

# B.C. Invasive Mussel Defence Program: 2021 Final Report



Ministry of  
Environment and  
Climate Change Strategy

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## ACKNOWLEDGEMENTS

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## GLOSSARY

<b>Abbreviation / Acronym</b>	<b>Definition</b>
AGRI	Ministry of Agriculture, Food and Fisheries
AIS	Aquatic invasive species
BISS	Boundary Invasive Species Society
CAS	Controlled Alien Species Regulation
CBSA	Canada Border Services Agency
CBT	Columbia Basin Trust
CDD	Clean, Drain, Dry
CO	Conservation Officer
COS	Conservation Officer Service
DFO	Fisheries and Oceans Canada
EB	Ecosystems Branch
ENV	Ministry of Environment and Climate Change Strategy
FLNRORD	Ministry of Forests, Lands, Natural Resource Operations and Rural Development (2021)
IMISWG	Inter-Ministry Invasive Species Working Group
TRAN	Ministry of Transportation and Infrastructure
NAD	North American datum
RAPP	Report All Poachers and Polluters; refers to a toll-free number used to report suspected poachers, polluters, or other infractions of the <i>Wildlife Act</i> .
RCMP	Royal Canadian Mounted Police
ZQM	Zebra and Quagga mussels
<b>Term</b>	<b>Definition</b>
AIS Passport	A system for local watercraft users that frequently operate in Alberta and/or B.C. lakes, and regularly stop at inspection stations. The goal of the passport is to expedite the inspection process at the mandatory watercraft inspection station. It is still mandatory for all passport holders to stop at all inspection stations in B.C. and Alberta; it is not a free pass.
Clean, Drain, Dry	Is a preventative step that all boaters should practise when moving any watercraft or water equipment between waterbodies to prevent the spread of aquatic invasive species. This includes boats that are just moving between lakes in B.C. to prevent the spread of species, such as Eurasian watermilfoil, already present in some lakes but not in others.

Decontamination	Is applied when there is an identified risk that a conveyance (either watercraft or water equipment) may be transporting AIS. The Provincial auxiliary conservation officers are trained at identifying and treating the risk of transporting AIS through specified decontamination procedures. For zebra and quagga mussels, decontamination procedures involve hot water with specific contact times to kill the mussels and high pressure to remove them and no chemicals are used.
Decontamination order	A written, legal instrument issued by conservation officers requiring parties to take measures (through written instruction) to remove confirmed or suspected invasive mussels before a watercraft can be launched in any B.C. waters.
Quarantine period	A drying time of 30 days that is required to ensure that confirmed (adult mussels) or suspected invasive mussels (microscopic veligers) are dead before a watercraft is considered free to launch in B.C. waters. This is based on the biology of dreissenid mussels that can survive as adults out of the water for up to 30 days under suitable temperature and humidity levels and the microscopic veliger stage, which could be present in standing water for three to four weeks.
Watercraft seal	A wire seal that is affixed to the watercraft in such a way that the seal would be broken if the watercraft were to be launched. Seals are used to monitor compliance with decontamination orders.
High-risk watercraft	<p>A high-risk watercraft may be any of the following:</p> <ul style="list-style-type: none"><li>• Any watercraft or equipment that has been launched in any waters of a province or state known or suspected of having zebra or quagga mussels in the past 30 days; or</li><li>• Any watercraft or equipment that is coming from or is registered in a state or province that has zebra or quagga mussel infestations and that is not clean, and to the extent practical, drained and dry; or</li><li>• Any watercraft that is dirty, crusty or slimy with the potential risk of transporting other AIS.</li></ul>

### EXECUTIVE SUMMARY

The Invasive Mussel Defence Program (IMDP; the Program) is a shared delivery between the B.C. Conservation Office Service (COS) and the Environmental Sustainability Division (ESD) within the Ministry of Environment and Climate Change Strategy (ENV). The Program would like to recognize the ongoing funding provided by BC Hydro, Fortis BC, Columbia Power Corporation, and Columbia Basin Trust to support its delivery.

During the 2021 season, stations were operational from April 1 to October 24, 2021, with 45 aquatic invasive species (AIS) inspectors operating across seven inspection stations and two roving stations (Figure 1). With pandemic protocols in place, the Program was able to safely carry out the AIS inspector training in spring 2021.

The Canada–U.S. border was closed for the majority of the 2021 season; however, it did re-open in mid-August, and may have contributed to the higher number of total inspections seen in 2021, compared to the previous year (see Table 1). The Program continued to work with Canada Border Services Agency (CBSA) to receive and follow up on notifications of watercraft coming through any of the southern border crossings.

The Program performed approximately 33,300 inspections during the 2021 season and crews interacted with approximately 61,700 people to promote Clean, Drain, Dry. Of the total watercraft inspected, 243 were identified as high-risk, 101 decontamination orders were issued, and 19 watercraft were issued quarantine periods to meet the required 30-day drying time. Provincial inspectors decontaminated a total of 153 watercraft.

Of the 33,300 inspections performed, 17 watercraft were confirmed to have adult invasive mussels. These watercraft came from Ontario (7), Manitoba (2), Michigan (1), Minnesota (1), Missouri (1), Ohio (1), Quebec (1), Colorado (1), Wisconsin (1) and Illinois (1) and were destined for the Okanagan (8), Lower Mainland (4), Vancouver Island (3), Kootenays (1), and Skeena (1). The Program received advanced notification on seven of the 17 mussel fouled boats either from another jurisdiction (e.g. AB, MT, ID, WA) or by Canada Border Services Agents (CBSA).

The average compliance rate at inspection stations in 2021 was 88.8%, which represents a slight increase from 87.7% in 2020. Of the watercraft that failed to stop at inspection stations, 86.2% were non-motorized watercraft, such as canoes, kayaks, and paddleboards, which pose a lower risk than motorized watercraft.

Overall, Conservation Officers issued 85 violation tickets and 45 warnings to motorists for failing to stop at inspection station(s), which is mandatory when transporting watercraft in B.C. Watercraft operators who fail to stop at an inspection station are reported to the Report All Poachers and Polluters (RAPP) hotline and full-time conservation officers respond and follow up.

Nine hundred water samples were collected across 75 lakes and 88 artificial substrate samples in 2021 to monitor for invasive mussels. All samples came back negative for the presence of invasive mussels.

## 1. BACKGROUND

### 1.1 HISTORY

The presence of zebra and quagga mussels (ZQM) can result in substantial economic, environmental, and social impacts. These impacts include increased maintenance costs to infrastructure such as hydropower, waterworks and irrigation, and degradation of native ecosystems, thereby affecting fisheries, recreation and tourism. Unlike B.C.'s native mussels, ZQM attach to hard surfaces, allowing them to be moved between water bodies by boats and equipment. While not present in B.C., ZQM could survive in B.C. freshwater systems and would cause devastating impacts to B.C.'s lakes and streams.

The introduction of these two aquatic invasive species (AIS) could lead to serious impacts on our native salmon populations and could affect the viability of important commercial, recreational and Aboriginal fisheries. In 2015, it was estimated that the costs associated with failing to prevent an invasion of invasive freshwater mussels (dreissenids) in the Pacific Northwest states and western Canadian provinces would exceed C\$500 million annually.<sup>1</sup> An economic risk assessment specific to B.C. estimates annual costs of at least C\$43 million if ZQM are introduced to B.C. This assessment does not include impacts to tourism, fisheries or property values.

The Program was launched in 2015 and has since adapted and expanded operationally and geographically each year through additional funding. This document reports on the logistics, activities, and findings of the Program's 2021 season for the operational period of April 1, 2021 to March 31, 2022. More information about previous seasons, including annual reports, is available on the Program website<sup>2</sup>.

### 1.2 REGULATORY AND JURISDICTIONAL FRAMEWORK

The Program is designed to mitigate the risk of ZQM introduction into B.C. by intercepting and inspecting watercraft travelling into or through B.C.

The Program consists of three main components:

- **Watercraft inspection and decontamination** to detect and respond to high-risk watercraft potentially transporting ZQM into B.C.;
- **Lake monitoring** to assess for the continued absence of ZQM in B.C. waters; and
- **Outreach and education** to promote the message of Clean, Drain, Dry to the boating community, in collaboration with our partners including the Invasive Species Council of B.C. and regional invasive species organizations.

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<sup>1</sup> Source: *Advancing a Defense Against Invasive Mussels: a Report Prepared by the Pacific Northwest Economic Region and Pacific States Marine Fisheries Commission.*

[http://www.pnwer.org/uploads/2/3/2/9/23295822/advancing\\_a\\_regional\\_defense\\_against\\_dreissenids\\_in\\_the\\_pacific\\_north\\_westfinal\\_1.pdf](http://www.pnwer.org/uploads/2/3/2/9/23295822/advancing_a_regional_defense_against_dreissenids_in_the_pacific_north_westfinal_1.pdf)

<sup>2</sup> <https://www2.gov.bc.ca/gov/content/invasive-mussels>

The continued success of the Program is a direct result of:

- Integrating science, education, and enforcement through a unique joint delivery between the Conservation Officer Service and Ecosystems Branch (EB);
- Multi-agency collaboration (within B.C.) for the delivery of Program operations;
- Cross-jurisdictional collaboration to coordinate inspection locations, training, policy and procedures, lake monitoring, and immediate notification of high-risk boats; and
- Stakeholder engagement to work collaboratively with the boating industry to prevent the introduction of ZQM into B.C.

Inspectors are trained to deliver the watercraft inspection program and have been designated as auxiliary conservation officers under the *Environmental Management Act*. This designation provides powers to intercept, stop, inspect, question, obtain information and issue decontamination orders. See *the Zebra and Quagga Mussel Early Detection and Rapid Response (ZQM EDRR) Plan* for more information on the Controlled Alien Species (CAS) Regulation as it pertains to ZQM (available at [www.gov.bc.ca/invasive-species](http://www.gov.bc.ca/invasive-species)).

Provincial legislation authorizes the Province to take action on ZQM. The CAS regulation under the *Wildlife Act* is the principle legislation that defines, lists, and affords provisions to regulate invasive mussels in B.C. Under the CAS Regulation, prohibitions apply in relation to any mussel listed in Schedule 4 (zebra, quagga, and conrad's false mussel). Specifically, it is illegal for a person to:

- possess, breed, ship, or transport prohibited mussels in B.C.;
- release prohibited mussels into B.C. waters; or
- allow a prohibited mussel to be released or escape into B.C. waters.

In June 2015, the Aquatic Invasive Species Regulation, under the federal *Fisheries Act*, was brought into force. This regulation prohibits the importation, possession, transportation, release and introduction of ZQM in the western provinces.

### 1.3 JURISDICTIONAL COORDINATION

Ongoing coordination with other jurisdictions in Canada and the U.S. has been critical for the overall success of the Program. Outside of B.C., the Program shares research, procedures, and notifications of high-risk boats with, but not limited to Alaska, Arizona, California, Idaho, Montana, Nevada, Oregon, Washington, Wyoming, Alberta, Manitoba, Saskatchewan and the Yukon. This is part of B.C.'s ongoing commitment as a signatory to the trans-boundary *Columbia River Basin Inter-agency Invasive Species Response Plan: Zebra Mussels and Other Dreissenid Species*<sup>3</sup>. As a signatory, B.C. receives notifications of high-risk watercraft from neighbouring states, and is provided access to professional advice on risk management and training opportunities. B.C. is also a member of the Western Regional AIS Panel and an active participant in the Pacific Northwest Economic Region (PNWER) invasive species working group.

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<sup>3</sup> Source: [https://docs.wixstatic.com/ugd/0e48c2\\_7c4f1faa1538443da76593b2e8a827b8.pdf](https://docs.wixstatic.com/ugd/0e48c2_7c4f1faa1538443da76593b2e8a827b8.pdf)

The *Inter-Provincial-Territorial Agreement for Coordinated Regional Defense Against Invasive Species* was signed in late 2015 by B.C., Yukon, Alberta, Saskatchewan, and Manitoba. One of the primary objectives under this agreement is to develop and address shared priorities for invasive species with an initial focus on invasive mussel prevention and rapid response.

## 2. PROGRAM LOGISTICS

### 2.1 OPERATIONS

Program operations were administered by the Ministry of Environment and Climate Change Strategy in 2021. The officer in charge (OIC), three sergeants and the auxiliary conservation officers represented the COS and oversaw the field operations of the watercraft inspection stations. The Ecosystems Branch within the Ministry led the science and policy aspects of the program including the lake monitoring program and research collaborations detailed in sections 5 and 6. The delivery of outreach and education and partnerships was shared between the COS and Ecosystems Branch.

#### *Hours of Operation*

During the 2021 season, stations were operational from April 1 to October 24, 2021, with 45 aquatic invasive species (AIS) inspectors operating across seven inspection stations and two roving stations (Figure 1). Each team had its own mobile decontamination units. The Golden inspection station had 12 inspectors during the peak boating season from May to early September, providing 24-hour coverage. The Yahk and Olsen (Hwy 3) stations operated dawn to dusk seven days a week during the peak season (May to early September). The Radium and Mt. Robson stations were operational 10 hours per day. AIS inspector retention during the pandemic was challenging, particularly the most northern station of Dawson Creek, which was difficult to staff. As a result, the Dawson Creek inspection station was only open for a limited period in the summer for the 2021 season.

In addition to conducting watercraft inspections at established stations, the inspection crews responded to high-risk watercraft notifications received from within the province and from other jurisdictions. The Program worked very closely with neighboring jurisdictions to send and receive notifications of high-risk boats either destined for B.C. or travelling to other jurisdictions. The program continued to implement roving inspection crews in the Okanagan and the Lower Mainland for the 2021 season. When they were not responding to high-risk watercraft notifications, the Okanagan crew rotated between setting up stations at alternate locations (Keremeos, Kaleden, Hwy 97C and Greenwood) as the Osoyoos border crossing being closed. Both roving crews conducted inspections and outreach at boat launches throughout the Okanagan and the Lower Mainland.

#### *Inspection Station Locations*

Data from the 2020 boating season along with monitoring of the US-Canada border closure and other pandemic travel restrictions were used to adjust program operations for the 2021 season (Figure 1). The locations and hours of operations were assessed for suitability based on encounter frequency (watercraft encounters divided by effort), safety or communication, direction of traffic targeted, the source location of boaters (percent coming from outside B.C.) and the number of high-risk and mussel fouled watercraft intercepted.

In addition to conducting watercraft inspections at established stations, the inspection crews responded to high-risk watercraft notifications from within the province and from other jurisdictions. The Program worked very closely with neighboring jurisdictions to share notifications of high-risk boats either destined for B.C. or traveling to other jurisdictions.

The COS Report All Poachers and Polluters (RAPP) hotline (1-877-952-7277) was used by the public to report any suspected invasive mussels, and notifications received were sent to watercraft inspectors. High-risk watercraft notifications from other jurisdictions were sent through an email distribution list to all inspectors and senior program leads. A response was then coordinated based on the location and availability of inspectors.

Figure 1. Watercraft inspection station locations for the 2021 season.



## 2.2 INSPECTION CREW TRAINING (AUXILIARY COs)

New inspectors were selected based on the candidate's education and background from a recognized compliance and enforcement or natural resource management program. These positions are excellent opportunities for senior students and recent graduates of environmental science and enforcement programs to gain hands-on experience and training towards a potential career in enforcement or environmental management.

Inspectors were trained in watercraft inspection and decontamination following the Uniform Minimum Protocols and Standards for Watercraft Interception Programs for Dreissenid Mussels in the Western United States (updated 2021)<sup>4</sup>. This is the standard protocol used for inspection and decontamination across the Pacific Northwest.

## 2.3 WATERCRAFT RISK ASSESSMENT

All motorists coming through watercraft inspection stations were asked a series of questions to determine if the watercraft was of high or low risk. Data were recorded electronically.

Two key questions asked by inspectors to determine watercraft risk were:

1. Where was the watercraft in the last 30 days?
2. How long has the watercraft been out of the water?

In accordance with ENV's watercraft risk assessment, if any watercraft or piece of equipment had been in the waters of any province or U.S. state known or suspected of having ZQM in the previous 30 days, it was considered high-risk. Any watercraft or equipment coming from a state or province that has quagga or zebra mussel infestations and was not clean to the satisfaction of inspectors, and had not been drained and dried, was also considered high risk, even if it had been out of the water for more than 30 days. Low-risk watercraft are those that have been used solely within B.C. or other non- ZQM infested provinces or states within the previous 30 days and are found to be Clean, Drain, Dry.

The inspectors verified information provided by watercraft owners through detailed watercraft inspections, and if required, through follow-up with third parties to confirm information obtained during interviews. Other circumstances may trigger a high-risk inspection such as unknown history of the watercraft; for example, if the owner of a recently purchased used boat does not know where the boat was last in the water, it would be considered high-risk.

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<sup>4</sup>Source: Elwell LC and S Phillips, editors. 2021. Uniform Minimum Protocols and Standards for Watercraft Inspection and Decontamination Programs for Dreissenid Mussels in the Western United States (UMPS IV). Pacific States Marine Fisheries Commission, Portland, OR. 55 pp.  
[https://docs.wixstatic.com/ugd/Oe48c2\\_16afde152b894bf4bff2c72d008e7bdd.pdf](https://docs.wixstatic.com/ugd/Oe48c2_16afde152b894bf4bff2c72d008e7bdd.pdf)

## 2.4 PROGRAM FUNDING AND BUDGET

### Overall Program Costs

The overall program costs for the operational delivery of the 2021 season from April 1, 2021 to March 31, 2022 was \$3.42 million from a total budget of \$3.5 million (see Table 1). The program budget outlined in Table 1 includes funding from the program partners and Government of B.C. funding (COS and ESD). This includes salary, travel, vehicle, training, lake monitoring, educational and miscellaneous equipment and maintenance costs as described below. Under the Provincial budget, \$250,000 went to ESD to cover salary, economic impact analysis report, research priorities, program reporting, inspection app maintenance and lake monitoring sample analysis. The Ecosystem Branch’s contribution to the lake monitoring program includes the annual review and update of the provincial protocol and chairing the technical committee for reviewing the Habitat Conservation Trust Foundation (HCTF) grant proposals. The lake monitoring costs also included the lab analysis of all water samples collected during the 2021 season.

The COS operational budget covered salary, travel, vehicle, training, lake monitoring, educational and miscellaneous equipment and maintenance costs. Non-capital equipment and maintenance costs included uniforms, highway signs and safety equipment. Salary costs included the 45 auxiliary conservation officers operating from either April to October or May to September. It also included the salary for the officer in charge, three sergeants, and one administrative coordinator. Education and awareness costs include the production of various outreach or education materials that were distributed by the inspectors at the watercraft inspection stations. In addition, internal ministry resources across both the ESD and COS went towards the design and delivery of the Program including significant resources from field officers across the province, as part of the moss ball response in spring 2021.

