

**Changing Channels:
Altering the Dis-course of “Invasive” Species Education**

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Abstract

This portfolio is focused on two discourses around "invasive" species, namely the dominant Western science narratives that emphasize elimination, control, and management and an Indigenous perspective that takes a longer view that recognizes perpetual change in ecosystems. Braiding these worldviews together may offer a more humane and healthier approach to not only conservation science but also "invasive" species education. There are four tasks in this portfolio. The first is a literature review that provides an overview of Western and Indigenous epistemologies and ontologies in regards to conservation science, relationships to Land, and other beings with whom we share a life, zeroing in on "invasive" species. Some of the educational implications of these discourses are woven throughout the literature review. The second task in my portfolio focuses explicitly on education and involves a review of current "invasive" species education in the Ontario environmental science curriculum, as well as observations from my experiences as an interpreter about how "invasive" species are discussed. The third task is an interpretive program focused on "invasive" species that applies ideas from the literature review in a practical way. The fourth and final task is a reflection paper on my learning journey.

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Chapter One: Introduction

I am both a science educator in the Ontario provincial school system and for the Canadian National Park system. I have found there is considerable overlap between the curriculum I teach in my grade 11/12 Environmental Science class and what I present to the general public attending a program I offer at the National Marine Conservation Area where I work. Another commonality I have found is the unfortunate lack of formalized inclusion of Indigenous perspectives. In the 264-page Environmental Science provincial curriculum document (Ministry of Education, 2017), there is not one single mention of Indigenous approaches to environmental health and sustainability. I also have found that within Parks Canada, there can be a hesitancy amongst non-Indigenous park interpreters to share with visitors facets of Indigenous culture, because of worries of cultural appropriation and the sentiment that *these are not our stories to tell*; yet the dearth of Indigenous people working in the National Park system and the subsequent absence of their voices, and the omission and erasure of perspectives that run counter to the dominant Western narrative, is also harmful (Johnston & Mason, 2021).

My portfolio focuses on one particular topic that demonstrates this epistemic clash of meanings around one species group: "invasive" species. "Invasive" species are defined as organisms that have been introduced into a new habitat and ecosystem, and that cause harm to human health and/or ecological or economic damage to their new environment (Invasive Species Center, 2022b). The title of my study, *Changing Channels: Altering the Dis-course of 'Invasive' Species Education*, invokes the idiom of introducing a new topic of discussion, or redirecting someone's attention (i.e., changing the channel). Likewise, the expression "altering the discourse" also points to the change of direction or pattern that my research undertakes relative to dominant discourses on "invasive" species. The title is also a metaphor for the reorganizing of

a river ecosystem following a newcomer species arriving from a different waterway or “channel.”

The literature review demonstrates that there are many diverse perspectives on the topic of “invasive” species, so I have chosen to put "invasive" in quotation marks to signal that it is a contested idea. In dominant discourses newcomer species are typically viewed with contempt, while many Indigenous Nations and ecologists understand the dynamic nature of ecosystems and recognize the “services” that newcomer species often provide. I wonder how dominant discourse around “invasive” species may harm the very environment that conservationists purport to protect. I ask myself if we might owe newcomer species and "novel" ecosystems more consideration and appreciation? And, finally, I wonder how educators could better incorporate Indigenous knowledges into teaching about "invasive" species.

I brought these questions to the literature review task in chapter two by exploring and comparing Western and Indigenous epistemologies and ontologies as they relate to “invasive” species and argue that balancing these perspectives may not only enable a more humane education for all, but also a more rigorous scientific approach in environmental science. I also incorporate ideas from five different, but potentially interconnected, areas of education — Indigenous education, science education, conservation education, environmental education, and humane education — to help me imagine how to teach differently, more consciously, and truthfully about "invasive" species. The literature review informed the development of an interpretive program that I intend to offer in the future, and that I hope other park interpreters and secondary environmental science teachers might also want to adapt to their contexts. In the final task of the portfolio, I conclude with a short reflection paper to discuss what I have learned through the portfolio process.

Situating Myself

I start by situating myself to explain where I am from and where I have been as a white settler educator working in provincial school and national park systems, teaching Canadians of many socio-cultural-racial backgrounds. As a youth, I was fortunate to have the opportunity to spend my summers roaming about the small campground that my father managed, and the freedom to explore the various ecosystems around it, forging a connection with nature at an early age. As a young adult, I volunteered extensively at two interpretation centres, where I realized how fun and engaging learning about the natural world could be. Experiencing my own academic challenges as a student as well as working to better engage high school students as a youth worker led me to the field of education, where I hoped to integrate and apply my passions for ecology and social justice.

While working for a local National Marine Conservation Area, I came across two interpretive programs on “invasive” species in Lake Superior. At the time I did not have the knowledge or language to communicate what it was about the programs that made me uncomfortable, but I certainly was resistant to delivering them to site visitors. During two recent Master of Education (MEd) courses, *Place and Land in Education* and *Animals in Education*, I learned how paradigms and language shape our relationships with Land and more-than-human beings. In both courses, I was drawn into lively discussions about “invasive” species with my peers, and saw how our understandings of the natural world are often shaped by colonial narratives learned within our school system and reinforced by societal norms. I realized that there was a lot to unpack on this topic, and that it tied well with issues that I care deeply about — such as respecting our planet and her inhabitants, environmental sustainability, and Indigenous rights. I thus jumped at an opportunity to learn more about this contested topic, offer

my perspective, and model an interactive way of engaging learners in “invasive” species discourse.

As a white MEd student with a background in biology, psychology, and education, I am neither an expert in conservation sciences nor in Indigenous worldviews. Instead, I draw on my new learnings as a graduate student, my personal experiences working with Indigenous and non-Indigenous students/publics, and on the published works of Indigenous and non-Indigenous scholars. While it is daunting to push my inquiry in this direction, I see it as my responsibility as a white settler committed to reconciliation and as a Treaty partner to learn how to do better (Truth and Reconciliation Commission of Canada, 2015; United Nations, n.d.).

I come from a white French Catholic family who immigrated to “New France” in the late 1700s and who was “given” land to settle and on which to establish itself. I thus am undeniably a beneficiary of settler colonialism and white supremacist thought. At the same time, I am also harmed — as we all are — by the consequences of both white supremacy and human supremacy, the worldview that humans are superior to, and thus can and ought to dominate the more-than-human world (Bell & Russell, 1999). While I am not a practicing Catholic, I recognize the atrocities that religious institutions have committed against Indigenous Peoples during our shared histories, and share in their grief (Braganza et al., 2018). I also acknowledge that the sacred stories told by practitioners of the Catholic faith — some of which will be discussed in the literature review — have had lasting negative and violent effects on Indigenous Peoples, women, and non-human beings (Jensen, 2016; Rakoczy, 2004; Sugirtharajah, 2006).

For part of my upbringing, I was raised by an Algonquin stepfather alongside my two step-siblings, and in this way became introduced to Indigenous culture. As a youth worker for almost a decade, I have also worked with Indigenous families in various locations throughout

Canada and have had the chance to live in beautiful communities, meet welcoming neighbours, and make new friends. I have learned so much from these experiences and from Indigenous teachings that have deeply resonated with me. In this portfolio, I hope to use my position of privilege to further amplify Indigenous voices and perspectives, and to help bring more beauty and balance into education about "invasive" species, and beyond. I contend that curriculum developers in formal education systems as well as conservation agencies need to recognize and celebrate Indigenous intelligence and expertise, co-create educational content, and be part of the de/re-constructing of academic and scientific communities to foster conditions in which all beings can be healthy and flourish.

Portfolio Tasks

My portfolio consists of 4 tasks: 1) a literature review; 2) a review of current practices around education about “invasive” species in Ontario curriculum and in interpretive programming, and ideas for how it could be improved or enhanced; 3) an interpretive activity that I developed for use by parks/conservation areas and environmental science teachers; and 4) a reflection on my learning journey throughout the creation of this portfolio.

The literature review provides an overview of current “invasive” species discourse in relation to Western science and Indigenous knowledge (IK) systems and points to ways environmental science educators and park interpreters might co-relate Western and Indigenous epistemologies, or bring into better or right relations, in their teaching on this topic.

The second task in my portfolio is a review of current “invasive” species education in the Ontario curriculum and within the world of park environmental interpretation, which are public science programs. In particular, I examine occurrences of “invasive” species content in grades 1-12 curricula, how “invasive” species are framed within their respective units, and what the

implications of these perspectives could be. I also look to my own site within the Canadian National Park system as a window into the larger world of “invasive” species interpretive programming. As this type of programming is not documented nor widely distributed in the same way as provincial curricula, I am limited to my own experiences and sources when researching “invasive” species programming within the parks interpretive field. In this section, I also offer suggestions for teaching about the topic of “invasive” species while honouring treaty promises made by settlers as an act of reconciliation.

The third task is an “invasive” species interpretive activity that I have created to apply my learning. These activities and resources will better equip parks interpreters and other educators in presenting a more nuanced perspective on “invasive” species while encouraging dialogue around colonization and what it means to be a good neighbour. The program is a 2-hour activity based on a "mystery" type of game. The scenario includes a cast of eight aquatic beings who live in Lake Superior — some who have long been established in the area and many who have been more recently introduced in various ways — who are trying to figure out what caused a local dog to fall ill. Each character has been given engaging backstories so that participants will understand that these creatures are agentic beings and subjects of their own lives (Bell & Russell, 1999; Jensen, 2016). The activity highlights various paths of introduction, the interconnection between human activity, climate change, and species distribution, and the impacts — both positive and negative — that newly-introduced species can have on their new habitats. Participants will also learn about the Lake Superior food chain, and learn the difference between often-confused terminology such as introduced, invasive, naturalized, and hyperabundant. I have also included an Interpretation Guide (in place of the "Party Planner Booklet" that typically accompanies these games) that includes step-by-step instructions on how to deliver the activity.

The guide also includes suggestions for mood-settings, as well as props and decor. The package includes “invitations” to the event that provides more details on the character descriptions and costume suggestions. The package features name tags representing each species involved as well as character booklets that give participants a loose script to guide them through each act. Finally, as with typical mystery games, the product includes the author’s (my) solution to the mystery that has been presented, as well as questions to help debrief the activity with participants.

The fourth and last task in my portfolio is a short reflection on my learning throughout my portfolio journey. In it, I share key insights that I am taking away with me as I complete my Master of Education in Environmental and Sustainability Education.

Chapter Two: Literature Review

An Introduction to "Invasive" Species

This literature review begins with an overview of who “invasive” species are, and how they differ from long-established, introduced, naturalized, or hyperabundant species. I then make a case for recognizing the dynamic nature of ecosystems over time, acknowledging that species migration is a natural process that has occurred throughout time. Next, I provide insights on “invasive” species’ pathways of introduction into a new habitat, and how human activity is a major catalyst for species migration. Following a snapshot of current “invasive” species discourse in curriculum documents and interpretation, I provide an overview of Western and Indigenous epistemologies, ontologies, and methodologies in regards to conservation science and relationships to Land and other beings with whom we share a life, zeroing in on "invasive" species. The next section of the literature review focuses on the language currently used in mainstream environmental science education to describe “invasive” species, and how militarized language and immigration metaphors elicit negative attitudes, beliefs, and behaviours towards them. While educational implications of these discourses and possibilities for learning about

these connections in different ways are woven throughout, at the end of this chapter I describe how the literature review informs the interpretive activity and curriculum that I developed in response. In particular, I present various ideas for subtly refuting militaristic and anti-immigrations discourses by incorporating non-Western BIPOC discourses — especially those grounded in Indigenous ways of knowing and worldviews — into curriculum and interpretive programming as a way of countering this colonial framing of species deemed “invasive.”

Using the Right Terminology

"Invasive" species are typically defined as organisms that have been introduced into a new habitat and ecosystem, and that cause harm to human health and/or ecological or economic damage to their new environment (Invasive Species Center, 2022b). Other definitions focus on the *potential* for introduced species to cause harm to an environment that is new to them, even if that harm is not yet documented (United States Department of the Interior, n.d.). These simple definitions belie the fact that “invasive” species discourse is fraught with confusing terminology, including a multitude of different descriptors that have ambiguous meanings or mean virtually the same thing, which points to a pressing need for the field to establish common terminology to more clearly articulate ecological concepts and management efforts (Colautti & MacIsaac, 2004).

One common method used in the literature to distinguish long-established species from more recent introductions separates species along colonial timelines, such as “local,” “indigenous” or “native” species versus “non-native” or “non-indigenous” species (Reo & Ogden, 2018). However, many researchers believe that using European settlement to demarcate species is an arbitrary choice (Van Dooren, 2011). Some even believe that “[t]here is no such thing as a native species” (Pearce, 2015, p. 50). In this literature review, I predominantly use

"long-established" to describe species that are considered "indigenous" to a local area, and alternate between "newcomer" and "newly-introduced" species when I refer to more recent arrivals in an ecosystem. I also use quotation marks when describing particularly contested terms, like "invasive" species.

I have noticed in my own professional experiences that, in schools and public programming alike, the terminology used to describe "invasive" species or related concepts is often inconsistent, which can leave students and the general public with misconceptions about their threat and impact. While many organisms have immigrated from their countries of origin, only about 10% of newcomer species survive in their new habitat (United States Environmental Protection Agency, n.d.). Only 10% of this subset (or 1% of the total) are actually labeled as "invasive," i.e., that presently cause ecological and economic harm in their new environment (United States Environmental Protection Agency, n.d.).

Further, while "invasive" species are almost exclusively discussed as a *species*-level problem, in actuality, they consist of a *population* of a species that has migrated into a new habitat and thrived (Van Dooren, 2011). As noted, most newly-introduced species are not able to tolerate the environmental and climate conditions of a new habitat over the long term. For instance, although there have been several piranha caught from lakes in British Columbia in the recent past, these aggressive tropical fish — most likely released by overwhelmed pet owners — likely cannot survive a B.C. winter, so have not proliferated in their new habitats ("Invasive piranha," 2019).

Even if a newcomer species *can* adapt to their new habitat, they may become a neutral or even integral part of the local food chain and local culture; think, for example, of the dandelion that is now referred to as "naturalized" in North America. Long-established species can also

“behave” like an “invasive” species — growing in population, taking over their habitat, and causing significant ecological and economic damage. For example, during a particularly cold winter in 2014, a group of wolves reached the Slate Islands via an 11-kilometre ice-bridge on Lake Superior and decimated the resident population of caribou normally protected by the geological barrier (Alexander, 2020). Such “native” species that proliferate and take over the resources of a habitat are referred to as "hyperabundant" as are long-established species that negatively impact a species at risk (Government of Canada, 2021a).

As I reflect on this confusing terminology, I know it is important that science educators and park interpreters come to understand and be able to better communicate the nuances of, and differences between, these different terms. Otherwise their students or the general public may develop an exaggerated perception of the abundance and threat of species that are not that problematic and also may not be able to understand which populations may be truly harmful.

How They Got Here and Why They Are Staying

The introduction of species into a new environment can be deliberate or accidental (Reo & Ogden, 2018). For example, a person may *deliberately* release imported ornamental plants, bait bucket contents, or pets into the environment, or a conservation authority may stock a species of fish in a lake to enhance recreational fishing experiences and augment tourism, or release a new species into the environment to prey upon and reduce the population of another. On the other hand, a person may purchase a product from a pet store or garden centre and *accidentally, even unknowingly*, introduce harmful organisms into the environment or carry foreign organisms into new habitats on shoes, vehicle tires, equipment, or in the ballast of their boat. A government agency may also accidentally introduce a species to a new environment through the dredging of transportation channels and canals.

Newcomer species can most often be found in landscapes that have been disturbed by natural events or human activity (Pearce, 2015). Spaces that have been transformed through deforestation, agriculture, urbanization, pollution, and climate change, to name a few examples, disrupt the local ecosystem, resulting in the displacement or loss of local populations (Scott, 2010). As opportunists, newcomer species that can adapt to the new environmental conditions can take advantage of the newly vacated ecological niche — in other words, “step in where others fail” (Pearce, 2015, p. 57). Because introduced species often turn up when long-established species are declining, they are often misrepresented as *causing* the decline. Thus “invasive” species are frequently blamed for the extinction of other species, when in actuality environmental degradation, and human overharvesting and overhunting may be the root cause (Pearce, 2015).

As mentioned above, only a fraction of newcomer species that arrive into a new habitat can adapt to, let alone thrive in, their new environment. Of those that have the necessary adaptations to establish themselves, many newcomer species become productive members of their community — interacting with other species as both predator and prey, and becoming part of the local food chain. For example, named after the French *dent de lion* — meaning “lion's tooth” — the dandelion is an introduced plant family whose various members are commonly found all over North America (Jackson, 2015). The flower originated in Europe, and was introduced by early settlers, perhaps deliberately for its medicinal properties (Mohler et al., 2021). Dandelions are often found in disturbed landscapes, and are known to clean heavy metals out of soil (Scott, 2010). Dandelions also were an important source of food during The Depression and World Wars because they were free, nutritious, and widely available, but after the 1950s, they became associated with poverty and hardship (Sutherland, 2021). Considered an

obnoxious “weed” for generations, especially given the North American obsession with lawns, more recently communities are (re)learning to embrace this harmless flower because of its obvious ecological, economical, and health benefits (Hopper, 2011). Most parts of the dandelion are edible and, in early spring especially, the plant is an important food source for insects, birds, and mammals alike (Hopper, 2011). The dandelion also is extremely important to the honey industry as it blooms from early spring to late fall, providing nectar for honeybees (Scott, 2010). The dandelion also increases milk production in cows and other farm animals, and has been used as a nursing aid for human mothers for millenia (Scott, 2010). Communities throughout the country now commonly hold initiatives such as "No Mow May" to draw attention to the importance of the dandelion, especially as the snow recedes and the “native” vegetation awakens more slowly (Sutherland, 2021).

As the example of the dandelion demonstrates, introduced species can come to be seen as neutral or even as an important part of their new ecosystem. When this accommodation happens, species are then often referred to as "naturalized," in a similar way to how a non-citizen of a country can acquire citizenship. While only a small fraction of introduced species are capable of establishing themselves in a new habitat as successfully as the dandelion, an even smaller fraction of newcomer species "take over" and become problematic. The ones that do are more adapted to the new, often settler-disrupted environmental conditions than the “native” species, and at times have no natural predators to control their population. A local example is sea lamprey, sometimes colloquially known as “the vampires of Lake Superior” who, by 1938, had made their way through the Great Lakes system through human-made channels — such as the Welland canal dredged to allow the passage of cargo ships — and into Lake Superior. Because they have no natural predators, the parasitic, eel-like fish that originated in the Baltic Sea quickly

propagated and decimated fish populations across the Great Lakes (Great Lakes Fishery Commission, 2021). The population is now “controlled” by the Ministry of Natural Resources and Forestry through regular lampricide applications (Great Lakes Fishery Commission, 2021).

It is a common saying that you cannot unscramble an egg. The idiom, appropriately about the mixing of different components, signifies that some processes are irreversible. In the same vein, there is no going back into a former, *idealized* ecosystem. Yet this basic idea still provokes an immense amount of debate among conservationists (Dempsey, 2021) even though newcomer species are staying. Because they are here. For now. Whether they hitchhiked on — or in — a migratory bird, or floated across the ocean on a piece of plastic debris, individuals who find themselves in a new habitat will strive to survive — and even thrive — according to their genetic makeup and physiological adaptations (Pearce, 2015). Nature is not stable, but is in constant flux (Pearce, 2015). All the same, every year an incredible amount of funding, labour, and other resources are directed at futile attempts to unscramble eggs.

Our Changing Climate

An important contemporary example of nature in flux is climate change, and it too is an important contributor to the phenomenon of "invasive" species. Alongside the direct ways of introducing newcomer species into the environment, settlers also indirectly contribute to species migration through activities that lead to climate change and global warming (Orion, 2015). The warming of land and water habitats causes changes in species distribution, as cold-loving species that cannot adapt to the temperature change move to cooler habitats (e.g., deeper in waters, towards the poles on land). For example, five of the most "extremely vulnerable" species around the Ontario Great Lakes are arctic-alpine disjunct plants that are found in cool, rocky coastal regions around, and on small islands within, Lake Superior (Ministry of Natural Resources and

Forestry, 2018). As the climate is projected to warm the area's surface waters by 2.9 to 6 degrees in the next century, the diminishing ice cover and resulting changes in species composition in this region may lead to these vulnerable plants becoming locally extirpated (Ministry of Natural Resources and Forestry, 2018).

Rising temperatures also are extending the range of wood-boring insects as they move further north, like the emerald ash borer who has moved into the Lake Superior region (Bencomo, 2013). These insects, who likely hitchhiked on firewood brought into the region, quickly kill their hosts, ash trees, and provide additional fuel for forest fires (Bencomo, 2013). And this has created a ripple effect since the increase in forest fires leads to more disturbances and clearing of areas, allowing newcomer species to move in, perpetuating further changes to the environment (Invasive Species Center, 2021). Likewise, droughts place further pressure on long-established species, which can lead to new species that can better tolerate dry conditions moving to the neighborhood and getting settled in. For example, while now colloquially regarded in the United States as "the vine that ate the South," the kudzu was once viewed as a saving grace. With its long taproot, it can grow in the worst drought conditions and bring new life to a cracked and desolate habitat (Pearce, 2015). However, once the kudzu started growing on agricultural lands, it became inconvenient and unwanted (Pearce, 2015).

Newcomer species can also arrive following natural disasters such as flooding, tornadoes, and hurricanes, all of which are on the rise due to our changing global climate (International Union for Conservation of Nature, 2021). For example, the chickens who inhabit Kauai Island in Hawaii are likely the descendants of domesticated birds whose cages blew open during the high winds caused by hurricanes Iwa and Iniki (Chang, 2015). As the chickens have no natural predators, they continue to multiply and roam the forests, streets, and beaches, delighting tourists

(Chang, 2015). Locally, water hyacinth is an aquatic plant native to the Amazon basin that is commonly imported as an ornamental plant for outdoor ponds (Ontario Federation of Anglers and Hunters, 2022). When the ponds get flooded, this species gets introduced to local bodies of water (Ontario Federation of Anglers and Hunters, 2022). As a single water hyacinth plant can produce up to 140 million offspring a year, the resulting mass can block waterways and affect fisheries (Pearce, 2015).

Diving into the ‘Ologies

Before I begin this section, I should state that there are few academic papers that offer an alternative to the dominant Western worldview of “invasive” species. It should also be noted that Indigenous knowledge is often transmitted orally and can be protected from outsiders and academia (Absolon, 2015), which presents a limitation for this literature review. That said, I did find materials that helped me think more critically about Western "invasive" species discourse I was marinated in during my previous academic studies and my professional life. What I have come to realize is that comparing Western and Indigenous views on “invasive” species discourse requires exploring worldviews. Becoming more familiar with aspects of both Western and Indigenous ontologies (ways of being), epistemologies (ways of knowing), axiologies (what is valued), and methodologies (ways of doing) can help educators understand why these discourses differ, contrast and even clash. One other caveat for this section is the tendency of some writers to overgeneralize and not recognize that there are different Indigenous perspectives and knowledge systems throughout the country and throughout the world. Whenever possible, I will include the names of the First Nations or First Peoples whose perspectives are shared in the supporting literature while doing my best to avoid pan-Indigenism.

Contrasting Settler "Place" and Indigenous "Land" in Environmental Science Education

A place is more than just a geographic location on Earth. In addition to being a mathematical point on our planet and a physical land or waterscape, a place is a space where human culture and identity emerge (Gruenewald, 2003). In a time reigned over by capitalism and globalization, when textbook publishers seek to produce materials that can be sold in as many jurisdictions as possible to maximize profits, the content of educational materials does not always reflect the students who use them. Yet place is an important topic in education and an entryway into exploring local history and culture (Gruenewald, 2003). There have been critiques of some approaches to place-based education for being too Eurocentric and apolitical (e.g., Tuck et al., 2014). More critical, post-colonial pedagogies celebrate Indigenous histories, languages, and traditions as the foundation of places (Chambers, 1999), histories that European settlers have often ignored and painted over. In his paper, "Edmonton Pentimento: Re-Reading History in the Case of the Papaschase Cree," Donald (2004) uses the metaphor of pentimento — the “phenomenon of earlier painting showing through a layer or layers of paint on a canvas” (p. 21) — to reveal how places have changed over time. Pentimento is Italian for "repentance" or deep regret (Collins, 2022), and the process of revealing submerged truths and narratives can also be understood as an act of restitution. In contrast, colonial notions of place — ones that ignore the hidden layers or take a painting at face value — largely contribute to the erasure of First Peoples and their relationships to land as well as to the myth of Black placelessness (Nxumalo & Cedillo, 2017).

Colonial notions of place permeate Western culture, including in art and popular culture. Examples include films such as *Grizzly Man* and *Into the Wild* that feature “Eurocentric celebrations of solitary heroism, rugged individualism, and ignorance of place” (Korteweg & Oakley, 2014, p. 131). Another great example is the art produced by the famous Group of Seven,

white male artists who traveled in the 1920s and 1930s through the country painting “wild” landscapes that captured the imaginations of urban Canadians, fostering a sense of collective pride. Rarely did these works capture any sense of the Peoples who already inhabited these “wild” landscapes, however. As one of my Indigenous Parks Canada colleagues once said to me, “It’s like they painted a scene and shook all the people out.” The Group of Seven’s perspective of remote landscapes as “wilderness” echoes the 1400’s “Doctrine of Discovery,” instructions from the Pope that provided legal and moral justification for settler colonialism, and the 1900’s “Manifest Destinies” in the United States that posited that settlers were destined to expand across North America (Calderon, 2014). “New” landscapes were considered *terra nullius*, “nobody’s land,” available for the taking, for conquest, and open to capitalist greed. Even when recognizing that these were not wild and empty landscapes, settlers believed that they had more claim to the occupied lands than their original occupants, seeing themselves as transforming the land from “worthless” to “valuable” (Brody, 2000). Today, even local forests are often viewed “as a 'wild,' empty, and unscribed space awaiting (...) discoveries” (Nxumalo & Cedillo, 2017, p. 104). The idea of “pristine” nature not only ignores the realities of First Peoples on the land, but also the countless transformations that these landscapes have undergone since humanity’s earliest days using fire to manipulate their environment.

