Live Organisms used in the Classroom as a Potential Vector of Species Introductions in British Columbia

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LIVE ORGANISMS USED IN THE CLASSROOM AS A POTENTIAL VECTOR OF SPECIES INTRODUCTIONS IN BRITISH COLUMBIA

by

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A Sea Grant initiative was developed to describe and evaluate the risk of live organisms in the classroom as a vector for the introduction and spread of invasive species. Background research was accomplished by sending an online questionnaire to British Columbia (BC) educators. BC curricula guidelines were reviewed to evaluate where the use of live organisms is recommended or purposed. A focus group discussion was conducted to evaluate the problem from the perspective of the educators and to develop solutions that the educators themselves would find effective. This study revealed that live organisms used as teaching tools in the classroom are a potential vector of invasive species in BC. Recommendations include the development of a standard and simple protocol to provide accurate and detailed information with the sale of any live organism in the province, and the amendment of current curricula to include species to use (or avoid) and how to properly care for and dispose of the live organisms. Outreach and training for educators regarding invasive species information, organism care, and proper disposal instructions will be the most effective method of managing live organisms in the classroom as a vector of invasive species introduction and spread.

RÉSUMÉ

Gartner, H., Herborg, L.M., Root, S., Brinsmead, J., Jacoby, C., Siemens, T., Wong, W., and Chan, S. 2011. Live organisms used in the classroom as a potential vector of species introductions in British Columbia. Can. Manuscr. Rep. Fish. Aquat. Sci. 2973: vi + 42 p.

L’initiative «Sea Grant» a été développée pour décrire et évaluer le risque que représentent les organismes vivants retrouvés dans les salles de classe en tant que vecteur à l’introduction et à la propagation des espèces envahissantes. Une recherche de base à été accomplie en envoyant un questionnaire en ligne aux éducateurs de la Colombie-Britannique (C.-B.). Les directives des programmes de la C.-B. ont été révisées pour déterminer les cours au sein desquelles l’utilisation d’organismes vivants était recommandée ou nécessaire. Un groupe de discussion a été mené pour évaluer le problème de la perspective des éducateurs et pour développer des solutions que les éducateurs considèrent eux-mêmes efficaces. Cette étude a révélé que les organismes vivants utilisés comme outil d’enseignement dans les salles d’enseignement constituent un vecteur potentiel pour les espèces envahissantes en C.-B. Les recommandations incluent le développement d’un protocole simple et standard fournissant de l’information précise et détaillée concernant la vente de tout organisme vivant dans la province, la modification des programmes actuels concernant les espèces que les éducateurs devraient utiliser (ou éviter) et les méthodes à utiliser pour s’occuper et disposer des

organismes vivants. La sensibilisation et la formation des éducateurs par rapport à l'information sur les espèces envahissantes, les soins apportés à l'organisme et les indications pour en disposer adéquatement seront les méthodes les plus efficaces pour la gestion des organismes vivants présents dans les salles de classe en tant que vecteur à l'introduction et à la propagation des espèces envahissantes.

1 INTRODUCTION

Worldwide, there are growing concerns related to the rate and extent of human-mediated introductions of species in terrestrial and aquatic environments (e.g., Ruiz et al. 2000). For the purpose of this report, we define invasive species as organisms that are transported beyond their native range to new geographic areas where they are able to persist, spread, and reproduce (sensu Elton 1958). Invasive species may have many ecological and economic effects on local communities and have been listed as the second greatest threat to worldwide biodiversity and imperilled species in the United States (Wilcove et al. 1998; Mack et al. 2000; Pimentel et al. 2000). In Canada, aquatic invasive species (AIS) have been identified as the second biggest threat to species at risk (SAR) of freshwater fishes (Dextrase and Mandrak 2006). The negative ecological and economic effects of invasive species have spurred a number of government agencies to develop management strategies to prevent the introduction and spread of these species. To be able to implement effective AIS management strategies, we must first understand the relative risk the different introduction pathways pose in the introduction of potential invaders (Carlton 1996). In the aquatic environment, there is some information available for a few vectors, such as ballast water, pet shops, and live food trade (Ricciardi and Rasmussen 1998; Rixon et al. 2005), but a large portion of the potential introduction vectors are poorly understood (Lodge et al. 2006). One potential vector of introduction and spread of invasive species are live organisms that are used in classrooms for school projects and as teaching tools.

In the classroom setting, live organisms can stimulate students' interest in a subject and may provide a practical hands-on learning experience. However, we are discovering that often the organisms used in the classroom are released into the wild or are taken home as pets by students. This suggests that the classroom release of live organisms is a practice that could introduce non-native species into aquatic environments and presents an opportunity for intervention and education related to this matter. Live plants and animals in the classroom is a potential vector of invasive species in British Columbia (BC) that is poorly understood and has not yet been researched.

To fill this knowledge gap, the BC Ministry of Environment participated in a North America-wide project focusing on the risk of live organisms in the classroom as a vector for the introduction and spread of AIS in BC. The work presented here is part of the Sea Grant Aquatic Invasive Species Research and Outreach (AISO) project ' Reducing the Risks of Schools, Science Curricula and Biological Supply Houses as Pathways for Spreading Aquatic Invasive Species: A Proposal addressing West Coast, Great Lakes and Gulf States Regional Priorities'. The project is a collaboration of numerous organisations from a number of jurisdictions across North America (Ontario, British Columbia, California, Florida, New York, Oregon, Washington, Illinois, and Indiana), spearheaded by Oregon State University (OSU). The AISO project involved three phases. The first phase was to conduct background research to evaluate the extent of the problem. This was accomplished by sending questionnaires to educators across the province of British Columbia to identify the species used, where they come from, the

fate of the organisms, and the level of awareness of invasive species of the educators. Curricula where the use of live organisms is recommended or purposed was also researched and summarized. The second phase involved conducting focus group discussions to evaluate the problem from the perspective of the educators and to develop solutions that the educators themselves would find effective. The final phase of the initiative was to synthesize and interpret the results to identify and develop prevention and management tools.

The following report follows the three phases of the Sea Grant project undertaken to describe and evaluate the risk of live organisms in the classroom as a vector for the introduction and spread of invasive species in BC.

2 METHODS

2.1 PHASE ONE – INITIAL RESEARCH

This research phase gathered background information on the use, identity, and sources of live organisms in BC classrooms from an online survey of BC educators. BC curricula recommendations for the use of live organisms in classrooms were then investigated.

2.1.1 Online Survey of BC Educators

An online questionnaire, 'Teacher Survey: Live Plants and Animals in the Classroom', was developed in 2009/2010 to be completed by educators to evaluate the role of schools, curricula, and biological supply houses as a potential pathway of AIS in BC. The questionnaire (provided in the Appendix) was developed using SurveyMonkey (www.surveymonkey.com) and was comprised of 28 questions, most of which were of a multiple choice format. The questionnaire consisted of questions that determined information about the educators themselves, whether (and why) they use live animals and plants in the classroom, what organisms they use in the classroom, where they get the organisms from, the fate of the organisms, and what information they are provided with related to these organisms. The questionnaire also focused on questions related to the educator's knowledge about invasive species, the prevalence of the topic in the classroom curricula, and what resources the educators would find helpful to further incorporate invasive species topics in their classroom. Each survey required approximately 20 minutes to complete.

The surveys were sent, after approval from the relevant school district, to several school districts across British Columbia. The aim was to disseminate the survey to urban/suburban, rural, and remote school districts based on the design utilised in other initiative jurisdictions. The school districts contacted were Surrey (urban/suburban), Kamloops (rural), Nanaimo-Ladysmith (rural), Alberni (remote), and Stikine (remote). The survey was also completed by participants present at an educators' workshop held in Vancouver, many of whom were from other school districts.

The data are primarily presented as the percent of responses for each answer to the corresponding question in the questionnaire. The data are presented this way as each

respondent did not have to answer every question, based on their answers to some of the previous questions (e.g., if an educator does not have live animals in the classroom they will not have to answer a question where they list the species they use in their classroom). The organisms utilised in the classroom are classified to the lowest taxonomic level based on the name provided by the educators. The Integrated Taxonomic Information System (ITIS: http://www.itis.gov/) was the resource primarily consulted for the current taxonomic standing/classification of organisms.

2.1.2 Curricula Review

The primary goals of the curricula review were: to assess potential places for students to observe and learn about invasive species; to assess potential risk areas for invasive species release and/or movement; and to analyze science kits recommended and/or utilised by educators, in order to determine the species listed and activities that require the collection and/or release of plants and animals.

The BC Ministry of Education sets the education standards for students in grades Kindergarten (K) to 12. These developed curricula are available online through the Ministry webpage (http://www.bced.gov.bc.ca/irp/welcome.php). The recommended science curricula for each grade level was researched to determine areas where the main objective of the lesson plan involved the use of plants and animals in the classroom. The lesson plans were then summarised within the context of whether there is an opportunity for students to learn about invasive species, or there is a potential risk for students to introduce and/or spread invasive species. Recommended science kits were also researched to determine which species are utilised, their source, and the potential for the catch and/or release of live organisms.

2.2 PHASE TWO – FOCUS GROUP DISCUSSIONS

In-depth investigations into educators' concerns and issues associated with live organisms and invasive species in the classroom were conducted via focus group discussions. By conducting this research centred on the primary stakeholders, the educators, the extent of the problem can be evaluated and effective strategies for developing practical solutions can be developed.

The BC focus group discussion was conducted at the Vancouver Aquarium in Vancouver, BC on August 28th, 2009. There were fifteen educators in attendance, selected using their response to a question in the online questionnaire that asked if they would be interested in attending a summertime focus group discussion. The discussions were centered on following four main questions:

- What values do living organisms have in science education and in your classroom?
- What are some of the main concerns associated with having live organisms in the classroom?
- Can you define what an invasive species is?
- What are some potential solutions for dealing with the concerns we have identified about invasive species in the classroom?

The focus group was intended to step participants through a discussion of values, concerns, knowledge, and solutions related to AIS in the classroom. The values proved helpful in assessing attitudes and behaviours of participants, which in turn informed the underlying premise of any solution. Concerns surfaced as potential barriers on a personal or institutional level; these concerns could reduce the effectiveness of any solution developed, enforced, or proposed. The knowledge section added a referencing benchmark on which researchers in phase three, and others concerned about this pathway, can build. Finally, discussion about solutions provided ideas about ways to address this issue in a realistic manner that will be most effective for educators.

Results are frequently expressed in terms of a percentage of the total comments made on a particular topic. Direct quotations of individuals (anonymous) are also utilised to highlight points made by the educators. In addition to the BC discussion group, there were five other discussion groups conducted in Portland (OR), Seattle (WA), Los Angeles (CA), Chicago (IL), and Toronto (ON) as part of the Sea Grant AISO project. The data presented in this report reflect the outcomes of the BC discussion group; however, some general commentaries and overall solutions may be gleaned from the report compiled from all discussion groups (Root 2010).

3 RESULTS

3.1 PHASE ONE – INITIAL RESEARCH

3.1.1 Online Survey of BC Educators

Respondents to the online survey

There were 72 educators from BC that completed the online questionnaire. Educators responded from northern BC (Stikine District), Vancouver Island (e.g., Alberni District), the Greater Vancouver area (e.g., Vancouver District), and central BC (e.g., Kamloops/Thompson District) (Table 1). A map of the school districts of British Columbia is available at http://www.bcstats.gov.bc.ca/data/pop/maps/sdmap.asp. However, most responses (77.8%) were from the Greater Vancouver area (Langley, Surrey, Delta, Richmond, Vancouver, and Burnaby). In particular, 68.1% of all responses were from educators that teach in the Surrey School District.

