

2015

British Columbia Spartina Eradication Program Progress Report

Prepared By
Ducks Unlimited Canada
#511 – 13370 78th Ave
Surrey, BC, V3W 0H6
604-592-0987
On Behalf of the BC Spartina Working Group



British Columbia Working Group Members Include:

City of Surrey
Coastal Invasive Species Committee (CISC)
Community Mapping Network (CMN)
Corporation of Delta
Invasive Species Council of Metro Vancouver (ISCMV)
Ducks Unlimited Canada (DUC)
Environment Canada – Canadian Wildlife Service (CWS)
Fisheries and Oceans Canada (DFO)
Friends of Semiahmoo Bay Society (FOSBS)
Ladner Rotary Club
Metro Vancouver
Ministry of Environment (MoE)
Ministry of Forests, Lands & Natural Resource Operations (FLNRO)
Port Metro Vancouver (PMV)
City of Port Moody
Vancouver Island Conservation Lands Management Program (VICLMP)

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Collectively these organizations and individuals contributed a total value of over \$410,000 as in-kind donations and direct funding.

The representatives to the BCSWG included Kathleen Moore (Environment Canada – Canadian Wildlife Service - CWS), Markus Merkens (Metro Vancouver), Angela Danyluk, Kevin Li (Corporation of Delta), Liana Ayach (City of Surrey-SHaRP), Dan Buffett & Matt Christensen (Ducks Unlimited Canada - DUC), Rob Knight (Community Mapping Network), Margaret Cuthbert (Friends of Semiahmoo Bay), Becky Brown (Ministry of Forests, Lands & Natural Resource Operations), Kim Keskinen, Ashley Graham (Port Metro Vancouver), Graham Watson, Tasha Murray (Invasive Species Council of Metro Vancouver), Matthias Herborg (Ministry of Environment), Rachelle McElroy (Coastal Invasive Species Committee-CISC), Steve Godfrey, Karen Barry, and Tom Reid (Vancouver Island Conservation Land Management Program, VICLMP).

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Over the course of summer and fall of 2015 and into early 2016, many other individuals and groups contributed to finding and removing Spartina *sp.* in BC. Many landowners provided access through their property to map and control Spartina and we thank them for their support. The BCSWG is grateful for the hard work by numerous volunteers and partner organizations that mapped and removed Spartina on the Fraser Delta and in the Baynes Sound area. The table below acknowledges, hopefully, all of those contributions to the BCSWG Program.

Table 1. List of 2015 participants by organization who helped map and control Spartina in BC

Organization	Participants
City of Surrey; SHaRP Program	Mandeep Banwait, Jason Coil, Alexander Cunha, Ben Dubé, Christina Girling, JP Herwieux, Sonya Kang, Amanda Luu, Andrew Mackinnon, Supreet Malhi, Walee Malik, Joseph Marriott, Cassidy Patten, Rimi Plaha, Jenya Sourgaeva, Kenzie Tran, Zoe Tymiak
Corporation of Delta	Adrian Avendano, Perry Browne, Taylor Hunt
Ducks Unlimited Canada	Matt Christensen
Environment Canada – Canadian Wildlife Service	Courtney Bridge, Chanel Lewis
Ministry of Forests, Lands & Natural Resource Operations	Becky Brown, Mike McCulloch
Port Metro Vancouver	Ashley Graham, Kim Keskinen
Raincoast Education Society	Dan Harrison, Luke Stime
Parks Canada	Jennifer Yakimishyn, Yuri Zharikov
Tsawwassen First Nation TFN Construction / Matcon Joint Venture	Simon Baird
Vancouver Island Conservation Lands Management Program	Clayton Billett, Steven Godfrey, Karen Barry, Hilary Blackman, Jake Mentz
Volunteers in the Fraser Delta	Mary Tang
Volunteers in Bayne’s Sound	Carol Hunter, Susan Fussell

EXECUTIVE SUMMARY

In 2015, the British Columbia Spartina Working Group (BCSWG) continued to work toward the eradication of non-native, invasive Spartina species along the BC Coast. BCSWG recognizes the potential impacts of Spartina on local shorelines and wildlife habitat and is striving to support the Pacific Coast Collaborative goal of eradication of all non-native Spartina species (*Spartina anglica*, *Spartina densiflora*, and *Spartina patens*) by 2018 along the coasts of BC, Washington, Oregon and California.

In 2015, the BC Spartina Eradication Program applied \$417,135 of in-kind and direct value to deliver program components focused on Monitoring, Removal, Herbicide, Coordination, Outreach and Science/Evaluation. The monitoring program included mapping approximately 180 km of shoreline in the Lower Mainland, 68 km of shoreline on the Central Coast and more than 660 km of shoreline on Vancouver Island, Denman, Hornby and Sandy Islands.

The 2015 inventory shows the abundance and density of *Spartina anglica* in Boundary Bay and Robert's Bank has continued to increase from 2007, however recruitment of seedlings has shown a precipitous decline since the introduction of herbicide treatment. Since the introduction of herbicide to the *S. anglica* treatment program, the geographic extent of this species has declined for the first time in BC.

On Vancouver Island, *S. densiflora* mapping and control was initiated more recently, with plant populations having a notable increase in abundance up to 2012-2013. However, since implementing dedicated manual/mechanical control measures populations are primarily new plants that are easily removed by hand and do not yet produce seed. *S. densiflora* was detected on Hornby for the first time in 2014 and was removed manually. The total amount of *S. densiflora* on the east coast of Vancouver Island, Denman and Hornby islands have been considerably reduced by mechanical and manual excavation, however there are still many seedlings establishing every year

S. anglica control in the Fraser Delta for 2015 focused on manual removal of small plants and herbicide treatment of large ones. *S. densiflora* control efforts in 2015 focused on manual removals. Cover trials were installed on *S.patens* in Baynes Sound and Burrard Inlet. A demonstration trial was implemented in Burrard Inlet to compare herbicide and covering treatment options on *S.patens*.

BACKGROUND

In 2003, *S. anglica* was found in the Fraser River Delta by Gary Williams, a consultant for the Port Metro Vancouver, while conducting habitat surveys of the intertidal areas. This was the first record of *S. anglica* in BC and raised concerns about the spread of this invasive cordgrass. The Fraser Delta has approximately 25,000 ha of tidal mud flat that is internationally recognized as important habitat for fish and migratory birds. In all of Canada, the Fraser Delta has the highest density of wintering waterfowl, shorebirds and raptors. Prior to 2003, *S. patens* was identified in both Burrard Inlet and Courtenay estuary (1979). In 2005, *S. densiflora* was confirmed in the Baynes Sound area of Vancouver Island. However based on anecdotal conversations, it is believed to have been present there for some time.

The impacts of *Spartina* species include: conversion of mudflats to monoculture stands, loss of habitat for waterfowl and fish, accretion of sediments, and modification of drainage patterns. Intertidal areas in Washington State dominated by *Spartina* have exhibited large declines in the abundance of shorebirds and waterfowl. Significant expenditures have been required to control *Spartina* in Washington State costing approximately one million dollars per year. Oregon and Washington states spent approximately \$50,000,000 over a ten year period in a concerted effort to eradicate *Spartina sp.* in their coastal habitats. It is only recently with sustained funding and use of herbicide that the States have significantly reduced the *Spartina* infestations. Controlling the spread at the early stages of species expansion is the most cost-effective approach and it is critical to control *Spartina* in BC as early as possible. The loss of important intertidal habitats in BC will be detrimental to a multitude of species, and will require considerably greater resources to control in the future.

The BCSWG formed in 2004 and includes members from both government and non-government organizations. The team represents a diversity of responsibilities including: environment, migratory birds, habitat restoration, and public use. In addition, the team liaisons with San Francisco Estuary *Spartina* Project and the Washington State Department of Agriculture, which are two U.S. agencies involved in *Spartina* eradication along the Pacific Coast. The focus of this group is to employ early detection and rapid response methods to eradicate *Spartina*. Currently, there are mapping and removal efforts taking place around the Fraser Delta, Burrard Inlet, and east coast of Vancouver Island and around selected Gulf Islands. However; more work is needed to monitor other parts of the BC Coastline and expand the eradication efforts.