Within the Western paradigm, not only can one feel *entitled* to land, but one can *own* the land (Korteweg & Russell, 2012), including all the materials and the living beings who reside there. Indeed, the “living, breathing nonhuman beings [are seen] as objects to be controlled and exploited by humans” (Bell & Russell, 1999, p. 73). The utilitarian view of non-human beings, otherwise known as resourcism, is apparent in the English language through metaphors of utility and ownership such as “stock,” “game,” and “timber” (Bell & Russell, 1999). Terms such as

"renewable" also implies that these "resources" are inexhaustible (Brody, 1981), a reflection of the influence of capitalism and the myth of infinite growth. One only has to look at the sheer quantity of post-secondary programs in "natural resource management" to understand how society is transmitting this perspective and these values from generation to generation.

Complementary to resourcism is extractivism, "the central fiction on which our economic model is based: that nature is limitless, that we will always be able to find more of what we need, and that if something runs out it can be seamlessly replaced by another resource that we can endlessly extract" (Klein, 2011, para. 25). As Willow (2016) states, "more than just a way of using the land, extractivism is also a way of thinking. It is a way of being in the world; a way of positioning ourselves in a relationship to the natural worlds we occupy" (p. 2). Our Canadian school system, at all levels, is deeply Eurocentric and continues to reinforce Western ideologies of colonialism, domination, and violence over "other" people and over nature (Simpson, 2014).

Indigenous Peoples' relations to nature, place, Land, and other beings typically sit in stark contrast to Western perspectives. In his book, *Wisdom Sits in Places: Landscape and Language Among the Western Apache*, Basso (1996) describes the importance of places, place names, and the stories that are etched into the Land. For many Indigenous Nations, the geographic area in which a person lives is more than a place, but is an area ascribed with cultural meaning by the people who live there or visit it. *Land*, a term now preferred by some Indigenous scholars (e.g., Tuck et al., 2014), represents much more than place. As Styres et al. (2013) suggest, place *exists on land*; Land *is*, therefore place *can be*. Or, as Kimmerer (2015) writes, Land is the mud carefully placed by Muskrat on Turtle's back that saves Skywoman from drowning, Land is the fertile soil that allows Skywoman's seeds to grow and nourish her and her relatives. In these perspectives, Land is sentient, a living thing (Styres et al., 2013). Or, as Scully (2020) suggests,

Land is agentic in and of itself. Land (and water) participates, teaches, and enacts its own processes; plants, animals, and humans are formed by and are reliant upon these interactions. This is the understanding of Land as First Teacher — Land shapes people, capital, communities. (p. 228)

Western and Indigenous Scientific Knowledges

Not only do Western "ways of being" on the Earth differ from Indigenous ontologies, so do its "ways of knowing" or epistemologies. When it comes to scientific knowledge, in particular, there are many ways that Western science has traditionally differed from Indigenous Knowledges. Generally speaking in broad outlines, Western science claims to be "objective" while favouring quantitative over qualitative methods (Mazzocchi, 2006) while Indigenous Knowledge systems have included observations, lived experiences and oral stories as rich knowledge sources, transmitted through the generations in Indigenous languages, since time immemorial (Chapin et al., 2013). Western science has largely prioritized evidence and explanation within the *physical* world, whereas Indigenous Knowledge systems also gives credence to all states of knowledge, including from the intellectual, physical, emotional and intuitive, and spiritual or metaphysical with ancestral connections (Wilson, 2008). Western science is often reductionist in nature, breaking down complex systems into parts and studying interactions through simple and controllable experiments — whether in the lab or in the field — that are verified through global replication (Mazzocchi, 2006). In contrast, Indigenous knowledges make use of *practical* experimentation on the Land and of *local* verification (Chapin et al., 2013). Finally, Western scientific knowledge has primarily been transmitted through academic channels (Mazzocchi, 2006) available to only a select few whereas Indigenous Knowledges are communicated through metaphor and story and shared more widely.

Of course, Western science is not a monolith and some have taken to heart critiques that have been levelled at it by Indigenous peoples, feminists, and others working in science studies (e.g., Bandeira, 2008; Bang et al., 2018; Keller, 1982). This dominant version of Western science, however, is the knowledge system that most settler educators have been exposed to and that continues to be reproduced or replicated in "school science" (Rudolf, 2003). Science education recently has embraced more diverse types of teaching and learning than it has in the past, including inquiry learning, experiential learning, and place-based approaches (Gruenewald, 2003). Some of these approaches resonate better with Indigenous approaches, such as attending to embodied learning (Bang et al., 2014) and learning from context and relationships (Simpson, 2014). Land, too, is important in Indigenous approaches and is the context for "coming to know" the world around us and the countless interrelationships we are a part of (Simpson, 2014).

Indeed, while their methodologies — or "ways of doing" — can differ from Western science, many Indigenous Peoples have a strong knowledge of science and ecology, particularly through their annual cycle of subsistence activities (Barnhardt & Kawagley, 2005). As Simpson (2014) writes, many Indigenous Peoples learn “from the land and with the land” (p. 7). In the wonderful article by Brayboy and Maughn (2009), "Indigenous Knowledges and the Story of the Bean," an Indigenous pre-service educator describes how she teaches her students about planting seeds by carefully observing the stars and waiting for certain constellations to be in position. Another example comes from Twance (2019) who shares how an Anishinaabe member of Pic Mobert First Nation who sustains their family by fishing on Lake Superior requires knowledge of “how to locate fish according to the seasons, the type of boat needed to withstand rough water, how to set nets and calculate boat speed, and the locations of safe harbours” (p. 10). Even moments described as a "hunch," such as picking a plentiful spot to fish, depend on a myriad of

subtle natural science observations and deep knowledge of factors such as wind speed and direction, quality of light, and barometric changes, to name a few (Ross, 1992).

Many Indigenous Peoples observe the flora and fauna around them, and learn from their many teachers in the animal and plant kingdoms (Kimmerer, 2015). In Simpson's (2014) retelling of "Kwezens makes a lovely discovery" — a traditional Michi Saagiig Nishnaabeg story she learned from Washkigaamagki (Curve Lake First Nation) Elder Gidigaa Migizi (Doug Williams) —Kwezens observes a red squirrel nibbling and sucking at the bark of a maple tree, and in mimicking the squirrel's actions discovers the sweet water within for herself and her community. The presence of such gifts teaches gratitude, abundance, and reciprocity (Kimmerer, 2020).

Indigenous cultures understand humans within an ecological context, and have respect for all aspects of creation (Ross, 1992). They seek to "live in ethical relationality with more-than-human others, where humans are not figured in hierarchical order in relation to others" (Nxumalo & Cedillo, 2017, p. 102). The philosophy of "All My Relation" illustrates how Indigenous communities relate to all beings with whom they share a life (Lowan, 2009). As Simpson (2014) writes,

First Nations people who continue to rely on traditional values and institutions look at the world and see themselves as a part of it — see themselves in a caring and supportive relationship to all human beings. They feel the earth is the source of life and give reverence to the earth and to the wonders of life coming from Mother Earth. They give spiritual regard and respect to the animals, the plants, the land, and to the universe. They feel related to everything and everything is a part of them — all things are connected. They see beauty everywhere. They respect themselves and others. (p. 5)

Indigenous Peoples thus know plants and animals as persons, as beings “whose existence has in itself an absolute worth” (Robinson, 2014, p. 674). Further, animals and plants are “self-aware rational beings whose existence is for themselves rather than for us” (Robinson, 2014, p. 674). These assemblages of *persons* are understood as *nations* rather than as different species (Reo & Ogden, 2018). Indigenous Peoples approach their interactions with more-than-human beings with humility, respect, and reciprocity (Simpson, 2014), and have countless rituals that celebrate the lives and deaths of these relatives (Brody, 2000).

The 'Ologies in Relation to “Invasive” Species

Within Western science, there are now competing views on “invasive” species and even on the idea of ecosystems (Pearce, 2015), although newly emerging ideas are currently more controversial. For the most part, though, the *challenges* that “invasive” species present in their new habitats such as harms to human health, ecological disruptions, and economic damage, are what is emphasized.

Some newly-introduced species can negatively impact human health by being vectors for diseases, such as the Asian tiger mosquito known for carrying the West Nile virus and Dengue fever (Mazza & Tricarico, 2018). Zebra mussels can increase the presence of toxic algal blooms, which affects the water supply of humans and wildlife alike (Invasive Species Center, 2022c). Other species can bite or sting, and cause physical injury to humans and other animals (Mazza & Tricarico, 2018). For example, the Asian giant hornet — otherwise known as the "murder hornet" — that found its way into BC in summer 2020 is said to feel like a "red hot fire poker being shoved into the skin with the pain lasting for hours” (Neustaeter, 2020, para.1). Newcomer species like the sea lamprey in Lake Superior can greatly impact their new ecological communities through predation of “native” populations, competing with long-established species

for resources, becoming parasitic, or bringing in disease (Government of Canada, 2017). Newly-introduced species also can sometimes cause other species' extirpation (Government of Canada, 2017); for example, after Europeans brought cats and mongooses to Hawaii to hunt down rats, many of the islands' bird species disappeared, including the Hawaiian rail, last seen in 1884 (Pearce, 2015). Some newcomers — for example burrowing aquatic species like the signal crayfish — may cause ecological disruptions by eroding river banks (Harvey et al., 2019), while others, like cheatgrass in Western North America, drastically alter the fire cycle (Brooks et al., 2004).

Economic consequences can also be associated with newly-introduced species. For example, zebra and quagga mussels have damaged property and infrastructure (Invasive Species Center, 2022c), and sea lamprey have reduced productivity in the fishing industry (Great Lakes Fishery Commission, 2021). The economic harms induced by introduced species can lead to restrictions on export and trade (Hulme, 2021). Interestingly, newcomer species who cause economic damage receive much more funding than those who cause ecological damage or harm to human health, which illuminates the priorities of many governments and policy-makers. For example, 30 years ago projects addressing the impacts of quagga and zebra mussels — who damage boats and water intake pipes — received the vast majority of funded opportunities nationally (Bell, 1994). Today, by far the largest sum of “invasive” species funding in Ontario is spent by municipalities on protecting or replacing trees affected by the emerald ash borer (Invasive Species Center, 2022a). While the distribution of ash trees is not limited to urban centres, and while the trees do perform economic, ecological, social, cultural, and health services to residents, the most important factor in the vilification of the ash borer by municipalities is the economic cost of replacing urban forests (Greene & Millward, 2016). Because of their ability to

withstand urban pressures, ash trees have been a preferred choice in city planting programs throughout Eastern Canada, and represent a large portion of cities' urban canopies (Greene & Millward, 2016). Due to this narrow tree species selection, and because city trees require stocking initiatives, cities such as Toronto and Ottawa stand to lose *hundreds of millions of dollars* to replace the dead trees with new varieties (Greene & Millward, 2016; Langechenier, 2018).

While I do not want to dispute that the examples listed above have actual impacts, in many cases, much of the "invasive" species discourse is dominated by discussion of *potential* consequences of "invasive" species. Indeed, their *actual* impacts are often exaggerated by scientists, policy-makers, and educators alike. For instance, in his 1992 book, *The Diversity of Life*, Wilson stated, "In recent centuries, and to an accelerating degree during our generation, habitat destruction is foremost among the lethal forces, followed by the invasion of exotic animals" (cited in Chew, 2005, p. 7). Soon after, in a 1998 issue of *BioScience*, Wilcove restated the point, "Habitat loss is the single greatest threat to biodiversity, followed by the spread of alien species" (p. 607). *BioScience* issued a disclaimer alongside the Wilcove *et al.* (1998) article that read in part,

We emphasize at the outset that there are some important limitations to the data we used.

The attribution of a specific threat to a species is usually based on the judgment of an expert source, such as a USFWS [Fish and Wildlife Service] employee who prepares a listing notice or a state Fish and Game employee who monitors endangered species in a given region. Their evaluation of the threats facing that species *may not be based on experimental evidence or even quantitative data. Indeed, such data often do not exist.* (cited in Chew, 2015, pp. 25-26, emphasis mine)

While the claim that "alien" species pose almost as big a threat to biodiversity as habitat loss has never been properly substantiated (Chew, 2015), it continues to circulate uncontested in the media, on conservation agency webpages, and in Government documents (e.g., Ellis, 2020; Government of Canada, 2017; Madren, 2011; National Wildlife Federation, n.d.). In actuality, some ecologists have come to believe that newcomer species can *promote* biodiversity by increasing hybridization and speciation — putting pressure on both newcomer and “native” species to adapt to a changing environment (Davis, 2003; MacDougall, 2003; Schlaepfer, 2018; Vermeij, 1991). Organizations that claim otherwise — like the National Invasive Species Council — *exclude* newcomer species from their biodiversity count, thus only providing part of the story (Pearce, 2015).

Regardless of the impact that introduced species have on their new habitat, positive or negative, humans have an ethical obligation to think beyond *populations* to consider the *individual* newcomers’ subjectivities, and the suffering that “control” techniques may have on their lives. It is surprising to me that groups of people who purport to love animals and nature so much can be so indifferent to the treatment of particular individuals based on the arbitrary nature of where their species originates from. For cues on how science educators can foster empathy for the experiences of other living beings, we can look towards the field of humane education. Caine (2012) asserts, “The essence of humane education is to find ways of relating to nature, to non-human animals and to each other that are nurturing, supportive and positive” (para. 2). Humane educators seek to provide accurate information so that learners may understand the consequences of their actions, foster critical thinking, and offer positive choices for a better world (Weil, 2007). Kindness, compassion, and respect for all beings is a hallmark of humane education (Caine, 2012), whether in a classroom or a conservation area. Humane education helps us frame

other beings not only as members of a species and ecosystem, then, but as individuals who deserve consideration.

When discussing newcomer species, instead of only dwelling on the challenges they can pose, educators can also remind students of “the profound similarities between human and non-human experiences” (Caine, 2012, para. 2). They could share the case in New York City where residents have mobilized efforts to protect the monk parakeet, a species of newly-introduced birds who have been establishing themselves across the United States following accidental and purposeful pet owner releases (Seymour, 2013). Residents have:

organized protests against utility company management tactics, worked with utility companies to develop more humane management strategies, sought support for humane management from local government, attempted to effect state legal protection for the birds, and made considerable efforts to garner the support of the public. (Seymour, 2013, p. 56)

Unfortunately, thus far, Western science and conservation efforts do not tend to consider the subjectivities of the organisms that have made their way into a new ecosystem. Instead, they are seen as *objects* to control. The methods involved in “managing” or “controlling” an “invasive” species population are often inhumane (Pearce, 2015; Seymour, 2013), but there is no public outcry as these species are viewed with contempt. Inhumane practices — such as baiting, trapping, gassing, poisoning, or deliberate infecting with lethal viruses — would never be tolerated by the general public if they caused such distress and torment to “native” or “domesticated” animals (Van Dooren, 2011).

The language that is used to categorize or describe beings, or actions upon beings, can influence the way that we as humans relate to more-than-human animals, and shape our

understanding and experience. Western approaches to conservation frequently refer to living beings as “predators,” “pests,” “weeds,” “vermin,” or “bugs,” which elicits a negative reaction from the public towards these species (Bell & Russell, 1999). As Van Dooren (2011) states, “No work needs to be done to justify the protection of some species and the destruction of others because these values are incorporated into the terminology” (p. 290). Even the language used to describe the methodology of conservationists — such as “controlling” or “managing” a population — contorts the reality of their actions, masking that these are in fact mass killing events (Bell & Russell, 1999). These methods also sometimes harm the very ecosystems they seek to help, for example, through the application of herbicides or the introduction of “biological controls” into the environment (Reo & Ogden, 2018), and they can even cause some “native” ones to go extinct. For example, conservation efforts to eradicate introduced rodents from the island of Hawadax in the Aleutian Islands (formerly known as “Rat Island”) poisoned most of the bald eagle population and hundreds of gulls (Gilman, 2019).

While there are many words for “pests” in the English language, Indigenous groups use more neutral terminology to speak of “invasive” species, and have a different perspective on species considered “pesky” within the Western paradigm. For example, the Sault Ste Marie Tribe of Chippewa Indians and Bay Mills Indian Community in Northern Michigan simply describe “invasive” plants as “weedy” (Reo et al., 2017). All beings are respected, considered teachers, and cherished for their respective gifts (Kimmerer, 2015). Ecosystems are viewed as dynamic and constantly changing, and the arrival of new species into an ecosystem is considered a natural form of migration: “Being new to an area, human-introduced, or even leading to environmental change does not make an animal or plant unwelcome or inherently bad” (Reo & Ogden, 2018, p. 1448). The term “invasive” fails “to make visible the motivation of settlers that brought flora and

fauna from their homelands to make these new lands like home — or what has been termed ecological imperialism” (Bang et. al, 2014, p. 47). It is more often the ideologies themselves, rather than the newcomer species, that Indigenous Peoples find invasive (Reo & Ogden, 2018).

As newcomers arrive, Indigenous Peoples often look for ways to relate to these new relatives, often through observation (Reo & Ogden, 2018). Many new residents offer gifts and utility. For example plantain, or “white man’s footprint,” is used to treat various ailments: “It’s a foreigner, an immigrant, but after five hundred years of living as a good neighbor, people forget that kind of thing” (Kimmerer, 2015, p. 214). Many new relatives also make great dietary staples, a local example being the rainbow smelt. Other beings make great building materials — for example, in addition to using it in recipes, the “invasive” broadleaf cattail is used by Indigenous communities for weaving and building lodges (Reo & Ogden, 2018). Some Indigenous communities, such as the Anishnaabe, have obligations to harvest and use these relatives for their particular gifts, whether they are newcomers or not: “Very old Anishnaabe teachings hold that if you do not use the plants and animals who offer themselves to the people, they will go away” (Reo & Ogden, 2018, p. 6).

It is not that Indigenous communities do not recognize the threat of particular “invasive” species, and they will use various technologies in their attempts to combat them (Reo & Ogden, 2018). For example, the Malanbarra Yidinji clan in Queensland, Australia traditionally use plants as poisons to selectively control two populations of “invasive” tilapia fish that are severely impacting long-established fish species (Gratani et al., 2011). In North America, hand-pulling is by far the most common method employed by Indigenous Nations to remove “invasive” plants, followed by mowing, chemical treatments, fire, hunting, biological controls, and grazing (Reo et al., 2017). Indigenous Nations also commonly partner with government bodies and non-

governmental organizations to prevent “invasive” species from entering their communities. For example, the Wabanaki Nations in Maine have partnered with the United States Animal and Plant Health Inspection Service to detect and respond to the anticipated arrival of the emerald ash borer (Reo et al., 2017). Indigenous Nations also actively educate community members on the subject of “invasive” species, share prevention strategies, save threatened seeds, transplant threatened species, and document traditional knowledges regarding “native” species (Willow, 2011). Contrary to how government “invasive” species funding is allocated primarily to species that cause negative economic impacts, Indigenous Peoples are primarily concerned about environmental impacts and cultural impacts such as access to traditional medicines or building materials (Reo et al., 2017).

An ethic of non-interference common to many Indigenous communities can also be at play in relating to "invasive" species (Ross, 1992). That may lead some communities to not intervene in the efforts of conservation authorities. This ethic of non-interference also applies to respecting the agency of other-than-human beings; as Kimmerer (2015) says,

All things have a purpose and ... we must not interfere with its fulfillment.... Maybe the task assigned to [settlers] is to unlearn the model of kudzu and follow the teachings of White Man’s Footstep, to strive to become naturalized to place, to throw off the mind-set of the immigrant. (p. 214)

I concur with Kimmerer (2015) who suggests that humankind has much to learn from our “immigrant plant teachers” (p. 214); if we *migrated* instead of colonized, became part of the community, were nourished by the lands and waters, were grateful for the gifts we received, *and gave back* to the Land and to our non-human relatives, the world would be a better place (Kimmerer, 2015).

On Language and Metaphor

The importance of language and metaphor has come up earlier in this literature review when, for example, I discussed the anthropocentrism and resourcism evident in words like "pest" or "timber." As Larson et al. (2005) wrote, “metaphors are important not only because they facilitate understanding but also because they do so by transporting meaning across the 'boundary' of science and society” (p. 245). A good metaphor can simplify complex mechanisms and interactions, turning public confusion into comprehension, and at times driving science to new insights, but it can also be problematic (Chew & Laubichler, 2003). Science is “ripe” with metaphorical language. Imprecise imagery “such as alien, assembly, cascade, colonize, community, competition, consumption, contest, defense, disturbance, efficiency, enemy, equilibrium, flow, founder, gradient, hierarchy, interaction, invasive, native, niche, node, productivity, sink, source, stability, succession, territory, [and] web” (Chew & Laubichler, 2003, p. 52) is so commonly used in scientific literature that it easily makes its way through the rigorous peer-review process unscathed. However, there are negative consequences of using metaphorical “short-cuts” rather than describing specific processes.

First, metaphors can be dangerous because they are interpreted through a cultural lens (Chew & Laubichler, 2003). A resonant example of this is the application of metaphors in eugenics, where those in power employ metaphorical language to subordinate others. Communities of colour, religious and sexual minorities, people with disabilities or mental health challenges, and people in poverty have historically been oppressed through metaphors, at times resulting in forced sterilizations or death. For example, "subordinates" were viewed as “weeds in the human garden,” “anchors on the ship of progress,” or waste products, to name a few (O’Brien, 2011, p. 10). The atrocities committed towards peoples of Jewish descent in Nazi

Germany were largely based on Darwinian metaphors of the natural world (Weikart, 2013). In particular, the Darwinian mechanism of natural selection “formed the backdrop for eugenics, killing the disabled, the quest for 'living space,' and racial extermination” (Weikart, 2013, p. 538). In the field of conservation ecology, we can see similar metaphors, with campaigns for “genetic integrity” and against the interbreeding of newcomer species and “native” ones (Smout, 2003).

Second, the context that informs our cultural understandings is dynamic, therefore the lens with which we understand metaphors is always changing (Chew & Laubichler, 2003). For example, in our current cultural context, the word “natural” has positive associations (Chew & Laubichler, 2003). Newcomer species that have migrated through “natural” means such as “seeds on the feet of birds, [or] fruits floating across bodies of water” (p. 247), are viewed more positively than those purposely or accidentally introduced by humans (Larson et al., 2005). Likewise, in our current cultural context, ecological “productivity” and “diversity” are viewed as virtuous traits (Chew & Laubichler, 2003). The polarization between “good” organisms and communities, and “bad” or “artificial” ones (Larson et al., 2005) easily lends itself to military and anti-immigration metaphors, as I will discuss below.

Beyond Militarized Language and Anti-Immigration Metaphors

The boundary between “native” and “non-native” can be divided along two axes: space and time (Lockwood et al., 2013). Geographic and temporal “outgroups” are subjected to scrutiny, and described using aggressive metaphorical language. One way that the Western science narrative around “invasive” species *others* living, breathing beings, is by describing them using militaristic metaphors. Goode (2016) writes,

While the distinction between native and non-native species dates to the 18th century, the term 'invasion' was first used in a 1958 book — “The Ecology of Invasions by Animals and Plants,” by Charles Elton — that drew on the militaristic vocabulary of the post-World War II era. (para. 5)

This is witnessed in “command and control” forms of environmental management (Reo & Ogden, 2018, p.7), and the “fight” against “invasive” species. In her highly influential 1962 book, *Silent Spring*, Carson popularized militarized language in ecological contexts, comparing human eradication of insects to “warfare” and also “declaring war” against companies that created harmful pesticides (Burke, 2004). In fact, her book was originally slated to be called *War Against Nature*, and throughout the text, Carson utilizes the metaphor “shelter” to describe the shared ecosystem of humans and more-than-human animals (Burke, 2004).

In time, the use of militarized thought and language as it relates to the environment has led to an entire sub-field of biology — “invasion ecology.” The field grapples with the intentional and accidental introductions and spread of newcomer species to new areas, and the ecological impacts they may cause (Parker, 2020). Other commonly “deployed” terms in the field include “biosecurity,” “border control,” “combat,” “strategies,” “attacks,” “defenses,” and “casualties” and “victims” (Larson et al., 2005). As proof of their culpability, the media also frequently portray introduced species as killers, describing them as “butchering,” “choking,” “slaughtering,” “smothering,” and “suffocating” members of their new communities (Larson et al., 2005).

Other “invasive” species campaigns have created “unwanted” posters for particular species: “If you catch it, kill it. It’s not a dead or alive thing, we want it dead” (Chew & Laubichler, 2003, p. 52). No matter if they are wrongly convicted. Scott (2010) argues, “A war

— either real *or imagined* — must be waged in order to gather public support and funding from the government... *War on Invasive Species, War on Terrorism, War on Drugs, War on Poverty*” (p. 8, emphasis in original). Framing the challenge of introduced species in terms of war or battle may be more newsworthy, and may incite the public to action (Chew & Laubichler, 2003). Research is more likely to be funded if circumstances are seen as catastrophic. While commonly employed in scientific literature, militarized language is emotion-based, inaccurate, and unscientific (Crawford, 2018), and has profound material consequences for the beings with whom these wars are being fought.

