2019

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

B.C. SPARTINA
Working Group
protecting our shorelines

EXECUTIVE SUMMARY

In 2019, the British Columbia Spartina Working Group (BCSWG) continued to work towards the eradication of non-native, invasive *Spartina* spp. (*S. anglica*, *S. densiflora*, and *S. patens*) along the coasts of British Columbia (BC) through the BC Spartina Eradication Program. The BCSWG recognizes the potential impacts of *Spartina* spp. on local shorelines and wildlife habitat and strives to support the Pacific Coast Collaborative in their kindred goal of eradicating all non-native, invasive *Spartina* spp. along BC's coastline.

In 2019, approximately $260,522 CAD in-kind and direct-value contributions were applied to complete program components focused on Monitoring, Removal, Herbicide, Coordination, and Outreach. Throughout the summer, fall, and winter months of this year, over 506 km of BC's coastline were surveyed for *Spartina* spp. Surveying efforts continue to indicate that these invasive species are limited to the Fraser River Delta, Boundary Bay, and Burrard Inlet areas of the Lower Mainland, and the Baynes Sound area of Vancouver Island and the Gulf Islands.

Between 2018 and 2019 *S. anglica* abundance decreased by 41%, leaf area decreased by 59%, and impacted area decreased by 30%. *S. patens* impacted area in BC increased from 165 ha to 167 ha and remains most prevalent in the Courtenay River Estuary. Spartina program herbicide treatments occurred for the first time outside of the Lower Mainland on *S. patens* in Baynes' Sound; the general locations were near Goose Spit in the Courtenay River Estuary, near Deep Bay and on Sandy Island. The number of *S. densiflora* plants found in 2019 increased by 39% which is largely attributed to mapping errors in 2018 under recording the number of plants. Overall *S. densiflora* is on the decline and the number of mature plants (those with seed heads) found is diminishing.

In 2019, the BCSWG continued to work with the City of Port Moody to monitor *Carex lyngbyei* planted as part of restoration efforts where *S. patens* had previously been present prior to treatment. Left untreated, *S. patens* grows into a dense monoculture meadow in the high salt marsh. Reestablishing native species within the now-bare patches can help prevent reinvasion by invasive species, including *S. patens.* The eradication of *S. patens* in this instance had been accomplished through shading them out with woven Nilex 2002 geotextile fabric as well as herbicide treatment efforts. Most other attempts to shade out *S. patens* with geotextile fabric have not been successful as wind and wave action as well as tampering by the public had uncovered the mats. As such, the BCSWG plans to use herbicide as the primary control method for *S. anglica* and *S. patens* in future. *S. densiflora* will continue to be treated with manual control methods and the effectiveness of these efforts will continue to be monitored to ensure progress towards eradication is being maintained.

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ACKNOWLEDGEMENTS

The work completed for the 2019 Spartina Eradication Program (SEP) could not have been undertaken without funding from:

Government of Canada | Gouvernement du Canada | British Columbia | Port of Vancouver

The British Columbia Spartina Working Group (BCSWG) is a Collaborative group that formed in 2004. It includes members from both government and non-government organizations. The SEP is primarily lead by the technical committee. However, the success of the programs early detection rapid response efforts is only possible from the entire Working Group (Figure 1).

Figure 1. Members of the BCSWG.

In addition, special thanks are extended to the field coordinators and many other individuals and groups who contributed to finding and removing *Spartina* spp. in British Columbia (BC). Many landowners provided access through their properties to map and control Spartina, and we thank them for their support. Those contributions to the BCSWG program are acknowledged in Table 1.

Table 1. List of 2019 participants who helped map and control *Spartina* spp in BC.

Organization	Participants
City of Surrey; SHaRP Program	The names were not recorded this year; however, the BC SWG is grateful for those that did participate in 2019 efforts. The BC SWG values to continued support and engagement by the City of Surrey and the SHaRP Program.
Corporation of Delta	Kevin Li
British Columbia Conservation Foundation	Katie Calon, Annabel Arnott, Mike Lee, Nicole Mulligan, Ryan Ford
Ducks Unlimited Canada	Matt Christensen, Megan Winand, Ben Kavanagh, Marisa Bischoff, Ben Siebert
Environment Canada – Canadian Wildlife Service	Kathleen Moore
Ministry of Forests, Lands, Natural Resource Operations and Rural Development	Val Miller, Becky Brown, Derek Hogan
Port Metro Vancouver	Kim Keskinen, Spencer Chaisson
West Coast Conservation Lands Management Program	Tom Reid, Curtis Rispin, Shawn Lukas, Sammy Penner
K'omoks First Nation	Cory Frank
Friends of Semiahmoo Bay	

BACKGROUND & ECOLOGY

In 2003, Gary Williams, a consultant for Port Metro Vancouver, discovered *S. anglica* growing in the Fraser River Delta while conducting habitat surveys of intertidal areas. This finding raised concerns about the spread of this invasive cordgrass as specimens of this species had not yet been discovered in BC.

Apart from *S. anglica*, two other species of invasive Spartina have been discovered in BC. *S. patens* was first identified in 1979 in both Burrard inlet as well as the Courtenay Estuary. *S. densiflora* was identified within the Baynes Sound area of Vancouver Island in 2005. Based on anecdotal evidence, however, this species has been present in the Baynes Sound area for some time.

Invasive *Spartina* spp. are detrimental to intertidal habitats. Throughout their establishment, *S. anglica* and *S. densiflora* convert important mudflat habitat into monoculture stands. These stands accrete sediments, modifying drainage patterns and reducing habitat for waterfowl and fish. *S. patens*, on the other hand, invades the higher salt marsh areas, outcompeting the diversity of salt marsh plants and replacing them with a dense, monoculture meadow that is very difficult to remove manually. Intertidal areas that became dominated by invasive Spartina in the state of Washington, USA, experienced large declines in their abundance of shorebirds and waterfowl. As a result, significant expenditures were required to control Spartina in this state, costing approximately $1,000,000 USD per year per year for more than two decades. Moreover, the states of Oregon and Washington combined spent approximately $50,000,000 USD over a ten-year period in a concerted effort to eradicate *Spartina* spp. along their coastlines. It is only recently, with sustained funding and the use of herbicide, that these two states have significantly reduced their infestations of Spartina.

Controlling the spread of an invasive species early in its expansion is the most cost-effective approach to its eradication. The Fraser River Delta on its own contains approximately 25,000 ha of tidal mud flats that are internationally recognized as important habitat for fish and migratory birds. In fact, this delta hosts the highest density of wintering waterfowl, shorebirds, and raptors in all of Canada. Failing to control invasive Spartina in BC

would result in a massive loss of essential habitats beyond just the Fraser River Delta and would require considerably more resources to manage them in the future. It is crucial to control invasive *Spartina* spp. in BC as early as possible.

The BCSWG formed in 2004 with the intent of eradicating invasive *Spartina* spp. from BC's coastlines. The working group is comprised of members of both government and non-government organizations. The BCSWG liaisons with the San Francisco Estuary Spartina Project and the Washington State Department of Agriculture, two USA agencies involved in eradicating invasive *Spartina* spp. along the Pacific Coast. The BCSWG has built on the Pacific Coast Collaborative Agreement as well as the West Coast Governor's Agreement in order to eradicate *Spartina* spp. from BC's coastlines. In order to do this, the focus of the BCSWG is to employ early detection and rapid response methods to eradicate invasive *Spartina* spp. in BC. In 2019, these methods took the form of mapping and actively controlling for Spartina between BC's Lower Mainland as well as Vancouver Island, Haida Gwaii, and some of the Gulf Islands (Figure 2). Despite these efforts, more work is needed to monitor other parts of BC's coastlines, as is the expansion of eradication efforts in all areas infested with *Spartina* spp.

DETECTION

The compilation and storage of data of *Spartina* spp. in BC has been a joint effort of Ducks Unlimited Canada (DUC) and the Community Mapping Network. This compiled data has been used for evaluating the progress of Spartina eradication as well as for planning future monitoring and control activities. DUC also maintains a geodatabase of the BCSWG spatial data. Finally, the data of *Spartina* spp. in BC is uploaded to the Invasive Alien Plant Program (IAPP) database. For more information on mapping methodology and spatial analyses, please visit www.spartina.ca. The location and approximate distribution of Spartina in BC in 2019 is shown in Figure 3.