The respondents included educators from all teaching levels; however, a majority of the respondents are, or have been, elementary school teachers that teach grades 1–8 (Figure 1). They have also taught a wide range of subjects, with a majority (97.2%) teaching science classes at some point in their career. Additionally, a number of the educators (6.9%) specified that they had been involved in outdoor or environmental education (Figure 2).

The use of live plants and animals in the classroom

Most educators (93.5%) believe that the use of live plants and animals in the classroom is an important teaching tool. Almost 85% of the respondents have, or have had, live plants or animals in their classrooms. Since live organisms are important teaching tools

in the classroom, the next step is to identify which organisms are being used, how they are being used, and why they were selected as teaching tools.

There are 131 organisms or groups of live organisms identified by educators as being used as teaching tools in BC (Table 2). The list includes organisms from all five of the kingdoms of classification of living things. There are terrestrial and aquatic organisms ranging from reptiles, to mammals, to coniferous plants. Many of the organisms (42.7%) used by educators are domesticated or cultivated organisms whose native ranges do not include BC. There are four known invasive organisms being used as teaching tools in the classroom: dandelion (*Taraxacum officinale*), red wiggler worm (*Eisenia foetida*), mealworm (*Tenebrio molitor*), and American bullfrog (*Lithobates catesbeianus*). Additionally, there were a number of responses of very ambiguous names or groups of organisms that could include invasive species. This ambiguity raised the concern that teachers were not able to identify the species they were using and they were not provided with species level information for the organisms they obtained from external sources. In particular, 21.4% of the listed organisms/groups of organisms may contain AIS. One example is the snail/slug listing which may include the following AIS: Japanese mudflat snail (*Batillaria attramentaria*), Manchurian cecina (*Cecina manchurica*), mouse-ear snail (*Myosotella myosotis*), Eastern mudsnail (*Ilyanassa obsoletus*), New Zealand mudsnail (*Potamopyrgus antipodarum*), Japanese oyster drill (*Ocinebrellus inornata*), Japanese bubble snail (*Haminoea japonica*), and Japanese nassa (*Hima fratercula*). Also, the ambiguous names may include other introduced species that have not yet established themselves in the province.

Educators reported obtaining live organisms for a number of teaching/classroom purposes, including as experiment or project subjects (91.8%), as short-term visitors for uses such as show and tell (70.5%), and as classroom pets (52.5%) (Figure 3). Some educators specified that the projects often involved raising an organism from larva to adulthood to learn about development and life history stages. Once the organism reaches adulthood, it is released to the natural environment (refer to section below). However, based on the responses of the educators, it is not clear whether these organisms are native or non-native to the local ecosystems.

The live organisms are selected as learning materials by a variety of individuals and organisations. Most educators (92.6%) indicated that they are directly involved in selecting the learning materials utilised in the classroom. Often (51.5%), there is an individual or team at each school that is also responsible for selecting learning materials (e.g., librarian). Some learning materials are selected by the school board/district (27.9%), or authorities at the provincial level (17.6%). Few educators (<3%) indicated that the materials were selected by their lab technicians, based on what parents had to offer, or someone outside the school/district/provincial authorities.

There are several programs and learning initiatives that encourage educators to use live organisms in the classroom. These include Salmonids in the Classroom (Fisheries and Oceans Canada (DFO)), Seaquaria, Pond Peeking, Project Wet, Once Upon a Seashore, Habitats, Project Wild, Backyard Biodiversity, Tomatosphere, butterfly

programs, and the Atlantic Salmon Classroom Hatchery Program. The live organisms recommended for use by these programs include native species, invasive species (primarily education related to issues and concerns), and many, very ambiguous suggestions where educators could include non-native species (Table 3). The programs most utilised by educators are the Salmonids in the Classroom (17.6%), Tomatosphere (8.8%), curriculum requirements (e.g., Biology 11, BC Science 7) (7.4%), and the Atlantic Salmon Classroom Hatchery Program (5.9%). The Atlantic Salmon Classroom Hatchery Program was likely reported by an educator that used to teach in Ontario, as it is an educational component of the Lake Ontario Atlantic Salmon Restoration Program (LOASRP)(http://www.bringbackthesalmon.ca/Classroom.cfm, accessed 28 March, 2010). This program involves the re-establishment of Atlantic Salmon (Salmo salar), a native species that was virtually extirpated from the wild in Ontario.

Sources of the live organisms

Most educators are responsible for obtaining the live organisms utilised in the classroom themselves (89.7%). Occasionally, there is a person or team at the school responsible for obtaining live organisms (33.8%), or the acquisition is coordinated by the school district/board (14.7%). Rarely, someone at the provincial level (2.9%) or individuals/groups outside the education system (4.4%) obtain the organisms. A few educators (2.9%) were unsure of who obtained the live organisms for them.

Educators obtain the live organisms used in the classroom from a number of sources. The main source of live organisms is plant nurseries (62.3%). Most educators collect the organisms themselves from their natural setting and/or bring in personal pets (52.5%). Students are also allowed to bring live organisms into the classroom (50.8%). Biological or scientific supply houses (44.3%), pet stores (44.3%), and zoos, aquaria, and pet shelters (33.1%) are all also common sources of organisms. Some educators (14.8%) receive organisms from the school board/district. A number of educators specified that some of these organisms were provided to the school board by DFO as part of the Salmonids in the Classroom program. Educators also specified that they often observed the organisms in their 'natural' settings, such as on farms or in the woods (6.6%). A few educators (3.3%) are given organisms from other teachers or researchers. There were also a few 'other' sources of organisms (4.9%).

The educators used the following biological or scientific supply houses: Boreal/Northwest (72.4%), Ward's Natural Science (6.9%), Carolina (6.9%), Spectrum Education Supplies Limited (6.9%), Fischer Science (3.4%), Grand Maison Mets (3.4%), and Westwind Sealabs (3.4%). Some educators (13.8%) could not remember the biological/scientific supply house they used at the time they completed the questionnaire. Boreal/Northwest, Spectrum Education Supplies Limited, and Westwind Sealabs are all Canadian supply houses. Ward's Natural Science and Fischer Science have both American and Canadian branches of the company. Carolina is an American company.

Information provided for live organisms

When educators obtain live organisms from any of the sources, most indicated that they are provided with the common name (79.7%), care instructions (74.6%), general biological category (i.e., plant or animal) (69.5%), and the scientific name (59.5%) of the live organisms they receive. Fewer educators were provided with information related to the biology (45.8%), native range (45.8%), origin (where shipped/collected from) (35.9%), or appropriate disposal methods (25.4%) of the organisms. A few educators (3.4%) specified that they did receive information related to the life cycle of the organism.

When the educators were not provided with sufficient information on the live organisms, they would refer to the internet (78.0%), any associated learning material of the teaching unit or science kit (54.2%), a colleague (40.7%), the supplier (28.8%), an expert (25.4%), the school board/district guidelines for plants/animals (10.2%), or books (6.7%). Approximately 20% of the educators mentioned that they have not needed to consult additional sources.

Fate of the organisms

The live organisms were often kept as pets in the classroom and by the educators (64.4%), or were given to students to take home (54.2%). Many live organisms were released into the wild (52.5%). Some of the organisms were disposed of in the trash/compost (33.9%) or flushed down the drain (11.9%). Some of the educators gave the organisms to other teachers (22.0%), returned them to the supplier (11.9%), or donated them to the appropriate organisation (e.g., museums, farms) (6.8%). Some of the organisms were eaten (13.6%) or pressure cooked to kill them (1.7%). Approximately 10% of the educators have euthanized the live organisms utilised in their classroom.

When asked whether the educators would ‘be willing to humanely euthanize a classroom animal if the methods were approved by the American or Canadian Veterinary Medical Association, and they were provided guidance and tools for carrying it out’ the responses were as follows: 40.7% said they would be unable to, 37.3% said they would be willing, 13.6% believed that this question was not applicable to the organisms they use as teaching tools, and 8.5% were unsure.

Education development and invasive species

Half of the educators surveyed have been involved in selecting, adapting, or creating new learning materials for their school or district/board (e.g., learning kits, books, activities or lesson plans). We asked these educators to evaluate whether, when choosing to use new learning materials, the requirements of live plants or animals as part of the learning material makes them more or less likely to select those materials. Educators usually responded that it made no difference in their decision (42.4%) or would make them more likely to select those materials (33.3%). Few teachers indicated that they would be less likely to select those materials (12.1%) or had ‘other’ factors that had to be incorporated with the issues of choosing live organism (12.1%). The ‘other’

factors associated were financial costs, the availability of the organisms, and whether the live organisms required are native to the local community.

The educators surveyed from BC have varying knowledge levels regarding invasive species, but most (80.6%) feel they have at least some working knowledge related to the topic. Six percent of the educators felt they were very knowledgeable about invasive species. Despite their knowledge of the subject, roughly half the educators (50.7%) have rarely or never taught their students about invasive species.

Of the educators that have taught their students about invasive species, most (75.0%) cover basic invasive species concepts such as definitions and examples. Some educators use invasive species as examples to teach benchmarks and standards (21.4%). Some educators have detailed units that cover many aspects of invasive species impacts and prevention (usually part of curriculum) (19.6%) or may integrate invasive species examples in multiple topics throughout the year (17.9%). Invasive species are also incorporated as teaching tools, where the students conduct outreach projects in their community (5.4%), practice identification skills in the field, or use them as subjects of research projects (1.8%). Few educators test students on their knowledge of invasive species (17.9%). One educator specified that, as a teaching tool, they have developed a webquest focusing on Atlantic Salmon released into Pacific waters and examining its effect on the local ecosystem.

As stated by the participants, part of the current curricula (BC Science 7, BC Science Probe 7, and BC Science 10) has sections related to invasive species. Otherwise, the educators find that there are few teaching materials that focus on invasive species other than presentations by visiting organisations (e.g., pine beetle presentation by the BC Ministry of Forestry). Almost all of the surveyed educators (97.0%) feel that a list of plants and animals considered to be invasive would be a welcome resource in the classroom. Most educators (82.1%) support the development of learning materials to help students understand the impacts of invasive species in local ecosystems. Many educators would also be interested in attending workshops focused on integrating invasive species education into the classroom (61.2%) or on the selection and care of plants and animals in the classroom (50.7%). Many educators (61.2%) would like better information about how to properly dispose of plants and animals, including a list of repositories or euthanasia guidelines. Better information about the biology and ecology of plants and animals (50.7%), as well as a list of biological supply houses that specialize in local or native species, would be additional welcome resources. One educator specified that more money focused on science programs would also facilitate education related to invasive species in the classroom.

3.1.2 Curricula Review

The BC Ministry of Education curricula encourages the use of live organisms as teaching tools in grades K through 8 (Table 4), with the exception of Grade 5, where the human body is the focus topic of the life sciences course. In the remaining grades, K through 8, this direct interaction with live organisms provides numerous opportunities for

students to learn about invasive species, but also presents numerous opportunities for students to spread and introduce invasive species.

The most frequent area of risk is associated with the use of plants in the classroom. Often, plants grown in the classroom are domesticated and/or cultivated plants whose native range does not include BC. The greatest threat for the introduction and spread of all organisms is related to the Grade 2 curriculum where students observe the development of a life cycle of an organism. The curriculum suggests a number of organisms (e.g., mealworm, ant, frog, or butterfly) without specifying the use of local native species, as opposed to non-native species, which are often available through biological supply houses (e.g., the local tailed frog (*Ascaphus truei*) vs. the introduced American bullfrog (*Lithobates catesbeiana*)). The great risk of this Grade 2 curriculum component is that usually, when the organisms have completed their development and become adults, the teachers and students release them into the local environment. Along with this Grade 2 curriculum component, the Grade 4 life sciences curriculum directly encourages the use of mealworms. Mealworms are the larvae of the beetle *Tenebrio molitor* which is being introduced around the world by human activities; it is not native to BC (Encyclopedia of Life; http://www.eol.org/pages/1041700, accessed January, 2011).

