BASELINE MONITORING OF EMERGENT SALT MARSH VEGETATION IN PADILLA BAY 2006-2011

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October 2011

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ACKNOWLEDGEMENTS

This report was funded in part through a cooperative agreement with the National Oceanic and Atmospheric Administration. The views expressed herein are those of the author and do not necessarily reflect the views of NOAA or any of its subagencies.

I would like to thank Carrie Wilcoxen (Padilla Bay NERR Natural Resources Assistant, Tristen Wuori (student volunteer), and Brittany Collins (Washington Conservation Corps/AmeriCorps) for their assistance with this project.

TABLE OF CONTENTS

INTRODUCTION

Located in Skagit County between Mount Vernon and Anacortes in northwestern Washington State, Padilla Bay is one of 28 National Estuarine Research Reserve (NERR) sites in the United States. These sites were established under the Coastal Zone Management Act of 1972, Section 315, the purpose of which is stewardship, education and research in representative estuaries throughout the coastal United States.

The research sector of the NERR System established a System-Wide Monitoring Program (SWMP) in 1995. The initial focus of this program was to establish a water quality monitoring dataset (via deployment of data loggers at 1-4 sites within the reserves) and to set up a weather station to monitor parameters such as rain, wind direction and speed, temperature and relative humidity. Within the past few years, there has been a movement toward expansion of SWMP into the biological monitoring realm. The research sector has proposed protocol for the collection of submerged aquatic vegetation, such as eelgrass, and for emergent salt marsh vegetation, such as *Salicornia* and *Distichlis*. The emergent salt marsh protocol is based on Roman, *et al.* (2001) and sets up permanent plots that are monitored at regular intervals. That protocol was developed for the long-term Coastal Ecosystem Monitoring Program at Cape Cod National Seashore in Massachusetts. Our Research sector has chosen to monitor eelgrass (*Zostera marina* and *Zostera japonica*). Therefore, the Stewardship sector has chosen to monitor emergent salt marsh as a complementary effort.

The impetus for monitoring our salt marsh vegetation comes from increasing pressures on habitat, climate change and sea level rise, proposals for re-routing Skagit River flood waters into the Swinomish Channel (just south of where it enters Padilla Bay), and our proximity to oil refineries. Padilla Bay has only remnant salt marshes remaining, in large part due to the diking and draining that occurred from the mid-1800s to the early 1900s. These efforts converted tidal mudflats and salt marshes to land used largely for agriculture. This is the sixth year of sampling at the Sullivan Minor salt marsh using modifications to the Roman, *et al.* (2001) protocol.

MATERIALS & METHODS

Monitoring Site Description

Sullivan Minor Salt Marsh

The 24-acre Sullivan-Minor salt marsh is part of the Reserve (Fig. 1). It was mudflat that was diked and drained in the early-to-mid 1800s. The dike fell to disrepair sometime in the early 1900s and all that is left of the dike is a berm on the outside of the marsh. There is a log accumulation in the northeastern corner and a freshwater channel (stormwater runoff) that is often plugged by drift eelgrass or sediment at its mouth in the summer. In summer, the water in the channel is often dark in color and appears to be anoxic when the mouth is plugged. There is evidence of freshwater runoff at the south end of the property as there is a cattail (*Typha latifolia*) stand present. The predominant vegetation in this salt marsh is pickleweed (*Salicornia virginica*) and salt grass (*Distichlis spicata*). Granger and Burg (1986) give a more complete listing of the vegetation at this site (Appendix 1), which includes vegetation on logs, in the freshwater areas of the site and on the berm.

Baseline Sampling Protocol

In 2004 we placed "permanent" plots as suggested by Roman, et al. (2001) but felt this impacted the salt marsh by creating permanent trails and compaction. We did not collect data in 2005. Starting in 2006, we modified the protocol by choosing random plots each year. This limits us in our data comparisons (we obtain an average for each plot, then average the plots for one data point for each species), but has less impact on the limited salt marsh we do have in Padilla Bay. Another departure from Roman, *et al.* (2001) is that we did not destructively measure biomass every month the first year to determine peak biomass. This decision was due to our limited salt marsh habitat and limited staff and time available in our schedule to collect the data. We made an educated guess as to when peak biomass might occur (see discussion) and have sampled around those dates each year (Table 1).