METHODS

Since 2017 surveying for *Spartina* spp. has involved using two ESRI[1] products, *Collector* and *Survey123*. Both products are applications for smart devices and take the place of Global Positioning System units. *Survey123* records the location and size of each individual plant or clone of *Spartina* spp. *Collector* provides real-time tracking of surveyors as well as preexisting Spartina mapping and tracking information. Data from multiple surveyors' *Collector* and *Survey123* applications are routinely uploaded to shared databases which the surveyors can then download onto their *Collector* apps. This process provides surveyors with accurate, updated visual representations as to what areas have already been surveyed as well as when these areas were surveyed. Such information is used to determine where subsequent surveying and control efforts are to be applied. In all, these applications allow the BCSWG to accurately and consistently track populations of *Spartina* spp. over time across multiple regions. These sites are called IAPP sites within the ESRI database. These IAPP sites mirror sites in the provincial IAPP database hosted by the Government of BC.

[1] ESRI (Environmental Systems Research Institute) is an international supplier of geographic information system software, web GIS and geodatabase management applications.

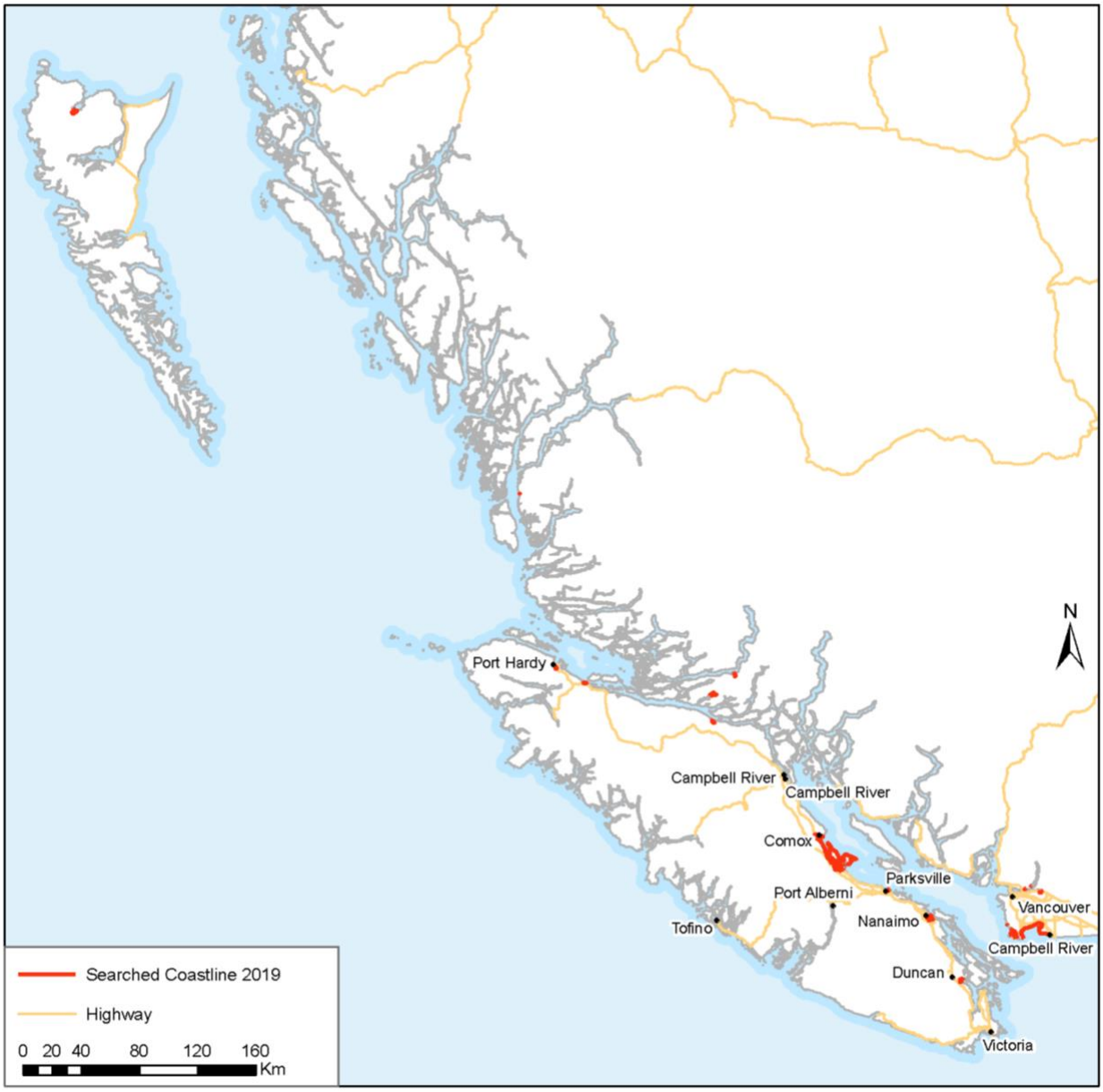

Figure 2. All areas searched for *Spartina* spp. in British Columbia in 2019.

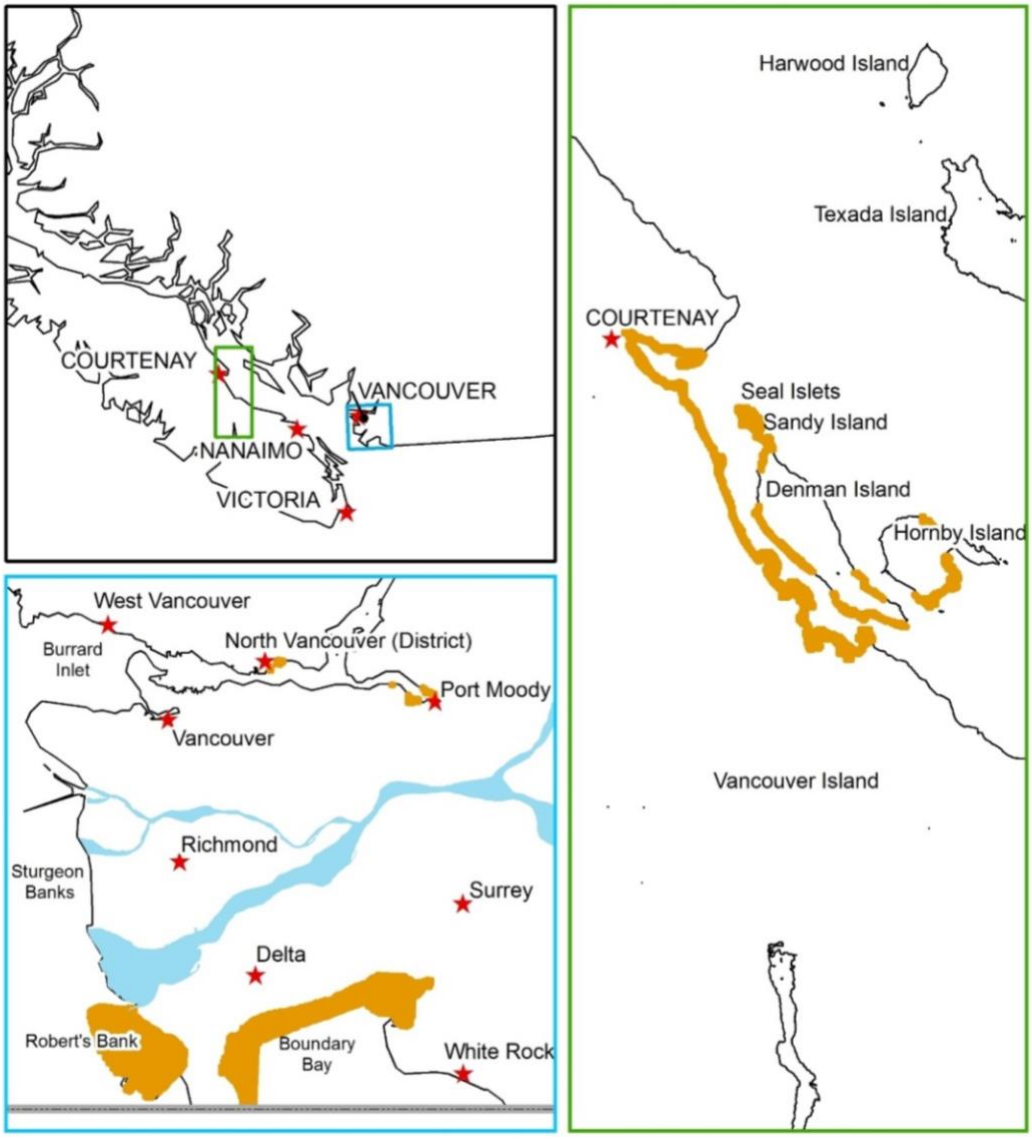

Figure 3. General locations where *Spartina* spp. are found in BC: Lower Mainland (Blue) and Baynes' Sound (Green). The approximate distribution of *Spartina* spp. is shown in orange.