In grades 9 through 12, the BC curricula continues studies based on live organisms, although it is not explicit that the students have direct interaction with the live organisms (Table 4). There are many current curricula that deal directly with the issue of species invasions. In the Grade 10 class 'Life Science: Sustainability of Ecosystems', students learn about how ecosystems can shift and change as a result of introduced species. In the Grade 12 class 'Sustainable Resources: Fisheries - Structure and Function of Aquatic Ecosystems', the students must illustrate the impact of an invasive species on an aquatic ecosystem. Also in the Grade 12 class, 'Sustainable Resources: Fisheries - Issues and Challenges Facing Sustainable Fisheries', the students discuss impacts resulting from the contact between cultured and wild species, as well as describe possible environmental impacts (e.g., species invasion) resulting from aquaculture. There are also numerous other curricula components in grades 9–12 where invasive species can be included in discussions and teaching, as the topics are related to invasive species.

There are a number of science kits recommended by the BC Ministry of Education that provide opportunities for students to bring live organisms into the classroom. Many of these science kits have components in place (or components could be easily added) to educate students on issues related to invasive species. 'Pond Peeking and Alien Invaders' is an example of a science kit that provides the opportunity for students to learn more about invasive species in the local ecosystem (http://www.bcfieldtrips.ca/node/623). This is a field trip learning experience where none of the organisms are brought back to the classroom. However, some of the science kits could lead to the introduction and spread of invasive species (Table 3). One such example is the science kit 'Hands on Science (Diversity of Living Things)'. This kit recommends mealworms be brought into the classroom as a teaching tool. The

science kit does not provide any proper disposal directions for educators, though it does suggest that mealworms are good food for other classroom organisms.

3.2 PHASE TWO – FOCUS GROUP DISCUSSIONS

3.2.1 The Value and Use of Live Organisms in the Classroom

Educators primarily (51.8%) value live organisms in the classroom because, as the students learn about live organisms, they learn how to be good stewards of both the organisms and their surrounding environments. Included within this discussion of stewardship, it was often highlighted how the connectedness between the students and the live organisms encourages the students to learn and work together to care for the organisms. One BC educator illustrated this point: "It's also wonderful to see... a group of students working together in trouble shooting, problem solving, caretaking, [and] really learning."

The educators also frequently mentioned (39.3%) how having the live organisms in the classroom provides motivation for the students to learn. This motivation comes from the stimulating and interactive nature of live organisms, which can influence the attitudes and behaviours of the students. This motivation may be particularly relevant in today's society as a BC elementary educator highlights:

> "A lot of the kids now days learn in so many different ways and having something in their [classroom], hands on, will teach some of the kids that will be lost in there otherwise. The big thing that you guys have mentioned is the hook, having them engage and excited about the learning, whether it be in their classroom or just their daily life."

Another value associated with having live organisms in the classroom mentioned by educators (8.9%) is that it can have an emotional and calming effect on the students. Speaking of having a sea aquarium in the classroom a BC outreach coordinator reported:

> "It focuses observation, and for the at risk kids in particular, or special needs kids in the school, that's the timeout period now. They're freaking out, throwing chairs, [so] you sit them in this quiet little space by the Seaquarium and they just immediately calm and that aspect of it I think is really important."

Discussions surrounding the values of the live organisms in the classroom also touched on how the organisms are used in the classroom. Most of the BC educators (94.5%) mentioned that they use the organisms as possessions to teach the students about responsibility. A number of educators mentioned that when they do have live organisms in the classrooms, they do nothing to care for them and leave the responsibility of keeping the organisms alive and healthy to the children.

A concern that came up during the day's discussion was that educators feel students in modern society are not spending enough time outdoors. One educator expressed concern that "The kids don't go out. They come to school, go back home, and they're stuck there. They go on the computer or watch TV. They don't do anything with

exploring outside." Many of the educators indicated that they are trying to make up for this lack of outdoor experience and play by bringing live organisms into the classroom and taking the students on field trips.

Besides the stewardship, motivational, and calming effects associated with them, educators strongly value live organisms as useful for teaching students about responsibility. Educators also find that live organisms in the classroom are helping to connect students to the outdoors in ways that most students do not have the opportunity to enjoy in modern society.

3.2.2 Concerns Associated with Having Live Organisms in the Classroom

Educators obviously value live organisms as teaching tools in the classroom, but we wanted to determine what the primary concerns and barriers are for educators having live organisms in the classroom. BC educators are concerned about a wide range of logistical barriers including policies (27.6%), the handling of species (27.6%), lack of information from biological supply houses (17.2%), health and safety (17.2%), costs (6.9%), and time (3.5%). The two most prominent concerns were related to policy and to the handling of species.

In terms of policy concerns, the BC educators' comments usually focused on rules and regulations in the context of curriculum coordination. The general comments seemed to be that, although there were guidelines in the curricula related to using live organisms in the classroom, these guidelines didn't sufficiently account for the amount of time and resources the educators spent on the general logistics and care associated with having live organisms in the classroom. Additional difficulties were highlighted that related to meeting the curricula recommendations, based on differing rules and regulations that appear in separate school districts and schools. Schools and districts have differing rules and regulations related to allowing live organisms in the classroom based on concerns of allergic reactions.

In terms of handling concerns, the BC educators' comments were related to both dealing with the care of the organisms, as well as the disposal of the organisms. The educators are concerned with trying to keep organisms alive, having them cared for over the summer months, disposing of them when dead, and their potential release into the environment. One educator brought up these multiple components and, without any prompting, related concerns to having invasive species in the classroom:

> "I think having animals in the classroom is phenomenal. I am doing a lot of species at risk recovery [and] I'm a little bit cautious about some of our species at risk being in the classroom and definitely very cautious of invasives [in the classroom]."

In the bi-national discussion group report it was found that, regardless of state, province, or country, participants in every group independently mentioned, without being prompted by researchers, the need to better understand the care and disposal of organisms. The source of information, whether a pet store, biological supply house, or another teacher, was not as important as credible facts.

Another concern frequently expressed by BC educators was related to the sources of the live organisms. This was consistent throughout all of the discussion group sessions as the educators uniformly described wanting more information and resources from organism suppliers (not just biological supply houses). More than half the comments described a lack of information provided by suppliers (e.g., biological supply houses, pet stores, and zoos) describing the species origin, what the organism thrives on, and what is to be done with the organism when it dies. This could be done through labels as one teacher suggests, "sometimes they are not labelled…they don't normally say where they came from, that would be nice to know."

While educators feel strongly about the value of live organisms in the classroom, logistical barriers, including policies, care and handling of species, and lack of resources, appear to affect classroom practices and the choices surrounding live organisms.

3.2.3 Invasive Species

This part of the discussion groups began with asking educators if they could provide a definition of an invasive species, building on the educators' previous comments, if necessary. As a result, the group touched on the three main components of invasive species: (1) species introduced or transported to a new area, (2) species takes over (invades) area due to lack of predators, and (3) introduced species competes with native species for resources (space, food, etc.). Many were able to build on the definition by providing insight such as: "I think most invasive species that I know of are inadvertently introduced by humans." Participants also provided evidence of more sophisticated knowledge about invasive species. One educator commented:

> "I was just going to say that if it is non-native I would think that it can be considered non-invasive because maybe it is not out-competing the native species there; so if it is not out-competing other species then I wouldn't consider it necessarily invasive even though it is non-native."

The educators were able to discuss some specific examples of invasive species. Through this discussion, it was mentioned by a number of educators that they don't think most of the common public, and even some of their colleagues, are very aware of invasive species. One educator indicated that there was a wide range of knowledge about invasive species among her colleagues and that, after hearing the previous discussions, she would double check some of her knowledge and the current status of some of the organisms used in her classroom: "Well, my awareness level is way up now and I am going to be checking the genetics on my butterfly to make sure they are okay."

The discussion briefly touched on what organisms the educators use in their classroom and how they dispose of them. The educators listed a number of domesticated and/or cultivated plants and animals (e.g., peas, beans, tomatoes, gerbils, marine invertebrates). Only a few comments were made on how the educators dispose of organisms when they are finished with them, but there was a variety of methods utilised. Educators will give them to the students when, "it is something that is easy to give to the

kids. They plant them in their own garden and it fosters a continuation of their project." Some educators give the organisms back to the organisation/program they came from. One teacher had an anecdotal story of a colleague who would flush the classroom goldfish down the toilet each year. If plants die, one educator stated that they compost them. A few educators mentioned that they will kill organisms, if need be. The most common method of euthanizing the organism was by throwing it in the freezer and then disposing of it in the garbage.

The discussions about disposal methods led to a short discussion on the subject of euthanasia. BC educators seemed to consider euthanasia a plausible option, as long as it was done in the right context, explained in detail to the students, and accomplished by humane methods. Unfortunately, few of the BC educators actively participated in this portion of the discussion. The remaining data presented on euthanasia pertain to the dataset as a whole for all discussion groups, conducted as part of the Sea Grant AISO project, not just BC educators.

Based on information compiled from all discussion groups, it appears the stance varies from those who are absolutely against euthanasia to those who were fine with it. When asked about euthanasia, one teacher replied, "Easy to say but hard to do." Results from the focus groups suggest no conclusive evidence of the educators being for or against euthanasia, but the individual comments send a clear message that euthanasia is a serious issue requiring thorough consideration by all participants, even those who are willing to do it. About 43% of the comments were supportive of properly euthanizing organisms, 22% were against any euthanizing, and 34% of the comments indicated mixed feelings on the subject. Educators provided a variety of reasons for their stance on this issue. Based on a few comments, teachers show a slight difference in their willingness to euthanize an invasive species versus a native or non-invasive species. A cross section of the responses on the subject follows:

- Participants do not feel comfortable killing native species to be used in experiments, particularly if they are unsure if it is a threatened or endangered species, "When you collect native species that are likely threatened or endangered there is a legal issue there as well as a moral issue."
- Some teachers feel that euthanizing invasive species is essential, but would prefer someone specific at the school be trained in the procedure. An elementary school teacher speaking about euthanasia in general said, "There are a lot of teachers who aren't and there is one person who is 'all right I'll do this, I have done it before.' It's fine, I am trained and I'll do it. It's not an issue."
- Other educators are strongly against the thought of euthanizing anything at all. A high school teacher from outside BC with this perspective said:

  "I just don't feel comfortable with that. About two weeks ago I had to euthanize some quagga mussels and I felt guilty. I had to put them in the freezer and I felt like what a waste. I used them for an experiment. I was done with my experiment and I had to euthanize them by putting them in the freezer and I felt like gosh these can be used for so much more. They could be used for many more experiments. Why my little

experiment and now they die. What a waste. So I just feel like it's wasteful to do that."

The range of values participants expressed about euthanasia is reflected in the range of practices that they accept and use. For some, the prospect of euthanizing organisms definitely influences their use of live organisms in the classroom.

BC educators were asked if they would have invasive species in their classroom. The participants indicated that they would not have invasive species in the classroom or would treat them differently. One teacher said, "As far as invasive plants are concerned, I remove them…will burn knapweed because I am really worried about dispersals and inadvertently one seed falls and you are done." Another reported, "I guess I don't value the lives of invasives as much as other organisms." The discussion then focused on the primary concerns associated with the spread of invasive species. Educators did indicate that if they know an organism is an invasive species they will treat it differently. An outreach coordinator explained, "I don't bring invasive plants into the classroom at all because I worry about dispersal. So we have a plastic one we teach [with]."

Most of the concerns expressed (70%) were associated with the spread of invasive species and ecological damage. These include comments on the ecological impacts on local ecosystems and the dispersal and distribution of invasive species. In terms of dispersal, the educators indicated that they are very concerned with dispersal, but often there is a bit of ignorance associated with the organisms. For example, one educator explained that, "they didn't know, of course, but it's just that again promotional company offering packets of seeds for your customers without knowing that you are bringing an invasive species in the area."