We took GPS readings around the Sullivan Minor salt marsh using the following as boundaries: the log accumulation on the north, the drainage ditch and cattail marsh on the east, the borrow ditch on the south, and the berm on the west. The polygon was placed on an aerial photo and random points (no less than 60 feet or 18.3 meters apart)

were generated using the free Hawth's Tools extension (www.spatialecology.com\htools) that was loaded into ARC GIS (Fig. 2). Those points were loaded into a hand-held Garmin (GPS12) and we used the "goto" function to locate the points in the field (2006-2009). In 2010 and 2011, the "goto" function was not working properly so we found the points on the aerial photo using landmarks. As the accuracy for the Garmin is typically ± 10 m our point location was at least as accurate as using the "goto." As per Roman, *et al.* (2001), we marked five wooden dowels at 11.1 cm intervals (each dowel had 10 marks). The plot location was 1- meter north of the point location. Another meter stick was laid perpendicular to the first meter stick on an east-west axis and the dowels were threaded through the vegetation at 0, 25, 50, 75, and 100 cm (on a north-south axis). A metal rod or "bayonet" was dropped through the vegetation at each point in the grid and any vegetation touching the rod was recorded as well as other cover types. We did not measure any of the "associated environmental variables" (i.e. water table level, soil water, salinity, or soil sulfides) suggested by Roman, *et al.* (2001).

RESULTS

2006

Species. Five plant species were found at Sullivan Minor: *Ambrosia chamissonis*, *Atriplex patula*, *Distichlis spicata*, *Salicornia virginica* and one grass, *Agrostis* sp. (Table 2).

Percent Cover. Cover categories are provided in Table 3. The highest percent covers of live plants were for *Distichlis spicata* (70.9%) and *Salicornia virginica* (51.9%) (Figs. 3 & 4). Percent cover of rooted dead plant material was highest for *Distichlis spicata* (62.7%) and *Salicornia virginica* (51.2%) (Figs. 3 & 4). Live *Atriplex patula* (5%), *Ambrosia chamissonis* (2.4%) and *Agrostis* sp. (0.2%) were also recorded in the plots with no rooted dead recorded for any species (Fig. 3).

The other cover categories were as follows: bare substrate (96.1%), litter/wrack (25.6%), rock (2.9%), trash (0.1%) (Fig. 3).

2007

Species. Six plant species were found at Sullivan Minor: *Atriplex patula*, *Cuscuta salina*, *Distichlis spicata*, *Lepidium* sp., *Salicornia virginica*, and *Vaucheria litorea* (Table 2).

Percent Cover. Cover categories are provided in Table 3. The highest percent covers of live plants were for *Salicornia virginica* (77.3%) and *Distichlis spicata* (68.3%) (Figs. 3 & 4). Percent cover of rooted dead plant material was highest for *Distichlis spicata* (58.3%), followed by *Salicornia virginica* (43.6%) (Figs. 3 & 4). Other species found live in the plots were: *Atriplex patula* (22.2%), *Cuscuta salina* (0.4%), *Lepidium* sp. (0.1%), and *Vaucheria litorea* (0.1%). Dead rooted *Atriplex* (0.1%) was found in one plot.

The other cover categories were as follows: bare substrate (95%), wrack/leaf litter (64.5%) and rock (1.7%) (Fig. 3).

2008

Species. Eight plant species were found at Sullivan Minor: *Ambrosia chamissonis*, *Atriplex patula*, *Cuscuta salina*, *Distichlis spicata*, *Lepidium* sp., *Salicornia virginica*, *Agrostis* sp. and *Aster* sp. (Table 2).

Percent Cover. Cover categories are provided in Table 3. The highest percent covers of live plants were for *Distichlis spicata* (76.3%) and *Salicornia virginica* (56.7%) (Figs. 3 & 4). Percent cover of rooted dead plant material was highest for *Distichlis spicata* (58.7%), followed by *Salicornia virginica* (13.5%) (Figs. 3 & 4). Other species found live in the plots were: *Atriplex patula* (13.3%), *Ambrosia chamissonis* (1.8%), *Cuscuta salina* (1.5%), and *Lepidium* sp. (0.4%). Live *Agrostis* sp. was found in one plot (0.1%) and a live *Aster* sp. was found in one plot (0.1%). Dead rooted *Atriplex* (0.1%) was found in one plot.

The other cover categories were as follows: bare substrate (17.7%), wrack/leaf litter (80.8%) and rock (1.2%) (Fig. 3).

2009

Species. Nine plant species were found at Sullivan Minor: *Achillea millefolium*, *Atriplex patula*, *Cuscuta salina*, *Distichlis spicata*, *Galium aparine*, *Grindelia integrifolia*, *Lepidium* sp., *Leymus mollis*, and *Salicornia virginica* (Table 2).

