Progress Report:
Monitoring of Efficacy and Restoration of *Spartina* Eradication in Palix River, Washington

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Introduction

The Palix River *Spartina* meadow has spread rapidly. Based on 1993 aerial surveys, the meadow was confined to a few small patches covering less than a few acres. In 2004 the entire intertidal area was solid *Spartina*. Research plots established by WSU from 1997 through 2003 indicated that control of *Spartina* at this site was feasible using the herbicide Habitat. WSDA applied for and received an LIP grant to treat this meadow in 2004.

Application Background: WSDA treated the Palix River *Spartina* meadow with Habitat on 8/18/2004 and 8/19/2004 by air. The outer meadow received 6 pt/ac of Habitat + 1% Competitor surfactant and the higher inner meadow received 5 pt/ac + 1% Competitor surfactant. The application had good dry time (all > 12hrs). Plant height was 5-6'; the canopy had fallen over and was lying down in 20 to 30% of the treated area. Plants were at full anthesis, early seed fill. Application conditions were overcast but dry.

Visual Observations: Based on visual observation, the overall efficacy at the site was ~ 85 to 90%. The upper region showed excellent control (95%); the low area near the river and channels showed mixed control (50 to 75%), especially along channels. Patchy control corresponded with bridge photos of plants lying down and of areas missed by the boom sprayer. There was regrowth on the edge of some of the sloughs, and the outer edge of the meadow.

Methods

Seed Viability: Seed heads were collected at seven sites along the south bank of the river on September 28, 2004 (Table 2). These sites were selected to provide a range of brown down (1= green *Spartina* to 10 = complete brown down). Seeds were separated from heads and assayed for germination using the method of Daehler et al.

Spartina Assessment: Stem density data were collected from seven transects on March 2, 2005, along the eastern section (near shore bank) of the meadow walking from the Palix River Bridge to the Niawiakum River Bridge. These early regrowth data were collected from a total of 187 quadrats. Transect locations at these sites were not noted with GPS, but are described as general locations in Appendix 1. On June 2, 2005, stem and seedling density data were collected from six transects located along the south and west banks of the meadow and headed inward toward the center of the meadow (Photo 1). These transects were approximately 500' long with 20 quadrats collected per transect (one every 25'; some transects were blocked due to large channels, deep water or wrack). GPS start points and transect directions are noted in Table 1.

On June 10, 2005, data were collected from seven sites along the south bank of the river. These

sites corresponded with seed viability study collection points. Data were collected along short transects (5m) that radiated out from the GPS seed collection point. Data from 70 quadrats were collected. All quadrat data (stem density, seedling number, native plant species) were collected using a 0.25 meter square along the transect. Raw data are provided in Appendix 2.

Migratory Shorebird and Waterfowl Survey: Visual observations of shorebird and waterfowl usage were conducted on two days during peak migration period (April 19, 2005 and May 6, 2005) using a spotting scope at five locations of approximately one hectare each within the meadow. Each site was observed for 10 minute counts, which coincided with tidal periods 0.25-1 hour prior to tidal submergence or after tidal withdraw. In addition, an aerial bird count of the meadow was conducted on April 24, 2005 during a high tide period that concentrated birds onto the upper meadow (Appendix 3).

Results and Discussion

Spartina Control: Although the overall control of *Spartina* at this site was good, there was considerable variation in efficacy depending on the location of the transects (Tables 1 and 2). The pre-count stem density at this site based on previous experiments was above 50 to 60 stems per $0.25m^2$. Stem density post treatment ranged from 0.05 to 10 stems per $0.25m^2$. The percentage of *Spartina*-free quadrats ranged from 0 to 100% and averaged 36% in the meadow and 44% along the south river bank. The variability in control resulted from numerous high stem density counts that were collected along the tidal channel banks or where the *Spartina* had lodged or had wrack on top of it.

Table 1. *Spartina* monitoring assessment of Palix River meadow, June 2005.

Site (GPS / Transect direction)*	Seedling density (#/$0.25m^2$)	Stem Density (#/$0.25m^2$)	%*Spartina*- free quadrats
# 1 (N 46.36.912/W123.55.056/Northeast)	3.6	2.6	0
# 2 (N 46.61572/W123.92213/Northwest)	18.3	0.84	0
# 3 (N 46.61887/W123.93588/North)	1.75	0.05	45
# 4 (100’ east of #5/Northeast)	0.23	0.15	69
# 5 (N 46.62614/W 123.94058/Northeast)	0.45	0.35	75
# 6 (N 46.37.567/W 123.56.433/East)	1.8	8.3	25
Average	4.3	2.0	36

* see photo for direction of transect

Table 2. *Spartina* seed viability and stem density along the south shore of the Palix River meadow, 2004/2005.