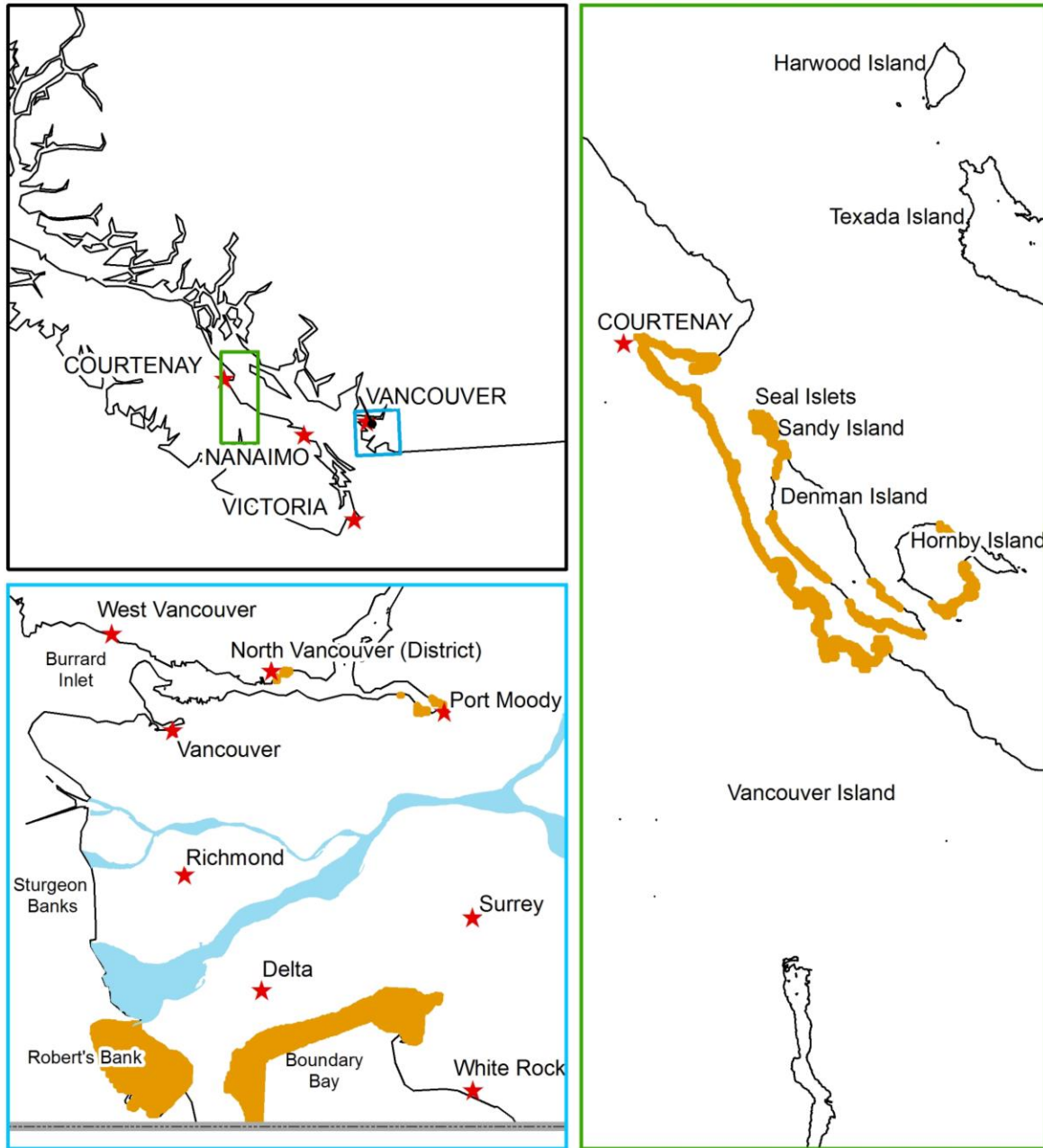


Figure 1. General Locations where *Spartina* is found in BC. Blue (Lower Mainland) & Green (Baynes' Sound). Approximate distribution of *Spartina* sp. shown in orange.

DETECTION

Data compilation and storage for *Spartina* sp. data (2004 to 2015) is provided in part by the Community Mapping Network (CMN). Species, plant size, GPS location and the extent of the area searched can be viewed at www.spartina.ca. This data is used for evaluating eradication progress, and planning future monitoring and control activities. Data for the 2006/07 Drift Card Study and Washington State Partners are also viewable at this web site. Ducks Unlimited Canada (DUC) also maintains ESRI shapefile copies of these data for GIS analysis.

Spartina data is also entered into the Invasive Alien Plant Program (IAPP) database (<http://www.for.gov.bc.ca/hra/Plants/application.htm>).

FRASER DELTA AND BOUNDARY BAY

In 2015, approximately 247 person days were devoted to map and remove *Spartina* along approximately 180 km of shoreline in the Fraser Delta. Mapping efforts continued to follow the same methods from 2008/09. The method of walking the intertidal habitat every June/July with hand held Global Positioning System (GPS) units (Garmin Etrex20, Garmin GPSmap76S, Garmin GPSmap60Cx/62Cs, Garmin 12XL, Garmin Dakota20, Marine Navigator Map 76/78) was used to identify the location of plants along Boundary Bay, Roberts Bank and Sturgeon Bank. *Spartina* size classes for each location were denoted as one of: single seedling, clone <0.3m, clone 0.3m - 1.0m, clone > 1.0m in diameter, or 5m area of single plants. Surveying flags were used to mark the location of the plants. The flags reduced searching time during removals and herbicide application and led to more effective removals by volunteers.

The extent of shoreline searched in 2015 was significantly more than in previous years because of a focused effort to search outside of the known locations of *Spartina* that had not been mapped in nearly a decade. While the expanded search areas included more of Corporation of Delta, Richmond and Vancouver (Figure 2), *S. anglica* was only found in the known areas of Boundary Bay and Roberts Bank. *S. anglica* is found in Boundary Bay between Blackie Spit and Beach Grove and at Robert's Bank between Brunswick Point and the north side of the Tsawwassen Ferry Terminal (Figure 3, Figure 4). *S. anglica* has been found growing in all intertidal zones and on a variety of substrates ranging from fine silt/mud, sand to cobble.



Figure 2. Coastline searched for *Spartina sp.* in the Lower Mainland in 2015

In 2015 the total abundance of *S. anglica* populations continued to increase however there is a reduction in recruitment or seedling/single plants (Figure 5). The number of plants with diameters of “0.3 to 1.0 m” and “> 1.0 m” tripled compared to 2014 mapping. This is thought to be due the large abundance of seedlings that were not treated in 2014 and grew into the next size class in 2015. As well some of the extremely large clones (>1.0m) that were not completely killed by herbicide application would be mapped as a smaller size class. Given mapping in Boundary Bay started much later in the season than in previous years and ended

much later due to safety and access concerns, the later detection would identify additional plants as they are often larger and easier to find. Figure 3 and Figure 4 below provide the distribution and size class of *S. anglica* in the Fraser Delta – Boundary Bay area.



Figure 3. 2015 *Spartina* Infestation in Roberts Bank

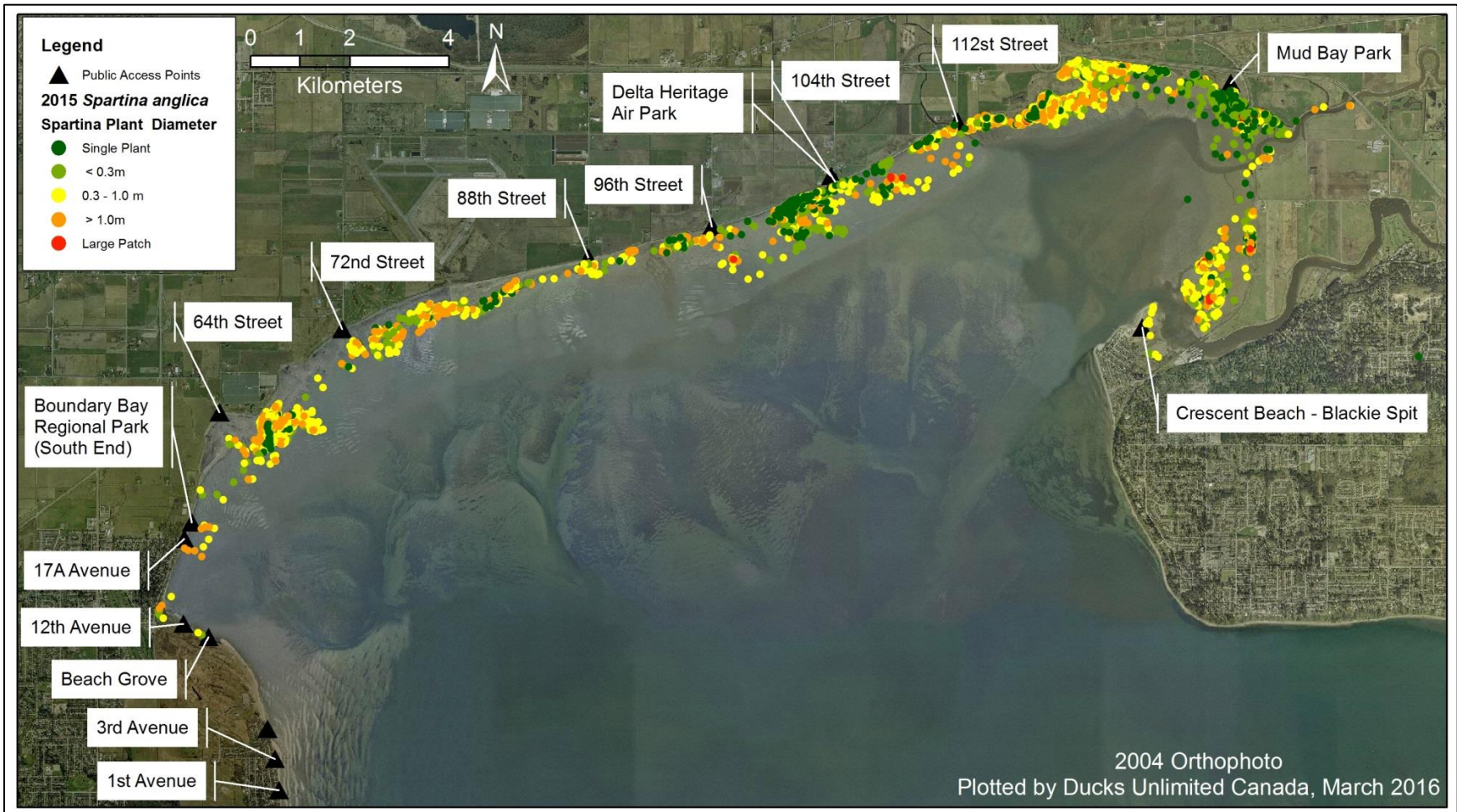


Figure 4. 2014 *Spartina* Infestation in Boundary Bay

Table 2. *S. anglica* Detected by Size Class from 2005-2015 in Boundary Bay and Roberts Bank.

Size	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Single plants	167	107	41	56	67	197	185	4497	5210	4431	832
< 0.3m	329	229	111	110	221	532	433	685	3548	6771	6692
0.3m-1.0m	204	210	108	60	234	475	441	538	1371	1252	8123
> 1.0m	90	42	33	61	149	184	296	1065	1334	1102	1930
Patch 5m dia.	0	97	49	47	12	78	55	7	36	29	66
Large Patch >5m	0	0	0	0	0	20	31	12	6	0	2
Total	790	685	342	334	683	1486	1441	6804	11505	13585	17645