**Table 1. Summary of 2021 operating budget and the actuals as of March 31, 2022.**

2021-2022	2021-2022 Program Budget	2021-2022 Program Actuals (as of March 31st)
Salary	\$2,423,500	\$2,447,749
Travel & Training	\$164,300	\$104,496
Corporate Overhead	\$80,000	\$80,000
Vehicle	\$287,000	\$268,181
Education/ Awareness/ Research	\$118,000	\$117,229
Non-capital equipment/ maintenance	\$282,200	\$241,682
Lake Monitoring	\$75,000	\$68,309
Equipment Amortization	\$20,000	\$44,381
<b>Total Operations</b>	<b>\$3,450,000</b>	<b>\$3,372,026</b>
Capital Equipment	\$50,000	\$49,014
<b>Total</b>	<b>\$3,500,000</b>	<b>\$3,421,040</b>

### 3. WATERCRAFT INSPECTION SUMMARY FOR 2021

#### 3.1 ALL WATERCRAFT ENCOUNTERS

During the 2021 season, the Program performed about 33,300 inspections, and the crews interacted with approximately 61,700 people to promote Clean, Drain, Dry. Of the total watercraft inspected, 243 were identified as high-risk, 101 were issued decontamination orders, and 19 were issued quarantine periods to meet the required drying time. Of the total watercraft inspected, 17 were confirmed to have adult invasive mussels.

The remainder of this section discusses the watercraft inspection data collected by the crews at each station across the entire season. Data have been summarized in several ways, including an assessment of total watercraft encounters (total number of watercraft inspected), and total effort (total operational hours). The ratio of watercraft encounters to effort was calculated as the encounter frequency to quantify the frequency at which watercraft came through the inspection stations. The encounter frequency was assessed across several different temporal scales (by month, day, and hour) as illustrated in Figures 3 through 10.

##### 3.1.1 Watercraft Inspection Summary by Station

Watercraft inspections (Figure 2) were highest at the Golden station (9,274), the Yahk station (7,237), the Radium station (6,277) and the Olsen station (5,316). Several of the stations (Golden, Radium and Olsen) saw either very similar or slightly increased total inspections in 2021 relative to the 2020 season. This illustrates that boater traffic was not significantly reduced despite provincewide travel restrictions at the start of the season and the U.S. border closure being in place for majority of the season.

The encounter frequency (watercraft encounters divided by effort) across each inspection station showed that the busiest inspection stations were Highway 97c, Keremeos, Olsen, Radium and Yahk (Figure 3). The station with the lowest frequency of boater traffic was Osoyoos but it also had the highest percent of high-risk boats. The Osoyoos inspection station is typically located at the Osoyoos border crossing; however, because of the US-Canada border closure, the inspection crew was roving between different locations in the Okanagan. As a result, the total number of inspections at the Osoyoos border decreased relative to past seasons due to the border closure for the majority of the season. Finally, it is important to note that the encounter frequency only represents boater traffic during operational hours.

Figure 2. Total inspections by station location for the 2021 season.

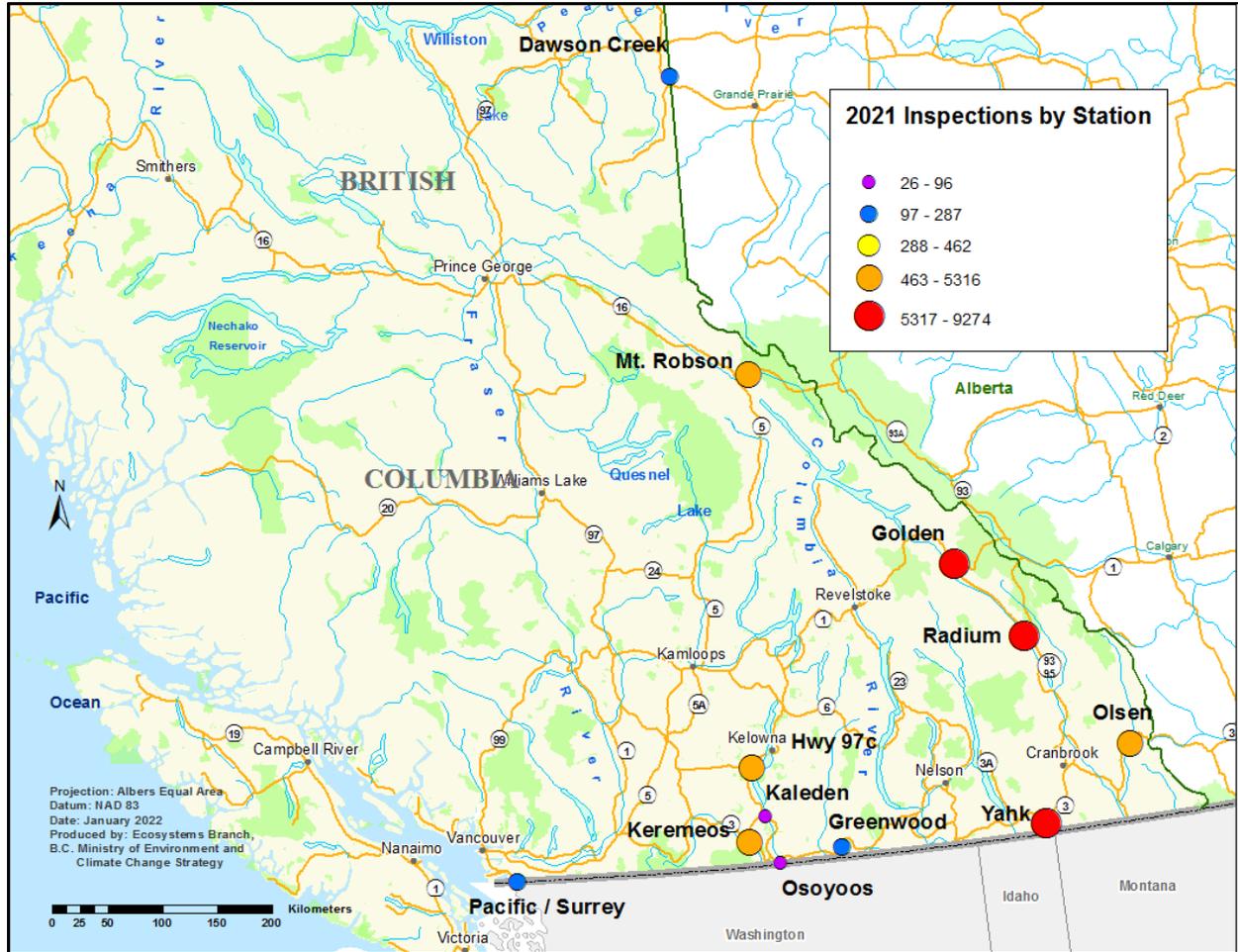
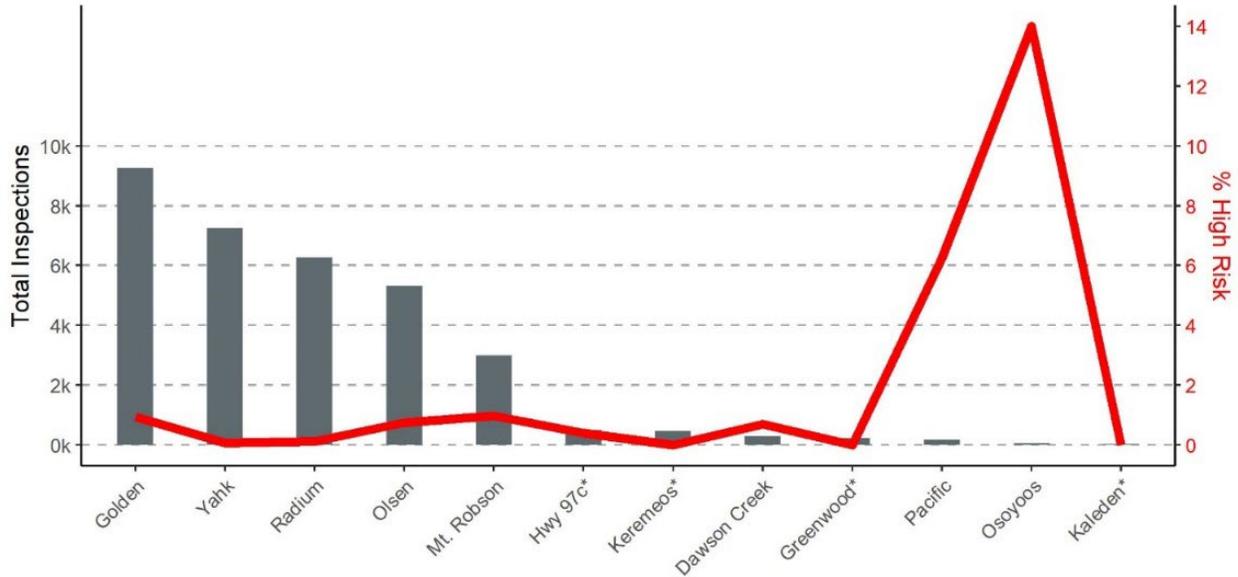


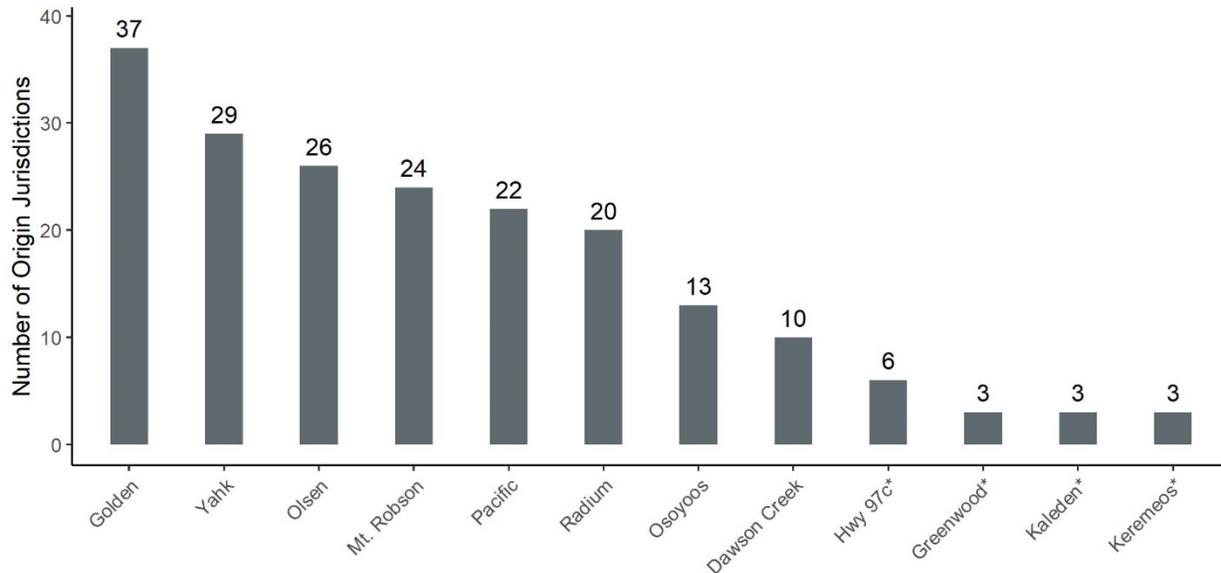
Figure 3. Encounter frequency (bars) by inspection station in comparison to percent of high-risk boats (line) per inspection station, from March to December 2021.



\*Denotes the roving inspection stations.

Watercraft inspection data were also used to quantify the boats coming from different jurisdictions— province or state (Figure 4). The Golden station inspected boats coming from 37 different provinces and states which represents an increase from 25 in the 2020 season. This increase in the number of jurisdictions that boats came from in 2021 is consistent with the re-opening of US border part way through the season and the easing of travel restrictions during the season. The data illustrate the importance of looking at both the total number of boats inspected as well as the proportion of high-risk boats going through each inspection station. The data also provide important information on the different routes boaters are travelling.

**Figure 4. Total number of jurisdictions (province/state) from which boats were coming that were intercepted at each inspection station for the 2021 season.**



\*Denotes the roving inspection stations.

### 3.1.2 Watercraft Inspection Summary by Month and by Day of the Week

Highway inspection stations were operational from April 1 to late October, 2021; and four scheduled inspections were carried out in December in response to notifications through the Program inbox. The inspection station’s total effort (operational hours) increased over the spring months (May and June), peaking in July and August (Figure 5). This data are consistent with previous seasons.

Figure 7 shows the total watercraft encounters and total effort by days of the week across the 2021 season. Watercraft encounters and encounter frequency peaked on Fridays, Saturdays and Sundays and were lowest on Tuesdays. This is consistent with the data from the 2019 and 2020 seasons. The encounter frequency was also high on Sundays, which is consistent with increased traffic on weekends. Total effort was similar across all days of the week, except Mondays, Tuesdays and Wednesdays, when it was slightly reduced by operational circumstances that required some stations to be closed on those days (Figure 7). Statutory holidays were included in the data; however, peaks in the volume of boats were typically seen on the Thursday, Friday and Saturdays of long weekends at the inspection stations along the eastern border. This reflects those stations intercepting out-of-province boaters travelling into B.C. for holiday long weekends.

Figure 5. Total inspections (left) and total effort (right) by month across inspection stations in 2021.

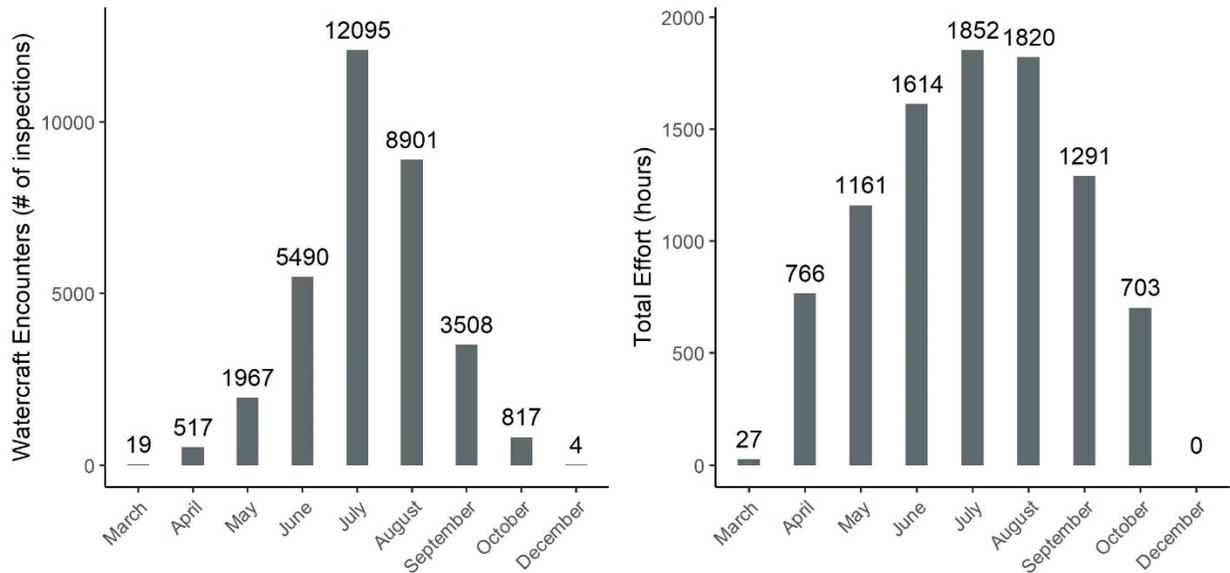
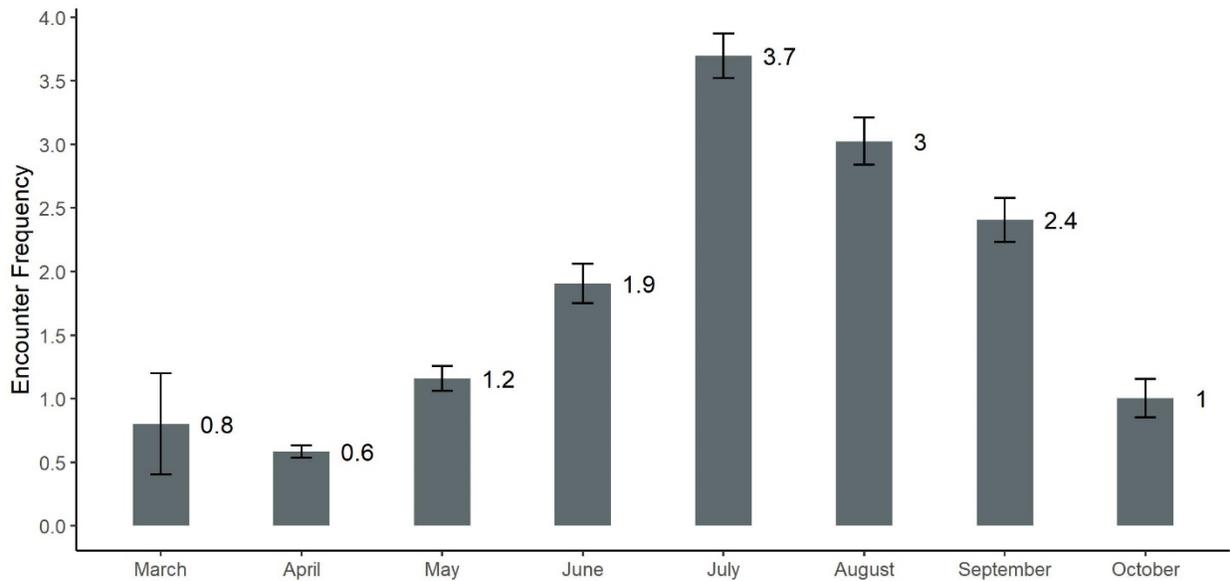
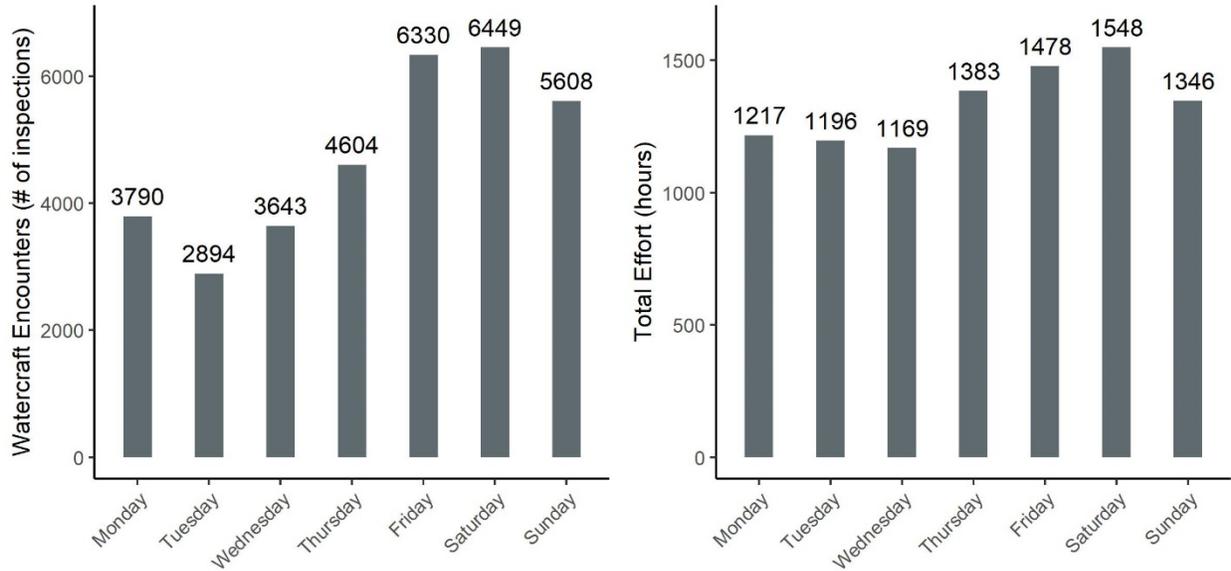


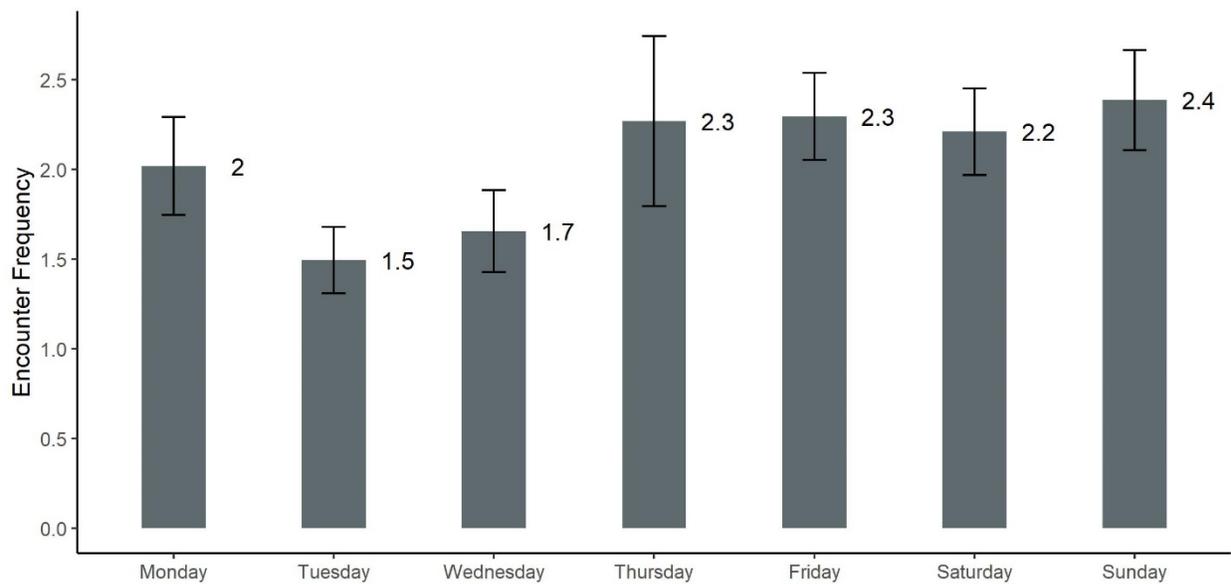
Figure 6. Encounter frequency by month across all inspection stations (error bars illustrate the standard error).



