A BASELINE ASSESSMENT OF PRIORITY INVASIVE SPECIES IN THE PUGET SOUND BASIN

PHASE II

A Project of the Washington Invasive Species Council
Conducted by ESA, Hook Knauer, SpatialDev, and Sarah Reichard



JANUARY 2014

WASHINGTON STATE
RECREATION AND CONSERVATION OFFICE
Washington Invasive
Species Council

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GLOSSARY

ACRONYMS AND ABBREVIATIONS USED IN THIS REPORT

AIS	Aquatic Invasive Species
ALEA	Aquatic Lands Enhancement Account
ANS	Aquatic Nuisance Species
ANSTF	Aquatic Nuisance Species Task Force
APHIS	Animal and Plant Health Inspection Service
Basin	Puget Sound Basin
AU	Assessment Unit
BLM	Bureau of Land Management
CFR	Code of Federal Regulations
Council	Washington Invasive Species Council
CWMA	Cooperative weed management area
DES	Washington State Department of Enterprise Services
Ecology	Washington State Department of Ecology
EDRR	Early Detection and Rapid Response
EPA	U.S. Environmental Protection Agency
ESA	Environmental Science Associates
GIS	Geographic information system
GPS	Geographic positioning system
ISA	Infectious salmon anemia
HCCC	Hood Canal Coordinating Council
IUCN	International Union for the Conservation of Nature
NGO	Nongovernmental organization
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NWCB	Noxious Weed Control Board
NWIFC	Northwest Indian Fisheries Commission

GLOSSARY

ACRONYMS AND ABBREVIATIONS USED IN THIS REPORT

PBWG	Pacific Ballast Water Group
PSMFC	Pacific States Marine Fisheries Commission
PSNERP	Puget Sound Nearshore Ecosystem Restoration Project
PSP	Puget Sound Partnership
RCO	Recreation and Conservation Office
RCW	Revised Code of Washington
RITT	Puget Sound Recovery Implementation Technical Team
TNC	The Nature Conservancy
USC	United States Code
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UW	University of Washington
WAC	Washington Administrative Code
WCAT	Watershed Characterization Technical Assistance Team
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington State Department of Natural Resources
WDOE	Washington State Department of Ecology
WISC	Washington Invasive Species Council
WISE	Washington Invasive Species Education
WRIA	Water Resource Inventory Area
WSDA	Washington State Department of Agriculture
WSDOT	Washington State Department of Transportation
WSPRC	Washington State Parks and Recreation Commission
WSU	Washington State University

GLOSSARY

TERMS USED TO DESCRIBE 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.
Impacts	Existing or documented negative effects 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; for example, on cargo ships from other countries.
Pathways of spread	Ways by which the species moves through the Puget Sound Basin; for example, being moved by streamflows or on vehicle tires.
Status	Species presence/absence at a specific location at a specific point in time.

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 found, 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.

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WORK SESSIONS

Plant invasive species work session participants (March 19th and June 25th, 2013): Wendy DesCamp (WA NWCB), Greg Haubrich (WSDA), Jenifer Parsons (Ecology), Chad Phillips (WSDA), Dave Heimer (WDFW), Sarah Reichard (UW), Lizbeth Seebacher (Ecology) and Jonathan Still (WSDA).

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WASHINGTON INVASIVE SPECIES COUNCIL

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COVER PHOTOS

Red Swamp Crayfish, courtesy of WDFW website

Butterfly Bush, courtesy of Tim Miller, Washington State Noxious Weed Control Board

Cherry Bark Tortrix, courtesy of Eric Lagasa, WSDA,

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I. EXECUTIVE SUMMARY

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 Council has identified 50 invasive species or species assemblages as the top priorities for assessment and action. In 2011 the Council published a Phase I baseline report focusing on the first 15 of these 50 invasive species in the Puget Sound Basin. This Phase II report provides a baseline assessment of an additional 21 species from the "top 50" list.

Invasive species degrade native ecosystems and impact human social and economic values. Ecological impacts include displacing native vegetation and wildlife, changing food webs, impairing water quality, and altering erosion and deposition processes of streams and rivers. In terms of human values, invasives can impact recreational opportunities, damage infrastructure, degrade agricultural resources, impact fisheries, and pose risks to human health.

Of the Council's 21 priority species in Phase II of the baseline assessment, 15 species have been documented in the Puget Sound Basin including 10 plant and 5 animal species. The remaining 6 priority species are not yet known to be established in the Basin but are considered to pose a threat of invading the region.

Numerous organizations are involved in preventing and managing the spread of invasive species in the Puget Sound Basin. However, there are opportunities to improve coordination of these efforts across jurisdictional and geographic boundaries. For example, a standardized data collection and reporting method for use by the various organizations involved with each species would encourage better data sharing across the region.

A number of organizations are doing education or outreach, and many are doing detection and control. Pooling data on productive programs could be cost-effective. Organizations would also benefit from having better information on pathways of introduction and spread to prevent invasives from becoming established in the first place.

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. Better data sharing among organizations would make better use of the limited funds and resources available for invasive species management across the region.

This baseline assessment serves as an initial step toward coordinating a statewide, strategic response to the threat of invasive species. The assessment is intended to ensure that available resources are used effectively, focused on the greatest ecological needs, and designed to create the highest benefit to native ecosystems and the human systems that depend on them.

II. INTRODUCTION

PURPOSE OF ASSESSMENT

In 2008, the Washington Invasive Species Council (WISC, the 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 and to establish strategies to fill those gaps.

This baseline assessment focuses on 21 priority invasive species selected by the Council (described under "The Species" below). The scope of this assessment is limited to the Puget Sound Basin, which for this report is defined to include all or portions of the following western Washington counties draining to the Sound: Whatcom, Skagit, Snohomish, King, Pierce, Lewis, Thurston, Mason, Kitsap, Jefferson, Clallam, San Juan, and Island.

THE CHALLENGE OF MANAGING INVASIVE SPECIES

Invasive, nonnative species pose a direct threat to native species and their habitats. Invasive species 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 propagated. These pathways include, but aren't limited to, the importation of seeds, plants, fruits and vegetables, and wood materials; ballast water discharges from ships; commercial and recreational boating and fishing equipment; travelers' clothes and shoes, cars, and airplanes; and people who release exotic pets, plants, and laboratory specimens 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 WISC, administered by the Recreation and Conservation Office (RCO), was established by the state legislature to coordinate 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

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. Many agencies and entities including tribes, non-profit organizations, and citizen groups are working on establishing policies for and physically controlling invasive species at the county, state, and federal levels. While there is some cooperation between these entities, there are wide differences in management approaches. Furthermore, gaps in communication and coordination across counties, between public and private lands, and between state, federal, tribal, and county lands hamper management efforts for the region as a whole.

Many different entities are also involved in collecting data on invasive species, ranging from state and federal resource agencies, to university researchers, to volunteer groups, to county noxious weed control boards. Some species are very well-documented, such as plants classified as Class A Noxious Weeds (eradication is required by law). The presence of other species is sparsely recorded. 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 central place that is accessible to managers or decision-makers.

In its 2008 strategic plan "Invaders at the Gate," the Council recognized that without understanding all facets of 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."[1] 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 is known about the species' location, rate of spread, and pathways of entry and transport; and which programs are in place to address them.

This baseline assessment is a component of coordinating a statewide, strategic response to the threat of invasive species. The assessment is intended to ensure that available resources are used effectively, focused on the greatest ecological needs, and designed to create the highest benefit to native ecosystems and the human systems that depend on them.

The Council has identified 50 invasive species or species assemblages as the top priorities for assessment and action.[2] In 2011 the Council published a Phase I baseline report focusing on the first 15 of these 50 invasive species in the Puget Sound Basin.[3] This Phase II report provides a baseline assessment of an additional 21 species from the "top 50" list.

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 2012, the Council retained Environmental Science Associates (ESA) and Hook Knauer, 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 21 species 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 that are being actively managed and those for which management activities are more limited. These species include plants, invertebrates (insects, clams, crayfish, crabs, and snails), and a virus, 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 number of locations, while still others have not yet been documented in the region but are considered significant threats.

The 21 priority species are as follows:

- Eurasian watermilfoil *(Myriophyllum spicatum)*
- Parrotfeather *(Myriophyllum aquaticum)*
- Purple loosestrife *(Lythrum salicaria)*
- Garden loosestrife *(Lysimachia vulgaris)*
- Bohemian knotweed *(Polygonum bohemicum)*
- Giant knotweed *(Polygonum sachlinense)*
- Japanese knotweed *(Polygonum cuspidatum)*
- Butterfly bush *(Buddleja davidii)*
- Garlic mustard *(Alliaria petiolata)*
- Giant hogweed *(Heracleum mantegazzianum)*
- Mediterranean snail *(Cernuella virgata)*

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

[2] Invasive Species Evaluated for Impacts, Prevention, Early Action (Species of High Threat in Washington), http://www.invasivespecies.wa.gov/documents/priorities/top50invasivespecies.pdf

[3] Washington Invasive Species Council, 2011. 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.

- New Zealand mud snail *(Potomopyrgus antipodarum)*
- Red swamp crayfish *(Procambarus clarkii)*
- Rusty crayfish *(Orconectes rusticus)*
- Chinese mitten crab *(Eriocheir sinensis)*
- Marine clam *(Corbula amurensis)*
- European green crab *(Carcinus maenas)*
- Cherry bark tortrix *(Enarmonia formosana)* - bark-boring moth
- European apple clearwing moth *(Synanthedon myopaeformis)*
- Eastern dogwood borer *(Synanthedon scitula)* - bark-boring moth
- Infectious salmon anemia *(ISA)* (Isavirus)

The three knotweed species (Bohemian, giant, and Japanese) are discussed together in this report, as are the three moth species (cherry bark tortrix, European apple clearwing, and Eastern dogwood borer moths).

JURISDICTIONS AND AUTHORITIES

The major types of organizations involved in management efforts for the 21 priority species, and major governing authorities, are as follows:

- ***County agencies***, including noxious weed control boards (NWCB), conservation districts, and surface water and public works divisions of county governments. Under Chapter RCW 17.10, county NWCBs must implement the state noxious weed law, ensuring that landowners carry out required control on their own property. County agencies focus mostly on controlling plant species and rarely work on invasive animals.
- ***State 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). Under Chapter 17.10 RCW, the State NWCB and WSDA are mandated to implement the noxious weed law. WSDA also administers plant quarantines and conducts invasive insect surveys and eradication efforts. WDFW has management authority for aquatic invasive species 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 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, provide funding for management activities (e.g., for invasive insect control), or conduct detection and control activities on their own lands.
- ***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.
- ***Non-governmental organizations (NGOs)*** such as watershed coalitions, citizen monitoring programs, and ecological restoration groups.
- ***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,*** which manage and control invasive species within their jurisdictions.
- ***Inter-regional agencies,*** such as Cooperative Weed Management Areas, the Pacific Marine Fisheries Commission, the Northwest Power and Conservation Council, and the 100th Meridian Initiative.

Many of these entities collaborate on invasive species management at local, regional, and state levels.

INTRODUCTION

REPORT STRUCTURE

The structure of this report is similar to the Phase 1 Baseline Assessment Report, completed in 2011. The report summarizes how subject species 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.

The report is organized as follows:

- Section III, Methods, explains how the project team gathered and used geographic data and other information from agencies, organizations, and experts.
- Section IV, Synthesis of Findings, provides an overview and summary of results for all of the priority species evaluated.
- Section V, Individual Species Summaries, describes each priority species in detail, including its ecology, status in Puget Sound, pathways of introduction and spread, impacts, management programs, and gaps. A series of maps is provided for each species; guidance for how to interpret each type of map is provided in Figures II-1 through II-3.
- Section VI, Invasive Species Management Components to Puget Sound Recovery, discusses the role of invasive species management in the overall effort to restore Puget Sound.
- Section VII, Involvement Opportunities, explains how to access the baseline data and participate in managing invasive species in Puget Sound.
- Section VIII, Appendices, includes additional background information and summary maps.

REPORT LIMITATIONS

The report authors compiled the information for the 21 priority species through diverse means. A broad-ranging survey was administered 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. The authors 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 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.

This baseline assessment presents information to support the Council's decision-making regarding management, funding, and outreach priorities. Maps are a primary feature of the report because they 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 in Puget Sound.

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. The project team did not create new data or modify existing data for the purposes of this assessment. 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, Methods).

While this report presents 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. 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 basin-wide spatial analyses. Overarching and species-specific gaps in availability of spatial data are addressed in Section IV, Synthesis of Findings, and Section V, Individual Species Summaries.

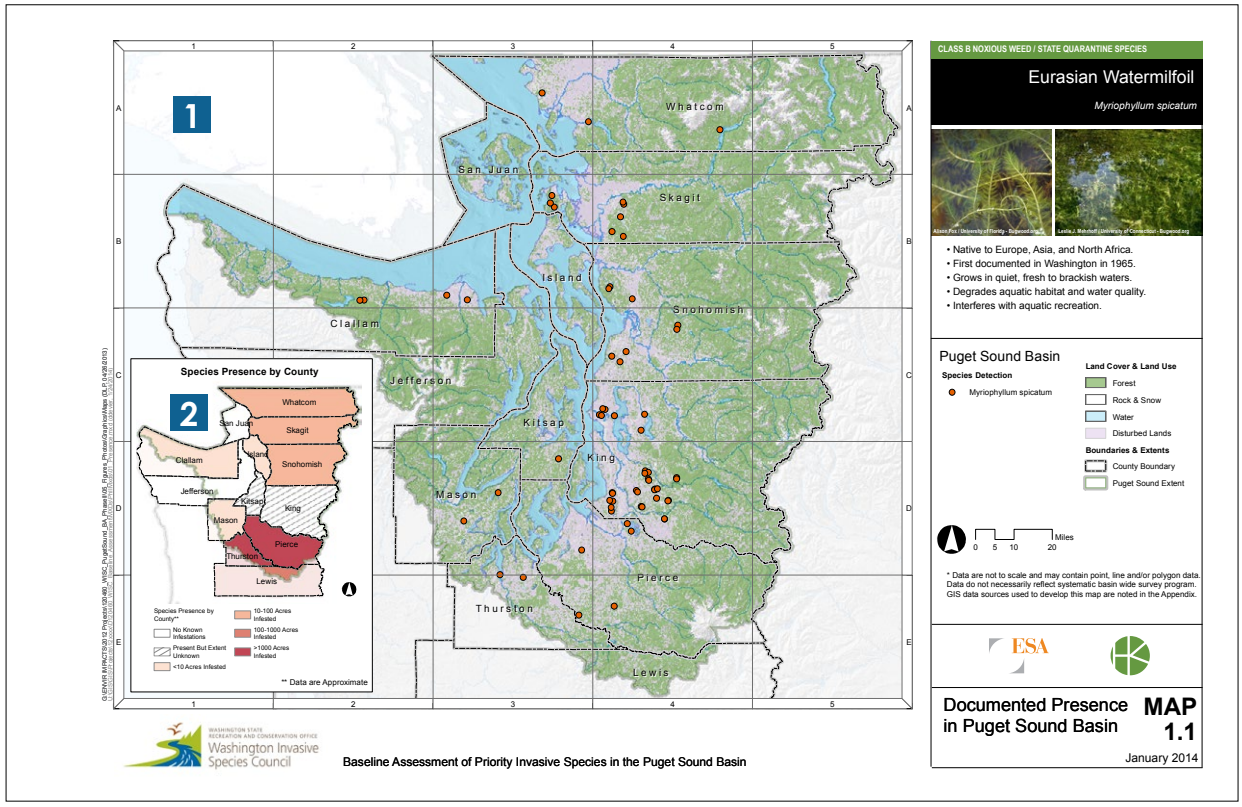


Figure II-1.

HOW TO INTERPRET THE "DOCUMENTED PRESENCE IN PUGET SOUND BASIN" MAPS

1 ***Main Map - Documented Presence*** The data displayed on these maps represent known occurences of individual species or populations. The data displayed were provided in a variety of formats including GPS, hard copy maps, and sighting reports. Data do not reflect systematic basin-wide surveys.

2 ***Inset Map - Species Presence by County*** The data displayed at the county level represent an approximation of the presence of a species in the county. The estimates are intended to complement the main map by providing more information on distribution of a species where specific location data have not been collected yet.

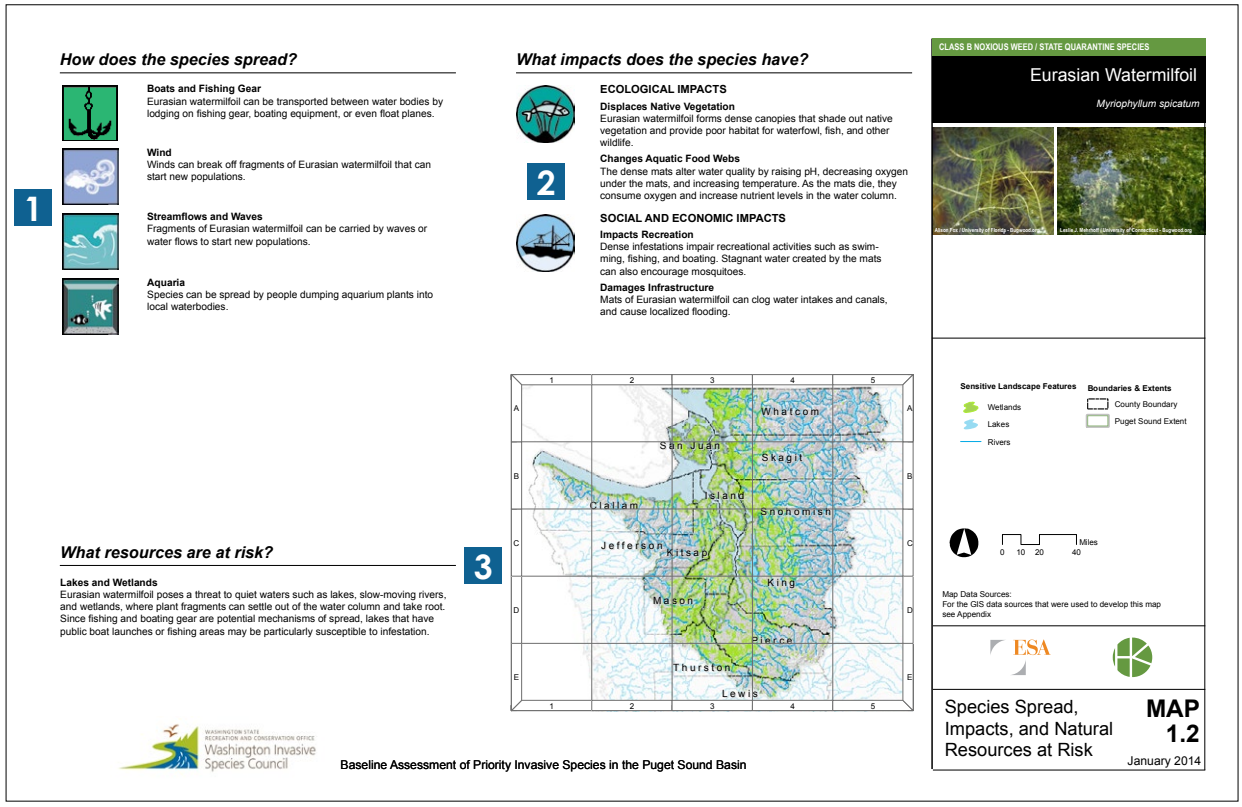


Figure II-2.

HOW TO INTERPRET THE "SPECIES SPREAD, IMPACTS, AND NATURAL RESOURCES AT RISK" MAPS

1 The most prevalent mechanisms of spread for each species. For a complete list of all of the species spread types and accompanying icons, see Table IV-1.

2 The ecological, and social and economic impacts of the species. For a complete list of all of the species impacts, see Tables IV-2 and IV-3.

3 Text and map describing natural resources put at risk by species.

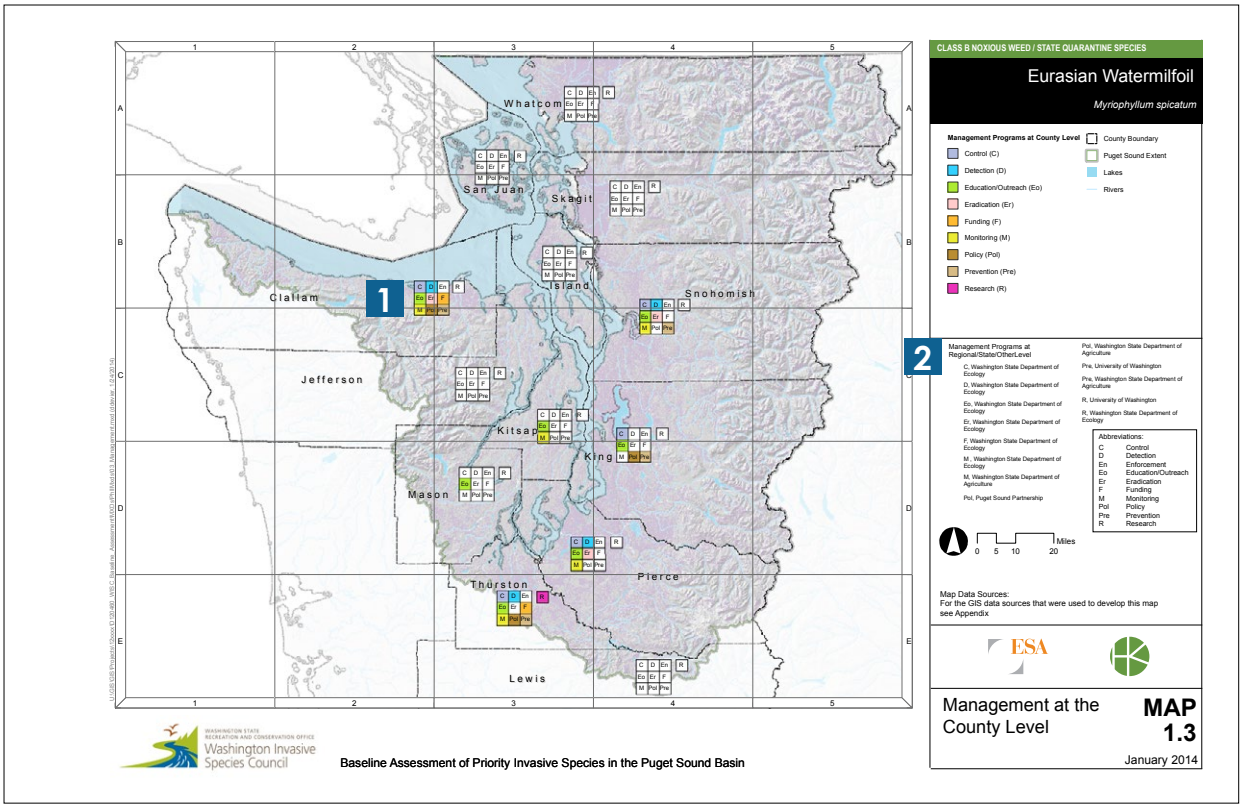


Figure II-3.

HOW TO INTERPRET THE "MANAGEMENT AT THE COUNTY LEVEL" MAPS

1 A color-filled box represents an active county-level management program type.

Control (C) - Treating, pulling, or otherwise removing/killing members of an invasive species population, with the goal of limiting its capability to establish or spread.

Detection (D) - Looking for new populations of invasive species.

Education/Outreach (Eo) - Helping 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 (En) - Ensuring laws governing the transport, control, or eradication of an invasive species are followed.

Eradication (Er) - Treating, pulling, or otherwise removing/killing an entire invasive species population, with the goal of completely removing the population.

Funding (F) - Providing funds to other organizations or agencies to conduct management activities.

Monitoring (M) - Surveying existing populations, or locations where populations were previously, to assess their status and trends.

Policy (Pol) - May include prohibitions against introduction of a species, or education/outreach designed to limit spread.

Prevention (Pre) - Helping to develop local, state, regional, or federal policies governing the management of invasive species.

Research (R) - Conducting research of the characteristics, spread, presence, response to treatment, or other attributes of an invasive species.

2 Regional and Statewide programs listed.

III. METHODS

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

DATA COMPILATION

We administered an online survey using Survey Monkey on October, 2012 to an initial distribution list of 246 individuals and organizations provided by Council staff. We also provided a project fact sheet to help individuals understand more about the project and target species for this phase of the baseline assessment (see Appendix C). The survey included several key questions for each species:

- Are you involved in programs or activities targeted at this species?
- Which of the below strategies or activities addressing the prevention, detection, or control of this species are you involved in?
- Do you have current or historical information for this species (Please consider the following types of data: published and unpublished reports, spread-sheets, or databases, GIS files, photos or images, other spatially explicit data)?
- What type of current or historic information do you have on this species?
- Would you like to upload data, URLs for online data, or programmatic information for this species at this time?

DATABASE DEVELOPMENT

The project team redesigned the Phase I baseline assessment (MS Access 2008 version) relational database to house and track the coordination, organizations, data files received and processed, programs, and references. The database was delivered along with the final geodatabase that includes all of the geospatial data collected from disparate sources for the project. The database includes:

- A front-end switchboard (Figure III-1) and set of forms to facilitate access viewing, querying, updating, and reporting items for species, organizations, and data.
- A catalog of organizations and individuals contacted as part of the baseline assessment that includes data and documents collected through the project (Figure III-2).
- Querying and reporting tools that summarize programs and data by species and region.
- Links to other external invasive species management resources and data sources.

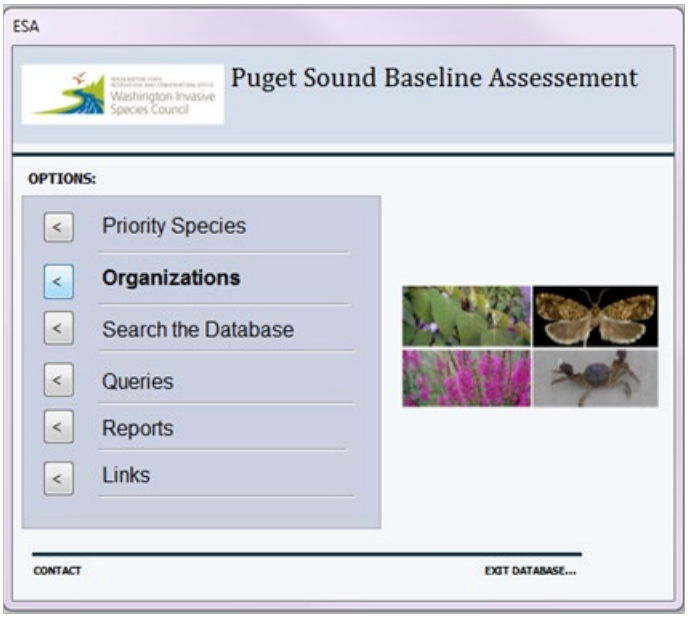


Figure III-1: Switchboard from MS Access Relational Database

METHODS

The database incorporates baseline information collected from the Phase I baseline assessment. This database is accessible online on the Washington Invasive Species Council's website at: http://www.invasivespecies.wa.gov/council_projects/baseline_assessment.shtml.

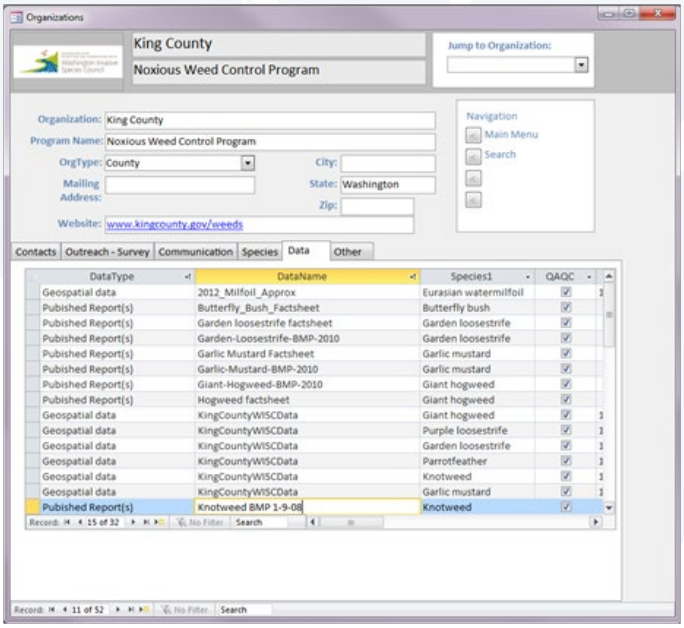


Figure III-2: Form displaying the organizational form and the data provided in the database

METADATA QUALITY REVIEW

We received data from a variety of sources throughout the Puget Sound Region. This included everything from personal communication to hard copy field maps to file geodatabases and Google Earth (.kmz) files. The quality of the data was reviewed by the project team for critical information including: observation/survey dates, methods, source, and activity. As part of the review, we developed a set of standards to validate the data to determine what information would need additional follow-up and what information met the criteria for inclusion into the species reports and maps. In most cases, we were able to use data files provided by all organizations and entities. Some required additional outreach or conversion of the data into more standardized formats.

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 priority species for this Phase II baseline assessment. To supplement information provided to the project team and to guide our species-specific analyses, we convened two groups of species experts: an animal expert working group and a plant expert working group. Each group met twice, in March and June 2013. 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.

SPATIAL SUMMARIES

We used the spatial data provided for the 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 Section V, Individual Species Summaries.

- ***Documented Presence*** Recorded locations of species presence in the Puget Sound Basin. This analysis includes all spatially explicit data on species presence in the Basin at any time. Species-specific disclaimers were needed for species that are known to be widespread (e.g., butterfly bush) or occurrences of these species in a particular county that are widely known but not recorded with spatially-explicit data (e.g., garden loosestrife in Snohomish and Skagit Counties).
- ***Species Pathways and Spread*** 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., boats and fishing gear, wind) are represented as icons in the Basin-wide "Species Spread, Impacts, and Natural Resources at Risk" maps in Section V.

- ***Resources at Risk*** Ecological features that are sensitive to invasion in the Puget Sound Basin. Resources currently impacted by or potentially threatened by a priority invasive species (e.g., wetlands, agricultural lands, estuaries) are included as data layers in the "Species Spread, Impacts, and Natural Resources at Risk" inset maps for each species in Section V.

MANAGEMENT ANALYSIS

Section V analyzes management efforts for the 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, for each species, we report the top three most commonly reported management program types, and the number of management efforts at each level. Broad regional programs that focus on multiple species in Puget Sound are not included in the summary of management programs for individual species.

GAP ANALYSIS

We assessed gaps in information for individual species and for the 21 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 Section IV, Synthesis of Findings; species-specific gaps are summarized in the relevant species discussions of Section V.

IV. SYNTHESIS OF FINDINGS

THE BASELINE ASSESSMENT

This Phase II baseline assessment summarizes the status and trends of 21 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 21 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.

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

Of the Council's 21 priority species, 15 species have been documented in the Puget Sound Basin (see Figure IV-1). The remaining six species are not yet known to be established in the Basin but are considered to pose a threat of invading the region.

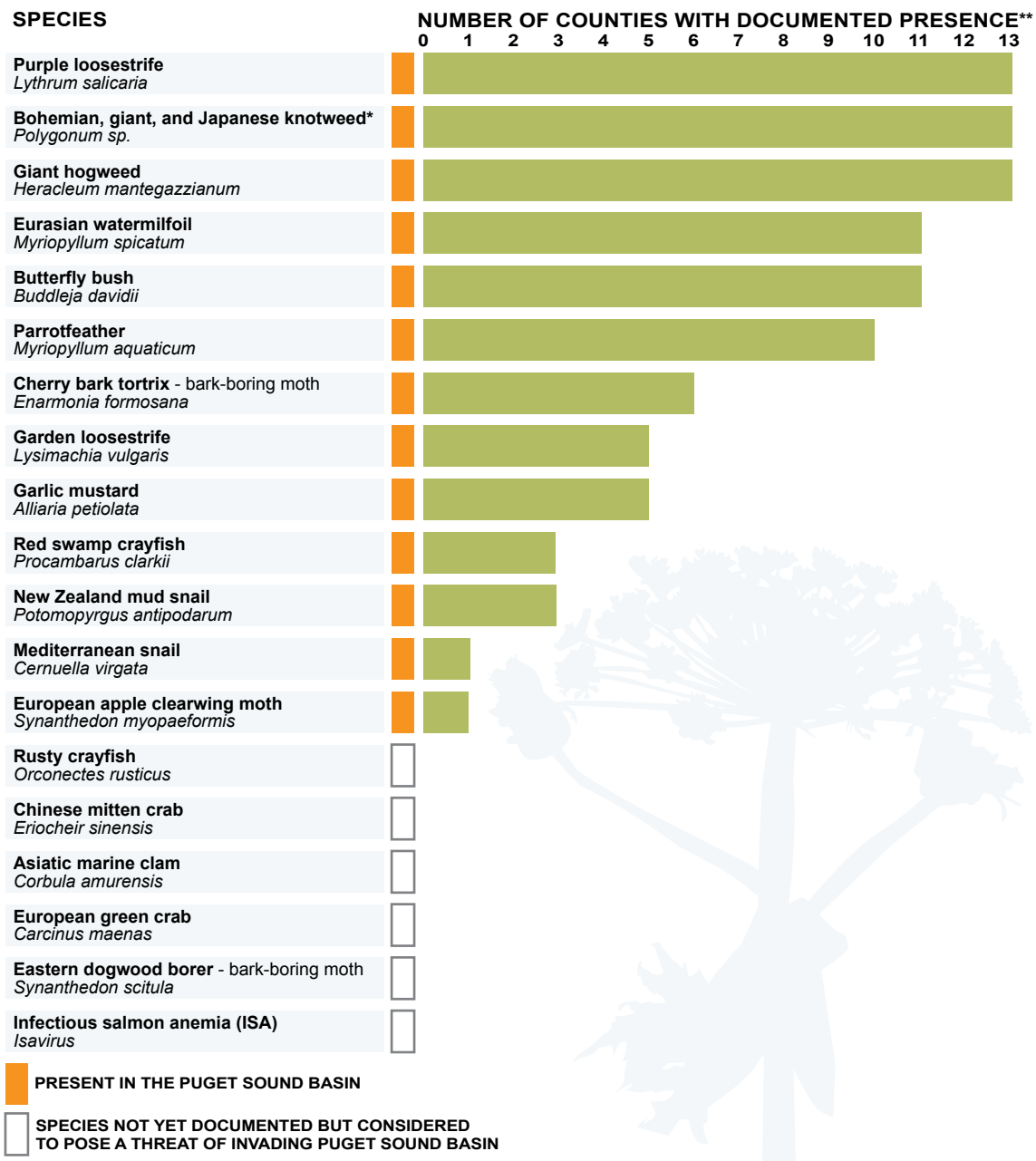
Figure F1 in Appendix F summarizes detection and notes the current status of the 21 species at the county scale. Throughout the report, information is often summarized by county due to the predominance of county-level management efforts for priority species in the Puget Sound Basin.

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, listed below and summarized in Table IV-1.

- ***Boats and Fishing Gear:*** Seven of the priority species can be spread among water bodies on boats or fishing gear. This is a significant pathway for Eurasian watermilfoil, for example, a freshwater aquatic plant whose long, feathery stems and leaves can be caught on boat propellers and other equipment.

SUMMARY OF PRIORITY SPECIES IN PUGET SOUND BASIN



*The three knotweed species are treated together because of their similar features and habitats, and the fact they can hybridize.

**Number of counties based on mapped (geospatial) species detections submitted to the project.

Figure IV-1.

- ***Wind:*** Eight species can be spread by wind. Aquatic plants may be carried by wind-blown currents. The tiny, winged seeds of terrestrial plants such as butterfly bush can be readily spread by wind. Wind also assists in the spread of adult bark-boring moth species.
- ***Streamflows and Waves:*** Eleven species can be spread by streamflows and waves. This includes not only aquatic species such as Eurasian water-milfoil and New Zealand mud snail, but also riparian terrestrial species such as knotweed. Ocean currents are a major factor in the spread of European green crab.
- ***Aquaria:*** Four species (two aquatic plants and two crayfish species) can be introduced or spread when people dump aquarium contents into local waters.
- ***Garden Ornamental:*** Nine of the 10 priority invasive plant species have been used as ornamental garden species. People continue to plant some of these species for their beauty or perceived benefit to wildlife (e.g., butterfly bush, which is actually thought to be detrimental to native butterfly species).
- ***Soil and Gravel Transport:*** Eight of the priority species can be spread by moving infested soil or gravel. Soil and gravel can contain viable seeds, roots, plant fragments, or even individual animals (such as New Zealand mud snails).
- ***Vehicles:*** Three of the priority species are thought to be spread by vehicles. Vehicles driving through wet areas can carry the seeds of purple loosestrife or tiny New Zealand mud snails over great distances. Mediterranean snails are known to climb onto vertical surfaces including vehicles and could "hitch a ride" to new areas.
- ***Wildlife:*** Three of the invasive species can be spread by wildlife, in particular waterfowl and other animal species that move among aquatic and upland areas, potentially transporting seeds, plant fragments, or snails.
- ***Trail Use:*** Hikers and off-road vehicles are similar to wildlife in their potential to transport three of the priority species (purple loosestrife, garlic mustard, and New Zealand mud snail).
- ***Shipping and International Trade:*** Seven of the priority species may be spread on cargo ships, in ballast water, or in infested agricultural materials such as fruit trees. Four of the six priority species that have not yet been documented in the Puget Sound Basin may be introduced through this pathway, highlighting the importance of continued vigilance at ports and other entry points.
- ***Live Bait:*** State regulations prohibit transporting live nonnative crayfish between water bodies. However, both of the priority crayfish species could be spread by anglers releasing unused live bait.
- ***Biological Supply Houses:*** Crayfish (including nonnative species) are sold for use in science classrooms. Well-meaning students or teachers may release them into local waters rather than euthanizing the crayfish when they are no longer needed for educational purposes.
- ***Food and Medicinals:*** All four priority crayfish and crab species could be introduced by people attempting to establish local populations as a food source. The most likely pathway for the ISA virus to reach fish in Puget Sound is thought to be from farmed Atlantic salmon in the open net pens in British Columbia.

As shown in Table IV-1, some species such as purple loose-strife can be spread through several different pathways, while others (such as some of the animal species) are limited to a few known pathways. The species summaries in this report (Section V) provide additional information about each of these pathways for individual priority species.

Table IV-1. Summary of Pathways of Introduction and Spread by Species. Species that have NOT been documented in the Puget Sound Basin are highlighted.

Species	Boats and Fishing Gear	Wind	Streamflows and Waves	Aquaria	Garden Ornamental	Soil and Gravel Transport	Vehicles	Wildlife	Trail Use	Shipping and International Trade	Live Bait	Biological Supply Houses	Food and Medicinals
Icon													
Eurasian watermilfoil *(Myriophyllum spicatum)*	X	X	X	X									
Parrotfeather *(Myriophyllum aquaticum)*	X		X	X	X								
Purple loosestrife *(Lythrum salicaria)*	X	X	X		X	X	X	X	X				
Garden loosestrife *(Lysimachia vulgaris)*	X		X		X								
Bohemian knotweed *(Polygonum bohemicum)*			X		X	X							
Giant knotweed *(Polygonum sachlinense)*			X		X	X							
Japanese knotweed *(Polygonum cuspidatum)*			X		X	X							
Butterfly bush *(Buddleja davidii)*		X	X		X	X							
Garlic mustard *(Alliaria petiolata)*		X			X			X	X				
Giant hogweed *(Heracleum mantegazzianum)*		X	X		X	X							
Mediterranean snail *(Cernuella virgata)*							X			X			
New Zealand mud snail *(Potomopyrgus antipodarum)*	X		X			X	X	X	X				
Red swamp crayfish *(Procambarus clarkii)*				X							X	X	X
Rusty crayfish *(Orconectes rusticus)*				X							X	X	X
Chinese mitten crab *(Eriocheir sinensis)*	X									X			X
Asiatic marine clam *(Corbula amurensis)*	X					X				X			
European green crab *(Carcinus maenas)*			X							X			X
Cherry bark tortrix *(Enarmonia formosana)* - bark-boring moth		X								X			
European apple clearwing moth *(Synanthedon myopaeformis)*		X								X			
Eastern dogwood borer *(Synanthedon scitula)* - bark-boring moth		X								X			
Infectious salmon anemia *(ISA)* (Isavirus)													X

IMPACTS OF INVASIVE SPECIES

Invasive species pose a threat to both ecological systems and human social and economic values, as summarized in Tables IV-2 and IV-3. The types of impacts that have been documented in this report are briefly described below:

ECOLOGICAL IMPACTS (TABLE IV-2)

- ***Displaces Native Vegetation and Wildlife:*** Fourteen of the priority invasive species are known to displace native vegetation or wildlife. Impacts on native vegetation often affect habitat for wildlife species. For example, purple loosestrife forms dense stands that outcompete native plants and provide poor habitat for waterfowl and other wildlife. Pollinators may favor purple loosestrife flowers, reducing pollination of native plants.

- ***Changes Aquatic Food Webs:*** Twelve of the priority species change aquatic food webs by degrading water quality, competing for food sources, changing the structure of aquatic habitat, affecting predator-prey interactions, blocking fish passage, altering nutrient cycles, transmitting or hosting diseases or parasites, bioaccumulating toxins, or physically displacing native aquatic species.

- ***Increases Erosion:*** The three knotweed species and giant hogweed can increase erosion of stream banks. These plants die back in winter, exposing the soil to rain and streamflows. Increases in erosion have indirect effects on aquatic communities by raising levels of turbidity and potentially damaging salmon redds.

SOCIAL AND ECONOMIC IMPACTS (TABLE IV-3)

- ***Impacts Recreation:*** Four of the priority species, all invasive plants, interfere with recreation by creating dense stands or mats of vegetation that can clog boat propellers or entangle swimmers. These species also indirectly affect hunting and recreational fishing by degrading wildlife habitat.

- ***Damages Infrastructure:*** Ten of the priority species damage infrastructure. Invasive aquatic plants can clog pipes or ditches and cause localized flooding. Plants such as knotweeds with extensive root systems are known to damage pavement. Red swamp crayfish and Chinese mitten crab can damage the structural integrity of levees and river banks through extensive burrowing.

- ***Agricultural Damage:*** Six of the priority species are known to cause agricultural damage. Purple loosestrife reduces the palatability of pastures for livestock, while garlic mustard can taint the flavor of milk. The Mediterranean snail's habit of climbing up on the stems of field crops can ruin the crops and damage harvesting equipment. The bark-boring moths damage both fruit trees and ornamental tree species.

- ***Human Health Risk:*** Four species pose a health risk to humans. Contact with the sap of giant hogweed can lead to severe burns. Consumption of raw or improperly prepared Chinese mitten crabs may transmit the Asian lung fluke. Green crabs can concentrate marine biotoxins and pass them up the food chain, causing illness in people who consume the crabs. Entanglement in Eurasian watermilfoil is a hazard to swimmers.

- ***Impacts Fisheries:*** Six of the priority species have a wide array of impacts on fisheries. Some of the impacts are indirect; for example, New Zealand mud snails can dominate aquatic ecosystems but provide poor food for fish. European green crabs can decimate bivalve populations, including commercially important species. Chinese mitten crabs have been known to steal bait off hooks and damage fishing nets.

Table IV-2. Summary of Ecological Impacts of Priority Invasive Species

Species	Displaces Native Vegetation and Wildlife	Changes Aquatic Food Webs	Increases Erosion
Eurasian watermilfoil *(Myriophyllum spicatum)*	X	X	
Parrotfeather *(Myriophyllum aquaticum)*	X	X	
Purple loosestrife *(Lythrum salicaria)*	X		
Garden loosestrife *(Lysimachia vulgaris)*	X		
Bohemian, giant, and Japanese knotweed* *(Polygonum sp.)*	X	X	X
Butterfly bush *(Buddleja davidii)*	X		
Garlic mustard *(Alliaria petiolata)*	X		
Giant hogweed *(Heracleum mantegazzianum)*	X		X
Mediterranean snail *(Cernuella virgata)*	X		
New Zealand mud snail *(Potomopyrgus antipodarum)*		X	
Red swamp crayfish *(Procambarus clarkii)*		X	
Rusty crayfish *(Orconectes rusticus)*		X	
Chinese mitten crab *(Eriocheir sinensis)*		X	
Asiatic marine clam *(Corbula amurensis)*		X	
European green crab *(Carcinus maenas)*		X	
Cherry bark tortrix *(Enarmonia formosana) - bark-boring moth*	X		
European apple clearwing moth *(Synanthedon myopaeformis)*	X		
Eastern dogwood borer *(Synanthedon scitula)* - bark-boring moth	X		
Infectious salmon anemia *(ISA)* (Isavirus)		X	

The three knotweed species are treated together in this report because of their similar features and habitats, and the fact they can hybridize.

Table IV-3. Summary of Social and Economic Impacts of Priority Invasive Species

Species	Impacts Recreation	Damages Infrastructure	Agricultural Damage	Human Health Risk	Impacts Fisheries
Eurasian watermilfoil *(Myriophyllum spicatum)*	X	X		X	
Parrotfeather *(Myriophyllum aquaticum)*	X	X			
Purple loosestrife *(Lythrum salicaria)*	X	X	X		
Garden loosestrife *(Lysimachia vulgaris)*	X	X			
Bohemian, giant, and Japanese knotweed* *(Polygonum sp.)*		X			
Butterfly bush *(Buddleja davidii)*		X			
Garlic mustard *(Alliaria petiolata)*			X		
Giant hogweed *(Heracleum mantegazzianum)*				X	
Mediterranean snail *(Cernuella virgata)*			X		
New Zealand mud snail *(Potomopyrgus antipodarum)*					X
Red swamp crayfish *(Procambarus clarkii)*		X			
Rusty crayfish *(Orconectes rusticus)*					X
Chinese mitten crab (Eriocheir sinensis)		X		X	X
Asiatic marine clam *(Corbula amurensis)*					X
European green crab *(Carcinus maenas)*				X	X
Cherry bark tortrix *(Enarmonia formosana)* - bark-boring moth			X		
European apple clearwing moth *(Synanthedon myopaeformis)*			X		
Eastern dogwood borer *(Synanthedon scitula)* - bark-boring moth			X		
Infectious salmon anemia *(ISA)* (Isavirus)					X

The three knotweed species are treated together in this report because of their similar features and habitats, and the fact they can hybridize.

MANAGEMENT EFFORTS

Organizations at multiple levels are involved in preventing and managing the spread of invasive species in the Puget Sound Basin. Table IV-4 summarizes management efforts by organizational level for the priority species. County agencies and organizations have the most numerous programs targeted at invasive plant species, followed by state entities. Fewer organizations have programs for the priority invasive animal species. Maps in Section V indicate the type of management programs reported by county agencies for each species.

Many agencies and entities are coordinating management of the same species. Almost all are working on education and outreach, and many are doing detection and control. In the absence of formal partnerships, cooperative management, status and trend monitoring protocols for individual species, and centralized data repositories, it is likely that existing invasive species management programs are not as productive or efficient as they could be.

Table IV-4. Programs addressing priority species in the Puget Sound Basin.

Species	No. Organizations with programs targeting priority species				Most common program types
	County	State	Federal	Other*	
Eurasian Watermilfoil	7	3	0	1	Education/outreach; Control, Monitoring & Prevention; Detection; Enforcement, Policy; Research
Parrotfeather	10	3	0	1	Education/outreach; Control and Monitoring; Policy; Detection; Funding; Prevention; Research
Purple loosestrife	9	3	0	0	Control; Education/outreach; Detection and Monitoring; Funding; Monitoring; Policy; Enforcement; Prevention
Garden loosestrife	6	3	0	0	Education/outreach; Control; Detection; Eradication; Funding; Monitoring; Policy; Enforcement; Prevention
Knotweeds	10	2	1	6	Education/Outreach; Control; Detection; Policy; Enforcement; Eradication; Funding; Prevention; Monitoring
Butterfly bush	9	2	0	1	Education/outreach; Monitoring; Control; Detection; Prevention; Policy; Eradication
Garlic mustard	9	2	0	0	Education/outreach; Monitoring; Detection; Policy; Enforcement; Funding; Prevention
Giant hogweed	10	2	0	0	Control; Education/outreach; Eradication; Detection; Monitoring; Enforcement; Policy; Funding; Prevention
Mediterranean snail	0	2	1	1	Control, Detection, Monitoring, Policy, Prevention; Enforcement; Eradication
New Zealand mud snail	2	2	3	1	Education/Outreach; Detection; Control; Prevention; Policy; Enforcement; Eradication; Prevention; Research; Monitoring
Red Swamp crayfish	0	2	0	1	Policy; Control; Detection; Enforcement; Education/outreach; Eradication; Monitoring; Prevention; Research
Rusty crayfish	0	2	0	1	Policy; Control; Detection; Enforcement; Education/outreach; Eradication; Monitoring; Prevention; Research
Chinese mitten crab	0	2	1	2	Policy; Control; Detection; Education/outreach; Enforcement; Monitoring; Prevention
Asiatic marine clam	0	1	0	2	Policy; Control; Prevention

"Other" includes city, private, NGO, research, inter-regional, and tribal organizations.

Species	No. Organizations with programs targeting priority species				Most common program types
	County	State	Federal	Other*	
European green crab	0	2	1	2	Policy; Detection; Enforcement; Education/outreach; Monitoring; Control; Prevention
Bark boring moths (cherry bark tortrix, European apple clearwig)	0	2	0	0	Education/Outreach; Policy; Monitoring
Infectious salmon anemia virus	0	0	0	2	Detection, Monitoring, Policy

"Other" includes city, private, NGO, research, inter-regional, and tribal organizations.

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. Table IV-5 summarizes some of the major funding sources for the state agencies that lead invasive species management in Puget Sound.

County NWCBs are funded either through a property assessment (authorized under RCW 17.10.240) or an appropriation from the county general fund. The Washington State NWCB has found that those counties with assessments typically have the most stable and effective noxious weed control programs. County funding is directed toward 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 IV-5. Major state agency funding sources for invasive species management.

Agency	Species addressed	Major funding sources
Ecology	Eurasian watermilfoil, parrotfeather	Freshwater Aquatic Weeds Account
WSDA	Purple loosestrife, knotweeds	Knotweed Control Program
WDFW	New Zealand mud snail, invasive crayfish species	Aquatic Nuisance Species (ANS) Program, Aquatic Invasive Species (AIS) Prevention and Enforcement Program
WDNR	Parrotfeather, purple loosestrife, knotweeds, butterfly bush	Natural Areas Program
WSDOT	Noxious weeds on State highway rights-of-way	WSDOT Maintenance Budgets

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, in turn affecting management decisions.

- Data collection methods are not standardized across all organizations assessing a given species. As a result, there is wide variability in the type and quality of data compiled for the majority of the priority species. For example, county noxious weed control boards have been providing knotweed data to the Washington Department of Agriculture on an annual basis, but each control board is collecting and managing its data differently, making it difficult to easily synthesize and maintain over the long term.

- Data collection efforts for some priority species and some geographic areas are more extensive, well-funded, and longer-term than for other species. The result is wide variability in the quantity and quality of data collected among the priority species. For example, because purple loosestrife and butterfly bush are so widespread and can infest remote areas, there are likely additional infestations that have not yet been recorded.
- Property ownership limits the ability of agencies to obtain accurate survey results for some invasive species. For example, because the Department of Ecology does not survey private lakes, it is possible there are additional infestations of nonnative aquatic vegetation (e.g., Eurasian water milfoil, parrotfeather) that have not yet been recorded.

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 them.

- There is good information about the pathways and impacts of the more widespread invasive species. However, the impacts of priority species that have not yet been documented in the Puget Sound Basin are unknown. Potential impacts can be inferred from research in other parts of the country or worldwide, but it is difficult to predict the consequences should these species become widespread here. For example, there is good information about the impacts of Asiatic marine clam in California, but this species is not yet documented in Puget Sound, and its impacts here (should it be introduced) are unknown.
- 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 among 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 (and too little funding) 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.

SYNTHESIS OF FINDINGS

MANAGEMENT EFFORTS

Gaps in management efforts and programs range from a lack of uniform management coverage for all 21 species throughout the 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 invasive plants, with fewer programs targeted toward invasive animal species.
- Funding levels for county noxious weed control boards are typically insufficient to cover those organizations' plant control mandates. This shortfall has significantly affected staff resources to carry out management objectives.
- There are variable levels of coordination among neighboring county weed boards.
- There are variable levels of management coordination among federal, state, local, and tribal entities across the Basin. This represents a missed opportunity to enhance efforts already being conducted by individual entities.
- There are variable levels of coordination with other states and Canadian provinces.
- 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 21 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 21 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.

IMPROVED COLLABORATION AND ALIGNMENT AMONG RELATED EFFORTS

There is a duplication of efforts across agencies, organizations, and entities managing the same invasive species, yet structured coordination and knowledge sharing are not common. In an era of shrinking program and research dollars, this lack of coordination across invasive species managers, researchers, and decision-makers limits the potential return on investment associated with individual efforts. For example, many public and private entities hire contractors and consultants to complete field work, yet there are no standard best management practices for field work in areas with known presence or vulnerability for WISC's priority invasive species.