The Western science narrative around “invasive” species also utilizes immigration metaphors, and often mirrors anti-immigration rhetoric. When former President Trump was in office, supporters of his harsh stance against “illegal immigrants” were driven by a fear of infectious disease and contamination (Crawford, 2018). This xenophobic rhetoric is evident when describing the uncontrollable fertility, reproduction, and “parasitism” of both “invasive” species and human immigrants (Subramaniam, 2001). At the same time, “native” species are often portrayed “as ‘defenseless,’ ‘delicate,’ ‘fragile,’ ‘susceptible,’ ‘vulnerable,’ and ‘weaker’ than invaders” (Larson et al., 2005, p. 251). The “invasive” Canada thistle, for example, is feared for its reproductive zeal, and the native female thistles are often cast as “passive helpless victims of the sexual proclivity of the foreign/exotic males” (Subramaniam, 2001, p. 31). Likewise, purple loosestrife is despised for its foreignness and fecundity (Ellis, 2022), even though native bees love it (Pearce, 2015), it has the capacity to clean spoiled waters, and can be used for medicine (Scott, 2010). This anti-immigrant rhetoric is extended to the false belief that human and non-human newcomers “steal” the resources of the local population. Even native populations, such as the hyperabundant black cormorant population in my hometown of Ottawa,

have elicited xenophobic reactions from local residents. Recreational fishers, in particular, have been pressuring the city to allow mass extermination of these birds because they have settled in the area, and are eating "too much" fish (Cotnam, 2020).

Just because organisms have not co-evolved together does not mean that they cannot get along. A newer model for the functioning of "novel" ecosystems is the idea of "ecological fitting" that is based on the premise that species perform specific functions within an ecosystem, and that an ecosystem can continue to thrive if a newcomer species replaces — or works alongside — a “native” species performing that same function (Janzen, 1985). Seeing that our ecosystems are a hodgepodge of species from all over the world at this point, I have no doubt that this is true. Residential gardens, both floral and vegetable, offer a variety of “native” and newcomer plants, insects, and microbes that work together to provide habitat and nourishment for other species.

“Invasive” species have particular patterns of mobility (e.g., hitchhiking in the ballast of ships) and settlement (e.g., establishing themselves in nutrient-rich areas) (Reo & Ogden, 2018). While not a perfect comparison given the lack of colonial intent, in some ways, the harms that some foreign species bring to their new environments replicate the violence that European colonization inflicted on Indigenous Peoples and their lands and ecosystems. Europeans sought to establish themselves in occupied territories and “tame” or “civilize” a “wild” or “savage” “Other.” They built large fortresses in which they spent most of their lives, while keeping Indigenous Peoples outside the walls (Donald, 2009). Similarly, settlers built their farms on Indigenous Peoples' lands, battling against “weeds” and erecting fences to keep “nature” away from the food they were growing (Brody, 2000). In Genesis, a sacred text of the Western world, Eve is caught eating an apple and, as punishment, humans are banished from the Garden of Eden

and cursed to “eat the plants of the field” (Brody, 2000, p. 75). In Catholicism, God planted the garden and its bounty and “wild” foods are stigmatized whereas in Indigenous culture all food is a gift from the Creator (Kimmerer, 2020), and “[h]ome is already Eden” (Brody, 2000, p. 90). Another example of this insider/outsider dichotomy is the establishment of the national park system for which I work. The first national park was established in Banff, Alberta in 1885, after which Westerners kept the Indigenous Peoples whose lands the parks are now on at bay (Nxumalo & Cedillo, 2017), and approached “invasive” species in a similar way. Often, the work involved in eradicating “invasive” species is viewed as patriotic (Pearce, 2015).

Reo and Ogden (2018) write how “invasive” species are described as “biological entities temporally connected to colonial timelines, using terms such as ‘alien’, ‘colonizing’, [and] ‘colonial’” (p. 1443). Similarly, Van Dooren (2011) notes that a “native” species is generally one that was present prior to European arrival. While the rate at which species have been introduced to new habitats since European contact *is* unprecedented, there is a certain arbitrariness in choosing European settlement as the divide between long-established and newcomer species (Van Dooren, 2011). Thus, some critics have proposed terms like “long-term residents,” “recently introduced species,” or “problem species” instead (Larson et al, 2005), recognizing the power of language.

Indigenous Peoples also use metaphorical language to describe their relationship with the environment and with introduced species, which elicit their own calls to action (Bach & Larson, 2017). While there are few examples inscribed in the scientific literature, one study of Australian Aborigines sheds light on how Indigenous Peoples use metaphors to promote understanding and stewardship of “Country” while bypassing militarism and nationalism. Bach and Larson (2017) share that “Aboriginal elders speak about weeds through passive, neutral language and prefer

metaphors for weed management that focus on health, care and creation” (p. 561). They go on to say,

Elders commonly used the term "introduced" to describe any plant that they understood to have arrived on their own since British colonization. It was purely descriptive and did not attribute any value, whether positive or negative, to the plant. The term "introduced" instead highlighted a plant's entanglement with humans and human activities. That a weed had been introduced commonly provoked curiosity and discussion among elders, which prompted a number of questions about the weed's relationship to humans: "From where was it introduced?", "Who introduced it?", "When did they introduce it?", "Why did they introduce it?", "Do people still like it or use it?", and "How did it become a weed?" (p. 571)

In contrast to Western ontologies that cast species as being “in” or “out” of place (Van Dooren, 2011), Indigenous groups tend to view newcomer species as belonging in their new habitat (Bach & Larson, 2017). Instead of perceiving introduced species as “pollution” in an otherwise “pure” or “pristine” environment, Indigenous Elders look at the ecosystem as a whole to determine whether it is in balance (Bach & Larson, 2017). In the Australian Aborigines' context, if a species is impacting a fresh-water source for example, Country is described as “sick” or “down” and if a species is restricting access to land, or to important cultural sites or practices, Country is described as “choked” (Bach & Larson, 2017). The metaphors used by Australian Aborigines do not focus on the villainification or eradication of “invasive” species, but on the protection and healing of Country (Bach & Larson, 2017). Contrary to the Western characterization of “invasive” species as “killers,” Australian Aborigines characterize introduced species, and native plants, that spread quickly as “cheeky,” which is not necessarily negative; for

example, fast-spreading passion fruit that is an important food source is said to be “cheeky” (Bach & Larson, 2017).

While there are many differences between Western and Indigenous ontologies, the use of metaphorical language as it relates to the environment — and to “invasive” species in particular — is an important meeting ground, and a site in which we can transfer concepts between one knowledge system and another. As I hope I have demonstrated above, Indigenous Peoples offer important alternatives to the colonizing and militarized language currently associated with resourcism, extractivism, and "invasive" species. Unfortunately, although Indigenous Peoples have been protecting their lands and waters since time immemorial, the field of conservation is still widely overrepresented by people of European descent who apply colonial metaphors to the conservation challenges associated with "invasive" species.

Re-membering our relationships with the natural world is an important lesson that dominant science - and society at large - can learn from Indigenous Knowledges. Learning from our plant and animal relatives, being grateful for their respective gifts, and living in reciprocity with the natural world (and each other) is what will get us through these dark times. As Simpson (2019) states, “As we continue to ignore that [...] we are losing the richness, the intelligence, and the generative capacity of Indigenous Knowledge to build these other worlds” (54:02 -54:14).

Conclusion

Some introduced species are undeniably harmful. The seed-eating Polynesian rats brought by the Rapa Nui to Easter Island deforested the island and ended their civilization; Black rats carried fleas to Europe and caused the "Black Death"; a North American fungus caused the potato famine in Ireland; and cholera brought to Latin America in ship ballast infected shellfish and killed 12,000 people (Pearce, 2015).

Other species may be deemed harmful, but later proven to not be a significant threat. For example the tamarisk, a flowering plant in the American West, was initially thought to consume too much water at the expense of native flora. Scientists representing mining operations that wanted access to water rights to make war armaments made exaggerated claims to incite their removal, so “demonizing tamarisk became part of the war effort” (Pearce, 2015, p. 56). In the end, tamarisk were found to not consume any more water than the average plant and to provide important shelter for endangered “native” birds (Goode, 2016). Scott (2020), evoking the words of Ralph Waldo Emerson, suggests “invasive” species such as the tamarisk are often ones “whose virtues have not yet been discovered” (p. 4).

"Invasive" species also can positively contribute to their new habitat, with many newcomer species bringing teachings and services to their new communities. For example, humans have purposely introduced tree species into ecosystems to increase rainfall (Pearce, 2015). Further, as Scott (2010) noted,

some provide food for human, animal, and other inhabitants, some protect the land after improper clearing and use, some renew degraded soils, some cleanse the waters, and some break down and clean up toxins and pollutants in the soil and air [...] *and* they are here for us to use as medicine. (p. 3)

As well, mixed communities comprising diverse “native” and newcomer species create "novel" and augmented ecosystems that can be more robust and adaptable to change — an idea termed “biotic resistance” (Pearce, 2015).

Finally, in some cases, the “invasive” species’ new home may be the only one that it has left. These species may be regarded as both “invasive” *and* endangered, creating the paradox of being under threat in both their native and new habitats, albeit for different reasons (Goode,

2016). The complicated nature of "invasive" species thus presents humans with the dilemma of letting them settle in or deliberately causing their extinction, or seek other solutions that are less binary.

As educators and conservationists, we must ask ourselves why we continue to prefer certain historical multispecies communities over others. In “exclusive ecological imaginaries” (Van Dooren, 2011, p. 290), any new species can be seen as a threat. But eradicating newcomer species does not restore a lost environment; indeed, in some cases it can lead to an overabundance of “native” species or increase their mortality due to mesopredator release (Van Dooren, 2011). At the end of the day, the “invasion” of an ecosystem by newcomer species really just means “change” (Goode, 2006). Just as family-owned businesses are succumbing to big box stores across Canada and beyond, Earth’s flora and fauna are becoming increasingly homogenized under globalization. Population growth, globalization, and our insatiable thirst for material objects are leading to the degradation of ecosystems, which causes the decline of long-established populations and the rise of newcomer species (Scott, 2010). As Pearce (2015) writes, “The more damage that humans do to nature — through climate change, pollution, and grabbing land for intensive agriculture and plantation forestry — the more important alien invasive species will be to ensuring nature’s survival” (p. 178). The habitats that environmentalists, scientists, and law-makers then strive to “keep pristine” actually require constant micromanaging, leading Pearce (2015) to call these increasingly-manufactured landscapes “theme parks for conservation scientists” (p. 178).

In response to what I have found in writing this literature review and in my review of existing "invasive" species education discussed in the next chapter, I have created an “invasive” species interpretive activity as one way of disseminating my new learning. The literature review

informs this project in several ways. First, the activity will clarify some of the often-confused terminology in “invasive” species discourse, such as invasive, introduced, naturalized, and hyperabundant, building on my concerns about the problematic language and metaphors typically found in "invasive" species discourse. Second, the activity will enable learners to explore species’ subjectivities through descriptive and relatable backstories and also allow them to learn about the Lake Superior ecosystem and food chain. Third, the program will also make clear to participants the interconnection between human activity, climate change, and species distribution, and allow them to ponder the impacts — both positive and negative — that introduced species can have on their new habitats. Fourth, by troubling Western, colonial perspectives on "invasive" species and incorporating insights from Indigenous perspectives — and by incorporating ideas coming from Indigenous education, science education, conservation education, environmental education, and humane education — learners may be able to broaden their perspectives on the topic, assuming that, like me, most of them have been marinated in dominant "invasive" species discourse. Finally, I hope that the activity will model how educators, whether they work in a park, for a conservation authority, or in a science classroom, can more accurately, and more humanely, teach about “invasive” species and "novel" ecosystems.

Chapter Three: Educating about "Invasive" Species

In the previous chapter, I discussed a few implications for education about "invasive" species, particularly the need to carefully consider the language we use. In this chapter, I describe the ways in which “invasive” species are currently written about in the Ontario provincial curriculum as well as what I know about how they are currently taught about to students in classrooms and to the general public through interpretative programming. I then make

a case as to why educators should move beyond colonial ontologies and binaries when teaching about the natural world, including “invasive” species education. Finally, I suggest frameworks that educators can use to incorporate multiple worldviews into sustainability and “invasive” species discourses that stem from the field of Indigenous education.

"Invasive" Species Discourse in Curriculum and Interpretation

The topic of "invasive" species comes up quite frequently in current Ontario curriculum documents. Within the elementary school curriculum, “invasive” species are covered most frequently in the Science curriculum document, as I expected. Students in Ontario learn about life systems — including "invasive” species — in grades 4, 6 and 7, in their "Habitats and Communities," "Biodiversity," and "Interactions in the Environment" units respectively (Ministry of Education, 2007). The definition of "invasive" species used in the Science curriculum document appropriately defines these as both being introduced *and* having negative effects on the new environment. The Science curriculum document lists zebra mussels, purple loosestrife, and the Asian longhorn beetle as primary examples. Interestingly, the document defines a “native” species as one “that originates or *naturally occurs* in an area (Ministry of Education 2007, p. 205, emphasis mine), as if species migration is *unnatural* in itself.

Grade 6 students also have the opportunity to learn about "invasive" species in their Social Studies class, within the unit, "People and Environments: Canada’s Interactions with the Global Community" that focuses on globalization and global solutions (Ministry of Education, 2013). Grade 7 students might also cover the topic in Geography within the units on "Physical Patterns in a Changing World" and "Natural Resources around the World" (Ministry of Education, 2013). I noted that the grade 7 Geography curriculum uses more neutral language when describing “invasive" species, and invites students to come to their own conclusions on the

“economic and environmental impact of invasive species” (Ministry of Education, 2013, p. 172). In addition, the grade 7 Geography curriculum specifically mentions the connections between human activity and the introduction of "invasive" species in their new environment (Ministry of Education, 2013) in contrast to the Science curriculum document in which this relationship is missing or ambiguous across all grade levels (Ministry of Education, 2007). For example, within the grade 4 Science curriculum, "invasive" species are listed as a factor in the “depletion or extinction of a plant or animal species” (Ministry of Education, 2007, p. 85), and "invasive" species are explicitly said to “reduce biodiversity” in the grade 6 Science curriculum (Ministry of Education 2007, p. 114). Finally, I want to note that the presence of "invasive" species is referred to as “an infestation” in the grade 7 Science curriculum (Ministry of Education, 2007, p. 127).

Within the high school Environmental Science curriculum, the topic of "invasive" species shows up in the context of five different courses; grade 9 Science (academic), grade 11 Environmental Science, both grade 11 and grade 12 Green Industries, and grade 12 Canadian and International Politics (Ministry of Education, 2017). Both the grade 9 Science and the grade 11 Environmental Science courses introduce the topic in neutral language, and explicitly connect the introduction and propagation of "invasive" species to human activities. It is important to note, however, that the grade 11 Environmental Science course is an elective that I have found is not offered by all schools.

The remaining three secondary courses outlined in the high school Environmental Science curriculum document tell a different story. They list “invasive” species as a biotic factor affecting natural resource harvest and product quality (Ministry of Education, 2017), and primarily focus on “pest and disease control techniques” (Ministry of Education, 2017, p. 249) and “disposal methods for invasive plants” (Ministry of Education, 2017, p. 244). Consistent

with the elementary Science curriculum documents, the high school documents define "invasive" species as "[n]on-indigenous species that have adverse [...] effects on the habitats they invade" (Ministry of Education, 2008, p. 256) and also list zebra mussels and purple loosestrife, as well as the round goby, as primary examples (Ministry of Education, 2017). Once again, I was interested to read the definition of "native" species within the high school Environmental Science curriculum document. In this case, the Ministry of Education defines "native" species as "species indigenous to a particular area or region that *have evolved over thousands of years, adapting to their surroundings, and have become an important part of the local ecosystem*" (Ministry of Education, 2008, p. 256, emphasis mine).

Omitted from any of the provincial curriculum documents was the inclusion of an alternative view of "invasive" species, Janzen's (1985) theory of "ecological fitting," where a species that performs a specific role within an ecosystem can be replaced with another that performs that same role, or the idea that novel ecosystems are unavoidable, resilient, and necessary in our changing environment. Also absent was any reference to introduced species becoming an important part of a local ecosystem or relevant examples of that. Instead, embedded in the text is a dominant narrative of "native" and "invasive" species separated by colonial timelines. Finally, there was not a single mention of an Indigenous perspective on the topic of conservation generally nor "invasive" species more specifically.

I have not had the opportunity to teach about "invasive" species within the context of a high school classroom. I can say that as someone with an Environmental Science teachable, "invasive" species was not a topic covered during my BEd. Two former university colleagues of mine generously shared their "invasive" species resources with me, as helpful teachers tend to do. Not having backgrounds in Science and no official guidance on the topic, they sought out

teaching resources online. Given that, when I looked through what they found to help them teach about the topic, I was not surprised by what I saw: anthropocentric ways of relating to non-human beings, derogatory illustrations of introduced species, fear-mongering videos about newcomer species “terrorizing,” “wreaking havoc,” or “bullying to extinction” other species in their new habitats, and ambiguity about the individual members of the species' suffering or fate under human interventions. I understand how this happened. Teachers are often generalists and cannot be familiar with the nuances of all the particular topics they find themselves teaching about. Teachers are also extremely busy, and may sometimes gravitate to dubious online resources they do not have time to assess critically, so they may not be able to do their homework so to speak. Perhaps as critiques of the discourse on “invasive” species become more widespread, teachers will be able to more readily find ecocentric information to support their teaching.

In my current position delivering interpretive programming for one of Parks Canada's National Marine Conservation Areas, I have come across two programs about aquatic "invasive" species in Lake Superior that are quite similar. The first is a simple demonstration of how to properly "clean, drain, and dry" your boat and recreational equipment. The other is more informational, where visitors can earn a sticker for learning about aquatic "invasive" species, and "be a Superior Hero" — a play on the word “superhero.” Both programs are accompanied by a giant reference binder full of information on Lake Superior's aquatic "invasive" species, jars of sea lamprey of various sizes preserved in formaldehyde, and a brochure featuring a big, ugly photo of a sea lamprey under the text, “The battle continues...”. While the programs do highlight pathways of introduction — and the connection between introduction, propagation, and human activity — there is no clarifying of terminology, no nuanced analyses, nor no alternative views

on offer. “Invasive” species are merely objects to be “controlled” by us, just as “native” ones are portrayed to be in desperate need of our protection.

Elsewhere in Parks Canada, other parks make use of common campaigns such as "Clean, Drain, Dry," and "Don't Let it Loose" (Canadian Council of Invasive Species, 2022). While I do not know of extensive programming around “invasive” species currently being delivered across the agency, the Government of Canada has recently announced it will be investing \$14.7 million over the next five years for conservation projects to prevent and manage aquatic "invasive" species in Banff, Jasper, Kootenay, Waterton Lakes, and Yoho national parks (Government of Canada, 2021c). This amount includes funding for staff training, funding allocated to local Resource Conservation teams to monitor and manage aquatic "invasive" species, and funding for public engagement in the form of inspections, decontaminations, permitting, and public programming. Entire visitor services teams in these regions will be dedicated to ensuring the success of the new self-certification permitting system, ensuring compliance, and conducting inspections and decontaminations. Interpretive products that they create may include signage, pamphlets, and educational programming, to name a few.

Internet searches for other organizations' “invasive” species programs reveal similar trends. While some agencies distinguish introduced species from “invasive” ones, most resources only contrast “native” and “invasive” species. Terms such as “alien,” “invaders,” and “Frankenfish” permeate the resources, and activities such as creating an "unwanted" poster seek to elicit negative attitudes, beliefs, and behaviours from participants towards newcomer species. Most resources do not encourage a nuanced dialogue around “invasive” species, naturalization, or their importance to novel ecosystems, nor offer alternative perspectives — Indigenous or otherwise.

Thus, both in the Ontario curriculum and in interpretation materials of Parks Canada and other conservation agencies, there is an overwhelming dominant narrative that is derived from Western science and fully conforms with a Western worldview. In this paradigm, newcomer species are seen as nuisances — intruders to be blocked, controlled, and exterminated by humans. In this human supremacist worldview, the land, the sky, the water, and all the beings with whom we share a life, exist primarily, or only, for our utility (Jensen, 2016). When humans perceive living beings as “resources,” or as threats to those resources, they have the power to transform entire landscapes for their convenience and comfort. Currently, then, “invasive” species education on the ground is almost exclusively framed within this dominant Western worldview. As noted, there is not one single mention of differing perspectives on this topic in provincial curriculum documents nor are these worldviews typically considered within the field of conservation education and park interpretation. In what follows, then, I make a few suggestions for how we might reimagine "invasive" species education.

Moving Beyond Colonial Ontologies and Binaries

As Simpson (2014) writes, “In a time of increasing environmental catastrophes and climate change, we need to be especially proactive in disrupting settler colonial commodification and ownership of the land” (p. 8). As noted above, colonial society tends to describe the world dichotomously, with “either or” binaries such as society/nature, us/them, civilized/ uncivilized, colonizer/colonized, and modernity/tradition (Raibmon, 2005). In the Bible, when God instructs Noah to build his ark, he instructs him to load seven pairs of “clean animals” (i.e., domesticated animals used in agriculture) and one pair each of “unclean animals” (i.e., untamed ones) (Brody, 2000). These instructions reveal an early sign of how Westerners viewed wild animals, as well as the people who ate them. The very use of the word “animals” to describe other beings distorts the

reality that all of us are part of an ecosystem, and we humans are also animals who need not be overseeing and controlling the environment around us for our own utility (Bell & Russell, 1999).

Further, as Nxumalo and Cedillo (2017) observe, “Black feminist geographies question the universality of the category of *human* in colonial human/non-human binaries” (p. 101, emphasis added). Many categories of humans (e.g., women, Indigenous peoples, Black peoples, queer peoples) have been *dehumanized*, often deemed to be not fully human but instead closer to other animals, thereby enabling their mistreatment (Bell & Russell, 1999). This dehumanization and myths of “purity” and “pollution” permeate many human cultures such as the Indian caste system or Jim Crow America (Harari, 2014), and are also reflected in modern conservation practices. In Canada, terms such as “mixed-blood” or “half-breed” clearly demonstrate the historical fear of “gene-mixing” of European and Indigenous populations, and the disdain towards the resulting Métis descendants (Lundgren, 1995). These sentiments are echoed in conservation efforts to keep “foreign” species from interbreeding with “native” populations. As Nxumalo and Cedillo (2017) suggest, there is an undeniable connection between “environmental vulnerabilities, human exceptionalism, anti-blackness, and settler colonialism” (p. 100).

As noted above, I have witnessed this duality replicated in the Ontario education system in school curriculum, in teacher training, and in classrooms. Such binaries also permeate the mandates of leading conservation agencies. In my position as a Heritage Presenter for the Canadian national park system, my role consists of “protecting” and “presenting” a site’s “natural” and “cultural” heritage (Government of Canada, 2021b). Aside from the concern that the very act of “presenting” heritage creates a division between those who have their heritage memorialized, and those who do not (Vogelaar & Hale, 2013), this separation of natural and cultural heritage implies that other animals do not have their own cultures and that human culture

falls outside of the scope of “nature.” In conservation discourses, binaries are utilized both in species identification (i.e., whether a species is “native” or “non-native”) and management (i.e., whether a species should be “protected” or eradicated) (Vogelaar & Hale, 2013).

Further, from the moment we are born, popular children’s media communicates anthropocentric understandings about the natural world, reinforcing a separation between humans and other-than-human beings (Timmerman & Ostertag, 2011). The more-than-human animals that children encounter are misplaced from each other, displaced from the child’s local context, decontextualized from the animal’s natural environment, and devoid of subjectivity — except for the anthropomorphic human attributes assigned to them (Timmerman & Ostertag, 2011). As children get older, these messages are reinforced throughout their schooling. As Bell and Russell (1999) state, “Educational institutions play an important role in organizing teaching and learning experiences along anthropocentric lines” (p. 70). And even though children may grow up role-playing hunting scenarios and connecting with the animal parts of themselves, maturing within Western culture demands a separation of ourselves from the animal world (Fawcett, 2002). Within a Western paradigm, then, children and adults are taught to see more-than-human beings more as parts of an ecosystem than as subjective beings who have rights and are worth moral consideration (Selby 1993). Worse, we begin to dislike and even fear certain beings because of their portrayal in the media or due to our lack of encounters with them (Fawcett, 2002; Selby; 1993).

We stop recognizing the ways in which more-than-human beings’ lives mirror our own, and begin to see them as objects, which is particularly obvious in our referring to a non-human animal with the pronoun *it* (Mann, 2020). Unlike in the English language and Western worldview where “the only way to be animate, to be worthy of respect and moral concerns, is to

be a human” (Kimmerer, 2015, p. 57), Indigenous languages and worldviews use the grammar of animacy (Kimmerer, 2015). In a world where everything is alive, English concepts that are trapped as nouns are animated in Indigenous languages as verbs. In Potawatomi, an Anishinaabe language, *wiikwegamaa* translates as “to be a bay” — “for this moment, the living water has decided to shelter itself between these shores” (Kimmerer, 2015, p. 55). Further, as Kimmerer (2015) discusses, a more-than-human being is not seen as an *it*. She states, “Saying *it* makes a living land into 'natural resources'. If a maple is an *it*, we can take up the chain saw. If a maple is a *her*, we think twice” (p. 57).

Through the metaphors that educators choose, the adjectives that we use to describe other beings, and the pronouns that we assign, language shapes our understanding and experiences, and can elicit positive, negative, or neutral thoughts about and actions towards the species with whom we share a life. It is therefore incredibly important for educators to be mindful of the hidden curriculum that can be unintentionally communicated to learners. Educators must choose their language carefully, and challenge normative assumptions and narratives. There are a number of examples from the humane education and environmental education literature that shed insight into how some educators are tackling language issues by bringing them out of the hidden curriculum and explicitly teaching about the power of language in shaping our relations to other species (e.g., Bell & Russell, 1999; Fawcett, 2002; Selby; 1993).