**Figure 7. Total inspections (left) and total effort (right) by day of the week across inspection stations. Statutory holidays were included in the analyses.**



**Figure 8. Encounter frequency by day of the week from March to December 2021, across inspection stations. Bars illustrate the standard error. Statutory holidays were included in the analyses.**



### 3.1.3 Watercraft Inspection Summary by Hour of the Day

Inspectors recorded the time of the inspection for every watercraft, and Figure 9 and Figure 10 illustrate that the volume of boater traffic was normally distributed across all inspection stations, peaking in the middle of the day. The Golden inspection station operated 24 hours a day from May to end of August. Figure 11 and Figure 12 show the total and high-risk inspections by time of day for the Golden station. A total of 342 inspections occurred between 10:00 p.m. and -6:00 a.m. at the Golden station but only four high-risk inspections occurred during this time. This shows that very few high-risk boats came through the Golden station at night.

Figure 9. Total inspections by time of day across all inspection stations for the 2021 season.

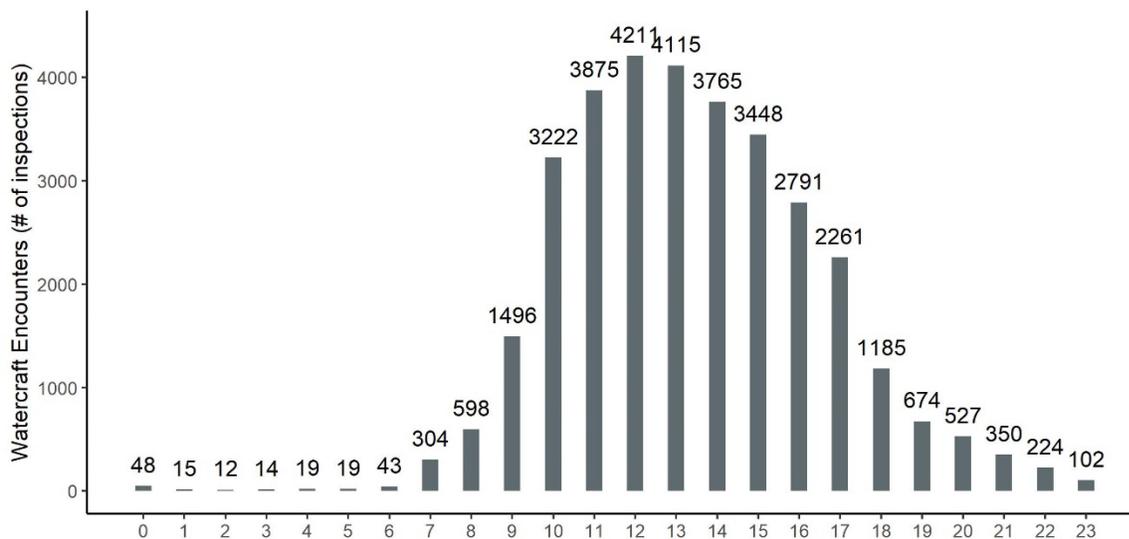


Figure 10. High-risk inspections by time of day across all inspection stations for the 2021 season.

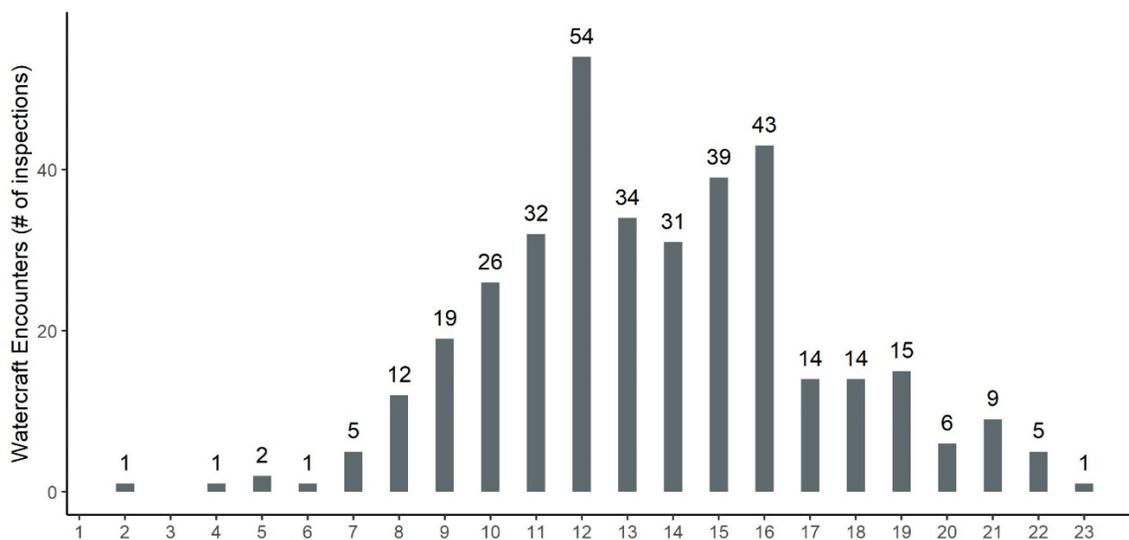


Figure 11. Total inspections by time of day for the Golden station for the 2021 season.

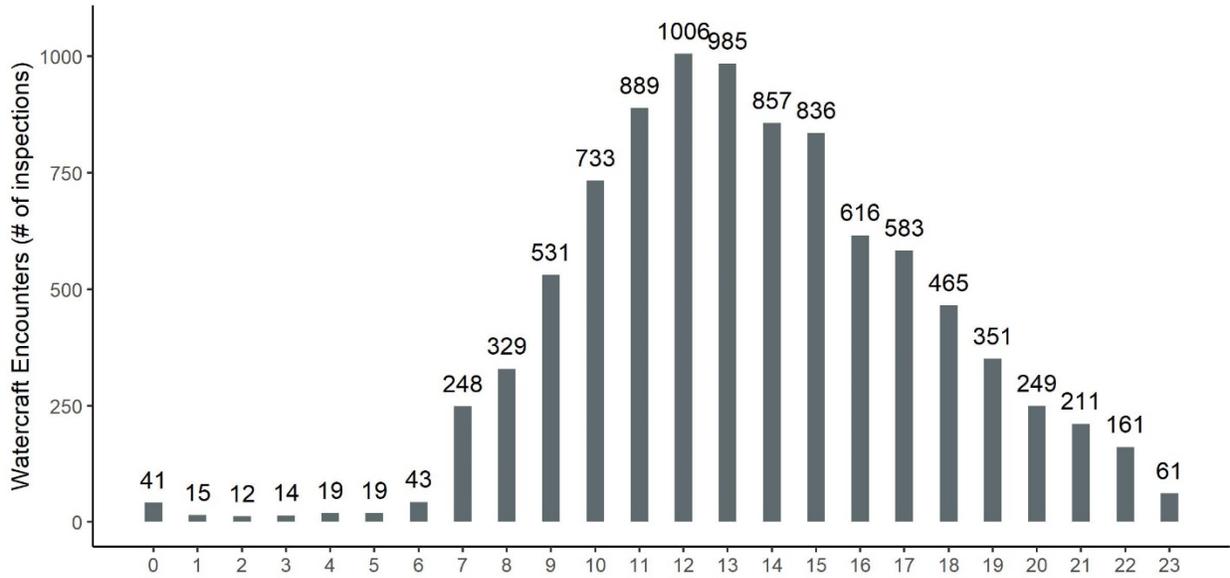
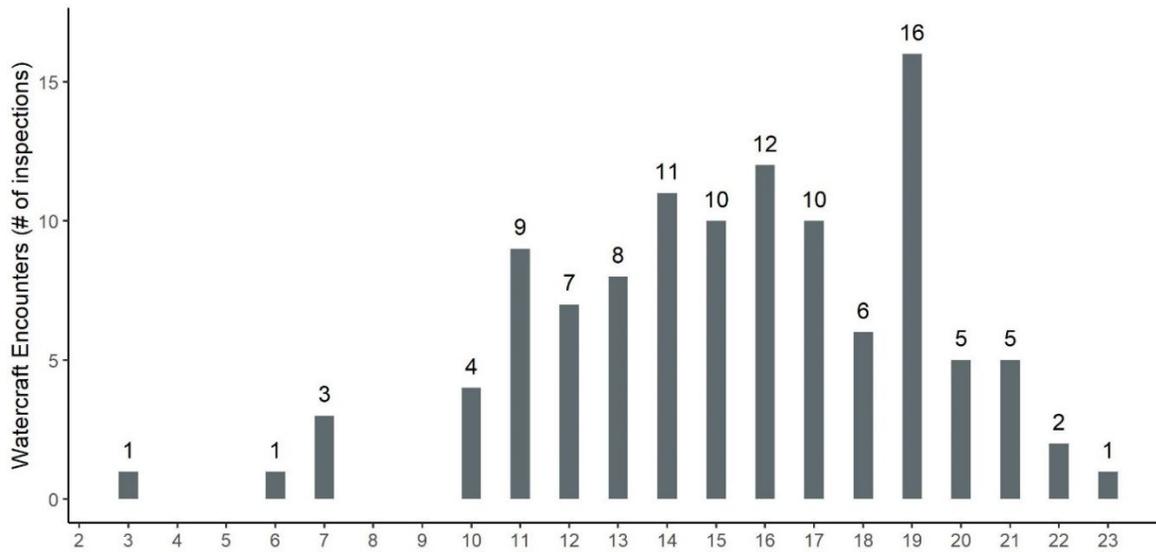


Figure 12. High-risk inspections by time of day for the Golden station for the 2021 season.



### 3.1.4 Source and Destination Locations

The most common destination waterbodies within B.C. were Shuswap Lake (11.4%), Windermere Lake (9.3%), Okanagan Lake (9.3%), Kootenay Lake (7.7%), Lake Kooconusa (6.8%), Columbia River (5.2%), Pacific Ocean (4.4%), Moyie Lake (2.4%) and Osoyoos Lake (2.3%) (Figure 13). Figure 14 shows the home residence for all watercraft inspections and this corresponds to the province or state where the watercraft is most commonly located or stored throughout the year. The home residence does not always correspond to where the watercraft was last launched. The majority of watercraft were travelling within B.C. or coming from Alberta, followed by other provinces (Saskatchewan, Manitoba, Ontario and Quebec), which is consistent with increased domestic travel during the pandemic.

Figure 13. Destination waterbodies by percent of all inspections during the 2021 season.

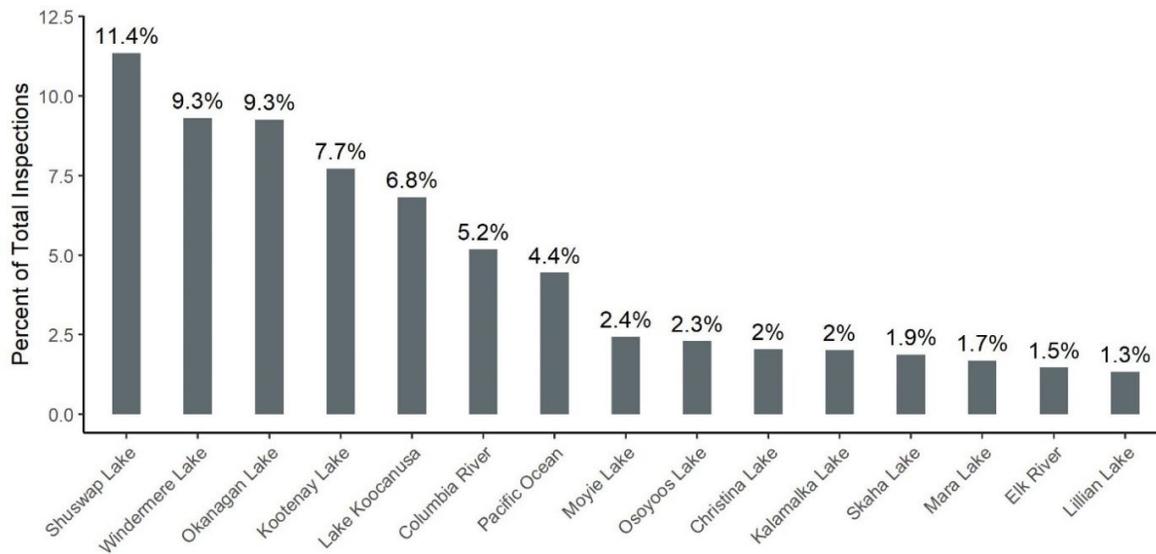
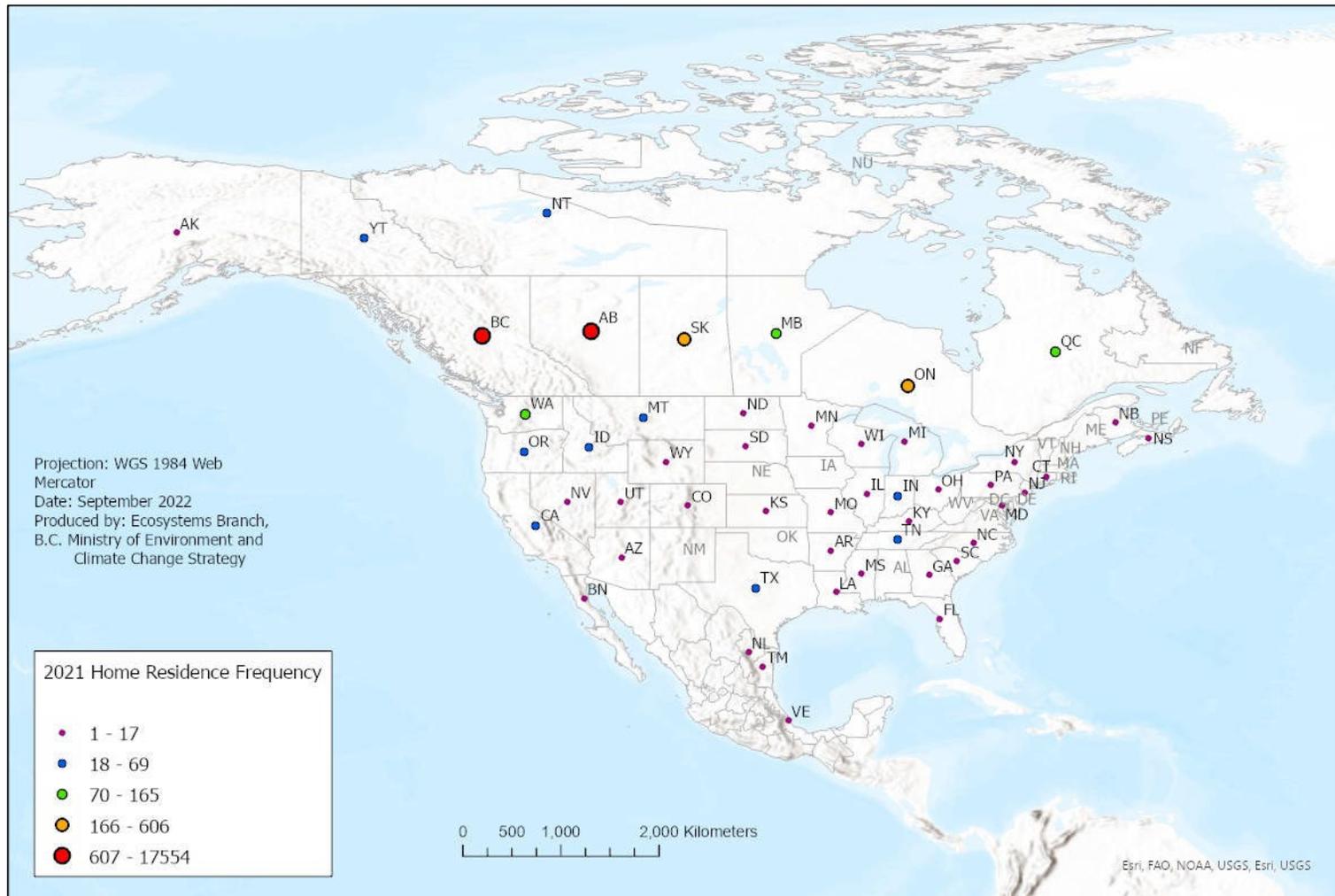


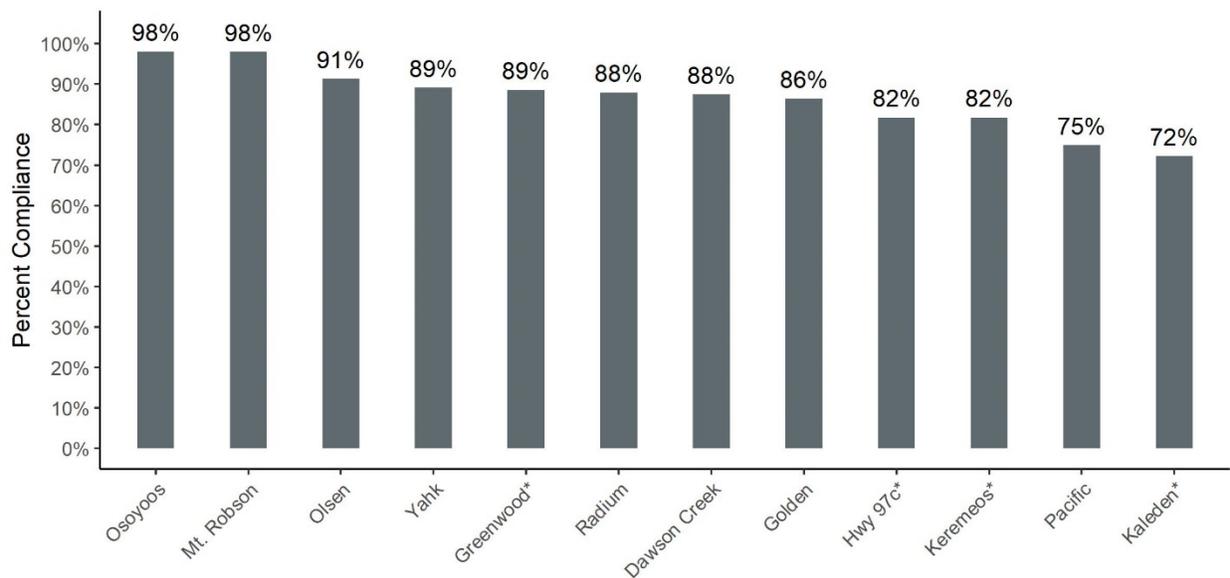
Figure 14. Home residence by province or state of all inspections during the 2021 season.