SYNTHESIS OF FINDINGS

The mission of the WISC is to coordinate and provide planning and policy direction to those involved in the management of invasive species in the state. Strengthening the coordination among and 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 Salmon Recovery Council and WRIA Plan implementation.
- Puget Sound Nearshore Ecosystem Restoration Project.
- NOAA Northwest Fisheries Science Center's Integrated Ecosystem Assessment.
- Pacific Northwest Invasive Plant Council.
- Aquatic Nuisance Species Task Force.
- Marine Resource Councils.

As an example of a first step toward better coordination, agencies in the Basin could select a widespread invasive species as a pilot and work together to decide who would take the lead on different aspects of management. Rather than multiple agencies developing outreach materials, one agency could be in charge of creating materials that are flexible enough to be used throughout the Basin. Another agency could coordinate control efforts across the Basin. This approach encourages agencies to be explicit about what they are doing and why, and to be more efficient. This approach has been effective at the federal level, where the Invasive Species Advisory Committee worked with agencies to develop cross-cut budgets on two species. The approach proved so successful it was later expanded.

V. INDIVIDUAL SPECIES SUMMARIES

EURASIAN WATERMILFOIL
Myriophyllum spicatum

1

Eurasian watermilfoil is a submersed aquatic plant (rooted on the bottom of a water body) with finely dissected feather-like leaves arranged in whorls. It prefers quiet water such as lakes where plant fragments can settle out of the water column and take root. This species can tolerate a range of salinity, pH, temperature, nutrients, and water depth, making it very adaptable. While it can survive temporary dessication, drying for more than a few days will kill the plant and is one way of preventing its spread on boats or trailers.


Alison Fox - University of Florida/Bugwood.org

STATUS AND TRENDS

Species Presence (Map 1.1) Eurasian watermilfoil has been documented in 11 Puget Sound counties, with the highest number of documented occurrences in King and Snohomish counties. Most counties have several documented occurrences, particularly in the east Puget Sound region. The species has not been documented in Jefferson and San Juan counties. See Table 1.1 for a summary of data obtained for this species.

Presence over time Native to Europe, Asia, and North Africa, this species was first documented in Washington in 1965 and has since spread throughout the state. In western Washington, Eurasian watermilfoil was found in Lake Washington in 1974. Since then it has spread into dozens of water bodies statewide.

Table 1.1. Eurasian watermilfoil data provided to the baseline assessment project.

File Type Provided	# of files	Spatial Extent	Data Provider
Spatially Explicit Data			
ESRI GIS data (shapefiles, geodatabase feature classes)	11	Clallam County, King County, Kitsap County, Mason County, Pierce County, Skagit County, Snohomish County, Thurston County, Whatcom County	WDOE, University of Washington Herbarium
Tabular Data with Lat/Long (X/Y) Coordinates	1	Statewide	WDOE
Hard Copy Maps	7	Statewide; Snohomish County	WSDA, Thurston County, Snohomish County
Other Data			
Management or survey reports	46	Clallam County, King County, Skagit County, Statewide	Clallam County, King County, Skagit County, WDOE

EURASIAN WATERMILFOIL

Myriophyllum spicatum

PATHWAYS

Pathways of introduction Eurasian watermilfoil was introduced to North America in the 1940s, likely through the aquarium trade or attached to boats.

Pathways of spread (Map 1.2) Eurasian watermilfoil appears to be spread among water bodies primarily through boating activity and even by float planes in some areas. Sale or transport of this plant is prohibited in Washington but could still occur accidentally or illegally, through the aquarium trade or dumping of aquaria into local waters.

Although Eurasian watermilfoil can potentially spread by both seeds and vegetative means, spread by plant fragments is considered the major method of reproduction. During the growing season, the plant fragments spontaneously, and it can also be fragmented by wind, waves, and boating activities. Each fragment has the potential to produce a new plant, allowing the species to spread rapidly once introduced.

IMPACTS AND AT-RISK RESOURCES

Ecological impacts (Map 1.2) Eurasian watermilfoil forms dense canopies that shade out native vegetation and provide poor habitat for waterfowl, fish, and other wildlife. The dense mats alter water quality by raising pH, decreasing oxygen under the mats, and increasing temperature. As the mats die, they consume oxygen and increase nutrient levels in the water column.

Social and economic impacts (Map 1.2) Dense milfoil infestations impair recreational activities such as swimming, fishing, and boating. The underwater stems can pose a drowning hazard and become entangled with boating and fishing gear. Where the milfoil prevents water flow and creates stagnant conditions, it can encourage breeding of mosquitoes which are a nuisance and potential health hazard for humans and wildlife. Mats of Eurasian watermilfoil can clog water intakes and canals, and cause localized flooding.

MANAGEMENT

Table 1.2 and Map 1.3 summarize commonly reported program types and the number of entities reporting management activities for Eurasian watermilfoil.

State- or Puget Sound-level activities The Washington Department of Ecology surveys public lakes for Eurasian watermilfoil to help determine where funds should be allocated for control. State funding has helped local governments and lake groups to manage and even eradicate Eurasian watermilfoil in some water bodies around the state. Ecology and WDFW have been testing the use of milfoil weevil, a potential biological control agent.

County-level activities Organizations in 9 of the 11 counties with documented Eurasian watermilfoil occurrences reported management activities, which include control, detection, education/outreach, eradication, funding, monitoring, policy, prevention, and research. The specific management actions being utilized in the individual counties are shown on Map 1.3.

Table 1.2. Commonly reported management program types and number of organizations targeting Eurasian watermilfoil.

Entity	Three Most Commonly Reported Management Program Types (frequency)	Number of Organizations with current management activities
County	Education/outreach (7), Control, Monitoring & Prevention (5), Detection (4)	7
State	Enforcement (13), Monitoring (13), Policy (13), Prevention (13)	3
Federal	None	
Other	Prevention (13), Research (13)	1

EURASIAN WATERMILFOIL

Myriophyllum spicatum

Federal-level activities There are no known federal-level management activities in place for this species.

Other activities Private lake associations or shoreline homeowner groups often focus on controlling milfoil infestations within their lakes. Lake groups typically hire a consultant to help identify appropriate control methods and obtain permits.

Legal Authorities Eurasian watermilfoil is on Washington's Wetlands and Aquatics Quarantine list, meaning it is prohibited to transport, buy, sell, offer for sale, or distribute Eurasian watermilfoil plants or plant parts (Washington Administrative Code 16-752-505). Eurasian watermilfoil also is listed as a Class B Noxious Weed in Washington, meaning it is designated for control in certain state regions.

Funding The state Freshwater Aquatic Weeds Account, managed by the Washington Department of Ecology, was established in 1991 to provide financial and technical assistance to control nonnative invasive aquatic plants. The funding for the account comes from a $3 increase in annual license fees for boat trailers. Grants are available for the development of integrated aquatic plant management plans and for control of established weed populations.

SUMMARY OF GAPS

Data collection and management The Department of Ecology and county noxious weed boards cannot survey private lakes. Therefore it is possible there are additional infestations of Eurasian watermilfoil that have not been recorded.

Knowledge and understanding of species status, pathways, and impacts There is good information about how the species spreads and its impacts on ecosystems and recreational activities.

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.

SPECIES FACT

All milfoils have feather-like leaves arranged in whorls around the stem. However, distinguishing nonnative from native milfoil species is difficult and may require expert assistance or even DNA analysis. The Department of Ecology provides aids to identification on its web page: http://www.ecy.wa.gov/programs/wq/plants/weeds/milfoil.html.

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CLASS B NOXIOUS WEED / STATE QUARANTINE SPECIES

Eurasian Watermilfoil

Myriophyllum spicatum


Alison Fox / University of Florida - Bugwood.org


Leslie J. Mehrhoff / University of Connecticut - Bugwood.org

- Native to Europe, Asia, and North Africa.
- First documented in Washington in 1965.
- Grows in quiet, fresh to brackish waters.
- Degrades aquatic habitat and water quality.
- Interferes with aquatic recreation.

Puget Sound Basin

Species Detection

- Myriophyllum spicatum

Land Cover & Land Use

- Forest
- Rock & Snow
- Water
- Disturbed Lands

Boundaries & Extents

- County Boundary
- Puget Sound Extent

0 5 10 20 Miles

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. GIS data sources used to develop this map are noted in the Appendix.

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

Species Presence by County

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

Species Presence by County**
- No Known Infestations
- Present But Extent Unknown
- <10 Acres Infested
- 10-100 Acres Infested
- 100-1000 Acres Infested
- >1000 Acres Infested

** Data are Approximate

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WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

ESA

Documented Presence in Puget Sound Basin

MAP 1.1

January 2014

How does the species spread?

Boats and Fishing Gear
Eurasian watermilfoil can be transported between water bodies by lodging on fishing gear, boating equipment, or even float planes.

Wind
Winds can break off fragments of Eurasian watermilfoil that can start new populations.

Streamflows and Waves
Fragments of Eurasian watermilfoil can be carried by waves or water flows to start new populations.

Aquaria
Species can be spread by people dumping aquarium plants into local waterbodies.

What resources are at risk?

Lakes and Wetlands
Eurasian watermilfoil poses a threat to quiet waters such as lakes, slow-moving rivers, and wetlands, where plant fragments can settle out of the water column and take root. Since fishing and boating gear are potential mechanisms of spread, lakes that have public boat launches or fishing areas may be particularly susceptible to infestation.

What impacts does the species have?

ECOLOGICAL IMPACTS

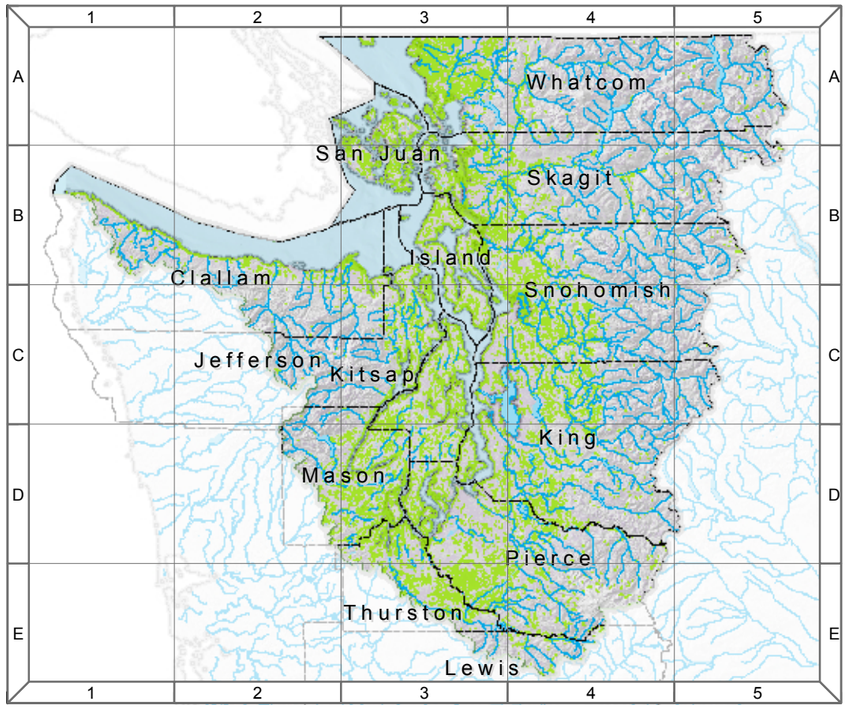
Displaces Native Vegetation
Eurasian watermilfoil forms dense canopies that shade out native vegetation and provide poor habitat for waterfowl, fish, and other wildlife.

Changes Aquatic Food Webs
The dense mats alter water quality by raising pH, decreasing oxygen under the mats, and increasing temperature. As the mats die, they consume oxygen and increase nutrient levels in the water column.

SOCIAL AND ECONOMIC IMPACTS

Impacts Recreation
Dense infestations impair recreational activities such as swimming, fishing, and boating. Stagnant water created by the mats can also encourage mosquitoes.

Damages Infrastructure
Mats of Eurasian watermilfoil can clog water intakes and canals, and cause localized flooding.



CLASS B NOXIOUS WEED / STATE QUARANTINE SPECIES

Eurasian Watermilfoil

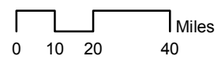
Myriophyllum spicatum


Alison Fox / University of Florida - Bugwood.org


Leslie J. Mehrhoff / University of Connecticut - Bugwood.org

Sensitive Landscape Features
- Wetlands
- Lakes
- Rivers

Boundaries & Extents
- County Boundary
- Puget Sound Extent



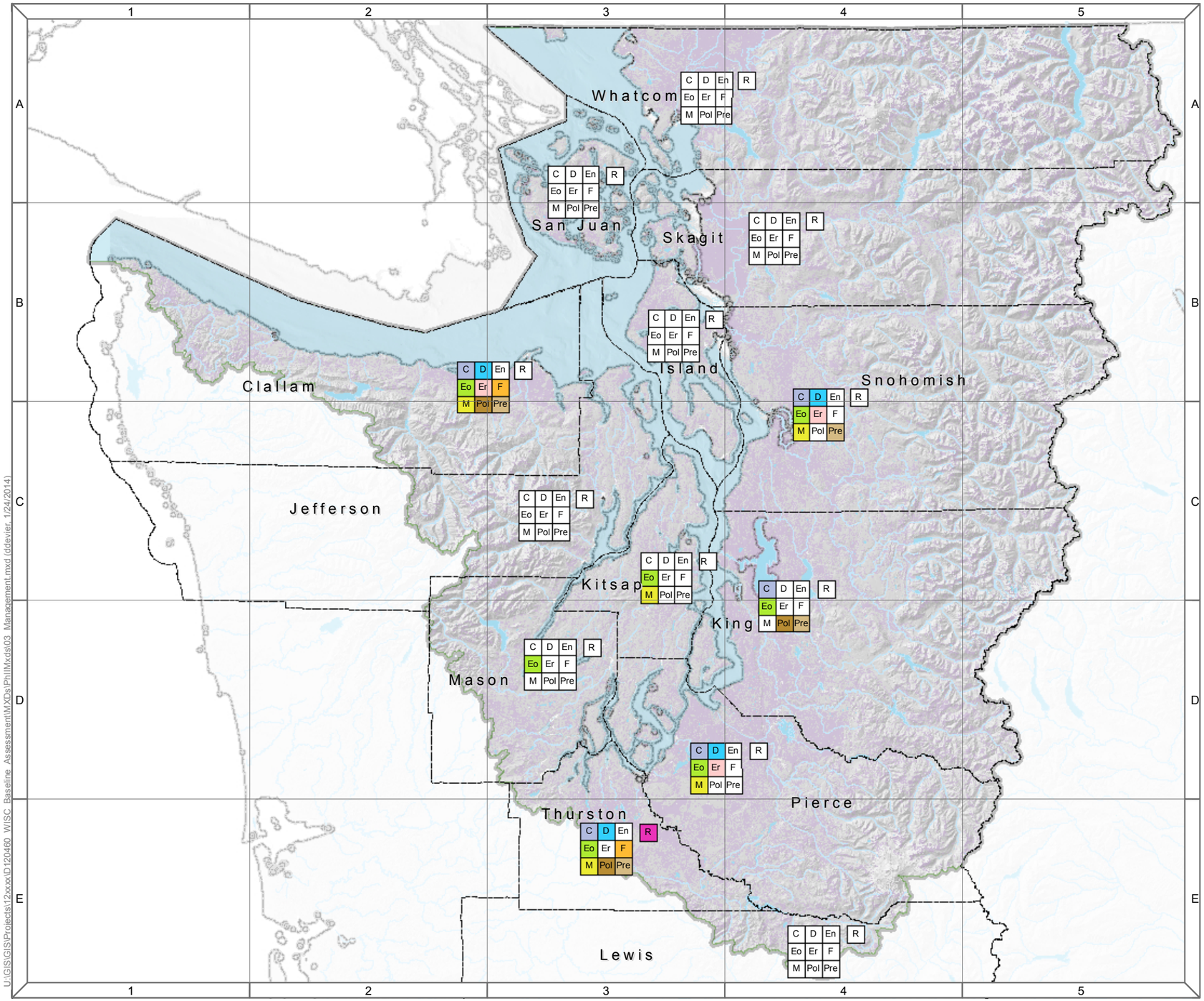
Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix

ESA

Species Spread, Impacts, and Natural Resources at Risk

MAP 1.2

January 2014



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CLASS B NOXIOUS WEED / STATE QUARANTINE SPECIES

Eurasian Watermilfoil

Myriophyllum spicatum

Management Programs at County Level

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

- County Boundary
- Puget Sound Extent
- Lakes
- Rivers

Management Programs at Regional/State/OtherLevel

C, Washington State Department of Ecology

D, Washington State Department of Ecology

Eo, Washington State Department of Ecology

Er, Washington State Department of Ecology

F, Washington State Department of Ecology

M , Washington State Department of Ecology

M, Washington State Department of Agriculture

Pol, Puget Sound Partnership

Pol, Washington State Department of Agriculture

Pre, University of Washington

Pre, Washington State Department of Agriculture

R, University of Washington

R, Washington State Department of Ecology

Abbreviations:

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

0 5 10 20 Miles

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

ESA

Management at the County Level

MAP 1.3

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

PARROTFEATHER
Myriophyllum aquaticum

2

Parrotfeather is a bright green aquatic plant with leaves that grow above the water and resemble tiny fir trees. It grows in slow-moving rivers, ditches, shallow freshwater lakes and ponds, and the wet soil found along shorelines.


Phil Westra/Bugwood.org


Howard Schwartz/Bugwood.org

STATUS AND TRENDS

Species Presence (Map 2.1) Parrotfeather has been documented in 10 Puget Sound counties, with the highest number of documented sites occurring in the east Puget Sound counties. Most of the documented sites are small, private ponds. A high presence rate is reported in northern Lewis County, although site-specific geospatial data are not available. See Table 2.1 for a summary of data obtained for this species.

Presence over time Parrotfeather was probably introduced from South America for the aquarium trade in the 1800s. The earliest record from Washington is 1944. It has since spread to many sites across western Washington.

Table 2.1. Parrotfeather data provided to the baseline assessment project.

File Type Provided	# of files	Spatial Extent	Data Provider
Spatially Explicit Data			
ESRI GIS data (shapefiles, geodatabase feature classes)	9	Island County, King County, Pierce County, San Juan County, Skagit County, Snohomish County, Whatcom County	WDOE, WSU, San Juan County, Whatcom County
Tabular Data with Lat/Long (X/Y) Coordinates	1	Whatcom County, Statewide	Whatcom County, WDOE
Hard Copy Maps	2	San Juan County, Statewide	San Juan County, WSDA
Other Data			
Management or survey reports	3	Clallam County, Island County, King County	Clallam County, Island County, King County

PATHWAYS

Pathways of introduction Parrotfeather was likely introduced primarily for use in fountains, ornamental ponds, and fish aquaria. The species escaped cultivation and has naturalized worldwide.

Pathways of spread (Map 2.2) All parrotfeather plants in the United States are female; the species doesn't form seeds but spreads readily by fragmentation of stems and rhizomes. The rhizomes can survive and be transported over long distances on boat trailers. The species can also be spread by people dumping aquaria into local water bodies. Parrotfeather has been used as an ornamental species in water gardens, although its sale and transport are illegal in Washington.

Unlike Eurasian watermilfoil, parrotfeather does not fragment on its own, but fragments can be broken off mechanically and readily root. A fragment as small as ½ inch that includes a node can form a new plant.

PARROTFEATHER

Myriophyllum aquaticum

IMPACTS AND AT-RISK RESOURCES

Ecological impacts (Map 2.2) Parrotfeather rapidly forms dense mats that can cover the water surface, accelerate flooding, block passage for salmon, shade out algae that form the base of the aquatic food web, cause water quality issues, and provide habitat for mosquito larvae.

Social and economic impacts (Map 2.2) Parrotfeathers' tough stems impede boating, swimming, and other water recreation. Dense infestations can clog drainage ditches and result in localized flooding.

MANAGEMENT

Table 2.2 and Map 2.3 summarize commonly reported program types and the number of entities reporting management activities for parrotfeather.

State- or Puget Sound-level activities The Washington Department of Ecology surveys public lakes for invasive aquatic plants such as parrotfeather to help determine where funds should be allocated for control.

County-level activities Organizations in 7 of the 10 Puget Sound counties with documented parrotfeather occurrences reported management activities, which include control, detection, enforcement, education/outreach, eradication, funding, monitoring, policy, prevention, and research.

Federal-level activities There are no known federal-level management activities in place for this species.

Other activities One organization reported prevention and research activity.

Table 2.2. Commonly reported management program types and number of organizations targeting parrotfeather.

Entity	Three Most Commonly Reported Management Program Types (frequency)	Number of Organizations with current management activities
County	Education/outreach (5), Control and Monitoring (4)	10
State	Policy, Monitoring (2), Control, Detection, Education/ Outreach, Funding, Prevention (1)	3
Federal	None	
Other	Prevention, Research (1)	1

Legal authorities Parrotfeather is on Washington's Wetlands and Aquatics Quarantine list, meaning it is prohibited to transport, buy, sell, offer for sale, or distribute parrotfeather plants or plant parts (Washington Administrative Code 16-752-505). Parrotfeather is listed as a Class B noxious weed in Washington, meaning it is designated for control in certain state regions.

Funding The state Freshwater Aquatic Weeds Account, managed by the Washington Department of Ecology, was established in 1991 to provide financial and technical assistance to control nonnative invasive aquatic plants. The funding for the account comes from a $3 increase in annual license fees for boat trailers. Grants are available for the development of integrated aquatic plant management plans and for control of established weed populations.

As part of the Natural Areas Program, the Washington Department of Ecology and Department of Natural Resources provide funding for local parrotfeather survey, control, outreach, and monitoring efforts.

PARROTFEATHER

Myriophyllum aquaticum

SUMMARY OF GAPS

Data collection and management The Department of Ecology and county noxious weed boards cannot survey private lakes. Therefore it is possible there are additional infestations of parrotfeather that have not been recorded.

Knowledge and understanding of species status, pathways, and impacts There is good information about how the species spreads and its impacts on ecosystems and recreational activities.

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.

SPECIES FACT

The emergent stems of parrotfeather are distinctive, sticking up from the water surface like tiny fir trees. The underwater portion of the plant may be mistaken for its relative, Eurasian watermilfoil.

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Washington State Noxious Weed Control Board. 1994. Written findings – Parrotfeather. Available: http://www.nwcb.wa.gov/siteFiles/Myriophyllum_aquaticum.pdf. Accessed December 2012.

CLASS B NOXIOUS WEED / STATE QUARANTINE SPECIES

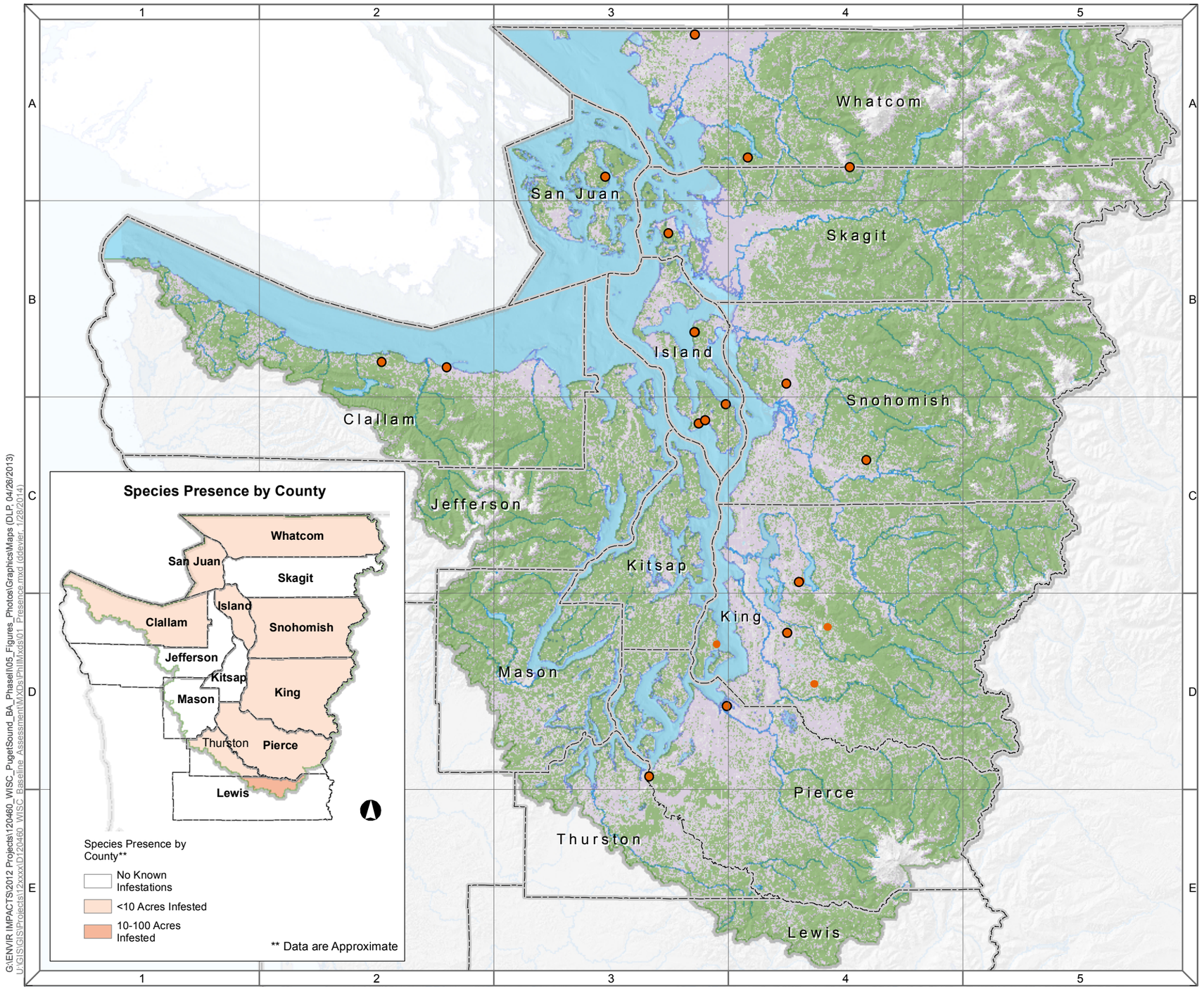
Parrotfeather

Myriophyllum aquaticum


Phil Westra/Colorado State University- Bugwood


Howard F. Schwartz/Colorado State University - Bugwood.org

- Native to South America.
- Earliest record from Washington is 1944.
- Grows in slow moving fresh waters and wet shorelines.
- Degrades aquatic habitat and water quality.
- Interferes with aquatic recreation.



Puget Sound Basin

Species Detection

- Myriophyllum aquaticum

Land Cover & Land Use

- Forest
- Rock & Snow
- Water
- Disturbed Lands

Boundaries & Extents

- County Boundary
- Puget Sound Extent

0 5 10 20 Miles

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. GIS data sources used to develop this map are noted in the Appendix.

ESA

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

Documented Presence in Puget Sound Basin

MAP 2.1

January 2014

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How does the species spread?

Boats and Fishing Gear
Parrotfeather rhizomes can be transported over long distances on boat trailers.

Aquaria
Parrotfeather can spread by people dumping aquaria into local waterbodies.

Streamflows and Waves
Fragments of parrotfeather can be broken off and carried to other waterbodies where they can readily root.

Garden Ornamental
Parrotfeather has been used as an ornamental plant in water gardens. Its sale and transport are illegal in Washington.

What resources are at risk?

Lakes and Wetlands
Shallow waters (lakes, ponds, ditches) are at greatest risk.

What impacts does the species have?

ECOLOGICAL IMPACTS

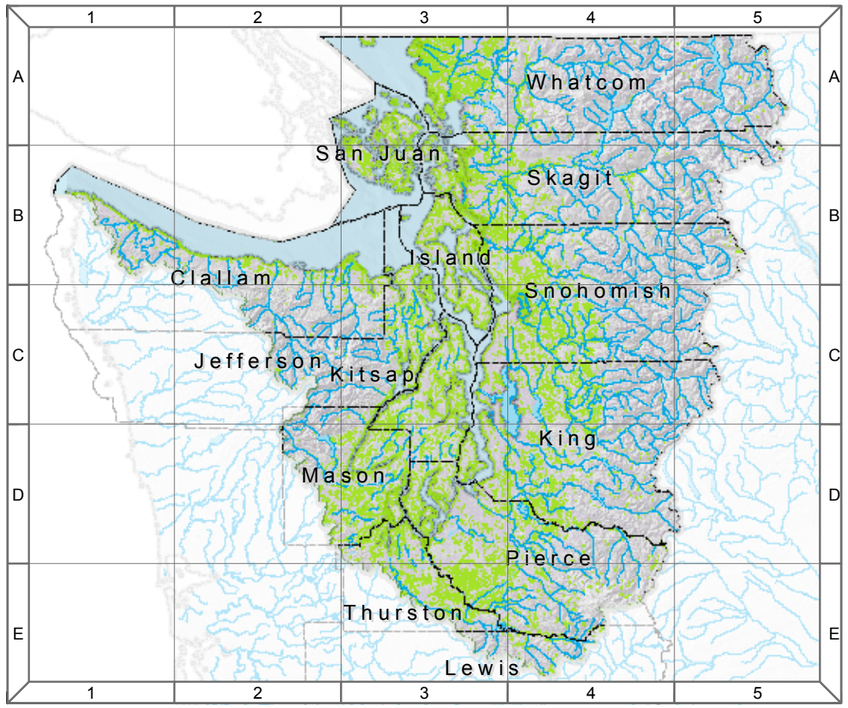
Displaces Native Vegetation
Parrotfeather rapidly forms dense mats that can cover the water surface and outcompete native vegetation.

Changes Aquatic Food Webs
Parrotfeather mats can block passage for salmon, shade out algae that form the base of the aquatic food web, and cause water quality issues.

SOCIAL AND ECONOMIC IMPACTS

Impacts Recreation
Parrotfeathers' tough stems impede boating, swimming, and other water recreation and increase habitat for mosquitoes.

Damages Infrastructure
Dense infestations can clog drainage ditches and result in localized flooding.



CLASS B NOXIOUS WEED / STATE QUARANTINE SPECIES

Parrotfeather

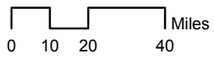
Myriophyllum aquaticum


Phil Westra/Colorado State University- Bugwood


Howard F. Schwartz/Colorado State University - Bugwood.org

Sensitive Landscape Features
- Wetlands
- Lakes
- Rivers

Boundaries & Extents
- County Boundary
- Puget Sound Extent



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

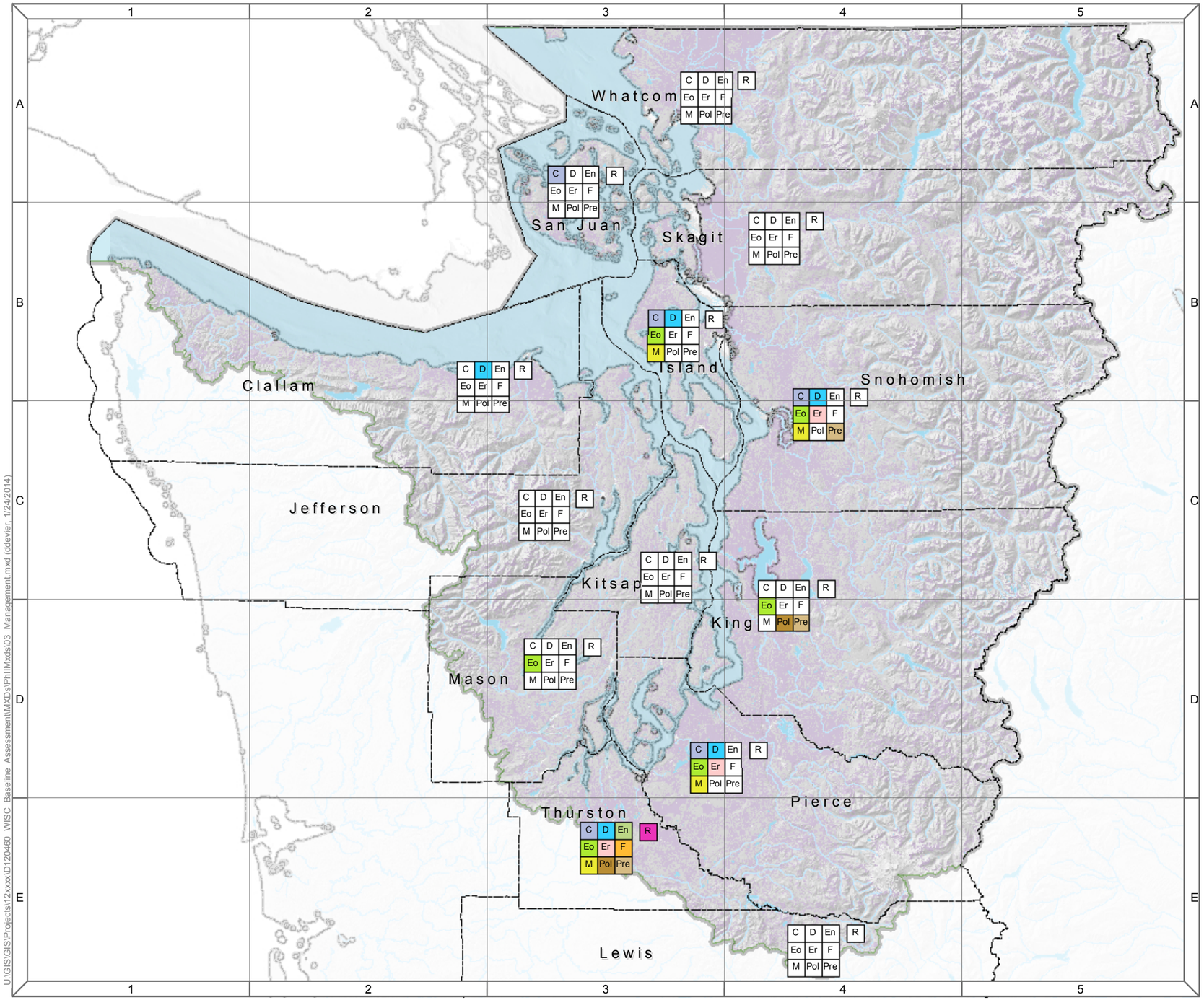
ESA

Species Spread, Impacts, and Natural Resources at Risk

MAP 2.2

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council



CLASS B NOXIOUS WEED / STATE QUARANTINE SPECIES

Parrotfeather

Myriophyllum aquaticum

Management Programs at County Level

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

- County Boundary
- Puget Sound Extent
- Lakes
- Rivers

Management Programs at Regional/State/OtherLevel

C, Washington State University

D, Washington State Department of Ecology

Eo, Washington State Department of Ecology

Er, Washington State Department of Ecology

F, Washington State Department of Ecology

M , Washington State Department of Ecology

M, Washington State Department of Agriculture

Pol, Puget Sound Partnership

Pol, Washington State Department of Agriculture

Pre, University of Washington

Pre, Washington State Department of Agriculture

R, University of Washington

Abbreviations:

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

0 5 10 20 Miles

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

ESA

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

Management at the County Level

MAP 2.3

January 2014

PURPLE LOOSESTRIFE
Lythrum salicaria

3

Purple loosestrife is a perennial wetland plant up to 9 feet tall, with showy spikes of purple flowers. It is found in freshwater and brackish wetlands, wet meadows, river and stream banks, pond edges, reservoirs, and ditches. Purple loosestrife is included on the IUCN's list of 100 of the world's worst alien invasive species.

STATUS AND TRENDS

Species Presence (Map 3.1) Purple loosestrife is widespread throughout the Puget Sound Basin, documented in all 13 Puget Sound counties. The highest concentration of detected occurrences is located in western King and Snohomish Counties. See Table 3.1 for a summary of data obtained for this species.

Presence over time Purple loosestrife was introduced to the eastern United States in ship ballast from Europe during the 1800s. During the next century the species spread west through waterways, and through planting as an ornamental and for bee forage. Major highways also appear to have played a historic role in spreading the species from east to west across the United States. It arrived in Pacific Northwest estuaries in the early 1900s, likely spread by marine traffic. Purple loosestrife was first collected in the state in 1929 from Lake Washington. It is now likely present in all counties throughout the Pacific Northwest.

Table 3.1. Purple loosestrife data provided to the baseline assessment project.

File Type Provided	# of files	Spatial Extent	Data Provider
Spatially Explicit Data			
ESRI GIS data (shapefiles, geodatabase feature classes)	20	Island County, Jefferson County, King County, Kitsap County, Lewis County, Mason County, Pierce County, San Juan County, Skagit County, Snohomish County, Thurston County, Whatcom County	WDOE, WSU, Jefferson County NWCB, University of Washington, WSDA, San Juan County, Snohomish County NWCB, Thurston County, Whatcom County
Tabular Data with Lat/Long (X/Y) Coordinates	2	Puget Sound-wide/Statewide	WDOE, WSDOT
Hard Copy Maps	2	San Juan County, Statewide	San Juan County NWCB, WSDA
Other Data			
Management or survey reports	11	Clallam County, Island County, King County, Statewide	WSDA, WDOE, Clallam County NWCB, King County NWCB, Island County NWCB

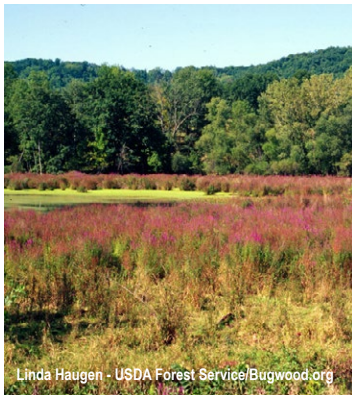
PURPLE LOOSESTRIFE

Lythrum salicaria

PATHWAYS

Pathways of introduction Native to Europe and Asia, purple loosestrife was introduced to eastern North America from ship ballast in the 1800s and as an ornamental plant in the 1900s. The expansion of the plant across the country coincided with development of national and regional transportation systems, commercial distribution of the plant for horticultural uses, and regional propagation of plant seed for growing bee forage.

Pathways of spread (Map 3.2) Each purple loosestrife plant can produce millions of tiny seeds annually, building a huge seed bank in the soil. Loosestrife can also spread by root fragments. Seeds and plant parts can be carried downstream by water or transported by people, animals, boats, and vehicles. Gardeners may trade the species as an ornamental, although sale and transport is illegal in the state. There is some evidence of wind dispersal.



SPECIES FACT

"The Union Bay Natural Area lies along the shoreline of Lake Washington at the University of Washington campus. This former marshland was historically used as a lumber mill and then as Seattle's largest garbage dump until the 1960s. Following closure of the landfill, efforts began to restore the site's ecology, including the control of invasive plant species that had overtaken the site. One of these species is purple loosestrife, which once covered most of the wetlands in the natural area. Control efforts started in 1990, first with hand removal and then with biological control using the Gallerucella beetle which is specific to purple loosestrife. This program has been very effective, with purple loosestrife reduced to isolated patches that are kept in check by the beetles."

- King County Noxious Weed Program

IMPACTS AND AT-RISK RESOURCES

Ecological impacts (Map 3.2) Purple loosestrife forms dense stands that outcompete native plants and provide poor habitat for waterfowl and other wildlife. These dense stands also trap sediment and can alter the flow of water. The abundant, showy flowers of purple loosestrife attract pollinators and have been shown to reduce pollination and seed set in some native plant species.

Social and economic impacts (Map 3.2) Large loosestrife infestations degrade recreational hunting and trapping areas. The species alters the structure and function of wetlands, clogs waterways and irrigation systems, and reduces the quality of livestock forage. Because older purple loosestrife plants are unpalatable to cattle and deer, the loosestrife can eventually take over pastures and hayfields.

MANAGEMENT

Table 3.2 and Map 3.3 summarize commonly reported program types and the number of entities reporting management activities for purple loosestrife.

State- or Puget Sound-level activities The Washington State Department of Agriculture (WSDA) works with county, state, and federal programs throughout the state to help coordinate research and control efforts for purple loosestrife.

Recognizing that purple loosestrife is found in almost every county in Washington and is difficult to eliminate in some areas, WSDA's goal is for long-term control of the species.

WSDA led the formation of a statewide noxious weed biological control working group in 2000. This group coordinates releases statewide of biocontrol agents including insect species for control of purple loosestrife.

PURPLE LOOSESTRIFE

Lythrum salicaria

County-level activities Purple loosestrife is present in all 13 Puget Sound counties, of which 8 reported management activities for this species. Reported management activities include control, detection, enforcement, education/outreach, eradication, funding, monitoring, policy, prevention, and research.

Federal-level activities There are no known federal-level management activities in place for this species.

Other activities There are no other known management activities in place for this species.

Table 3.2. Commonly reported management program types and number of organizations targeting purple loosestrife.

Entity	Three Most Commonly Reported Management Program Types (frequency)	Number of Organizations with current management activities
County	Control and Education/outreach (8), Detection and Monitoring (6)	9
State	Detection, Eduction/outreach, Funding, Monitoring, Policy (2), Control, Enforcement, Prevention (1)	3
Federal	None	
Other	None	

Legal authorities The Washington State Department of Agriculture devotes significant resources to managing this species under the Control of Spartina and Purple Loosestrife regulation (Chapter 17.26 RCW, Chapter 16.752 WAC). Purple loosestrife is listed as a Class B Noxious Weed in Washington, meaning it is designated for control in certain state regions.

According to the State quarantine law (WAC 16.752.400-415), it is illegal to transport, buy, sell, offer to sell or to distribute plants, plant parts or seeds of purple loosestrife into or within the state of Washington. The quarantine applies to all purple loosestrife species, including any hybrid cross and all named cultivars.

Funding As the lead state agency for purple loosestrife control, WSDA uses its allocated state funds to assist county noxious weed boards and other entities with control activities. In addition, as part of the Natural Areas Program, the Washington Departments of Agriculture, Ecology, and Natural Resources provide funding for local survey and control efforts.

SUMMARY OF GAPS

Data collection and management While the highest concentration of detected occurrences is located in western King and Snohomish Counties, it is unclear whether this reflects the actual distribution of purple loosestrife in the basin, or a greater intensity of survey effort in these counties.

Knowledge and understanding of species status, pathways, and impacts Because purple loosestrife is so widespread and can infest remote areas, there are likely additional infestations that have not yet been recorded. The pathways and impacts of the species are well known.

Management efforts While purple loosestrife is documented in all 13 Puget Sound Basin counties, only 8 counties reported management activities.

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CLASS B NOXIOUS WEED / STATE QUARANTINE SPECIES

Purple Loosestrife

Lythrum salicaria


Steve Dewey/Utah State University/Bugwood.org


Linda Haugen/USDA Forest Service/Bugwood.org

- Native to Europe and Asia.
- First collected in Washington in 1929.
- Grows in fresh and brackish water, wet shorelines.
- Degrades aquatic habitat.
- Impacts hunting and grazing areas.

Puget Sound Basin

Species Detection

- Lythrum salicaria

Land Cover & Land Use

- Forest
- Rock & Snow
- Water
- Disturbed Lands

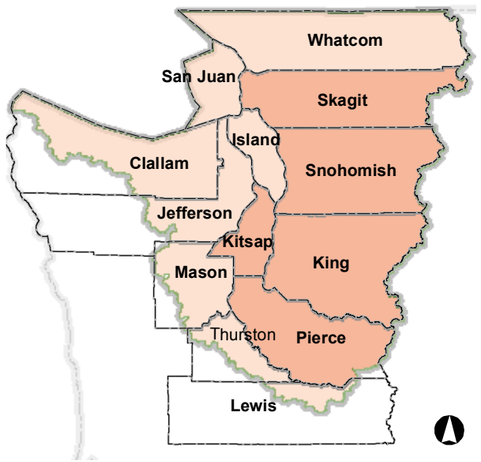
Boundaries & Extents

- County Boundary
- Puget Sound Extent

Miles
0 5 10 20

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. GIS data sources used to develop this map are noted in the Appendix.

Species Presence by County



Species Presence by County**

- <10 Acres Infested
- 10-100 Acres Infested

** Data are Approximate

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

ESA

Documented Presence in Puget Sound Basin

MAP 3.1

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

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How does the species spread?

Soil and Gravel Transport
Transport of soil contaminated with purple loosestrife seeds or root fragments can spread the plant to new areas.

Boats and Fishing
Purple loosestrife seeds or root fragments can be spread on boats or fishing gear.

Vehicles
Seeds and plant parts can be carried by vehicles to new areas, for example by sticking to muddy tires. The expansion of the plant across the country coincided with development of national and regional transportation systems.

Wind
There is some evidence of wind dispersal of purple loosestrife.

Wildlife
Purple loosestrife seeds and plant parts can be transported by wildlife moving between different wetlands or riparian areas.

Streamflows and Waves
Seeds and plant parts can be carried downstream by water.

Trail Use
Hikers can spread seeds that stick to muddy boots or gear.

Garden Ornamental
While sale and transport of purple loosestrife is illegal in the State, it is still traded by gardeners.

What resources are at risk?

Waterbodies and Shorelines
Purple loosestrife is widespread in the Puget Sound region, being found in freshwater and brackish wetlands, wet meadows, river and stream banks, pond edges, reservoirs, and ditches.

What impacts does the species have?

ECOLOGICAL IMPACTS

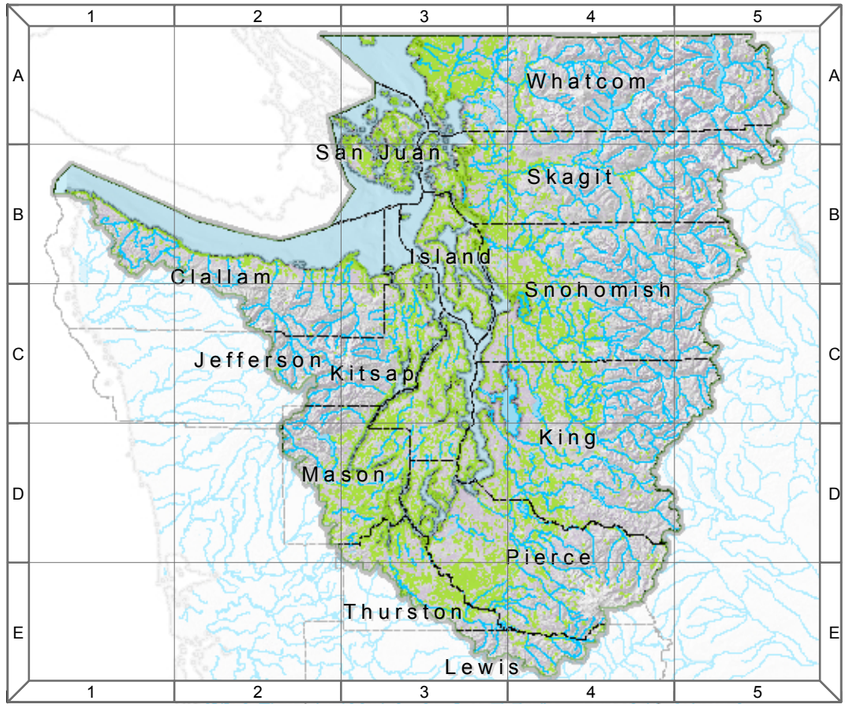
Displaces Native Vegetation and Wildlife
Purple loosestrife forms dense stands that outcompete native plants and provide poor habitat for waterfowl and other wildlife. Pollinators may favor purple loosestrife flowers, reducing pollination of native plants.

SOCIAL AND ECONOMIC IMPACTS

Impacts Recreation
Large loosestrife infestations degrade recreational hunting and trapping areas.

Damages Infrastructure
Dense stands can trap sediment and alter the flow of water, clogging waterways and irrigation systems.

Agricultural Damage
Because older purple loosestrife plants are unpalatable to cattle and deer, the loosestrife can eventually take over pastures and hayfields.



CLASS B NOXIOUS WEED / STATE QUARANTINE SPECIES

Purple Loosestrife

Lythrum salicaria


Steve Dewey/Utah State University/Bugwood.org


Linda Haugen/USDA Forest Service/Bugwood.org

Sensitive Landscape Features
- Wetlands
- Lakes
- Rivers

Boundaries & Extents
- County Boundary
- Puget Sound Extent

Miles
0 10 20 40

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

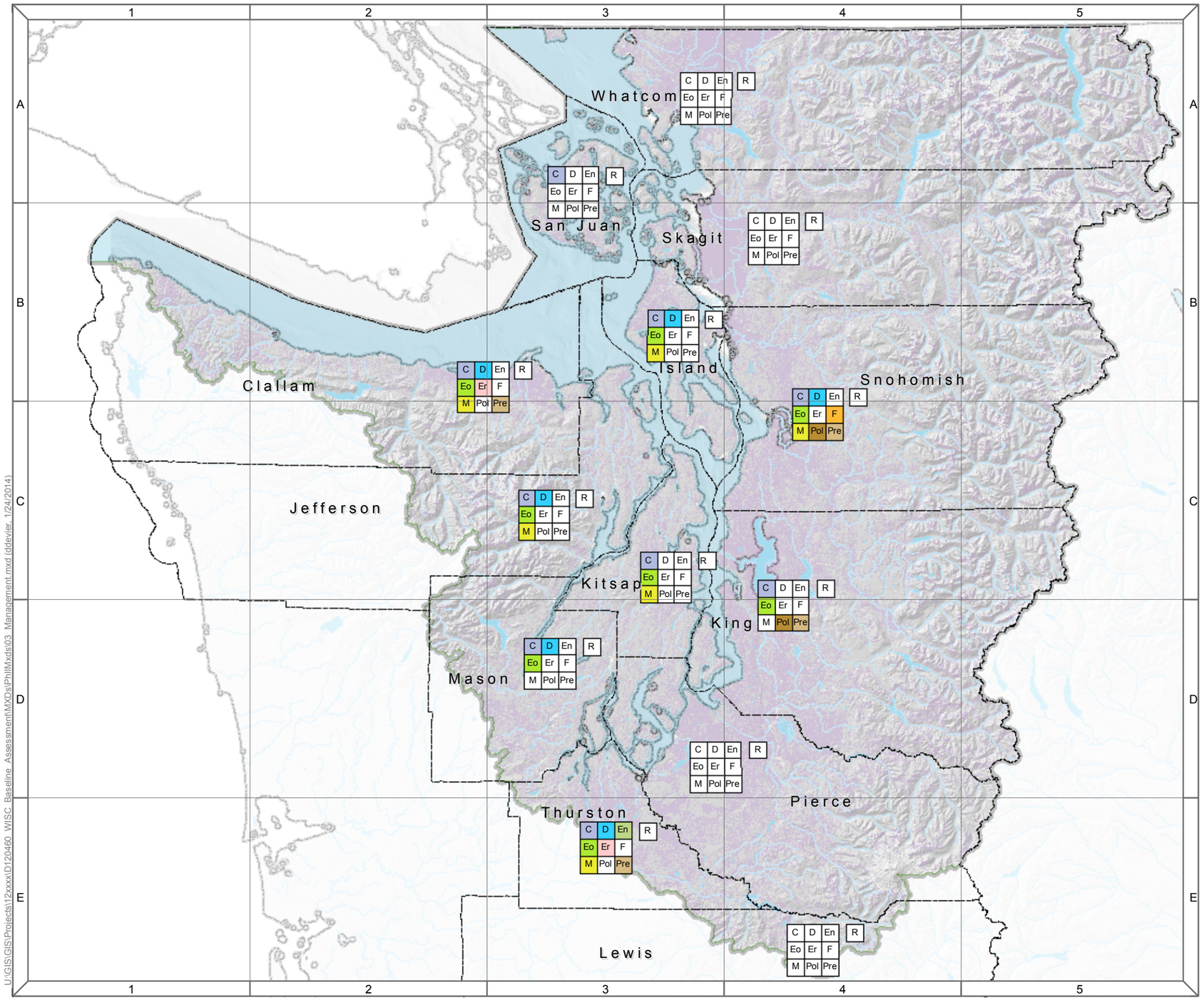
ESA

Species Spread, Impacts, and Natural Resources at Risk

MAP 3.2

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council



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CLASS B NOXIOUS WEED / STATE QUARANTINE SPECIES

Purple Loosestrife

Lythrum salicaria

Management Programs at County Level

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

- County Boundary
- Puget Sound Extent
- Lakes
- Rivers

Management Programs at Regional/State/OtherLevel

C, Washington State Department of Ecology

D, Washington State Department of Agriculture

D, Washington State Department of Ecology

Eo, Washington State Department of Agriculture

Eo, Washington State Department of Ecology

Er, Washington State Department of Ecology

F, Washington State Department of Agriculture

F, Washington State Department of Ecology

M , Washington State Department of Ecology

M, Washington State Department of Agriculture

Pol, Puget Sound Partnership

Pol, Washington State Department of Agriculture

Pre, Washington State Department of Agriculture

Abbreviations:

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

0 5 10 20 Miles

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

ESA

Management at the County Level

MAP 3.3

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

GARDEN LOOSESTRIFE
Lysimachia vulgaris

4

Garden loosestrife is an invasive wetland plant, around 3 feet tall, with bright yellow flowers clustered near the top of the stem. Garden loosestrife spreads by seeds and rhizomes (creeping roots) that form dense underground mats that are difficult to remove. The garden loosestrife population in King County appears to be more aggressive, larger, and more productive than in other parts of the world, based on literature about the species.

