British Columbia Spartina Eradication Program 2014 Progress Report

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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)

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Acknowledgements

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The representatives to the BCSWG included Kathleen Moore (Environment Canada – Canadian Wildlife Service - CWS), Markus Merkens (Metro Vancouver), Angela Danyluk (Corporation of Delta), Liana Ayach (City of Surrey-SHaRP), Dan Buffett (Ducks Unlimited Canada - DUC), Rob Knight (Community Mapping Network), Margaret Cuthbert, Alison Prentice(Friends of Semiahmoo Bay), Dave Ralph, Becky Brown(Ministry of Forests, Lands & Natural Resource Operations), Kim Keskinen (Port Metro Vancouver), Jennifer Grenz, Tasha Murray (Invasive Species Council of Metro Vancouver), Matthias Herborg (Ministry of Environment), Rachelle McElroy (Coastal Invasive Species Committee-CISC).

In addition special thanks are extended to the field coordinators (Rob Knight, Matt Christensen, Alison Millham, and Jenny Balke) for their dedication and hard work amid the uncertainty of funding as well as BC Conservation Foundation (BCCF) coordinator Katie Calon. Several work crews were a cornerstone to the implementation of the Spartina mapping and control work and they include BCCF, CISC, DUC, CWS, Denman Island, Vancouver Island Conservation Land Management Program, Corporation of Delta, and the City of Surrey summer students.

Over the course of summer and fall of 2014 and into early 2015, 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 on Vancouver Island. The table below acknowledges, hopefully, all of those contributions to the BCSWG Program.

Table 1. List of 2014 Spartina program participants by agency

Organization	Participants
City of Surrey; SHaRP Program	Alyssa Togado, Brennan Williams, Chester Hitz, Jessica Vanditmars, Nimisha Sharma
Environment Canada – Canadian Wildlife Service	Claudia Gasparovic, Sean Tippett
Friends of Semiahmoo Bay Society	Alison Prentice, Sarah Brookes, Chantelle Kingston, Ben Oldham, Dalyn McConachie
Ministry of Forests, Lands & Natural Resource Operations	Dave Ralph, Becky Brown
BC Ministry of Environment	Matthias Herborg
Other Volunteers on Fraser Delta	John McGarvie, Julia Alards-Tomalin, Tara Matthews, and Frederique Guemas, Derek Tam
Volunteers & Subcontractors in Bayne's Sound	Volunteers: Isabelle Fusey, Mark Van Bekel, Lynne Madson, Carol Hunter, Subcontractors: Ansa Herriotts, Bee Smith, Bronwynne Fogarty, Christophe Cateron, Dagen Noble, David Fraser, David Miller, Dillon Choppin, Dylan Gale, Eli Hanson, Emily Guinane, Jori Phillips, Megan Babb, Micahel J. Brownlee, Michael McNulty, Paige Scott, Paul Walton, Robin Pickell, Sebastian Berg, Simon Natrass, Stirling Fraser, Tesla Ingram, Tim Fuchs, Wendy Boothroyd, Wesley Ritter and Yogi Dascalie
BC Wildlife Federation-Go Wild Program	Taylor Stefanik, Paige Scott
BC Parks	Derek Moore, Daniel Kriss
Streamside Native Plants	Richard Wahlgren
Rotary Club of Ladner	Roy Sakata
Corporation of Delta	Angela Danyluk, Kim Houghton, Perry Browne, Robyn Nitychoruk and Taylor Hunt
Comox Valley Regional District	In Kind contribution of waste disposal fees.
Vancouver Island Conservation Lands Management Program	Steven Godfrey, Clayton Billett, Dawson Clermont
Tsawwassen First Nation TFN Construction / Matcon Joint Venture	Sidney Cassidy, Simon Baird, Debbie Wright, Tia Williams, Mark Gauti, Joe Thwaite,
Port Metro Vancouver	Caroline Dorr, Crystal Lloyd, Ashley Graham, Kim Keskinen,

Executive Summary

In 2014, 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 S*partina patens*) by 2018 along the coasts of BC, Washington, Oregon and California.

In 2014, the BC Spartina Eradication Program applied $354,969 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 35 km of shoreline in Boundary Bay and Robert's Bank, 20 km of shoreline in Burrard Inlet and more than 120 km of shoreline on Vancouver Island, Denman, Hornby and Sandy Islands.

The 2014 inventory shows the abundance and density of *Spartina anglica* in Boundary Bay and Robert's Bank has continued to increase from 2007, however the rate of increase has slightly tapered off 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. The total acres of *S. densiflora* on the east coast of Vancouver Island, Denman and Hornby islands have also been considerable reduced by mechanical and manual excavation.

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 have been significantly reduced in size. On Hornby Island 27 km of shoreline was searched to find three new infestations of *S. densiflora* that were manually excavated. This is the first time that *S. densiflora* was detected on Hornby Island and ongoing monitoring for Hornby Island should be done because of its extensive foreshore salt marshes at risk to Spartina invasion and the relatively low abundance of Spartina found there to date. On Denman Island approximately 23 km of shoreline was searched and confirmed that all mature *S. densiflora* plants have been removed from the shoreline since a concerted removal effort began in 2012, however ongoing monitoring and removals of new growth will be required for a few years.

S. anglica control in the Fraser Delta for 2014 focused on manual removal of small plants and herbicide treatment of large ones. *S. densiflora* control efforts in 2014 focused on manual and mechanical excavation in Bayne's Sound. Cover trials were installed on *S. patens* in Baynes Sound and Burrard Inlet. As well mechanical excavation was attempted on *S. patens* in Baynes Sound.

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.