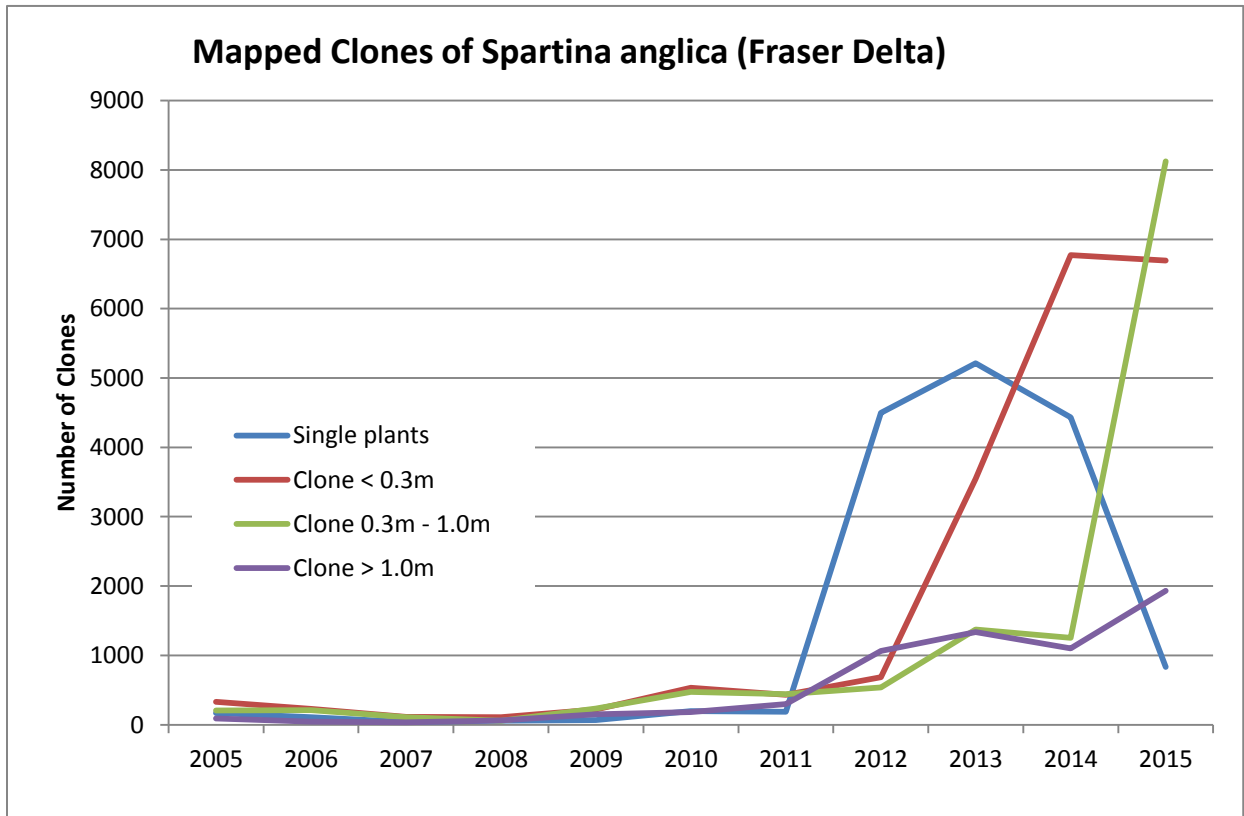


Figure 5. *S. anglica* Size Classes Mapped from 2005-2015

BURRARD INLET

In 2015 the north and south shoreline of Burrard Inlet from Reed Point Marina in Port Moody to Pt Atkinson in West Vancouver was mapped by a combination of boat and foot based surveys. No new locations were found. *S.patens* is found in two main geographic areas of Burrard Inlet, Maplewood Flats Conservation Area and Port Moody Arm as shown in Figure 6. *S.patens* appears to have a relatively stable population and clone expansion is slower compared to *S. anglica*.

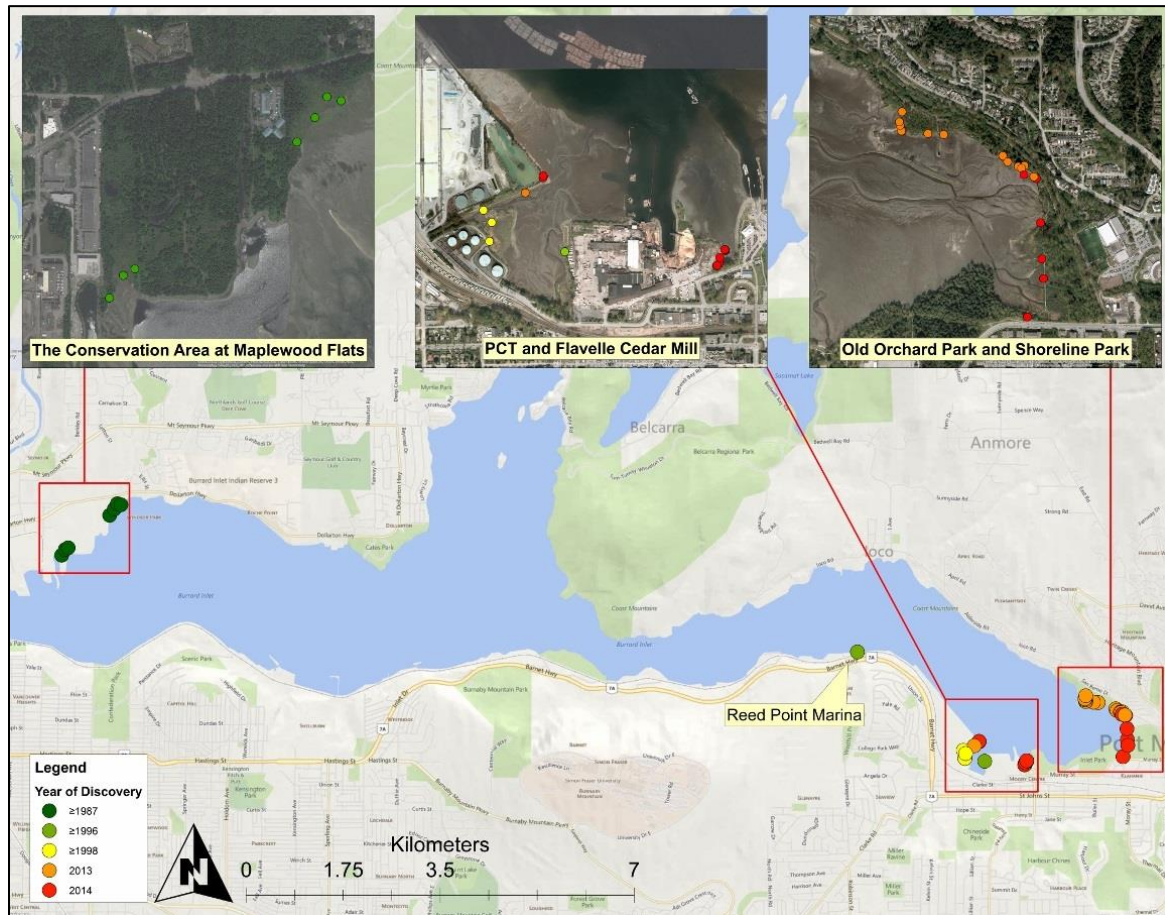


Figure 6. Current Mapped Distribution of *S.patens* in Burrard Inlet – 2015

VANCOUVER ISLAND

Approximately 450 kilometers on the east coast on Vancouver Island were surveyed for *Spartina*, including boat-based circumnavigation of four Northern Gulf Islands (Quadra Island, Cortes Island, Savary Island, Texada Island), as well as the southern portion of Gabriola Island. No *Spartina* was detected during any boat surveys of the Gulf Islands (Figure 7). Most *S.*

densiflora found on the east coast of Vancouver Island was new germination from seed and/or rhizomes as shown in Table 3.

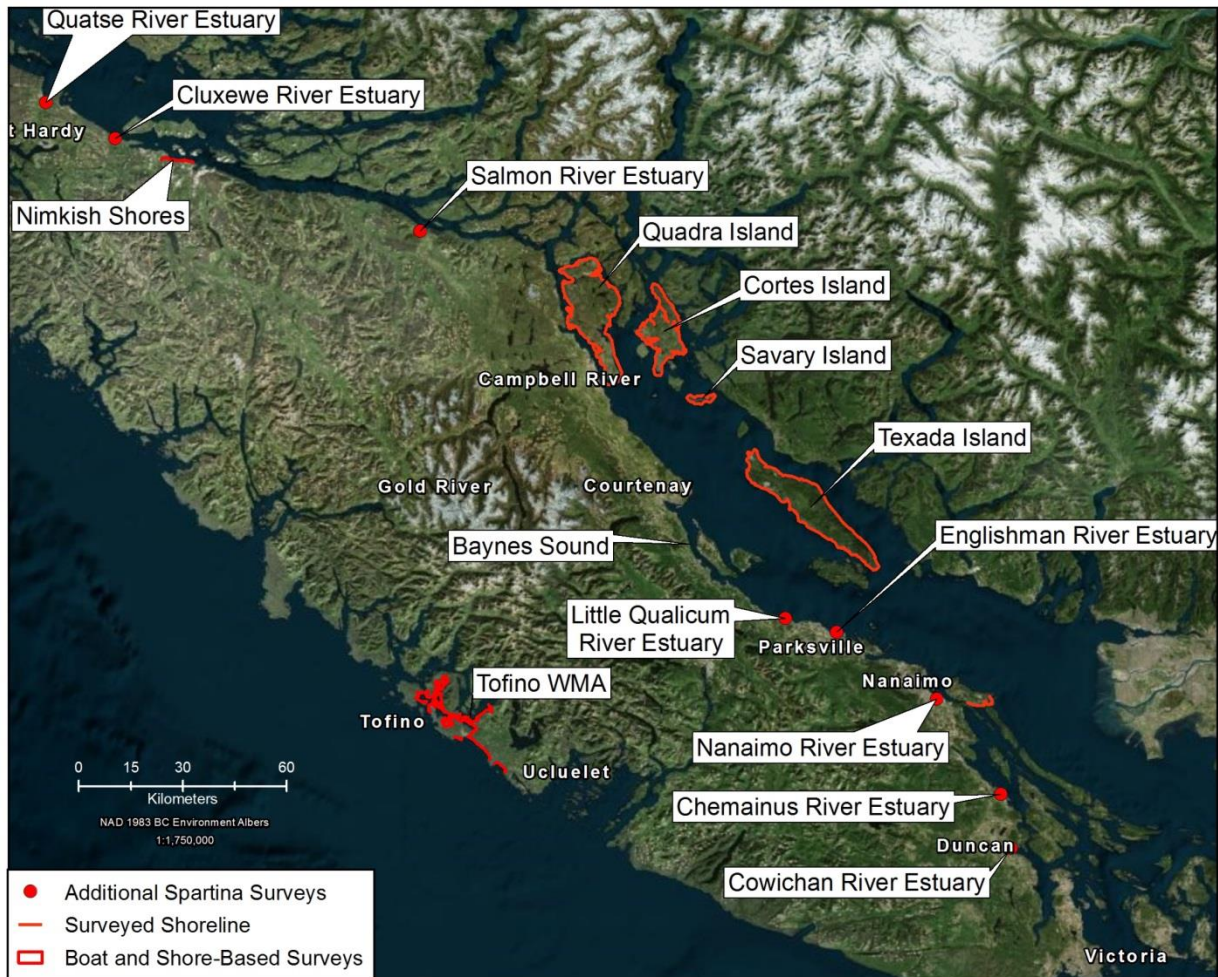


Figure 7. Vancouver Island and Gulf Island *Spartina* search areas

There has been a reduction in the average size of *S. densiflora* plants throughout Baynes Sound however the number of plants recorded have increased with most being seedlings. Ongoing mapping and manual removal will be required for *S. densiflora* to continue reducing the overall population in BC. Those sites which received manual digging treatments in previous years have shown very little vegetative re-growth from previously dug clones, although there are often new clones beginning to establish themselves from seed.