Fewer educators (30%) indicated economic costs as a concern associated with the spread of invasive species. The economic concerns were both related to the discussion of why some jurisdictions in the US spend money to introduce certain species ("Who wants and needs that bass?"), as well as the costs associated with dealing with invasive species.

The BC educators that participated in our discussion group had a good understanding of basic concepts related to invasive species. A number of domesticated and/or cultivated organisms were listed as being used in the classroom, but educators indicated that they do not have invasive species in their classroom and that they would treat the invasive species differently if they did. This could be a possible factor in whether or not educators were willing to euthanize organisms used in their classroom. The primary concern for having invasive species in the classroom is related to ecological issues such as dispersal.

3.2.4 Suggested Solutions

After reviewing the concerns and issues associated with live organisms and invasive species in the classroom, the participants were asked to come up with potential solutions that would best facilitate educators. The main solutions that came out of the

BC discussion included: outreach programs, educational liaisons, and policy change. These solutions are discussed below.

Outreach

Educators (33.3%) felt that knowledge barriers could be addressed and concerns mitigated through effectively developed and placed outreach efforts. Online, written, and professional development materials were the three types participants suggested. BC educators placed heavy emphasis on outreach via written communication and professional development (42.1% for each media) versus online development (15.8%).

Though BC educators suggested written communication, most felt very strongly that it had to be via quick yet informative methods. Small fact sheets and booklets were identified by most educators as a potential effective written communication. It also seems that this method would be most effective in conjunction with online materials. One BC educator described a "starter guide/how-to manual for new teachers or teachers who feel like they don't know very much about invasive species in general... just sort of maybe like an intro package with a list of contacts if you want to learn more about certain things, like different contacts or websites."

The online component described by BC educators would also have to be designed to make the process very simple for educators. Compiled from all the discussion groups of the AISO project, it seems the best set-up would be a one-stop-shop website where they can find resources on live plants and animals in the classroom, invasive species information, curriculum suggestions, and other information. A frustrated teacher said, "Right now it is just a hodgepodge of a bunch of websites that I really don't understand or know what they are or know what they have." A good summary for the online outreach was from a middle school teacher who desired, "Something authoritative but not overwhelming. Not too difficult but easy to get at. Easily accessible information one way or the other."

BC educators strongly felt training through workshops or conferences might be an effective avenue to educate about disposal, handling, and other issues related to invasive species. The educators suggested that effectively spreading the message about invasive species through professional development efforts could reach the masses through big functions with hundreds of teachers in attendance, or at local in-service days.

Policy change

Some of the solution comments made by the educators (17.5%) were about making policy changes at the school district level. The major categories included standardized procedures and modified regulations. One elementary teacher, not allowed to have organisms in the classroom for a variety of reasons, responded, "I think the first step should be actually getting live plants and animals in the classroom, whether they be invasive or non-invasive."

As we already know, the BC Ministry of Education recommends the use of live organisms in the classroom; however, educators feel that there is not enough detailed information and standardised procedures provided with the recommendations. The primary concerns are lack of information the educators do not receive sufficient information on which species are appropriate to use and which are not, as well as they receive no information on the proper disposal methods of organisms. One educator shared that they had never thought of freezing organisms before, and he thinks that, "If you have an actual guide or something official from the Ministry, or whatever, that said these are the correct ways to get rid [of organisms], more educators would be more aware and actually use these disposal methods. "

Liaison

Many of the solution comments (29.8%) centered on the idea that, for changes to be effective and prompt, there needs to be some sort of education liaison or network involved. These liaisons could partner with local organizations such as non-profits, NGOs, or government organizations to ensure that they have up-to-date information on the care and disposal of live organisms and invasive species. The liaisons also need to work with biological supply houses, pet stores, and plant nurseries so that any live organism sold comes with a fact sheet. As one teacher highlighted:

> "When the materials come to your classroom, it should also come with instructions on what to do with them after the fact...[such as] here's your butterflies, if you're going to release them, make sure they have this, this, this, and this or find something else to do with them...and making something like the WHMIS manual that if you have something but you don't know what you're supposed to do with it, offer like, there's a resource to find it, [and] the credible information to deal with it..."

The final way the liaisons could help is by adapting the places where the current curriculum recommends the use of live organisms, providing more detail about invasive species, and the proper care and disposal for all organisms.

General

There were also general comments (19.3%) about solutions related to a number of aspects surrounding invasive species but focused on two primary topics. The first topic was the need to also educate the general public. For example, one teacher indicated that it would be effective if the outreach manuals were user friendly for the general public so that educators could distribute them to the parents of their students. The second topic involved concerns about the feasibility of having enough financial resources to support outreach programs and educational liaisons for the educators.

The BC educators described a number of solutions to better inform students and educators on the issues surrounding invasive species, as well as to prevent any further introductions and spread. To effectively manage live organisms in the classroom as a vector of invasive species, it will be pertinent to review and implement each of these recommended strategies.

4 SUMMARY AND POTENTIAL SOLUTIONS: PHASE THREE – IDENTIFYING AND DEVELOPING POSSIBLE PREVENTION AND MANAGEMENT TOOLS

This study confirms that live organisms used in the classroom are a vector for invasive species introduction and spread in BC. It is also very apparent that educators greatly value live organisms as teaching tools. BC educators are responsible for selecting and obtaining the live organisms, as well as determining their fate once they are no longer needed in the classroom. Educators are the most pivotal component of this vector and currently a lack of information and training is leading to potentially problematic releases of non-native species. To prevent any further introduction and spread of invasive species via this vector, there are a number of actions that need to be taken so that educators are up-to-date on invasive species issues and are receiving sufficiently detailed information on the organisms they use in their classrooms.

The curricula developed by the BC Ministry of Education are the guidelines educators follow to help select which live organisms to have in the classroom and when to teach students about invasive species topics. In the senior science grades (9-12), there is a lot of content related to invasive species issues incorporated into the curricula; however, there is little to no content in the younger education grades (K-8). The current curricula could be updated to incorporate some basic information at the younger grade levels as these are the grades where live organisms are actively used in the classroom, and thus there is a higher risk of introduction and spread of invasive species. Additionally, when encouraging the use of live organisms in the classroom, the curricula guidelines need to be more explicit on which species to use as the 'groups' listed (e.g., frogs) often include both native and invasive species. Suppliers of science kits recommended by the current curricula, and utilised by educators, need to be contacted to ensure that they follow similar amendments to provide sufficient information to educators so as to reduce the risk of the use and release of invasive species.

Educators listed four invasive species as being used in the classroom: dandelions, red wiggler worms, mealworms, and bullfrogs. The common dandelion, the red wiggler worm, and mealworms were all invasive terrestrial species listed by educators. The American bullfrog (*L. Catesbeianus*) is an AIS listed by educators and sold by the biological supply house Boreal/Northwest in the biology section of their website (http://boreal.com/biology/c/1674/ accessed 18 March, 2010). The American bullfrog is considered one of the world's 100 worst invasive species (Lowe et al. 2000). Its native distribution is primarily the eastern United States but it is spreading around the world and is predicted to have hotspots of suitable habitat worldwide (Ficetola et al. 2007). In addition to the American bullfrog, there is a strong possibility that more AIS may be used as teaching tools, as many of the educators provided very general names for the organisms. Over 20% of the ambiguous species aggregate categories have the potential for including at least one species of AIS. This is a red flag that educators are not being provided with sufficient information from either the recommended curricula and/or the multiple sources from which the educators are obtaining their live organisms.

Biological supply houses were originally thought to be the major source of live organisms for educators. Though biological supply houses were listed by both our

online survey and discussion group participants, it is evident that educators obtain their live organisms from a number of sources (e.g., plant nurseries and pet shops). These multiple sources are not providing educators with sufficiently detailed information pertaining to the live organisms they supply. As an example, most educators in the online survey (79.7%) said that they were given the full common name for organisms they received, but only 51.9% of the organisms listed by their common names were identifiable to at least the Genus level (Table 2). From the discussion group proceedings and the online survey, it is evident that the majority of educators are not being provided with information related to the biology of the organisms, their native ranges, the origin of where they were collected and shipped from, as well as the appropriate disposal methods. It will be a difficult task to try to coordinate the multiple sources to provide such information with the sale of each live organism. Many of the organizations selling live organisms are businesses that are trying to make a profit and these businesses may find tasks associated with providing detailed information time and resource consuming. One way to facilitate the process would be to develop a simple, but standardised, information sheet that would accompany the sale of any live organism in the province. In the long term, goals should include determining a means of international regulation as many of the supply houses included Canadian and American affiliates.

The information sheet would include headings related to the common name, scientific name, biology, native range, origin of collection and shipping, as well as the appropriate disposal methods for each species or taxon group. These are the areas of information that are most important in terms of managing invasive species. Providing educators with this information may help them make decisions related to the use and disposal of live organisms in the classroom. Educators that participated in the discussion group indicated that, if they were provided with the appropriate information, they would be willing to make adjustments related to the selection and fate of species in the classroom based on their invasiveness.

The fate of the live organisms used in the classroom is of concern, as many of the practices listed by educators may result in direct transfer of the organisms into the environment. More than half of the educators participating in the online survey indicated that, when the role of the organism in the classroom was complete, it was taken home as a pet of the teacher or students. Organisms taken home might be released at a later date, as the release of unwanted pets is unfortunately widespread (Rixon et al. 2005). Additionally, more than half of the online survey educators (52.5%) indicated that they would release the live organisms into the wild. This may partially be attributed to the fact that live organisms in the classroom are often used for students to observe and learn about lifecycles. Usually, at the end of the development period, the adults are released in the local environment. This practice is only safe when it is effectively monitored to ensure the release of native species into the appropriate environment. An example of this is the Salmonids in the Classroom Project spear-headed by DFO. DFO sponsors the transfer of eggs of native Pacific salmon (Coho (*Oncorhynchus kisutch*) or Chum (*Oncorhynchus keta*)) from hatcheries to classrooms where students observe development until the fry development stage, following which

they are released into suitable streams. The program follows the DFO Wild Salmon Policy in ensuring that the fry raised in the classroom are released to the same streams where they were spawned as eggs, or if this is not possible, are transported to other streams following official transplant guidelines (B. Bowler, Fisheries and Oceans Education Coordinator, North Vancouver, BC, pers. comm.). An example of an inappropriate release would be if students were to watch the development of mealworms, from larvae, into pupae, and then into adult darkling beetles (*Tenebrio molitor*). Darkling beetles are an introduced cosmopolitan species that have been spread by human activities (http://www.eol.org/pages/1041700 accessed January, 2011). The release of live organisms into the local environment by educators not only poses a risk of introducing potential invasive species into the province, but also sends a problematic message to the students that they may replicate at home. The one situation where the release is of lower risk is when the educators themselves have collected the organisms from the local environment and are re-releasing them when the organisms are no longer being used in the classroom. This practice carries a much lower risk, but still may cause the secondary spread of non-native species or disease. It is important to inform educators so that they are aware of invasive species that may be in their area, as well as that they should try to return the organisms as close to the collection location as possible.

Educators also indicated that the remains of the organisms may be disposed of in the trash or compost. This is of particular concern for plant species as the seeds and roots of 'dead' plants can be transported (i.e., by wind) and grow in favourable new environments. Combined with the fact that the greatest risk of spread from curricula recommendations was for plant species, educators should not use composting as a disposal method unless they are certain the species is native to the area. There were a number of teachers that indicated that dead organisms were flushed down the drain. These drain systems often connect to local streams, rivers, or oceans, posing the risk that some aquatic species or potential pathogens and parasites might survive and be introduced into natural waters. Members of the discussion group differed from the online survey participants in that a number of the educators would freeze organisms before disposing of them. Freezing is a simple, yet effective, method of ensuring that the organisms are dead and is a relatively humane from of euthanasia. It also kills some, but not all, of the pathogens or parasites associated with the organism.

