in this report represent the current state of knowledge about the Council's 15 priority species. To supplement information provided to the project team and to guide our species-specific analyses, we convened three groups of species experts in May 2010. These work sessions focused on evaluating the quality and thoroughness of data and management information collected, and informing our assessment of major pathways and affected natural and cultural resources. Greater detail pertaining to the engagement of species experts may be found in Appendix A0.3

Spatial Summaries

We used the spatial data provided for 12 of the Council's 15 priority species to summarize the following types of information in map and narrative format at the Puget Sound Basin scale and/or the county scale. For more information on the types and number of data files received for each species, see the individual species summaries in Section V.

- **Species status**. Recorded locations of species presence and/or absence in the Puget Sound Basin. This analysis includes all spatially-explicit data on species presence in the Basin at any time. Survey data noting absence of a species at specific locations were only included in cases where the team was able to procure data representing coordinated, basin-wide, species-specific survey efforts (e.g., Lymantriids, wood-boring beetles, zebra and quagga mussels).
- **Species pathways.** Points of entry and pathways of spread within the Puget Sound Basin. Entry points and pathways of spread relevant to each priority species (e.g., roads, river corridors) are included as data layers in the Basin-wide maps under "Pathways & Sensitive Landscape Features" within each species summary, and in the associated county-scale maps in the Appendix.
- **At-risk resources**. Ecological and human dimensions of the Puget Sound ecosystem at risk from invasion by a priority species. Resources currently impacted by or potentially threatened by a priority species (e.g., wetlands, agricultural lands, lowland forests) are included as data layers in the Basin-wide maps under "Pathways & Sensitive Landscape Features," and in the associated county-scale maps in the Appendix.

The project team had originally planned to include a trend analysis for the priority species. However, high quality, comprehensive, basin-wide data supporting trend analyses were available for few of the priority species.



Management analysis

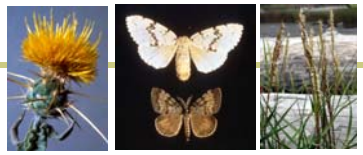
We analyzed management efforts for each of the Council's 15 priority species in the Puget Sound Basin, noting activities at the county, state, and federal level, as well as those efforts reported by cities, tribes, non-governmental entities, inter-regional agencies, and universities (grouped as "other"). We also describe the existing legal authorities to manage each species, and funding dedicated for management efforts for the species. In addition, we report the top three most commonly reported management program types, and the number of management efforts at each level. Broad regional programs that may have an effect on the management of these species in Puget Sound but do not focus on these species are not analyzed here.

Gap Analysis

We assessed gaps in information for individual species and for the 15 priority species as a group in the following topic areas:

- **Data collection and information management.** We reviewed the spatial extent, coverage, and resolution of data collected for each species, the time period of data collection, the continuity and consistency of data collection, and the degree to which data and information are shared across organizations working on a species.
- **Knowledge and understanding of species status, pathways, and impacts.** We focused on gaps in current understanding of species biology and ecology, pathways of entry and spread, and documented or potential impacts to ecological and human dimensions of the ecosystem. We drew our information from a review of published literature, from data and information provided to the project, and from conversations with data providers and topical experts.
- **Management efforts.** We reviewed the extent and coverage of programs and management efforts at all organizational levels, authorities governing management efforts, and funding availability to support programs.

Overall gaps are summarized at the end of the Overarching Themes section; species-specific gaps are summarized in the relevant species sections.



IV. State of Knowledge: Overarching Themes Related to Status and Trends, Pathways, Impacts, Management

This section summarizes themes for the Council's 15 priority species overall.

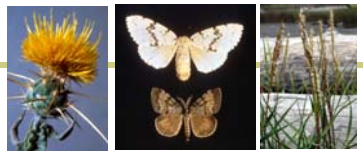
Status and Trends

Not all of the Council's 15 priority species are currently in the Puget Sound Basin. Some have not yet been introduced, such as *Caulerpa*; others have been detected, but since detection appear to have been successfully eradicated, such as hydrilla. Certain Lymantriid moths have been detected in isolated locations, but have not become established. Of the species which are currently present in the Puget Sound Basin, some are present today in much smaller numbers than in previous years, due to aggressive control efforts, namely, *Spartina* species.

Table 2, below, summarizes species presence and absence (see Appendix A0.5 for mapped summary of species detection in the Basin). The 13 counties with land and waters within the Puget Sound Basin (Basin) are used throughout the report to summarize spatial distribution (Clallam, Island, Jefferson, King, Kitsap, Lewis, Mason, Pierce, San Juan, Skagit, Snohomish, Thurston, and Whatcom counties). We used this county-level unit because so much invasive species management occurs at the county scale; watershed or other units could also be used.

Table 2. Priority species presence and absence in the Puget Sound Basin, with habitat type and life form.

Species	Detected in Puget Sound Basin (number of counties in which currently present)	Habitat type	Life form
Brazilian elodea	yes (9)	freshwater	plant
Caulerpa	no	marine	algae
Common reed	yes (7)	freshwater	plant
Feral swine	no	terrestrial	mammal
Hydrilla	yes, but eradicated	freshwater	plant
Knapweeds	yes (13)	terrestrial	plant
Kudzu	no	terrestrial	plant
Lymantriid moths	yes, but not established	terrestrial	invertebrate
Nutria	yes (5)	terrestrial	mammal
Spartina	yes (8)	marine	plant
Tunicates	yes (12)	marine	invertebrate
Variable-leaf milfoil	yes (2)	freshwater	plant
VHS	yes, sporadically	marine/ freshwater	virus
Wood-boring beetles	yes, but eradicated	terrestrial	invertebrate
Zebra, quagga mussels	no	freshwater	invertebrate



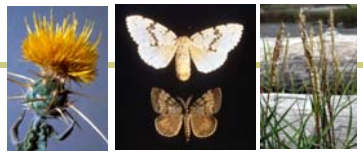
Of the 11 species that have been detected in the Basin, two are present in all or most of the 13 counties (knapweeds and tunicates), four species are present in five to nine counties (Brazilian elodea, common reed, nutria, *Spartina*), one is present in just two counties (variable-leaf milfoil), and two species have only been detected sporadically in limited locations (Lymantriids, VHS).

Pathways

Major pathways by which invasive species may be introduced to the Puget Sound Basin or spread from one location to another are summarized in Table 3 below, along with associated priority species. There is significant overlap between several of these pathways, and other pathways may also exist, but those listed below represent pathways which may require separate management approaches.

Table 3. Major pathways and species which may move via that pathway.

Pathway	Species
Aquaria. Sold by pet stores and online vendors, and introduced when people dump unwanted aquarium materials.	Brazilian elodea, *Caulerpa*, hydrilla, variable-leaf milfoil
Biological supply houses. Contained in materials sold to schools for use in science classes, and introduced accidentally or intentionally.	Brazilian elodea
Boats and other water-based equipment. Carried on hulls or other surfaces, or in the boat's sea chest and ballast water.	Brazilian elodea, *Caulerpa*, hydrilla, *Spartina*, tunicates, VHS fish diseases, and zebra or quagga mussels
Commercial markets. Introduced for uses such as food, medicinals, or fur.	Feral swine, nutria
Garden ornamentals. Sold at nurseries, home improvement centers, and over the internet, either for their ornamental value or as a contaminant.	Brazilian elodea, hydrilla, kudzu, *Spartina,* variable-leaf milfoil, wood-boring beetles
Firewood and wood products. Introduced via wood imported from other regions, states, or countries.	Lymantriids, wood-boring beetles
Live bait release. Intentionally or unintentionally released after fishing.	VHS fish diseases
Livestock or livestock feed, other fine materials. Transported on livestock or in their digestive systems, or as a contaminate on materials.	Knapweeds, *Spartina*
Shipping. Transported by maritime commerce, whether on materials such as wood products or in ships' ballast water and sea chests.	*Phragmites*, Lymantriids, tunicates, wood-boring beetles, zebra or quagga mussels
Trail use. Spread by pedestrians, bikers, and others along and between trails.	Knapweeds, *Spartina*
Transportation. Transported on tires, wheel wells, undercarriage, or otherwise on vehicles, farm equipment, and mobile machinery, or by travelers using airplanes, rail, and cars.	Knapweeds, Lymantriids, zebra or quagga mussels



Impacts and At-risk Resources

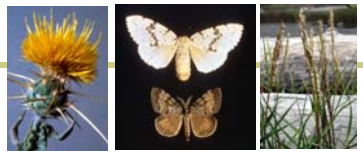
Invasive species may have a number of impacts to ecological and human systems, which are often tightly linked but are separated out here for emphasis on particular impacts. Table 4 summarizes major ecological and human impacts and provides examples of how specific species impact key resources. In addition to the direct impacts listed here, the cost of controlling or attempting to eradicate established populations can often be high.

Table 4. Major impacts and examples discussing species and at-risk resources.

Impacts	Examples of impacts
Ecological impacts	
Alter physical processes	Dense stands of Brazilian elodea, hydrilla, or variable leaf milfoil restrict water movement (increasing water temperatures), trap sediment, and reduce dissolved oxygen within fresh waterbodies. Knapweed can accelerate soil erosion rates. *Phragmites* can alter nutrient cycles and hydrologic regimes.
Outcompete native species.	Invasive tunicates outcompete native species for food and space and may siphon out the gametes of other species. *Spartina* outcompetes native eelgrass, affecting the communities eelgrass supports; *Caulerpa* could also threaten eelgrass communities.
Cause mortality of native species.	VHS weakens the blood vessels of fish, eventually causing death. Feral swine and nutria can spread diseases.
Human dimension impacts	
Reduce the value of natural resource industries	Kudzu takes over working farm, forest, and ranch lands. Establishment of wood-boring insects or Lymantriids would likely lead to quarantines on wood or agricultural products from the infested areas, impacting forestry, agriculture, and wholesale nursery sectors.
Interfere with infrastructure	Zebra and quagga mussels can clog piping and mechanical systems of industrial plants, utilities, locks, and dams.
Interfere with recreational activities	Aquatic plants, such as Brazilian elodea, hydrilla, and variable-leaf milfoil, can clog waters for swimming and boating. Thick stands of *Spartina* or *Phragmites* can block shoreline access for activities such as kayaking or fishing.
Impact human health	Lymantriid caterpillars can cause allergic reactions.

Management

Invasive species management in Washington State initially focused on the threat noxious weeds posed to the state's agricultural industry. Since 1881, legislation has required landowners to control their weeds. In 1969 the Legislature established noxious weed control boards in each county, with a focus on terrestrial plants. Management of invasive freshwater plants was initially funded through a U.S. Army Corps of Engineers program focused on control of Eurasian



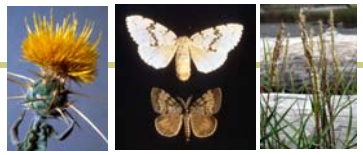
watermilfoil. In 1991, the Legislature established the Aquatic Weeds Management Program and designated the Washington State Department of Ecology as lead; the federal program ceased shortly thereafter. Focused efforts to control *Spartina* species have been funded by the Legislature since 1995.

Non-native insects have become of increasing concern to the state's agriculturalists and foresters, and current survey efforts for wood-boring insects and Lymantriid moths are managed by WSDA and funded in part by the U.S. Department of Agriculture. The arrival of European green crab on the Washington Coast drove the state to coordinate its response to aquatic nuisance species such as tunicates or zebra and quagga mussels. Detection of the Council's priority virus is focused on threats to salmon species. Management of invasive mammals is limited compared to the management activities for the other priority species and there is currently no management of *Caulerpa*.

Jurisdictions and Authorities

The major types of organizations involved in management efforts for the 15 priority species, and major governing authorities, are:

- **County-level agencies**, including noxious weed control boards (NWCB), conservation districts, and surface water and public works divisions of county governments. Under Chapter RCW 17.10, the state noxious weed law, county NWCBs must implement the state noxious weed list, ensuring that landowners carry out required control on their own property. County-level agencies rarely work on invasive species other than plants (Island County reported education/outreach on tunicates).
- **State-level agencies**, including the Washington State Departments of Ecology (Ecology), Fish and Wildlife (WDFW), Agriculture (WSDA), Natural Resources (WDNR), and Transportation (WSDOT); the Washington State Parks and Recreation Commission (WSPRC), and the State Noxious Weed Control Board (NWCB). Combined, these state agencies reported management activities for every one of the priority species. Under Chapter 17.10 RCW, the State NWCB and WSDA are mandated to implement the noxious weed list. WSDA also administers plant quarantines, has the lead role for *Spartina* control under Chapter 17.26 RCW, and conducts invasive insect surveys and eradication efforts. WDFW has management authority for aquatic invasive species and mammals, under RCW 77.12.020. Ecology surveys for, and funds, eradication and control efforts of freshwater aquatic weeds through the Freshwater Aquatic Weeds Account (RCW 43.21A.650).
- **Federal-level agencies**, including the U.S. Forest Service (USFS), Department of Agriculture (USDA), Fish & Wildlife Service (USFWS), and Geological Survey (USGS); and the National Park Service. Among other activities, federal agencies may set legal frameworks for invasive species management (e.g., hydrilla is on the federal noxious weed list), provide funding for management activities (e.g., for invasive insect control), or conduct detection and control activities on their own lands (e.g., USFS and Park Service management of knapweed on USFS and National Parks land).
- **Tribes** which conduct management activities on reservation lands and associated resource lands, as well as the Northwest Indian Fisheries Commission (NWIFC) which provides resources,



coordination, and data collection services to tribes. *Note that a limited number of tribes provided input to the project.*

- **Non-governmental organizations (NGOs)**, such as People for Puget Sound and the Reef Environmental Education Foundation (REEF). Many of these organizations focus on marine species, reporting activities for species such as *Spartina* and tunicates. *Note that a limited number of NGOs provided input to the project.*
- **Universities**, including Washington State University (WSU), Washington Sea Grant (affiliated with the University of Washington), Portland State University, and Oregon State University. Although these entities typically receive state funding, here they are considered separately from state agencies.
- **Cities** may control invasive species on municipal lands. Note that a limited number of cities provided input to the project.
- **Inter-regional agencies**. These include Cooperative Weed Management Areas, the Pacific Marine Fisheries Commission, and the 100th Meridian Initiative.

Many of these entities collaborate on invasive species management. For example, *Spartina* control has proved to be an excellent example of collaboration between many levels of agencies on invasive species control and eradication, administered by WSDA and including county, state, federal, and tribal agencies, non-profits, and private landowners.

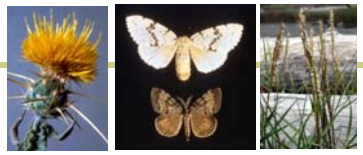
Programs that are no longer active are not discussed here, such as the Puget Sound Marine Invasive Species Volunteer Monitoring Program, run by Nahkeeta Northwest, which trained volunteers to monitor for *Caulerpa*, *Spartina,* and tunicates among 30 non-native species.

Funding

Funding for invasive species management efforts is complex. Many agencies combine multiple funding sources for a given program, which may in turn address multiple species. The exact mix of those funds may change from year to year. Likely reflecting this complexity, few organizations surveyed provided information about their funding sources. The project team conducted basic research to identify major funding sources for management efforts, with an emphasis on understanding how county NWCBs fund their efforts. Table 5 below briefly summarizes some of the major funding sources for the state agencies with lead invasive species management responsibility: WSDA, WDFW, and Ecology, followed by a discussion of funding for county NWCBs.

Table 5. Major funding sources for the major state agencies with invasive species management mandates.

Agency	Species addressed	Major funding sources
Ecology	Brazilian elodea, common reed, hydrilla, *Spartina,* variable-leaf milfoil, zebra and quagga mussels	Freshwater Aquatic Weeds Account, state general fund, federal funds (e.g., NOAA funding for *Spartina* control)



WSDA	Brazilian elodea, common reed, hydrilla, knapweeds, kudzu, Lymantriids, *Spartina,* variable-leaf milfoil, wood-boring beetles	State general fund, appropriations from the state Aquatic Lands Enhancement Account, grants through Ecology's Freshwater Aquatic Weeds Account, USDA (USFS, APHIS)
WDFW	Brazilian elodea, *Caulerpa*, common reed, hydrilla, knapweed, kudzu, nutria, *Spartina,* tunicates, variable-leaf milfoil, VHS fish diseases, zebra and quagga mussels	State funds (e.g., dedicated funding through ESSB 5699 for zebra and quagga mussels, emergency funding for tunicate control, contracts with WSDA for *Spartina* control, and Salmon Recovery Funding Board grants), federal funds (e.g., EPA, USFWS)

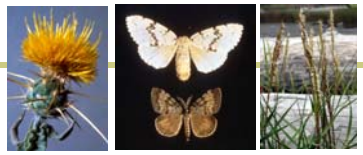
County NWCBs are funded either through a property assessment (authorized under RCW 17.10.240) or an appropriation from the county general fund (see Table 6 for a summary). The Washington NWCB has found that those counties with assessments typically have the most "stable and effective" noxious weed control programs.[4] Six of the 13 Puget Sound counties use assessments, with rates ranging from county to county. This county-level funding is directed towards coordination and implementation of noxious weed control and eradication, with much of the on-the-ground control efforts funded by private landowners, as required under RCW 17.10. Some county noxious weed control boards also contract with state or federal agencies.

Table 6. Funding sources for the county noxious weed control boards.

County	Funding sources
Clallam	Assessment, grants, and contracts with WSDA
Island	County general fund, grants, and contracts with WSDA
Jefferson	County general fund, grants, and contracts with WSDA
King	Assessment, grants
Kitsap	Assessment
Lewis	County general fund
Mason	County general fund (assessment under discussion), cooperative agreements with USFS
Pierce	Assessment, grants
San Juan	Assessment
Skagit	County general fund, contracts with WSDA
Snohomish	County general fund, grants, and contracts with WSDA
Thurston	Assessment, settlement reimbursement, grants
Whatcom	County general fund

Funding dedicated for, or associated with, management of each species is further detailed, as information was available, in the subsequent species summaries section.

[4] Washington State Noxious Weed Control Board, *2008 Report of the Washington State Noxious Weed Control Board.*



Management Program Types

We categorized management programs as falling into one or more of ten distinct categories. These are defined in the Glossary and were used, along with an option for "other", in the November 2009 survey. The frequency of each program type is as follows: control (34 entities reported control-type programs), detection and education/outreach (30 entities each), monitoring (29), eradication (25), prevention (18), funding and policy (9), research (4), and enforcement (2). Table 7 describes the three most commonly reported program types by county, state, federal, and other entities, as well as the number of organizations at each level which were identified to have invasive species management programs.

Table 7. Most commonly reported management program types at the county, state, and federal level, and by other organizations.

	Three most commonly reported management program types (frequency)	Number of organizations with current management activities
County	Control (17), monitoring (15), education/outreach (13)	19
State	Detection and education/outreach (6), control, eradication, and funding (5)	8
Federal	Control (6), detection (5), monitoring (4)	7
Other [5]	Education/outreach (9), detection (7), control, eradication, and monitoring (6)	13

Maps in the species summaries sections indicate the type of management programs reported by county-level agencies for each species. State- and federal-level programs typically cover the entire Puget Sound Basin, and thus those programs are not included in the maps but described in the narrative for each jurisdictional level.

Summary of Gaps

This section presents major gaps in data collection and management; knowledge and understanding of species status, pathways, and impacts; and management efforts for the Council's 15 priority invasive species. In many cases, there are clear cause and effect relationships between the gaps identified in these three categories.

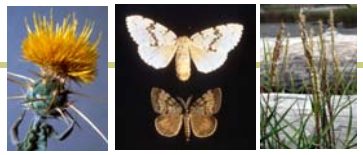
Priority gaps

Data collection and information management gaps

Gaps in data collection and management can limit our ability to draw conclusions about species presence and trends, which in turn affect management decisions.

- Data collection methods are not standardized across all organizations assessing a given species. As a result, there is wide variability in the quality of data compiled here for the majority of the priority species. For example, tunicate data submitted to the project ranged from GIS shapefiles of

[5] "Other" refers to non-governmental organizations, tribes, universities, cities, and interregional agencies.



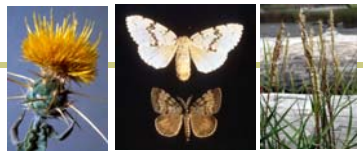
transects surveyed by state agency divers on a biannual basis, to occasional reported sightings from recreational divers trained to identify invasive tunicates, to observations made by scientists at docks and marinas.

- Data collection efforts are much more extensive, well-funded, and long-term for some of the Council's priority species than for others, resulting in wide variability in the quantity and quality of data collected between the priority species. For example, the knapweed species presence map (Map 6.1) indicates isolated extensive populations of this species in King, Thurston, and Whatcom counties, bordered by counties in which little knapweed presence is indicated. It is likely that these data do not accurately portray knapweed distribution on the ground.
- Citizen-science programs exist for a very small number of the priority species, even though these programs can produce large quantities of high quality data when effective protocols for data collection and reporting are implemented. For example, People for Puget Sound trains volunteers to conduct *Spartina* surveys from their kayaks; these data are particularly needed because the remaining *Spartina clones* are often isolated and hard to reach by foot.

Knowledge and understanding of species status, pathways, and impacts

Gaps in our knowledge and understanding of species status, pathways, and impacts make it difficult to target management efforts to most effectively prevent, control, and eradicate species.

- Compiled data for a given species may inaccurately indicate greater presence in one area than for another, due to differences in funding of data collection efforts as highlighted above, or due to variability in the amount of available data shared with the project.
- A lack of standardized, comprehensive data sets limits our ability to complete more detailed spatial and temporal analyses of species status, trends, pathways, and impacts.
- In certain regions and for certain species, there is limited data-sharing and communication between organizations collecting data for the same species. This lessens the likelihood of potential partners developing collaborative approaches for data collection and management that will support improved understanding of species presence, behavior, and impacts in the Basin.
- There are too few research programs targeted at understanding points of entry and pathways of spread in the Puget Sound Basin for the priority species.
- There are too few research programs focused on understanding potential impacts of the priority species to ecological and human dimensions, particularly in the Puget Sound Basin. Invasive species impacts to agricultural and forestry resources are fairly well understood, but areas needing further study include impacts to recreational use trends and characteristics, human health, and other resource-based economic sectors (e.g., aquaculture, fishing).
- There are too few research programs underway to better understand the effects of a shifting climate upon the ability of these species to invade and spread.

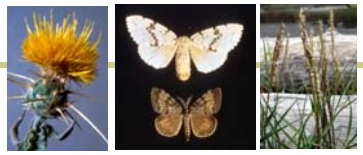


- A lack of agency, professional, and academic knowledge and understanding at the species level translates to gaps in societal understanding. The general public is relatively unaware of the existence of these species, their potential impacts posed to ecological and socio-economic resources, and the role they themselves can play in preventing and detecting invasive species.

Management efforts

Gaps in programs range from a lack of uniform management coverage for all 15 species throughout Puget Sound Basin to variable levels of management coordination among entities managing the same species within the Basin.

- To date, invasive species management efforts primarily address 12 of the 15 priority species. This study found that there is a lack of funding and associated programs to manage invasive mammals (feral swine and nutria), and the alga *Caulerpa.*
- Funding levels for county noxious weed control boards is typically insufficient to cover those organizations' plant control mandates. For example, in 2008, the Kitsap County Noxious Weed Control Board forecast a budget shortfall of $37,000 for 2010. This shortfall has significantly affected staff resources to carry out management objectives.
- There are variable levels of coordination between neighboring county weed boards. Noxious weed boards in Jefferson and Clallam county partner to collaborate with state and federal agencies on invasive plant management. Other counties appeared less aware of their neighbors' activities.
- There are variable levels of management coordination between federal, state, local and tribal entities across the Basin. This represents a missed opportunity to enhance efforts already being conducted by individual entities. An example that could be replicated for other species is the Washington State Department of Agriculture's *Spartina* program. WSDA has effectively coordinated with about 25 local, state, federal, tribal, and non-profit entities to successfully move towards eradication of *Spartina*.
- There are variable levels of coordination with other states and Canadian provinces. Although there has been extensive regional collaboration to prevent the spread of zebra and quagga mussels, little to no regional coordination was reported for most of the priority species.
- Too few programs target pathways of introduction and spread. Most management efforts focus on species control or eradication, or on general outreach and education.
- Most invasive species programs are not evaluated for effectiveness and, as a result, there is a corresponding lack of understanding regarding which programs are or are not working and why.



V. State of Knowledge: Individual Species Summaries

This section provides summaries of the data and management program analyses for each of the 15 species.

1. Brazilian elodea (*Egeria densa)*

Brazilian elodea is a bright green, robust, freshwater plant that grows in still or slow-moving fresh water (lakes, ponds, streams). It forms dense monocultures that can restrict water movement, trap sediment, reduce dissolved oxygen, and crowd out native plants. Brazilian elodea originates from South America and was likely introduced to Washington via the aquarium trade.

Figure 2. Brazilian elodea in the Sammamish River (King County). *Katie Messick, King County NWCB.*

Status and Trends

Species Presence. Brazilian elodea has been documented in ten Puget Sound Basin counties (see Map 1.1), with the greatest number of documented occurrences in central Puget Sound's King County. For all other counties, there is only one spatially-referenced observation of presence, with the exception of Island County where presence has been spatially documented in two locations.

Presence over time. Brazilian elodea was first reported in Long Lake in Kitsap County in the 1970s. It was documented in a few additional locations in the 1970s and 1980s. Ecology staff began actively looking for *E. densa* in 1994, and the species had been documented in nine counties by the mid 1990s.

Files used in the analysis. Two shapefiles were provided to the project, and both were used in the spatial analysis. One observation of Brazilian elodea from the UW Burke Herbarium, which was not noted in any other data files, was converted to a shapefile and included in the spatial analysis.

Files not used in the analysis. A map image from WSDA contained data at a coarser scale than other datasets provided, and thus was not used. Anecdotal reports confirmed by separate spatial datasets were not used. Management reports were used in the program analysis rather than the status analysis. A selection of the images provided are included elsewhere in this section. See Table 8 for a summary of data provided.

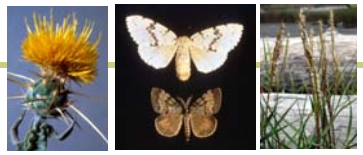


Table 8. Brazilian elodea data provided to the baseline assessment project. Data files included in the spatial summaries are noted with an asterisk (*). For more detail on spatial data see Appendix A1.1.

File type provided (quantity)	Spatial extent	Data provider
Spatially explicit data		
GIS shapefiles (2*)	King County, Puget Sound Basin	King County NWCB, Ecology
Observations with latitude & longitude (1*)	Island, Jefferson, San Juan, Skagit counties	UW Burke Herbarium
Images with location (1 set)	Sammamish River (King County)	King County NWCB
Map image (1)	Washington State	WSDA
Other data		
Anecdotal reports (3)	Lake Leland (Jefferson County), multiple waterways (King County)	Clallam County NWCB, Jefferson County NWCB, King County NWCB
Management reports (2 sets)[6]	Lone Lake (Island County), Big Lake (Skagit County)	Island County NWCB, Skagit County

Pathways

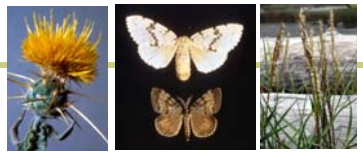
In this section and the following Impacts and At-risk Resources section, the discussions reference species-specific basin-wide "Pathways and At-risk Resources" maps and the county-scale maps included as appendices. Included in these maps are all publicly available data layers representing those pathways and sensitive landscape features relevant to this species (e.g., boat ramps, roads, wetlands).

Pathways, Impacts, and At-risk Resource Data Layers

Particular data layers were selected for inclusion in the county-scale maps based on our understanding of pathways and potentially-impacted resources relevant to specific priority species. Our understanding of spatial units and landscape features relevant to a particular species was informed by our background research, input from data providers, discussions with Council staff, and consultation with species and regional experts during the work sessions held in May 2010.

Pathways of introduction. Brazilian elodea was once sold in pet stores and nurseries. While sale and transport of the species is now banned in Washington, it may still be sold illegally over the internet, via trades, and through biological supply houses. It can also be unintentionally included as a contaminant with other plants or aquarium material or because it has been misidentified as the native *Elodea canadensis*. Because introductions of this species are associated with human activities, a correlation between development and locations of occurrence is likely. Although no formal spatial analysis was completed, there appears to be a spatial relationship between waterbodies located in developed areas of each county and the presence of this species (e.g., see multiple locations within densely-settled King County in Map 1.2). At the same time, Brazilian elodea is present in areas of rural

[6] Note, these counts represent the number of reports and descriptions provided to the project, and do not account for additional management reports and grant reports accessible on Ecology's website.



settlement, such as Lake Leland in Jefferson County, underscoring the fact that the species can be introduced by a single person. Public boat ramps are also mapped as a possible entry point to specific water bodies, but there does not appear to be a direct relationship between boat ramps and species occurrence.

Pathways of spread. Recreational fishing and boating may spread the species through transport of fragments. Fresh waterbodies with adjoining development or public access points are particularly susceptible. Brazilian elodea can be spread between hydraulically connected waterbodies, such as between Lake Washington and Lake Union, as shown in Map 1.2. Furthermore, plants growing within flood zones may be transported to new water bodies via flood waters. See Map 1.2 and Appendices A1.10-A1.22 for the spatial distribution of potential pathways of concern.

Impacts and At-risk Resources

Map 1.2 and Appendices A1.10-A1.22 show the status of Brazilian elodea within close proximity to landscape features sensitive to its presence, including natural features such as rivers, streams, lakes, ponds, swamps and marshes, as well as infrastructure elements such as canals, ditches, and reservoirs.

Ecological impacts. Dense monocultures of Brazilian elodea can restrict water movement, trap sediment, and reduce dissolved oxygen. *E. densa* poses a threat to native finfish and shellfish because it crowds out native freshwater plants, reducing native plant diversity and forage for fish, blocking fish passage, and increasing water temperatures by reducing water circulation.

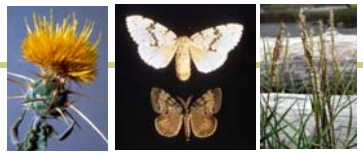
Human dimension impacts. Dense stands of Brazilian elodea impair recreational uses of waterbodies, and can even pose a drowning risk. They can interfere with water supply reservoirs, dams, navigation, flood control, and surface water management. Removing established populations of Brazilian elodea can be very costly and take many years.

Management

Overall, *E. densa* is typically managed within specific lakes; often by county-level agencies but also by lake management districts and homeowner groups. Ecology provides funding and technical assistance and conducts research and surveys. Table 9 summarizes commonly reported program types and the number of entities reporting management activities for Brazilian elodea.

State- or Puget Sound-level activities. Ecology's Aquatic Weeds program provides funding and technical assistance for local eradication and control efforts at the local levels. Ecology staff monitor lakes for Brazilian elodea and have conducted trials on methods to control the species. The Washington NWCB coordinates and supports the activities of county NWCBs, and works with WSDA to update and implement the state noxious weed list. WDNR, WSDOT, and WDFW prevent and survey for any new Brazilian elodea infestations on agency lands.

County-level activities. Organizations in nine of the ten counties with Brazilian elodea reported control, detection, eradication, education/outreach, monitoring, and prevention efforts targeted at the species. Management in many lakes focuses on control, to allow for recreation, with eradication seen as unattainable. Lead responsibility for management varies from lake to lake,



with NWCBs, private lake associations or lake districts, conservation districts, and public works departments all playing roles. San Juan County NWCB had reported detection and education/outreach efforts, but had not detected the Brazilian elodea reported by UW scientists at a private pond on San Juan Island. It can be challenging for NWCB staff to survey privately-owned ponds unless invited to do so by the owner(s).

Lewis and Thurston counties have Brazilian elodea populations in waterbodies which lie outside of the Puget Sound Basin boundaries. Lewis County reported detection and education/ outreach efforts, and Thurston County has led an extensive Brazilian elodea control effort in the Chehalis River. Clallam County reported no management efforts for this species. For a geographic depiction of management activities, see Map 1.3.

Federal-level activities. Olympic National Forest staff have Brazilian elodea on a watch list, with the goal of increasing awareness of aquatic invasives among employees. The USGS maintains a database of aquatic species data and reports, with an online portal for reporting of new sightings.

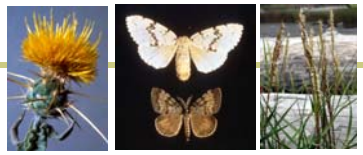
Other activities. The Council hired the Pacific Education Institute to teach educators about invasive species and using invasives as live specimens and to develop curricula for classroom learning on invasive species. Washington Sea Grant is part of an international team focused on reducing introduction of species such as Brazilian elodea via biological supply houses and science classrooms. Researchers at UW are developing a model to forecast the invasion of three aquatic plants in Washington lakes, including Brazilian elodea, based on lake attributes, with the goal of informing and enhancing prevention, monitoring, detection, and eradication efforts. The NWIFC provides services to member tribes to support their invasive species management efforts. The UW Burke Herbarium collects and shares information on Brazilian elodea among other plants.

Table 9. Commonly reported management program types and number of organizations targeting Brazilian elodea.

	Three most commonly reported management program types (frequency)	Number of organizations with current management activities
County	Detection and education/outreach (6), control and monitoring (5)	10 (present in 10)
State	Detection, education/outreach, and funding (4)	7
Federal	Detection and other: tracking distribution (1)	2
Other	Education/outreach (6), prevention (3), research (2)	8

Legal authorities. Brazilian elodea is listed as a Class B Noxious Weed, meaning it is designated for control on a regional basis, including the following portions of Puget Sound: Clallam County; King County, except Lakes Washington, Sammamish, Union, and Fenwick; and Lewis County (Chapter 17.10 RCW, WAC 16-750-011(16)). Brazilian elodea is on the state's list of quarantined species, meaning transport, purchase, sale, or distribution of the plant or plant parts is prohibited (WAC 16-752-505). These laws govern state- and county-level management.

Funding. The Freshwater Aquatic Weeds Account (RCW 43.21A.650) was established in 1991 as a $3 increase in annual license fees for boat trailers. Ecology disburses grant awards from this account and uses some of the funds for its own surveys and management. This account is typically



limited to public-access lakes and to waterbodies designated by WDFW for fly-fishing (RCW 43.21A.660). Aquatic Weeds funds have supported control efforts in Island, Jefferson, King, Pierce, and Skagit counties. In addition, efforts in several counties are funded by district dues or private association fundraising, including the Big Lake District (Skagit County), Ohop Lake (Pierce County), and Lake Limerick (Mason County). Control efforts at Long Lake in Kitsap County have been funded through a direct appropriation from the state Legislature. For an overview of funding sources for Ecology and county NWCBs, see Tables 5 and 6.

Summary of gaps

This summarizes gaps specific to Brazilian elodea; some of the overarching gaps identified in Section IV are applicable as well.

Data collection and management. Ecology and county NWCBs cannot survey private lakes and so may be missing populations.

Knowledge and understanding of species status, pathways, and impacts. Although species presence is not indicated for three counties, it is not currently known whether that accurately represents actual absence, or is due to existing data on species presence/absence for those counties not being shared with the project. Throughout the Basin, data compiled for the project likely do not accurately depict trends or changes in species presence in the Basin over time. Ecology began surveying lakes for Brazilian elodea in 1994, at least partially explaining the increase in species detection in the Basin post-1994. General understanding of pathways of introduction and spread, as well as potential impacts to basin resources are fairly well understood from work on this species in other regions. However, there is little local documentation on how Brazilian elodea is spreading in the Basin, or the potential extent or scale of impacts to basin resources.

Management efforts. State-level funding, monitoring, and support are limited to public-access lakes, meaning that control in private lakes must be carried out by lake residents, with varying success. Particularly in private lakes, control efforts focus on allowing residents recreational access, but do not attempt to curb the growth of the population as a whole.

