Spartina Eradication Program 2010 Progress Report

Washington State Department of Agriculture

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Photos provided by Richard Fuller (City of Tacoma)
Dave Heimer, Les Holcomb (WDFW),
Jonathan Still and Tanner Ketel (WSDA).

Cover Photo: One of the *Spartina anglica* plants at a recently discovered infestation near the Port of Tacoma in Pierce County, Washington. See the Puget Sound section of this report for more information about this new find.

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Extreme care was used during the compilation of the maps in this report to ensure accuracy. However, due to changes in data and the need to rely on outside sources of information, the Department of Agriculture cannot accept responsibility for errors or omissions, and, therefore, there are no warranties which accompany this material.

PROGRESS OF THE 2010 *SPARTINA* ERADICATION PROGRAM

January 2011

Washington State Department of Agriculture

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Acronyms used in this report:

ALEA	Aquatic Lands Enhancement Account
ATV	All Terrain Vehicle
DNR	Department of Natural Resources, Washington State
GIS	Geographic Information System
GPS	Global Positioning System
IWM	Integrated Weed Management
NAP	Natural Area Preserve
NPDES	National Pollutant Discharge Elimination System
PSP	Puget Sound Partnership
TNC	The Nature Conservancy
USFWS	U.S. Fish and Wildlife Service
WSDA	Washington State Department of Agriculture
WDFW	Washington State Department of Fish and Wildlife
WSU	Washington State University

Concepts or Definitions used in this report:

Solid Acres	A measure of how many acres a dispersed population would occupy if all plants were grouped together.
Affected Acres Treated	A measure of how many acres had one or more healthy plants treated during a given year.

Executive Summary

The Washington State Department of Agriculture (WSDA) has served as the lead state agency for the eradication of invasive *Spartina* since 1995. WSDA facilitates the cooperation - of local, state, federal, and tribal governments; universities; interested groups; and private landowners - that is responsible for the tremendous success of the program. From a statewide high of 9,000 solid acres infested in 2003, the program has reduced *Spartina* to a projected 12 solid acres in 2011. These final, solid 12 acres are a collection of individual plants and small clumps spread along thousands of miles of shoreline in the Puget Sound, Willapa Bay and Grays Harbor.

Spartina, commonly known as cordgrass, is an aggressive noxious weed that has severely disrupted the ecosystems of native saltwater estuaries in Washington State. Left unchecked, *Spartina* out competes native vegetation and converts mudflats and estuaries into monotypic *Spartina* meadows. As a result, important migratory shorebird and waterfowl habitat are lost, the threat of flooding is increased, and the state's shellfish industry is severely impacted.

The next four years will be pivotal as the cooperators work throughout the intertidal waters of Washington State to find and eradicate the remaining infestations. WSDA remains confident that with continued funding the goal of eradication can be reached. Figure 1 is a projection of *Spartina* reduction within Washington State over the next four years assuming continued funding.

The 2010 *Spartina* survey and eradication season proved to be successful with better than expected results. During 2010 project partners surveyed more than 80,000 acres of saltwater estuaries and more than a thousand miles of shoreline in 14 counties for evidence of *Spartina*.

This eradication program is an unprecedented success story; however, the last few acres of *Spartina* will by far be the most difficult to find and eradicate.

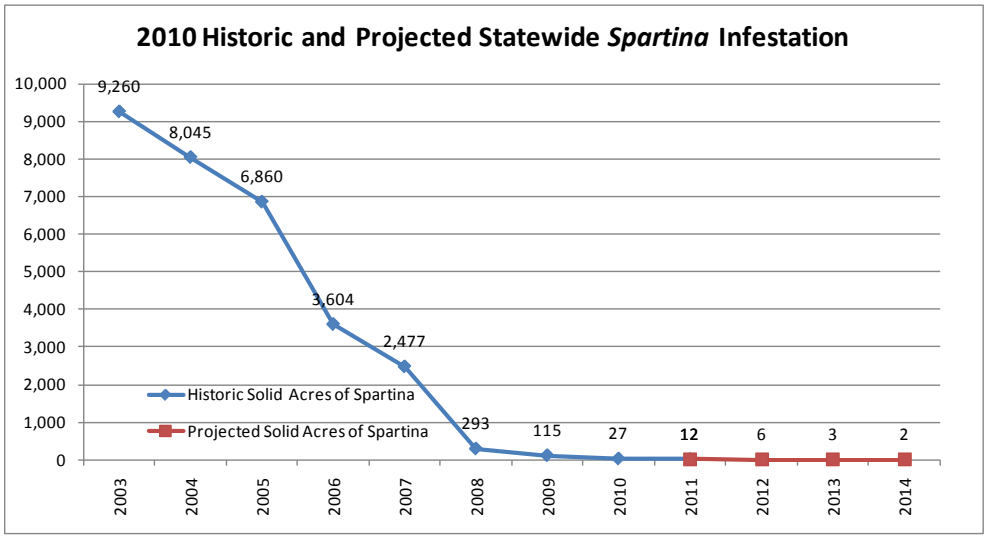

Figure 1: Solid acres of *Spartina* by year statewide based on WSDA estimates. The blue line represents historic *Spartina* infestation since 2003. The red line indicates the projected *Spartina* infestation level through 2014. Projection assumes continued funding.

Willapa Bay

The 2010 Willapa Bay treatment program was successful. All known infestations were treated and a significant reduction was achieved. Monitoring of the program's 2010 Willapa Bay effort indicated that fewer than 18 solid acres of *Spartina* was present. This was a 79% reduction from approximately 85 solid acres in Willapa Bay during the 2009 season. In 2010, the program continued efforts aimed at eradicating the scattered infestations and individual plants remaining throughout the Bay. WSDA estimates fewer than 7 solid acres of *Spartina* will be present in Willapa Bay during the 2011 treatment season.

Grays Harbor

2010 was a productive year for *Spartina* survey and eradication in Grays Harbor. WSDA, Washington Department of Fish and Wildlife (WDFW) and the United States Fish and Wildlife Service (USFWS) continued to work together to treat all known infestations. The vulnerable habitat of Grays Harbor was surveyed two times during the 2010 season, with a total of 0.11 solid acres of *Spartina* found and treated. Of the 0.11 solid acres treated in Grays Harbor, 0.046 solid acres were *S. alterniflora* and 0.064 solid acres were *S. densiflora*. This is an 80% reduction from the approximate 0.54 solid acres treated in Grays Harbor during the 2009 season. Additionally, 38 miles of coastline were surveyed, stretching from Cape Shoalwater to the Moclips River, yielding no new *Spartina* finds. WSDA estimates that fewer than 0.05 solid acres of *Spartina* will remain in Grays Harbor during the 2011 treatment season.

Puget Sound

In 2010, more than 8.5 solid acres of *Spartina* were found and treated in Puget Sound, the Strait of Juan de Fuca, and Hood Canal. This is a 70% reduction from the 29 solid acres present in 2009. In a continued effort, WSDA crews surveyed over 470 miles of shoreline in Puget Sound that had not been previously surveyed. WSDA estimates that fewer than 5 solid acres of *Spartina* will remain in Puget Sound in 2011. Increased effort and cooperation between partner groups made this reduction possible. Further cooperation between partners and emphasis on eradication, survey, and outreach will ensure the continued success of the Puget Sound *Spartina* program.

2010 Trends

The above successes are a result of the continued level of state funding provided to WSDA, WDFW, and the Department of Natural Resources (DNR), as well as federal funding provided to USFWS. Central to this success is continued cooperation of WSDA, WDFW, DNR, and other state agencies, universities, USFWS, counties, tribes, private organizations and private landowners.

With the largest of the state's infestations now controlled, the effort has evolved into a 'survey and eradicate' model focused on finding and treating the remaining individual plants and scattered infestations that exist throughout the previously infested area. This requires significant personnel on the ground to give individual attention to the same areas that helicopters or large machines were previously able to cover in a relatively short amount of time. The amount of herbicide needed to treat the infestations has declined, bringing herbicide costs down. However, the number of personnel needed has increased labor and transportation costs. As a result, to meet the program's goal of eradicating *Spartina*, continued funding is imperative during the coming years.

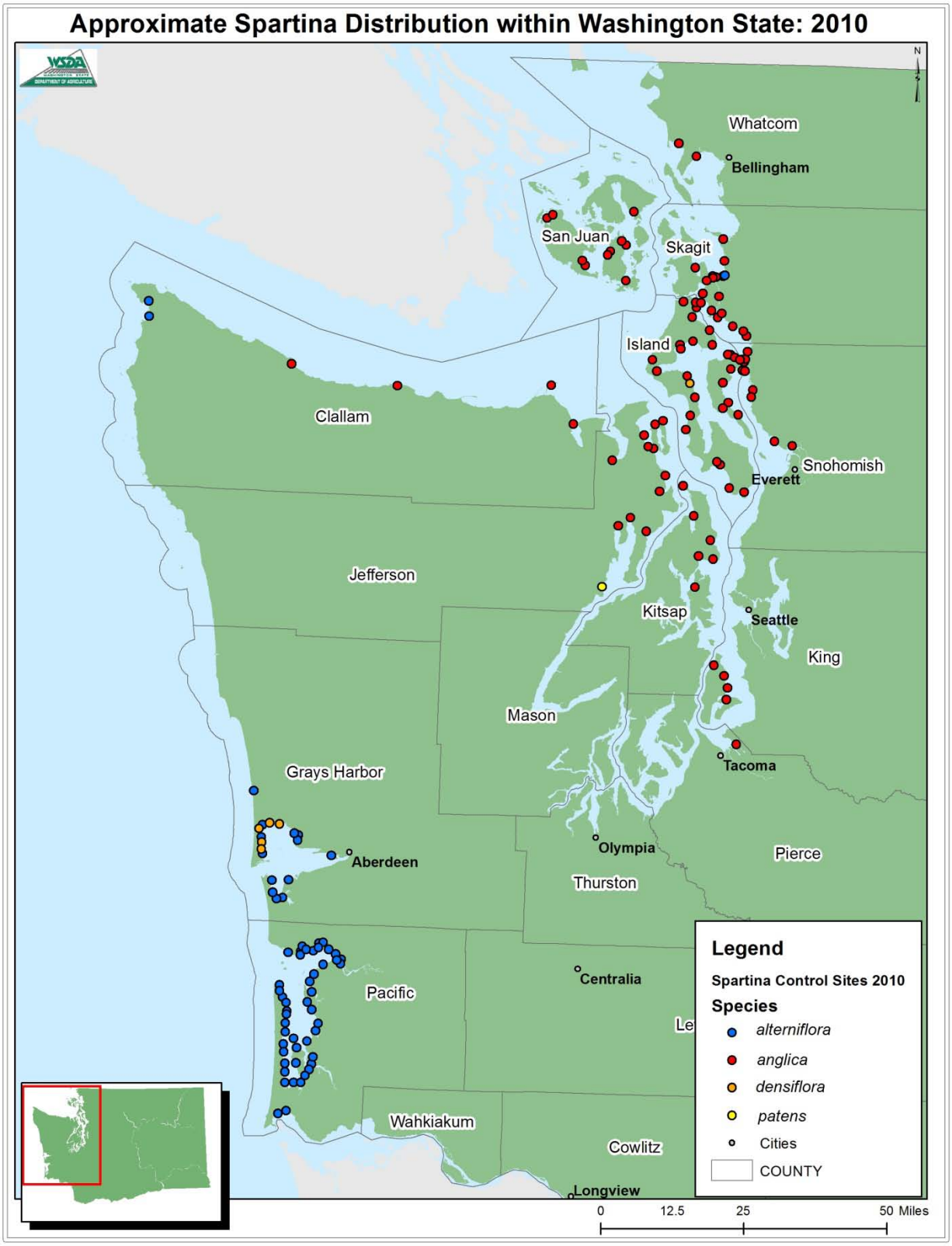

Figure 2: Distribution of invasive *Spartina* sites in Washington State 2010.

Spartina Eradication Program

WSDA *Spartina* Program

In 2010, the WSDA *Spartina* Eradication Program worked collaboratively with partner agencies to continue *Spartina* eradication.

WSDA hired, equipped and coordinated a crew to treat infestations in Clallam, Jefferson, and Kitsap counties; assisted the Swinomish, Suquamish, Makah, Puyallup and Tulalip tribal communities and the noxious weed control boards in San Juan, Clallam, and Jefferson counties with eradication work; worked cooperatively with Washington Department of Fish and Wildlife (WDFW), Washington Department of Ecology (DOE) and the U.S. Fish and Wildlife Service (USFWS) in Puget Sound and Grays Harbor; worked cooperatively with the Department of Natural Resources (DNR), WDFW, USFWS, The Nature Conservancy (TNC), the Shoalwater Tribe, Pacific County, the aquaculture industry, University of Washington and Washington State University on infestations in Willapa Bay.

WSDA continued to work cooperatively with the Department of Ecology to administer the state's National Pollutant Discharge Elimination System (NPDES) general permit for aquatic noxious weed control, facilitating the control programs of federal, state and local governmental agencies and other entities.

WSDA provided resources through interagency agreements, contracts and cost-share to state and local government agencies and private landowners. WSDA organized and facilitated the exchange of *Spartina* eradication information through regional planning and informational meetings, and continued to explore more efficient and cost-effective ways to eradicate *Spartina* with partner agencies.

In 2010, WSDA continued to allocate funding for resources and *Spartina* work crews in counties with the majority of the infestations. In Willapa Bay, $230,000 was designated for Pacific County to continue the transition toward greater county involvement. In the Puget Sound, WSDA provided resources totaling $187,500 by entering into agreements with the noxious weed control boards in Skagit, Island and Snohomish counties, the Swinomish Tribe and WDFW. WSDA staff participated in field activities throughout the control season and facilitated coordination meetings to ensure contract priorities were adequately addressed. WSDA continued working with WDFW, DNR, WSU and USFWS to explore the potential for restoration of once-infested tidelands to functioning shorebird and waterfowl habitat.