### 3.1.5 Compliance

During each shift, inspectors recorded watercraft that failed to stop at the inspection station and used this number as a measure of compliance. The compliance rate for a shift was calculated as the number of watercraft that stopped divided by the total number of boats that went by an inspection station. The average compliance across all the inspection stations for the 2021 season was 88.8%, which represents a slight increase from 87.7% in 2020.

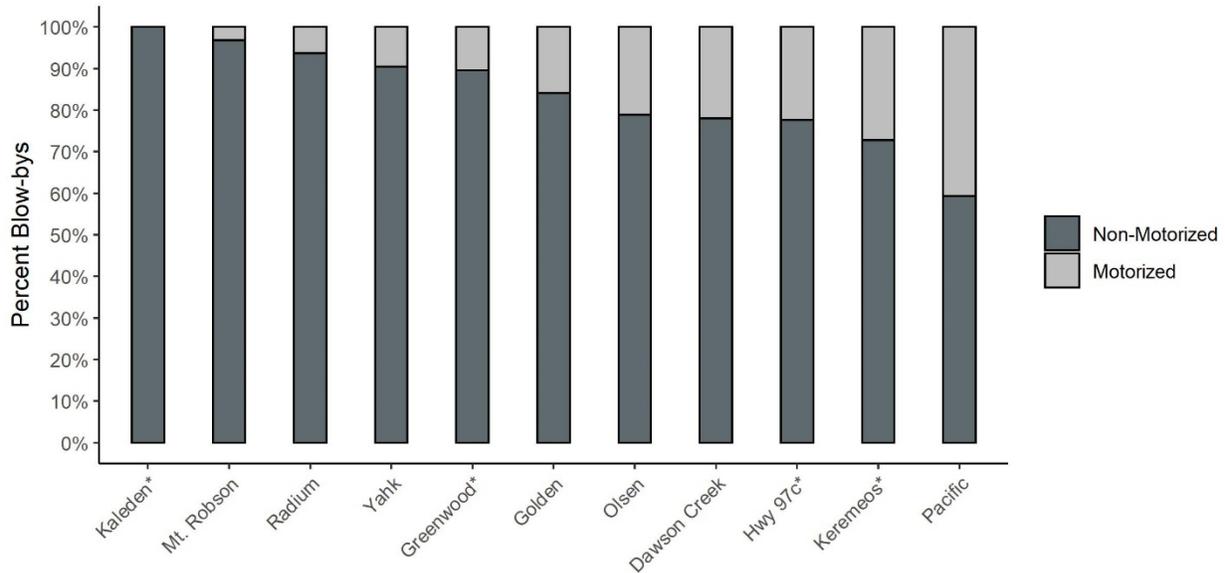
Figure 15. Percent compliance by inspection station for the 2021 season.



\*Denotes the roving inspection stations.

During the 2021 season, inspectors also recorded whether the watercraft that failed to stop were motorized or non-motorized. Figure 13 shows that, on average across all the months, 86.2% of the watercraft that failed to stop were non-motorized. This is a slight decrease from the 2020 season of 88% non-motorized watercraft that failed to stop. This shows that continued outreach and education to the non-motorized boating community are necessary to help raise awareness that inspection stations are mandatory for all types of watercraft. It is also important to note that at some of the inspection stations such as Golden, a large proportion of the non-motorized watercraft that fail to stop at the inspection station are local boaters and low risk. While these boaters are not exempt from stopping at stations, it does indicate reduced risk for the majority of the non-motorized watercraft that fail to stop at the stations. However continued outreach and education is important to raise awareness with the local boating community that it is mandatory to stop at any open inspection station in BC.

Figure 16. Percent of non-compliant watercraft (“blow bys”) broken down by the watercraft type for each inspection station.

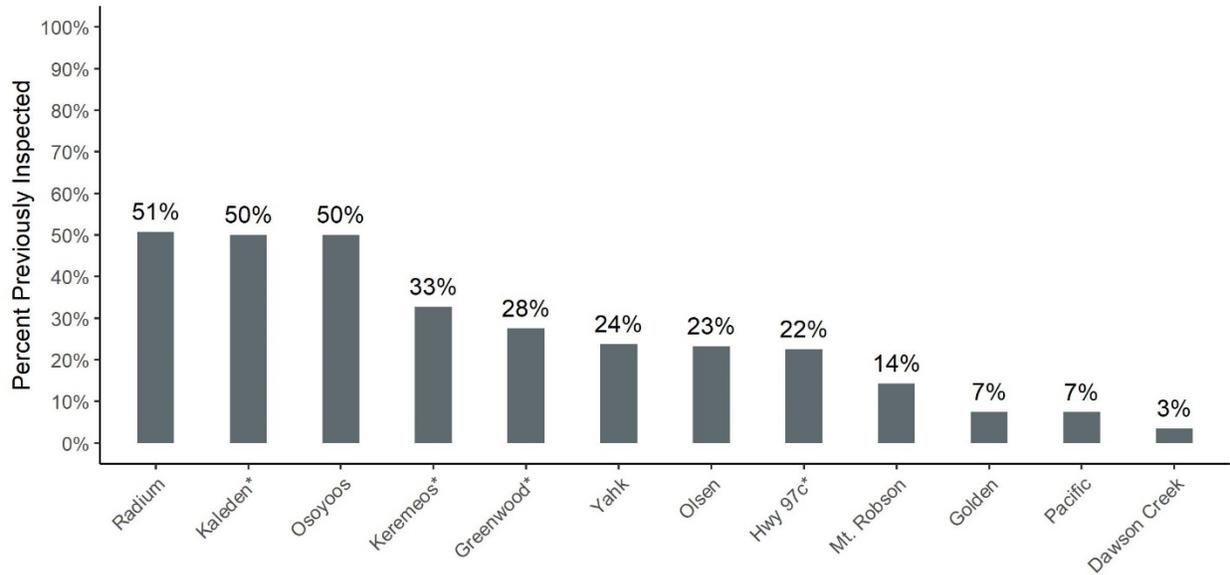


\*Denotes the roving inspection stations

The inspectors also recorded when and if each watercraft coming through a station had been through a previous inspection in B.C. or elsewhere. Figure 14 shows the percentage of boats that stopped at multiple inspection stations. The highest percentages of previously inspected watercraft by station occurred at Radium (51%), Kaleden (50%), Osoyoos (50%), Keremeos (33%), and Greenwood (28%). The timing of when the boater had been through a previous inspection was also recorded at each station. Of the previously inspected watercraft across all stations, 4.2% had been through over one year prior, 30.5% had been through within the last year, 55.3% had been through within 30 days and 10.0% on the same day (Figure 15). This represents a slight decrease from 2020 (18%) in the number of boats that were previously inspected on the same day. These data are looked at closely to assess program efficiencies and to minimize redundancies of same-day inspections with the placement of inspection stations.

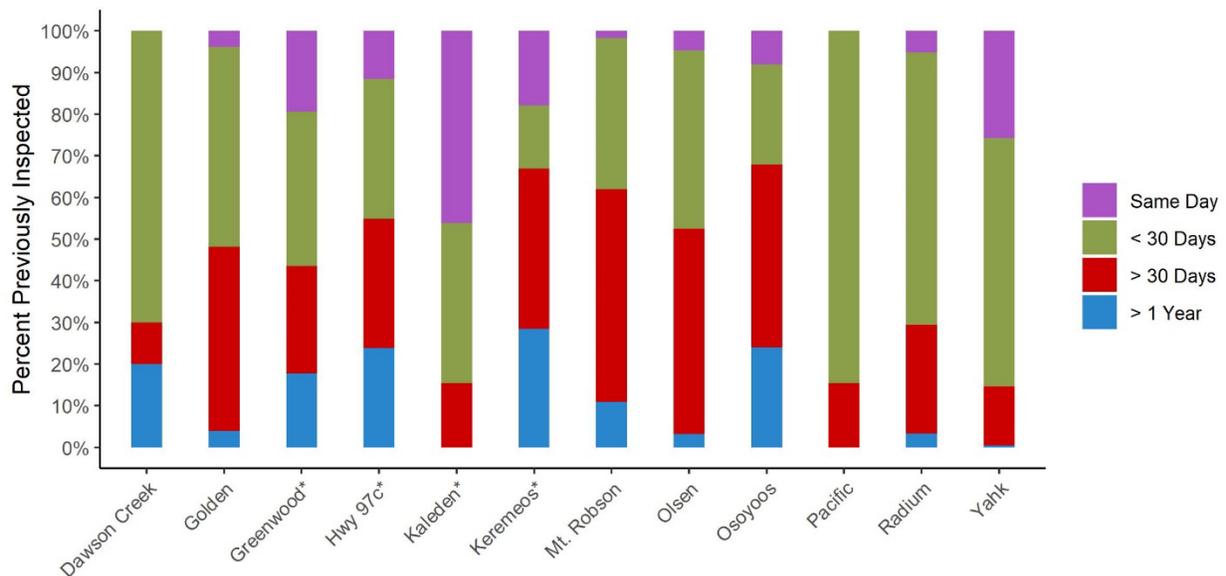
2021 INVASIVE MUSSEL DEFENCE PROGRAM FINAL REPORT

Figure 17. Percent of watercraft intercepted by inspection station that had been previously inspected (either in B.C. or another jurisdiction).



\*Denotes the roving inspection stations.

Figure 18. Frequency of watercraft previously inspected at another watercraft inspection station (either in B.C. or another jurisdiction).



\*Denotes the roving inspection stations.

### 3.2 HIGH-RISK WATERCRAFT ENCOUNTERS

Watercraft can be identified as high-risk for several different reasons based on the information obtained by the inspectors during the inspection and interview process. High-risk watercraft are identified as any watercraft or equipment that meet the following criteria:

- Launched in any waters of a province or state known or suspected of having zebra or quagga mussels in the past 30 days and is not clean, and to the extent practical, drained and dry;
- Coming from or is registered to a state or province that has zebra or quagga mussel infestations and is not clean, and to the extent practical, drained and dry;
- Appear dirty, crusty or slimy with the potential risk of transporting other AIS.

#### 3.2.1 By Station and Month

There were a total of 243 high-risk inspections during the 2021 season which represented an overall increase relative to the 2020 season. Since the Program has been operational, the total number of high-risk boats inspected has consistently peaked in July.

Figure 19. Total high-risk inspections by month across the 2019–2021 seasons.

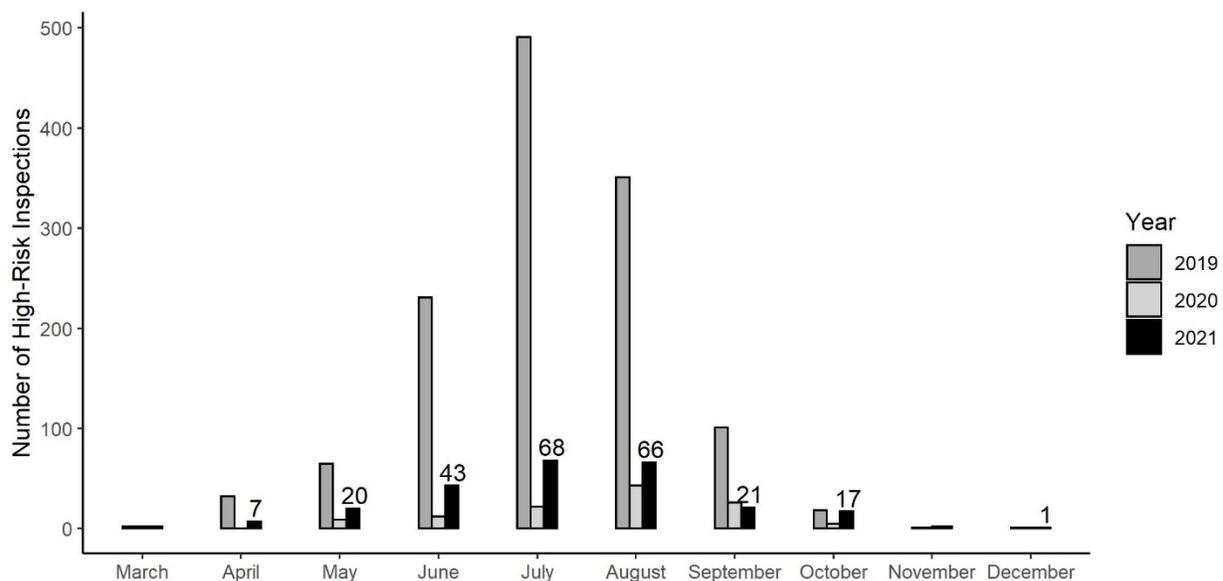
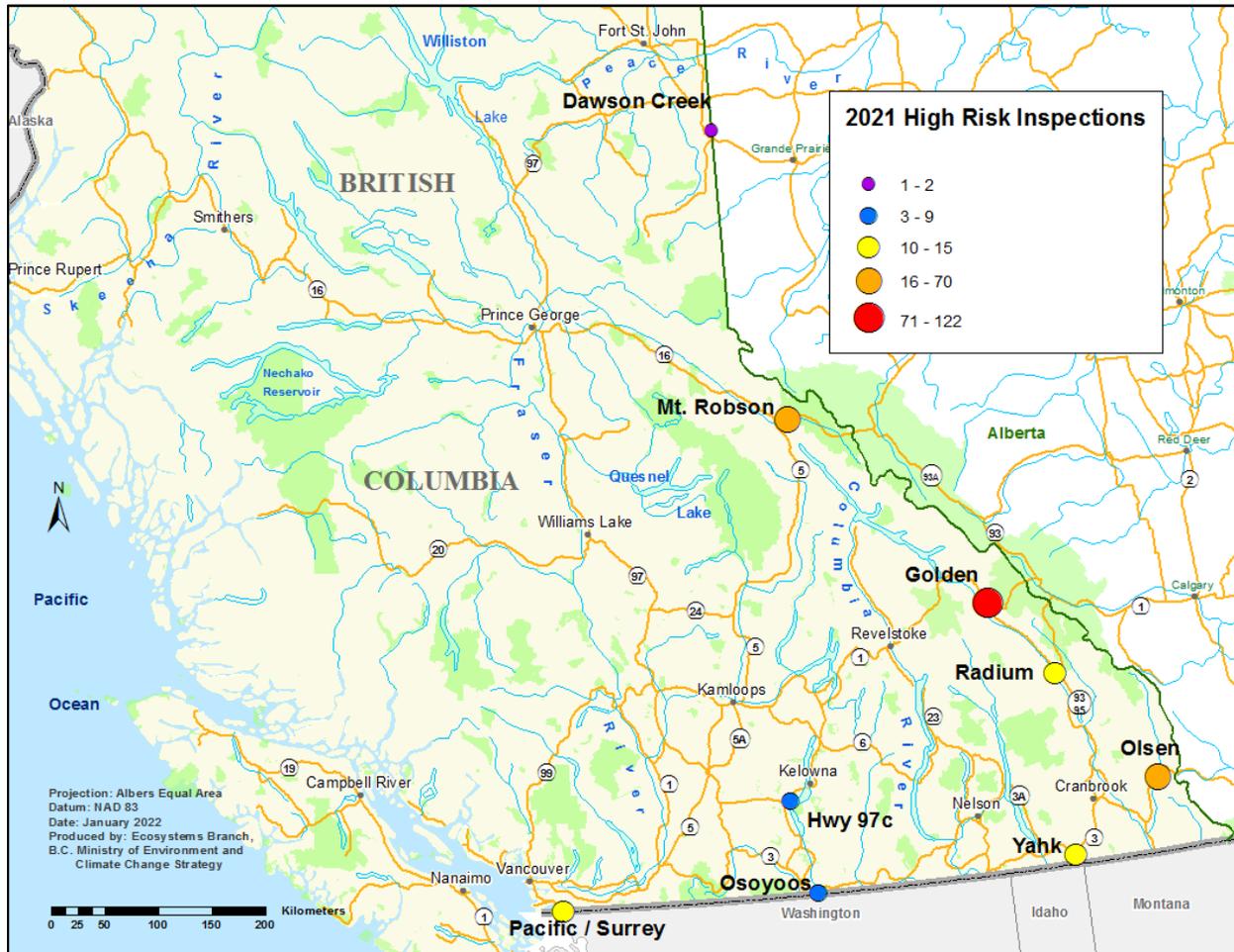


Figure 17 illustrates the number of high-risk inspections by station. The Golden station intercepted the most high-risk watercraft (87), followed by Olsen on Highway 3 (40), Mt. Robson (29) and Radium (7). This is consistent with increased inter-provincial travel and travel from the US as restrictions eased over the season.

Figure 20. The number of high-risk inspections by inspection station for the 2021 season.



### 3.2.1 High-risk Inspection Findings

Of the 243 high-risk watercraft inspected, 153 were decontaminated, 101 were issued a decontamination order and 19 had associated quarantine periods to allow for sufficient drying time. Not all high-risk watercraft require a decontamination. A watercraft may initially be considered high-risk for either dreissenid mussels or other AIS when they enter an inspection station. However, following a thorough inspection, it may be deemed low risk without further action required (i.e. decontamination) if it is found to be Clean, Drain, Dry. In addition to the previously cited 243 high-risk inspections, there were 121 high-risk inspections that were deemed Clean, Drain, Dry either after a thorough inspection and/or completion of a decontamination.