Site (GPS)	Percent Germination Lab *	Browndown rating**	Seedling density (#/0.25m^2)	Std. Dev.	Stem Density (#/0.25m^2)	Percent *Spartina* free quadrats
#1 (N46.62783/ W123.95111	4.96	1	1.60	2.22	10.0	40
#2 (N46.61805/ W123.94193	4.76	3	2.00	1.76	6.00	30
#3 (N46.61667/ W123.93764	0.00	7	0.00	0.00	0.00	100
#4 (as above, on lower bank	25.62	3	0.70	0.82	0.00	50
#5 (N46.61246/ W123.91730	0.29	5	2.60	1.78	0.00	10
#6 (150' southeast of #5)	5.83	3	2.00	1.56	2.0	20
#7 (N46.60888/ W123.91528	1.92	1	4.00	0.52	0.00	60
Average	6.2		1.84	1.24	2.57	44

*Seedling germination study conducted in the lab using an average of 207 seeds per site.
** Brown rating (1 to 10) at time of collection 1= none (green), 10= completely browned down.

Seed Viability: Seed germination ranged from poor (0.29%) to excellent (>25%). Not surprisingly, there was a general lack of relationship between lab data on germination and seedling data in the field. Seed transport likely accounts for this difference. The bulk of seedlings observed were along the southern edge of the meadow. This can be expected, based on the movement of pollen with the NW winds toward this section of meadow.

Native Plants: No native marsh plants were observed within any of the quadrats during this survey (data not shown, all zeroes).