Table 3. Change in abundance of *S. densiflora* plants between Summer 2015 and after manual treatment in Spring 2016 on the East Coast of Vancouver Island

Size Class	Summer 2015	Spring 2016
<i>S</i> (Seedling)	107	0
<i>A</i> (<30cm)	55	0
<i>B</i> (30cm – 100cm)	2	0
<i>C</i> (>100cm)	0	0
<i>D</i> (Site of several seedlings)	72	20
TOTAL	236	20

Approximately 140 kilometers on the west coast of Vancouver Island (including Tofino WMA) was surveyed for *Spartina* by the Raincoast Education Society (RES) and Pacific Rim National Park staff during 2015-16. Survey locations included: Arakun and Ducking flats, Maltby Slough, South Bay, Laddie, Mike's Islands, Grice Bay to Cannery Bay & Indian Island, Tonquin Beach & Duffin Cove to Tofino Botanical Gardens, Raccoon Island, east side of Vargas Island & South portion of Meares Island (including Opitsaht IR), Long Beach, Comber's Beach, Wickaninnish Beach, and Florencia Bay, Radar Beach, and Schooner Cove (Figure 8). No *Spartina* was observed.

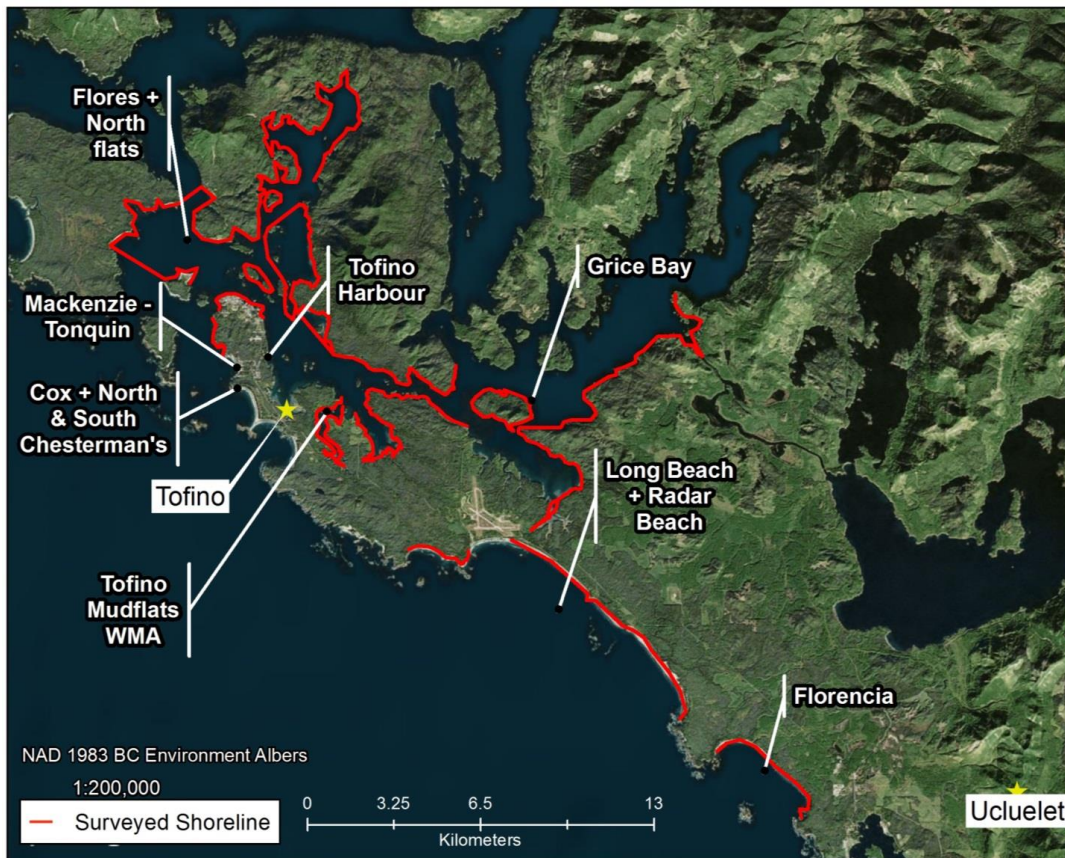


Figure 8. Tofino Wildlife Management Area (WMA) 2015 *Spartina* search areas

S.patens remains primarily contained in the Courtenay Estuary, with isolated patches found along Sandy Island, Royston, Union Bay and Buckley Bay. Approximately 8 hectares of *S.patens* was mapped in Baynes Sound from Goose Spit to Royston.

DENMAN ISLAND, HORNBY ISLAND AND SANDY ISLAND

In 2015, approximately 40 kms and 30 kms of shoreline were searched for *Spartina* on Denman Island and Hornby Island, respectively. Mapping and removals on the shorelines of Denman and Hornby Islands were coordinated by Jenny Balke and Hornby Island activities were supported by Ryan May. The 2015-16 program initiated in October 2015 and completed in March 2016. Similar to the east coast of Vancouver Island, primarily seedlings and single plants up to 30 cm in diameter were found. Complete circumnavigation of both Denman and Hornby Islands and removal of all plants found were achieved. *S. densiflora* was not observed in any new general areas of Hornby Island, but regenerating seedlings were found in all three previous locations, on the north, east and southern coasts. In total, approximately 13 000 plants were found on Denman and Hornby Islands. All plants were removed and composted on Denman Island. In 2015, the area impacted expanded to both to the west of Grassy Point, as well as east almost to Trailee Pt. most often no more than 4 plants were found at a time however a few small dense patches were found to have over 200 seedlings.



Figure 9. *S. densiflora* seedlings on Denman Island



Figure 10. Locations of *S. densiflora* and *S. patens* found in Baynes Sound in 2015

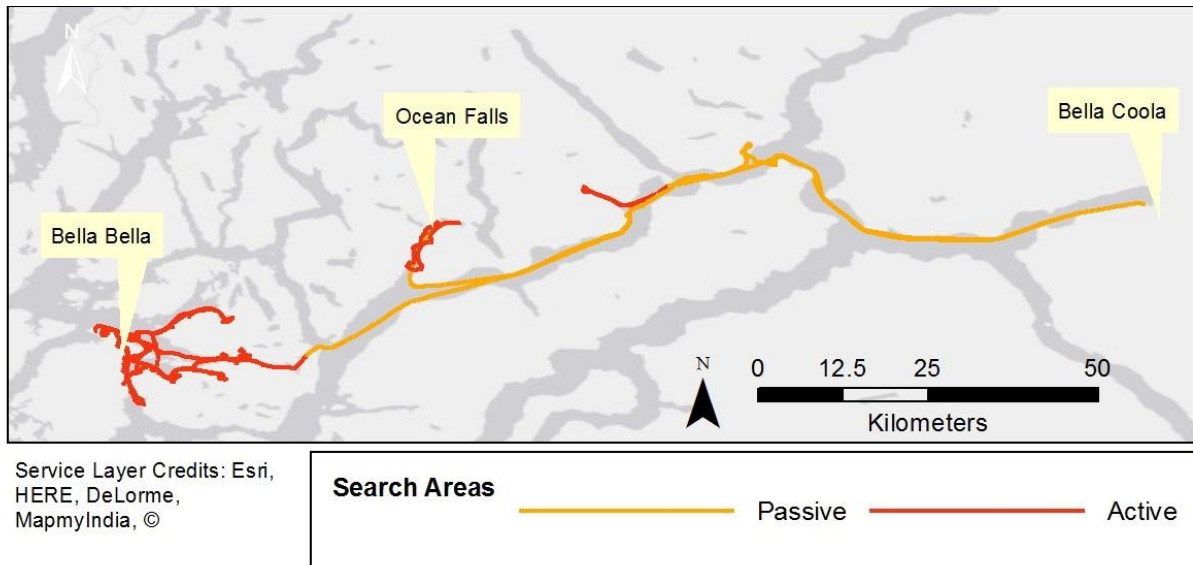


Figure 11. Central Coast Shoreline Searched for *Spartina sp.*

A survey on the Central Coast was completed for the first time in 2015 to a) evaluate the use of boat surveys covering large areas and b) inventory remote areas outside of Vancouver Island. However, no *Spartina* was detected. *Spartina* surveys on the Central Coast were conducted by Becky Brown and Matt Christensen. The vessel crew, (Louis Malo and Said 'Fred' Svidahl), and local team members, (Lisa Norden and Chris Nelson), provided information for survey planning to include: historical and current industrial activity areas, locations of habitat that could potentially support *Spartina*, and navigational expertise. The large open channels were mostly comprised of solid rock ridges occasionally capped with narrow vegetated benches, thereby limiting potential *Spartina* infestation. Inlets frequently had cobble/gravel beaches, and seldomly there were shallow sloped beaches with rocky mud substrate. The searched areas are shown in Figure 11 where a passive survey used the main vessel looking from a distances between 200 to 500 m and an active survey used a smaller skiff targeting areas with a higher likelihood of suitable *Spartina* growth and often landing on shore.

Surveys by skiff were conducted to locate and approach suitable habitat to become familiar with native vegetation within each intertidal habitat type. A few times during the passive survey interval the foreshore was examined closely to calibrate what was observed by boat. Seedhead morphology, vertical structure and growth pattern became a checklist for confirming presence/non-presence of *Spartina*. Extensive lengths of shoreline prohibited active survey technique at every foreshore habitat with established grass, rush and reed species populations.

It was determined that if *Spartina* was positively identified at a site then adjacent sites would also be surveyed for presence/absence as well.

CONTROL & REMOVAL

FRASER DELTA AND BOUNDARY BAY

MANUAL CONTROL

With integrated control plan continued in 2015 with the herbicide use on *S. anglica* and manual removals (i.e. pulling and digging) of single plants and small clones and the use of herbicide for clones greater than 0.3m in diameter.