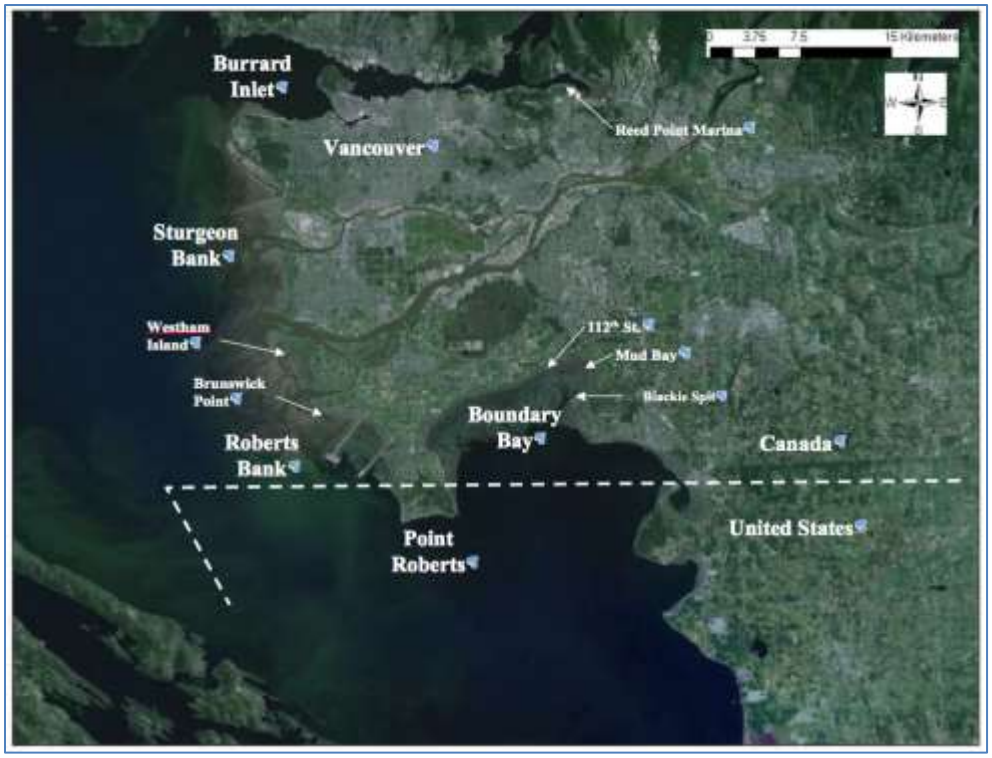


Figure 1. Areas in the Vancouver Lower Mainland

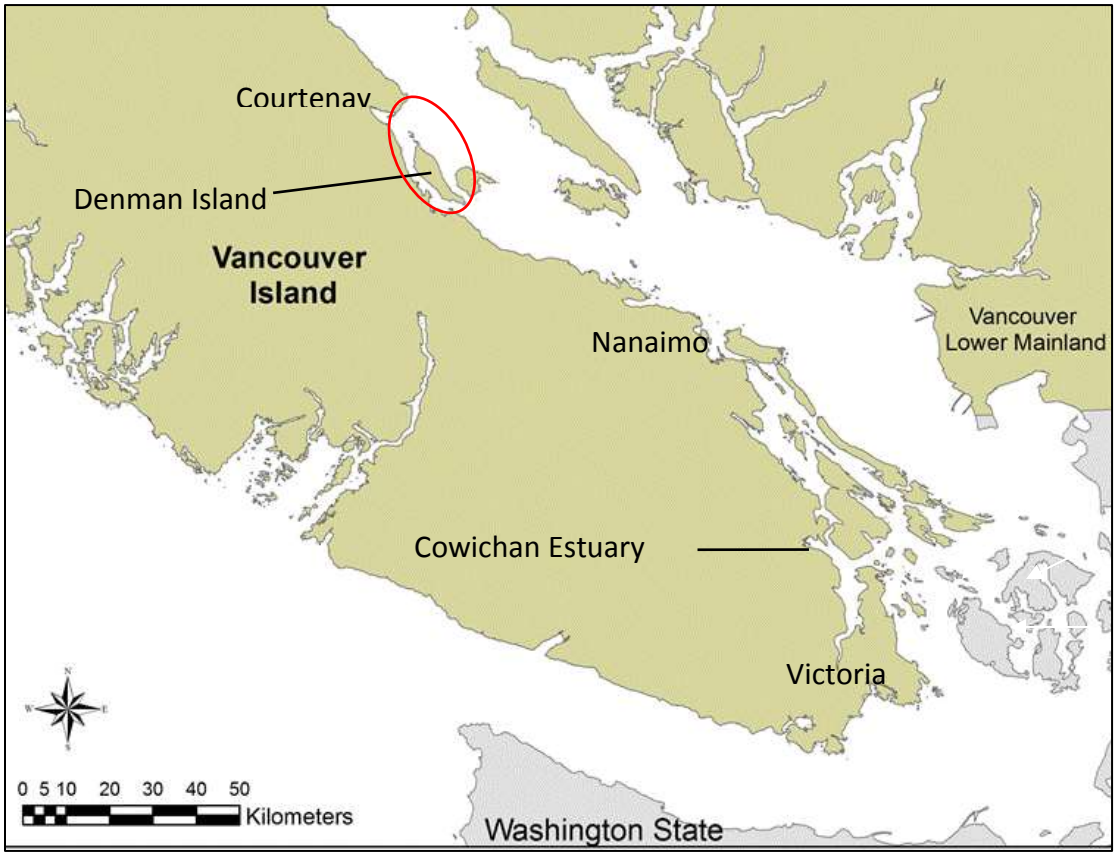


Figure 2. Areas on Vancouver Island

Detection

Data compilation and storage for Spartina sp. data (2004 to 2014) 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 2014, approximately 196 person days were devoted to map and remove Spartina along approximately 35km 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 2014 was the same as in June 2013 covering shores and mudflats of Mud Bay, Boundary Bay between the US border from south of the Little Campbell River to Point Roberts and Roberts Bank rounding Brunswick Point to the south arm of the Fraser River. The intertidal areas west of Westham Island were not surveyed in 2014 because of limited manpower. *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. *S. anglica* has been found growing in all intertidal zones and on a variety of substrates ranging from fine silt/mud, sand to cobble. It was found as seedlings, as larger isolated clones and integrated with other native marsh vegetation.

Until 2014 all size classes had steadily increased since 2007 despite considerable control efforts using mechanical removal by hand and machine (Table 2). Herbicide application in 2013 is probably the primary driver behind the slightly lower annual rate of increase of *S. anglica* from 2013 to 2014. Mapping efforts are consistent from 2004 -2013. Mapping efforts in 2014, extended later into the growing season as a result of balancing mapping and herbicide control with the weather and tide cycles. While historically the mapping has been done every June and July additional plants are often found later in the growing season 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.