Percent Cover. Cover categories are provided in Table 3. The highest percent covers of live plants were for *Distichlis spicata* (68.9%), *Salicornia virginica* (64.5%), and *Atriplex patula* (22.9%) (Figs. 3 & 4). Percent cover of rooted dead plant material was highest for *Distichlis spicata* (63.8%) and *Salicornia virginica* (35.1%) (Figs. 3 & 4). Other species found live in the plots were: *Lepidium* sp. (3.5%), *Leymus mollis* (0.4%), *Cuscuta salina* (0.4%), *Galium aparine* (0.2%) and *Achillea millefolium* (0.1%).

The other cover categories were as follows: wrack/leaf litter (84.9%), bare (23.6%) and rock (1.1%) (Fig. 3).

2010

Species. Eight plant species were found at Sullivan Minor: Aster sp., *Atriplex patula*, *Cuscuta salina*, *Distichlis spicata*, *Grindelia integrifolia*, *Leymus mollis*, *Salicornia virginica* and an unidentified grass (Table 2).

Percent Cover. Cover categories are provided in Table 3. The highest percent covers of live plants were for *Distichlis spicata* (89.1%), *Salicornia virginica* (33.5%), and *Atriplex patula* (2.5%) (Figs. 3 & 4). Percent cover of rooted dead plant material was highest for *Distichlis spicata* (72.7%) and *Salicornia virginica* (24.6%) (Figs. 3 & 4). Other species found live in the plots were: *Cuscuta salina* (2.7%), *Atriplex patula* (2.5%), *Grindelia integrifolia* (1%), an unidentified grass (0.2%) and *Leymus mollis* (0.1%).

The other cover categories were as follows: bare (94%), wrack/leaf litter (83.1%), and rock (1.4%) (Fig. 3).

2011

Species. Ten plant species were found at Sullivan Minor: *Agrostis alba*, *Aster* sp., *Atriplex patula*, *Cuscuta salina*, *Distichlis spicata*, *Lepidium* sp., *Potentilla anserina*, *Salicornia virginica*, *Sonchus arvensis*, and one unidentified grass (Table 2).

Percent Cover. Cover categories are provided in Table 3. The highest percent covers of live plants were for *Distichlis spicata* (61.0%), *Salicornia virginica* (40.0%), *Agrostis alba* (14.3%) and *Atriplex patula* (7.9%) (Figs. 3, 4A, 4B). Percent cover of rooted dead plant material was highest for *Distichlis spicata* (50.6%), *Salicornia virginica* (19.3%), and *Agrostis alba* (2.2%) (Figs. 3, 4A, 4B). Other species found live in the plots were: *Potentilla anserina* (5.4%), *Cuscuta salina* (4.6%), *Lepidium* sp. (0.7%), *Sonchus arvensis* (0.4%), and *Aster* sp. (0.1%) (Fig 3).

The other cover categories were as follows: wrack/leaf litter (87.5%), bare (11.3%), and rock (4.8%) (Fig. 3).

DISCUSSION

This is the sixth year of collecting baseline salt marsh data (percent cover) at Sullivan Minor in late July. Burg et al. (1980) found average dry weights of live and dead material from a *Distichlis spicata – Salicornia virginica* association in the Nisqually delta (south Puget Sound) peaked in August (July (630 g/m^2), August (920 g/m^2), September (770 g/m^2)), so our percent cover sampling may not be at peak biomass.

Percent cover of live *Salicornia* in our study was highest in 2007 (51.9%, **77.3**%, 56.7%, 64.5%, 33.5%, 40.0%; 2006-2011, respectively). Percent cover of live *Distichlis* was highest in 2010 (70.9%, 68.3%, 76.3%, 68.9%, **89.1**%, 61.0%; 2006-2011, respectively). Percent cover of dead *Distichlis* was highest in 2010 (62.7%, 58.3%, 58.7%, 63.8%, **72.7**%, 50.6%; 2006-2011, respectively). Percent cover of dead *Salicornia* was highest in 2006 (**51.2**%, 43.6%, 13.5%, 35.1%, 24.6%, 19.3%; 2006-2011, respectively).

The range of percent cover for the dominant live plants in the plots in late July (all years inclusive) was: *Distichlis* (61.0% - 89.1%), *Salicornia* (33.5% - 77.3%), and *Atriplex* (2.5% - 22.9%) (Table 4). The range of percent cover for the dominant dead plants in the plots in late July (all years inclusive) was: *Distichlis* (50.6% - 72.7%), *Salicornia* (13.5% - 51.2%), and *Atriplex* (0% - 0.6%) (Table 4). It will likely take 10 years of data collection to document the natural variation in late July at this site.