STATUS AND TRENDS

Species Presence (Map 4.1) Garden loosestrife has been detected in Whatcom, Skagit, Snohomish, King, and Thurston Counties. Most of the known garden loosestrife in the Puget Sound region is concentrated in King County. Major populations are found around Lake Sammamish, Lake Washington, the Sammamish River, Lake Burien, and the Snoqualmie Valley. See Table 4.1 for a summary of data obtained for this species.

Presence over time Garden loosestrife is a native of Eurasia and was likely introduced to the U.S. as an ornamental plant. It is now widespread throughout the East and West Coasts. The species was first documented in Washington in the 1970s.

Table 4.1. Garden loosestrife data provided to the baseline assessment project.

File Type Provided	# of files	Spatial Extent	Data Provider
Spatially Explicit Data			
ESRI GIS data (shapefiles, geodatabase feature classes)	4	King County, Kitsap County, Whatcom County	University of Washington Herbarium, WDOE
Tabular Data with Lat/Long (X/Y) Coordinates	1	Puget Sound, Statewide	WSDOT, WSDA
Hard Copy Maps	1	Statewide	WSDA
Other Data			
Management or survey reports	7	King County, Puget Sound	King County, WDOE

PATHWAYS

Pathways of Introduction Garden loosestrife was introduced to North America from Europe as an ornamental in the 1900s and is now naturalized in lakes and wetlands.

Pathways of spread (Map 4.2) Garden loosestrife spreads by seeds and rhizomes (creeping roots). Seeds can disperse through water, and recent research indicates seed production may play a more important role than previously thought. Research on seed germination of garden loosestrife has shown that the seeds can overwinter (become dormant) if germination conditions are not appropriate in the autumn, at the time of seed maturation, and then germinate rapidly during summer conditions. In most cases, nearly 100% of the seeds germinate eventually. This flexibility allows seeds to germinate under widely varying climatic conditions.

While sale and transport of the species is prohibited in Washington, it may still be mistakenly transplanted by gardeners.

GARDEN LOOSESTRIFE

Lysimachia vulgaris

IMPACTS AND AT-RISK RESOURCES

Ecological impacts (Map 4.2) Garden loosestrife displaces native vegetation along streambanks, wetlands, and shorelines and reduces habitat for waterfowl and fish. It can clog small streams and capture sediment, interfering with water flow.

Social and economic impacts (Map 4.2) Dense patches of garden loosestrife hamper boating, swimming, and other water recreation.

MANAGEMENT

Table 4.2 and Map 4.3 summarize commonly reported program types and the number of entities reporting management activities for garden loosestrife.

State- or Puget Sound-level activities Three organizations reported programs for garden loosestrife.

County-level activities Garden loosestrife management activities have been reported in three of the five counties (Snohomish, King, and Thurston) with documented occurrences, as well as in Kitsap and Mason Counties. Reported management activities for this species include control, detection, enforcement, education/outreach, eradication, monitoring, policy, prevention, and research.

With funding from the Washington State Department of Ecology, the King County Noxious Weed Control Program performed garden loosestrife surveys and treatment along the Snoqualmie River between 2007 and 2010. While a significant decrease in garden loosestrife was not observed, the project appeared to have reduced the spread of the species. The County is continuing to work with the Washington State Department of Natural Resources and private landowners on annual control efforts on the river and off-channel areas.

Federal-level activities There are no known federal-level management activities in place for this species.

Other activities There are no other known management activities in place for this species.

Table 4.2. Commonly reported management program types and number of organizations targeting garden loosestrife.

Entity	Three Most Commonly Reported Management Program Types (frequency)	Number of Organizations with current management activities
County	Education/outreach (5), Control, Detection, and Eradication (3)	6
State	Detection, Funding, Monitoring, Policy (2), Control, Enforcement, Education/outreach, Eradication, Prevention (1)	3
Federal	None	None
Other	None	None

Legal authorities Garden loosestrife is a Class B noxious weed. This species is also on the Washington quarantine list (known as the prohibited plants list) and it is prohibited to transport, buy, sell, offer for sale, or to distribute plants or plant parts of this species, into or within the state of Washington. It is further prohibited to intentionally transplant wild plants and/or plant parts of this species within the state of Washington.

Funding The Department of Ecology has provided funding to King County for garden loosestrife control.

GARDEN LOOSESTRIFE

Lysimachia vulgaris

SUMMARY OF GAPS

Data collection and management While intensive surveys for garden loosestrife have been completed in some areas such as the Snoqualmie River, it is possible there are undocumented infestations in other areas such as private lakes.

Knowledge and understanding of species status, pathways, and impacts Research on the role of seeds in spreading garden loosestrife to new areas is ongoing.

Management efforts Limited information is available about control methods, which are currently considered insufficient.

SPECIES FACT

"Identifying garden loosestrife (also known as yellow loosestrife) can be confusing, especially by its name. First, although it shares habitat and invasive tendencies with purple loosestrife (Lythrum salicaria), it looks very different and is not even related to this other noxious wetland invader. Also, garden loosestrife has a closely related look-alike also known as garden or yellow loosestrife (Lysimachia punctata) that is often used as an ornamental in this area… Garden loosestrife is easiest to identify when it flowers in July and August."

- King County Noxious Weed Program

REFERENCES

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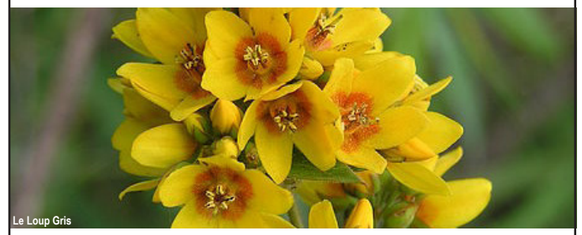
CLASS B NOXIOUS WEED / STATE QUARANTINE SPECIES

Garden Loosestrife

Lysimachia vulgaris



- Native to Eurasia.
- First documented in Washington in 1978.
- Lives in lakes and wetlands.
- Degrades aquatic habitat.

The data displayed in this map represents data that has been submitted for this baseline assessment and does not necessarily reflect a systematic basin-wide survey program. Additional occurences for this species are known.

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

Species Presence by County

Species Presence by County**
- No Known Infestations
- <10 Acres Infested
- 10-100 Acres Infested
- No Data or Insufficient Data

** Data are Approximate

Puget Sound Basin

Species Detection
- Lysimachia vulgaris

Land Cover & Land Use
- Forest
- Rock & Snow
- Water
- Disturbed Lands

Boundaries & Extents
- County Boundary
- Puget Sound Extent

0 5 10 20 Miles

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. GIS data sources used to develop this map are noted in the Appendix.

ESA

Documented Presence in Puget Sound Basin

MAP 4.1

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

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U:\GIS\GIS\Projects\12xxx\ID\20460_WISC_Baseline_Assessment\MXDs\PHIIMxds\01_Presence.mxd (ddever 1/28/2014)

How does the species spread?

Garden Ornamental
While the sale or transport of garden loosestrife is prohibited in Washington, it is an attractive flowering plant that could be mistakenly transplanted as an ornamental species.

Boats and Fishing
Garden loosestrife spreads primarily by seeds and rhizomes that could get caught in boating or fishing gear and spread to other waterbodies.

Streamflows and Waves
Seeds can disperse through water and are a secondary source of spread.

What resources are at risk?

Lakes and Wetlands
Documented infestations of garden loosestrife are currently limited, but the species could readily spread to other lakes and wetlands.

What impacts does the species have?

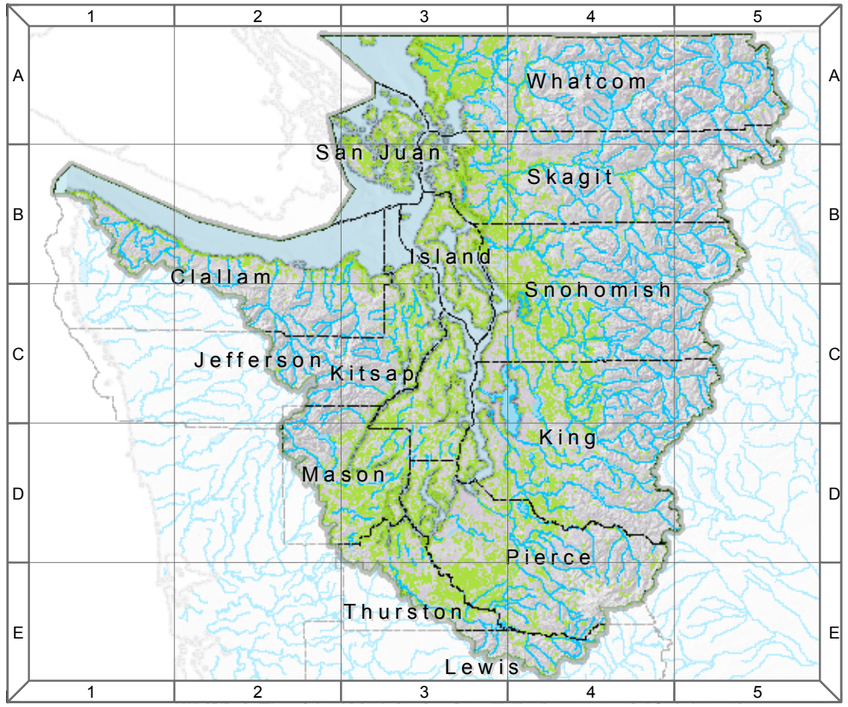
ECOLOGICAL IMPACTS

Displaces Native Vegetation
Garden loosestrife displaces native vegetation along streambanks, wetlands and shorelines and reduces habitat for waterfowl and fish.

SOCIAL AND ECONOMIC IMPACTS

Damages Infrastructure
Garden loosestrife can clog small streams and capture sediment, interfering with water flow.

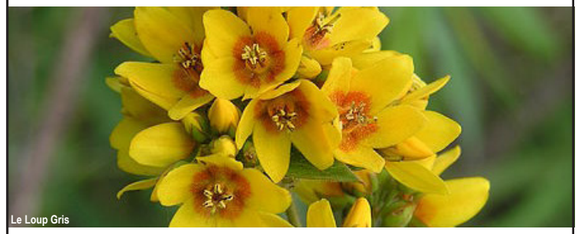
Impacts Recreation
Dense patches of garden loosestrife hamper boating, swimming, and other water recreation



CLASS B NOXIOUS WEED / STATE QUARANTINE SPECIES

Garden Loosestrife

Lysimachia vulgaris


Le Loup Gris

Sensitive Landscape Features
- Wetlands
- Lakes
- Rivers

Boundaries & Extents
- County Boundary
- Puget Sound Extent

Miles
0 10 20 40

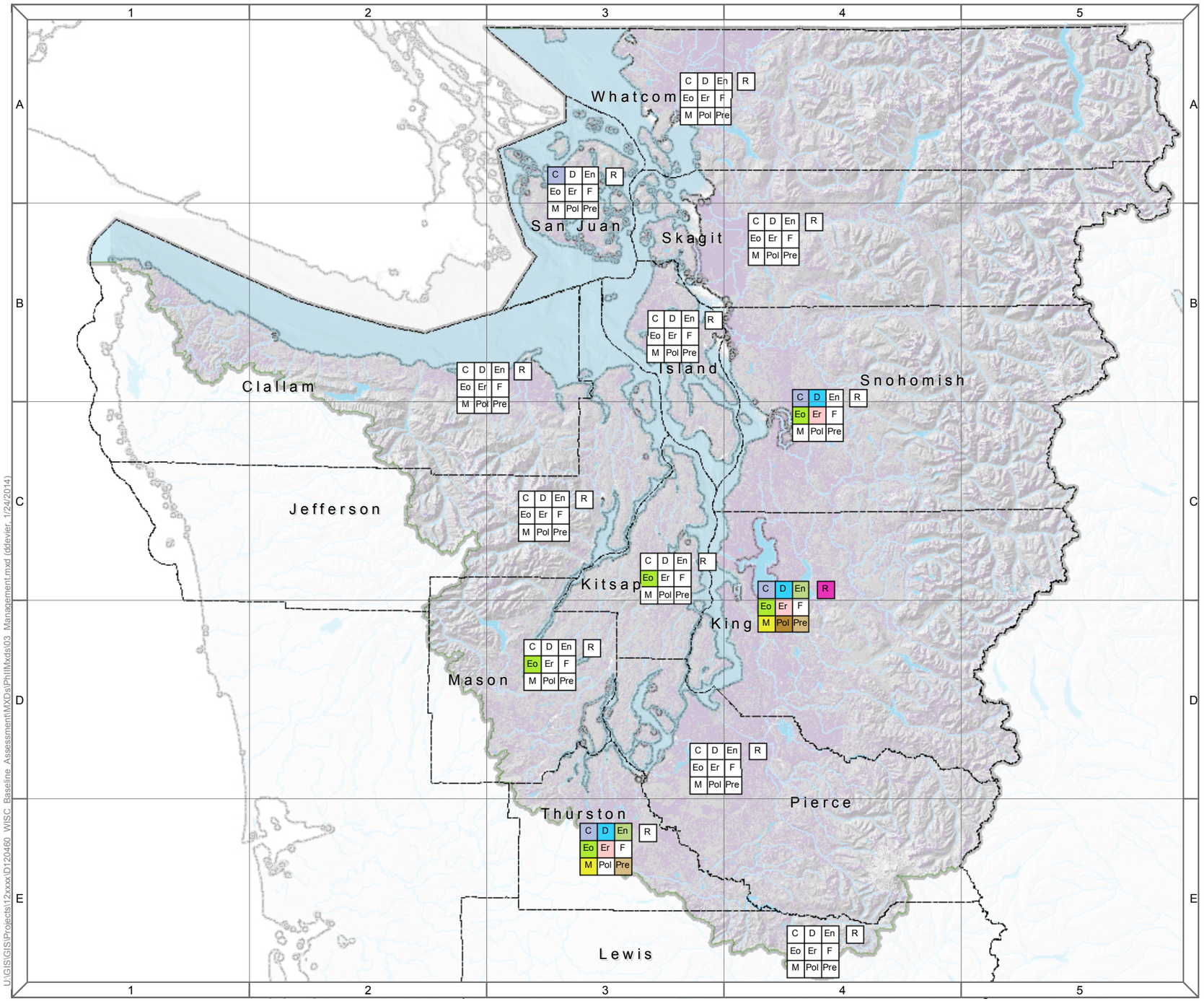
Map Data Sources:
For the GIS data sources that were used to develop this map see Appendix

ESA

Species Spread, Impacts, and Natural Resources at Risk

MAP 4.2

January 2014



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CLASS B NOXIOUS WEED / STATE QUARANTINE SPECIES

Garden Loosestrife

Lysimachia vulgaris

Management Programs at County Level

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

- County Boundary
- Puget Sound Extent
- Lakes
- Rivers

Management Programs at Regional/State/OtherLevel

C, Washington State Department of Ecology

D, Washington State Department of Agriculture

D, Washington State Department of Ecology

Eo, Washington State Department of Ecology

Er, Washington State Department of Ecology

F, Washington State Department of Agriculture

F, Washington State Department of Ecology

M , Washington State Department of Ecology

M, Washington State Department of Agriculture

Pol, Puget Sound Partnership

Pol, Washington State Department of Agriculture

Pre, Washington State Department of Agriculture

Abbreviations:

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

0 5 10 20 Miles

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

ESA

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

Management at the County Level

MAP 4.3

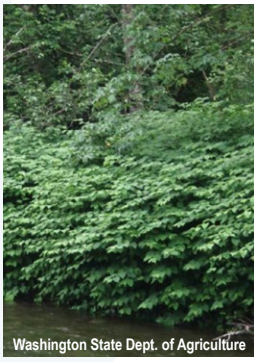
January 2014

KNOTWEEDS - BOHEMIAN, GIANT, AND JAPANESE 5

Polygonum bohemicum, P. sachlinense, P. cuspidatum

There are three related species of knotweed in our region that share similar characteristics and habitat: Japanese, giant, and Bohemian. They grow aggressively along roadways, neglected gardens, streambanks, and other moist areas. The most common invasive knotweed in western Washington, Bohemian knotweed, is a hybrid between giant and Japanese knotweeds and shares features of both parent species. Japanese knotweed is the smallest of the three species, while giant knotweed can grow up to 16 feet tall and has very large leaves. Knotweed has bamboo-like canes that grow rapidly in spring and die back in the winter.


Tom Heutte/Bugwood.org


Washington State Dept. of Agriculture

STATUS AND TRENDS

Species Presence (Map 5.1) Knotweeds have been documented in all of the Puget Sound counties with widespread infestations occurring in Whatcom, King, Thurston and Mason Counties. See Table 5.1 for a summary of data obtained for this species.

Presence over time Knotweed was introduced to the U.S. from Asia as an ornamental plant in the 1800s. It has since become widespread because of the lack of natural predators and ability to spread by root and stem fragments.

Table 5.1. Knotweed data provided to the baseline assessment project.

File Type Provided	# of files	Spatial Extent	Data Provider
Spatially Explicit Data			
ESRI GIS data (shapefiles, geodatabase feature classes)	46	Site-level, County-level, Puget Sound	Clallam County, Hood Canal Salmon Enhancement Group, Island County, Jefferson County, King County Mason County, Pierce County, Swinomish Tribe, Thurston County, University of Washington, WSDA, WSDOT, Whatcom County
Tabular Data with Lat/Long (X/Y) Coordinates	1	Puget Sound	WSDOT
Hard Copy Maps	4	San Juan County, WSDOT Highway Corridors	San Juan County, WSDA
Other Data			
Management or survey reports	14	Clallam County, Island County, King County, Statewide	Clallam County, Island County, King County, WSDA, WSU

PATHWAYS

Pathways of introduction The knotweed species were introduced to the United States from Asia as ornamental plants by 1890. Due to their widespread use, lack of natural predators, and ability to spread by root and stem fragments, they are now widespread throughout North America.

Pathways of spread (Map 5.2). Knotweed fragments are typically spread by water and in contaminated soil. Even small pieces of the stem or rhizome can form a new plant. Flooding can wash entire large clumps of knotweed downstream where they can colonize new areas. Illicit or incidental dumping or reuse of soil or landscaping debris contaminated with knotweed stems, rhizomes, or seeds can start a new infestation.

KNOTWEEDS - BOHEMIAN, GIANT, AND JAPANESE

Polygonum bohemicum, P. sachlinense, P. cuspidatum

Japanese knotweed can germinate from seed, but the frequency of sexual reproduction is unclear. It was initially believed that the only genotype in the United States was female and could not produce seeds. It appears that other genotypes are actually present and that female plants can produce seeds without pollen. The role of seed production in giant knotweed is unknown, but it is clear that their hybrid, the Bohemian knotweed, produces both male and female fertile forms. Seeds may provide another mechanism for knotweeds to spread even more rapidly in the future.

Japanese knotweed is sometimes sold in other states and on the internet under the name *Fallopia japonica* and may be mistakenly sold as an ornamental plant in Washington under that name even though it is illegal. It may also be sold under *Polygonum* by some nurseries and possibility *Reynoutria japonica* by others.

Tom Heutte/Bugwood.org

Washington State Dept. of Agriculture

SPECIES FACT

In its native habitats of Asia, knotweed evolved to grow on volcanic slopes with poor soils. This characteristic allows knotweed species to readily colonize streambanks with sandy or gravelly soils that are inhospitable to Puget Sound native plant species.

IMPACTS AND AT-RISK RESOURCES

Ecological impacts (Map 5.2) Knotweed grows vigorously, creating dense colonies that make it hard or impossible for other native plants to survive. The knotweed plants sprout early in the spring and grow rapidly, shading out native species. Dense stands of knotweed can clog small streams. Knotweed has a large root mass but provides poor erosion control for stream and river banks. Its ability to outcompete other species results in an altered natural ecosystem. Once established, knotweed forms an extensive root system and is very difficult to eradicate.

One study of knotweed in riparian areas in the Skagit River watershed found a negative correlation between knotweed invasion and the species richness and abundance of native understory herbs, shrubs, and juvenile trees. In addition, knotweed leaves contributed significantly less nitrogen to riparian soils and the aquatic environment than leaf litter from native plant species, potentially impacting aquatic food webs.

Social and economic impacts (Map 5.2) Knotweed can grow through roadway surfacing and building foundations, requiring expensive repairs. Dense stands of knotweed along roadways can block signs and views, creating hazardous driving conditions.

MANAGEMENT

Table 5.2 and Map 5.3 summarize commonly reported program types and the number of entities reporting management activities for knotweed.

State- or Puget Sound-level activities The Washington State Department of Agriculture (WSDA) is mandated to address knotweed. In 2004, WSDA began a pilot program for control efforts starting in southwest Washington. Since then, WSDA has been a clearinghouse for knotweed control information and maintains a database of all known knotweed locations in the state. Annual reports provide detailed information on annual presence and control efforts for each of the counties.

KNOTWEEDS - BOHEMIAN, GIANT, AND JAPANESE

Polygonum bohemicum, P. sachlinense, P. cuspidatum

The 2005 Washington State Integrated Knotweed Management Plan has the following objectives:

- Restore riparian areas by removing knotweed to enhance public access, and salmon and wildlife habitat.
- Monitor results of control efforts for site efficacy and seasonal regrowth. Modify and improve future control methods based on this information.
- Retreat sites if necessary.
- Treat each river system downstream from the headwaters to prevent reinfestation of treated areas, thereby building on the successes of each previous treatment season.

County-level activities Knotweed management activities have been reported in all Puget Sound counties, with the exception of Whatcom, Skagit, and Lewis. Reported activities include control, detection, enforcement, education/outreach, eradication, funding, monitoring, policy, prevention, and research.

In addition, county noxious weed boards are partnering with numerous other organizations and agencies to control invasive knotweeds, particularly along major river systems of the Puget Sound region. Partners include city governments; local, state, and federal parks; state and federal natural resource management agencies; Native American tribes; conservation districts; nonprofit organizations; utilities; transportation departments; regional fisheries enhancement groups; floodplain management agencies; and private landowners.

On the Olympic Peninsula, the Olympic Knotweed Working Group is a consortium of government entities, tribes, and non-profit organizations that meets twice a year to exchange information and strategize effective knotweed control.

In 2012, Thurston County adopted “containment area” regulations covering all invasive knotweed species on proposed development sites (Thurston County Code Chapter 17.30.050). Regulations cover movement of soil and vegetation as well as equipment cleaning requirements.

Snohomish County received a grant from WSDA in 2013 to survey and control knotweed along the Pilchuck River from its headwaters at Spada Lake to the confluence with the Snohomish River.

Federal-level activities The Natural Resources Conservation Service maintains a distribution database for this species that can be found at: http://plants.usda.gov/java/county?state_name=Washington&statefips=53&symbol=POCU6.

Other activities Washington has several cooperative weed management areas (CWMAs), which work across jurisdictional lines to address specific weed problems. A CWMA is a partnership of federal, state, and local government agencies, tribes, individuals, and various interested groups that manage weeds within a defined area. For example, the Skagit Cooperative Weed Management Area Working Group has undertaken a long-term, basin-wide approach to knotweed control in the Upper Skagit watershed. Another CWMA has been created in Grays Harbor County to treat knotweed in the Lake Quinault, Queets-Clearwater area. King County also uses CWMAs to target knotweed control along major river systems.

Oregon State University has been working with an international group of scientists to develop a biological control program for invasive knotweeds.

Native American tribes in the Puget Sound region have been active in identifying and controlling knotweed infestations. The Tulalip Tribes completed an inventory of knotweed infestations on the Tulalip Reservation in 2005. In the Sauk-Suiattle watershed, The Nature Conservancy, Skagit Fisheries Enhancement Program, and Sauk-Suiattle Tribe have worked on knotweed eradication along with the Washington Conservation Corps.

KNOTWEEDS - BOHEMIAN, GIANT, AND JAPANESE

Polygonum bohemicum, P. sachlinense, P. cuspidatum

Table 4.2. Commonly reported management program types and number of organizations targeting knotweed.

Entity	Three Most Commonly Reported Management Program Types (frequency)	Number of Organizations with current management activities
County	Education/Outreach(10), Control(9), Detection(8)	10
State	Policy(2), Detection, Enforcement, Education/outreach, Eradication, Funding, Prevention (1)	2
Federal	Education/outreach (1)	1
Other	Control (3), Monitoring (1), Eradication (1)	6

Legal authorities Knotweed is listed as a Class B noxious weed, meaning that it is designated for control in certain state regions. Knotweed species are also on Washington's Noxious Weed Seed and Plant Quarantine list, meaning it is prohibited to transport, buy, sell, offer for sale, or distribute knotweed plants, plant parts, or seeds (Washington Administrative Code 16-752-600).

Funding The Washington State Department of Agriculture (WSDA) plays a significant role in invasive knotweed control. The WSDA Knotweed Control Program provides funding, technical support, permitting, and other services to entities throughout the state to implement knotweed control projects and has received over $3 million for knotweed control since 2004. In 2011, the WSDA Knotweed Control Program budget was approximately $470,000 and supported knotweed control activities in 15 counties. Local entities were able to use these funds as match for additional grants.

At the federal level, Title II of the federal Secure Rural Schools and Community Self-Determination Act authorizes funding for projects on or benefitting National Forest land, including control of noxious and exotic weeds. For example, King, Jefferson, and Clallam Counties are working with the U.S. Forest Service to fund and implement knotweed control efforts on local Forest Service lands.

Counties have also reported obtaining funds for knotweed control from tribes, nonprofit organizations, the Salmon Recovery Funding Board, EPA, U.S. Fish and Wildlife Service, conservation districts, and Washington State Department of Ecology. The USFWS has provided funding for knotweed survey and control in Grays Harbor, King, Skagit, and Snohomish Counties, and participates in the Olympic Knotweed Working Group.

As part of the Natural Areas Program, the Washington State Department of Ecology, Washington State Recreation and Conservation Office, and the Mountains to Sound Greenway organization provide funds for local knotweed survey and control efforts.

SUMMARY OF GAPS

Data collection and management Knotweed data compiled by the project varied widely in methods of collection and reporting. County-level noxious weed control boards have been providing their data to the Washington Department of Agriculture on an annual basis, but each control board is collecting and managing its data differently, making it difficult to easily synthesize and maintain over the long term. Additionally, data across the various organizations (e.g., NGOs, researchers, tribes, state agencies) collecting and sharing information is also diverse.

Knowledge and understanding of species status, pathways, and impacts There is good information on the methods of vegetative dispersal for knotweed species, although the role of seed germination is unclear.

Management efforts Most counties in combination with state organizations have strong education/outreach programs and ongoing control efforts.

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CLASS B NOXIOUS WEED / STATE QUARANTINE SPECIES

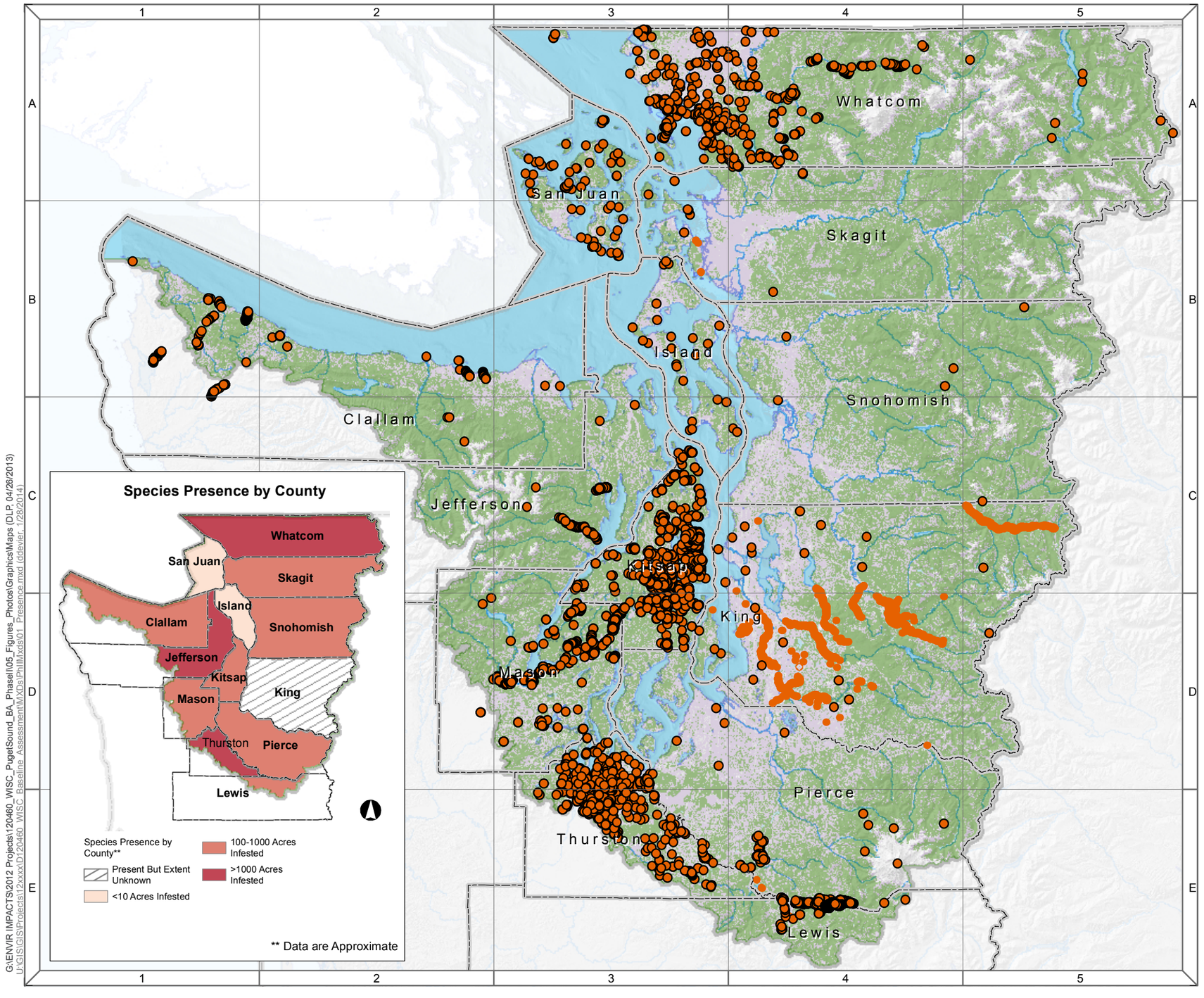
Bohemian, Giant and Japanese Knotweed

Polygonum bohemicum, Polygonum sachlinense, and Polygonum cuspidatum

Tom Heutte/USDA Forest Service/Bugwood.org

Washington State Department of Agriculture - Snoqualmie

- Native to Asia.
- Introduced to the U.S. in the 1800s.
- Invades disturbed areas and streambanks.
- Forms dense stands, degrades riparian habitat.



Puget Sound Basin

Species Detection

- Polygonum bohemicum, sachlinense, cuspidatum

Land Cover & Land Use

- Forest
- Rock & Snow
- Water
- Disturbed Lands

Boundaries & Extents

- County Boundary
- Puget Sound Extent

0 5 10 20 Miles

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. GIS data sources used to develop this map are noted in the Appendix.

ESA

Documented Presence in Puget Sound Basin

MAP 5.1

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

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How does the species spread?

Soil and Gravel Transport
Transport or dumping of soil or landscaping debris contaminated with knotweed seeds, fragments or roots can spread the plant to new areas.

Garden Ornamental
Knotweed may be mistakenly sold as an ornamental plant under a different name.

Streamflows and Waves
Knotweed in riparian areas can be washed downstream and start new infestations.

What resources are at risk?

Riparian Areas and Streams
Because it is already widespread throughout Puget Sound and can be transported by water, riparian areas and streams are especially vulnerable to additional infestations.

Disturbed Areas
Knotweed thrives in disturbed soils such as roadsides and construction sites, and it can be readily transported to these areas by contaminated fill material or equipment. New construction and redevelopment provides opportunities for additional knotweed populations to become established.

What impacts does the species have?

ECOLOGICAL IMPACTS

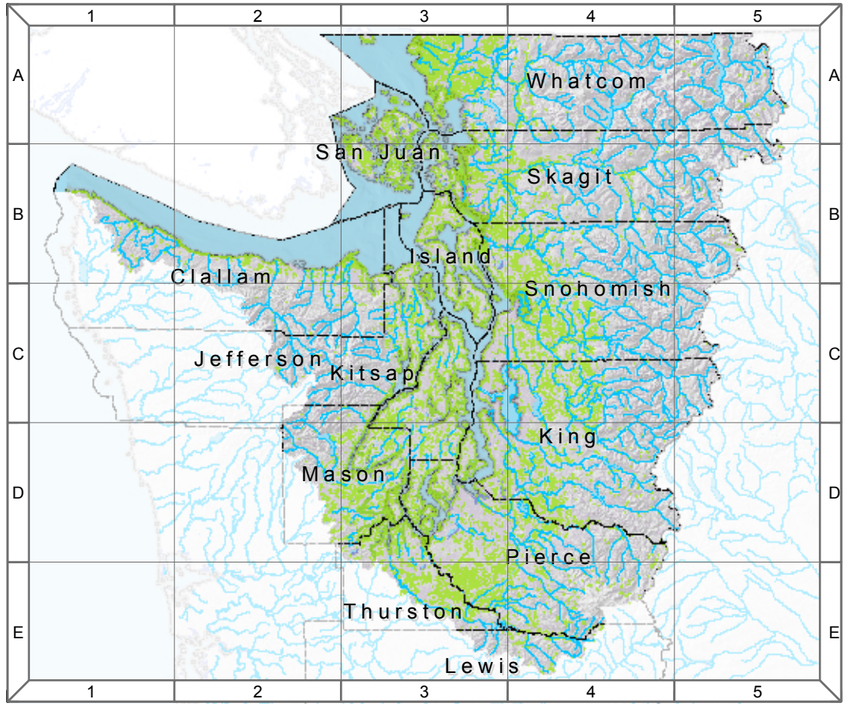
Displaces Native Vegetation
Knotweed forms dense stands that displace native vegetation, particularly in riparian areas.

Increases Erosion
Clumps of knotweed can be washed from streambanks, increasing bank erosion.

Changes Aquatic Food Webs
Knotweed leaf litter from riparian areas provides poor quality organic material to stream habitats.

SOCIAL AND ECONOMIC IMPACTS

Damages Infrastructure
Knotweeds can grow through and damage roadway surfacing and building foundations. Dense stands along roadsides can block signs and obstruct views, creating hazardous driving conditions.



CLASS B NOXIOUS WEED / STATE QUARANTINE SPECIES

Bohemian, Giant and Japanese Knotweed

Polygonum bohemicum, Polygonum sachlinense, and Polygonum cuspidatum


Tom Heutte/USDA Forest Service/Bugwood.org


Washington State Department of Agriculture - Snoqualmie

Sensitive Landscape Features
- Wetlands
- Lakes
- Rivers

Boundaries & Extents
- County Boundary

Miles
0 10 20 40

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

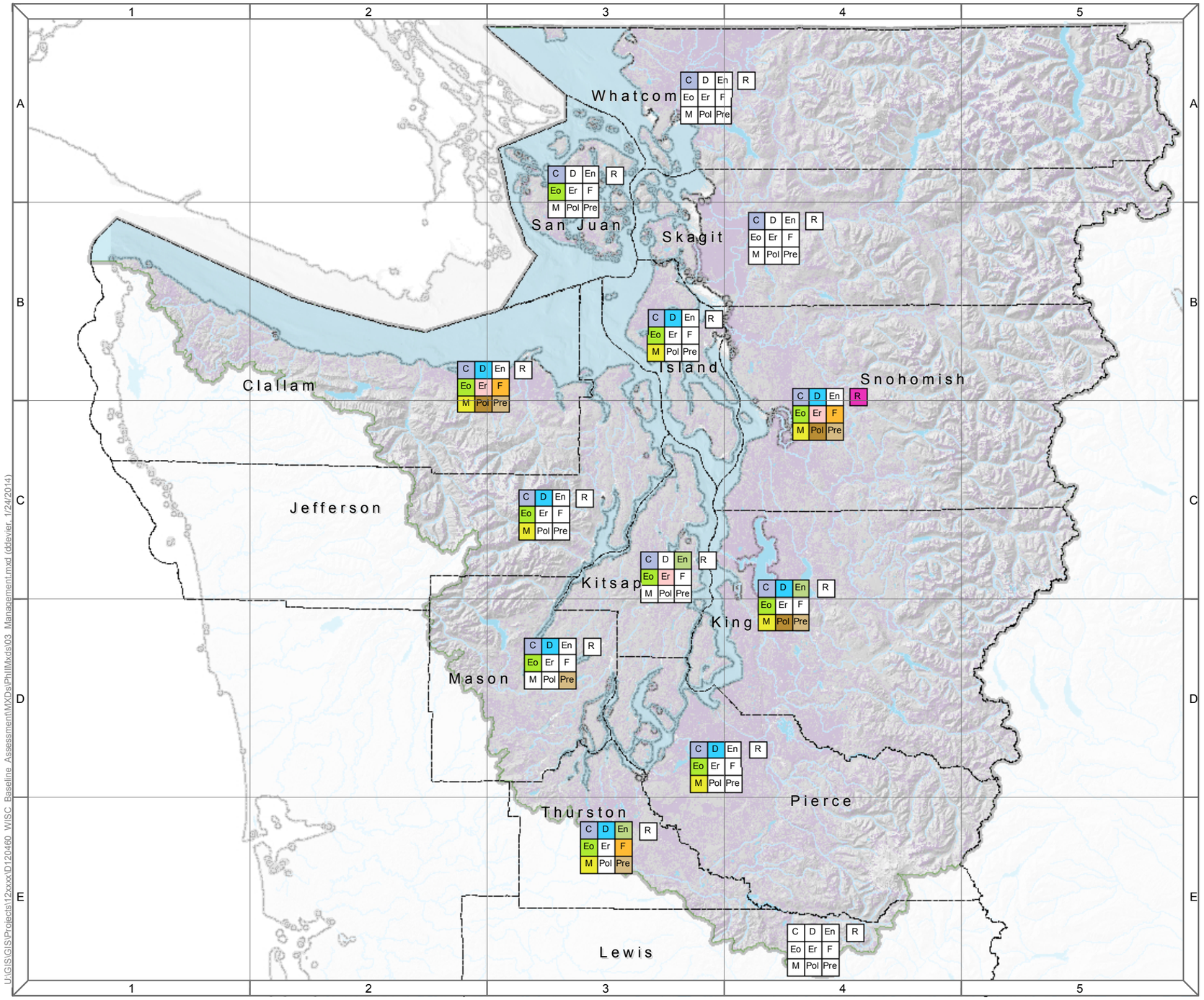
ESA

Species Spread, Impacts, and Natural Resources at Risk

MAP 5.2

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council



CLASS B NOXIOUS WEED / STATE QUARANTINE SPECIES

Bohemian, Giant and Japanese Knotweed

Polygonum bohemicum, Polygonum sachlinense, and Polygonum cuspidatum

Management Programs at County Level

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

- County Boundary
- Puget Sound Extent
- Lakes
- Rivers

Management Programs at Regional/State/OtherLevel

C, Washington State Department of Agriculture

D, Washington State Department of Agriculture

Eo, Washington State Department of Agriculture

Er, Washington State Department of Agriculture

F, Washington State Department of Agriculture

M, Washington State Department of Agriculture

Pol, Puget Sound Partnership

Pol, Washington State Department of Agriculture

Pre, Washington State Department of Agriculture

Abbreviations:

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

Miles
0 5 10 20

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

ESA

Management at the County Level

MAP 5.3

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

BUTTERFLY BUSH

Buddleja davidii

6

The butterfly bush is a perennial, woody shrub with fragrant purple flowers. A hardy shrub up to 15 feet tall, it flourishes in well drained soils and can invade both native habitats and disturbed areas such as roadsides. Butterfly bush is a beloved garden ornamental species, making control efforts challenging.

STATUS AND TRENDS

Species Presence (Map 6.1) Butterfly bush has been identified in 11 of the Puget Sound counties, with the highest occurrences recorded in Whatcom, Skagit, and northern Thurston Counties. However, the species is so widespread that it is not being tracked by some agencies, and so the mapped occurrences should be considered to underestimate its prevalence in Puget Sound. See Table 6.1 for a summary of data obtained for this species.

Presence over time Butterfly bush is an introduced shrub from China that has been widely planted as an ornamental and butterfly plant throughout North America. It was noted as a common roadside plant in western Washington during the 1970s and is now very common throughout the region.

Table 6.1. Butterfly bush data provided to the baseline assessment project.

File Type Provided	# of files	Spatial Extent	Data Provider
Spatially Explicit Data			
ESRI GIS data (shapefiles, geodatabase feature classes)	9	Clallam County, Island County, Jefferson County, King County, Pierce County, Skagit County, Snohomish County, Thurston County, Whatcom County	University of Washington Herbarium, Jefferson County NWCB, Thurston County, Whatcom County
Google Earth KMZ files	0		
Tabular Data with Lat/Long (X/Y) Coordinates	0		
Hard Copy Maps	0		
Other Data			
Management or survey reports	0		

PATHWAYS

Pathways of introduction Butterfly bush, an introduced shrub from China, has been widely sold and planted as an ornamental and butterfly-attracting plant throughout North America.

Pathways of spread (Map 6.2) The abundant, winged seeds (up to 3 million per plant) of butterfly bush are spread by wind, water, machinery, and transport of gravel or soil that carries seeds. Seedlings can also be washed downstream during floods. Butterfly bush can root from cut or broken branches and resprout from the rootstock if the plant is damaged. Some nurseries still sell butterfly bush and it is available for sale over the internet.

BUTTERFLY BUSH

Buddleja davidii

IMPACTS AND AT-RISK RESOURCES

Ecological impacts (Map 6.2) Butterfly bush forms dense, shrubby thickets that exclude all other plants and displace native vegetation. While sold as a butterfly nectar source, the species may actually have negative effects on native butterfly populations by displacing native nectar plants. It does not provide a larval (caterpillar) food source for native butterfly species.

Butterfly bush is particularly problematic along riverbanks, where it can prevent native plants from reestablishing after floods. In riparian zones of the Pacific Northwest, it is functioning as a pioneering species, colonizing sand and gravel bars within the active channel and floodplain that have historically been dominated by cottonwood and willows. The strong roots of butterfly bush stabilize riverbanks, thereby limiting opportunities for the river to naturally meander.

Butterfly bush may also alter soil nutrient concentrations, as the invasive utilizes and accumulates nitrogen and phosphorus differently from the native shrubs it outcompetes. Once established, it is difficult to remove because it resprouts easily and the numerous seeds remain viable in the soil for several years.

Social and economic impacts (Map 6.2) Aside from potentially competing with timber crops, human dimension impacts of butterfly bush are not commonly reported. The species could be a nuisance in developed areas and along roadsides where it can grow in very poor soils and even in cracks in pavement.

MANAGEMENT

Table 6.2 and Map 6.3 summarize commonly reported program types and the number of entities reporting management activities for butterfly bush.

State- or Puget Sound-level activities Two organizations reported management activities.

County-level activities Management activities for butterfly bush vary among local jurisdictions, with an emphasis on education/outreach. With ongoing economic challenges, funding for monitoring and control of butterfly bush is generally considered a low priority. However, Thurston and King Counties have reported a variety of management activities, including control, detection, enforcement, education/outreach, monitoring, policy, and prevention.

Federal-level activities There are no known federal-level management activities in place for this species.

Other activities The State of Oregon banned the sale of butterfly bush (except for sterile varieties) in 2010.

The Jamestown S'Klallam Tribe has been working to eradicate butterfly bush along the Dungeness River as part of a large-scale riparian restoration project.

Table 6.2. Commonly reported management program types and number of organizations targeting butterfly bush.

Entity	Three Most Commonly Reported Management Program Types (frequency)	Number of Organizations with current management activities
County	Education/outreach (9), Monitoring (3), Control, Detection, Prevention (2)	9
State	Policy (2), Detection, Monitoring (1)	2
Federal	None	
Other	Eradication (1)	1

BUTTERFLY BUSH

Buddleja davidii

Legal authorities The butterfly bush is listed as a Class B Noxious Weed in Washington, meaning it is designated for control in certain state regions. Butterfly bush is not on the prohibited plants list administered by the Washington State Department of Agriculture, but some nurseries have volunteered to stop selling it and are offering non-invasive alternative plant species or alleged sterile cultivars.

Funding As part of the Natural Areas Program, the Washington Department of Natural Resources and the Mountains to Sound Greenway organization provide funds for local butterfly bush survey and control efforts.

SUMMARY OF GAPS

Data collection and management Because butterfly bush is already widespread and can reach remote areas, the full extent of infestations is undocumented.

Knowledge and understanding of species status, pathways, and impacts There is good and expanding information about the impacts of butterfly bush on native species and ecosystems.

Management efforts Research into the cultivation of sterile varieties is ongoing, with mixed success. One cultivar thought to be sterile was found to produce by seed under field conditions. It is also thought that sterile strains may extend the flowering period of butterfly bush because the plants would not devote as much energy toward seed production. Given concerns that butterfly bush displaces native nectar plants and does not provide a food source for caterpillars, the overall effect of such strains on native butterflies could be negative.


Tim Miller

SPECIES FACT

Butterfly bush has been designated for control in Thurston County because of concerns that it is spreading into natural areas such as the Nisqually River where it poses a threat to riparian habitat. The Thurston County Noxious Weed Control Agency produced an educational video about butterfly bush in 2007 which is available at: http://www.co.thurston.wa.us/tcweeds/Weedlistdetail/butterflybushvideo.htm.

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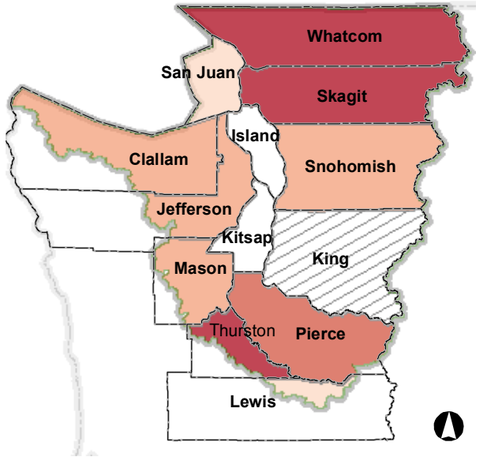
DISCLAIMER: Butterfly bush has been identified in 11 of the Puget Sound counties, with the highest occurrences recorded in Whatcom, Skagit, and northern Thurston Counties. However, the species is so widespread that it is not being tracked by some agencies, and so the mapped occurrences significantly underestimate its prevalence in Puget Sound. See Table 6.1 for a summary of data obtained for this species.

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

Species Presence by County



Species Presence by County**
- No Known Infestations
- Present But Extent Unknown
- <10 Acres Infested
- 10-100 Acres Infested
- 100-1000 Acres Infested
- >1000 Acres Infested

** Data are Approximate

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CLASS B NOXIOUS WEED

Butterfly Bush

Buddleja davidii


Tim Miller/Washington State Noxious Weed Control Board

- Native to China.
- Grows in disturbed sites, riverbanks and gravel bars.
- Displaces native vegetation.
- May negatively affect native butterfly populations.

Puget Sound Basin

Species Detection
- Buddleja davidii

Land Cover & Land Use
- Forest
- Rock & Snow
- Water
- Disturbed Lands

Boundaries & Extents
- County Boundary
- Puget Sound Extent

* Data are not to scale and may contain point, line and/or polygon data.Data do not necessarily reflect systematic basin wide survey program. For the GIS data sources that were used to develop this map see Appendix.

Miles
0 5 10 20

ESA

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

Documented Presence in Puget Sound Basin

MAP 6.1

January 2014

How does the species spread?

Soil and Gravel Transport
Seeds can be spread through transport of contaminated gravel or soil.

Garden Ornamental
Butterfly bush has been widely sold and planted as an ornamental and butterfly plant throughout North America. It is still sold by some nurseries.

Streamflows and Waves
Seedlings can be washed downstream during floods.

Wind
The abundant winged seeds can be blown by wind to new sites.

What impacts does the species have?

ECOLOGICAL IMPACTS

Displaces Native Vegetation
Butterfly bush forms dense, shrubby thickets that exclude all other plants and displace native vegetation. In riparian zones of the Pacific Northwest, it colonizes sand and gravel bars that were historically dominated by native cottonwood and willows. Butterfly bush does not provide a larval (caterpillar) food source for native butterfly species.

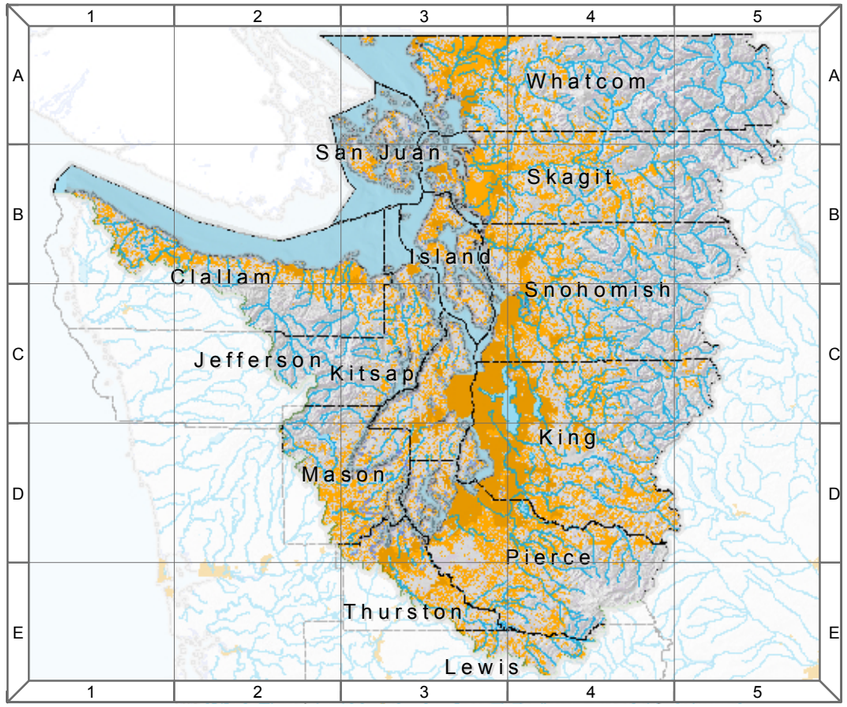
SOCIAL AND ECONOMIC IMPACTS

Social and Economic
Butterfly bush could be a nuisance in developed areas due to its ability to colonize roadsides and disturbed soils.

What resources are at risk?

Riparian Areas and Streams
Because it is already widespread throughout Puget Sound and can be transported by wind and water, riparian areas and streams are especially vulnerable to additional infestations.

Disturbed Areas
Butterfly bush thrives in disturbed soils such as roadsides and construction sites, and it can be readily transported to these areas by contaminated fill material or equipment. New construction and redevelopment provides opportunities for additional butterfly bush populations to become established.



CLASS B NOXIOUS WEED

Butterfly Bush

Buddleja davidii

Sensitive Landscape Features
- Riparian Areas and Streams Near Disturbed Areas
- Riparian Areas and Streams

Boundaries & Extents
- County Boundary
- Puget Sound Extent

Miles
0 10 20 40

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

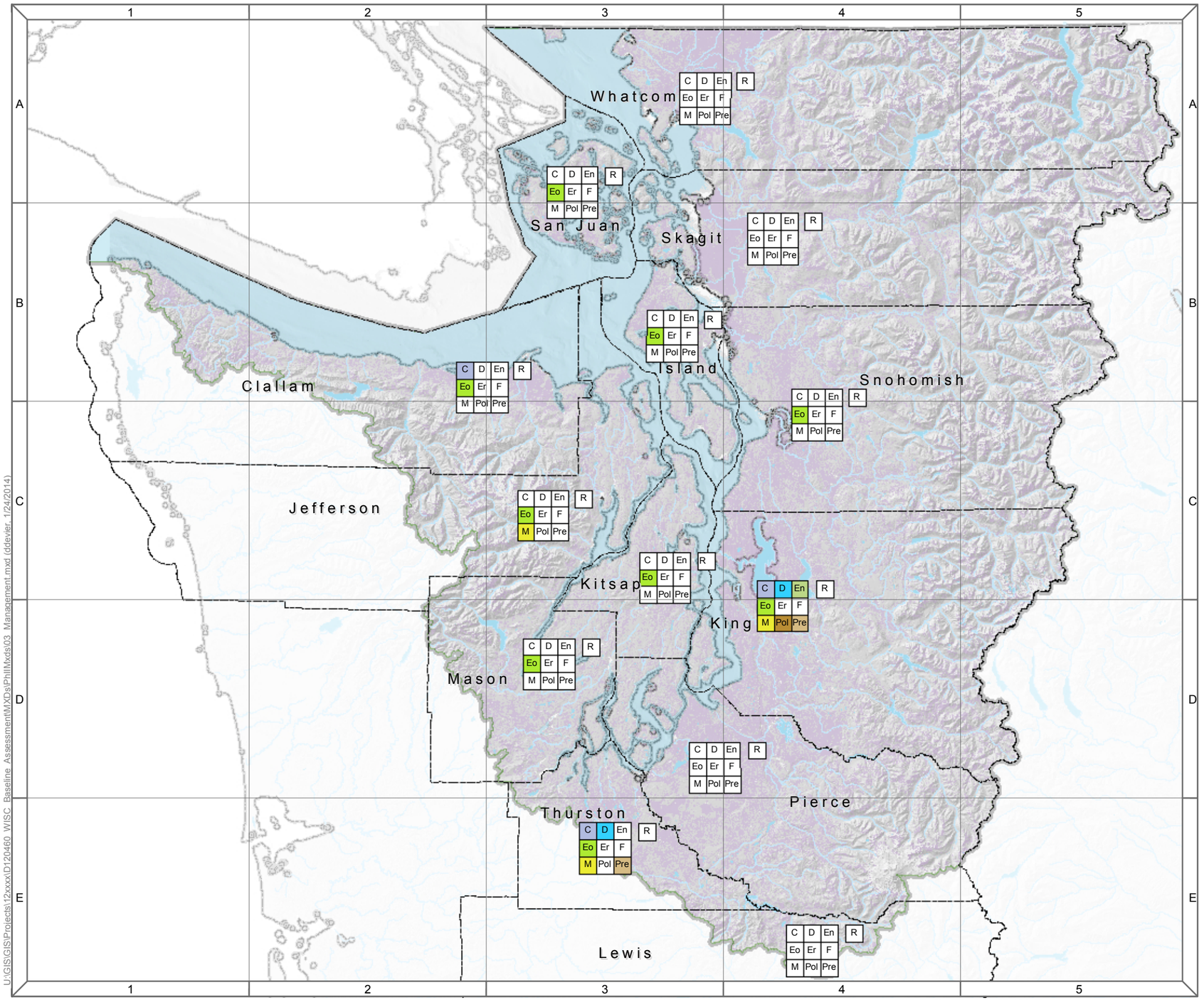
ESA

Species Spread, Impacts, and Natural Resources at Risk

MAP 6.2

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council



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CLASS B NOXIOUS WEED

Butterfly Bush

Buddleja davidii

Management Programs at County Level

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

- County Boundary
- Puget Sound Extent
- Lakes
- Rivers

Management Programs at Regional/State/OtherLevel

D, Washington State Department of Agriculture

M, Washington State Department of Agriculture

Pol, Puget Sound Partnership

Pol, Washington State Department of Agriculture

Abbreviations:

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

Miles
0 5 10 20

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

ESA

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

Management at the County Level

MAP 6.3

January 2014

GARLIC MUSTARD

Alliaria petiolata

7

Garlic mustard is an herb that grows to about 3 feet tall with small white flowers near the top. The new leaves and the root have a strong garlic odor when crushed. It can grow in sun or shade and in a variety of soil types. Garlic mustard spreads quickly through forested areas, even where there is a relatively stable native vegetation community, making it highly invasive and difficult to control.