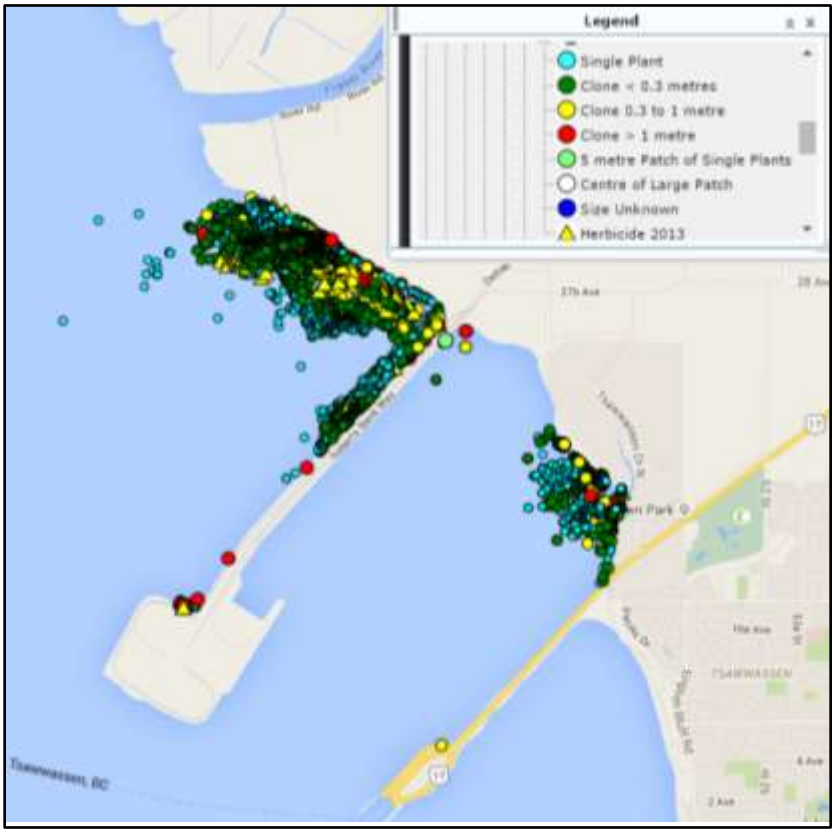


Figure 3. 2014 Spartina Infestation in Roberts Bank

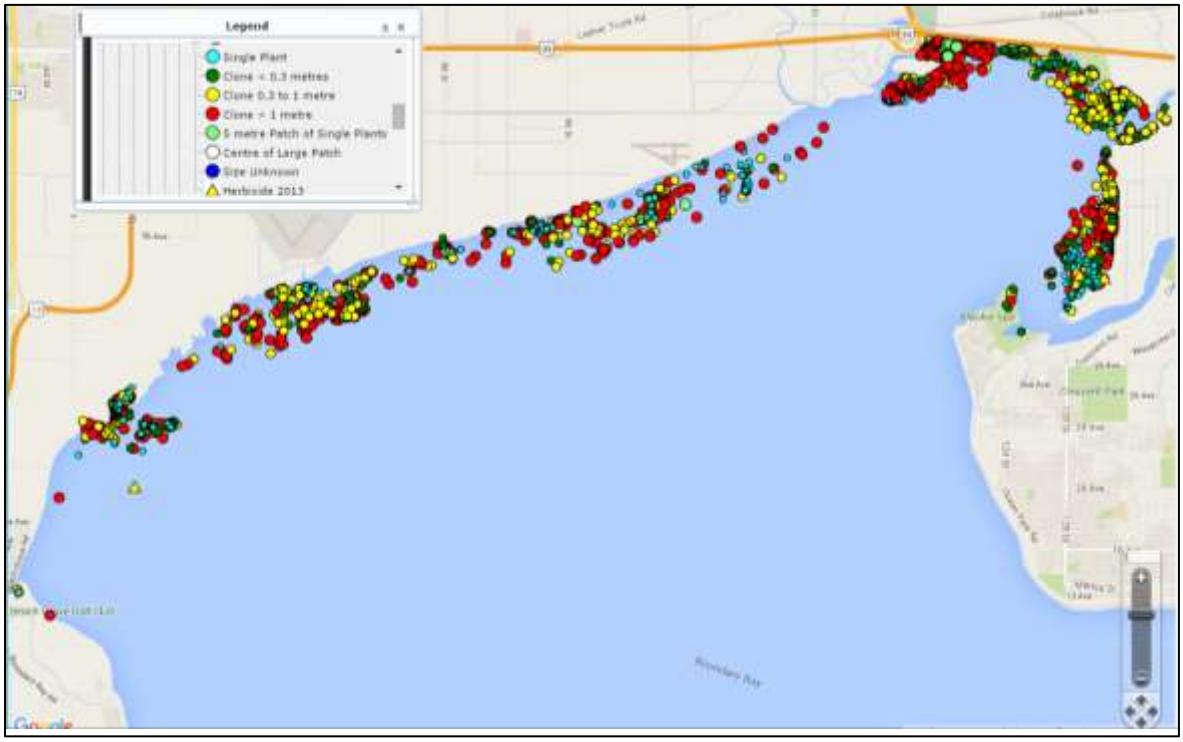


Figure 4. 2014 Spartina Infestation in Boundary Bay

Table 2. Abundance of *S. anglica* Detected by Size Class from 2005-2012 in Boundary Bay and Roberts Bank.

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

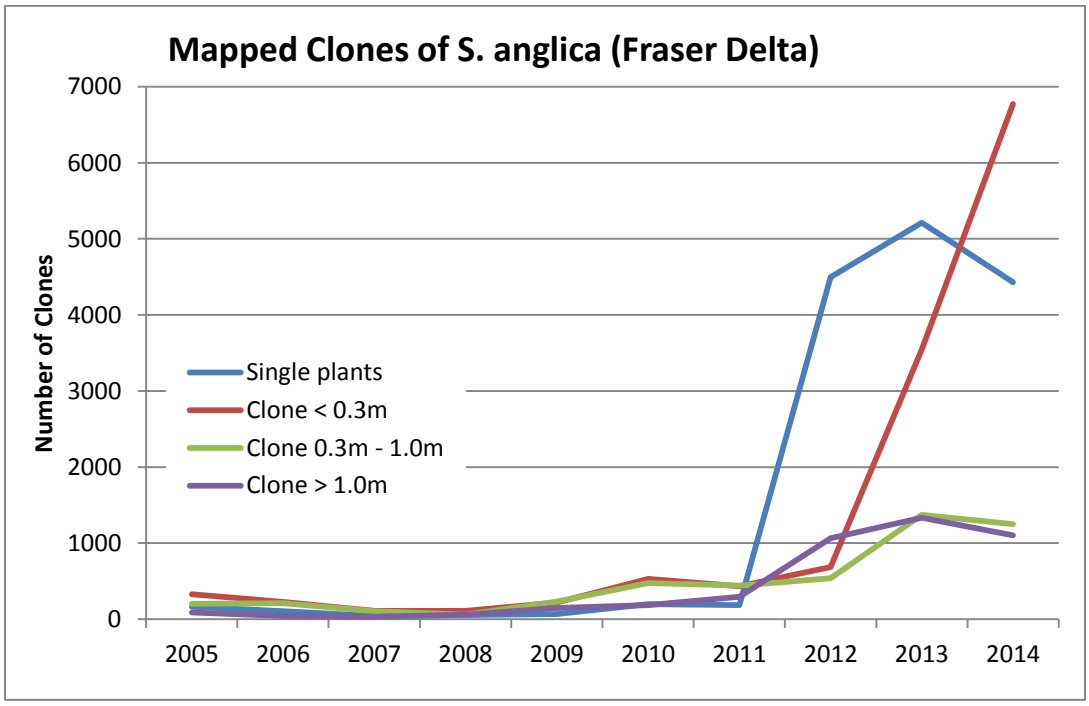


Figure 5. *S. anglica* Size Classes Mapped from 2005-2014

Burrard Inlet

S. patens is found in two main geographic areas of Burrard Inlet, Maplewood Flats Conservation Area and Port Moody Arm as shown in Figure 7. *S. patens* appears to be have a relatively stable distribution compared to *S. anglica*, however with increased search effort and improved search image of the mappers, more *S. patens* has been found in Port Moody Arm in 2014 as shown in Figure 7. Additional mapping work was conducted by foot in 2014 in the Port Moody arm of Burrard inlet (Figure 6) and a few small infestations were found.