The BCSWG analyzes the surveyed IAPP sites by using several metrics:

1. The number of plants or plant clones detected
2. The size of each plant or plant clone (single plant or seedling; patch with diameter less than 30 cm; patch with diameter of 30 cm to 1 m; patch with diameter of 1 m to 5 m; patch with diameter of approximately 5 m; patch with diameter greater than 5 m)
3. The estimated leaf area (number of plants or plant clones detected x size of each plant or plant clone = number of square meters a dispersed colony would occupy if all Spartina plants were grouped into a single cluster)

Each IAPP site is then divided into a grid of 1 ha cells. With this grid, the metrics are then summarized at a single cell level as well as an accumulation of all the cells within the site. These summaries are titled Cell Summaries and Site Summaries, respectively (Figure 4). These summaries are analyzed on a per-species basis. Moreover, with these summaries, the BCSWG determines how much shoreline has been impacted by *Spartina* spp. (how many 1 ha grid cells had one or more occurrences of Spartina). Together, the metrics used by the BCSWG accurately depict spatial trends on a larger scale. By analyzing them in comparison with one another, the BCSWG can effectively plan and develop monitoring and control activities for the future. For more information on how these metrics and summaries are calculated, see Appendix A.

Map of Comox Harbour with Spartina plants represented as points

Cell Summary showing the total number of plants in each cell representing total abundance

Site Summary (site boundary shown in red)

Figure 4. Cell Summaries and Site Summaries of Comox Harbour, BC.

MAINLAND BC

In 2019, Over 340 person days were spent surveying the Fraser River Delta, Boundary Bay, and Burrard Inlet areas for *Spartina* spp. (Figure 5). Surveying in the Fraser River Delta occurred from the northern tip of Sturgeon Banks, Richmond, to the Canada-USA border south of causeway that leads to the BC Ferries Terminal in Delta. Surveying along Boundary Bay occurred from the Canada-USA border south of Beach Grove Park, Delta, to where the Campbell River joins Boundary Bay in White Rock. Some of the surveying in Burrard Inlet occurred in The District of North Vancouver within the Maplewood Flats Conservation Area as well as in Deep Cove. The remainder of the surveying in Burrard Inlet occurred in Port Moody along the Reed Point Marina, within the Pacific Coast Terminal property, in Old Mill Park, and in Old Orchard Park. Of all the surveys that took place in mainland BC in 2019, *S. anglica* was only found in the Fraser River Delta and Boundary Bay areas, and *S. patens* was only found in Burrard Inlet (Figure 3).

Several other sites were also surveyed for *Spartina* spp. along the coast of mainland BC in 2019. These include the Koeye River Estuary, Glendale Cove, and Fulmore River Estuary (Figure 6). These other sites were surveyed opportunistically for *Spartina* spp. in tandem with other work that was taking place in these locations. No data was recorded in *Collector* or *Survey123* during these surveys. Moreover, no *Spartina* spp. were observed during these surveys (Figure 3).

Figure 5. Fraser River Delta, Boundary Bay, and Burrard Inlet surveyed for *Spartina* spp. in 2019.

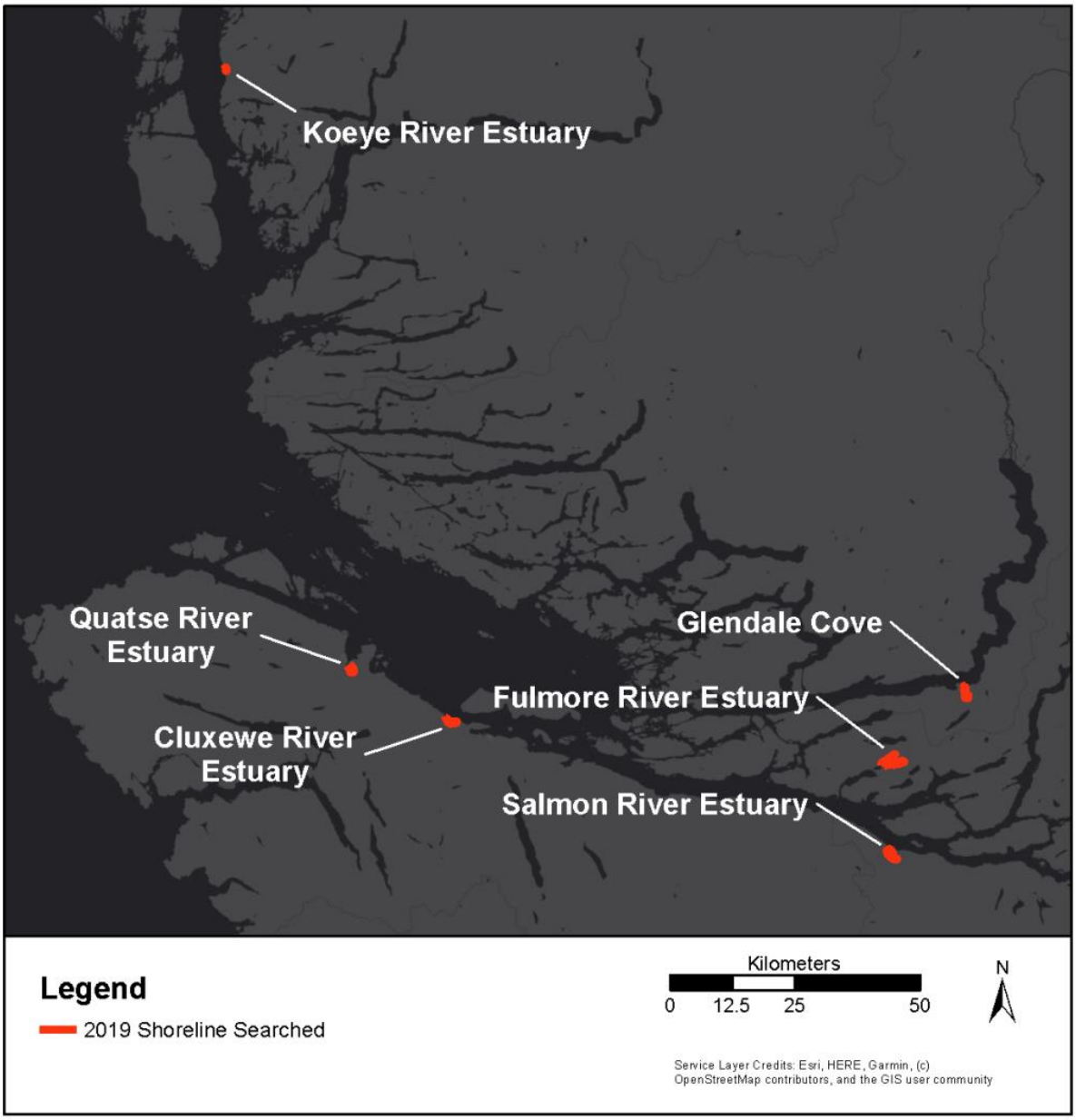

Figure 6. Additional sites surveyed for *Spartina* spp. along the mainland coast of BC as well as along Vancouver Island.