Not all watercraft that were decontaminated require a decontamination order and quarantine period. Quarantine periods are issued when: standing water or mussels are found and the boat has been out of the water less than 30 days; if inspectors cannot confirm the history of the boat at the time of

inspection; or if a full decontamination cannot be completed at the time of inspection. Quarantine periods were enforced by applying wire seals to the boats and inspectors followed up at the end of the quarantine period to ensure the seals were still intact prior to the boat being launched.

Inspectors also record other findings during inspections: three inspections found aquatic plants and four inspections found marine mussels or barnacles. Inspectors routinely offer to clean the watercraft to ensure they are free of aquatic plants and Clean, Drain, Dry before leaving an inspection station.

In addition to the 243 watercraft identified as high-risk for either dreissenid mussels or other AIS, 318 watercraft were identified as coming from an area in Alberta of high-risk for whirling disease (*Myxobolus cerebralis*). Inspectors were equipped with outreach and education resources on whirling disease to share with watercraft owners and conveyed the importance of Clean, Drain, Dry for boats and gear to prevent the spread of the disease.

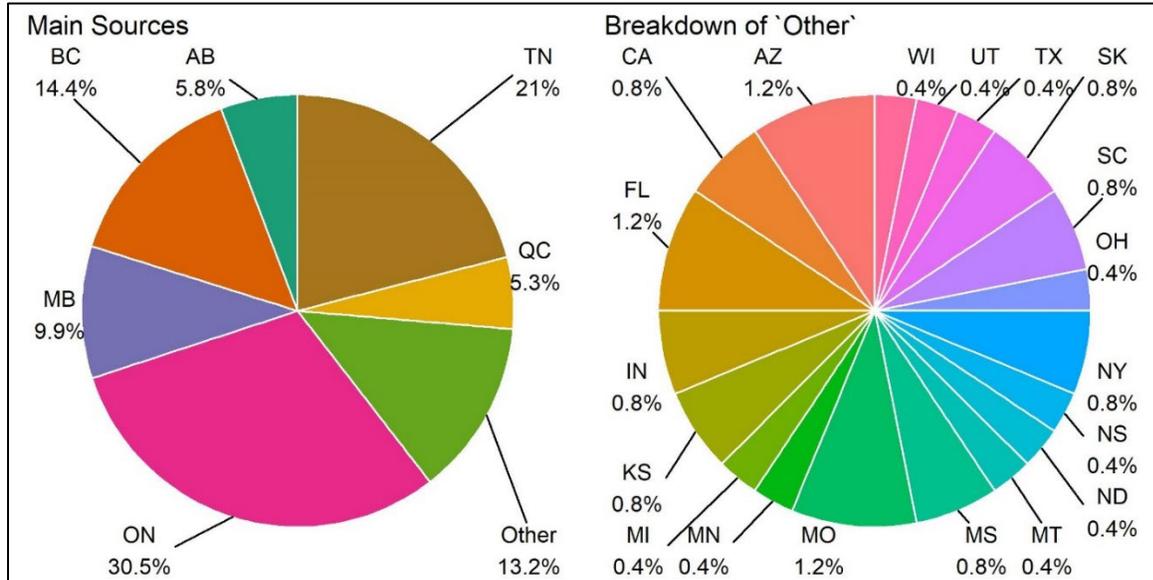
A total of 95 of the 243 high-risk watercraft (39%) had been through a previous inspection station within either B.C. or another jurisdiction. This represents a slight decrease from the 2020 season with 45% of the high inspections previously inspected. Collectively, these results still highlight the importance and effectiveness of the perimeter defence approach. Having multiple inspection stations across jurisdictions intercepting high-risk boats coming from the east and for educating the boating public is critical to mitigate the risk of ZQM to B.C.

### 3.2.2 Source and Destination Locations

Of the 243 high-risk watercraft identified by inspection crews, 74 came from Ontario (30.5%), 51 from Tennessee (21.0%), 35 from B.C. (14.4%), 24 from Manitoba (9.88%), 14 from Alberta (5.76%), 13 from Quebec (5.35%), and 32 (13.2%) came from other provinces and states (Figure 18). It is important to note that a watercraft may be low risk for dreissenid mussels but high-risk for other AIS if they are not found to be Clean, Drain, Dry. Therefore, if a watercraft coming from Alberta or traveling within B.C. is not Clean, Drain, Dry it will be considered high-risk if further action such as decontamination is required.

Of the high-risk watercraft inspected, 28% were destined for waterbodies in the Okanagan region, 13.6% for waterbodies in the Kootenay region, 13.6% for the Lower Mainland, 7.4% for the Pacific Ocean, 5.3% for the Thompson-Nicola, 5.3% for Vancouver Island, 2.1% for the Omineca, 1.2% for the Skeena, 0.8% for the Cariboo, 0.4% for the Peace and 1.6% were destined for another jurisdiction outside B.C. (Figure 19). For the remaining 20.6% of the high-risk watercraft, the destination waterbody was unknown. The destination waterbody could have been unknown for a variety of reasons such as the commercial hauler does not know where it will be launched, or the owner does not know the specific waterbody where they plan to launch it next. If a watercraft was still considered high risk following inspection and decontamination, the destination jurisdiction (other provinces, territories or US states) was notified.

Figure 21. Source locations of the high-risk inspections identified during the 2021 season.



The abbreviations for the left portion of the figure, clockwise, are as follows: Alberta (AB), British Columbia (BC), Manitoba (MB), Ontario (ON), Tennessee (TN), and Quebec (QC). For the right portion of the figure, the abbreviations, clockwise, are as follows: Arizona (AZ), California (CA), Florida (FL), Indiana (IN), Kansas (KS), Michigan (MI), Minnesota (MN), Mississippi (MS), Missouri (MO), Montana (MT), New York (NY), North Dakota (ND), Nova Scotia (NS), Ohio (OH), Saskatchewan (SK), South Carolina (SC), Texas (TX), Utah (UT), and Wisconsin (WI).

Figure 22. Destination regions of all high-risk inspections identified during the 2021 season.

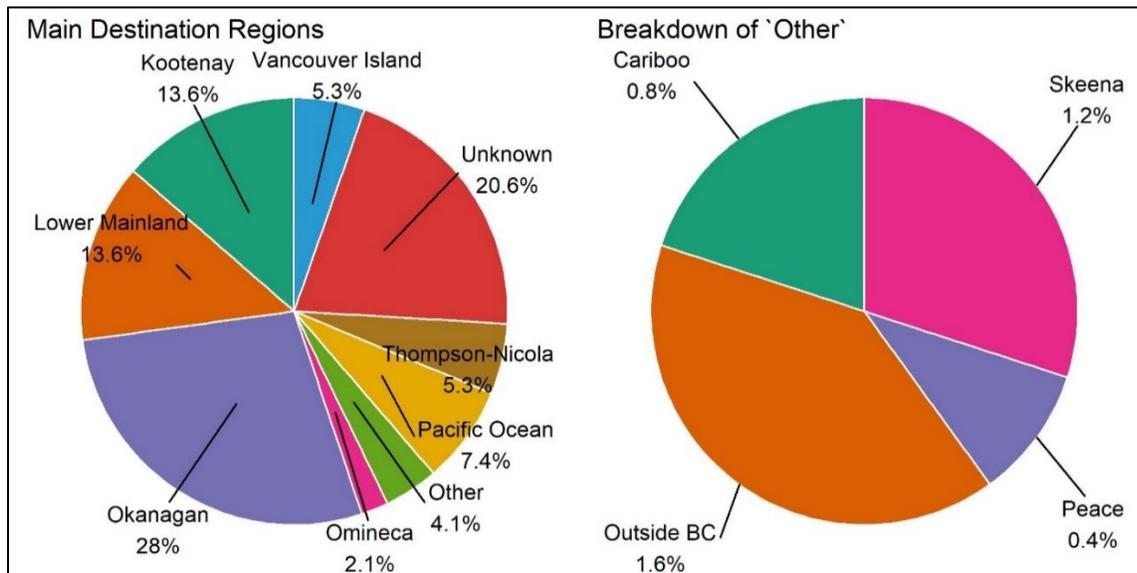


Figure 23. Source locations of the high-risk watercraft inspected during the 2021 season.

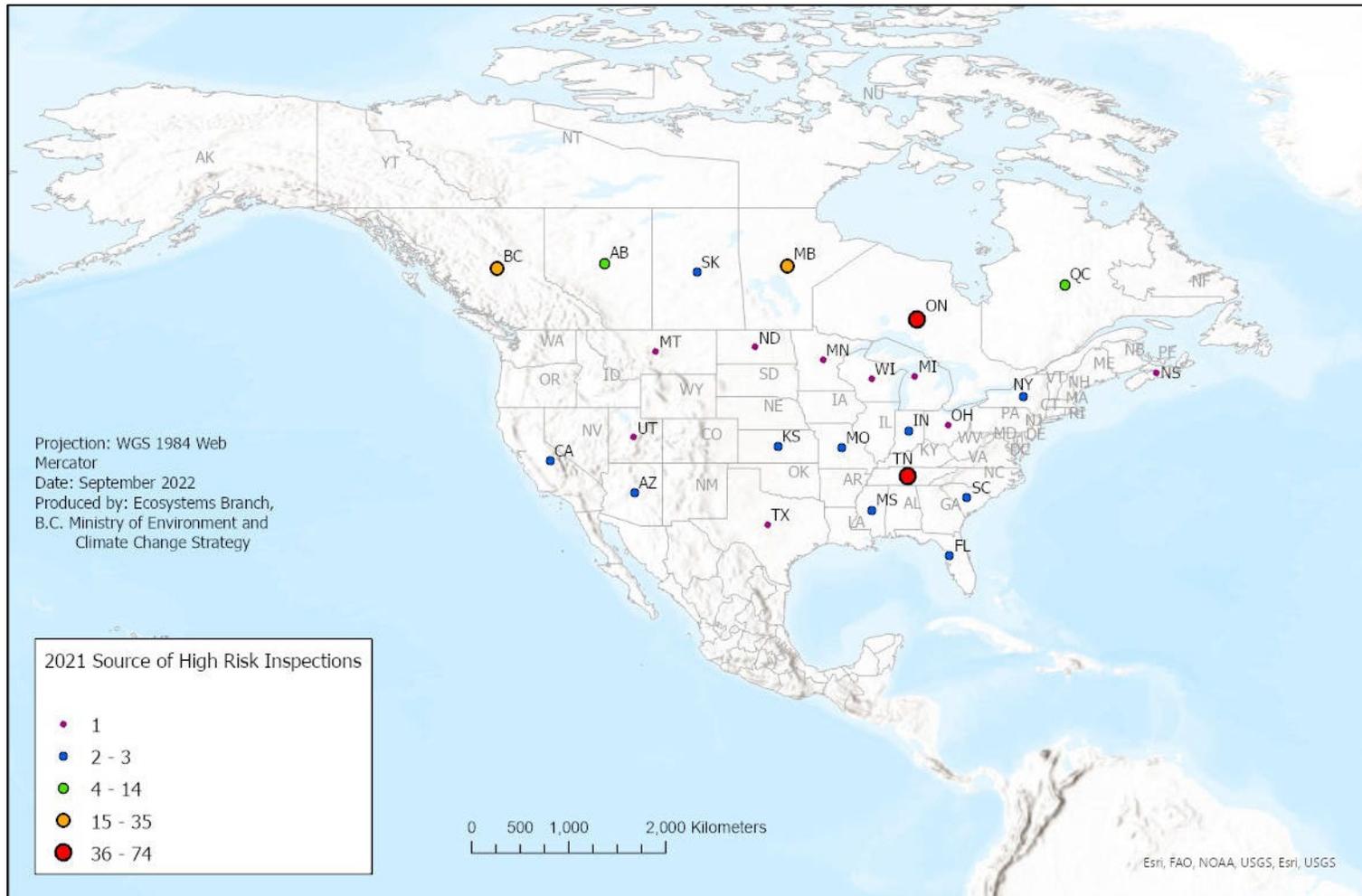
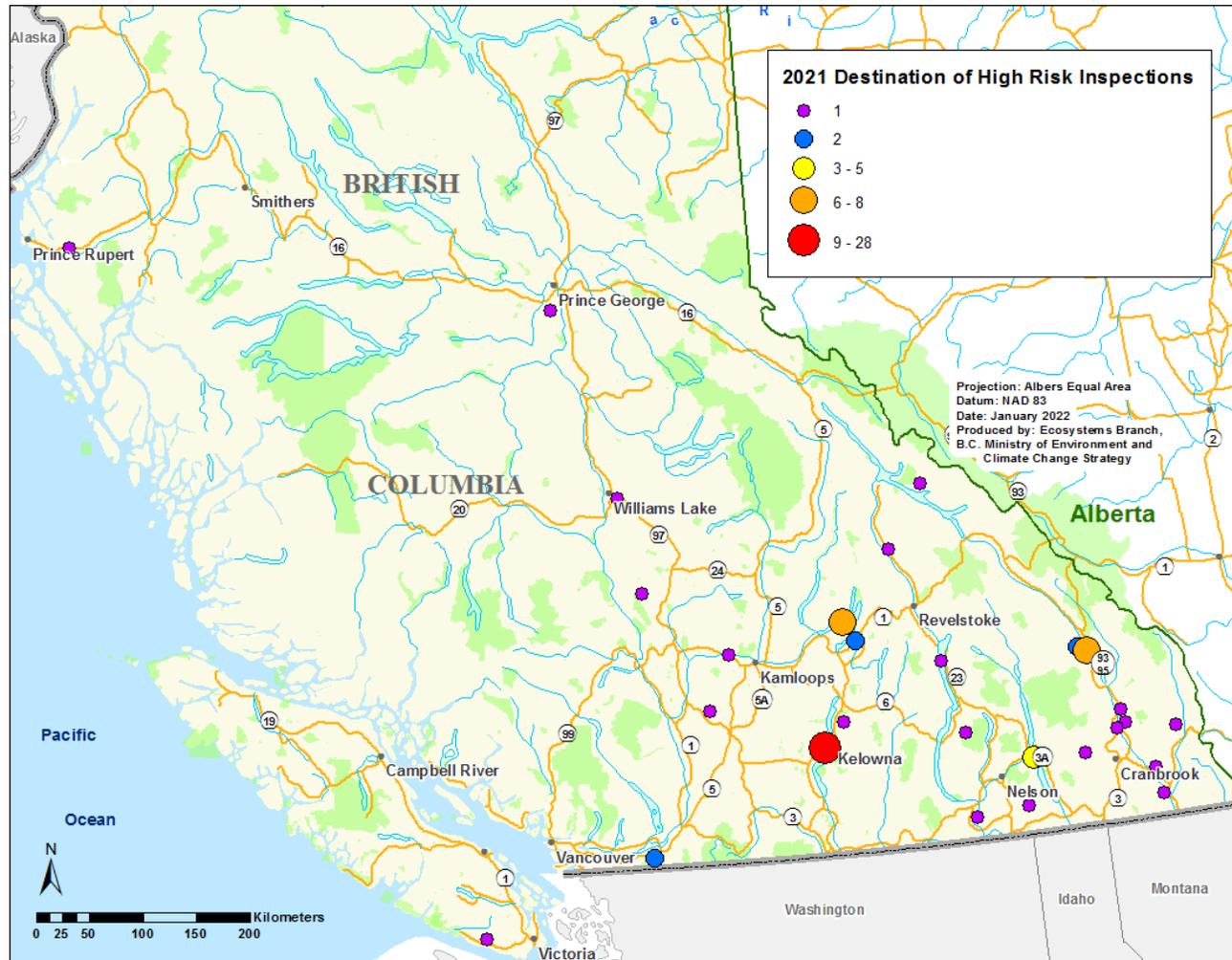


Figure 24. Destination locations of the high-risk inspections identified during the 2021 season.



### 3.2.3 Watercraft Types

During the 2021 season, the type of watercraft was recorded for all inspections and grouped into four categories:

- **Non-motorized or hand launched:** boats that are not launched from trailers and do not have motors or engines. Examples include canoes, kayaks, paddle boards.
- **Simple watercraft:** A boat with an open hull and no containers or interior compartments and a single outboard motor. This is a hand-launched boat that is either launched from a trailer or adds a motor. Examples include car toppers (with engine), aluminium runabouts, open hull fishing boats (no live wells).
- **Complex watercraft:** A boat that has interior compartments or a closed hull or more than one motor. Examples include fishing boats, speed boats and jet boats.
- **Very complex watercraft:** A complex watercraft with more than one internal water system—e.g. generator, air conditioners, sea strainers, swamp coolers— or other sources of unverifiable water (e.g. ballast tanks). Examples include cabin cruisers, wakeboard boats, houseboats and larger sailboats.

Non-motorized watercraft comprised the highest percentage of the total watercraft inspected in 2021, (64%), followed by complex (24%), very complex (4%) and simple watercraft (8%) (Figure 22). This is consistent with the 2020 data with 63% of total inspections being non-motorized watercraft. While very complex watercraft only made up 4% of the total inspections, they represented 20% of the high-risk inspections (Figure 23). Similarly, complex watercraft only made up 8% of the total inspections but represented 43% of the high-risk inspections.

Generally, the results are consistent with very complex watercraft posing greater risk for transporting invasive mussels or other AIS as there are more crevices and hidden places that cannot be visually inspected. However, canoes, kayaks and small sailboats can still pose a risk of transporting standing water with potentially viable invasive mussel larvae as they are more commonly moved between waterbodies from multiple jurisdictions in short periods of time.

Figure 25. Total watercraft inspected by watercraft type (see above for explanation of each category) for the 2021 season.

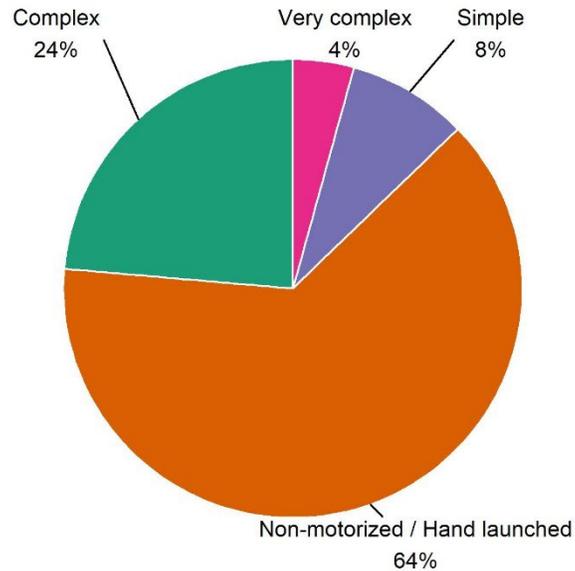
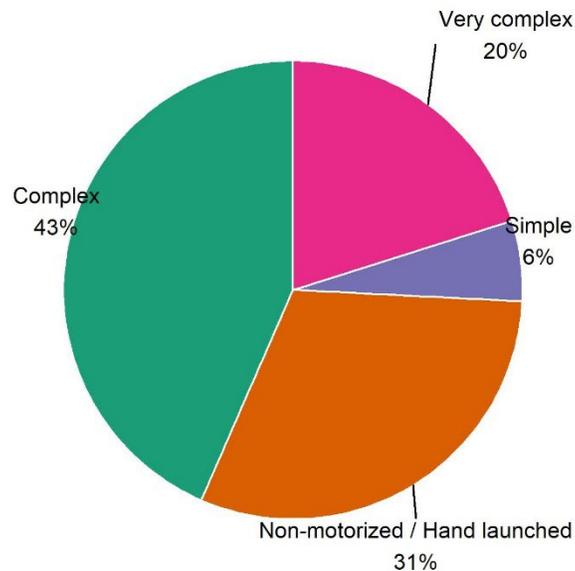


Figure 26. High-risk inspections by watercraft type for the 2021 season.