During 2010 WSDA participated in ongoing efforts related to the West Coast Governors' Agreement on Ocean Health. In this agreement the Governors of Washington, California, and Oregon committed to eradicate all non-native *Spartina* on the western U.S. coast by 2018. As part of this agreement an Action Coordination Team shares knowledge and developments with representatives from the three states, federal government, tribal governments, non-governmental organizations, and the Province of British Columbia. This continued high level intergovernmental cooperation will aid ongoing eradication programs and enhance future efforts.

Budget

WSDA allotted $2.31 million of the appropriation from the Aquatic Lands Enhancement Account (ALEA) for statewide *Spartina* activities during the 2009-2011 biennium. Table 1 describes how WSDA allocated funds to conduct *Spartina* eradication activities throughout Western Washington.

Table 1: WSDA *Spartina* Budget Activity by Area – FY10 and FY11

Activity	Puget Sound/ Olympic Peninsula		Willapa Bay		Grays Harbor		Total
	FY10	*FY11*	*FY10*	*FY11*	*FY10*	*FY11*	*FY10&11*
[1]WSDA Eradication & Coordination Activities	$265,000	$290,000	$185,000	$185,000	$125,000	$125,000	$1,175,000
[1]Purchased Services							
Pacific Co.			$180,000	$230,000			$410,000
Skagit Co.	$30,000	$30,000					$60,000
Island Co.	$50,000	$50,000					$100,000
Snohomish Co.	$50,000	$75,000					$125,000
Swinomish Tribe	$7,500	$7,500					$15,000
WDFW	$25,000	$25,000	$70,000	$100,000		$125,000	$345,000
DNR				$80,000			$80,000
Total	**$427,500**	**$477,500**	**$435,000**	**$595,000**	**$125,000**	**$250,000**	
Biennial Total		**$905,000**		**$1,030,000**		**$375,000**	**$2,310,000**

Notes for Table 1:

1. WSDA Eradication and Coordination Activities: Expenses include WSDA eradication, survey, restoration activities, salaries and benefits, herbicide, equipment, travel, legal fees, public notification expenses and other goods and services.
2. Purchased Services: WSDA interagency agreements and intergovernmental agreements to accomplish *Spartina* eradication goals.

Other agencies received additional funding for *Spartina* activities during the 2009-2011 biennium. This funding was provided from ALEA, federal agreements, grants and other sources. Table 2 describes where these funds were allocated.

Table 2: Other Agencies *Spartina* Budget Activity by Area – FY10 and FY11

Agency	Puget Sound/ Olympic Peninsula		Willapa Bay		Grays Harbor		Total
	FY10	*FY11*	*FY10*	*FY11*	*FY10*	*FY11*	*FY10&11*
[1]WDFW	$111,000	$111,000	$180,000	$155,000			$557,000
[2]DNR			$323,000	$305,000			$628,000
[3]USFWS			$250,000	$250,000	$247,000	$275,000	$1,022,000
TOTAL	**$111,000**	**$111,000**	**$753,000**	**$710,000**	**$247,000**	**$275,000**	
Biennial Total		**$222,000**		**$1,463,000**		**[1]$522,000**	**$2,207,000**

Notes for Table 2:

1. WDFW Willapa Bay FY10 includes $28,000 in restoration grant funding.
2. DNR Willapa Bay FY10 includes approximately $18,000 in restoration grant funding.
3. USFWS funds in Willapa are expended by the Willapa National Wildlife Refuge for eradication efforts on Refuge lands. USFWS funds in Grays Harbor are contracted to WSDA and WDFW to support eradication efforts throughout the Harbor.

Spartina Eradication Effort in Willapa Bay

For programmatic purposes, this geographic region includes the mouth of Willapa Bay, Willapa Bay, and all rivers, streams and creeks that feed into the Bay, and all intertidal areas on the Washington side of the Columbia River.

Extent of the Infestation in Willapa Bay

Spartina alterniflora is the only species of invasive *Spartina* infesting Willapa Bay. All infestations within Willapa Bay were treated during the 2010 season and most were treated two or more times. This season the program continued efforts aimed at eradicating the scattered infestations and individual plants remaining throughout the Bay.

WSDA estimates that, during the 2010 season, approximately 17 solid acres of *Spartina* were treated in Willapa Bay. This estimate is based on a compilation of the treatment data reported by the cooperators. Table 3 identifies areas of the Bay treated and the cooperators conducting the treatments.

The affected acres treated reached a high of 25,430 in 2009 due to the addition of small recently discovered infestations, while many areas of the Bay continued to require small-scale treatments to scattered plants. In 2010 the affected acres treated have declined to 14,468. This is a positive indication that the program is not only proving to be effective at reducing overall solid acres of *Spartina* but trending toward eradication in some areas of the bay.

The decline in affected acres treated does not reduce the need to have a detailed monitoring program in place throughout the Bay. In 2010 the cooperators surveyed well over 30,000 acres of potential *Spartina* habitat, most of it two or more times during the course of the season. This level of vigilance will be necessary during the coming years in order to achieve eradication.

WSDA estimates fewer than 18 solid acres of *Spartina* were present in Willapa Bay over the course of the 2010 treatment season. This estimate is derived from treatment acreages reported by the cooperators (17acres) and includes an additional 5% to account for late season emergence, survey or application misses and other contributing factors.

Over the past eight years, the combined effort in Willapa Bay has been extremely effective and has reduced the overall infestation from a high of 8,500 solid acres in 2003 to fewer than 18 solid acres in 2010. This is an overall reduction of 99.8% achieved in seven treatment seasons. If the 2010 treatment season meets expectations and achieves an overall efficacy of 60% or greater, then fewer than 7 solid acres of *Spartina* are expected in Willapa Bay during the 2011 treatment season.

Figures 3, 4 and 5 are maps of North Willapa Bay, South Willapa Bay, and Columbia River respectively, including treatment area names.

Table 3: Summary of 2010 Willapa Bay *Spartina* Eradication Effort

Site	***Estimated Solid Acreage Treated***	***Estimated Affected Acres Treated***	***Entity Conducting Treatment***
North Willapa Area			
North Cove / Toke Point	.56	500	ST - PC - WDFW
Toke Point / Cedar River	.375	500	WDFW
Cedar River / Smith Creek	.265	800	WDFW
Smith Creek / Willapa Meadow	1.98	1,000	WDFW
Mailboat Slough	1.175	400	PC
South Bend / Raymond	.105	500	PC
S. Willapa River / Rose Ranch	.04	60	DNR
Rose Ranch / Stony Point	.17	180	DNR
Ellan Sands	.02	1,000	PC
Bone River / South Stony Point	.0275	50	DNR
Wilson Point/Niawiakum River	.256	250	DNR
Bay Center / Palix / Nemah Beach	1	1,250	DNR - PC
South Willapa Area			
North Nemah / South Nemah / Seal Slough	.81	2,000	PC
Naselle	1.1025	500	DNR - TNC
Willapa National Wildlife Refuge	6.237	4000*	USFWS
Long Beach Peninsula	2.705	1,500	DNR - WSDA - PC
Mouth of Columbia River / Baker Bay	.015	3	WSDA
Total	**16.84**	**14,468**	

WSDA = Department of Agriculture, WDFW = Department of Fish and Wildlife, DNR = Department of Natural Resources, , USFWS = U.S. Fish and Wildlife Service, TNC = The Nature Conservancy, ST = Shoalwater Tribe, PC = Pacific County

*Estimate of less than 4000 at time of publication.

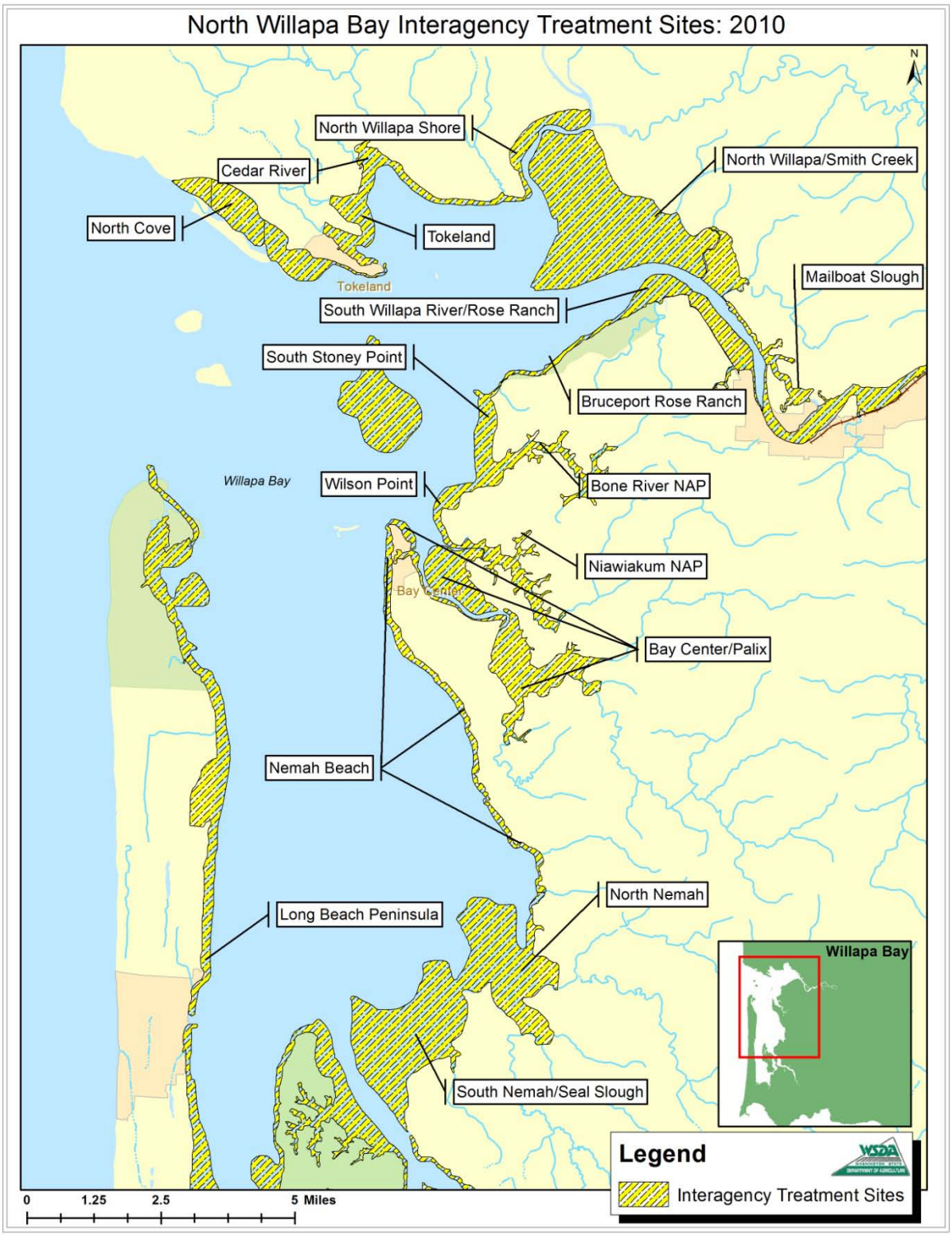

Figure 3: 2010 north Willapa Bay interagency *Spartina* treatment sites.

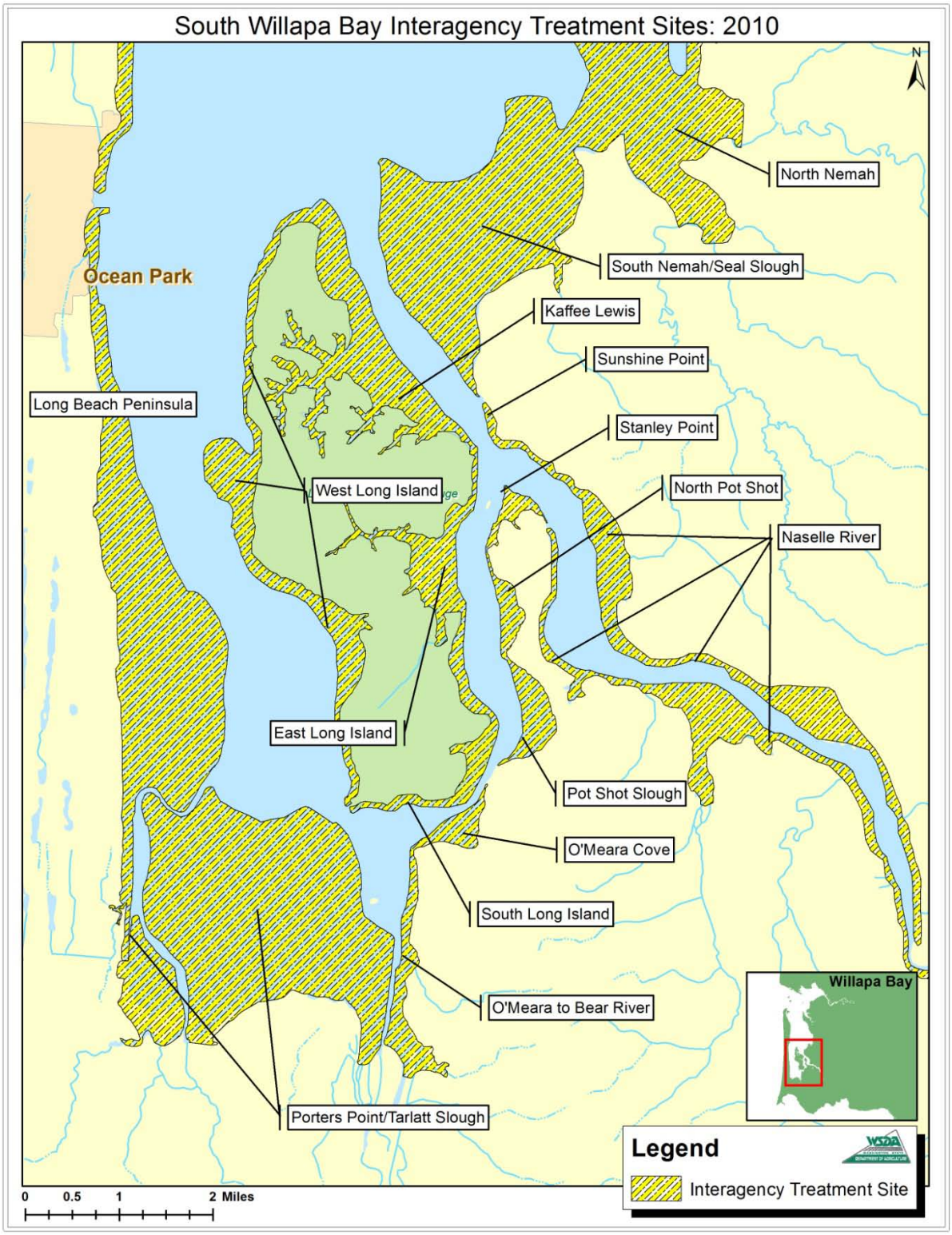

Figure 4: 2010 south Willapa Bay interagency *Spartina* treatment sites.