Brazilian Elodea

Egeria densa

Puget Sound Basin

Species Detection (1977 - 2009)

Observed*

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program.

Land Cover & Land Use

- Developed
- Cultivated Lands
- Grassland
- Deciduous Forest
- Coniferous & Mixed Forest
- Scrub / Shrub
- Freshwater Wetland
- Estuarine Wetland
- Beaches, Bars & Flats
- Rock & Snow
- Water

Boundaries & Extents

- County Boundary
- Puget Sound Extent

Whatcom
San Juan
Skagit
Island
Snohomish
Clallam
Jefferson
Kitsap
King
Mason
Grays Harbor
Pierce
Thurston
Lewis

Lynden
Ferndale
Bellingham
Friday Harbor
Anacortes
Mount Vernon
Oak Harbor
Coupeville
Port Angeles
Port Townsend
Everett
Monroe
Edmonds
Seattle
Bellevue
Bremerton
Port Orchard
Renton
Kent
Federal Way
Tacoma
Puyallup
Lakewood
Shelton
Olympia

JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

Miles
0 5 10 20

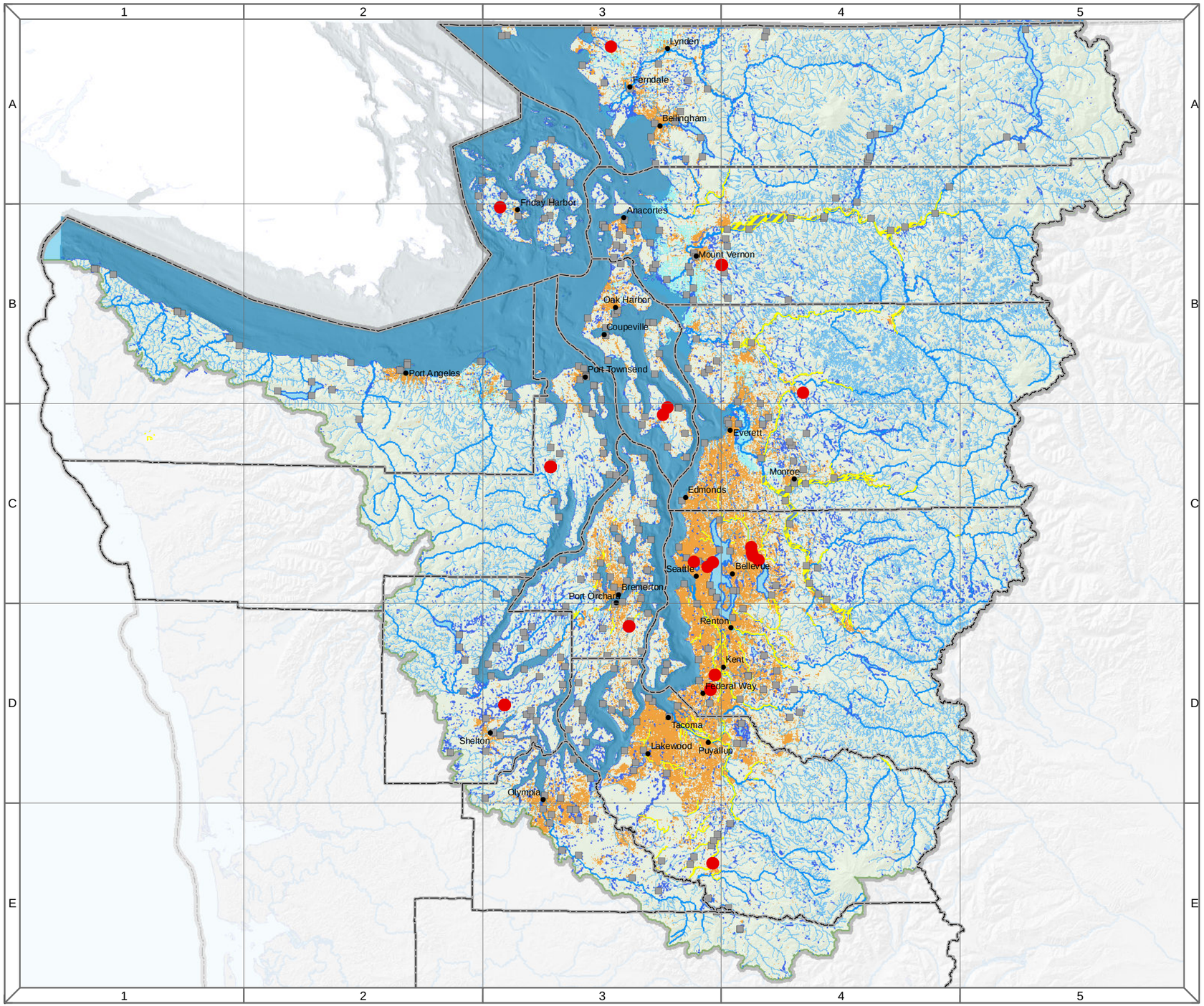
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species:
Documented Presence in Puget Sound Basin

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 1.1

February 2011



Brazilian Elodea

Egeria densa

Puget Sound Basin

Species Detection (1977 - 2009)

Observed*

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. See Appendix for county scale maps.

Boundaries & Extents

County Boundary

Puget Sound Extent

Pathways & Sensitive Landscape Features

Boat Ramps

River / Stream

Canal / Ditch

Flood Zones

Lake / Pond

Reservoir

Swamp / Marsh

Sea / Ocean

Land Cover & Land Use

Developed

JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

Miles
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WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species:
Species Locations, Potential Pathways, Sensitive Landscape Features

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 1.2

February 2011

Brazilian Elodea

Egeria densa

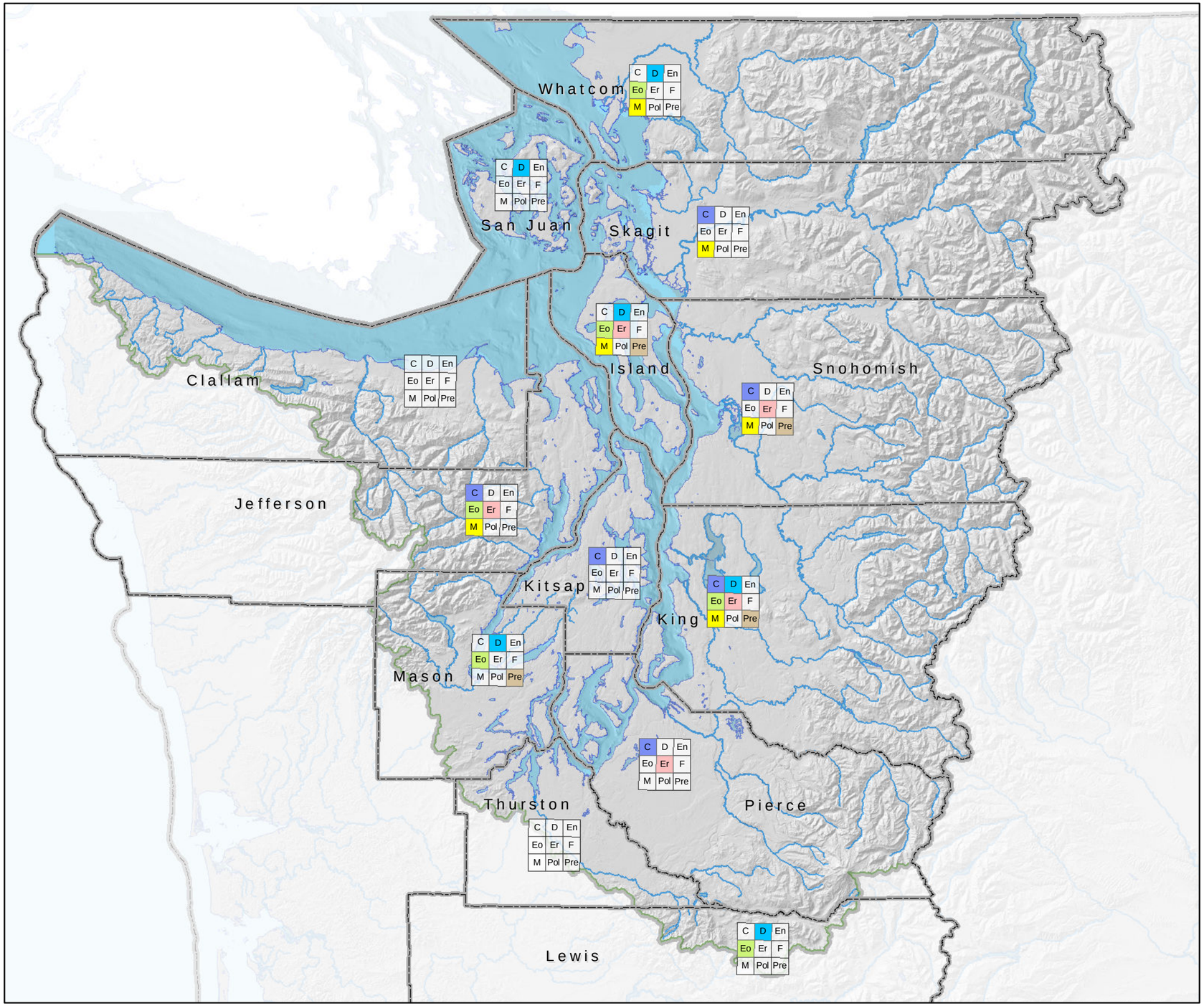
Puget Sound Basin

Management at the County Level

- Control (C)
- Detection (D)
- Enforcement (En)
- Education / Outreach (Eo)
- Eradication (Er)
- Funding (F)
- Monitoring (M)
- Policy (Pol)
- Prevention (Pre)

Boundaries & Extents

- County Boundary
- Puget Sound Extent



JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

0 5 10 20 Miles

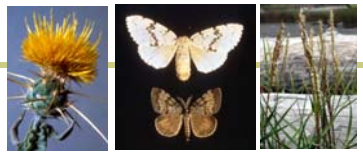
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species:
Management at the County Level

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 1.3

February 2011



2. Caulerpa (*Caulerpa taxifolia*)

Caulerpa is a marine alga that has infested waters off Southern California and the Mediterranean Sea. It is native to the Caribbean Sea and the Indian Ocean and prefers muddy bottoms, warm harbors, and protected waters. If *Caulerpa* adapts to the cooler waters of Puget Sound, or if local water temperatures increase sufficiently to support *Caulerpa,* this species could have devastating impacts to Washington.

Status and Trends

Caulerpa has not yet been documented in Puget Sound, and no datasets were shared with the project, thus no maps are presented here.

Figure 3. Caulerpa. ***Caulerpa Action Team Archive, Bugwood.org***

Pathways

Pathways of introduction. Sold for use in aquaria.

Pathways of spread. These pathways include people dumping aquarium material and transport via ballast water/sea chests. Pathways may also include recreational fishing and boating, but to a lesser extent due to the distance of any source of *Caulerpa*.

Impacts and At-risk Resources

Ecological impacts. In the Mediterranean Sea, *Caulerpa* has infested thousands of acres of seafloor. It created ecological and economic devastation by overgrowing and eliminating native sea grasses, reefs, and other native communities. *Caulerpa* can be toxic to some herbivores, and may also retard the growth of key phytoplankton. Specific impacts of concern include eelgrass beds and flounder nursery grounds; *Caulerpa* could also impact bicarbonate cycling, possibly complicating the already negative effects of climate-induced ocean acidification on bicarbonate-dependent processes.

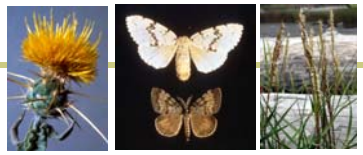
Human dimension impacts. In areas it has invaded, *Caulerpa* has negatively impacted tourism and recreational activities and had a costly impact on commercial fishing by altering the fishery and entangling fishing nets.

Management

Current management activities are regional in nature. Table 10 summarizes commonly reported program types and the number of entities reporting management activities for *Caulerpa*.

State or Puget Sound-level activities. The Washington Ballast Water Program, managed by WDFW, has developed discharge performance standards and hired a Ballast Water Inspector to reduce the threat of introductions of species such as *Caulerpa* via the discharge of ballast water.

County-level activities. None reported.



Federal-level activities. The Pacific Marine States Fisheries Commission coordinates ballast water management decisions among regulators, managers, scientists and the shipping industry, while USFWS and NOAA co-chair the ANS Task Force; both work to prevent the introduction of *Caulerpa* among other species. The USDA conducts detection, education/outreach, enforcement, and prevention activities, as needed, on a regional basis, to implement the federal noxious weed list.

Other activities. Washington Sea Grant presents on aquatic invasive species topics to general audiences, with species addressed including *Caulerpa*.

Table 10. Commonly reported management program types and number of organizations targeting *Caulerpa.*

	Three most commonly reported management program types (frequency)	Number of organizations with current management activities
County	None	0 (present in 0)
State	Prevention and policy (1)	1
Federal	Education/outreach (3), prevention (3), policy (2)	3
Other	None	0

Legal authorities. *Caulerpa* is on the federal noxious weeds list, under CFR 7 360.

Funding. The Washington Ballast Water Program is funded by USFWS, Ecology, and the Pacific States Marine Fisheries Commission.

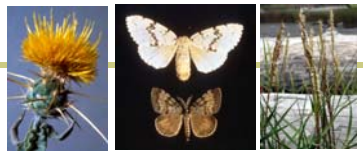
Summary of Gaps

This summarizes gaps specific to *Caulerpa*; some of the overarching gaps identified in Section IV are applicable as well.

Data collection and management. No current coordinated survey efforts were reported. Nahkeeta Northwest previously managed the Puget Sound Marine Invasive Species Volunteer Monitoring Program, which trained volunteers to conduct sampling for *Caulerpa* among other species; this program is no longer funded.

Knowledge and understanding of species status, pathways, and impacts. Species presence is not indicated anywhere in the Basin; at this time, it is not known whether this indicates actual absence, or is due to lack of data. Knowledge of potential pathways of entry and spread, as well as understanding of potential impacts to Basin resources, is derived from work on the effects of invasive *Caulerpa* in other areas.

Management efforts. Management for *Caulerpa* is limited to related efforts through the Washington Ballast Water Program as well as federal-level coordination via the Pacific Marine States Fisheries Commission and the ANS Task Force. There is no clear program or campaign in Washington addressing the potential for people to introduce *Caulerpa* via aquaria.



3. Common reed (*Phragmites australis*)

Common reed, also known as *Phragmites*, is a large grass that can grow up to 15 feet in height. *Phragmites* grows in wetlands and wet areas, such as marshes, tidal estuaries, ditches along highways, and the borders of lakes, ponds, and rivers. This species is native to Washington, however in the 1990s, some land managers proposed listing common reed as an invasive species because it appeared to be aggressively invading wetland areas. Subsequent research established that a non-native genotype had been introduced in Washington, and the non-native genotype of *Phragmites* became a priority for the Council.

Figure 4. *Phragmites* in Lake Washington (King County). *Jeff Adams, Washington Sea Grant.*

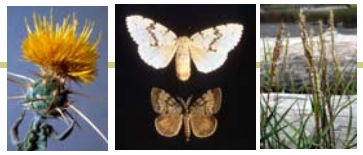
Status and Trends

Species presence. Populations of non-native common reed were reported to the project as located in Island, Jefferson, King, Pierce, Snohomish, Thurston, and Whatcom counties. As shown in Map 3.1, spatial data provided for the period 2001-2009 from nine state and county sources (see Appendix A3.1) suggest populations are concentrated in the central part of Puget Sound, primarily in King County, with limited occurrences to the south near Olympia in Thurston County, north to Bellingham Bay in Whatcom County, and as far west as the northern tip of Hood Canal in Jefferson County.

Presence over time. Phragmites is likely still entering into and spreading throughout the Puget Sound Basin, but exact trends are difficult to pinpoint as genotyping and mapping of exotic and native strains has only recently been completed. Spatial data provided by Ecology and WSPRC indicate the presence of non-native common reed in only Island and King counties in 2001-2002. More recent data show presence of the species in Jefferson, King, Pierce, Snohomish, Thurston, and Whatcom counties, but again, the recent nature of efforts to identify and map this species makes it difficult to know when the non-native strain first invaded each location.

Files used in the analysis. All but one of the GIS shapefiles provided were used in the spatial analysis, as noted below. Two additional files were converted into shapefiles and used in the analysis: the spatially explicit observation of a population in Bellingham being controlled by Whatcom County NWCB staff, and a spreadsheet describing *Phragmites* observations during a survey of Fort Casey State Park (Island County). See Table 11 for a summary of data provided.

Files not used in the analysis. The shapefile from Seattle Urban Nature was provided later in the process and showed a population already described in other shapefiles. The spatially explicit



observations from UW Burke Herbarium did not appear to have been genotyped and thus could not be positively noted as the non-native genotype. These observations were at Mercer Slough (King County) and Langley (Island County); neither of these locations was indicated in other data files. A selection of the images provided are shown in this section; one was of the Bellingham population (Whatcom County) described above as being included in the spatial analysis, the other was in Lake Washington (King County), where other datasets had already described presence.

Table 11. Common reed data provided to the baseline assessment project. Data files included in the spatial summaries are noted with an asterisk (*). For more detail on spatial data see Appendix A3.1.

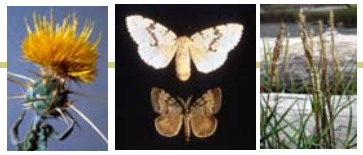
File type provided (quantity)	Spatial extent	Data provider
Spatially explicit data		
GIS shapefiles (7*)	Jefferson, King, and Thurston counties, Washington State, Puget Sound Basin, Seattle	King*, Jefferson*, and Thurston County NWCBs*, WSDA*, Ecology*, WSDOT*, Seattle Urban Nature
Observations with latitude & longitude (2 sets*)	Island, King, Snohomish counties; Whatcom County	UW Burke Herbarium, Whatcom County NWCB*
Spreadsheet with locations (1)	Fort Casey State Park (Island County)	WSPRC*
Images with location (2)	Lake Washington (King County), Bellingham (Whatcom County)	Washington Sea Grant, Whatcom County NWCB

Pathways

In this section and the following Impacts and At-risk Resources section, the discussions reference species-specific basin-wide "Pathways and At-risk Resources" maps and the county-scale maps included as appendices. Included in these maps are all publicly available data layers representing those pathways and sensitive landscape features relevant to this species (e.g., boat ramps, roads, wetlands). See the text box on page 33 for more detail.

Pathways of introduction. The non-native genotype of common reed was likely introduced via ship ballast or overland by rail from the East Coast. Map 3.2 supports the hypothesis that the species was introduced via ballast, showing that one of the earliest detected populations of *Phragmites*, on the western most point of Whidbey Island in Island County, is located adjacent to one of the largest convergence points of the Sound's major shipping lanes. Immediately southeast of this population, following the drift path of a north-to-south (or left-to-right) trending drift cell is another documented population of *Phragmites* (see Appendix A3.11 for a higher resolution map of *Phragmites* sites in Island County).

Pathways of spread. Marine shipping, marine currents or drift cells, and fresh water transport, as well as local gardening (transplanting of wild populations) and estuary restoration projects are all suggested pathways for the spread of *Phragmites*. Although a spatial overlay of documented *Phragmites* populations on potential pathways of spread suggests the species is moving along river corridors, drift cells, and transportation corridors near developed areas (see Map 3.2 and



Appendices A3.10-3.22), sufficient data do not currently exist to support a formal analysis to identify primary pathways of spread.

Impacts and at-risk resources

Ecological impacts. Common reed aggressively invades wet and wetland areas, with impacts to waterfowl, migratory birds, riparian vegetation, waterfowl habitat, wetlands, freshwater systems, and freshwater fauna. It can alter nutrient cycles and hydrologic regimes. Data presented in Map 3.2 and Appendices A3.10-3.22 suggest that *Phragmites* is more successful at colonizing disturbed areas near development. It is likely that freshwater wetland, riparian and estuarine habitat within or close to developed areas are at increased risk of invasion by *Phragmites*, and therefore damage to habitat quality as well as ecological and hydrologic processes.

Human dimension impacts. Dense infestations limit shoreline access, can alter drainage and diking, and increase fire risk.

Management

State and county agencies conduct detection, education and outreach, and as necessary eradication, control, monitoring, and policy-related activities for common reed. Table 12 summarizes commonly reported program types and the number of entities reporting management activities for *Phragmites*.

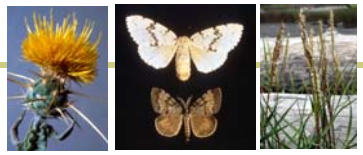
State or Puget Sound-level activities. The Washington NWCB recently classified the non-native genotype of *Phragmites* as a Class B noxious weed, designated for control. Beginning in 2003, WSDA surveyed *Phragmites* populations to determine the distribution of native and non-native genotypes across the state, with input from county noxious weed control boards. WSDOT has worked with Jefferson County to control *Phragmites* on a state highway, as part of its obligation to control this species on agency lands. WSPRC has surveyed for common reed, among other invasives, in the majority of Puget Sound area parks larger than 100 acres.

County-level activities. Phragmites populations were reported in seven counties, of which Jefferson, King, Snohomish, Thurston, and Whatcom counties reported eradication and control efforts, as well as prevention, detection, monitoring, education/outreach, and policy efforts. Island County reported only detection and education/outreach efforts. Pierce County reported no management efforts.

Of the six counties from which *Phragmites* was not reported, organizations in Clallam, Mason, and San Juan counties reported prevention, detection, and education/outreach efforts while Skagit and Lewis counties reported no activities for common reed. No population was reported from Kitsap County, however the Kitsap NWCB reported detection, control, education/outreach, monitoring, and policy efforts. For a geographic depiction of management activities, see Map 3.3.

Federal-level activities. The Olympic National Forest was the only federal agency to report any activities for Phragmites, noting that they have the species on a watch list.

Other activities. Seattle Urban Nature (now part of EarthCorps) conducted a survey of habitats and species in Seattle from 1998-2000, and documented common reed in the Duwamish River. A



student at Oregon State University is developing a weed mapper tool that will track *Phragmites* along with other terrestrial plants. Washington Sea Grant presents on aquatic invasive species topics to general audiences, with species addressed including *Phragmites*. The UW Burke Herbarium collects and shares information on plants including *Phragmites*.

Table 12. Commonly reported management program types and number of organizations targeting *Phragmites*.

	Three most commonly reported management program types (frequency)	Number of organizations with current management activities
County	Detection (10), education/outreach (6), eradication, control, monitoring, and prevention (5)	10 (present in 7)
State	Detection (5), control, eradication, and funding (4)	6
Federal	Detection (1)	1
Other	Education/outreach (4)	4

Legal authorities. *Phragmites* is a Class B Noxious Weed, meaning it is designated for control in specific regions of the state, including most Puget Sound counties except Whatcom, Skagit, and Pierce counties (Chapter 17.10 RCW, WAC 16-750-011(58)). However, Whatcom and Pierce counties have added *Phragmites* to their noxious weed lists as county-selected weeds.

Funding. WSDA's genotyping effort was funded by an Aquatic Weeds grant, through Ecology. The Washington Weed Mapper project is funded by the U.S. Bureau of Land Management. For an overview of funding sources for Ecology, WSDA, and county NWCBs, see Table 5 and Table 6.

Summary of Gaps

This summarizes gaps specific to common reed; some of the overarching gaps identified in Section IV are applicable as well.

Data collection and management. Data provided for this species covers a limited timeframe (about ten years) due to the relatively recent identification of the invasive genotype. Coordination of data collection and sharing began only recently with WSDA's state-wide survey and genotyping effort.

Knowledge and understanding of species status, pathways, and impacts. Species presence was not indicated for six counties. This may be due in part to existing data not being shared with the project, rather than an absence of *Phragmites* in those counties. For example, no population was reported in Kitsap County, however the Kitsap NWCB reported detection and control efforts for the species, suggesting a gap in data documenting presence in Kitsap County. Impacts to at-risk resources resulting from *Phragmites* invasions are fairly well understood but data on the primary pathways of spread and specific at-risk resources within Puget Sound Basin are limited.

Management efforts. Management efforts at the county-level appear to be limited in some cases, and do not directly address known populations of the invasive genotype. For example, the species was reported from Island and Pierce counties, but neither county reported control or eradication efforts. Lack of management efforts targeting this wide-spread species could reflect *Phragmites'* recent addition to the state noxious weed list.

Common Reed

Phragmites australis

Puget Sound Basin

Species Detection (2001 - 2009)

Observed*

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program.

Land Cover & Land Use

- Developed
- Cultivated Lands
- Grassland
- Deciduous Forest
- Coniferous & Mixed Forest
- Scrub / Shrub
- Freshwater Wetland
- Estuarine Wetland
- Beaches, Bars & Flats
- Rock & Snow
- Water

Boundaries / Extents

- County Boundary
- Puget Sound Extent

Whatcom
San Juan
Skagit
Island
Snohomish
Clallam
Jefferson
Kitsap
King
Mason
Pierce
Grays Harbor
Thurston
Lewis

Lynden
Ferndale
Bellingham
Friday Harbor
Anacortes
Mount Vernon
Oak Harbor
Coupeville
Port Angeles
Port Townsend
Everett
Monroe
Edmonds
Seattle
Bellevue
Bremerton
Port Orchard
Renton
Kent
Federal Way
Tacoma
Puyallup
Lakewood
Shelton
Olympia

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CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

0 5 10 20 Miles

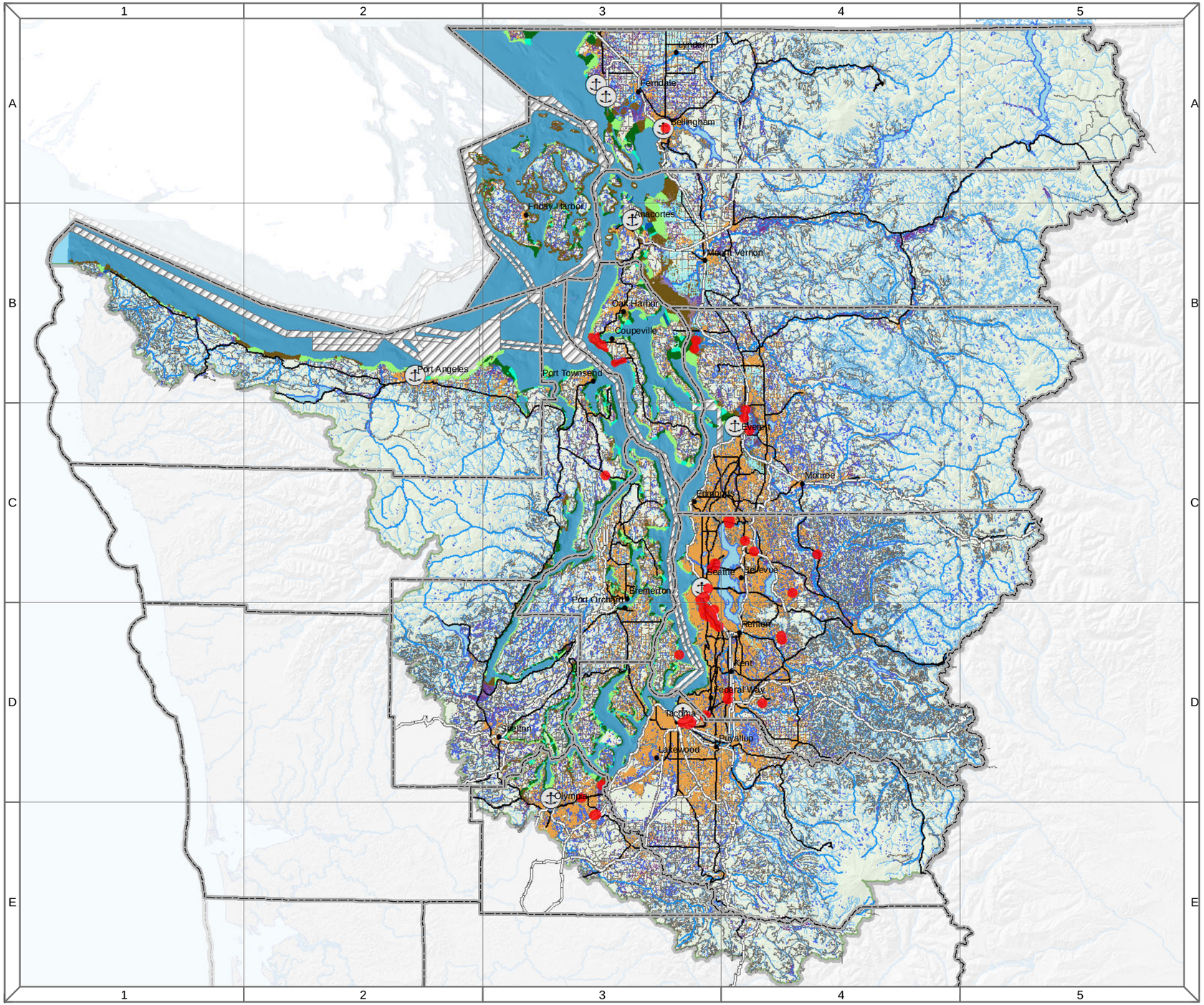
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species: Documented Presence in Puget Sound Basin

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 3.1

February 2011



Common Reed

Phragmites australis

Puget Sound Basin

Species Detection (2001 - 2009)

Observed*

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. See Appendix for county scale maps.

Boundaries / Extents

- County Boundary
- Puget Sound Extent

Pathways & Sensitive Landscape Features

- Ports
- Shipping Lanes
- River / Stream
- Canal / Ditch
- Lake / Pond
- Reservoir
- Swamp / Marsh
- Sea / Ocean
- Roads - Interstate, US, & State Routes
- Roads - Other Routes
- Railroads

Land Cover & Land Use

- Developed
- Freshwater Wetland
- Estuarine Wetland

Drift Cells

- Left to Right
- Right to Left
- Convergence Zone
- Divergence Zone
- No Appreciable Drift

JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

Miles
0 5 10 20

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species: Species Locations, Potential Pathways, Sensitive Landscape Features

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

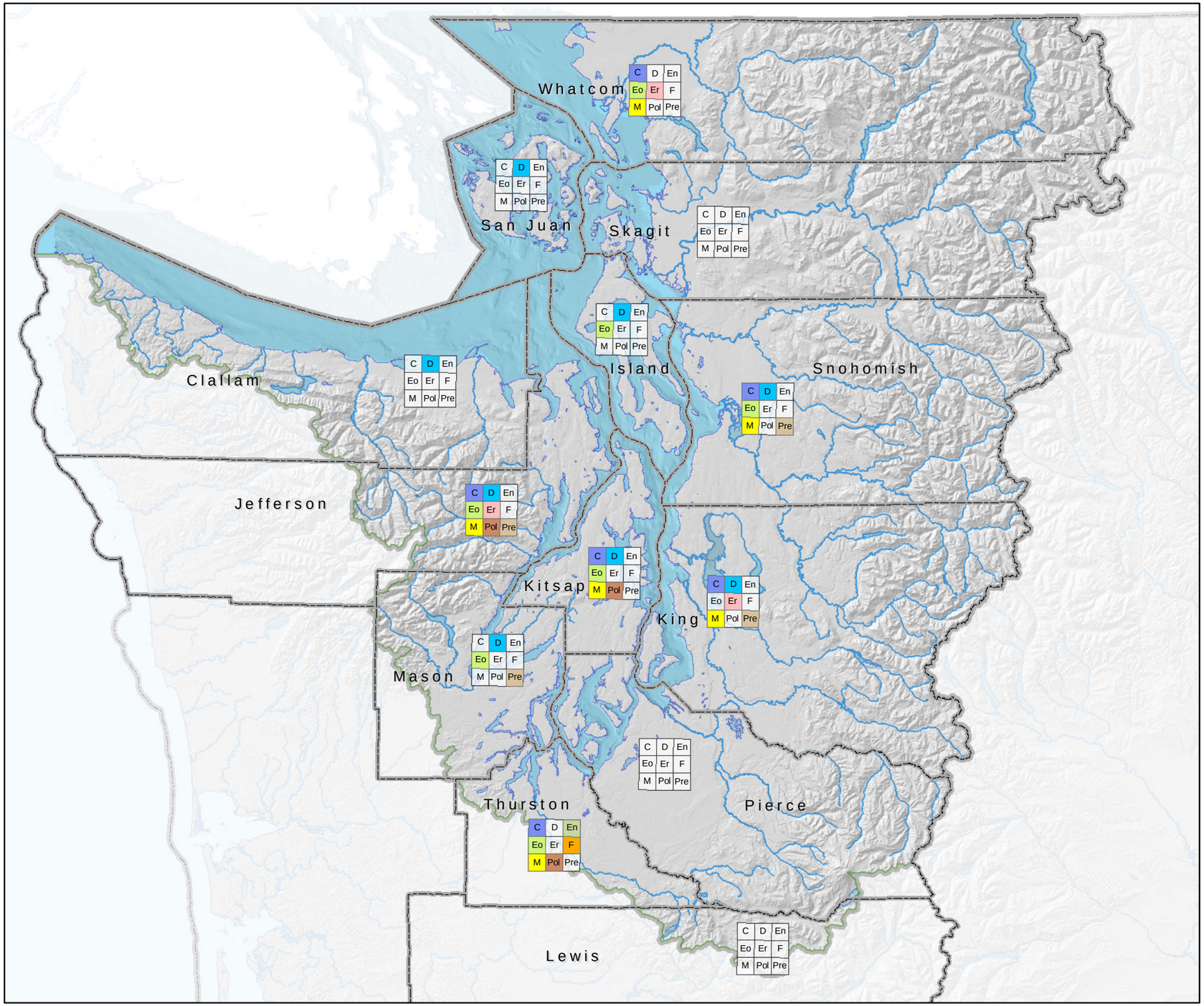
MAP 3.2

February 2011

Common Reed

Phragmites australis

Puget Sound Basin



Management at the County Level

- Control (C)
- Detection (D)
- Enforcement (En)
- Education / Outreach (Eo)
- Eradication (Er)
- Funding (F)
- Monitoring (M)
- Policy (Pol)
- Prevention (Pre)

Boundaries & Extents

- County Boundary
- Puget Sound Extent

JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

0 5 10 20 Miles

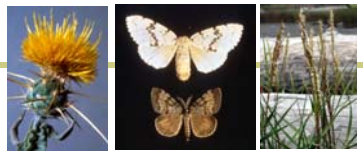
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species:
Management at the County Level

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 3.3

February 2011



4. Feral swine (*Sus scrofa*)

Feral pigs are once-domestic pigs which have escaped or were released intentionally, creating free-ranging feral swine populations. They prefer lowland wooded areas with adequate understory vegetation and water sources, but may be found in a wide variety of habitats with available water.

Status and Trends

Feral swine have not been documented in Puget Sound, but have been reported on the Southeastern Olympic Peninsula. Due to the lack of formal documentation of species presence, no maps are presented here.

Figure 5. Feral swine. *Lloyd Loope, U.S. Geological Survey, Bugwood.org*

Pathways

Pathways of introduction. Feral swine are often introduced for hunting purposes. They may also escape from farms.

Pathways of spread. Natural migration.

Impacts and At-risk Resources

Ecological impacts. Feral swine consume many types of native vegetation, destroying lowland forests and grasslands. They prey upon smaller animals, and are disease vectors. Their rooting and wallowing activities destabilize soils and increase erosion, with impacts to water quality; these activities also create shallow depressions which catch water, increasing mosquito populations. Feral swine can facilitate the invasion of other exotic species.

Human dimension impacts. Feral swine can cause significant damage to agricultural fields and can sicken livestock. They can cause particular damage to areas being reforested or restored.

Management

No agencies reported management activities for feral swine.

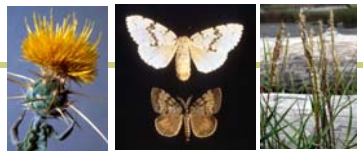
Legal authorities. Feral swine is classified as deleterious exotic wildlife under RCW 77.12.020 and WAC 232-12-017, meaning it is a non-native species considered dangerous to the environment or wildlife of the state. WDFW has lead authority under this regulation.