A few organizations undertook hand removals of infestations:

- City of Surrey's SHARP and SNAP summer crews: Boundary Bay in the Serpentine River Estuary and Mud Bay and;
- Corporation of Delta's Noxious Weed Control Crew: Robert's Bank and Boundary Bay from Pt Robert's to west of 112 St.
- Tsawwassen First Nation/ Matcon Civil Join Venture throughout Robert's Bank and Boundary Bay
- Environment Canada - Canadian Wildlife Service Summer Students: Robert's Bank and Boundary Bay

The high priority areas for control continue to be Roberts Bank (from Brunswick Point to the Deltaport Causeway), Boundary Bay at 112th Street, & Boundary Bay at Mud Bay, to reduce dispersal to uninfected areas.

As in previous years, participants dug up individual plants and smaller clones using hand shovels, loading them into re-usable shopping bags. The shopping bags were dumped into large garbage cans and transported to a dumpster for disposal. Using inexpensive molded snow sleds enabled participants to bring removed plants from further out on the mud flats while keeping the lift weight in each bag smaller.

A three person *Spartina* crew was hired through BCCF for June, July, August and part of September. The crew focused on hand removals, mapping, supervising volunteer removal activities, and providing mapping support for the herbicide use. In 2015, 4972 'S' size (single plants or seedlings) and 2570 'A' size (< 30 cm in diameter) clones were manually removed.

PERMITTING BACKGROUND

For more than a decade Spartina control work in BC on *S. anglica* using only mechanical/manual was not able to achieve containment. Therefore, since 2010, a small sub-group of the BC Spartina Working Group has worked with staff from provincial and federal Canadian agencies to determine the requirements and process to use herbicide as a control activity on Spartina. The sub-group evaluated the ecological impacts and best management information based on the success of using two herbicides to control Spartina in the United States (Washington, Oregon and California). It was determined that herbicide use in BC would require registration of the herbicides with the federal Pest Management Regulatory Authority (PMRA) as well as a Pesticide Use Permit (PUP) from the BC provincial Ministry of Environment.

The BC Ministry of Environment, as a member of the BC SWG, submitted an emergency use registration to the PMRA in February 2012 for the use of 2 herbicides to control Spartina: Rodeo (active ingredient glyphosate) and Habitat (active ingredient imazapyr) along with supplementary documentation including the proposed methods, evaluation and monitoring process. On February 13, 2013, the PMRA granted the emergency registration of the herbicides Habitat (imazapyr) and Rodeo (glyphosate) for control of Spartina in intertidal areas of BC until December 31, 2013. The application for emergency use registration with PMRA requires that a new application be submitted annually. In 2013, and since that time, the decision was made to only use Habitat (imazapyr) along with the surfactant (Ag Surf II) to control Spartina following consultation with Washington State staff and to minimize overall herbicide use. As part of the approval, PMRA identified that the surfactant Ag-Surf II is to be used with the herbicides that would bind the herbicide with the plant and reduce the amount of herbicide needed. The PMRA reviewed all the potential surfactants and recommended the surfactant based on its low toxicity in the environment.

In 2013, the BC Ministry of Environment submitted a Pesticide Use Permit (PUP) for both herbicides (Rodeo (active ingredient glyphosate) and Habitat (active ingredient imazapyr) to BC Ministry of Environment. Consultation was conducted prior to and after the submission of the PUP. The (PUP) No. 804-0004-2013/2015 was issued in June 2013 for a 3 year period ending December 30, 2015. Follow-up reports are provided to the Section Head – Integrated Pest Management Coastal Region on or before December 31, of each calendar year as a requirement of the PUP. Approval to use the approved herbicides for the 2015 season in the

Boundary Bay and Roberts Bank Wildlife Management Area was provided by BC Ministry of Forest, Lands and Natural Resource Operation from July 13 and up to and including October 15.

HERBICIDE CONTROL ACTIVITIES

Approximately 166 people days were spent on herbicide application in 2015. Herbicide treatment of *S. anglica* (11 200 clones) was completed in the Roberts Bank and part of Boundary Bay east of 112 ST. The 2015 treatment is estimated to be 3.13 ha of solid spartina spread over more than 5700 ha of intertidal habitat (based on 4.67 L/ha of herbicide and 14.62 litre of Habitat (24% imazapyr) used). Approximately 9.7 L of surfactant, Ag-Surf II (92% alcohol ethoxylate) and over 1900 L of fresh water were mixed with the herbicide. The treatments were conducted: at low tide during the day to allow a 4 hour drying time after application. Weather was clear to partially cloudy with temperatures between 17 C & 23 C. Herbicide was applied to *S. anglica* plants on Aug 10 - 18, 20, 25-27, Sep 10, 11, 21-23, and 27-29. Below are maps of the herbicide treated areas (Figure 12, Figure 13).

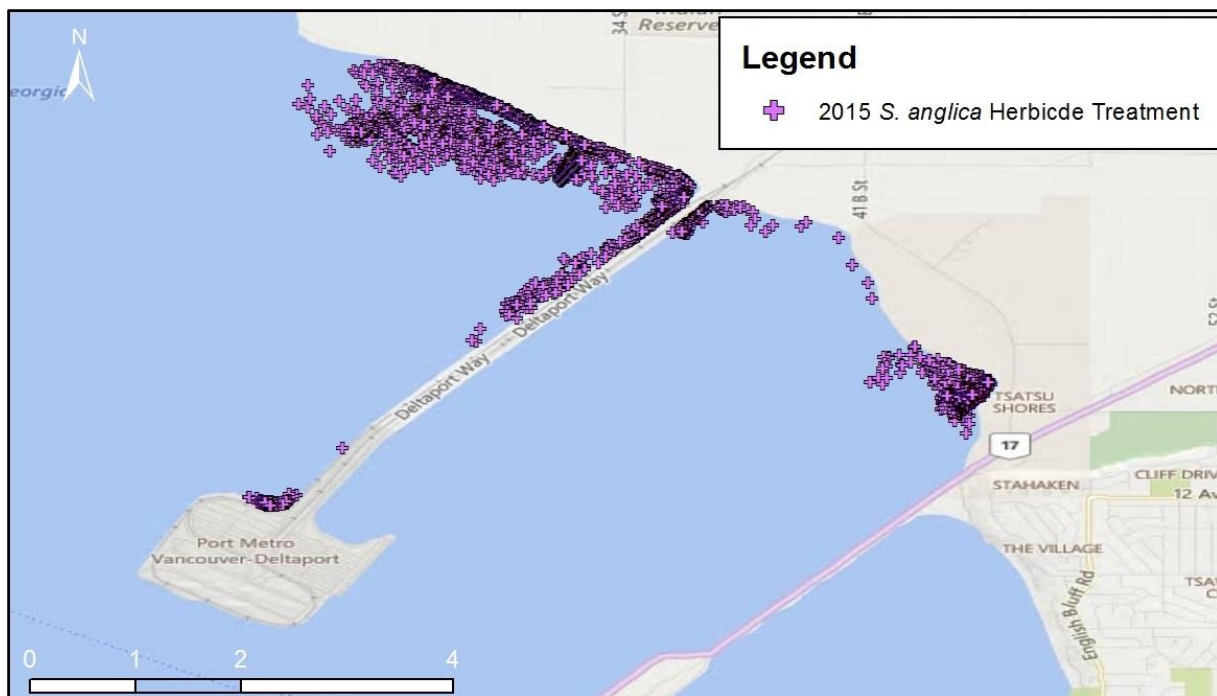


Figure 12. *Spartina* Infestation Treated with Imazapyr (purple cross) in Roberts Bank in 2015

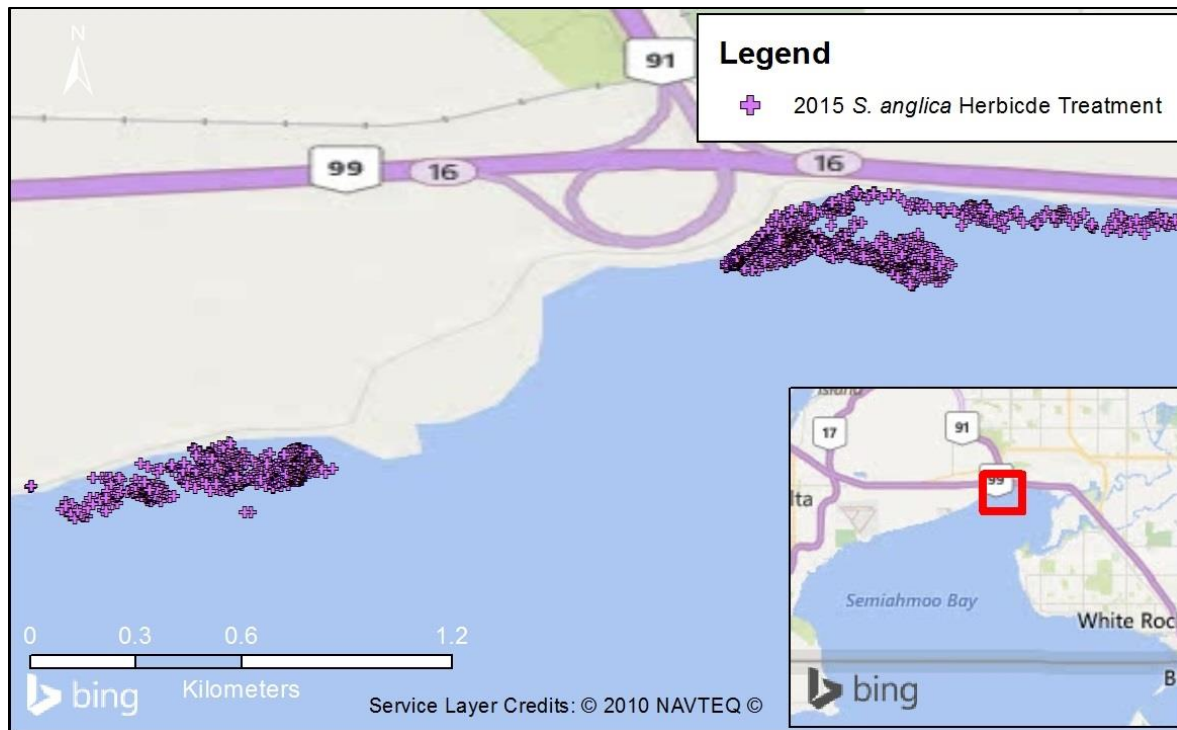


Figure 13. Spartina Infestation Treated with Imazapyr (purple cross) in Boundary Bay in 2015

BURRARD INLET

MANUAL CONTROL

The *S.patens* infestations pose a challenge to the traditional BC *Spartina* control techniques of manual digging, as *S.patens* does not grow in tufts or clones but grows in a dense mat that eventually forms a meadow. This species also grows in the high salt marsh where a greater diversity of native plants are found compared to *S. anglica* which is generally found in bare mud. Therefore digging the established plant populations would significantly modify the topography and likely create collateral damage by eliminating all native plant populations. A shading technique was identified as a pilot experiment in 2012. This technique utilizes the approach used in Oregon to control *S.patens*, where the plants are covered for two years using a geotextile fabric manufactured by Nilex. Upon removal of the geotextile the native plant populations re-established on the site rather than the non-native *Spartina*. To date, the results have been mixed, with each new trial building on the lessons learned from the previous trial.