STATUS AND TRENDS

Species Presence (Map 7.1) Documented infestations of garlic mustard are present in King, Island, Snohomish, Clallam, and Pierce Counties. The highest levels of recorded occurrences are in western King County, particularly west of Lake Washington and along the lower Cedar River. See Table 7.1 for a summary of data obtained for this species.

Presence over time Garlic mustard was introduced to North America from Europe in the 1800s, possibly as an edible herb. It has become widespread on the East Coast and in the midwestern U.S. On the West Coast, it was recorded in Idaho in 1892; in Portland, Oregon, in 1959; and in the Seattle area in 1999.

Table 7.1. Garlic mustard data provided to the baseline assessment project.

File Type Provided	# of files	Spatial Extent	Data Provider
Spatially Explicit Data			
ESRI GIS data (shapefiles, geodatabase feature classes)	5	Island County, King County, Pierce County, Snohomish County	WSU, University of Washington Herbarium, WSDA, Snohomish County NWCB
Tabular Data with Lat/Long (X/Y) Coordinates	0		
Hard Copy Maps	1	Statewide	WSDA
Other Data			
Management or survey reports	3	Clallam County, Island County, King County	Clallam County, Island County, King County

PATHWAYS

Pathways of introduction Native to Europe, garlic mustard was first collected in the United States in 1868 but was not recorded in Washington until the 1990s. It may have been introduced for food or medicinal use.

Pathways of spread (Map 7.2) Garlic mustard invades disturbed areas such as roadsides, but it can also invade relatively intact forests, particularly within small disturbed areas such as along trails. The species produces abundant seeds and can self-pollinate, meaning that one plant can start a new population. Seeds can be transported by wind, animals, and foot traffic. Gardeners or landscapers could also spread garlic mustard by intentionally planting it as a food or medicinal herb, or through using equipment or mulch contaminated with the seeds. Garlic mustard plants resprout from the top of the root even if the rest of the plant has been removed.

GARLIC MUSTARD

Alliaria petiolata

IMPACTS AND AT-RISK RESOURCES

Ecological impacts (Map 7.2) Garlic mustard outcompetes native plants, changing the structure of forest communities and reducing food sources and habitat for wildlife. A shade-tolerant species, it invades forested areas and is difficult to control once it has reached a site. It produces chemicals that inhibit the growth of other plants and fungi. Garlic mustard also has been shown to cause the death of larvae of certain butterfly species that hatch on the plant. It produces cyanide, which can be toxic to vertebrate species as well.

Social and economic impacts (Map 7.2) In Europe, garlic mustard is the host plant for viruses affecting horticultural and agricultural crops. Canadian farmers report that when cattle eat the rosettes of garlic mustard, the milk has a bad flavor.

MANAGEMENT

Table 7.2 and Map 7.3 summarize commonly reported program types and the number of entities reporting management activities for garlic mustard.

State- or Puget Sound-level activities Garlic mustard is on the state list of Class A noxious weeds (eradication is required).

County-level activities Garlic mustard management activities have been reported in all of the counties with documented occurrences, as well as Thurston, Mason, Kitsap, and Jefferson Counties. Reported management activities include control, detection, enforcement, education/outreach, eradication, monitoring, policy, and prevention.

Federal-level activities There are no known federal-level management activities in place for this species.

Other activities There are no other known management activities in place for this species.

Table 7.2. Commonly reported management program types and number of organizations targeting garlic mustard.

Entity	Three Most Commonly Reported Management Program Types (frequency)	Number of Organizations with current management activities
County	Education/outreach (9), Monitoring (7), Detection (6)	9
State	Policy (2), Detection, Enforcement, Funding, Monitoring, Prevention (1)	2
Federal	None	
Other	None	

Legal authorities Garlic mustard is listed as a Class A Noxious Weed in Washington, meaning its eradication is required. Garlic mustard also is on Washington's Terrestrial Noxious Weed Seed and Plant Quarantine list, meaning it is prohibited to transport, buy, sell, or offer for sale, garlic mustard plants, plant parts, or seeds (Washington Administrative Code 16-752-610).

Funding Over the past few years, the Washington State Noxious Weed Control Board has provided funding for garlic mustard control efforts by noxious weed boards in Skamania and Clark Counties as well as the City of Bellevue Parks and Recreation Department. In addition, the United States Forest Service has provided grant funding to the Washington State Department of Agriculture for control efforts in King County.

GARLIC MUSTARD

Alliaria petiolata

SUMMARY OF GAPS

Data collection and management The known populations of garlic mustard are concentrated in the heavily populated western part of King County, with a few isolated populations documented in more remote areas (Map 7.1). It seems likely that more populations are present in areas that have not been completely surveyed.

Knowledge and understanding of species status, pathways, and impacts There is good information about the pathways and impacts of garlic mustard.

Management efforts Garlic mustard is a Class A noxious weed, and management activities have been reported in all of the counties with documented occurrences.

SPECIES FACT

The Stewardship Network, headquartered in Michigan, coordinates an annual Garlic Mustard Challenge in Midwest communities. Volunteer groups compete to see who can pull and bag the most garlic mustard. In 2013, volunteers removed over 260,000 pounds of this invasive species.

REFERENCES

Boersma, P.D., S.H. Reichard, and A.N. Van Buren. 2006. Invasive Species in the Pacific Northwest. University of Washington Press, Seattle.

King County Noxious Weed Control Program. 2010. Best management practices – garlic mustard. Available: http://your.kingcounty.gov/dnrp/library/water-and-land/weeds/BMPs/Garlic-Mustard-Control.pdf. Accessed December 2012.

King County Noxious Weed Control Program. 2012. Garlic mustard - Alliaria petiolata. Available: http://www.kingcounty.gov/environment/animalsAndPlants/noxious-weeds/weed-identification/garlic-mustard.aspx. Accessed December 2012.

Washington Invasive Species Council. Fact sheet – Garlic mustard. Available: http://www.invasivespecies.wa.gov/documents/priorities/garlicmustard_factsheet.pdf. Accessed December 2012.

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CLASS A NOXIOUS WEED / STATE QUARANTINE SPECIES

Garlic Mustard

Alliaria petiolata


David Cappaert/Michigan State University/Bugwood.org


Leslie J. Mehrhoff/University of Connecticut/Bugwood.org

- Native to Europe.
- First recorded in Washington in the 1990s.
- Grows in disturbed areas including forests.
- Displaces native plants.
- Produces toxic substances.

Puget Sound Basin

Species Detection

- Alliaria petiolata

Land Cover & Land Use

- Forest
- Rock & Snow
- Water
- Disturbed Lands

Boundaries & Extents

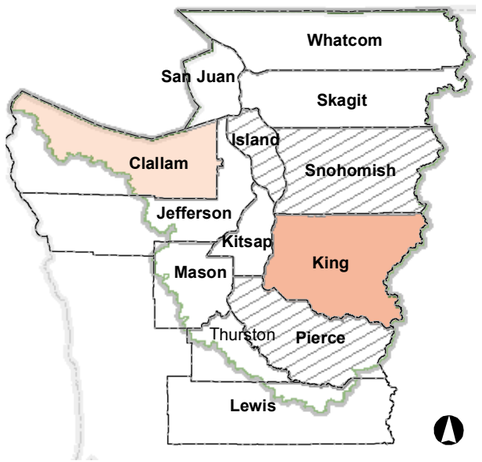
- County Boundary
- Puget Sound Extent

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

Miles
0 5 10 20

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. GIS data sources used to develop this map are noted in the Appendix.

Species Presence by County



Species Presence by County**
- No Known Infestations
- Present But Extent Unknown
- <10 Acres Infested
- 10-100 Acres Infested

** Data are Approximate

ESA

Documented Presence in Puget Sound Basin

MAP 7.1

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

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How does the species spread?

Trail Use
Garlic mustard seeds can be spread through foot traffic along trails near infested forest areas.

Wind
Seeds can be blown by wind to new sites.

Wildlife
Wildlife could spread garlic mustard seeds as the animals move through infested forest areas.

Garden Ornamental
Garlic mustard may have been introduced as a food or medicinal plant. It could be spread through intentional transplanting or use of contaminated equipment or mulch.

What resources are at risk?

Forests
Garlic mustard is of particular concern for its ability to colonize forests. The species produces abundant seeds and can self-pollinate, meaning that one plant can start a new population. Seeds can be readily transported, and plants can resprout from the top of the root even if the rest of the plant has been removed.

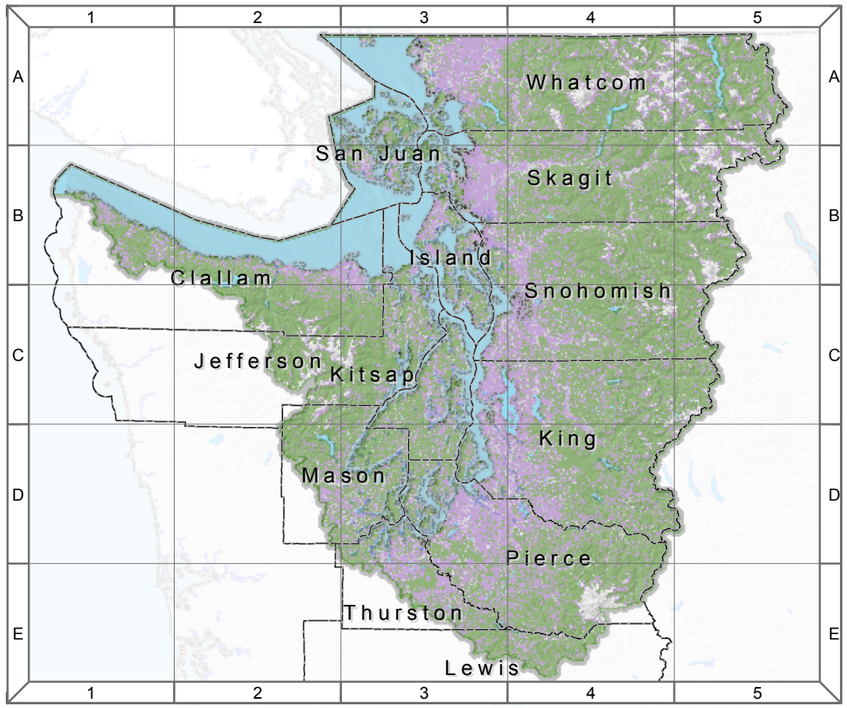
What impacts does the species have?

ECOLOGICAL IMPACTS

Displaces Native Vegetation
Garlic mustard outcompetes native plants, changing the structure of forest communities and reducing food sources and habitat for wildlife. A shade-tolerant species, it invades forested areas and is difficult to control once it has reached a site. It produces chemicals that can inhibit the growth of other plants and fungi. Garlic mustard also has been shown to cause death of larvae of certain butterfly species that hatch on the plant. It produces cyanide, which can be toxic to vertebrate species as well.

SOCIAL AND ECONOMIC IMPACTS

Damages Crops
In Europe, garlic mustard is the host plant for viruses affecting horticultural and agricultural crops. Canadian farmers report that when cattle eat the rosettes of garlic mustard, the milk has a bad flavor.



CLASS A NOXIOUS WEED / STATE QUARANTINE SPECIES

Garlic Mustard

Alliaria petiolata


David Cappaert/Michigan State University/Bugwood.org


Leslie J. Mehrhoff/University of Connecticut/Bugwood.org

Sensitive Landscape Features
- Forested Areas
- Disturbed Lands

Boundaries & Extents
- County Boundary
- Puget Sound Extent

Miles
0 10 20 40

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

ESA

Species Spread, Impacts, and Natural Resources at Risk

MAP 7.2

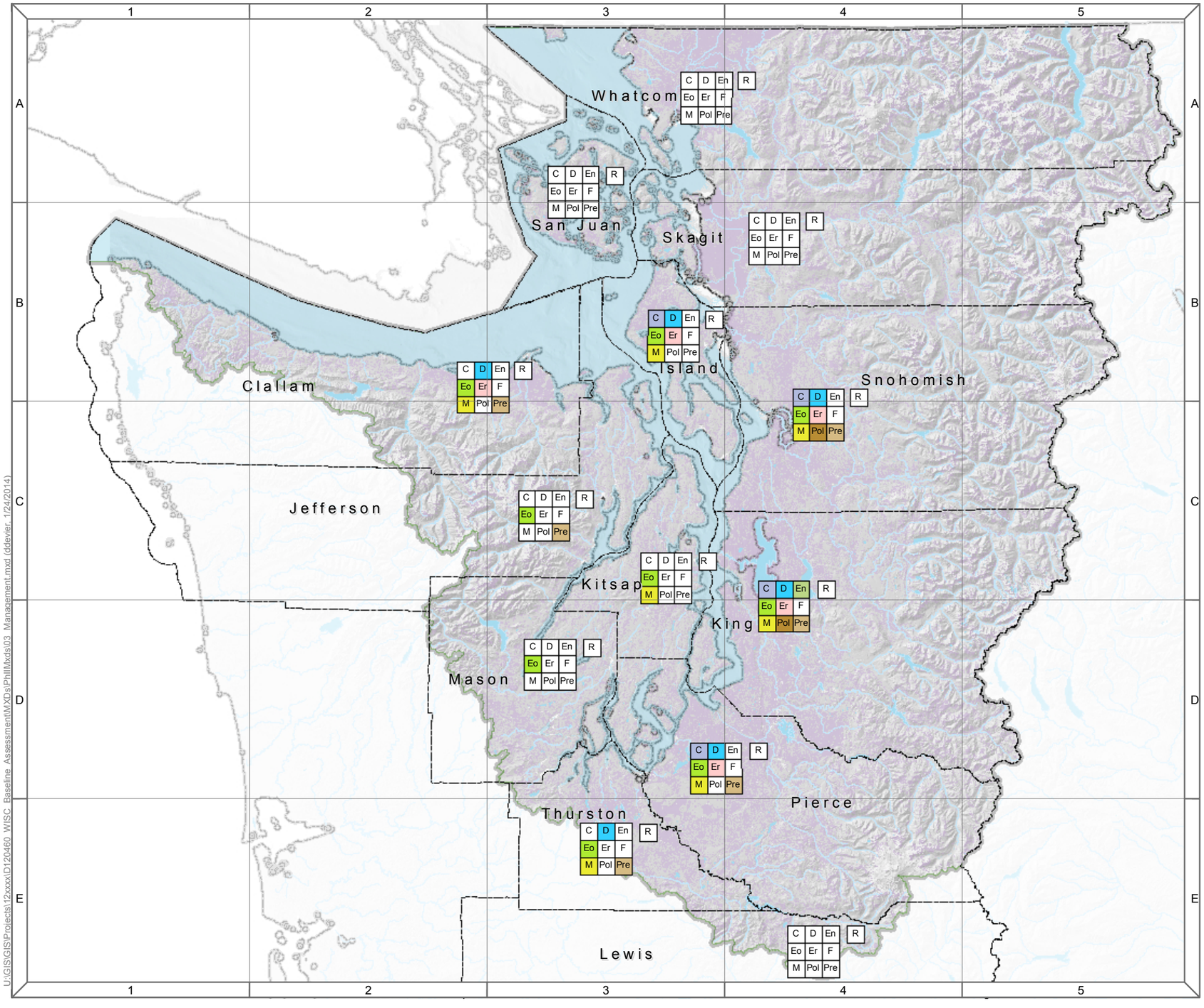
January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

CLASS A NOXIOUS WEED / STATE QUARANTINE SPECIES

Garlic Mustard

Alliaria petiolata



Management Programs at County Level

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

- County Boundary
- Puget Sound Extent
- Lakes
- Rivers

Management Programs at Regional/State/OtherLevel

D, Washington State Department of Agriculture

F, Washington State Department of Agriculture

M, Washington State Department of Agriculture

Pol, Puget Sound Partnership

Pol, Washington State Department of Agriculture

Pre, Washington State Department of Agriculture

Abbreviations:

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

Miles
0 5 10 20

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

ESA

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

Management at the County Level

MAP 7.3

January 2014

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GIANT HOGWEED
Heracleum mantegazzianum

8

Giant hogweed grows 15 to 20 feet tall with leaves up to 5 feet wide. It is shade-tolerant but also thrives in full sun and can colonize roadsides, streambanks, vacant lots, and other areas. While the invasive nature of the plant is an issue, the major concern is for human health. The sap of giant hogweed makes skin vulnerable to severe sunburn, blistering, and scarring. Contact of the sap with the eyes, combined with exposure to sunlight, can cause blindness.


Washington State Department of Transportation

STATUS AND TRENDS

Species Presence (Map 8.1) Giant hogweed has been detected in all Puget Sound counties. It is most common in the urban areas of south and west-central Puget Sound, as well as along roadsides and riparian corridors. See Table 8.1 for a summary of data obtained for this species.

Presence over time Giant hogweed is native to southwest Asia. It was introduced to the United States in the early 1900s as an ornamental plant and possibly as a food source (the seeds are used in Persian cuisine). It was known in the Seattle area by the 1950s.

Table 8.1. Giant hogweed data provided to the baseline assessment project.

File Type Provided	# of files	Spatial Extent	Data Provider
Spatially Explicit Data			
ESRI GIS data (shapefiles, geodatabase feature classes)	9	Island County, Jefferson County, King County, Mason County, Pierce County, Snohomish County, Thurston County, Whatcom County	WSU, Jefferson County NWCB, University of Washington Herbarium, Mason County, WSDA, Snohomish County Noxious Weed Control Board, Thurston County, Whatcom County, WSDOT
Tabular Data with Lat/Long (X/Y) Coordinates	1	Statewide	WSDOT
Hard Copy Maps	1	Statewide	WSDA
Other Data			
Management or survey reports	6	Clallam County, Island County, King County, Statewide	Clallam County, Island County, King County, WSU

PATHWAYS

Pathways of introduction Giant hogweed was introduced from Asia as an ornamental species and potentially a Persian spice plant.

Pathways of spread (Map 8.2) Giant hogweed readily spreads by seed, crowding other plants and invading moist natural areas such as riverbanks. Seeds are spread by wind, water, soil erosion, and human activities such as moving or dumping contaminated soil. Seeds can float for several days before settling and germinating in new areas. The species can also resprout from its persistent rootstock.

While the transport and sale of giant hogweed is illegal, it has long been an ornamental garden species. Gardeners who are unaware of its toxic properties could still trade or transplant the species.

GIANT HOGWEED

Heracleum mantegazzianum

IMPACTS AND AT-RISK RESOURCES

Ecological impacts (Map 8.2) Giant hogweed outcompetes other plants and takes over natural and seminatural areas such as riverbanks and forests. It can tolerate full shade and seasonal flooding, and its seeds can be viable for several years. Giant hogweed increases erosion on steep banks because the shallow-rooted plants die back in winter, exposing the soil to rain and streamflows.

Social and economic impacts (Map 8.2) Giant hogweed exudes a clear watery sap containing furanocoumarins that sensitize human skin to ultraviolet radiation. Contact with the furanocoumarins can result in severe burns to the affected areas that can turn into blistering and painful dermatitis. Scars and sensitivity to sunlight can last for many years. Contact with the eyes combined with expose to sunlight can cause blindness.

SPECIES FACT

Giant hogweed is truly a giant member of the carrot family, growing 10 to 15 feet tall with leaves up to 5 feet wide.

MANAGEMENT

Table 8.2 and Map 8.3 summarize commonly reported program types and the number of entities reporting management activities for giant hogweed.

State- or Puget Sound-level activities Giant hogweed is a Class A noxious weed and control is required in Washington state.

County-level activities Giant hogweed was once widely scattered throughout San Juan and Orcas Islands, but it has been largely eradicated. The San Juan County Noxious Weed Control Board and private landowners are monitoring sites that had previous infestations to ensure control of any seedlings that regenerate.

Giant hogweed management activities have been reported in all Puget Sound counties, with the exception of Whatcom, Skagit, and Lewis. Reported management activities include control, detection, enforcement, education/outreach, eradication, monitoring, policy, and prevention.

Federal-level activities There are no known federal-level management activities in place for this species.

Other activities There are no other known management activities in place for this species.

Table 8.2. Commonly reported management program types and number of organizations targeting giant hogweed.

Entity	Three Most Commonly Reported Management Program Types (frequency)	Number of Organizations with current management activities
County	Control, Education/outreach, Eradication (9), Detection, Monitoring (8), Enforcement (6)	10
State	Policy (2), Detection, Enforcement, Funding, Monitoring, Prevention (1)	2
Federal	None	
Other	None	

GIANT HOGWEED

Heracleum mantegazzianum

Legal authorities Giant hogweed is listed as a Class A Noxious Weed in Washington, meaning its eradication is required, but care must be taken to avoid contact with the toxic sap. The species is on Washington's Terrestrial Noxious Weed Seed and Plant Quarantine list, meaning it is prohibited to transport, buy, sell, offer for sale, or distribute giant hogweed plants, plant parts, or seeds (Washington Administrative Code 16-752-610). Importation and interstate transport of giant hogweed is regulated by the U.S. Department of Agriculture under the Federal Noxious Weed list (7 CFR 360). It is listed as a Federal Noxious Weed under the Plant Protection Act, which makes it illegal in the U.S. to import, export, or transport between states without a permit.

Funding Over the past few years, the Washington State Noxious Weed Control Board has provided funding for giant hogweed control efforts by several county weed boards in the Puget Sound region, including Mason, Snohomish, Clallam, and Jefferson Counties.

SUMMARY OF GAPS

Data collection and management Giant hogweed is well documented in the central Puget Sound counties, particularly near urban areas (Map 8.1). There may be additional occurrences in more rural areas that have not been recorded.

Knowledge and understanding of species status, pathways, and impacts There is good information about the pathways and impacts (both ecological and human health) of giant hogweed.

Management efforts Giant hogweed has been detected in all Puget Sound counties, with control efforts reported in all but three counties. At least one county (San Juan) has been successful in controlling this species.

REFERENCES

Boersma, P.D., S.H. Reichard, and A.N. Van Buren. 2006. Invasive Species in the Pacific Northwest. University of Washington Press, Seattle.

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CLASS A NOXIOUS WEED / STATE QUARANTINE SPECIES / FEDERAL NOXIOUS WEED LIST

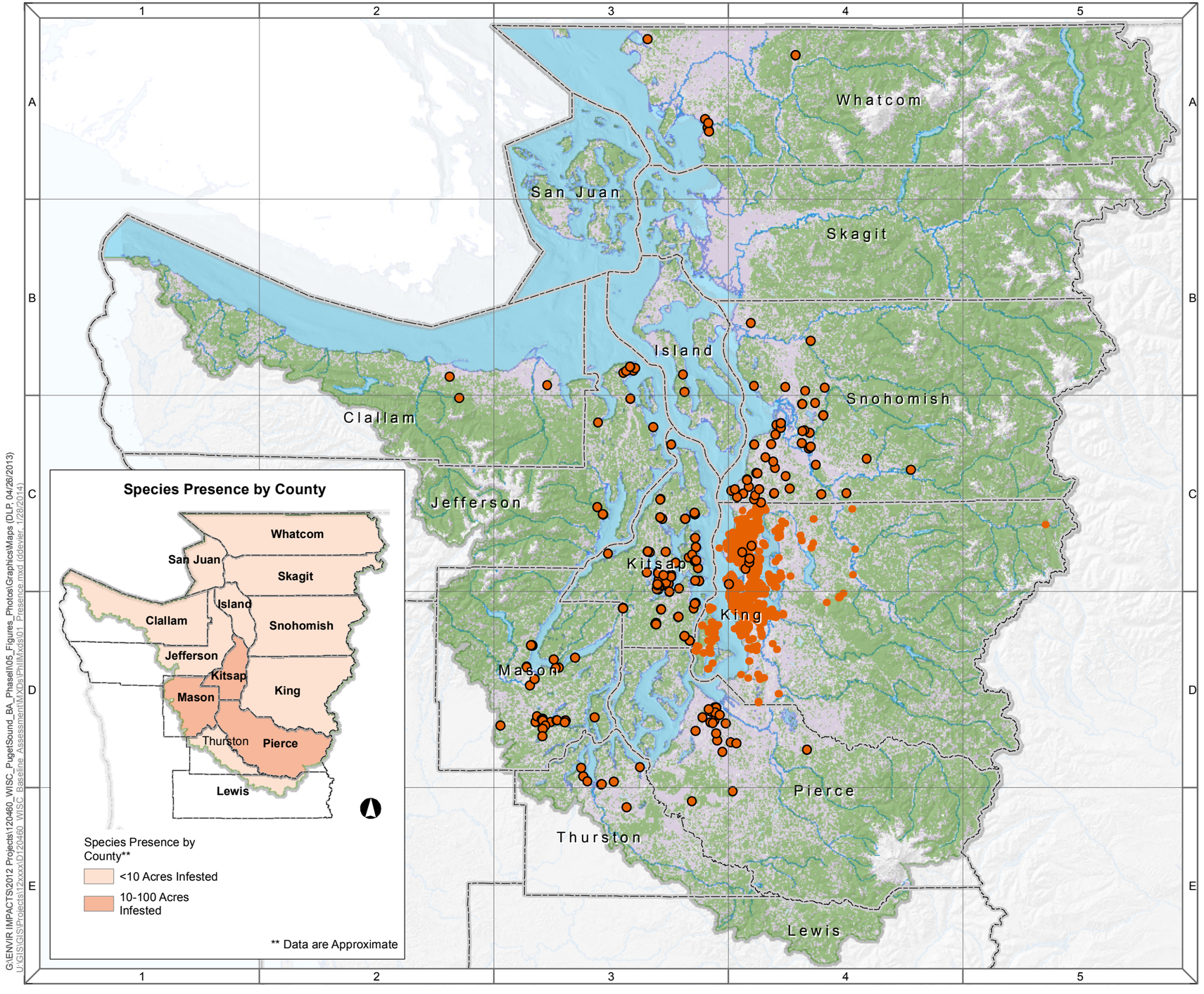
Giant Hogweed

Heracleum mantegazzianum


Washington State Department of Transportation


Washington State Noxious Weed Control Board

- Native to Asia.
- Known in the Seattle area in the 1950s.
- Grows in disturbed areas and streambanks.
- Displaces native vegetation.
- Sap makes human skin vulnerable to severe sunburn and blistering.



Puget Sound Basin

Species Detection

- Heracleum mantegazzianum

Land Cover & Land Use

- Forest
- Rock & Snow
- Water
- Disturbed Lands

Boundaries & Extents

- County Boundary
- Puget Sound Extent

0 5 10 20 Miles

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. GIS data sources used to develop this map are noted in the Appendix.

ESA

Documented Presence in Puget Sound Basin

MAP 8.1

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

How does the species spread?

Soil and Gravel Transport
Giant hogweed seeds can be spread through transport of contaminated gravel or soil.

Wind
Seeds can be blown by wind to new sites.

Streamflows and Waves
Seeds can be washed downstream during floods. Seeds can float for several days before settling and germinating in new areas.

Garden Ornamental
It is illegal to sell or transport giant hogweed, but unknowing gardeners could still trade or transplant it.

What resources are at risk?

Riparian Areas and Forests
Giant hogweed can tolerate shade and flooding, allowing it to colonize forests or streambanks in areas of disturbed soils.

Disturbed Areas
Giant hogweed thrives in disturbed soils such as roadsides and construction sites, and it can be readily transported to these areas by contaminated fill material or equipment. New construction and redevelopment provides opportunities for additional populations to become established.

What impacts does the species have?

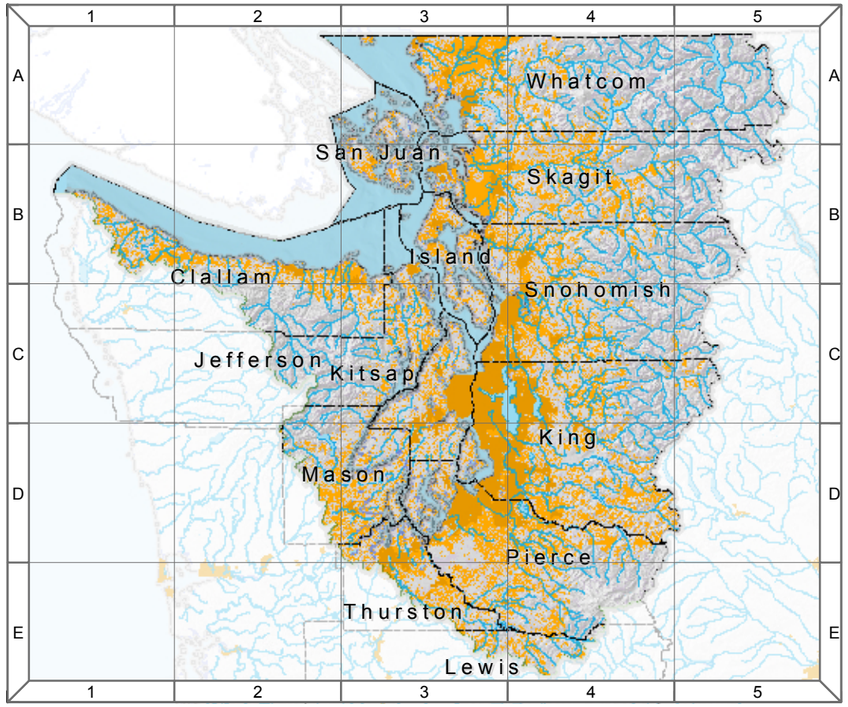
ECOLOGICAL IMPACTS

Displaces Native Vegetation
Giant hogweed outcompetes other plants and takes over natural areas, especially moist environments such as riverbanks. It can tolerate full shade and seasonal flooding, and its seeds can be viable for several years.

Increases Erosion
Giant hogweed increases erosion on steep banks because the shallow-rooted plants die back in winter, exposing the soil to rain and streamflows.

SOCIAL AND ECONOMIC IMPACTS

Toxic to Humans
Giant hogweed exudes a clear watery sap containing furanocoumarins that sensitize human skin to ultraviolet radiation. Contact with the furanocoumarins can result in blindness or severe burns that can turn into blistering and painful dermatitis. Scars and sensitivity to sunlight can last for many years.



CLASS A NOXIOUS WEED / STATE QUARANTINE SPECIES / FEDERAL NOXIOUS WEED LIST

Giant Hogweed

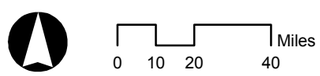
Heracleum mantegazzianum


Washington State Department of Transportation


Washington State Noxious Weed Control Board

Sensitive Landscape Features
- Riparian Areas and Streams Near Disturbed Areas
- Riparian Areas and Streams

Boundaries & Extents
- County Boundary
- Puget Sound Extent



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

ESA

Species Spread, Impacts, and Natural Resources at Risk

MAP 8.2

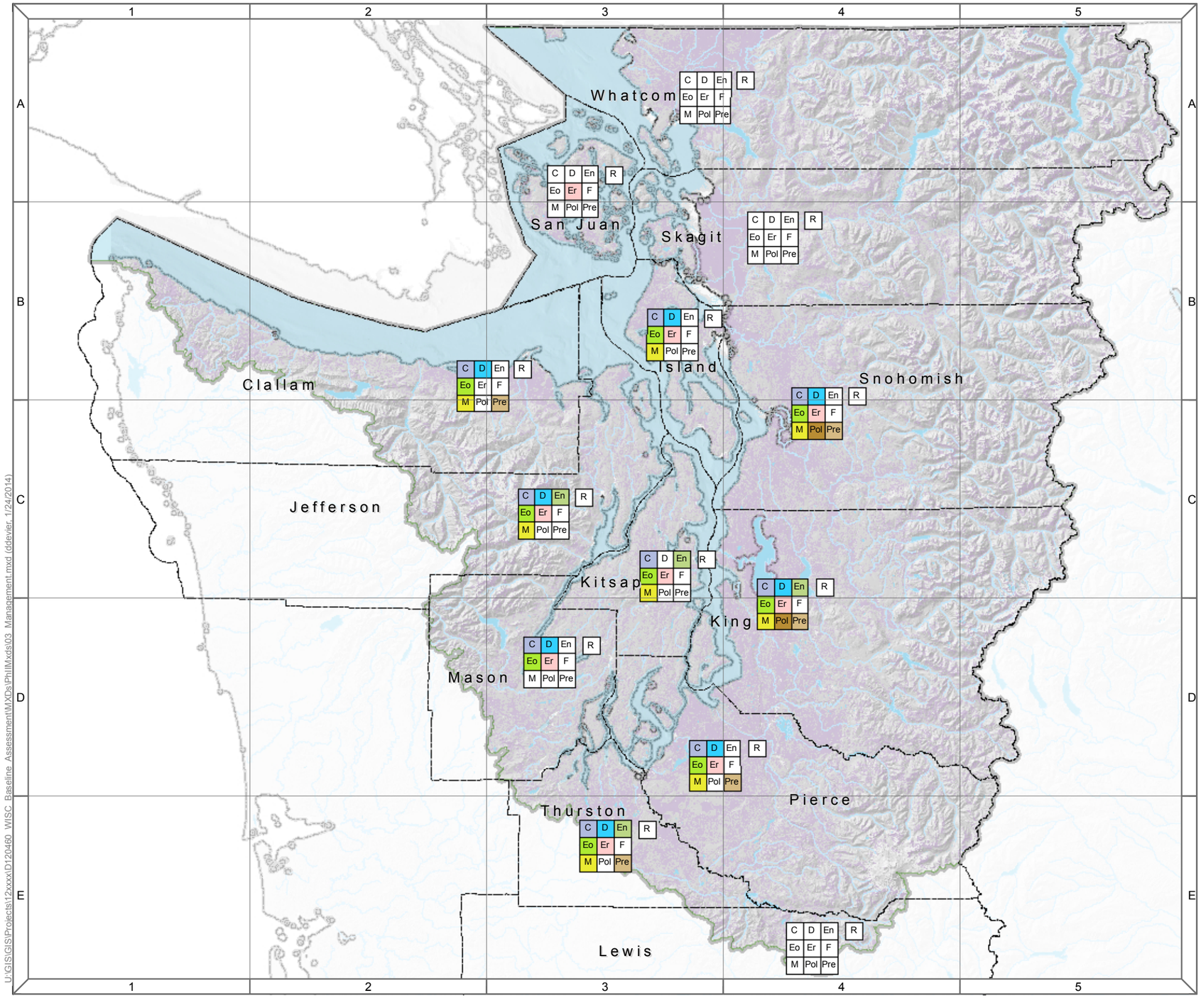
January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

CLASS A NOXIOUS WEED / STATE QUARANTINE SPECIES / FEDERAL NOXIOUS WEED LIST

Giant Hogweed

Heracleum mantegazzianum



Management Programs at County Level

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

- County Boundary
- Puget Sound Extent
- Lakes
- Rivers

Management Programs at Regional/State/OtherLevel

D, Washington State Department of Agriculture

F, WA State Noxious Weed Control Board

F, Washington State Department of Agriculture

M, Washington State Department of Agriculture

Pol, Puget Sound Partnership

Pol, Washington State Department of Agriculture

Pre, Washington State Department of Agriculture

Abbreviations:

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

0 5 10 20 Miles

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

ESA

Management at the County Level

MAP 8.3

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

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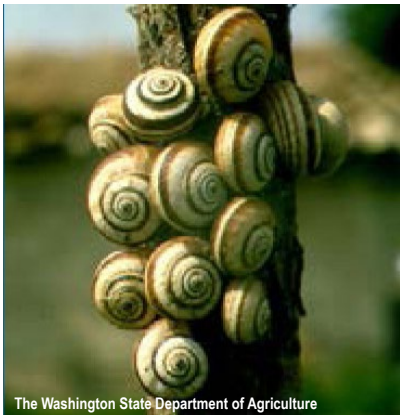
MEDITERRANEAN SNAIL 9

Cernuella virgata

The Mediterranean snail is a small terrestrial species (less than 1 inch across), white or tan in color and sometimes with dark brown spiral bands. It is also known as the vineyard snail or maritime garden snail. These snails climb to the top of vertical structures such as vegetation, particularly crops, where they can survive long periods of hot and dry weather without food. They are a serious crop pest in some parts of the world.


The Washington State Department of Agriculture


The Washington State Department of Agriculture

STATUS AND TRENDS

Species Presence (Map 9.1) To date the Mediterranean snail has been documented in only one location in the Puget Sound region, at the Port of Tacoma adjacent to the Blair Waterway. See Table 9.1 for a summary of data obtained for this species.

Presence over time The Mediterranean snail was found at the Port of Tacoma, Washington, in late 2005. Active eradication of this population began in 2007. The infestation has been reduced from around 300 acres down to 40 acres.

Table 9.1. Mediterranean snail data provided to the baseline assessment project.

File Type Provided	# of files	Spatial Extent	Data Provider
Spatially Explicit Data			
ESRI GIS data (shapefiles, geodatabase feature classes)	1	Site-level (Port of Tacoma)	USDA
Tabular Data with Lat/Long (X/Y) Coordinates	0		
Hard Copy Maps	0		
Other Data			
Management or survey reports	3	Site-level (Port of Tacoma)	USDA, WSDA, Port of Tacoma

PATHWAYS

Pathways of introduction Native to the Mediterranean region and western Europe, this exotic snail was likely introduced to North America on ships carrying cargo containers.

Pathways of spread (Map 9.2) Land snails are generally slow moving and not highly mobile. However, they can be spread more quickly and potentially over long distances through dispersal by humans or animals. Other land snail species with similar behaviors (climbing onto vertical structures) have been found to be transported on cars and livestock. Snails could also be carried on trucks, rail cars, or farm equipment.

MEDITERRANEAN SNAIL

Cernuella virgata

IMPACTS AND AT-RISK RESOURCES

Ecological impacts (Map 9.2) While the Mediterranean snail may impact native flora and fauna, the exact types of ecological impacts that could occur in the Puget Sound region are unknown. As an invasive species, it may displace native snail and slug species, with unpredictable consequences for native species food webs.

Social and economic impacts (Map 9.2) Mediterranean snails eat cereal and legume crops, pasture vegetation, and likely many types of native plants. They go into a dormant stage in the summer, often on top of crops, which can lead to clogging of harvesting machinery and contamination of harvested crops. These snails also can carry plant, animal, and human diseases. The Mediterranean snail is a serious pest in agricultural areas of Australia, where researchers are attempting to find a biological control agent.

MANAGEMENT

Table 9.2 and Figure 9.3 summarize commonly reported program types and the number of entities reporting management activities for Mediterranean snail.

State- or Puget Sound-level activities The WSDA and Puget Sound Partnership reported activities for Mediterranean snail.

County-level activities No county-level management activities for Mediterranean snail were reported.

Federal-level activities The USDA Animal and Plant Health Inspection Service (APHIS) has published detailed guidelines for agencies to use when developing emergency response programs for infestations of terrestrial gastropods, including the Mediterranean snail. The guidelines cover activities beginning with confirming the identification of the suspected pest species, through regulatory requirements, pest surveys, and treatment methods.

Other activities The Port of Tacoma infestation was addressed through joint efforts by the State Department of Agriculture, the USDA, and the Port of Tacoma.

Table 9.2. Commonly reported management program types and number of organizations targeting Mediterranean snail.

Entity	Three Most Commonly Reported Management Program Types (frequency)	Number of Organizations with current management activities
County	None	
State	Control, Detection, Monitoring, Policy, Prevention (1)	2 (WSDA, PSP)
Federal	Enforcement	1 (USDA)
Other	Control, Detection, Eradication (1)	1 (Port of Tacoma)

MEDITERRANEAN SNAIL

Cernuella virgata

Legal authorities The federal Plant Protection Act (7 USC 7711) prohibits the introduction of plant pests such as the Mediterranean snail into the United States. The U.S. Department of Agriculture Animal and Plant Health Inspection Service (APHIS), along with state agricultural departments, works to ensure that plant pests are not introduced or spread in the United States. Importers should examine overseas shipments and report any suspected invasive snails to the Washington State Department of Agriculture.

Funding The costs to eradicate Mediterranean snails at the Port of Tacoma were initially shared by the federal government (USDA–APHIS), Washington State, the Port, the City of Tacoma, and private landowners. In 2008, USDA–APHIS provided $86,000 for eradication activities in Washington as part of a five-year control plan.

SUMMARY OF GAPS

Data collection and management A limited number of files were provided about the distribution of this snail species, reflecting its very limited extent in the basin (one location). It has been several years since the species was detected at the Port of Tacoma, and no additional populations have been recorded to date.

Knowledge and understanding of species status, pathways, and impacts This species has so far been confined to one geographic area around the Port of Tacoma. Should it become more widespread, its impacts will be unpredictable.

Management efforts Control efforts at the Port of Tacoma have been successful in reducing the extent of Mediterranean snail from 300 down to 40 acres.

SPECIES FACT

The Mediterranean snail was intercepted as U.S. ports of entry on 455 occasions between 1985 and 2009. The top three countries of origin for infested shipments were Italy, Spain, and Australia. In general, invasive snails were most commonly found on quarry products such as tiles and on containers, according to the USDA.

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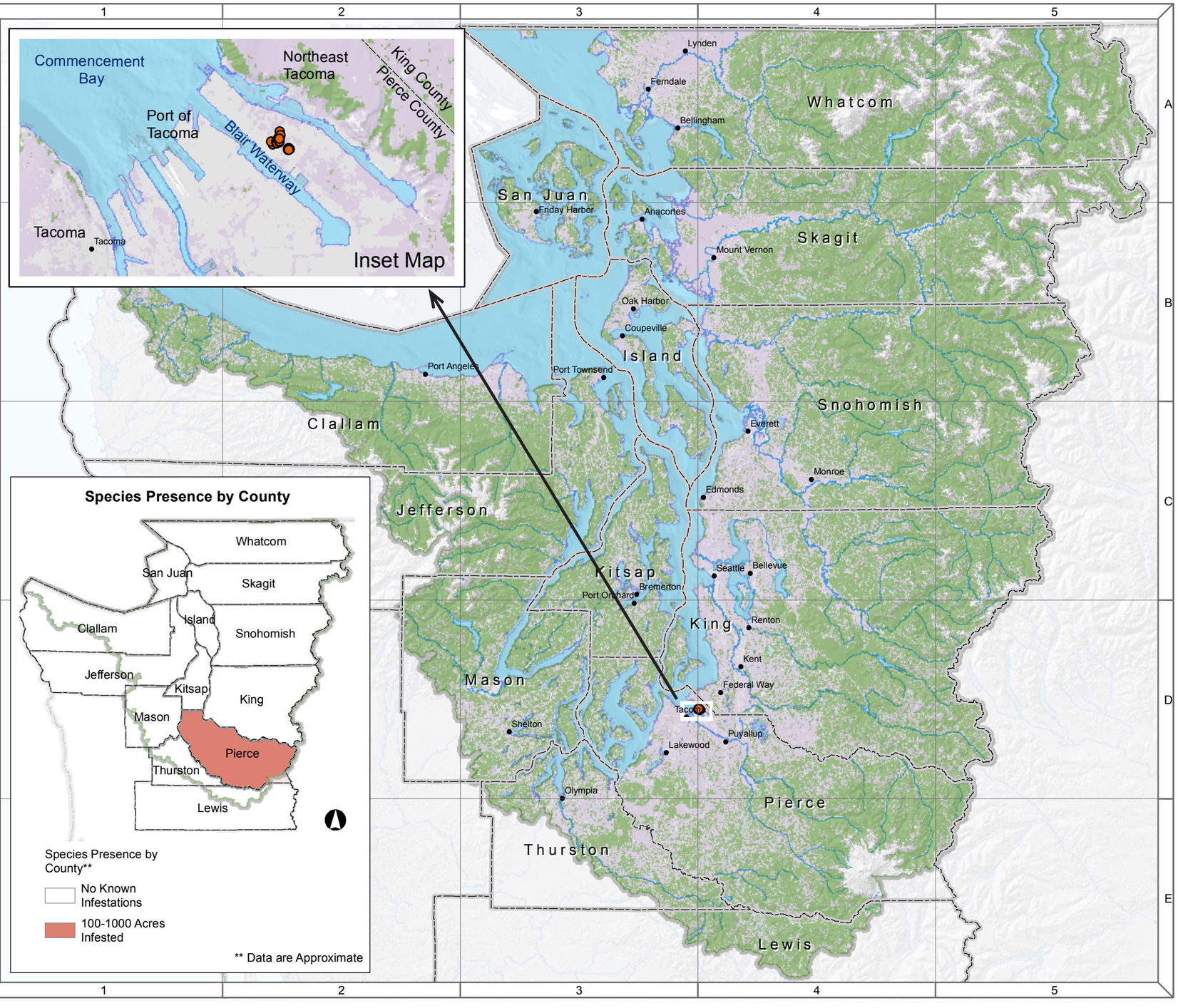

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FEDERALLY REGULATED AS A PLANT PEST

Mediterranean Snail

Cernuella virgata

- Native to Mediterranean and western Europe.
- Found at Port of Tacoma in 2005.
- Infests field crops, clogs harvesting machinery.

Puget Sound Basin

Species Detection

- Cernuella virgata

Land Cover & Land Use

- Forest
- Rock & Snow
- Water
- Disturbed Lands

Boundaries & Extents

- County Boundary
- Puget Sound Extent

Miles
0 5 10 20

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. GIS data sources used to develop this map are noted in the Appendix.

ESA

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

Documented Presence in Puget Sound Basin

MAP 9.1

January 2014

How does the species spread?

Shipping and International Trade
This exotic snail was likely introduced to North America on cargo containers. It was found at the Port of Tacoma in 2005.

Vehicles
Other land snail species with similar behaviors (climbing onto vertical structures) have been found to be transported by cars and livestock. Snails could also be carried on trucks, rail cars, or farm equipment.

What impacts does the species have?

ECOLOGICAL IMPACTS

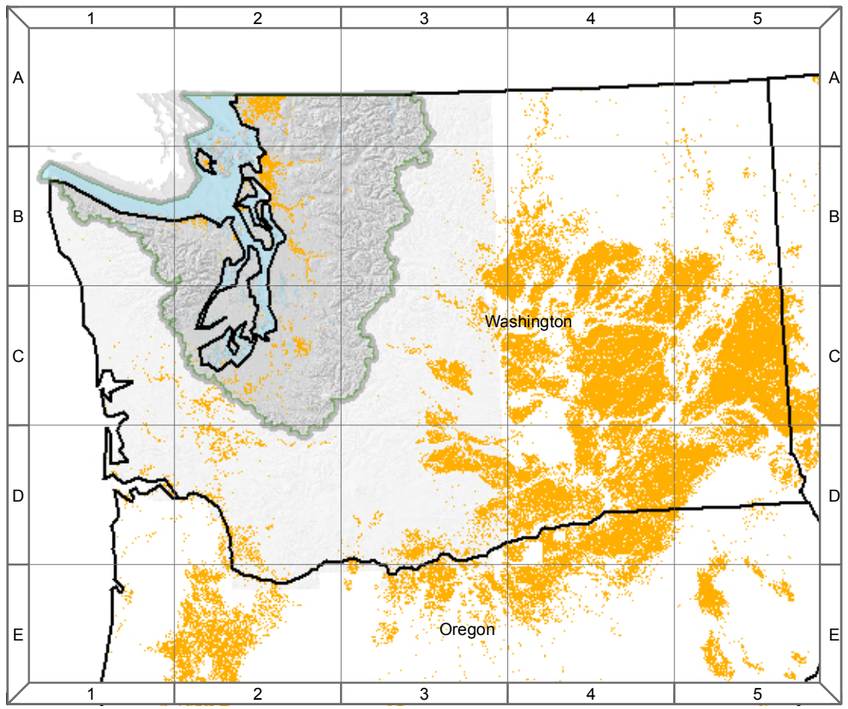
Impacts Native Wildlife
Mediterranean snails may displace native snail and slug species.

SOCIAL AND ECONOMIC IMPACTS

Damages Crops
Mediterranean snails eat and contaminate cereal and legume crops and clog harvesting machinery. These snails also can carry plant, animal, and human diseases.

What resources are at risk?

The Mediterranean snail is a serious pest in agricultural areas of Australia. These snails climb to the top of vertical structures such as vegetation, particularly crops, where they can survive long periods of hot and dry weather without food. Agricultural areas such as Whatcom and Skagit County could be impacted by an infestation of this species. While rural agricultural areas are generally located far from major shipping ports, there is the potential for the species to be spread long distances through attachment to trucks or other vehicles.



FEDERALLY REGULATED AS A PLANT PEST

Mediterranean Snail

Cernuella virgata


Washington State Department of Agriculture


Washington State Department of Agriculture

Sensitive Landscape Features
- Agricultural Lands (especially East of Cascades)

Boundaries & Extents
- Puget Sound Extent
- State Boundary

Miles
0 15 30 60

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

ESA

Species Spread, Impacts, and Natural Resources at Risk

MAP 9.2

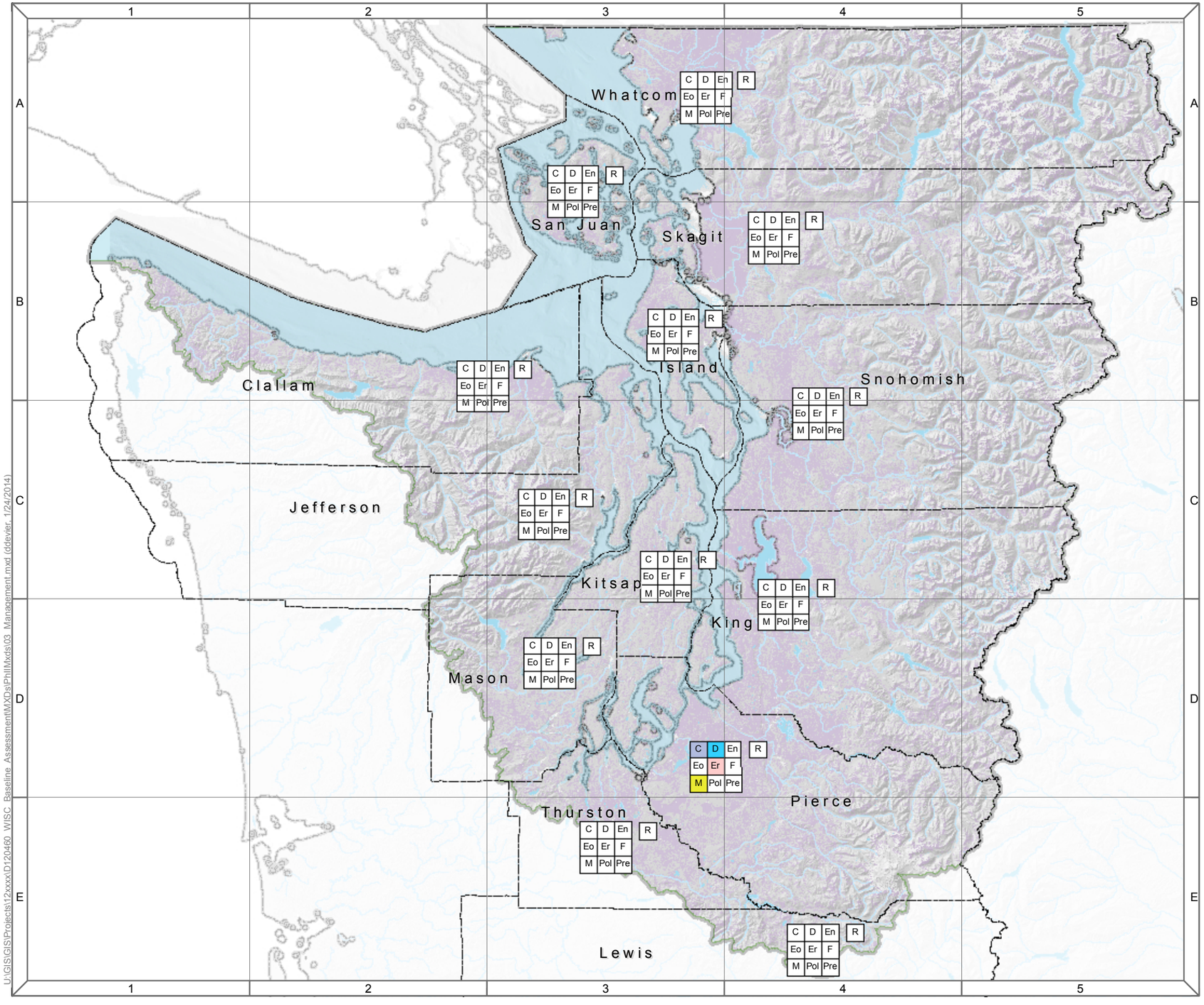
January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

FEDERALLY REGULATED AS A PLANT PEST

Mediterranean Snail

Cernuella virgata



Management Programs at County Level

- Control (C)
- Detection (D)
- Eradication (Er)
- Monitoring (M)

- County Boundary
- Puget Sound Extent
- Lakes
- Rivers

Management Programs at Regional/State/OtherLevel

C, Washington State Department of Agriculture

D, USDA-Animal and Plant Inspection Service

D, Washington State Department of Agriculture

Er, Washington State Department of Agriculture

M, Washington State Department of Agriculture

Pol, Puget Sound Partnership

Pre, Washington State Department of Agriculture

Abbreviations:

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

Miles
0 5 10 20

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

ESA

Management at the County Level

MAP 9.3

January 2014

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WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

NEW ZEALAND MUD SNAIL

Potomopyrgus antipodarum

10

New Zealand mud snails are tiny aquatic snails (less than 6 mm—about the size of a grain of rice). Their shells are light to dark brown but can appear black when wet. The opening of the shell has a movable cover called the operculum that allows the snail to seal itself inside, which protects it from short-term exposure to chemicals and drying out.