Summary of Gaps

This summarizes gaps specific to feral swine; some of the overarching gaps identified in Section IV are applicable as well.

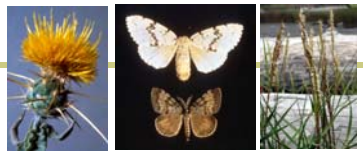
Data collection and management. No data collection efforts were reported.

Knowledge and understanding of species status, pathways, and impacts. The species does not appear to be present in the region. At this time it is not known whether that indicates actual absence, or is due to existing data not being shared with the project. Although feral swine's



potential ecological impacts to native and working lands is fairly well understood from feral swine control efforts in other parts of the country, this understanding has not been used to assess the potential extent of damage to Puget Sound Basin resources.

Management efforts. One apparent gap is the lack of education and outreach programs targeted at residents who may be involved with the introduction of this species as hunting game.



5. Hydrilla (*Hydrilla verticillata*)

Hydrilla is a freshwater aquatic plant which can tolerate a range of water flow rates, temperatures, acidity, light, salinity, and nutrient concentrations. It grows in a variety of fresh waterbodies such as lakes, rivers, reservoirs, and irrigation canals. Hydrilla is considered one of the most invasive aquatic weeds in the U.S. It is native to parts of Asia, Africa, and Australia.

Figure 6. Hydrilla. *Chris Evans, River to River CWMA, Bugwood.org.*

Status and Trends

Species Presence. Hydrilla was documented in Pipe and Lucerne Lakes in south-central King County in 1994 (see Map 5.1). Species locations were mapped in 1995.

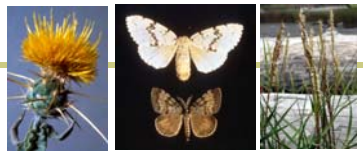
Presence over time. Efforts to eradicate the hydrilla in Pipe and Lucerne lakes began in 1995. After years of reductions, the population now appears to have been eradicated; monitoring is ongoing to confirm that the species does not reoccur. Hydrilla has not spread to other areas of the Basin.

Files used in the analysis. Ecology and King County Lakes Stewardship provided GIS shapefiles which describe the hydrilla populations in Pipe and Lucerne Lakes; these were used in the spatial summaries.

Files not used in the analysis. The UW Burke Herbarium records were not used as they duplicate the GIS shapefiles described above. The management reports were used to inform the program analysis. An image provided by King County is shown in Figure 6. Table 13 summarizes data provided.

Table 13. Hydrilla data provided to the baseline assessment project. Data files included in the spatial summaries are noted with an asterisk (*). For more detail on spatial data see Appendix A5.1.

File type provided (quantity)	Spatial extent	Data provider
Spatially explicit data		
GIS shapefiles (2)*	Pipe and Lucerne Lakes (King County)	King County Lake Stewardship Program*, Ecology*
Observations with latitude & longitude (1)	Pipe and Lucerne Lakes (King County)	UW Burke Herbarium
Images with location (1 set)	Pipe Lake (King County)	King County Lake Stewardship Program
Other data		
Management reports (6+)	Pipe and Lucerne Lakes (King County)	King County Lake Stewardship Program, Ecology



Pathways

In this section and the following Impacts and At-risk Resources section, the discussions reference species-specific basin-wide "Pathways and At-risk Resources" maps and the county-scale maps included as appendices. Included in these maps are all publicly available data layers representing those pathways and sensitive landscape features relevant to this species (e.g., boat ramps, roads, wetlands). See text box on page 33 for more detail.

Pathways of introduction. Hydrilla was once sold in pet stores and nurseries, but its sale is illegal both in Washington and in the country as a whole. It is possible that online aquarium retail sites may illegally sell and ship hydrilla to U.S. customers. It may also be unintentionally included as a contaminant with commercially marketed ornamental pond and aquarium plants. The species may be introduced to waterbodies by people dumping unwanted aquarium or garden materials. Any fresh waterbody may face hydrilla introductions, particularly those with adjoining development or public access. The single location of hydrilla infestation lies within the developed area of Puget Sound lowlands, near the Cities of Covington and Maple Valley (see Map 5.2). Ecology staff hypothesize that hydrilla was introduced in those lakes as a contaminant on exotic water lilies, based on the former extensive populations of exotic water lilies in these lakes as well as the fact that a popular water gardening mail order firm was known to have hydrilla in its water lily culture.

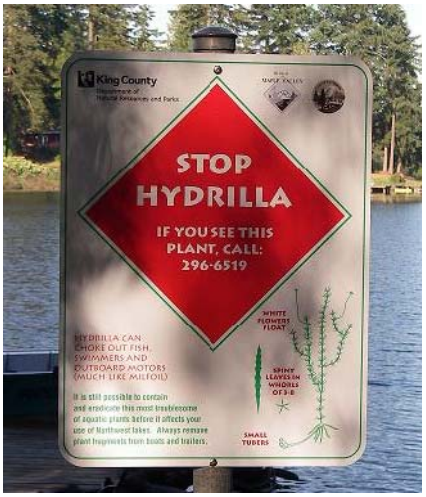


Figure 7. "Stop Hydrilla". ***Beth Cullen, King County Lakes Stewardship Program.***

Pathways of spread. Hydrilla can spread via recreational fishing and boating, however the species is more likely to be newly introduced to Washington waterbodies rather than spread from the more distant waterbodies in which it is currently located.

Impacts and At-risk Resources

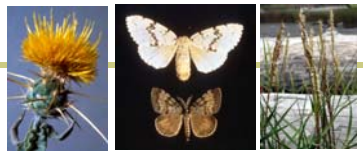
Ecological impacts. Dense monocultures of hydrilla can restrict water movement, trap sediment, and reduce dissolved oxygen. Hydrilla poses a threat to native finfish and shellfish because it crowds out native freshwater plants, reducing native plant diversity and forage for fish, and increases water temperatures due to reduced water circulation.

Human dimension impacts. Dense stands of hydrilla impair recreational uses of waterbodies, such as boating, swimming, and fishing. It can interfere with water supply reservoirs, dams, navigation, flood control, and surface water management.

Management

Table 14 summarizes commonly reported program types and the number of entities reporting management activities for hydrilla.

State or Puget Sound-level activities. Ecology's Aquatic Weeds Program has lead state responsibility for funding and assisting eradication efforts in the two affected lakes. Ecology staff



continue to survey other lakes to detect any new invasions of this species. The Washington NWCB coordinates and supports the activities of county NWCBs in their management efforts and implements the state noxious weed list, which includes hydrilla. State agencies such as WSDOT and WDFW are responsible for detecting this species on agency lands.

County-level activities. Hydrilla was documented in Pipe and Lucerne Lakes in King County in 2005. Ecology provided funding and technical assistance to the King County Lake Stewardship Program, which in turn worked with the cities of Covington and Maple Valley to eradicate this species from these two lakes. King County continues to manage ongoing surveys and monitoring to ensure the plants do not return. Island, Kitsap, Lewis, Mason, Thurston, and Whatcom NWCBs, and Snohomish County's Lake Management Program reported prevention, detection, and education/outreach activities targeted at this species. The remaining five counties did not report any activities for hydrilla. For a geographic depiction of management activities, see Map 5.3.

Federal-level activities. Hydrilla is on a "watch list" for Olympic National Forest staff. The USDA conducts detection, education/outreach, enforcement, and prevention activities, as needed, on a regional basis, to implement the Federal Noxious Weed List. The USGS maintains an aquatic invasive species database, which includes hydrilla, with a portal to report new sightings.

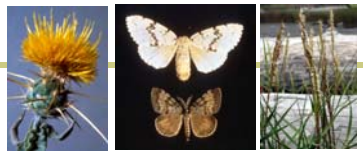
Other activities. The UW Burke Herbarium collects and shares information on plants including noxious weeds and maintains a website for reference, for species including hydrilla.

Table 14. Commonly reported management program types and number of organizations targeting hydrilla.

Species	Three most commonly reported management program types (frequency)	Number of organizations with management activities
County	Education/outreach (7), detection and prevention (6)	8 (present in 0)
State	Detection (3), education/outreach, monitoring, and funding (2)	4
Federal	Detection (2), prevention, education/outreach, enforcement, and other: tracking distribution (1)	3
Other	Detection and education/outreach (1)	1

Legal authorities. Hydrilla is listed as a Class A Noxious Weed, meaning eradication is required (Chapter 17.10 RCW) and is on the state's list of quarantined species, prohibiting transport, purchase, sale, or distribution of the plant or plant parts (WAC 16-752-505). These laws govern state- and county-level management. Hydrilla is also on the federal noxious weed list (7 CFR 360).

Funding. When the Freshwater Aquatic Weeds Account (RCW 43.21A.650) was established, use of funds from the account was limited to public-access lakes and to waterbodies designated by WDFW for fly-fishing. In response to the need to manage hydrilla in Pipe and Lucerne Lakes, which do not allow public access, the Legislature amended RCW 43.21A.660 to allow funds to be used for hydrilla management in any waterbody. Ecology disburses funds via grants and also uses this account for the Aquatic Weeds Program activities.



King County has funded its eradication efforts primarily through Aquatic Weeds grants, with some matching funds from the cities of Covington and Maple Valley (where the lakes are located). The NWCBs reporting management efforts are funded either by property assessments (two counties) or through the county's general fund (four counties). For an overview of funding sources for Ecology and county NWCBs, see Table 5 and Table 6.

Summary of Gaps

This summarizes gaps specific to hydrilla; some of the overarching gaps identified in Section IV are applicable as well.

Data collection and management. The small number of data files is understood to be an accurate reflection of the limited extent of species presence in the Basin. No major data gaps were identified at this point in time.

Knowledge and understanding of species status, pathways, and impacts. It is very likely, due to Ecology's extensive survey efforts, that we have an accurate understanding of this species' absence from public-access lakes. It is more difficult to assess whether this species is truly absent from all privately-owned lakes. Probable pathways of introduction and spread in the Puget Sound Basin are well understood for this species. A general understanding of potential impacts to local resources can be extrapolated from work on this species in other areas where hydrilla has invaded, but there is limited information on the potential extent and scale of impacts to Basin resources.

Management efforts. Not all counties reported activities such as detection, education/outreach, and prevention for hydrilla. At this point it is not known whether this accurately reflects a lack of program efforts for some counties or rather a lack of information provided to the project.

Hydrilla

Hydrilla verticillata

Puget Sound Basin

Species Detection (1994 - 2006)

Observed*

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program.

Land Cover & Land Use

- Developed
- Cultivated Lands
- Grassland
- Deciduous Forest
- Coniferous & Mixed Forest
- Scrub / Shrub
- Freshwater Wetland
- Estuarine Wetland
- Beaches, Bars & Flats
- Rock & Snow
- Water

Boundaries & Extents

- County Boundary
- Puget Sound Extent

JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

0 5 10 20 Miles

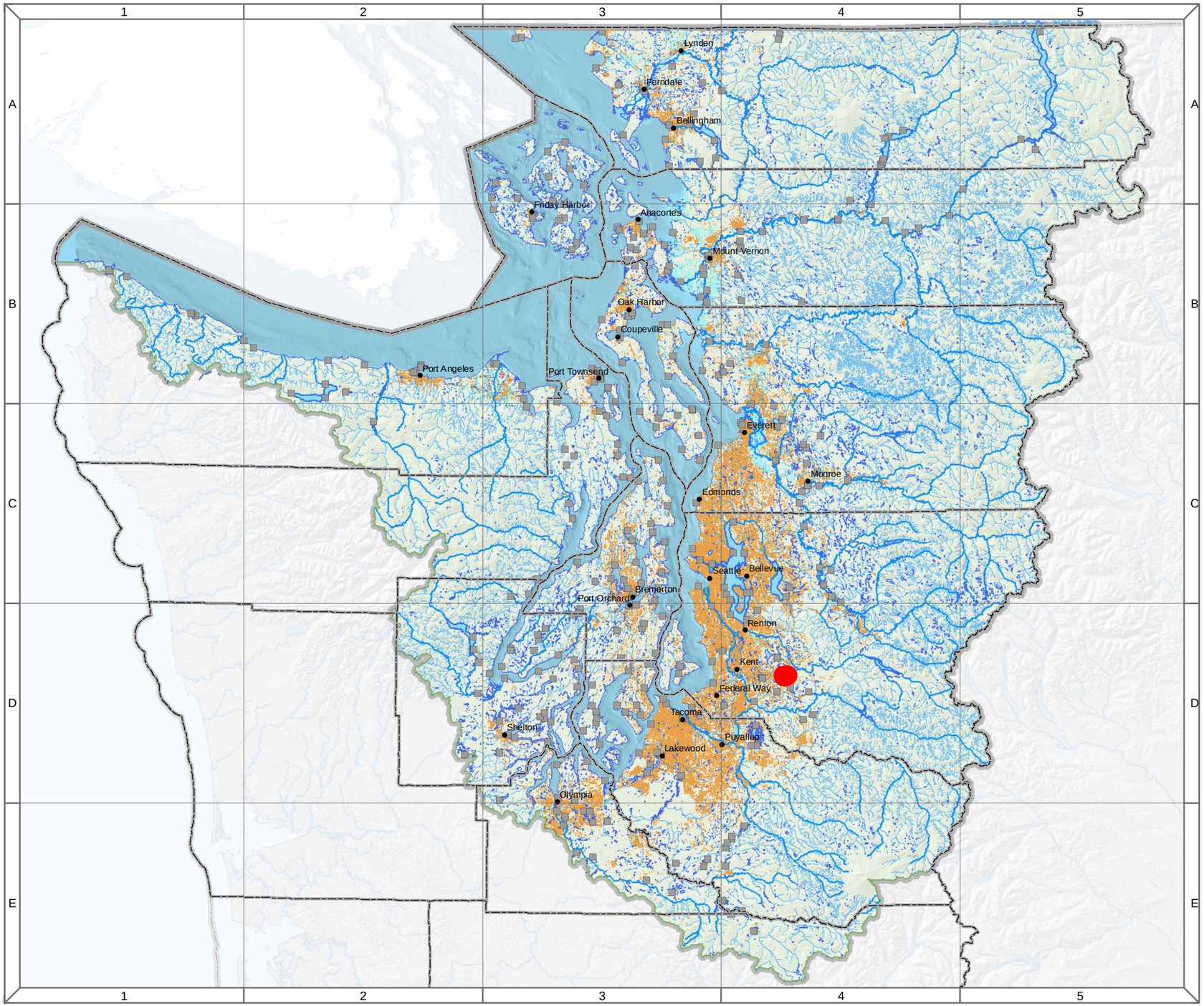
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species: Documented Presence in Puget Sound Basin

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 5.1

February 2011



Hydrilla

Hydrilla verticillata

Puget Sound Basin

Species Detection (1994 - 2006)

Observed*

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. See Appendix for county scale maps.

Boundaries & Extents

County Boundary

Puget Sound Extent

Pathways & Sensitive Landscape Features

Boat Ramps

River / Stream

Canal / Ditch

Lake / Pond

Reservoir

Swamp / Marsh

Land Cover & Land Use

Developed

JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

Miles
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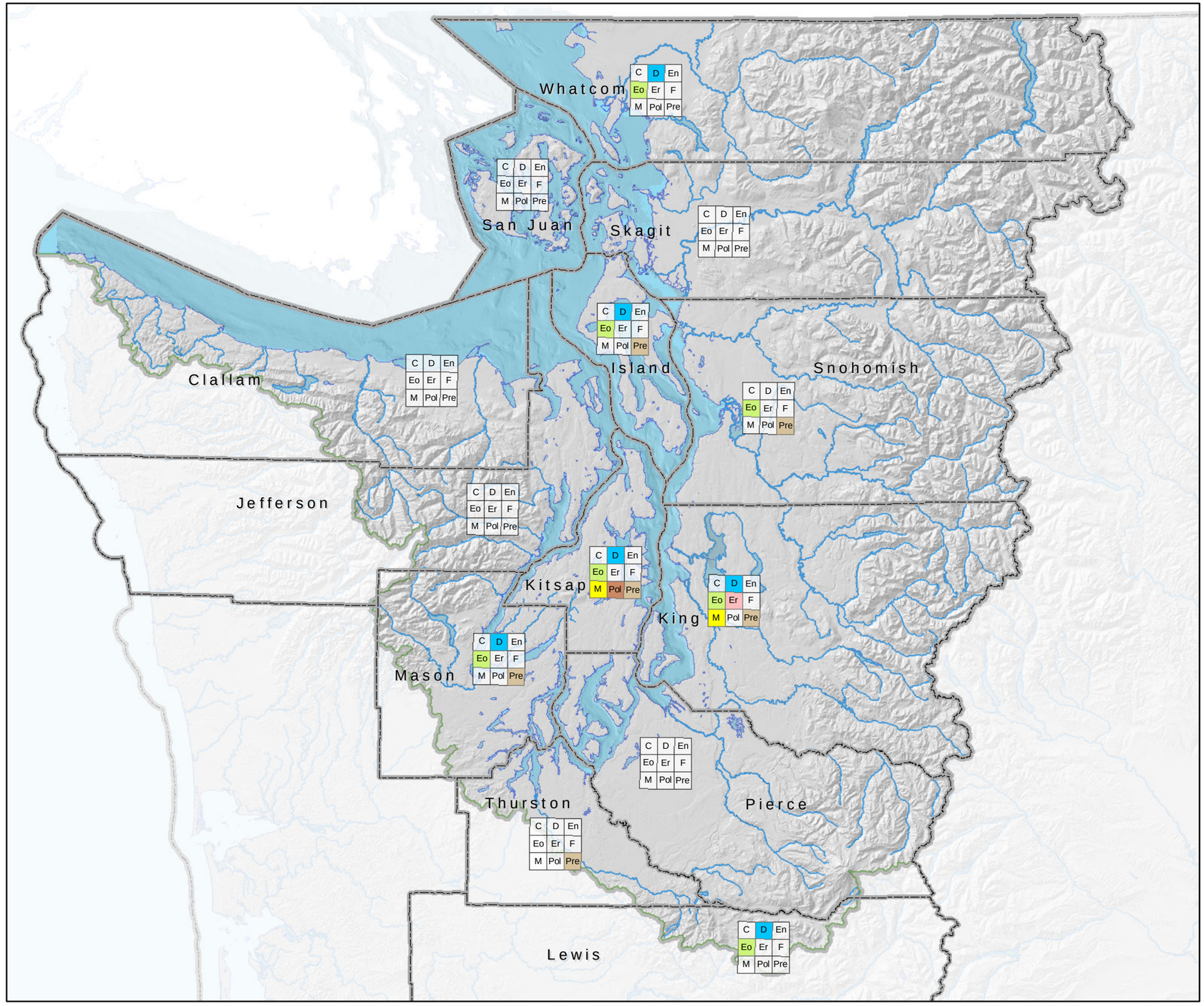
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species:
Species Locations, Potential Pathways, Sensitive Landscape Features

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 5.2

February 2011



Hydrilla

Hydrilla verticillata

Puget Sound Basin

Management at the County Level

- Control (C)
- Detection (D)
- Enforcement (En)
- Education / Outreach (Eo)
- Eradication (Er)
- Funding (F)
- Monitoring (M)
- Policy (Pol)
- Prevention (Pre)

Boundaries & Extents

- County Boundary
- Puget Sound Extent

JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

Miles
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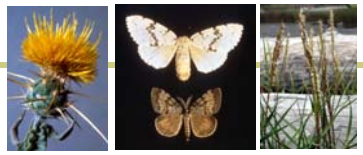
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species:
Management at the County Level

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 5.3

February 2011



6. Knapweeds (*Centaurea* species)

Knapweeds are a group of fast growing invasive plants that have caused significant economic and environmental losses in the West, increasing production costs for ranchers, impairing wildlife habitat, decreasing plant diversity, increasing soil erosion rates, decreasing the appeal of recreational lands, and posing wildfire hazards. Knapweeds are native to Europe and were likely introduced to the U.S. with alfalfa seed. They are typically found in disturbed areas such as roadsides and railroads. This group involves multiple species, including bighead (*C. macrocephala*), black (*C. nigra*), brown (*C. jacea*), diffuse (*C. diffusa*), meadow (*C. pratensis* or *jacea x nigra*), spotted (*C. biebersteinii* or *maculosa* or *stoebe*), and Vochin knapweeds (*C. nigrescens*).

Figure 8. Spotted knapweed. ***Marisa Williams, University of Arkansas, Fayetteville, Bugwood.org.***

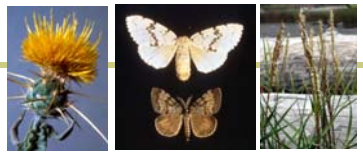
Status and Trends

Species presence. Knapweeds are established to a greater extent on the East side of the Cascades, but most species have been documented in the Puget Sound Basin, with at least one species in every county in the Basin. Note that the maps presented here do not differentiate between species, with the goal of demonstrating the presence and absence of this group as a whole. Spatial data for the period 1987-2009 (see Map 6.1, data providers listed in Appendix A6.1) show that infestations of knapweeds are located primarily in the Puget Sound lowlands with limited documented occurrences at higher elevations along road corridors in King, Pierce, Thurston, and Whatcom counties. Clallam, King, Thurston, and Whatcom counties documented the most extensive infestations.

Presence over time. Although the project team received a large number of data files for this species group, data were not provided in a format to allow any detailed analysis of changes in species presence over time. We were able to map pre-1995 occurrences and post-1996 occurrences separately, but manipulation of data files to further isolate specific years, or groups of years, was beyond the scope of this project. The extent of presence of knapweeds in Thurston County and the single population documented in Jefferson County pre-1995, suggest that knapweeds were likely present to some degree throughout the Basin before 1995.

Files used in the analysis. All GIS shapefiles provided were used in the spatial summaries. See Table 15 for a summary of data provided. The following files were converted into shapefiles for use in the summaries:

- Reported knapweed locations with latitude and longitude from San Juan and Skagit County NWCBs and Olympic National Park. Latitude and longitudes were estimated using Google Maps (San Juan County), using the assessor's database (Skagit County), or otherwise (Olympic National Park).
- Reports from WSPRC on knapweed presence within state parks.



- Spreadsheets with knapweed locations from Kitsap and Whatcom County NWCBs.

Files not used in the analysis. A number of files either did not contain spatial information which was readily usable in this analysis, or was not already represented in other files:

- UW Burke Herbarium records were too numerous to digitize.
- A spreadsheet of locations to which knapweed notices have been issued, provided by Pierce County NWCB, did not contain consistent spatial information for conversion to a shapefile.
- Spreadsheet of mile markers at which knapweed was detected in Mt. Rainier National Park lacked readily translatable geographic information and data appeared to be outside Puget Sound Basin.
- Data depicted in the map image provided by San Juan County NWCB was provided separately in GIS form by San Juan County Public Works.
- WSDA map images contain data at the county level which would not have added value to the more site specific data provided by others.

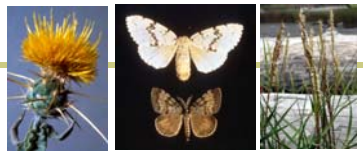


Table 15. Knapweed data provided to the baseline assessment project. Data files included in the spatial summaries are noted with an asterisk (*). For more detail on spatial data see Appendix A6.1.

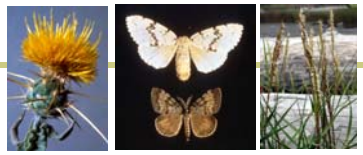
File type provided (quantity)	Spatial extent	Data provider
Spatially explicit data		
GIS shapefiles (20)*	Clallam, King, Kitsap, Lewis, San Juan, Thurston, and Whatcom counties; Mt Baker-Snoqualmie and Olympic National Forests; Birch Bay, Federation Forest, and Nisqually-Mashel State Parks; Swinomish Reservation; WSDOT rights-of-way	Clallam, King, Kitsap, and Jefferson County NWCB, Lewis County NWCB and Oregon State University, San Juan County Public Works, Thurston and Whatcom County NWCB*; USFS-Mt. Baker-Snoqualmie and Olympic National Forests*; WSPRC*; Swinomish Tribe*; WSDOT*
Observations with latitude & longitude (3)*	San Juan and Skagit counties, Olympic National Park, Washington State	San Juan and Skagit County NWCB*, Olympic National Park*, UW Burke Herbarium
Dataset with locations (4)*	Kitsap, Pierce, and Whatcom counties, Mt. Rainier National Park	Kitsap*, Pierce, and Whatcom* County NWCB, Mt. Rainier National Park
Map image (4)	San Juan County, Washington State	San Juan County NWCB, WSDA
Other data		
Management or survey reports (3)*	Kitsap County; Birch Bay, Federation Forest, Lake Isabella, Nisqually-Mashel State Parks	Kitsap County NWCB; WSPRC*

Pathways

In this section and the following Impacts and At-risk Resources section, the discussions reference species-specific basin-wide "Pathways and At-risk Resources" maps and the county-scale maps included as appendices. Included in these maps are all publicly available data layers representing those pathways and sensitive landscape features relevant to this species (e.g., boat ramps, roads, wetlands). See text box on page 33 for more detail.

Pathways of introduction. Knapweed was likely introduced to Washington with hay or alfalfa seed.

Pathways of spread. Knapweed may be carried with crops or hay transported on roads from the East side of the Cascades; railroads may also be a pathway. A spatial overlay of documented knapweed populations on infrastructure corridors (road and rail) suggests strongly that these species are moving throughout the Basin along these corridors (see Map 6.2 and Appendices 6.10-6.22). Gravel pits and horse trails are also thought to be possible pathways. For example, the relatively isolated populations of knapweed along the East shore of Maury Island (Appendix A6.13, C1) might be associated with Glacier Northwest's gravel mine on that shoreline.



Impacts and At-risk Resources

Ecological impacts. Knapweeds can impair wildlife habitat, but have been documented in few areas in the Puget Sound Basin where wildlife forage. Knapweeds can also decrease plant diversity and increase soil erosion rates.

Human dimension impacts. On the East side of the Cascades, knapweeds have significant impacts to farming and ranching activities. In the Puget Sound Basin, an overlay of documented knapweed populations on cultivated lands suggests that large expanses of agricultural lands are potentially at risk of invasion by knapweeds (Map 6.2). For example, King County includes cultivated areas to the south near Enumclaw (Appendix A6.13, D2), and to the north along the Snoqualmie River valley (Appendix A6.13, A2) that could be at risk from knapweeds. This species group can also decrease the appeal of recreational lands and pose wildfire hazards, control can be costly and time-consuming for landowners, and there is some evidence that hand control of diffuse knapweed puts people at risk of exposure to potentially carcinogenic sap.

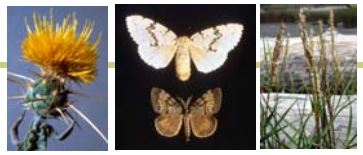
Management

Table 16 summarizes the various entities actively involved in knapweed management.

State or Puget Sound-level activities. WSDA offers detection, eradication, control, and funding assistance to local and state partners. For example, WSDA funds Cooperative Weed Management Areas for eradication or control of knapweeds. Washington NWCB advises WSDA on noxious weed control, coordinates and supports the activities of county NWCBs, and implements the state noxious weed list. State agencies with major land holdings conduct prevention, detection, and control for knapweed on agency properties. For example, WSDOT trains maintenance crews to monitor for and control knapweed where required.

County-level activities. Knapweeds have been documented in every Puget Sound county, and every county NWCB reported control activities. Many reported additional activities, including detection, education/outreach, enforcement, eradication, funding, monitoring, prevention, and policy. County NWCBs reported being involved with monitoring knapweed locations around the county, conducting control and assisting landowners with control efforts as appropriate, leading and participating in education and outreach efforts, and pursuing funding for control efforts. Other organizations involved in control or prevention efforts at the county scale include the San Juan County Public Works Department and the Clallam Conservation District. Skagit County noxious weed board staff indicated that the majority of the knapweeds in the county were under federal or tribal jurisdiction. For a geographic depiction of management activities, see Map 6.3.

Federal-level activities. All major National Forests and National Parks in the Puget Sound Basin reported detection and control efforts for knapweed, to varying degrees. Olympic National Park is treating a single knapweed population along Lake Crescent. Staff at Olympic National Forest actively survey for and control knapweed populations, in coordination with Clallam and Jefferson counties. North Cascades National Park conducts early detection of and rapid response to knapweed species along the North Cascades Scenic Highway with the goal of preventing spread into adjoining park lands. Mt. Baker – Snoqualmie National Forest staff monitor for knapweed



populations in the course of other activities, and do control in selected sites. Mount Rainier National Park monitors for and treats knapweed, in coordination with Lewis County when appropriate, and holds volunteer work parties to remove invasives.

Other activities. WSU Extension promotes the use of integrated weed control methods for knapweed. Mountains to Sound Greenway Trust surveys for knapweed and controls populations found, mainly in the Middle and South Fork Snoqualmie Basins, and provides data to King County NWCB. Bellingham Parks and Recreation Department reported efforts to prevent and detect knapweed introduction and control and monitor any populations on City property. The Swinomish Tribe controls knapweed on tribal lands. A student at Oregon State University is developing a weed mapper tool that will track knapweed along with other terrestrial plants. The UW Burke Herbarium collects and shares information on plants including noxious weeds and maintains a website for reference, for species including knapweed.

Table 16. Commonly reported management program types and number of organizations targeting knapweeds.

Species	Three most commonly reported management program types (frequency)	Number of organizations with current management activities
County	Control (12), detection (10), education/outreach and monitoring (9)	13 (present in 13)
State	Control (4), detection, education/outreach, eradication, and prevention (3)	4
Federal	Control (5), detection (4), monitoring and prevention (3)	5
Other	Education/outreach (3), control and detection (2)	4

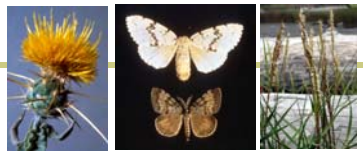
Legal authorities. Specific knapweed species are included on both the Class A Noxious Weed list, meaning eradication is required, and the Class B Noxious Weed list, meaning they are designated for control in certain regions of the state (Chapter 17.10 RCW). All knapweed species are on the state's list of quarantined species, prohibiting transport, purchase, sale, or distribution of the plant or plant parts (WAC 16-752-505). These laws govern state- and county-level management.

Funding. Knapweed management comes from a wide variety of sources. For an overview of funding sources for WSDA and county NWCBs, see Table 5 and Table 6.

Summary of Gaps

This summarizes gaps specific to knapweed; some of the overarching gaps identified in Section IV are applicable as well.

Data collection and management. We received a large number of data files for knapweeds, including many spatially-referenced shapefiles. However, we have much more data in some regions (e.g., King County) than others (e.g., Skagit County). This likely does not accurately represent the presence of knapweeds in the Basin but is rather a reflection of widely varying data collection efforts across the region and varying degrees of collaboration between agencies and jurisdictions. Given the widespread presence of knapweed in the Basin, there is a gap in basin-



wide data collection efforts and a gap in effective management and coordination of data collection and reporting efforts.

Knowledge and understanding of species status, pathways, and impacts. Knapweed was reported as present for all Puget Sound Basin counties. The discrepancies in the resources devoted to knapweed documentation between counties limits our confidence in concluding that compiled data accurately represent the spatial extent and distribution of knapweed in the Puget Sound Basin. Pathways of spread and potential impacts associated with knapweed invasion appear to be well understood.

Management efforts. Although every county NWCB, along with many other agencies, reported management efforts for knapweed, the level of effort exerted and funding available appears to vary significantly between organizations. It is possible that a more consistent and coordinated effort could help to check the spread of knapweed in the Puget Sound Basin.

Knapweeds

Centaurea species

Puget Sound Basin

Species Detection (1987 - 2009)

Observed*

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program.

Land Cover & Land Use

- Developed
- Cultivated Lands
- Grassland
- Deciduous Forest
- Coniferous & Mixed Forest
- Scrub / Shrub
- Freshwater Wetland
- Estuarine Wetland
- Beaches, Bars & Flats
- Rock & Snow
- Water

Boundaries & Extents

- County Boundary
- Puget Sound Extent

Whatcom
San Juan
Skagit
Island
Snohomish
Clallam
Jefferson
Kitsap
King
Pierce
Mason
Grays Harbor
Thurston
Lewis

Lynden
Ferndale
Bellingham
Friday Harbor
Anacortes
Mount Vernon
Oak Harbor
Coupeville
Port Angeles
Port Townsend
Everett
Monroe
Edmonds
Seattle
Bellevue
Bremerton
Port Orchard
Renton
Kent
Federal Way
Tacoma
Puyallup
Lakewood
Shelton
Olympia

JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

0 5 10 20 Miles

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species: Documented Presence in Puget Sound Basin

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 6.1

February 2011

Knapweeds

Centaurea species

Puget Sound Basin

Species Detection (1987 - 2009)

Observed*

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. See Appendix for county scale maps.

Boundaries & Extents

County Boundary

Puget Sound Extent

Pathways & Sensitive Landscape Features

Roads - Interstate, US, & State Routes

Roads - Other Routes

Railroads

Sea / Ocean

Land Cover & Land Use

Developed

Cultivated Lands

Grassland

JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

Miles
0 5 10 20

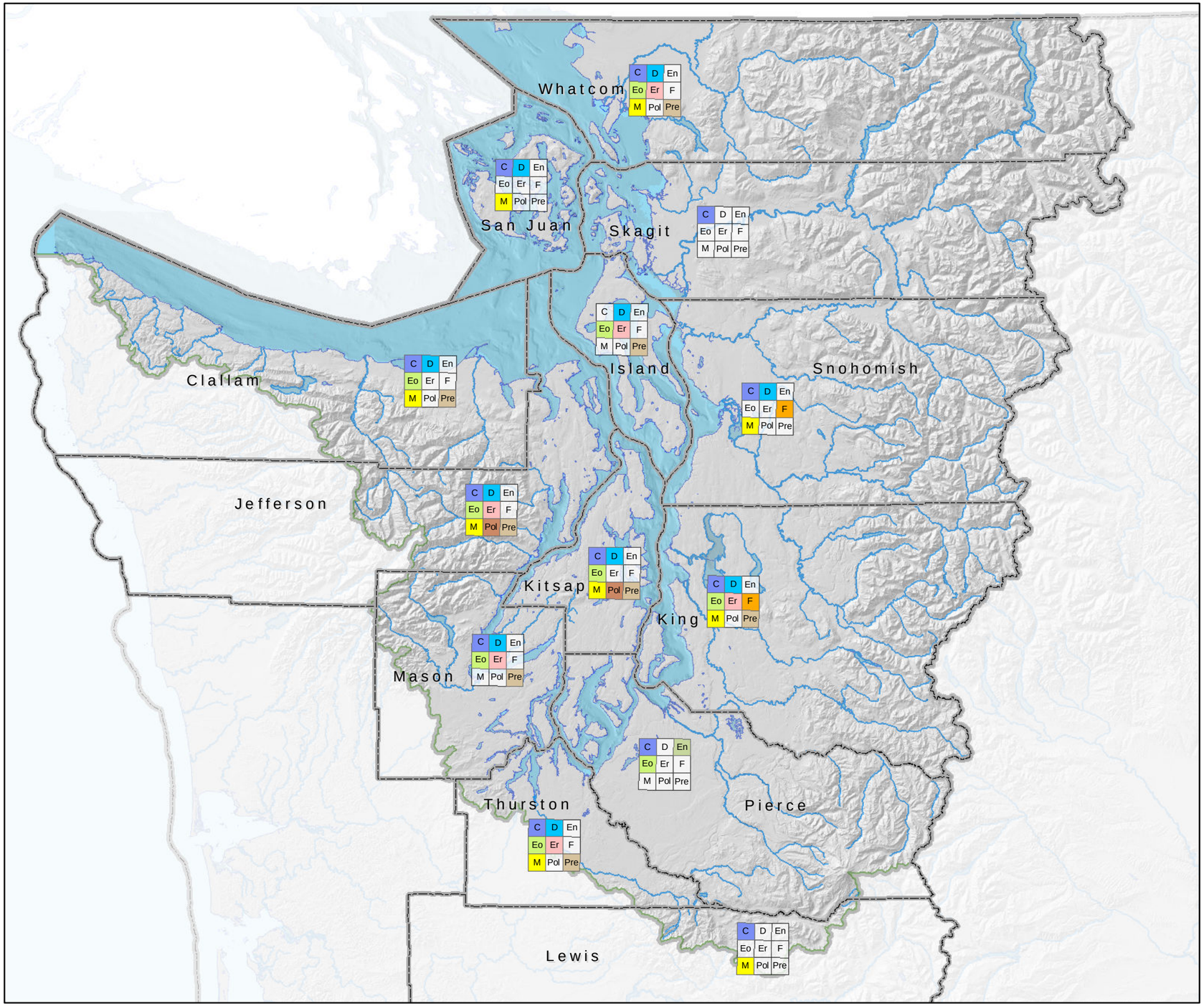
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species: Species Locations, Potential Pathways, Sensitive Landscape Features

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 6.2

February 2011



Knapweeds

Centaurea species

Puget Sound Basin

Management at the County Level

- Control (C)
- Detection (D)
- Enforcement (En)
- Education / Outreach (Eo)
- Eradication (Er)
- Funding (F)
- Monitoring (M)
- Policy (Pol)
- Prevention (Pre)

Boundaries & Extents

- County Boundary
- Puget Sound Extent

JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

0 5 10 20 Miles

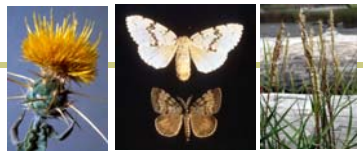
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species:
Management at the County Level

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 6.3

February 2011



7. Kudzu (*Pueraria montana* var. lobata)

Kudzu is a climbing semi-woody vine that can grow rapidly in a variety of conditions. It is a highly aggressive invasive plant that blankets other vegetation as well as infrastructure, and is extremely difficult to control once established. Today, kudzu covers over 2 million acres of forests, buildings, and land in the southern U.S., with significant economic impacts.