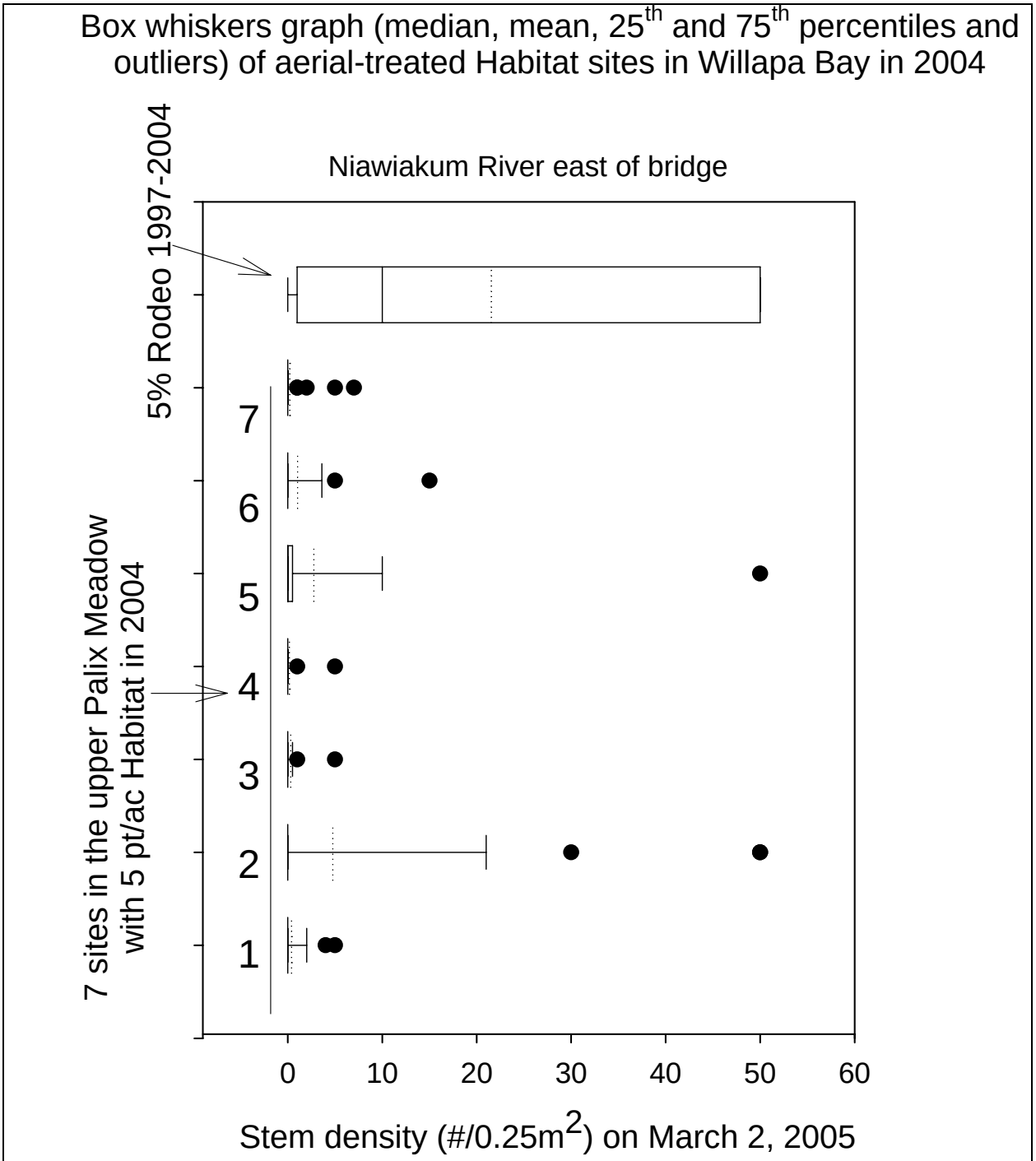

Figure 1. Early stem density count upper Palix Meadow, March 2005

Bird usage: Bird usage in the Palix meadow is dramatically lower than pre-*Spartina* infestation (pers. communication Dick Wilson). Ground bird surveys yielded no shorebirds or waterfowl present, while the aerial survey showed a very small number of shorebirds and waterfowl (Table 3). At present, it is still unclear what the most critical factors are driving shorebird usage of tide flats post-*Spartina* control—prey density, prey accessibility, predator avoidance behavior, or

other variables. Research on changes in prey density post-*Spartina* control has been inconsistent. Studies in France (Triplet et al. 2002), England (Evans 1986) and Tasmania (Kriwoken and Hedge 2000) indicate reduced invertebrate density post-*Spartina* control, while White (1995) and Rader (1984) reported higher invertebrate densities in areas where *Spartina* had been removed. Studies in Willapa Bay found the presence of *Spartina* reduced the abundance and richness of benthic invertebrates (O'Connell 2002, Zipperer 1996). Regardless of prey density, if tideland sediment is still inaccessible to beak probing after *Spartina* removal, owing to vegetative cover, thick rootmat or dry firm sediment, it is less likely to be utilized for foraging (Stralberg et al., White 1995). For all five areas ground surveyed in the Palix meadow, there was no evidence of shorebird usage in either the live *Spartina* or in areas of dead stubble. Two ground count surveys will be conducted in fall of 2005 to assess shorebird and waterfowl presence in these areas.

Table 3. Assessment of birds in the Palix River Meadow in spring 2005.

Ground Bird Survey				**Aerial Bird Survey**			
Date	Site (GPS)	Shorebird	Waterfowl	Date	Site	Shorebird	Waterfowl
4/19/2005	#1 N 46.61245 W 123.91736	0	0	4/24/2005	Entire Meadow	20	10
4/19/2005	#2 N 46.61481 W123.93198	0	0				
4/19/2005	#3 N 46.61657 W 123.93775	0	0				
4/19/2005	#4 N 46.62209 W 123.9465	0	0				
4/19/2005	#5 N 46.62736 W 123.95016	0	0				
5/6/2005	#1 N 46.61245 W 123.91736	0	0				
5/6/2005	#2 N 46.61481 W 123.93198	0	0				
5/6/2005	#3 N 46.61657 W 123.93775	0	0				
5/6/2005	#4 N 46.62209 W 123.9465	0	0				
5/6/2005	#5 N 46.62736	0	0				