Educators must also actively work to dismantle the structures that allow dominant worldviews to erase Indigenous ones in educational settings. Currently, respect for Indigenous intelligence is “threatened by land-theft, environmental contamination, the legacy of residential schools and state-run education, colonial gender violence, [and] climate change” (Simpson, 2019, 28:41-28:53). In all domains, we as a society need to (re)connect with the natural world

and with our non-human relatives, be stewards of the environments in which Indigenous intelligence is cultivated and supported, amplify marginalized voices, and engage in anti-colonial practices, for the health of our ecosystems and for an equitable future.

Braiding Perspectives

As Kimmerer (2015) writes in her book, *Braiding Sweetgrass*, “Sweetgrass, as the hair of Mother Earth, is traditionally braided to show loving care for her well-being” (p. 203). As a tangible object, a braid is composed of three or more strands of hair or fibre that are woven together to form a complex structure (Collins, 2022). Canadian curriculum scholars sometimes invoke a braid of sweetgrass or the Métis sash as representations of interwoven strands (see, for example, Donald, 2009; Hasebe-Ludt et al., 2009). To braid is also a verb, that is, the *process* of weaving the strands together (Collins, 2022). As a language arts metaphor, a braid is an interpretation of unique narratives and how they interact with each other to form a composition — or, as Hasabe-Ludt et al. (2009) suggest, a type of visiting with others. Donald (2009) states, “The assumption is that braiding in these ways will facilitate a textual encounter of diverse perspectives that creates a provocative interpretive engagement” (p. 8). There is also a certain tension, a reciprocity, between the braider, the holder, and the strands (Kimmerer, 2015), that for me represents a framework and space held for the process to unfold.

While I have highlighted stark differences between Western and Indigenous epistemologies and ontologies in the previous chapter, in particular when it comes to science, I think it is also important to note that there can be much common ground. And this, I suggest, provides one way of moving forward in thinking about "invasive" species education. As a society, we need to push ourselves to move past the colonial “either/or” binary, towards a more

complex and holistic “both/and” approach. Our lives — and our futures — are “relational and braided rather than isolated and independent” (Donald, 2009, p. 9).

Certainly, those of us working within a Western paradigm have much to learn from Indigenous ontologies, epistemologies, axiologies, and methodologies. As Nicholas (2018) states, “There are many cases where science and history are catching up with what Indigenous peoples have long known” (para. 11). These knowledges are encoded in Indigenous stories, languages, and art like pictographs, and have been transmitted from generation to generation for thousands of years — and continue to do so (Nicholas, 2018; Twance, 2019). Some scholars believe that Indigenous knowledges may even be better suited to analyze complex environmental issues than Western science (Mazzocchi, 2006). I would argue that it is no coincidence that, globally, lands protected by Indigenous communities have more biological diversity than ones protected under other jurisdictions (Reo & Ogden, 2018). For example, researchers who have studied biodiversity in Canada, Australia, and Brazil, have found that there are more birds, mammals, and amphibians on lands managed or co-managed by Indigenous communities (The University of British Columbia, 2019).

Indigenization is a process by which Indigenous ontologies, epistemologies, axiologies, and methodologies are incorporated into societal structures, including formal and informal education. While indigenization is important, it is not enough, however. Max Liboiron is a Métis associate professor and researcher at Memorial University who instead advocates for anti-colonial methodologies in diverse disciplines, including science. Observing that mere inclusion is not a sufficient response to colonialism, Liboiron (2021a, 2021 b) makes a good case for why all fields — including environmental science education — need to reflect on the coloniality of their practices, regardless of intent, and then work to change them. Practicing anti-colonial

science is also an important step towards reconciliation (Wotherspoon & Milne, 2020). The Truth and Reconciliation Calls to Action include the acknowledgement and “inclusion” of Indigenous content and worldviews into school curriculum (Calls #62-65), and the right for Indigenous Peoples to determine the protection and management of their lands (Joseph, 2018). In addition to incorporating Indigenous content into classroom lessons and interpretive programming, curriculum developers need to be co-creating content with, paying for the expertise of, and giving credit to, Indigenous knowledge-holders. To cite only the person who *wrote* about a component of Indigenous knowledge disregards the many Elders and teachers who contributed to the development of that knowledge (Absolon, 2015). Anti-colonial practices thus promote including knowledge contributors as authors rather than just citing them in an academic text (Liboiron, 2021a).

There are a number of existing frameworks that seek to braid together Indigenous and dominant science worldviews. “Two-eyed seeing,” or *etuaptmumk*, is a term coined by Elder Albert Marshall of Unama’ki Cape Breton that has been taken up by science educators and environmental educators for quite some time now (e.g., Hatchet et al., 2009; Knapp, 2013; McKeon, 2012). Also known as integrative science, native science, and ecological *métissage* (Knapp, 2013), this approach, among other things, “attempts to bring together the lens of Indigenous knowledge and that of Western science, to see the world from both perspectives” (Donovan, 2022, para. 2). Other existing frameworks, approaches, or concepts that link Indigenous and Western knowledges include cultural interface, ethical space, Indigenous cultural responsiveness theory, insurgent research, expansive learning, hybridity, polycentric global epistemology, rhizomes, the Three Sisters framework, transrational knowing, working the hyphen, living on the ground, *guswentah* or two-row wampum, and Indigenous *métissage* (Levac

et al., 2018). Although these frameworks vary in their inspirations, content, and scope, they generally promote opportunities for dialogue and witnessing, respecting and acknowledging differences, balancing power, collaborating, and promoting accountability and new knowledge (Levac et al., 2018).

I find the idea of *métissage*, which is derived from the Latin word *mixtus* “meaning mixed, like a cloth of different fibres” (Chambers et al., 2008, p. 151), particularly inspiring. One of the defining features of woven fabric or of a braid is that each strand is as important as the other, moving from the background to the foreground and back again, never *blending* with the other strands, but bringing its own unique flair to the composition (Chambers et al., 2008). Likewise, *métissage* can be used as a practical tool in research and in communication, by allowing multiple perspectives to be showcased without subjugating any views to the dominant narrative. As Hasebe-Lutd et al. (2009) describes,

[M]étissage [is] an artful research praxis that mixes binaries such as colonized and colonizer, local with global, East with West, North with South, particular with universal, feminine with masculine, vernacular with literate, and theory with practice. We braid strands of place and space, memory and history, ancestry and (mixed) race, language and literacy, familiar and strange, with strands of tradition, ambiguity, becoming, (re)creation, and renewable into a *métissage*. (p. 9)

I position that *métissage* can be used as an effective tool in science education. In the classroom, hands-on activities that encourage students to explore the world from the perspective of various people and beings could be informed by a *métissage* approach (see, for example, Lowan, 2011; Roth, 2008; Worley, 2006). In her Science classroom in Victoria, B.C., Gloria Snively (2009) uses “cross-cultural science” to teach students about the historical importance of

dentalium to the Ehattesaht and Quatsino Peoples, and to guide students into solving an ecology/engineering problem grounded in their ingenuity. More generally, métissage has been incorporated into the classroom through photography activities (Beavington, 2021) and life-writing exercises (Hasebe-Ludt et al., 2009), showcasing students' learning in a variety of creative ways. Relating this to "invasive" species education, an engaging classroom activity could see students writing narratives about a particular newcomer organism, or drawing (Fawcett, 2002) or taking photos (Beavington, 2021), to imagine the organism's perspective. Role-playing members of an ecosystem, similar to the ways educators use a "Council of All Beings" (Seed et al., 2007) or "Beetle Bedlam" (van Kampen, 1996) also holds promise for braiding in perspectives of other species.

Another application of métissage could occur in the creation of park signage and other non-personal interpretation products. Currently, national parks are mandated to have bilingual — that is French and English — signage in all of their public sites, but there is rarely any inclusion of local Indigenous languages, never mind any mention of Indigenous worldviews (Twance, 2019). Twance (2019) argues that interpreting “natural” and “cultural” heritage through Indigenous frames of reference is *necessary*, considering these community perspectives are “often at odds with commonly accepted interpretations offered in the literature and in Park signage and educational programming” (p. 8). A commitment to métissage could enable the elevation of local Indigenous voices and disrupt the dominance of Western narratives.

Métissage could also inform the creation of interpretation programs and conservation projects when developed in partnership with local Indigenous communities. The Australian government and Northern Aborigines have recently implemented the Aboriginal natural and cultural resource management (NCRM) sector, in which Indigenous "rangers" carry out their

work using a mixture of traditional knowledge and modern conservation practice (Bach & Larson, 2017). Programs such as these offer important and alternate perspectives in “invasive” species discourse and “management” and could be highlighted in interpretation programs. So too could programs that focus on ecological health rather than species eradication, and describe creative possibilities such as implementing traditional controlled burns, replanting local species, or reducing landscape disturbances from tourism and recreation (Bach & Larson, 2017). Indigenous Nations also actively educate their community members on the subject of “invasive” species, share prevention strategies, save threatened seeds, transplant threatened species, and document traditional knowledge regarding native species (Bach & Larson, 2017), and educators could build on these insights in developing interpretive programs that braid perspectives.

Whatever tools educators use in braiding these paradigms together, the importance of introducing diverse perspectives cannot be understated. It is important to remember, however, that Indigenous Knowledges are often undocumented to protect them from non-Indigenous misuse and mis-appropriation (Absolon, 2015).

Conclusion

While Ontario students do have an opportunity to learn about “invasive” species in their classroom, a more nuanced approach could help students understand not only the negative impacts but also the positive impacts newcomer species can have on a habitat as well as appreciate the complexities and services of “novel” ecosystems. Park interpreters also could do the same, sharing with visitors the gifts of newcomer species and being mindful of the language they use to describe them to avoid villainizing species based solely on their country of origin. Indeed, both classroom curriculum and interpretive programming would benefit from presenting multiple perspectives on “invasive” species education and conservation, including local

Indigenous perspectives. To do so, educators need to be better informed about Indigenous perspectives on science and on frameworks for how to best include multiple worldviews. Curriculum developers, both in the school system and in agencies such as Parks Canada, need to strengthen relationships with local Indigenous communities so that they can engage in ethical collaborative research with individuals and community members to develop content for curriculum and interpretation. As my literature review and this chapter revealed, there are consequences to offering one-sided or limited perspectives — for people, "invasive" species, and the planet.

Chapter Four: Mystery on Lake Superior

About Mystery on Lake Superior

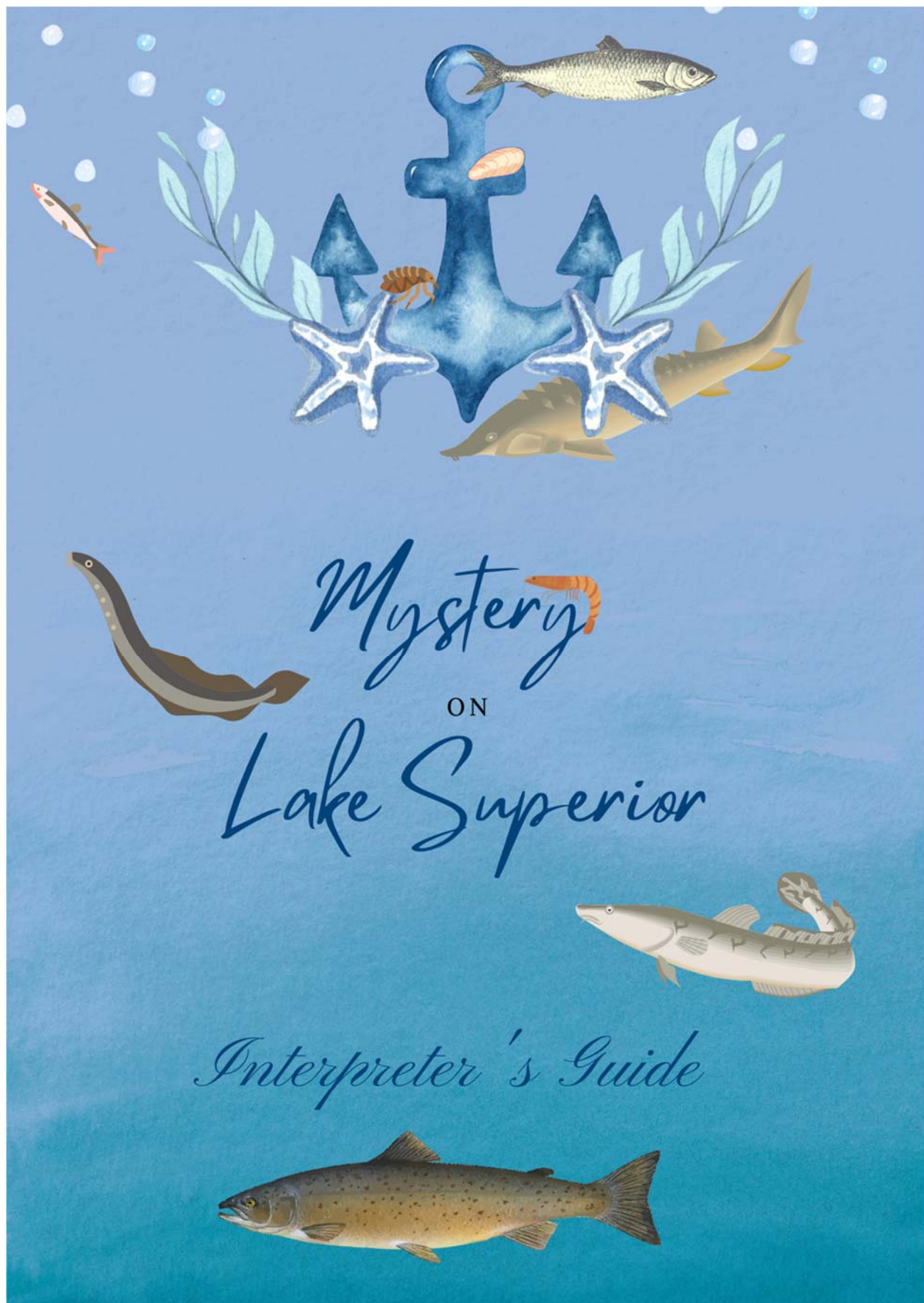
Mystery on Lake Superior is an interpretive activity I designed based on my learnings from my MEd. Whether an educator is a classroom teacher or a park interpreter, they can facilitate a unique experience that is both fun and informative where students can learn about “invasive” species and habitats in Lake Superior. The game is inspired by the *métissage* framework of highlighting various narratives, without any one story becoming dominant or submissive to another. The narratives explored in *Mystery on Lake Superior* are the stories of nine aquatic animals who live in or around a fictional bay on the North Shore of Lake Superior. Some of them are species long-established in the area, while others are newcomers to the Little Bay habitat. By exploring their backstories, participants will be guided to reflect on the subjectivities of non-human animals. The plot of the activity is that following the incident of a dog Max’s poisoning on the shores of Little Bay, the nine aquatic animals meet to solve the mystery of what happened.

As the game progresses, participants learn the background information of each character and potential suspect, their potential pathway of introduction into Lake Superior, as well about their impacts - both positive and negative - on the local ecosystem. Participants will also learn how Little Bay and its aquatic community are being impacted by climate change. Using the information revealed by each character, the Lake Superior food web, and the 'evidence' page, players must look for clues to help solve the mystery at hand.

This activity is suitable for ages 12 and up. Younger players, and those who need support reading, may be paired up with a friend or family member and play together as one character.

Interpreter's Guide

The interpreter's guide will help educators prepare the activity for their players. It contains the guidelines for organizing the activity, rules of play, costume suggestions, and mood-setting.



Mystery
ON
Lake Superior

Interpreter's Guide



INTRODUCTION

Welcome to Mystery on Lake Superior!

This activity is suitable for ages 12 and up. Younger players, and those who need support reading, may be paired up with a friend or family member and play together as one character.

This interpretive activity is designed to create intrigue and excitement for the players while they learn about Lake Superior and its inhabitants. In particular, learners will explore the positive, negative, and neutral consequences of newly-introduced species in their new habitat, and how newcomer species interact with human-caused changes to an ecosystem.

Whether in a classroom, or out in the field, you set the stage for solving the mystery. You and the players are all suspects. All of you have engaging backstories about your connection to Little Bay, Lake Superior and you will discover information to help solve the mystery of Max's poisoning. Use your creativity and powers of deduction to determine how the incident happened, who or what is the culprit, and what their motives are. Use all of the revealed information as well as the 'evidence' and their knowledge of the Lake Superior food web to come to your conclusion.

You are the LAKE STURGEON, the facilitator.

This interpreter's guide will help you to prepare the interpretive activity for your players. It contains the guidelines for organizing your activity, rules of play, costume suggestions, and mood-setting.

PREPARATION

As the facilitator, you must prepare some items ahead of time. You will need to print these items:

1. Interpreter's Guide
2. Invitations
3. Character Manuals (8)
4. Name Tags (8)
5. Author's Solution and Debrief

CAST THE ROLES

You can either cast the players' roles ahead of time so that they may prepare, or cast the roles on the day of the activity and you provide the suggested costumes and accessories.

You might strategically cast the roles to give bigger speaking roles - such as ZEBRA MUSSEL and SEA LAMPREY - to stronger readers.

An extension of this activity could involve students researching their assigned character ahead of the game to learn whether they are long- or newly-established, including their role in the Lake Superior food chain, and understand the impacts that their character has in the ecosystem.

Confirm a date and time, and distribute the Invitations.

ON THE DAY OF THE ACTIVITY

Distribute the Name Tags.

Once everyone is ready to start, distribute their Character Manuals. Remind players that **THESE ARE ONLY TO BE OPENED UPON YOUR INSTRUCTION.**

EXTRA PLAYERS

Extra players can be included in the activity. They will not have character roles to play, but they can assist in gathering information and solving the mystery.

TO BEGIN

Have your players open their Character Manuals to the 'HOW TO PLAY guidelines.' Read the guidelines out loud as players follow along, and answer any questions they may have.

The activity proceeds as follows:

Instruct characters to read their background, and examine the Lake Superior food web and the evidence page. Allow them time to read and become familiar with this information.

Start the activity by introducing yourself, in character as LAKE STURGEON, using the information from your background section. Have players follow suit, in any order.

The activity progresses through three scenes. During each scene the characters will have new information about themselves and others to reveal.

For each character, each scene contains two parts:

- The first part, "REVEAL THIS INFORMATION ABOUT YOURSELF when prompted" is the information each player shares only when asked.
- The second part, "REVEAL ALL OF THIS INFORMATION ABOUT ANOTHER" is the information each player wants to make sure other players know.

Characters should not progress to the next scene until instructed by you, LAKE STURGEON.

When the final scene is completed, each character will share their deduction of how the incident happened, who or what is the culprit, and what the suspect's motives are.

LAKE STURGEON finishes the activity by reading the Author's Solution, and leading the Debrief.

NOTES

- In each scene, a player has been designated to begin revealing information about another player. As the facilitator, LAKE STURGEON will know who the starting player is for each scene.
- Remind players to change "you" to "I" or "me" and "your" to "my" when reading.
- In Mystery on Lake Superior, characters may begin accusing each other about their role in the incident, or they may begin working together to solve the mystery. Let the activity unfold organically, and take note of their strategies (and the attitudes, beliefs, or behaviours that may emerge) and use these to inform the Debrief at the end of the activity.
- Little Bay is a fictitious bay on Lake Superior, and the residents' names - as well as the incident - have been created for the purposes of this activity. Any resemblances to actual places, persons, or similar incidents are entirely coincidental.

COSTUME SUGGESTIONS

KIWI - Big circular sunglasses, silver fabric

RAINBOW SMELT - Rainbow print fabric and accessories

ZEBRA MUSSEL - Zebra print fabric and accessories

SEA LAMPREY - Dark fabric, vampire fangs

CHINOOK SALMON - Gold fabric and accessories, gold crown

BURBOT - Green polka dot fabric, fake goatee

OPOSSUM SHRIMP - Red sheer fabric, small sunglasses

SPINY WATERFLEA - White sheer fabric and accessories, spikes

MOOD-SETTING SUGGESTIONS

As the facilitator, choose a setting - whether indoors or outdoors - that is comfortable and quiet enough to allow conversation between the players. You may want to use props or decorations to set the mood. For example, maritime-themed objects and blue decor will have your players feeling like they are underwater.

CASTING

KIYI: _____

RAINBOW SMELT: _____

ZEBRA MUSSEL: _____

SEA LAMPREY: _____

CHINOOK SALMON: _____

BURBOT: _____

OPOSSUM SHRIMP: _____

SPINY WATERFLEA: _____

Invitation

The following invitation is provided for the interpreter to print (or email) to each Mystery on Lake Superior participant. The invitation can be customized by inserting the player's assigned character on page two, as well as the location and date that the activity will take place. Each invitation also includes a description of the scene of the incident, a description of each suspect, as well as costume suggestions (which can be provided by the interpreter).



Mystery
ON
Lake Superior

Invitation

Dear _____

A dog from one of the camps on Little Bay, Lake Superior has been poisoned. You are a suspect. You have been seen swimming around the bay where the dog and his family live in the time preceding him getting sick.

Your presence is requested at

_____ (location)

at

_____ (day/time).

SCENE

For thousands of years, Lake Superior has been a haven for the aquatic living beings who live in its waters, and for the terrestrial beings that drink and fish from it.

Plants, animals, and bacteria have come and gone, and been important members of the community.

As human animals have set up camps along the coast, the shoreline around Little Bay has become more lively. During the day, children and dogs play at the water's edge, while parents cook and socialize. At night, light from their bonfires shine across the water's surface. Music and laughter can often be heard echoing off the rocks.

But not tonight. Tonight all is quiet.

Human friends and neighbours are gathered around the shoreline, speaking in hushed voices about who - or what - could have it in for poor Max and his family. The dog was found outside by the Lake shaking and salivating uncontrollably. It appeared he had been poisoned.

Who knows what could have happened if Dr. Patricia Heeler hadn't been at camp that day?

Something fishy is going on here, and we're determined to find out what it is.

LAKE STURGEON, the oldest and wisest animal in Lake Superior, is requesting a meeting of all the aquatic animals seen in Little Bay immediately prior to Max's poisoning.

Though LAKE STURGEON rarely speaks up, still waters run deep.

SUSPECTS

KIYI - whose family has lived near Little Bay for generations. Kiyi has been upset about the growing number of cottages and lights at Little Bay. Could KIYI have had something to do with Max's poisoning? As they say, blood is thicker than water...

RAINBOW SMELT - is a newer resident of Little Bay. After a tough smelting season, this little fishy has been fighting to keep their head above the water. Could RAINBOW SMELT have an appetite for revenge?

ZEBRA MUSSEL - hasn't come out of their shell since moving to Little Bay with their many relatives. Recently a few members damaged infrastructure around the bay, and the family has found itself in hot water. Is ZEBRA MUSSEL really timid, or are they in on the trouble?

SEA LAMPREY - and their family have been living near Little Bay for the last few decades. This 'vampire of Lake Superior' came to the lake with many of their relatives, but their population has dwindled as humans have poisoned their larvae. Is it really water under the bridge?

SUSPECTS

CHINOOK SALMON - Hailing from the Pacific ocean, this 'King Salmon' is in uncharted waters in Little Bay. They said they were just in the area looking for a tasty treat, but are we falling for their trick hook, line, and sinker?

BURBOT - is named from a French word meaning 'mud'. Like **KIYI**, **BURBOT** is concerned about the human animals on the shoreline and blames them for the lack of ice on the lake in recent winters. Are humans to blame? Or is **BURBOT** just muddying the waters?

OPOSSUM SHRIMP - and their family are long-established in Lake Superior. **OPOSSUM SHRIMP** has not been feeling well lately - just barely treading water. Are they desperate for change before they are dead in the water?

SPINY WATERFLEA - While new to the area, this little zooplankton certainly doesn't feel like a fish out of water in Lake Superior. The only problem is that the humans' new 'Clean, Drain, Dry' program is drying up all their eggs in the sun! Is **SPINY WATERFLEA** trying to pour cold water on the program?