Status and Trends

Kudzu has not been documented in the Puget Sound Basin, although in 2001 it was identified and subsequently eradicated in Clark County, Washington. As the species has not been documented and no datasets for kudzu were shared with the project, no maps are presented here.

Figure 9. Kudzu. ***Division of Plan Industry Archive, Florida Department of Agriculture and Consumer Services, Bugwood.org.***

Pathways

Pathways of introduction. Kudzu was introduced to the U.S. in 1876 at the Philadelphia Centennial Exposition and was promoted for ornamental and forage purposes as well as to minimize erosion. It could be introduced in Washington as an ornamental (can be illegally purchased online; seeds and cuttings can be obtained by trades) as many people are unaware of its invasive potential.

Pathways of spread. Kudzu spreads via vegetative growth. Reproduction by seed is believed to be minimal.

Impacts and At-risk Resources

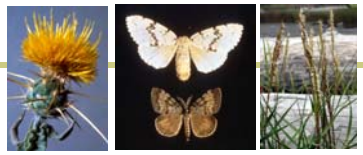
Ecological impacts. Kudzu blankets forests and other vegetation, severely limiting other plants' capabilities for growth. Trees may be covered with kudzu and damaged by the weight of the vines, resulting in loss of limbs or tree death from lack of enough light for photosynthesis.

Human dimension impacts. Kudzu can cover infrastructure, and the weight of its vines can bring down power lines and collapse buildings. Kudzu can impact agricultural and recreational areas. In the Southeast, kudzu has been shown to increase ozone levels above regulatory thresholds due to nitrogen fixation.

Management

State and county agencies work to detect any new kudzu invasion and conduct outreach and education to help prevent its spread in Washington. Table 17 summarizes commonly reported program types and the number of entities reporting management activities for kudzu.

State or Puget Sound-level activities. Four state agencies reported statewide efforts to prevent and detect kudzu introductions, to conduct outreach and education, and to fund efforts and drive policy. For example, WSDOT's training and maintenance operations include monitoring and



detection of kudzu on highway rights of way. The Washington NWCB coordinates and supports county-level efforts to prevent and detect kudzu invasions, as described below.

County-level activities. Island, King, Kitsap, Lewis, and Snohomish County NWCBs reported detection and education/outreach efforts; three of these counties reported additional prevention efforts (Map 7.1). King County reported that county residents have submitted reports of kudzu sightings; subsequent verification visits indicated the plants in question were not kudzu. The remaining seven Puget Sound counties did not report any management efforts for kudzu. However this is likely at least partially an artifact of data collection, as all NWCBs should be actively surveying for Class A noxious weeds such as kudzu.

Federal-level activities. The only effort reported at the federal level was that kudzu is on a watch list for Olympic National Forest staff.

Other activities. A student at Oregon State University is developing a weed mapper tool that will track any kudzu detections, along with other terrestrial plants.

Table 17. Commonly reported management program types and number of organizations targeting kudzu.

Species	Three most commonly reported management program types (frequency)	Number of organizations with management activities
County	Detection and education/outreach (5), prevention (3)	5 (present in 0)
State	Education/outreach (4), detection and funding (3)	4
Federal	Detection	1
Other	Education/outreach (2), detection and policy (1)	2

Legal authorities. Kudzu is listed as a Class A Noxious Weed, meaning eradication is required (Chapter 17.10 RCW), and is on the state's list of quarantined species, meaning transport, purchase, sale, or distribution of the plant or plant parts is prohibited (WAC 16-752-505). These laws govern state- and county-level management.

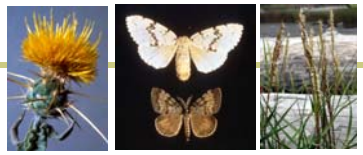
Funding. Each of the management efforts described above are a small part of the organization's overall operations. See Table 5 and Table 6 for details on funding for state and county organizations.

Summary of Gaps

This summarizes gaps specific to kudzu; some of the overarching gaps identified in Section IV are applicable as well.

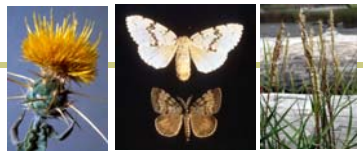
Data collection and management. The study did not identify gaps in data collection and management of kudzu. Organizations at every level reported efforts to detect kudzu, should it ever be introduced to the Puget Sound Basin.

Knowledge and understanding of species status, pathways, and impacts. The study did not identify gaps in knowledge and understanding of kudzu in the Puget Sound Basin. Species presence was not indicated for any county; this likely accurately represents absence of the species from the



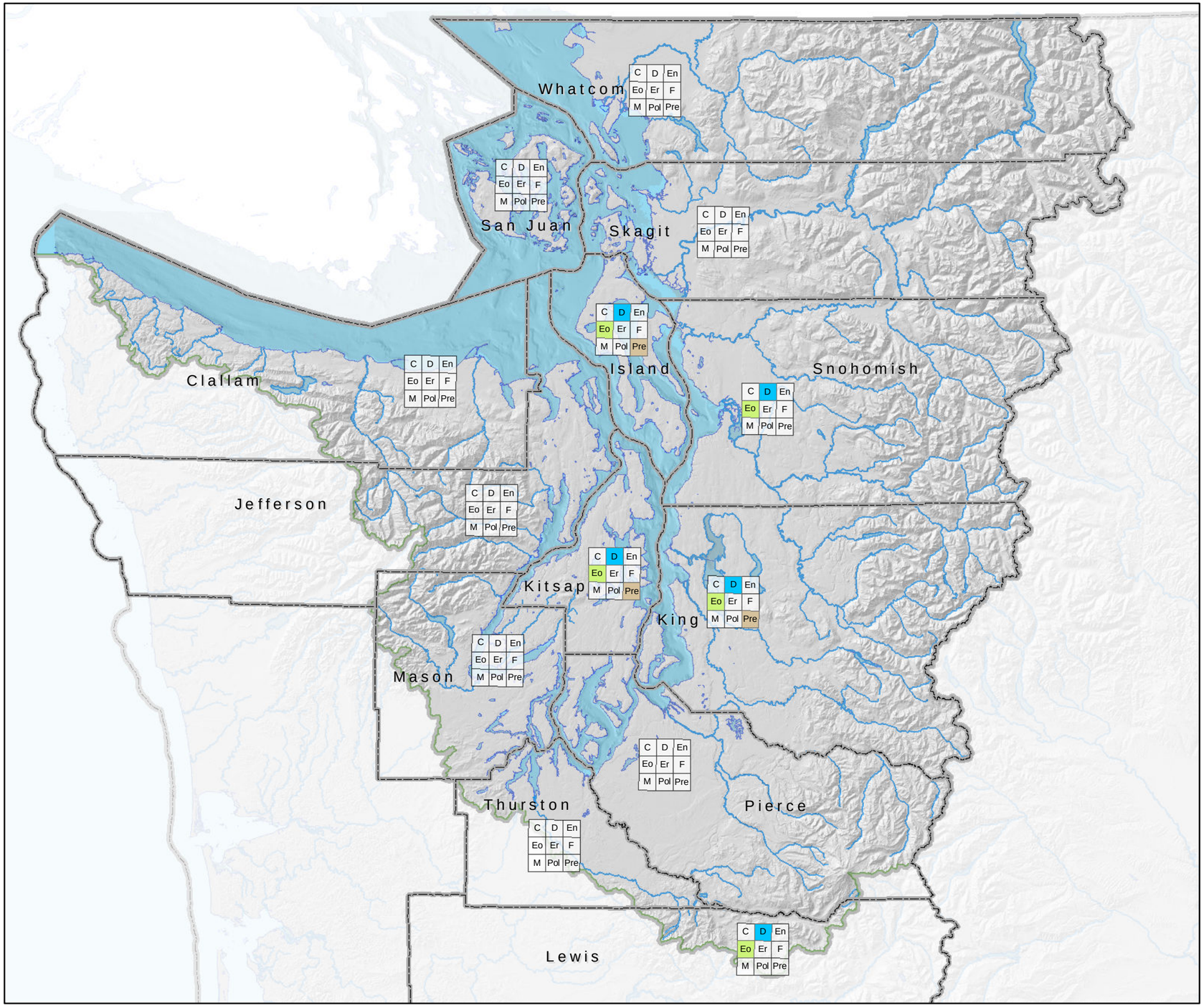
Puget Sound Basin. Pathways of spread and potential impacts to Basin resources are well understood due to the extensive efforts to understand and eradicate this species in other regions of the country.

Management efforts. There is a potential gap in kudzu management at the county level. Not all counties reported management efforts, but that may be due to the fact that not all counties completed the survey, rather than an actual gap in management efforts.



Kudzu

Pueraria montana var. lobata



Puget Sound Basin

Management at the County Level

- Control (C)
- Detection (D)
- Enforcement (En)
- Education / Outreach (Eo)
- Eradication (Er)
- Funding (F)
- Monitoring (M)
- Policy (Pol)
- Prevention (Pre)

Boundaries & Extents

- County Boundary
- Puget Sound Extent

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CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

0 5 10 20 Miles

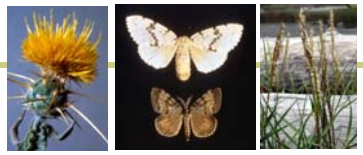
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species:
Management at the County Level

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 7.1

February 2011



8. Lymantriid Moths (Asian, European, Rose), Nun Moths, and Siberian Moths

Invasive species in the Lymantriid family include Asian, European, and rosy gypsy moths; nun moths; and Siberian moths. The gypsy moth is one of the worst American forest pest insects. It devours the leaves of more than 500 different species of trees and shrubs and causes enormous damage to the environment and the economy.

Status and Trends

Species presence. No permanent populations have established in the state. A small number of European gypsy moths are regularly detected; no Asian gypsy moths have been trapped in the state since 1999. Data included in Map 8.1 suggest that when present, these species are primarily found in the central and southern part of Puget Sound Basin, and largely in the lowlands on the eastern side of the Basin. Note that our maps do not distinguish between the species within this group, to highlight status and trends of the group as a whole.

Figure 10. Lymantriids – Asian and European Gypsy Moths. *USDA APHIS PPQ Archive, USDA APHIS PPQ, Bugwood.org.*

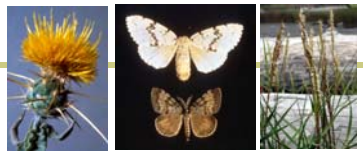
Presence over time. It is difficult to draw any trends in European gypsy moth presence, as a varying number of those moths are trapped each year. On the other hand, no Asian gypsy moths have been trapped in the state since 1999.

Files used in the analysis. All GIS shapefiles provided were used in the analysis. These included a shapefile of all Asian gypsy moth detections recorded via WSDA survey efforts since 1972, all European gypsy moth detections from 2007, 2008, and 2009, and all WSDA trap placements for invasive moths in 2007, 2008, and 2009. Trap placement locations and European gypsy moth detections from years previous to 2007 are recorded in paper files; WSDA staff have converted all Asian gypsy moth detections into GIS files. See Table 18.

Files not used in the analysis. Annual reports and presentations provided by WSDA were used to inform the program analysis but not used in the data analysis.

Table 18. Lymantriid data provided to the baseline assessment project. Data files included in the spatial summaries are noted with an asterisk (*). For more detail on spatial data see Appendix A8.1.

File type provided (quantity)	Spatial extent	Data provider
Spatially explicit data		
GIS shapefiles (5)*	Washington State	WSDA*
Other data		
Management or survey reports (2)	Washington State	WSDA



Pathways

In this section and the following Impacts and At-risk Resources section, the discussions reference species-specific basin-wide "Pathways and At-risk Resources" maps and the county-scale maps included as appendices. Included in these maps are all publicly available data layers representing those pathways and sensitive landscape features relevant to this species (e.g., boat ramps, roads, wetlands). See text box on page 33 for more detail.

Pathways of introduction. European gypsy moths were introduced to the Eastern U.S. in the late 1800s and have since been spreading westward; Asian gypsy moths have been more recently introduced. Both moths can be introduced via shipments, particularly of wood and wood products, from Asia, Siberia, and nearby areas. An overlay of documented occurrences of these species on land use patterns and transportation infrastructure suggests that Lymantriids are entering the Basin via ports and possibly via road and rail lines associated with Port activities (Map 8.2).

Pathways of spread. European gypsy moth females are flightless and thus this species is generally transported by people moving furniture and other goods that house the moths. The other moths would likely preferentially spread along riparian corridors. Although these corridors are thought to be major pathways of spread for these species and are surveyed regularly, particularly those corridors passing through industrial areas, data collected along major road, rail, and river corridors in Pierce County suggest that the invasive Lymantriids are not currently spreading to any great extent along these corridors out of developed areas into adjacent sensitive natural areas.

Impacts and At-risk Resources

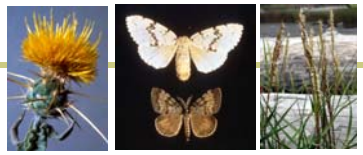
Ecological impacts. Lymantriids defoliate trees, causing tree death with widespread ecological damage. Denudation of riparian areas raises water temperatures, adds nutrients, and reduces dissolved oxygen, affecting aquatic species. The Puget Sound Basin is dominated by deciduous, coniferous and mixed forests, and riddled with dense networks of riparian corridors, all of which are highly vulnerable to negative impacts associated with infestation by these species (Map 8.2).

Human dimension impacts. Lymantriid establishment would likely lead to quarantines on products from the infested areas, with significant impacts to the state economy. Defoliated trees could reduce recreational and tourism values and could increase energy use. Lymantriids would likely be managed at the neighborhood scale, using commercial pest controllers, with associated human and ecological threats. Caterpillars can cause allergic reactions. Since pathways for these species are linked to human infrastructure and activities, urban forests and the people living in developed areas of Puget Sound are at risk from infestations by these species (Map 8.2).

Management

See Table 19 for a summary of management efforts for Lymantriids.

State or Puget Sound-level activities. WSDA has led efforts to manage Lymantriids in Washington since 1972. WSDA staff annually trap for Asian and European gypsy moths, setting out a total of 23,213 gypsy moth traps across the state in 2009. Asian gypsy moth surveys in 2009 included a waterway survey from the Canadian border along Puget Sound, as well as surveys at the ports of Tacoma and Seattle. The entire state was surveyed for European gypsy moths at a density of one



trap per square mile, with delimiting survey grids placed around sites where moths were trapped in 2007 and 2008. WSDA also set out 925 Nun moth traps and 1528 Siberian moth traps around the state. WSDA began using GIS to track survey locations and results in 2007. WSDA conducts eradication as needed, with the last reported eradication effort being in Kent in 2007.

County-level activities. None reported.

Federal-level activities. USDA funds and otherwise assists WSDA on survey and eradication efforts.

Other activities. None reported.

Table 19. Commonly reported management program types and number of organizations targeting priority Lymantriids.

	Three most commonly reported management program types (frequency)	Number of organizations with current management activities
County	None	0
State	Detection (1)	1
Federal	Funding (1)	1
Other	None	0

Legal authorities. WSDA has the authority to quarantine areas which become infested with gypsy moths under the Agricultural Pest Quarantine (RCW 17.24.041, Chapter 16-470 WAC). USDA could apply its federal quarantine authority, under 7 CFR 301, to restrict interstate movement of regulated articles from quarantined areas if gypsy moths became established in Washington.

Funding. The USDA Animal and Plant Health Inspection Service (APHIS) Plant Protection and Quarantine program funds WSDA's detection and delimiting efforts and European gypsy moth eradication. WSDA also receives monies from the state general fund for these efforts.

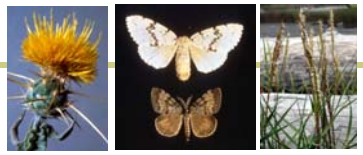
Summary of gaps

This summarizes gaps specific to Lymantriids; some of the overarching gaps identified in Section IV are applicable as well.

Data collection and management. WSDA manages comprehensive surveys for these species; no gaps in data collection and management were identified.

Knowledge and understanding of species status, pathways, and impacts. No gaps in understanding of Lymantriids in the Puget Sound Basin were identified. The priority species have not been detected in four Puget Sound Basin counties and it is likely, based on WSDA's extensive survey efforts, that this accurately represents species absence during surveys. Pathways of spread and potential impacts to Basin resources appear to be well understood due to significant efforts to understand and control these species in other parts of the country.

Management efforts. A potential gap in management efforts associated with invasive Lymantriids is that no education/outreach or prevention activities targeted at major pathways were reported for this species.



Lymantriid Moths

e.g., Asian, European gypsy moths

Puget Sound Basin

Species Detection (1991 - 2009)

- Observed*
- Surveyed But Not Found*

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program.

Land Cover & Land Use

- Developed
- Cultivated Lands
- Grassland
- Deciduous Forest
- Coniferous & Mixed Forest
- Scrub / Shrub
- Freshwater Wetland
- Estuarine Wetland
- Beaches, Bars & Flats
- Rock & Snow
- Water

Boundaries & Extents

- County Boundary
- Puget Sound Extent

Whatcom
San Juan
Skagit
Island
Snohomish
Clallam
Jefferson
Kitsap
King
Mason
Grays Harbor
Pierce
Thurston
Lewis

Lynden
Ferndale
Bellingham
Friday Harbor
Anacortes
Mount Vernon
Oak Harbor
Coupeville
Port Angeles
Port Townsend
Everett
Monroe
Edmonds
Seattle
Bellevue
Bremerton
Port Orchard
Renton
Kent
Federal Way
Tacoma
Shelton
Puyallup
Lakewood
Olympia

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Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

0 5 10 20 Miles

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species: Documented Presence in Puget Sound Basin

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 8.1

February 2011

Lymantriid Moths

e.g., Asian, European gypsy moths

Puget Sound Basin

Species Detection (1991 - 2009)

- Observed*
- Surveyed But Not Found*

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. See Appendix for county scale maps.

Boundaries & Extents

- County Boundary
- Puget Sound Extent

Land Cover & Land Use

- Developed
- Deciduous Forest
- Coniferous & Mixed Forest

Pathways & Sensitive Landscape Features

- Ports
- International Airport
- Airport
- River / Stream
- Lake / Pond
- Reservoir
- Swamp / Marsh
- Sea / Ocean
- Railroads
- Roads - Interstate, US, & State Routes

JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

Miles
0 5 10 20

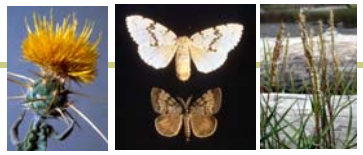
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species: Species Locations, Potential Pathways, Sensitive Landscape Features

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 8.2

February 2011



9. Nutria (*Myocastor coypus*)

Nutria are medium-sized rodents native to South America that can grow up to 40 inches from their nose to the tip of their round, rat-like tail. They typically live near freshwater, although they may be found away from water bodies, and may also be found near brackish or salt water. Nutria feed aggressively on the roots and stems of wetland and riparian plants, destroying associated plant material. Their feeding and burrowing habits can cause severe damage to riparian ecosystems and associated infrastructure.

Status and Trends

Species presence. Nutria have been reported at locations in King, Skagit, Snohomish, Thurston, and Whatcom counties. Map 9.1 shows data provided to the project team by two sources, the University of Washington (point data) and Portland State University (polygon data), summarizing documented occurrences of nutria during the period 2006-2007.

Presence over time. Due to limited data on nutria presence in the region, we are unable to map or assess changes in the presence of nutria in Puget Sound Basin at this time.

Figure 11. Nutria at Lake Washington (King County). *Jeff Adams, Washington Sea Grant.*

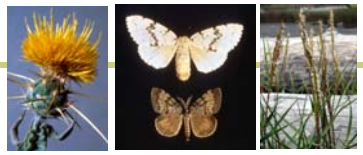
Files used in the analysis. The project team converted the following data into GIS shapefiles:

- Spreadsheet of nutria sightings in the greater Seattle area, with latitude and longitude, provided by former UW students who had conducted a senior thesis project on nutria distribution.
- A map image of nutria distribution in certain regions of Puget Sound, based on WDFW fish and wildlife biologist estimates as reported to a Portland State University student.

See Table 20 for a summary of data provided to the project.

Files not used in the analysis. The following pieces of information were not used in the analysis.

- Data provided by USDA Wildlife Services described the number of nutria trapped or shot in several Puget Sound counties. Data were not available at a finer scale than county boundaries, and since more fine-scale data were available for each of those counties, the USDA data were not used.
- The images provided by Washington Sea Grant were not used in the analysis but included here.
- Anecdotal reports of nutria in locations including the UW campus adjoining Lake Washington, Portage Bay, and Lake Sammamish. These locations were already represented in other data files.
- A report on the status and potential management of nutria in Washington and Oregon was used to inform the program analysis but not the status analysis. However, a map from that report was converted into a shapefile, as described above.



- A thesis report from UW graduate students was used as context for a separate data file of nutria sightings (see above), but no data from the thesis was used for the status analysis.

Table 20. Nutria data provided to the baseline assessment project. Data files included in the spatial summaries are noted with an asterisk (*). For more detail on spatial data see Appendix A9.1.

File type provided (quantity)	Spatial extent	Data provider
Spatially explicit data		
Dataset with locations (2)*	King and Skagit counties, Seattle and surrounding areas	USDA Wildlife Services, UW*
Map image (1)*	Washington	Portland State University*
Image with locations (2)	Near University of Washington (Seattle)	Washington Sea Grant
Other data		
Management or survey reports (2)	Washington and Oregon, Seattle and surrounding areas	Portland State University, UW
Anecdotal reports (2 sets)	King County	WDFW, University of Washington

Pathways

In this section and the following Impacts and At-risk Resources section, the discussions reference species-specific basin-wide "Pathways and At-risk Resources" maps and the county-scale maps included as appendices. Included in these maps are all publicly available data layers representing those pathways and sensitive landscape features relevant to this species (e.g., boat ramps, roads, wetlands). See text box on page 33 for more detail.

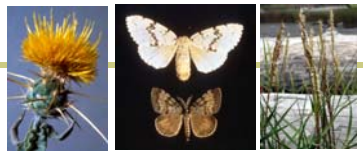
Pathways of introduction. Nutria were introduced to the U.S. in the 1930s for fur production. They were released into the wild when fur industries failed, and routinely escaped from fur farms as well.

Pathways of spread. Nutria can migrate along riparian corridors and overland between waterbodies. An overlay of documented occurrences on waterbodies and riparian corridors in the Basin suggest that in developed areas, nutria are moving along hydrologically linked corridors such as the Lake Washington, Sammamish Slough, and Lake Sammamish Corridor (Map 9.2). Development might function as a barrier to nutria movement overland within the Puget lowlands.

Impacts and At-risk Resources

Ecological impacts. Nutria are voracious eaters and can destroy aquatic vegetation and spread disease, impacting native species including muskrats, waterfowl, finfish, and shellfish. Freshwater and estuarine habitats linked hydrologically to aquatic habitats with documented nutria presence are likely at risk of nutria infestation and associated negative impacts in the Puget lowlands (Map 9.2 and Appendices A9.10-9.22).

Human dimension impacts. Nutria can damage man-made structures such as dikes, irrigation facilities, and surface water management structures. Infrastructure including canals and ditches,



dikes and levees, and reservoirs located in developed and rural areas adjacent to nutria-infested aquatic habitats (e.g., municipalities along the Lake Washington-Lake Sammamish corridor shown in Map 9.2 and Appendices A9.10-9.22) are likely at risk from nutria burrowing and/or feeding activity.

Management

Table 21 summarizes commonly reported program types and the number of entities reporting management activities for nutria.

State or Puget Sound-level activities. WDFW leads nutria outreach and education efforts through its Living with Wildlife program, which offers web resources regarding nutria and receives reports of nutria sightings from the public. WDFW also focuses on prevention of nutria spread and eradication, and has worked with USDA and The Nature Conservancy to eradicate nutria populations in Skagit County.

County-level activities. Although nutria were reported as present in King, Skagit, Snohomish, Thurston, and Whatcom counties, no county-level agency surveyed reported any management efforts targeted at nutria. Skagit Conservation District, other Conservation Districts, and local dike and drainage districts have been reported to be involved in nutria management.

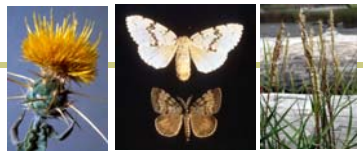
Federal-level activities. The USDA APHIS Wildlife Services division has been working with state agencies and researchers to develop a National Management and Control Plan for nutria. USDA Wildlife Services also offers nutria trapping/killing services at the request of state, county, or municipal jurisdictions, or individual property owners. USDA has worked with the University of Washington to control nutria populations at Lake Washington, and with WDFW and The Nature Conservancy in Skagit County. The USGS maintains an invasive aquatic species database, with a portal for the public to report sightings of species such as nutria.

Other activities. The Center for Lakes and Reservoirs at Portland State University is home to an effort to develop a framework for nutria management in the Pacific Northwest.

Table 21. Commonly reported management program types and number of organizations targeting nutria.

	Three most commonly reported management program types (frequency)	Number of organizations with current management activities
County	None	0 (present in 5)
State	Control, detection, education/outreach, enforcement, eradication, monitoring, prevention	1
Federal	Control (2), education/outreach and funding (1), other: tracking distribution (1)	3
Other	Control (1), detection (1), education/outreach (2), policy (1), prevention (2), and monitoring (1)	4

Legal authorities. Nutria is classified as a Prohibited Aquatic Animal Species (WAC 220-12-090). WDFW's website states that all live-trapped nutria should be euthanized and not returned to the wild.



Funding. Overall, there appears to be limited funding dedicated to nutria management in the Puget Sound Basin. USDA's control efforts are paid for by the jurisdiction requesting the services. The Portland State University effort receives funding from multiple sources including the USGS National Wetlands Research Center, USFWS Pacific Region, EPA Region 10, WDFW, as well as Oregon Department of Fish and Wildlife Invasive Species and Wildlife Integrity Program and the Clean Water Services Water Resources Program.

Summary of Gaps

This summarizes gaps specific to nutria; some of the overarching gaps identified in Section IV are applicable as well.

Data collection and management. The study identified a gap in basin-wide data collection and information management efforts. Data files shared with the project included varying levels of spatial information and detail. We are not aware of any systematic data collection efforts for this species, but anecdotal reports suggest that this species may be more widespread than the data indicate.

Knowledge and understanding of species status, pathways, and impacts. The study suggests numerous gaps in understanding of nutria presence and movement within the Basin. Species presence was not indicated for seven counties. At this time it is not known whether that is due to lack of data or to existing data not being shared with the project. Characterization of species status also appears to be challenged by the fact that individuals can migrate significant distances. Likely pathways of spread and potential impacts to water and land resources appear to be fairly well understood due to work in other parts of the country. This study found little evidence of assessments of the current and potential damage to freshwater and adjacent terrestrial resources in the Basin.

Management efforts. The study identified gaps in management of nutria in the Basin. Nutria management is largely site-specific, in response to observed nutria and subsequent requests from private landowners and local organizations for control assistance. Some contacts mentioned the need for more state-wide or regional leadership and coordination. There is limited funding dedicated to nutria management.

Nutria

Myocastor coypus

Puget Sound Basin

Species Detection (2006 - 2007)

Observed* Observed*

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program.

Land Cover & Land Use

- Developed
- Cultivated Lands
- Grassland
- Deciduous Forest
- Coniferous & Mixed Forest
- Scrub / Shrub
- Freshwater Wetland
- Estuarine Wetland
- Beaches, Bars & Flats
- Rock & Snow
- Water

Boundaries & Extents

- County Boundary
- Puget Sound Extent

Whatcom
San Juan
Skagit
Island
Snohomish
Clallam
Jefferson
Kitsap
King
Pierce
Mason
Thurston
Lewis

Lynden
Ferndale
Bellingham
Friday Harbor
Anacortes
Mount Vernon
Oak Harbor
Coupeville
Port Angeles
Port Townsend
Everett
Monroe
Edmonds
Seattle
Bellevue
Bremerton
Port Orchard
Renton
Kent
Federal Way
Tacoma
Shelton
Puyallup
Lakewood
Olympia

JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

0 5 10 20 Miles

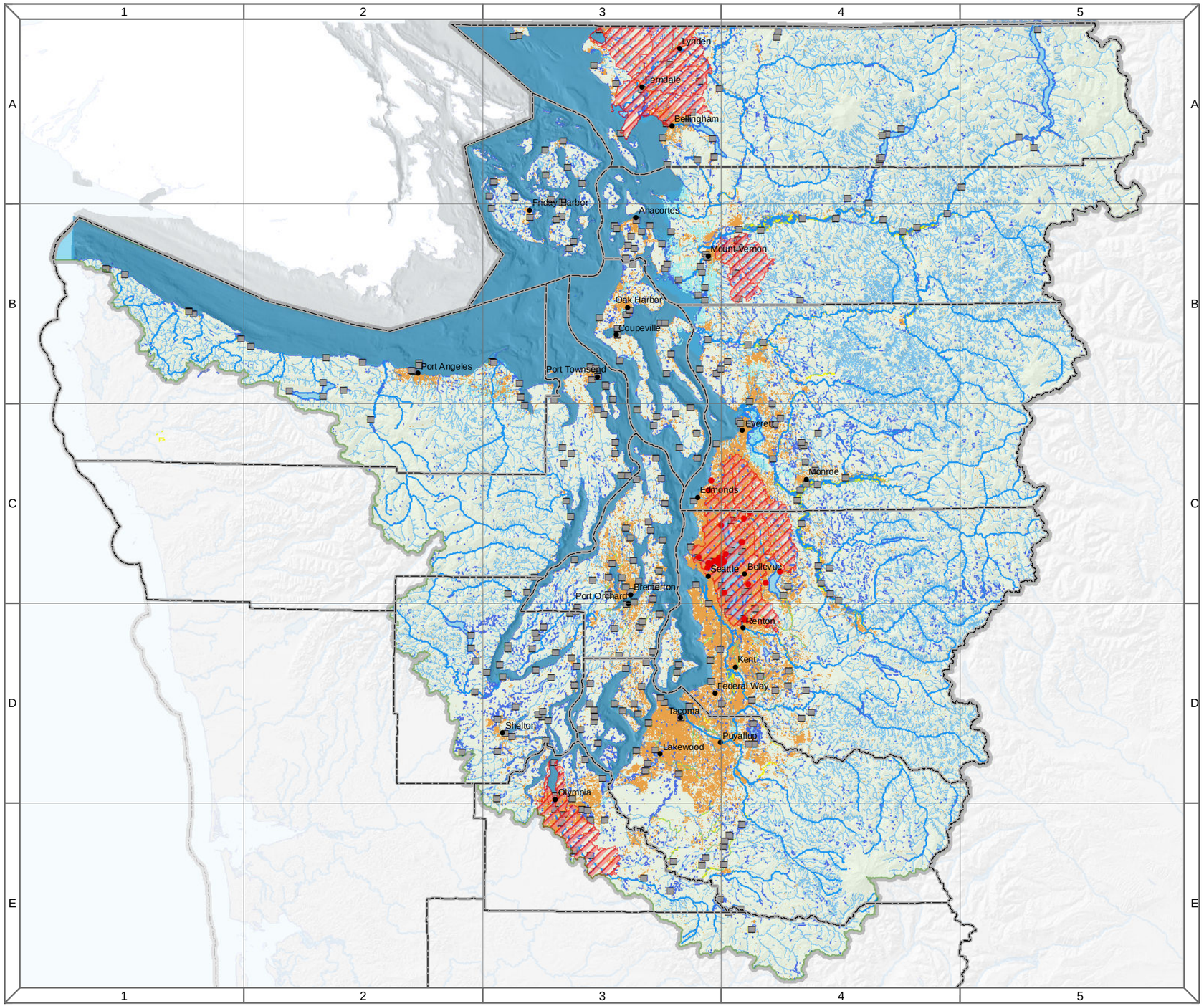
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species: Documented Presence in Puget Sound Basin

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 9.1

February 2011



Nutria

Myocastor coypus

Puget Sound Basin

Species Detection (2006 - 2007)

Observed* Observed*

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. See Appendix for county scale maps.

Boundaries & Extents

- County Boundary
- Puget Sound Extent

Pathways & Sensitive Landscape Features

- Boat Ramps
- River / Stream
- Canal / Ditch
- Flood Zones
- Lake / Pond
- Reservoir
- Swamp / Marsh
- Sea / Ocean

Land Cover & Land Use

- Developed

JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

Miles
0 5 10 20

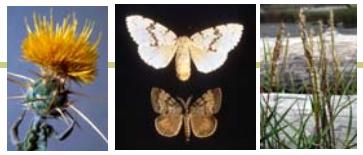
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species:
Species Locations, Potential Pathways, Sensitive Landscape Features

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 9.2

February 2011



10. Spartina (*Spartina alterniflora, S. anglica, S. patens, S. denisflora*)

The priority *Spartina* group is a group of four species of aquatic grasses that grow in circular clumps called 'clones'. They grow on the mud flats and marshes of Puget Sound and coastal estuaries, including intertidal saltwater areas as well as the perimeters of freshwater areas. These grasses outcompete native plant species, including rare and endangered plant species, reducing marsh biodiversity and ecological functions.

Status and Trends

Species presence. *Spartina* can be found in parts of Puget Sound, Grays Harbor, and Willapa Bay, and near the mouth of the Columbia River. State and local agencies have been working on *Spartina* control for many years and have made much headway. To date, *Spartina* has been documented in 9 of 13 Puget Sound counties (Map 10.1), primarily along the shorelines of the islands and peninsulas of central Puget Sound, around the mouths of the Skagit, Skykomish and Stillaguamish Rivers, and to a lesser degree along the Whatcom and Clallam County shorelines.