	W 123.95016						

Appendix 2
Raw data on stem density

Date	Site	Quadrats	Seedling Count	Stem Density/0.25m^2
6/10/2005	Palix 1 PS Bank 1	1	0	40
6/10/2005	Palix 1 PS Bank 1	2	2	40
6/10/2005	Palix 1 PS Bank 1	3	5	20
6/10/2005	Palix 1 PS Bank 1	4	6	5
6/10/2005	Palix 1 PS Bank 1	5	2	5
6/10/2005	Palix 1 PS Bank 1	6	1	0
6/10/2005	Palix 1 PS Bank 1	7	0	0
6/10/2005	Palix 1 PS Bank 1	8	0	0
6/10/2005	Palix 1 PS Bank 1	9	0	0
6/10/2005	Palix 1 PS Bank 1	10	0	0
6/10/2005	Palix 2 PS Bank 2	1	0	0
6/10/2005	Palix 2 PS Bank 2	2	3	0
6/10/2005	Palix 2 PS Bank 2	3	0	0
6/10/2005	Palix 2 PS Bank 2	4	2	0
6/10/2005	Palix 2 PS Bank 2	5	4	0
6/10/2005	Palix 2 PS Bank 2	6	3	0
6/10/2005	Palix 2 PS Bank 2	7	0	0
6/10/2005	Palix 2 PS Bank 2	8	5	0
6/10/2005	Palix 2 PS Bank 2	9	2	0
6/10/2005	Palix 2 PS Bank 2	10	1	60
6/10/2005	Palix 3 PS Bank 3	1	0	0
6/10/2005	Palix 3 PS Bank 3	2	0	0
6/10/2005	Palix 3 PS Bank 3	3	0	0
6/10/2005	Palix 3 PS Bank 3	4	0	0
6/10/2005	Palix 3 PS Bank 3	5	0	0
6/10/2005	Palix 3 PS Bank 3	6	0	0
6/10/2005	Palix 3 PS Bank 3	7	0	0
6/10/2005	Palix 3 PS Bank 3	8	0	0
6/10/2005	Palix 3 PS Bank 3	9	0	0
6/10/2005	Palix 3 PS Bank 3	10	0	0
6/10/2005	Palix 4 PS Bank 4	1	1	0
6/10/2005	Palix 4 PS Bank 4	2	2	0
6/10/2005	Palix 4 PS Bank 4	3	0	0
6/10/2005	Palix 4 PS Bank 4	4	0	0
6/10/2005	Palix 4 PS Bank 4	5	1	0
6/10/2005	Palix 4 PS Bank 4	6	0	0
6/10/2005	Palix 4 PS Bank 4	7	2	0
6/10/2005	Palix 4 PS Bank 4	8	0	0
6/10/2005	Palix 4 PS Bank 4	9	1	0

6/10/2005	Palix 4 PS Bank 4	10	0	0
6/10/2005	Palix 5 PS Bank 5	1	2	0
6/10/2005	Palix 5 PS Bank 5	2	4	0
6/10/2005	Palix 5 PS Bank 5	3	2	0
6/10/2005	Palix 5 PS Bank 5	4	5	0
6/10/2005	Palix 5 PS Bank 5	5	2	0
6/10/2005	Palix 5 PS Bank 5	6	0	0
6/10/2005	Palix 5 PS Bank 5	7	1	0
6/10/2005	Palix 5 PS Bank 5	8	5	0
6/10/2005	Palix 5 PS Bank 5	9	4	0
6/10/2005	Palix 5 PS Bank 5	10	1	0
6/10/2005	Palix 6 PS Bank 6	1	2	0
6/10/2005	Palix 6 PS Bank 6	2	2	0
6/10/2005	Palix 6 PS Bank 6	3	0	0
6/10/2005	Palix 6 PS Bank 6	4	4	0
6/10/2005	Palix 6 PS Bank 6	5	3	0
6/10/2005	Palix 6 PS Bank 6	6	3	0
6/10/2005	Palix 6 PS Bank 6	7	2	0
6/10/2005	Palix 6 PS Bank 6	8	0	0
6/10/2005	Palix 6 PS Bank 6	9	4	0
6/10/2005	Palix 6 PS Bank 6	10	0	20
6/10/2005	Palix 7 PS Bank 7	1	1	0
6/10/2005	Palix 7 PS Bank 7	2	0	0
6/10/2005	Palix 7 PS Bank 7	3	0	0
6/10/2005	Palix 7 PS Bank 7	4	1	0
6/10/2005	Palix 7 PS Bank 7	5	0	0
6/10/2005	Palix 7 PS Bank 7	6	0	0
6/10/2005	Palix 7 PS Bank 7	7	0	0
6/10/2005	Palix 7 PS Bank 7	8	1	0
6/10/2005	Palix 7 PS Bank 7	9	0	0
6/10/2005	Palix 7 PS Bank 7	10	1	0
6/2/2005	Palix meadow PLX1	1	2	16
6/2/2005	Palix meadow PLX1	2	3	1
6/2/2005	Palix meadow PLX1	3	2	10
6/2/2005	Palix meadow PLX1	4	4	1
6/2/2005	Palix meadow PLX1	5	10	0
6/2/2005	Palix meadow PLX1	6	6	0
6/2/2005	Palix meadow PLX1	7	3	0
6/2/2005	Palix meadow PLX1	8	4	0
6/2/2005	Palix meadow PLX1	9	2	0
6/2/2005	Palix meadow PLX1	10	4	0
6/2/2005	Palix meadow PLX1	11	0	1
6/2/2005	Palix meadow PLX1	1	27	0
6/2/2005	Palix meadow PLX1	2	>25	0
6/2/2005	Palix meadow PLX1	3	>25	10