Figure 5: 2010 Columbia River *Spartina* treatment sites.

Roles of Willapa Bay Cooperators in 2010

- **WSDA** – Continued cooperation with the Department of Ecology to ensure NPDES coverage was available to qualified applicators. Provided resources, equipment and herbicide to WDFW, DNR, Pacific County and private property owners to ensure proper treatment of all sites. Conducted eradication activities on the Long Beach Peninsula and Columbia River in cooperation with Pacific County and DNR. Conducted surveys of Baker Bay and the Columbia River estuary in cooperation with Clatsop County, OR and United States Coast Guard. Participated in post season surveys with WDFW and DNR.

- **DNR** – Conducted eradication activities in Palix River, Nemah Beach, Wilson Point, Naselle River, Rose Ranch, Stony Point, South Willapa River and the Natural Area Preserves. DNR also cooperatively treated the Long Beach Peninsula with Pacific County and WSDA. Expanded restoration and monitoring activities in cooperation with WDFW. Participated in post season surveys with WSDA and WDFW.

- **WDFW** – Conducted eradication activities from Toke Point to the Willapa River Meadow. Expanded restoration and monitoring activities in cooperation with DNR, Western Washington University and WSU. Participated in post season surveys with WSDA and DNR.

- **USFWS** – Conducted eradication activities on Long Island and from the Stanley Point area south to the northern boundary of the Tarlatt Slough treatment area.

- **Pacific County –** Conducted eradication activities on the Long Beach Peninsula in cooperation with DNR and WSDA. Treated Ellan Sands, North Nemah, South Nemah and Seal Slough. Conducted treatments between North Cove and Toke Point in cooperation with Shoalwater Tribe. Pacific County also cooperatively treated the Palix River and Bay Center areas with DNR. Provided staff time to conduct Class A Noxious Weed compliance activities for *Spartina alterniflora*. Conducted late season surveys in cooperation with UW-ONRC.

- **Shoalwater Tribe –** Worked closely with state and federal partners. Provided staff time to evaluate previous treatments and consult regarding 2010 activities. Conducted eradication activities on tribal-owned lands between North Cove and Toke Point in cooperation with Pacific County.

- **University of Washington Olympic Natural Resources Center (UW-ONRC) –** Continued to develop tidal elevation maps of various treatment sites to predict the dry time that plants receive on specific days. Organized a late season survey of *Spartina* in Willapa Bay.

- **Washington State University (WSU**) – Continued research to improve efficacy of control tools**.** Continued research on impacts of *Spartina* to shorebirds and waterfowl.

- **The Nature Conservancy (TNC) –** Worked closely with the cooperators in the Technical Committee. Cooperated with DNR to treat Ellsworth Slough in the Naselle River.

Recommendations for the Future

With the successes of the past eight years and the massive reductions of *Spartina* in Willapa Bay, continued support and funding are more important than ever. In 2010, the Willapa Bay *Spartina* Eradication Program continued to focus on small-scale treatments of scattered infestations and individual plants found throughout the Bay. The transition from large-scale treatments of meadows has required an increase in the numbers of personnel on the ground to give individual attention to areas that helicopters or large machines were previously able to cover in a relatively short amount of time. As the large meadows have broken up into small, scattered plants under the pressure of eradication, the amount of herbicide needed to treat the infestation has declined. This programmatic shift has resulted in lowered herbicide costs and increased labor costs. Under this regime, WSDA anticipates the overall cost of re-treating scattered infestations over the next two years will not differ significantly from the cost of conducting the previous large-scale applications. It is anticipated that with continued programmatic success the cost of conducting the Willapa Bay *Spartina* eradication program in 2013 and beyond will begin to decrease.

WSDA estimates fewer than 7 solid acres of *Spartina* will be present in Willapa Bay during the 2011 treatment season. With the successful eradication of over 8,000 solid acres of *Spartina* in Willapa Bay over the past eight years, it is critical that program continuity is maintained. Figure 6 is a projection of *Spartina* reduction within Willapa Bay over the next four years with continued funding.

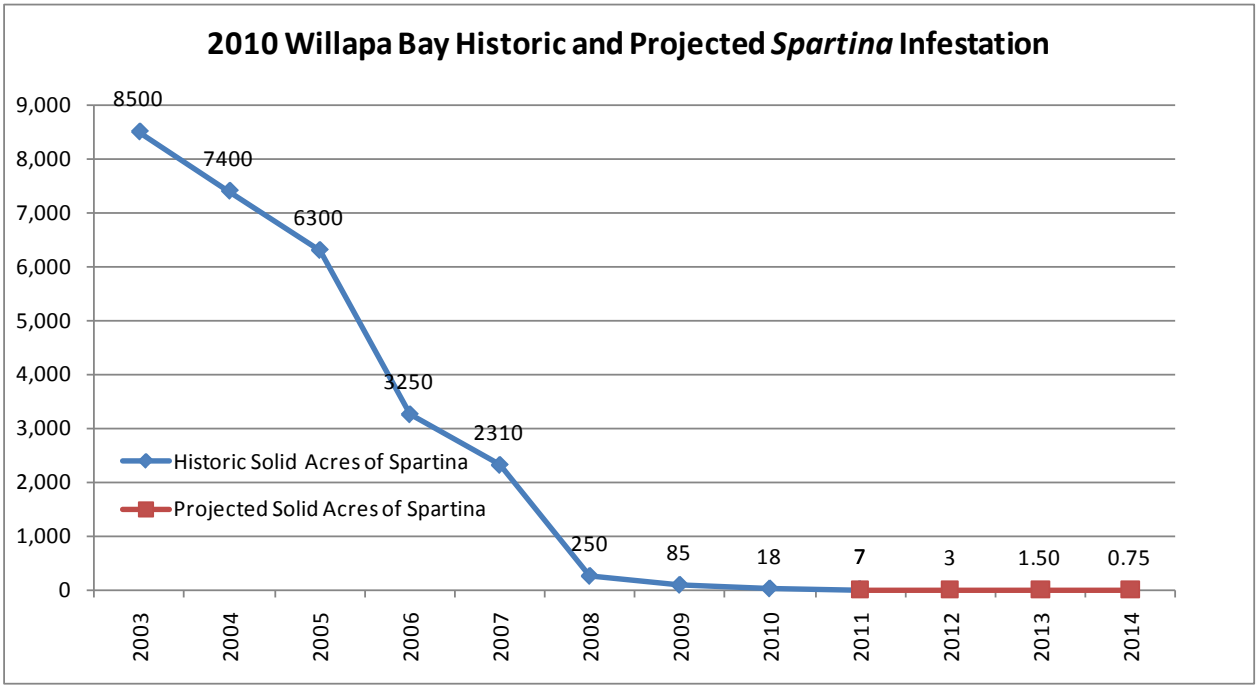

Figure 6: Solid Acres of *Spartina* in Willapa Bay by year, based on WSDA estimates. The blue line represents the historic area of *Spartina* since 2003. The red line represents the projected *Spartina* area through 2014. Projection assumes continued funding.

Spartina Eradication Effort in Grays Harbor

For programmatic purposes this geographic area includes Grays Harbor, its surrounding tributaries, and the coast from Cape Shoalwater to Cape Flattery (Figure 7).

Two species of *Spartina* infest Grays Harbor. The most prevalent species in Grays Harbor during the 2010 season was *Spartina densiflora*, a South American cordgrass species that tends to grow higher in intertidal zones and blends in well with native grasses. *S. densiflora* totaled roughly 60% of the infestation. *S. alterniflora*, though more widespread in terms of affected acreage than *S. densiflora*, totaled approximately 40% of the infestation.

Figure 7. Grays Harbor *Spartina* project area.

Historical Overview of the Grays Harbor Infestation

Survey and control work started in Grays Harbor in 1995. However, due to the overwhelming size of the *Spartina* infestation in Willapa Bay, resources to conduct a comprehensive survey in Grays Harbor were not available until 2005. An aerial survey in late summer of 2005 located an estimated 10 solid acres of *Spartina* and spurred an effort to undertake a more thorough survey and treatment program.

Of the 10 solid acres located through the aerial survey, WDFW treated 6.5 solid acres during the remainder of the 2005 season. WDFW also treated 3.5 solid acres, including all known infestations, during the 2006 season. The experience gained during the 2005 and 2006 treatment seasons led the project partners to conclude that a more aggressive effort was needed to achieve eradication in Grays Harbor.

As a result, in 2007 staff from WSDA, U.S. Fish and Wildlife Service and WDFW combined forces to achieve the most thorough survey and treatment regime in the Harbor to that point. Approximately 25,000 acres of intertidal lands in Grays Harbor and its tributaries with the potential for *Spartina* infestations were surveyed. Additionally, a coastal aerial survey revealed a 0.7 acre infestation in Grass Creek and also a relatively large infestation just south of Cape Flattery. Both infestation areas were *S. alterniflora*, and treated in the 2007 and 2008 seasons. The 2007 season yielded a total of 2.51 solid acres of *Spartina* treated in Grays Harbor and the Copalis River drainage.

While conducting three whole Harbor survey circuits in 2008, Grays Harbor crews found and treated 0.445 solid acres of *Spartina*. Of the 0.445 acres treated in Grays Harbor, 0.279 solid acres were *S. alterniflora* and 0.166 solid acres were *S. densiflora*. A positive sign in 2008 was that half-gallon low-pressure sprayers were adequate to treat the reduced numbers of plants in Grays Harbor.

In 2009, two circuits of the entire Harbor were completed, treating an estimated 0.54 solid acres of *Spartina*. Crews treated approximately 0.26 solid acres of *S. alterniflora* and 0.28 solid acres of *S. densiflora*. In the Bills Spit area of Grays Harbor a dense population of *S. densiflora* exists, so transect methodology was used to maximize detection of *S. densiflora* plants hidden among other vegetation. Within the transect area (discussed in appendix 3), 0.19 solid acres of *S. densiflora* was treated. An additional 0.09 solid acres was treated outside of the transect boundaries. Crews continued to use half-gallon low pressure sprayers with excellent results.

2010 Survey and Treatment Season in Grays Harbor

With the opportunity furnished by continued federal funding from the USFWS Nisqually National Wildlife Complex and approximately $125,000 in dedicated state funds, the cooperators developed three major goals for the 2010 treatment season:

1) Achieve at least two comprehensive rounds of survey and treatment throughout Grays Harbor, treating all known infestations with emphasis on high salt marsh area surveys.
2) Survey coastal sites that may harbor undetected *Spartina* infestations.

3) Continue to incorporate *S. densiflora* transect methods in the Bills Spit area. Transect methodology is a systematic survey technique to maximize detection of a target species. (Description and analysis of the results is discussed in appendix 3 of this report).

Grays Harbor surveys continued during the 2010 season. Some amount of either *S. densiflora* or *S. alterniflora* was found within most of the historically infested areas, although populations of both species were significantly reduced (80%) in solid acreage from the 2009 season. *S. alterniflora* comprised 40% of the infestation, but continued to be more widespread in terms of total area present. *S. densiflora* occurred in a more limited area yet comprised greater solid acreages treated (Figure 8).

During the 2008 and 2009 surveys, crews observed *S. densiflora's* continuing northerly spread from Bills Spit to North Bay. This trend was reversed in the 2010 observations, with decreases in both *S. densiflora* gps points and associated solid acreage treated (Figure 9). The decrease is attributed to introduction of the new transect methodology in 2009.