Figure 12. *Spartina* near Camano Island (Island County). *Jeff Adams, Washington Sea Grant.*

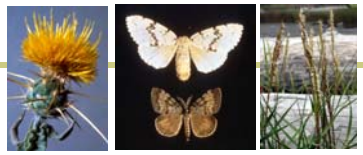
Presence over time. Data files provided to the project did not included sufficient information about dates of data collection to support an analysis of change over time for this species. However, WSDA management reports indicate that by 2009, partners had achieved an estimated 97% reduction in *Spartina* from its peak extent over a combined total of more than 1,000 acres in 1997 in Puget Sound.[7]

Files used in the analysis. All GIS shapefiles provided to the project were used in the spatial analysis. Data provided by San Juan County NWCB on observed *Spartina*, with specific latitude and longitude provided for each point, were converted to a GIS file for use in the analysis. See Table 22 for a summary of data provided to the project.

Files not used in the analysis. The following files were not used in the analysis:

- *Spartina* locations provided by UW Burke Herbarium which, when cross-referenced against GIS data, did not appear to indicate any new sites.
- Records of spraying locations from Snohomish County NWCB were not readily translatable into presence/absence; other treatment data were minimal and thus the concept was not portrayed.
- The image provided by Washington Sea Grant was not used in the analysis but included here.
- Anecdotal reports were confirmed by GIS data.

[7] WSDA, Spartina *eradication program 2009 progress report* (draft), March 2010.



- WSDA's annual reports to the legislature were used to inform the program analysis.
- Dosewallips and Deception Pass reports were supplemented by a GIS file for Dosewallips State Park and by use of a state-wide state parks GIS layer for Deception Pass State Park.

Table 22. *Spartina* data provided to the baseline assessment project. Data files included in the spatial analysis are indicated with an asterisk (*). For more detail on spatial data see Appendix A10.1.

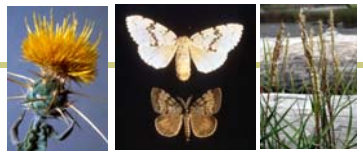
File type provided (quantity)	Spatial extent	Data provider
Spatially explicit data		
GIS shapefiles (18)*	Puget Sound Basin; Island, San Juan, Skagit, and Whatcom counties; Swinomish Reservation; Dosewallips State Park; San Juan County	WSDA*, People for Puget Sound*, Swinomish Tribe*, WSPRC*, San Juan County NWCB*
Observations with latitude & longitude (1)	Island, Jefferson, Snohomish counties	UW Burke Herbarium
Dataset with locations (2)*	San Juan County, Snohomish County	San Juan County NWCB*, Snohomish County NWCB
Map image (2)	San Juan Island	San Juan County NWCB
Image with locations (1)	Near Camano Island, Island County	Washington Sea Grant
Other data		
Management or survey reports (14)	Washington State, Deception Pass and Dosewallips State Parks	WSDA, WSPRC
Anecdotal reports (2)	Jefferson County, Vashon Island	Jefferson County NWCB, King County NWCB

Pathways

In this section and the following Impacts and At-risk Resources section, the discussions reference species-specific basin-wide "Pathways and At-risk Resources" maps and the county-scale maps included as appendices. Included in these maps are all publicly available data layers representing those pathways and sensitive landscape features relevant to this species (e.g., boat ramps, roads, wetlands). See text box on page 33 for more detail.

Pathways of introduction. *Spartina* species were likely introduced to the West Coast in shipments of oysters; such accidental inclusion is still a threat. *Spartina* appears to have been recently reintroduced from Canada via marine currents and this path of entry is still considered a threat. *S. anglica* was brought in intentionally for dike stabilization and cattle fodder, possibly explaining the heavy infestation in areas around the reclaimed farmlands in the Skagit Delta (Map 10.2).

Pathways of spread. Spartina may hitchhike on boats, ballast water, currents, or waterfowl. Newly restored sites may offer habitat for new *Spartina* infestations, and restoration projects might disturb existing infestations and release propagules into transportation streams (marine currents and drift cells, shipping lanes). Overlaying current and proposed restoration projects on drift cell



maps (e.g., Map 10.2) could help managers identify potential new sources of *Spartina* as well as sites at risk of invasion.

Impacts and At-risk Resources

Ecological impacts. Spartina's ability to trap large quantities of sediment allows it to significantly alter inter-tidal mud flats and salt marshes in the Puget Sound and alter water flow, such as has occurred in Skagit Bay, Padilla Bay, and Samish Bay (Map 10.2). *Spartina* outcompetes natives, such as eelgrass with impacts to broader eelgrass communities, and negatively impacts native shellfish and shorebirds. Eelgrass beds and intertidal areas throughout the Sound (represented in county maps by Drift Cell Zones extending to 10m depth, see Appendices A10.10-10.22) are at risk of negative impacts associated with *Spartina* infestations.

Human dimension impacts. Spartina has negative impacts on marine industries in the nearshore (e.g., fishing, crabbing, shellfish harvesting). It can increase flooding along the shoreline by increasing sedimentation, and dense stands impact shore-based recreation.

Management

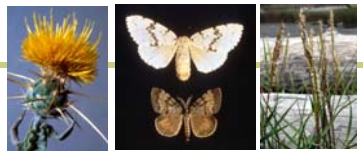
WSDA coordinates management activities across the state, with partners at multiple levels. Table 23 summarizes commonly reported program types and the number of organizations reporting management activities.

State or Puget Sound-level activities. WSDA has been working since 1995 as the lead state agency to eradicate *Spartina*, coordinating cooperation with many entities, including all counties bordering Puget Sound, WDNR, WDFW, WSPRC, USFWS, U.S. Navy, Padilla Bay National Estuarine Research Reserve, People for Puget Sound, The Nature Conservancy, Vashon Maury Land Trust, and the Makah, Suquamish, Swinomish, and Tulalip Tribes. WSDA also participates in regional *Spartina* eradication efforts via the West Coast Governors' Agreement on Ocean Health, and through an Action Coordination Team with representatives from California, Oregon, Washington, federal and tribal governments, non-governmental organizations, and British Columbia.

State agencies which own lands infested with *Spartina,* including Ecology, WDFW, WDNR, and WSPRC conduct survey, eradication, and control efforts on these properties in partnership with other state and local agencies. The State NWCB advises WSDA on noxious weed control, coordinates and supports the activities of county NWCBs, and implements Chapter 17.10 RCW.

County-level activities. Spartina is currently documented in Clallam, Island, Jefferson, Kitsap, San Juan, Skagit, Snohomish, and Whatcom counties. NWCBs in each of these counties reported either control, eradication, or both types of activities, as well as a mix of detection, education/outreach, funding, monitoring, policy, and prevention activities specific to each county. These efforts are typically in partnership with WSDA, as well as local organizations such as non-profits and tribes.

Spartina is not currently documented in King, Mason, Pierce, or Thurston counties. King, Mason, and Thurston counties each reported prevention activities, along with a combination of detection, education/outreach, and monitoring activities specific to each county. Pierce County reported no activities for *Spartina,* however WSDA did report collaboration with Pierce County. Lewis County is



not included because it does not border the Sound. For a geographic depiction of management activities, see Map 10.3.

Federal-level activities. USFWS funded WDFW, WSDA, and Coastal Resources Alliance for Spartina control and monitoring in Puget Sound. The agency partnered with Clallam County Noxious Weed Control Board, the Makah Tribal nation, and WSDA to treat *Spartina* infestations in Clallam County. The USGS maintains an invasive aquatic species database, with a portal for the public to report sightings of species such as *Spartina.*

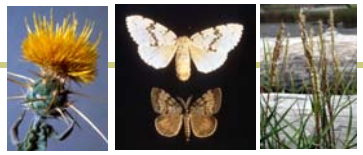
Other activities. People for Puget Sound has been conducting education and outreach and annual Spartina Dig Days since 2000, and in 2007, began recruiting and training volunteer kayakers to survey priority shorelines for *Spartina.* Washington Sea Grant funded a *Spartina* eradication and education service-learning project with WSDA, Island County NWCB, and students, and developed a *Spartina* control handbook. The Swinomish and Stillaguamish Tribes both reported control and eradication efforts, in coordination with other agencies. A student at Oregon State University is developing a weed mapper tool that will track any *Spartina* detections. Metro Parks Tacoma's North Pacific Aquarium and Washington Sea Grant both conduct education and outreach on aquatic invasive species topics to general audiences. The Puget Sound Partnership coordinates prevention and education/outreach activities for *Spartina*. The UW Burke Herbarium collects and shares information on plant species including *Spartina.*

Table 23. Commonly reported management program types and number of organizations targeting *Spartina*.

	Three most commonly reported management program types (frequency)	Number of organizations with current management activities
County	Detection, education/outreach, and prevention (7)	10 (present in 8)
State	Control, education/outreach, and eradication (5)	7
Federal	Control, detection, funding, education/outreach, and other: tracking distribution (1)	3
Other	Education/outreach (4), eradication (3), control and detection (2)	7

Legal authorities. Washington's Wetlands and Aquatics Quarantine list, administered by WSDA, prohibits transport, purchase, sale, offers for sale, or distribution of *Spartina* plants or plant parts (Chapter 17.24 RCW, WAC 16-752-500). All four invasive *Spartina* species are listed as Class A Noxious Weeds in Washington, meaning eradication is required (Chapter 17.10 RCW, Chapter 16-750 WAC). The state and county programs described here are covered under this regulation. The Control of Spartina and Purple Loosestrife act (Chapter 17.26 RCW, Chapter 16.752 WAC) focuses WSDA action on control and future eradication of *Spartina* and purple loosestrife.

Funding. WSDA receives funding for the *Spartina* program via an appropriation from the state Aquatic Lands Enhancement Account In 2009, WSDA provided a total of $162,500 in contracts with Island, Skagit, and Snohomish county NWCBs, the Swinomish Tribe, and WDFW. For an overview of funding sources for WSDA and county NWCBs, see Table 5 and Table 6.



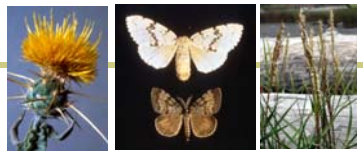
Summary of Gaps

This summarizes gaps specific to *Spartina*; some of the overarching gaps identified in Section IV are applicable as well.

Data collection and management. Data collection for *Spartina* has benefited from being the focus of state regulations and dedicated funding. The only potential gaps may be in coordinated management of the resulting large quantities of data, both internally and between agencies.

Knowledge and understanding of species status, pathways, and impacts. No current gaps in understanding of *Spartina* in the Basin were identified. Although species presence was not indicated for five counties, the extensive regional coordination and cooperation of *Spartina* surveys and management suggest that this accurately indicates the absence of this species in those locations. However, as populations are eradicated, the clones remaining are increasingly remotely located, complicating survey efforts. Major pathways of new introductions and spread and impacts to ecological and human dimensions of the ecosystem appear to be well understood.

Management efforts. No gaps were identified.



Spartina

Spartina alterniflora, S. anglica, S. patens, S. denisflora

Puget Sound Basin

Species Detection (2003 - 2009)

Observed*

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program.

Land Cover & Land Use

- Developed
- Cultivated Lands
- Grassland
- Deciduous Forest
- Coniferous & Mixed Forest
- Scrub / Shrub
- Freshwater Wetland
- Estuarine Wetland
- Beaches, Bars & Flats
- Rock & Snow
- Water

Boundaries & Extents

- County Boundary
- Puget Sound Extent

Whatcom
San Juan
Skagit
Island
Snohomish
Clallam
Jefferson
Kitsap
King
Mason
Pierce
Thurston
Lewis

Lynden
Ferndale
Bellingham
Friday Harbor
Anacortes
Mount Vernon
Oak Harbor
Coupeville
Port Angeles
Port Townsend
Everett
Monroe
Edmonds
Seattle
Bellevue
Bremerton
Port Orchard
Renton
Kent
Federal Way
Tacoma
Shelton
Puyallup
Lakewood
Olympia

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CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

0 5 10 20 Miles

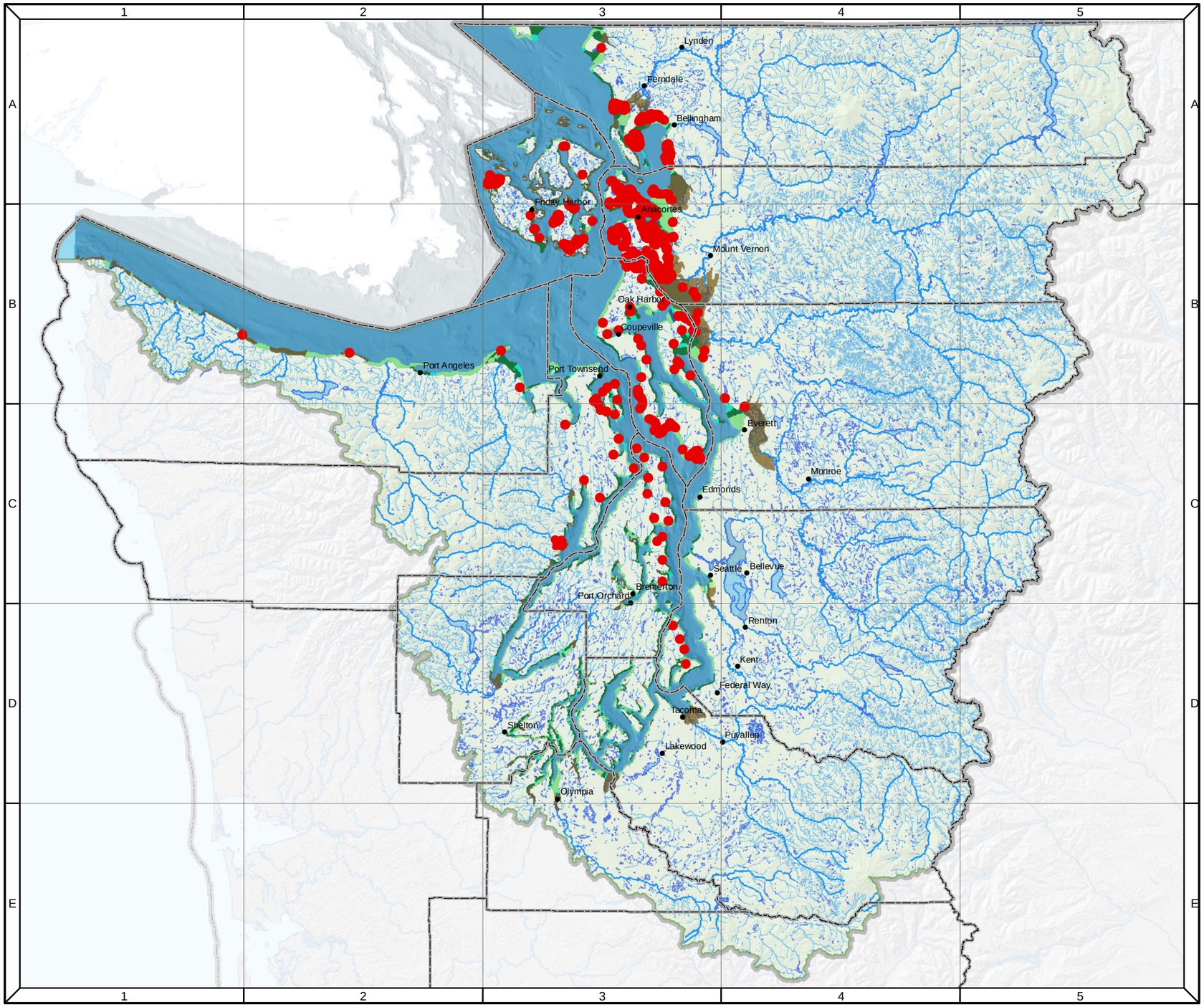
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species: Documented Presence in Puget Sound Basin

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 10.1

February 2011



Spartina

Spartina alterniflora, S. anglica, S. patens, S. denisflora

Puget Sound Basin

Species Detection (2003 - 2009)

Observed*

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. See Appendix for county scale maps.

Boundaries & Extents

County Boundary

Puget Sound Extent

Pathways & Sensitive Landscape Features

River / Stream

Lake / Pond

Reservoir

Swamp / Marsh

Sea / Ocean

Drift Cells

Left to Right

Right to Left

Convergence Zone

Divergence Zone

No Appreciable Drift

JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

0 5 10 20 Miles

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species:
Species Locations, Potential Pathways, Sensitive Landscape Features

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

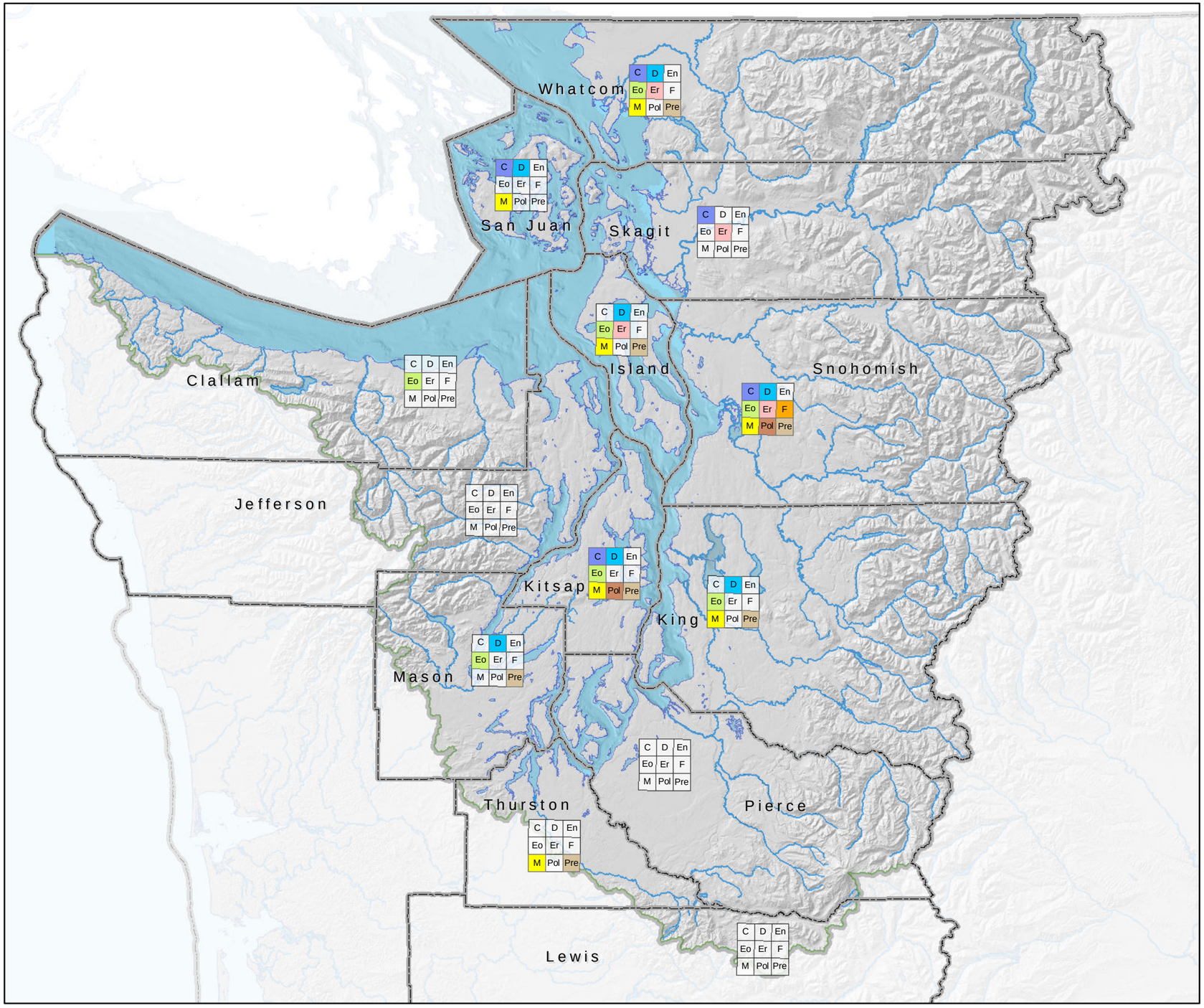
MAP 10.2

February 2011

Spartina

Spartina alterniflora, S. anglica, S. patens, S. denisflora

Puget Sound Basin



Management at the County Level

- Control (C)
- Detection (D)
- Enforcement (En)
- Education / Outreach (Eo)
- Eradication (Er)
- Funding (F)
- Monitoring (M)
- Policy (Pol)
- Prevention (Pre)

Boundaries & Extents

- County Boundary
- Puget Sound Extent

JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

Miles
0 5 10 20

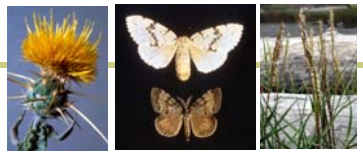
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species:
Management at the County Level

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 10.3

February 2011



11. Tunicates (*Didemnum vexillum*, *Styela clava*, *Ciona savignyi*)

Tunicates are invertebrate marine animals with a firm but flexible body covering. Tunicates typically spend most of their lives attached to docks, rocks, the undersides of boats, or the sea floor. Invasive tunicates negatively impact native marine species and disrupt ecosystems, and can impact aquaculture, boating, and marine infrastructure. The Council's initial list of priority species included *Didemnum vexillum*, *Styela clava*, and *Ciona savignyi*; the Council has more recently become interested in *Ciona intestinalis* as well.

Figure 13. Invasive tunicate, *Didemnum vexillum,* in Puget Sound. *Janna Nichols, REEF.*

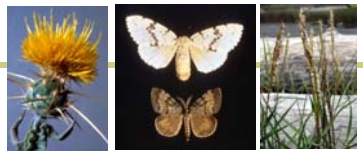
Status and trends

Species presence. The original priority invasive tunicates (*Didemnum vexillum*, *Styela clava*, and *Ciona savignyi*) have been documented in many locations around Puget Sound. Map 11.1 includes data provided from four sources (see Appendix A11.1 for data sources) for the period 2005-2009 and shows invasive tunicates present in the marine waters off the coast of all twelve counties fronting the Puget Sound. Note that the maps presented here do not differentiate between species, with the goal of demonstrating the presence and absence of this group as a whole. When combined with the unmapped sightings listed below, the only nearshore areas that appear to be relatively free of invasive tunicates are the waters from Everett north to Port Susan and Skagit Bay, the inlets north of Olympia and some short stretches of Clallam County's shoreline.

Tunicates were also observed in a number of locations since 1998 by UW scientists. The locations of these observations were not specific enough to be converted into a GIS file. Cross-referencing of these data against the maps suggests the presence of one of the invasive tunicate species in the following additional locations:

- Whidbey Island Lagoon Point (Island County).
- Port Orchard, Poulsbo Yacht Club, and Poulsbo-Liberty Bay Marina (Kitsap County).
- Gig Harbor Marina and Key Peninsula-Longbranch Marina (Pierce County).
- Taylor Shellfish mussel rafts at Totten Inlet (either Thurston or Mason County).
- Blaine Marina (Whatcom County).

Presence over time. Data as provided to the project do not include sufficient information about the dates data were collected to support a trend analysis for the period 2005-2009 using all of the spatial data compiled.



Files used in the analysis. A summary of data files provided may be found in Table 24. The two shapefiles provided, both documenting tunicates in Hood Canal and provided by the Skokomish Tribe and WDFW, were used in the analysis. Two datasets were converted to GIS shapefiles for use in the analysis:

- Data provided by REEF of non-native tunicate sightings throughout the Puget Sound, and explanatory data to locate survey sites.
- Data on *S. clava* abundance at Pleasant Harbor Marina in Mason County.

Files not used in the analysis. The following data and information provided were not used in the spatial analysis:

- Several of the management and survey reports noted below indicated the presence of data sets which we were then able to track down and use in the spatial analysis. Other reports were used as context in the program analysis.
- The images provided by REEF were not used in the analysis.
- Tunicate survey data from UW scientists had location information that was not specific enough to be converted into a GIS file. See discussion above.

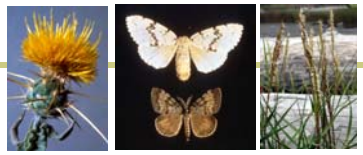
Table 24. Tunicate data provided to the baseline assessment project. Data files included in the spatial summaries are indicated by an asterisk (*). For more detail on spatial data see Appendix A11.1.

File type provided (quantity)	Spatial extent	Data provider
Spatially explicit data		
GIS shapefiles (2)*	Hood Canal	Skokomish Tribe*, WDFW*
Dataset with locations (5)*	Puget Sound Basin; Pleasant Harbor Marina (Jefferson County)	UW, REEF*; Tulane University*
Image with locations (1 set)	Various locations (Puget Sound Basin)	REEF
Other data		
Management or survey reports (8)	Hood Canal; Puget Sound	Skokomish Tribe, WDFW; REEF, Tulane University, UW, WDFW, WDNR

Pathways

In this section and the following Impacts and At-risk Resources section, the discussions reference species-specific basin-wide "Pathways and At-risk Resources" maps and the county-scale maps included as appendices. Included in these maps are all publicly available data layers representing those pathways and sensitive landscape features relevant to this species (e.g., boat ramps, roads, wetlands). See text box on page 33 for more detail.

Pathways of introduction. Tunicates have been introduced via ballast water and sea chests in marine vessels.



Pathways of spread include commercial and recreational watercraft, either via sea chests and ballast water or hull fouling. At a more local scale, pathways could include divers visiting multiple tunicate sites. Possible pathways of spread including marinas and ports are overlaid on documented tunicate sightings in Map 11.2 (Kitsap County) and Appendices A11.10-A.11.22.

Impacts and at-risk resources

Ecological impacts. Invasive tunicates outcompete native species for food and space, may siphon out the gametes of other species, and possibly prey on other species. 11.2 (and Appendices A11.10-A11.22) overlays documented tunicate sightings on areas of potential habitat for the group of species, namely nearshore waters to a depth of 200 feet. Many of these shallow areas throughout the Sound are sensitive to tunicate infestations. In areas close to current populations of tunicates, these areas are likely vulnerable to invasion.

Human dimension impacts. Invasive tunicates can negatively impact aquaculture and can cover and weigh down underwater infrastructure such as docks or boat hulls and deter recreational and commercial boating. Overwater structures, marinas, and associated watercraft shown in Map 11.2 (and related appendices) are potentially at risk of damage from invasive tunicates, particularly those within close proximity of existing populations.

Management

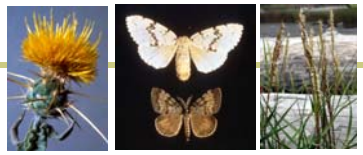
WDFW leads invasive tunicate management efforts, which typically occur at site-specific scales. For a summary of management activities, please see Table 25.

State or Puget Sound-level activities. WDFW has lead state responsibility, and through its Invasive Tunicate Species Management Program conducts prevention, detection, eradication, control, monitoring, education/outreach, and enforcement activities. The program includes surveying marinas for invasive tunicates, and removing tunicates from boats in infested marinas to prevent spread. In addition, WDFW implements the Washington State Ballast Water Program, to reduce the threat of introductions of invasive species such as tunicates via the discharge of ballast water.

County-level activities. Invasive tunicates have been reported in every county which borders Puget Sound, however only Island County reported any management efforts, namely conducting education and outreach regarding tunicate species. (Map 11.3)

Federal-level activities. USFWS has participated in the Tunicate Response Advisory Committee, led by WDFW, funds the "Stop Aquatic Hitchhikers" campaign, and conducts associated outreach and education efforts. The USGS maintains a database of invasive aquatic species data and reports, with a portal for the public to report sightings of species such as tunicates.

Other activities. Reef Environmental Education Foundation (REEF) educates scuba divers on detection of invasive tunicates, and manages a database of these volunteers' sightings. REEF offers a basic invertebrate identification class, and has trained over 400 divers; the organization also created a laminated identification card for divers' use in cooperation with Washington Sea Grant and WDFW. Divers can submit observations to www.reef.org.



The Skokomish Tribe has developed an Aquatic Nuisance Species Management Plan for species including tunicates. Staff have previously conducted tunicate surveys in Hood Canal on a contract basis for WDFW. The Pacific States Marine Fisheries Commission administers the Pacific Ballast Water Group, which coordinates discussion of solutions to ballast water management issues affecting tunicate introduction and spread. Metro Parks Tacoma's North Pacific Aquarium and Washington Sea Grant both conduct education and outreach on aquatic invasive species topics to general audiences. The NWIFC assists member tribes in their invasive species management efforts.

Table 25. Commonly reported management program types and number of organizations targeting invasive tunicates.

	Three most commonly reported management program types (frequency)	Number of organizations with current managementactivities
County	Education/outreach (1)	1 (present in 12)
State	Education/outreach, prevention, policy (1)	1
Federal	Control, education/outreach, funding, other: tracking distribution (1)	2
Other	Education/outreach (4), prevention and policy (3)	5

Legal authorities. Under RCW 77.12.020, WDFW is charged by the state legislature to prevent the introduction or spread of prohibited and unlisted aquatic animal and plant species, including tunicates. Chapter 77.120 RCW (the State Ballast Water Act) sets the framework for ballast water management to prevent the introduction of species such as tunicates.

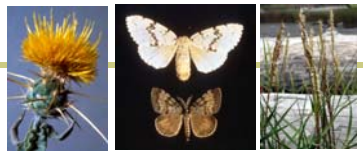
Funding. The WDFW Tunicate Program has been funded by the Legislature, via emergency funds in 2006, and directed through Puget Sound Partnership in 2007. The WDFW Aquatic Nuisance Species program is funded by the EPA and dedicated state funding through ESSB 5699. The Washington Ballast Water Program is funded by USFWS, Ecology, and the Pacific States Marine Fisheries Commission.

Summary of Gaps

This summarizes gaps specific to tunicates; some of the overarching gaps identified in Section IV are applicable as well.

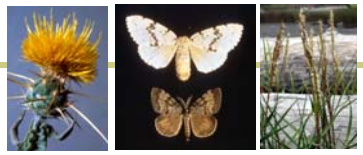
Data collection and management. The tunicate data compiled by the project varied widely in methods of collection and reporting. This is likely due to the wide diversity of organizations (e.g., NGOs, researchers, tribes, state agencies) collecting and sharing information on tunicates. There is a gap in coordination of data collection methods and data management across contributing organizations.

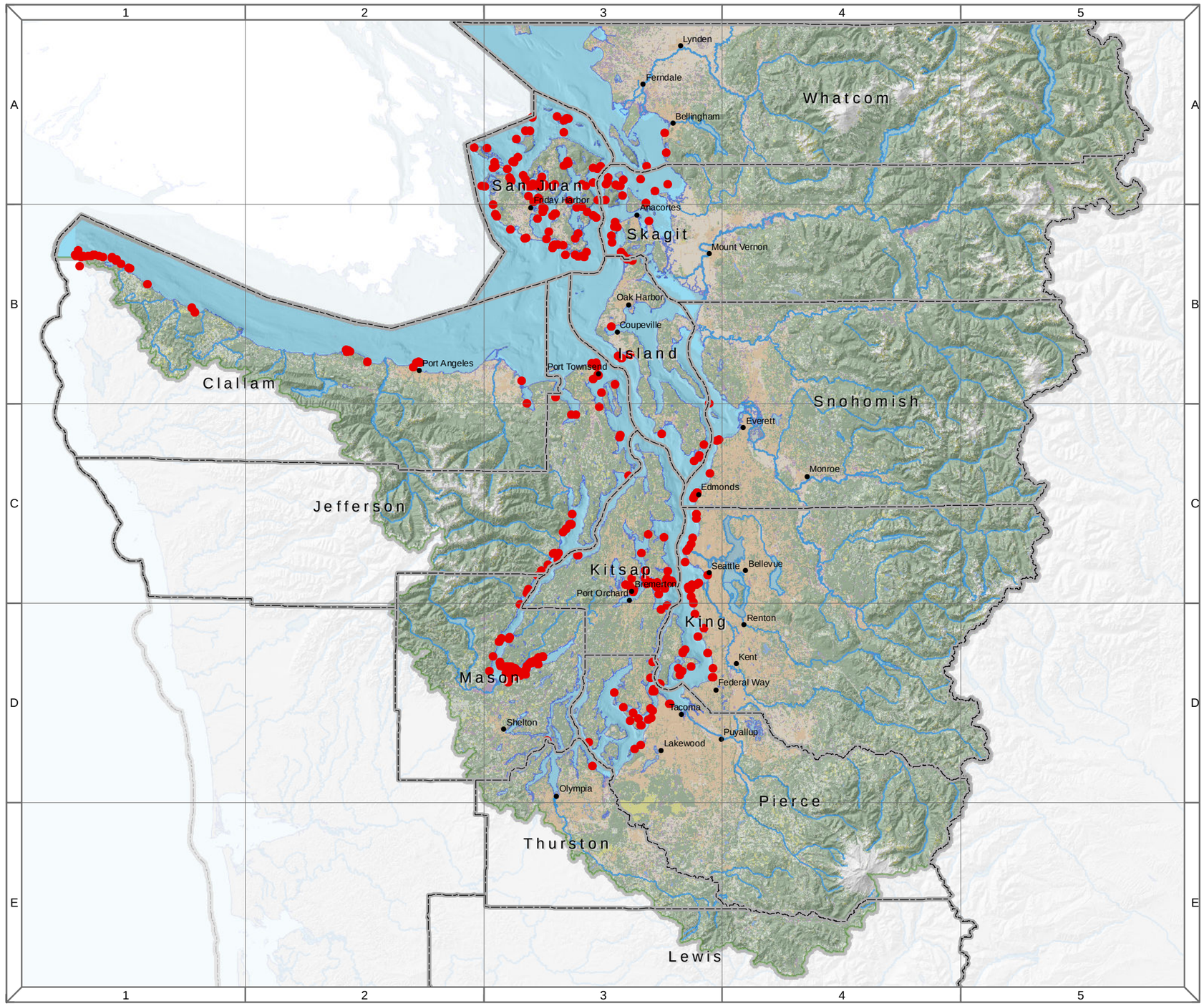
Knowledge and understanding of species status, pathways, and impacts. The study identified likely gaps in the state of knowledge regarding to invasive tunicate presence and movement in the Basin. Understanding of tunicate distribution in Puget Sound may be somewhat hampered by the wide variability in data collection and reporting methodologies, as noted above, as well as by the apparent real variability in species presence over time. Likely pathways of spread and potential



impacts to marine and nearshore resources are fairly well understood but little information exists about documented entry points, pathways, and specific impacts in Puget Sound.

Management efforts. There are gaps in management of invasive tunicates. Management efforts could be enhanced with a more visible and locally-supported education/outreach campaign, as well as heightened control efforts.





Tunicates

Didemnum vexillum, Styela clava, Ciona savignyi

Puget Sound Basin

Species Detection (2005 - 2009)

Observed*

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program.

