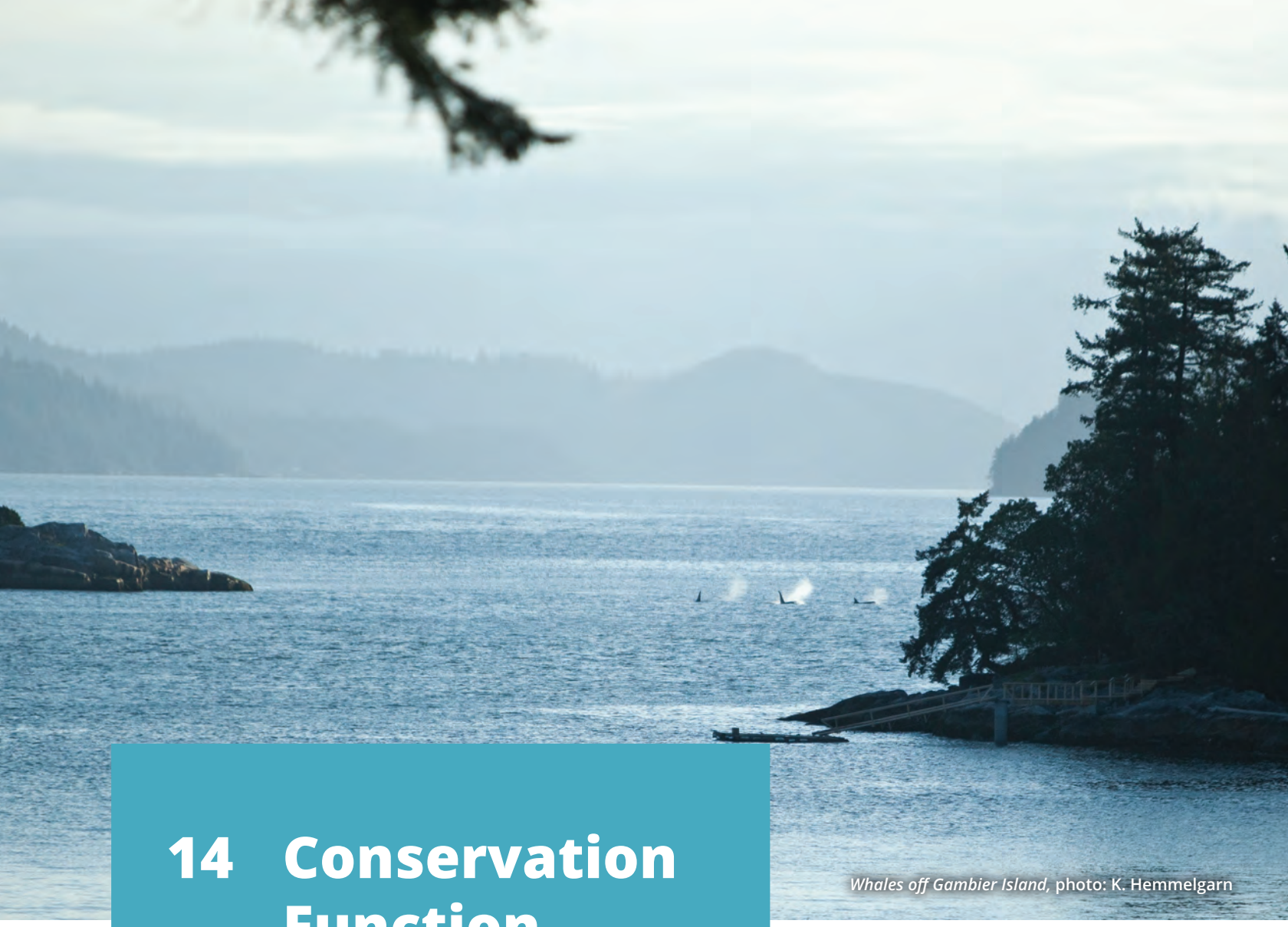


Whales off Gambier Island, photo: K. Hemmelgarn

14 Conservation Function

The primary conservation function of a Biosphere Region is to make a significant contribution to the conservation of landscapes, ecosystems, species and genetic variation, both within the Biosphere Region itself and beyond its boundaries to further share the impacts and benefits of the Biosphere Region with the surrounding ecosystems and communities. As discussed in Sections 3, 4 and 11, the natural features that define the Biosphere Region reveal an ecological mosaic of considerable significance for biodiversity conservation. Further, the communities of the Biosphere Region are ideally positioned for and committed to serving as a model region to demonstrate the means of achieving an effective balance between the conservation of this biodiversity and enabling sustainable development in a viable economy.