Figure 6 Foot survey search track in Burrard Inlet September-October 2014

Figure 7. Current Mapped Distribution of *S. patens* in Burrard Inlet – 2014

Vancouver Island, Denman Island & Hornby Island

To date all known Spartina locations outside of the Lower Mainland are located in Baynes Sound to include: the east coast of Vancouver Island, Denman Island, Hornby Island and Sandy Island. In 2014 on the east coast of Vancouver Island a total of approximately 70 km of shoreline was mapped by both foot and boat surveys. Most *S. densiflora* inventoried on the east coast of Vancouver Island was new germination from seed and/or rhizomes.

In 2014 approximately 22 km and 27 km of shoreline was surveyed for Spartina on Denman Island and Hornby Island, respectively. *S. densiflora* was discovered in 3 general regions on Hornby Island's shores for the first time in 2014 to include the northeast coast, the western shore, and the southeast shores (shown in Figure 8). Most of these sites were sparsely populated with *S. densiflora* and the plants were seedlings. However a couple locations were more established with several mature plants and seedlings. This reinforces the need for regular monitoring and expanding search efforts beyond known infestations as some of these sites likely had been established for 1 to 2 years. On Denman Island, 11 new IAPP sites of *S. densiflora* plants were recorded. Despite considerable removal efforts in 2013, most sites in 2014 had *S. densiflora* regeneration. A small fraction of the sites that were treated with mechanical and manual removal had the most considerable reduction (characterized as having only 1 or a few small plants regenerating in 2014). Most re- growth appears to be from a seedbank although larger stems have been observed growing from buried root/tiller fragments. Occasionally re-growth was noted from clipped plants that were overlooked among the longer stems of other dense salt marsh vegetation.

In 2014, specific areas outside of Baynes Sound were checked for Spartina, but no Spartina was detected. These areas include: Campbell River areas, Sunshine Coast, Deep Bay (south) to Qualicum Beach, French Creek, Englishman River, Tofino, and Ucluelet; as well as Gulf Islands such as Sandy Island, Gabriola, Cortez, Texada, Savary, and Quadra.

As partners in the Spartina eradication program for Vancouver Island, the VICLMP continues to search for Spartina species in the areas that they manage and work on throughout estuaries and conservation areas on Vancouver Island. If Spartina presence or absence is noted with a dedicated survey effort the detection type is noted as active, whereas when the Spartina surveys are done while conducting other project work it is defined as a passive survey. While no Spartina was found outside of Baynes Sound, (Table 2) below summarizes the effort and location of detection in 2014:

Table 2. 2014 Spartina Detection Completed in Conservation Lands of Estuaries

Estuary	Detection type	Spartina Detected	Effort (man hours)
Cowichan	Passive	No	2
Chemainus	Passive	No	2
Nanaimo River	Active	No	4
Englishman River	Passive	No	2
Little Qualicum	Passive	No	2
Fanny Bay	Active	Yes – Removed	3
Coal Creek	Active	Yes – Removed	2
Salmon River	Passive	No	2
Cluxewe	Active	No	2
Quatse	Passive	No	1
Tofino Mudflats	Passive	No	6

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

S. patens remains primarily contained in the Courtenay Estuary, with isolated patches found along Sandy Island, Royston, Union Bay and Buckley Bay. However several new S. patens patches were identified within the previously identified population extent of Baynes Sound and in close proximity to existing known patches. These identified patches mean the existing populations are larger than previously thought but due to their large size are thought to be have been present but not detected in previous years.

Figure 8. 2014 Locations of *S. densiflora* (yellow) and *S. patens* (red)

Control & Removal

Fraser Delta and Boundary Bay – Manual Control

With continued herbicide use on *S. anglica* in 2014, the integrated control plan was modified to focus 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. The use of excavator to dig and bury plants was discontinued in 2013.

A few organizations undertook hand removals of infestations:

- Friends of Semiahmoo Bay Society: Boundary Bay - Blackie Spit and;
- 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.

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 stop dispersal to uninfected areas.

As in previous years, participants dug up individual plants and smaller clones using hand shovels, loading them into large garbage bags. The garbage bags were pulled using snow sleds

to an area accessible to the ATV or pick-up truck. At 112th Street, Brunswick Point and Mud Bay Park one or two small all-terrain vehicles gathered up the filled bags filled and transported them along the dyke to a nearby disposal bin stationed for the removal work. Using inexpensive moulded snow sleds enabled participants to bring removed plants from further out on the mud flats while keeping the lift weight in each bag smaller and reducing the bags ripping.

A three person Spartina crew was hired through BCCF for June, July, August and September. The crew focused on hand removals, manual seed head clipping, additional mapping, herbicide efficacy trials data collection, supervising volunteer removal activities, and provide mapping support for the herbicide use. In 2014, 587 'S' size and 1029'A' size clones were manually removed.

Figure 9. Manual Control Locations at Roberts Bank & Boundary Bay

Fraser Delta and Boundary Bay – Herbicide Control

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 ministries to determine the requirements and process required 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 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. Therefore Rodeo (glyphosate) was not used in 2013. As a result the annual emergency use application submitted to PMRA in January 2014 by the BC Ministry of Environment only included the use of 1 herbicide, Habitat (active ingredient: imazapyr), to control Spartina. The application included supplementary documentation including the proposed methods, evaluation and monitoring process. On May 16, 2014, the PMRA granted the emergency registration of the herbicides Habitat (imazapyr) for control of Spartina in intertidal areas of BC until December 31, 2014. As part of the approval, PMRA identified the use of the surfactant Ag-Surf II 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 in the Boundary Bay and Roberts Bank Wildlife Management Area was provided by BC Ministry of Forest, Lands and Natural Resource Operation from July 16, 2014 and up to and including September 30, 2014.