A difficulty encountered over the years is calibration of people collecting the data. The category of greatest difficulty is the "dead" category and making sure the dead plant

is still rooted. If the plant is not rooted, then it is recorded as "Wrack/leaf litter." *Salicornia* stems often appear dead, but when followed to their roots, reveal that they are living plants. This category takes more patience than any of the other categories. Another category for potential errors is the "bare substrate" category as it is often difficult to see the substrate clearly without disturbing the vegetation around the point or points next to it. One way to reduce errors is for one person to "read" all the plots and to break the data collection into smaller segments so the reader doesn't get too fatigued.

Cuscuta salina is a parasitic plant on *Salicornia*, so is not rooted, but was counted as a live plant. It is commonly present at Sullivan Minor in localized areas.

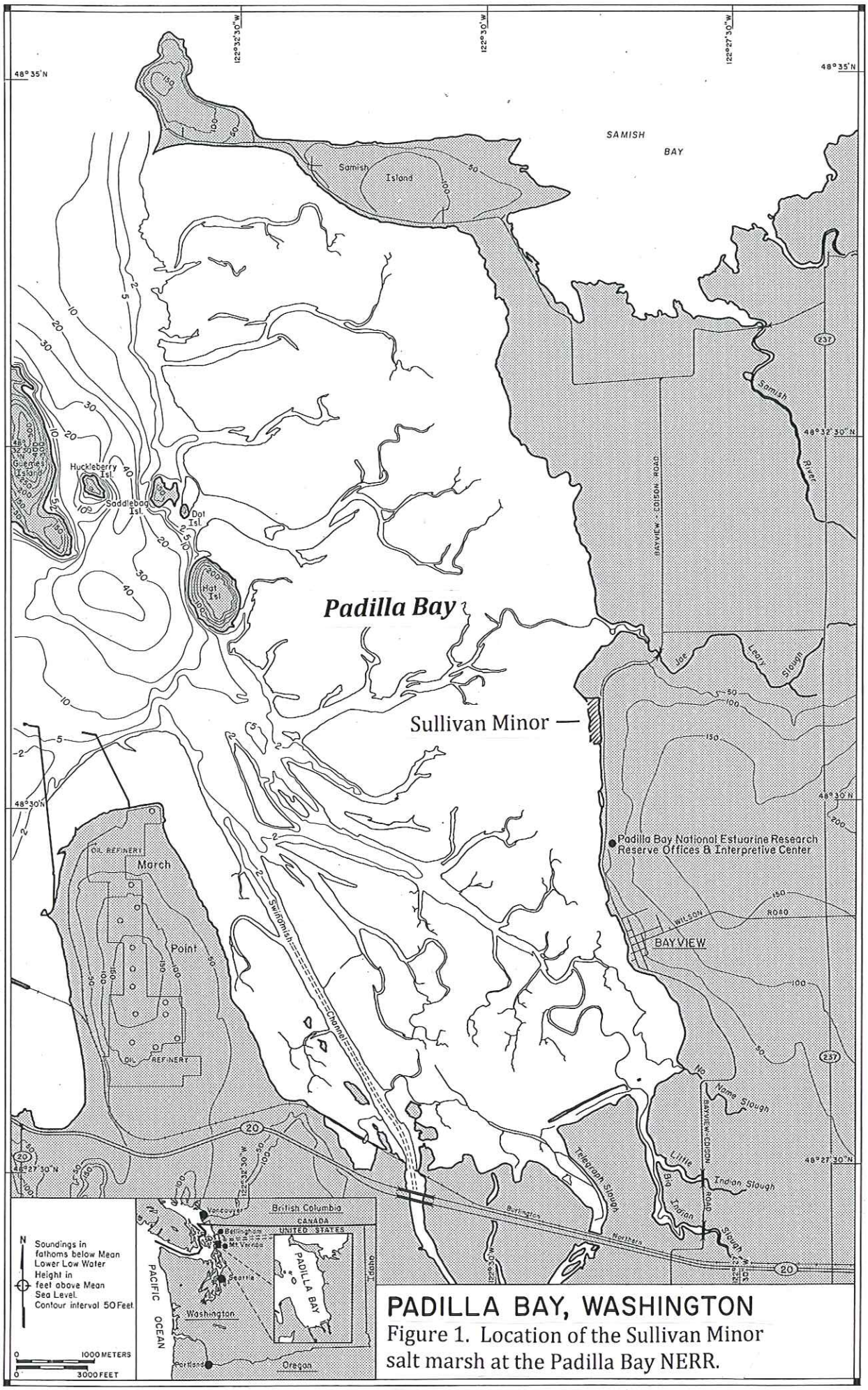
We expect to collect data at this same site in the coming years to provide a baseline against which to measure future changes.