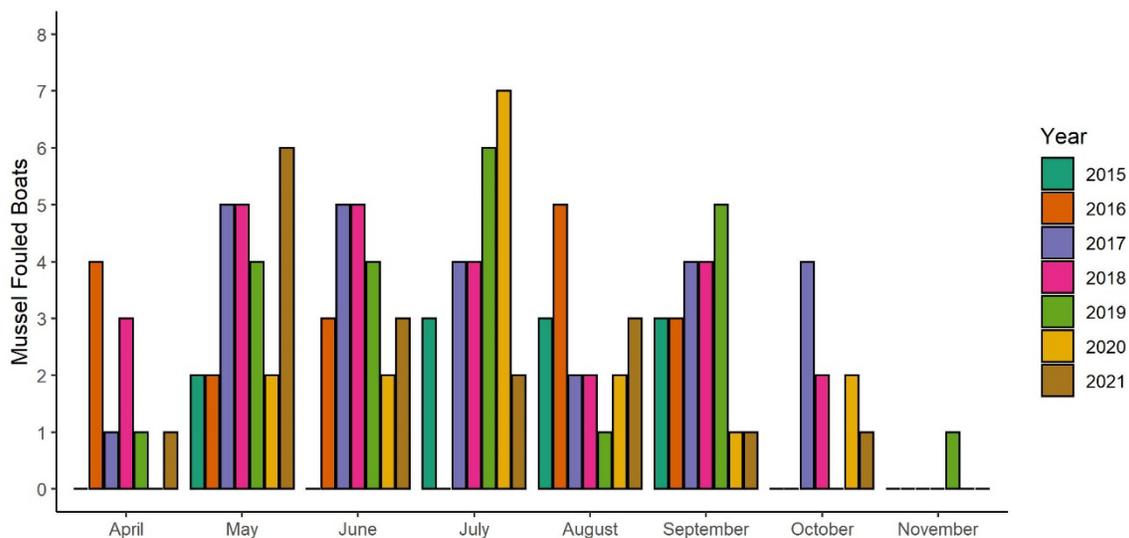
### 3.3 MUSSEL-FOULING WATERCRAFT

A total of six mussel-fouled boats were intercepted in May, which is slightly higher relative to previous years when the program saw peaks in the number of mussel-fouled boats in July and September (Figure 27). One mussel-fouled boat was intercepted between 4:00 and 5:00 a.m. However, it had been previously inspected at an Alberta inspection station and had been out of the water for more than a year.

A total of 17 mussel-fouled watercraft were encountered, of which B.C. received advance notification for seven. These notifications came from another jurisdiction (in Canada or U.S.) or the Canadian Border Services Agency (CBSA). This represents a decrease from previous seasons, when advance notifications were received for over 50% of the mussel-fouled boats. The Program, did however, see an increase in the number of high-risk watercraft notifications received from other jurisdictions with 73 in 2021 relative to 56 notifications in 2020.

As illustrated in Figure 27, the Program saw an increase in the number of mussel-fouled boats intercepted in the spring (May) and not all inspection programs in other jurisdictions may have been operating at full capacity. This could potentially explain the decrease in the number of advance notifications the Program received in 2021. However, it is difficult to determine the exact reason. It still highlights the importance of having several jurisdictional layers of inspection stations, as it increases the likelihood of detection and timely decontamination of high-risk boats.

**Figure 27. The number of mussel-fouled watercraft intercepted by month across all seasons of the Program (2015–2021).**



The 17 mussel-fouled boats were coming from Ontario (7), Manitoba (2), Colorado (1), Illinois (1), Michigan (1), Minnesota (1), Missouri (1), Ohio (1), and Quebec (1) (Figure 25). The proportion of mussel-fouled boats that came from eastern or Great Lakes jurisdictions in the 2021 season was 76% and consistent with 75% in 2020.

Figure 28. Source provinces and states of the 16 mussel-fouled watercraft intercepted during the 2021 season.

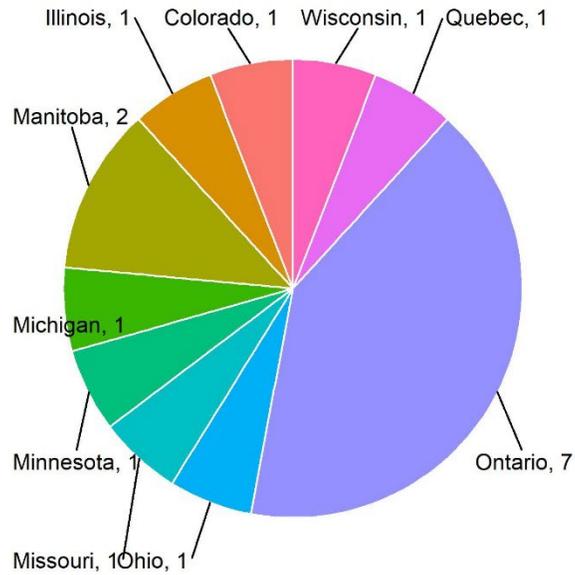


Figure 29. Destination regions in B.C. of the 16 mussel-fouled watercraft intercepted during the 2021 season.

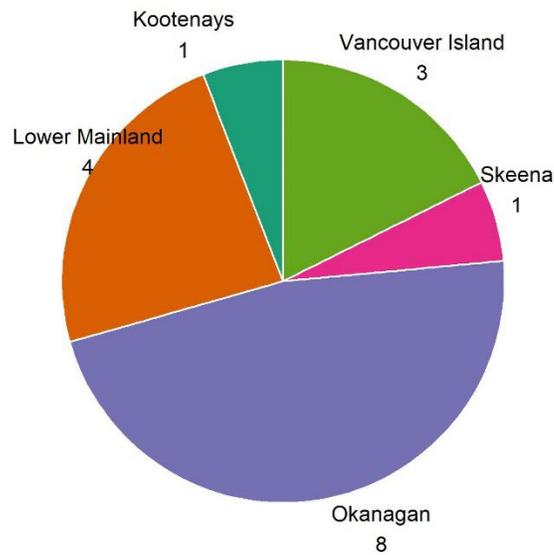
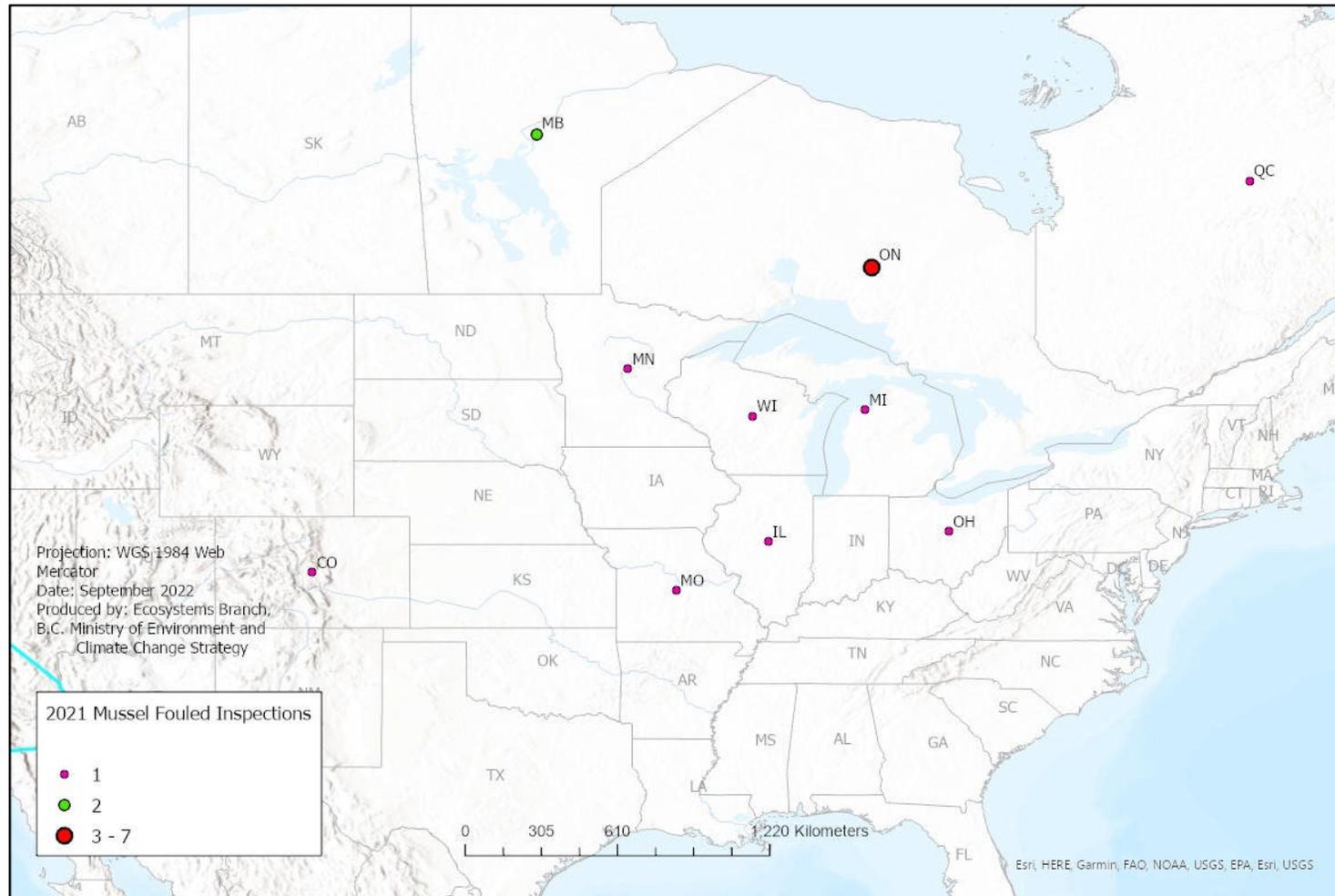
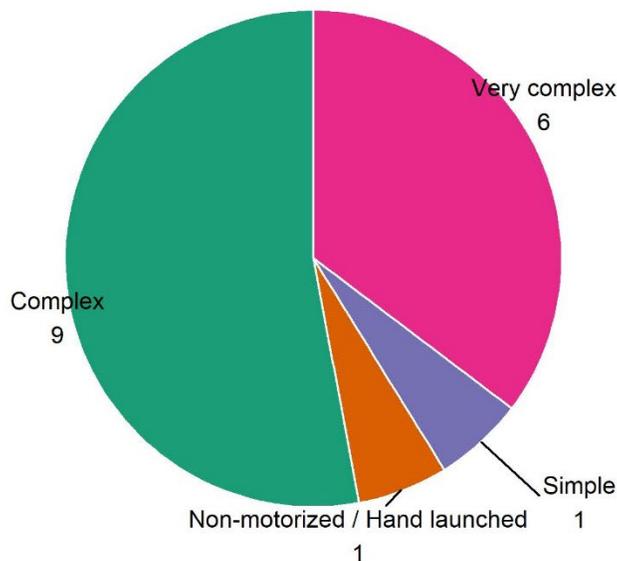


Figure 30. Source location of mussel-fouled boats.



The destination of the mussel-fouled boats by region was the Okanagan (8), Lower Mainland (4), Vancouver Island (3), Kootenays (1), and Skeena (1) (Figure 26). Of the 17 mussel-fouled watercraft, six (35%) were very complex watercraft, nine (53%) were complex watercraft, one was a simple watercraft (6%) and the last was a non-motorized watercraft (6%) (Figure 28). The non-motorized watercraft was a kayak coming from Ontario and pieces of mussel shells were found inside the kayak. This represents only the second non-motorized mussel-fouled watercraft that has been intercepted since the program first started in 2015. Five of the seven mussel-fouled boats destined for either the Lower Mainland or Vancouver Island were confirmed to be going to either saltwater or dry storage, while the destination waterbody was unknown for the remaining two watercraft.

Figure 31. Watercraft type of the 17 mussel-fouled watercraft intercepted during the 2021 season.



### 3.4 COMMERCIALY HAULED WATERCRAFT

Of the total watercraft inspected (33,300), 338 were commercially hauled, representing 1% of the total boats inspected. Commercially hauled watercraft represent a very low percentage of total watercraft inspected; however, they demonstrate a disproportionately high-risk of carrying invasive mussels: 33% of high-risk watercraft were commercially hauled and 41% of the mussel-fouled watercraft (seven of the 17 boats) were commercially hauled.

The Golden station intercepted the highest number of commercially hauled watercraft (112), followed by Pacific and Surrey (96), Osoyoos (20), Mt. Robson (19) and Yahk (17) (Figure 29). These data are consistent with the 2019 and 2020 seasons, which also saw the Golden and Pacific stations intercepting the most commercially hauled boats. This is expected as the Pacific border crossing is one of the main crossings in the lower mainland that permits commercial traffic. The Trans-Canada Highway, where the Golden station is located, is another primary travel route for commercially hauled watercraft. Despite

the east Kootenay inspection stations (Olsen and Yahk) having high watercraft encounter frequency, they only saw 24 commercially hauled watercraft, indicating Highway 3 is not a major route for commercial haulers during the operating hours of the inspection stations.

The most common source locations for commercially hauled boats outside of B.C. were Alberta, Tennessee, Washington, and Ontario (Figure 30). Commercially hauled boats include a combination of new boats being shipped from manufacturers to marinas or dealers and used boats purchased privately but are too large to be transported recreationally. New boats from manufacturers in the U.S. are frequently transported to Alberta and then shipped to B.C. (typically the Okanagan). Common locations of boat manufacturers in the U.S. include Florida, Indiana, Texas, and Washington.

Some shipments of new boats are tested in high-risk waterbodies prior to be transported into B.C. and pose a risk of transporting standing water that could contain invasive mussels. Therefore, some shipments of new boats require follow up by AIS inspectors when they arrive at the destination. Used boats being commercially hauled from mussel-infested jurisdictions pose the highest risk for transporting invasive mussels and a common source location is the Great Lakes (Figure 30). Scheduled inspections at the destination are typically required for commercially hauled boats as they are typically plastic wrapped and inaccessible for inspection and decontamination during transport.

**Figure 32. Number of commercially hauled boats intercepted at the watercraft inspection stations during the 2021 season.**

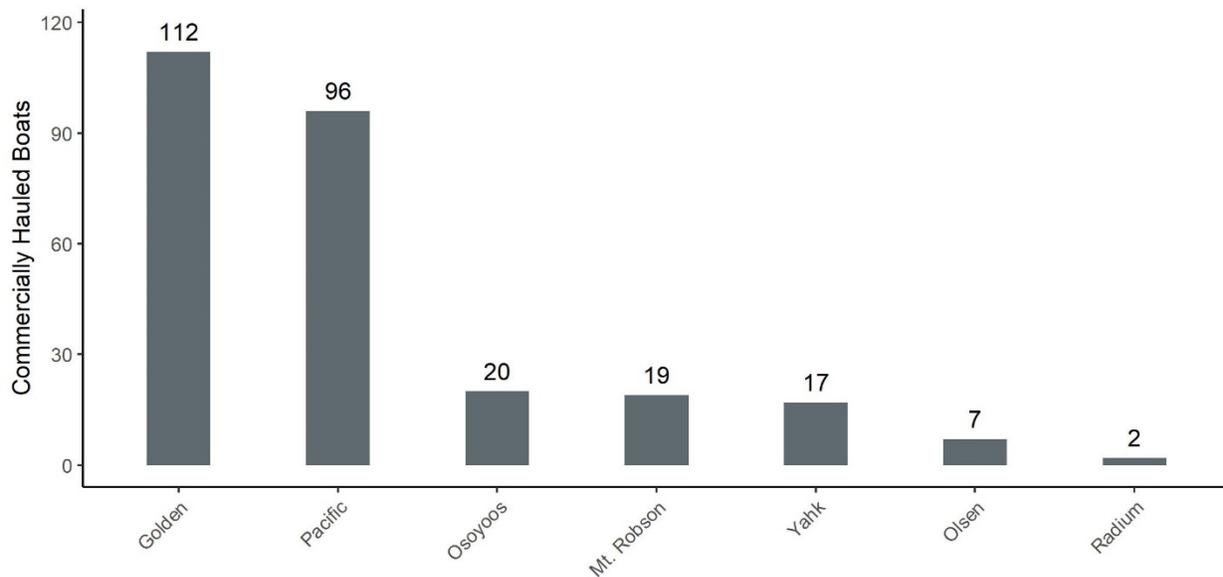
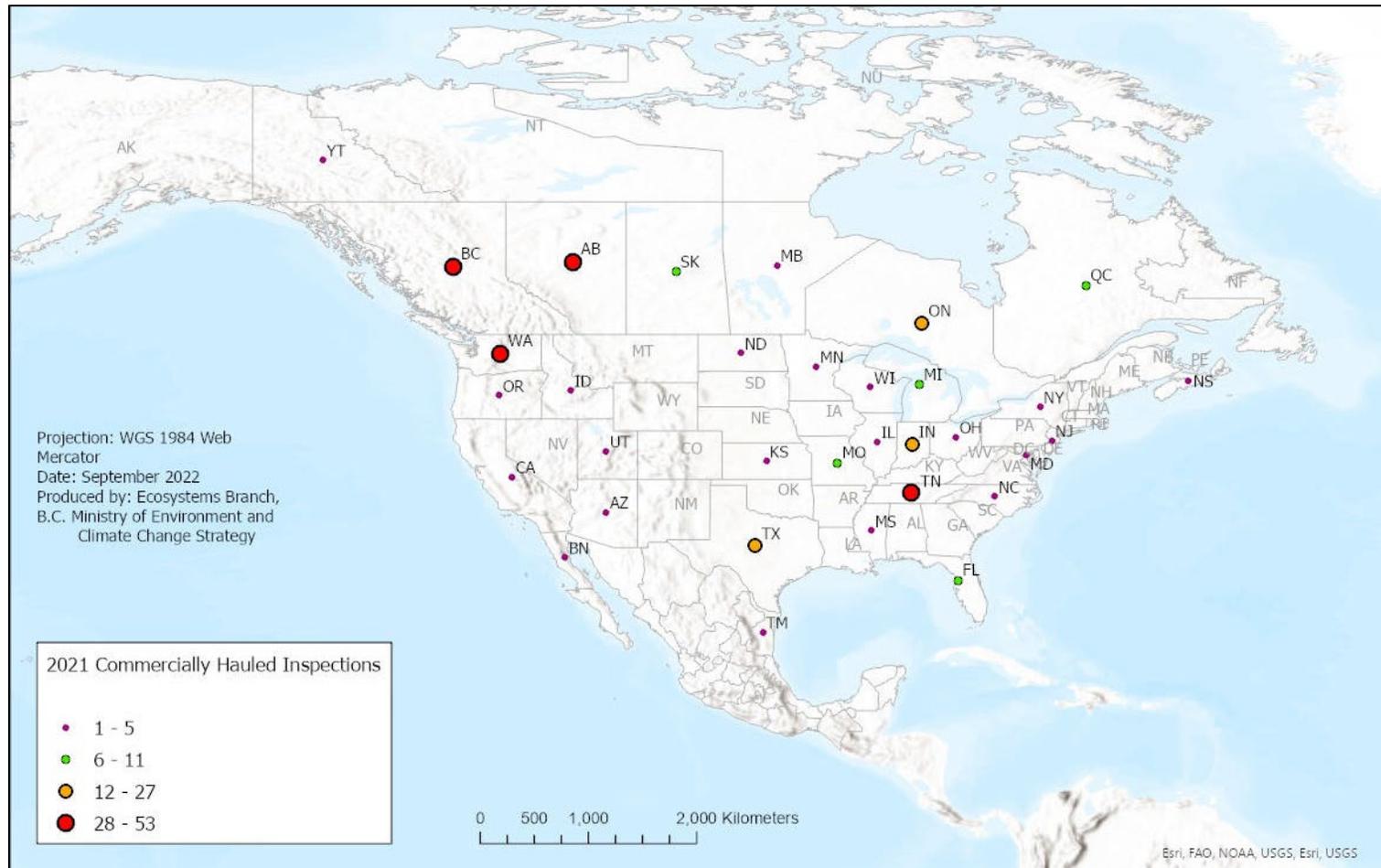


Figure 33. Source location of commercially hauled watercraft coming from outside B.C.