VANCOUVER ISLAND, HAIDA GWAII, & GULF ISLANDS

Over 80 person-days were spent mapping the Baynes Sound area for *Spartina* spp. in 2019 (Figure 7). Surveying occurred from Goose Spit Park in Comox to Deep Bay in Bowser. Surveying also occurred around both Denman Island and Hornby Island as well as in the Englishman River Estuary in Parksville. *S. densiflora* and *S. patens* were found within the Baynes Sound Area on Vancouver Island and some of the Gulf Islands (Figure 3). The Nanaimo River and Cowichan River estuaries on Vancouver Island were also were briefly surveyed for *Spartina* spp. in 2019 (Figure 8). These surveys were done opportunistically in tandem with other work that was taking place in these estuaries. For this reason, no data was recorded in *Collector* or *Survey123* during these surveys. Moreover, no Spartina was found during these surveys.

Figure 7. Baynes Sound area surveyed for *Spartina* spp. in 2019.

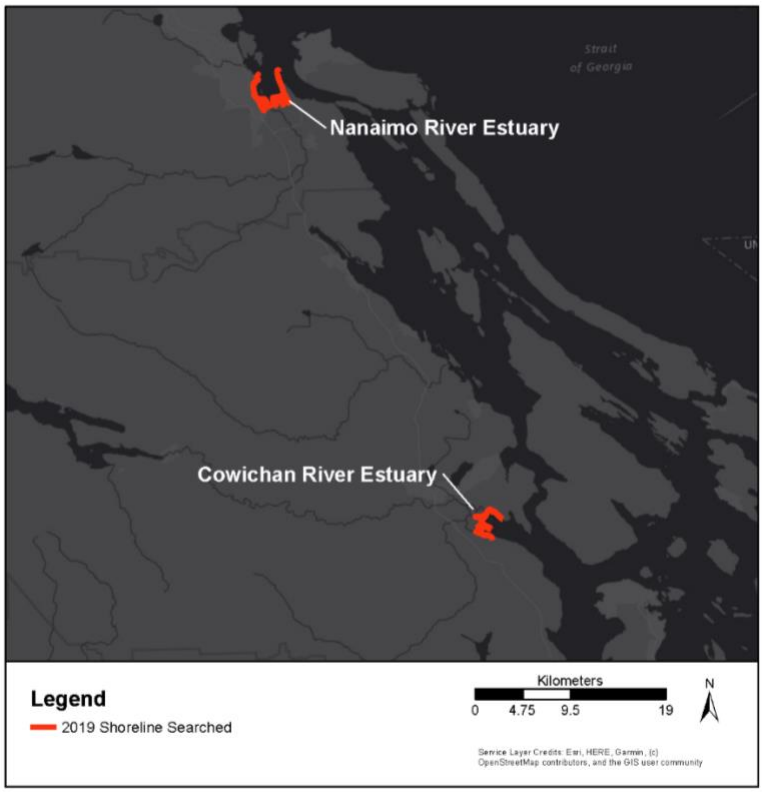

Figure 8. Nanaimo River and Cowichan River Estuaries surveyed for *Spartina* spp. in 2019.

A number of additional sites were also surveyed opportunistically for *Spartina* spp. in 2019. These surveys were done in tandem with other work that was taking place in these locations. For this reason, no data was recorded in *Collector* or *Survey123* during these surveys. The Quatse River Estuary, Cluxewe River Estuary, Salmon River Estuary were surveyed on Vancouver Island (Figure 6). The Naden River/Davidson Creek Estuary and Kumdis Slough were surveyed on Haida Gawaii (Figure 9).

Figure 9. Additional sites surveyed for *Spartina* spp. in Haida Gawaii.

CONTROL & REMOVAL

MANUAL REMOVAL

S. ANGLICA

As in previous years, participants in 2019 manually removed size 'S' (single plants or seedlings) plants of *S. anglica* using hand shovels. These smaller clones were loaded into cloth bags or sleds and disposed of in a dumpster. The dumpster was regularly collected by a waste management company and disposed of at the Vancouver landfill. Clones of larger class sizes were not treated manually but with herbicide instead.

S. DENSIFLORA

Manual removal has shown promise in effectively controlling *S. densiflora* since 2015; as such no herbicide has been used to control this species. In 2018, technicians on Vancouver Island and adjacent islands within Baynes Sound removed entire *S. densiflora* plants using pickaxes (Figure 10). Plants bearing a mature seed head were bagged before being uprooted to reduce seed dispersal during removal. All clones were loaded into heavy plastic bags and dropped off at a local landfill for dispersal. These plants were then moved off site to either isolated compost sites or landfills. *S. densiflora* was controlled during the fall and winter as it is the only standing, green plant in the marshes during these months. This timing helped reduce search efforts.

Figure 10 Pickaxe used by technicians to manually remove S. densiflora (photo credit: Leanne Letson).

S. PATENS

Manual control for *S. patens* has involved covering mats of this species with a Nilex 2002 geotextile fabric. The intent behind this was to kill the mats by shading them out over a period of multiple years. Nilex 2002 geotextile fabric has been used to shade out *S. patens* in Burrard Inlet and Baynes' Sound as a means of control since 2012 with limited success. Numerous locations, methods and patch sizes have been trialed using the covering method. The fabric is installed over patches of *S. patens* for a minimum of 2 years and has only shown signs of reducing *S. patens* patch biomass before rapid re-establishment, typically within 1 growing season. As well Baynes' Sound has a more active shoreline, subject to wind and wave action that disturbs and removes the cover fabric and this requires maintenance and monitoring that is not practical. Due to the limited success with eradicating *S. patens* using covering and manual removal techniques and following a small herbicide pilot trial at PCT in 2015, operational scale herbicide treatment was employed on *S. patens* beginning in 2016. No manual removal was applied to *S. patens* in 2018, however geotextile fabric was removed during the summer of this year. For a breakdown of the timeline of treatments for *S. patens* by the BCSWG, see Figure 11.

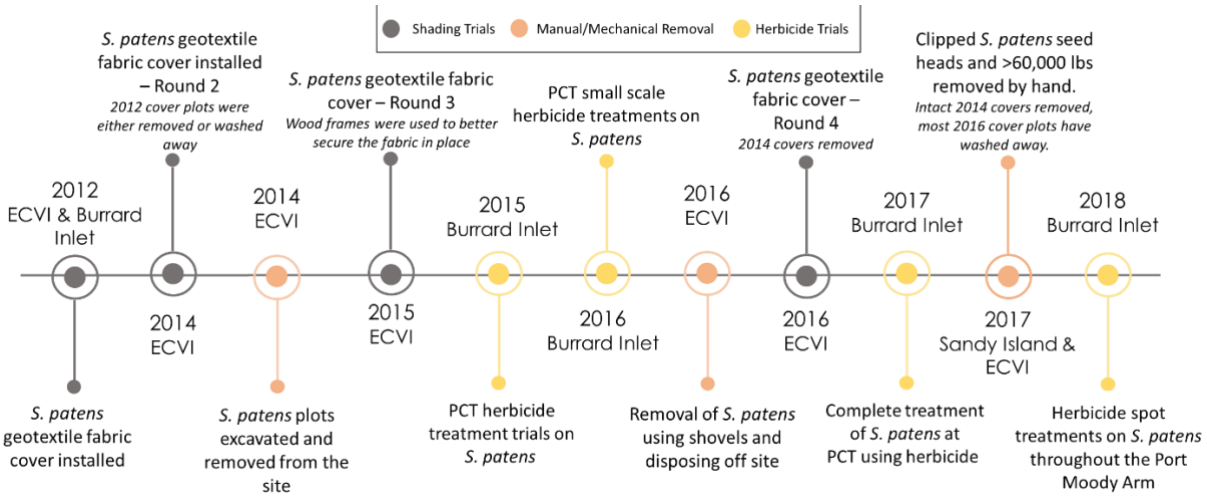

Figure 11 Timeline of *S. patens* control methods.

HERBICIDE

For more than a decade, the treatment of *Spartina* spp. solely used non-herbicide control methods with limited success. Therefore, since 2010, a sub-group of the BCSWG has worked with federal and provincial Canadian agencies to determine the requirements and process of using herbicide to control *Spartina* spp. in BC. The sub-group evaluated the ecological impacts and best management practices of two herbicides used to control Spartina in the states of Washington, Oregon, and California, USA. From these evaluations, it was determined that herbicide was to be used but that the project first required the herbicides be registered with the federal Pest Management Regulatory Agency (PMRA) and that a Pesticide Use Permit (PUP) would be required from the BC provincial Ministry of Environment.