REFERENCES

Burg, M.E., D.R. Tripp and E.S. Rosenberg. 1980. Plant associations and primary productivity of the Nisqually salt marsh on southern Puget Sound, Washington. Northwest Science 54(3): 222-236.

Granger, T. and M. Burg. 1986. Plant communities of a salt marsh in Padilla Bay, Washington. Report to Washington Department of Ecology, Padilla Bay NERR by WDOE/Shorelands & CZM Program, Wetlands Section, Olympia, Washington. Padilla Bay NERR Reprint Series No. 4, 1990.

Roman, C.T., M-J. James-Pirri, and J.F. Heltshe. 2001. Monitoring salt marsh vegetation: a protocol for the Long-term Coastal Ecosystem Monitoring Program at Cape Cod National Seashore. Long-term Coastal Ecosystem Monitoring Program, Cape Cod National Seashore, Wellfleet, Massachusetts.



PADILLA BAY, WASHINGTON

Figure 1. Location of the Sullivan Minor salt marsh at the Padilla Bay NERR.

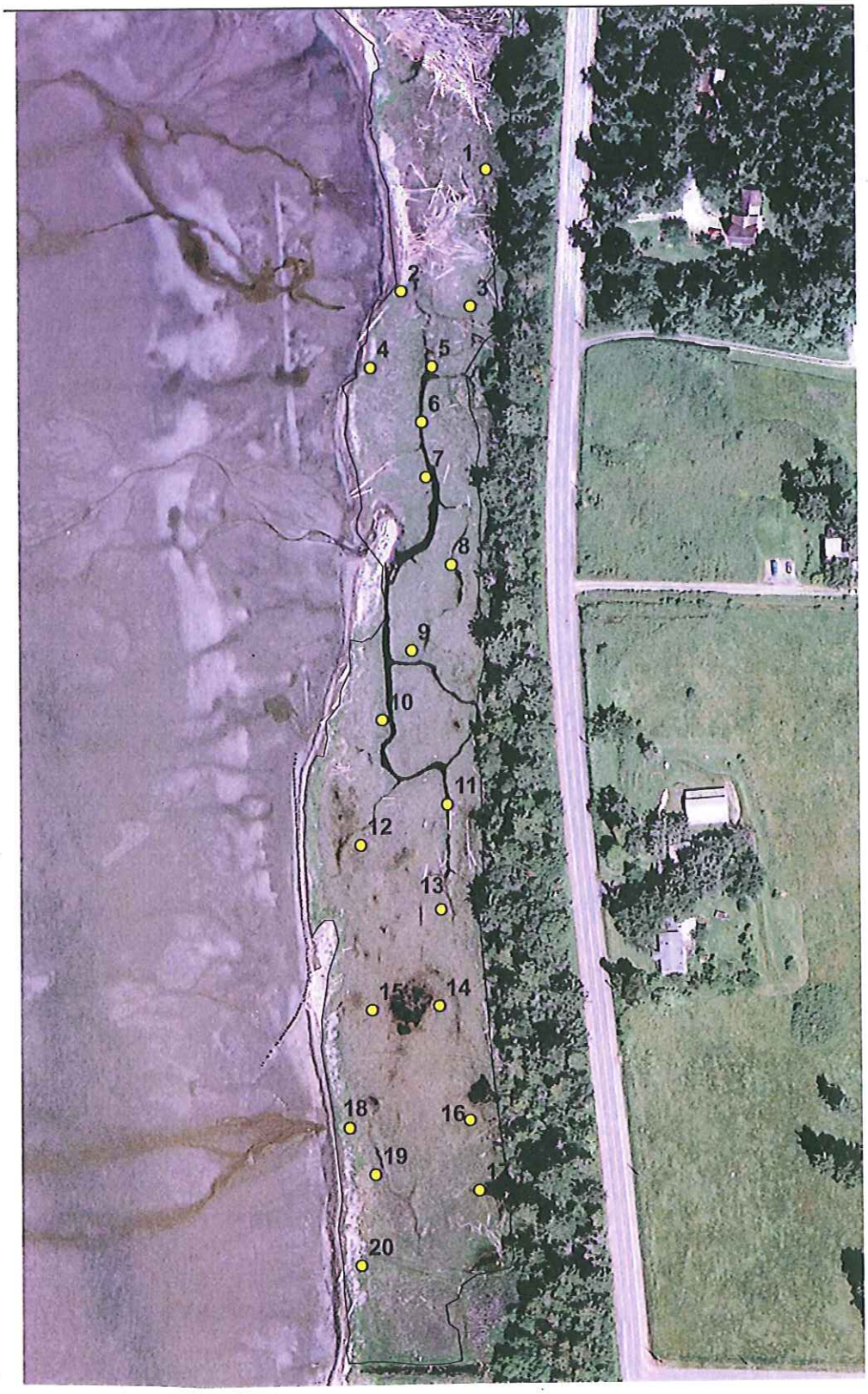


Figure 2. Locations of 2011 random sampling plots at the Sullivan Minor salt marsh in Padilla Bay, Skagit County, Washington (minimum distance: 60 ft).

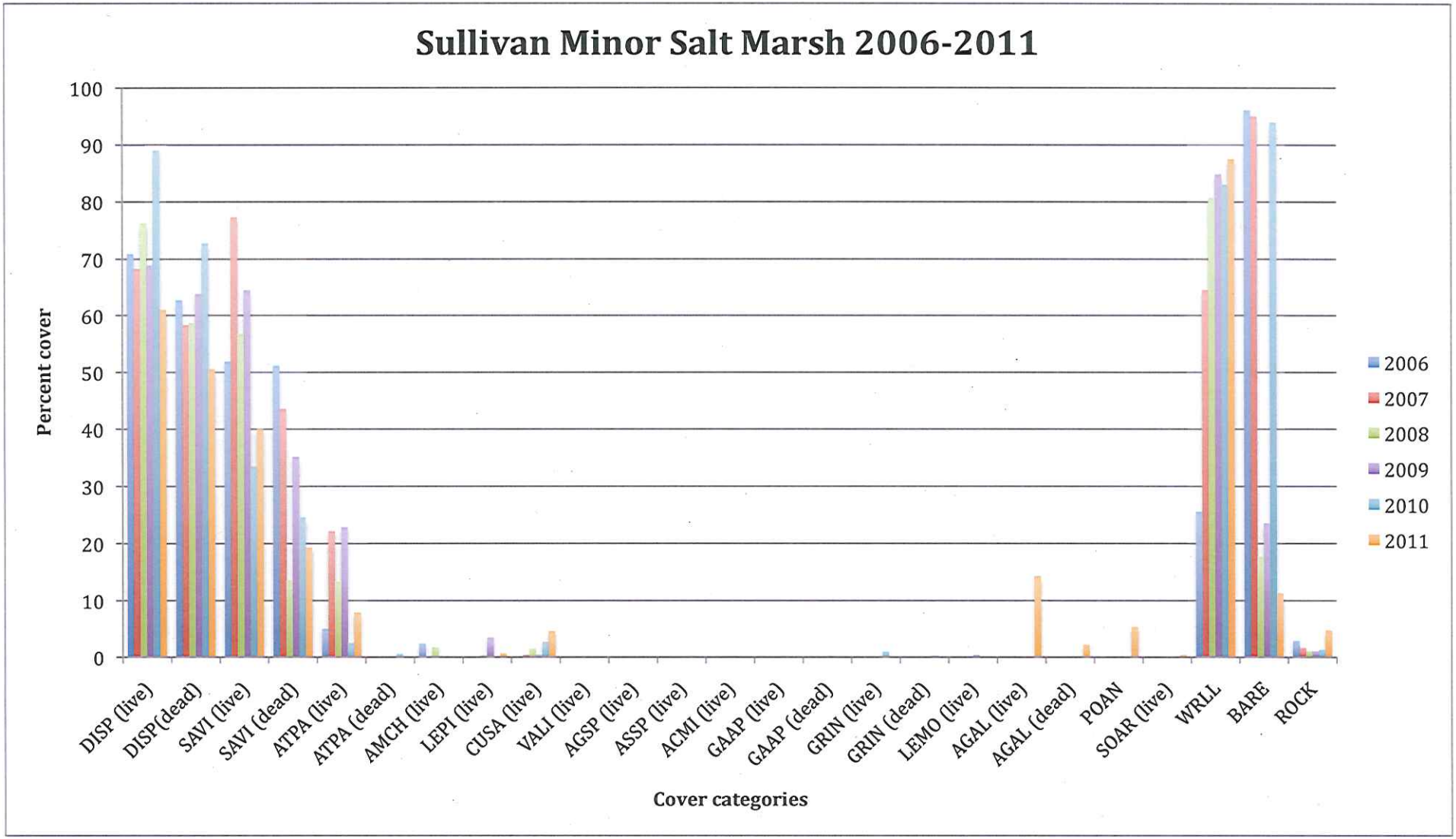


Figure 3. Comparison of percent cover of all cover categories found at Sullivan Minor salt marsh (live and dead) from 2006-2011 (n=20 plots).