In 2012, at Reed Point Marina, Burrard Inlet west of Port Moody, a patch of *S.patens* (Figure 14.A) was covered by 500 square meters of a geotextile fabric designed to shade out the covered plants. The site had been covered for two years prior and only bare mud existed when the cover was removed in August of 2014. By August 2015, the site was revisited to find substantial re-growth of *S.patens* as well as some non-Spartina vegetation (Figure 14.D). It is suspected that the re-establishment of Spartina is due to a large energy reserve in the roots limiting the effectiveness of the cover material and possibly the existence of a seedbank. No additional activities are planned for the Reed Point Marina site as it will be altered as part of the PCT potash handling expansion facility development.

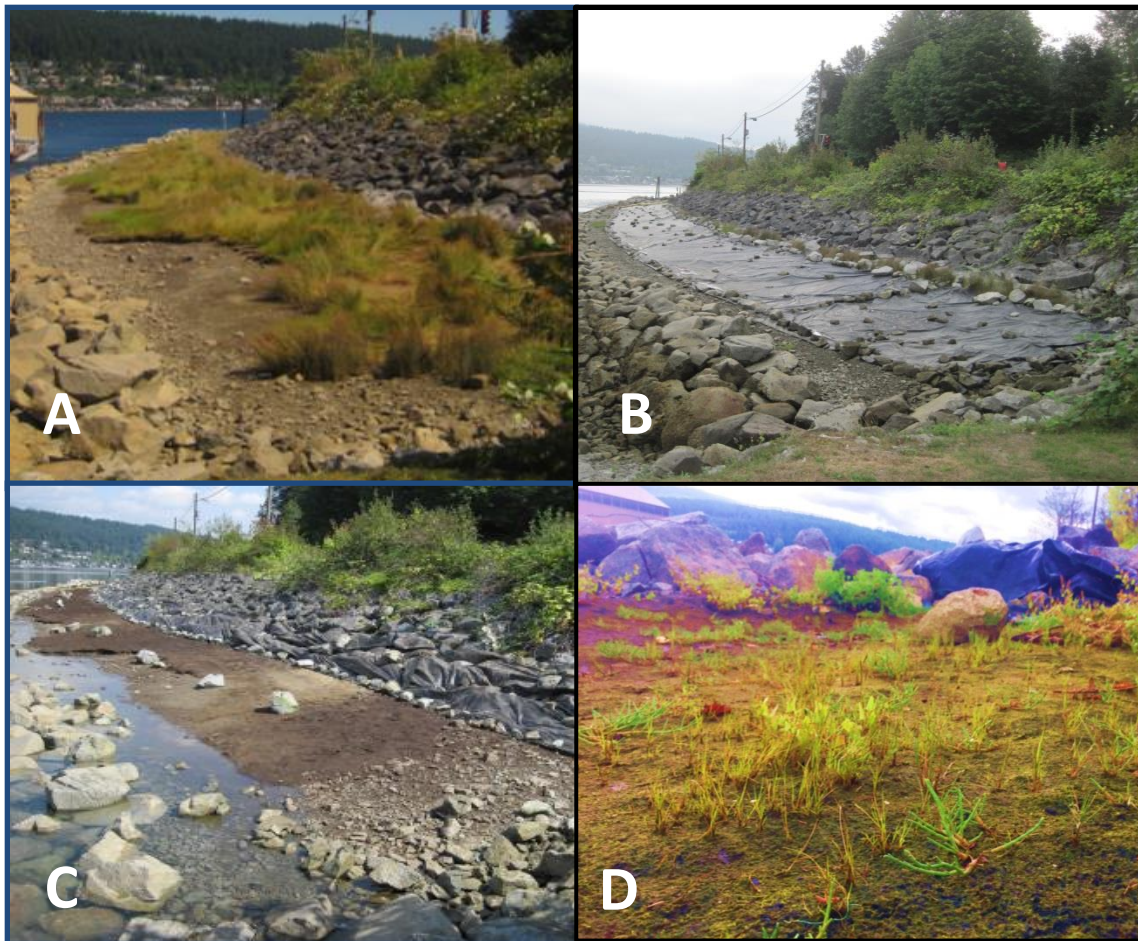


Figure 14. A) August 2012 - Patch of *S.patens* at Reed Point Marina prior to covering B) August 2014 - Geotextile fabric installed just prior to replacement on adjacent satellite clones C) August 2014- After two years of covering, bare mud exists D) August 2015 – After one growing season (photo shown at 300% saturation to illuminate vegetation establishment (both Spartina and non-spartina)).



Figure 15. Exposed half of plot (green *Spartina* plants) previously covered with one layer polyethylene cover in place for one year

In September 2013, Port Metro Vancouver established a second site (Pacific Coast Terminals) to evaluate geotextile technique to control *S.patens*. Plots were pre-treated with steam or cutting and subsequently covered with material (2 plots of Nilex 2002 woven geotextile and 2 plots of black polyethylene), along with a control plot (no treatment). The polyethylene was more prone to damage from wave action, wildlife and weather conditions, requiring regular monitoring and maintenance. Stressed *S.patens* recovered quickly anywhere the cover material was damaged and sunlight could penetrate. While the geotextile appeared less effective at blocking sunlight, it remained intact and in place throughout the study. One layer of either cover material did not achieve a complete reduction in live stems after twelve months. Pre-treating by applying steam or mowing had no significant effect.

Covering materials from the 2013 trials have been reinstalled in several combinations to evaluate different cover combinations:

- One plot with geotextile overlying polyethylene was installed in March 2014 and will be removed in August 2016 (three years of cover).
- A second plot of a single layer of polyethylene (2013-2014) was divided in to two plots (Figure 15):

- One plot made up ½ of the original plot was left uncovered in September 2014 and monitored throughout the 2015. *S.patens* was the dominant vegetation by the end of the 2015 growing season.
- The other ½ of the plot was covered with a double layer of polyethylene in September 2014. This was removed in August 2015.
- A single layer of geotextile that was in place for two years was removed in August 2015.
- A single layer of geotextile was installed in August 2015 immediately adjacent to where it had been installed for two years and will remain in place for 2 growing seasons.
- A double layer of polyethylene was installed in August 2015, however over winter monitoring has found significant damage to the material.

Follow up assessments have been conducted approximately every two months on plots that were removed in August 2015 to document the rate of establishment of vegetation (spartina and non-spartina).

Three covering plots were installed on the Shoreline Park foreshore in Port Moody (Figure 16). Adjustments were made to increase the efficacy of the cover plots based on previous results from PCT and Reed Point Marina. Firstly, double layers were used instead of single layers. A layer of Nilex 2002 woven geotextile fabric was included to provide more protection for the bottom layer of polyethylene sheeting, which is the layer that limits sun penetration better. Secondly, cover plots were installed with the intent that they will remain in place for at least 2 years, possibly more. Lastly, cover plots were installed on smaller sizes of infestations than in previous efforts. *Spartina* patches treated along Shoreline Trail are an order of magnitude smaller than other sites to date, to determine if cover plots are more effective in smaller patches which may have lower seedbank abundances and lower adjacent *Spartina* populations. Over the course of the next two years, the cover plots from both PCT and Shoreline Trail Park will provide insight to treatment efficacy for different site complexities. Complexities between PCT and Shoreline Park include a difference in substrate, tidal regime and patch size. Evaluating alternative site characteristics is anticipated to assist in identifying those site types where cover plots may be most effective.



Figure 16. Locations and Before/After photos of three cover plots installed in Port Moody in August 2015

VANCOUVER ISLAND MANUAL CONTROL

The Vancouver Island Conservation Lands Management coordinated the control of *S. densiflora* and *S.patens* on the east coast of Vancouver Island except for Denman, Hornby and Sandy Islands.

MANUAL REMOVALS

162 *S. densiflora* individual plants and seedlings and 92 additional patches of several seedlings encountered during the 2015 surveys were manually removed using hand tools (mattocks and shovels). Approximately 1500 kg of waste material was bagged using heavy duty bags and taken to the Comox Valley Waste Management Center for disposal. A total of 50 person hours was dedicated to the removal of *S. densiflora*. With less mature *S. densiflora*, control efforts are

focused on seedlings. It has been noted that *S. densiflora* seedlings break off when manually pulled. It is recommended that each plant is manually dug or left until large enough to pull manually without breaking at the stem.

SHADING

A total of 55 person-hours were dedicated to construction and installation of five additional *S.patens* shade trial sites during the winter of 2015-2016. ArmTec 855 woven geotextile fabric was applied to each site and percent cover of additional species was estimated visually prior to construction. One shade trial was installed in October 2015 and revisited three months after construction to find significant damage to the cover material caused by wave action. Given the exposed nature of these sites, the next four cover plots installed in February 2016 were constructed using a wooden frame (2"x4" treated lumber) and rebar (5/8") method, similar to shade trials constructed during the 2014-2015 field season by the CISC.

To date 12 shade trials have been installed on the East Coast of Vancouver Island from the Comox foreshore at Beach Drive to Royston. Two shade trials were installed in 2012 and were found to be damaged by wind and wave action or vandalism in 2013. They were removed in January 2015 and have not been checked for re-establishment of vegetation (*Spartina* or native) to date; assessment will occur in summer 2016. Five were installed in 2014 and four of these were found to be in tact in February 2015. These four from 2014 will be evaluated and removed in 2016 if no *S.patens* is found growing. These sites employed rebar stakes and lumber frames constructed of pressure treated 2" x 4". A total of 2 person hours by VICLMP during the 2015-2016 field season was dedicated to assessment and maintenance of the four shade trials from 2014.

MECHANICAL EXCAVATION

On February 26th, 2016 no regeneration of *S.patens* or native vegetation was observed at any of the 8 excavated sites (from 2014-15). Figure 17 shows the absence of both *S.patens* regrowth and succession of native intertidal plant species approximately one year after excavation. VICLMP staff dedicated 2 hours to the assessment of these sites. No mechanical excavations were undertaken in 2015.