Herbicide application continued in 2014 commencing in July. Herbicide treatment of all *S. anglica* clones (16,000 clones) was completed in the Roberts Bank and Boundary Bay area. In the previous year, only clones in Roberts Bank and a small area in Mud Bay were treated. The 2014 treatment is estimated to be 3.13 ha (7.7 acres) of solid spartina spread over more than 14 000 acres (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 July 11-15, July 25-29, August 6-8, August 11-12, August 21-23, and September 5-8. Herbicide application on August 21 and 22 was supported by Washington State Department of Agriculture staff and the use of one of their airboats in Mud Bay. Below are maps of the herbicide treated areas (Figure 10, Figure 11).

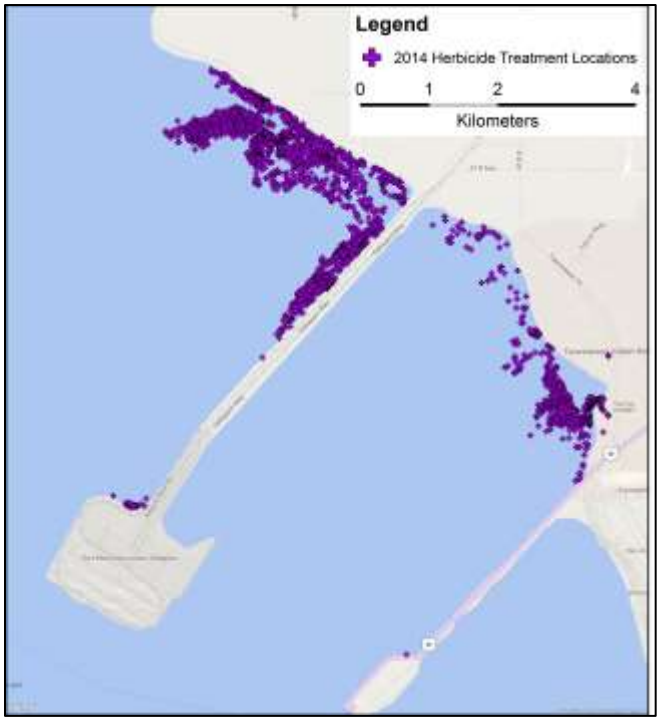


Figure 10. July and August 2014 Spartina Infestation Treated with Imazapyr (purple cross) in Roberts Bank

Figure 11. August and September 2014 Spartina Infestation Treated with Imazapyr (purple cross) in Boundary Bay

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 significant 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 (geofabric). Upon removal of the geofabric the native plant populations re-established on the site rather than the non-native Spartina.

In 2012, at Reed Point Marina, Burrard Inlet west of Port Moody, a patch of *S. patens* (Figure 12.A) was covered by 500 square meters of a geotextile fabric (Figure 12.B) designed to shade out the covered plants. The *S. patens* meadow was completely surrounded by rip-rap on a constructed intertidal bench and the cover is well protected from winter wave action by the adjacent marina. The cover remained stable throughout the winter/spring of 2012-13 Observations in 2013 identified that areas with only one layer of geofabric had some weak but active plants, whereas areas with two layers of geofabric were bare mud and had no plants growing. In August 2014, the geofabric was removed, doubled up and placed over the adjacent rip rap to cover satellite clones that were not able to be covered in the original installation. This will help determine if two layers will reduce the period of covering. The area that had been covered since August 2012 had only bare mud when the cover was removed in August of 2014 (Figure 12.C).

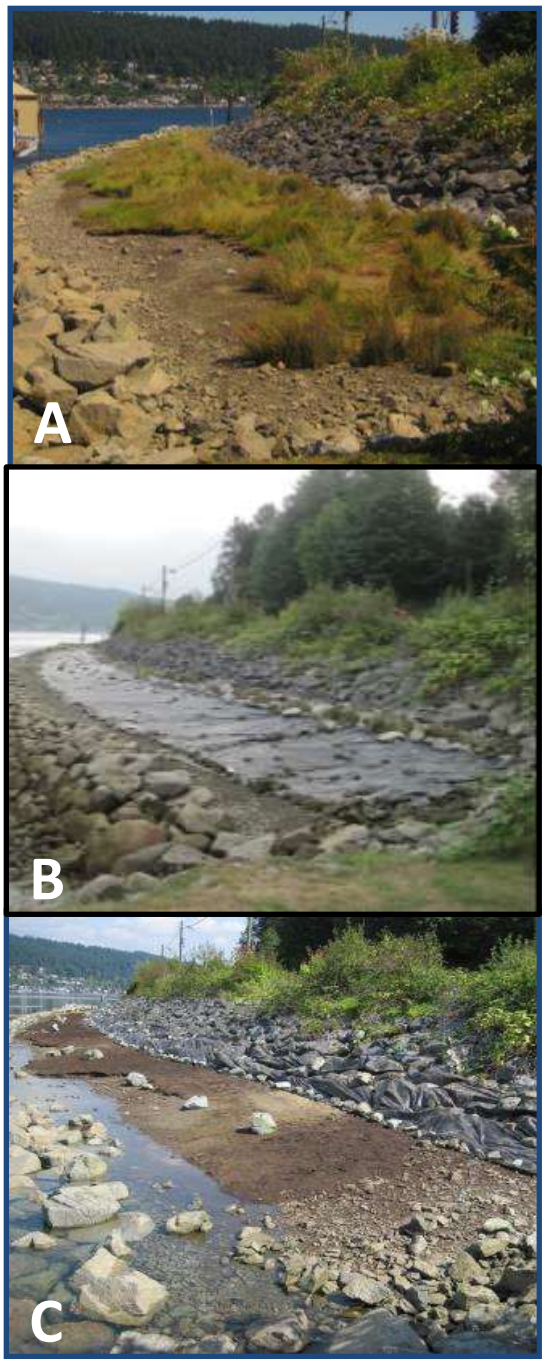


Figure 12. A) August 2012 - Patch of *S. patens* at Reed Point Marina prior to covering B) August 2014 - Geotextile fabric installed just prior to replacement on adjacent satellite clones C) August 2014- After two years of covering, bare mud and S. patens on the perimeter

In September 2013, Port Metro Vancouver established a second site (Pacific Coast Terminals) to evaluate geofabric technique to control *S. patens*. A total of 4 plots of *S. patens* (100 feet by approximately 10 feet each) 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). Initial observations are that the polyethylene appeared to have been more effective than geotextile at *S. patens* control. However the polyethylene was also 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, suggesting that stressing *S. patens* prior to covering does not reduce the length of time required for covering to be effective. At the PCT site, one combined plot with geotextile overlying polyethylene was installed in March 2014. As well polyethylene was reinstalled as a folded double layer in September 2014. The exposed half of the previously covered polyethylene area will be monitored to assess reinvasion. A single layer of geotextile was reinstalled in the same location and will be monitored for an additional year.