These hardy snails can tolerate a wide range of habitats, including brackish water, and many different substrates such as rock, gravel, sand, and mud. They reproduce at a phenomenal rate and reach extremely high densities, rapidly consuming plant material and displacing native aquatic species.

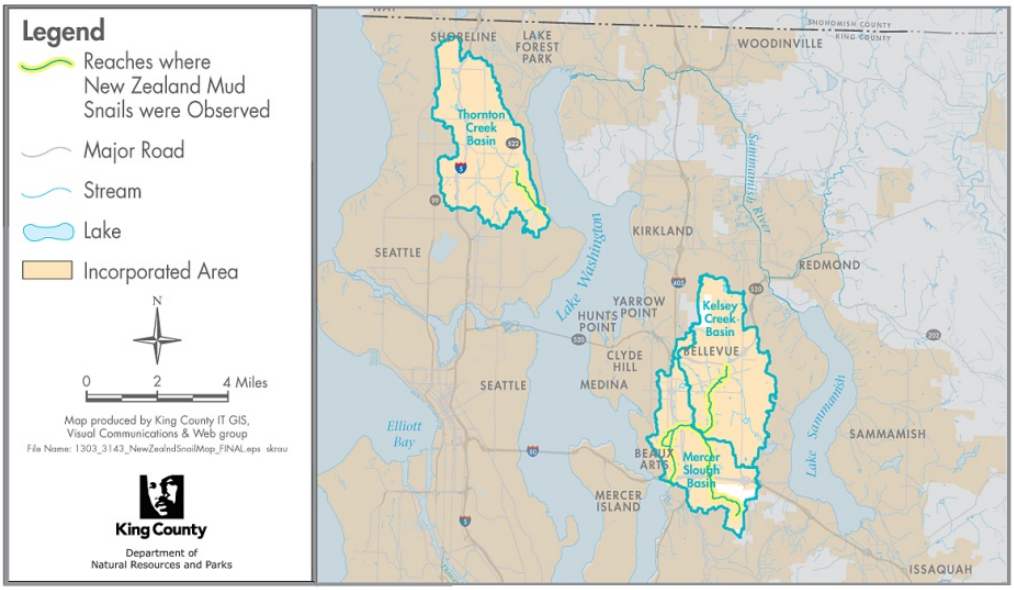
Robyn Draheim - Portland State University

STATUS AND TRENDS

Species Presence (Map 10.1) The New Zealand mud snail was first detected in the Puget Sound Basin at Capitol Lake in Thurston County in 2009. Since then, there have been efforts at the local, state, and federal levels to further identify the scope of the problem and control any further spread of the species. Additional observations have been detected at several locations in King County (see figure below). See Table 10.1 for a summary of data obtained for this species.

Presence over time The New Zealand mud snail is native to freshwater streams and lakes of New Zealand. It was found in the Snake River, Idaho, in the 1980s, and during the subsequent two decades it spread to 10 western states. It is also known to be present in the Great Lakes.

The species was discovered in the lower Columbia River in the late 1990s and in Olympia's Capitol Lake in 2009. In one nearshore area of Capitol Lake, snail density was estimated to be 20,000 per square meter. A study by University of Washington scientists in 2011 found New Zealand mud snails present along the littoral zone of Lake Washington, north and south of the Thornton Creek outlet. The snails were discovered in the Kelsey Creek watershed of Bellevue during 2012, and in Snohomish County in 2013.



Presence of New Zealand mud snail in King County (2012). Map Courtesy of King County.

NEW ZEALAND MUD SNAIL

Potomopyrgus antipodarum

Table 10.1. New Zealand mud snail data provided to the baseline assessment project.

File Type Provided	# of files	Spatial Extent	Data Provider
Spatially Explicit Data			
ESRI GIS data (shapefiles, geodatabase feature classes)	3	King County, Snohomish County, Thurston County	WDFW, WDOE, City of Bellevue
Tabular Data with Lat/Long (X/Y) Coordinates	0		
Hard Copy Maps	2	Site-level (King County), Site-level (Thurston County)	WDFW
Other Data			
Management or survey reports	18	King County, Thurston County	Washington Department of Fish & Wildlife, WDOE, King County, City of Bellevue

PATHWAYS

Pathways of introduction The New Zealand mud snail was likely introduced to the Great Lakes by ships carrying ballast water from Europe. Western populations may have arrived in water used to transport live game fish.

Pathways of spread (Map 10.2) This snail can survive short periods out of water and may be spread by humans or animals. Human pathways include contaminated boating, fishing, or scientific gear; vehicle tires or boat trailers; and gravel or dredge spoils transported from infested areas. Hatchery fish or eggs are another potential source of spread, although hatcheries are routinely inspected and quarantined if the snails are found. New Zealand mud snails can survive passage through the guts of fish and can also be transported by wildlife and floating mats of algae.

A female snail can give birth to 90 live young snails two to three times per year. In the Pacific Northwest, the populations consist of female clones that do not require a male snail to reproduce. For this reason, a single snail can start a new population.

IMPACTS AND AT-RISK RESOURCES

Ecological impacts (Map 10.2) Different scientific studies have reported complex and variable ecological impacts of New Zealand mud snails. It is known that New Zealand mud snails can achieve extremely dense populations that dominate river and lakebed habitats and consume most of the available plant material. This snail species thrives in disturbed watersheds and benefits from increased nutrient loads that favor growth of algae. A study in Wyoming found that the snails dominated carbon and nitrogen cycles in an infested stream, potentially impacting the food web. In streams of the greater Yellowstone ecosystem, high densities of New Zealand mud snail were associated with low colonization of other macroinvertebrates.

A study in California streams found that as New Zealand mud snail populations rose and fell over time, the abundance of native grazing herbivores declined and then recovered, providing evidence of direct negative competitive impacts of the invasive snails. However, the snails had a positive indirect effect on some types of herbivores by causing a change in the dominant type of algae. In other studies, New Zealand mud snails outcompeted native aquatic snails and insects, potentially disrupting the aquatic food chain.

NEW ZEALAND MUD SNAIL

Potomopyrgus antipodarum

In 2004 and 2005, researchers found the first evidence of Chinook salmon eating New Zealand mud snails in the lower Columbia River, possibly indicating the snails are becoming more dominant as a food source. However, another study in the Columbia River estuary found that fish did not eat less native prey when New Zealand mud snails were present, but actually increased their consumption of certain native species, illustrating the complexity of impacts resulting from this invasive species.

Social and economic impacts (Map 10.2) Snail infestations are a concern for fisheries. The snails are consumed by rainbow trout and other fish but provide little nutritional value, often passing undigested through the fish. New Zealand mud snails are an issue of concern (and an added expense) for hatchery managers. Fish stocking and transfers of eggs or fish from contaminated hatcheries may introduce or spread the snails to previously uninfested facilities or water bodies. Monitoring of hatcheries has become necessary, and quarantines are put in place for infested facilities.

The presence of the snail may result in some water bodies being closed to human use in order to prevent further spread. Local governments such as the City of Bellevue have already undertaken decontamination methods that result in extra time and costs.

SPECIES FACT

The City of Bellevue has developed a strong response to the discovery of New Zealand mud snails in the Kelsey Creek watershed during 2012. City staff are working on staff training and protocols, cleaning facilities for gear and equipment, public outreach, and decontamination requirements for consultants who work in area streams and wetlands. In addition, the City created a mobile application for tracking the snails in Bellevue and surrounding areas.

MANAGEMENT

Table 10.2 and Map 10.3 summarize commonly reported program types and the number of entities reporting management activities for New Zealand mud snail.

State- or Puget Sound-level activities The Washington Aquatic Nuisance Species Management Plan (2001) classifies New Zealand mud snails under Management Class 2. This class includes invasive species that are present and established in the state. Management activities focus on mitigating impacts, controlling population size, and preventing dispersal to other water bodies.

Capitol Lake in Olympia, where the snail was discovered in 2009, is managed by the Washington State Department of Enterprise Services (DES). Water levels in the lake are controlled by opening or closing spillways. The lake is now periodically lowered during freezing weather to kill snails and prevent the spread of the snails to other water bodies.

In 2011, New Zealand mud snails were found in Thornton Creek in Seattle. This stream is the subject of intensive restoration and volunteer efforts that have the potential to spread the snails to other water bodies. To reduce this risk, the Washington State Aquatic Invasive Species Prevention and Enforcement Program, along with the Washington Department of Ecology, King County, and Seattle Public Utilities, held a workshop in 2011 to train workers and volunteer groups entering Thornton Creek in proper decontamination procedures.

County-level activities Two counties (King and Thurston) reported management activities for New Zealand mud snail. King County maintains a web page with information on how to identify the species and measures to prevent its spread (http://www.kingcounty.gov/environment/animalsAndPlants/biodiversity/threats/Invasives/Mudsnails.aspx).

NEW ZEALAND MUD SNAIL

Potomopyrgus antipodarum

Federal-level activities The Aquatic Nuisance Species Task Force (ANSTF) is an intergovernmental entity established under the Non-indigenous Aquatic Nuisance Prevention and Control Act of 1990 (Act, 6 USC. 4701-4741), as amended by the National Invasive Species Act of 1996. The ANSTF is cochaired by the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA). The ANSTF coordinates national efforts to prevent the introduction and spread of aquatic invasive species including New Zealand mud snail. In 2003, the ANSTF established the New Zealand mud snail Management Plan Working Group to create a national management and control plan. The National Management and Control Plan for the New Zealand mud snail was published in 2007.

In addition, the USFWS surveys for New Zealand mud snails at national fish hatcheries in western Washington. The Columbia River Fisheries Program Office has been intermittently monitoring for New Zealand mud snails at lower Columbia River basin national fish hatcheries since 2006. Many federal fish hatcheries have developed regional Hazard Analysis and Critical Control Point Plans that are used as a risk assessment and management tool to prevent the spread of this species.

Other activities Researchers at Oregon State University have developed a statistical model to predict which nonnative species may become invasive. Funded by Oregon Sea Grant, the model evaluates the pathways of spread, whether species can survive in new environments, and the economic impacts of control. Using the New Zealand mud snail invasion in Olympia as a test case, the model's results matched actual data with 95 percent accuracy.

Legal authorities The Washington Administrative Code (WAC 220-12-090) classifies New Zealand mud snails as a prohibited aquatic animal species. Live specimens cannot be possessed, purchased, sold, imported, transported, propagated, or released without a permit.

Funding The USFWS provides funding and technical assistance for management, monitoring, and control efforts for species including New Zealand mud snails throughout the Pacific Northwest. The USFWS has provided funding to the WDFW Aquatic Nuisance Species (ANS) Program for implementation of the state ANS Management Plan for over a decade.

The Washington Department of Fish and Wildlife provided funding to create a New Zealand mud snail management plan for Capitol Lake. WISC has funded three surveys for this species in the Puget Sound Basin.

Table 10.2. Commonly reported management program types and number of organizations targeting New Zealand mud snail.

Entity	Three Most Commonly Reported Management Program Types (frequency)	Number of Organizations with current management activities
County	Education/Outreach, Detection, Control, Prevention (2)	2 (King, Thurston)
State	Education/Outreach(2), Policy(2), Control, Detection, Enforcement, Eradication, Prevention, Research (1)	2 (PSP, WDFW)
Federal	Prevention (1), Monitoring (1), Detection (1)	3
Other	Monitoring, Research	1 (University of Washington)

NEW ZEALAND MUD SNAIL

Potomopyrgus antipodarum

SUMMARY OF GAPS

Data collection and management. Detailed information is available for areas where this species is known to occur.

Knowledge and understanding of species status, pathways, and impacts The ecological impacts of New Zealand mud snail are complex and still being studied, but it is clear this species has the potential to cause significant changes in aquatic habitats in a variety of ways.

Management efforts Prevention is the only effective management tool for this species. There is no known method to eradicate New Zealand mud snails from a body of water once they have been introduced. Control methods such as dewatering would have drastic impacts on native species. Unfortunately prevention is also challenging because of the very small size of the snails and the fact that a single snail can start a new population.

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STATE PROHIBITED AQUATIC ANIMAL SPECIES

New Zealand Mud Snail

Potomopyrgus antipodarum


Robyn Draheim/Portland State University


Robyn Draheim/Portland State University

- Native to New Zealand
- Discovered in the lower Columbia River in the late 1990s.
- Lives in fresh and brackish waters.
- Achieves dense populations through cloning.
- Alters aquatic habitats and food webs.

Puget Sound Basin

Species Detection

- Potomopyrgus antipodarum

Land Cover & Land Use

- Forest
- Rock & Snow
- Water
- Disturbed Lands

Boundaries & Extents

- County Boundary
- Puget Sound Extent

Miles
0 5 10 20

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. GIS data sources used to develop this map are noted in the Appendix.

ESA

Documented Presence in Puget Sound Basin

MAP 10.1

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

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How does the species spread?

Boats and Fishing Gear
NZMS can be transported between water bodies by lodging on fishing gear, boating equipment, or float planes. Potential for spread through contaminated fish hatchery stock.

Trail Use
The tiny NZMS can lodge in boots or scientific equipment that come in contact with infested waters. If gear is not properly decontaminated, the snails can be carried to new areas.

Wildlife
NZMS can survive passage through the guts of fish and could also be spread by waterfowl or other wildlife.

Streamflows and Waves
The snails can also be transported by floating on mats of algae.

Vehicles
Driving vehicles or boat trailers into contaminated waters can spread NZMS.

Soil and Gravel Transport
Transport of dredge material or stream gravel contaminated with NZMS could spread it to new areas.

What resources are at risk?

Streams, Lakes, and Estuaries
Known NZMS infestations are currently limited to a few areas of Puget Sound, and there have been efforts at the local, state and federal levels to control any further spread of the species (e.g., decontamination protocols). However, streams, lakes, and estuaries are still at risk of new infestations through various means of transport. Even a few snails can produce a new dense population through cloning.

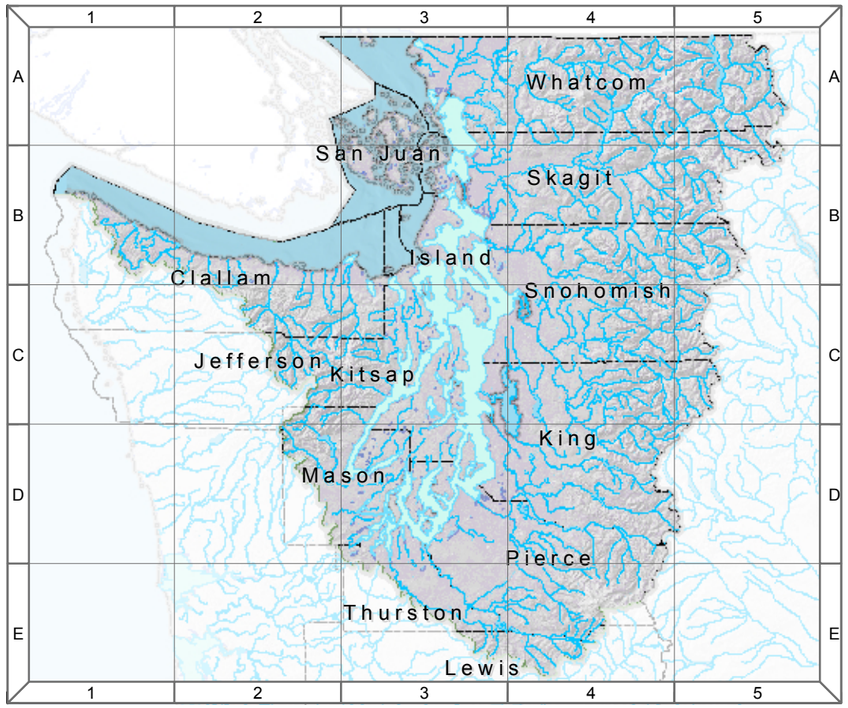
What impacts does the species have?

ECOLOGICAL IMPACTS

Changes Aquatic Food Webs
NZMS forms extremely dense populations that dominate benthic habitats. The species can change nutrient cycles, potentially altering aquatic food webs. Native invertebrate species may be displaced.

SOCIAL AND ECONOMIC IMPACTS

Impacts Fisheries
NZMS is a poor food source for fish. Transfer of eggs or fish from contaminated hatcheries could spread NZMS to new areas. Hatcheries incur extra costs to inspect and quarantine their facilities.



STATE PROHIBITED AQUATIC ANIMAL SPECIES

New Zealand Mud Snail

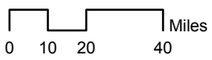
Potomopyrgus antipodarum


Robyn Draheim/Portland State University


Robyn Draheim/Portland State University

Sensitive Landscape Features
- Estuary
- Lakes
- Rivers

Boundaries & Extents
- County Boundary
- Puget Sound Extent



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

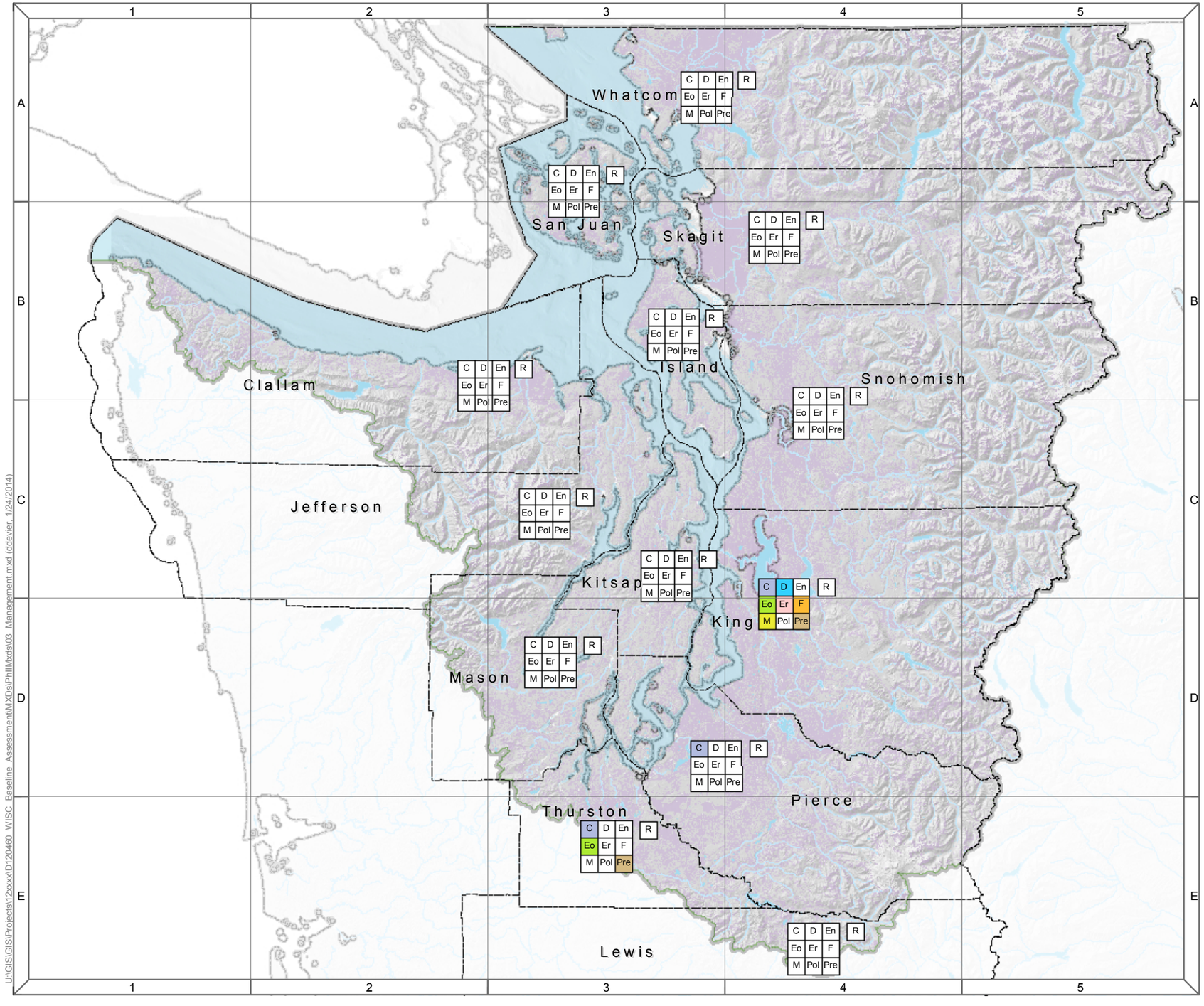
ESA

Species Spread, Impacts, and Natural Resources at Risk

MAP 10.2

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council



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STATE PROHIBITED AQUATIC ANIMAL SPECIES

New Zealand Mud Snail

Potomopyrgus antipodarum

Management Programs at County Level

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

- County Boundary
- Puget Sound Extent
- Lakes
- Rivers

Management Programs at Regional/State/OtherLevel

C, Washington State Department of Fish and Wildlife

D, Washington State Department of Fish and Wildlife

M , Washington State Department of Fish and Wildlife

M, University of Washington

Pol, Puget Sound Partnership

R, University of Washington

Abbreviations:

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

Miles
0 5 10 20

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

ESA

Management at the County Level

MAP 10.3

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

RED SWAMP CRAYFISH

Procambarus clarkii

11

Crayfish are freshwater crustaceans related to but smaller than lobsters. The red swamp crayfish is native to the southcentral United States and northeastern Mexico. It is said to be the most widely introduced crayfish in the world. The red swamp crayfish inhabits lakes, wetlands, and slow-moving streams and can tolerate brackish or stagnant water. It burrows in the mud to find moisture during drought periods.


Washington Department of Fish and Wildlife

STATUS AND TRENDS

Species Presence (Map 11.1) The species has been documented at a few, scattered locations in Pierce, King, and Snohomish Counties. To date, there have been limited survey efforts for the species in the greater Puget Sound region. See Table 11.1 for a summary of data obtained for this species.

Presence over time The red swamp crayfish appeared in California in the 1920s, in Idaho in 1975, and in Oregon during the 1980s. The species was first discovered in Washington in 2000, within Pine Lake in Sammamish.

Table 11.1. Red swamp crayfish data provided to the baseline assessment project.

File Type Provided	# of files	Spatial Extent	Data Provider
Spatially Explicit Data			
ESRI GIS data (shapefiles, geodatabase feature classes)	3	King County, Pierce County, Snohomish County	University of Washington School of Aquatic and Fishery Science
Google Earth KMZ files	0		
Tabular Data with Lat/Long (X/Y) Coordinates	0		
Hard Copy Maps	0		
Other Data			
Management or survey reports	3	King County, Snohomish County	USGS, WDFW

PATHWAYS

Pathways of introduction Native to the southeastern United States, the red swamp crayfish was likely introduced to Washington as a bait species. It was first found in Pine Lake in King County and has become widespread in the Sammamish River basin.

Pathways of spread (Map 11.2) In addition to being used as live bait, red swamp crayfish could be introduced by people hoping to raise them as a food source (they are a commercial food species in the southeastern U.S.). While it is illegal to import or transport them in Washington, it may be possible to order live crayfish through biological supply houses for use in schools. Well-meaning students or teachers may release the crayfish into local water bodies, or they could be dumped by other aquarium owners.

RED SWAMP CRAYFISH

Procambarus clarkii

IMPACTS AND AT-RISK RESOURCES

Ecological impacts (Map 11.2) Rapidly reproducing, nonnative crayfish may displace native crayfish populations by outcompeting for food and habitat. They may alter habitats by grazing on aquatic vegetation, and their burrowing activities can displace native bottom-dwelling species. In California, red swamp crayfish negatively affect amphibian populations. Red swamp crayfish are also an intermediate host for parasites affecting vertebrate species.

Social and economic impacts (Map 11.2) Burrowing by the red swamp crayfish can damage levees and water control structures.

MANAGEMENT

Table 11.2 and Map 11.3 summarize commonly reported program types and the number of entities reporting management activities for red swamp crayfish.

State- or Puget Sound-level activities WDFW has enforcement responsibility over nonnative crayfish and also provides public education, such as posting signs at infested lakes, contacting boaters and anglers, and distributing identification information to the public.

County-level activities No county-level management actions for red swamp crayfish were reported.

Federal-level activities There are no known federal-level management activities in place for this species.

Other activities Scientists at the University of Washington recently completed an assessment of the state of crayfish—both native and nonnative species—in the Pacific Northwest. They found the number of alien crayfish species in the region now exceeds that of native crayfish. Four alien crayfish species are documented in Washington state, including the red swamp, Sanborn's, virile, and White River.

Legal authorities Nonnative crayfish are a prohibited aquatic animal species in Washington (WAC 220-12-090), meaning they may not be legally purchased or transported in the state. Crayfish are caught in the state's recreational and commercial fisheries, which are managed by WDFW. Catch limits are set for native crayfish. Nonnative crayfish such as the red swamp crayfish are not subject to catch restrictions but must be kept in a separate container and must be dead before being removed from the riparian area (immediate vicinity of water body).

Funding In 2005, the Washington state legislature established the Aquatic Invasive Species (AIS) Prevention and Enforcement Program which is managed by WDFW in collaboration with the Washington State Patrol. The program is primarily funded through dedicated fees on resident recreational watercraft with support from the USFWS. Over the past several years, budget reductions have resulted in reduced AIS management capacity and the loss of personnel.

Table 11.2. Commonly reported management program types and number of organizations targeting red swamp crayfish.

Entity	Three Most Commonly Reported Management Program Types (frequency)	Number of Organizations with current management activities
County	None	
State	Policy (2), Control, Detection, Enforcement, Education/ outreach, Eradication, Monitoring, Prevention (1)	2 (PSP, WDFW)
Federal	None	
Other	Control, Detection, Education/outreach, Monitoring Prevention, Research (1)	1 (University of Washington)

RED SWAMP CRAYFISH

Procambarus clarkii

SUMMARY OF GAPS

Data collection and management To date, there have been limited survey efforts for the species in the greater Puget Sound region.

Knowledge and understanding of species status, pathways, and impacts The effects of invasive crayfish species on aquatic ecosystems in Washington, and their interactions with native species, are not well understood.

Management efforts Budget constraints have reduced the capacity of state agencies to address this species.

SPECIES FACT

Residents who live around Pine Lake in Sammamish have a new opportunity to help survey and eradicate red swamp crayfish from the lake. The University of Washington and Washington Sea Grant have started a volunteer program for lakeshore residents, teaching them to trap, identify, and remove these invasive crayfish. As of August 2013, volunteers had removed over 1,600 crayfish. More information about the project is available online at: http://depts.washington.edu/oldenlab/

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RED SWAMP CRAYFISH

Procambarus clarkii

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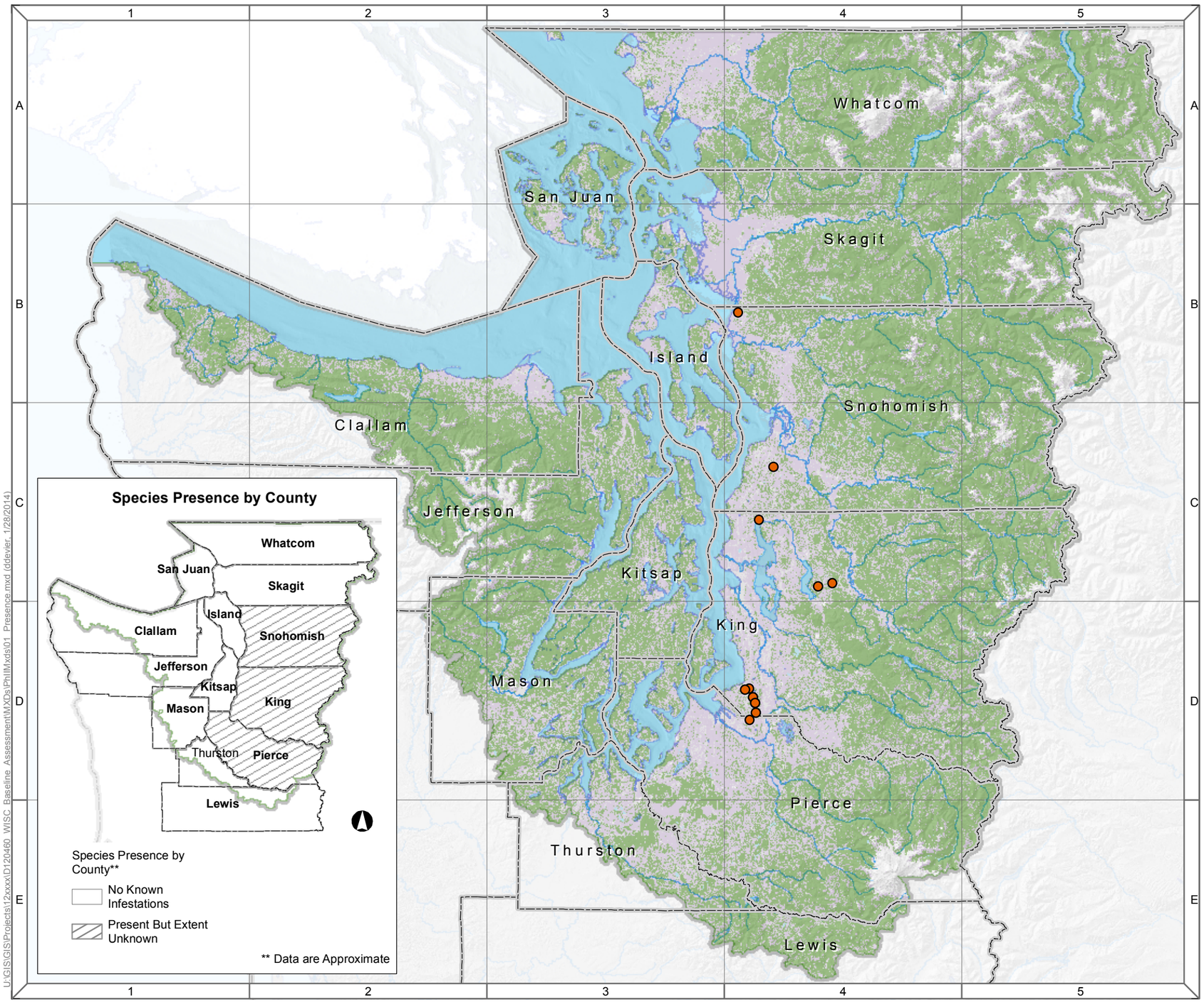
STATE PROHIBITED AQUATIC ANIMAL SPECIES

Red Swamp Crayfish

Procambarus clarkii

- Native to southcentral United States and northeastern Mexico.
- First discovered in Washington in 2000.
- Inhabits slow-moving fresh, brackish, and even stagnant waters.
- May displace and spread diseases to native crayfish.
- Alters aquatic habitats.
- Damages levees and riverbanks by burrowing.

Puget Sound Basin



Species Detection

- Procambarus clarkii

Land Cover & Land Use

- Forest
- Rock & Snow
- Water
- Disturbed Lands

Boundaries & Extents

- County Boundary
- Puget Sound Extent

0 5 10 20 Miles

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. GIS data sources used to develop this map are noted in the Appendix.

ESA

Documented Presence in Puget Sound Basin

MAP 11.1

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

How does the species spread?

Live Bait
Red swamp crayfish may be spread through use as live bait.

Aquaria
Red swamp crayfish could be introduced to waterbodies by people dumping live aquarium species.

Biological Supply Houses
Could be ordered online as part of science curriculum kits (not legal in Washington).

Food and Medicinals
A commercial food species in the southeastern states, red swamp crayfish could be introduced for aquaculture although it is illegal in Washington.

What resources are at risk?

The red swamp crayfish inhabits lakes, wetlands, and slow-moving streams and can tolerate brackish or stagnant water. It burrows in the mud to find moisture during drought periods, allowing it to live in seasonally dry areas.

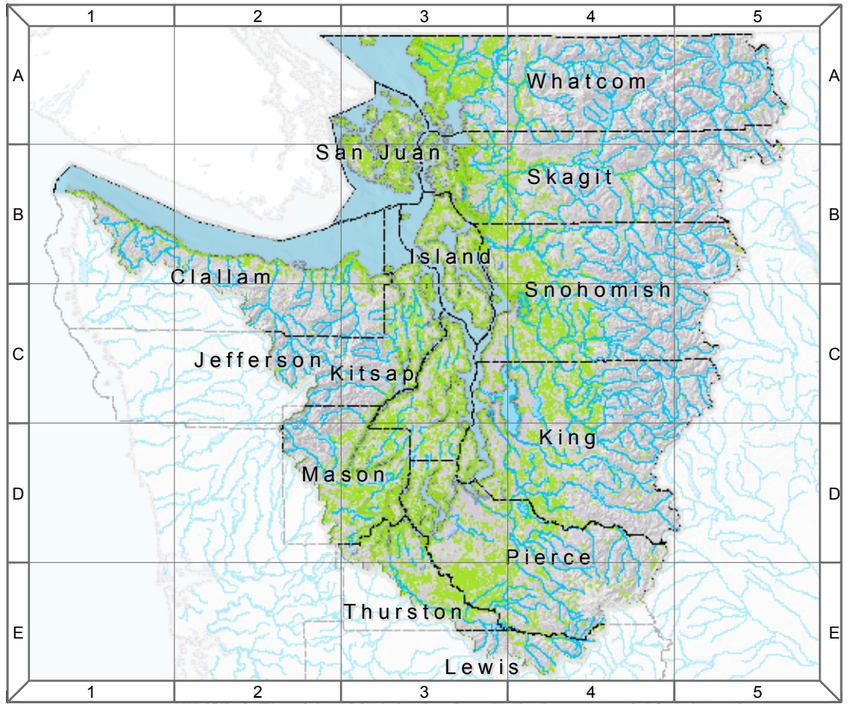
What impacts does the species have?

ECOLOGICAL IMPACTS

Changes Aquatic Food Web
Red swamp crayfish may displace native crayfish populations by outcompeting for food and habitat. They may alter habitats by grazing on aquatic vegetation and displacing native bottom-dwelling species through burrowing. They are an intermediate host for parasites of vertebrate species.

SOCIAL AND ECONOMIC IMPACTS

Damages Infrastructure
Burrowing by the red swamp crayfish can damage levees and water control structures.



STATE PROHIBITED AQUATIC ANIMAL SPECIES

Red Swamp Crayfish

Procambarus clarkii

Sensitive Landscape Features
- Wetlands
- Lakes
- Rivers

Boundaries & Extents
- County Boundary
- Puget Sound Extent

Miles
0 10 20 40

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

ESA

Species Spread, Impacts, and Natural Resources at Risk

MAP 11.2

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

STATE PROHIBITED AQUATIC ANIMAL SPECIES

Red Swamp Crayfish

Procambarus clarkii

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

C	D	En	R
Eo	Er	F	
M	Pol	Pre	

County Boundary
Puget Sound Extent
Lakes
Rivers

Management Programs at Regional/State/OtherLevel

C, University of Washington

D, University of Washington

Eo, University of Washington

M, University of Washington

Pol, Puget Sound Partnership

Pre, University of Washington

R, University of Washington

Abbreviations:

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

0 5 10 20 Miles

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

ESA

Management at the County Level

MAP 11.3

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

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RUSTY CRAYFISH
Orconectes rusticus

12

Rusty crayfish require permanent fresh water. Unlike the red swamp crayfish, they do not burrow but find cover under logs and other structures in ponds or streams. Adults reach a maximum length of 4 inches. They are opportunistic feeders, consuming plants, fish eggs, small fish, invertebrates, and detritus.


Jeff Gunderson

STATUS AND TRENDS

Species Presence (Map 12.1) The rusty crayfish is not yet documented in the Puget Sound Basin. See Table 12.1 for a summary of data obtained for this species.

Presence over time The rusty crayfish is native to the Ohio River basin. It has been widely introduced outside of its native range primarily through its use as bait, and is now established in several U.S. states and in Canada. It is not yet known in Puget Sound, but it is present in the John Day River in Oregon where it was discovered in 2005. By 2010, the species' range in the John Day River had more than doubled, reaching high densities in some areas.

Table 12.1. Rusty crayfish data provided to the baseline assessment project.

File Type Provided	# of files	Spatial Extent	Data Provider
Spatially Explicit Data			
ESRI GIS data (shapefiles, geodatabase feature classes)	0		
Google Earth KMZ files	0		
Tabular Data with Lat/Long (X/Y) Coordinates	0		
Hard Copy Maps	0		
Other Data			
Management or survey reports	3	Pacific Northwest	USGS, WDFW, ANS

PATHWAYS

Pathways of introduction The introduction and establishment of rusty crayfish in the John Day River in Oregon is believed to be a result of the biological supply trade for science curricula in schools. Live crayfish can be ordered from biological supply companies, and teachers or students may release them into water bodies after they are used in the classroom. People could also introduce them in hopes of establishing a food source, or could release them from bait buckets.

Pathways of spread (Map 12.2) The pathways of introduction described above could also spread the rusty crayfish to new areas. A study in 2007-2008 found rusty crayfish available for classroom use at science distribution centers in the Seattle area. At that time, more than half of Washington schools were using crayfish in their laboratories.

Female crayfish can produce several hundred eggs per brood, and they store the males' sperm until the eggs are ready for fertilization. Therefore, one female carrying viable sperm and eggs could start a new population if released to suitable habitat.

RUSTY CRAYFISH

Orconectes rusticus

IMPACTS AND AT-RISK RESOURCES

Ecological impacts (Map 12.2) The rusty crayfish has been found to displace native crayfish species in the Midwest. Surveys in the John Day River watershed in Oregon in 2005 found no evidence of the native crayfish species *Pacifastacus leniusculus* in areas where the rusty crayfish was collected. The rapidly reproducing, nonnative rusty crayfish have a high metabolic rate and consume more food than native species, and they can force native crayfish out of sheltered areas, increasing the risk of predation. Rusty crayfish eat a wide range of items including terrestrial leaf litter, benthic algae, macrophytes, aquatic invertebrates, fish eggs, and detritus. They can destroy aquatic plant beds.

A study in Michigan found rusty crayfish to be significantly more adept at moving upstream through culverts than native crayfish species. This may mean that the rusty crayfish is more able to occupy fragmented stream habitats.

There is some evidence that rusty crayfish require relatively high levels of dissolved calcium and pH, potentially limiting the types of water bodies where they can become established.

Social and economic impacts (Map 12.2) Invasive crayfish feed on fish eggs and compete with juvenile salmon for habitat, potentially impacting fisheries.

MANAGEMENT

Table 12.2 and Map 12.3 summarize commonly reported program types and the number of entities reporting management activities for rusty crayfish.

State- or Puget Sound-level activities WDFW has enforcement responsibility over nonnative crayfish and also provides public education, such as posting signs at infested lakes, contacting boaters and anglers, and distributing identification information to the public.

A multi-stakeholder work group has been formed to replace prohibited crayfish with native crayfish species for use in statewide grade and middle school science curricula, with expected full implementation for use in statewide K-12 science curricula.

County-level activities No county-level management actions for red swamp crayfish were reported.

Federal-level activities There are no known federal-level management activities in place for this species.

Other activities The University of Washington reported management activities for this species.

Table 12.2. Commonly reported management program types and number of organizations targeting rusty crayfish.

Entity	Three Most Commonly Reported Management Program Types (frequency)	Number of Organizations with current management activities
County	None	
State	Policy (2), Control, Detection, Enforcement, Education/ outreach, Eradication, Monitoring, Prevention (1)	2 (PSP, WDFW)
Federal	None	
Other	Control, Detection, Education/outreach, Monitoring Prevention, Research (1)	1 (University of Washington)

RUSTY CRAYFISH

Orconectes rusticus

Legal authorities Nonnative crayfish are a prohibited aquatic animal species in Washington (WAC 220-12-090), meaning they may not be legally purchased or transported in the state. Crayfish are caught in the state's recreational and commercial fisheries, which are managed by WDFW. Catch limits are set for native crayfish. Nonnative crayfish such as the rusty crayfish are not subject to catch restrictions but must be kept in a separate container and must be dead before being removed from the riparian area (immediate vicinity of water body).

Funding In 2005, the Washington state legislature established the Aquatic Invasive Species (AIS) Prevention and Enforcement Program which is managed by WDFW in collaboration with the Washington State Patrol. The program is primarily funded through dedicated fees on resident recreational watercraft with support from the USFWS. Over the past several years, budget reductions have resulted in reduced AIS management capacity and the loss of personnel.

Jeff Gunderson

SPECIES FACT

Washington has only one native crayfish species, the signal crayfish (Pacifasticus leniusculus). It has an overall uniform brown or blue color and smooth claws. For more information on distinguishing native from nonnative crayfish species, including photos of each species, see the WDFW identification guide available at:

http://wdfw.wa.gov/fishing/shellfish/crayfish/crayfish_id_guide.pdfe-lake/

SUMMARY OF GAPS

Data collection and management The rusty crayfish is not yet documented in the Puget Sound Basin.

Knowledge and understanding of species status, pathways, and impacts The effects of invasive crayfish species on native crayfish in the Pacific Northwest are not well understood. Research is needed on the use of crayfish as a "natural" pest management tool by golf courses. Crayfish may be able to move over land to other water bodies.

Management efforts Budget reductions have limited the capacity of state agencies to address this species.

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STATE PROHIBITED AQUATIC ANIMAL SPECIES

Rusty Crayfish

Orconectes rusticus

Jeff Gunderson/MInnesota Sea Grant

- Native to Ohio River basin.
- Found in Oregon in 2005; not yet known in Puget Sound.
- Inhabits permanent fresh waters.
- Displaces native crayfish species.

Puget Sound Basin

No detections.

Land Cover & Land Use

- Forest
- Rock & Snow
- Water
- Disturbed Lands

Boundaries & Extents

- County Boundary
- Puget Sound Extent

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

Miles
0 5 10 20

Species Presence by County

Species Presence by County**

No Known Infestations

** Data are Approximate

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. GIS data sources used to develop this map are noted in the Appendix.

ESA

Documented Presence in Puget Sound Basin

MAP 12.1

January 2014

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WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

How does the species spread?

Live Bait
Rusty crayfish may be spread through use as live bait.

Aquaria
Rusty crayfish could be introduced to waterbodies by people dumping live aquarium species.

Biological Supply Houses
Could be ordered online as part of science curriculum kits (not legal in Washington).

Food and Medicinals
Rusty crayfish could be introduced for aquaculture although it is illegal in Washington.

What resources are at risk?

Streams, Rivers, Lakes and Permanently Flooded Wetlands
Rusty crayfish are restricted to fresh water habitats that are inundated year-round. Lakes or wetlands in more developed areas, and popular fishing areas, are more susceptible to human introduction of this species.

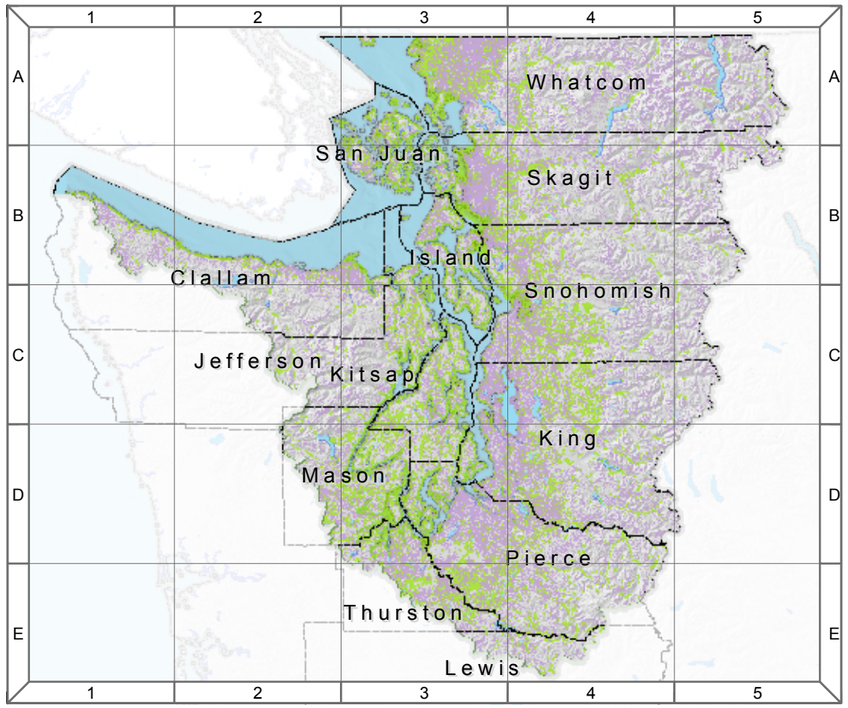
What impacts does the species have?

ECOLOGICAL IMPACTS

Changes Aquatic Food Web
Rusty crayfish displace native crayfish species. They reproduce rapidly and consume aquatic plants, algae, invertebrates, and fish eggs.

SOCIAL AND ECONOMIC IMPACTS

Potential Fisheries Impacts
Invasive crayfish feed on fish eggs and compete with juvenile salmon for habitat.



STATE PROHIBITED AQUATIC ANIMAL SPECIES

Rusty Crayfish

Orconectes rusticus


Jeff Gunderson/MInnesota Sea Grant

- Native to Ohio River basin.
- Found in Oregon in 2005; not yet known in Puget Sound.
- Inhabits permanent fresh waters.
- Displays native crayfish species.

Sensitive Landscape Features
- Lakes
- Wetlands
- Disturbed Lands

Boundaries & Extents
- County Boundary
- Puget Sound Extent

Miles
0 10 20 40

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

ESA

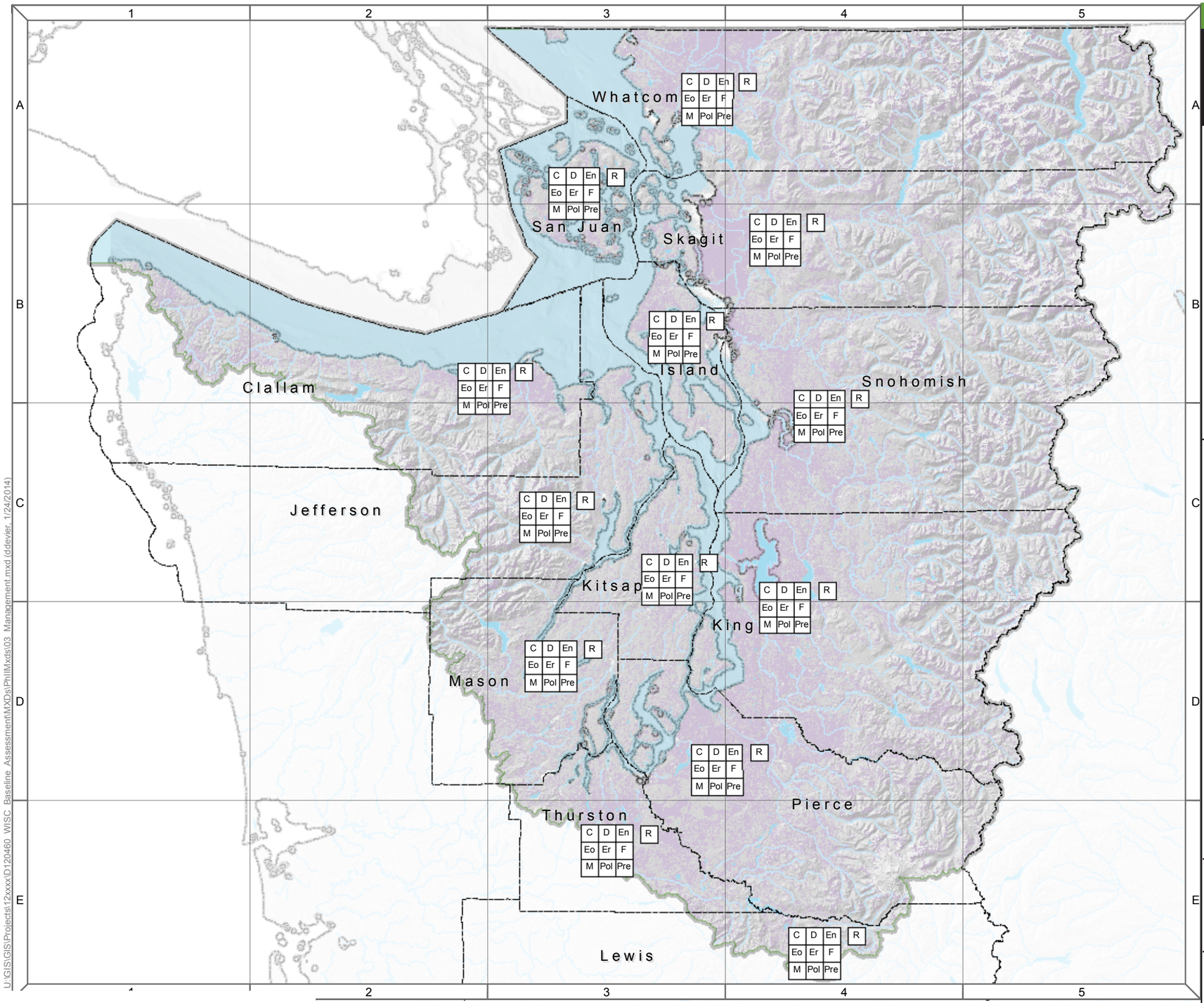
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

Species Spread, Impacts, and Natural Resources at Risk

MAP 12.2

January 2014



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STATE PROHIBITED AQUATIC ANIMAL SPECIES

Rusty Crayfish

Orconectes rusticus

- County Boundary
- Puget Sound Extent
- Lakes
- Rivers

Management Programs at Regional/State/OtherLevel

- C, University of Washington
- D, University of Washington
- Eo, University of Washington
- M, University of Washington
- Pol, Puget Sound Partnership
- Pre, University of Washington
- R, University of Washington

Abbreviations:

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

0 5 10 20 Miles

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

ESA

Management at the County Level

MAP 12.3

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

CHINESE MITTEN CRAB
Eriocheir sinensis

13

The Chinese mitten crab is light brown to green in color, with brown hairy patches resembling mittens on its claws. It spends most of its life in fresh water but reproduces in salt water. It is a carnivorous species, feeding on gastropods, bivalves, invertebrates, fish and fish eggs as well as detritus.


US Fish and Wildlife Service


NY State Department of Env. Conservation

STATUS AND TRENDS

Species Presence (Map 13.1) The Chinese mitten crab has not yet been recorded in the Puget Sound region. The species has been reported, but not confirmed, in the Columbia River near Portland. Shipments of live, illegally imported mitten crabs have been confiscated in Seattle. While the species has not yet been documented here, Puget Sound appears to have the right combination of habitat, salinity, flushing time, and temperature to allow for larval development and maintenance of Chinese mitten crab populations. See Table 13.1 for a summary of data obtained for this species.

Presence over time Native to Korea and China, this species was found in Germany in the early 1900s. It was first reported in the San Francisco estuary in the 1990s and has become widespread in the watershed. Chinese mitten crabs have recently appeared in the Chesapeake and Delaware Bays.