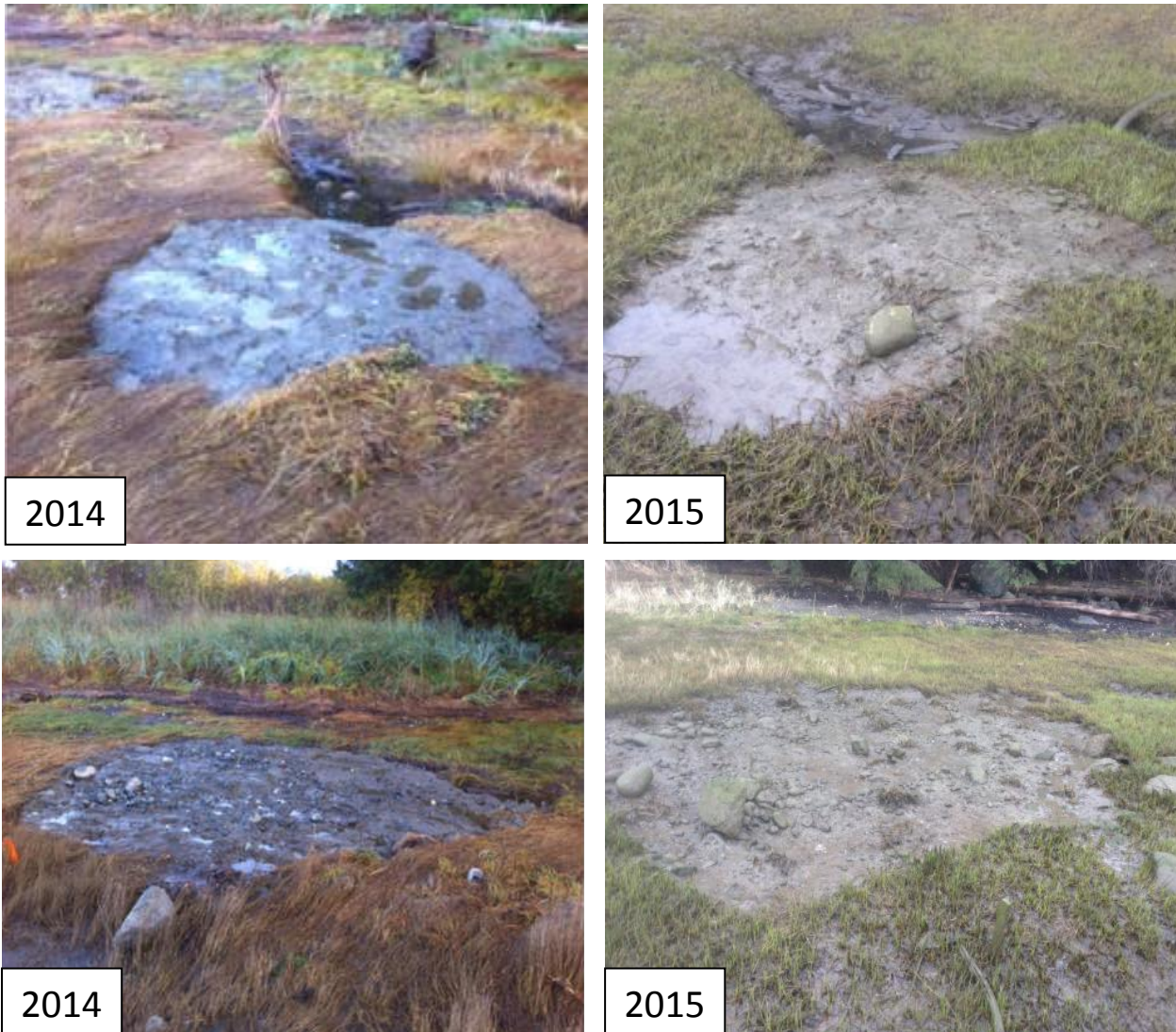


Figure 17. Excavation trials conducted on *S.patens* near Royston in 2014 compared to 2015

DENMAN ISLAND, HORNBY ISLAND AND SANDY ISLAND – MANUAL CONTROL

MECHANICAL EXCAVATION

In total, approximately 13 000 plants were found on Denman and Hornby Islands. All plants were removed and composted on Denman Island (Figure 18). On Denman Island tracking of mapping and removal efforts for 37 different areas since 2013 has provided some insight into the success of the manual and mechanical removal efforts. The majority (32) of revisited areas have recorded less or no regeneration of *S. densiflora* plants while five areas have had the number of regenerating seedlings increased. The magnitude of the decreased regeneration is

the range of 100's and 1000's of seedlings, while that of the increase in all five sites is in the range of 10's and one site less than 100. The amounts by which the number of regenerating seedlings increased or decreased are shown in Figure 19.



Figure 18. *S. densiflora* compost pile on Denman Island

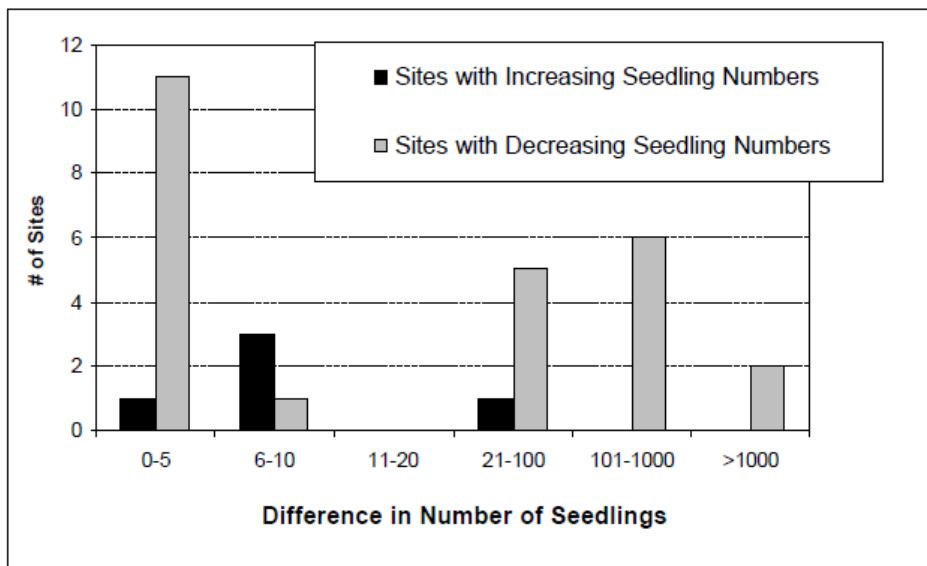


Figure 19. Number of sites on Denman Island with increasing or decreasing seedlings

Table 4. Summary Table of Spartina Mapped and Treated in 2015*

LOCATION	AREA MAPPED (HA)	SPARTINA DETECTED (Y/N)	AREA IMPACTED BY SPARTINA (HA)	HERBICIDE TREATED AREA (HA)	MANUAL TREATED AREA (HA)
BOUNDARY BAY	2579	Y	583	39	435
ROBERTS BANK	2523	Y	306	259	226
STURGEON BANKS	1021	N	0	0	0
BURRARD INLET (WEST)	2170	N	0	0	0
BURRARD INLET (EAST)	83	Y	31	4	4
DENMAN ISLAND	1395	Y	275	0	275
HORNBY ISLAND	739	Y	16	0	16
EAST COAST VANCOUVER ISLAND	2307	Y	670	0	670
GULF ISLANDS	12 854	N	0	0	0
CENTRAL COAST	2504	N	0	0	0
TOFINO	5051	N	0	0	0
TOTAL	33 226	-	1881	302	1626

*Area estimates are based on a grid of 1 hectare cells for BC's coastline. Activities such as mapping, Spartina present (area impacted), control – manual, and control-herbicide that occurred within a cell were tabulated in the table above.

SCIENCE – EVALUATION - MONITORING

BURRARD INLET – HERBICIDE VS SHADING COMPARISON TRIAL

Activities in 2015 also included the application of herbicide to a small area of the *Spartina* infestation at PCT (12 m² in total). The rationale for including herbicide treatment was based on the following considerations:

- Cover plots have had a relative low efficacy to-date;
- Rocky and steep terrain at some areas of PCT site makes cover plot application challenging;
- The site is extensive and long-established indicating it likely has extensive roots and seed bank;
- Herbicide treatment may have lower impact to native vegetation compared to other methods; and,
- Better understand logistics, challenges for use of herbicide with *S.patens*.

The herbicide used for these treatments was Imazapyr in the same formulation as used for *S. anglica*. The herbicide treatment plots will be monitored 8 months after application, after the first year and at the end of the 2nd year. Interim photo monitoring will be conducted approximately every two months. Results of this study will inform and guide for future planning and treatment action.

HERBICIDE EFFICACY MONITORING – BOUNDARY BAY & ROBERT’S BANK

40 plots were placed at Robert’s Bank to evaluate efficacy of herbicide treatment application between clones growing in the mud and those growing intermixed with native vegetation. The plots were stratified to have 20 in intertidal vegetation and 20 in open mud. Each set of 20 was made up of 10 plants that were greater than 1.0 m in diameter and 10 that were between 0.30-1.0 m in diameter. We will be evaluating control efficacy based on size and location of clones.

OUTREACH

INFORMATION AND INTERNET RESOURCES

- Community Mapping Network provides web mapping and other information on the distribution of *Spartina sp.* in BC. www.spartina.ca
- The BCSWG uses an email “List Serve” to communicate & coordinate with identified volunteers and partner organizations in BC. spartina-ca@vancouvercommunity.net
- Friends of Semiahmoo Bay Society uses their web site for volunteer call out, information & partner links <http://www.birdsonthebay.ca/>
- Corporation of Delta website: <http://www.delta.ca/environment-sustainability/plants-wildlife/invasive-plants>
- City of Port Moody website:
<http://www.portmoody.ca/index.aspx?page=1260#Saltmeadow> Cordgrass (*Spartina patens*)
- Coastal Invasive Species Committee: <http://www.coastalisc.com/priority-invasive-plants>

SPARTINA IN THE MEDIA

- a. The Province newspaper – Front Page Article (May 10, 2015)

SPARTINA PRESENTATIONS AND WORKSHOPS

- a. Training Workshop – Tofino (August 2015)
- b. Training Workshop – Denman Island (October 2015)
- c. Delta Environmental Committee – presentation (December 2015)
- d. Fanny Bay Community Meeting – presentation (January 2016)
- e. Pacific Estuarine Research Society – poster (March 2016)

FINANCES

The BCSWG partners and individual volunteers contributed over \$195,000 of in-kind time and resources to the project, in addition to external funding from grants and partners. These in-kind contributions were essential to the success of the project. Figure 20 shows the percentage of contributions by component and the ratio of in-kind to direct (cash) contributions. The recent history of financial contributions (cash and in-kind) of the BC Spartina Working Group is found in Figure 21. Table 5 summarizes the income and expenditures for 2015.