Euthanasia may become an important component of managing the live organisms in the classroom vector as it would allow educators to continue using certain species while preventing them from entering the local environment. When asked whether the educators would be willing to humanely euthanize a classroom animal if the methods were approved by the American or Canadian Veterinary Medical Association, and they were provided the guidance and tools for carrying it out, less than half of the educators (40.7%) said they would be unable to, 13.6% believed that this question was not applicable to the organisms they use as teaching tools, and 8.5% were unsure. The results from the discussion group were slightly different from the online survey as discussion group participants considered euthanasia a plausible option, as long as it was done in the right context, explained in detail to the students, and accomplished by

humane methods. The difference in attitude between the two groups may be attributed to two factors. First, discussion group participants were not randomly selected from the questionnaire participants but were educators that volunteered after taking the online survey and may have had a greater interest or concern regarding AIS. The second factor contributing to the difference in attitude may be attributed to the workshop setting, where the educators had been involved in invasive species discussions throughout the day and were more sensitive to the issues and concerns surrounding AIS use, care, and disposal in the classroom. Increased information, training, and guidance on euthanasia topics for educators will be an important component of developing management strategies for this vector.

The BC educators that participated in the online survey and discussion groups had varying knowledge levels regarding invasive species, but most felt they have at least some working knowledge related to the topic. The discussion group educators did indicate, however, that they feel that many of their colleagues had lower levels of working knowledge regarding invasive species and that there needs to be greater outreach to inform all educators in BC. Regardless of the level of knowledge related to invasive species, the educators of the discussion group indicated they are concerned with the many implications of having invasive species in the classroom and they would be willing to be involved in mitigating the risks associated with the vector. Educators from both the online survey and discussion groups provided insight into information and tools that would be effective. An important first step would be to develop an outreach program where educators receive a current list of plants and animals considered invasive in BC, better information on how to properly dispose of plants and animals, and material to help educators and students understand the impacts of invasive species in local ecosystems. In addition to this outreach program, a beneficial resource to include could be a website with similar content that can be updated and modified over time. Many of the educators also indicated that they would be interested in attending workshops focused on integrating invasive species education into the classroom or on the selection and care of plants and animals in the classroom.

Live organisms in the classroom is a vector for invasive species introduction and spread in BC that can be mitigated and managed by taking a number of actions to help educators make informed decisions in the classroom. The following is a list of simple steps that the Ministry of Environment can take that will help minimize the risk of having live organisms in the classroom:

- Collaborate with the BC Ministry of Education to make amendments to current curricula so they are specific on which species educators should use (or avoid) and how to properly care for and dispose of the live organisms.
- Develop, with the BC Ministry of Education, basic background information on invasive species to incorporate into the curricula of younger grades and a recommendation to use native species whenever feasible.
- Develop a standard protocol to provide more accurate and detailed information with the sale of any live organism in the province. A standardized information sheet may be the best approach as numerous companies and organizations sell

live organisms. This step may need to involve international regulation to prevent the introduction and spread of invasive species across the borders.

- Develop outreach packages for educators that include basic information related to invasive species. In conjunction with the outreach package, there needs to be a simple but effective website developed where educators can access the most up-to-date information.
- Develop, with the BC Ministry of Education, training opportunities for educators on topics related to invasive species and proper disposal instructions.

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Table 1. District information for the respondents of the online survey
(District map available at: http://www.bcstats.gov.bc.ca/data/pop/maps/sdmap.asp)

District Name	District Code	# of Respondents
Cariboo-Chilcotin	27	1
Langley	35	1
Surrey	36	49
Delta	37	1
Richmond	38	2
Vancouver	39	2
Burnaby	41	1
Sea to Sky	48	1
Okanagan Skaha	67	2
Nanaimo-Ladysmith	68	2
Cowichan Valley	69	1
Alberni	70	1
Kamloops/Thompson	73	4
Stikine	87	3
		***n*=72**

Table 2. The identity and taxonomic classification of organisms utilised by BC educators as teaching tools in the classroom
(Organisms groups are broken down by Kingdom and Phylum classification)

Name Provided*	Class	Order	Family	Genus	Species
Monera-Bacteria					
Bacteria					
Bacillus sp.	Schizomycetes	Eubacteriales	Bacillaceae	*Bacillus*	
Fungi and Plantae					
Fungi					
Lichens					
Protozoa and Animalia					
Protists					
Protozoa- Ciliophora					
Paramecium	Ciliatea	Hymenostomatida	Parameciidae	*Paramecium*	
Plantae					
Plants/Flowers[3]					
Algae/Seaweed[3]					
Plantae-Bryophyta					
Mosses					
Plantae-Coniferophyta					
Conifers	Coniferopsida	Coniferales			
Cedar (cones)	Pinopsida	Pinales	Pinaceae	*Cedrus*	
Pine (cones)	Pinopsida	Pinales	Pinaceae	*Pinus*	
Douglas Fir	Pinopsida	Pinales	Pinaceae	*Pseudotsuga*	*menziesii*
Hemlock (cones)	Pinopsida	Pinales	Pinaceae	*Tsuga*	
Plantae-Euglenophycota					
Euglena	Euglenophyceae	Euglenales	Euglenaceae	*Euglena*	
Plantae-Magnoliophyta					
Grass[3]	Liliopsida	Cyperales	Poaceae		
Bunchgrass	Liliopsida	Cyperales	Poaceae		
Wheat[1]	Liliopsida	Cyperales	Poaceae	*Triticum*	
Corn[1]	Liliopsida	Cyperales	Poaceae	*Zea*	*mays*
Elodea	Liliopsida	Hydrocharitales	Hydrocharitaceae	*Elodea*	
Aloe[1]	Liliopsida	Liliales	Aloeaceae	*Aloe*	
Amaryllis[1]	Liliopsida	Liliales	Amaryllidaceae	*Amaryllis*	
Onions/Chives[1]	Liliopsida	Liliales	Liliaceae	*Allium*	
Spider Plant[1]	Liliopsida	Liliales	Liliaceae	*Chlorophytum*	*comosum*
Hyacinths[1]	Liliopsida	Liliales	Liliaceae	*Hyacinthus*	
Daffodils[1]	Liliopsida	Liliales	Liliaceae	*Narcissus*	
Tulips[1]	Liliopsida	Liliales	Liliaceae	*Tulipa*	
Celery[1]	Magnoliopsida	Apiales	Apiaceae	*Apium*	
Carrots[1]	Magnoliopsida	Apiales	Apiaceae	*Daucus*	
Sunflowers[1]	Magnoliopsida	Asterales	Asteraceae		
Marigolds[1]	Magnoliopsida	Asterales	Asteraceae		
Yarrow	Magnoliopsida	Asterales	Asteraceae	*Achillea*	
Sage Brush	Magnoliopsida	Asterales	Asteraceae	*Artemisia*	

Name Provided*	Class	Order	Family	Genus	Species
Balsamroot	Magnoliopsida	Asterales	Asteraceae	*Balsamorhiza*	
Chrysanthemums[1]	Magnoliopsida	Asterales	Asteraceae	*Chrysanthemum*	
Dandelions[2]	Magnoliopsida	Asterales	Asteraceae	*Taraxacum*	
Lettuce[1]	Magnoliopsida	Asterales	Asteraceae	*Lactuca*	*sativa*
Marigolds[1]	Magnoliopsida	Asterales	Asteraceae	*Tagetes*	
Christmas Cactus[1]	Magnoliopsida	Caryophyllales	Cactaceae	*Opuntia*	*leptocaulis*
Carnations[1]	Magnoliopsida	Caryophyllales	Caryophyllaceae	*Dianthus*	*caryophyllus*
Beans[1]	Magnoliopsida	Fabales	Fabaceae		
Sweet Peas[1]	Magnoliopsida	Fabales	Fabaceae	*Lathyrus*	*odoratus*
Peas[1]	Magnoliopsida	Fabales	Fabaceae	*Pisum*	*sativum*
Fava Bean[1]	Magnoliopsida	Fabales	Fabaceae	*Vicia*	*faba*
Hazelnut[1]	Magnoliopsida	Fagales	Betulaceae	*Corylus*	
Geraniums[1]	Magnoliopsida	Geraniales	Geraniaceae		
Sage[1]	Magnoliopsida	Lamiales	Lamiaceae	*Salvia*	
Venus Flytrap[1]	Magnoliopsida	Nepenthales	Droseraceae	*Dionaea*	*muscipula*
Peppers[1]	Magnoliopsida	Piperales	Piperaceae		
Jade Plant[1]	Magnoliopsida	Rosales	Crassulaceae	*Crassula*	*ovata*
Antelope Brush	Magnoliopsida	Rosales	Rosaceae	*Purshia*	*glandulosa*
Blackberries	Magnoliopsida	Rosales	Rosaceae	*Rubus*	
African Violet[1]	Magnoliopsida	Scrophulariales	Gesneriaceae	*Saintpaulia*	
Tomatoes[1]	Magnoliopsida	Solanales	Solanaceae		
Potatoes[1]	Magnoliopsida	Solanales	Solanaceae	*Solanum*	*tuberosum*
Begonias[1]	Magnoliopsida	Violales	Begoniaceae	*Begonia*	
Cucumbers[1]	Magnoliopsida	Violales	Cucurbitaceae	*Cucumis*	*sativus*
Pumpkins[1]	Magnoliopsida	Violales	Cucurbitaceae	*Cucurbita*	
Plantae-Pteridophyta					
Sword Fern	Filicopsida	Polypodiales	Dryopteridaceae	*Polystichum*	*munitum*
Ferns	Filicopsida				
Animalia					
Invertebrates[3]					
Animalia- Annelida					
Worms[3]					
Earthworms	Clitellata (Oligochaeta)				
Red Wiggler Worms[2]	Clitellata (Oligochaeta)	Haplotaxida	Lumbricidae	*Eisenia*	*foetida*
Animalia-Arthropoda					
Tarantula[1]	Arachnida	Araneae	Theraphosidae		
Daphnia	Branchiopoda	Diplostraca	Daphniidae	*Daphnia*	
Brine Shrimp[3]	Crustacea	Anostraca			
Crabs[3]	Crustacea	Decapoda			
Hermit crabs	Crustacea	Decapoda	Paguroidea		
Insects[3]	Insecta				
Lady beetles	Insecta	Coleoptera	Coccinellidae		
Mealworms[2]	Insecta	Coleoptera	Tenebrionidae	*Tenebrio*	*molitor*
Preying Mantis[1]	Insecta	Dictyoptera	Mantidae		