COSTUME SUGGESTIONS

KIWI - Big circular sunglasses, silver fabric

RAINBOW SMELT - Rainbow print fabric and accessories

ZEBRA MUSSEL - Zebra print fabric and accessories

SEA LAMPREY - Dark fabric, vampire fangs

CHINOOK SALMON - Gold fabric and accessories, gold crown

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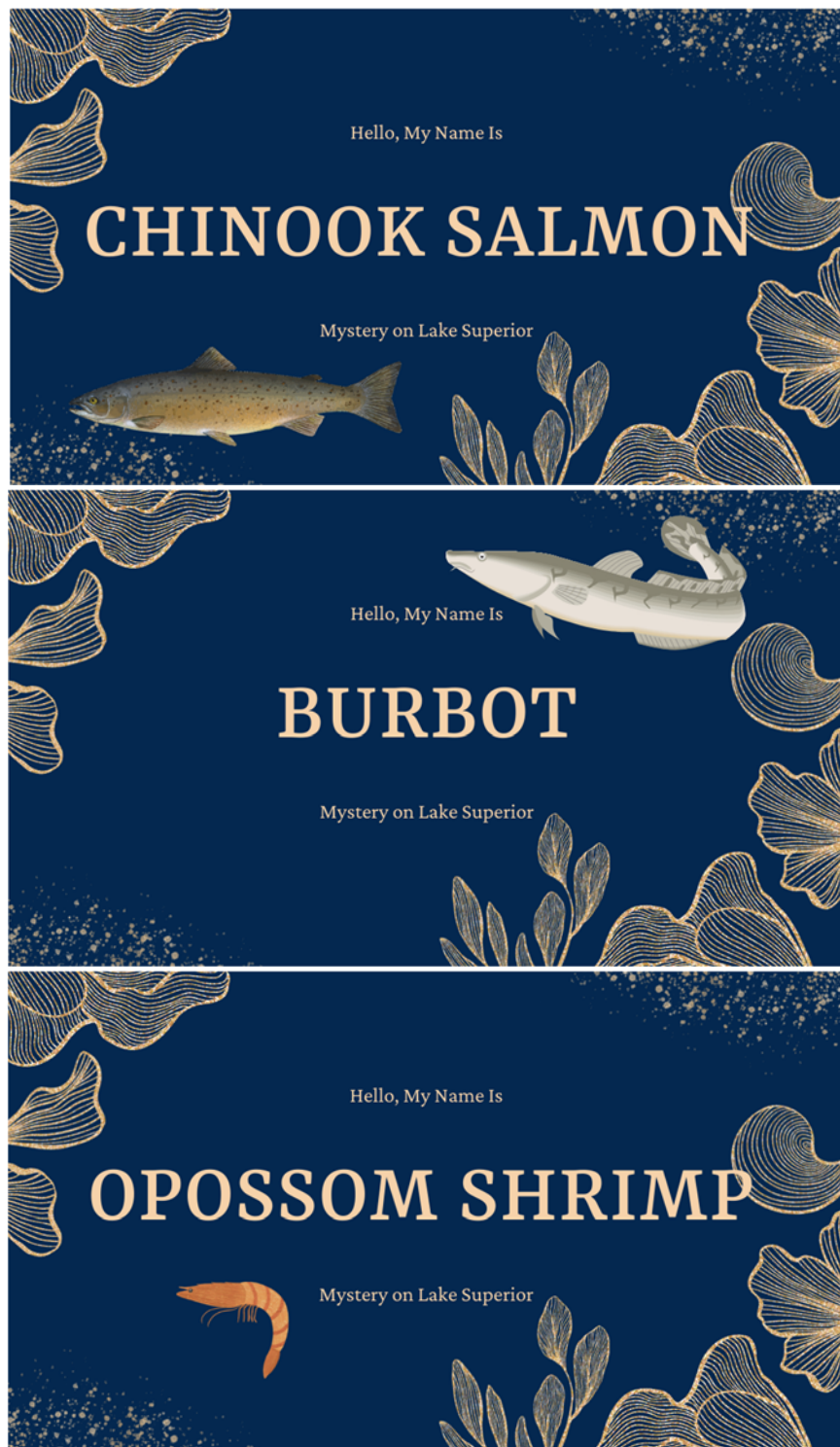
SPINY WATERFLEA - White sheer fabric and accessories, spikes

Name Tags

The following name tags are provided for the interpreter to print and hand out to each player on the day of the activity.



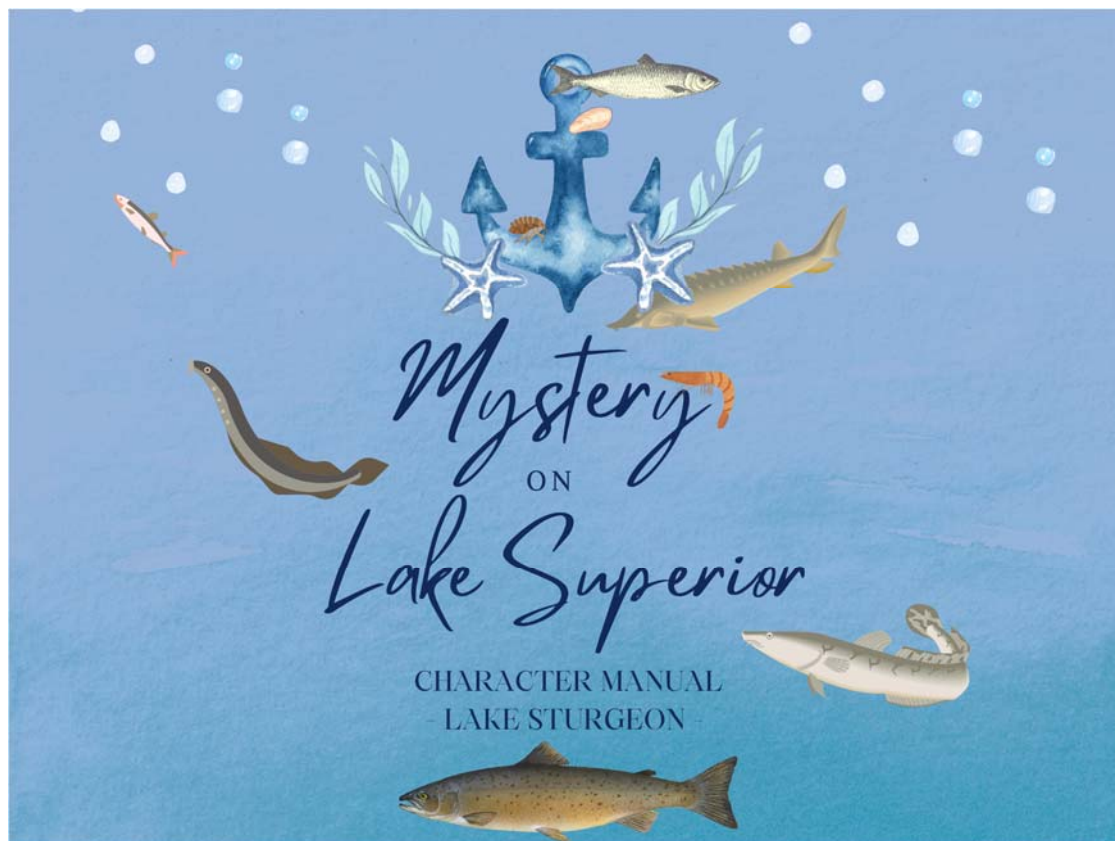






Character Manuals

The following character manuals are provided for the interpreter to print and hand out to each player on the day of the activity. Each character manual contains guidelines on how to play the game, background information on their assigned character, a Lake Superior food web, an evidence page, and information related to each of the three scenes of the activity.



HOW TO PLAY GUIDELINES

A dog from one of the camps on Little Bay, Lake Superior has been poisoned. You are a suspect. You have been seen swimming around the bay where the dog and his family live in the time preceding him getting sick.

Something fishy is going on here, and we're determined to find out what it is.

LAKE STURGEON, the oldest and wisest animal in Lake Superior, is requesting a meeting of all the aquatic animals seen in Little Bay immediately prior to Max's poisoning.

All of you are suspects. Players should introduce their characters, reveal their backstories, and divulge information about themselves and others during each of the four rounds of the activity. The object of *Mystery on Lake Superior* is to determine how the incident happened, who or what is the culprit, and what their motives are. Suspects must reveal all information in the character booklet truthfully when asked. If one of the characters accuses you, you may try to re-cast suspicion upon them to try to deflect attention.

Try to stay in character throughout!

The activity begins by revealing each character's background story then progresses through four scenes. During each scene the characters will have new information to reveal.

For each character, each scene contains two parts:

- The first part, "REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED" is the information each player shares only when asked.
- The second part, "REVEAL ALL OF THIS INFORMATION ABOUT ANOTHER" is the information each player wants to make sure other players know.

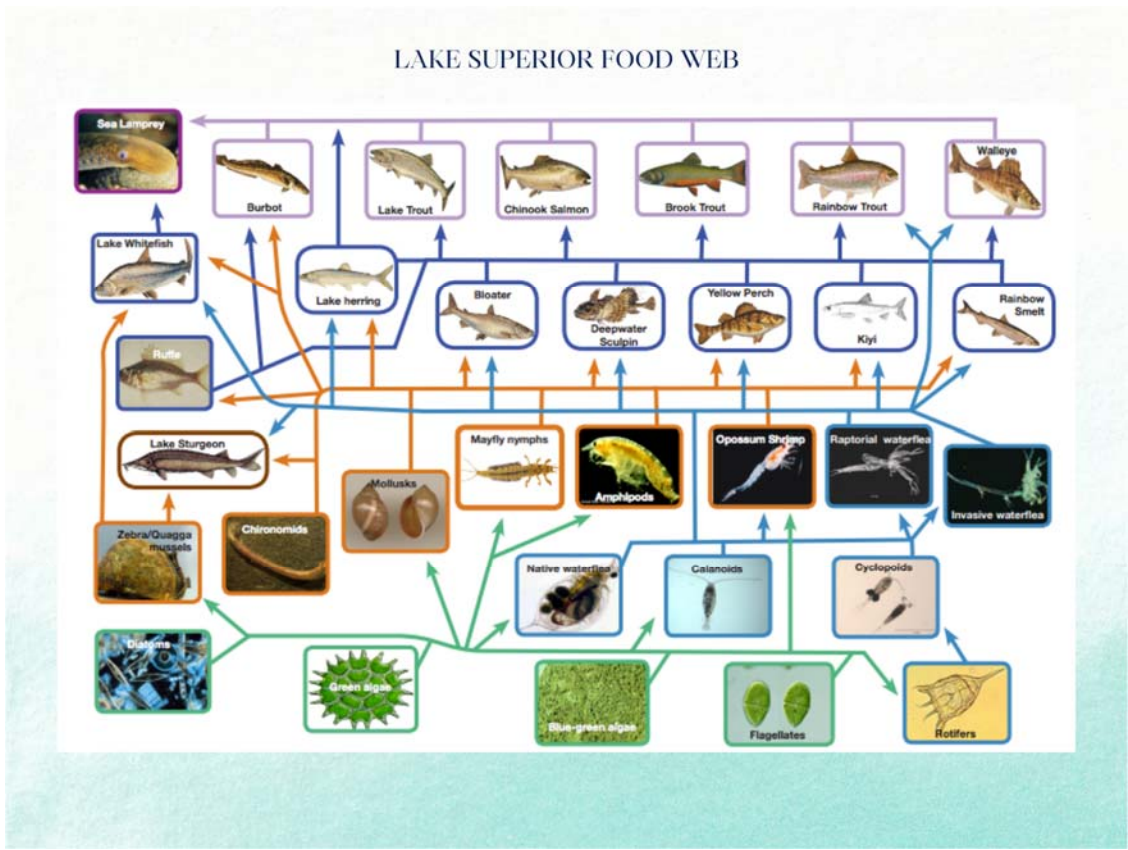
Each character must reveal both parts before the activity can progress to the next scene. Characters should not flip their pages until instructed by LAKE STURGEON.

LAKE STURGEON finishes the activity by reading the Author's Solution, and leading the debrief.

BACKGROUND

USE THIS INFORMATION TO INTRODUCE YOURSELF:

- You are LAKE STURGEON.
- You are 99 years old! Can they believe it? As the oldest and wisest resident of Lake Superior, you feel a certain responsibility towards its aquatic members, the residents of Little Bay, in particular.
- Back in your prime, you used to migrate long distances to spawn. These days, you are quite content staying near Little Bay. Plus, the humans have installed hydroelectric dams that make the passage much more difficult. That being said, you have seen much of Lake Superior, and traveled up several of its tributaries. This is the first time you have ever seen anything quite as fishy as Max's poisoning - and you are determined to bring all the creatures in Little Bay together and figure out what happened.
- You are aware of all the interconnections between the aquatic animals in the Lake Superior food web. In fact, today some of the macroinvertebrates and zooplankton that you would normally feast on are participating in this very meeting. Let us agree to a truce for the time being, until we can make sense out of all of this. Agreed?



EVIDENCE

THE LITTLE BAY BULLETIN

Vol 11-22

@newsonthebay

CLOSE CALL LEAVES COMMUNITY SHAKEN



Max the dog had a close encounter with death Friday, May 20th 2022, after he was found shaking and salivating uncontrollably outside his family's camp by the water's edge. Luckily, Dr. Patricia Heeler was at camp with her family for the long weekend, and saved the day! Municipal authorities are warning residents to keep their children and pets away from the water until further notice.

Update - RE: Alien Invasion

The battle continues to cleanse our great bay of the evil invasive species that have plagued Little Bay residents in recent years, and continue to terrorize the aquatic... (con't. p.6)



Read more on newsonthebay.com

SCENE ONE - LAKE STURGEON

KIYI BEGINS this scene by revealing information about another meeting attendee.

USE THIS INFORMATION TO SUMMARIZE SCENE ONE once KIYI has revealed their final information.

- You are very familiar with the ways of SEA LAMPREY - and have the scars to prove it.
- Again, thanks to everyone for agreeing to a truce for the time being, until we get to the bottom of this.
- It seems that we have several meeting attendees here today that are from long-established families near Little Bay. These include myself, KIYI, BURBOT, and OPOSSUM SHRIMP.
- We also have meeting attendees who are newcomers to Little Bay, including RAINBOW SMELT, ZEBRA MUSSEL, SEA LAMPREY, CHINOOK SALMON, and SPINY WATERFLEA. Some of these newcomers have been intentionally introduced to Lake Superior by humans, others have been accidentally brought in from afar.
- All of you were seen in Little Bay in the time leading up to the incident. But why - and how - would any of you poison the humans' dog?
- Next, we'll dive a little deeper and find out what kind of community member you have been during your time in Little Bay. Do you positively impact your community? Or are your impacts negative or neutral?

INSTRUCT PLAYERS TO TURN THEIR PAGE

SCENE TWO - LAKE STURGEON

OPOSSUM SHRIMP BEGINS this scene by revealing information about another meeting attendee.

USE THIS INFORMATION TO SUMMARIZE SCENE TWO once OPOSSUM SHRIMP has revealed their final information.

- Thanks to Everyone for sharing their roles and experiences in the Little Bay community
- Many of us here today seem to have complicated relationships with our aquatic and human Little Bay neighbours.
- Some of us - CHINOOK SALMON, RAINBOW SMELT, KIYI, and MYSELF - have been fished - or overfished - by humans.
- Others - like BURBOT and SEA LAMPREY - feel underappreciated in our shared ecosystem.
- Most of us are both predator and prey to our aquatic neighbours.
- While all of these complex connections are muddying the waters of the events preceding the incident, one thing is for sure - Little Bay has been changing. But how is that connected to the dog's poisoning?

INSTRUCT PLAYERS TO TURN THEIR PAGE

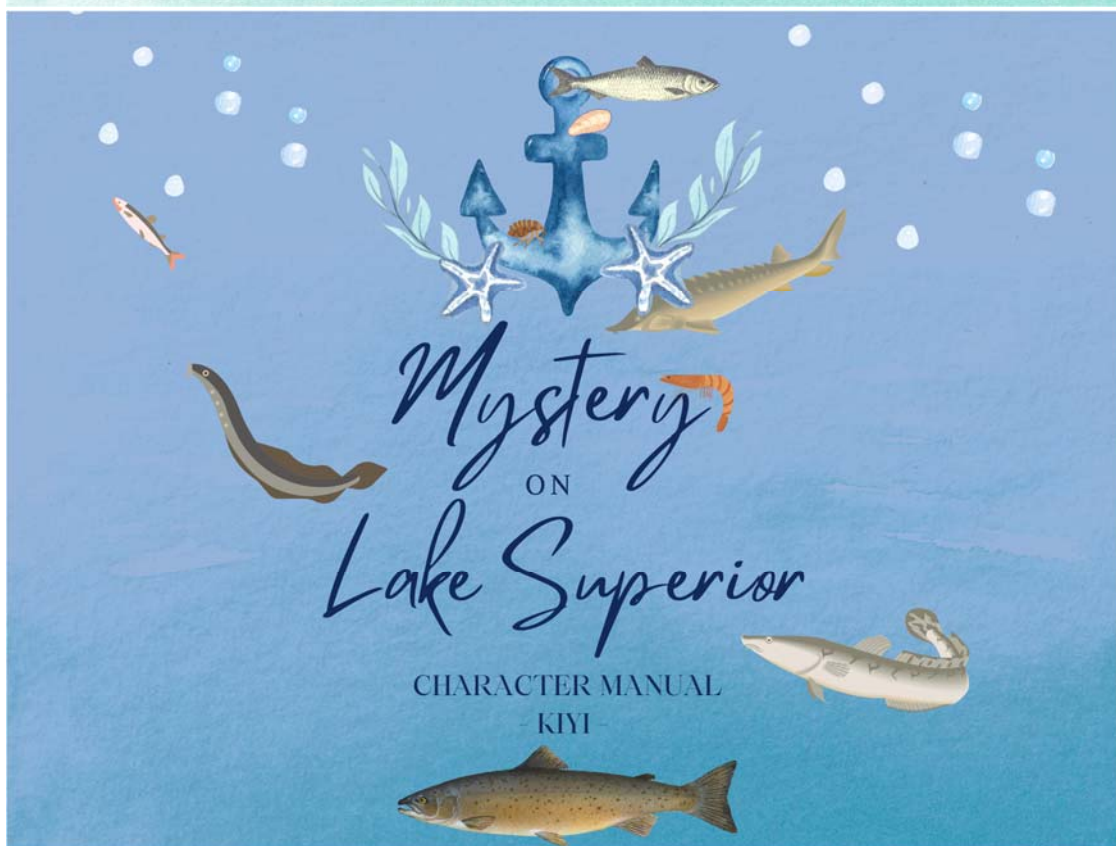
SCENE THREE - LAKE STURGEON

CHINOOK SALMON BEGINS this scene by revealing information about another meeting attendee.

USE THIS INFORMATION TO SUMMARIZE SCENE THREE once CHINOOK SALMON has revealed their final information.

- Thanks to Everyone for sharing their concerns.
- It seems that in many ways the humans themselves are to blame for the negative qualities that they attribute to our recently established Little Bay critters.
- It is also clear that both the water and shoreline of Little Bay have changed considerably.
- You have noticed many of these changes. There used to be so much ice on Lake Superior that humans used to cut and harvest big blocks out of it. There are less fish than there used to be, but more different species of plants and animals and newcomers have moved in. There are more camps dotted along the shore, and more lights on at night. There is more rain, and more chemicals leaching into the ground.
- You have also noticed other changes. Not only is the water getting warmer, but the lake is staying stratified for longer. This means that the warmer water on the top of Lake Superior, and the colder water at the bottom, are not mixing the way they used to. This is a problem for the deep-water species that rely on the mixing for nutrients and air. There are also bigger storms, with higher wind speeds, than you have ever seen before.
- You are beginning to understand how Max was poisoned. But before you share your thoughts, what does everyone else think? What events led to Max's poisoning, who or what is the culprit, and why did they do it?

ONCE EVERYONE HAS SHARED, PROGRESS TO THE AUTHOR'S SOLUTION + DEBRIEF.



HOW TO PLAY GUIDELINES

A dog from one of the camps on Little Bay, Lake Superior has been poisoned. You are a suspect. You have been seen swimming around the bay where the dog and his family live in the time preceding him getting sick.

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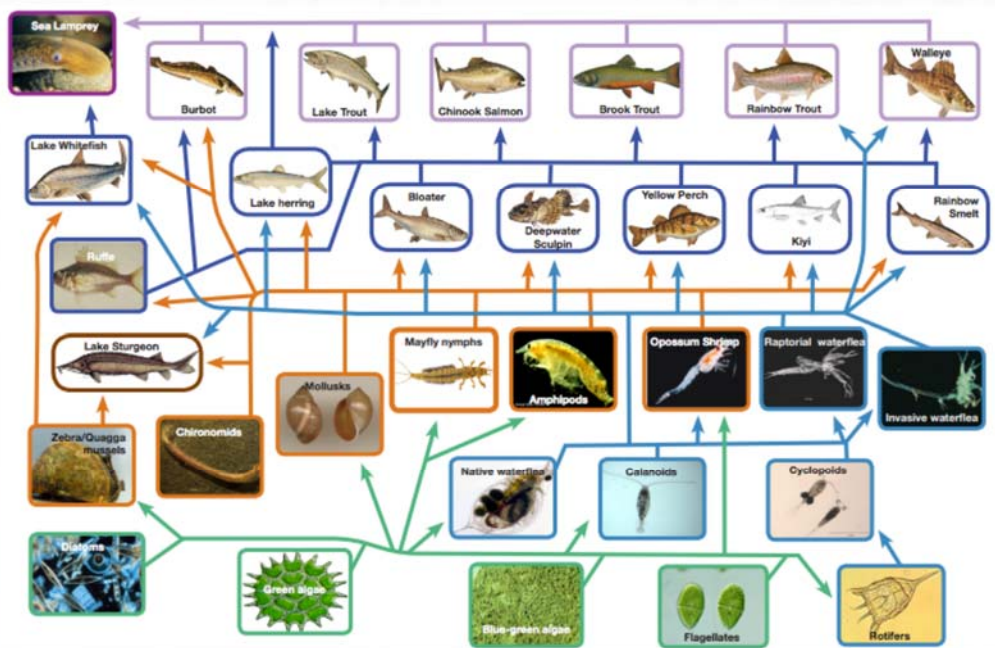
LAKE STURGEON finishes the activity by reading the Author's Solution, and leading the debrief.

BACKGROUND

USE THIS INFORMATION TO INTRODUCE YOURSELF:

- You are KIYL.
- You are a member of the whitefish family.
- You can usually be found in the deeper waters of Lake Superior - as deep as 200 meters!
- You have big eyes that help you see in the dark depths of Lake Superior, and at night while you are hunting your prey.
- You undergo daily vertical migrations - following your prey up the water column, filling your belly, then returning to deeper waters.
- You swear you have nothing to do with Max's poisoning, but you are happy that LAKE STURGEON has called this meeting - you have some concerns of your own to bring up!

LAKE SUPERIOR FOOD WEB



EVIDENCE

THE LITTLE BAY BULLETIN

Vol 11-22

@newsonthebay

CLOSE CALL LEAVES COMMUNITY SHAKEN

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[Read more on newsonthebay.com](#)

SCENE ONE - KIWI

REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED BY SEA LAMPREY:

- You dislike that a lamprey from the SEA has taken over your community.
- Recently, your cousin died from an infection following a sea lamprey attack. You know that a single sea lamprey can lay up to 100,000 eggs when they spawn, and you worry for your children.

YOU START SCENE 1 BY REVEALING ALL OF THIS INFORMATION ABOUT CHINOOK SALMON:

The night before the incident, you saw CHINOOK SALMON and their young in Little Bay. You distinctly remember it was them because even though you yourself were hungry, you kept having to hide to avoid becoming their lunch. It boils your blood to hear CHINOOK refer to themselves as the 'King'. They are not even from here! It just is not right for a foreign fish to come into Lake Superior and claim to rule the water and all the living beings within it. Is CHINOOK SALMON using poison to try to take over the land and its dwellers as well?

DO NOT TURN THE PAGE UNTIL INSTRUCTED BY LAKE STURGEON

SCENE TWO - KIYI

REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED BY BURBOT:

- You are hanging in there. Times are not as tough as they once were. After millennia of being fished sustainably by local Indigenous peoples, newcomer humans began to arrive, and that is where the problems began for you. Along with overfishing, pollution from the logging industry, and the arrival of our friend SEA LAMPREY, your family's population began crashing.
- You were especially alarmed when you heard that your closest cousin, the Lake Ontario Kiyi, recently went extinct due to overfishing as well as predation and competition from SEA LAMPREY and RAINBOW SMELT. You are now considered a species of 'special concern'.
- But now, even as the KIYI population has been recovering, new changes are occurring. Your family is beginning to feel the strain again. Adult KIYI are having fewer offspring, and you are worried about your children's futures.

REVEAL ALL OF THIS INFORMATION ABOUT OPOSSUM SHRIMP:

You are even worried about your favourite food source. While you were in Little Bay the other night, you caught sight of OPOSSUM SHRIMP, and could definitely have eaten them and filled your belly - if they did not look so sick. Fearing getting sick yourself, you decided to eat a mayfly nymph instead.

DO NOT TURN THE PAGE UNTIL INSTRUCTED BY LAKE STURGEON

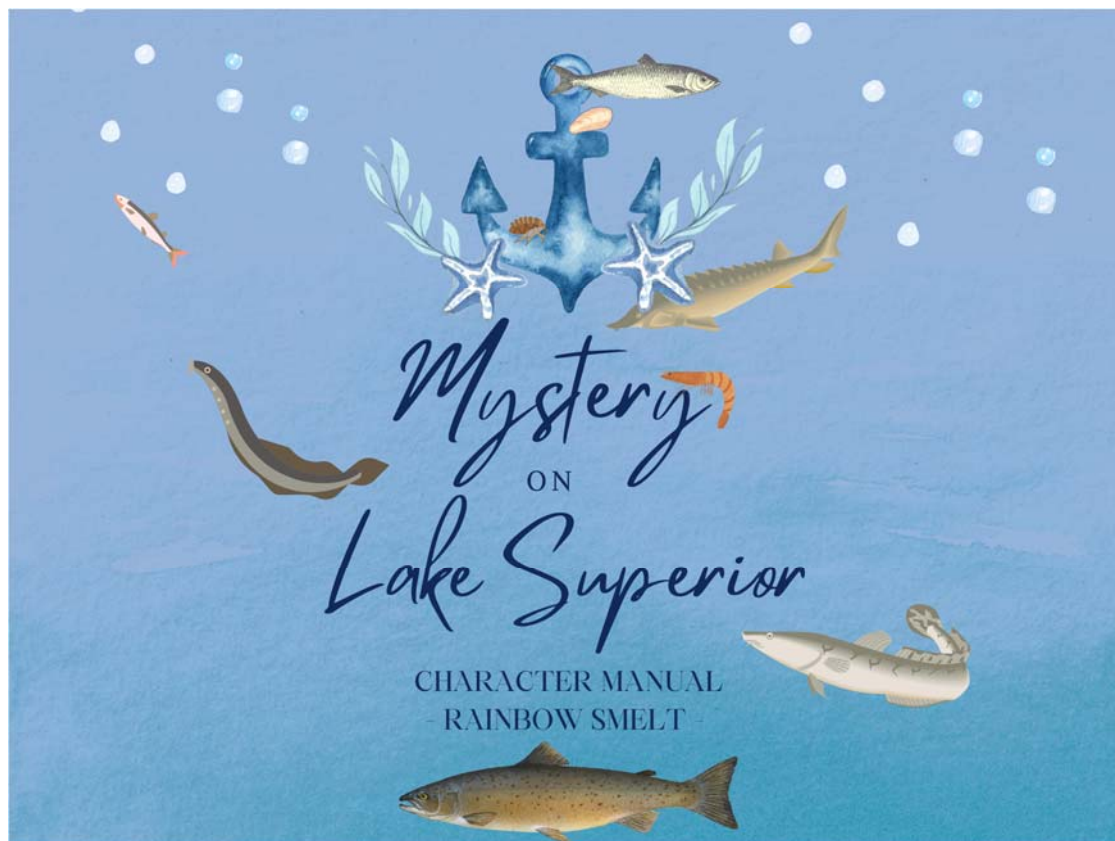
SCENE THREE - KIYI

REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED BY ZEBRA MUSSEL:

- You are not trying to hide anything. If they must know, you are wearing sunglasses because your eyes are light-sensitive.
- Now that there are more camps at Little Bay, there are more lights on at night which makes it hard for you to see, hunt for OPOSSUM SHRIMP, and escape predators like CHINOOK SALMON. Usually in winter you can catch a break, but with so little ice on the bay this year, more light is shining into the water.
- Thankfully a new plant has made its way into Little Bay, which helps you catch your breath while hiding from predators - though it does make it hard to find food sometimes.