Based on observations at PCT in March 2014, covering *S. patens* over the winter months may have protected the plants from harsh conditions. This suggests that the initial installation of cover materials will be more effective if conducted before the growing season, rather than over the winter. Monitoring is ongoing to determine the re-establishment capabilities of both native vegetation and *S. patens*. Measurements will include stem density, stem height, and percent coverage measured.

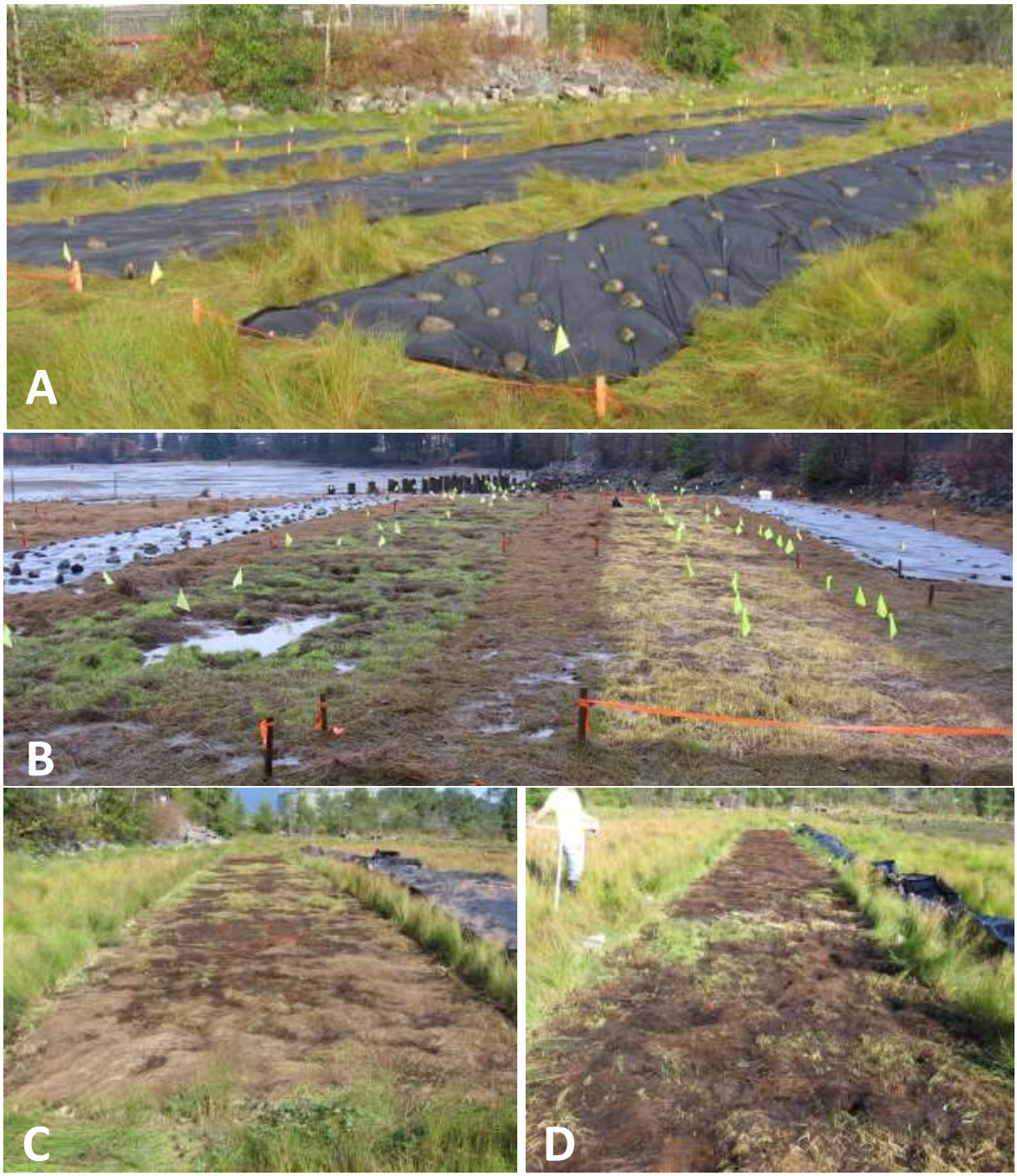


Figure 13 a) 2013 Geofabric and Polyethylene cover material trials installed in September at Pacific Coast Terminals in Port Moody Arm. b) Uncovered plots in March 2014, with geotextile on left (green) and polyethylene on right (yellow). c) After 1 year of geotextile covering d) After 1 year of polyethylene covering Photo Credit: Kim Keskinen

Vancouver Island, Denman Island & Hornby Island– Manual Control

The Coastal Invasive Species Committee (CISC) and J. Balke Ecofocus Environmental Consultants (Ecofocus) coordinated the control of *S. densiflora* and *S. patens* in the Baynes Sound area, with some assistance from the Vancouver Island Conservation Land Management Program (VICLMP). All known infestations on the east coast of Vancouver Island and Sandy Island were treated with manual removals in late 2014 and early 2015. Approximately 2000 kg of *S. densiflora* was removed from Bayne's Sound. 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.

On the Comox foreshore, two small patches of *S. patens* (1.1m^2, 1.3m^2) were covered in 2012 with 2 layers of geofabric and secured with stakes. Both plots were vandalized in June 2013 and the sites were repaired. In January 2015 the sites were revisited to find one had completely washed away. The other was intact but the stakes securing the fabric had become dislodged. The cover material was removed and no plants were observed at either site in January 2015 and follow up monitoring should take place in summer 2015. A shade trial was also installed on Sandy Island in 2013 but was found to have been washed away in late 2014.

For *S. patens* control in 2014, 8 cover plots were installed (totaling approximately 100 m^2) and 8 mechanical excavation trials (totaling approximately 66 m^2) were completed. At the excavation trial sites, crews collected native seeds from nearby native species e.g. *Plantago maritima, Triglochin maritima* and *Grindelia stricta* and distributed them onto the disturbed site after excavation. Both CISC and Ecofocus prepared more detailed reports on mapping and removal for Vancouver Island that are provided in a separate report (Vancouver Island Spartina Eradication Program 2014 - 2015 Progress Report prepared by Mike Reid, James MacLeod, and Alison Millham, April 26, 2015 and Dense-flowered Cordgrass *S. densiflora* Removal Project Denman & Hornby Islands 2015, prepared by J. Balke Ecofocus Environmental Consultants, March 31, 2015).