Name Provided*	Class	Order	Family	Genus	Species
Ants	Insecta	Hymenoptera	Formicidae		
Mason Bees	Insecta	Hymenoptera	Megachilidae	*Osmia*	
Butterflies	Insecta	Lepidoptera			
Monarch Butterflies	Insecta	Lepidoptera	Nymphalidae	*Danaus*	*plexippus*
Painted Lady Butterflies	Insecta	Lepidoptera	Nymphalidae	*Vanessa*	*cardui*
Bees	Insecta	Neoptera	Hymenoptera		
Grasshoppers	Insecta	Orthoptera	Acrididae		
Crickets	Insecta	Orthoptera	Gryllidae		
Stick bugs	Insecta	Phasmatodea			
Walking Stick	Insecta	Phasmatodea	Phasmatidae		
Crayfish[3]	Malacostraca	Decapoda	Cambaridae		
Animalia-Chordata					
Fish[3]	Actinopterygii				
Goldfish[1]	Actinopterygii	Cypriniformes	Cyprinidae	*Carassius*	*auratus*
Frogs/Toads[3]	Amphibia	Anura			
Spadefoots[3]	Amphibia	Anura	Pelobatidae		
Bullfrogs[2]	Amphibia	Anura	Ranidae	*Lithobates*	*catesbeianus*
Salamanders[3]	Amphibia	Caudata			
Tiger Salamander	Amphibia	Caudata	Ambystomatidae	*Ambystoma*	
Newts[3]	Amphibia	Caudata	Salamandridae		
Birds[3]	Aves				
Ducklings[3]	Aves	Anseriformes	Anatidae		
Quail	Aves	Galliformes	Phasianidae		
Chicks[1]	Aves	Galliformes	Phasianidae		
Canaries[1]	Aves	Passeriformes	Fringillidae	*Serinus*	
Budgies[1]	Aves	Psittaciformes	Psittacidae	*Melopsittacus*	*undulatus*
Cockatiel[1]	Aves	Psittaciformes	Psittacidae	*Nymphicus*	*hollandicus*
Owls	Aves	Strigiformes	Strigidae		
Great Horned Owl	Aves	Strigiformes	Strigidae	*Bubo*	*virginianus*
Pigs[1]	Mammalia	Artiodactyla	Suidae		
Dogs	Mammalia	Carnivora	Canidae	*Canis*	*lupus familiaris*
Cats[1]	Mammalia	Carnivora	Felidae	*Felis*	*catus*
Ferrets[1]	Mammalia	Carnivora	Mustelidae	*Mustela*	
Rabbits	Mammalia	Lagomorpha	Leporidae		
Guinea Pigs[1]	Mammalia	Rodentia	Caviidae	*Cavia*	*porcellus*
Mice/Rats	Mammalia	Rodentia	Muridae		
Hamsters[1]	Mammalia	Rodentia	Muridae		
Gerbils[1]	Mammalia	Rodentia	Muridae (Gerbillinae)		
Teddy Bear Hamsters[1]	Mammalia	Rodentia	Muridae	*Mesocricetus*	*auratus*
Degus[1]	Mammalia	Rodentia	Octodontidae	*Octodon*	*degus*
Lizards[3]	Reptilia	Squamata			
Snakes[3]	Reptilia	Squamata (Serpentes)			

Name Provided*	Class	Order	Family	Genus	Species
Boa Constrictor[1]	Reptilia	Squamata	Boidae	*Boa*	*constrictor*
Geckos[1]	Reptilia	Squamata	Gekkonidae		
Leopard Gecko[1]	Reptilia	Squamata	Gekkonidae	*Eublepharis*	*macularius*
Iguanas[1]	Reptilia	Squamata	Iguanidae		
Anole Lizards[1]	Reptilia	Squamata	Polychrotidae	*Anolis*	
Ball Python[1]	Reptilia	Squamata	Pythonidae	*Python*	*regius*
Turtles[3]	Reptilia	Testudines			
Salmon[3]	Actinopterygii	Salmoniformes	Salmonidae		
Coho Salmon	Actinopterygii	Salmoniformes	Salmonidae	*Oncorhynchus*	*kisutch*
Animalia-Cnidaria					
Hydra[3]	Cnidaria	Hydrozoa	Anthoathecatae	Hydridae	
Animalia-Echinodermata					
Sea Stars[3]	Echinodermata	Asteroidea			
Sea Cucumbers[3]	Echinodermata	Holothuroidea			
Animalia-Mollusca					
Clams[3]	Bivalvia				
Squid[3]	Cephalopoda				
Snails/Slugs[3]	Gastropoda				
Animalia-Platyhelminthes					
Platyhelminthes[3]					
Planaria[3]	Turbellaria	Tricladida	Planariidae	*Planaria*	

***** [1]domesticated/cultivated non-native organism, [2]invasive organism, [3]potential of AIS included within category

Table 3. Science kits recommended by current BC curricula guidelines, and/or listed as being used by educators, where there are opportunities for education and/or the introduction and spread of invasive species

Science Kit	Grade	Overview	Organisms Used	Opportunity to learn about, spread, and/or introduce invasive species
Primarily Plants (AIMS Activities)	K-3	Students explore plant growth, seeds and spores, plant needs, and plant parts. They dissect seeds, create plastic bag gardens, and observe and record daily growth.	lima bean, corn, radish	This program has students growing plants that include cultivated plants that are not native to BC. It would be important to educate teachers and students on what can be done with the plants when they are no longer needed in the classroom.
Once Upon A Seashore	K-6	This curriculum focuses on basic ecology concepts explored from a variety of disciplines. The lessons and activities are designed to culminate in a field trip to the seashore. Chapters cover seashore organisms; basic ecology concepts associated with seashores, tides, tide pools, and predator/prey relationships; plankton; sandy beaches; rocky shores; tidal fluctuations; and people and the sea.	marine organisms	This is a program where many of the topics surrounding marine invasive organisms can be incorporated into the chapters studied. At the final seashore field trip students can attempt to identify which organisms are native and which are invasive.
Pan Canadian Science Place (It's Alive and Healthy Habitats)	K-6	Lessons that aim to build on students' prior knowledge of living things and habitats, engage their interest in the topic, explore concepts with open-ended or directed explorations and information, and help students to apply what they have learned to their real world.		This program encourages students to collect and bring live organisms into the classroom. In this program there is the opportunity to teach students about which organisms are native or invasive to the local environment and educate them on how to prevent their spread. There is also a risk that this program could spread non-native species.
Backyard Biodiversity	K-7	Helps students discover the life that exists around them and investigate the threats and solutions to ecosystems and their resident plants and wildlife. Five modules and a community action toolkit cover topics such as endangered species, global thinking/local action, wildlife, and ecology.		This program can directly educate students about issues surrounding invasive species as they are one of the primary threats to local ecosystems and are part of a global issue that can be dealt with on local scales.

Science Kit	Grade	Overview	Organisms Used	Opportunity to learn about, spread, and/or introduce invasive species
Salmonids in the Classroom	K-7	Fisheries and Oceans Canada supports salmon incubation in schools. Raising salmon in the classroom is an opportunity to teach students to understand, respect, and protect freshwater, estuarine and marine ecosystems, and to recognize how all humans are linked to these complex environments. Additional opportunities include salmon dissections, stream studies, and access to hatchery programs.	Pacific salmon - Coho (*Oncorhynchus kisutch)* - Chum (*Oncorhynchus keta)*	Through this program students become aware of issues surrounding Pacific salmon and their habitats in order to encourage students to become stewards of environmental sustainability. There is potential to include education on the topic of Atlantic Salmon aquaculture on the BC coast. This introduced species may be detrimental to the survival of the Pacific species through escape events and increased disease.
Seaquaria	K-12	Brings local marine ecosystems into schools through permanent aquaria and curriculum-linked programming. The program fosters environmental awareness, engagement, respect and stewardship, while optimizing joint multi-disciplinary learning of teachers, students, and the community.	marine invertebrates and fishes	This program provides an opportunity to learn about native and invasive organisms and how they interact in the marine environment. This program has the potential to spread invasive species if all organisms are not returned to the place from which they were collected.
Project WILD	K-12	Project WILD links students and wildlife through its mission to provide wildlife-based conservation and environmental education that fosters responsible actions toward wildlife and related natural resources. Through the use of balanced curriculum materials and professional training workshops, Project WILD accomplishes its goal of developing awareness, knowledge, skills, and commitment.		This program focuses on protecting wild organisms and their environments. As invasive species are one of the greatest threat to biodiversity, the program could teach about invasive species and the way to prevent their spread.
Hands on Science (Growth and Changes in Animals)	2,3	The lessons introduce students to the characteristics of animal groups, animal behaviours and habitats, life cycles of various animals, and their needs for survival. Students also investigate how humans harm and help animals.	butterflies, frogs, mealworms, ants, bees, flies, mosquitoes, chickens, chicks, tadpoles, toads, fishes, guinea pigs, birds, rabbits, gerbils, snakes	This program encourages students to collect and bring organisms to class. Some of the recommended organisms are domesticated organisms whose native range does not include BC. A number of the organisms listed should be more specific (e.g., studying frogs could include the invasive American bullfrog). This program also includes the risk of spread of the introduced mealworm.

Science Kit	Grade	Overview	Organisms Used	Opportunity to learn about, spread, and/or introduce invasive species
Hands on Science (Growth and Changes in Plants)	2,3	The lessons introduce students to the parts of a plant, types of plants, plant life-cycles, the needs of plants for survival, and how plants are affected by seasonal changes and human behaviour.	plants in flower, white carnations, cacti	This program encourages students to collect and bring live organisms into the classroom. The plants recommended for use include domesticated plants that are not native to BC. It would be important to educate teachers and students on what can be done with the plants when they are no longer needed in the classroom.
Hands on Science (Habitats and Communities)	4-6	The lessons introduce students to plant and animal habitats, and humans' environmental responsibilities for these living things. Students investigate animal and plant adaptations and relationships within a community. They also learn about the herbivores, carnivores, omnivores, predators, prey, scavengers, producers, consumers, and decomposers that comprise various food chains and food webs.	fish, guinea pig, bird, rabbit, gerbil, snake	The live organisms in this program include domesticated animals. The topics covered in this kit could include a focus on invasive species. For example, humans' environmental responsibilities for living things can include how invasive species threaten local ecosystems and how humans can work on preventing further introductions and spread.
Hands on Science (Diversity of Living Things)	4-6	The lessons introduce students to the classification system for living things. Students investigate the animal, plant, fungus, protist, and moneran kingdoms, to observe, identify, compare, and classify various living things. As well, they explore the field of archaeology through a study of fossils.	ferns, cacti, flowering plants, moss, and mealworms	This program encourages students to work with an invasive species (mealworms) and domesticated organisms.
Pond Peeking and Alien Invaders	6,7	Field trip where students visit the pond and identify invertebrates lurking within. Students also explore the forest and field and learn which plants and animals are native or alien species.	pond, forest, and field organisms	This program directly teaches student about invasive or 'alien' species.

Table 4. Summary of current BC science curricula guidelines that are related to live organisms in the classroom and invasive species

The objective of each course along with lesson plan components where students may have the opportunity to learn about invasive species (L) and/or have a potential risk for students to introduce and/or spread invasive species (R).