While Section 14.1 below summarises the general characteristics of the landscapes and ecosystems of Átl'ka7tsem/Howe Sound which have been described in greater detail in Sections 4 and 11, the Conservation Function of the proposed AHSBR is described specifically in Sections 14.2, 14.3 & 14.4.

14.1 Landscapes and Ecosystems

(At the level of landscapes and ecosystems (including soils, water and climate)

14.1.1 Location of Ecosystems and/or Land Cover Types of the Biosphere Reserve

The dominating feature of the landscape of Átl'ka7tsem/ Howe Sound is the fjord of the same name. Recognized as one of the most beautiful fjords in the world, the combination of terrestrial and marine ecosystems produces a remarkable blend of wilderness, biodiversity and accessibility with its complex landscape of high, steeply sloped mountains, glaciers, deep inlets, rugged islands and protected ocean waters. The diverse marine environments of the fjord are surrounded on two sides by the mountains of the Coast Range to the east and the Tantalus Mountains to the west, by the archipelago of the Howe Sound islands guarding the fjord's entrance to the south and the estuaries and riparian habitats of the Squamish and Cheakamus River valleys to the north (Section 19.2).

The following addresses these terrestrial and marine ecosystems, and their component land covers and marine habitats. Terrestrial ecosystems are described by their principal divisions of forests, alpine and freshwater systems, and marine by coastal, benthic and pelagic habitats.

Terrestrial Ecosystems

Terrestrially, this complex landscape has created a mosaic of ecosystems and land cover types to rival any other landscape in Canada, primarily due to the range in elevation from sea level to the highest peak at 2,678 metres within a relatively short distance. The seaside climate is 'mediterranean' in nature with hot, dry summers and warm, moist winters, with forests adapted to these conditions. Transitioning to higher elevation forests that are cooler and capture more moisture, the classic west coast "temperate rainforest" dominates. Transitioning further to the subalpine and alpine environments of the mountain ranges' highest peaks, their extreme cold and heavy snow conditions transform the forest to an often treeless expanse.

Forests

Átl'ka7tsem/Howe Sound lies between the Coast Mountains and the Pacific Ocean, resulting in different air fronts converging and producing significant amounts of moisture in the form of rain or snow. The resulting temperate rainforest, that covers about 82% of the AHSBR's land area, is a highly productive and diverse ecosystem which is part of a much larger forest in North America comprising almost half of the world's temperate rainforest (OGSC, 2019). These forests are predominantly coniferous with the dominant species including Douglas fir, western red cedar and western hemlock (see Section 4.2.3) (Meidinger and Pojar, 1991).

The variation in elevation and the proximity to the moderating influence of the ocean are reflected in the classification of these forests into biogeoclimatic (BC) zones and subzone variants. The area below 900 metres is in the Coastal Western Hemlock (CWH) BC which, on average, is the wettest BC zone in BC, encompassing the low and mid-elevation coastal forests on windward slopes. From sea level to about 150 metres, these forests are drier and characterized by warm, dry summers and moist, mild winters and are typically dominated in drier sites by the coastal variety of Douglas fir. The low to mid-elevation forests are covered by Western hemlock, accompanied by minor amounts of grand fir, red alder and bigleaf maple. Finally, the very wet, maritime forests occur only at elevations greater than 650 metres (BC Environment, 2006; Madrone Environmental Services Inc., 2009).

At higher elevations exceeding 900 metres and as high as 1,800 metres on south coast west-facing slopes, forests of Mountain Hemlock predominate, accompanied by amabilis fir, yellow cedar, western red cedar, Douglas fir and western white pine. This forest thrives in the long, wet and cold winters with short, cool summers and high snowfalls. The forest is typically older with 86% being in age classes 7-9 (120-250+ years), often with old growth stands exceeding 1,000 years old (Banner, 2011; BC Parks 1997). Tree growth thins approaching the tree line and often transitions into subalpine heath, meadow, bog and fen vegetation. (BC Parks, 1997; Meidinger and Pojar, 1991)

Alpine Tundra

The Alpine Tundra zone occurs above 1,600 metres along the windward spine and summits of the Coast Mountains. This zone is subject to the harshest climate in BC with cold temperatures for most of the year and very high snow falls. Around the tree line, vegetation is lush with mountain hemlock, yellow cedar and subalpine fir. Under storey vegetation and ground cover above the tree line is typically characterized by low-growing evergreen dwarf shrubs such as white and pink mountain-heather (MacKenzie and Meidinger, 2006). Above the tree line, trees are stunted and show the 'krummholz' form and are populated primarily by mountain hemlock, whitebark pine, Englemann Spruce, subalpine fir and subalpine larch. On average, about 88% of this zone lacks vegetation and is covered by rock, snow and ice (CFCG, 2017).