Table 13.1. Chinese mitten crab data provided to the baseline assessment project.

File Type Provided	# of files	Spatial Extent	Data Provider
Spatially Explicit Data			
ESRI GIS data (shapefiles, geodatabase feature classes)	0		
Tabular Data with Lat/Long (X/Y) Coordinates	0		
Hard Copy Maps	0		
Other Data			
Management or survey reports	2	Nationwide/Pacific Northwest	USFWS

PATHWAYS

Pathways of introduction This species was likely introduced to North America in ship ballast or as a food source. Shipments of illegally transported crabs destined for food markets have been intercepted on the West Coast. This includes live crabs, which were apparently being brought in to establish a fishery. The species is a prolific breeder, with each female producing up to a million eggs.

Pathways of spread (Map 13.2) The Chinese mitten crab may spread through attachment to fishing gear, in ship ballast, or through deliberate introduction to new areas as a food source. They can also travel over land during migration or to get around obstacles.

CHINESE MITTEN CRAB

Eriocheir sinensis

IMPACTS AND AT-RISK RESOURCES

Ecological impacts (Map 13.2) The Chinese mitten crab is an omnivore, consuming aquatic plants, algae, detritus, fish eggs, and a variety of macroinvertebrates. In large numbers, the mitten crabs can prey on and outcompete native aquatic species, including freshwater native crayfish and other sensitive species. They consume salmonid eggs, posing a threat to fish populations that are already under stress. The Chinese mitten crab can bioaccumulate contaminants that then may be passed up the food chain.

The Chinese mitten crab is included on the IUCN's list of 100 of the world's worst alien invasive species. Species were selected for the list using two criteria: their serious impact on biological diversity and/or human activities, and their illustration of important issues of biological invasion.

Social and economic impacts (Map 13.2) Juvenile crabs burrow to escape predation and drying during low tides, potentially damaging levees and riverbanks, clogging fish screens and pipes, and hampering water delivery. In Europe, burrowing by the crabs has led to erosion, loss of riparian vegetation, and weakening and even collapse of riverbanks. Mitten crabs have been known to steal bait off hooks and damage fishing nets.

Consumption of mitten crabs by humans (and mammalian predators) may be harmful due to the potential to transmit the Asian lung fluke in raw or improperly prepared crabs. Although the lung fluke has not been detected in the California population, potential intermediate lung fluke hosts exist on the West Coast.

MANAGEMENT

Table 13.2 and Map 13.3 summarize commonly reported program types and the number of entities reporting management activities for Chinese mitten crab.

State- or Puget Sound-level activities In addition to its ballast water enforcement responsibilities, WDFW posts signage in Puget Sound and distributes educational material to boaters and anglers about the mitten crab.

Washington Sea Grant has assisted by analyzing ballast water samples collected by WDFW and testing ballast water treatment tools.

County-level activities There are no reported county-level management activities for this species.

Federal-level activities The Aquatic Nuisance Species Task Force (ANSTF) is an intergovernmental entity established under the Non-indigenous Aquatic Nuisance Prevention and Control Act of 1990 (Act, 6 USC. 4701-4741), as amended by the National Invasive Species Act of 1996. The ANSTF is co-chaired by the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA). The ANSTF coordinates national efforts to prevent the introduction and spread of aquatic invasive species. In 2003 "The National Management Plan for the Genus Eriocheir (Mitten Crabs)" was approved by the ANSTF.

Other activities The Pacific Ballast Water Group (PBWG) promotes development and implementation of safe, economical, effective management of aquatic nuisance species associated with West Coast shipping. The PBWG serves as a coordinating body to share information and formulate solutions on ballast water management in Canada, California, Oregon, Washington, and Alaska. The Pacific States Marine Fisheries Commission (PSMFC) is the administrative entity for the PBWG.

Legal authorities Mitten crab is classified as a Prohibited Aquatic Animal Species in Washington, meaning it may not be possessed, purchased, sold, propagated, transported, or released into state waters (Revised Code of Washington 77.12.020, Washington Administrative Code 220-12-090). The genus Eriocheir is listed as an Injurious Wildlife Species under the federal Lacey Act (16 U.S.C. §§ 3371–3378), which bans the importation and interstate transport of live crabs.

CHINESE MITTEN CRAB

Eriocheir sinensis

Table 13.2. Commonly reported management program types and number of organizations targeting Chinese mitten crab.

Entity	Three Most Commonly Reported Management Program Types (frequency)	Number of Organizations with current management activities
County	None	
State	Policy (2), Control, Detection, Education/outreach, Enforcement, Monitoring, Prevention (1)	2
Federal	Enforcement (1)	1 (USFWS)
Other	Control (1), Prevention (1)	2

The Washington State Fish and Wildlife Commission adopted updated ballast water rules in 2009. The rules were developed in consultation with the state Ballast Water Work Group, consisting of shipping representatives, state and federal agencies, the Northwest Indian Fisheries Commission, environmental groups, scientists, and other interested parties.

Washington State ballast water law (Chapter 77.120 RCW, Chapter 220-150 WAC) is implemented and enforced by WDFW. Vessels of 300 gross tons or more are required to exchange their ballast water in the open ocean to reduce the number of potentially invasive coastal organisms from other ports arriving in ballast water tanks. The intent is to exchange potentially invasive coastal species for deep ocean species that would have less chance of survival in Washington state waters. However, ballast water exchange is not always completely effective at eliminating all potentially invasive species.

In 2012, the U.S. Coast Guard adopted updated regulations on ballast water management by establishing a standard for the allowable concentration of living organisms in ships' ballast water discharged in waters of the United States, and establishing an approval process for ballast water management systems (33 CFR Part 151 and 46 CFR Part 162). WDFW has been working with the Ballast Water Work Group to develop state standards for treated ballast water that will correlate with other coastal states and the U.S. Coast Guard.

Funding The Washington Ballast Water Program is funded largely by the state general fund and the Aquatic Lands Enhancement Account (ALEA). The Pacific States Marine Fisheries Commission has funded outreach, monitoring, and ecological research projects for Chinese mitten crab conducted by Portland State University.

SPECIES FACT

The Chinese mitten crab is catadromous, meaning that adult crabs reproduce in salt water and their offspring migrate to fresh water to mature.

CHINESE MITTEN CRAB

Eriocheir sinensis

SUMMARY OF GAPS

Data collection and management The Chinese mitten crab has not yet been recorded in the Puget Sound Basin, and little data was available for this study. However, shipments of live, illegally imported mitten crabs have been confiscated in Seattle, and Puget Sound appears to have conditions favorable to the establishment of this species.

Knowledge and understanding of species status, pathways, and impacts There is good information about the ecology and impacts of Chinese mitten crab.

Management efforts Budget reductions limit the capacity of state agencies to address this species. The implementation of updated regulations on ballast water management would presumably reduce the potential for mitten crabs to enter Puget Sound via this pathway.

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STATE PROHIBITED AQUATIC ANIMAL SPECIES / FEDERAL INJURIOUS WILDLIFE SPECIES

Chinese Mitten Crab

Eriocheir sinensis

US Fish and Wildlife Service

New York State Department of Environmental Conservation

- Native to Korea and China.
- Not yet documented in Puget Sound.
- Spends most of its life in fresh water; reproduces in salt water.
- Displaces native aquatic species.
- May prey on salmonid eggs.
- Damages water control structures and fishing gear.

Puget Sound Basin

No detections.

Land Cover & Land Use

- Forest
- Rock & Snow
- Water
- Disturbed Lands

Boundaries & Extents

- County Boundary
- Puget Sound Extent

Miles
0 5 10 20

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. GIS data sources used to develop this map are noted in the Appendix.

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

Species Presence by County

Species Presence by County**

- No Known Infestations

** Data are Approximate

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ESA

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

Documented Presence in Puget Sound Basin

MAP 13.1

January 2014

How does the species spread?

Food and Medicinals
Introduction as a food source is one way the Chinese mitten crab may have been introduced to North America. Shipments of illegally transported crabs destined for food markets have been intercepted on the West Coast.

Boats and Fishing Gear
The Chinese mitten crab may spread through attachment to fishing gear.

Shipping and International Trade
Chinese mitten crabs may have been transported to North America in ship ballast, and this is still a possible source of introduction.

What resources are at risk?

Streams and Estuaries
If Chinese mitten crabs become established in the Puget Sound region, they have the potential to alter aquatic food webs in both fresh waters (where they rear) and salt waters (where they spawn).

What impacts does the species have?

ECOLOGICAL IMPACTS

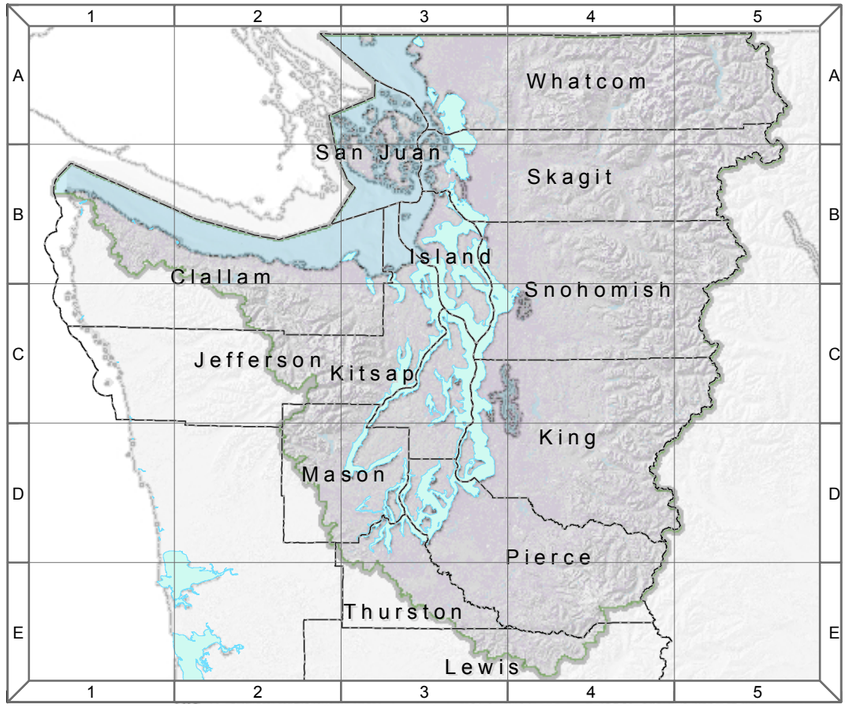
Changes Aquatic Food Webs
Abundant populations of Chinese mitten crabs can prey on and outcompete native aquatic species and consume salmonid eggs. The crabs may bioaccumulate toxins that can be passed up the food chain.

SOCIAL AND ECONOMIC IMPACTS

Damages Infrastructure
Juvenile crabs burrow to escape predation and drying during low tides, potentially damaging levees and riverbanks, clogging fish screens and pipes, and hampering water delivery.

Impacts Fisheries
Mitten crabs have been known to steal bait off hooks and damage fishing nets.

Potential Health Risk
Consumption of raw or improperly prepared crabs may transmit the Asian lung fluke.



STATE PROHIBITED AQUATIC ANIMAL SPECIES / FEDERAL INJURIOUS WILDLIFE SPECIES

Chinese Mitten Crab

Eriocheir sinensis


US Fish and Wildlife Service


New York State Department of Environmental Conservation

Sensitive Landscape Features
Estuary

Boundaries & Extents
County Boundary
Puget Sound Extent

Miles
0 10 20 40

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

ESA

Species Spread, Impacts, and Natural Resources at Risk

MAP 13.2

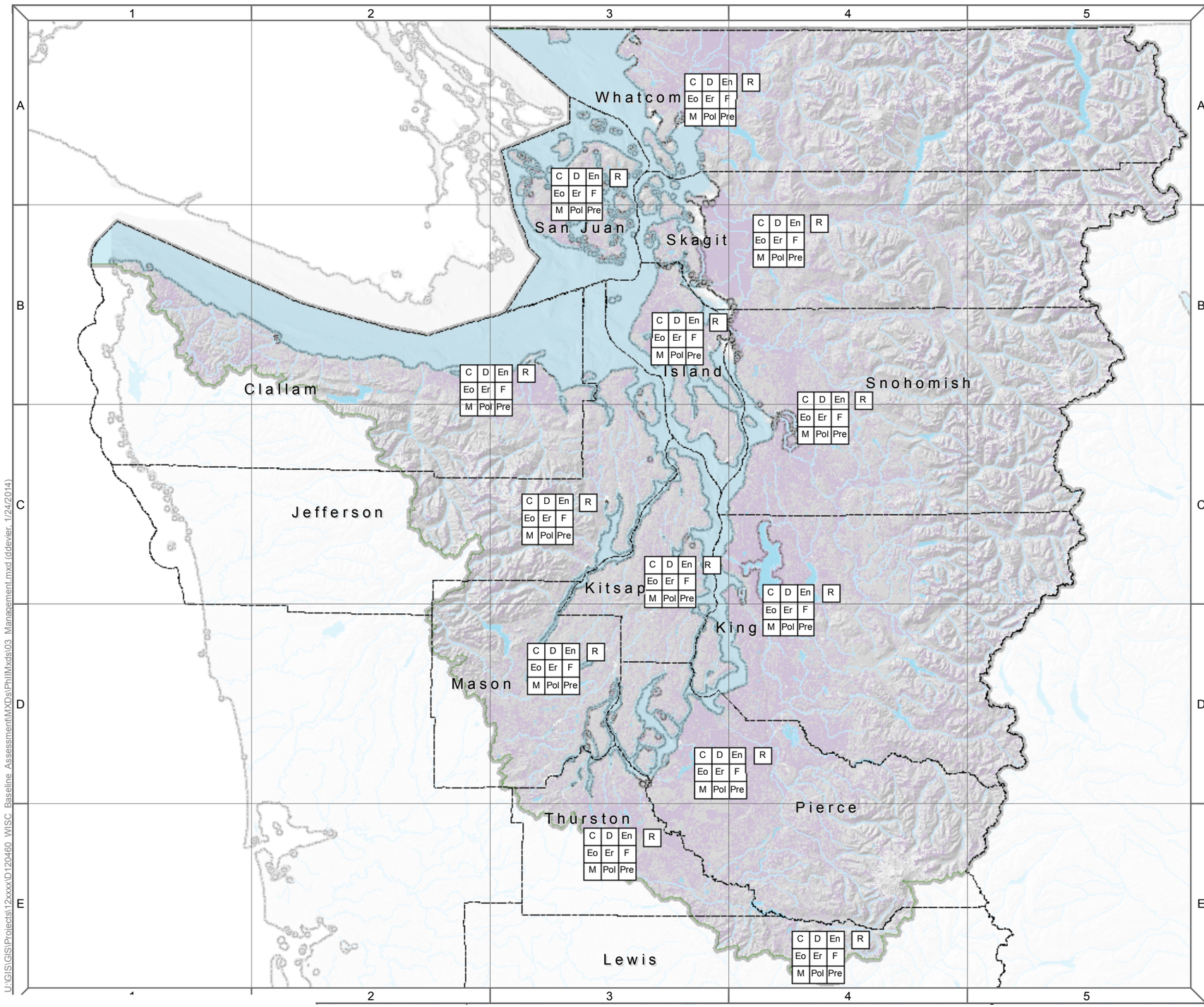
January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

STATE PROHIBITED AQUATIC ANIMAL SPECIES / FEDERAL INJURIOUS WILDLIFE SPECIES

Chinese Mitten Crab

Eriocheir sinensis



- County Boundary
- Puget Sound Extent
- Lakes
- Rivers

Management Programs at Regional/State/OtherLevel

- Eo, Washington State Department of Fish and Wildlife
- Pol, Aquatic Nuisance Species Task Force
- Pol, Puget Sound Partnership

Abbreviations:

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

0 5 10 20 Miles

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

ESA

Management at the County Level

MAP 13.3

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

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ASIATIC MARINE CLAM
Corbula amurensis

14

The Asiatic marine clam is also known as the overbite clam or Amur River clam. It has a tan, white, or yellow shell up to about 25 mm long. It lives partly buried in the sediment, with its hind third or half exposed above the surface. The marine clam is primarily subtidal but occasionally abundant on intertidal mudflats. A highly tolerant species, it can live in saltwater or brackish habitat, including polluted areas with low oxygen levels. It reaches maturity at a few months of age, and a single female can produce hundreds of thousands of eggs.

STATUS AND TRENDS

Species Presence (Map 14.1) The Asiatic marine clam is not yet detected in Puget Sound. See Table 14.1 for a summary of data obtained for this species.

Presence over time Native to southern Siberia and Asia, this species is thought to have entered San Francisco Bay from ship ballast in 1986.

Table 14.1. Asiatic marine clam data provided to the baseline assessment project.

File Type Provided	# of files	Spatial Extent	Data Provider
Spatially Explicit Data			
ESRI GIS data (shapefiles, geodatabase feature classes)	*NO DATA*		
Tabular Data with Lat/Long (X/Y) Coordinates			
Hard Copy Maps			
Other Data			
Management or survey reports			

PATHWAYS

Pathways of introduction The Asiatic marine clam has not yet reached Puget Sound, but it has become a serious problem in parts of San Francisco Bay, where it carpets the bottom with thousands of clams per square meter in some areas. These dense clam populations have displaced native marine species and consumed large amounts of plankton.

Pathways of spread (Map 14.2) Asiatic marine clams could continue to spread in ship ballast or on contaminated gear. Large in-water equipment such as dredges and barges could also spread the species.

IMPACTS AND AT-RISK RESOURCES

Ecological impacts (Map 14.2) The Asiatic marine clam is a filter feeder with a high filtration rate. Studies in San Francisco Bay found a high rate of consumption of phytoplankton as well as copepod larvae by this clam species. By removing these tiny organisms from the water column, the clams may allow more light penetration through the water and change the aquatic plant community.

ASIATIC MARINE CLAM

Corbula amurensis

The Asiatic marine clam bioaccumulates selenium. Birds and fish that feed on the clams may experience resultant birth defects, impaired hatching, and reduced growth of young life stages.

Social and economic impacts (Map 14.2) Reductions in phytoplankton due to high levels of filtration by the Asiatic marine clam could have indirect impacts on commercial fisheries.

MANAGEMENT

Table 14.2 and Map 14.3 summarize commonly reported program types and the number of entities reporting management activities for the Asiatic marine clam.

State- or Puget Sound-level activities Washington State ballast water law (Chapter 77.120 RCW) is implemented and enforced by WDFW.

Washington Sea Grant has assisted by analyzing ballast water samples collected by WDFW and testing ballast water treatment tools.

County-level activities No county-level management actions for Asiatic marine clam were reported.

Federal-level activities There are no known federal-level management activities in place for this species.

Other activities The Pacific Ballast Water Group (PBWG) promotes development and implementation of safe, economical, effective management of aquatic nuisance species associated with West Coast shipping. The PBWG serves as a coordinating body to share information and formulate solutions on ballast water management in Canada, California, Oregon, Washington, and Alaska. The Pacific States Marine Fisheries Commission (PSMFC) is the administrative entity for the PBWG.

Legal authorities The Washington State Fish and Wildlife Commission adopted updated ballast water rules in 2009. The rules were developed in consultation with the state Ballast Water Work Group, consisting of shipping representatives, state and federal agencies, the Northwest Indian Fisheries Commission, environmental groups, scientists, and other interested parties.

Washington State ballast water law (Chapter 77.120 RCW, Chapter 220-150 WAC) is implemented and enforced by WDFW. Vessels of 300 gross tons or more are required to exchange their ballast water in the open ocean to reduce the number of potentially invasive coastal organisms from other ports arriving in ballast water tanks. The intent is to exchange potentially invasive coastal species for deep ocean species that would have less chance of survival in Washington state waters.

In 2012, the U.S. Coast Guard adopted updated regulations on ballast water management by establishing a standard for the allowable concentration of living organisms in ships' ballast water discharged in waters of the United States, and establishing an approval process for ballast water management systems (33 CFR Part 151 and 46 CFR Part 162). WDFW has been working with the Ballast Water Work Group to develop state standards for treated ballast water that will correlate with other coastal states and the U.S. Coast Guard.

Funding The Washington Ballast Water Program is funded largely by the state general fund and the Aquatic Lands Enhancement Account (ALEA).

Table 14.2. Commonly reported management program types and number of organizations targeting marine clam.

Entitiy	Three Most Commonly Reported Management Program Types (frequency)	Number of Organizations with current management activities
County	None	
State	Policy (1)	1
Federal	None	
Other	Control (1), Prevention (1)	2

ASIATIC MARINE CLAM

Corbula amurensis

SUMMARY OF GAPS

Data collection and management The Asiatic marine clam has not yet been detected in Puget Sound, and no data were available for this report.

Knowledge and understanding of species status, pathways, and impacts There is good information about this species' impacts in California. Because it is not yet documented in Puget Sound, its impacts here (should it be introduced) are unknown.

Management efforts To date there are no known county or federal programs to address the Asiatic marine clam. Budget reductions limit the capacity of state agencies to address this species. The implementation of updated regulations on ballast water management would presumably reduce the potential for the clams to enter Puget Sound via this pathway.

SPECIES FACT

A study in San Francisco Bay found that Asiatic marine clams passed apparently unharmed through the digestive tract of a white sturgeon. These wide-ranging fish could potentially transport the clams to new areas.

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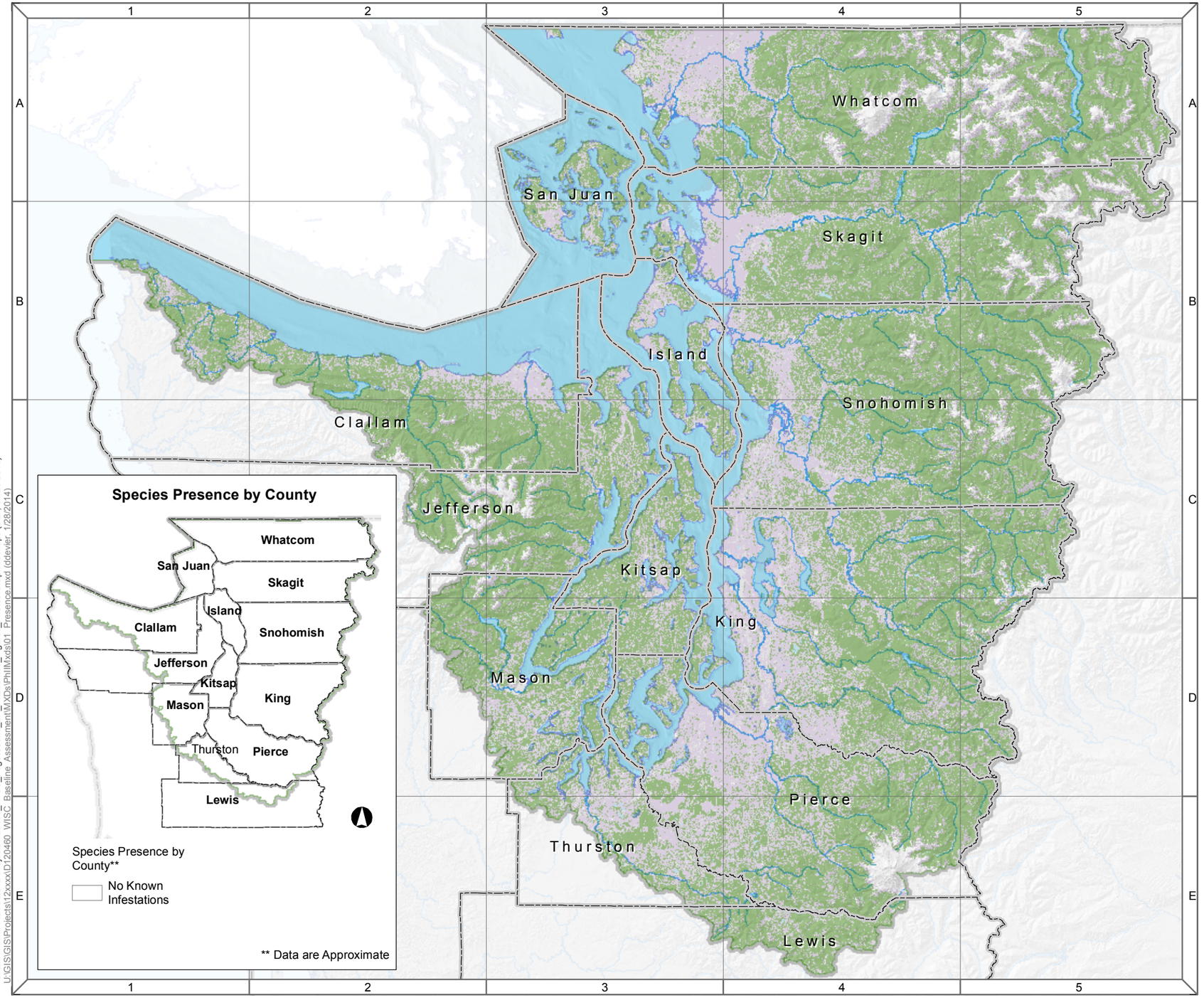
Asiatic Marine Clam

Corbula amurensis

- Native to southern Siberia and Asia.
- Not yet known in Puget Sound.
- Lives in saltwater or brackish habitat including polluted waters.
- Dense populations displace native marine species, alter aquatic food webs.
- Potential impacts on commercial fisheries.

Puget Sound Basin

No detections.



* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. GIS data sources used to develop this map are noted in the Appendix.

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WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

ESA

Documented Presence in Puget Sound Basin

MAP 14.1

January 2014

How does the species spread?

Boats and Fishing Gear
The Asiatic marine clam may be spread on contaminated fishing gear.

Shipping and International Trade
Native to southern Siberia and Asia, this species is thought to have entered San Francisco Bay from ship ballast in 1986. This remains a possible source of introduction to Puget Sound.

Soils and Gravel Transport
Large in-water equipment such as dredges and barges could spread the species.

What impacts does the species have?

ECOLOGICAL IMPACTS

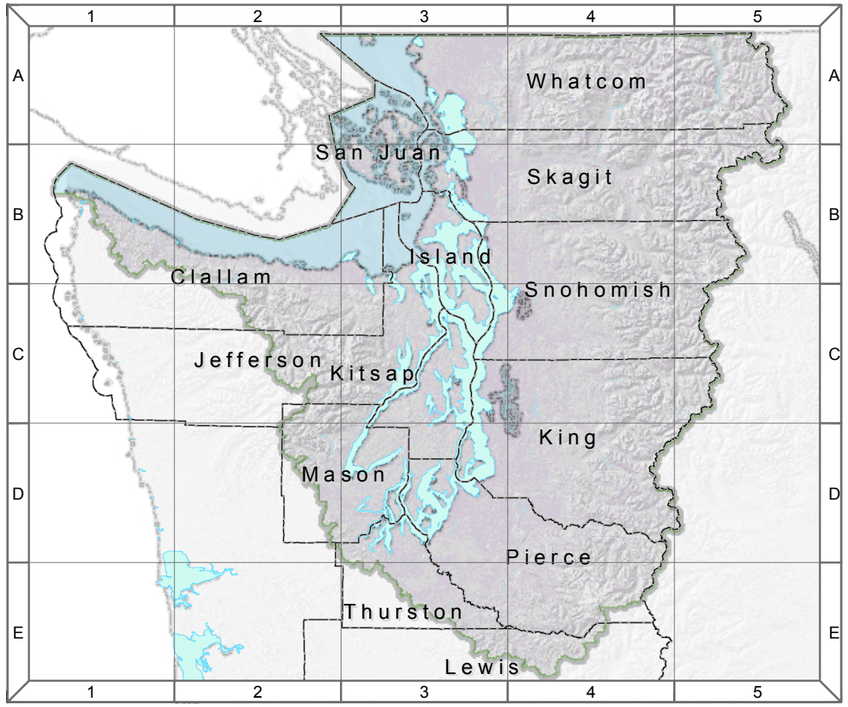
Changes Aquatic Food Webs
The high rate of filter feeding by the Asiatic marine clam may allow more light penetration through the water and change the aquatic plant community. The clams bioaccumulate selenium which could be toxic to fish and birds that feed on them.

SOCIAL AND ECONOMIC IMPACTS

Impacts Fisheries
Reductions in phytoplankton due to high levels of filtration by the Asiatic marine clam could have indirect impacts on commercial fisheries.

What resources are at risk?

Estuaries
The Asiatic marine clam can reach high densities in the bottom sediments of marine and brackish waters.



Asiatic Marine Clam

Corbula amurensis

Sensitive Landscape Features
Estuary

Boundaries & Extents
County Boundary
Puget Sound Extent

Miles
0 10 20 40

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

ESA

Species Spread, Impacts, and Natural Resources at Risk

MAP 14.2

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Asiatic Marine Clam

Corbula amurensis

C	D	En	R
Eo	Er	F	
M	Pol	Pre	

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

- County Boundary
- Puget Sound Extent
- Lakes
- Rivers

Management Programs at Regional/State/OtherLevel

D, Washington State Department of Fish and Wildlife

M , Washington State Department of Fish and Wildlife

Pol, Puget Sound Partnership

Abbreviations:

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

Miles: 0 5 10 20

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

ESA

Management at the County Level

MAP 14.3

January 2014

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WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

EUROPEAN GREEN CRAB
Carcinus maenas

15

European green crabs grow up to 3 inches across the carapace (shell). They are typically found in high intertidal areas and marshes in coastal estuaries and wave-protected embayments, and they can live on a variety of surfaces including sand, mudflats, shells, cobble, algae, and rock. The European green crab also tolerates a range of salinities and temperatures. European green crabs have a widely varied diet, including bacteria, algae, jellyfish, crustaceans, bivalves, fish, insects, vegetation, and detritus. Older crabs favor bivalves and will excavate down several inches to obtain them. A voracious predator, the green crab has been shown to consume more than 62 bivalves per day in laboratory experiments. The European green crab is included on the IUCN's list of 100 of the world's worst alien invasive species.


Luis Miguel Bugallo Sanchez

STATUS AND TRENDS

Species Presence (Map 15.1) The European green crab is not yet detected in Puget Sound. See Table 15.1 for a summary of data obtained for this species.

Presence over time The European green crab is native to the eastern Atlantic. It was introduced to the eastern coast of the U.S. in the early 1800s, and is currently found along most of the northeast coast of North America.

Along the West Coast, the species is limited to protected coastal waters, from California to Vancouver Island. The species was introduced to San Francisco Bay in 1989. It was found in Coos Bay, Oregon, in 1997, and in Willapa Bay and Grays Harbor, Washington, in 1998. Specimens were found on Vancouver Island, British Columbia, in 1999 and 2000. The population on Vancouver Island is growing and spreading.

In Washington, European green crabs have not been observed on rocky shores or cobble beaches but have been exclusively associated with tidal/salt marshes and oyster beds in Willapa Bay and Grays Harbor. It was hoped that the species would die out following initial introduction from California, but instead it appears to have survived and maintained self-sustaining populations, although these populations appear to be small compared to those on the East Coast.

Table 15.1. European green crab data provided to the baseline assessment project.

File Type Provided	# of files	Spatial Extent	Data Provider
Spatially Explicit Data			
ESRI GIS data (shapefiles, geodatabase feature classes)	1	Puget Sound (monitoring sites)	WDFW/Nahkeeta Northwest
Tabular Data with Lat/Long (X/Y) Coordinates	0		
Hard Copy Maps	0		
Other Data			
Management or survey reports	7	Pacific Northwest	WDFW/Nahkeeta Northwest

EUROPEAN GREEN CRAB

Carcinus maenas

PATHWAYS

Pathways of introduction Native to the eastern Atlantic, the European green crab was probably introduced to the West Coast in ballast water, through the live seafood or bait trade, or as hitchhikers on kelp used to pack imported shellfish.

Pathways of spread (Map 15.2) Potential pathways for dispersal of European green crab include transport of larvae by ocean currents, ballast water exchange, and the transfer of live shellfish or aquaculture equipment.

The crabs have a short lifespan and rely on prolific breeding to maintain their populations (female crabs can produce 185,000 eggs at a time under good conditions). Local populations are mostly likely to persist in protected embayments where the larvae are unlikely to be washed out to sea. However, larval dispersal on ocean currents is the main way the species spreads over long distances. Along the West Coast of North America, the green crab spread over 740 miles north from San Francisco Bay in less than a decade, carried by strong El Nino ocean currents.

While populations of the green crab in Washington estuaries have been smaller than those in California, there is concern that the species could flourish if it reaches Puget Sound, where there are fewer large predators, many suitable habitats, and less chance for larvae to be washed out to sea. Scientific modeling predicts Puget Sound to be highly suitable for green crabs. A modeling study commissioned by the National Marine Fisheries Service – Alaska Region identified hundreds of miles of Puget Sound shoreline as providing critical habitat attributes needed by the European green crab. The attributes included in the model were: semi-protected and protected wave exposures; sediment-dominated shorelines; mudflats and tidal flats; organic shorelines (marshes, estuaries); fine sediment in the lowest intertidal; eelgrass in the subtidal; and salt marsh vegetation in the supratidal.

IMPACTS AND AT-RISK RESOURCES

Ecological impacts (Map 15.2) The European green crab can have dramatic negative impacts to native shore crab, clam, flatfish, and oyster populations through predation and digging for prey. In one study in California, the densities of native clams and shore crabs declined by 5 to 10 times within a few years of green crab arrival. The digging activities of green crabs searching for bivalves can disturb the sediments and slow eelgrass restoration efforts. European green crabs may impact the health of shore birds by transmitting the worm *Profilicollis botulus*.

Social and economic impacts (Map 15.2) European green crabs can decimate bivalve populations, including commercially important species. The green crab is blamed for the destruction of soft-shell clam industries in New England and Canada in the 1950s. It poses concerns for Washington's shellfish industry as well.

Green crabs can concentrate marine biotoxins and pass them up the food chain, causing illness in people who consume the crabs.

Luis Miguel Bugallo Sanchez

SPECIES FACT

The term "green crab" is somewhat misleading because color is variable in this species. Each crab is typically mottled with various shades of green, yellow, brown, and red.

EUROPEAN GREEN CRAB

Carcinus maenas

MANAGEMENT

Table 15.2 and Map 15.3 summarize commonly reported program types and the number of entities reporting management activities for European green crab.

State- or Puget Sound-level activities Following discovery of the European green crab in Willapa Bay during the late 1990s, WDFW received state funding to monitor for the species along the Washington Coast and in Puget Sound. The coastal program focused on monitoring the abundance and distribution of the crabs and developing control techniques, and the Puget Sound program was focused on monitoring for presence and absence. WDFW subsequently contracted with Nahkeeta Northwest to coordinate volunteer monitoring for European green crabs and other nonnative invasive species in Puget Sound. Over several years, Nahkeeta Northwest trained over 400 citizens and monitored 200 sites in Puget Sound, Hood Canal, San Juan Islands, southern Georgia Strait, and the Strait of Juan de Fuca. No green crabs have been detected or positively identified in Washington's inland waters.

Washington State ballast water law (Chapter 77.120 RCW) is implemented and enforced by WDFW. In addition to its ballast water enforcement responsibilities, WDFW posts signage in Puget Sound and distributes educational material to boaters and anglers about the European green crab.

Washington Sea Grant has assisted by analyzing ballast water samples collected by WDFW and testing ballast water treatment tools.

County-level activities No county-level management actions for European green crab were reported.

Federal-level activities In 1998, the European green crab was formally recognized as an aquatic nuisance species (ANS) by the Federal ANS Task Force.

Other activities The Pacific Ballast Water Group (PBWG) promotes development and implementation of safe, economical, effective management of aquatic nuisance species associated with West Coast shipping. The PBWG serves as a coordinating body to share information and formulate solutions on ballast water management in Canada, California, Oregon, Washington, and Alaska. The Pacific States Marine Fisheries Commission (PSMFC) is the administrative entity for the PBWG.

The Washington State University Extension Beach Watcher program trains volunteers to monitor intertidal areas, including watching for invasive species such as European green crab. As of 2011, the program was running in Jefferson, Island, San Juan, Kitsap, Skagit, and Snohomish Counties, and funding was being sought to expand the program to southern Puget Sound.

Table 15.2. Commonly reported management program types and number of organizations targeting European green crab.

Entity	Three Most Commonly Reported Management Program Types (frequency)	Number of Organizations with current management activities
County	None	
State	Policy (2), Detection, Enforcement, Education/outreach, Monitoring, Prevention (1)	2
Federal	Policy (1)	1
Other	Control (1), Prevention (1)	2

Legal authorities The green crab is classified as a Prohibited Aquatic Animal Species in Washington, meaning it may not be possessed, purchased, sold, propagated, transported, or released into state waters (Revised Code of Washington 77.12.020, Washington Administrative Code 220-12-090).

The Washington State Fish and Wildlife Commission adopted updated ballast water rules in 2009. The rules were developed in consultation with the state Ballast Water Work Group, consisting of shipping representatives, state and federal agencies, the Northwest Indian Fisheries Commission, environmental groups, scientists,

and other interested parties. Washington State ballast water law (Chapter 77.120 RCW, Chapter 220-150 WAC) is implemented and enforced by WDFW. Vessels of 300 gross tons or more are required to exchange their ballast water in the open ocean to reduce the number of potentially invasive coastal organisms from other ports arriving in ballast water tanks. The intent is to exchange potentially invasive coastal species for deep ocean species that would have less chance of survival in Washington state waters.

In 2012, the U.S. Coast Guard adopted updated regulations on ballast water management by establishing a standard for the allowable concentration of living organisms in ships' ballast water discharged in waters of the United States, and establishing an approval process for ballast water management systems (33 CFR Part 151 and 46 CFR Part 162). WDFW has been working with the Ballast Water Work Group to develop state standards for treated ballast water that will correlate with other coastal states and the U.S. Coast Guard.

Funding Funding for volunteer monitoring efforts in Puget Sound has been cut due to budget constraints.

The Washington Ballast Water Program is funded largely by the state general fund and the Aquatic Lands Enhancement Account (ALEA). The Pacific States Marine Fisheries Commission has funded several European green crab studies through various universities.

SUMMARY OF GAPS

Data collection and management While this species is not yet documented in the basin, the conditions in Puget Sound appear to be ideal for invasion by this species.

Knowledge and understanding of species status, pathways, and impacts There is good information about the pathways and impacts of European green crab.

Management efforts State funding restrictions will continue to inhibit the ability of WDFW and other agencies to monitor for this species. Volunteer beach watcher programs may help to fill some of the gaps.

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STATE PROHIBITED AQUATIC ANIMAL SPECIES

European Green Crab

Carcinus maenas

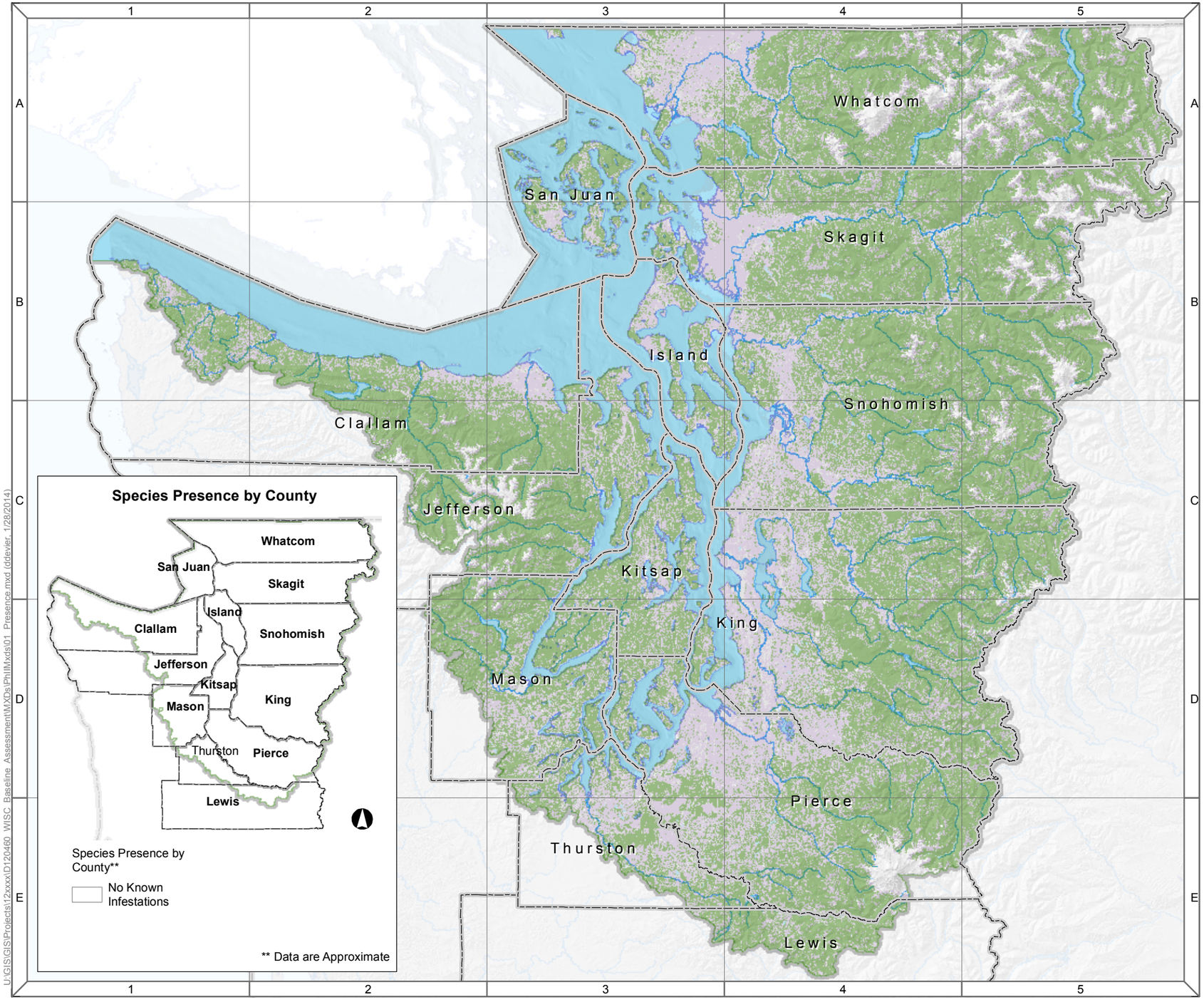

U.S. Geological Survey


Luis Miguel Bugallo Sanchez

- Native to the eastern Atlantic.
- Inhabits estuaries.
- Found in Willapa Bay and Grays Harbor in 1998.
- Not yet known in Puget Sound.
- Negative impacts on native shellfish and shorebirds.
- Could impact commercial shellfish industry.

Puget Sound Basin

No detections.



Land Cover & Land Use

- Forest
- Rock & Snow
- Water
- Disturbed Lands

Boundaries & Extents

- County Boundary
- Puget Sound Extent

Miles
0 5 10 20

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. GIS data sources used to develop this map are noted in the Appendix.

ESA

Documented Presence in Puget Sound Basin

MAP 15.1

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

How does the species spread?

Food and Medicinals
The transfer of live shellfish or aquaculture equipment could spread European green crabs.

Shipping and International Trade
Green crabs may be spread through ballast water exchange.

Streamflows and Waves
Green crabs have apparently been spread along the west coast of North America by strong El Nino ocean currents.

What resources are at risk?

Estuaries
European green crabs pose a threat to shellfish beds, mudflats, and non-rocky portions of the intertidal zone.

What impacts does the species have?

ECOLOGICAL IMPACTS

Changes Aquatic Food Webs
The European green crab eats smaller crustaceans and many other plants and animals, and it can have dramatic negative impacts to native crab, clam, and oyster populations. European green crabs may impact the health of shore birds by transmitting the worm Profilicollis botulus.

SOCIAL AND ECONOMIC IMPACTS

Impacts Fisheries
Invasion by the European green crab poses concerns for Washington's shellfish industry.

STATE PROHIBITED AQUATIC ANIMAL SPECIES

European Green Crab

Carcinus maenas


U.S. Geological Survey


Luis Miguel Bugallo Sanchez

Sensitive Landscape Features
- Estuary

Boundaries & Extents
- County Boundary
- Puget Sound Extent

Miles
0 10 20 40

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

ESA

Species Spread, Impacts, and Natural Resources at Risk

MAP 15.2

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

STATE PROHIBITED AQUATIC ANIMAL SPECIES

European Green Crab

Carcinus maenas

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

C D En R
Eo Er F
M Pol Pre

County Boundary
Puget Sound Extent
Lakes
Rivers

Management Programs at Regional/State/OtherLevel

D, Washington State Department of Fish and Wildlife

M , Washington State Department of Fish and Wildlife

Pol, Puget Sound Partnership

Abbreviations:

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

Miles
0 5 10 20

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

ESA

Management at the County Level

MAP 15.3

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

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CHERRY BARK TORTRIX, EUROPEAN APPLE CLEARWING MOTH, EASTERN DOGWOOD BORER

16

ENARMONIA FORMOSANA, SYNANTHEDON MYOPAEFORMIS, SYNANTHEDON SCITULA

The cherry bark tortrix, apple clearwing moth, and dogwood borer are invasive insect pests new to the Pacific Northwest that threaten many important fruit and ornamental tree varieties in Washington State. The immature (larva) stage of these species feeds inside the bark of host trees and shrubs, causing damage that disrupts the flow of sap. The resulting girdling damage and surface wounds stress infested host trees, expose them to plant pathogens and other pests, and may kill infested trees if untreated.

STATUS AND TRENDS

Species Presence (Maps 16.1a and 16.2a) Since its first detection near the Canadian border in 1991, the cherry bark tortrix has steadily spread by natural dispersal, extending its range southward in western Washington and into western Oregon. Based on visual observations and pheromone-trap surveys by the Washington State Department of Agriculture (WSDA), it is now present in all Puget Sound Basin counties, but it hasn't yet been detected in eastern Washington. Along the Interstate 5 corridor, cherry bark tortrix currently infests most cherry and plum trees from Olympia north to Canada and is increasing its attacks on apple trees in this area. Isolated populations now occur as far south as Salem, Oregon.

The apple clearwing moth was first found in Whatcom County in 2008, following detection in British Columbia, Canada, in 2005. To date, the species has not been detected in other Puget Sound counties. The Pacific Northwest occurrences of both the apple clearwing moth and cherry bark tortrix are currently the only known populations of the exotic pests in North America.

The dogwood borer is native to the eastern United States, where it is an important pest of a wide range of fruit trees, ornamental plants, and native trees and shrubs. Only found in eastern Washington so far (Chelan, Douglas, and Spokane Counties in 2008 and 2009), the detections represent the first occurrence of the pest in western North America. The species is included here for the imminent threat it represents to the Puget Sound Basin and region. Current knowledge of regional occurrence is very limited and more surveys are needed.

See Table 16.1 for a summary of data obtained for these species. All GIS point-source record data submitted represent either USDA APHIS-funded pheromone-trap survey results or WSDA staff observations and collections.

Presence over time As has been observed with cherry bark tortrix, increasing distribution of apple clearwing moth and dogwood borer is expected to occur in the region through natural spread, although at an unpredictable rate. All three species have been detected fairly early in their introduced presence here, but neither local eradication nor regulatory containment have been practical considerations, given current fiscal and environmental constraints and the likelihood of natural dispersal from significant established populations.

Table 16.1. Cherry bark tortrix data provided to the baseline assessment project.

File Type Provided	# of files	Spatial Extent	Data Provider
Spatially Explicit Data			
ESRI GIS data (shapefiles, geodatabase feature classes)	0		
Tabular Data with Lat/Long (X/Y) Coordinates	1	King County, Pierce County, Skagit County Snohomish County, Thurston County, Whatcom County	WSDA
Hard Copy Maps	0		
Other Data			
Management or survey reports	3	Puget Sound/Statewide	WSDA

CHERRY BARK TORTRIX, EUROPEAN APPLE CLEARWING MOTH, EASTERN DOGWOOD BORER

ENARMONIA FORMOSANA, SYNANTHEDON MYOPAEFORMIS, SYNANTHEDON SCITULA

PATHWAYS

Pathways of introduction Both cherry bark tortrix and apple clearwing moth have expanded into Washington State and the Puget Sound Basin via natural spread from introduced populations in B.C., Canada. The pathways for their introduction into Canada likely represent unregulated movement of infested plant material from Europe, either through unrecognized (and/or inadequately inspected) regulatory channels or illegal transport (smuggling). The pathway for introduction of dogwood borer into eastern Washington likely resulted from unregulated transport of infested stock.

Pathways of spread (Maps 16.1b and 16.2b) Due to regulatory and fiscal constraints, future spread and increasing damage from all three moth species is likely to occur through natural spread (adult moth dispersal) and observed increasing populations. Some potential exists for human-aided dispersal (transport of infested host plants), although infestation of young/transplantable stock is rare as adult moths prefer to lay eggs on mature trees. There is also a lack of existing or effective biological control agents (parasites and predators that regulate insect populations) for these introduced exotic pests that might help to reduce spread and host tree damage. Previous foreign activities to identify and import biological control organisms from the cherry bark tortrix native range were not successful.

IMPACTS AND AT-RISK RESOURCES

Ecological impacts (Maps 16.1b and 16.2b) Due to the important and abundant hosts attacked by cherry bark tortrix in both homegrown fruit trees and abundant naturalized trees, ecological impacts may be realized through both homeowner applied pesticide usage and reduction or elimination of the wild tree food (fruit) source for wildlife. In addition, both pests threaten many native trees such as black hawthorn, bitter cherry, and Oregon crab apple.

Social and economic impacts (Maps 16.1b and 16.2b) Cultivated trees and shrubs attacked by cherry bark tortrix and the apple clearwing moth include all stone fruits (cherry, plum, peach, apricot), apple, pear, pyracantha, mountain ash, laurels, hawthorn, photinia, and quince, all of which are at risk for infestation, decline, and potential mortality. Infestation therefore represents potential impacts due to costs associated with increased pesticide usage, replanting or replacement costs, and eventual reduction in economic value of both host trees and property values due to direct costs, losses, and stigma of vulnerability of hosts. To some extent, these impacts have already been realized by commercial and home orchardists, landscape managers, and nursery producers in heavily infested areas, including the overall reduction of sales and use of susceptible host trees.

MANAGEMENT

Table 16.2 and Maps 16.1c and 16.2c summarize commonly reported program types and the number of entities reporting management activities for bark-boring moths.

State- or Puget Sound-level activities WSDA and WSU Extension have conducted detection, education and outreach, and control development activities for cherry bark tortrix and the apple clearwing moth. Future involvement in these activities is dependent on external funding from either USDA APHIS, the U.S. Farm Bill, other federal and state agency resources, or commercial industry grants.

No state agency or university involvement, with the exception of outreach and education activities related to pesticide applicator licensing or extension information requests (existing activities and resources), is currently planned or expected for these new pests.

County-level activities There are no reported county-level management activities for these species.

Federal-level activities There are no known federal-level management activities in place for these species.

Other activities There are no other known management activities in place for these species.

Legal authorities The introduction into or release within the state of a plant pest is prohibited, except under special permit issued by the Washington Department of Agriculture (RCW 17.24.051). The Department of Agriculture has the authority to inspect plants and plant products that are being transported into or within the state for plant pests and diseases (RCW 17.24.021).

To prevent the introduction of plant pests into the United States, the Animal and Plant Health Inspection Service (APHIS) of the U.S. Department of Agriculture regulates the importation of plant stock under the authority of the federal Plant Protection Act (7 CFR part 319).

Funding No funding sources for bark tortrix, apple clearwing moth, or dogwood borer management were reported.

Table 16.2. Commonly reported management program types and number of organizations targeting Cherry bark tortrix.

Entity	Three Most Commonly Reported Management Program Types (frequency)	Number of Organizations with current management activities
County	None	
State	Education/Outreach (2), Policy, Monitoring (1)	2 (PSP, WSDA)
Federal	None	
Other	None	

SUMMARY OF GAPS

Data collection and management Data provided for these species cover a limited and disjunct timeframe due to the annual survey grant funding and changing priorities of federal exotic pest surveys. Survey data for cherry bark tortrix are from 1991-1993, 1995, 1998, and 2011. Apple clearwing moth data were collected in 2007 and 2008.

Knowledge and understanding of species status, pathways, and impacts Species presence is not indicated for several Puget Sound Basin counties due to the limited coverage possible with available grant funding, rather than an absence of cherry bark tortrix in those counties. The presence of cherry bark tortrix in the Kitsap and Olympic Peninsula counties has been verified by visual inspection but no point-source data are available. Impacts to at-risk resources resulting from cherry bark tortrix and apple clearwing moth invasions are fairly well understood, but quantified data on the values of at-risk resources and changing public and municipal landscape management practices within Puget Sound Basin are limited.

Management efforts Management efforts at any level have been very limited for both containment and impact mitigation, due to funding constraints and practical regulatory considerations. Educational and outreach efforts of both WSDA and WSU Extension have likely both improved pesticide treatment methodologies and protected at-risk host trees. However, the continued spread and increasing populations of these new pests throughout the region in unmanaged, wild, and native trees will undoubtedly continue from all current indications. Management of problems and impacts from these pests, as for many recently introduced organisms, is constrained by current economic priorities, which limit or preclude all potentially effective options based on classical biological control or the development of entomopathogenic, microbial, or other pest control innovations.