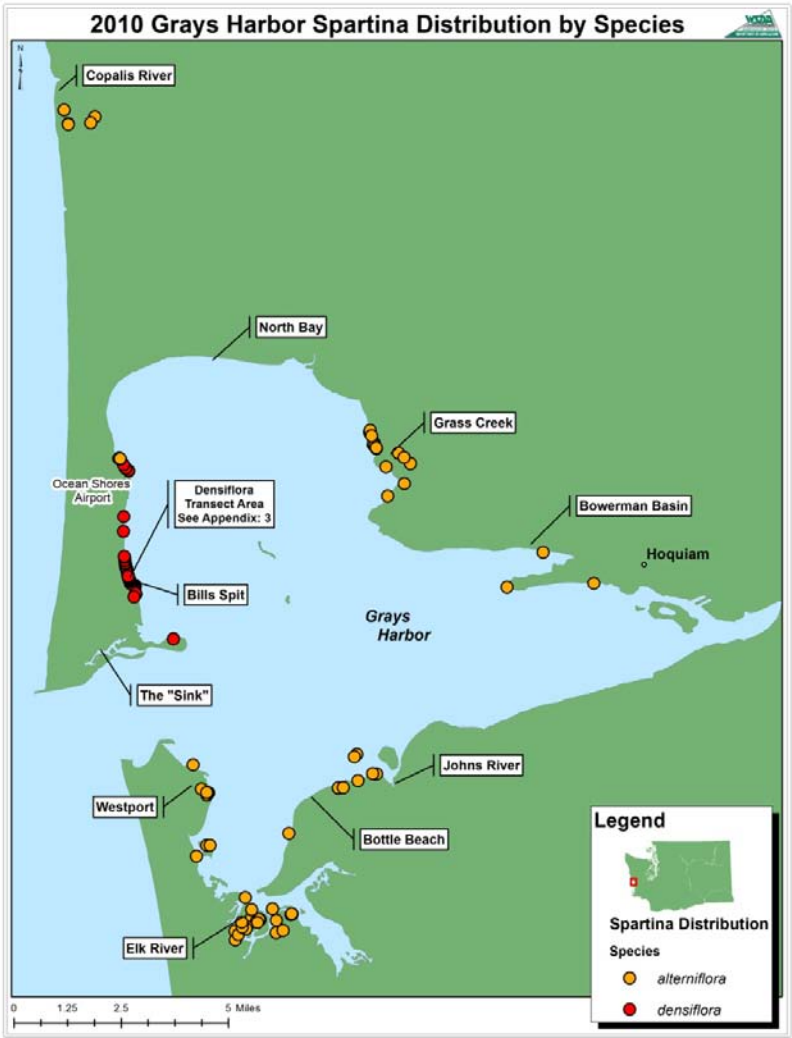

Figure 8: *Spartina* distribution *S. alterniflora* (yellow) and *S. densiflora* (red), Grays Harbor, 2010.

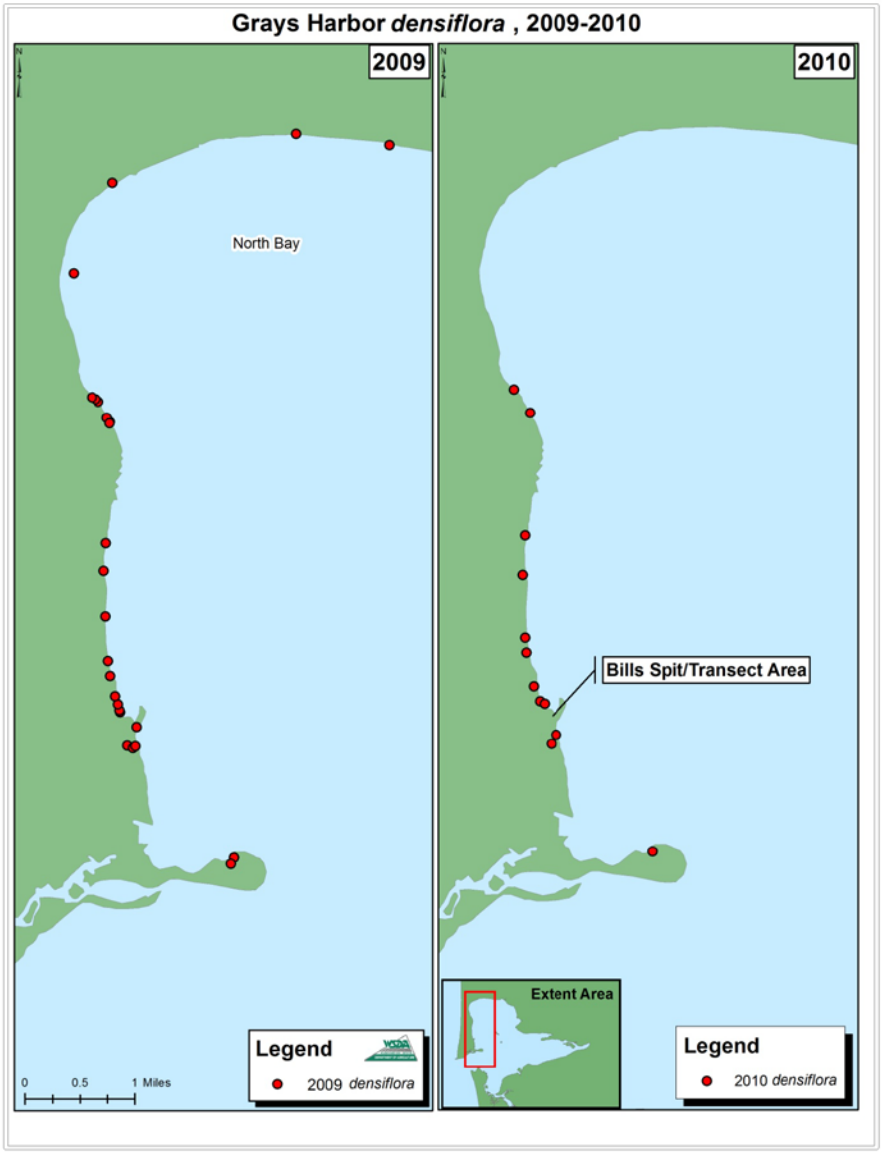

Figure 9. Comparison of *S. densiflora* infestation points, 2009-2010.

Consistent with recommendations provided in the 2009 *Spartina* report, WDFW hired the Grays Harbor crew in mid-April of 2010 to conduct *S. densiflora* surveys in the Bills Spit and North Bay areas. Spring surveys for *S. densiflora* are highly effective, because the green *S. densiflora* plants are visible among the senesced native vegetation, maximizing its detection. During these spring surveys, detected *S. densiflora* was flagged within the transect area and dug outside of the transect area. During April and May, approximately 214 plants (0.02 solid acres) were dug outside of the transect area. When crews noted that there was a substantial decrease in the numbers of plants contained within the transect area, a decision was made to forgo the use of herbicide application in favor of digging within the transect area as well. Two rounds of transects were completed yielding approximately 477 plants or 0.044 solid acres of *S. densiflora*. Description and analysis of the transect results are discussed in appendix 3 of this report.

Staff from WSDA and WDFW continued to work in joint crews throughout the June 1 to October 31 treatment season, achieving two Harbor survey circuits and *densiflora* transect laps, treating an estimated 0.046 solid acres of *alterniflora* and 0.064 acres of *densiflora* for a total of 0.11 solid acres of *Spartina*. This is an 80% reduction from the 0.54 solid acres that existed in 2009. Because of the reduced amount of *Spartina*, crews used a combination of herbicide application and mechanical treatment (digging) as the IWM tool(s).

Along with two survey and treatment circuits in the main Grays Harbor water body and surrounding tributaries and two *densiflora* transect laps performed in Bills Spit, the Grays Harbor crew also surveyed 38 miles of the outer coastline. This survey was conducted by foot and all-terrain vehicles, extending from Cape Shoalwater to Westport and continuing north from southwest Ocean Shores to the Moclips River. The 2010 coastal surveys yielded no new *Spartina* infestations.

S. densiflora located outside of the transect area in 2010 inhabited areas from Damen Point, extending north beyond the transect area to the Ocean Shores airport (Figure 9). Crews treated (dug) 0.02 solid acres of *S. densiflora* located outside of the transect area compared to 0.09 solid acres in 2009 for a 78% reduction in *S. densiflora*.

Table 4 identifies the areas in which either *S. alterniflora* or *S. densiflora* occurs and compares the percentage reduction/increase in solid acres treated between the 2009 and 2010 seasons. The data shows that meticulous survey efforts in Grays Harbor and transect methodology on Bills Spit have resulted in large reductions of *Spartina*. The reductions may also be influenced by a reduced seed bank within the Harbor.

Table 4. Sites and areas (solid acres) of *Spartina* treated in 2009 and 2010 with corresponding percent reduction/increase between the two years.

Site	*Acres Treated in 2009*	*Acres Treated in 2010*	*Percent Reduction*	*Spartina Species*
Bills Spit	0.20	0.044	87%	*S. densiflora*
Bottle Beach	0.016	0.0026	84%	*S. alterniflora*
Bowerman Basin	0.0052	0.00009	99%	*S. alterniflora*
Chenois Creek	0.005	0.00	100%	*S. alterniflora*
Copalis River	0.034	0.006	83%	*S. alterniflora*
Damen Point	0.003	0.0002	94%	*S. alterniflora/densiflora*
Elk River	0.0845	0.027	69%	*S. alterniflora*
Grass Creek	0.037	0.0074	80%	*S. alterniflora*
Humptulips River	0.00	0.0008	-1%	*S. alterniflora*
Johns River	0.03	0.0012	96%	*S. alterniflora*
North Bay	0.009	0.0007	93%	*S. alterniflora/densiflora*
Ocean Shores	0.09	0.02	100%	*S. densiflora*
Point Brown	0.03	0.00	100%	*S. alterniflora*
Rennie Island	0.00	0.00	0	*S. alterniflora*
Westport (Fire Cr. Pt.)	0.005	0.0004	92%	*S. alterniflora*
Total Acres Treated	**0.54**	**0.11**	**80%**	

Recommendations for the Future

The 2010 survey and treatment season in Grays Harbor was successful. Continued cooperation between partner agencies provided the resources needed to achieve detailed surveys and treatments during the 2010 season. Two Harbor survey circuits and *S. densiflora* transect laps were completed, with all known *Spartina* infestations treated.

After the success of the 2010 season, WSDA expects that less than 0.05 solid acres of *Spartina* will be present in Grays Harbor during the 2011 treatment season (Figure 10). Since 2005, the Grays Harbor effort has achieved a 99% overall reduction in *Spartina*.

Specific recommendations for the 2011 Grays Harbor survey and treatment season include:

1) Conduct a minimum of two comprehensive rounds of survey and treatment throughout Grays Harbor with emphasis on high salt marsh areas.
2) Hire Grays Harbor crews in early spring to conduct transect surveys and dig *S. densiflora* located outside the Bills Spit transect area before the competing vegetation becomes too high.
3) Develop transect methodology utilizing advanced GPS technology.
4) Continue to perform coastal surveys and extend the Grays Harbor survey well inland of the salt marsh to insure that no outlying infestations are missed.

Figure 10 is a projection of *Spartina* reduction within Grays Harbor over the next four years with continued funding.

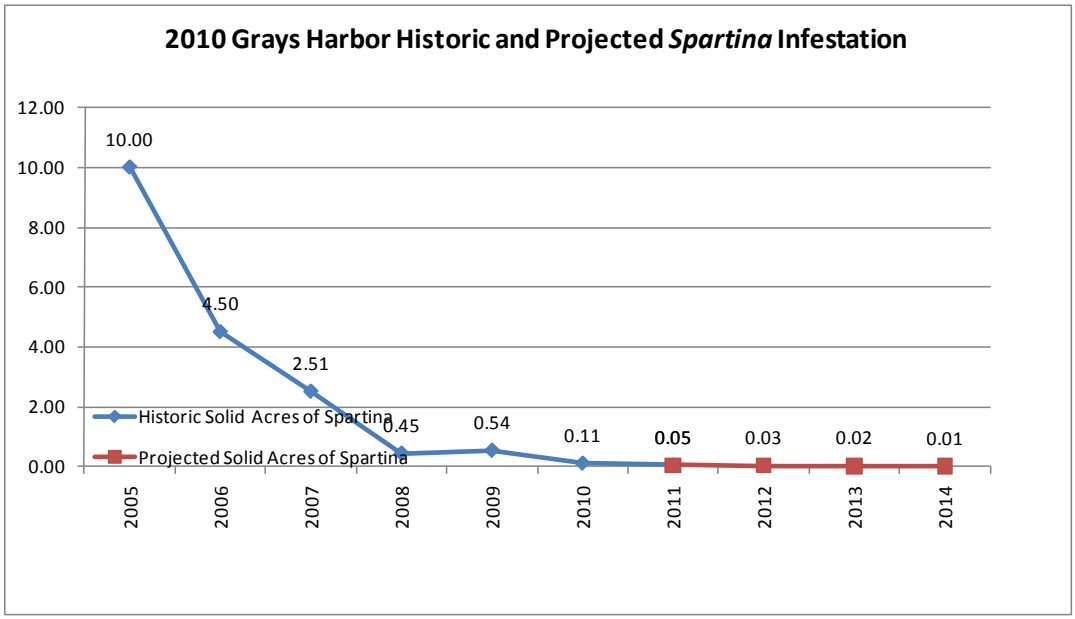

Figure 10: Solid Acres of *Spartina* in Grays Harbor by year, based on WSDA estimates. The blue line represents the historic area of *Spartina* since 2005. The red line represents the projected *Spartina* area through 2014. Projection assumes continued funding.

Spartina Eradication Effort in Puget Sound, Hood Canal, and the Strait of Juan de Fuca

Overview

For programmatic purposes, this geographic region ranges west to Cape Flattery, north to Whatcom County and south to south Puget Sound including Hood Canal. This region includes all waters in the Puget Sound basin. There are more than 2,400 miles of shoreline in these waters. Along the shores of Puget Sound, four species of *Spartina* are found: *Spartina anglica, Spartina alterniflora, Spartina densiflora, and Spartina patens*. Of these four species, *S. anglica* is the most abundant and accounts for more than 99% of the infestation. *S. anglica* was introduced to Snohomish County in 1961 and the infestation increased to a peak of more than 1000 acres by 1997. *S. alterniflora, S. densiflora* and *S. patens* are limited in distribution and extent; combined, these three species account for less than 0.1 solid acre throughout Puget Sound. Figure 11 shows the geographic area and distribution of *Spartina* in the Puget Sound region.