Freshwater: Rivers, Wetlands, Lakes and Riparian Areas

Valley bottom ecosystems between the mountain ranges include ribbons of riparian forests along the various river and stream courses, lakes and wetlands. These riparian ecosystems are, generally speaking, among the most productive systems in AHSBR providing habitat for about 25% of vertebrate, invertebrate and vascular plant species in BC (Government of BC, 2019c). Riparian forests contain species that prefer moist soils such as black cottonwood, red alder, western red cedar and Sitka spruce, and have an understory of willows, red-osier dogwood and salmonberry, with a herbaceous layer of rushes, sedges and skunk cabbage. These habitats are home to numerous species of insects, crustaceans and amphibians, including the blue-listed red-legged frog, as well as many of the same species of birds and mammals found in the adjacent higher elevation forests (Melville and Lindquist, nd).

Wetlands, in the form of marshes and bogs, are a common component of riparian forests. Marshes are moist sites with saturated nutrient rich soils characterized by a vegetation of sedges, grasses and reeds. Bogs are nutrient poor and their soils are saturated with acidic soil and cool conditions favouring the growth and long-term accumulations of peat formed by *Sphagnum* moss, accompanied by stunted trees of lodgepole pine and an understory of bog blueberry, Labrador tea, bog cranberry and skunk cabbage. Wetlands are important habitat for a variety of amphibians, birds and small mammals.

Riverine habitats vary from steep mountain streams, with little to no fish bearing capacity, to larger rivers such as the Squamish and its three tributaries: the Cheakamus, Mamquam, and Elaho rivers, with deep slow water and shallow braided channels. The rivers support significant fish populations, including rainbow, steelhead and cutthroat (anadromous and non-anadromous) trout; chum, pink, chinook, coho and sockeye salmon, bull trout and dolly varden (Melville and Lindquist, nd).

In addition to the Squamish River watershed, there are multiple mountain streams that flow directly into both the east and west shores of Howe Sound. Although many of these smaller creeks are inaccessible to salmon, they are known to spawn in the lower reaches of several of these creeks such as McNab, Britannia and Furry Creek.

Nearly all the lakes in Átl'ka7tsem/Howe Sound are located in the alpine or sub-alpine zones and are fed by snow melt, the largest being Garibaldi Lake. Other notable alpine lakes include Echo Lake, Lake Lovely Water, Henriette Lake, Brennan Lake and Deeks Lake. There are also several lakes near sea level as well, including Alice Lake, Stump Lake, Fawn Lake and Edith Lake that offer valuable habitat for waterfowl, amphibians and resident fish populations (Melville and Lindquist, nd).

Marine Ecosystems

Where land meets the sea, the steep mountain slopes continue steeply below sea level to depths of 275 meters. Being a classic fjord, Howe Sound has multiple basins separated by submerged glacial sills that cause distinctive oceanic circulation patterns and oceanographic conditions that influence the composition of marine life. Marine environments in the Sound range from shallow coastal habitats and productive estuaries to deep fjord pelagic waters and benthic habitats.

Coastal Environments

Coastal and nearshore tidal and subtidal marine habitats, generally those at sea level to less than 20 metres in depth, include rocky shores with hard substrate, sandy beach and soft bottom subtidal habitats and are associated with distinct biological communities and submerged aquatic vegetation, such as eelgrass and kelp beds. Coastal habitats, notably sand and gravel beaches, are critically

Squamish River estuary, photo: B. Turner

important for the reproduction of some forage fish species, in particular herring that spawn in subtidal and intertidal vegetation such as eelgrass or kelp as well as bedrock, and sand lance and surf smelt that spawn on pebble and sand beaches just below the high tide line.

Eelgrass is critical habitat for many marine species including waterfowl, fish and invertebrates with about 80% of marine invertebrates and important fish species using this habitat during some part of their life cycle. Because of where eelgrass grows, in shallow, protected waters, they are very vulnerable to development practices that disturb the seabed or disrupt the penetration of sunlight from above, as from log storage or boat moorage (OWHS, 2017).

Estuaries

There are several estuaries in Howe Sound that play a critical role in sustaining marine life (Molnar, 2015). Estuaries are naturally rare on the BC coast, comprising only 2.3% of the natural shoreline (BC Conservation Data Centre, 2006). Many of the smaller estuaries in the Sound have been impacted by industrial and residential development, as well as log storage, gravel extraction, dredging and waste disposal (BC Fish and Wildlife Branch, 1979). The largest estuary in the Sound is at the mouth of the Squamish River, accounting for 96% of all estuarine habitat in the Sound (Molnar, 2015).