REVEAL ALL OF THIS INFORMATION ABOUT OPOSSUM SHRIMP:

In fact, when you caught sight of OPOSSUM SHRIMP looking very ill the other night, they were nestled into a bloom of this plant. Was OPOSSUM SHRIMP just a prey hiding from predators, or a fugitive hiding from a crime they committed?



HOW TO PLAY GUIDELINES

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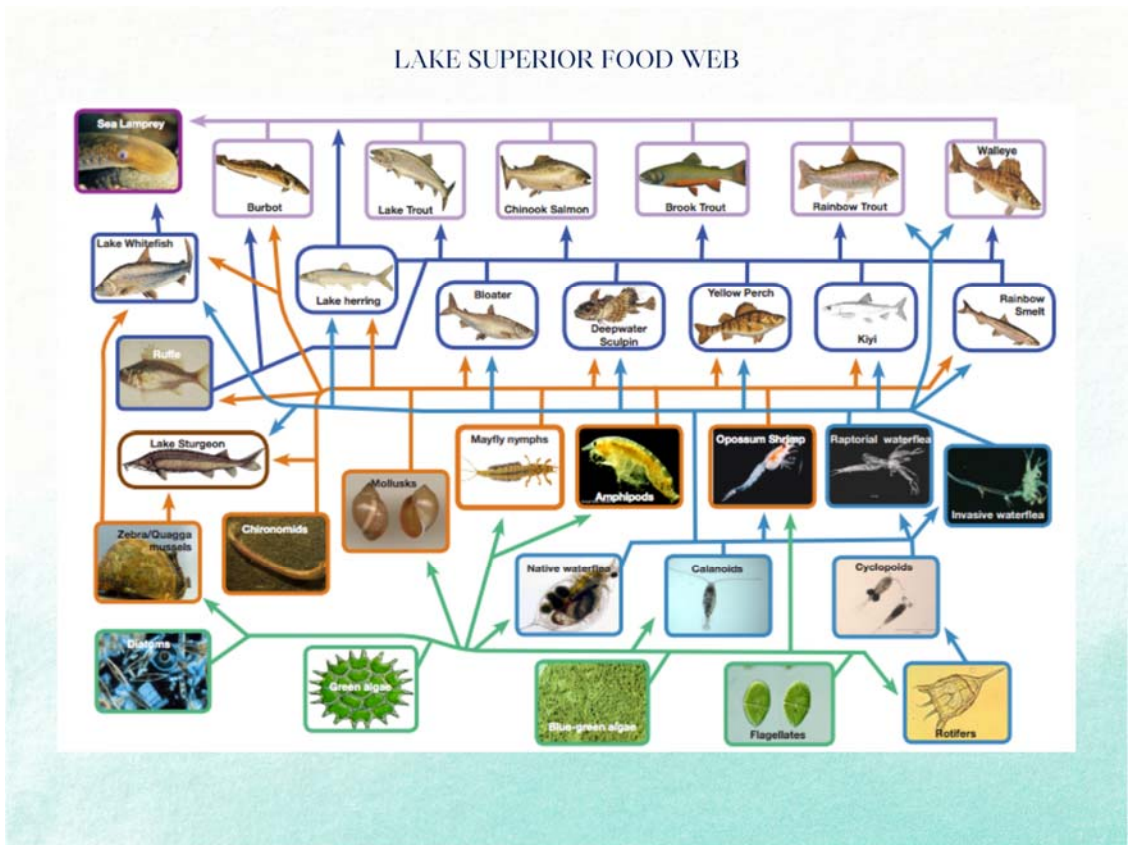
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BACKGROUND

USE THIS INFORMATION TO INTRODUCE YOURSELF:

- You are RAINBOW SMELT.
- You are a little nervous to be here. You are new to the area, and do not want to cause any trouble.
- You have a bit of an underbite, and have large prominent teeth on your tongue.
- You are tall and lanky, and not a particularly good swimmer.
- You tend to swim near the surface of the water, and do not stray very far from the coast. You swear you had nothing to do with Max's poisoning - but you do not feel all that sorry about it



EVIDENCE

THE LITTLE BAY BULLETIN

Vol 11-22

@newsonthebay

CLOSE CALL LEAVES COMMUNITY SHAKEN



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Read more on newsonthebay.com

SCENE ONE - RAINBOW SMELT

REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED BY CHINOOK SALMON:

- While some humans do call you 'invasive', RAINBOW SMELT have actually been purposely introduced into Lake Superior, just like CHINOOK SALMON.
- In fact, you were introduced over 100 years ago to feed stocked fish species, like CHINOOK.
- You originally come from the ocean too, the North Atlantic ocean that is.
- You were in Little Bay about to eat some plankton, microscopic plants floating on the surface of the water, but you did not have a chance to eat anything before being startled by a predator.

REVEAL ALL OF THIS INFORMATION ABOUT BURBOT:

You were on your way to your favourite dinner spot, when you spotted BURBOT across the bay. They were meant to be gone months ago! What brings them to Little Bay so late in the year? Could they have something to do with the incident? Besides the 'King', BURBOT is the only one you have ever had a problem with in these parts.

DO NOT TURN THE PAGE UNTIL INSTRUCTED BY LAKE STURGEON

SCENE TWO - RAINBOW SMELT

REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED BY ZEBRA MUSSEL:

- It is true! Though some humans still call you 'invasive', many others refer to you as 'naturalized' - which means that you are a newcomer who has become an important part of your new ecosystem. Like... dandelions on land.
- Not only do your kin feed Lake Superior fish, but you also feed local humans. Every spring, humans take part in 'smelting' events where they catch smelt in nets, often at night, and clean and fry them up. Your family has been called the 'french fries of the lake'.
- To be honest, you barely made it through the smelting season this spring. You do not know if you could make it through another one next year. If only there was a way to stop humans from fishing near Little Bay...

REVEAL ALL OF THIS INFORMATION ABOUT SPINY WATERFLEA:

Like ZEBRA MUSSEL, you also eat phytoplankton - so you know firsthand that there are still enough microscopic plants in Little Bay to feed the community - for now. One critter that is eating more than their share of zooplankton though, is SPINY WATERFLEA. They have actually been eating Daphnia - the long-established waterflea species in Little Bay - and are completely replacing that population!

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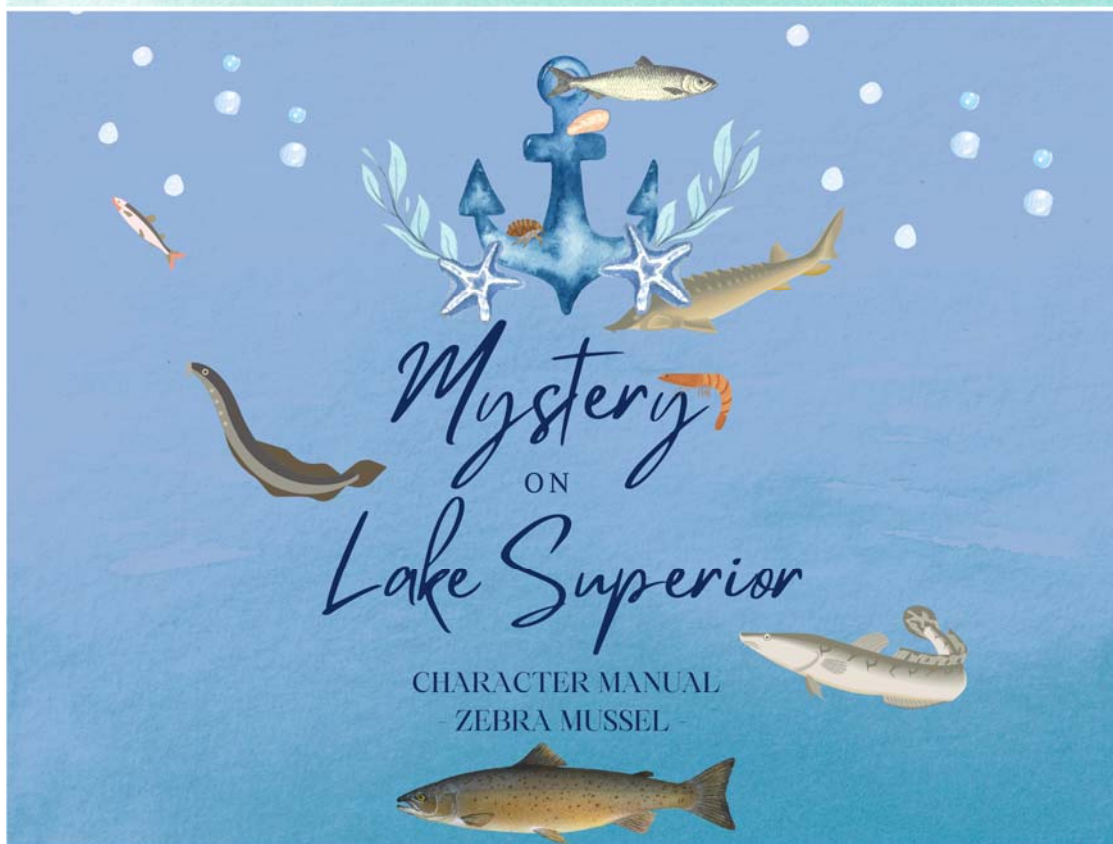
SCENE THREE - RAINBOW SMELT

REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED BY SPINY WATERFLEA:

- It is true that you have been daydreaming about putting an end to the smelting season, but what can you do about it? You are a tiny fish.
- On the American side of Lake Superior, there are new restrictions for human smelt consumption because there have been higher rates of “forever chemicals” found in the smelt there - but who is the winner in that situation?
- At least regulations are changing for pollutants found in products such as non-stick pans and firefighter foam to prevent so many chemicals entering our Great Lake. But they say that Lake Superior has a 191-year ‘retention rate’ - which means that it takes water and pollutants a long time to flow through.

REVEAL ALL OF THIS INFORMATION ABOUT ZEBRA MUSSEL:

Humans are distrustful of ZEBRA MUSSEL for the same reason, are they not?



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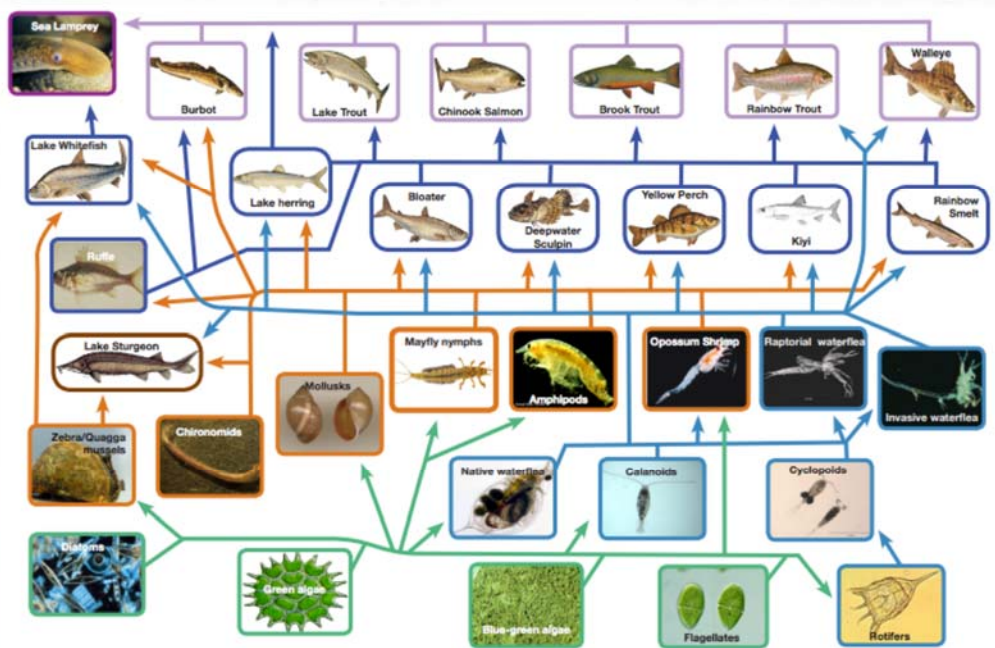
BACKGROUND

USE THIS INFORMATION TO INTRODUCE YOURSELF:

- You are ZEBRA MUSSEL.
- You come from a big, rambunctious family who loves to travel and see the world.
- You yourself are a little shy - some say you have yet to come out of your shell.
- You have a big appetite, and do not mind eating others' food scraps - you do not need a 3 star meal!

You heard about Max's poisoning, but do not know what all the fuss is about - has anyone not heard of animals getting poisoned before?

LAKE SUPERIOR FOOD WEB



EVIDENCE

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SCENE ONE - ZEBRA MUSSEL

REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED BY SPINY WATERFLEA:

- It is true that you were in Little Bay prior to the dog's poisoning. It is also true that the humans were upset that your family was blocking the water intake pipes. But you were not trying to cause any trouble - you were just trying to eat! ussels filter phytoplankton through a siphon to eat, and water intake pipes are the perfect place to filter food that is floating by.
- Like SPINY WATERFLEA, your family migrated from the Black Sea when a distant relative found themselves transported by ship ballast water to North America.

REVEAL ALL OF THIS INFORMATION ABOUT OPOSSUM SHRIMP:

While you were clinging to the buoy in Little Bay and feasting on all the tasty phytoplankton, you noticed OPOSSUM SHRIMP was also snacking on some phytoplankton - and looking real green. What was OPOSSUM SHRIMP doing on the surface during the day? And why did they look so ill?

DO NOT TURN THE PAGE UNTIL INSTRUCTED BY LAKE STURGEON

SCENE TWO - ZEBRA MUSSEL

REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED BY OPOSSUM SHRIMP:

- Yes, it is true that you and your family members all have big appetites, but because you are not a picky eater, you are often eating food that others just do not want. Slime? Yum. Sludge? Yes please! Fish poop? You are here for it! There is only one plant that you just cannot stand...
- In fact, you humans often talk about you 'invading' lakes and stealing resources from the long-established species there, when it is often quite the opposite. By the time you arrived in Lake Erie, for example, it had gotten so polluted that you were the only mussel species who would dine there! Once your relatives moved in and started feasting and filtering Lake Erie's water, the water became clear enough for sunlight to penetrate deeper, which helped aquatic plants recover, providing shelter for fish species.
- And some humans love that you make the water more clear.
- Plus, you provide another service for your new ecosystem - you are an important source of food for LAKE STURGEON. Before you arrived, LAKE STURGEON was endangered from overfishing, but your presence has helped their population bounce back.

REVEAL ALL OF THIS INFORMATION ABOUT RAINBOW SMELT:

And you are not the only proof that newcomer species can provide important services to their new habitats. Take RAINBOW SMELT, for example. They were introduced to Lake Superior to feed fish like CHINOOK SALMON, but they now also play an important role in local human culture, do they not?

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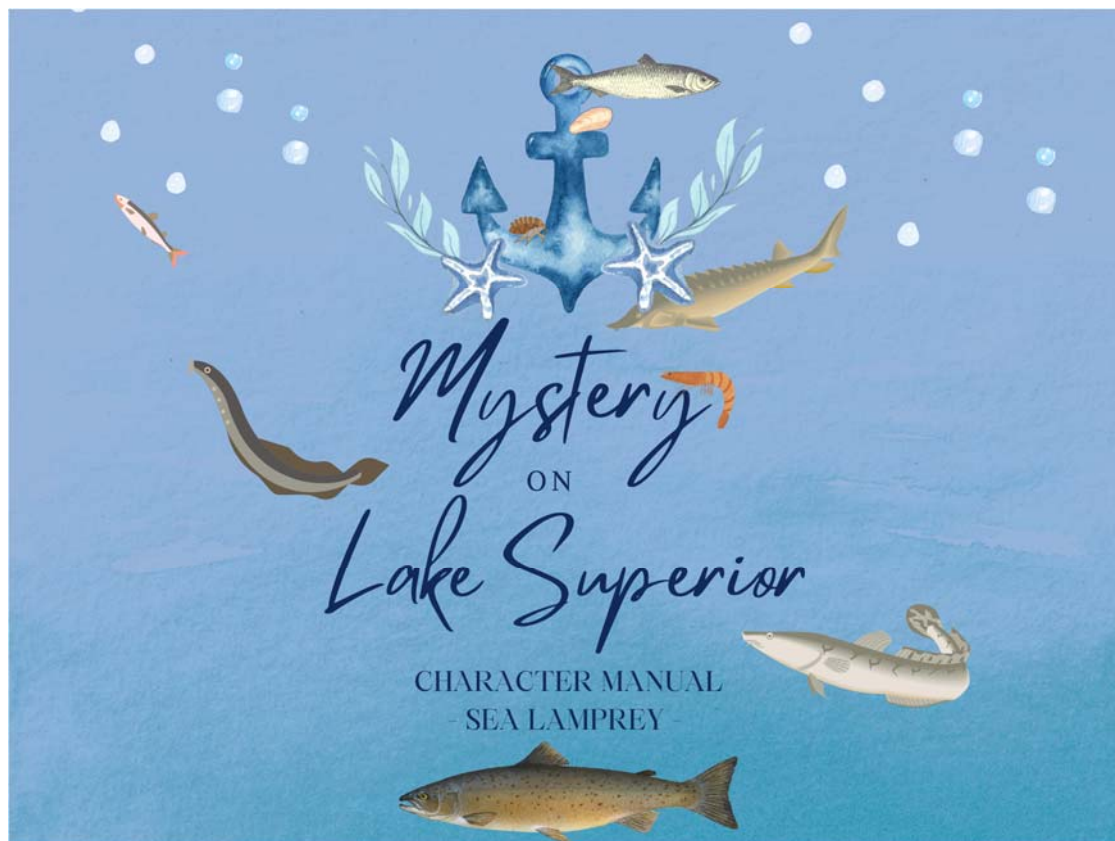
SCENE THREE - ZEBRA MUSSEL

REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED BY RAINBOW SMELT:

- It is true, humans do not eat you because they think you are toxic, but it is not your fault - you just have a belly full of their sludge! The toxins that you and your family members eat become concentrated in your bodies, and sometimes you are blamed when fish or birds eat a mussel and get sick. But where did the toxins come from in the first place?
- As far as getting dogs sick... you know that there are mussels - like the dark false mussel in the U.S. and Mexico - that can make dogs sick. But you swear you had nothing to do with Max's poisoning!
- The worst you ever did to Max was accidentally cut his paw when he stepped on you that one time.

REVEAL ALL OF THIS INFORMATION ABOUT KIYI:

Say, why does KIYI have those sunglasses on anyway? That sure seems suspicious to you!



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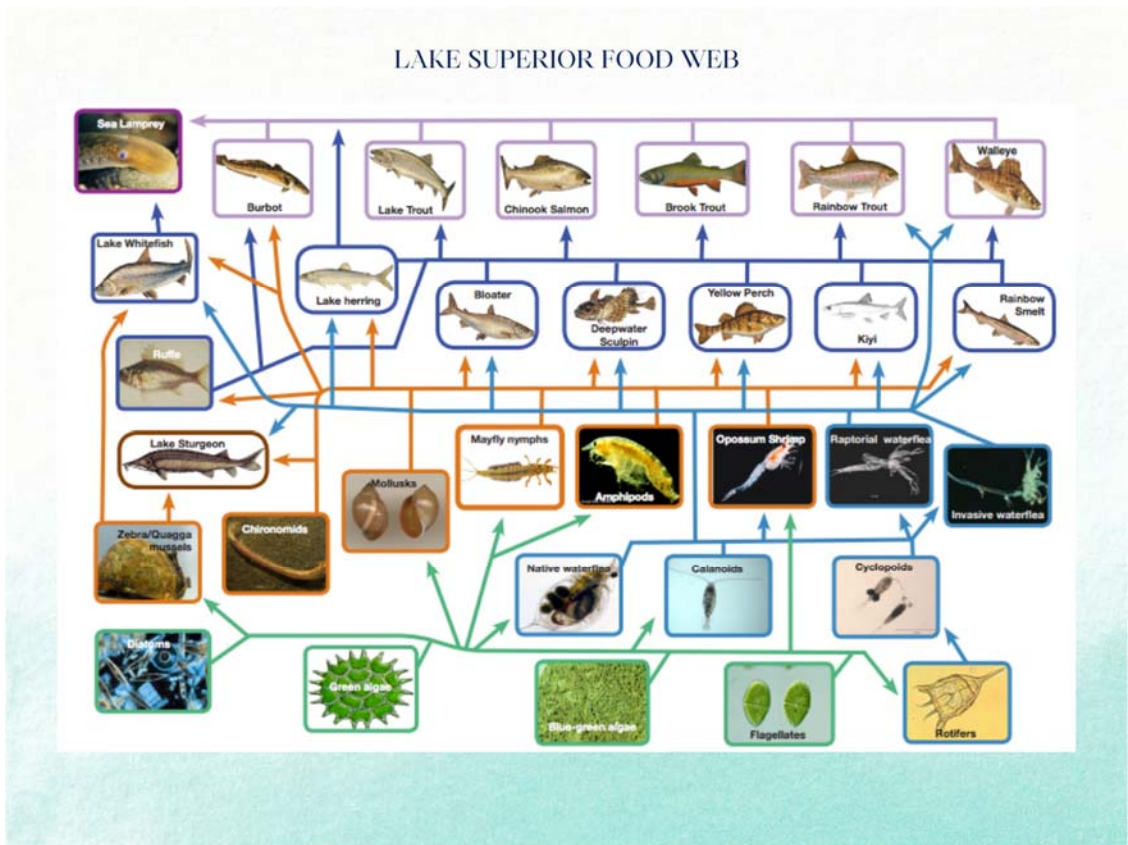
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BACKGROUND

USE THIS INFORMATION TO INTRODUCE YOURSELF:

- You are SEA LAMPREY.
 - You are a jawless fish, resembling an eel or even a snake.
 - Human scientists describe you as 'primitive' because your family genes haven't changed in 340 million years. You are adaptable in changing conditions, and have survived 4 major extinction events.
 - You have a bit of a bad reputation - some even call you 'the vampire of Lake Superior'.
 - Some aquatic animals even refer to you as 'parasitic', but they are exaggerating! You just get by with a little help from your friends.
- You do not feel too bad about Max's poisoning - after all, humans have been poisoning your loved ones for decades.



EVIDENCE

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SCENE ONE - SEA LAMPREY

REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED BY OPOSSUM SHRIMP:

- You know that Little Bay residents - both aquatic, and human - are afraid or get squeasy when they see you. In your homewaters of the Atlantic ocean, your hosts have co-evolved with you over thousands, even millions, of years. And they do not die when you feed off them a little.
- In Lake Superior though, it is a different story. But it is not your fault - you and your family have to eat!
- Your family migrated to Lake Ontario in 1835, and have slowly traveled the Great Lakes through a series of human-made shipping channels. Over 110 years later, you and your relatives finally made it to Lake Superior.
- Thanks to a little help from your friends STURGEON, BURBOT, CHINOOK SALMON, and KIYI, you have made a good life here for yourself.

REVEAL ALL OF THIS INFORMATION ABOUT KIYI:

Now of course KIYI would never admit to being your friend. A creature from a long-established family in Lake Superior certainly does not want to be seen with a newcomer like you.

DO NOT TURN THE PAGE UNTIL INSTRUCTED BY LAKE STURGEON

SCENE TWO - SEA LAMPREY

REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED BY CHINOOK SALMON:

- That was then, but things are different now! There are far fewer SEA LAMPREY in Lake Superior, and in Little Bay, today.
- Plus, you would much prefer to latch onto a lake trout, so why is CHINOOK SALMON so sore?
- Besides, where you come from, bigger fish eat SEA LAMPREY and keep your population in check. It's not your fault that fish here think that you are unappetizing.
- CHINOOK SALMON acts like the 'King' because humans like to fish and eat them. Well, guess what? You're edible too! While you don't have the cutest smile, it is said that you have a delicious taste. For thousands of years, in different parts of Europe, you were considered a delicacy, served to only royalty, or the elite. The Sea Lamprey Society in Denmark recently held a feast dedicated to you. In Portugal, sea lamprey is an important part of a traditional Sunday dinner.