The 2010 control season was successful; favorable weather and efficient cooperation between partner groups facilitated high levels of control. Below are some highlights of the 2010 treatment season. Following these brief highlights are more detailed reports on a regional basis.

- Just over 8.5 solid acres of *Spartina* were located and treated during the 2010 season, a 70% reduction from the *Spartina* present in 2009.
- The Puget Sound program has achieved a 99% reduction in *Spartina* from the peak infestation of more than 1,000 solid acres in 1997.
- The survey effort in Puget Sound remained a priority for WSDA. This year's exploration of new shoreline miles identified and allowed control of several small, previously unknown infestations before they could become new sources of spread.

Table 5: Estimated solid acres of *Spartina* in 2010 by county as reported by WSDA and records from *Spartina* cooperators

County	*Estimated Solid Acres of Spartina*
Island	**2.56**
Snohomish	**4.13**
Skagit	**1.84**
Clallam	**0.012**
San Juan	**0.019**
Kitsap	**0.079**
Jefferson	**0.0003**
Pierce	**0.0014**
Whatcom	**0.00**
King	**0.00**
Total	**8.64**

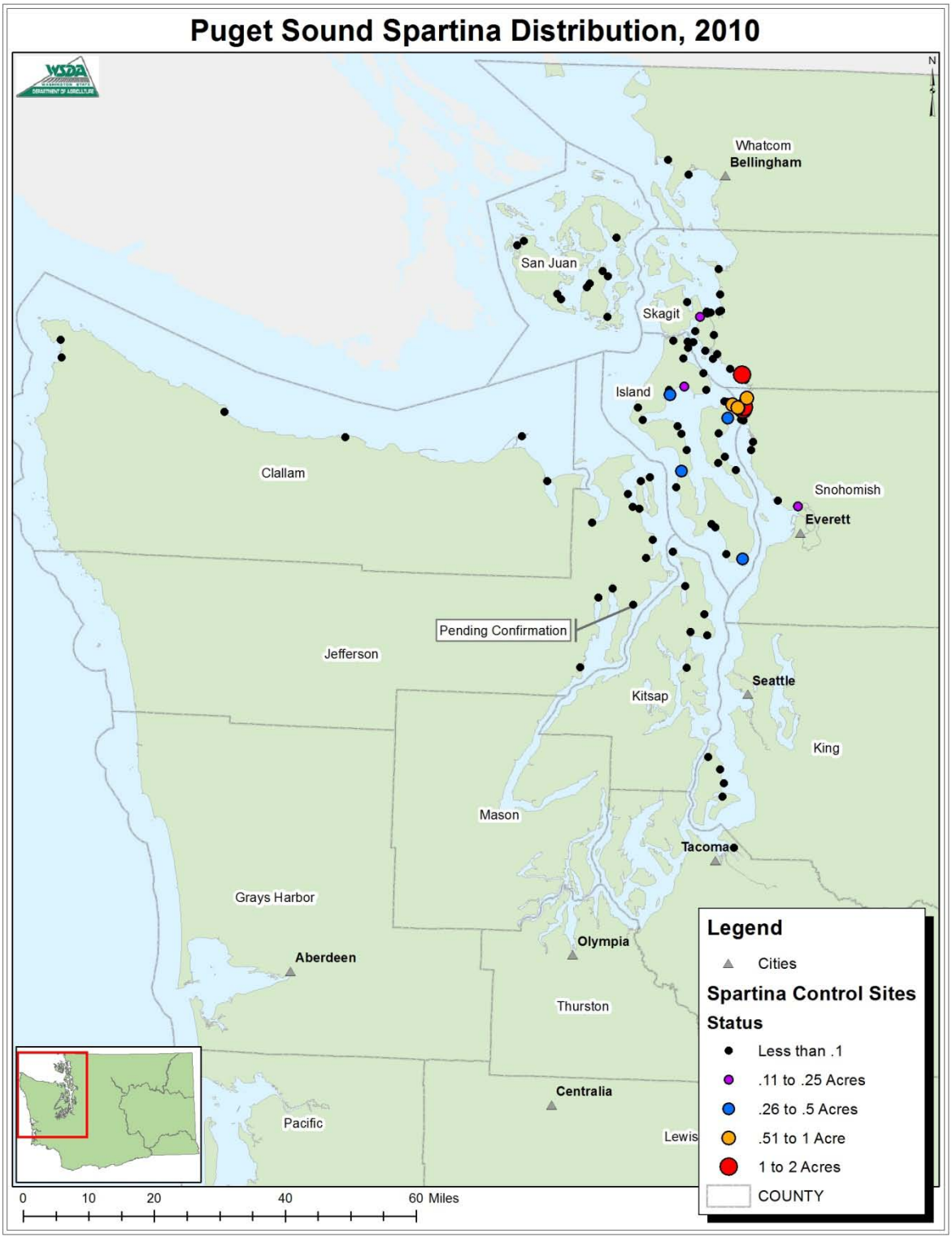

Figure 11: Extent and distribution of *Spartina* sites in Puget Sound. For clarity on the map, some smaller infestations have been combined. The largest infestations remain near the original introduction site of *S. anglica* in Snohomish County.

Island County

In 2010, Island County had the second largest infestation of *Spartina* in Puget Sound. The Island County Noxious Weed Control Board and Washington State Department of Fish and Wildlife conducted the *Spartina* eradication work in Island County. A total of approximately 2.56 solid acres of *Spartina* were found and treated in Island County this season. This is a 76% reduction from 2009. Washington State Department of Agriculture provided Island County $50,000 for *Spartina* eradication activities in 2010.

Table 6: Depicts the past and present solid acres of *Spartina* treated, as well as percent reductions in Island County

Year	*Spartina* Treated (solid acres)	% Reduction from previous year
2002	300	
2003	325	-8% (net increase)
2004	164	49%
2005	134	18%
2006	99	26%
2007	97	2%
2008	15.4	84%
2009	10.6	31%
2010	**2.6**	**76%**
	% Reduction from Peak Acreage	**99%**

Washington State Department of Fish and Wildlife treated a total of 1.33 solid acres in Island County in 2010. 0.9 solid acres were located and treated from Davis Slough heading northwest to English Boom on Camano Island. In 2009, nearly 7 solid acres were treated by WDFW in the same area. Triangle Cove continues to show high levels of reduction with only 0.04 solid acres treated in 2010. In one treatment lap, 0.35 solid acres were treated at Hancock Lake this season.

Island County Noxious Weed Control Board and its contractor Wildlands Management controlled the major *Spartina* infestations and seed sources on Whidbey Island in 2010. 1.22 solid acres of *Spartina* were treated by Wildlands Management throughout Island County in 2010. Cultus Bay, Crescent Harbor and Maylors Marsh contained the majority of solid acreage treated in 2010. Due to some unforeseen circumstances, some of the smaller sites on Whidbey Island did not receive treatment in 2010; these sites will be high priority during the 2011 season.

Wildlands Management mechanically removed Puget Sound's only known infestation of *Spartina densiflora* in Race Lagoon located on Whidbey Island. Less than 15 individual plants were located and removed at this site in 2010. Continued survey and treatment efforts aimed at eradication of this infestation will remain a high priority.

Snohomish County

The largest *Spartina* infestation in Puget Sound is in Snohomish County. The Snohomish County Noxious Weed Control Board, Washington State Department of Fish and Wildlife, The Nature Conservancy and the Tulalip Tribal Nation found and treated 4.13 solid acres of *Spartina* in 2010. This is a 69% reduction from the 13.49 solid acres present in 2009. Washington State Department of Agriculture provided Snohomish County $50,000 for *Spartina* eradication activities in 2010.

The Snohomish County Noxious Weed Control Board (SCNWCB) treated 1.53 solid acres of *Spartina*. Their main focus was in Southeast Skagit Bay, where just over 1 solid acre was treated. Skagit Bay was also the site of some late season seed head clippings over a 122 acre area.

SCNWCB led a cooperative treatment at Big Flats on the Tulalip Tribal Nations land near Marysville. During this treatment over a tenth of an acre was treated in a single tide. Next year WSDA hopes to conduct multiple treatment laps in this area to achieve maximum efficacy. With assistance from the Tulalip tribe, WSDA, SCNWCB and WDFW conducted mechanical *Spartina* removal in Tulalip Bay. Approximately 100-150 square feet of *Spartina anglica* were removed from the Bay, however, this infestation is expected to continue its expansion. WSDA predicts that between one half to one solid acre of *Spartina* will still be present in the 2011 treatment season.

Washington State Department of Fish and Wildlife (WDFW) focused their efforts on WDFW owned and managed lands in Snohomish County. WDFW treated approximately 0.51 solid acres in southeast Skagit Bay and 1.94 solid acres on North Leque Island in 2010.

Cumulatively, WDFW and SCNWCB, treated 1.56 solid acres of *S. anglica* in southeast Skagit Bay in 2010. That is an 84% reduction from the 9.6 solid acres treated in 2009.

In 2010, The Nature Conservancy (TNC) chemically treated 0.14 solid acres of *Spartina* on their 4,000 acre Port Susan Preserve.

Table 7: Depicts the past and present solid acres of *Spartina* treated as well as percent reductions in Snohomish County

Year	*Spartina* Treated (solid acres)	% Reduction from previous year
2002	238	
2003	343	-44% (net increase)
2004	350	-2% (net increase)
2005	375	-7% (net increase)
2006	215	43%
2007	60	72%
2008	21.3	65%
2009	13.5	37%
2010	**4.1**	**69%**
	% Reduction from Peak Acreage	**99%**

Skagit County

In 2010, Skagit County had the third largest infestation of *Spartina* after Snohomish and Island County in Puget Sound. Approximately 1.84 solid acres of *Spartina* were found and treated in 2010 by Skagit County Noxious Weed Control Board, Department of Ecology, Washington State Department of Fish and Wildlife, WSDA, and the Swinomish Tribal Nation. This is a 60% reduction from 4.61 solid acres treated in 2009. WSDA provided $30,000 to Skagit County Noxious Weed Control Board and $7,500 to the Swinomish Tribal Nation for *Spartina* eradication activities in 2010.

The Skagit County Noxious Weed Control Board treated a total of 1.47 solid acres of *Spartina* in 2010. All of this acreage was treated around Fir Island, which is located between the North Fork and South Fork of the Skagit River.

In its ninth year of partnership with WSDA, the Swinomish Tribal Nation engaged in *Spartina* control on their lands. Two rounds of treatment were completed by the Swinomish Tribe throughout their land. A total of 0.37 solid acres of *Spartina anglica* was treated using herbicide. Turner's Cove was the most heavily infested area with just over a tenth of an acre treated in 2010. In 2009, 0.35 solid acres of *Spartina* were treated in Turner's Cove and 5.1 solid acres in 2008. This is a 98% reduction from 2008. The Swinomish Tribal Nation's continued cooperation is essential to eliminate *Spartina* from Skagit County.

The Department of Ecology (DOE) has controlled *Spartina* on their Padilla Bay Estuarine Research Reserve since 1996. Two species of *Spartina* exist in Padilla Bay, *Spartina anglica* and *Spartina alterniflora*. In the 2010 treatment season, DOE treated/dug less than 0.001 solid acres of *Spartina*. 25 square feet were *Spartina anglica* and only 9 square feet were *Spartina alterniflora*. The *S. alterniflora* infestation on Dike Island is the only known remaining population in Puget Sound. With the minimal amount of *S. alterniflora* remaining, DOE expects to eradicate this species from Padilla Bay in the next few years.

Table 8: Depicts the past and present solid acres of *Spartina* treated as well as percent reductions in Skagit County

Year	*Spartina* Treated (solid acres)	% Reduction from previous year
2002	37	
2003	26	30%
2004	13.5	48%
2005	10	26%
2006	10	0%
2007	6	40%
2008	6.2	-3% (net increase)
2009	4.6	26%
2010	**1.8**	**60%**
	% Reduction from Peak Acreage	**95%**

Clallam, Jefferson, Kitsap, King, San Juan, Pierce and Whatcom Counties

In 2010, WSDA continued to work with the Noxious Weed Control Boards of Clallam, Jefferson, Kitsap, King, San Juan, Pierce and Whatcom Counties as well as the U.S. Navy, State Parks, Merrill Ring, Vashon Maury Land Trust, Suquamish Tribe, Puyallup Tribe, Makah Tribe and U.S. Fish and Wildlife Service (USFWS) to conduct surveys and control *Spartina*. These cooperators played an important role in all aspects of integrated weed management from consent to control work in the 2010 season.

In Kitsap County, a total of 0.079 solid acres of *Spartina* were treated or removed in 2010. WSDA and the Suquamish Tribe worked together to treat the largest known infestation in the central Puget Sound at Doe-Kag-Wats. This site has significant challenges with continually shifting driftwood that litters the cove and makes surveying difficult and dangerous. 0.07 solid acres of *Spartina* were treated using herbicide in 2010 which is a slight increase from 2009. Eradication at this site will require repeated visits in the coming years.

Less than 0.019 solid acres of *Spartina anglica* was dug or treated using herbicide in San Juan County in 2010. Low Point, which is located on southeast San Juan Island, was the most heavily infested area with 0.015 solid acres treated using herbicide in 2010. The largest site mechanically controlled in the county is located on San Juan Island south of Roche Harbor in Westcott Bay. At this site, eighty square feet of *Spartina anglica* was dug by the San Juan County Noxious Weed Control Board and WSDA in 2010. San Juan, Orcas and Lopez Island all had *Spartina* removed in 2010. People for Puget Sound also participated, conducting a number of volunteer kayak surveys in 2010.