Grade	Topic	Objectives	Lesson Plan Components
K	Life Science: Characteristics of Living Things	• Describe features of local plants and animals • Compare local plants and common animals • Sort and classify variety of animals (e.g., wild animals and pets)	• Students bring their pets to school (R)(L) • Set up a plant station in the classroom (R) • Prepare some small cuttings of easily propagated plants (e.g., ivy, geraniums, coleus) (R) • As a class, take a field trip into the school yard and observe different trees (L)
1	Life Science: Needs of Living Things	• Classify organisms according to given criteria: common features and structure • Observe and sort local plants and animals • Show respect for living things • Describe how the basic needs of plants and animals are met in their environment	• Take a walk in a forest or wild area. Have students find evidence of animal life (e.g., tracks, droppings, feathers, nests) (L) • Students take a walk around their neighbourhood and look for living and non-living things, making a picture of each item (L) • Grow seeds in different media (R) • With a magnifier or low magnification microscope, have students observe a plant, insect, or a small animal (e.g., caterpillar). Tell them to draw what they see (L) • Have students observe several types of plants and identify the basic parts (L) • Have student pairs identify the basic needs and the care required for pets, indoor plants (L) • Invite a local plant specialist (Aboriginal Elder, botanist, herbologist) to make a presentation on local plant species (L)
2	Life Science: Animal Growth and Changes	• Observe and record the life cycles of a variety of animals • Classify familiar animals according to similarities and differences in appearance, behaviour, and life cycles	• Have students observe and record daily the changes of a mealworm, ant, frog, or butterfly lifecycle (L) (R)
3	Life Science: Plant Growth and Changes	• Compare familiar plants according to similarities and differences in appearance and life cycles • Describe ways in which plants are important to other living things and the environment	• Provide plant samples for students to observe (L) (R) • Set up a plant observation centre where students sort and classify plants (L) (R) • Students conduct experiments to compare conditions needed for healthy plant growth (e.g., water, light, soil) using seeds, cuttings, tubers, and shoots (L) (R) • Conduct a walking field trip to look for connections among plants and other living things (L)

Grade	Topic	Objectives	Lesson Plan Components
4	Life Science: Habitats and Communities	• Compare the structures and behaviours of local animals and plants in different habitats and communities • Analyse simple food chains • Determine how personal choices and actions have environmental consequences	• Observe animals and plants sharing habitat (e.g., aquarium, terrarium) (L) (R) • Take students to visit local ecosystems (e.g., tide pools, forests, wetlands) (L) • Set up a colony of mealworms, which can be obtained from a pet store or scientific supply company (R)
6	Life Science: Diversity of Life	• Demonstrate the appropriate use of tools to examine living things that cannot be seen with the naked eye • Analyse how different organisms adapt to their environments	• Students create wet slides using fresh or brackish pond water (or live specimens) (L) (R)
7	Life Science: Ecosystems	• Assess survival needs and interactions between organisms and the environment • Analyse the roles of organisms as part of interconnected food webs, populations, communities, and ecosystems • Evaluate human impacts on local ecosystems	• Identify local ecosystems within your school district (L) • On a schoolyard walk, have students study interactions among living and non-living parts in the natural ecosystem (L) • Visit an estuary region to observe the many types of interactions (L) • Evaluate the likely effects of habitat loss for certain species (L)
8	Life Science: Cells and Systems	• Demonstrate knowledge of the characteristics of living things	• Using compound microscopes, have students work in pairs to identify organisms and signs of life that are observed in a pond water sample (L) (R)
8	Earth & Space Science: Water Systems on Earth	• Describe factors that affect productivity and species distribution in aquatic environments	• Students research a given aquatic species (L) • Students read articles dealing with one or more methods by which aquatic environments are monitored (L) • Relate human activities to the distribution of aquatic species(L)
10	Life Science: Sustainability of Ecosystems	• Explain various ways in which natural populations are altered or kept in equilibrium • Explain the interaction of abiotic and biotic factors within an ecosystem	• Explain how species adapt or fail to adapt to environmental conditions and set up a gallery walk depicting examples (L) • Give examples of how foreign species can affect an ecosystem and have students research specific examples of ecosystems that have changed as a result of introduction of species (e.g., Purple loosestrife (*Lythrum salicaria*), American bullfrog, European starling (*Sturnus vulgaris*) in North America; deer on the Queen Charlotte Islands; Eurasian milfoil (*Myriophyllum spicatum*), Scotch broom (*Cytisus scoparius*), zebra mussels (*Dreissena polymorpha*) in the Great Lakes)) (L) • Invite a guest speaker (e.g., Aboriginal Elder, wildlife protection officer, zoologist) to talk about how disease, pollution, habitat destruction, or resource exploitation have affected a local ecosystem, and the efforts to counter those effects. Where possible, follow up with a field trip to the ecosystem (L)

Grade	Topic	Objectives	Lesson Plan Components
11	Science & Technology: Agriculture	• Describe elements of agricultural systems found locally, provincially, and globally • Describe the role of genetics in agriculture	• Outline how a local agricultural system is similar to and different from one found elsewhere in Canada or the world (L) • Identify plants and animals that have been genetically engineered and the effects this has on local agriculture (L) • State possible reasons new varieties of plants and animals are being developed for public consumption (L)
11	Science & Technology: Natural Resources and the Environment	• Discuss the impact of society on natural resource management and the environment	• Describe local and global environmental issues (L) • Relate how societal pressures influence the extraction process of a natural resource (L)
11	Biology 11: Ecology	• Analyse the functional inter-relationships of organisms within an ecosystem	• Describe the process of ecological succession, with reference to terms such as pioneer species and climax community (L)
11	Sustainable Resources 11: Fisheries	• Analyse the environmental, social, and economic significance of fisheries at the local, provincial, and global levels • Assess current practices related to management of sustainable fishery resources in British Columbia • Analyse challenges and opportunities faced by fishery industries in British Columbia	• Analyse the direct impact of threats to habitat and habitat loss on fisheries (L) • List factors that influence the survival of wild species (e.g., climatic variation, population dynamics, fishing pressure, habitat pressure, diseases, parasites) (L) • Identify examples of British Columbia aquatic species at risk (e.g., extinct, extirpated, endangered, threatened, of special concern) and outline pressures on these species (L) • Identify factors that affect the sustainability of fisheries (L)
12	Sustainable Resources 12: Fisheries – Fishery Resources and Society	• Assess the importance of fisheries in British Columbia and Canada • Analyse the impact of fishing and ocean resources on global development and international relations	• Identify the role aquatic species play in a healthy human diet (L) • Discuss the roles of aquatic species in Aboriginal cultures (e.g., food, social, and ceremonial needs) (L) • Discuss the ocean as an internationally shared resource (L)
12	Sustainable Resources 12: Fisheries – Structure & Function of Aquatic Ecosystems	• Investigate interactions found within aquatic ecosystems	• Illustrate the impact of an invasive species (e.g., Eurasian milfoil, Atlantic salmon, zebra mussel, bass) on an aquatic ecosystem (L)
12	Sustainable Resources 12: Fisheries – Sustainable Fishery Operation & Management	• Describe methods used to produce cultured stock	• Identify and describe organisms raised through aquaculture (L)

Grade	Topic	Objectives	Lesson Plan Components
12	Sustainable Resources 12: Fisheries – Issues and Challenges Facing Sustainable Fisheries	• Outline economic and political issues and challenges related to fisheries • Analyse sustainability issues and challenges related to fisheries • Assess issues and challenges related to aquaculture	• List economic issues that impact fisheries (e.g., increased production costs, market fluctuations, competition) (L) • List sustainability issues that impact fisheries (e.g., over harvesting, predation, habitat degradation) (L) • Discuss impacts (e.g., transfer of parasites, disease) resulting from contact between cultured and wild species (L) • Describe possible environmental impacts (e.g., pollution, species invasion) resulting from aquaculture (L)

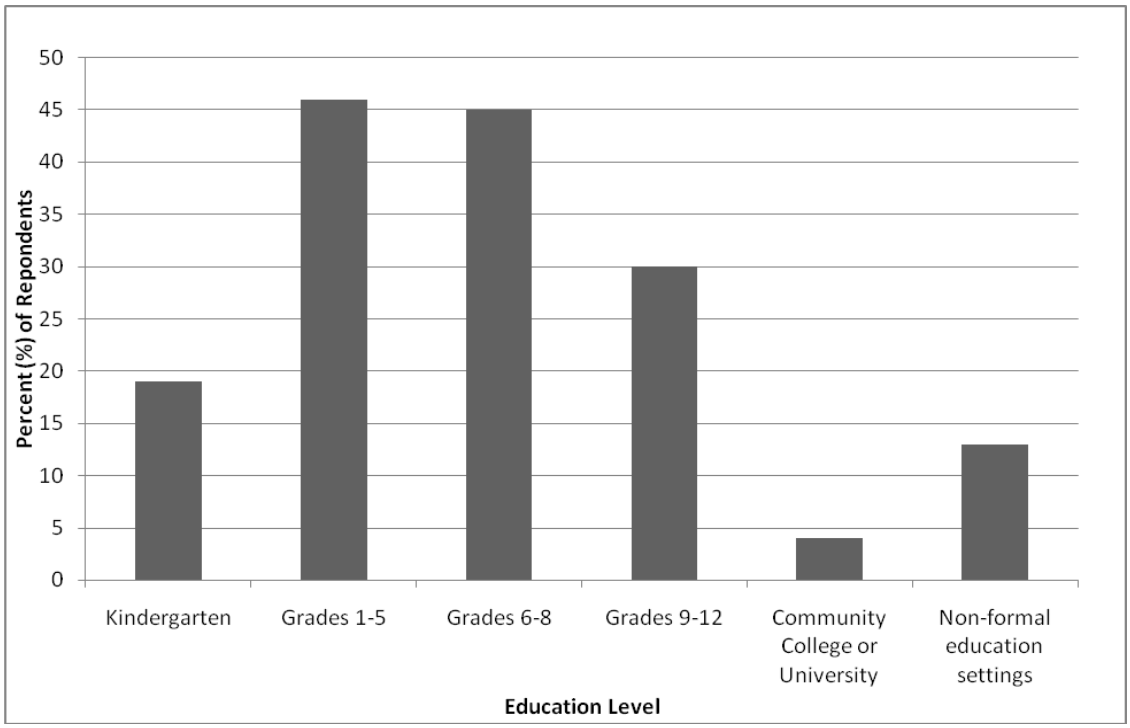

Figure 1. The education levels taught by the respondents of the online survey (*n*=72)

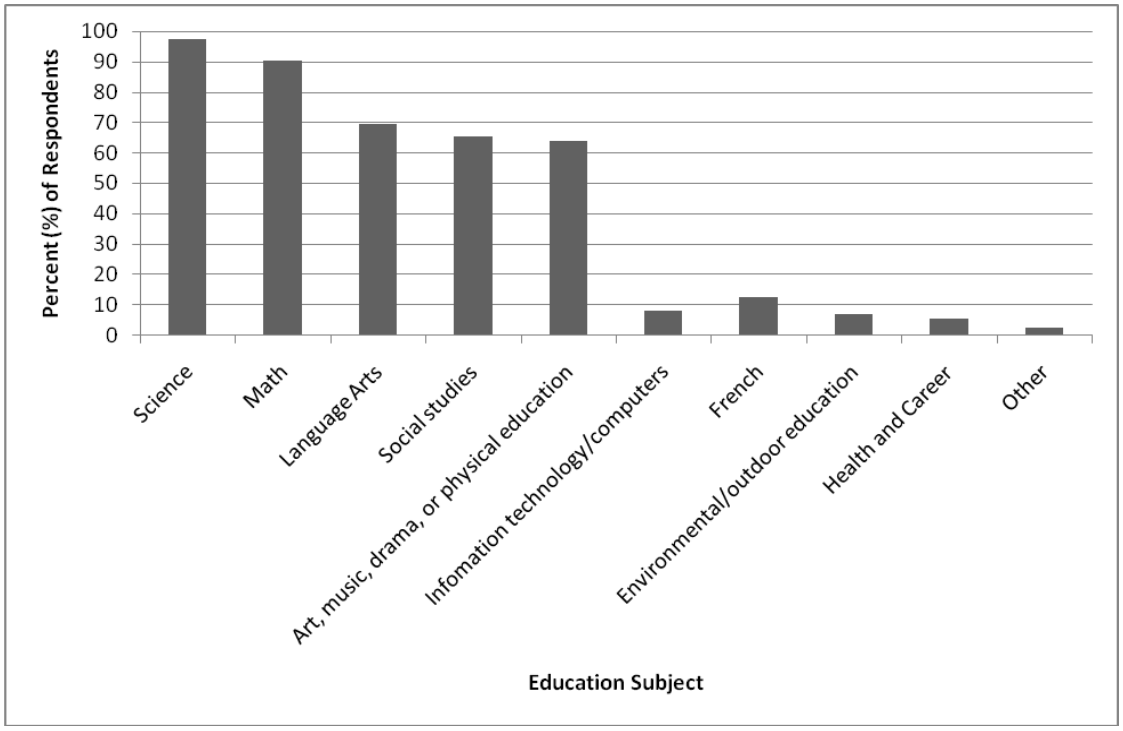

Figure 2. The subject material taught by the respondents of the online survey (*n*=72)