Land Cover & Land Use

- Developed
- Cultivated Lands
- Grassland
- Deciduous Forest
- Coniferous & Mixed Forest
- Scrub / Shrub
- Freshwater Wetland
- Estuarine Wetland
- Beaches, Bars & Flats
- Rock & Snow
- Water

Boundaries & Extents

- County Boundary
- Puget Sound Extent

JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

0 5 10 20 Miles

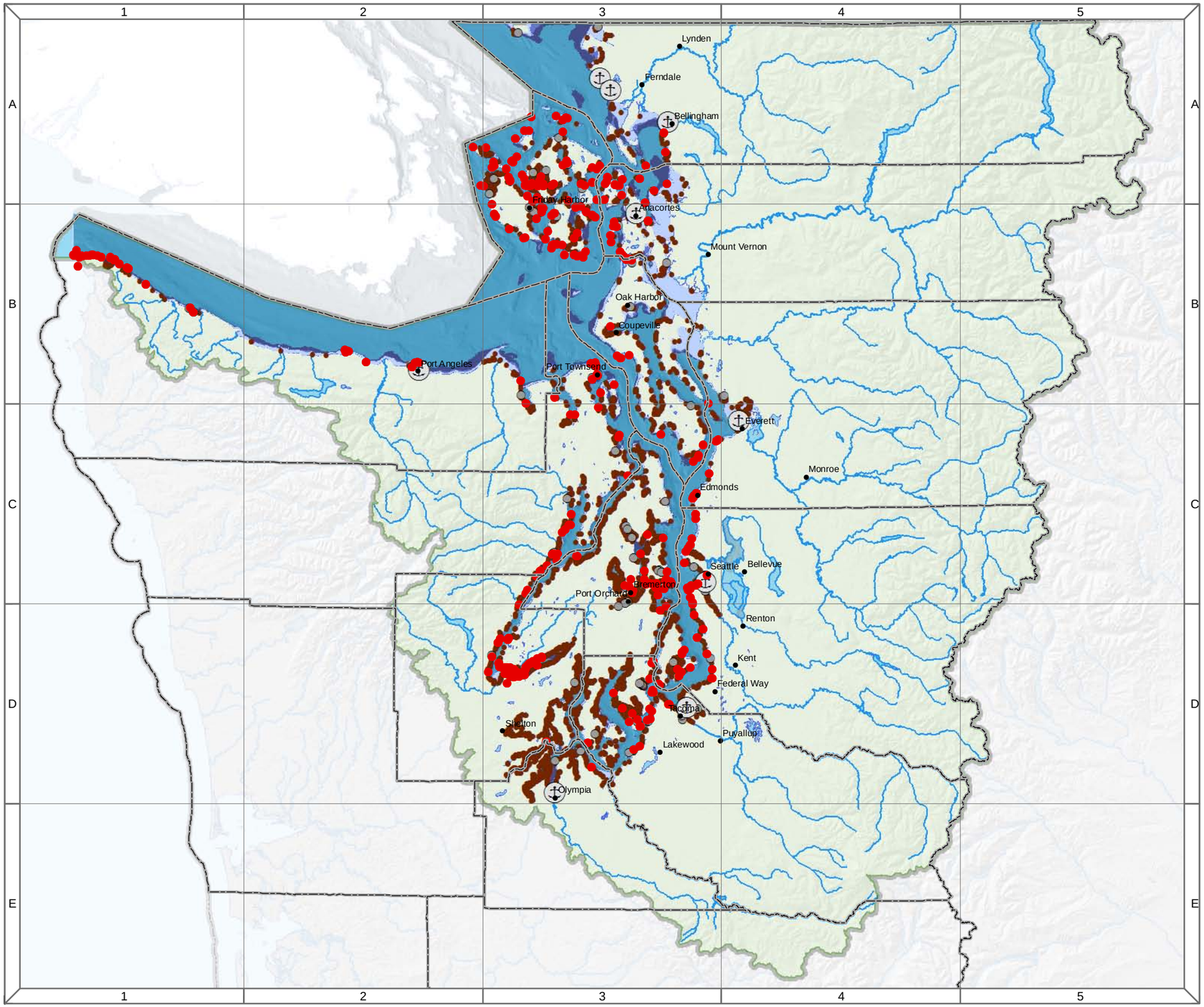
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species: Documented Presence in Puget Sound Basin

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 11.1

February 2011



Tunicates

Didemnum vexillum, Styela clava, Ciona savignyi

Puget Sound Basin

Species Detection (2005 - 2009)

Observed*

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. See Appendix for county scale maps.

Boundaries & Extents

County Boundary

Puget Sound Extent

Pathways & Sensitive Landscape Features

Ports

Marina

Overwater Structure

Sea / Ocean

Shoreline Depth

0' - 40' depth

40' - 75' depth

75' - 200' depth

JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

0 5 10 20 Miles

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species:
Species Locations, Potential Pathways, Sensitive Landscape Features

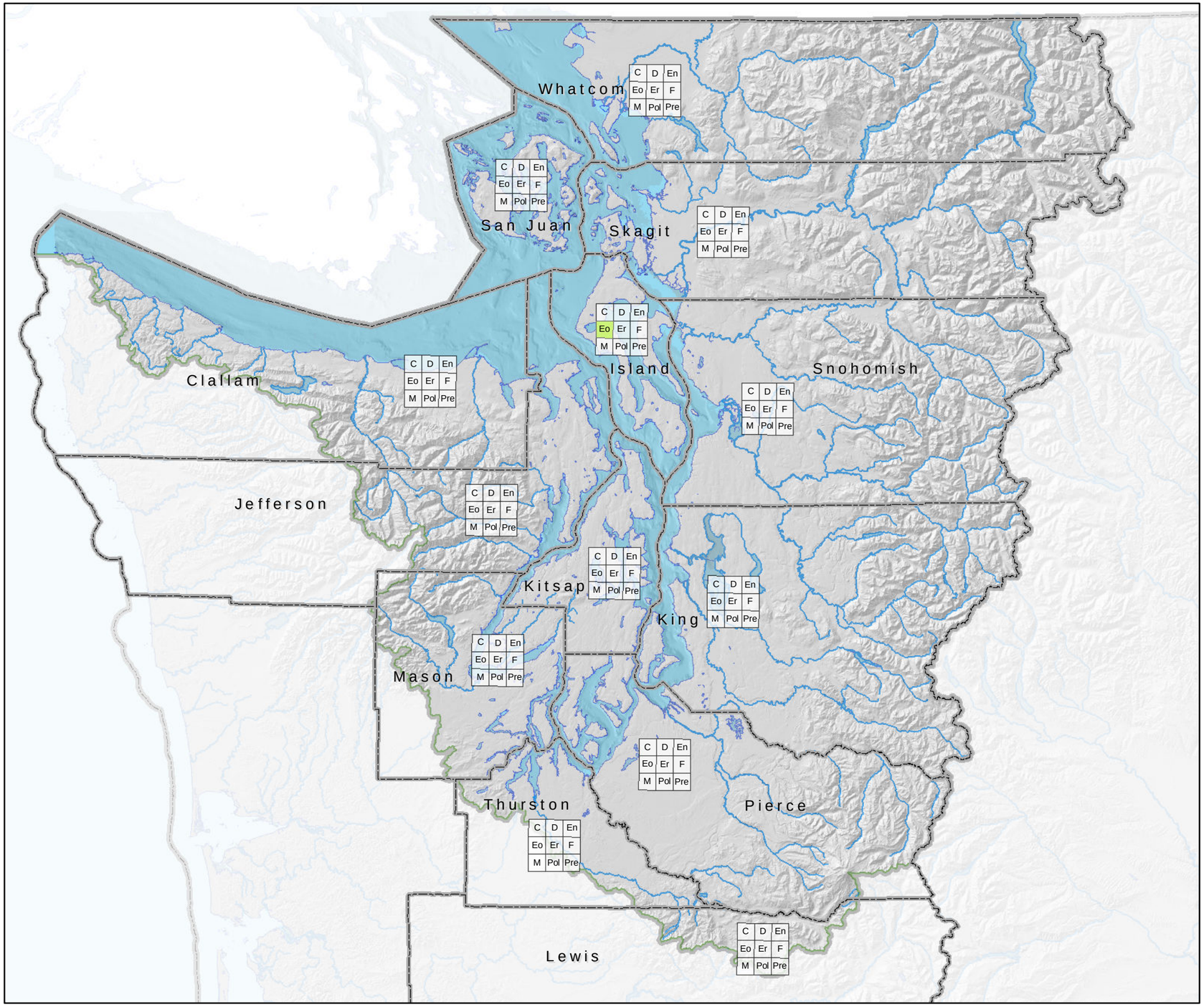
A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 11.2

February 2011

Tunicates

Didemnum vexillum, Styela clava, Ciona savignyi



Puget Sound Basin

Management at the County Level

- Control (C)
- Detection (D)
- Enforcement (En)
- Education / Outreach (Eo)
- Eradication (Er)
- Funding (F)
- Monitoring (M)
- Policy (Pol)
- Prevention (Pre)

Boundaries & Extents

- County Boundary
- Puget Sound Extent

JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

0 5 10 20 Miles

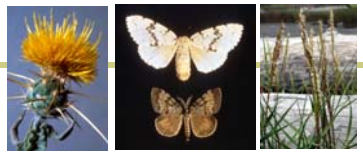
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species:
Management at the County Level

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 11.3

February 2011



12. Variable-leaf milfoil (*Myriophyllum heterophyllum*)

Variable-leaf milfoil is a submersed aquatic plant native to the eastern United States that has both underwater and emergent leaves with green or dark red to reddish brown stems. It is found in freshwater lakes, ponds, and slow moving rivers. Variable-leaf milfoil can crowd out native species, reduce habitat quality for fish and wildlife, and be a nuisance to swimmers and boaters.

Status and Trends

Species presence. Variable-leaf milfoil has been documented at five lakes in the Puget Sound Basin: Clear, Florence, and Josephine Lakes in Pierce County, and Blue and Clear Lakes in Thurston County. These populations were reported as native plants for many years. DNA analysis identified the plants in Blue Lake as the invasive *M. heterophyllum* in 2006; genetic analysis confirmed the invasive was present in the other four lakes in 2007. Data provided for the period 2006-2009 is included in Map 12.1.

Figure 14. Variable leaf milfoil. *Graves Lovell, Alabama Department of Conservation and Natural Resources, Bugwood.org.*

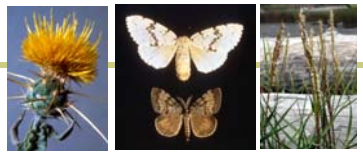
Presence over time. The species does not appear to be spreading to other areas of Puget Sound and has possibly been eradicated from Pierce County's Clear Lake as Ecology does not report species presence in this lake for 2008, 2009, or 2010. Following the confirmation of the invasive in these five lakes using genetic analysis, Ecology staff returned to other lakes where the native milfoil species had been observed and genetically analyzed those plants to confirm that they were not actually the invasive *M. heterophyllum*.

Files used in the analysis. The two GIS shapefiles provided to the project were both used in the spatial analysis. These covered the populations in the five lakes in Pierce and Thurston counties. See Table 26 for a summary of data provided to the project.

Files not used in the analysis. The UW Burke Herbarium data point was included in shapefiles.

Table 26. Variable-leaf milfoil data provided to the baseline assessment project. Data files included in the spatial analysis are indicated with an asterisk (*). For more detail on spatial data see Appendix A12.1.

File type provided (quantity)	Spatial extent	Data provider
Spatially explicit data		
GIS shapefiles (1)*	Clear Lake (Thurston County)	Thurston County NWCB*
Observations with location (1)*	Blue Lake (Thurston County)	UW Burke Herbarium*
Other data		
Management or survey reports (2)	Pierce and Thurston counties	Ecology



Pathways

In this section and the following Impacts and At-risk Resources section, the discussions reference species-specific basin-wide "Pathways and At-risk Resources" maps and the county-scale maps included as appendices. Included in these maps are all publicly available data layers representing those pathways and sensitive landscape features relevant to this species (e.g., boat ramps, roads, wetlands). See text box on page 33 for more detail.

Pathways of introduction. Variable-leaf milfoil was once sold in pet stores and nurseries; while its sale and transport is against the law in Washington, it may still be sold illegally over the internet or unintentionally included as a contaminant with other plants or aquarium material. It may be introduced to waterbodies by people dumping aquarium or aquatic garden materials. Fresh waterbodies with adjoining development or recreational use may face variable-leaf milfoil introductions.

Pathways of spread. Variable leaf milfoil may be spread between waterbodies by hitchhiking on recreational fishing and boating equipment. Infestations within flood zones may pose a heightened risk of transportation. All of the five lakes with variable-leaf milfoil in the Puget Sound Basin are adjacent to development, and three of the five lakes have public-access boat ramps, suggesting dumping of aquarium material and transport via watercraft are potential pathways of introduction and spread for this species.

Impacts and At-risk Resources

Ecological impacts. Dense monocultures can restrict water movement, trap sediment, and reduce dissolved oxygen. Variable-leaf milfoil crowds out native freshwater plants, reducing native plant diversity and forage for fish, and increases water temperatures by reducing water circulation. Map 12.2 shows sensitive aquatic habitats.

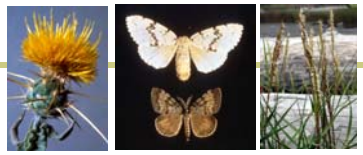
Human dimension impacts. Dense stands of variable-leaf milfoil impair recreational uses of waterbodies. The species can interfere with water supply reservoirs, dams, navigation, flood control, and surface water management. Map 12.2 shows species status data overlaid on infrastructure sensitive to variable-leaf milfoil infestation, including reservoirs, canals and ditches.

Management

Variable-leaf milfoil is managed in specific lakes by county-level agencies with funding and technical assistance from Ecology. For a summary of management activities, see Table 27.

State or Puget Sound-level activities. Ecology has lead responsibility for funding and assisting eradication efforts in affected lakes, state-wide. Ecology staff conduct monitoring to guide treatment in affected lakes. The Washington NWCB coordinates and supports the activities of county NWCBs in their management efforts for variable-leaf milfoil, and implements Chapter 17.10 RCW (the state noxious weed list), which includes variable-leaf milfoil.

County-level activities. Pierce and Thurston counties work together on prevention, detection, eradication, control, and monitoring efforts. Island, King, Kitsap, Lewis, Mason, Whatcom counties reported prevention, detection, and education/outreach activities. This includes all counties



bordering Pierce and Thurston counties. The remaining five counties did not report any activities for this species. For a geographic depiction of management activities, see Map 12.3.

Federal-level activities. The USGS maintains an aquatic invasive species database, with a function for the public or others to report sightings of species such as variable-leaf milfoil. The Olympic National Forest include this species on its invasives watch list.

Other activities. Washington Sea Grant presents aquatic invasive species topics to general audiences. The UW Burke Herbarium collects and shares information on variable-leaf milfoil, among other species.

Table 27. Commonly reported management program types and number of organizations targeting variable leaf milfoil.

	Three most commonly reported management program types (frequency)	Number of organizations with current management activities
County	Education/outreach (6), detection (5), prevention (4)	8 (present in 2)
State	Detection and funding (2), control, education/outreach, eradication, funding, monitoring, prevention, policy (1)	3
Federal	Detection, other: tracking distribution	2
Other	Detection, education/outreach (1)	1

Legal authorities. Variable-leaf milfoil is listed as a Class A Noxious Weed, meaning eradication is required (Chapter 17.10 RCW) and is on the state's list of quarantined species, meaning transport, purchase, sale, or distribution of the plant or plant parts is prohibited (WAC 16-752-505). These laws govern state- and county-level management.

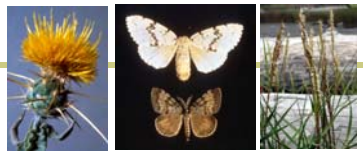
Funding. The Freshwater Aquatic Weeds Account (RCW 43.21A.650), was established in 1991 as a $3 increase in annual license fees for boat trailers. Use of funds from this account is typically limited to public-access lakes and to waterbodies designated by WDFW for fly-fishing. Pierce and Thurston County fund their control efforts with Aquatic Weeds grants, backed by program funding through property assessments. The other county NWCBs reporting management efforts are funded either by property assessments (two counties) or through the county's general fund (four counties). Ecology's efforts are also funded by the Freshwater Aquatic Weeds Account.

Summary of Gaps

This summarizes gaps specific to variable-leaf milfoil; some of the overarching gaps identified in Section IV are applicable as well.

Data collection and management. Although a very small number of data files were compiled for variable-leaf milfoil, this project assumes that this is an accurate reflection of the limited extent of known species presence in the Puget Sound Basin. No gaps in data collection or management were identified for this species.

Knowledge and understanding of species status, pathways, and impacts. There are likely gaps in regional understanding of the status and movement of variable-leaf milfoil in the Basin.



Considering that it took several years to identify and verify the presence of this species in Pierce and Thurston County lakes, it is possible that variable-leaf milfoil is present and undetected in lakes with private shoreline ownership and no public access. The potential extent of impacts to local resources is fairly well understood, but specific pathways of entry and spread have not been documented in the region.

Management efforts. The study identified possible gaps in management of this species at the county level. Not all counties reported detection efforts for variable-leaf milfoil; however, not all counties responded to the online survey.

Variable Leaf Milfoil

Myriophyllum heterophyllum

Puget Sound Basin

Species Detection (2006 - 2009)

Observed*

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program.

Land Cover & Land Use

- Developed
- Cultivated Lands
- Grassland
- Deciduous Forest
- Coniferous & Mixed Forest
- Scrub / Shrub
- Freshwater Wetland
- Estuarine Wetland
- Beaches, Bars & Flats
- Rock & Snow
- Water

Boundaries & Extents

- County Boundary
- Puget Sound Extent

JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

0 5 10 20 Miles

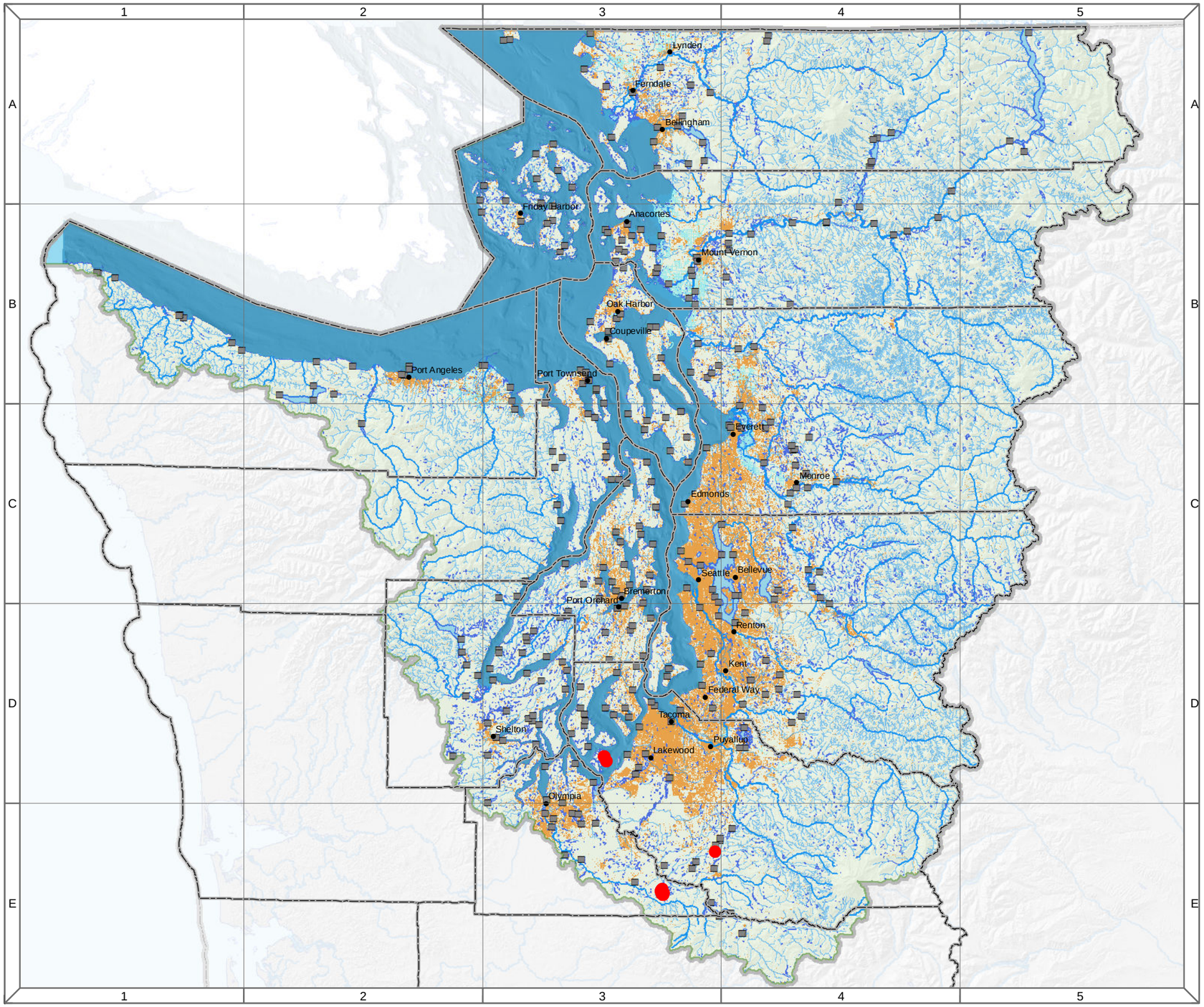
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species: Documented Presence in Puget Sound Basin

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 12.1

February 2011



Variable Leaf Milfoil

Myriophyllum heterophyllum

Puget Sound Basin

Species Detection (2006 - 2009)

Observed*

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. See Appendix for county scale maps.

Boundaries & Extents

- County Boundary
- Puget Sound Extent

Pathways & Sensitive Landscape Features

- Boat Ramps
- River / Stream
- Canal / Ditch
- Lake / Pond
- Reservoir
- Swamp / Marsh
- Sea / Ocean

Land Cover & Land Use

- Developed

JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

0 5 10 20 Miles

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species:
Species Locations, Potential Pathways, Sensitive Landscape Features

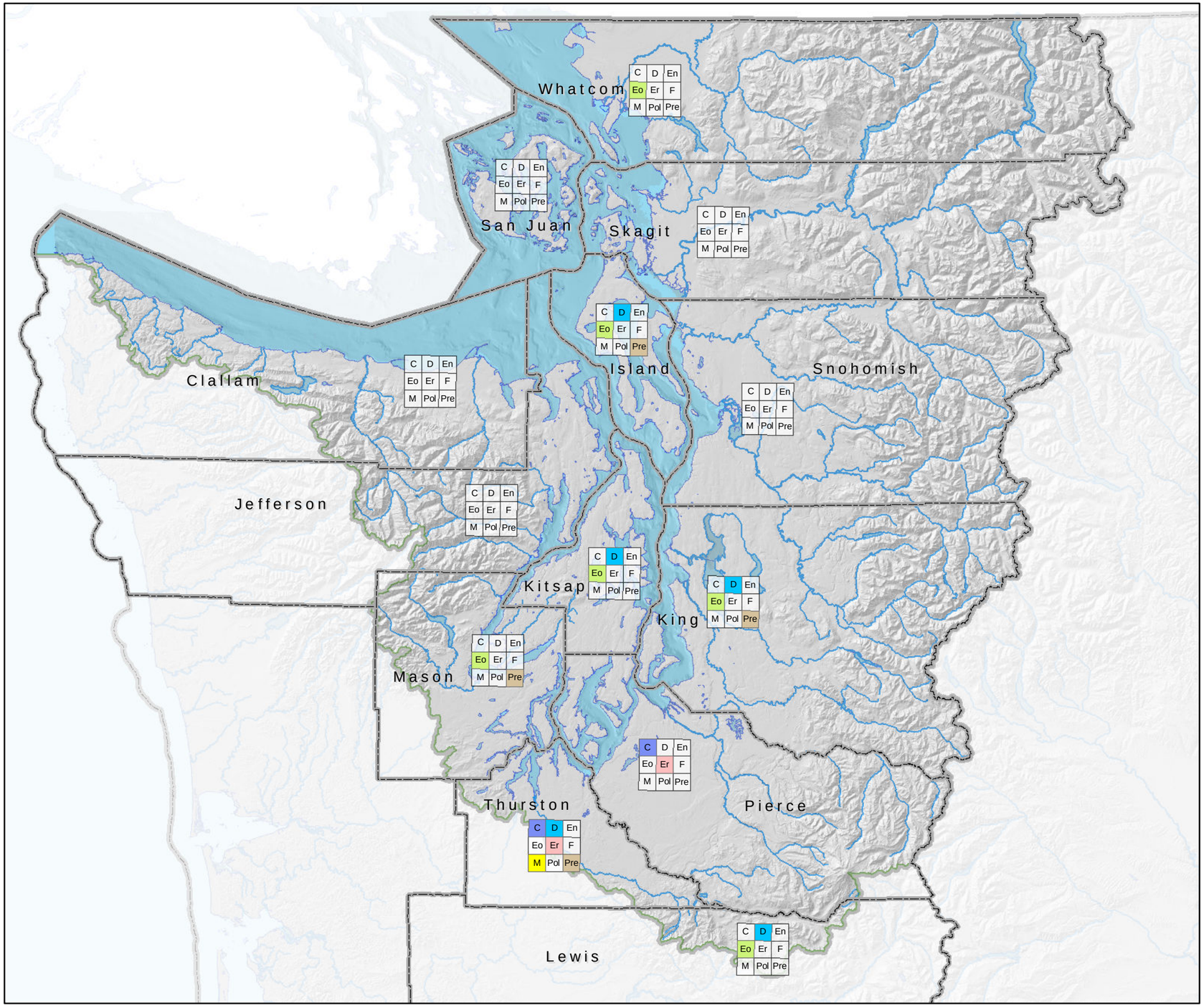
A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 12.2

February 2011

Variable Leaf Milfoil

Myriophyllum heterophyllum



Puget Sound Basin

Management at the County Level

- Control (C)
- Detection (D)
- Enforcement (En)
- Education / Outreach (Eo)
- Eradication (Er)
- Funding (F)
- Monitoring (M)
- Policy (Pol)
- Prevention (Pre)

Boundaries & Extents

- County Boundary
- Puget Sound Extent

JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

0 5 10 20 Miles

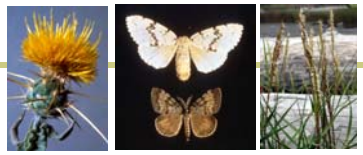
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species:
Management at the County Level

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 12.3

February 2011



13. VHS (Viral Hemorrhagic Septicemia virus), Types IVa and IVB

Viral Hemorrhagic Septicemia (VHS) is a virus that attacks and weakens the blood vessels of fish and can ultimately cause death. Type IVa is typically found in marine waters and Type IVb has thus far been documented only in fresh waters.

Status and Trends

Species presence. VHS Type IVa was first detected in the Puget Sound Basin in 1988. It has been documented at hatcheries in the Nooksack, Snohomish, and Kitsap watersheds and is likely derived from marine environments. VHS Type IVb has been documented in the Great Lakes and has only been found in freshwater. It has not been detected in Puget Sound. Data provided by NWIFC cover the period 1988-2006 and show five points of detection for VHS type IVa located at Puget Sound hatcheries in Whatcom, King, and Pierce counties (Map 13.1).

Figure15. VHS. Jim Winton, U.S. Geological Survey.

Presence over time. Data provided to the project document VHS type IVa detections in Whatcom County at a single hatchery in 1988-1989, at a different Whatcom hatchery in 1998, in Pierce County at a single hatchery in 2002, and most recently two detections in 2005-2006 at hatcheries in King and Whatcom counties. The data provided to the project team do not suggest that the virus is spreading in the Basin, although it has been present in the area for over twenty years.

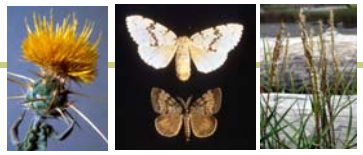
Files used in the analysis. The Northwest Indian Fisheries Commission (NWIFC) provided a report from their fish health database with all VHS type IVa detections since 1989 from the three agencies which sample fish for this pathogen at their respective hatcheries: NWIFC, WDFW, and USFWS. The first two VHS type IVa detections were in 1988 and are not included in this database. See Table 28.

Table 28. VHS data provided to the baseline assessment project. Data files included in the spatial summaries are noted with an asterisk (*). For more on spatial data see Appendix A13.1

File type provided (quantity)	Spatial extent	Data provider
Spatially explicit data		
Dataset with locations (1)*	Puget Sound Basin	NWIFC*

Pathways

In this section and the following Impacts and At-risk Resources section, the discussions reference species-specific basin-wide “Pathways and At-risk Resources” maps and the county-scale maps included as appendices. Included in these maps are all publicly available data layers representing



those pathways and sensitive landscape features relevant to this species (e.g., boat ramps, roads, wetlands). See text box on page 27 for more detail.

Pathways of introduction. Type IVa appears to be endemic to the Pacific Northwest; Type IVb could be introduced from the Great Lakes via live or frozen bait and recreational or commercial watercraft, as well as by transport of herring eggs to reestablish populations.

*Pathways of spread***.** These viruses could be spread by fish migration, live or frozen bait, recreational or commercial watercraft, and transport of herring eggs to reestablish populations.

Impacts and At-risk Resources

Ecological impacts. VHS weakens the blood vessels of fish, eventually causing death. The virus can affect many native finfish and related food webs. Map 13.2 overlays hatcheries on the Basin's extensive, often fish bearing, riparian network. Hatcheries are present in most Puget Sound counties, except for Lewis and Island counties, and represent a direct link between any virus-bearing hatchery fish, native fish populations, and associated food webs.

Human dimension impacts. VHS could have significant negative impacts to fisheries, affecting a significant industry, food source, and cultural asset in the Puget Sound Basin.

Management

Management activities are summarized in Table 29.

State or Puget Sound-level activities. The Fish Health Program at WDFW leads the state's detection efforts for VHS. Staff screen salmon at state hatcheries for regulated viral pathogens including VHS. WDFW is also authorized to ensure that private aquaculturists test for diseases. These efforts are coordinated with those of the USFWS and NWIFC. In addition, WDFW's recreational watercraft management plan identifies monitoring for the virus as part of the efforts against zebra and quagga mussels.

County-level activities. No county-level management activities were reported.

Federal-level activities. USFWS leads detection efforts at federal fish hatcheries in Puget Sound, screening salmon for pathogens of national concern. These efforts began in the late 1990s, in response to evidence of the impacts of Salmonid Whirling Disease to wild trout populations. These efforts are coordinated with those of WDFW and NWIFC. In addition, scientists at the National Oceanic and Atmospheric Administration (NOAA) conduct research on the impacts of VHS virus.

Other activities. The Northwest Indian Fisheries Commission screens salmon at tribal hatcheries for regulated viral pathogens including VHS, and compile data from other agencies which test for this virus. NWIFC provides education and disease response services.

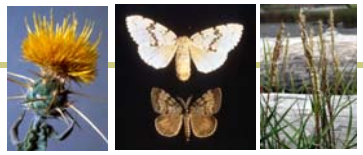


Table 29. Commonly reported management program types and number of organizations targeting VHS viruses.

	Three most commonly reported management program types (frequency)	Number of organizations with current management activities
County	None	0
State	Detection (1)	1
Federal	Detection (1), research (1)	2
Other	Detection (1)	1

Legal authorities. The Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State, RCW 77.12.455, is designed to limit the spread of fish pathogens within and between watersheds. NWIFC and WDFW have lead authority for monitoring for the virus at hatcheries and implementing controls to prevent the virus from spreading.

A U.S. Federal Order aims to prevent the spread of VHS into aquaculture facilities by restricting the interstate movement and importation of live fish of VHS-susceptible species. Canadian agencies have also placed restrictions on the movement of fish or fish products that could represent a risk for spreading the virus to regions outside of the currently-known geographic range.

Funding. USFWS screening efforts are funded through the National Wild Fish Health Survey, monies requested by USFWS in response to impacts of Salmonid Whirling Disease, which began fiscal year 1997. Funding sources for the NWIFC and WDFW were not identified but are likely part of the larger fish health program.

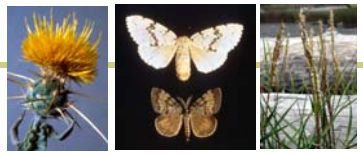
Summary of Gaps

This summarizes gaps specific to VHS; some of the overarching gaps identified in Section IV are applicable as well.

Data collection and management. This study identified no gaps in data collection and management for VHS type IVa, as monitoring for type IVa is ongoing and well-coordinated across the Basin. No data collection efforts were reported for type IVb, which does not appear to have been detected in this region.

Knowledge and understanding of species status, pathways, and impacts. There are gaps in regional understanding of the potential impacts and pathways of movement of VHS in the Basin. However, extensive research is ongoing to characterize and better understand the distribution and impacts of the type IVa virus. There appears to be little research into Type IVb in this region.

Management efforts. There are gaps in management efforts associated with type IVb, as efforts to prevent the spread of type IVb from the Great Lakes appear to be limited. Reported management efforts focus on monitoring for type IVa.



VHS

Viral Hemorrhagic Septicemia Virus, types IVa and IVb

Puget Sound Basin

Species Detection (1989 - 2006)

Observed*

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program.

Land Cover & Land Use

- Developed
- Cultivated Lands
- Grassland
- Deciduous Forest
- Coniferous & Mixed Forest
- Scrub / Shrub
- Freshwater Wetland
- Estuarine Wetland
- Beaches, Bars & Flats
- Rock & Snow
- Water

Boundaries & Extents

- County Boundary
- Puget Sound Extent

JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

Miles
0 5 10 20

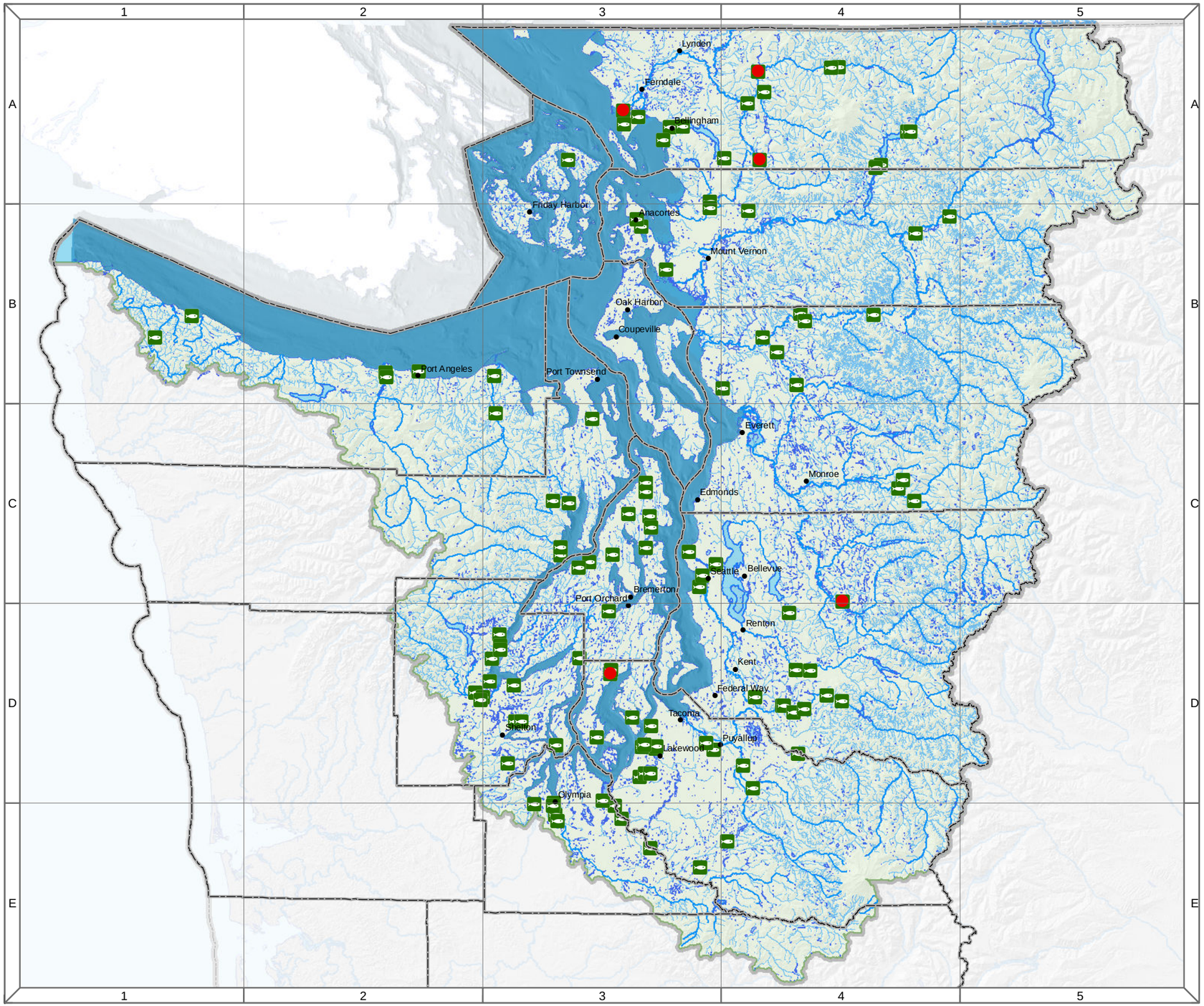
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species: Documented Presence in Puget Sound Basin

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 13.1

February 2011



VHS

Viral Hemorrhagic Septicemia Virus, types IVa and IVb

Puget Sound Basin

Species Detection (1989 - 2006)

Observed*

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. See Appendix for county scale maps.