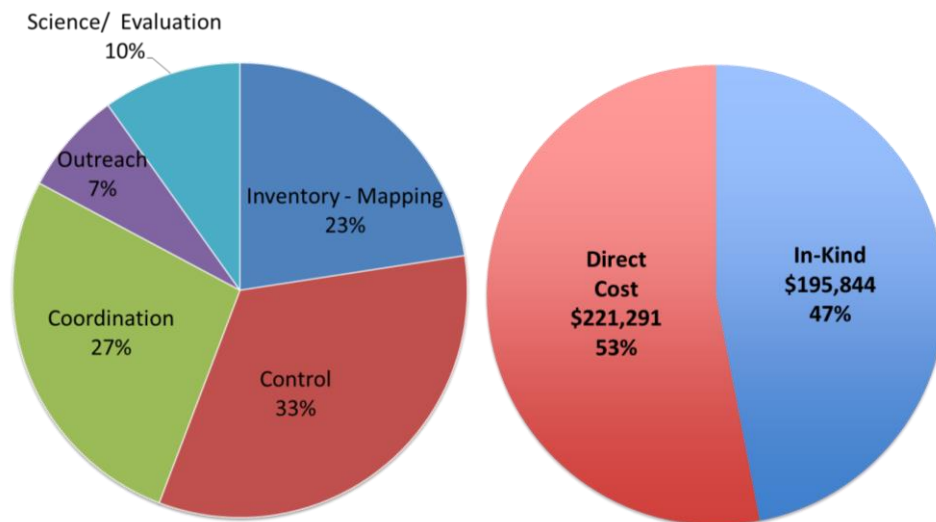


Figure 20. 2015 Spartina Program Expenditures by Component & Type/Amount

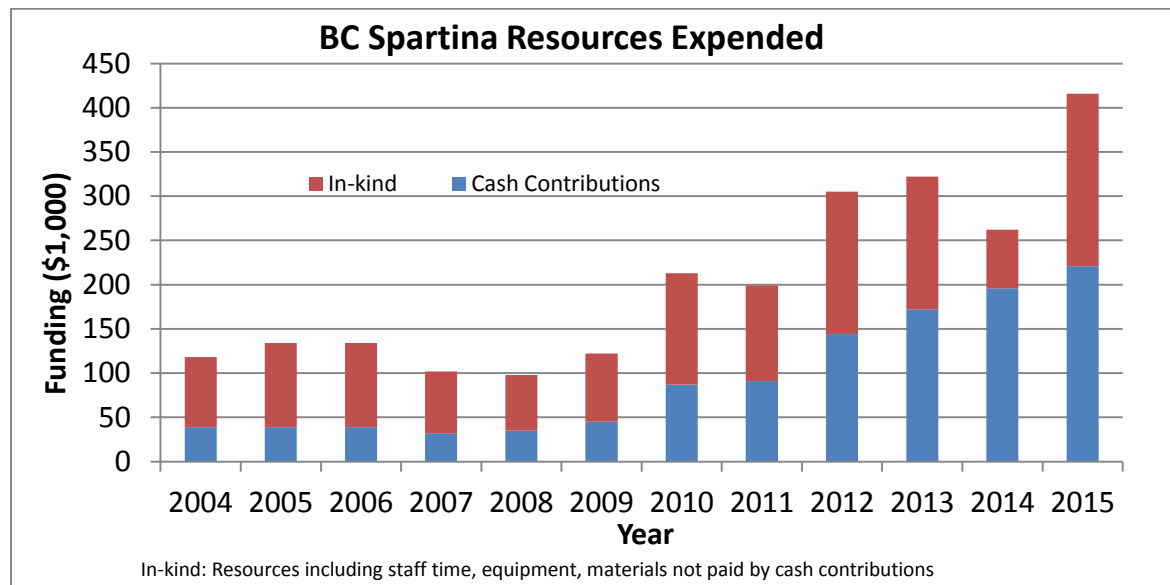


Figure 21. BC Spartina Resources Contributed Over Time

**Table 5. BC Spartina Eradication Program Direct Cost (Cash) Contributions - BCSWG 2015
Committed & Expenditures by Program Components**

Direct Costs (Cash)	Committed & Expenditures by Program Components					
	Inventory	Control	Coordination	Outreach	Science/ Evaluation	Total
Lower Mainland BCCF Crew	\$16,500	\$17,138	\$3,879		\$1,450	\$38,967
Lower Mainland Coordinator contracts (Lower Mainland)	\$3,500	\$2,500	\$2,764			\$8,764
Coordinator Contracts (ECVI, Denman, Hornby, Tofino Area)	\$11,640	\$13,000	\$8,000	\$3,000		\$35,640
Ducks Unlimited Canada	\$15,000	\$15,000	\$22,056	\$10,000	\$10,500	\$72,556
Other Contractor-Website, transport	\$8,613	\$5,588		\$126		\$14,327
Materials, Supplies, misc.	\$2,472	\$3,637		\$728		\$6,837
Contractor - Herbicide Application		\$44,200				
SubTotal	\$49,281	\$91,063	\$17,143	\$4,354	\$4,450	\$221,291

PARTNERSHIPS

Developing partnerships are a key principle of the BC Spartina Working Group to achieve control and eradication of Spartina plants. This principle is demonstrated in the diversity of partnerships (government, non-government, community, industry) that are part of the steering committee.

In 2015 membership was expanded in the number of and/or the involvement of the following agencies: Parks Canada, RainCoast Education Society, City of Port Moody, Vancouver Island Conservation Lands Management Program.

Given the nature that Spartina is a cross border issue, it follows that maintaining partnerships with organizations in Washington State and others states are important. The Washington State Department of Agriculture (WSDA) has been a long term partner with the BCSWG and the BC SWG attended the North Puget Sound Spartina Planning meeting in May 2015.

At a high level, the Pacific Coast Collaborative (PCC) leaders signed the “Action Plan for Ocean Conservation and Coastal Climate Change Adaptation” on February 12, 2010. One of the actions in this plan is to reduce or prevent the spread of invasive species, with Spartina being a top priority. The PCC issued a “Spartina Progress Report for the Pacific Coast Collaborative Leaders Forum November 16th, 2010” which states British Columbia, Washington, Oregon, and California have jointly committed to eradicate non-native Spartina by 2018.

This document and the Action Plan for Ocean Conservation can be viewed at <http://spartina.ca> in the “Atlas Documents” section.

RECOMMENDATIONS FOR 2016

While the Spartina Project documented several successes and shortfalls in 2015, further resources and progress is required to achieve the Pacific Coast goal of eradication of non-native Spartina by 2018. Therefore the following recommendations should be taken into consideration:

1. Mapping and Control (General)
 - a. Continue the partnership approach to Spartina mapping and control
 - b. Consider cross training crews from Lower Mainland and Vancouver Island to improve search pattern recognition of the different Spartina species.
 - c. Continue to expand mapping areas beyond known distribution
 - d. Secure multi-year financial funding to enable longer planning intervals and a consistent core program that can be expanded upon with additional annual funding.
 - e. Utilize an integrated pest management approach towards eradicating *S.patens*. Explore chemical treatments, excavator treatments and hand-digging and associated restoration requirements.
 - f. Implement grid of 1 ha cells for mapping and control to better document results of overall Spartina program.

- g. Systematic expansion of search areas rather than annually checking the same areas and confirming non-presence. If an area has had non-presence consistently then check it every other year or every 3 years and check new areas annually.
- 2. Restoration
 - a. Control efforts on *S. anglica* and *S. densiflora* have not required any restoration assistance to date. It is possible that *S.patens* will not require considerable intervention as well although this is not suspected to be the case due to nature of this species' growth form and the diverse salt marsh habitat that it is found in. In recent years, increasing focus on *S.patens* monitoring and control has presented some challenges and questions about what eradication looks like for this species and the habitat it is associated with. A review of methods for control & restoration and associated monitoring/evaluation criteria should be implemented.
- 3. Fraser Delta and Boundary Bay
 - a. Target herbicide application with two complete passes to ensure every plant is treated once.
 - b. Consider mapping and spraying at the same time if resources allow.
- 4. Burrard Inlet
 - a. Continue to develop and strengthen relationships with Burrard Inlet stakeholders to support Burrard Inlet eradication goal of *S.patens*
 - b. Develop a plan to address *S.patens* infestation in Burrard Inlet including proposed control techniques and associated restoration activities and long term mapping/early detection goals.
- 5. Vancouver Island
 - a. Initiate mapping and control in early spring 2016 (before plants begin to flower) and continue removals into winter 2016. Control efforts should focus on previous priority sites continuing to deplete these *Spartina* infestations.
 - b. Continue to employ active, foot based surveys where *Spartina* has been detected in previous years from Courtney to Deep Bay, and on Denman, Hornby and Sandy Islands.
 - c. Complete boat or foot based surveys in previous unchecked areas near known existing or historic infestation sites eg. Lasqueti Island
- 6. Partnerships and Outreach
 - a. Continue to support the community efforts of *Spartina* searching and mapping in the Tofino area and in other Vancouver Island estuaries by:

- i. Providing stimulus funding for initiating a program and/or acquiring additional funding support
 - ii. Providing training and resources (such as staff time, boats, mapping equipment)
 - iii. Encouraging volunteer mapping and removal days to foster a greater understanding of the importance and challenges in eradicating Spartina
 - b. Host training session on native plant ID and spartina ID for stakeholders and other agencies who work in potential Spartina infested areas on east coast of Vancouver Island?
 - c. Increase awareness of Spartina activities using various methods such educational display at public events like World Oceans Day, Farmers Market or Earth Day. Contact local stewardships groups such as Project Watershed or Comox Valley Naturalists directly to see if they would like to participate in the project –
 - d. Publish several articles in local newspapers and post online to garner support for project.
7. Test aerial detection techniques with new technologies such as a remote controlled, electric, unmanned aerial vehicle (UAV). These activities would be most suitable to detecting large clones and large meadows of Spartina.