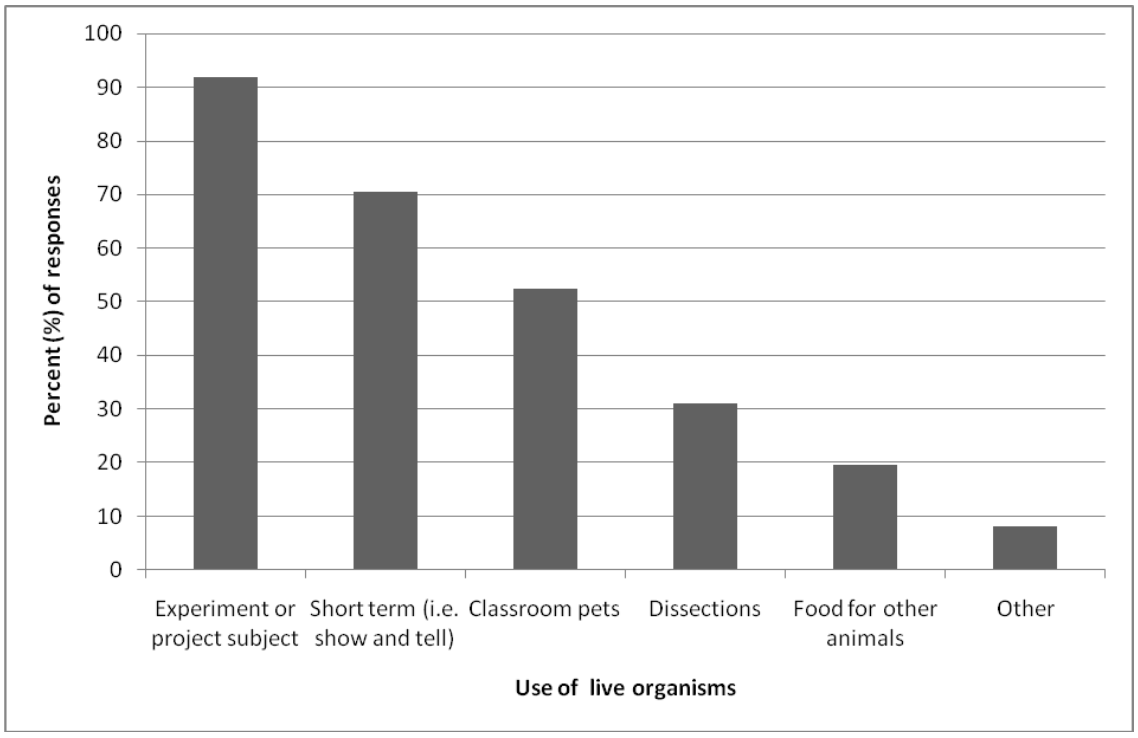

Figure 3. The teaching/classroom purpose of live organisms utilised in the classroom by respondents of the online survey (*n*=61)

APPENDIX: ONLINE QUESTIONNAIRE — TEACHER SURVEY

Questions of the 'Teacher Survey: Live Plants and Animals in the Classroom'

1. Please read this important information before proceeding with the survey! This survey is part of a study facilitated by Oregon State University in partnership with Ontario Ministry of Natural Resources, British Columbia Ministry of Environment, University of Florida, University of Illinois, Cornell University, University of Washington, University of California, and University of Southern California. The survey aims to understand the use of living plants and animals in the classroom and awareness of invasive species. Our goal is not to limit the use of live plants and animals, rather information gathered from this study will help us develop appropriate educational materials and other solutions that will help prevent the establishment of invasive species in the environment. Your participation in this study is voluntary and you may refuse to answer any question(s) for any reason. All responses you provide will be kept confidential and secured in a password-protected computer database. No personal or identifying information will be associated with your responses. There are no foreseeable risks beyond those risks that exist in everyday life for participants in this project as the questions are not of a sensitive nature nor are they invasive. It is expected that there will be direct benefits to society and your participation is extremely valued. Your contribution to this study will be used to develop tools that help prevent potentially invasive species from being spread to the natural environment through classroom use. At the end of this survey you will have the option of entering a drawing for an invasive species learning kit. Teachers who wish to be eligible can click on a hyperlink that will allow them to email one of the lead researchers. If you have questions about the survey, please feel free to contact Co-Principal Investigator Tania Siemens at 541-914-0701 or tania.siemens@oregonstate.edu, Jeff Brinsmead with the Ontario Ministry of Natural Resources at 705-755-7868, or Matthias Herborg with the BC Ministry of Environment at 250 356 7683 or matthias.herborg@gov.bc.ca.
    - I have read and understand this consent form and voluntarily agree to participate in this survey
    - Decline survey

2. Please indicate where you currently teach:
    - Province of Ontario or British Columbia
    - California, Florida, New York, Oregon, or Washington
    - Illinois or Indiana
    - Other (please specify)

3. Please enter the 5-digit zip or Canadian postal code where your school is located.

4. Do you teach or have you taught any of the following grades or levels?
    - Kindergarten
    - Grades 1-5
    - Grades 6-8
    - Grades 9-12
    - Community College or University
    - Non-formal education settings (museums, aquaria, or other organization that provide educational programs)
    - Other (please specify)

5. Do you specialize or have you specialized in any of the following areas?
    - Special education
    - Vocational education
    - Bilingual education
    - English language learners
    - Other (please specify)

6. Do you teach or have you taught any of the following subjects?
    - Science
    - Math
    - Language arts
    - Social studies
    - Art, music, or physical education
    - Other (please specify)

7. How would you describe the geographic setting of your school?
    - City
    - Suburb
    - Rural
    - Other (please specify)

8. How would you rate the importance of living plants and animals as teaching tools in your classroom?
    - Important
    - Somewhat important
    - Neither important or unimportant
    - Somewhat unimportant
    - Unimportant

9. Have you ever had or currently have living animals or plants in your classroom?
    - Yes
    - No

10. Indicate whether or not you currently use (or have used) live plants or animals for the following purposes in your classroom.
    - Classroom pets
    - Short-term visitors (e.g., show and tell)
    - Experimental/project subjects
    - Food for other animals
    - Dissections
    - Other (please specify)

11. What plants or animals have you used in your classroom (list)?

12. Please indicate whether or not you have obtained your classroom plants or animals in the following ways.
    - They were purchased from a biological/science supply house
    - They were purchased form a pet store
    - They were purchased form a plant nursery
    - A student purchased or brought them from home
    - They were given to me by the school or district/board
    - They were given to my classroom by someone other than the school or district/board (e.g., zoo, aquarium, or pet humane centre)
    - I collect them myself from the wild
    - I do not know who supplies them
    - Other (specify)

13. If you obtained your plants and animals from a biological/science supply house, please list the names of the specific supply house(s) you used.

14. Indicate whether or not the following information came with your classroom plants or animals when they arrived.
    - The biology of the plant of animal
    - Information about the plant or animal's native range
    - The scientific or Latin name (e.g., *Lithobates catesbeiana)*
    - The common name (e.g., bull frog)
    - General category of plant or animal (e.g., frog)
    - Where they were shipped from (country, state, city, etc.)
    - Care instructions
    - Disposal instructions
    - Other (please specify)

15. If desired information about the plant or animal was not provided, where did you look for additional information? Check all that apply.
    - I looked on the plant/animal supplier web page
    - I searched the internet
    - I asked a colleague at work
    - I asked an outside expert (e.g., University Extension Agent)

- I reviewed the district/board guidelines on plants/animals in the classroom
- I called the plants/animals supplier
- I looked over the learning materials associated with that plant or animal
- I haven't had the need to look for further information
- Other (please specify)

16. Indicate whether or not you have disposed of the live plants or animals in your classroom in each of the following ways.
    - They were returned to the supplier
    - They were given away to a student
    - They were given to another teacher
    - They were donated to a university, museum, or science program
    - They were kept in the classroom until they died on their own
    - They were released into the wild
    - They were disposed of by flushing
    - They were put in the storm drain (drain on the road side)
    - They were euthanized
    - They were disposed of in the trash
    - They were eaten
    - Other (please specify)

17. To what extent do you agree or disagree with this statement. "I would be willing to humanely euthanize a classroom animal if the methods were approved by the American or Canadian Veterinary Medical Association, and I was provided guidance and tools for carrying it out."
    - Agree
    - Somewhat agree
    - Neither agree or disagree
    - Somewhat disagree
    - Disagree
    - Not applicable

18. Who is responsible for <u>selecting</u> the classroom learning materials at your school? Check all that apply.
    - The teacher selects learning material for his/her class
    - A person or team at our school
    - A person or team at our school district/board
    - A person or team at the State or Provincial level
    - Someone outside the school, district/board, or State/Provincial level educational authorities
    - Don't know
    - Other (please specify)

19. Who is responsible for obtaining the plants and animals specified by the learning materials used at your school? Check all that apply.
    - The teacher obtains the live plants or animals for his/her class
    - A person or team at our school
    - A person or team at our school district/board
    - A person or team at the State or Provincial level
    - Someone outside the school, district/board, or State/Provincial level educational authorities
    - Don't know
    - Other (please specify)

20. What learning materials in your school utilize live plants or animals? Check all that apply.
    - Full Option Science System (FOSS)
    - Science and Technology for Children (STC)
    - Science Education for Public Understanding Program (SEPUP)
    - Tomatosphere
    - Atlantic Salmon Classroom Hatchery Program
    - None
    - Don't know
    - Other (please list other learning materials here. Please spell out acronyms and separate entries with commas.)

21. Have you been involved in selecting, adapting, or creating new learning materials for your school or district/board (e.g., learning kits, books, activities, or lesson plans)?
    - Yes
    - No

22. Please complete this sentence: "In general, when I evaluate whether or not to use new learning materials, the requirement of live plants or animals in the materials..."
    - Makes me MORE likely to select those materials
    - Makes me LESS likely to select those materials
    - Makes no difference in my decision
    - Other (please specify)

23. How would you describe your current knowledge of invasive species?
    - I have no knowledge of invasive species
    - I have little knowledge of invasive species
    - I have some knowledge of invasive species
    - I have a good working knowledge of invasive species
    - I am very knowledgeable about invasive species

24. What are some educational products that you think would help prevent invasive species from being released from classrooms into the wild? Check all that apply.
    - A list of plants and animals considered invasive in the region
    - Better information about the biology and ecology of the plant or animal
    - A list of biological supply houses that specialize in local or native species
    - Learning material to help students understand the impacts of invasive species
    - Workshops for teachers and developers of learning materials on integrating invasive species education into the classroom
    - Workshops for teachers and developers of learning material on the selection and care of plants and animals in the classroom
    - Better information about how to properly dispose of plants and animals when you are done with them, including a list of repositories or euthanasia guidelines
    - I do not think new educational products are necessary
    - Other (please specify)

25. Thinking about all of your classroom settings, to what degree to you teach about invasive species?
    - I teach about invasive species often
    - I teach about invasive species sometimes
    - I rarely teach about invasive species
    - I have not taught about invasive species at all

26. How do you incorporate (or have incorporated in the past) teaching about invasive species into your classroom? Check all that apply.
    - I cover basic invasive species concepts such as definitions and give a few examples
    - I teach a detailed unit that covers many aspects of invasive species impacts and prevention
    - I use invasive species as examples to teach benchmarks and standards
    - I integrate invasive species examples to teach multiple topics throughout the school year
    - Students are tested on their knowledge of invasive species
    - Students conduct outreach projects in their community related to awareness and control of invasive species
    - Other (please specify)

27. Do you know of learning materials where invasive species are the focus? Please list them here and separate entries by commas. Please spell out acronyms.

28. Please share any additional thoughts regarding the use of living plants and animals in the classroom or education on invasive species.