6/2/2005	Palix meadow PLX2	4	>25	1
6/2/2005	Palix meadow PLX2	5	18	0
6/2/2005	Palix meadow PLX2	6	>25	0
6/2/2005	Palix meadow PLX2	7	12	0
6/2/2005	Palix meadow PLX2	8	9	0
6/2/2005	Palix meadow PLX2	9	4	0
6/2/2005	Palix meadow PLX2	10	8	0
6/2/2005	Palix meadow PLX2	11	>25	0
6/2/2005	Palix meadow PLX2	12	15	0
6/2/2005	Palix meadow PLX2	13	20	0
6/2/2005	Palix meadow PLX3	1	0	0
6/2/2005	Palix meadow PLX3	2	6	1
6/2/2005	Palix meadow PLX3	3	1	0
6/2/2005	Palix meadow PLX3	4	4	0
6/2/2005	Palix meadow PLX3	5	1	0
6/2/2005	Palix meadow PLX3	6	0	0
6/2/2005	Palix meadow PLX3	7	1	0
6/2/2005	Palix meadow PLX3	8	0	0
6/2/2005	Palix meadow PLX3	9	6	0
6/2/2005	Palix meadow PLX3	10	5	0
6/2/2005	Palix meadow PLX3	11	1	0
6/2/2005	Palix meadow PLX3	12	0	0
6/2/2005	Palix meadow PLX3	13	0	0
6/2/2005	Palix meadow PLX3	14	2	0
6/2/2005	Palix meadow PLX3	15	0	0
6/2/2005	Palix meadow PLX3	16	7	0
6/2/2005	Palix meadow PLX3	17	0	0
6/2/2005	Palix meadow PLX3	18	0	0
6/2/2005	Palix meadow PLX3	19	1	0
6/2/2005	Palix meadow PLX3	20	0	0
6/2/2005	Palix meadow PLX4	1	1	0
6/2/2005	Palix meadow PLX4	2	0	0
6/2/2005	Palix meadow PLX4	3	0	2
6/2/2005	Palix meadow PLX4	4	0	0
6/2/2005	Palix meadow PLX4	5	1	0
6/2/2005	Palix meadow PLX4	6	0	0
6/2/2005	Palix meadow PLX4	7	0	0
6/2/2005	Palix meadow PLX4	8	0	0
6/2/2005	Palix meadow PLX4	9	0	0
6/2/2005	Palix meadow PLX4	10	0	0
6/2/2005	Palix meadow PLX4	11	1	0
6/2/2005	Palix meadow PLX4	12	0	0
6/2/2005	Palix meadow PLX4	13	0	0
6/2/2005	Palix meadow PLX5	1	0	0
6/2/2005	Palix meadow PLX5	2	0	0

6/2/2005	Palix meadow PLX5	3	0	0
6/2/2005	Palix meadow PLX5	4	0	0
6/2/2005	Palix meadow PLX5	5	1	2
6/2/2005	Palix meadow PLX5	6	0	0
6/2/2005	Palix meadow PLX5	7	0	0
6/2/2005	Palix meadow PLX5	8	0	2
6/2/2005	Palix meadow PLX5	9	0	0
6/2/2005	Palix meadow PLX5	10	0	0
6/2/2005	Palix meadow PLX5	11	0	0
6/2/2005	Palix meadow PLX5	12	0	0
6/2/2005	Palix meadow PLX5	13	0	0
6/2/2005	Palix meadow PLX5	14	0	1
6/2/2005	Palix meadow PLX5	15	3	0
6/2/2005	Palix meadow PLX5	16	5	2
6/2/2005	Palix meadow PLX5	17	0	0
6/2/2005	Palix meadow PLX5	18	0	0
6/2/2005	Palix meadow PLX5	19	0	0
6/2/2005	Palix meadow PLX5	20	0	0
6/2/2005	Palix meadow PLX6	1	0	0
6/2/2005	Palix meadow PLX6	2	3	20
6/2/2005	Palix meadow PLX6	3	2	0
6/2/2005	Palix meadow PLX6	4	0	0
6/2/2005	Palix meadow PLX6	5	2	0
6/2/2005	Palix meadow PLX6	6	2	10
6/2/2005	Palix meadow PLX6	7	0	5
6/2/2005	Palix meadow PLX6	8	3	0
6/2/2005	Palix meadow PLX6	9	0	0
6/2/2005	Palix meadow PLX6	10	2	0
6/2/2005	Palix meadow PLX6	11	4	20
6/2/2005	Palix meadow PLX6	12	0	10
6/2/2005	Palix meadow PLX6	13	0	0
6/2/2005	Palix meadow PLX6	14	2	10
6/2/2005	Palix meadow PLX6	15	3	10
6/2/2005	Palix meadow PLX6	16	2	25
6/2/2005	Palix meadow PLX6	17	1	20
6/2/2005	Palix meadow PLX6	18	4	15
6/2/2005	Palix meadow PLX6	19	6	20
6/2/2005	Palix meadow PLX6	20	0	0