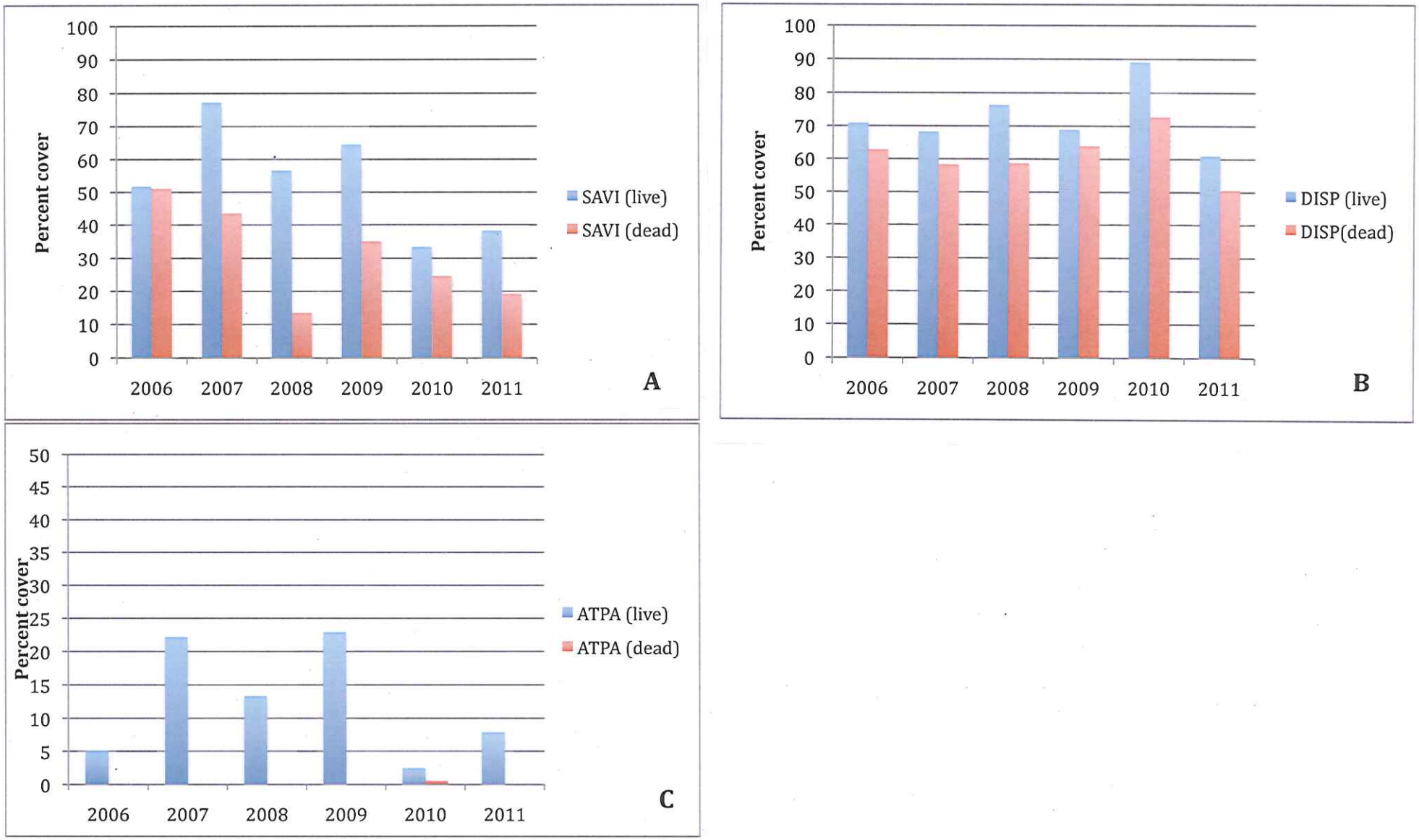


Figure 4. Comparison of live and dead percent cover for the dominant species (A. *Salicornia virginica*, B. *Distichlis spicata*, and C. *Atriplex patula*) at the Sullivan Minor salt marsh from 2006-2011.