Figure 14 S. patens 2014 excavation trial

Table 3 *S. patens* manual control efforts in Bayne's Sound by the BC SWG to date.

Treatment Type	UTM Zone	Easting	Northing	Location	Area(m^2)	Status
Cover	10	360020	5504034	Comox foreshore surveyed or axcessed from Beach Drive - below high tide.	1.1	Removed January 2015 (after 2 yrs of covering) - Follow up monitoring needed in Summer 2015
	10	360020	5504034		1.3	
	10	366240	5498151	Sandy Island	4	Washed away by tides and wind in late 2014
	10	360518	5500893	Gartley point at end of Carey rd.	42.4	Ongoing monitoring for securement and damage until 2017
	10	359102	5501800	End of Hilton Rd. in Royston (The Royston wrecks)	18.1	
	10	359104	5501800		3.6	
	10	359053	5501842		13.3	
	10	359115	5501939		22.3	
Excavation	10	359000	5501839		2.6	Follow up monitoring needed for re-establishment of native vs Spartina vegetation in 2015
	10	359005	5501838		22.3	
	10	359021	5501841		9.2	
	10	359046	5501847		14.1	
	10	359050	5501845		2.8	
	10	359051	5501849		8.9	
	10	359055	5501848		3.0	
	10	359058	5501845		2.8	

Science – Evaluation - Monitoring

As part of the PMRA and PUP permitting for herbicide application on *S. anglica*, a series of monitoring projects have been underway since 2013. The results of these studies can be summarized as follows:

- **The impact of imazapyr on Salicornia:** Mean imazapyr residue in Salicornia at a distance of 5.0 m from herbicide treated Spartina plants were near or below the mean detection limit of the lab equipment immediately following treatment. Subsequent sampling of Salicornia at the next day after tide submersion, 1 week later after tide submersion and 12 days later after tide submersion showed no imazapyr was detected with in the mean detection limit of the lab equipment (1.0 ug/L). Given this information, a buffer of 5.0m between Spartina treated plants with imazapyr and Salicornia that may be harvested for human consumption appears appropriate as the mean imazapyr residue level observed in this project at time of herbicide treatment was near the limit of detection of the equipment and two orders of magnitude below the 100 ug/kg Maximum Residue Limit

(MRL) set by the Canada Food and Drugs Act for the prohibition of the sale of food containing a pesticide residue

- **Efficacy of different concentrations of herbicides on Spartina:** *S. anglica* treated with half label rates had poor to moderate control while all full label rates and combinations of herbicide (active ingredients imazapyr, glyphosate) had good control.
- **Herbicide residue persistency in water samples:** The results show that there was no detectable glyphosate during any time period, as well the treatment of imazapyr and glyphosate using the wick application did not have detectable levels of imazapyr nor glyphosate. The non-detection of glyphosate 48 hrs after treatment is consistent with similar monitoring projects conducted in 2006 and 2007 in Washington State (Taylor 2006, Anderson 2007). Imazapyr was detected in two of six samples one week after treatment at concentrations of 0.053 ug/L and 0.087 ug/L, however the presence appears to be due to cross contamination rather than representing presence in the field.
- **Impact of herbicide on non-target plants**: monitoring for the effect and re-establishment of native vegetation found no statistically significant effects of herbicide treatment.

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 http://www.portmoody.ca/index.aspx?page=1260#Saltmeadow Cordgrass (*S. patens*)
- Coastal Invasive Species Committee: http://www.coastalisc.com/priority-invasive-plants

Spartina in the media

a. Delta Optimist Newpsaper Article (April 25, 2014)
b. Conservator Magazine Article (September 24, 2014). http://www.conservator.ca/2014/09/striking-back-spartina/

Spartina Presentations and Workshops

a. Invasive Species Council of BC Forum and AGM Speed Sessions (January 2015)
b. BCIT Restoration Class Presentation (November 2014)
c. Burrard Inlet Stakeholders Workshop (February and March 2015)
d. Salish Sea Ecosystem Conference (May 1, 2014)
e. Provincial Parks and Grounds Spring Training (February 2015)

Finances

The BCSWG partners and individual volunteers contributed over $128,000 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 14 shows the percentage of contributions by component and the ratio of in-kind to direct (cash) contributions. Table 3 details the contributions by all partners for each Component of the Program and Table 4 summarizes the income and expenditures for 2014.