The Squamish Estuary provides habitat, rearing areas and food for migrating salmon populations and accounts for the vast majority of all spawning capacity in the Sound (OWHS, 2017; Golder Associates, 2005). The Estuary is such an important habitat to many avian species including waterfowl and songbirds that it has been protected as a Wildlife Management Area and designated in 2017 as an Important Bird and Biodiversity Area (IBA).

Fjord Pelagic and Benthic Environments

Oceanographically, Átl'ka7tsem/Howe Sound is a true fjord with an average depth of 275 metres and a length of 46 kms extending from its entrance seaward of Bowen Island and the Pasley Group to the estuary of the Squamish River. The Sound has two distinct basins, the 'sound' portion at the entrance to the fjord which is 20 kms across, and the more 'fjord-like' portion where it narrows between steep precipitous cliffs near Porteau Cove to about 3.5 kms wide and extending 26 kms inland to the estuary of the Squamish River. The two basins are divided by a sill that rises to 35 metres below the surface, blocking the northward movement of deep oceanic waters creating the relative stagnation of bottom waters in the basin north of the sill (Thompson, 1981).

Átl'ka7tsem/Howe Sound is recognized for its specialised benthic fauna that is typical of fjord environments with steep rocky walls. This fauna is characterized by cup corals and encrusting hard corals, brachiopods and sponges. The soft corals and glass sponges are accompanied by predatory molluscs, echinoderms and various species of fish (Levings et al, 1983). As discussed in Section 11.6.3.2, hexactinellid or glass sponge reefs are a globally unique ecosystem whose presence in the ocean waters of western Canada is a recent discovery. They are thought to exist nowhere else in the world but in the Pacific waters off western Canada and the United States.

14.1.2 Describe the state and trends of the ecosystems and/or land cover types described above and the natural and human drivers of the trends.

As described in the introduction, the region has been undergoing an environmental recovery over the past thirty years. The restoration projects, pollution regulations, improved forestry practices, planning and marine protections have resulted in key environmental measures that are trending in the right direction. As people in the region are celebrating the return of the whales and dolphins to Howe Sound a rash of new proposed developments were announced that raised concerns about the lack of a comprehensive plan for the entire Sound that could threaten this recovery.

Throughout the AHSBR region, concerns have been expressed about the accelerating rate of land and resource development proposals and, in particular, about the potential cumulative effects of these developments on environmental values in both the terrestrial and marine realms.

In 2013 local governments in the region resolved to send a clear message to the provincial government that social license had been obtained from the surrounding communities for the creation of a Land and Marine Resource Management Plan that would encompass the entire AHSBR. The Minister responsible for Forests Lands and Natural Resources Operations (FLNRO) committed to a pre-planning process. Heading into 2014, FLNRO informed stakeholders that the LRMP process had been replaced by new approach called the Cumulative Effects Assessment (CEA). Subsequently, AHSBR worked closely with local government partners to shape agendas for the Howe Sound Community Forum and other venues to earn support for and encourage engagement in a provincial CEA planning process. Regional and Local Government support for the planning process grew and by the fall of 2014 and FLNRO confirmed they would in fact undertake a Cumulative Effects Assessment (CEA) process for Howe Sound.

Commencing in 2015, the BC Government approved the initial application of the new Cumulative Effects Framework (CEF) in the Howe Sound region to implement "…a coordinated, multi-sector approach to assessing and managing cumulative effects" (Government of BC, 2019). The project provides important baseline information and implement a long-term monitoring program, based initially on seven key values: aquatic ecosystems, old growth forests, forest biodiversity, forest visual quality, grizzly bears, Roosevelt elk and marbled murrelet (Government of BC, 2019).

Marbled murrelet, photo: C. Olsen

The CEF project is especially relevant in the forests of AHSBR, where about 58% of the original forests have been removed through timber harvesting, and only 30% remains at lower elevations. This is known to have had a significant impact on forest and wildlife biodiversity (see Section 4.5.3.1). Indeed, FLNRORD says it is currently exploring a number of actions in response to the CEA results such as: "assessing recent trends in these indicators, comparing these predictions to available site-specific forest biodiversity assessments and applying these risk assessments to land and resource planning and management decisions where possible." It says the management of forests and wildlife habitat has evolved considerably over the past several decades so that there are now a number of legal conservation tools being used to retain a more appropriate balance/interspersion of old, mature and early seral forest stands (FLNRORD, 2019).