Appendix 1

Stem Monitoring data from 3/2/2005 from the upper Palix meadow								
Habitat @ 5pt/ac								Rodeo 5% since 1997
Site 1	Site 2	Site 3	Site 4	Site 5	Site 5	Site 6	Site 7	
Palix R. E section along bank, just N. of bridge	Palix R. channel N. bank next to bridge out to 1st slough	Palix meadow just N. of Patten's 2003 imazapyr strip	E. edge of Palix meadow	Upper Palix meadow 300' out from E shoreline	NE corner of Palix meadow	NE Palix meadow to outer S. bank of Niawiakum R.	S. bank of Niawiakum R. W. of Bridge	S. bank of Niawiakum E of Bridge
0	0	0	0	0	0	0	0	2
0	0	0	0	0	0	0	0	10
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	25
0	0	0	0	0	0	0	0	10
0	0	0	0	0	0	0	0	50
0	0	0	0	0	0	0	0	50
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	10
0	0	0	0	0	0	0	0	20
0	0	0	0	0	0	0	0	50
0	0	0	0	0	0	0	0	3
0	0	0	0	0	0	0	0	50
0	0	0	0	0	0	0	0	50
0	0	0	0	0	0	0	0	50
0	0	0	0	0	0	0	0	1
0	0	5	0	0	0	0	0	35
0	0	1	0	0	3	0	0	1
0	0		0	0	5	0	0	1
0	0		0	0	15	0	0	10
0	0		0	0		0	0	25
0	0		0	0		0	0	35
0	0		0	0		0	5	50
0	0		0	0		0	7	
0	5		0	0		0	2	
0	1		0	0		0	1	
0	20		0	0		0		
0	50		0	0		0		
5	50		0	0				
2	30		0	10				
2	5			10				
4	1		1	10				
			5	10				
				10				
				2				
				2				
				2				
				7				
				50				

Appendix 3 Raw data on bird counts

Palix ***Spartina*** Meadow—Bird Survey Spring 2005

Date—4/19/2005
Started with overview from bridge. Meadow is expansive. Vehicle traffic on bridge is heavy, only able to do quick overview of area from here. Lots of standing dead *Spartina.*

High Tide: 10:54 am/ 7.4 ft
Weather: T 58, clouds: 10, light wind
Area 2/10:25 am: Regrowth/green in foreground. Lots of standing dead *Spartina*. Thick growth is not shorebird friendly. Some smaller areas of accumulated wrack.
Bird Count: 0
Area 3/10:40 am: Thick area of *Spartina.* No bare areas. *Spartina* regrowth prevalent
Bird Count: 0
Area 4/10:55 am: Same as above.
Bird Count: 0
Area 5/11:10 am: Dick Wilson's House. Nice overview of *Spartina* Meadow. Dick said he has seen flocks of Dunlin fly over, but no landings. Too much stubble. Areas of standing dead *Spartina* as well as regrowth.
Bird Count: 0
Area 6/11:45 am: Meadow viewed from construction pullout.
Bird Count: 0
****

Day 2 5/6/2005
High Tide: 13:30/8.0 feet
Weather: 60 F Clouds: 9.0

Area 2/14:55 pm: 1 hour past high tide. Receding tide.
Bird Count: 0 shorebirds, 1 heron
Area 3/15:10 pm:
Bird Count: 0 shorebirds
Area 4/15:25 pm:
Bird Count: 0 shorebirds, 3 heron
Area 5/15:40 pm:
Bird Count: 0 shorebirds, 1 heron, 1 duck
Area 6/15:55 pm:
Bird Count: 0 shorebirds

REFERENCES

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