As members of the BCSWG, the BC Ministry of Environment and the BC Ministry of Forests, Lands, and Natural Resources Operations submitted an emergency use registration to the PMRA in February 2012 for the use of 2 herbicides with different active ingredients to control Spartina. These were Rodeo (glyphosate) and Habitat (imazapyr). The emergency response registration also included proposed methods on using the herbicides as well as proposed evaluation and monitoring processes. The PMRA granted the emergency registration of Habitat and Rodeo on February 13, 2013, allowing for their use until December 31, 2013. The PMRA requires a new application be submitted annually for the emergency use of herbicides. In 2013, it was decided that only Habitat, mixed with the surfactant Ag Surf II, was to be used to treat *Spartina* spp. in BC. This decision was made following consultation with agencies from Washington State, USA, with the purpose of minimizing the use and impact of herbicide to treat Spartina. By mixing Ag Surf II with Habitat, the herbicide would bind to targeted plants, reducing undesired spreading of herbicide to the adjacent environment. The decision to use Ag Surf II made by the PMRA following a review of multiple surfactants. The review identified Ag Surf II as having a lower toxicity among the other surfactants.

Annual reports are provided to the Section Head of the Integrated Pest Management Coastal Region by December 31 as a requirement of the PUP. Approval to use herbicides in Boundary Bay and Roberts Bank Wildlife Management Area for the 2017 and 2018 herbicide application seasons was provided by the West Coast Operations Division of the BC Ministry of Forest, Lands, and Natural Resource Operations.

S. ANGLICA

In 2019, approximately 90 person-days were spent applying herbicide to *S. anglica* in the Fraser River Delta and Boundary Bay areas. Over 4700 clones of *S. anglica* were treated in the Lower Mainland (Figure 12 & Figure 13). A second pass to treat plants that were missed in the first pass was completed in the marsh area of Robert's Bank only, no other areas received a second pass in 2019. Approximately 0.909 ha, spread over more than 496 ha of intertidal habitat, was treated with 566 L of herbicide mix in 2019 (Table 2).

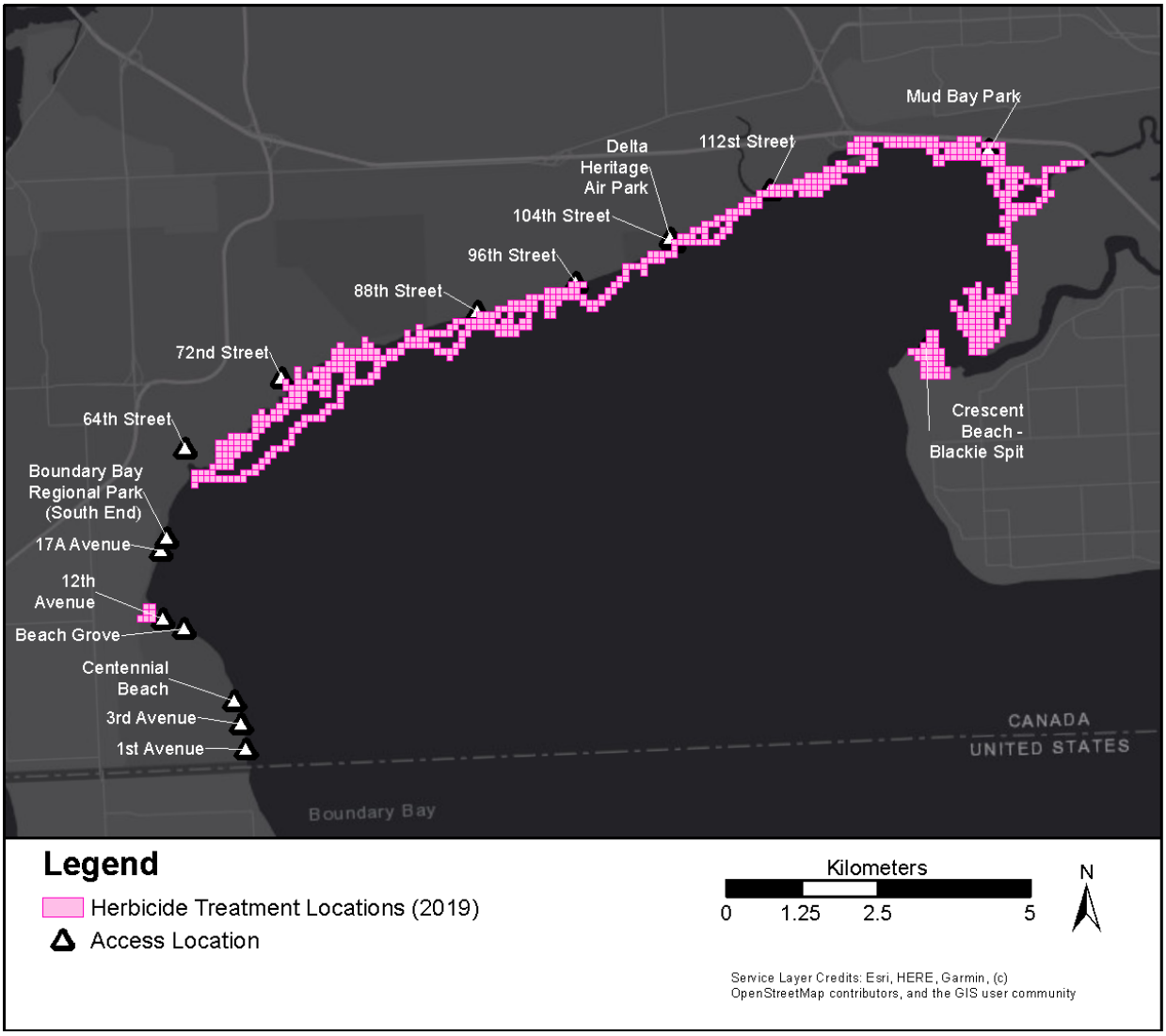

Figure 12. 2019 *S. anglica* treatment areas in Boundary Bay. Each pink square represents a 1 ha grid cell where one or more *S. anglica* plants were treated.