Table 1. Dates of data collection for percent cover of live and dead species at the Sullivan Minor salt marsh on the eastern shore of Padilla Bay, Washington from 2006-2011.

Month	Dates	Year
July	26-27	2006
July	25-26	2007
July	30-31	2008
July	23-24	2009
July	26-27	2010
July	26-28	2011

Table 2. Plant species and families found at the Sullivan Minor salt marsh sampling in Padilla Bay, Washington, from 2006-2011.

Family	Common Name	Scientific Name	2006	2007	2008	2009	2010	2011
Agrostideae	Bentgrass	*Agrostis sp.*	X	*	X	*	*	X
Asteraceae	Aster	*Aster sp.*	*	*	X	*	*	X
Asteraceae	Silver burweed	*Ambrosia chamissonis*	X	*	X	*	X	*
Asteraceae	Gumweed	*Grindelia integrifolia*	*	*	*	X	*	*
Asteraceae	Common Yarrow	*Achillea millefolium*	*	*	*	X	*	*
Asteraceae	Field sowthistle	*Sonchus arvensis*	*	*	*	*	*	X
Chenopodiaceae	Salt bush	*Atriplex patula*	X	x	X	X	X	X
Chenopodiaceae	Pickleweed	*Salicornia virginica*	X	X	X	X	X	X
Convolvulaceae	Salt marsh dodder	*Cuscuta salina*	*	X	X	X	*	X
Cruciferae	Pepper grass	*Lepidium sp.*	*	X	X	X	*	X
Poaceae	Salt grass	*Distichlis spicata*	X	X	X	X	X	X
Poaceae	Dune grass	*Leymus mollis*	*	*	*	X	*	*
Rosaceae	Pacific cinquefoil	*Potentilla anserina*	*	*	*	*	*	X
Rubiaceae	Cleavers	*Galium aparine*	*	*	*	X	*	*
Vaucheriaceae		*Vaucheria litorea*	*	X	*	*	*	*

* none found in plots

Table 3. Key for cover categories in Fig. 3.

ACMI	*Achillea millefolium*
AGAL	*Agrostis alba*
AGSP	*Agrostis sp.*
AMCH	*Ambrosia chamissonis*
ASSP	*Aster sp.*
ATPA	*Atriplex patula*
CUSA	*Cuscuta salina*
DISP	*Distichlis spicata*
GAAP	*Galium aparine*
GRIN	*Grindelia integrifolia*
LEPI	*Lepidium sp.*
LEMO	*Leymus mollis*
POAN	*Potentilla anserina*
SAVI	*Salicornia virginica*
SOAR	*Sonchus arvensis*
VALI	*Vaucheria litorea*
BARE	bare substrate (sand/mud)
ROCK	gravel, cobble, rock
TRSH (2006)	trash (wood)
WRLL (2006)	wrack, leaf litter
WRLL (2007-2011)	wrack, leaf litter, wood

Table 4. Range of live and dead percent cover for the dominant salt marsh species compared across years (***High***, **Low**).

LIVE

	Distichlis	*Salicornia*	*Atriplex*
2006	70.9	51.9	5.0
2007	68.3	***77.3***	22.2
2008	76.3	56.7	13.3
2009	68.9	64.5	***22.9***
2010	***89.1***	**33.5**	**2.5**
2011	**61.0**	40.0	7.9

DEAD

	Distichlis	*Salicornia*	*Atriplex*
2006	62.7	***51.2***	**0.0**
2007	58.3	43.6	0.1
2008	58.7	**13.5**	0.1
2009	63.8	35.1	0.1
2010	***72.7***	24.6	***0.6***
2011	**50.6**	19.3	**0.0**

Appendix 1. Sullivan Minor salt marsh species (Granger and Burg, 1986).

Salt grass	*Distichlis spicata*
Pickleweed	*Salicornia virginica*
Salt bush	*Atriplex patula*
Salt marsh sandspurry	*Spergularia canadensis*
Salt marsh dodder	*Cuscuta salina*
Pepper-grass	*Lepidium sp.*
Creeping bentgrass	*Agrostis alba*
Aster sp.	*Aster sp.*
Foxtail barley	*Hordeum jubatum*
Composite sp.	
Yarrow	*Achillea millefolium*
Gumweed	*Grindelia integrifolia*
Tideland alkali grass	*Puccinellia lucida*
Grass sp.	
Pacific water parsley	*Oenanthe sarmentosa*
Reed canary grass	*Phalaris arundinacea*
European bittersweet	*Solanum dulcamara*
Cattail	*Typha latifolia*