### 3.5 AIS PASSPORT

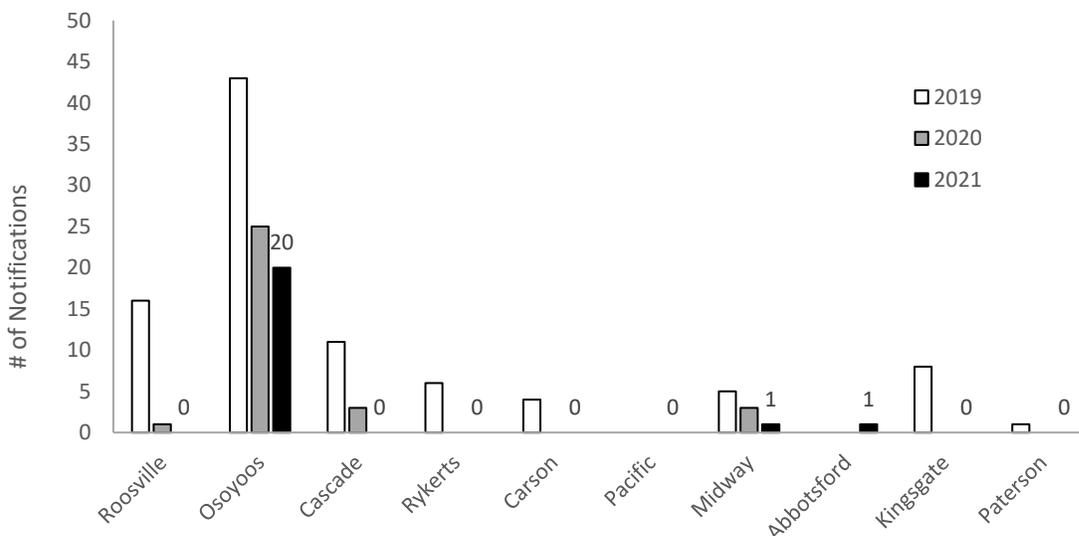
B.C. and Alberta launched a joint AIS passport in 2017 that is intended for watercraft travelling frequently through B.C. and Alberta. When the AIS passports are issued, boaters sign a commitment to practice Clean, Drain, Dry and stop at all inspection stations. It is still mandatory for all passport holders to stop at inspection stations, but the inspection process is quicker. The AIS passport is stamped each time a boater goes through an inspection station. The AIS passport serves as a record of past watercraft inspections.

Of the roughly 33,300 total inspections for the 2021 season, 2,645 (7.94%) were AIS passport holders. These boaters are asked a reduced number of questions during the inspection process. If the watercraft has not been launched outside of B.C. or Alberta in the last 30 days and the boat is found to be Clean, Drain, Dry, then the AIS passport is stamped, and the watercraft is released.

### 3.6 CANADA BORDER SERVICES AGENCY NOTIFICATIONS

During the 2021 season, the Program worked directly with CBSA to receive notifications of watercraft at the southern border crossings. While the US border was closed to non-essential travel throughout most of the 2021 season, commercially hauled boats were still permitted to cross the border. For the 2021, season, the Program received 25 notifications from CBSA at several different border crossings that inspectors responded to (Figure 34). This represents a decrease from the notifications received from CBSA in 2020 (32). These numbers reflect all the notifications that were received through the Program’s email during the season. The Program also receives notifications from CBSA during the winter months when the inspection stations are closed. These notifications are also followed up by the AIS sergeants in the COS.

Figure 34. CBSA notifications received across southern US border crossings for the 2018 to 2021 seasons.



### 3.7 K9 INSPECTIONS

The Program launched the AIS K9 Unit in 2017 with the training of B.C.'s first multi-purpose detection dog (K9), Kilo and in 2020, a second detection K9 Major, joined the Program. In 2020 Sergeant Dan Bartol took over as the handler for Kilo and they are based in Golden.

In fall 2021, the Program welcomed Sergeant Denny Chretien to the team, with the retirement of Sergeant Cynthia Mann. Sergeant Chretien completed training as the new handler for COS detection dog Major. The pair officially began duties in spring 2022 with the start of the inspection season. Sgt. Chretien and K9 Major are based out of Cranbrook.

Both K9 teams conducted inspections at the various watercraft inspection stations throughout the 2021 season. In addition, they typically attend various outreach or education events throughout the year. However, because of COVID-19, the number of outreach events was significantly reduced for the 2021 season. The K9s also support various enforcement-related inspections and searches for the Conservation Officer Service. A significant amount of time is required by the handlers each year for ongoing training and off duty care and maintenance of the K9s.

## 4. OUTREACH AND EDUCATION ON CLEAN, DRAIN, DRY

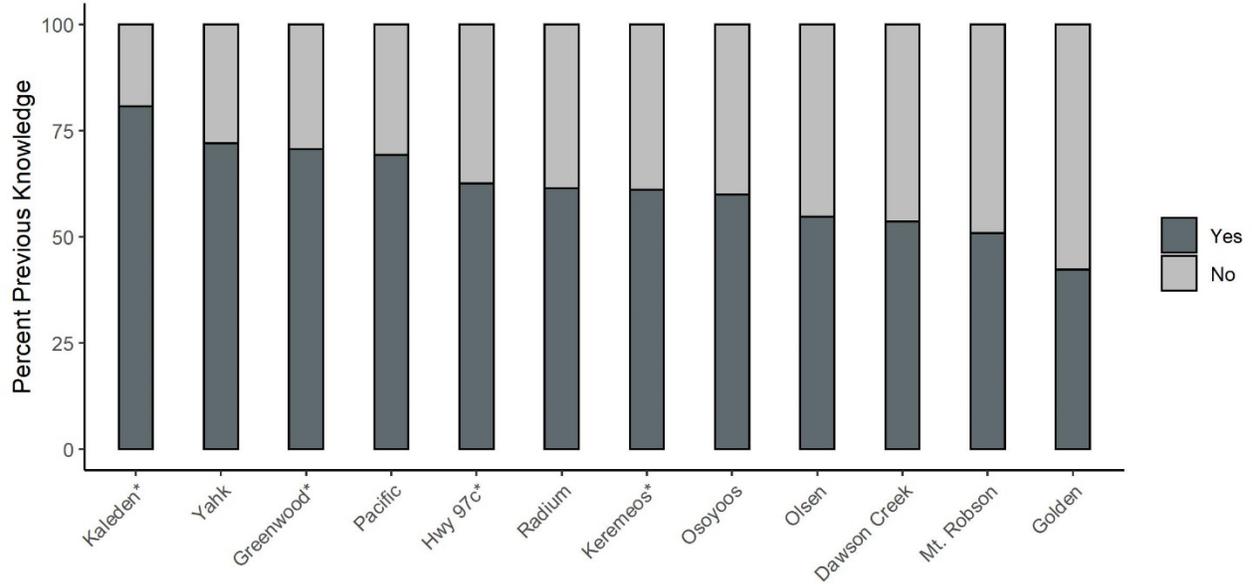
### 4.1 INSPECTION STATIONS

Inspection crews had approximately 61,700 interactions across all the inspection stations during the 2021 season to promote the message of Clean, Drain, Dry (CDD). Inspectors recorded whether the watercraft owner had any previous knowledge of AIS or CDD as a measure of efficacy of the Program to educate the public about AIS and CDD.

For the 2021 season, watercraft owners having previous knowledge of AIS and CDD averaged 57%, which is consistent with the 2020 season (61%). Figure 32 shows the breakdown of previous knowledge by watercraft inspection station with Kaleden the highest at 81%. Figure 33 shows that the top source of previous knowledge was the previous inspection station visited (in B.C.) (84%), followed by highway inspection signs (5%), personal experience (6%), word of mouth (2%), and other sources (3%). Of the previous other inspection stations visited, 6% were from Alberta and the remaining 1% were from other jurisdictions.

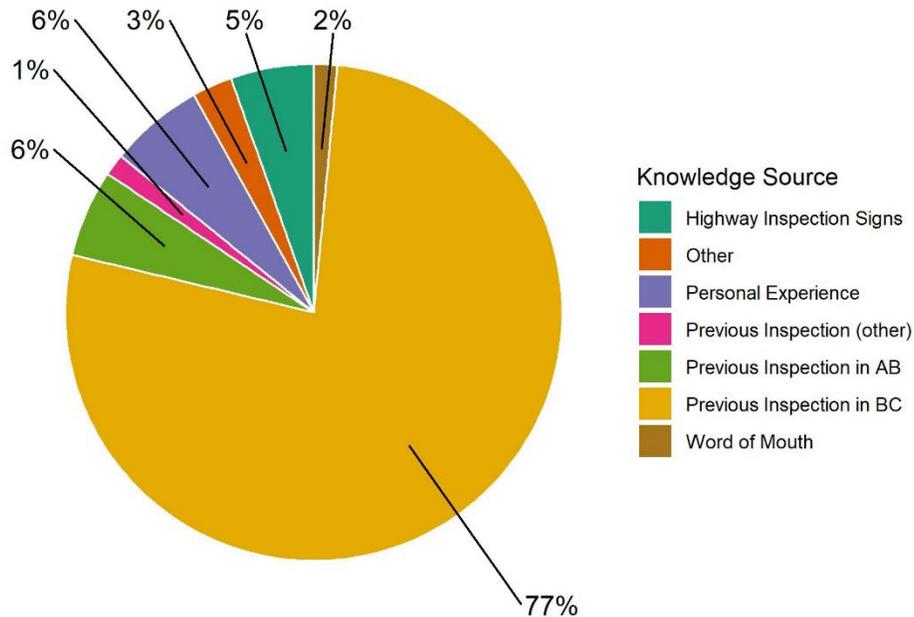
Other sources of knowledge include, but are not limited to, provincial government TV advertising or news, provincial government, signs at boat launches, US–Canada border inspection, highway billboard signs, regional invasive species groups, radio, internet, TV advertising or news and social media. Data were collected from boaters attending inspection stations. These data provide important information to effectively target the boating community to raise awareness about AIS and CDD in future years of the Program.

Figure 35. Watercraft owners' previous knowledge of aquatic invasive species and/or Clean, Drain, Dry by watercraft inspection station for 2021.



\*Denotes the roving inspection stations.

Figure 36. Primary sources of previous knowledge of aquatic invasive species or Clean, Drain, Dry.



The Program also received 135 public inquiries over the 2021 season through its email ([COS.Aquatic.Invasive.Species@gov.bc.ca](mailto:COS.Aquatic.Invasive.Species@gov.bc.ca)), which is monitored by all the inspectors and senior program leads. These emails included reports of suspected invasive mussels, which were immediately followed up on; there were no confirmed reports of invasive mussels. Most emails were from boaters bringing their boats into B.C. and contacting the Program about the watercraft inspection stations and necessary steps to take. The Program saw an increase in the number of public inquiries (135) relative to the 2019 (85) and 2020 (118) seasons. This is a positive sign as increased awareness about the Program among boaters bringing their boats into B.C. leads to increased compliance. The increase may also be linked to boaters wanting to ensure they are in compliance with COVID-19 public health orders.

## 4.2 OUTREACH EVENTS

While provincial inspection stations are the first priority of the Program, in past seasons when time permitted, inspection crews also attended local events to educate the public about Clean, Drain, Dry, invasive mussels, and other high-risk AIS. Unfortunately, due to the ongoing pandemic, crews were unable to attend many outreach events in person during the 2021 season. The Okanagan and Lower Mainland roving crews did conduct inspections and outreach at several boat launches throughout the summer months. The crews also continued to provide outreach materials and promote Clean, Drain, Dry at the inspection stations throughout the season.

## 5. LAKE MONITORING

Monitoring is critical for early detection of new invasive species incursions in B.C. and is an important first step in the *Provincial Early Detection Rapid Response (EDRR) Plan*<sup>5</sup>. The Province has been conducting lake monitoring for ZQM since 2011. B.C. is one of many jurisdictions across North America conducting monitoring and active prevention efforts for invasive mussels.

The *British Columbia Dreissenid Mussel Lake Monitoring Field Protocol*<sup>6</sup> was updated and published in December 2020. It details the provincial protocols used for lake monitoring for invasive mussels. As a signatory of the *Columbia River Basin Inter-Agency Invasive Species Response Plan: Zebra Mussels and Other Dreissenid Species*, B.C. has committed to following the accepted standards for the collection, preservation and analysis of invasive mussel veliger samples. As such, B.C. uses a specified cross-polarized microscopy method, which is done through a designated lab to ensure the provincial standards are met. Waterbodies are prioritized for sampling based on best available science and data to optimize use of available resources. Available resources must be allocated for both the number of priority waterbodies to be sampled and the frequency of sampling within an individual waterbody. The frequency of sampling includes both the number of sample sites within the waterbody and frequency

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<sup>5</sup> Source: [https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/invasive-species/guidance-resources/final\\_imiswg\\_bc\\_is\\_edrr\\_plan\\_nov\\_2014.pdf](https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/invasive-species/guidance-resources/final_imiswg_bc_is_edrr_plan_nov_2014.pdf)

<sup>6</sup> Source: [https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/invasive-species/invasive-mussels/2019\\_invasive\\_mussel\\_field\\_protocol.pdf](https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/invasive-species/invasive-mussels/2019_invasive_mussel_field_protocol.pdf)

with which they are sampled throughout the season. Large priority waterbodies (e.g., Shuswap and Okanagan Lakes) are prioritized for sampling at multiple locations throughout the sampling season. Table 2 provides a summary of the total number of samples collected and the number of waterbodies sampled by year since the Program started in 2015. The total number of waterbodies sampled decreased slightly since the 2017 season as resources have been allocated to balance both the number of priority waterbodies sampled and the frequency in which they are sampled. More information about the criteria used to prioritize waterbodies for sampling can be found in the provincial field protocol referenced above.

**Table 2. Total number of plankton tow samples collected, and waterbodies sampled by season since the Program started in 2015.**

Year	Total Samples	Total Waterbodies
2015	161	58
2016	233	98
2017	402	109
2018	800	90
2019	892	79
2020	954	89
2021	900	75

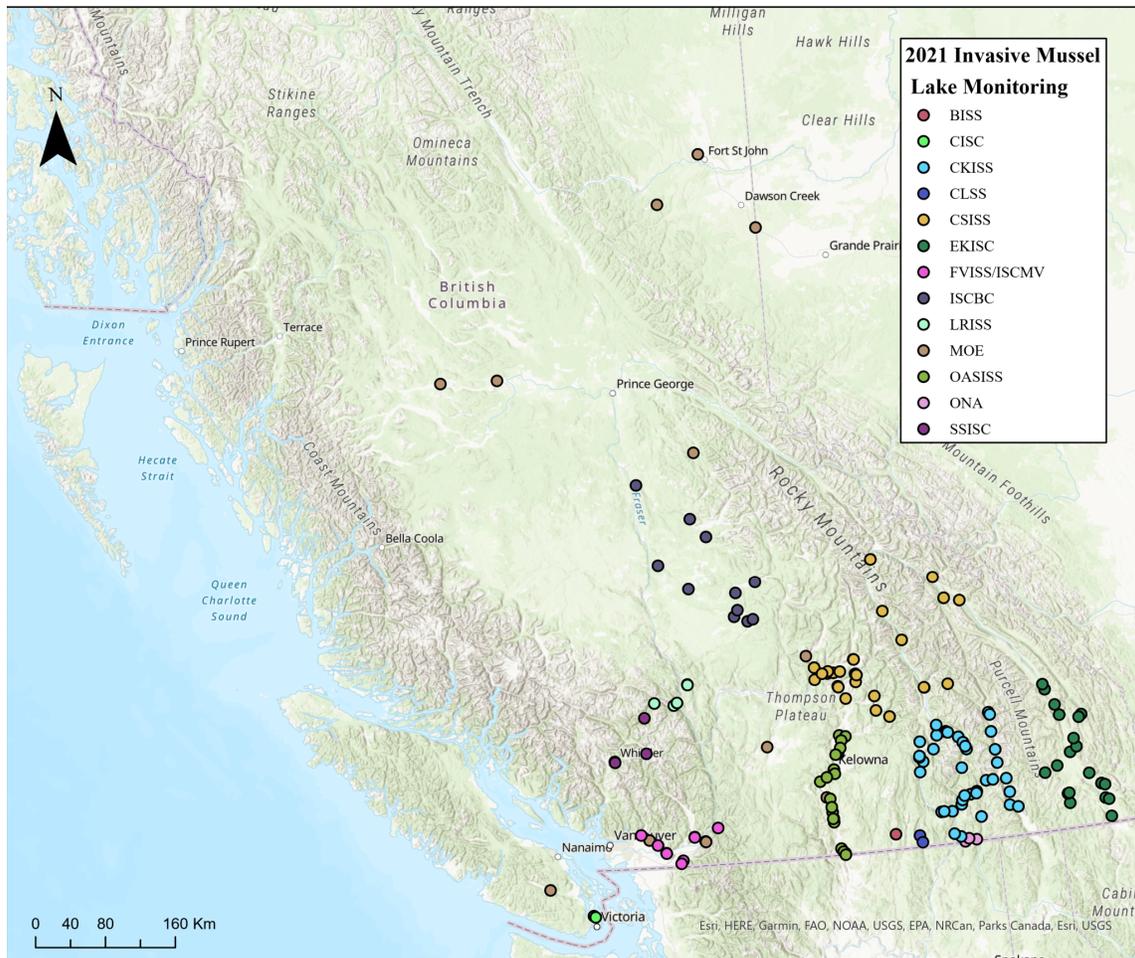
The Habitat Conservation Trust Foundation (HCTF) announced a new granting program in 2018 in partnership with ENV designed to fund community efforts to monitor lakes in B.C. for the presence of invasive freshwater mussels. More information about the program is available at <https://hctf.ca/grants/invasive-mussel-monitoring-grants/>

For the 2021 season, sampling was carried out by both partner organizations and Ministry regional biologists from early June to October. A total of 12 grants were administered by HCTF with funding provided by ENV and Fisheries and Oceans Canada for the collection of water samples in priority waterbodies across the province. The grant recipients were: Boundary Invasive Species Society (BISS), Coastal Invasive Species Committee (CISC), Central Kootenay Invasive Species Society (CKISS), Christina Lake Stewardship Society (CLSS), Columbia-Shuswap Invasive Species Society (CSISS), East Kootenay Invasive Species Society (EKISS), Fraser Valley Invasive Species Society (FVISS), Invasive Species Council of British Columbia (ISCBC), Lillooet Regional Invasive Species Society (LRISS), Okanagan and Similkameen Invasive Species Society (OASISS), Okanagan Nation Alliance (ONA), and Sea to Sky Invasive Species Council (SSISC).