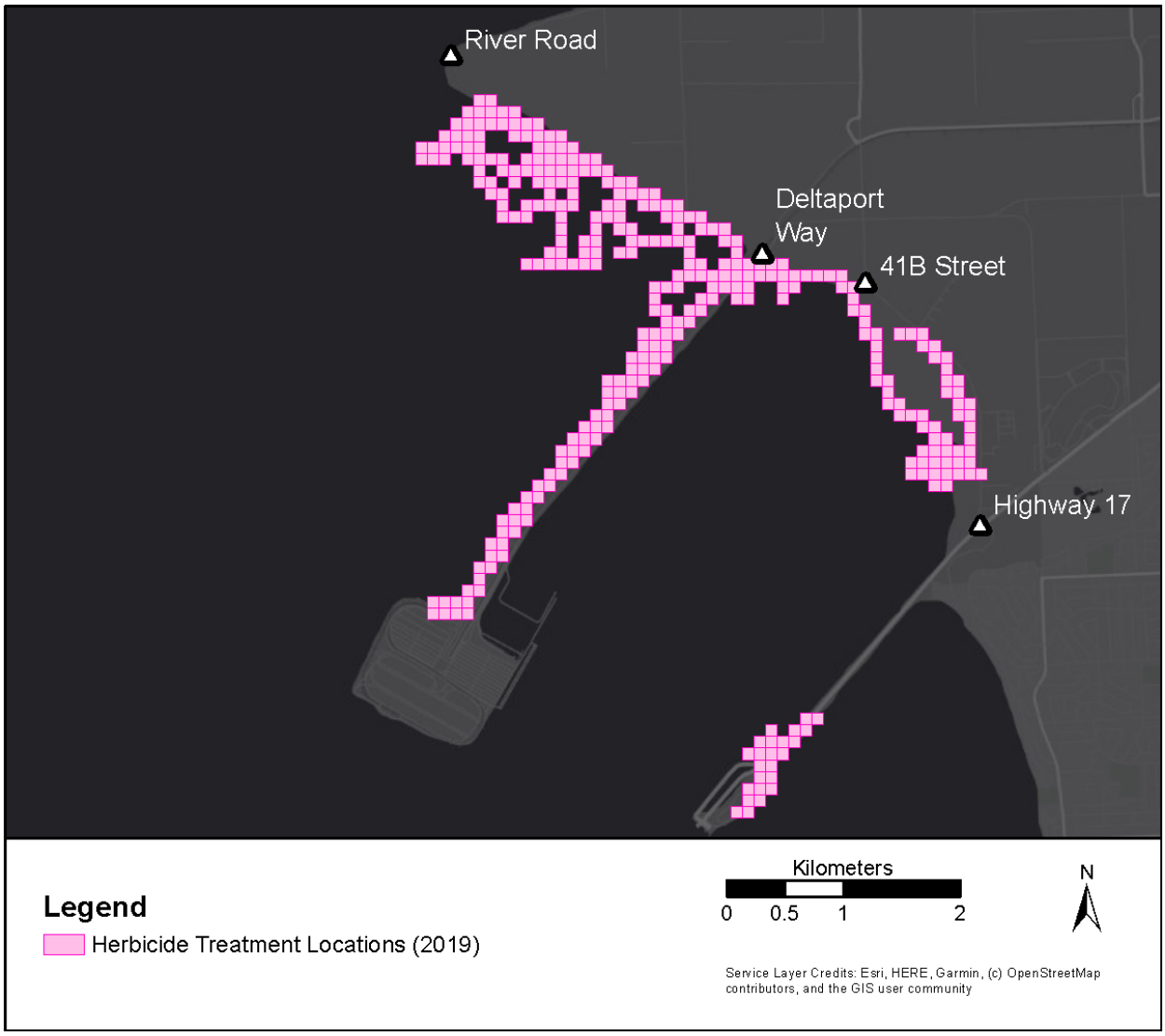

Figure 13. 2019 *S. anglica* treatment areas at the Roberts Bank Wildlife Management Area and the Tsawwassen First Nation. Each pink square represents a 1 ha grid cell where one or more *S. anglica* plants were treated

S. PATENS

Following several years of various manual and mechanical control efforts herbicide became the primary treatment method for *S. patens* in Burrard Inlet in 2016. Likewise, no manual removal efforts were undertaken on *S. patens* in 2019. Any *S. patens* receiving treatment in 2019 was treated with herbicide. Approximately 10 person-hours were spent applying herbicide to *S. patens* in the Burrard Inlet. Approximately 0.040 ha of *S. patens* over 27 ha of shoreline in Burrard Inlet was treated with 25 L of herbicide mix in 2019 (Table 3). Additionally, for the first-time herbicide treatments on *S. patens* in Baynes' Sound occurred; approximately 0.912 ha of *S. patens* over 50 ha of *S. patens* was treated with 567 L of herbicide mix in 2019 (Table 4).

Table 2. Amount of herbicide used to manage *S. anglica* since 2013.

	2013	2014	2015	2016	2017	2018	2019
Volume of herbicide mix used (L)	1089.5	2595	1949.5	3744	2412	1109	566
Volume of Habitat used (L)	8.17	19.46	14.62	28.08	18.09	8.32	4.25
Amount active ingredient (Imazapyr) used (kg)	1.96	4.671	3.51	6.74	4.34	2.00	1.02
Volume of surfactant Viterra Ag Surf II (alcohol ethoxylate) used (L)	5.44	12.97	9.75	18.72	12.06	5.55	2.83
Amount active ingredient (kg)	5.01	11.937	8.97	17.22	11.10	5.10	2.60
Estimated ha	1.75	4.17	3.90	6.01	3.87	1.78	0.909

Table 3. Amount of herbicide used to manage *S. patens* in the Lower Mainland since 2016.

	2016	2017	2018	2019
Volume of herbicide mix used (L)	216	583	17	25
Volume of Habitat used (L)	1.62	4.37	0.128	0.1875
Amount active Ingredient (Imazapyr) used (kg)	0.388	1.05	0.0306	0.0450
Volume of surfactant Viterra Ag Surf II (alcohol ethoxylate) used (L)	1.08	2.92	0.0850	0.125
Amount active ingredient used (kg)	1.17	3.17	0.0923	0.136
Estimated ha	0.347	0.94	0.0273	0.040

Table 4 Amount of herbicide used to manage *S. patens* in Baynes' Sound in 2019.

	2019
Volume of herbicide mix used (L)	567
Volume of Habitat used (L)	4.25
Amount active Ingredient (Imazapyr) used (kg)	1.02
Volume of surfactant Viterra Ag Surf II (alcohol ethoxylate) used (L)	2.84
Amount active ingredient used (kg)	2.61
Estimated ha	0.912

RESULTS

The number of plants of *S. anglica* decreased between 2018 and 2019 by about 41% and estimated leaf area and the impacted area declined by 59% and 30% respectively. The number of seedlings and large plants decreased while the number of plants greater than 30 cm and less than 1.0 m in diameter increased. The reduction of larger plants is likely a result of herbicide treatments in 2018, and those plants that were not entirely killed may be smaller as a result of herbicide treatment only partially killing them. As well reductions in seedlings indicates a reduction in recruitment by the *S. anglica* population in the lower mainland.

The number of *S. densiflora* plants increased by 30% which is largely attributed to mapping errors in 2018 under recording the number of plants. In 2018 *S. densiflora* plants of size classes 'S' and size 'A' were not recorded by surveyors. Instead, they labeled groups of smaller plants as size class 'D'. This may have been due to the change in surveying procedure (i.e. the introduction of *Collector* and *Survey123*) that year. These errors also resulted in the estimated leaf area for this species being higher in 2018 than any previous year. *S. densiflora* mapping in 2019 found approximately 0.007 ha of *S. densiflora*, which is a significant reduction from any previous year.

S. patens metrics have been the most variable out of the three species of Spartina found in BC in part due to its mat-like growth pattern compared to the upright clumps and tufts of *S. anglica* and *S. densiflora*. *S. patens* continues to expand in BC predominantly in the Courtenay River Estuary where the population is the greatest and most widespread. The extensive area that *S. patens* impacts in the Courtenay River Estuary makes it difficult to discern where one patch ends and another begins. As well due to the large area *S. patens* covers in the Courtenay River Estuary it is difficult to consistently and accurately measure the area by foot. *S. patens* mapping in 2019 confirmed the extent of the population in BC impacts approximately the same locations as detected in 2017 and 2018.

Table 5 Summary of Spartina spp. invasion in BC from 2013 to 2019

	S. anglica			*S. patens*			*S. densiflora*		
Year	Estimated Leaf Area (ha)	Impacted Area (ha)	Number of Plants Detected	Estimated Leaf Area (ha)	Impacted Area (ha)	Number of Plants Detected	Estimated Leaf Area (ha)	Impacted Area (ha)	Number of Plants Detected
2013	0.8209	940	8511	-	-	-	-	-	-
2014	0.55	937	13921	-	-	-	-	-	-
2015	1.435	898	18074	3.35	107	320	0.4021	197	14090
2016	1.637	973	23260	3.39	127	354	0.3977	292	4181
2017	1.167	900	12512	2.68	156	823	0.0147	149	2872
2018	0.6362	709	8051	1.13	165	617	0.495	200	1836
2019	0.258	496	4742	3.34	167	963	0.007	206	2557

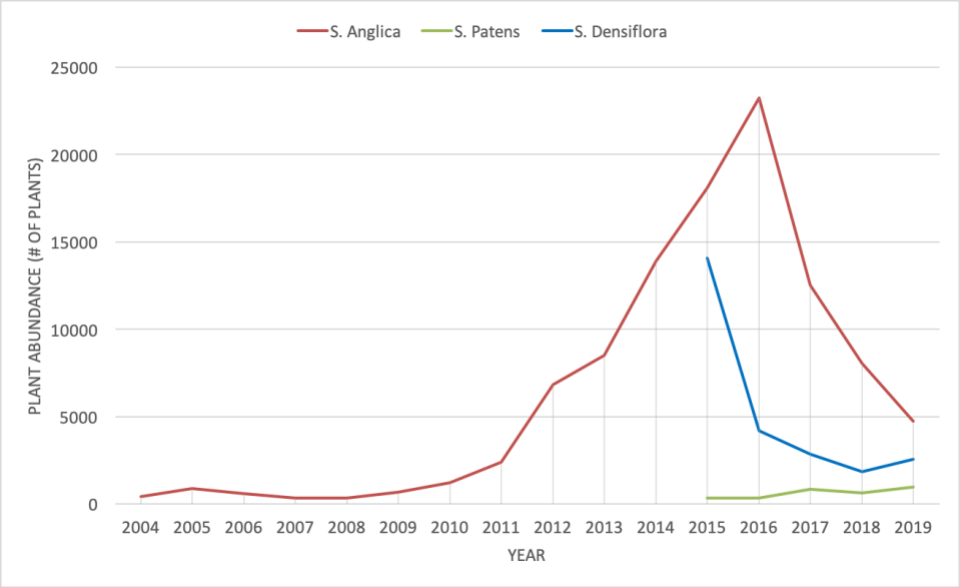

Figure 14. The abundance of *Spartina* spp. in BC from 2004 to 2019.