CHERRY BARK TORTRIX, EUROPEAN APPLE CLEARWING MOTH, EASTERN DOGWOOD BORER

ENARMONIA FORMOSANA, SYNANTHEDON MYOPAEFORMIS, SYNANTHEDON SCITULA

REFERENCES

LaGasa, Eric. 2013. Chief Entomologist, Pest Program, Plant Protection Division, Washington State Department of Agriculture, Olympia, Washington.

Washington State Dept. of Agriculture

SPECIES FACT

Because of the damage caused by these insects, the use of flowering cherry trees for municipal and streetside planting has been discontinued in Whatcom County (Bellingham). The WSU Extension recommends against purchasing and planting susceptible varieties in currently infested areas. The economic value and potential impacts to flowering cherry trees alone, which are abundant and historically prominent landscape elements in many municipal, school, and government facility landscapes, are considerable but unquantified.

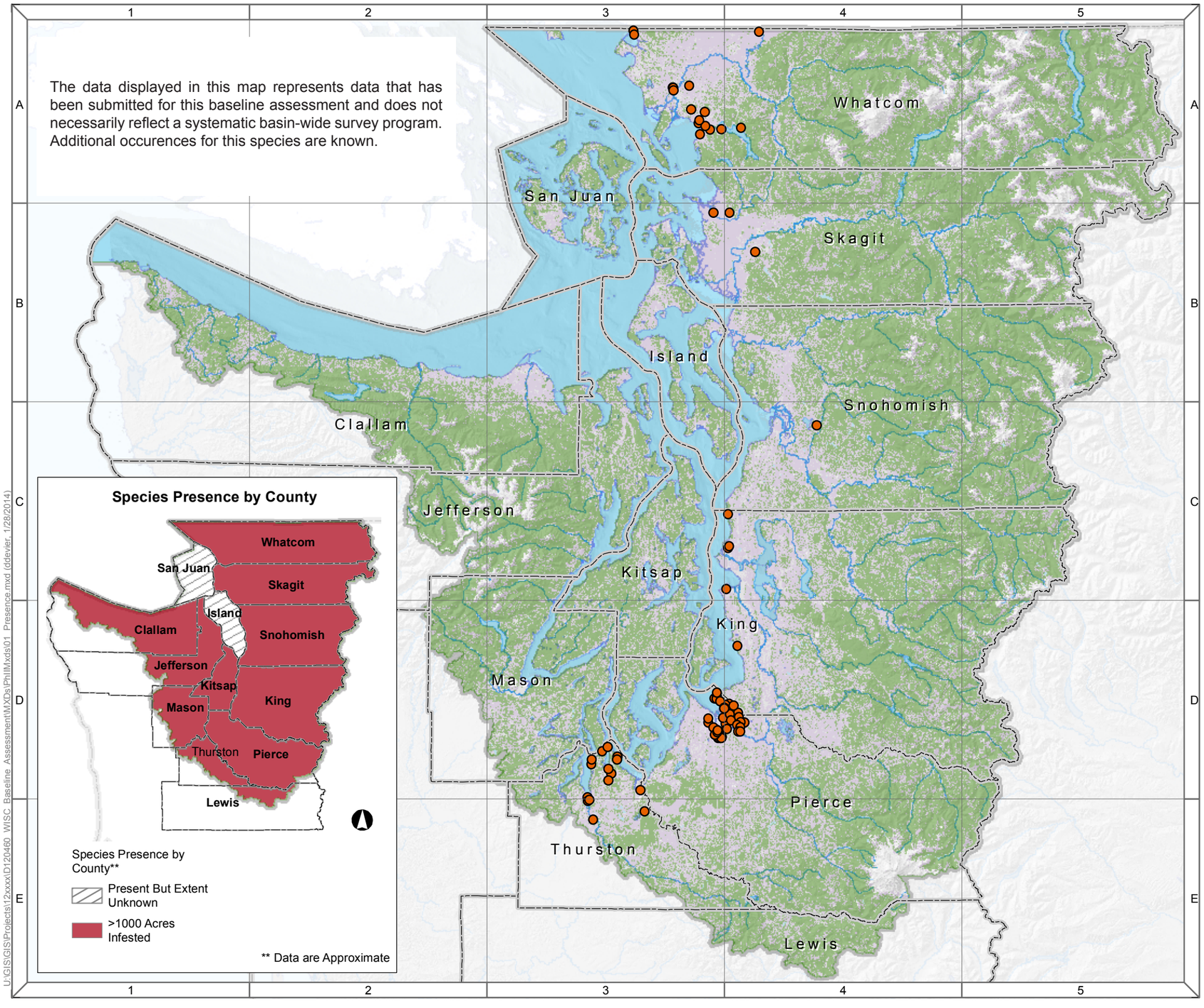
REGULATED PLANT PEST

Cherry Bark Tortrix

Enarmonia formosana

- Cherry bark tortrix found near Canadian border in 1991.
- Damages native, ornamental, and fruit trees.
- Infestations may lead to increased use of pesticides.

The data displayed in this map represents data that has been submitted for this baseline assessment and does not necessarily reflect a systematic basin-wide survey program. Additional occurences for this species are known.



Species Presence by County

Species Presence by County**

- Present But Extent Unknown
- >1000 Acres Infested

** Data are Approximate

Puget Sound Basin

Species Detection

- Enarmonia formosana

(Insect Trap Locations* 1991 - 2013)

Land Cover & Land Use

- Forest
- Rock & Snow
- Water
- Disturbed Lands

Boundaries & Extents

- County Boundary
- Puget Sound Extent

0 5 10 20 Miles

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. GIS data sources used to develop this map are noted in the Appendix. Data points represent locations of insect trap records, this species is widespread throughout the Puget Sound area.

ESA

Documented Presence in Puget Sound Basin

MAP 16.1a

January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

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How does the species spread?

Shipping and International Trade
Some potential exists for human-aided dispersal (transport of infested host plants), although infestation of young/transplantable stock is rare as adult moths prefer to lay eggs on mature trees.

Wind
Winds may help disperse adult moths.

What impacts does the species have?

ECOLOGICAL IMPACTS

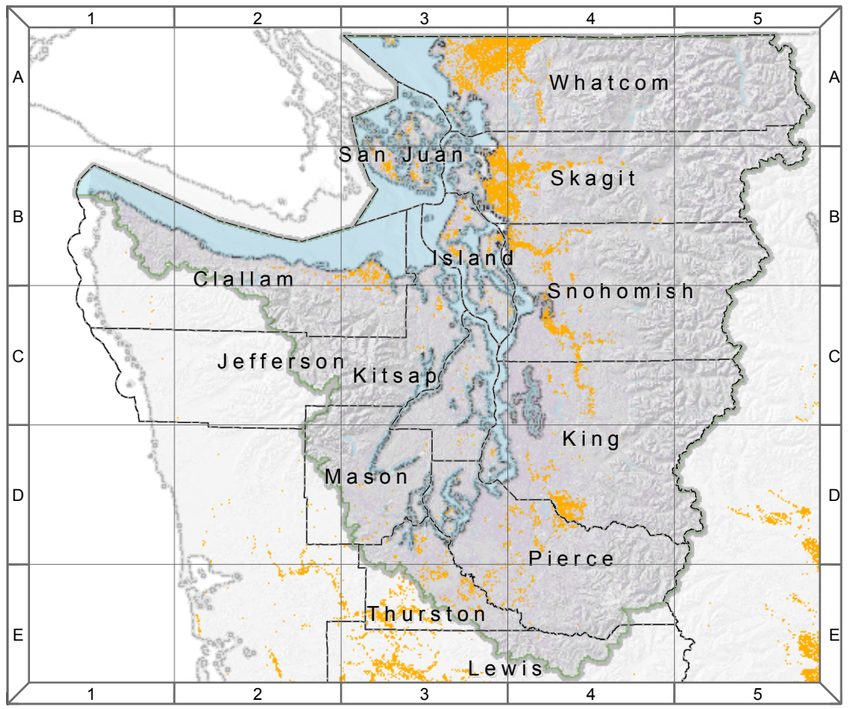
Displaces Native Vegetation
Cherry bark tortrix threatens many native trees such as black hawthorn, bitter cherry and Oregon crab apple.

SOCIAL AND ECONOMIC IMPACTS

Damages Crops or Ornamental Plants
Cherry bark tortrix damages stone fruits (cherry, plum, peach, apricot), apple, pear, pyracantha, mountain ash, laurels, hawthorn, photinia, and quince. Infestation may result in increased pesticide usage, replanting or replacement costs, and eventual reduction in economic value of both host trees and property values.

What resources are at risk?

Along the I-5 corridor, cherry bark tortrix is increasing its attacks on apple trees in this area. Cultivated croplands (specifically fruit tree orchards) in Whatcom and Skagit Counties are of particular concern. The economic value and potential impacts to flowering cherry trees alone, which are abundant and historically prominent landscape elements in many municipal, school, and government facility landscapes, are considerable but unquantified.



REGULATED PLANT PEST

Cherry Bark Tortrix

Enarmonia formosana

Sensitive Landscape Features
- Agricultural Lands

Boundaries & Extents
- County Boundary
- Puget Sound Extent

0 10 20 40 Miles

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

ESA

Species Spread, Impacts, and Natural Resources at Risk

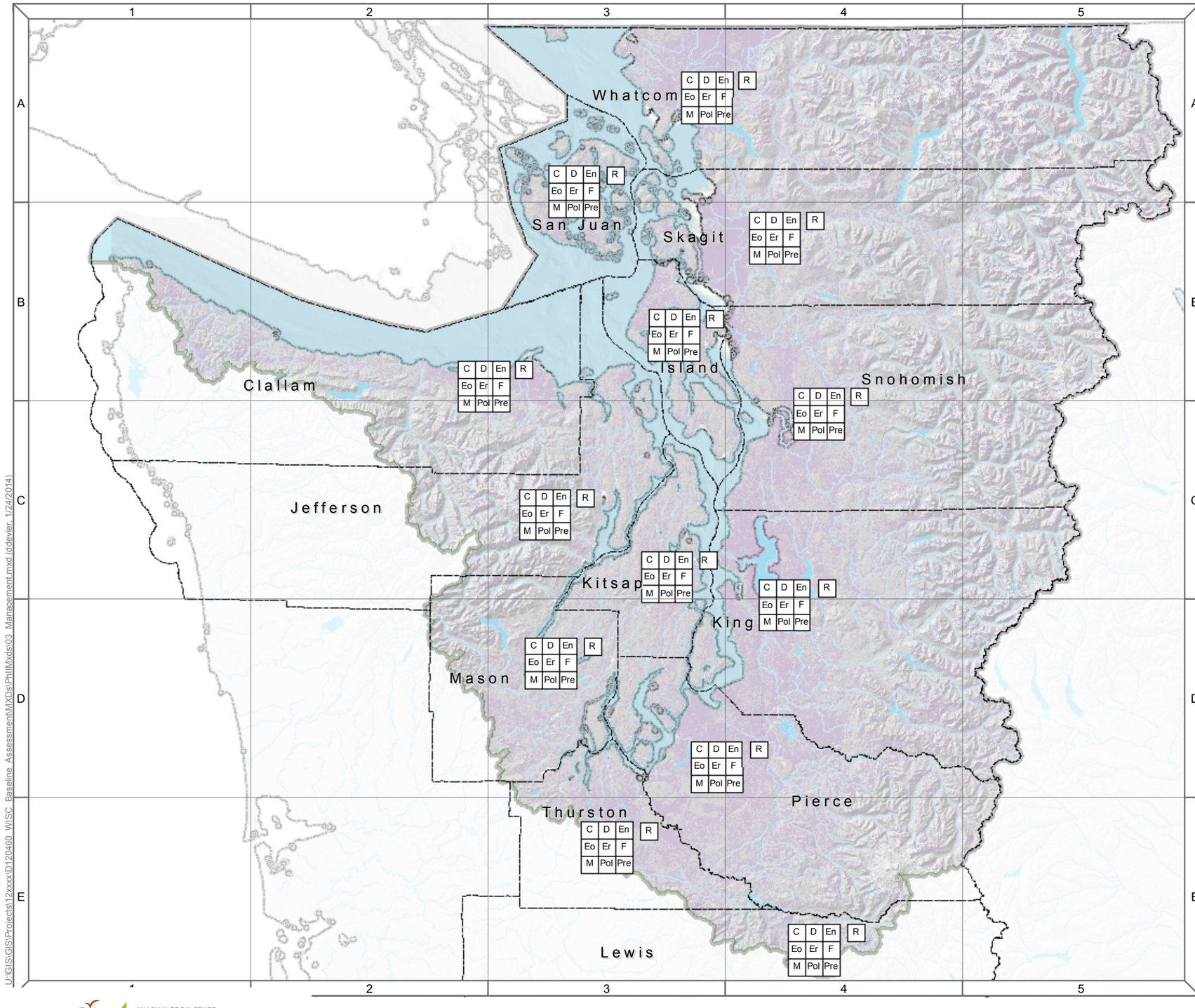
MAP 16.1b

January 2014

REGULATED PLANT PEST

Cherry Bark Tortrix

Enarmonia formosana



County Boundary

Puget Sound Extent

Lakes

Rivers

Management Programs at Regional/State/OtherLevel

Eo, Washington State Department of Agriculture

Abbreviations:

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

0 5 10 20 Miles

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

ESA

Management at the County Level

MAP 16.1c

January 2014

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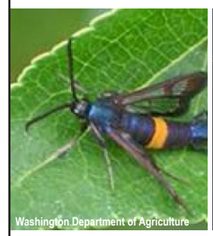
WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

REGULATED PLANT PEST

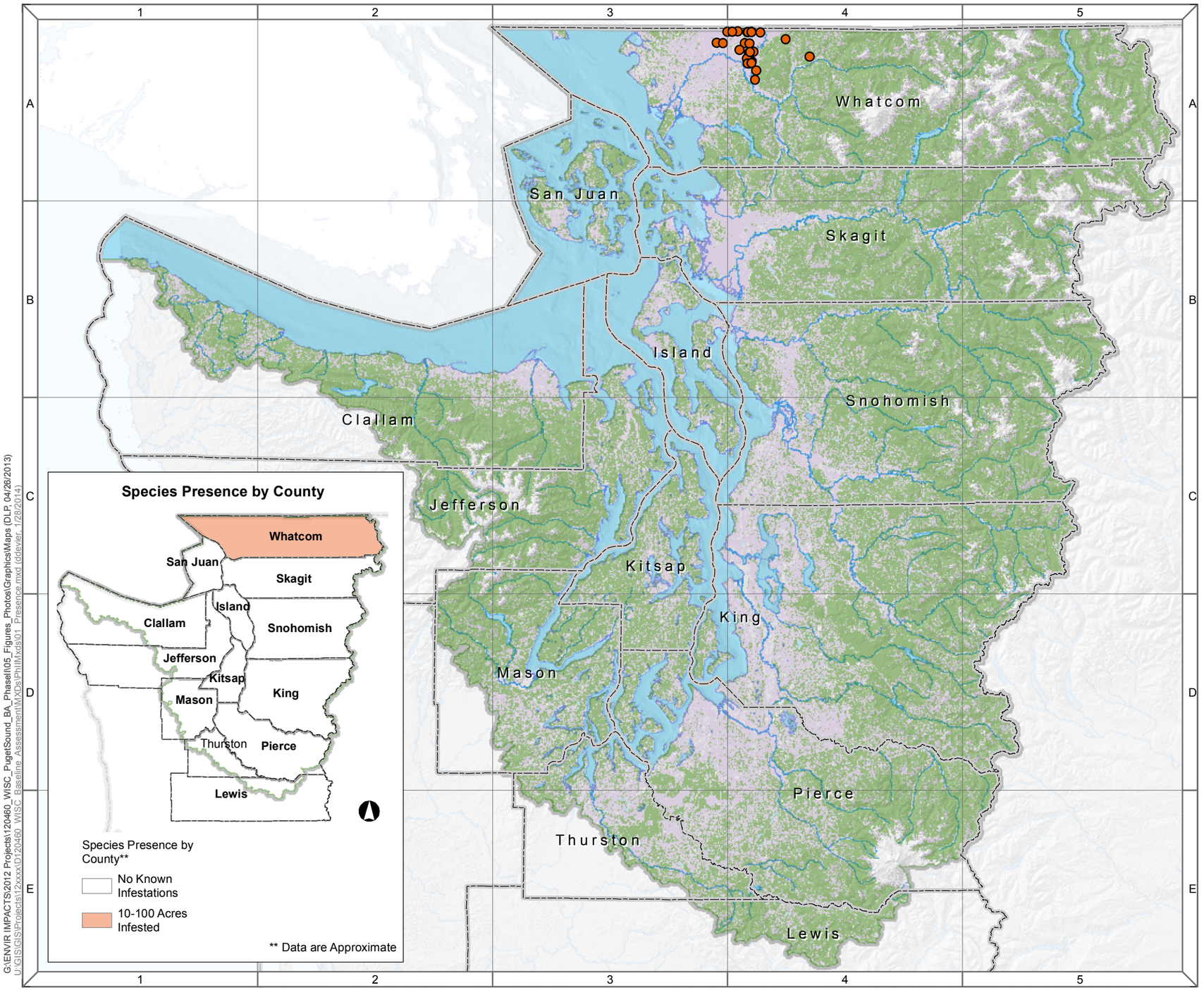
European Apple Clearwing Moth

Synanthedon myopaeformis


Washington Department of Agriculture


Eric LaGasa/WSDA

- Apple clearwing moth first found in Whatcom County in 2008.
- Damages native, ornamental, and fruit trees.
- Infestations may lead to increased use of pesticides.



Puget Sound Basin

Species Detection

- Synanthedon myopaeformis

(Insect Trap Locations* 1991 - 2013)

Land Cover & Land Use

- Forest
- Rock & Snow
- Water
- Disturbed Lands

Boundaries & Extents

- County Boundary
- Puget Sound Extent

0 5 10 20 Miles

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. GIS data sources used to develop this map are noted in the Appendix. Data points represent locations of insect trap records.

ESA

Documented Presence in Puget Sound Basin

MAP 16.2a

January 2014

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How does the species spread?

Shipping and International Trade
Some potential exists for human-aided dispersal (transport of infested host plants), although infestation of young/transplantable stock is rare as adult moths prefer to lay eggs on mature trees.

Wind
Winds may help disperse adult moths.

What impacts does the species have?

ECOLOGICAL IMPACTS

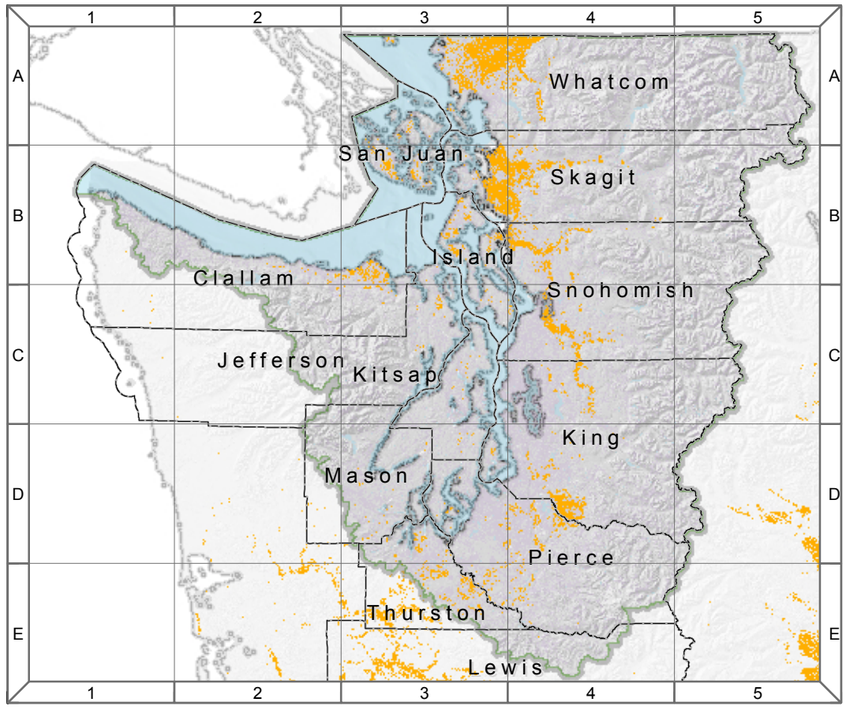
Displaces Native Vegetation
Apple clearwing moth threatens many native trees such as black hawthorn, bitter cherry and Oregon crab apple.

SOCIAL AND ECONOMIC IMPACTS

Damages Crops or Ornamental Plants
Apple clearwing moth damages stone fruit trees, apple, pear, pyracantha, mountain ash, laurels, hawthorn, photinia, and quince. Infestation may result in increased pesticide usage, replanting or replacement costs, and eventual reduction in economic value of both host trees and property values.

What resources are at risk?

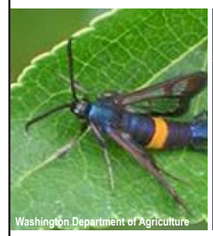
Cultivated croplands (specifically fruit tree orchards) in Whatcom and Skagit Counties are of particular concern. The economic value and potential impacts to flowering cherry trees alone, which are abundant and historically prominent landscape elements in many municipal, school, and government facility landscapes, are considerable but unquantified.



REGULATED PLANT PEST

European Apple Clearwing Moth

Synanthedon myopaeformis


Washington Department of Agriculture


Eric LaGasa/WSDA

Sensitive Landscape Features
Agricultural Lands

Boundaries & Extents
County Boundary
Puget Sound Extent

0 10 20 40 Miles

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

ESA

Species Spread, Impacts, and Natural Resources at Risk

MAP 16.2b

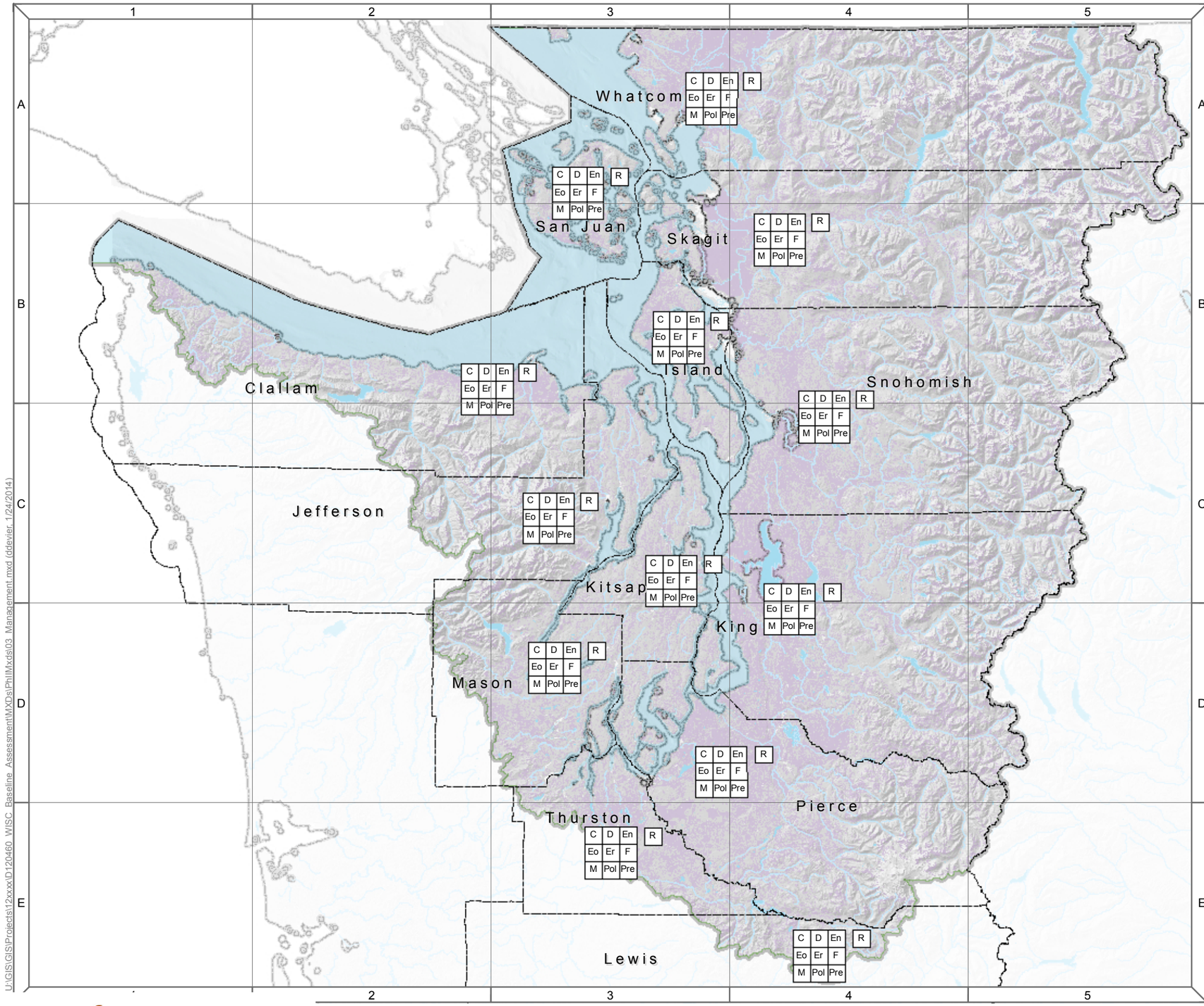
January 2014

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

REGULATED PLANT PEST

European Apple Clearwing Moth

Synanthedon myopaeformis



County Boundary

Puget Sound Extent

Lakes

Rivers

Management Programs at Regional/State/OtherLevel

Eo, Washington State Department of Agriculture

Abbreviations:

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

Miles

0 5 10 20

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

ESA

Management at the County Level

MAP 16.2c

January 2014

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WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

INFECTIOUS SALMON ANEMIA (ISA) 17

Isavirus

Infectious salmon anemia (ISA) virus is a member of the genus Isavirus in the family Orthomyxoviridae. Infected fish may exhibit lethargy, skin darkening, severe anemia (pale gills), petechial hemorrhaging (small blood spots on the abdomen near the pectoral fins and vent), and abdominal swelling. Its victims can be seen gasping at the surface, lethargic and often swollen with fluids. The external signs of ISA disease are very similar to those of other common salmon diseases, so ISA disease can only be diagnosed by laboratory testing. Mortality in farmed populations can reach 90 percent.

ISA was first identified in Norway in 1983 and subsequently was identified in other parts of the world where Atlantic salmon (Salmo salar) are farmed, including Scotland, Ireland, eastern Canada, eastern United States, and Chile. The virus may have been moved to new areas through shipments of eggs or fish.

In 2011, university researchers from British Columbia, Canada, reported a suspect positive test for ISA in Pacific wild salmon. The Canadian government and independent experts were not able to detect ISA virus in the same samples or in thousands of other samples from wild and farmed salmon from the same region. While there is currently no evidence that ISA virus is currently present in the Pacific Northwest, the introduction of ISA virus would likely have serious impacts on Atlantic salmon farming. There is also concern that, if introduced, the virus might adapt to Pacific salmon and cause disease in wild fish. For these reasons, ISA was elevated as a priority for the Washington Invasive Species Council.

STATUS AND TRENDS

Species Presence (Map 17.1) Outbreaks of ISA occurring in farmed Atlantic salmon have been identified and managed in salmon farming operations across Europe, the east coasts of the United States and Canada, and in South America since 1983. Wild Atlantic salmon might also be susceptible but, despite extensive surveillance efforts, there have not been any ISA disease outbreaks in any wild populations of Atlantic or Pacific salmon anywhere in the world.

See Table 17.1 for a summary of data provided. There were two spreadsheet files available for the baseline assessment. The first was provided by the 2012-2013 ongoing Congress-directed collaborative surveillance effort in Puget Sound conducted by the Northwest Indian Fisheries Commission (NWIFC) and its member tribes, the Department of Commerce National Oceanic and Atmospheric Administration (NOAA), the Washington Department of Fish and Wildlife (WDFW), the Department of Interior Fish and Wildlife Service (USFWS), and the Department of Agriculture Animal and Plant Health Inspection Service (APHIS). The information in the spreadsheet was converted to a shapefile to show the location of all sampled fish. The second was provided by Wild Fish Conservancy, a nonprofit conservation organization headquartered in Duvall, Washington.

Presence over time The ISA disease has never been found in Pacific wild populations, including the Puget Sound. In 2011, Congress directed the National Aquatic Animals Task Force to initiate a surveillance program. The program involved geographically distributed, biannual sampling of Pacific salmon native to the Pacific Northwest for 2 years, as well as enhanced sampling of commercial Atlantic salmon and rainbow trout. In 2012 – 2013, over 400 fish from 19 stocks in the Salish Sea were tested for known strains of ISA using molecular methods. All tests were negative.

INFECTIOUS SALMON ANEMIA (ISA)

Isavirus

Table 17.1. Infectious salmon anemia data provided to the baseline assessment project.

File type provided (quantity)	Spatial extent	Data provider
Spatially explicit data		
Spreadsheet with locations/ species of samples taken in 2012-2013 (1)	Salish Sea, Columbia Basin, Washington Coast	Northwest Indian Fisheries Commission, Washington State Department of Fish and Wildlife, and the US Fish and Wildlife Service
Spreadsheet with locations/ species of samples taken in 2012-2013 (1)	Puget Sound	Wild Fish Conservancy

PATHWAYS

Pathways of introduction and spread (Map 17.2)

Regardless of the route of introduction of ISA virus into Puget Sound, it would likely be first detected in the fish most susceptible to ISA virus disease: farmed Atlantic salmon raised in net pens in British Columbia and Washington. If the disease took hold in the farmed fish, there is concern that it might spread to wild Pacific salmon migrating through areas where Atlantic salmon are farmed. Many fish pens in British Columbia are in the corridor that millions of Canadian salmon, both juvenile outmigrants and adult returns, use every year. Wild salmon of Canadian origin have a similar migration pattern in many cases to Puget Sound salmon. During migration through Canada and while feeding in the marine waters of Canada and Alaska, it is possible that salmon originating from Puget Sound could co-mingle with Canadian fish. The most likely pathway for transmission would be from fish-to-fish in the water column.

Shipments of salmon and their eggs into the Pacific Northwest are highly regulated and controlled by state and federal regulations. All movements of salmon into Washington are rigorously reviewed by the Washington Department of Fish and Wildlife, and shipments associated with any significant risk of ISA virus introduction are denied. Movements of susceptible fish into Washington occur only through federal, state, and commercial aquaculture routes where there is both regulation and active oversight to prevent the introduction of ISA virus or other important disease organisms. There is no movement of potentially-infected fish by the general public including for bait and ornamental purposes.

IMPACTS AND AT-RISK RESOURCES

It is important to note that there has been no evidence that ISA virus exists on the Pacific Coast or that Pacific salmon are susceptible to the ISA disease. The following section discusses the potential impacts as opposed to the actual impacts.

Ecological impacts (Map 17.2) Mortality of ISA-infected farmed Atlantic salmon is high and has resulted in farming facility management activities that include biosecurity, quarantine, and depopulation. If ISA were to adapt to wild Pacific salmon stocks, many of those closed-facility management techniques would be ineffective. The potential results of ISA infection are unknown as there have never been any outbreaks of the disease in Pacific salmon or in Puget Sound.

INFECTIOUS SALMON ANEMIA (ISA)

Isavirus

Social and economic impacts (Map 17.2) Salmon provide the economic backbone for jobs in the fishing industry in Puget Sound, which includes fishermen, fish processers, and many others who provide fishing necessities such as boats and equipment. Salmon are also the spiritual foundation for many Puget Sound tribes and are protected by treaties with the United States. The cultural significance of the fish to all residents of Puget Sound cannot be overstated. If ISA infection in Puget Sound salmon resulted in mortality, the impacts across the economic and cultural landscape would be significant, though there is currently no indication that this is a possibility.

MANAGEMENT

Currently, there are no active management actions taking place for ISA by any groups in Puget Sound, other than surveillance. Other management efforts in the United States that could potentially apply to Puget Sound in the case of a breakout of the disease are listed below.

Federal-level activities In 2002- 2003, USDA APHIS became involved with ISA in the eastern United States. At the time, ISA was widespread in the salmon farming industry. Biosecurity measures, disease surveillance, testing at laboratory facilities, quarantines, and depopulations at infected sites were conducted. An ongoing control program was instituted and carries on currently. APHIS is currently involved (2012-2013) in the surveillance effort in the Pacific Northwest.

Legal authorities On the federal level, the Department of Agriculture, APHIS, has authority over all farm-raised fish as well as animals that have the potential to impact farm-raised fish. The Department of Commerce, NOAA, has authority for all wild marine species of aquatic animals. The Department of Interior, USFWS, has authority for all wild freshwater aquatic species not in the jurisdiction of a state. In the case of salmon, both NOAA and USFWS have jurisdiction over the species. APHIS and NOAA have a history of collaborating on other infectious disease investigations and control programs. The state of Washington and tribes also regulate fish movements and collaborate on disease prevention through the Washington Co-Managers' Plan. Should there be an emergency situation regarding ISA in Puget Sound, it is with the state's or tribe's jurisdiction working with its co-manager to determine how best to address the issue with coordination provided from APHIS, NOAA, and USFWS.

Funding APHIS has funded the NWIFC and WDFW to run a surveillance program in Washington State and the Columbia Basin since 2011. The funding is expected to continue through 2014.

SUMMARY OF GAPS

Data collection and management Currently, data collection is part of the surveillance effort that is taking place in Washington State and the Columbia Basin. Since there has been no evidence of ISA existing in the Puget Sound, no data are being collected on ISA nor are there current management efforts.

Knowledge and understanding of species status, pathways, and impacts The initial suspect ISA virus detections in Canada were not confirmed, and extensive testing since then has not produced any evidence of ISA virus in the Pacific Northwest. However, it is possible that some virus related to ISA does exist in salmon in the Northwest and may have caused the initial suspect positive results. Research is currently underway to look for an ISA virus relative. If one is found, more research would be required to determine its origin and its potential to harm wild and farmed salmon populations.

There has been research demonstrating that Pacific salmon species are not susceptible to ISA disease, but further work with more species and under more conditions is worthwhile.

Management efforts Since there have been no ISA outbreaks in the Puget Sound, there is no management effort underway.

REFERENCES

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Washington Department of Fish and Wildlife. 2013. Species & Ecosystem Science - Infectious Salmon Anemia Monitoring Program. Available: http://wdfw.wa.gov/conservation/research/projects/salmon_anemia/.

Infectious Salmon Anemia (ISA)

Isavirus

- Causes numerous symptoms in fish, with mortality up to 90%.
- Potentially present but unconfirmed in Canadian Pacific wild salmon.
- Infection of wild salmon stocks could have major impacts on aquatic food webs, commercial and Tribal fisheries.

Puget Sound Basin

Unconfirmed ISA virus found central BC coastal watershed. (Report to 112th Congress of the US, 2012).

Central Coast British Columbia

Queen Charlotte Sound

Moresby Canyon

Vancouver Island

Vancouver

Bellingham

Seattle

Olympia

Species Presence by County

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

Species Presence by County**

No Known Infestations

** Data are Approximate

× Monitoring Locations - No Species Detected*

Puget Sound Extent

Approximate area of unconfirmed ISA virus finding (2011)

0 12.5 25 50 Miles

* Data are not to scale and may contain point, line and/or polygon data. Data do not necessarily reflect systematic basin wide survey program. GIS data sources used to develop this map are noted in the Appendix.

ESA

Documented Presence in Puget Sound Basin

MAP 17.1

January 2014

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WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

How does the species spread?

Food and Medicinals
If ISAV were to infect fish in Puget Sound, it would likely emerge in farmed Atlantic salmon in the open net pens in British Columbia. Outbreaks of ISAV occurring in farmed Atlantic salmon have been identified and managed in salmon farming operations across Europe, eastern United States and Canada, and South America since 1983. Wild Atlantic salmon might also be susceptible though, currently, there have not been any ISAV outbreaks documented in any wild salmon populations (including Pacific salmon) anywhere in the world.

What impacts does the species have?

ECOLOGICAL IMPACTS

Changes Aquatic Food Webs
If ISAV were to infect wild stocks, the result could be significant and could cause widespread mortality that would impact entire populations as well as food webs that depend on Pacific salmon in Puget Sound.

SOCIAL AND ECONOMIC IMPACTS

Impacts Fisheries
A widespread ISAV infection in Puget Sound salmon would have significant impacts to salmon fisheries in Puget Sound.

What resources are at risk?

Salmon provide the economic backbone for jobs in the fishing industry in Puget Sound, which includes fishermen, fish processers and many others who provide fishing necessities such as boats and equipment. Salmon are also the spiritual foundation for many Puget Sound Tribes and are protected by treaties with the United States. The cultural significance of the fish to all residents of Puget Sound cannot be overstated.

Infectious Salmon Anemia (ISA)

Isavirus

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

ESA

Species Spread, Impacts, and Natural Resources at Risk

MAP 17.2

January 2014

Infectious Salmon Anemia (ISA)

Isavirus

Whatcom: C D En R | Eo Er F | M Pol Pre

San Juan: C D En R | Eo Er F | M Pol Pre

Skagit: C D En R | Eo Er F | M Pol Pre

Island: C D En R | Eo Er F | M Pol Pre

Clallam: C D En R | Eo Er F | M Pol Pre

Snohomish: C D En R | Eo Er F | M Pol Pre

Jefferson: C D En R | Eo Er F | M Pol Pre

Kitsap: C D En R | Eo Er F | M Pol Pre

King: C D En R | Eo Er F | M Pol Pre

Mason: C D En R | Eo Er F | M Pol Pre

Pierce: C D En R | Eo Er F | M Pol Pre

Thurston: C D En R | Eo Er F | M Pol Pre

Lewis: C D En R | Eo Er F | M Pol Pre

- County Boundary
- Puget Sound Extent
- Lakes
- Rivers

Management Programs at Regional/State/OtherLevel

D, Wild Fish Conservancy

M, Wild Fish Conservancy

Pol, Puget Sound Partnership

Abbreviations:

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

0 5 10 20 Miles

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

ESA

Management at the County Level

MAP 17.3

January 2014

U:\GIS\GIS\Projects\12xxxx\D120460_WISC_Baseline_Assessment\MXDs\PhIIIMxds\03_Management.mxd (ddevier, 1/24/2014)

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

VI. INVASIVE SPECIES MANAGEMENT COMPONENTS TO PUGET SOUND RECOVERY

Restoring Puget Sound is a major priority for many government agencies, tribes, non-profit groups, and other organizations. The Puget Sound Partnership, the state agency tasked with leading the restoration of Puget Sound, estimated that in 2010 alone over $230 million was spent on Puget Sound protection and restoration projects (Puget Sound Partnership, 2012). Types of restoration projects that are common in the region include removal of shoreline armoring, floodplain reconnection, removal of fish passage barriers, wetland/estuary rehabilitation, and riparian enhancement.

The Puget Sound region has experienced widespread habitat loss, water quality degradation, and reduced abundance of important plant and animal species. The ecological health of the region is also impacted by invasive species infestations. Invasive aquatic plants, such as Eurasian watermilfoil, affect lakes and rivers in the region by shading out beneficial plants and reducing dissolved oxygen levels. Invasive aquatic animals, such as New Zealand mud snail, can outcompete native aquatic species that other species (including native salmon and trout) depend on for food. Terrestrial invasive plants, such as knotweeds, can rapidly colonize an area and outcompete native plant species, which can result in loss of food sources and habitat for native fish and wildlife.

In the context of restoration planning, successful invasive species control has a number of potential challenges. Restoration actions, such as restoring a riparian area or wetland at a specific site, can often eliminate or reduce invasive species presence for a period of time, but if surrounding areas are colonized, more extensive control strategies (beyond the boundaries of the restoration site) may be needed to ensure that the species does not invade the restored area. For example, knotweed along a riparian corridor can be carried by the stream and quickly establish itself in downstream areas.

When restoration actions and invasive species control programs are planned and implemented at a watershed scale, the chances of success can improve. This chapter describes existing Puget Sound restoration plans and programs with invasive species management components, as well as a new tool for informing watershed management decisions: the Puget Sound Watershed Characterization.

THE ROLE OF INVASIVE SPECIES MANAGEMENT IN REGIONAL RECOVERY EFFORTS

Invasive species management is a key component of several Puget Sound restoration plans and programs, which are summarized below.

PUGET SOUND ACTION AGENDA

The Puget Sound Partnership developed the *Puget Sound Action Agenda*, which is a "road map" that details the work needed to achieve the Partnership's goal of restoring the health of Puget Sound by 2020. The latest version of the Action Agenda identifies key ongoing programs, local priorities for different areas of Puget Sound, and more than 200 specific strategies and actions needed to reach the 2020 restoration goal.

Strategy B5.3 in the Action Agenda is to "prevent and rapidly respond to the introduction and spread of terrestrial and aquatic invasive species." The stated goal of the strategy is to: 1) gain an understanding of invasive species presence and extent in Puget Sound terrestrial and aquatic ecosystems; 2) prevent the introduction of new high-priority, high-risk invasive species to these ecosystems; 3) rapidly respond when new priority invasive species are detected; 4) stop invasive species already here from spreading to other locations; and 5) completely eliminate invasive species as soon as possible, wherever possible.

The Action Agenda describes several ongoing programs and near-term actions that are working to prevent and respond to invasive species in Puget Sound. These include the Washington Invasive Species Council (WISC), which works to provide policy direction and planning support for regional invasive species efforts. The WISC also coordinates control strategies with various government, tribal, and private partners. The WISC has recently expanded its invasive species baseline assessment to include an additional 21 invasive species (this report), and is currently developing an early detection and monitoring program plan for priority invasive species in the Sound.

WDFW invasive species control programs are also described in the Action Agenda. Through its Aquatic Invasive Species Prevention and Enforcement and Ballast Water Management programs, WDFW works to minimize the invasive species introduction risks associated with hull fouling and ballast water discharges. According to the Action Agenda, WDFW is working to strengthen these programs by developing implementable recommendations for managing invasive species transported on and in the hulls of recreational watercraft and commercial ships, as well as improve the effectiveness of open sea exchange and treatment to meet state ballast water standards. WDFW is also working to develop plans to respond to a potential zebra/quagga mussel invasion in the Puget Sound Basin and limit the spread of New Zealand mud snails. These recommendations and plans are scheduled to be completed in 2015.

PUGET SOUND CHINOOK RECOVERY

Chinook salmon were listed in Puget Sound under the Endangered Species Act in 1999. In response, a coalition of public- and private-sector stakeholders, called the Shared Strategy for Puget Sound, developed the Puget Sound Salmon Recovery Plan (SSDC, 2007). The Recovery Plan was originally submitted to the National Marine Fisheries Service (NMFS) in 2005, and in 2006 NMFS issued a supplement to the plan. Among other elements, the supplement identified a critical need to develop and implement a rigorous monitoring and adaptive management framework to assess the effectiveness of actions and progress towards recovery.

In March of 2013, the Puget Sound Recovery Implementation Technical Team (RITT) released a draft framework for developing monitoring and adaptive management plans for Puget Sound Chinook Recovery. The team found that monitoring and adaptive management programs are occurring at both the local (i.e., watershed) and regional (i.e., Puget Sound) scales, but they lack consistency and comparability. The draft framework developed by the RITT aims to retain the individual salmon recovery approaches developed for different watersheds, while providing the consistency required for a Puget Sound-wide assessment of Chinook salmon recovery. The framework provides a scientific basis for evaluating the status of the recovery plan implementation in a common format.

The framework (RITT et al., 2013), which is still in development, utilizes eight categories of information, or "elements," which include ecosystem components, key ecological attributes, indicators, pressures, stresses, contributing factors, drivers, and strategies. These elements are used as the basis for conceptual models that determine what kind of restoration action is likely to be the most effective for Chinook recovery. The presence of nonnative species that prey on juvenile Chinook (such as northern pikeminnow) is used as an indicator in the "key ecological attributes" and "pressures" models.

PSNERP

The Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) is a collaborative effort among government agencies, universities, tribes, and environmental organizations that works to protect and restore natural processes that create and maintain Puget Sound nearshore ecosystems and biological resources. PSNERP projects include community outreach and education, technical study, and restoration site selection and design.

PSNERP developed a set of 21 "management measures" to use in the development of restoration solutions to address nearshore ecosystem degradation in the Puget Sound (Clancy et al., 2009). The measures were developed to be applied individually at specific sites or combined into larger, more comprehensive restoration and protection efforts at the basin or sub-basin scale. Management measure #10 involves invasive species control.

The management measure contains considerations for invasive plants that should be utilized during restoration design and implementation. First, a feasibility assessment should be conducted prior to invasive species control efforts. This includes an assessment of baseline information of the distribution and abundance of the target species, an understanding of its life history, an analysis of adjacent land uses and invasive plant seed sources, and potential risks of control efforts, such as herbicide use. After project implementation, PSNERP recommends enacting a maintenance program to avoid recolonization, as well as a long-term monitoring program to verify that invasive species are under control and that native species are being reestablished.

PUGET SOUND WATERSHED CHARACTERIZATION PROJECT

The Puget Sound Watershed Characterization Project is a set of water and habitat assessments that compares areas within a watershed in terms of their relative value for protection and restoration, and helps identify areas where new development will have the least impact on ecological processes and habitat. The assessments cover water resources (both water flow and water quality) and fish and wildlife habitats in the terrestrial, freshwater, and marine nearshore areas over the entire drainage area of Puget Sound. The characterization provides readily accessible watershed-based information that can be used to help answer two fundamental questions:

- Where on the landscape should management efforts be focused first, whether actions for planning (e.g., protection or additional development) or mitigation (e.g., restoration); and
- What types of activities and actions are most appro priate to that place, whether restoration, protection, conservation, or development?

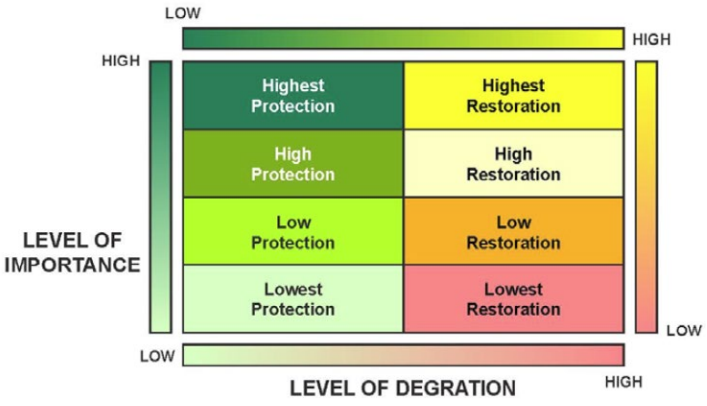
The characterization is composed of a number of assessments that fall into three main categories:

- ***Water Flow,*** which contains models that assess the delivery (i.e., precipitation) and storage of surface waters, as well as the recharge and discharge of ground water.
- ***Water Quality,*** which contains models that assess the export potential of sediments, phosphorous, and nitrogen, as well as the capacity to generate and transport pathogens and metals to downstream areas.
- ***Fish and Wildlife Habitats,*** which assesses the relative conservation values of terrestrial, freshwater, and marine habitats.

For upland and freshwater habitats, the assessment results were presented in terms of sub-watersheds, or “Assessment Units” (AUs). In total, there are 2,940 AUs in the characterization, which range in area from approximately 1 to 10 square miles. The marine shoreline habitat assessment used shoreline reaches with an average length of approximately one-quarter mile.

The main products of the characterization are color-coded maps that show the management priorities for the AUs and marine shoreline reaches throughout the Puget Sound Basin. In general, the relative priority of the AUs and marine shorelines for protection, restoration, or conservation is a function of the importance of the area to provide ecological processes or values (e.g., improving water quality, recharging ground water, and habitat/species conservation), and the degree to which the fundamental processes have been interrupted or degraded (by activities such as development or deforestation). For example, as shown in Figure VI-1, an AU with a high level of degradation and a low level of importance would be a low restoration priority, while an AU with a comparatively high level of degradation and a high level of importance would be a higher priority for restoration.

Figure VI-1. Characterization Management Priorities Matrix.



By using the watershed characterization along with other science-based information, planners, decision-makers, and restoration practitioners can:

- Develop and prioritize solutions to environmental problems based on an understanding of processes at a watershed or landscape scale;
- Replace planning based solely on site-scale considerations or jurisdictional boundaries with broader-scale more coordinated watershed planning;
- Guide site-scale reviews with watershed-scale context on ecological processes to ensure projects not only meet regulatory requirements but also more fully achieve their intended outcomes;
- Move towards integrated resource planning and management grounded in a landscape-scale understanding of how ecosystems work.

The Draft User's Guide for the Puget Sound Watershed Characterization (Ecology, 2013) recommends the following five-step framework to facilitate watershed-based decision-making:

1. Identify and define the environmental problem or issue
2. Identify and gather available watershed-based information
3. Integrate and apply watershed-based information (e.g., the water flow, water quality and habitat assessments) with finer-scale data
4. Develop and implement solutions and actions
5. Monitor results and adapt

As stated in the user's guide, the watershed characterization is a coarse-scale assessment, and should not be the only tool used to make management decisions at a site-scale. However, along with the use of finer-scale information, the characterization can help make informed decisions that can help maintain or improve conditions at the watershed scale.

The sub-sections below illustrate how invasive species data can be used along with characterization data and the corresponding management framework to help inform watershed restoration decisions in one sample watershed: Hood Canal. Specifically, this example shows how the Hood Canal Coordinating Council's (HCCC's) knotweed survey information can be used to inform decisions about where and how to implement riparian habitat enhancement.

IDENTIFY AND GATHER AVAILABLE WATERSHED-BASED INFORMATION

Step two in the framework is to gather the watershed characterization information for the study area. The Washington State Department of Ecology is currently developing a web mapping tool which will allow users to easily access characterization data and maps for their area of interest. In addition, Ecology formed the Watershed Characterization Technical Assistance Team (WCTAT) to help users interpret and use the characterization data.

The watershed characterization data for the Hood Canal region for water flow and freshwater habitat value are presented in Figures VI-2 and VI-3. For water flow, AUs in the higher-elevation portions of the region are typically priorities for protection because, in terms of water flow processes, they have high importance and low degradation (green shaded AUs). The lower-elevation AUs are also of high importance, but tend to show higher levels of degradation (yellow shaded AUs). The AUs with the highest priority for restoration of water flow processes are located along the Tahuya, Union, and Skokomish Rivers and Leland Creek.

The freshwater habitat data rank the AUs by habitat conservation score, which ranges from 1 to 10, with 10 representing areas with the highest habitat value for salmonids. The map shows that AUs associated with the major rivers and creeks that drain to Hood Canal have the highest scores, while AUs located along the Hood Canal shoreline and those located in the mountainous upper watersheds of Jefferson and Mason Counties typically have lower freshwater habitat conservation scores. In particular, AUs along the Quilcene, Duckabush, Hamma Hamma, Skokomish, Tahuya, and Union Rivers have the highest habitat conservation scores.

Figure VI-2. Overall results for Water Flow processes across the Hood Canal region.