Boundaries & Extents

County Boundary

Puget Sound Extent

Pathways & Sensitive Landscape Features

Fish Hatchery

River / Stream

Lake / Pond

Reservoir

Swamp / Marsh

Sea / Ocean

JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

Miles
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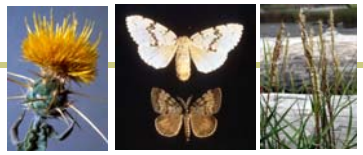
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species: Species Locations, Potential Pathways, Sensitive Landscape Features

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 13.2

February 2011



14. Wood-boring insects (Cerambycidae, Buprestidae, Scolytidae, Siricidae families)

This category includes a large number of non-native insects which are considered serious threats to Washington's forests and fruit trees.

Status and Trends

Species presence. Insects in this group have been detected in the Puget Sound Basin, but no exotic populations appear to have become established. The citrus long-horned beetle *Anoplophora chinensis* (family Cerambycidae) was detected in a Washington nursery in 2001 and was subsequently eradicated. The bark beetle *Xyleborinus alni* (family Scolytidae) was documented in the late 1990s in and around the Olympia-Tacoma area. Sites surveyed by WSDA in 2009 are included in Map 14.1.

Figure 16. Asian long-horned beetle. *Dennis Haugen, USDA Forest Service, Bugwood.org.*

Files used in the analysis. We used two shapefiles provided by WSDA, from the 2009 Emerald Ash Borer survey and a broader exotic wood-boring insect survey in 2009. A summary of data provided may be found in Table 30.

Files not used in the analysis. WSDA provided one shapefile from its Exotic Pine Pest Survey in 2009, which was focused on Eastern Washington and thus outside of the scope of this project.

Table 30. Wood-boring beetle data provided to the baseline assessment project. Data files included in the spatial summaries are indicated with an asterisk (*). For more detail on spatial data see Appendix A14.1.

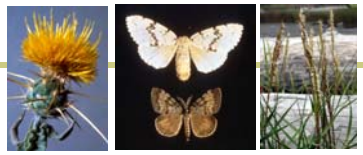
File type provided (quantity)	Spatial extent	Data provider
Spatially explicit data		
GIS shapefiles (3)*	Washington	WSDA*

Pathways

In this section and the following Impacts and At-risk Resources section, the discussions reference species-specific basin-wide "Pathways and At-risk Resources" maps and the county-scale maps included as appendices. Included in these maps are all publicly available data layers representing those pathways and sensitive landscape features relevant to this species (e.g., boat ramps, roads, wetlands). See text box on page 27 for more detail.

Pathways of introduction. These insects can be transported into the Puget Sound Basin on or in wood products and wood packaging (includes woody plants, dunnage, logs, chips, and waste woods used to package materials in freight) that have not been adequately preserved or sanitized and that are shipped from host countries.

Pathways of spread. Once in the Puget Sound Basin, these insects can spread on their own through the Basin's lowland forests. They could also be transported over long distances by movement of



the products described above from transfer stations (break bulk facilities) to other areas in the Basin. A transport vector of increasing concern is firewood cut from infested trees and subsequently sold and distributed.

Impacts and At-risk Resources

Ecological impacts. Wood-boring insects can kill trees and woody plants of many genera over wide areas. Management typically requires killing the host plants.

Human dimension impacts. Successful establishment of wood-boring insects would likely lead to quarantines being imposed on products shipped from the infested areas, with a significant impact to the state economy including forestry, agriculture, and wholesale nursery sectors.

Management

WSDA has primary authority and responsibility for detection, delimitation, and eradication of these invasives. For a summary of management activities, please see Table 31.

State or Puget Sound-level activities. WSDA conducts trapping and visual surveys for wood-boring insects, including a survey focused on wood-boring beetles, a survey targeting high-risk sites (e.g., break-bulk freight facilities), and a survey based on forest types and pathways. They conduct associated education activities, and have received some false positive reports. WDNR conducts an annual state forest aerial survey which could identify new wood-boring beetles, and provide education and technical assistance forest landowners on invasive species.

County-level activities. No county-level programs were reported.

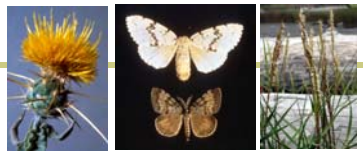
Federal-level activities. USDA-APHIS and WSDA worked together closely to eradicate the citrus long-horned beetles detected in Tukwila. USDA provides funding, guidance, and identification capabilities to WSDA's survey efforts.

Other activities. None reported.

Table 31. Commonly reported management program types and number of organizations targeting wood-boring beetles.

	Three most commonly reported management program types (frequency)	Number of organizations with current management activities
County	none	0
State	Detection (2), education/outreach (2), policy and monitoring (1)	2
Federal	None	0
Other	None	0

Legal authorities. Federal quarantine authority under 7 CFR 301 could be applied if these insects established in Washington. Such a quarantine would restrict interstate movement of regulated articles from quarantined areas. The state could also use its agricultural quarantine authority (RCW 17.24.041).



Funding. USDA Plant Protection and Quarantine program funds WSDA's survey efforts.

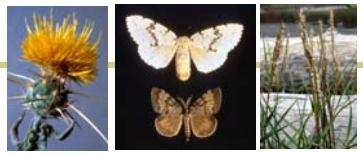
Summary of Gaps

This summarizes gaps specific to wood-boring insects; some of the overarching gaps identified in Section IV are applicable as well.

Data collection and management. No specific gaps in WSDA's surveys for wood-boring insects were identified; however, it is likely challenging for the agency to adequately survey all likely introduction sites and surrounding areas for this diverse group of species.

Knowledge and understanding of species status, pathways, and impacts. A possible gap in understanding of species status in the Basin was identified. Established presence is not currently indicated for the Basin. At this time, it is not known whether that accurately reflects lack of establishment, or is due to lack of data or to existing data not being shared with the project. Potential pathways of spread and the potential extent of impacts to local resources are fairly well understood due to extensive efforts to control these species in other regions of the world.

Management efforts. Although gaps in programs targeting these species were not identified, addressing the pathways by which wood-boring beetles, and other wood-boring insects, may be introduced to the Puget Sound Basin is a significant challenge. Given the large quantities of wood products and packaging being imported into the Basin which may host these insects, as well as the sheer number and diversity of species of concern, it will likely be difficult to effectively target all potential pathways of entry and spread.



Wood - Boring Beetles

Cerambycidae, Buprestidae,
Scolytidae, Siricidae families

Puget Sound Basin

Species Detection (2009)

- Observed*
- Surveyed But Not Found*

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program.

Land Cover & Land Use

- Developed
- Cultivated Lands
- Grassland
- Deciduous Forest
- Coniferous & Mixed Forest
- Scrub / Shrub
- Freshwater Wetland
- Estuarine Wetland
- Beaches, Bars & Flats
- Rock & Snow
- Water

Boundaries & Extents

- County Boundary
- Puget Sound Extent

JONES JONES ARCHITECTS LANDSCAPE ARCHITECTS PLANNERS

CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

0 5 10 20 Miles

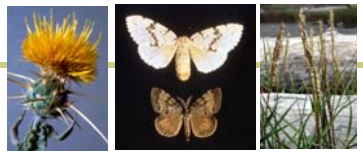
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species: Documented Presence in Puget Sound Basin

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 14.1

February 2011



15. Zebra and quagga mussels (*Dreissena polymorpha*, *D. rostriformis bugensis*)

Zebra and quagga mussels are tiny freshwater mollusks. They colonize lakes and rivers and are typically found in calmer waters, such as those upstream of dams, and on surfaces. They can dramatically affect food webs and human infrastructure, having tremendous impacts on the waterbodies which they colonize.

Figure 17. Quagga mussel. *Amy Benson, U.S. Geological Survey, Bugwood.org.*

Status and Trends

Species presence. Neither zebra nor quagga mussels have yet been detected in the Puget Sound Basin. These mussels are found in lakes and reservoirs in the Great Lakes area and Lake Mead, Nevada. Sites surveyed by WDFW in 2001-2009 are included in Map 15.1.

Files used in the analysis. We converted a dataset with mussel survey locations, provided by WDFW, to a shapefile. See Table 32 for a summary of data provided to the project.

Table 32. Zebra and quagga mussel data provided to the baseline assessment project. Data files included in the spatial summaries are indicated with an asterisk (*). For more detail on spatial data see Appendix A15.1.

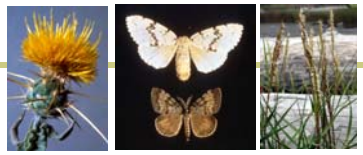
File type provided (quantity)	Spatial extent	Data provider
Spatially explicit data		
Dataset with locations (1*)	Puget Sound Basin	WDFW*

Pathways

In this section and the following Impacts and At-risk Resources section, the discussions reference species-specific basin-wide "Pathways and At-risk Resources" maps and the county-scale maps included as appendices. Included in these maps are all publicly available data layers representing those pathways and sensitive landscape features relevant to this species (e.g., boat ramps, roads, wetlands). See text box on page 27 for more detail.

Pathways of introduction. These mussels were introduced to the Great Lakes via ballast water. Such an introduction may be possible in Columbia River harbors, with their proximity to fresh water, with subsequent transport to the Puget Sound via recreational craft. The Ballard Locks may be a viable entry port; no other viable entry points were identified in the Puget Sound.

Pathways of spread. Zebra and quagga mussels are easily transported on boats, trailers, and other recreational watercraft. Any fresh waterbody with recreational use may face mussel introductions. Lakes may be more or less susceptible to successful invasions based on their dissolved calcium levels, as these mussels need certain levels of calcium at multiple stages in their life history.



Impacts and At-risk Resources

Ecological impacts. Zebra and quagga mussels can cause significant ecological damage, impacting native mollusks and zooplankton and thereby affecting natural food webs. They can cover fish ladders, harming salmon, and can cut fish internally if ingested. They can enhance the growth of toxic cyanobacteria.

Human dimension impacts. These mussels can clog piping and mechanical systems of industrial plants, utilities, locks, and dams. They can weigh down docks, buoys, or houseboats. Shells on beaches can cut people's feet. Mass die-offs in water-supply bodies can affect the taste of drinking water. Concerns about transporting mussels or eventual quarantines can affect trade and tourism.

Management

Management activities are summarized in Table 33.

State or Puget Sound-level activities. WDFW has lead authority for prevention, detection, education/outreach, policy, and enforcement efforts to prevent mussel introductions. WDFW enforcement staff check boats carried on trailers at designated locations across the state, ordering decontamination of the boat if it is found to carry invasive mussels. WDFW coordinates the Washington State Ballast Water Program, which focuses on the transport of species such as zebra and quagga mussels, and participates in regional coordination efforts such as the 100th Meridian Initiative and the Pacific Ballast Water Group. Ecology Aquatic Weeds Program staff collect samples at area lakes for WDFW, to assist with detection efforts.

County-level activities. No counties reported management efforts.

Federal-level activities. USFWS leads federal efforts to prevent and detect the spread of these mussels, to conduct outreach and education, and to fund local programs. USFWS and NOAA co-chair the nationwide Aquatic Nuisance Species Task Force, which has zebra and quagga mussel control as a priority. The USGS maintains an aquatic invasive species database, with an online function for the public to report species such as zebra or quagga mussels.

Other activities. The Pacific Ballast Water Group coordinates information-sharing and formulation of consensus solutions on ballast water management and research issues of common concern to regulators, managers, scientists and the shipping industry on the West Coast. The 100th Meridian Initiative works to prevent the spread of zebra mussels and other aquatic nuisance species in jurisdictions West of the 100th Meridian, and to monitor and control any populations. Washington Sea Grant and Metro Parks Tacoma conduct outreach on general aquatic invasive species topics. The NWIFC assists member tribes in invasive species management.

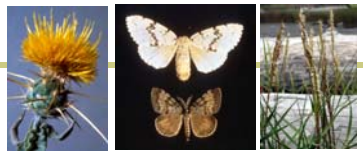


Table 33. Commonly reported management program types and number of organizations targeted zebra and quagga mussels.

	Three most commonly reported management program types (frequency)	Number of organizations with current management activities
County	none	0 (present in 0)
State	Detection (3), education/outreach (2), enforcement (1), prevention (2), policy (1)	2
Federal	Detection, education/outreach, funding, other: tracking distribution, prevention	2
Other	Control (2), detection (2), education/outreach (4), eradication (2), monitoring (2), prevention (2), policy (2)	4

Legal authorities. Zebra and quagga mussels are classified as Prohibited Aquatic Animal Species under RCW 77.12.020 and WAC 220-12-090, meaning they may not be possessed, purchased, sold, propagated, transported, or released into state waters. WDFW has lead authority under this regulation.

Funding. The WDFW Aquatic Nuisance Species program is funded by the EPA and dedicated state funding through ESSB 5699. The Washington Ballast Water Program is funded by USFWS, Ecology, and the Pacific States Marine Fisheries Commission. Ecology's survey efforts are funded through the Freshwater Aquatic Weeds Account.

Summary of Gaps

This summarizes gaps specific to zebra and quagga mussels; some of the overarching gaps identified in Section IV are applicable as well.

Data collection and management. No gaps were identified in current data collection and management efforts.

Knowledge and understanding of species status, pathways, and impacts. No gaps in understanding of invasive mussels in the Basin were identified. Significant resources have been devoted to assessing these mussels' pathways and impacts. Our understanding that these mussels are not yet present in the Puget Sound Basin is most likely accurate, based on fairly extensive ongoing survey efforts. Potential pathways of spread and the potential extent of impacts to local resources are well understood from work in other regions of the country.

Management efforts. The study identified a potential gap in management of invasive mussels in the Basin. Inspectors continually find boats entering the state which are carrying these mussels. Adequate enforcement capacity is critical, but appears to be effectively addressed with current programs.

Zebra, Quagga Mussels

Dreissena polymorpha, D. rostriformis bugensis

Puget Sound Basin

Species Detection (2001 - 2009)

- Observed*
- Surveyed But Not Found*

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program.

Land Cover & Land Use

- Developed
- Cultivated Lands
- Grassland
- Deciduous Forest
- Coniferous & Mixed Forest
- Scrub / Shrub
- Freshwater Wetland
- Estuarine Wetland
- Beaches, Bars & Flats
- Rock & Snow
- Water

Boundaries & Extents

- County Boundary
- Puget Sound Extent

Whatcom
San Juan
Skagit
Island
Snohomish
Clallam
Jefferson
Kitsap
King
Mason
Pierce
Thurston
Lewis

Lynden
Ferndale
Bellingham
Friday Harbor
Anacortes
Mount Vernon
Oak Harbor
Coupeville
Port Angeles
Port Townsend
Everett
Monroe
Edmonds
Seattle
Bellevue
Bremerton
Port Orchard
Renton
Kent
Federal Way
Tacoma
Shelton
Puyallup
Lakewood
Olympia

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CASCADIA CONSULTING GROUP

Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

0 5 10 20 Miles

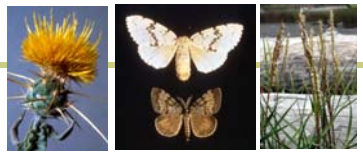
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Invasive Species: Documented Presence in Puget Sound Basin

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

MAP 15.1

February 2011



VI. Appendices

Appendices included with report

A0.1	References and Background Research
A0.2	Organizations Contacted for Baseline Assessment Project
A0.3	Expanded Methods
A0.4	Base Data Layers and Data Sources used for Baseline Assessment Spatial Summaries and Management Mapping
A0.	Baseline Assessment of Invasive Species: Detection by County

For all 15 priority invasive species (# = species number, see below):

A#.1	Data Files and Data Sources Included in Baseline Assessment Spatial Summaries

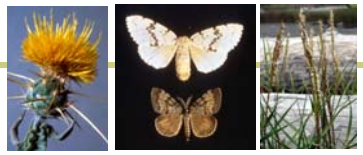
Additional maps included in full Appendix (# = species number, see below)

For all 15 priority invasive species:

A#.2	Documented Presence in Puget Sound Basin
A#.3	Species Locations, Potential Pathways, Sensitive Landscape Features (Puget Sound Basin)
A#.4	Baseline Assessment of Invasive Species – Management at the County Level

For species with documented presence in given county:

A#.10	Clallam County – Species Locations, Potential Pathways, Sensitive Landscape Features
A#.11	Island County – Species Locations, Potential Pathways, Sensitive Landscape Features
A#.12	Jefferson County – Species Locations, Potential Pathways, Sensitive Landscape Features
A#.13	King County – Species Locations, Potential Pathways, Sensitive Landscape Features
A#.14	Kitsap County – Species Locations, Potential Pathways, Sensitive Landscape Features
A#.15	Lewis County – Species Locations, Potential Pathways, Sensitive Landscape Features
A#.16	Mason County – Species Locations, Potential Pathways, Sensitive Landscape Features
A#.17	Pierce County – Species Locations, Potential Pathways, Sensitive Landscape Features
A#.18	San Juan County – Species Locations, Potential Pathways, Sensitive Landscape Features
A#.19a/b	Skagit County – Species Locations, Potential Pathways, Sensitive Landscape Features
A#.20	Snohomish County – Species Locations, Potential Pathways, Sensitive Landscape Features
A#.21	Thurston County – Species Locations, Potential Pathways, Sensitive Landscape Features
A#.22a/b	Whatcom County – Species Locations, Potential Pathways, Sensitive Landscape Features



Priority Species

(In some cases, data were not available for priority species and no maps were created)

1) Brazilian elodea (*Egeria densa)*
2) Caulerpa (*Caulerpa taxifolia*) - no data available
3) Common reed (*Phragmites australis*)
4) Feral swine (*Sus scrofa*)
5) Hydrilla (*Hydrilla verticillata*)
6) Knapweeds (*Centaurea* species)
7) Kudzu (*Pueraria montana* var. *lobata*) – no data available
8) Lymantriid moths (initially focused on Asian, European gypsy moths)
9) Nutria (*Myocastor coypus*)
10) Spartina (*Spartina alterniflora*, *S. anglica*, *S. patens*, *S. denisflora*)
11) Tunicates (*Didemnum vexillum*, *Styela clava*, *Ciona savignyi*)
12) Variable-leaf milfoil (*Myriophyllum heterophyllum*)
13) VHS (Viral Hemorrhagic Septicemia Virus), Type IVa (Type IVb was later added)
14) Wood-boring beetles (Cerambycidae, Buprestidae, Scolytidae, Siricidae families)
15) Zebra, quagga mussels (*Dreissena polymorpha*, *D. rostriformis bugensis*)

A0.1 References and Background Research*

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A0.2 Organizations Contacted for the Baseline Assessment Project

Organization	Type of Organization	Contacted** (Y/N)	Surveyed*** (Y/N
Project Participation Status*: Yes			
Bellingham Parks & Recreation Department	City	Y	Y
Carnegie Mellon University	Research	Y	N
Conservation District, Clallam County	County	Y	Y
Conservation District, Jefferson County	County	N	Y
EarthCorps	NGO	Y	Y
Herrera Environmental Consultants	Private	Y	N
King County Department of Natural Resources & Parks	County	Y	Y
King County Lakes Stewardship	County	Y	N
Kitsap County	County	Y	Y
Metro Parks Tacoma	City	Y	Y
Mountains to Sound Greenway	NGO	Y	Y
Nahkeeta Northwest	NGO	Y	Y
National Forest, Mt. Baker-Snoqualmie	Federal	Y	N
National Park, Mount Rainier	Federal	Y	N
National Park, North Cascades	Federal	Y	N
National Park, Olympic	Federal	Y	N
NOAA Fisheries	Federal	Y	N
Northwest Indian Fisheries Commission	Tribe	Y	Y
Noxious Weed Control Board, Clallam County	County	Y	Y
Noxious Weed Control Board, Island County	County	Y	Y
Noxious Weed Control Board, Jefferson County	County	Y	Y
Noxious Weed Control Board, King County	County	Y	Y
Noxious Weed Control Board, Kitsap County	County	Y	Y
Noxious Weed Control Board, Lewis County	County	Y	Y
Noxious Weed Control Board, Mason County	County	Y	Y

* "Project Participation Status" = information and/or data were included in summaries, analyses, or activities referenced in report
** "Contacted" = responded to survey or contacted through follow-up outreach
*** "Surveyed" = included in original online survey (Fall 2010)

Organization	Type of Organization	Contacted** (Y/N)	Surveyed*** (Y/N
Project Participation Status*: Yes			
Noxious Weed Control Board, Pierce County	County	Y	Y
Noxious Weed Control Board, San Juan County	County	Y	Y
Noxious Weed Control Board, Skagit County	County	Y	Y
Noxious Weed Control Board, Snohomish County	County	Y	Y
Noxious Weed Control Board, Thurston County	County	Y	Y
Noxious Weed Control Board, Washington State	State	N	Y
Noxious Weed Control Board, Whatcom County	County	Y	Y
Oregon State University	Research	Y	N
People for Puget Sound	NGO	Y	Y
Portland State University	Research	Y	N
Puget Sound Partnership	State	N	Y
Reef Environmental Education Foundation	NGO	Y	N
San Juan County Public Works	County	Y	N
Seattle Urban Nature Project (now EarthCorps)	NGO	Y	N
Skagit County Public Works	County	Y	N
Skokomish Tribe	Tribe	Y	Y
Snohomish County Surface Water Management	County	N	N
Stillaguamish Tribe	Tribe	Y	Y
Swinomish Tribe	Tribe	Y	N
Tulane University	Research	Y	N
University of Washington	Research	Y	Y
University of Washington - Friday Harbor Labs	Research	Y	Y
University of Washington Herbarium, Burke Museum	Research	Y	N
US Department of Agriculture	Federal	Y	N
US Fish & Wildlife Service	Federal	Y	Y
US Forest Service - Mount Baker-Snoqualmie National Forest	Federal	Y	Y

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** "Contacted" = responded to survey or contacted through follow-up outreach
*** "Surveyed" = included in original online survey (Fall 2010)

Organization	Type of Organization	Contacted** (Y/N)	Surveyed*** (Y/N
Project Participation Status*: Yes			
US Forest Service - Olympic National Forest	Federal	Y	N
US Geological Survey	Federal	Y	Y
Vashon/Maury Island Land Trust	NGO	Y	Y
WA Department of Agriculture	State	Y	Y
WA Department of Ecology	State	Y	Y
WA Department of Fish & Wildlife	State	Y	Y
WA Department of Natural Resources	State	Y	Y
WA Department of Transportation	State	Y	Y
WA State Parks & Recreation Commission	State	Y	Y
Washington Sea Grant	State	Y	Y
Washington State University	Research	N	Y
Washington State University Extension	State	N	Y
WSU King County Extension	Research	N	Y
Project Participation Status*: No			
Association of Washington Cities	Regional	N	Y
Audubon Society Seattle	NGO	N	Y
Backyard Wildlife Habitat	Federal	Y	Y
Bainbridge Island Land Trust	NGO	N	Y
Bellevue Stream Team	City	N	Y
Capitol Land Trust	NGO	Y	Y
Cascade Land Conservancy	NGO	N	Y
Chehalis River Basin Land Trust	NGO	N	Y
Citizens for a Healthy Bay	NGO	N	Y
City of Black Diamond	City	N	Y
City of Sammamish	City	N	Y
Clark County	County	N	Y

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** "Contacted" = responded to survey or contacted through follow-up outreach
*** "Surveyed" = included in original online survey (Fall 2010)

Organization	Type of Organization	Contacted** (Y/N)	Surveyed*** (Y/N
Project Participation Status*: No			
Clark County Parks Department	County	N	Y
Columbia Land Trust	NGO	N	Y
Conservation Commission	State	N	Y
Conservation District, Clark County	County	N	Y
Conservation District, King County	County	Y	Y
Conservation District, Pierce County	County	Y	Y
Conservation District, San Juan County	County	N	Y
Conservation District, Thurston County	County	N	Y
Conservation District, Whidbey Island	County	N	Y
Conservation Distrtict, Mason County	County	N	Y
Conservation Northwest	NGO	N	Y
Dungeness River Audubon Center	NGO	N	Y
Friends of Gray's Harbor	NGO	N	Y
Friends of Hylebos Wetlands	NGO	Y	Y
Friends of Lower White River	NGO	Y	Y
Friends of the Cedar River Watershed	NGO	Y	Y
Friends of the Deschutes	NGO	N	Y
Friends of the San Juans	NGO	N	Y
Great Peninsula Conservancy	NGO	Y	Y
Harbor Wildlife	Regional	N	Y
Hood Canal Coordinating Council	Regional	N	Y
Hood Canal Salmon Enhancement Group	Regional	N	Y
Island County Shore Stewards	County	N	Y
Issaquah Alps Trail Club	NGO	N	Y
Jamestown S'Klallam Tribe	Tribe	N	Y
Jefferson Land Trust	NGO	Y	Y

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** "Contacted" = responded to survey or contacted through follow-up outreach
*** "Surveyed" = included in original online survey (Fall 2010)

Organization	Type of Organization	Contacted** (Y/N)	Surveyed*** (Y/N
Project Participation Status*: No			
Kitsap County Parks & Recreation	County	N	Y
Kitsap County Stream Team	County	N	Y
Lower Columbia River Fish Enhancement Group	Regional	N	Y
Lummi Island Heritage Trust	NGO	Y	Y
National Wildlife Federation	NGO	N	Y
Nisqually Indian Tribe	Tribe	N	Y
Nisqually River Foundation	NGO	Y	Y
Nisqually Stream Stewards	NGO	N	Y
Nooksack Salmon Enhancement Association	Regional	N	Y
North Cascades Institute	NGO	N	Y
North Olympic Land Trust	NGO	Y	Y
Noxious Weed Control Board, Clark County	County	N	Y
Noxious Weed Control Board, Columbia County	County	N	Y
Noxious Weed Control Board, Cowlitz County	County	Y	Y
Noxious Weed Control Board, Grays Harbor County	County	Y	Y
Noxious Weed Control Board, Pacific County	County	N	Y
Noxious Weed Control Board, Skamania County	County	Y	Y
Noxious Weed Control Board, Wahkiakum County	County	N	Y
Pacific Science Center	NGO	N	Y
Pacific Shellfish Institute	NGO	N	Y
Pacific States Marine Fisheries Commission	Federal	Y	N
Padilla Bay Reserve	Federal	N	Y
Pierce County Biodiversity Alliance	County	Y	Y
Pierce County Public Works and Utilities, Water Programs	County	N	N
Port Townsend Marine Science Center	NGO	N	Y
Puget Sound Action Team (now Puget Sound Partnership)	State	N	N

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** "Contacted" = responded to survey or contacted through follow-up outreach
*** "Surveyed" = included in original online survey (Fall 2010)

Organization	Type of Organization	Contacted** (Y/N)	Surveyed*** (Y/N
Project Participation Status*: No			
Puget Sound Restoration Fund	NGO	N	Y
Puyallup River Watershed	County	N	Y
San Juan County Marine Resources Committee	County	N	Y
Seattle Aquarium	Private	N	Y
Seattle Parks & Recreation Department	City	Y	Y
Seattle Public Utilities	City	Y	N
Shoreline Parks & Recreation Department	City	N	Y
Sierra Club	NGO	N	Y
Skagit Land Trust	NGO	N	Y
South Sound GREEN (Global Rivers Environmental Education Network)	NGO	N	Y
Squaxin Island Tribe	Tribe	N	Y
Stewardship Partners	NGO	N	Y
Stilly-Snohomish FETF (Fisheries Enhancement Task Force)	NGO	Y	Y
Streamkeepers of Clallam County	County	N	Y
Tahoma Audubon Society	NGO	N	Y
Taylor Shellfish	Private	N	Y
The Evergreen State College	Research	Y	Y
The Nature Conservancy	NGO	N	Y
Trust for Public Land	NGO	N	Y
Tulalip Tribe	Tribe	N	Y
Volunteers for Outdoor Washington	NGO	N	Y
WA Invasive Species Coaliton	State	N	Y
Washington Native Plant Society	NGO	N	Y
Washington State Association of Counties	Regional	N	Y
Washington Wildlife & Recreation Coalition	NGO	N	Y
West Sound Watersheds Council	Regional	Y	N

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** "Contacted" = responded to survey or contacted through follow-up outreach
*** "Surveyed" = included in original online survey (Fall 2010)

Organization	Type of Organization	Contacted** (Y/N)	Surveyed*** (Y/N
Project Participation Status*: No			
Whatcom Land Trust	NGO	N	Y
Whidbey Island Wildlife Habitat Project	Regional	N	Y
Wilderness Society Northwest Region	NGO	N	Y
Woodland Park Zoo	City	Y	Y
WSU - Beach Watchers	Research	N	Y
WSU Island County Extension	Research	N	Y
WSU Jefferson County Extension	Research	N	Y
WSU Mason County Extension	Research	N	Y
WSU Mt Vernon Station	Research	N	Y

* "Project Participation Status" = information and/or data were included in summaries, analyses, or activities referenced in report
** "Contacted" = responded to survey or contacted through follow-up outreach
*** "Surveyed" = included in original online survey (Fall 2010)

A0.3 Baseline Assessment Project Expanded Methods

This section describes how the project team compiled, reviewed, and analyzed data and program information on the 15 priority species. The methods used here support the analyses presented in Sections IV and V of the report.

OUTREACH

The project team began work in fall 2009 by reaching out to staff at state natural resource agencies, noxious weed control boards, non-profits, federal agencies, tribes, and other organizations that were thought to be involved with the management of invasive species.

Survey

We initially used a survey to identify and collect information on relevant data sets and programmatic efforts. We administered an online survey from November 2-24, 2009 to an initial distribution list of 196 individuals and organizations provided by Council staff. The Council and Council staff provided input on the online survey design and language. The survey posed four questions for each species:

1. Are you involved in programs or activities targeted at this species?
2. If so, what types of programs (choose one or more: control, detection, education/outreach, enforcement, eradication, funding, monitoring, prevention, policy, research, or other)?
3. Do you have data for this species?
4. If so, what type of data (e.g., reports, databases, GIS files) and how much (e.g. , 1-3 files, 4-6 files) is available to share with the project?

Respondents also had the option to provide additional detailed information about programs and data, or to upload data files if desired. During this three-week period, 60 of 196, or 30% of contacts on the initial distribution list responded to the survey. The 60 responses represented 58 organizations, or 39% of the 147 organizations surveyed. An additional 18 organizations, as well as other contacts at several organizations, were reached through follow-up phone calls and emails. The remaining 69 of the 147 organizations surveyed were not prioritized for contacting. It should be noted that at least 15 of the organizations on the initial distribution list do not work within the Puget Sound Basin (see Appendix A0.2 for a full list of organizations surveyed).

Of the organizations contacted, 19 of those within the Puget Sound Basin reported no data or programs for the fifteen priority species. It is also worth noting that two major groups—tribes and nonprofit organizations—did not respond to the extent originally expected. In addition, the contact list included a limited number of city agencies, which were not prioritized for follow-up outreach due to an expected lack of invasive species programs and data collection efforts at the municipal level. The project team briefed the Council in December 2009 on initial findings, and Council members and staff suggested additional data sources and programs for further research.

Survey Follow-up

The project team followed up with survey respondents by phone and e-mail to collect any data or program information that respondents were willing to share. Specifically, we confirmed the availability of data files, asked data providers about their data (e.g., type, spatial extent, collection method), and inquired about the nature and focus of programmatic activities. We also began following up with individuals who had not responded to the survey, but had been identified by Council members, staff, and others or through online research as potential keepers of relevant data and/or programmatic information.

The project team compiled data and program information, as well as metadata describing these datasets and program records. Outreach and information gathering continued throughout the course of the project, with a small number of data files and program information received during the fall of 2010.

DATABASE DEVELOPMENT

The project team constructed an Access-based relational database to house baseline assessment information, to provide a framework for tracking and updating information throughout the span of the project, and to allow easy generation of summary reports. Project information is organized into the following categories:

- **Organizations and contacts.** Directory of all organizations and individuals contacted throughout the span of the baseline assessment project, cross-referenced to data and programmatic information provided to the project.
- **Data.** Records of all data files received and processed by the project team, including original files, files modified from original files for use in the spatial analysis, and files not used in the analysis.
- **Programs.** Directory of known programs targeted at the 15 priority species, including brief summaries and associated contacts and organizations.
- **References.** Library of all references identified and consulted throughout the span of the project.

The database has been turned over to the Council to function as an updatable repository for invasive species information. Currently, the database houses information for the 15 priority species, but it is designed to accommodate inclusion of additional species if desired. Information can be summarized and sorted by species, by type of organization and/or programs addressing specific species, or by type and coverage of available data.

To facilitate project team collaboration, we also developed an online, password-protected database entry portal for adding and modifying all information in the database. Although the portal is not currently designed as a public interface to the project database, it could be altered in the future to provide a web-based, user-friendly way to engage collaborators and the public in the project. Figure 1 shows a snapshot of one data entry or data modification page.

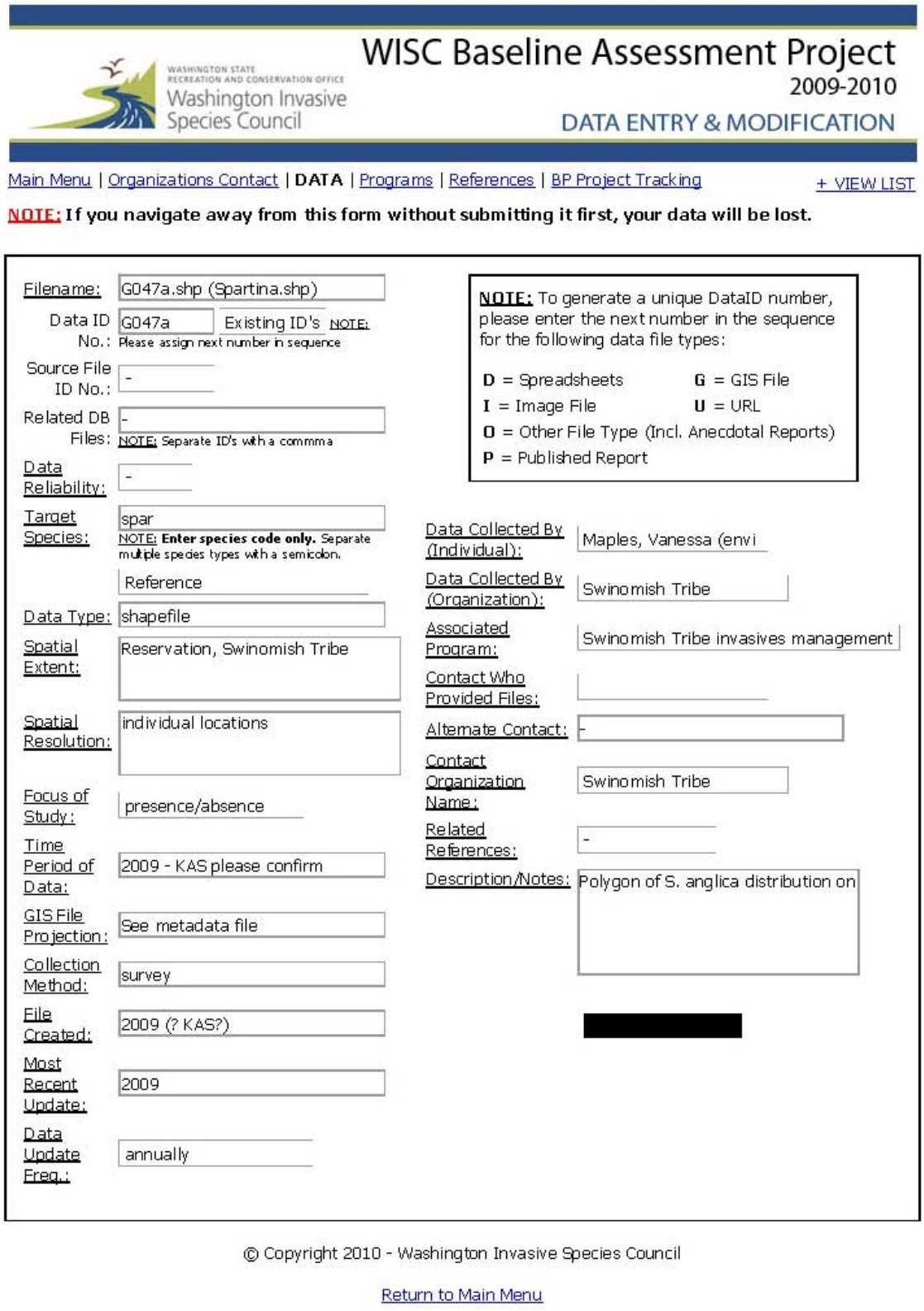

Figure 1. Online Database Entry Portal: data entry and modification page.