Around 0.012 solid acres of *Spartina alterniflora/anglica* were treated or removed from Clallam County in 2010. With help from the Clallam County Noxious Weed Control Board, United States Department of Fish and Wildlife, Merrill Ring and the Makah Tribal Nation, two survey circuits were completed and all known infestations were treated in 2010.

Historically, Jefferson County has contained the only known infestation of *Spartina patens* in Washington State at Dosewallips State Park on Hood Canal. WSDA crew surveyed the site during the 2010 season, and retired Evergreen State College professor Dr. Dave Milne surveyed the site in early October. No *Spartina patens* was found during these surveys. This is the first year *Spartina patens* has not been found at this site. This is a definite sign that the infestation is being controlled; however, the extremely elusive nature of this species leads WSDA to believe that future surveys will be required prior to declaring eradication. All together, Jefferson County accounted for only 13 square feet of *Spartina anglica* dug in 2010.

For the first time in program history, *Spartina* was found and treated in Pierce County in 2010. In late October, two rounds of digging removed 60 solid square feet of *Spartina anglica* at Squally Beach in Commencement Bay near the Port of Tacoma.

Surveys were conducted in King and Whatcom Counties in 2010. In King County, historic sites were surveyed, and no *Spartina* was present. In Whatcom County, a few small clones were discovered on the Nooksack Delta within the Lummi Reservation. These clones were not treated in 2010 but will be high priority for the 2011 treatment season.

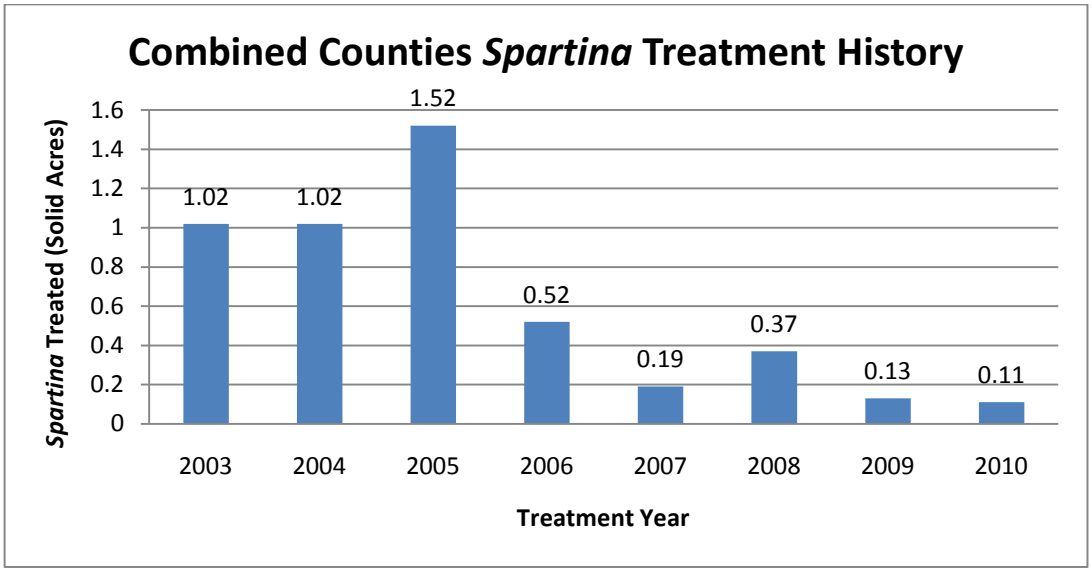

Figure 12: Depicts the past and present solid acres of *Spartina* treated in Clallam, Jefferson, Kitsap, King, San Juan, Pierce and Whatcom Counties

Recommendations for the Future

Continuous control and the elimination of major seed producing populations of *Spartina* in Puget Sound have resulted in significant decreases in remaining acreage. Less than 9 solid acres of *Spartina* were found and treated in 2010 throughout Puget Sound, Hood Canal, and the Straits of Juan de Fuca. This is a 99% reduction from the height of the infestation in 1997 at 1,000 solid acres. The *Spartina* management paradigm in Puget Sound has shifted from aerial treatments, boom sprayers and large scale mechanical control, towards a more labor intensive effort that uses fewer material resources and less herbicide. However, personnel needs on the ground are increasing as infestations decrease in an effort to promote more extensive and detailed surveys.

In an effort to increase shoreline and estuarine survey and treatment in 2011 WSDA is exploring hiring a second two person survey crew for the field season. The existing crew would continue to be responsible for WSDA's sites in Kitsap, Jefferson and Clallam County. The new crew would extend survey efforts throughout Puget Sound and be available to assist cooperators.

Tulalip Bay located near Marysville and home to the Tulalip Tribal Nation is an area of concern for WSDA and partner groups. The ½ – 1 solid acre infestation of *S. anglica* is proving to be difficult to remove mechanically. Collaboration between tribal biologists and WSDA is planned for this winter to find a solution that is more practical and less destructive to shoreline habitat than digging. Large-scale mechanical removal in areas such as Tulalip Bay has proven to be destructive to shoreline habitat, creating large holes and promoting erosion that will be evident for many years to come.

Once again the 2010 field season confirmed that cooperation and coordination is essential to the success of the *Spartina* Eradication Program in Puget Sound. Increased survey and pooled resources will be important for eradicating remaining infestations. With continued collaboration between cooperators in the region and sustained funding, the future success of the Puget Sound *Spartina* program looks bright. Figure 13: is a projection of *Spartina* reduction within Puget Sound over the next three years with sustained funding.

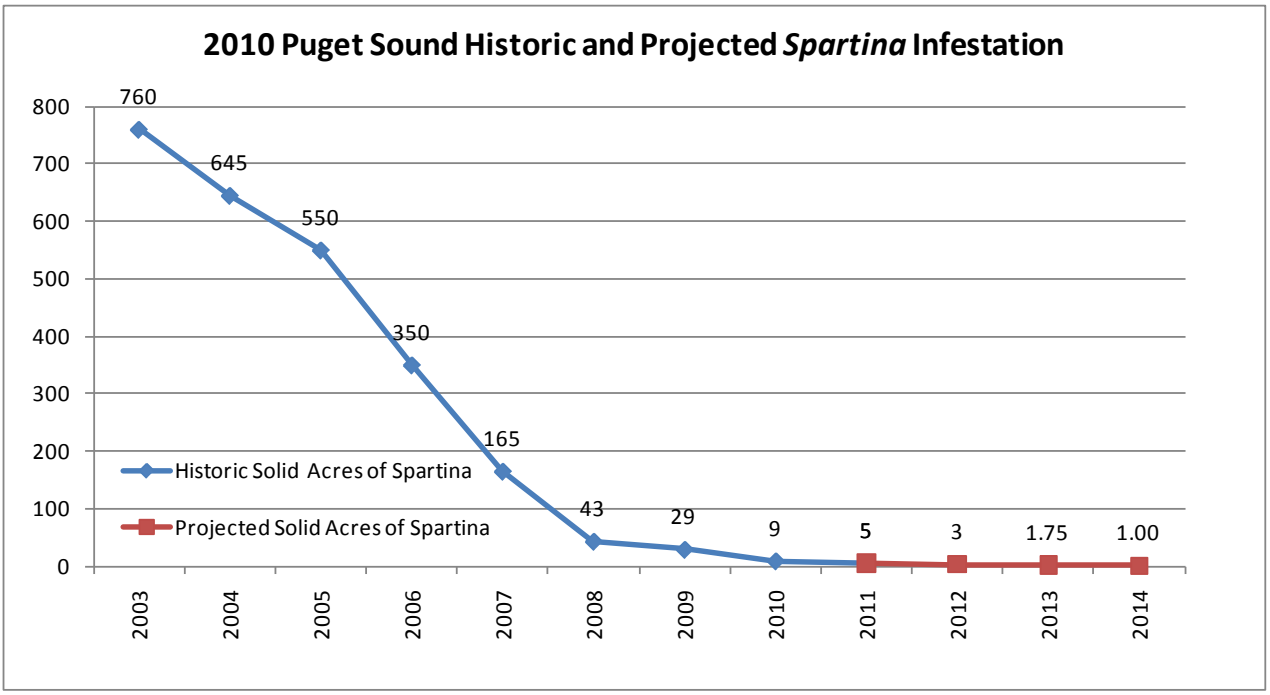

Figure 13: Area (Acres) of *Spartina* in Puget Sound based on WSDA estimates. The blue line represents the historic area of *Spartina* and the red line represents the projected area of *Spartina*. Projected area assumes sustained funding. All areas are in solid acres.

Appendices

Appendix 1 - *Spartina* in Washington State

Why is *Spartina* a problem?

The invasive noxious weed *Spartina* is found in various intertidal areas of Washington State. *Spartina* can modify the hydrology of estuaries, causing increased flooding. It out competes native vegetation, forming monotypic meadows that accumulate sediment. This disturbance can lead to reduced plant diversity, elevated intertidal areas and displacement of invertebrates, which are a major food source for shorebirds and juvenile salmon. *Spartina* can destroy valuable shorebird, waterfowl and salmon habitat. *Spartina* also has the ability to threaten both the natural and commercial shellfish beds that are important to the economy of Washington State.

Which species of *Spartina* occur in Washington State?

There are currently four species of non-native *Spartina* known to occur in Washington. *Spartina alterniflora* is most widely found in Willapa Bay, with fewer than 7 solid acres estimated to currently infesting the Bay. *Spartina alterniflora* is also known to occur in Skagit, Clallam, and Grays Harbor counties.

Spartina anglica is present in Skagit, Snohomish and Island counties. It has also been found in San Juan, Whatcom, King, Pierce, Kitsap, Clallam and Jefferson counties in small infestations. It currently infests approximately 8 solid acres in the Puget Sound region.

Spartina patens is known to occur at only one location in the state: Dosewallips State Park in Jefferson County. This infestation receives annual surveys and is controlled by digging, covering and herbicide applications as needed. The current infestation size is very limited (a few square feet at most), with no finds during the 2010 season.

Spartina densiflora is a South American species that was discovered in 2001 in both Grays Harbor and Island counties. The species currently infests less than one tenth of an acre in Grays Harbor and a few square feet in Island County.

Figure 15 shows each of the four species.

How was *Spartina* introduced into Washington State?

Spartina alterniflora was unintentionally introduced to Willapa Bay along with oysters shipped from the east coast during the late 1800's. In Puget Sound, landowners introduced *Spartina alterniflora* in an effort to stabilize shorelines. *Spartina anglica* was similarly introduced into Puget Sound at a farm located in Port Susan in the early 1960's to serve as bank stabilization and as a potential source of feed for cattle. The modes of introduction for both *Spartina patens* and *Spartina densiflora* are unknown.

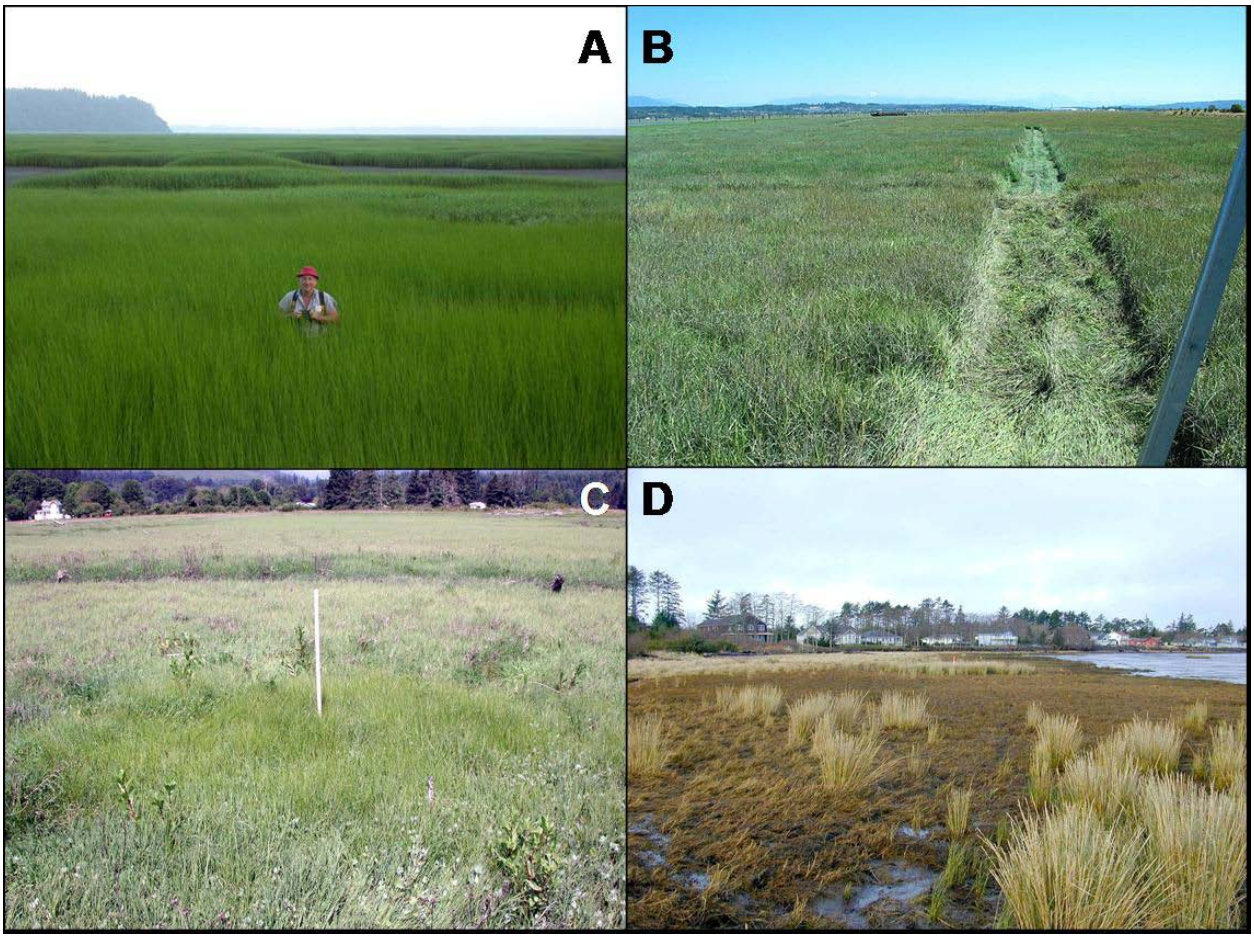

Figure 1-1: The four species of *Spartina* present in Washington. A) A meadow of *S. alterniflora* in Willapa Bay, B) A meadow of *S. anglica* in Skagit Bay (2003), C) *S. patens* at Dosewallips (2001), and D) clones of *S. densiflora* in Grays Harbor County.