REVEAL ALL OF THIS INFORMATION ABOUT BURBOT:

In that respect, you are really no different from BURBOT - a tasty, yet underappreciated, member of the community.

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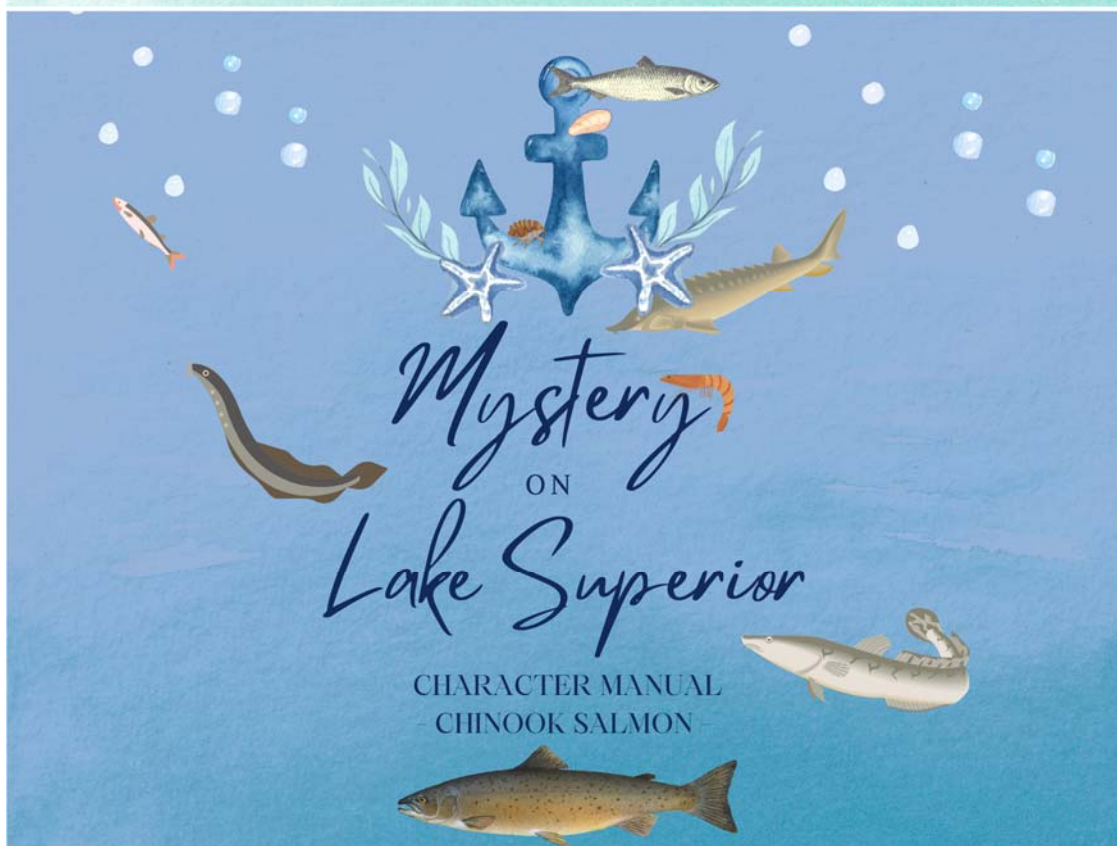
SCENE THREE - SEA LAMPREY

REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED BY BURBOT:

- No, BURBOT has it all wrong! Sure, you bioaccumulate mercury in your body. But the reason you have so much mercury in your body is because it is in the blood of other fish, like lake trout, whose blood you feed on. And they got it from other fish that they ate, and from the water. Where did this mercury come from in the first place, you might ask? It drifted into Lake Superior from the air because of human mining practices in the past.
- So yes, you are edible by humans, but should be tested first to make sure that your mercury levels are acceptable, like Health Canada guidelines recommend.
- Besides, you are much less toxic than that chemical TFM that humans put in the river where you lay your eggs - that stuff is lamprey poison!
- Thankfully, you notice that as the water is getting warmer, the chemical is less effective on your young.

REVEAL ALL OF THIS INFORMATION ABOUT SPINY WATERFLEA:

You are not the only one who is enjoying Little Bay's warming waters. SPINY WATERFLEA is loving the warm waters! They told you themselves. And speaking of SPINY WATERFLEA... just the other day, they were also talking about pulling the plug on the human's new 'Clean, Drain, Dry' program. Just how far was SPINY WATERFLEA willing to go to stop that program?



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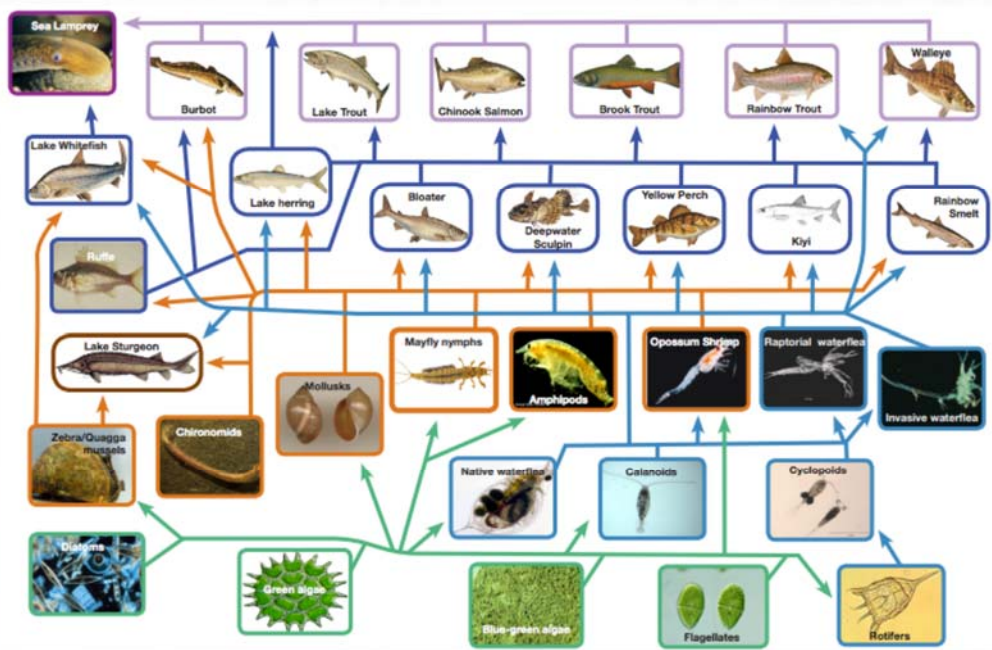
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BACKGROUND

USE THIS INFORMATION TO INTRODUCE YOURSELF:

- You are CHINOOK SALMON.
- Many call you 'KING SALMON', or just 'THE KING', because wherever you go you are the top predator in your food web.
- You do not have anything to do with Max's poisoning - you were just in the wrong place at the wrong time.
- Does anyone have any questions? Good. Are we done here?

LAKE SUPERIOR FOOD WEB



EVIDENCE

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SCENE ONE - CHINOOK SALMON

REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED BY KIYI:

- You were in Little Bay that night because you were looking for RAINBOW SMELT to munch on.
- It's true that you are not from Lake Superior, but does that mean that you are necessarily evil? You come from the North Pacific Ocean, where you were an apex predator, at the top of the food chain just as you are here.
- You were purposely introduced by humans into Lake Superior to get rid of 'pesky' alewife fish who arrived into the lake in the 1950s and started 'taking over'. Truthfully, you do not see what's so bad about the alewife, but you are not complaining - they are delicious! As are kiyi.
- Humans like CHINOOK so much that they purposely stock them for recreational fishing. So they are your only predator.

REVEAL ALL OF THIS INFORMATION ABOUT RAINBOW SMELT:

Speaking of fish that might be 'pesky', RAINBOW SMELT is also not from here. Humans even refer to them as 'invasive'. Sounds like they might be up to no good. On top of that, I saw RAINBOW SMELT in Little Bay the night before the dog's poisoning. I tried to chase them, but they got away. I bet they have something to do with the incident!

DO NOT TURN THE PAGE UNTIL INSTRUCTED BY LAKE STURGEON

SCENE TWO - CHINOOK SALMON

REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED BY SPINY WATERFLEA:

- True, you have eaten some of SPINY WATERFLEAs relatives, but they did not make a tasty snack. Their long spines make them difficult to swallow, and to digest. Those spines are probably still in your belly right now! You are better off leaving SPINY WATERFLEA to gunk up fishing lines, and snack on someone else. Those recreational fishers deserve it anyway, trying to bait and hook you all the time.

REVEAL ALL OF THIS INFORMATION ABOUT SEA LAMPREY:

In your opinion, a bigger threat to the Little Bay and Lake Superior communities is SEA LAMPREY. Like KIWI and LAKE STURGEON, you have personal experience with SEA LAMPREY. You know that when they first arrived into the Great Lakes, SEA LAMPREY killed millions of fish - which tore apart aquatic communities, and also negatively impacted the livelihood of humans that relied on the fishing industry. As few as 1 in 7 fish survive a SEA LAMPREY attack.

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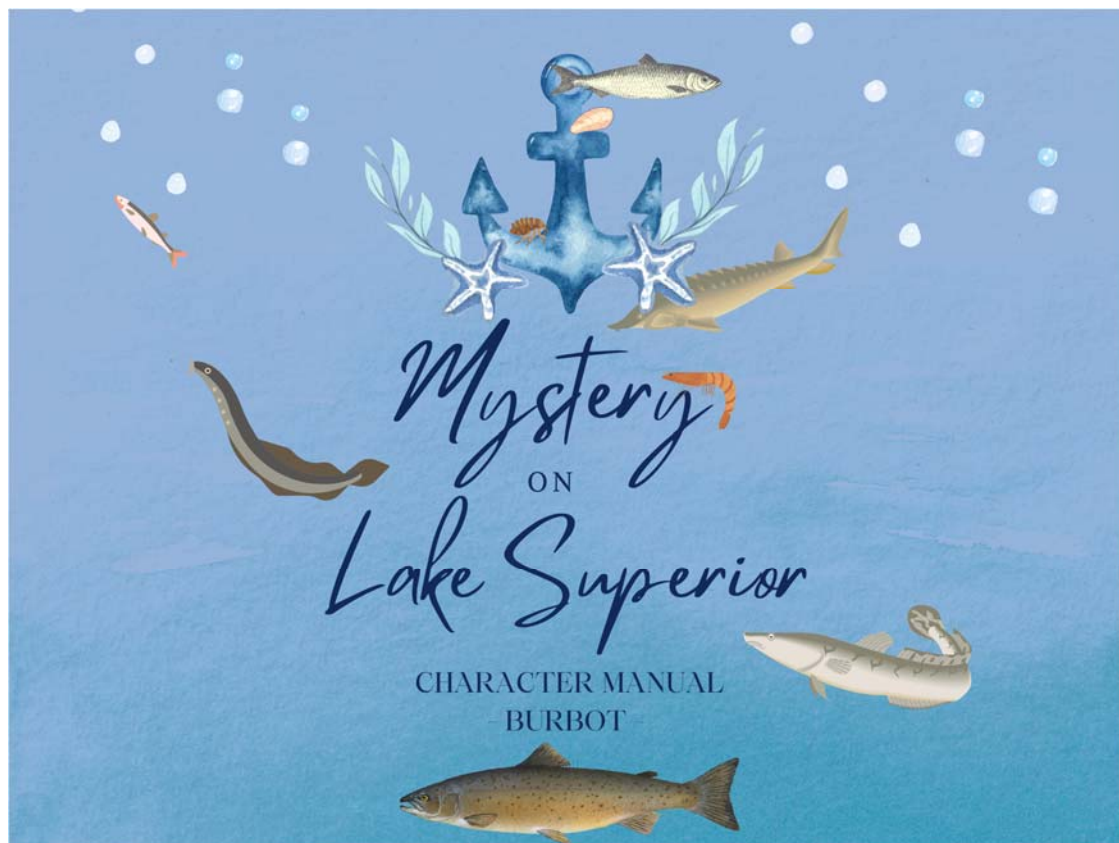
SCENE THREE - CHINOOK SALMON

REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED BY OPOSSUM SHRIMP:

- The night that you went into Little Bay with your young looking for a bite to eat, you noticed an odd smell in the water. When you followed it, it seemed to be leaching out of the soil at the very end of the bay, where a cabin is located near the water. There was a chemical smell coming from the soil as well. Suddenly, your offspring became very sick, and you swam away with them back into deeper waters to escape the effluent.

YOU BEGIN SCENE THREE BY REVEALING ALL OF THIS INFORMATION ABOUT BURBOT:

You are not sure about changes to Little Bay, but as someone who has spent years living alongside BURBOT in the deeper parts of Lake Superior, you can certainly attest to their change of behaviour this spring. BURBOT is usually so cool and collected - like the water in Superior's depths. Now they are often unpredictable, like Superior's surface. Why is BURBOT so frantic these days? Are they trying to hide something?



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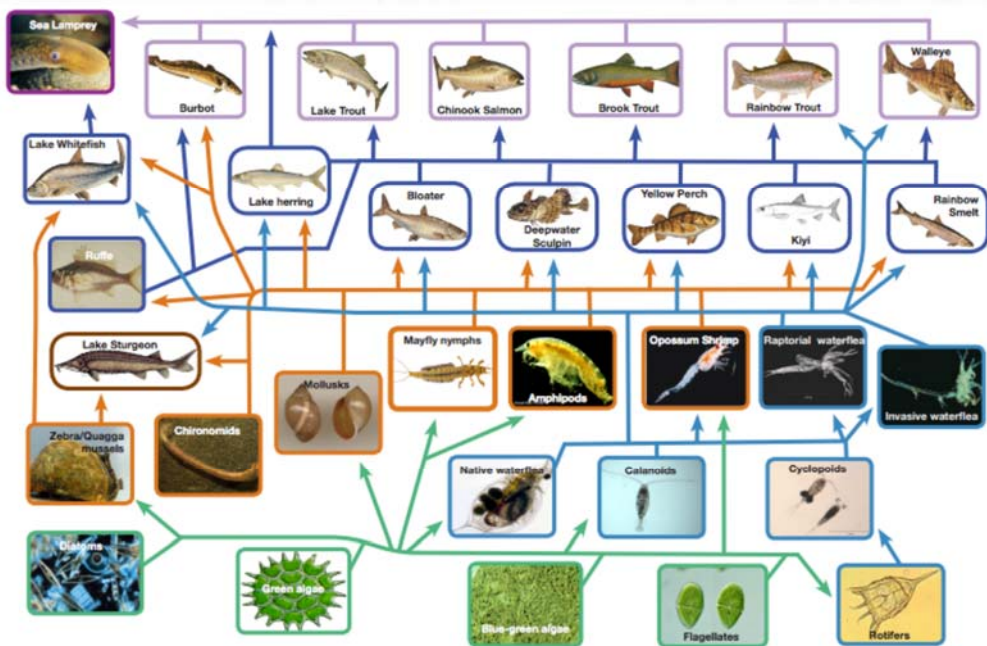
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BACKGROUND

USE THIS INFORMATION TO INTRODUCE YOURSELF:

- You are BURBOT, from a French word meaning 'mud', but might refer to the barbel on your chin.
 - You love cold water, and are usually found in deep waters far from shore.
 - You engage in daily vertical migrations to the surface looking for a tasty treat.
 - In the winter when you are most active, you make your way into more shallow waters to spawn. This usually happens before March, but this winter was an unusual and confusing one, which is why you find yourself in Little Bay presently.
- You do not know who or what poisoned Max - but maybe we have bigger fish to fry.

LAKE SUPERIOR FOOD WEB



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SCENE ONE - BURBOT

REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED BY RAINBOW SMELT:

- Sure, you might occasionally dine on one of their relatives, but RAINBOW SMELT leaves out an important detail - they also eat yours! RAINBOW SMELT eat your young fry before they grow up to fend for themselves. Mere babies! RAINBOW SMELT are the real 'bad dudes' - they should be banned from Little Bay, and from Lake Superior altogether!
- RAINBOW SMELT has also been 'stealing all the food' from our local cisco population. But that's a red herring. Or is that a lake herring? Anyhow...
- You and your family have lived in Lake Superior since before anyone can remember. And besides RAINBOW SMELT's arrival and impact on your family, there have been other changes going on in Little Bay - worrying ones.
- You usually come to Little Bay to spawn in the wintertime, but you have found that in recent years, there is less and less ice cover on the bay. And you need ice cover in order to spawn. This is why you are still around Little Bay so late in the year, if others must know - you have been looking for the ice.

REVEAL ALL OF THIS INFORMATION ABOUT SPINY WATERFLEA:

Speaking of 'bad dudes', while you were swimming through Little Bay you noticed SPINY WATERFLEA there, clinging to a rope from one of the buoys. They were in a big clump with hundreds of their relatives - gross! Surely SPINY WATERFLEA was up to no good.

DO NOT TURN THE PAGE UNTIL INSTRUCTED BY LAKE STURGEON

SCENE TWO - BURBOT

REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED BY SEA LAMPREY:

- That is right, you are unappreciated! While you are a tasty relative of the Atlantic cod, many anglers here won't eat you. Which is good news for you - you cannot count the winters that you have been tricked by humans out ice-fishing with their fancy lures.

REVEAL ALL OF THIS INFORMATION ABOUT KIYI:

Speaking of overfishing - how has your family been lately, KIYI? How are the kids?

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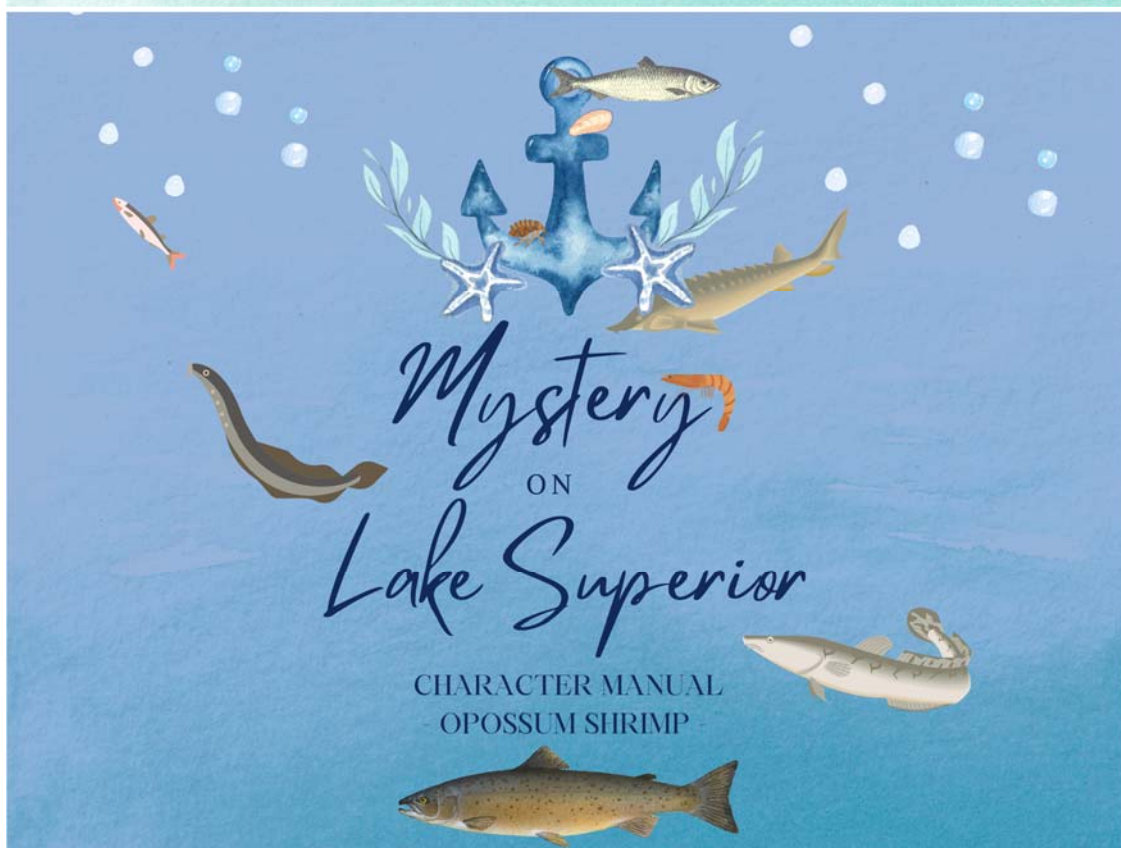
SCENE THREE - BURBOT

REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED BY CHINOOK SALMON:

- No, no, you are not trying to hide anything - except for eggs that is! You usually spawn by late March, but here we are in May and you still have not been able to lay your eggs.
- The problem is, there has not been much ice on Little Bay this winter, and you need ice to spawn. Why is there so little ice?

REVEAL ALL OF THIS INFORMATION ABOUT SEA LAMPREY:

You were thinking about what SEA LAMPREY said about being edible. You swear that just the other day your friend walleye had mentioned that they don't eat SEA LAMPREY because they are toxic. Could SEA LAMPREY have been involved in Max's poisoning?



HOW TO PLAY GUIDELINES

A dog from one of the camps on Little Bay, Lake Superior has been poisoned. You are a suspect. You have been seen swimming around the bay where the dog and his family live in the time preceding him getting sick.

Something fishy is going on here, and we're determined to find out what it is.

LAKE STURGEON, the oldest and wisest animal in Lake Superior, is requesting a meeting of all the aquatic animals seen in Little Bay immediately prior to Max's poisoning.

All of you are suspects. Players should introduce their characters, reveal their backstories, and divulge information about themselves and others during each of the four rounds of the activity. The object of Mystery on Lake Superior is to determine how the incident happened, who or what is the culprit, and what their motives are. Suspects must reveal all information in the character booklet truthfully when asked. If one of the characters accuses you, you may try to re-cast suspicion upon them to try to deflect attention.

Try to stay in character throughout!

The activity begins by revealing each character's background story then progresses through four scenes. During each scene the characters will have new information to reveal.

For each character, each scene contains two parts:

- The first part, "REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED" is the information each player shares only when asked.
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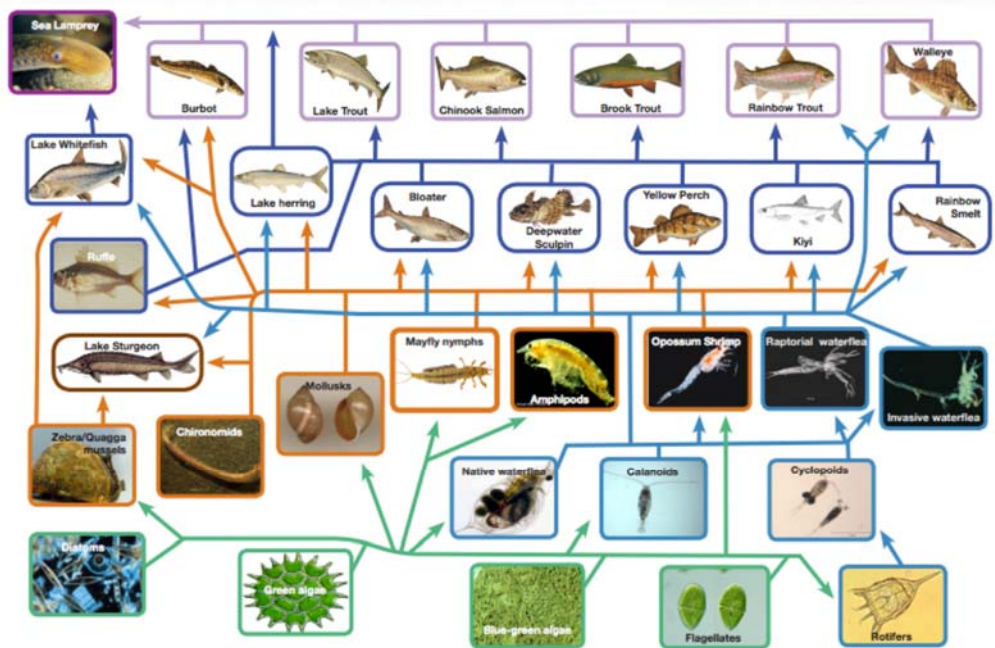
LAKE STURGEON finishes the activity by reading the Author's Solution, and leading the debrief.

BACKGROUND

USE THIS INFORMATION TO INTRODUCE YOURSELF:

- You are OPOSSUM SHRIMP.
 - You may be a tiny shrimp, but have a big personality!
 - You are upset about some of the changes happening in Little Bay lately! If you were not feeling so lousy these days, maybe you would actually do something about it.
- Who cares that Max got sick? We underwater creatures have our own problems to deal with!

LAKE SUPERIOR FOOD WEB



EVIDENCE

THE LITTLE BAY BULLETIN

Vol 11-22

@newsonthebay

CLOSE CALL LEAVES COMMUNITY SHAKEN



Max the dog had a close encounter with death Friday, May 20th 2022, after he was found shaking and salivating uncontrollably outside his family's camp by the water's edge. Luckily, Dr. Patricia Heeler was at camp with her family for the long weekend, and saved the day! Municipal authorities are warning residents to keep their children and pets away from the water until further notice.