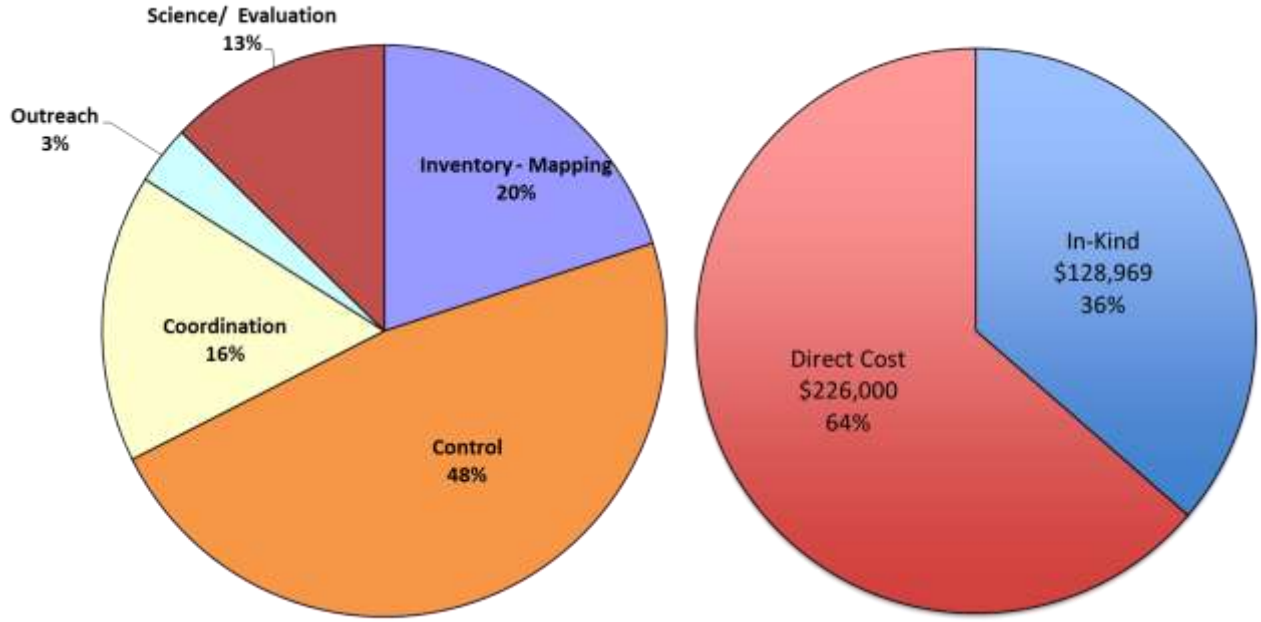


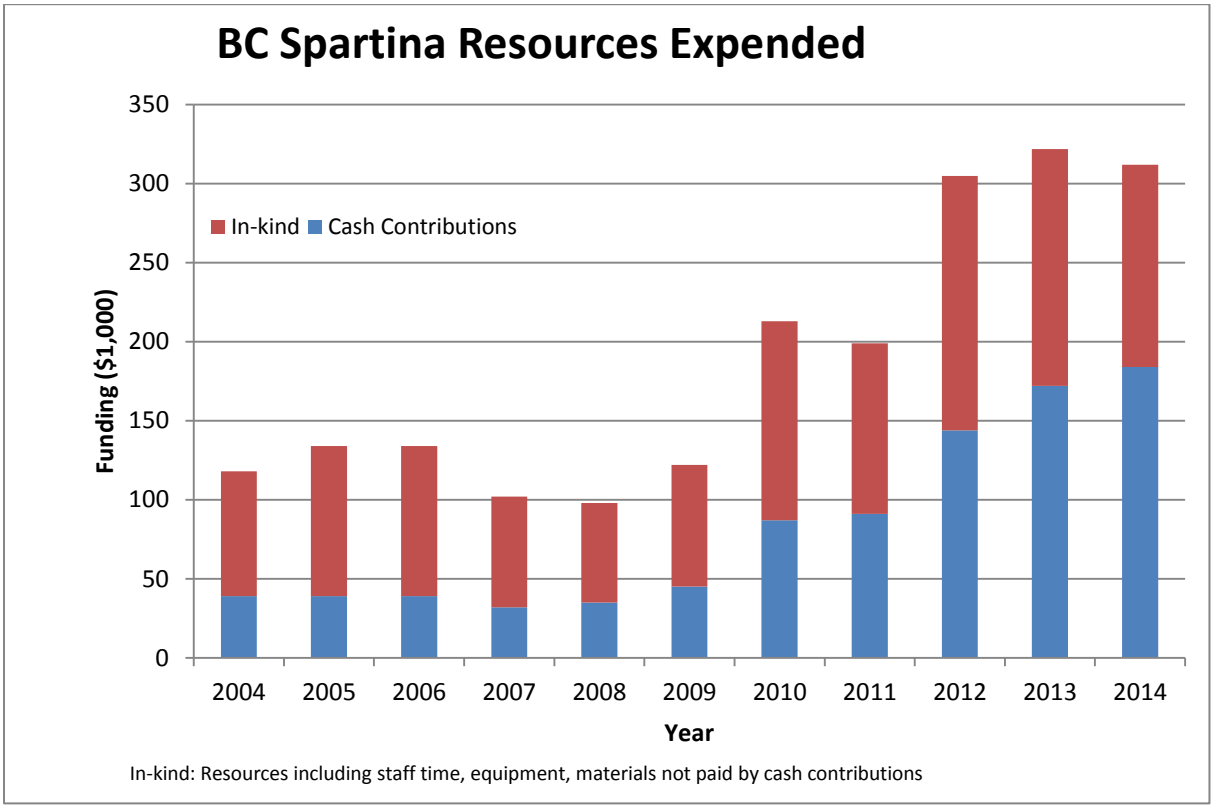
Figure 14. 2014 Spartina Program Expenditures by Component & Type/Amount

Table 4. BC Spartina Eradication Program Direct Cost (Cash) Contributions - BCSWG 2014

Direct Costs (Cash)	Committed & Expenditures by Program Components					
	Inventory	Control	Coordination	Outreach	Science/ Evaluation	Total
Lower Mainland BCCF Crew	$7,000	$13,314			$2,541	$22,855
Lower Mainland Coordinator contracts (R Knight, M Christensen)	$10,000	$20,488	$7,000		$5,000	$42,488
DUC		$9,288	$17,217			$26,505
Lab Analysis					$15,608	$15,608
Other Contractor-Website, transport		$6,747				$6,747
Materials, Supplies, misc.	$2,157					$2,157
Vancouver Island Contracts (CISC, Denman Isld)	$17,000	$50,139	$10,000	$4,000	$3,500	$84,639
Contractor - Herbicide Application		$25,000				Funds Spent
SubTotal	$36,157	$124,977	$34,217	$4,000	$26,649	$226,000

Over the recent history, financial contribution of the cash and in-kind of the BC Spartina Working Group is found below:

Figure 15. BC Spartina Resources Contributed Over Time



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.

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 were directly involved with BC inventory and herbicide control activities in 2014.

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 2015

While the Spartina Project documented several successes in 2014, 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. 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. Expand mapping areas beyond known distribution
    d. Secure financial funding earlier to enable earlier mapping and removal work for *S. densiflora* and *S. patens* prior to seed setting in September
    e. Utilize an integrated pest management approach towards eradicating *S. patens*. Explore chemical treatments, excavator treatments and hand-digging and associated restoration requirements.
2. Fraser Delta and Boundary Bay
    a. Target herbicide application in Boundary Bay for the clones not treated in 2014 and repeat herbicide application in Roberts Bank for the missed and newly emerged plants.
3. Burrard Inlet
    a. Continue to develop and strengthen relationships with Burrard Inlet stakeholders to support Burrard Inlet eradication goal of S. patens
    b. Continue to 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.
4. Vancouver Island
    a. Initiate mapping and control in early spring 2015 (before plants begin to flower) and continue removals into winter 2015. Control efforts should focus on previous priority sites continuing to deplete these Spartina infestations.
    b. Continue to employ active, foot based surveys where possible from Courtney to Deep Bay, and on Denman and Hornby Islands
5. Partnerships and Outreach
    a. Increase volunteer/community participation in mapping and control to:
        i. Maximize the work completed during low tides and
        ii. Foster a greater understanding of the importance and challenges in eradicating Spartina
    b. Continue to support the community efforts of Spartina searching and mapping in the Tofino area and in other Vancouver Island estuaries
6. Outreach

a. Consider the use of t-shirts and hats for field workers to wear to showcase the project and its funders while giving credibility to workers as they hike beaches that are often cultivated for oysters.
b. 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 - offer ID training. 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.

References

Anderson, Kevin. 2008. 2007 Spartina Eradication Program Water Quality Monitoring. January 2008. Washington State Department of Agriculture.

Taylor, Randy. 2007. 2006 Spartina Eradication Program Water Quality Monitoring. Washington State Department of Agriculture. January 22, 2007