METADATA QUALITY

REVIEW

In the spring of 2010, the project team conducted a review of the completeness and quality of metadata associated with each data file and all programmatic information received. This review provided a framework

for identifying gaps in compiled data and information that could be filled through further outreach, thus improving the quality of both the database and the subsequent spatial analyses and program summaries.

The review focused on assessing the quality of metadata (e.g., dates, locations, methods, names of collectors) associated with information provided to the project. For the data records, the project team identified a subset of critical metadata associated with each record that provided essential information for understanding the data file. These included the species name, spatial extent of data, individual and organization providing the data, data collection method, individual and organization collecting the data, and time period of data collection. When this review was conducted, in April 2010, 69% of the 134 data records included all critical metadata. A major gap in critical information that proved problematic for the subsequent spatial summaries was that the time period of data collection was provided for only 82% of the records.

We identified an additional set of preferred metadata categories that would provide useful information and would be desirable for future data collection efforts, but were not used to screen data files for inclusion in the assessment. These categories include reliability of data as ranked by data provider, description of data, data update frequency, associated published reports or papers, and associated programs.

The project team conducted a similar metadata quality analysis for the program records, identifying critical and preferred metadata that provide important information for understanding a program, such as the spatial extent of the program or the species addressed by the program. As of April 2010, the project team had compiled information for all critical metadata attributes for 65% of the 119 program records. Critical program metadata included identification of the organization running the program, contact names of individuals at the organization, species addressed and types of programs, spatial extent of the program, and dates of activity for the program. In subsequent months we were able to fill a majority of these gaps through additional research, which included web searches, document reviews, and in-person and phone conversations. Preferred metadata for Puget Sound Basin programs included the program website, program start date, funding sources for the program, available associated data sets, and names of associated programs.

ASSESSMENT FRAMEWORK

The project team developed an assessment framework for identifying and organizing species-specific spatial information. The framework was developed to ensure that all gap analyses and spatial summaries addressed the Council's key questions for this Baseline Assessment, to ensure consistency across all summaries and analyses completed for priority species, and to provide a structure for soliciting input from regional experts on the 15 priority species.

The assessment framework was designed around the following questions:

1. Where does this species currently exist (status)?
2. How have populations changed since species arrival (trends)?
3. What are the pathways of introduction for this species (documented and potential)?
4. What are the pathways of spread for this species (documented and potential)?
5. How has the species been managed or treated to date, and where (management)?
6. What are the known ecological impacts and threats to habitats, other species, and processes, of this species (documented and potential)?
7. What are the known economic and human dimensions impacts and threats (documented and potential)?
8. Does current understanding of potential climate change impacts to Puget Sound ecosystems suggest additional considerations related to above topics for this species?

In May 2010, we convened three expert workgroups focused on terrestrial, freshwater, and marine species to solicit their input on data and programmatic information compiled by the project team, and key aspects of the Puget Sound ecosystem associated with each species. Individual participants were identified from the original contact list provided by Council staff and through further discussions within the project team and with Council

staff. Participants represented state and county agencies, non-profits, universities, and interstate commissions. All regional experts are listed in the acknowledgements section of this report.

In each session, participants were asked to provide feedback on the following:

- **Data compilation.** Reviewed list of data compiled by the project team and commented on the quality and relevance of proposed data to be included in spatial summaries and gap analyses. Identified any data files that the project team had not yet acquired but should pursue for inclusion in summaries and analyses. Identified any data files that should not be included in summaries and analyses.
- **Species biology/ecology.** Reviewed and provided input to the project team's understanding of critical aspects of species biology/ecology that should inform spatial summaries and gap analyses, such as associated habitats, associated species, associated ecological processes, and/or associated human dimensions (e.g., economic, health).
- **Pathways and at-risk resources.** Reviewed and provided input to project team's preliminary list of ecological and socio-economic factors to consider for species-specific summaries related to pathways of introduction and spread, impacts and threats to ecological and human dimensions of the ecosystem, and any potential impacts of climate change on priority species ability to invade or spread within the Basin.

The project team used input from these sessions to finalize the list of spatial data files to be used in assessing the state of knowledge for each of the priority species. The list includes spatial units relevant to each species such as biological and ecological components of the ecosystem (e.g., wetlands, river corridors), potential pathways of entry and spread (e.g., boat ramps, road corridors), and associated sensitive or vulnerable aspects of the ecosystem (e.g., land cover types). A complete list of spatial data files used for the project can be found in Appendix A0.4. Spatial data files used for each species are listed in the legend of each species-specific presence map (see A#.2; # denotes the species number) and of each map of species-specific pathways and sensitive landscape features (see Appendices A#.3 and A#.10-22b).

DATA SYNTHESIS

Spatial summaries: Maps and narrative

Using the assessment framework as a guide and considering expert input regarding which datasets to include, the project team analyzed spatial data provided for 12 of the Council's 15 priority species (see below for discussion of type and quantity of data received). For each of the 12 species, the following types of information are summarized in map and narrative format at the Puget Sound Basin scale and/or the county scale:

- **Species status**. Recorded locations of species presence/absence in the Puget Sound Basin. This summary includes all spatially-explicit data on species presence in the Basin at any time as well as survey data for a limited number of priority species. Survey data noting absence of a species at specific locations were only included in cases where the team was able to procure data representing coordinated, basin-wide, species-specific survey efforts (e.g., Lymantriids, wood-boring beetles, zebra and quagga mussels). Species status is spatially summarized at the basin scale and at the county scale.
- **Species pathways.** Points of entry and pathways of spread within the Puget Sound Basin. Entry points and pathways of spread relevant to each priority species (e.g., boat ramps, roads, river corridors) are included as data layers in basin-wide and county-scale maps under "Pathways & Sensitive Landscape Features."
- **At-risk resources.** Ecological and human dimensions of the Puget Sound ecosystem at risk from invasion by a priority species. Resources currently impacted by or potentially threatened by a priority species (e.g., wetlands, agricultural lands, lowland forests) are included as data layers in basin-wide and county-scale maps under "Pathways & Sensitive Landscape Features."

Due to a lack of basin-wide data for most species, as well as inconsistencies across datasets provided to the project team (discussed in Introduction), we did not conduct basin-wide, species-specific spatial analyses. Accurate high-resolution spatial analyses of species status and trends, pathways, and threats and impacts to ecosystem resources would have required data compilation, manipulation, and creation above and beyond the scope of this project. Based on conversations with data providers and managers, it is the project team's understanding that for most species, data supporting Puget Sound Basin-scale spatial analyses do not currently exist.

The summaries presented in Section IV include all data files provided to the project that were spatially-explicit, were provided as or readily convertible to GIS files, and appropriately represented the species when mapped (e.g., knapweed data points appeared in terrestrial environments and not marine environments). When possible, the project team reviewed spatial summary maps with data providers to ensure that data were accurately represented.

Treatment of individual species versus species groups

Of the Council's 15 priority species, five represent groups of species rather than single species:

- Lymantriid moths (initially focused on Asian, European gypsy moths)
- *Spartina* (*Spartina alterniflora, S. anglica, S. patens, S. denisflora*)
- Tunicates (*Didemnum vexillum, Styela clava, Ciona savignyi*)
- VHS (Viral Hemorrhagic Septicemia Virus), Type IVa (Type IVb was later added)
- Wood-boring beetles (Cerambycidae, Buprestidae, Scolytidae, Siricidae families)
- Zebra, quagga mussels (*Dreissena polymorpha, D. rostriformis bugensis*)

Based on recommendations from Council staff and limitations associated with the scope of this project, spatial summaries and gap analyses associated with these species groups were presented collectively in all areas of this report, including discussions of presence/absence, consideration of at-risk natural resources and human dimensions of the ecosystem, and associated programmatic efforts .

Species data

Types of data received

The project team did not compile data files for *Caulerpa*, feral swine, or kudzu. These three species have not been documented in the Puget Sound Basin, although kudzu was identified and eradicated from Clark County in 2001, nor are there broad and well-documented survey efforts for these species as there are for species such as zebra and quagga mussels.

The project team compiled spatially-explicit data for the remaining 12 priority species. We received original shapefiles for nine of the 15 priority species: Brazilian elodea (two files), common reed (seven files), gypsy moths (five files), hydrilla (two files), knapweeds (20 files), *Spartina* (18 files), tunicates (two files), variable-leaf milfoil (one file), and wood-boring beetles (three files). In addition, we received spatially-explicit data that could be converted into shapefiles for three additional species: nutria, VHS type IVa, and zebra and quagga mussels, as well as for Brazilian elodea, common reed, hydrilla, knapweeds, *Spartina*, tunicates, and variable-leaf milfoil.

The project team received a smaller number of data files characterized as reports, ranging from reports on management efforts to anecdotal reports that roughly describe the presence of a priority species, as well as images depicting seven of the priority species.

There are wide variations in the quantity of different types of data compiled for each of the 12 species. We received a high quantity of data files for knapweeds and for *Spartina,* many of which are spatially-referenced shapefiles. In contrast, we have limited data, with varying levels of spatial information and detail, for species

such as nutria. In some cases, such as for hydrilla or variable-leaf milfoil, the small number of data files likely does not indicate a lack of information but is rather a reflection of the extent of species presence in the basin, as these two species have only been documented in a small number of lakes in the Puget Sound Basin.

Data processing

We processed compiled data, when possible, to support the development of basin-wide, spatially-explicit summaries for each species.

- All shapefiles were converted to a common projection.
- Spreadsheets and reports with spatial information (street addresses and GPS points) were converted to shapefiles.
- Images were georeferenced and converted to shapefiles.

Numerous datasets received by the team included data for a number of the priority species as well as data for native species and non-priority invasive species. Data for the 15 priority species were isolated and non-relevant information discarded from the data file.

In a limited number of cases, data files compiled by the project team included large quantities of spatial data that could not be processed for inclusion in the spatial summaries due to the time required to manipulate the data. For example, extracting spatial information from spreadsheet columns that also include notes, dates, and names exceeded the scope of this project. In these cases, the data are discussed in the narrative and included in the database but are not included in the spatial summaries.

Base spatial data

The project team compiled base data supporting map-based spatial summaries. We selected appropriate base data for each species based on relevant pathways and at-risk resources, guided by input from the expert workshops. The base data provided the spatial structure for representation of the following: species presence, pathways of entry and spread, species-specific programmatic efforts, and at-risk ecological resources and human dimensions of the Puget Sound ecosystem. For a complete list of base data compiled for the project see Appendix A0.4.

Types and sources of data

Spatially-explicit base data (shapefiles) were compiled from a variety of sources, including regional, state, and federal agencies. Data include linear features such as shorelines, roads, rail and river corridors; natural water features such as lakes, wetlands, and marshes; built infrastructure such as ports, marinas, and developed areas; ecological process units such as drift cells; elevationally-defined units based on topographic and bathymetric data; land management and political boundaries; and land cover and land use data. For a complete list of base data sources see Appendix A0.4.

Non-spatial data

A number of individuals or organizations provided the project with data sets that were either not spatially explicit or would require more time to convert to GIS shapefiles than covered by the scope of this project. For example, USDA Wildlife Services provided data from their past nutria trapping efforts that indicated only the county in which nutria were trapped. We cross-checked these data against those provided by others, and found that other data sets indicate presence of nutria in each of those counties referenced by the USDA, but with a more explicit spatial location (e.g., sub-watershed, specific points along Lake Washington). In this case, the project likely did not lose any information by not incorporating this particular dataset in the spatial summaries.

In other cases, data were in formats that would have been excessively time-consuming to translate into a GIS database. For example, University of Washington scientists provided data from over a decade of surveys for tunicates; however these survey points did not include specific geographic information such as latitude and longitude. Observations from this dataset that appear to be additional to those mapped are listed in the tunicate narrative summary in Section III.

In general, we converted data sets into GIS files if they were provided early in the process, included latitude and longitude information or other clear spatial information, and had a limited number of points requiring manual spatial referencing. All data relating to species presence or absence that could not be included in the map-based spatial summaries are referenced in the species-specific narratives in Section III.

Program analysis

We analyzed programmatic efforts for each of the Council's 15 priority species in the Puget Sound Basin, with a focus on efforts at the county, state, and federal level, as well as those efforts reported by cities, tribes, non-governmental entities, and universities. Broad regional programs that may have an effect on the management of these species in Puget Sound but do not focus on these species are not analyzed here. A complete list of regional programs not included in the species-specific analysis is presented in Section IV.

For each species, we analyzed the extent of programmatic efforts using the following categories.

- State or Puget Sound-level activities—types of programs, whether a single agency has lead responsibility.
- County-level activities —types of programs, distinguished by counties where the species has and has not been documented, documented with maps as applicable.
- Federal-level activities—types of programs, integration with state, regional, or county activities.
- Other activities—programmatic efforts led by NGOs, tribes, universities, or other entities.
- Legal authorities—existing legal authorities to manage this species, programs covered by these authorities.
- Funding—funding dedicated for programmatic efforts for this species. Overall funding sources for major local and state governmental agencies are summarized in Tables 5 and 6 in the report.
- Pathways—whether these programs address major pathways for this species.
- Overall statistics—top three most commonly reported program types, number of programmatic efforts at each level.

Gap Analysis

We assessed gaps in information for individual species and for the 15 priority species as a group in the following topic areas:

- **Data collection and information management.** We reviewed the spatial extent, coverage, and resolution of data collected for each species, the time period of data collection, the continuity and consistency of data collection, and the degree to which data and information are shared across organizations working on a species.
- **Knowledge and understanding of species status, pathways, and impacts.** We focused on gaps in current understanding of species biology and ecology, pathways of entry and spread, and documented or potential impacts to ecological and human dimensions of the ecosystem. We drew our information from a review of published literature, from data and information provided to the project, and from conversations with data providers and topical experts.
- **Programmatic efforts.** We reviewed the extent and coverage of programs and management efforts at all organizational levels, authorities governing management efforts, and funding availability to support programs.

Overall gaps are summarized at the end of the Overarching Themes section of the report; species-specific gaps are summarized in the relevant species sections.

Data Layers

Boundaries & Extents

- County Boundary
- Puget Sound Extent

Pathways & Sensitive Landscape Features

- Port
- Shipping Lane
- Boat Ramp
- Marina
- Overwater Structure
- International Airport
- Airport
- Fish Hatchery
- Perenial River / Stream
- Canal / Ditch
- Lake / Pond
- Reservoir
- Swamp / Marsh
- Sea / Ocean
- Flood Zones
- Railroads
- Roads - Interstate, US, State Routes
- Roads - Other Routes

Shoreline Depth

- 0' - 40' depth
- 40' - 75' depth
- 75' - 200' depth

Drift Cell Type

- Left to Right
- Right to Left
- Convergence Zone
- Divergence Zone
- No Appreciable Drift

Land Cover & Land Use

- Developed
- Cultivated Lands
- Grassland
- Deciduous Forest
- Coniferous & Mixed Forest
- Scrub / Shrub
- Freshwater Wetland
- Estuarine Wetland
- Beaches, Bars & Flats
- Rock & Snow
- Water

Data Source

Boundaries and Extents

County Boundary
COUNTY.shp
Washington Department of Transportation (WDOT)
Available FTP: http://www.wsdot.wa.gov/mapsdata/geodatacatalog/

Puget Sound Extent
Puget Sound Action Areas (PSAA)
NOAA, Puget Sound Partnership
Note: PSAA were dissolved to create the Puget Sound Extent by Jones & Jones.

Pathways and Sensitive Landscape Features

Port
Shipping Lanes
SERC, Marine Invasives Research Lab
National Ballast Information Clearing House;
NOAA ENC

Boat Ramp
launches.shp
1997, Washington State Department of Health
ftp://ftp3.doh.wa.gov/geodata/layers/launches.exe

Overwater Structure
Overwater_Structure_Marine.shp
2007. Washington State Dept. of natural Resources
http://fortress.wa.gov/dnr/app1/dataweb/dmmatrix.html
Note: Original polygon shapefile was converted to a point shapefile by Jones & Jones.

Marina
shore_pub_ac.shp
Marine Shoreline Public Access Project
Washington Dept of Ecology
http://www.ecy.wa.gov/services/gis/data/data.htm
Note: Original line shapefile was converted to a point shapefile by Jones & Jones.

International Airport
Airport
AirportsWSDOT.shp
Washington Department of Transportation (WDOT)
http://www.wsdot.wa.gov/mapsdata/geodatacatalog/

Fish Hatchery
StreamNet
http://www.streamnet.org/query_intro.html

Perennial Rivers & Streams
Intermittent Streams
Canal / Ditch
NHDFlowLine.shp
USGS National Hydrography Dataset (NHD)
http://viewer.nationalmap.gov/viewer/

Lake / Pond, Reservoir
Swamp / Marsh
Sea / Ocean
NHDWaterbody.shp
USGS National Hydrography Dataset (NHD)
http://viewer.nationalmap.gov/viewer/

Flood Zones
FEMA Flood Data
Washington Dept. of Ecology
http://www.ecy.wa.gov/services/gis/data/data.htm

Railroads
Trans_RailFeature.shp
USGS
http://viewer.nationalmap.gov/viewer/

Major Road Routes
Minor Road Routes
Trans_RoadSegment.shp
USGS
http://viewer.nationalmap.gov/viewer/

Shoreline Depth
Department of Commerce (DOC), National Oceanic and Atmospheric Administration (NOAA), National Ocean Service (NOS), Special Projects (SP)
http://estuarinebathymetry.noaa.gov/
Note: Data adjusted by Jones & Jones to fill missing gaps between bathymetry data and shoreline.

Drift Cell Type
fd_GSUs.shp
Puget Sound Nearshore Ecosystem Restoration Project (PSNERP)

Land Cover & Land Use
WA_2006.img
Department of Commerce (DOC), National Oceanic and Atmospheric Administration (NOAA), National Ocean Service (NOS), Coastal Services Center (CSC)
http://www.csc.noaa.gov/

[redacted]

Map Data

Coordinate System:
NAD 1983 StatePlane Washington South FIPS 4602 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Units: Foot US

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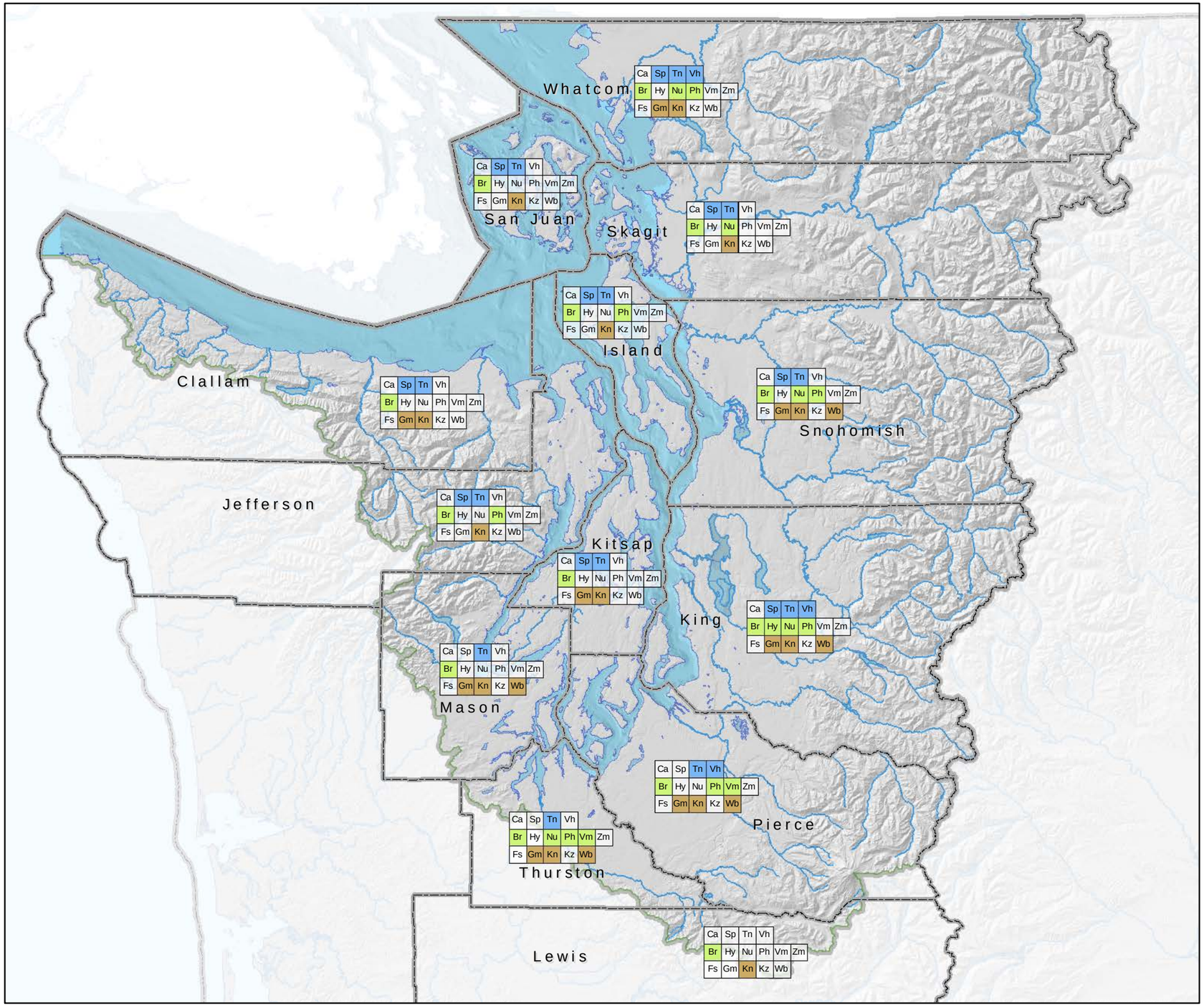
Base Data Layers and Data Sources used for Baseline Assessment Spatial Analysis and Program Mapping

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

A 0.4
February 2011



Species Detection by County*

* All detection data across species (1974 - Current).
* Data does not necessarily indicate current presence.

Puget Sound Basin

Ca	Sp	Tn	Vh			Marine
Br	Hy	Nu	Ph	Vm	Zm	Freshwater
Fs	Gm	Kn	Kz	Wb		Terrestrial

Marine Species Detected

- Ca: Caulerpa
- Sp: Spartina
- Tn: Tunicates
- Vh: VHS Type IVa (Type IVb not yet detected in PSB)

Freshwater Species Detected

- Br: Brazilian elodea
- Hy: Hydrilla (Eradicated in King County)
- Nu Nutria
- Ph: Common reed
- Vm: Variable leaf milfoil
- Zm: Zebra, quagga mussels

Terrestrial Species Detected

- Fs Feral swine
- Gm: Lymantriid moths (Detected but not established)
- Kn: Knapweeds
- Kz: Kudzu
- Wb: Wood - boring beetles (Detected but not established)

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Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix.

0 5 10 20 Miles

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Baseline Assessment of Invasive Species: Detection by County

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

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Brazilian Elodea

Egeria densa

Date: Source

- 1977: WA Department of Ecology
- 1990: WA Department of Ecology
- 1994: WA Department of Ecology
- 1995: WA Department of Ecology
- 1996: WA Department of Ecology
- 1997: WA Department of Ecology
- 1998: WA Department of Ecology
- 1999: WA Department of Ecology
- 1999, Burke Museum Herbarium Collections
- 2000: WA Department of Ecology
- 2001: WA Department of Ecology
- 2002: WA Department of Ecology
- 2003: WA Department of Ecology
- 2004: WA Department of Ecology
- 2005: WA Department of Ecology
- 2006: WA Department of Ecology
- 2007: WA Department of Ecology
- 2008: WA Department of Ecology
- 2009: Noxious Weed Control Board, King County
- 2009: WA Department of Ecology

Species Detection (1977 - 2009)

Observed*

Data Type

Point

Line

Polygon

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program.

Brazilian elodea in the Sammamish River (King County).
Katie Messick, King County NWCB.

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Data Files and Data Sources Included in Baseline Assessment
Spatial Analysis

Common Reed

Phragmites australis

Date: Source

- 2002: WA Department of Ecology
- 2004 - 2009: Noxious Weed Control Board, Jefferson County
- 2008: Noxious Weed Control Board, King County
- 2009: Noxious Weed Control Board, King County
- 2009: Noxious Weed Control Board, Whatcom County
- Unknown: Noxious Weed Control Board, Thurston County
- Unknown: WA Department of Agriculture
- 2004 - 2009: WA Department of Transportation
- 2001: Washington State Parks
- 2003 -2009: WA State Parks & Recreation Commission

Species Detection (2001 - 2009)

Observed*

Data Type

- Point
- Line
- Polygon

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program.

Phragmites in Lake Washington (King County).
Jeff Adams, Washington Sea Grant.

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Spatial Analysis

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Hydrilla

Hydrilla verticillata

Date: Source

- 1994: WA Department of Ecology
- 1995: WA Department of Ecology
- 1996: WA Department of Ecology
- 1997: WA Department of Ecology
- 1998: WA Department of Ecology
- 1999: WA Department of Ecology
- 2002: WA Department of Ecology
- 2003: King County Lakes Stewardship
- 2004: King County Lakes Stewardship
- 2005: King County Lakes Stewardship
- 2006: King County Lakes Stewardship

Species Detection (1994 - 2006)

Observed*

Data Type

Point

Line

Polygon

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program.

Hydrilla. *Chris Evans, River to River CWMA, Bugwood.org.*

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Data Files and Data Sources Included in Baseline Assessment
Spatial Analysis

Knapweeds

Centaurea species

Date: Source

- 1987: Noxious Weed Control Board, Thurston County
- 1990: Noxious Weed Control Board, Thurston County
- 1991: Noxious Weed Control Board, Thurston County
- 1992: Noxious Weed Control Board, Thurston County
- 1993: Noxious Weed Control Board, Thurston County
- 1994: Noxious Weed Control Board, Thurston County
- 1995: Noxious Weed Control Board, Thurston County
- 1996 - Present: Noxious Weed Board, Skagit County
- 1996: Noxious Weed Control Board, Thurston County
- 1997: Noxious Weed Control Board, Thurston County
- 1998: Noxious Weed Control Board, Clallam County
- 1998: Noxious Weed Control Board, Thurston County
- 1999: Noxious Weed Control Board, Clallam County
- 1999: Noxious Weed Control Board, Thurston County
- 1999: Oregon State University
- 2000: Noxious Weed Control Board, Clallam County
- 2000: Noxious Weed Control Board, Thurston County
- 2000: Oregon State University
- 2001: Noxious Weed Control Board, Clallam County
- 2001: Noxious Weed Control Board, Thurston County
- 2001: Oregon State University
- 2002 - 2009: National Park, Olympic
- 2002: Noxious Weed Control Board, Clallam County
- 2002: Noxious Weed Control Board, Thurston County
- 2003: Noxious Weed Control Board, Clallam County
- 2003: Noxious Weed Control Board, Thurston County
- 2004 - 2009: Noxious Weed Control Board, Jefferson County
- 2004: Noxious Weed Control Board, Clallam County
- 2004: Noxious Weed Control Board, Thurston County
- 2005: Noxious Weed Control Board, Lewis County
- 2005: Noxious Weed Control Board, Thurston County
- 2006: Noxious Weed Control Board, Lewis County
- 2006: Noxious Weed Control Board, Thurston County
- 2007 - 2009: Noxious Weed Control Board, San Juan County
- 2007 - 2009: Noxious Weed Control Board, Whatcom County
- 2007: Noxious Weed Control Board, Lewis County
- 2007: Noxious Weed Control Board, Thurston County
- 2008: Noxious Weed Control Board, King County
- 2008: Noxious Weed Control Board, Thurston County
- 2009: Noxious Weed Control Board, King County
- 2009: Noxious Weed Control Board, Kitsap County
- 2009: Noxious Weed Control Board, Thurston County
- 2009: Swinomish Tribe
- 2004 - 2009: WA Department of Transportation
- 2007: San Juan County Public Works
- 1995: US Forest Service - Olympic National Forest
- 1997: National Forest, Mt Baker - Snoqualmie
- 1997: US Forest Service - Olympic National Forest
- 1998: National Forest, Mt Baker - Snoqualmie
- 2002: National Forest, Mt Baker - Snoqualmie
- 2002: US Forest Service - Olympic National Forest
- 2003 - 2009: WA State Parks & Recreation Commission
- 2003: National Forest, Mt Baker - Snoqualmie
- 2003: US Forest Service - Olympic National Forest
- 2004: National Forest, Mt Baker - Snoqualmie
- 2004: US Forest Service - Olympic National Forest
- 2005: National Forest, Mt Baker - Snoqualmie
- 2005: US Forest Service - Olympic National Forest
- 2006: National Forest, Mt Baker - Snoqualmie
- 2006: US Forest Service - Olympic National Forest
- 2006: WA State Parks & Recreation Commission
- 2007: National Forest, Mt Baker - Snoqualmie
- 2008: National Forest, Mt Baker - Snoqualmie
- 2009: National Forest, Mt Baker - Snoqualmie
- 2009: Swinomish Tribe

Species Detection (1987 - 2009)

Observed*

Data Type

Point

Line

Polygon

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program.

Spotted knapweed. *Marisa Williams, University of Arkansas, Fayetteville, Bugwood.org.*

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Data Files and Data Sources Included in Baseline Assessment
Spatial Analysis

Lymantriid Moths

e.g., Asian, European gypsy moths

Date: Source

- 1991: WA Department of Agriculture
- 1994: WA Department of Agriculture
- 1995: WA Department of Agriculture
- 1996: WA Department of Agriculture
- 1997: WA Department of Agriculture
- 1999: WA Department of Agriculture
- 2007: WA Department of Agriculture
- 2008: WA Department of Agriculture
- 2009: WA Department of Agriculture
- 2007: WA Department of Agriculture
- 2008: WA Department of Agriculture
- 2009: WA Department of Agriculture

Species Detection (1991 - 2009)

Observed*

Surveyed But Not Found*

Data Type

Point

Line

Polygon

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program.

Lymantriids – Asian and European Gypsy Moths.
USDA APHIS PPQ Archive, USDA APHIS PPQ, Bugwood.org.

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Spatial Analysis

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Nutria

Myocastor coypus

Date: Source

- 2006, University of Washington
- 2007, Portland State University

Species Detection (2006 - 2007)

Observed*

Data Type

- Point
- Line
- Polygon

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program.

Nutria at Lake Washington (King County). *Jeff Adams, Washington Sea Grant.*

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Data Files and Data Sources Included in Baseline Assessment
Spatial Analysis

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

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Spartina

Spartina alterniflora, S. anglica, S. patens, S. denisflora

Date: Source

- 2007-2009: Noxious Weed Control Board, San Juan County
- 2007: People for Puget Sound
- 2008: People for Puget Sound
- 2008: WA Department of Agriculture
- 2009: People for Puget Sound
- 2009: Swinomish Tribe
- 2009: WA Department of Agriculture
- 2007: People for Puget Sound
- 2008: People for Puget Sound
- 2009: People for Puget Sound
- 2003 - 2009: WA State Parks & Recreation Commission
- 2005: WA State Parks & Recreation Commission
- 2009: Swinomish Tribe

Species Detection (2003 - 2009)

Observed*

Data Type

Point
Line
Polygon

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program.

Spartina near Camano Island (Island County).
Jeff Adams, Washington Sea Grant.

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Data Files and Data Sources Included in Baseline Assessment
Spatial Analysis

A Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

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Tunicates

Didemnum vexillum, Styela clava, Ciona savignyi

Date: Source

- 2005: Tulane University
- 2005: WA Dept. of Fish and Wildlife
- 2006 - 2009: REEF Environmental Education Foundation
- 2006: REEF Environmental Education Foundation
- 2006: Skokomish Tribe
- 2006: Tulane University
- 2007: REEF Environmental Education Foundation
- 2007: Tulane University
- 2007: WA Dept. of Fish and Wildlife
- 2008: REEF Environmental Education Foundation
- 2008: Tulane University
- 2009: REEF Environmental Education Foundation

Species Detection (2005 - 2009)

Observed*

Data Type

Point

Line

Polygon

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program.

Invasive tunicate, *Didemnum vexillum*, in Puget Sound.
Janna Nichols, REEF.

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Data Files and Data Sources Included in Baseline Assessment
Spatial Analysis

Variable Leaf Milfoil

Myriophyllum heterophyllum

Date: Source

- 2006: WA Department of Ecology
- 2007: WA Department of Ecology
- 2008: WA Department of Ecology
- 2009: Noxious Weed Control Board, Thurston County
- 2009: WA Department of Ecology

Species Detection (2006 - 2009)

Observed*

Data Type

Point

Line

Polygon

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Variable leaf milfoil. *Graves Lovell, Alabama Department of Conservation and Natural Resources, Bugwood.org.*

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VHS

Viral Hemorrhagic Septicemia Virus, types IVa and IVb

Date: Source

- 1989: Northwest Indian Fiesheries Commision
- 1998: Northwest Indian Fiesheries Commision
- 2002: Northwest Indian Fiesheries Commision
- 2005: Northwest Indian Fiesheries Commision
- 2006: Northwest Indian Fiesheries Commision

Species Detection (1989 - 2006)

Observed*

Data Type

Point

Line

Polygon

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VHS. *Jim Winton, U.S. Geological Survey.*

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Wood - Boring Beetles

Cerambycidae, Buprestidae,
Scolytidae, Siricidae families

Date: Source

2009, WA Dept. of Agriculture

Species Detection (2009)

Observed*

Surveyed But Not Found*

Data Type

Point

Line

Polygon

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Asian long-horned beetle. *Dennis Haugen, USDA Forest Service, Bugwood.org.*

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Zebra, Quagga Mussels

Dreissena polymorpha, D. rostriformis bugensis

Date: Source

- 2001, Washington Dept. of Fish & Wildlife
- 2002, Washington Dept. of Fish & Wildlife
- 2003, Washington Dept. of Fish & Wildlife
- 2004, Washington Dept. of Fish & Wildlife
- 2005, Washington Dept. of Fish & Wildlife
- 2006, Washington Dept. of Fish & Wildlife
- 2007, Washington Dept. of Fish & Wildlife
- 2008, Washington Dept. of Fish & Wildlife
- 2009, Washington Dept. of Fish & Wildlife

Species Detection (2001 - 2009)

- Observed*
- Surveyed But Not Found*

Data Type

- Point
- Line
- Polygon

* Data are not to scale and may contain point, line and/or polygon data.
Data do not necessarily reflect systematic basin wide survey program.

Quagga mussel.
Amy Benson, U.S. Geological Survey, Bugwood.org

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