Update - RE: Alien Invasion

The battle continues to cleanse our great bay of the evil invasive species that have plagued Little Bay residents in recent years, and continue to terrorize the aquatic... (con't. p.6)



[Read more on newsonthebay.com](http://newsonthebay.com)

SCENE ONE - OPOSSUM SHRIMP

REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED BY ZEBRA MUSSEL:

- ZEBRA MUSSEL is right. While you swim from deeper waters to the surface every day - a process known as diurnal vertical migration - you usually only go to the surface at night once the sun goes down, and everything is dark. You have been doing this your whole life, as your parents had before you, and theirs before that.
- But lately you have been feeling sick, and have not had the energy to return to the depths, out of the brightness. The dazzling sun is making you dizzy.
- You have so little energy, you worry about escaping your predators KIWI and RAINBOW SMELT.

REVEAL ALL OF THIS INFORMATION ABOUT SEA LAMPREY:

There is someone else that makes you feel sick - SEA LAMPREY. You saw them swim by on the day of the incident. There is something about the way they look - all sleek and snake-like. And the rows of razor-sharp teeth in their jawless mouth! Ick! You heard that when they eat, they bite into a fish's flesh and stay there, drilling a hole into the fish's side with a needle sharp tongue and sucking all their blood out. Humans call them the 'vampires of Lake Superior', and you can understand why. Surely such a parasite would not think twice about poisoning a dog?

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SCENE TWO - OPOSSUM SHRIMP

REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED BY KIYI:

- You are grateful that KIYI decided not to eat you that night.
- You have started to notice Little Bay changing as well. Not only are the animal residents of the bay changing, but new plant residents are moving in as well.

YOU START SCENE 2 BY REVEALING ALL OF THIS INFORMATION ABOUT ZEBRA MUSSEL:

You have something to say! Every night when you've made your way to the water's surface to feed on phytoplankton, you've noticed that there have been fewer and fewer microscopic plants available to eat. You have noticed that ZEBRA MUSSEL and their relatives have enormous appetites, and that they have been eating the sea lion's share of plankton. You and your family have even started talking about leaving Little Bay and moving somewhere where there is more food to sustain you. Talk about being a bad neighbour! But plans to move out came to a halt when you started getting sick.

DO NOT TURN THE PAGE UNTIL INSTRUCTED BY LAKE STURGEON

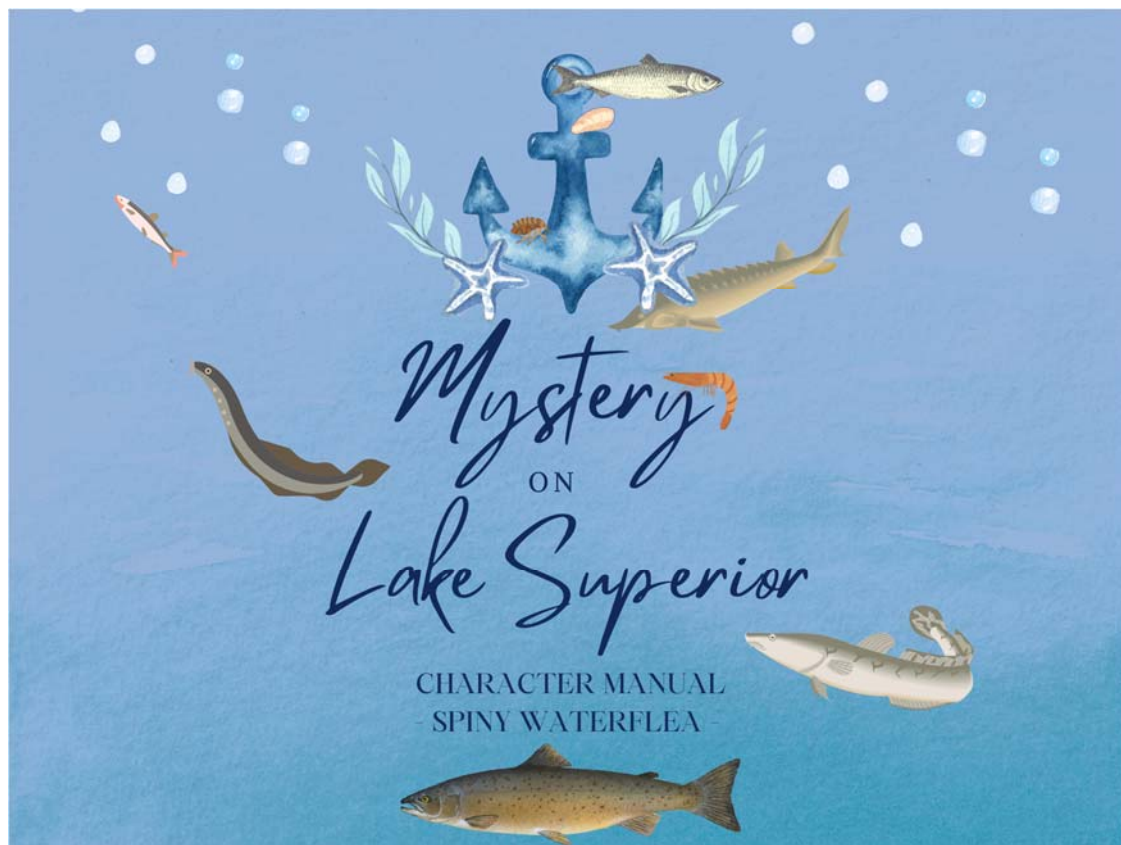
SCENE THREE - OPOSSUM SHRIMP

REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED BY KIYI:

- For a matter of fact, you were hiding out from the rain that night. It has been raining more over the last few years - has anyone else noticed?
- You were also having a bite to eat. You did not recognize these microscopic plants, and you were having a taste to see if they were any good. You did not much like it, however, and after a tiny bite went looking for different phytoplankton to eat.

REVEAL ALL OF THIS INFORMATION ABOUT CHINOOK SALMON:

That same night, you also saw CHINOOK SALMON and their young in the bay. They were swimming away really fast - what was it, exactly, that CHINOOK was swimming away from? Seems mighty suspicious...



HOW TO PLAY GUIDELINES

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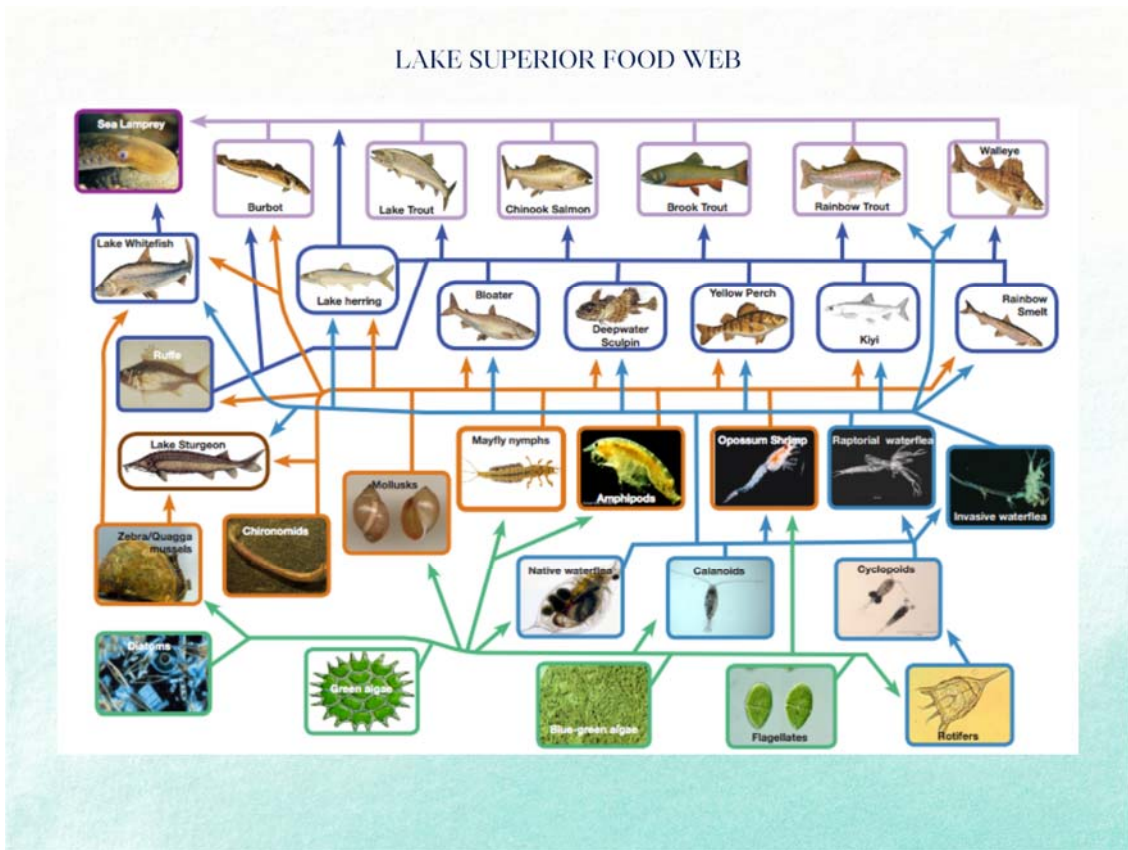
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LAKE STURGEON finishes the activity by reading the Author's Solution, and leading the debrief.

BACKGROUND

USE THIS INFORMATION TO INTRODUCE YOURSELF:

- You are SPINY WATERFLEA. You are not an insect, but a small crustacean.
 - You had not heard about Max's poisoning, but you are happy to join the meeting - it is nice to finally meet all the neighbours!
 - Does this council meet regularly? Can you join a neighbourhood committee? You will have to bring your famous phytoplankton cakes next time!
- Since we are all meeting, you have some concerns of your own to bring up...



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Read more on newsonthebay.com

SCENE TWO - SPINY WATER FLEA

REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED BY RAINBOW SMELT:

- Yes, you and your kin have been eating 'native' waterflea in Little Bay. But you cannot help it, they are so tasty! You are surprised that others haven't eaten them in the same quantity - they do not even have spiky exteriors to protect them from predators!
- As far as taking over the habitat - it is not your fault that you reproduce quickly and have many, many offspring!
- It is also not your fault that predators do not seem to want to eat you here in Lake Superior. In other regions that your relatives have moved to, SPINY WATERFLEA have become important members of the food chain.

REVEAL ALL OF THIS INFORMATION ABOUT CHINOOK SALMON:

CHINOOK SALMON has, in fact, eaten some of your relatives. So has RAINBOW SMELT and KIYL. Why are you not considered 'naturalized' and an important member of your community?

DO NOT TURN THE PAGE UNTIL INSTRUCTED BY LAKE STURGEON

SCENE THREE - SPINY WATER FLEA

REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED BY SEA LAMPREY:

- You are known to survive cold water and harsh conditions, but in warm waters you and your many, many offspring really thrive!
- Because of their spikey exteriors, your relatives are fairly safe from predators in Little Bay. The main threat to their survival happens when your offspring are still eggs, when humans cause them to dry up and die under the hot sun as part of their 'Clean, Drain, Dry' program.
- Sure, you have schemed about stopping the program - but you swear, you are all talk and no action!
- Besides, where would you get poison? You are just a puny crustacean.

REVEAL ALL OF THIS INFORMATION ABOUT RAINBOW SMELT:

But speaking of stopping humans' activity, I heard that RAINBOW SMELT has been plotting to put an end to the smelting season. What tricks does RAINBOW SMELT have up their sleeve?

SCENE ONE - SPINY WATER FLEA

REVEAL THIS INFORMATION ABOUT YOURSELF WHEN PROMPTED BY BURBOT:

- BURBOT is just upset because they tried to eat some of your cousins, and their spines got stuck and gave them a belly ache. That is not your fault.
- When BURBOT swam, you were just out for a family dinner, eating plankton and minding your own business.
- Just because you are not from Little Bay does not make you a 'bad dude'.
- You did not choose to come to Little Bay. One day back in the 1980s your great, great, great, great, great, great, great grandmother was swimming and having fun near their home on the Black Sea when all of a sudden the water she was in got sucked up into a giant metal whale. She was there for a long time. When it finally dumped her out, she found herself here, in Lake Superior!

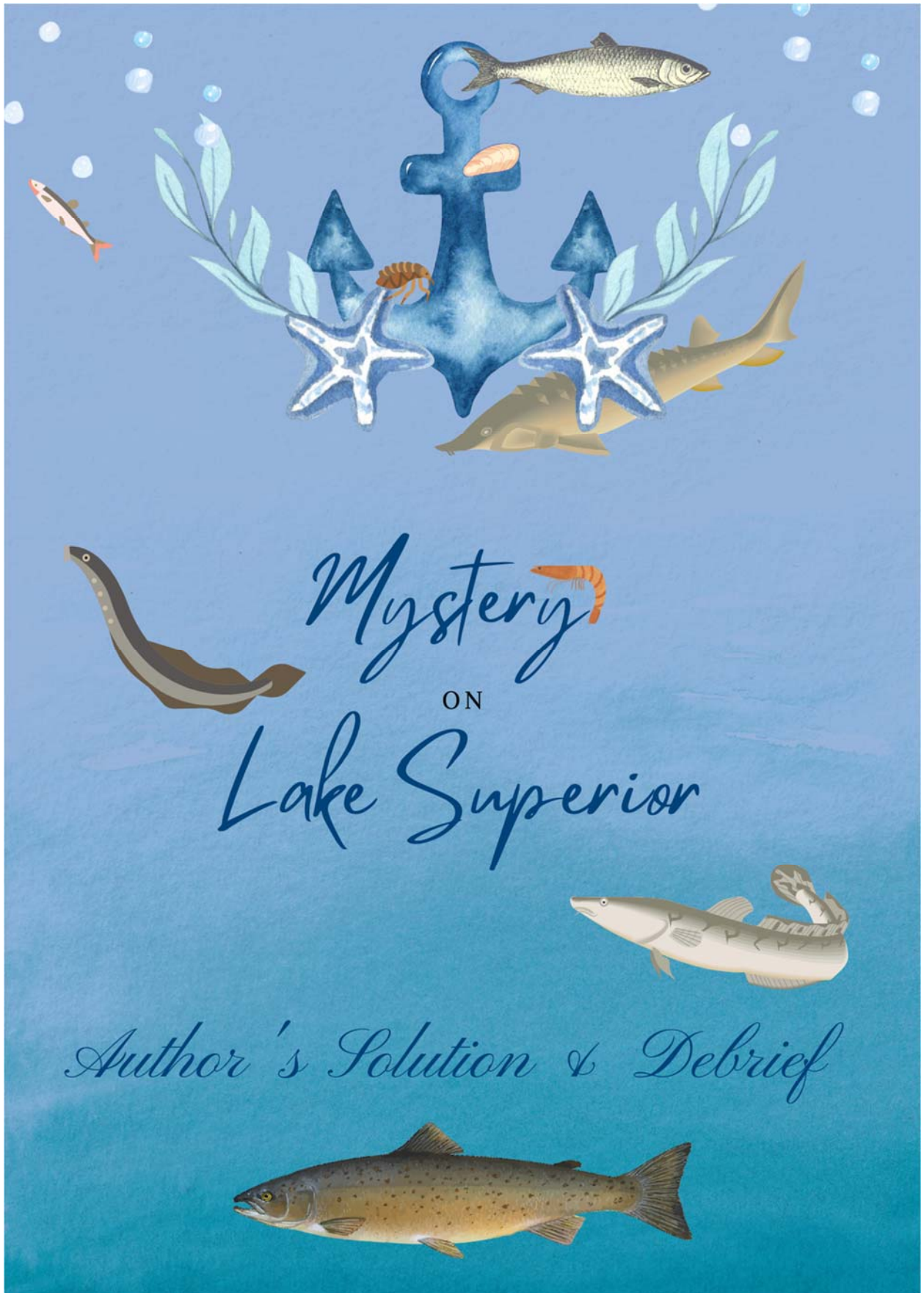
REVEAL ALL OF THIS INFORMATION ABOUT ZEBRA MUSSEL:

Besides, you were not the only one clinging to the Little Bay buoys. You saw ZEBRA MUSSEL and their family there the day before the incident, clinging onto buoys, boats, and water intake pipes. The human residents seemed upset. Could ZEBRA MUSSEL be involved in the dog's poisoning?

DO NOT TURN THE PAGE UNTIL INSTRUCTED BY LAKE STURGEON

Author's Solution & Debrief

The last component of the activity is the author's solution and debrief booklet. Following the completion of the last scene, participants each have the opportunity to share their determination of how the incident happened, who or what is the culprit, and what their motives are. The interpreter then reads the author's solution to the mystery. Once players have processed the solution, the interpreter leads a debriefing session to check for understanding, and to help learners make connections to real world situations. The first section of debrief questions help summarize the activity, while latter questions guide learners into critical reflection.



Mystery
ON
Lake Superior

Author's Solution & Debrief



AUTHOR'S SOLUTION

While the Earth's climate has been warming and cooling for millions of years, we are undoubtedly experiencing unprecedented global warming. Human activities such as deforestation, agriculture, and burning fossil fuels are contributing to the growing crisis of climate change.

Climate change looks different all over the world depending on geography, local ecosystems and infrastructure. On the North Shore of Lake Superior, where the fictional town of Little Bay is located, climate change is causing bigger storms, with increased wind speeds and rainfall. The North Shore is also experiencing significant air and water temperature increases.

Because Lake Superior has a bigger surface area than any other freshwater lake in the world, it has the capacity to absorb enormous amounts of radiant heat from the sun. This means that Lake Superior is warming faster than any other lake in the world. As ice coverage in the winter decreases, the lake can absorb that energy year-round.

SOLUTION CONTINUES ON NEXT PAGE

Warming waters means that some long-established species are struggling to survive, while some newcomer species are starting to thrive. Warming waters also means that species that have never before been seen on the North Shore might begin to make their appearance. Cyanobacteria, otherwise known as blue-green algae, is a type of phytoplankton that can be found in ecosystems throughout the world. In order to grow, they require warm water, sunlight, and nutrients. While Lake Superior's waters are generally much too cold for blue-green algae to thrive, the shallow warm waters of Little Bay are a perfect habitat. The increased rainfall in the area, combined with the increased development along the shoreline of Little Bay, led to the overflow of a camp septic system which leached sewage and chemicals into the bay. These nutrients, the dazzling sunlight, and the bay's warming waters provided the optimal conditions for the blue-green algae to thrive.

ZEBRA MUSSELS do not eat blue-green algae, but are known to clear the water of other phytoplankton, allowing the cyanobacteria more sunlight to grow. OPOSSUM SHRIMP will eat blue-green algae if there are limited food options available to them, which does not kill them, but may affect their reproduction. Blue-green algae removes available oxygen from the water as it decomposes, which makes it difficult for aquatic organisms to breathe, especially gilled fish like KIWI.

Human exposure to harmful blue-green algae may result in a rash, sore throat, diarrhea and vomiting, eye irritations, allergic reactions, and breathing difficulties. Pets who ingest high levels of toxins from blue-green algae can become very sick, and even die.

SOLUTION CONTINUES ON NEXT PAGE

The day of the incident, Max was last seen playing and drinking water from Little Bay. Max ingested cyanobacteria which made him very sick, and he was found shaking and salivating uncontrollably.

Luckily for Max and his family, Dr. Patricia Heeler was able to help Max, and save the day!

DEBRIEF QUESTIONS

In *Mystery on Lake Superior*, we met a diverse cast of species - some of whom were long-established in the Little Bay area and some of whom were newer residents. Use what you learned from the activity to answer these questions.

- Why might a newcomer organism migrate to a new habitat?
 - How do newcomer species arrive into a new habitat?
 - What are examples of newcomer species in Lake Superior?
 - What are ways newcomer species can harm their environment?
 - What are ways they can be beneficial to their new environment?
 - What strategies were used to solve the mystery?
-
- Are some species inherently “good” or “bad”?
 - Is a species “bad” if they eat another species? Why, or why not?
 - Why might humans consider some species “good” and others “bad”? (Which species do we prefer, and why?)
 - What helps propagate - or spread - the idea of “good” and “bad” species?
-
- For how long have species been migrating from one place to another?
 - In what ways does plant and non-human animal migration into new ecosystems resemble human migration from one region to another?
 - What lessons can humans learn from our plant and non-human animal relatives about being a good neighbour or community member when migrating to a new region?

Chapter Five: Final Reflection

When creating *Mystery on Lake Superior*, I was inspired by the concept of *métissage* and how multiple narratives might be shared without any one story dominating another. I was also spurred by a recent experience hosting a ‘mystery’ party game for a group of friends, and thought that this would be an engaging model for an interpretive activity about the vilification of newcomer species.

In a similar vein to a typical mystery party game, I chose a cast of eight characters, all of whom are aquatic animals in Lake Superior with their own perspectives of life in the lake and whose storylines reveal interesting facts about themselves and others. I also chose to have an additional character facilitate the activity, who would be aware of the author’s (my) solution to the mystery, and who would make observations that would support the debrief of the activity following its completion. For this role, I chose a lake sturgeon — a fish who is long-established in Lake Superior, yet endangered by overfishing, and who can live up to 100 years and could therefore have noticed the ways in which the lake has changed over time. The resurgence of sturgeon in Lake Superior can also in part be attributed to the introduction to the region of an “invasive” species — zebra mussels — reinforcing the idea of newcomer species’ “services” to their new habitat.

Of the eight remaining characters, five are newcomer species who have been introduced in diverse ways: chinook salmon and rainbow smelt who were, and are still, purposely stocked in Lake Superior, zebra mussels and spiny waterflea who were introduced through ship ballast, and sea lamprey who have made their way through the Great Lakes system through human-made channels. The other three characters — the burbot, the kiyi, and the opossum shrimp — are long-

established species in Lake Superior who experience impacts related to these newcomer species as well as changes to the environment due to climate change.

Along with the author's solution, I have provided a list of recommended debrief questions that the interpreter could use to solidify the participants' new learnings as well as engage them in critical reflection. The first few questions are meant to recapitulate information from the activity, such as who were the long-introduced and newcomer animals in Little Bay, how did newcomer species first become introduced to Lake Superior, and what harms and benefits newcomer species can have on their habitat, as well as reflect on how they chose to solve the mystery (i.e., collaboratively versus competitively). The next set of questions guide participants in reflecting on the animals' subjectivities as well as reasons why humans perceive various species as having different inherent worth. Finally, the last set of questions guide learners into thinking about ecosystems as dynamic rather than static, make connections between species migration and human migration and colonization, and reflect on lessons that humans can learn from our non-human relatives.

In creating this portfolio, I wanted to incorporate my new learnings from the research process, and from my MEd as a whole. First, I wanted to create an alternative discourse to the vilification of "invasive" species, and guide readers and activity participants into rethinking their relationships with newcomer species. Throughout the papers and activity, I used neutral language such as "newcomer species" rather than terminology that elicits a negative reaction, such as "invasive," "aliens," or "foreigners." By purposefully using terminology such as "long-established" and "newly-introduced," I disrupted the dominant way of arbitrarily separating species along colonial times lines. I also hoped to guide learners into rethinking their relationships with non-human beings more generally, and challenge colonial notions of land and

living beings, by describing the aquatic residents in ‘Mystery on Lake Superior’ as subjects of their own lives rather than objects to be controlled. I also strived to use the grammar of animacy (Kimmerer, 2015) by depicting the characters as subjective beings, although I did find myself reverting to dominant Western ways of describing non-human animals as objects, but then caught myself and word-smithed accordingly. My own challenges in breaking this ingrained habit is an example of the hidden curriculum that can unintentionally be communicated to learners by their educators through the language we use. I thus also used descriptors such as “human residents of Little Bay” to remind students of “the profound similarities between human and non-human experiences” (Caine, 2012, para. 2), and of our place as an animal within a shared ecosystem.

In each scene of the interpretive activity, I provided information on the (local to me) Lake Superior ecosystem and clarified confusing terminology as well as dispelled common myths associated with "invasive" species — such as misconceptions surrounding biodiversity loss and the responsibility of newcomer species in the decline of long-established ones. Through the characters’ stories, I described the ways that Little Bay was impacted by climate change, and other ways in which human activity intersects with “invasive " species' introduction and propagation. The way each character’s story was woven together was inspired by Indigenous education, and frameworks that braid narratives together such as *métissage*. Through the activity — and the debrief questions, in particular, I wanted to guide participants into reflecting on Canada’s history of colonization and what it means to be a good neighbour.

Due to time constraints and the limited scope of a portfolio project, I was not able to work with community partners — local Indigenous groups, in particular — to generate ideas for, or co-create, the interpretive activity. I recognize that is not ideal; as I noted in Chapter 3,

working with interested members of one's local Indigenous community is important if one is to take an anti-colonial approach. While it may be more challenging, given its province-wide mandate, for provincial curriculum to include local perspectives of any sort, including Indigenous ones, educators nonetheless should try to find ways to adapt the curriculum to their local context. School boards and organizations may already have an Indigenous advisory council with whom they can consult and collaborate. Additionally, environmental science educators who have been marinated in traditional Western approaches to science need to educate themselves on Indigenous culture and anti-colonial science to broaden and deepen their approach.

While the development of my activity was not ideal given I was not able to apply all the learning I experienced through writing the literature review portion of this portfolio, or through my MEd studies more generally, I nonetheless was able to apply much of it. And this does not have to be the end of this activity as I can continue to refine it after the MEd or develop new activities, using more participatory and inclusive approaches. Indeed, completing this portfolio is not the end of my learning journey. I am interested in doing future work that aligns and overlaps with, and supports, the work of Indigenous scholars, perhaps focusing on “novel ecosystems” using an anti-colonial framework. If I was to turn back time and begin this portfolio anew, that is how I would re-frame my research. That said, I do not regret the decisions I made throughout the portfolio process as they became the catalyst for further reflection and much learning. As a settler — as well as someone who works in multiple levels of government — I have the *privilege, power, and personal responsibility* to share what I have learned along my personal and academic journey as a step toward both reconciliation and making the world a better place for all its inhabitants.

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