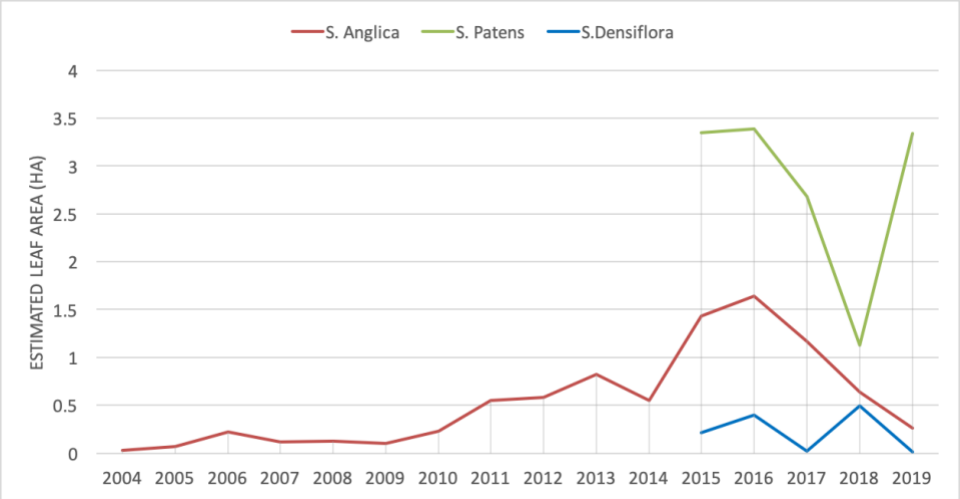

Figure 15. Estimated leaf area of *Spartina* spp. from 2004 to 2019.

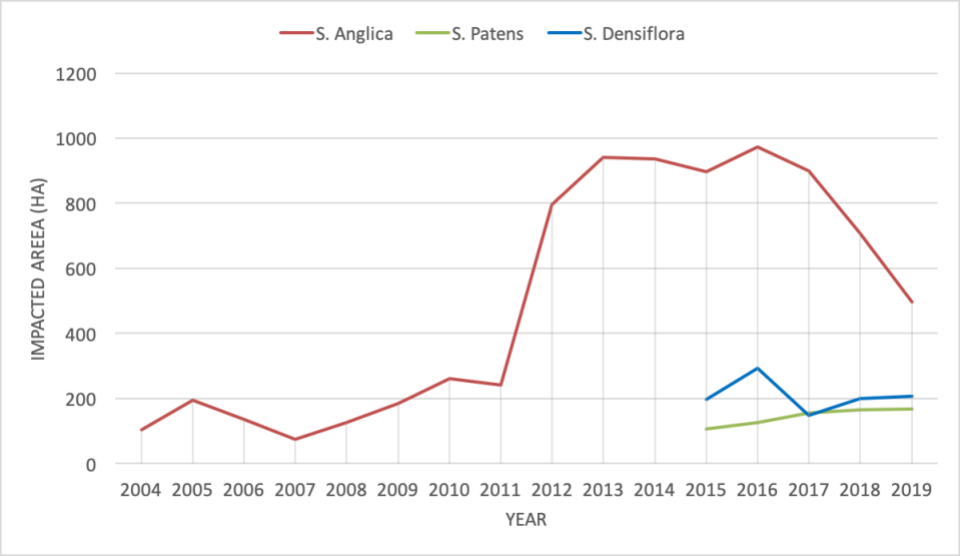

Figure 16. Amount of shoreline impacted by Spartina spp. from 2004 to 2019.

RESTORATION

Control and eradication efforts to date on *S. anglica* and *S. densiflora* have been successful without requiring additional restoration efforts. However, *S. patens* requires additional restoration beyond controlling for the invasive species. *S. anglica* and *S. densiflora* invade mudflats and areas of shoreline that typically has limited plant abundance and diversity. Where *S. anglica* and *S. densiflora* occur within native vegetation, it is typically in clusters surrounded by native vegetation that rapidly re-establishes after Spartina treatments. *S. patens* tends to invade the high salt marsh where there is a much higher diversity and abundance of native plants. Planting of native species is speeds up marsh restoration and prevents re-invasion. The large, barren areas that are left behind following the removal of these meadows are at risk of reinvasion by *S. patens* or other invasive plant species. By planting native species in these now-barren patches, the resilience of these habitats increases and the ability for invasive species to monopolize again is reduced. Considering this, the BCSWG is working with the City of Port Moody to test the planting of nursery *Carex lyngbyei* in areas where *S. patens* meadows have been removed. *Carex lyngbyei* is a dominant species that thrives at low- to middle-elevation tidal zones, which include high marsh elevations where *S. patens* grows. *Carex lyngbyei* was planted at the end of the 2018 program year. Goose grazing is a known pressure on marsh plants and particularly marsh restoration plantings, as such goose ex-closure fencing was installed to minimize these pressures. Regular monitoring and maintenance was conducted throughout 2018 to ensure the goose ex-closure fence remained intact and the plantings took root.

Preliminary discussions with the Wild Bird Trust, the Port of Vancouver and Tsleil-Waututh Nation proceeded in 2019 to discuss treatment of *S. patens* at Maplewood Flats and restoration of this salt marsh. As a part of these discussions some native plant seed from the marsh at Maplewood Flats was collected and propagated at the Wild Bird Trust nursery on site. Additionally, a short proposal has been drafted for a graduate student project; the proposal is targeted for the British Columbia Institute of Technology – Simon Fraser University Master of Science - Ecological Restoration Stream.

OUTREACH

INFORMATION AND INTERNET RESOURCES

- The Community Mapping Network provides web mapping and other information on the distribution of Spartina spp. in BC: www.spartina.ca
- The Friends of Semiahmoo Bay Society uses their web site for volunteer call out, information, and 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 (*S. patens*)
- Coastal Invasive Species Committee website: http://www.coastalisc.com/priority-invasive-plants

A new website has been drafted and is expected to be finalized early in the 2020 program year. The new and improved website will serve to better recognize funders and program partners, provide a centralized place to access data and information about the program including spatial data, provide information on what Spartina is and why it's bad- for the public and industry professionals.

FINANCES

The total program value in 2019 was approximately $260,522 including $230,522 in cash expenditures and $30,000 in in kind contributions. Unfortunately, in kind contributions for the project were not tracked as meticulously as in previous years; $30,000 is considered a conservative estimate. In total $267,644 cash was raised for the SEP and $230,522 of this was applied to eradicating *Spartina* spp. in BC. Approximately $37,000 was not spent in the 2019 program year as planned and will be applied in the 2020 program year instead.

For a breakdown of the revenue and expenditures for the SEP for 2019, see Table 6 Table 7. The recent history of financial contributions (cash and in-kind) of the BC Spartina Working Group is found in Figure 17. The in-kind contributions were provided by the following agencies:

- BC Conservation Foundation
- BC Ministry of Environment
- BC Ministry of Forests, Lands and Natural Resource Operations
- City of Surrey – ShaRP & SNAP Programs
- Vancouver Island Conservation Land Management Program
- Community Mapping Network
- Corporation of Delta
- Environment Canada- Canadian Wildlife Service
- Friends of Semiahmoo Bay Society
- K'omoks First Nation
- Port of Vancouver
- City of Port Moody

Table 6. The sources of revenue for the BC Spartina Eradication Program revenue for 2018.