How do we eradicate *Spartina*?

Spartina spreads quickly and is difficult to eradicate. A successful eradication program involves four steps:

1) Preventing an existing infestation from producing seed;
2) Treating an existing infestation for several consecutive years using integrated pest management (IPM) techniques (including mechanical, chemical or manual control, or a combination of these methods);
3) After eradication is achieved, monitoring the area to ensure no re-establishment occurs;
4) Continuing to survey shorelines, educate the public, and follow-up on possible sightings of new infestations.

Appendix 2 – Increased WSDA Survey Efforts in Puget Sound, Hood Canal and the Strait of Juan de Fuca

Contributed by Tanner Ketel, WSDA

The goal of the state wide eradication program is the complete removal of all invasive *Spartina* species from Washington State. With significant decreases in solid acreage of *Spartina* achieved in the past eight years, an increase in shoreline survey is more important than ever. Accurate delimitation of known infestations and early detection of new populations are key to the success of any eradication program. Since 2007, WSDA and its cooperators have increasingly made survey a priority. The following details the increasing survey activities and new finds of the past four field seasons.

Throughout the course of the control seasons when time and tides permit, WSDA and cooperators participated in shoreline and estuarine surveys in fourteen counties in Washington State. This concerted effort utilized staff from WSDA, WDFW, county noxious weed boards, People for Puget Sound, and numerous private citizens volunteering their time. Surveys were conducted with watercraft, various types of rough terrain vehicles, and helicopter observation. Shoreline was identified in areas with potential *Spartina* habitat and surveyed.

During 2007, 373 miles of shoreline were surveyed statewide. A large portion (273 miles) consisted of helicopter surveys along the outer coast funded by USFWS. In addition, 40 miles of shoreline were surveyed in the Puget Sound region in 2007.

During 2008, survey activities increased in the Puget Sound region. A total of 364 miles of shoreline were surveyed in Puget Sound. Areas of Whatcom County, San Juan County, and portions of the south Puget Sound were surveyed by boat. People for Puget Sound (PPS) organized volunteer surveys in San Juan, Whatcom, Island, and Skagit Counties; with volunteers, PPS surveyed more than 53 miles of shoreline.

In 2009, in addition to the previously known survey/treatment areas in Puget Sound, 454 miles of shoreline were surveyed by foot and boat by WSDA. 93 of these miles were in Puget Sound predominantly around the northern end of the Kitsap Peninsula. 155 miles of Hood Canal were surveyed, focusing on the elusive species *Spartina patens*. 161 new shoreline miles were surveyed in San Juan County. In addition, Parks Canada, Ducks Unlimited Canada, and a crew from WSDA worked together to conduct a survey of 46 miles of shoreline along the Canada-Washington border in the Gulf Islands. Also, a total of 103 shoreline miles was surveyed by volunteer kayakers from People for Puget Sound.

In 2010, in addition to susceptible areas surveyed in past years, 470 never-before-explored shoreline miles were surveyed by WSDA. Of these, 390 miles are located in south Puget Sound, encompassing a large part of the Thurston, Pierce and King County shoreline.

Increased outreach and the continued emphasis on survey led to some significant finds in the 2010 season. The first was on Hope Island located just southeast of Deception Pass in Skagit County. In fall 2009, volunteer kayakers found this infestation, which consisted of 58 solid square feet of

Spartina anglica. This infestation was removed manually by WSDA and cooperators later the same season. This area will receive additional survey emphasis in the coming years.

Increased outreach led to a discovery of *S. anglica* in Commencement Bay located in Pierce County. 60 solid square feet of *Spartina* was dug and removed from this area in late October. This find is significant as it is the most southern find ever in Puget Sound and the first find in Pierce County.

On Bainbridge Island near a previously known site in Manzanita Bay, a hidden culvert led to a small lagoon on private property which contained a sizeable infestation of *Spartina anglica.* The landowner was contacted and a survey revealed over 300 square feet of *Spartina*. Consent was obtained and WSDA treated the infestation in early October.

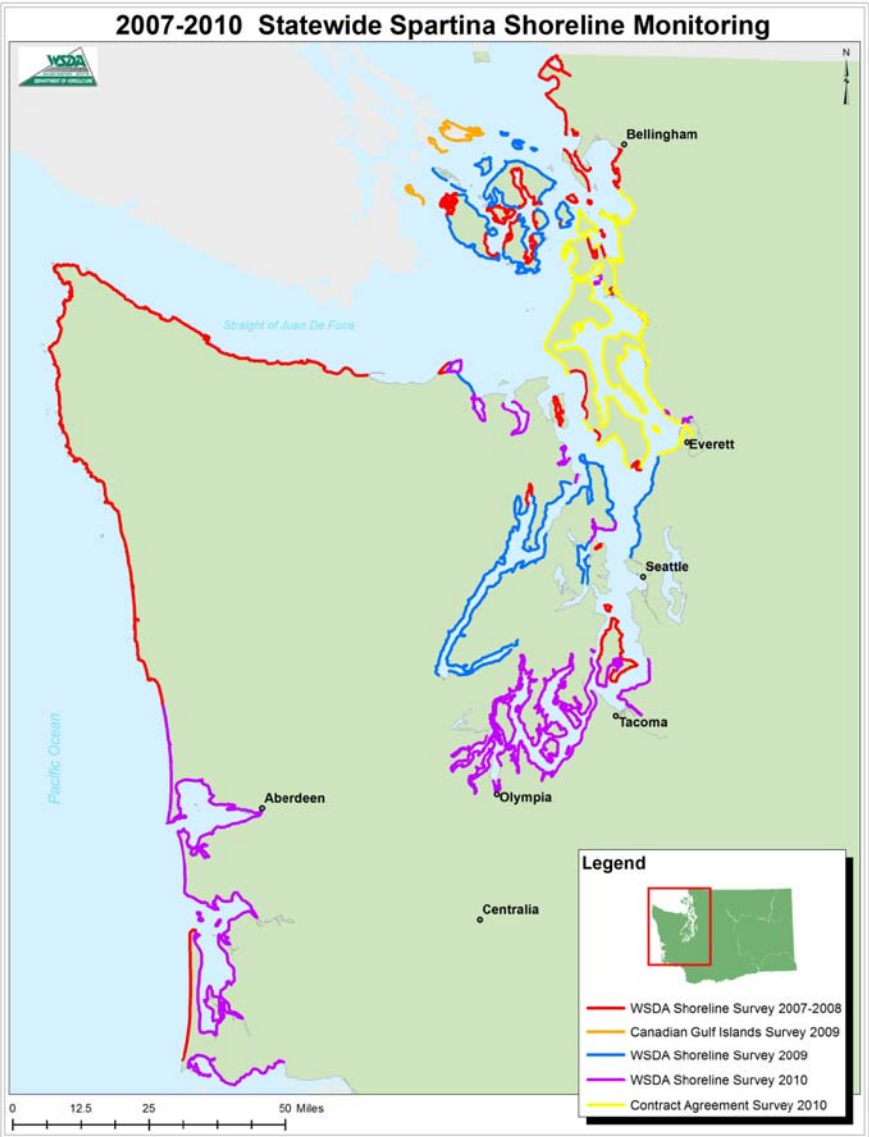

Figure 1-2: WSDA performed surveys in Puget Sound, Grays Harbor and Willapa Bay.

The past four years of survey yielded several previously unknown finds in the Strait of Juan de Fuca, Neah Bay area, Commencement Bay and throughout Puget Sound. An infestation of *S. alterniflora* was discovered by aerial survey in the Waatch and Sooes River estuaries on Makah Tribal lands. Ground based surveys detected *S. anglica* infestations in the Pysht River Estuary, at Salt Creek, and on Dungeness Spit in Clallam County. Boat surveys in San Juan County revealed new infestations of *S. anglica* on Low Point, White Point, and Swifts Bay located on San Juan and Lopez Islands. A volunteer survey lead by People for Puget Sound discovered infestations of *S. anglica* at the mouth of the Red River and Nooksack River Delta in Whatcom County as well as a *S. anglica* find on Dredge Islands at the north end of the Swinomish Channel in Skagit County. Increased outreach has led to discoveries in Commencement Bay in Pierce County as well as finds on Hope Island in Skagit County.

Subsequent to discovery, all of these sites were the focus of targeted management efforts. The total area of these finds is less than one solid acre. Though these sites are relatively small, their discovery and management are important in preventing the renewed spread of *Spartina* within the region. Within the next two years, WSDA anticipates completing a five-year survey of Puget Sound, Hood Canal, and Strait of Juan de Fuca.

Appendix 3 – 2009-2010 Grays Harbor *Spartina densiflora* Transect Study

Contributed by Nels Mikkelsen, WSDA

OVERVIEW

Grays Harbor hosts the largest infestation of *Spartina densiflora* in Washington State. *S. densiflora* is a South American cordgrass species of *Spartina* that was discovered in Grays Harbor in 2001 (Figure 1-3).

Figure 1-3. *Spartina densiflora.*

Historically, *S. densiflora* was found in Grays Harbor on the eastern side of the Ocean Shores Peninsula. The two primary sites were Bills Spit and east of the Ocean Shores airport. However, as in 2008, crews noticed that in 2009 the Bills Spit infestation had increased in both number of sites and solid acreage, with scattered plants discovered about a mile to the north. Crews continued to find *S. densiflora* in North Bay, extending from Campbell Slough west roughly 1.5 miles.

Areas of Grays Harbor infested with *S. alterniflora* typically respond well to eradication treatments and show high levels of reduction from year to year. However, in spite of aggressive treatment efforts, the two areas infested with *S. densiflora* (Bills Spit/North Bay) showed an increase in solid acres treated and gps points from 2008 to 2009 (2009 *Spartina* Report, Figure 9, Page 17).

In response to the increases observed in 2008, surveys targeting *S. densiflora* were performed in the early spring months of 2009. In Washington State, *S. densiflora* remains green and does not senesce in the winter like most of the native salt marsh plants. Spring surveys make locating *S. densiflora* easier due to its visibility among the senesced surrounding native vegetation. In April/May of 2009, significant numbers of *S. densiflora* plants were identified in the Bills Spit area, and the cooperators agreed that an alternative method of survey and treatment was necessary to achieve eradication. In late May 2009, the cooperators began to address the main infestation in Bills Spit with a transect methodology, so that complete coverage could be achieved through meticulous survey and treatment efforts (Figure 2-3). Transect methodology is a systematic survey technique to maximize detection of a target species. Descriptions of the methods used to create and manage the transects and corresponding data are discussed on the following pages.

Results from the first circuit of transect survey and treatments in 2009 revealed over 2,000 individual *S. densiflora* plants. In the second circuit, over 1,400 plants were found and treated for a 22% decrease. A total of 0.19 solid acres were treated within the approximate 4 acre transect area in 2009. Crews noticed what appeared to be tolerance to herbicide application, as many of the first circuit plants were still not showing the physical effects of herbicide treatment 3 months post treatment.

However, in 2010 early spring surveys conducted in the transect area showed a substantial decrease in numbers of *S. densiflora* plants. The reduced numbers of plants made it cost effective for the cooperators to forgo the use of herbicide in favor of mechanical (digging) treatment as the preferred IWM tool. A key factor in choosing mechanical treatment versus chemical treatment in 2010 was *S. densiflora's* observed tolerance to chemical treatment during 2009. Removal of plants showing tolerance to herbicide treatment via digging ensured the best chance of achieving control in 2010.