The Province was successful in receiving four years of federal funding in 2019 under the Canada Nature Fund for Aquatic Species at Risk to support invasive mussel lake monitoring activities within the Fraser and Columbia River Watersheds. Fisheries and Oceans Canada also provided financial support of the 2021 lake monitoring activities. More information about the Canada Nature Fund for Aquatic Species at Risk is available at <https://www.dfo-mpo.gc.ca/species-especes/sara-lep/cnfasar-fnceap/index-eng.html>

A total of 900 plankton tow samples were collected across 75 priority waterbodies and 88 substrate samples were deployed (Figure 13) during the 2021 season. All samples tested negative for the presence of invasive mussels. A complete list of waterbodies sampled in 2021 can be found in Appendix B.

**Figure 37. 2021 Lake monitoring plankton tow sampling locations, please see above for the full names of the sampling agencies.**



## 6. PARTNERSHIPS AND COLLABORATIONS

Partnerships are the foundation of the Program and below is a summary of several of the many partnerships that the Program is involved with.

### RESEARCH

The Province is updating the original economic impact assessment that was conducted in 2013 that estimated the cost if zebra and quagga mussels were to be introduced into B.C. (\$43 million annually). The analysis requires updating to reflect a more accurate assessment of the costs associated with invasive mussel introduction into B.C. across a broader range of sectors and will be expanded to include a cost–benefit analysis. The report is going through a peer review process. It will provide estimates of the impacts to sectors such as hydropower, recreation and tourism, irrigation and property values. Preliminary results estimate impacts to exceed the 2013 study. Once this updated economic impact assessment report is complete, we will publish it and share it with our partners.

### CROSS-BORDER:

The Program continued to work directly with CBSA to receive notifications of watercraft at the southern border crossings, including 24-hour coverage along several of the southern border crossings. The Program receives notifications for all types of watercraft, including canoes, kayaks and river rafts. Due to the US-Canada border closure for the majority of the season, the Program received a limited number of notifications during the 2021 season.

In early March 2021, zebra mussels were confirmed in “moss balls” (*Cladophora* species) in B.C. as well as across Canada and the U.S. The aquarium and water-garden moss balls were sold in pet stores and garden centres. Conservation Officers and the ministry’s science experts worked closely with our Canadian and American counterparts to address the situation. The COS contacted more than 1,100 aquatic retailers and distributors throughout the province and conducted hundreds of on-site inspections to prevent the sale of potentially contaminated moss balls. More than 9,000 moss balls that were suspected or confirmed to be contaminated with zebra mussels were seized or surrendered to the COS as part of the response.

In early March 2022 the Program hosted a joint workshop with DFO Pacific Region to get training on Incident Command Structure (ICS). The workshop provided additional opportunity to review lessons learned from the moss ball response and how ICS could be integrated into the provincial ZQM Early Detection Rapid Response Plan (EDRR).

### CROSS-AGENCY:

Within Canada, B.C. is an active participant on several federal, provincial, territorial invasive species committees including the Invasive Alien Species National Committee and the National Aquatic Invasive Species Committee (NAISC). B.C. is also a signatory of the *Interprovincial Territorial Agreement for Coordinated Regional Defence Against Invasive Species*. Through this agreement, B.C. collaborates with Alberta, Yukon, Saskatchewan and Manitoba on enhanced coordination for preventing and managing

AIS; the initial emphasis is on zebra and quagga mussels. A central component of this work is coordination of the watercraft inspection programs to enhance the perimeter defence approach across western Canada.

As an example, the Program has been working with western provinces to streamline the process for assessing the risk of new watercraft that are being commercially transported into Canada. Some new boats are tested in high-risk areas prior to shipment to Canada and pose a risk of transporting standing water that could contain invasive mussels. A process was established across the western provinces to standardize the assessment of manufacturers testing procedures to determine the risk of transporting AIS. Manufacturers are considered exempt from any automatic quarantine or inspection follow up if their testing procedures are determined to reduce the risk of transporting AIS — such as testing using non-natural water sources or filling ballast systems with antifreeze. It is still mandatory for any new watercraft shipments to stop at all inspection stations along their travel route. The goal of this initiative is to have a consistent and coordinated approach across the western provinces that will facilitate efficiencies for both the watercraft inspection programs and manufacturers.

Ongoing coordination with other jurisdictions in Canada and the U.S. has been critical for the overall success of the Program. Outside of B.C., the Program shares research, procedures and notifications of high-risk boats with Alaska, Alberta, Arizona, California, Idaho, Manitoba, Montana, Nevada, Oregon, Saskatchewan, Washington, Wyoming, and the Yukon. This is part of B.C.'s ongoing commitment as a signatory to the trans-boundary *Columbia River Basin Inter-agency Invasive Species Response Plan: Zebra Mussels and Other Dreissenid Species*. As a signatory, B.C. receives notifications of high-risk watercraft from neighbouring states, and is provided access to professional advice on risk management and training opportunities. B.C. is also a member of the Pacific Northwest Economic Region (PNWER) invasive species working group and recently took on the role as technical co-chair of the working group.

#### EXTERNAL PARTNERS:

At the provincial level, the Program works on outreach and education messaging directly with the non-governmental community, including the Invasive Species Council of BC and regional invasive species organizations across the province. The Province appreciates the ongoing support provided by invasive species groups to help educate British Columbians on the threat of invasive mussels and promoting the consistent messaging of Clean, Drain, Dry.

## 7. SUMMARY OF LESSONS LEARNED AND IMPROVEMENTS

At the end of each season, the Program undergoes an annual review that considers ongoing feedback from the AIS inspectors, partners, and the public, as well as lessons learned from other jurisdictions across western Canada and the United States. This report summarizes lessons learned from the 2021 season, which were considered in the planning and implementation of the 2022 season.

### 7.1 GENERAL OPERATIONS

Building on the success of having two roving crews during the 2020 season, the Program continued to implement both the Okanagan and Lower Mainland roving crews for the 2021 season. The roving crews were able to respond to high-risk watercraft notifications and conduct outreach at local boat launches as time permitted. The Okanagan and Lower Mainland receive the highest volume of high-risk watercraft. The roving crew's build the Program's capacity in these regions to respond to the high-risk watercraft notifications coming from other inspection stations in B.C. (such as Golden), other jurisdictions (Alberta, Saskatchewan, Idaho, Oregon, Montana, Washington and CBSA). Watercraft cannot always be decontaminated during transportation at a roadside inspection station and may therefore require follow-up upon arrival at the destination. When the watercraft is intercepted at the B.C. inspection station, it is issued a decontamination order that requires it to report to an inspection crew for decontamination upon its arrival. When they weren't responding to high-risk watercraft notifications, the Penticton crew rotated between setting up stations at alternative locations (Keremeos, Kaleden, Greenwood, and Hwy 97C) due to the Osoyoos border crossing being closed for most of the season. The roving crew also conducted inspections and outreach at boat launches throughout the Okanagan region.

The Program continues to explore and maximize incremental improvements to program operations and processes to increase efficiencies in program delivery.

### 7.2 INSPECTION STATIONS

Due to recruitment challenges the Dawson Creek inspection station was only operational for a short period of time during the 2021 season. This marks the second season that the station was not able to open as planned. Recruitment and retention of AIS inspector positions at the norther inspection stations in particular (Dawson Creek and Valemount) has always been a challenge since the Program started. However since the start of the pandemic and the current competitive job market, recruitment at these locations has become much more difficult. The Program will continue to look for new and innovative ways to address these hiring challenges and will continue to work closely with other neighbouring jurisdictions that are facing similar issues.

### 7.3 COMPLIANCE

The average compliance across all the inspection stations for the 2021 season was 88.8%, which represents a slight increase from 87% in 2020. Of the watercraft that failed to stop at the inspection station, 88% were non-motorized watercraft such as canoes, kayaks, and paddleboards, which pose a

much lower risk than motorized watercraft. Overall, the compliance at the stations operating in 2021 was similar to the 2020 season.

A total of 85 violation tickets and 45 warnings were issued by Conservation Officers to motorists for failing to stop at inspection stations. This marks a slight decrease from the 2020 season (101 tickets and 76 warnings). When full-time Conservation Officers were not on site to issue tickets and warnings to motorists, the inspectors reported all high-risk boats that failed to stop to the RAPP line. RAPP line notifications were circulated to all the full-time Conservation Officers within the region. The Program also received support from local RCMP with apprehending motor vehicles transporting watercraft that failed to stop at the inspection stations.

## APPENDIX A 2021 WATERCRAFT INSPECTION STATION DETAILS

Station Name	Hwy #	Region	Type	Traffic Direction
Dawson Creek	2	Peace	Permanent	Westbound
Fraser Valley	n.a.	Lower Mainland	Roving crew	n.a.
Golden	1	Kootenay	Night Inspection	Westbound
Mt. Robson	16	Omineca	Permanent	Westbound
Olsen (Hwy 3)	3	Kootenay	Permanent	Westbound
Osoyoos	176 Ave	Lower Mainland	Permanent	Northbound
Penticton	n.a.	Okanagan	Roving crew	n.a.
Radium	95	Kootenay	Permanent	Southbound
Yahk	95 and 3	Kootenay	Permanent	Westbound

## APPENDIX B 2021 LAKE MONITORING SAMPLING DETAILS

Waterbody	Region	Sampling Group/Agency	Sampling Method(s)	Adult or veliger ZQM detected? (Y/N)
<b>Adams Lake</b>	Thompson-Nicola	CSISS	Plankton tow / Substrate sampling	no
<b>Adams Lake</b>	Thompson-Nicola	MOE	Plankton tow / Substrate sampling	no
<b>Alouette</b>	Lower Mainland	MOE	Plankton tow	no
<b>Alta Lake</b>	Lower Mainland	SSISC	Plankton tow	no
<b>Anderson Lake</b>	Thompson-Nicola	SSISC	Plankton tow	no
<b>Anderson Lake</b>	Thompson-Nicola	LRISS	Plankton tow	no
<b>Anderson Lake</b>	Lower Mainland	SSISC	Plankton tow	no
<b>Arrow Lake, Lower</b>	Kootenay	CKISS	Plankton tow / Substrate sampling	no
<b>Arrow Lake, Upper</b>	Kootenay	CKISS	Plankton tow	no
<b>Bowron Lake</b>	Cariboo	MOE	Plankton tow	no
<b>Bridge Lake</b>	Cariboo	ISCBC	Plankton tow / Substrate sampling	no
<b>Canim Lake</b>	Cariboo	ISCBC	Plankton tow	no
<b>Charlie Lake</b>	Peace	MOE	Plankton tow	no
<b>Christina Lake</b>	Okanagan	CLSS	Plankton tow / Substrate sampling	no
<b>Columbia Lake</b>	Kootenay	EKISC	Plankton tow	no
<b>Columbia River</b>	Kootenay	CKISS	Plankton tow	no
<b>Columbia River</b>	Kootenay	CSISS	Plankton tow	no
<b>Cowichan Lake</b>	Vancouver Island	MOE	Plankton tow	no
<b>Cultus Lake</b>	Lower Mainland	FVISS/ISCMV	Plankton tow / Substrate sampling	no
<b>Deka Lake</b>	Cariboo	ISCBC	Plankton tow	no
<b>Dragon Lake</b>	Cariboo	ISCBC	Plankton tow / Substrate sampling	no
<b>Duncan Lake</b>	Kootenay	CKISS	Plankton tow	no
<b>Elk Lake</b>	Vancouver Island	CISC	Plankton tow	no
<b>Elk Lake</b>	Vancouver Island	MOE	Plankton tow	no
<b>Francois Lake</b>	Skeena	MOE	Plankton tow	no

Waterbody	Region	Sampling Group/Agency	Sampling Method(s)	Adult or veliger ZQM detected? (Y/N)
Fraser Lake	Omineca	MOE	Plankton tow	no
Gardom Lake	Okanagan	CSISS	Plankton tow / Substrate sampling	no
Harrison Lake	Lower Mainland	FVISS/ISCMV	Plankton tow / Substrate sampling	no
Hatzic Lake	Lower Mainland	FVISS/ISCMV	Plankton tow	no
Horsefly Lake	Cariboo	ISCBC	Plankton tow	no
Jewel Lake	Okanagan	BISS	Plankton tow / Substrate sampling	no
Kalamalka Lake	Okanagan	OASISS	Plankton tow / Substrate sampling	no
Kalamalka Lake	Okanagan	MOE	Plankton tow / Substrate sampling	no
Kawkawa lake	Lower Mainland	FVISS/ISCMV	Plankton tow	no
Kawkawa Lake	Lower Mainland	FVISS/ISCMV	Plankton tow / Substrate sampling	no
Kinbasket Reservoir	Kootenay	CSISS	Plankton tow / Substrate sampling	no
Koocanusa	Kootenay	EKISC	Plankton tow	
Koocanusa Lake	Kootenay	EKISC	Plankton tow / Substrate sampling	no
Kootenay Lake	Kootenay	CKISS	Plankton tow / Substrate sampling	no
Kootenay River (Nelson)	Kootenay	CKISS	Plankton tow	no
Lac Des Roches	Thompson-Nicola	ISCBC	Plankton tow	no
Lac La Hache	Cariboo	ISCBC	Plankton tow / Substrate sampling	no
Lake Revelstoke	Kootenay	CSISS	Plankton tow / Substrate sampling	no
Lazy Lake	Kootenay	EKISC	Plankton tow	no
Lillooet Lake	Lower Mainland	SSISC	Plankton tow	no
Lillooet Lake	Thompson-Nicola	SSISC	Plankton tow	no
Little Shuswap lake	Thompson-Nicola	CSISS	Plankton tow / Substrate sampling	no

Waterbody	Region	Sampling Group/Agency	Sampling Method(s)	Adult or veliger ZQM detected? (Y/N)
<b>Mabel Lake</b>	Okanagan	CSISS	Plankton tow	no
<b>Mahood Lake</b>	Thompson-Nicola	ISCBC	Plankton tow / Substrate sampling	no
<b>Mara Lake</b>	Thompson-Nicola	CSISS	Plankton tow	no
<b>Moberly Lake</b>	Peace	MOE	Plankton tow	no
<b>Monroe Lake</b>	Kootenay	EKISC	Plankton tow / Substrate sampling	no
<b>Moyie Lake</b>	Kootenay	EKISC	Plankton tow	no
<b>Nicola Lake</b>	Thompson-Nicola	MOE	Plankton tow / Substrate sampling	no
<b>Norbury Lake</b>	Kootenay	EKISC	Plankton tow / Substrate sampling	no
<b>Okanagan Lake</b>	Okanagan	OASISS	Plankton tow / Substrate sampling	no
<b>Okanagan Lake</b>	Okanagan	MOE	Plankton tow / Substrate sampling	no
<b>Osoyoos Lake</b>	Okanagan	OASISS	Plankton tow / Substrate sampling	no
<b>Osoyoos Lake</b>	Okanagan	MOE	Plankton tow	no
<b>Pavilion Lake</b>	Thompson-Nicola	LRISS	Plankton tow / Substrate sampling	no
<b>Pend d'Oreille River</b>	Kootenay	ONA	Plankton tow / Substrate sampling	no
<b>Pitt Lake</b>	Lower Mainland	FVISS/ISCMV	Plankton tow / Substrate sampling	no
<b>Premier Lake</b>	Kootenay	EKISC	Plankton tow / Substrate sampling	no
<b>Quesnel Lake</b>	Cariboo	ISCBC	Plankton tow / Substrate sampling	no
<b>Rosen Lake</b>	Kootenay	EKISC	Plankton tow	no
<b>Saint Mary's Lake</b>	Kootenay	EKISC	Plankton tow	no
<b>Seton Lake</b>	Thompson-Nicola	LRISS	Plankton tow / Substrate sampling	no
<b>Sheridan Lake</b>	Cariboo	ISCBC	Plankton tow / Substrate sampling	no

Waterbody	Region	Sampling Group/Agency	Sampling Method(s)	Adult or veliger ZQM detected? (Y/N)
<b>Shuswap Lake</b>	Thompson-Nicola	CSISS	Plankton tow / Substrate sampling	no
<b>Shuswap Lake</b>	Thompson-Nicola	MOE	Plankton tow / Substrate sampling	no
<b>Skaha Lake</b>	Okanagan	OASISS	Plankton tow	no
<b>Slocan Lake</b>	Kootenay	CKISS	Plankton tow	no
<b>St. Marys Lake</b>	Kootenay	EKISC	Plankton tow	no
<b>Stave Lake</b>	Lower Mainland	FVISS/ISCMV	Plankton tow / Substrate sampling	no
<b>Sugar Lake</b>	Okanagan	CSISS	Plankton tow	no
<b>Summit Lake</b>	Kootenay	CKISS	Plankton tow	no
<b>Surveyors Lake</b>	Kootenay	EKISC	Plankton tow	
<b>Swan Lake</b>	Peace	MOE	Plankton tow	no
<b>Tie Lake</b>	Kootenay	EKISC	Plankton tow	no
<b>Trout Lake</b>	Kootenay	CSISS	Plankton tow / Substrate sampling	no
<b>Upper Arrow Lake</b>	Kootenay	CSISS	Plankton tow / Substrate sampling	no
<b>Wahleach</b>	Lower Mainland	MOE	Plankton tow	no
<b>Wasa Lake</b>	Kootenay	EKISC	Plankton tow	no
<b>Whatshan Lake</b>	Kootenay	CKISS	Plankton tow	no
<b>White Lake</b>	Thompson-Nicola	CSISS	Plankton tow / Substrate sampling	no
<b>Whiteswan Lake</b>	Kootenay	EKISC	Plankton tow	no
<b>Whitetail lake</b>	Kootenay	EKISC	Plankton tow	no
<b>Whitetail Lake</b>	Kootenay	EKISC	Plankton tow	no
<b>Williams Lake</b>	Cariboo	ISCBC	Plankton tow / Substrate sampling	no
<b>Windemere Lake</b>	Kootenay	EKISC	Plankton tow	no
<b>Windemere Lake</b>	Kootenay	EKISC	Plankton tow	no
<b>Wood Lake</b>	Okanagan	OASISS	Plankton tow / Substrate sampling	no

*\*Please see section 5 for the full names of the sampling groups or agencies.*