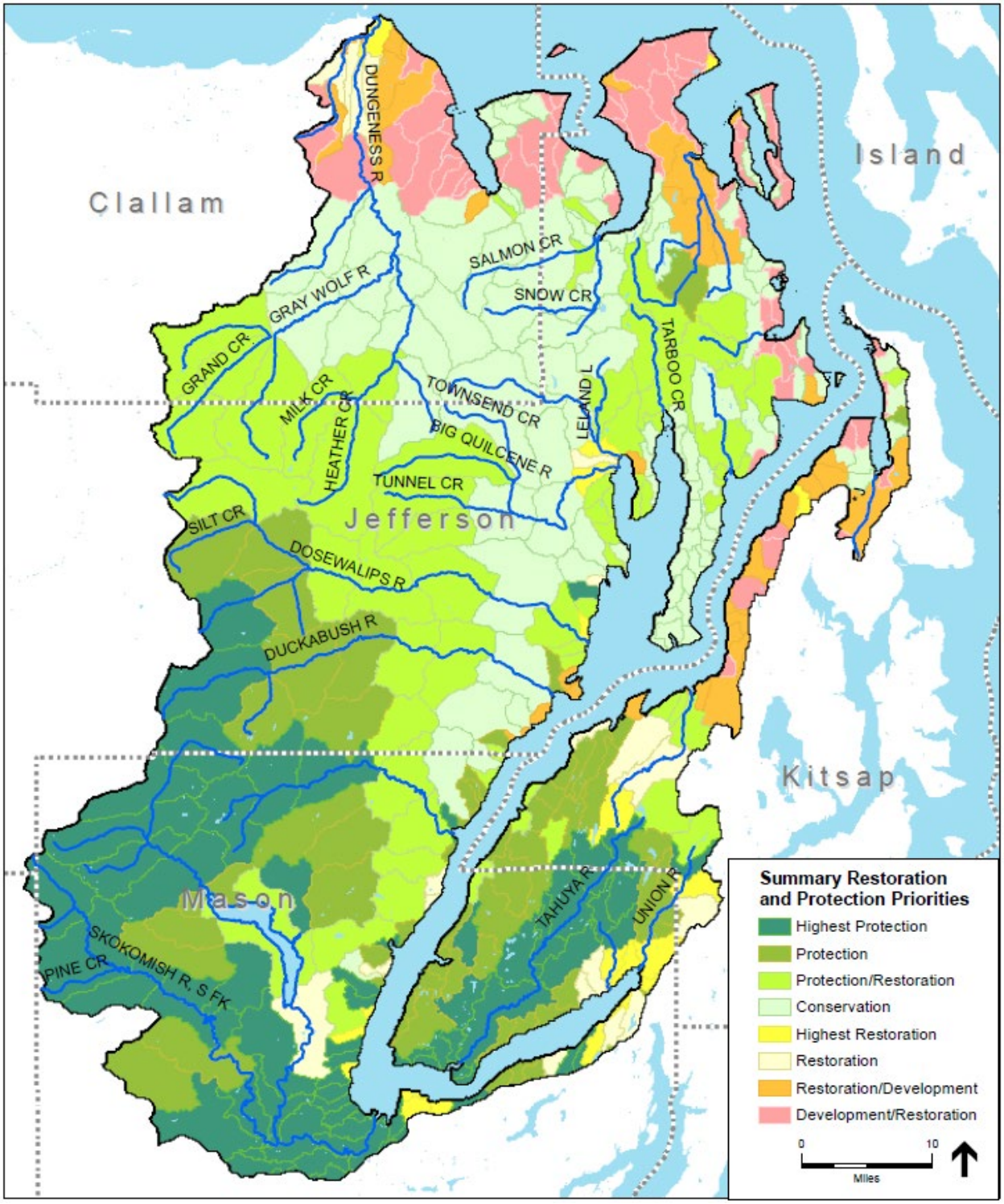
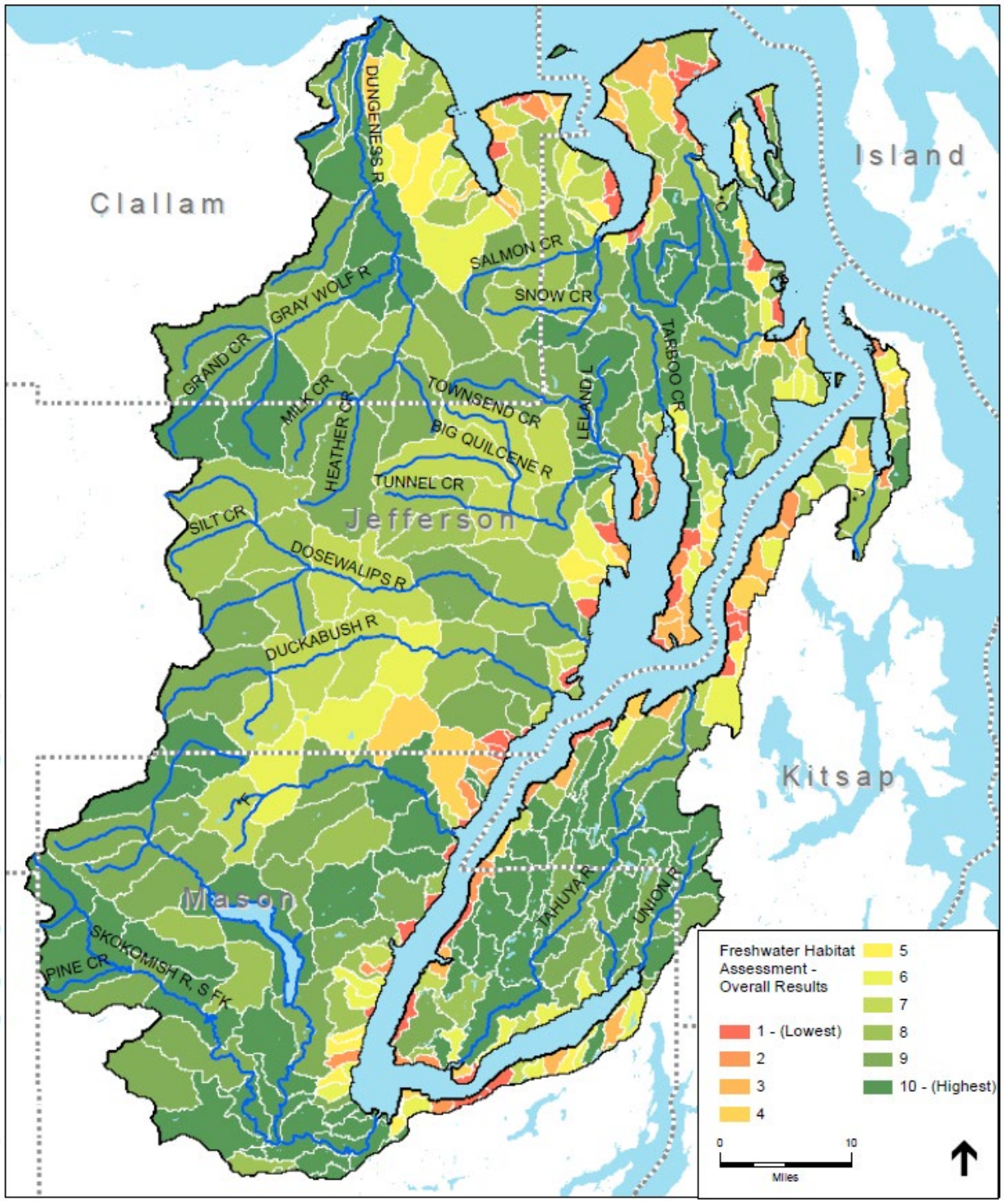


Figure VI-3. Overall results for freshwater habitat conservation value across the Hood Canal region.

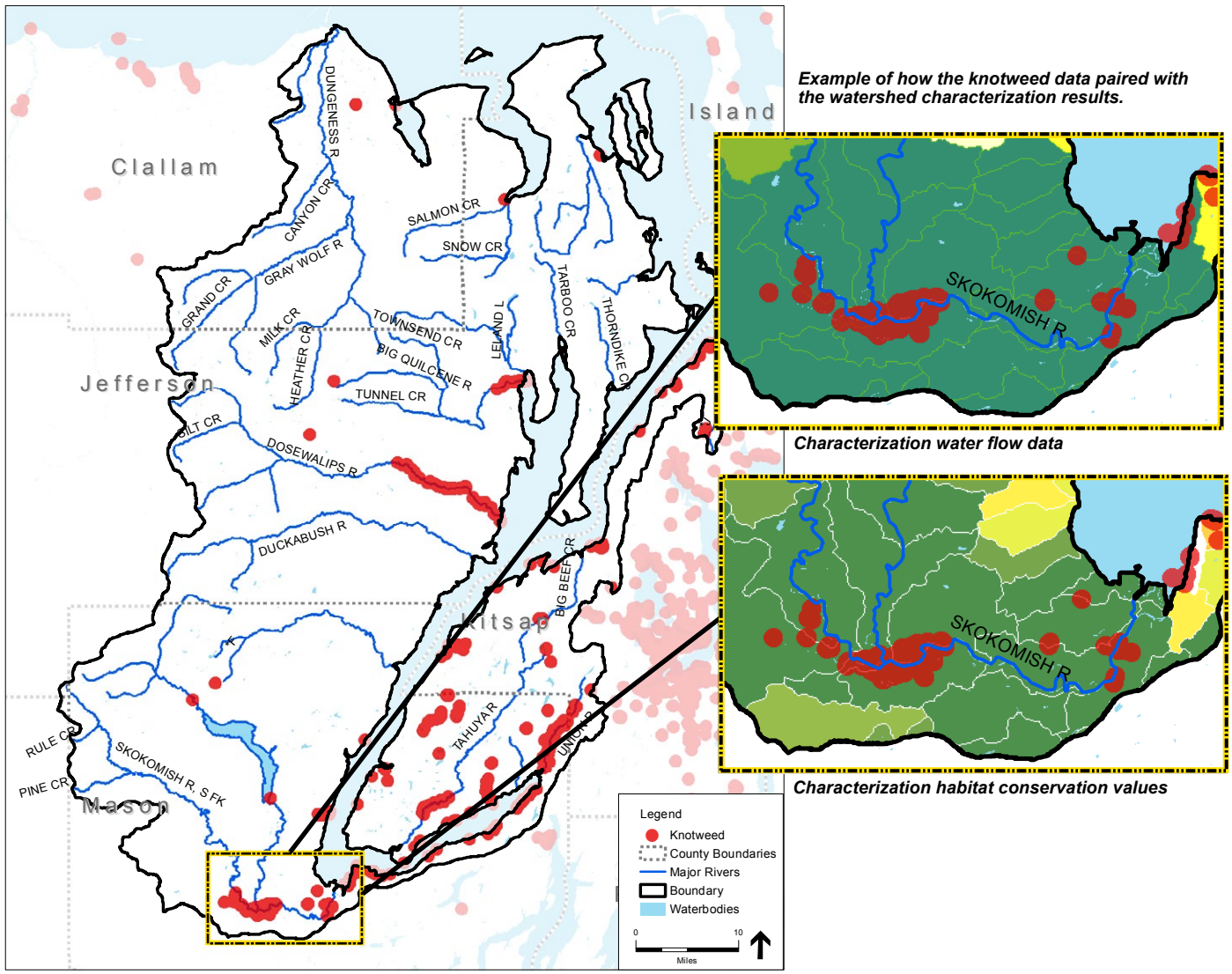


APPLY WATERSHED-BASED INFORMATION

After the characterization data are collected, additional watershed-based information, such invasive species data, can be analyzed. HCCC has conducted knotweed surveys as part of the Hood Canal Regional Knotweed Control Strategy (Figure VI-4). Much of the funding for the HCCC's knotweed survey was provided by the Washington State Department of Agriculture, through their Statewide Knotweed Control Program.

Among the areas surveyed, the highest recorded occurrences of knotweed are along lower Tunnel Creek and the lower Dosewallips River in Jefferson County, the lower Skokomish River in Mason County, and along the Tahuya and Union Rivers in Mason County. In addition, nearshore areas of the lower Canal, east of the "Great Bend," have significant documented knotweed infestations.

Figure VI-4. HCCC knotweed survey data for the Hood Canal region.



DEVELOP AND IMPLEMENT SOLUTIONS AND ACTIONS

As a whole, the characterization shows that AUs along the lower Skokomish River and upper and lower Tahuya River are the highest restoration priorities for restoring water flow processes (Figure VI-2). These rivers also have high freshwater habitat conservation values (Figure VI-3), and are identified as providing habitat for the Endangered Species Act-listed summer chum.

The HCCC data also show the presence of knotweed in these areas (Figure VI-4). As an example, the inset maps in Figure VI-4 show the knotweed data overlain on the characterization data along the lower Skokomish River. As described in Section V of this report, knotweed creates dense colonies that can shade out native plants and can accelerate erosion of stream banks. Given that knotweed can spread rapidly to downstream areas through root and stem fragments, riparian restoration projects downstream of knotweed-infested areas may have a substantial risk of failure. Therefore, for the Skokomish and Tahuya Rivers, restoration practitioners could increase the likelihood of restoration project success by first working to eradicate knotweed in upstream areas.

MONITOR RESULTS AND ADAPT

The final step in the framework is to monitor results over time and adapt the management actions, if needed. For long-term monitoring of riparian restoration projects, restoration practitioners can measure changes in downstream water quality, native vegetation reestablishment, and other related factors. The WISC baseline assessment, along with the mobile invasive species application described in the next section, are useful tools to track the progress of invasive species eradication efforts. The results of monitoring can help identify what changes should be made to existing or future restoration projects in order to improve results.

The Hood Canal Knotweed Strategy (HCCC, 2009) contains provisions for monitoring the effectiveness of knotweed eradication efforts. The primary elements of this monitoring program are:

- Conduct initial assessment/treatment surveys;
- Implement control efforts;
- Return annually to treatment site to conduct subsequent inventories and follow up treatments;
- Retreat/replant if needed;
- Create annual reports on efficacy and extent of efforts; and
- Participate in knotweed control group meetings to share data and lessons learned.

REFERENCES

Ecology. 2013. Draft Users Guide for the Puget Sound Watershed Characterization (Draft). Olympia, WA.

HCCC (Hood Canal Coordinating Council). 2009. Hood Canal Regional Knotweed Control Strategy (Draft). Poulsbo, WA.

Puget Sound Partnership. 2012. The 2012/2013 Action Agenda for Puget Sound. Tacoma, WA.

RITT (Puget Sound Recovery Implementation Technical Team), et al. 2013. Puget Sound Chinook Salmon Recovery: A Framework for the Development of Monitoring and Adaptive Management Plans (Draft). Seattle, WA: NOAA Fisheries.

SSDC (Shared Strategy Development Committee). 2007. Puget Sound Salmon Recovery Plan. Seattle, WA.

VII. INVOLVEMENT OPPORTUNITIES

HOW CAN I GET THE WISC BASELINE ASSESSMENT DATA?

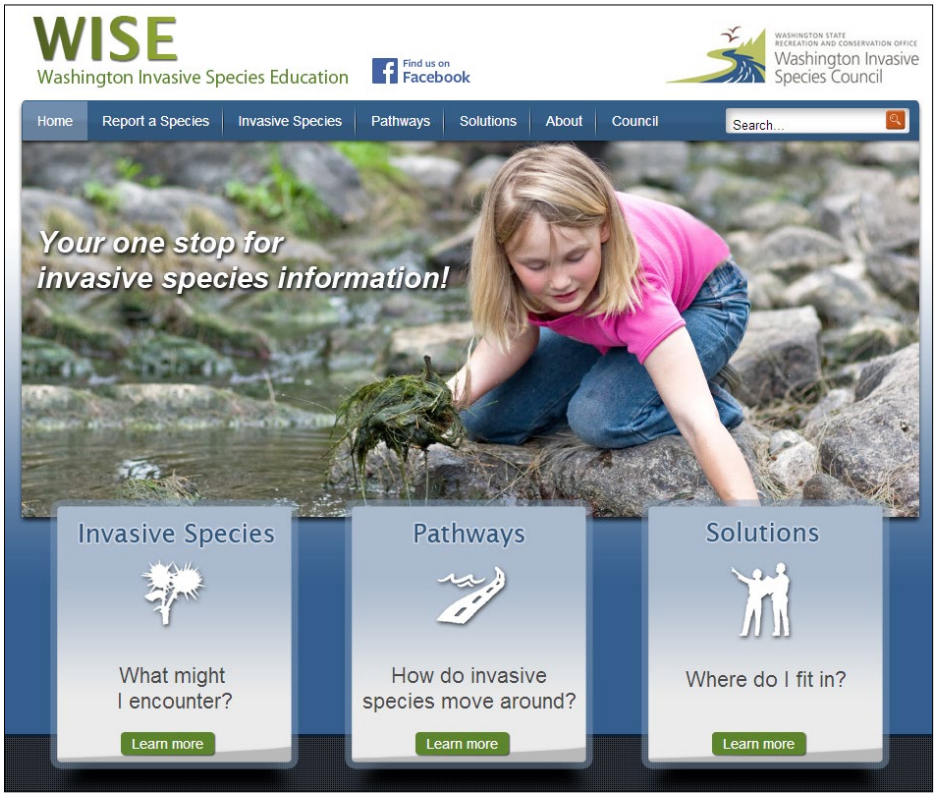
The baseline assessment includes a collection of digital files that can be accessed on the WISC website: http://www.invasivespecies.wa.gov/council_projects/baseline_assessment.shtml.

This includes:

- Microsoft Access relational database that includes the organizations, data collected, references and pre-defined queries and reports
- File geodatabase for all species used in the assessment and to create the maps in this report

WISC/WISE WEBSITE OPPORTUNITIES

The Washington Invasive Species Council has a number of ways to get involved on their website. Through their education program, Washington Invasive Species Education (WISE), there are several resources to learning more about invasive species and becoming an active participant in the prevention, detection, and control of invasive species. Visit their website at: http://www.wise.wa.gov/.



INVOLVEMENT OPPORTUNITIES

CONTACT YOUR LOCAL NOXIOUS WEED CONTROL BOARD

Each county in the State of Washington has a county weed board to conduct weed work, coordinate with landowners, and survey, control, and monitor priority invasive species in their region. For a complete list of the county noxious weed boards, visit: http://www.nwcb.wa.gov/nwcb_county.htm.

EARLY DETECTION AND RAPID RESPONSE (EDRR) PROGRAMS

Prevention of harmful invasive species entering into the state is the first line of defense against invasions. There are several programs in place in the region and in Washington State that are helping to apply EDRR in the management of invasive species. For a list of management plans that include EDRR, visit: http://www.invasivespeciesinfo.gov/toolkit/wa.shtml.

DOWNLOAD THE MOBILE INVASIVE SPECIES APPLICATIONS

WISC has developed a new tool for reporting sightings of priority species in Washington State for mobile (iOS and Android) devices. This crowd-sourcing tool allows anyone to help support the detection of species and report these sightings to a central database using GPS and photo tools in the application along with a brief description to submit a sighting report. To learn more about the mobile application and how you can download this on your mobile device, visit: http://www.invasivespecies.wa.gov/report.shtml.

VIII. APPENDICES

APPENDIX A

Appendix A. Additional References and Background Research

The following is a list of general references used to identify regionwide programs and trends for invasive species in the Puget Sound Basin. References consulted for individual priority species are listed in the species summaries in Section V of this report.

Boersma, P.D., S.H. Reichard, and A.N. Van Buren. 2006. Invasive Species in the Pacific Northwest. University of Washington Press, Seattle.

Ecology. 2013. Draft Users Guide for the Puget Sound Watershed Characterization (Draft). Olympia, WA.

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Washington Invasive Species Council, 2011. 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.

APPENDIX B

Appendix B: Organizations and Individuals Outreached

Org Type	Name		Job Title	Program
City				
	City of Bellingham			
	Clayton	Snider	Natural Resources Specialist	Parks and Recreation
County				
	Clallam County			
	Cathy	Lucero	Program Manager	Noxious Weed Control Board
	Grays Harbor			
	Nancy	Ness	Coordinator	Noxious Weed Control Board
	Island County			
	Janet	Stein	Program Coordinator	Noxious Weed Control Board
	Jefferson County			
	Eve	Dixon	Coordinator	Noxious Weed Control Board
	King County			
	Beth	Ledoux	Water Quality Planner	Water and Land Resources
	Dennis	Chambreau	State and Federal Weed Specialist	Noxious Weed Control Board
	Katie	Messick	Aquatic Lands Specialist	Noxious Weed Control Board
	Sally	Abella	Senior Engineer	Lakes Stewardship
	Sasha	Shaw	Education Specialist	Noxious Weed Control Board
	Steven	Burke	Program Manager	Noxious Weed Control Board

Org Type	Name		Job Title	Program
	Ben	Peterson	Noxious Weed Control Specialist	Noxious Weed Control Board
	Kitsap County			
	Kathy	Peters	Habitat Biologist	Noxious Weed Control Board
	Kathy	Peters	Habitat biologist	
	Dana	Coggon	Program Manager	Noxious Weed Control Board
	Mason County			
	Patricia	Grover	Coordinator	Noxious Weed Control Board
	Pierce County			
	Beki	Shoemaker	Program Coordinator	Noxious Weed Control board
	Melissa	Buckingham	Program Coordinator	Urban Conservation
	Renee	Mitchell	Knotweed Control Program Manager	Knotweed Control Program
	San Juan County			
	Rich	Lee	Field Coordinator	Noxious Weed Control Board
	Judy	Jackson	Assistant Coordinator	Noxious Weed Control Board
	Skagit County			
	Tracy	Alker	MRC and LMD Program Coordinator	Public Works
	Gene	Williams	Senior Planner	Surface Water Management
	Bill	Rogers		Noxious Weed Control Board
	Snohomish County			
	Gene	Williams	Senior Planner	Surface Water

Org Type	Name		Job Title	Program
	Sonny	Gohrman	Noxious Weed Coordinator	Noxious Weed Control Board
	Thurston County			
	Rick	Johnson	Program Coordinator	Noxious Weed Control Board
	Whatcom County			
	Laurel	Baldwin	Program Coordinator	Noxious Weed Control Board
Federal				
	Bureau of Land Management			
	Sean	MacDougall	Invasive Species Coordinator	
	Gifford Pinchot National Forest			
	Carol	Chandler	Forest Wildlife, Invasive and Botany Program Manager	Invasive and Botany Program
	Pacific States Marine Fisheries Commission			
	Steven	Phillips	Aquatic Nusiance Species Prevention Program Manager	
	US Department of Agriculture			
	Roger	Woodruff	State Director WA/AK	
	Clinton	Campbell		APHIS - Washington
	US Fish & Wildlife Service			
	Kevin	Aitkin	Fish Biologist	
	US Forest Service			
	Cheryl	Bartlett	Botanist	Olympic National Forest
	US Geological Survey			
	Jim	Winton	Chief, Fish Health Section	USGS Western Fisheries Research Center

Org Type	Name		Job Title	Program
	US National Park Service			
	Dan	Campbell	Exotic Plant Management Specialist	Exotic Plant Management Program
	US Olympic National Forest			
	Cheryl	Bartlett	Botanist/Invasive Plant Program Coordinator	Invasive Plant Program
NGO				
	Conservation Northwest			
	Dave	Werntz	Sceince and Conservation Director	
	Earthcorps			
	Nelson	Salisbury	Ecologist	
	Sharon	London	Strategic Initiatives Director	
	Hood Canal Coordinating Council			
	Luke	Cherney	Habitat Assessment Biologist	
	PNW IPC			
	Julie	Combs	Director of EDRR Citizen Science Program	
	Puget Creek Restoration Society			
	Scott	Hansen	Ecologist - Board Member	
	Puyallup Watershed Coalition			
	Dave	Seabrook	Chair	
	Seattle Audubon Society			
	Herbert	Curl Jr	Volunteer Staff	
	The Nature Conservancy			
	Lisa	Younger	Manager, Strategic Ownership	
	Woodland Park Zoo			

Org Type	Name		Job Title	Program
	David	Selk	Horticulturist	

Private

Herrera Environmental Consultants

Josh	Wozniak		

Research

Pacific Shellfish Institute

Andrew	Suhrbier	Senior Biologist	

Padilla Bay Reserve

Sharon	Riggs		

University of Washington

Dave	Giblin	Herbarium Collections Manager	Herbarium, Burke Museum
Julian	Olden	Aquatic and Fishery Science	
Megan	Dethier	Research Associate Professor	Friday Harbor Labs
Richard	Strathmann	Professor Emeritus	

Washington State University

Jennifer	Andreas	IWCP Director	Integrated Weed Control Project
Tim	Miller	Extension Weed Specialist	Mount Vernon Station

State

Mason Conservation District

Brandee	Gregory	Natural Resource Technician	Natural Resources Program

WA - Department of Natural Resources

Org Type	Name		Job Title	Program
	Todd	Brownlee	Invasive Species Operations Coordinator	Aquatic Resources Division
	Pene	Speaks	Asst Division Manager	Conservation, Recreation and Transactions Division
	Karen	Ripley	Forest Health Program Manager	
	John	Gamon	Nat Heritage Prog Mgr	
	Joe	Arnett	Botanist	Washington Natural Heritage Program
	Roberta	Davenport	Natural Areas Manager	Pacific Cascade Region
	WA Department of Agriculture			
	Eric	LaGasa	Chief Entomologist	
	Greg	Haubrich	Noxious Weed Coordinator	Pest Program
	Tanner	Ketel	Knotweed Coordinator	Pest Program
	Chad	Phillips	Spartina and Knowtweed	Pest Program
	Mary	Toohey		
	WA Department of Ecology			
	Jenifer	Parsons	Aquatic Plant Specialist	
	Kathy	Hamel	Aquatic Plant Specialist	
	Lizbeth	Seebacher	Wetland & Aquatic Biologist	
	WA Department of Transportation			

Org Type	Name		Job Title	Program
	Ray	Willard	Roadside Maintenance Program Manager	Roadside Maintenance
	WA Parks & Recreation Commission			
	Lisa	Lantz	Respource Stewardship Manager	
	Washington Department of Fish and Wildlife			
	Jesse	Schultz		Aquatic Invasive Species Unit
	Allen	Pleus	AIS Coordinator	
	David	Heimer	Noxious Weed Coordinator	
	Washington Sea Grant			
	Jeff	Adams	Marine Water Quality Specialist	
	Washington State Noxious Weed Control Board			
	Alison	Halpern	Executive Secretary	
Tribe				
	Lummi Natural Resources			
	Alan	Chapman	ESA Coordinator	
	Stillaguamish Tribe			
	Pat	Stevenson	Environmental Manager	
	Swinomish Tribe			
	Jon	Boe	Environmental Management Specialist	

APPENDIX C

Appendix C: Expanded Methods

Outreach
The project team began work in fall 2012 by building off of the Baseline Assessment Phase I contact list in the database. The primary contacts included 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.

Online Survey
We initially used a survey to identify and collect information on relevant data sets and programmatic efforts. We administered an online survey using SurveyMonkey on October, 2012 to an initial distribution list of 270 individuals and organizations provided by Council staff. The Council and Council staff provided input on the online survey design and language. The survey posed five key questions for each species:

1. Are you involved in programs or activities targeted at this species?
2. Which of the below strategies or activities addressing the prevention, detection or control of this species are you involved in?
3. Do you have current or historical information for this species (Please consider the following types of data: published and unpublished reports, spreadsheets, or databases, GIS files, photos or images, other spatially explicit data)?
4. What type of current or historic information do you have on this species?
5. Would you like to upload data, URLs for online data or programmatic information for this species at this time?

The 70 responses represented 52 organizations, or 31% of the 168 organizations surveyed. An additional 42 organizations, as well as other contacts at several organizations, were reached through follow-up phone calls and emails. The remaining 74 of the organizations surveyed were not prioritized for contacting.

Of the organizations contacted, 25 of those within the Puget Sound Basin reported no data or programs for the twenty-one 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 2012 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.

Washington Invasive Species Council

WASHINGTON STATE
RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

ONLINE SURVEY BACKGROUND INFORMATION

INTRODUCTION

The Washington Invasive Species Council (WISC) is conducting Phase 2 of its baseline assessment of priority aquatic/terrestrial invasive species of Puget Sound. The Phase 1 Puget Sound Baseline Assessment project, completed in December 2010, includes 15 of the Washington Invasive Species Council's (WISC) 50 priority invasive species. This work identified the extent and impacts of the 15 species in the Puget Sound Basin and gaps in protection and control. The Council has already begun work to fill some of the education and outreach, management and policy gaps found for these species.

This Phase 2 project will build on the Phase 1 work, incorporating similar methodology and deliverables for 15 additional priority species or species groups. Invasive species information from disparate sources will be brought together for a regional examination of success and gaps in efforts, information, and authorities. A database of information and species maps will be created and provided as a resource through the Council's web site. In successive years, following completion of the project, the Council will send out the survey tool to its extensive contacts list and incorporate new invasive species information into the online database and the Puget Sound Watershed Characterization.

This Baseline Assessment will advance WISC goals towards a statewide, strategic response to the threat of invasive species.

European apple clearwing moth (*Washington State Department of Agriculture*)

FREQUENTLY ASKED QUESTIONS

What is the goal of this project?

The region currently lacks an understanding of the status and trends of invasive species within the Puget Sound Basin. The goal of this project is to compile and evaluate existing data and knowledge, much of which is not centrally located, to complete a baseline assessment of fifteen priority invasive species or species groups within the Puget Sound Basin. Information will be used to identify gaps in data and programs in place to address these species and ultimately guide policy recommendations to improve prevention, early detection, and rapid response strategies and actions.

How were priority species chosen for this assessment?

The species included in this assessment were selected to represent a wide range of taxonomic groups and were those that had the higher impact scores as measured by the Council's impact assessment tool (www.invasivespecies.wa.gov/priorities.shtml).

What information will be used to complete the baseline assessment?

Existing baseline data, studies and program information will be solicited from state and federal agencies, counties, conservation and industry groups, tribes, universities, and other entities within the Puget Sound Basin. Species-specific data and programmatic information will be compiled, evaluated, and summarized across the target priority species and associated pathways.

What is the project timeline?

The Baseline Assessment Project will be completed by December 2013 and help serve as an initial step towards coordinating a statewide, strategic response to the threat of invasive species. The Puget Sound Baseline Assessment of these priority invasive species will also serve as a template to inform an expanded, statewide baseline assessment for all 50 priority species in Washington State.

PRIORITY SPECIES

PLANTS

Eurasian Watermilfoil (*Myriophyllum spicatum*)

Eurasian watermilfoil is a submersed plant that grows in a variety of still and flowing fresh water bodies. It can tolerate a range of salinity, pH, and temperature. Watermilfoil forms dense mats that shade native aquatic plants, inhibit water flow, and hamper recreation. It is native to Europe, Asia, and North Africa.

Parrotfeather (*Myriophyllum aquaticum*)

Parrotfeather is a bright green aquatic plant with leaves that grow above the water and resemble tiny fir trees. It grows in slow moving rivers, ditches, and shallow freshwater lakes and ponds, as well as on wet soil along shorelines. Parrotfeather rapidly forms dense mats of vegetation that can take over shallow lakes, ponds, and ditches. It is native to South America.

Loosestrifes – Purple (*Lythrum salicaria*) and Garden (*Lysimachia vulgaris*)

Purple loosestrife is a tall, perennial wetland plant with reddish-purple flowers, found in sunny wetlands, wet meadows, river and stream banks, pond edges, reservoirs, and ditches. It is native to Europe and Asia, and is now responsible for a considerable amount of the degradation to wetland habitats throughout the United States. Garden loosestrife, with bright yellow flowers, is unrelated to purple loosestrife, but invades wetlands and has a high reproductive rate.

Knotweeds – Bohemian (*Polygonum bohemicum*), Giant (*P. sachlinense*), and Japanese (*P. cuspidatum*)

Japanese knotweed, an escaped ornamental, is a shrubby perennial that was first introduced in the United States from Asia. It grows very aggressively along roadways, neglected gardens, streambeds, and in moist, wet places.

Butterfly Bush (*Buddleja davidii*)

The butterfly bush is a perennial, woody shrub with purple flowers. It is a very popular ornamental plant, often found in gardens. It also is common along riverbanks and river gravel bars where it out-competes native plants and alters soil nutrients.

Garlic Mustard (*Alliaria petiolata*)

Garlic mustard is single-stalked plant, which typically grows to about 3 feet tall with small white flowers near the top and smells like garlic. Garlic mustard is a shade tolerant, invasive species with the capability to establish in our state. It is difficult to control once it has reached a site and is native to northern Europe.

Giant Hogweed (*Heracleum mantegazzianum*)

Giant hogweed, introduced from Asia, is a very large plant which can grow in a variety of environments. It has a caustic sap that chemically burns skin, leaving permanent scars. It spreads by seed and can be transported easily to backyards, ravines, parks, streams, and roadsides. It crowds out other plants and takes over natural areas, especially moist environments such as riverbanks. It is shade-tolerant, but also thrives in full sun.

INSECTS

Bark-Boring Moths – Cherry Bark Tortrix (*Enarmonia formosana*), European Apple Clearwing Moth (*Synanthedon myopaeformis*), Eastern Dogwood Borer (*S. scitula*)

The cherry bark tortrix, European apple clearwing moth, and the eastern dogwood borer are invasive insect pests that threaten many fruit tree varieties in Washington State.

PRIORITY SPECIES

ANIMALS

New Zealand Mud Snail (*Potomopyrgus antipodarum*)

New Zealand mud snails are tiny (less than 6 mm) aquatic snails that are adaptable to diverse climates and environmental conditions. They are found in freshwater and brackish environments.

Mediterranean Snail (*Cernuella virgate*)

Mediterranean snails are small (less than 1 inch across) and white or tan in color with dark brown spiral bands. These snails often are found on top of vegetation, particularly crops, where they can survive long periods of hot and dry weather without food. They can clog harvesting machinery, contaminate crops, and carry a variety of diseases.

Crayfish – Red Swamp (*Procambarus clarkia*) and Rusty (*Orconectes rusticus*)

Crayfish are freshwater crustaceans related to lobsters. In the Pacific Northwest, three species of invasive crayfish are present: northern, red swamp, and rusty. The northern crayfish is native to Montana, Wyoming, the upper Mississippi River, the Great Lakes, and the Hudson River. The red swamp and rusty are native to the southeastern U.S. These crayfish are usually found in brooks and streams where there is running water and shelter against predators.

Chinese Mitten Crab (*Eriocheir sinensis*)

A mitten crab is light brown to green in color, with brown hairy patches resembling mittens on its claws. It spends most of its life in freshwater, but reproduces in saltwater. A mitten crab can prey on and compete with many native aquatic species, posing a threat to ecosystems and fisheries. It is native to Asia.

Marine Clam (*Corbula amurensis*)

Corbula amurensis, commonly known as the overbite clam, Asian marine clam or Amur River clam, is a tan, white or yellow clam, up to about 25 mm long. It lives partly buried in the sediment, with its hind third or half exposed above the surface. The right half of the shell is a bit larger than the left and slightly “overbites” it at the lower margin, which distinguishes the marine clam from similar-looking clams on the Pacific Coast.

European Green Crab (*Carcinus maenas*)

The European green crab is a small shore crab that is not necessarily green like its name implies. It typically is found in high intertidal areas and marshes in coastal estuaries and wave-protected embayments, and can live on a variety of surfaces including sand, mudflats, shells, cobble, algae, and rock. It is an opportunistic feeder and aggressive invader. It is native to the eastern Atlantic from Norway to North Africa.

DISEASES

Infectious Salmon Anemia (ISA) (*Isavirus*)

Infectious salmon anemia (ISA) is best known as a viral disease of Atlantic salmon that causes severe losses to infected fish farms. As the name implies, it causes severe anemia of infected fish. The disease can progress slowly throughout an infected farm and, in the worst cases, death rates may approach 100 percent. No treatment exists for infectious salmon anemia.

The online survey is available at: https://www.surveymonkey.com/s/WISC_OnlineSurvey. If you have any questions or technical issues associated with the survey, please contact Mike Leech at mleech@esassoc.com or (206) 789-9658.

APPENDIX D

Appendix D

Data Files and Data Sources Included in Baseline Assessment

Species	DataType	Count
City		
City of Bellingham	Georeferenced Maps or Photos	1
City of Bellingham	Tabular data	1
County		
San Juan County	Unpublished Report(s)	1
Skagit County	Georeferenced Maps or Photos	7
Skagit County	Pubished Report(s)	3
Federal		
US Department of Agriculture	Georeferenced Maps or Photos	10
US Department of Agriculture	Pubished Report(s)	2
NGO		
Earthcorps	Geospatial data	1
Earthcorps	Unpublished Report(s)	1
Earthcorps	Website	1
Puget Creek Restoration Society	Geospatial data	1
Puget Creek Restoration Society	Tabular data	1
Puget Creek Restoration Society	Unpublished Report(s)	1
Seattle Audubon Society		0
Research		
University of Washington		0
State		
WA - Department of Natural Resources	Geospatial data	1
WA - Department of Natural Resources	Tabular data	1

Species		DataType	Count
	WA Department of Agriculture	Geospatial data	1
	Washington Department of Fish and Wildlife	Geospatial data	1
		Total Count:	**35**

Butterfly bush

	County		
	Clallam County	Unpublished Report(s)	1
	Island County	Unpublished Report(s)	1
	King County	Photos	1
	King County	Pubished Report(s)	1
	Thurston County	Geospatial data	1
	Thurston County	Geospatial data	1
	Research		
	University of Washington	Geospatial data	1
	State		
	WA Department of Agriculture	Hardcopy map(s)	1
	WA Department of Transportation	Geospatial data	1
	WA Department of Transportation	Tabular data	1
		Total Count:	**10**

Chery bark tortrix

	State		
	WA Department of Agriculture	Geospatial data	1
	WA Department of Agriculture	Photos	3
	WA Department of Agriculture	Unpublished Report(s)	1
		Total Count:	**5**

Chinese mitten crab

	State		
	Washington Department of Fish and Wildlife	Website	1
		Total Count:	**1**

Species	DataType	Count
Eurasian watermilfoil		
County		
Clallam County	Unpublished Report(s)	1
King County	Geospatial data	1
King County	Photos	1
King County	Pubished Report(s)	1
Skagit County	Pubished Report(s)	39
Skagit County	Pubished Report(s)	1
Thurston County	Geospatial data	3
Thurston County	Hardcopy map(s)	1
State		
WA Department of Agriculture	Hardcopy map(s)	1
WA Department of Ecology	Georeferenced Maps or Photos	2
WA Department of Ecology	Geospatial data	1
WA Department of Ecology	Pubished Report(s)	5
WA Department of Ecology	Pubished Report(s)	1
WA Department of Ecology	Pubished Report(s)	1
WA Department of Ecology	Pubished Report(s)	4
WA Department of Ecology	Tabular data	1
WA Department of Ecology	Tabular data	1
WA Department of Ecology	Unpublished Report(s)	1
WA Department of Ecology	Unpublished Report(s)	2
WA Department of Ecology	Unpublished Report(s)	7
WA Department of Ecology	Unpublished Report(s)	2
	Total Count:	**77**

European apple clearwing moth

Species	DataType	Count
State		
WA Department of Agriculture	Geospatial data	1
WA Department of Agriculture	Photos	1
WA Department of Agriculture	Unpublished Report(s)	1
	Total Count:	**3**

European Green Crab

Private		
Nahkeeta Northwest	Geospatial data	1
Nahkeeta Northwest	Pubished Report(s)	1
State		
Washington Department of Fish and Wildlife	Pubished Report(s)	1
Washington Department of Fish and Wildlife	Unpublished Report(s)	5
	Total Count:	**8**

Garden loosestrife

County		
King County	Geospatial data	1
King County	Photos	1
King County	Pubished Report(s)	3
Research		
University of Washington	Geospatial data	1
State		
WA Department of Agriculture	Hardcopy map(s)	1
WA Department of Ecology	Georeferenced Maps or Photos	1
WA Department of Ecology	Pubished Report(s)	2
WA Department of Ecology	Tabular data	1
WA Department of Ecology	Unpublished Report(s)	1
WA Department of Ecology	Unpublished Report(s)	1
WA Department of Transportation	Geospatial data	1

Species	DataType	Count
WA Department of Transportation	Tabular data	1
	Total Count:	**15**

Garlic mustard

County		
Clallam County	Unpublished Report(s)	1
Island County	Unpublished Report(s)	1
King County	Geospatial data	1
King County	Pubished Report(s)	3
Snohomish County	Geospatial data	1
Research		
University of Washington	Geospatial data	1
State		
WA Department of Agriculture	Hardcopy map(s)	1
	Total Count:	**9**

Giant hogweed

County		
Clallam County	Unpublished Report(s)	1
Island County	Unpublished Report(s)	1
Jefferson County	Geospatial data	1
King County	Geospatial data	1
King County	Photos	1
King County	Pubished Report(s)	3
Mason County	Geospatial data	1
Snohomish County	Geospatial data	1
Thurston County	Geospatial data	1
Research		
University of Washington	Geospatial data	1

Species		DataType	Count
	Washington State University	Pubished Report(s)	1
	State		
	WA Department of Agriculture	Hardcopy map(s)	1
	WA Department of Transportation	Geospatial data	1
	WA Department of Transportation	Tabular data	1
		Total Count:	**16**

Infectious Salmon Anemia

	Federal		
	US Geological Survey	Pubished Report(s)	2
		Total Count:	**2**

Knotweed

	County		
	Clallam County	Geospatial data	9
	Clallam County	Unpublished Report(s)	1
	Island County	Geospatial data	1
	Island County	Unpublished Report(s)	1
	Jefferson County	Geospatial data	1
	Jefferson County	Geospatial data	5
	King County	Geospatial data	1
	King County	Photos	1
	King County	Pubished Report(s)	3
	Mason County	Geospatial data	1
	Pierce County	Geospatial data	9
	San Juan County	Hardcopy map(s)	1
	Thurston County	Geospatial data	1
	Whatcom County	Geospatial data	1
	NGO		

Species	DataType	Count
Hood Canal Salmon Enhancement Group	Geospatial data	4
Research		
University of Washington	Geospatial data	2
Washington State University	Pubished Report(s)	1
State		
WA Department of Agriculture	Geospatial data	2
WA Department of Agriculture	Geospatial data	1
WA Department of Agriculture	Hardcopy map(s)	3
WA Department of Agriculture	Pubished Report(s)	7
WA Department of Agriculture	Pubished Report(s)	1
WA Department of Transportation	Geospatial data	1
WA Department of Transportation	Tabular data	1
Tribe		
Swinomish Tribe	Geospatial data	1
	Total Count:	**60**

New Zealand mudsnail

State		
WA Department of Ecology	Geospatial data	1
Washington Department of Fish and Wildlife	Geospatial data	1
Washington Department of Fish and Wildlife	Geospatial data	1
Washington Department of Fish and Wildlife	Geospatial data	2
Washington Department of Fish and Wildlife	Hardcopy map(s)	1
Washington Department of Fish and Wildlife	Hardcopy map(s)	1
Washington Department of Fish and Wildlife	Pubished Report(s)	4
Washington Department of Fish and Wildlife	Pubished Report(s)	5
Washington Department of Fish and Wildlife	Unpublished Report(s)	3
Washington Department of Fish and Wildlife	Unpublished Report(s)	6

Species	DataType	Count
	Total Count:	**25**

Parrotfeather

County		
Clallam County	Unpublished Report(s)	1
Island County	Unpublished Report(s)	1
King County	Geospatial data	1
King County	Photos	1
King County	Pubished Report(s)	1
San Juan County	Hardcopy map(s)	1
Thurston County	Geospatial data	1
Research		
University of Washington	Geospatial data	1
State		
WA Department of Agriculture	Hardcopy map(s)	1
WA Department of Ecology	Geospatial data	1
WA Department of Ecology	Tabular data	1
	Total Count:	**11**

Purple loosestrife

County		
Clallam County	Unpublished Report(s)	1
Island County	Unpublished Report(s)	1
Jefferson County	Geospatial data	1
King County	Geospatial data	1
King County	Photos	1
King County	Pubished Report(s)	3
San Juan County	Hardcopy map(s)	1
Snohomish County	Geospatial data	1

Species	DataType	Count
Thurston County	Geospatial data	1
Whatcom County	Geospatial data	1
Research		
University of Washington	Geospatial data	1
State		
WA Department of Agriculture	Hardcopy map(s)	1
WA Department of Agriculture	Pubished Report(s)	2
WA Department of Ecology	Georeferenced Maps or Photos	7
WA Department of Ecology	Geospatial data	1
WA Department of Ecology	Pubished Report(s)	1
WA Department of Ecology	Pubished Report(s)	2
WA Department of Ecology	Tabular data	1
WA Department of Ecology	Unpublished Report(s)	1
WA Department of Transportation	Geospatial data	1
WA Department of Transportation	Tabular data	1
Tribe		
Swinomish Tribe	Geospatial data	1
	Total Count:	**32**

Red swamp crayfish

Research		
University of Washington	Geospatial data	1
University of Washington	Pubished Report(s)	1
	Total Count:	**2**

Rusty crayfish

Research		
University of Washington	Geospatial data	1
University of Washington	Pubished Report(s)	2

Species	DataType	Count

Total Count: 3

APPENDIX E

Data Layers

- Estuary
- Wetlands
- Riparian Areas and Streams Near Disturbed Areas
- Agricultural Lands (especially East of Cascades)
- Rivers

Boundaries & Extents

- County Boundary
- Puget Sound Extent
- State Boundary

Land Cover & Land Use

- Forest
- Rock & Snow
- Water
- Disturbed Lands

Data Sources

Boundaries and Extents Map Data

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.

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

Hydrologic Map Data

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

Estuary
The Nature Conservancy
http://www.tnccmaps.org/estuaries

Transportation Map Data

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/

Land Cover & Land Use Map Data

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/

Agricultural Lands
northwest.img
Washington Department of Fish & Wildlife (WDFW)
http://wdfw.wa.gov/conservation/gap/

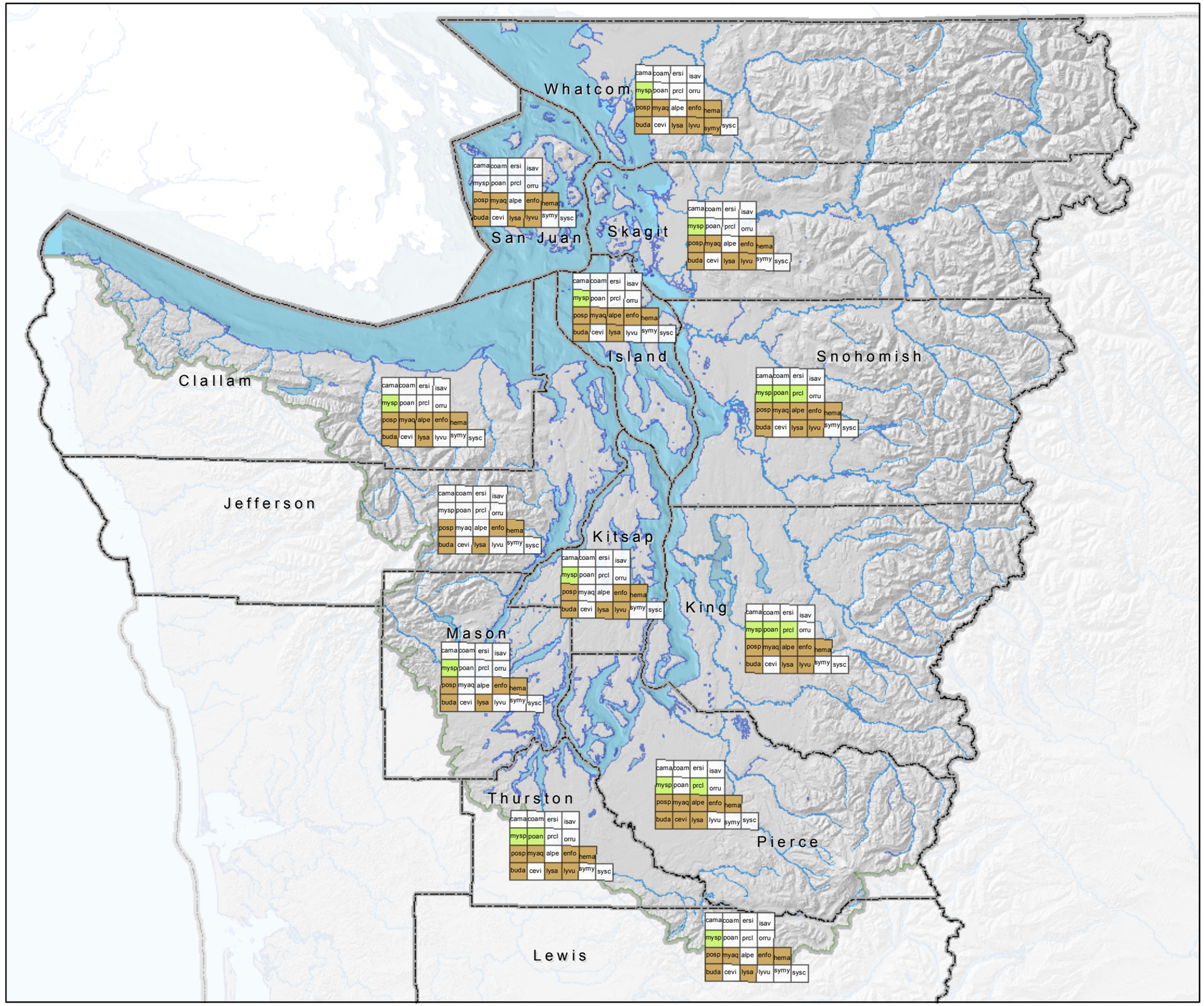
Map Data & Contact Information

ESA

Appendix E

January 2014

APPENDIX F



Species Detection by County

Puget Sound Basin

cama	coam	ersi	isav		Marine
mysp	poan	prcl	orru		Freshwater
posp	myaq	alpe	enfo	hema	Terrestrial
buda	cevi	lysa	lyvu	symy	sysc

Marine Species Detected

- cama, European Green Crab
- coam, Marine clam
- ersi, Chinese mitten crab
- isav, Infectious salmon anemia virus

Freshwater Species Detected

- mysp, Eurasian watermilfoil
- orru, Rusty crayfish
- poan, New Zealand mudsnail
- prcl, Red swamp crayfish

Terrestrial Species Detected

- alpe, Garlic mustard
- buda, Butterfly bush
- cevi, Mediterranean snail
- enfo, Cherry bark tortrix
- hema, Giant hogweed
- lysa, Purple loosestrife
- lyvu, Garden loosestrife
- myaq, Parrotfeather
- posp, Knotweed
- symy, European apple clearwing moth
- sysc, Eastern dogwood borer

0 5 10 20 Miles

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

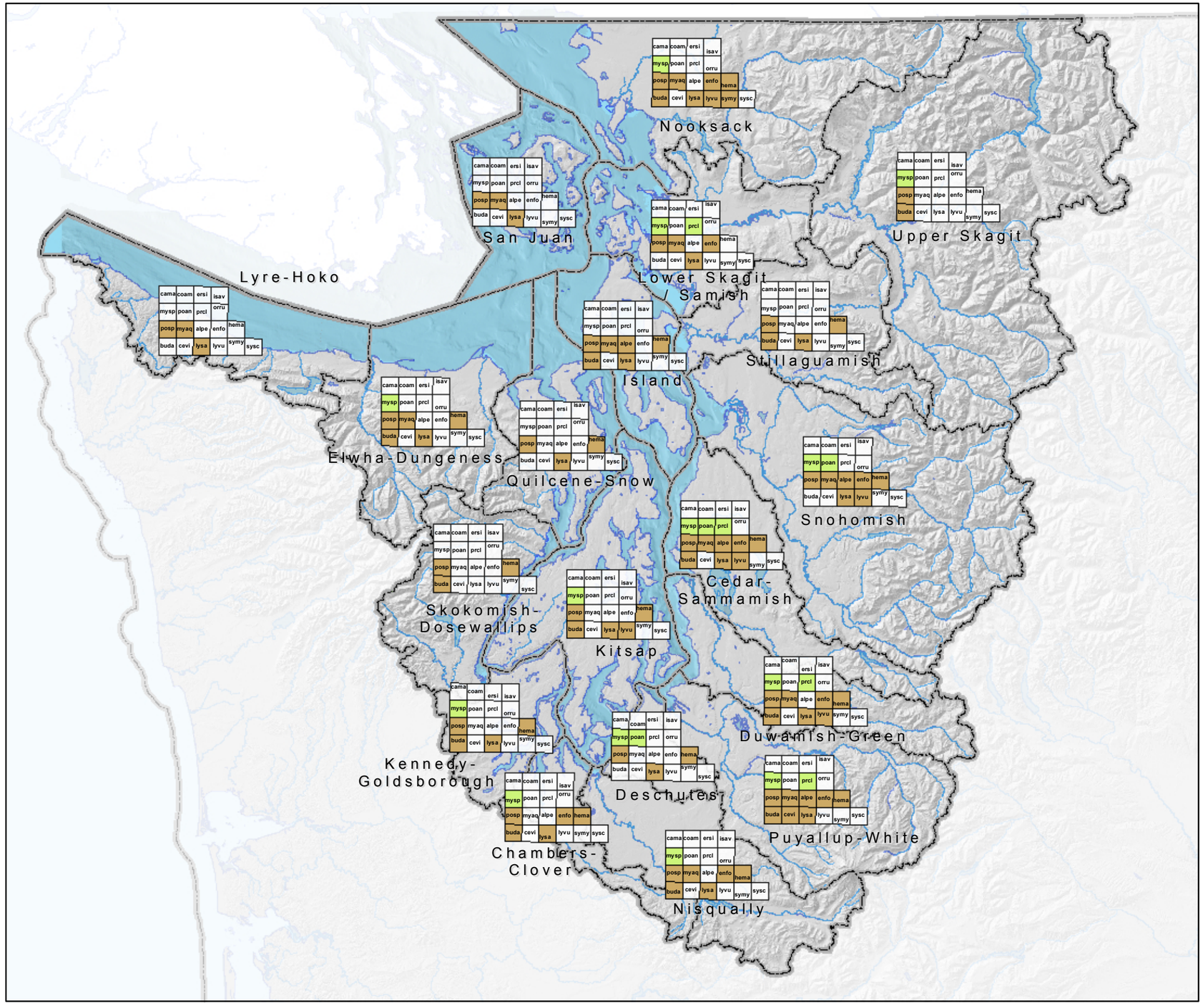
ESA

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

Appendix F-1

January 2014



Species Detection by WRIA

Puget Sound Basin

cama	coam	ersi	isav		Marine
mysp	poan	prcl	orru		Freshwater
posp	myaq	alpe	enfo	hema	Terrestrial
buda	cevi	lysa	lyvu	symy	sysc

Marine Species Detected

- cama, European green crab
- coam, Marine clam
- enfo, Marine clam
- isav, Infectious salmon anemia virus

Freshwater Species Detected

- mysp, Eurasian watermilfoil
- orru, Rusty crayfish
- poan, New Zealand mudsnail
- prcl, Red swamp crayfish

Terrestrial Species Detected

- alpe, Garlic mustard
- buda, Butterfly bush
- cevi, Mediterranean snail
- enfo, Cherry bark tortrix
- hema, Giant hogweed
- lysa, Purple loosestrife
- lyvu, Garden loosestrife
- myaq, Parrotfeather
- posp, Knotweed
- symy, European apple clearwing moth
- sysc, Eastern dogwood borer

0 5 10 20 Miles

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

ESA

WASHINGTON STATE RECREATION AND CONSERVATION OFFICE
Washington Invasive Species Council

Baseline Assessment of Priority Invasive Species in the Puget Sound Basin

Appendix F-2

January 2014