Revenue		
Source	**Through DUC**	**Through BC SWG Member**
Province of BC	$200,000	-
Port Metro Vancouver	$12,000	-
Government of Canada -Coastal Restoration Fund	$38,000$	-
Government of Canada – Canada Summer Jobs	-	$17,644
Subtotal	$250,000	$17,644
Grand Total	**$267,644 CAD**	

Table 7. A breakdown of the expenditures for the BC Spartina Eradication Program for 2018.

Expenditures		
Category	**Mainland BC**	**Vancouver Island & Gulf Islands**
Travel	$650	$3,867
Gas, Mileage, Truck Rental	$6,419	$780
Personnel - Contractors	$86,563	$44,539
Personnel - Staff	$65,204	$14,965
Small tools, Supplies etc.…	$5,323	$2,213
Subtotal	$146,514	$66,364
Total	**$230,522 CAD**	

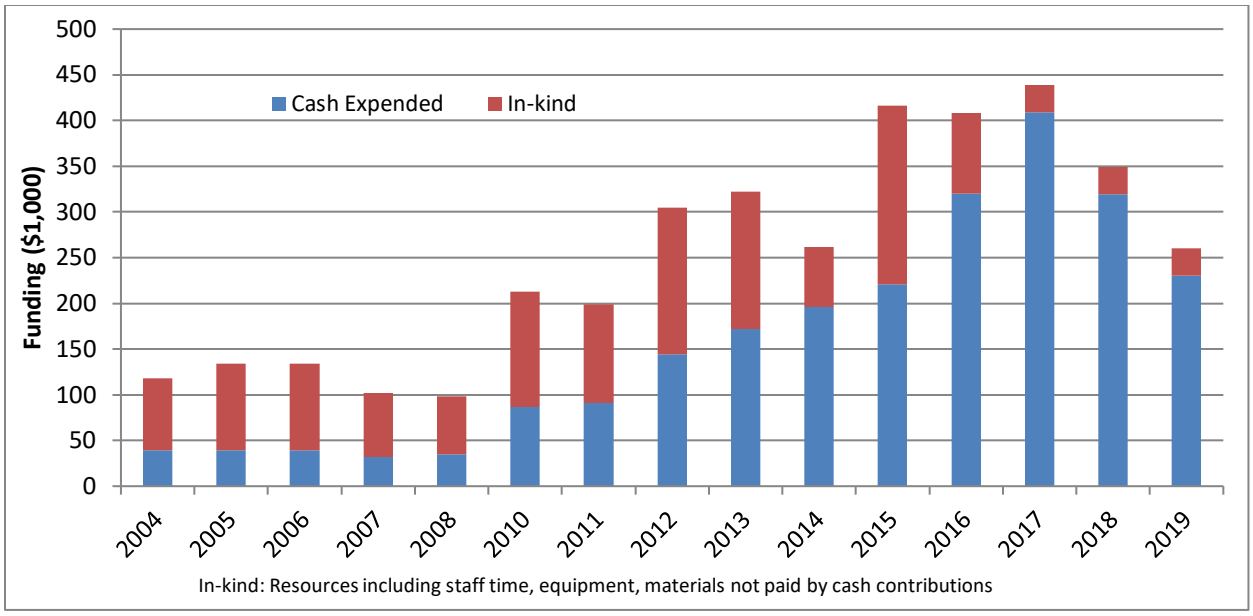

Figure 17. Contributions to the BC Spartina Eradication Program over time.

RECOMMENDATIONS FOR 2020

COORDINATION

- Ensure reporting is up to date and on time.
- Resume annual planning meetings. Instead of one planning meeting, host two planning meetings-one for each region.

MONITORING

- Continue to inventory core areas for Spartina species to evaluate control effort success.
- Consider including some metric of distribution as an additional evaluation lens for the program.

TREATMENTS

- Apply herbicide twice over two passes to decrease chances of missing plants.
- Expand herbicide treatment on *S. patens* in Baynes' Sound to the extent feasible without compromising any progress made on *S. anglica* eradication made to date. Identify opportunities to improve herbicide treatment program delivery efficiency between regions given limited treatment season and treatment condition windows (tides and weather).
- Treat all documented *S. patens* at Maplewood Conservation Area and focus on restoration plans for the site. Treat all remaining *S. patens* in Burrard Inlet.

SCIENCE AND EVALUATION

- Complete an assessment on herbicide treatment efficacy. Include measures to detect any signs of resistance.
- Test aerial detection techniques with new techniques such as remote-controlled, electric, unmanned aerial vehicles (UAVs). These activities would be used to detect large clones and large meadows of *S. patens* in particular.

RESTORATION

- Continue to assess the establishment of *Carex lyngbyei* restoration plantings in Port Moody Arm and monitor for reinvasion of *S. patens*.
- Work with BCIT Ecological Restoration Program to develop marsh restoration plans for *S. patens* treated sites to prevent reinvasion.

CONCLUSION

In conclusion, the eradication of *S. anglica* in 2019 proved successful with the continued use of herbicide as well as the use of *Collector* and *Survey123*. In 2019, increased mapping efforts in Baynes' Sound improved confidence in the BC SWG records of *Spartina* spp. locations and abundance however more years of complete surveys are required to more confidently detect trends. Baynes' Sound requires more resources for inventory and increasing control efforts; in particular herbicide treatment of *S. patens* will be the only effective means towards eradication. The *S. densiflora* population in Baynes' Sound should continue to be inventoried and progress towards eradication be evaluated; should manual control efforts not continue to suppress the population towards eradication, herbicide may be required. The BCSWG will continue with its partnership approach in striving to protect BC's shores and eradicate invasive Spartina.

APPENDIX A – METRIC & SUMMARY CALCULATIONS

The point data for each species of Spartina is collated into a spatial database for subsequent analysis using three different metrics:

1. The number of plants or plant clones detected
2. The size of each plant or plant clone (single plant or seedling; patch with diameter less than 30 cm; patch with diameter of 30 cm to 1 m; patch with diameter of 1 m to 5 m; patch with diameter of approximately 5 m; patch with diameter greater than 5 m)
3. The estimated leaf area (number of plants or plant clones detected x size of each plant or plant clone = number of square meters a dispersed colony would occupy if all Spartina plants were grouped into a single cluster)

Each IAPP site is divided into a grid of 1 ha cells which is used to summarize the data that has been analyzed through the metrics above. These summaries occur at a single cell level as well as an accumulation of all the cells within the site. They are titled Cell Summaries and Site Summaries, respectively. Summaries occur on a per-species basis. Moreover, with these summaries, the BCSWG determines how much shoreline has been impacted by *Spartina* spp. (how many 1 ha grid cells had one or more occurrences of Spartina).

Cell Summaries: The total number of observations for each size class is calculated for each cell on a per species basis. The estimated leaf area of a species in a cell is calculated by multiplying the total number of observations for each size class by the size class's Areal Coefficient (Table 7) and summing the values for each size class.

Site Summaries: The summing of the metrics of all of the cells within an IAPP site.

Table 8. Size Classes and their Areal Coefficients

Size Class	Description	Areal Coefficient (m^2)
S	Single Plant or Seedling	0.002
A	Patch with diameter less than 30 cm	0.071
B	Patch with diameter of 30 cm to 1 m	0.785
C	Patch with diameter of 1 m to 5 m	3.14
D	Patch with diameter of approximately 5 m	19.625
M	Patch with diameter greater than 5 m	38.465

The resulting equation for the estimated leaf area of a Spartina species in a cell is:

Estimated Leaf Area =(**Σ**S*0.002)+(**Σ**A*0.071)+(**Σ**B* 0.785)+(**Σ**C*3.14)+(**Σ**D* 19.625)+(**Σ**M*38.465)

For example, a cell with multiple *S. anglica* observations of 10 seedlings (Size S), 3 patches of a diameter of 30 cm to 1 m (Size A), 5 patches with a diameter of 1 m to 5 m) Size C, and 1 patch greater than 5 m (Size M) would have an area of $54.398\ m^2$.

Area = (10*0.002 m^2)+(3*0.071 m^2)+(5*3.14 m^2)+(1*38.465 m^2)

$\text{Area} = 0.020\ m^2 + 0.213\ m^2 + 15.7\ m^2 + 38.465\ m^2$

$\text{Area} = 54.398\ m^2$