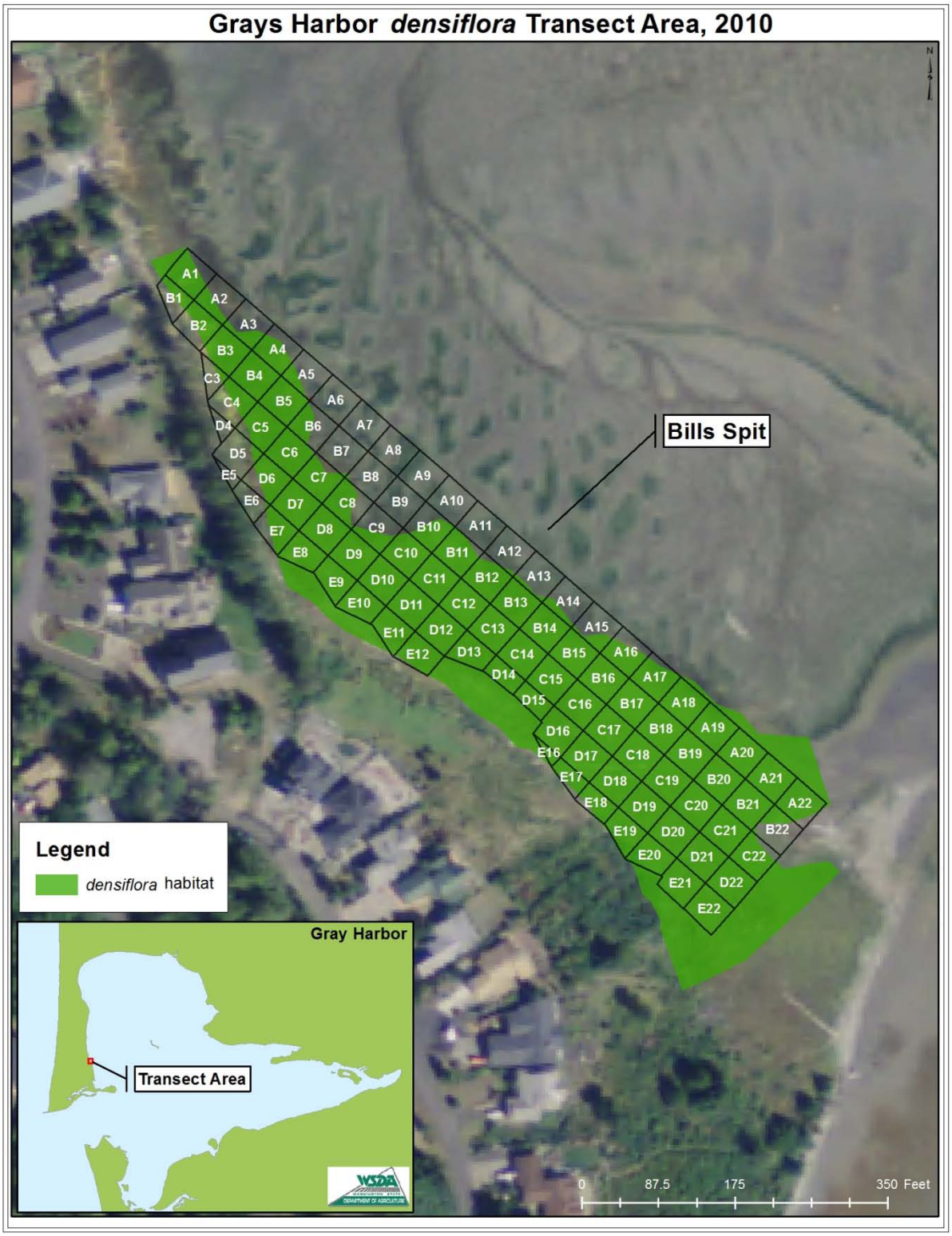

Figure 2-3. Bills Spit *S. densiflora* infestation area and corresponding transect schema.

TRANSECT GRID SYSTEM

Preliminary discussions between cooperators focused on a grid system where the Bills Spit infestation could undergo a complete and thorough coverage approach. This approach included the tracking of total herbicide mix used and total plant numbers within "cells" of designated transects (Figure 2-3). Herbicide mix use within a cell could be tracked to more easily stay within the herbicide label rates. Also, plant numbers within a cell could be tracked to provide total cell/transect counts between rounds. The data collected could then be entered into an Excel spreadsheet for tracking purposes, generation of field data gathering sheets and final report writing (Table 1-3).

Table 1-3. SAMPLE 2009 Grays Harbor *S. densiflora* Transect Data Sheet

Transect	A area	A oz.	A#	B area	B oz.	B#	C area	C oz.	C#	D area	D oz.	D#	E area	E oz.	E#
1	1760	1	2	1320	3	2									
2	1760	6	5	1760	82	81									
3	1760	0	0	1760	70	72	1056	38	59						
4	1760	0	0	1760	28	34	1760	105	152	770	66	76			
5	1760	0	0	1760	10	13	1760	94	95	1452	99	102	330	8	8
6	1760	0	0	1760	0	0	1760	29	33	1760	86	122	880	32	23
7	1760	0	0	1760	0	0	1760	15	18	1760	190	136	1452	33	26
8	1760	0	0	1760	0	0	1760	2	3	1760	24	28	1386	0	0
9	1760	0	0	1760	2	2	1760	13	11	1760	52	36	1496	0	0
10	1760	0	0	1760	10	11	1760	84	67	1760	100	74	1408	0	0
11	1760	0	0	1760	4	4	1760	26	25	1760	10	8	1298	0	0
12	1760	0	0	1760	6	6	1760	58	66	1760	47	27	836	0	0
13	1760	0	0	1760	12	12	1760	8	10	1760	0	0	418	0	0
14	1760	0	0	1760	4	4	1760	1	1	1760	4	2	396	0	0
15	1760	0	0	1760	0	0	1760	17	12	1760	51	6	286	0	0
16	1760	0	0	1760	2	1	1760	60	33	1760	18	12	528	0	0
17	1760	1	1	1760	0	0	1760	16	8	1760	30	12	990	0	0
18	1760	0	0	1760	58	65	1760	17	9	1760	69	49	1100	0	0
19	1760	2	3	1760	3	1	1760	3	1	1760	101	64	1606	69	44
20	1760	3	3	1760	3	4	1760	0	0	1760	97	57	1760	34	27
21	1760	0	0	1760	0	0	1760	9	7	1760	16	13	1760	20	16
22	1760	0	0	1760	1	1	1760	0	0	1760	1	1	1760	10	8
Totals	38720	13	14	38280	298	313	32736	595	610	30382	1061	825	19690	206	152

159,808 sq. ft.= 3.67 acres

2,173 oz.= 16.98 gallons

1,914 *densiflora* plants

Contributing factors to determine cell size included the expanse of the treatment area (approx. 4 acres), tidal influences (survey time), survey crew numbers (3-5 individuals) and allowable herbicide application rates (label rate). Therefore, based upon these variables, 40x44 ft. (1,760 sq. ft.) cells were identified to maximize the efficiency of our field operations in time and space.

To determine the maximum amount of herbicide mix that could be applied to each cell we used the 2009 Grays Harbor mix rate. This rate was derived from calibrated treatment equipment and was set at a maximum application rate of 100 gallons tank mix per acre. Thus, twenty five 40x44 ft. cells (1,760 sq. ft.) equates to one acre (25 cells x 1,760sq. ft.=43,560 sq. ft.= 1 acre), therefore, the 100 gallon maximum rate per acre divided by 25 cells (1 acre) equals a maximum application rate of 4 gallons herbicide mix per cell (512 usable ounces).

Utilizing a cell size with an easily tracked maximum allowable amount of herbicide ensures that all herbicide label rates and applicable federal and state laws are followed.

TRANSECT AREA DELINEATION

Preliminary measurements of the main infestation area were made according to the mudflat to saltwater vegetation transition and the upper salt marsh to upland vegetation transition within the main infestation. The northerly and southerly ends of the transect area served as a "bottleneck" due to the reduced distance between the mudflat and the high marsh. Here, the amount of *S. densiflora* was reduced in conjunction with reduced suitable habitat. Continuing northerly and southerly away from the transect area the amount of plants found were reduced and scattered. GPS points were then collected at the northern and southern boundaries. From this data, a linear relative north to south line was established.

This relative north/south linear line was adjusted to effectively cover the boundary of the mudflat to salt marsh vegetation transition. It was also adjusted to contain 22 transects spaced at intervals of 44 feet which were pre-marked for accurate tracking of herbicide mix use totals as per the prior discussion in the "Transect Grid System" section. The 22 transects x 44 feet equaled 968 lineal feet. Stakes were then established at the northern and southern ends with an additional "midpoint" stake established to accelerate daily surveys with a reduced length of line.

With the establishment of the lineal mudflat to salt vegetation transition line it was then necessary to establish the high salt marsh vegetation to upland vegetation "westerly" boundary line and corresponding transect stakes. A compass reading was established at the northern boundary stake to the west to determine the easterly/westerly boundary. This compass reading was subsequently used to determine each easterly/westerly transect line moving north to south along the mudflat to salt vegetation line at the 44 ft mark intervals.

The salt marsh vegetation to upland vegetation transition stakes are curvilinear and conform to the natural vegetation transition. This natural transition area created "partial cells". Partial cells were measured for area and a corresponding maximum herbicide mix application rate was calculated so as not to violate the herbicide label rates. Figure 2-3 depicts the approximate grid system layout in the Bills Spit area of North Bay.

TRANSECT FIELD APPLICATION

With favorable tides and weather a crew of 3-5 individuals from WDFW and WSDA used heavy ropes to determine transect boundary lines between the mudflat transition line and the upland transition stakes. The ropes were pre-marked at 40 ft. intervals and measuring tapes were used to delineate cell boundaries from rope to rope, thus creating the 40x44 ft. cells. The first cells immediately west of the mudflat transition line were marked as A1. Continuing west through transect 1, the next cell was B1, C1 etc (Figure 2-3). Crew members began surveys at the mudflat

transition line (cell A) and moved westerly through the cells equipped with ½ gallon low pressure sprayers marked in increments of 4 ounces and count "clickers". Crew members were spaced equidistant to one another and treated/tallied every *S. densiflora* plant found. At the completion of each cell crew members provided to the data recorder ounces of herbicide mix used and total plant numbers. These numbers were entered on a field data spreadsheet. Surveys were terminated prior to the minimum 4 hour recommended herbicide mix dry time in accordance with tidal fluctuations. Field data was transferred to Excel spreadsheets at the conclusion of each survey day.

RESULTS

The 2010 round 1 survey and treatment operations began in earnest June 14th and were completed on June 17th. A total of 3 survey days were needed to complete the 22 transects in round 1, or roughly 7 transects completed per survey day. As discussed, the decision was made to use mechanical treatment (digging) in 2010 due to the reduced numbers of plants. 194 individual *S. densiflora* plants were dug for a total of 0.008 solid acres. Sizes ranged from single stemmed plants a few inches in height to multi-stemmed plants 2-3 ft. high and 1-2 ft. in diameter. In general, plant sizes were much smaller in 2010 than in 2009.

Round 2 survey and treatment operations began October 26th and were completed on October 28th. A total of 3 survey days were needed to complete the 22 transects or roughly 7 transects completed per survey day. 283 individual *S. densiflora* plants were dug in round 2 for a total of 0.03 solid acres.

Therefore, the total estimate of *S. densiflora* plants found and treated in rounds 1 and 2 are approximately 477 or 0.044 solid acres. Overall, there was a 32% increase in the numbers of plants found from round 1 to round 2. This increase can be partially attributed to the seasonal changes occurring in the native vegetation from June to November. Round 1 treatment began in June when the native vegetation is actively growing making finding plants more difficult. Round 2 treatments began in late October when most of the native vegetation had senesced. Additionally, extremely small plants that were not detected in the June transects have had 6 months to grow and are therefore large enough to be detected by the November transects. Figure 3-3 depicts the distribution and numbers of *S. densiflora* plants within cells from 2009 to 2010. An 86% reduction in plant numbers was achieved from 2009 to 2010.

Figure 3-3: 2009-2010 Grays Harbor transect grid system layout and corresponding plant numbers within cells. Darker shaded areas indicate larger numbers of *S. densiflora* plants.

CONCLUSION/DISCUSSION

S. densiflora is an austral cordgrass exhibiting bunchgrass type growth. Methods of growth and reproduction are tiller action and seed production. During the last 20 years *S. densiflora* has been recorded as aggressively invading estuarine environments in the USA, Spain and Morocco (Bortolus, 2006). Recently, an infestation has also been found near Denman Island in British Columbia, making this the most northerly known population to date. While this species is one of

the three most widely distributed worldwide, it is among the least studied within the *Spartina* genus. Unlike native salt marsh plants in Washington State, this salt tolerant species exhibits a C_4 metabolism which enables it to cope better with local environmental variables and microhabitat conditions (Kittelson & Boyd, 1997; Nieva *et al*., 1999, 2005). Additionally, its morphology lends itself to concealment within native salt marsh flora.

These combined ecological characteristics make survey and potential treatment a difficult task. Furthermore, *S. densiflora* has shown a tolerance to herbicide application. Its dense multi-stem morphology and reduced leaf surface area may be a factor in its tolerance. Notably, during our 2009 transect treatments, the smaller *S. densiflora* plants showed a high tolerance, while efficacy appears to be higher in the larger multi-stemmed plants, which have more leaf surface area. Similar results have been reported in San Francisco where there exists a large infestation of *S. densiflora*. Results there indicate only a 30-40% mortality rate from herbicide application (Drew Kerr, personal communication).

The transect effort in Grays Harbor has shown that complete coverage in densely infested areas is possible. While it is not clear that the treated plants exhibiting the effects of herbicide damage will ultimately perish, there may be an associated decrease in plant vigor and seed production. The high efficacy rate (86%) that was achieved from 2009 to 2010 may be due to a combination of tidal scour and severe winter conditions. Weakened plants that show the effects of herbicide damage may not possess the root strength to stay anchored to the substrate in harsh conditions. Nonetheless, more definitive work is needed to address *S. densiflora's* tolerance to herbicide application. Suggestions include studies with different surfactants that can penetrate the thick cuticle in order to adequately introduce foliar and systemic herbicide chemicals.

With continued funding the cooperators will continue to apply transect methods in the Bills Spit area of Grays Harbor. Recommendations for the 2011 season include the hiring of Grays Harbor crew members in the spring months to allow them time to familiarize with *S. densiflora* identification, perform transect survey and treatment and document and dig *S. densiflora* existing outside of the transect area. Additionally, we are exploring the use of highly precise (sub ft.) GPS units to perform transects via satellite and GIS software. This technique may lead to the development of a highly accurate and quickly deployable transect methodology for use in finding and treating difficult-to-detect invasive plant species in the future.

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