Contemporary forest management policy, implemented through Landscape Unit Planning, recognizes the error of these historic ways, and is now starting to place a clear priority on the conservation of forest biodiversity and other values, while continuing to maintain an economically viable, albeit reduced, timber harvesting industry. Climate change and historical ways are challenging the government into what is now an urgent transition period for the forest sector. AHSBR's location so close to Metro Vancouver is in a unique position to work with FLNRORD, community forest operators, local and regional governments and First Nations, to bring stakeholders together around innovative ideas and best practices as we move through this transition period.

In the marine environment, Átl'ka7tsem/Howe Sound, the industrial facilities discharged their effluent directly into Howe Sound contaminating sea life, drastically decreasing populations of forage fish and suffocating the sea floor. Today, with many of these sources of pollution and stress now in the past, the Sound's marine ecosystems are rebounding with populations of herring, anchovy, salmon, Pacific white-sided dolphins, killer whales (orca), pinnipeds (seals and sea lions), and humpback whales returning in numbers not seen in a century. Fish stocks have rebounded to enable the resumption of a salmon recreational fishery and commercial fisheries for prawn and shrimp.

However, human-caused pressures continue to drive change in Átl'ka7tsem/Howe Sound. Climate change is perhaps the most significant concern, causing ocean warming, sea level rise, ocean acidification and possibly changes in fish populations and rearing behavior. The BC Coast edition of OceanWatch is monitoring the long-term warming trend in BC's coastal waters that have risen by 0.1 degree Celsius per decade since 1981. This ongoing warming is expected to affect the abundance of phytoplankton production, a primary food source for fish, mammals and birds (OWHS, 2019). Increased vessel traffic, population growth and associated shoreline development can directly affect habitat through damage from boat mooring and abandonment, dock construction over sensitive habitats such as eelgrass, increased fishing activity with damage to sensitive habitats such as glass sponge reefs, increased pollution and invasive species.

Increased vessel traffic can lead to noise pollution, increased risk of collisions and contact with sea bottom habitats (OWHS, 2017). In addition, the CEF recognizes the scope of these environmental changes underway in BC in conjunction with increased development pressures, and will work to identify and manage the cumulative effects of all these changes and activities to ensure sustainability going forward (Government of British Columbia, 2019d).

The return of the dolphins and whales to Howe Sound inspires people to protect this fragile recovery. The trend is currently towards gathering of more information that includes Indigenous ways of knowing, and to consider the value of nature's assets in decision making. Throughout the region there is strong community effort and collaboration among organizations working on the many restoration and conservation initiatives. These efforts support Canada's pathway to Target 1, the Aichi Biodiversity Targets.

14.1.3 What kind of protection regimes (including customary and traditional) exist in the core area(s) and Buffer Zone(s)?

The Legal Acts that apply to the Core Areas and Buffer Zones are described in Section 17.1.2. The parks fall under the *BC Park Act*, the Ecological Reserve managed under the *Ecological Reserves Act*, the *Este-Tiwilh*/Sigurd Creek Conservancy, managed under the *Protected Areas of British Columbia Act*, and the *Skwelwil'em* Squamish Estuary Wildlife Management Area (WMA) managed under the BC

Wildlife Act. The Conservancy is co-managed by BC and the Squamish Nation under a 2007 collaboration agreement. All conform to the standards for IUCN Category I, II, III or IV protected areas. The Conservancy is located adjacent to the north end of Tantalus Provincial Park providing important connectivity to an additional 12,000 ha of high elevation wilderness of importance to mountain goat and grizzly bear, managed for biodiversity conservation under BC's *Land Act*. The WMA, ecological reserve and one of the provincial parks provide direct connectivity from the high elevations of Tantalus to the Squamish River and estuary. BC Parks employs rangers and contracts with Park Operators to manage the parks in order to meet the objectives of the park management plans.

The terrestrial Buffer Zone is mostly comprised of provincially owned Public land that is immediately adjacent to and contiguous with the protected areas in the Core Areas. Most of these adjacent Public lands are legally identified as 'Protected Areas', 'Resource Exclusion Areas' under the *Forest and Range Practices Act*, the *Land Act* or the *Environment and Land Use Act*. They include areas, known as Conservation Lands, managed as Wildlife Habitat Areas, Ungulate Winter Ranges, Old Growth Management Areas, Wildland Areas or areas with specific Visual Quality Objectives. Generally speaking, these areas are excluded from or have limited access for resource activities such as forest harvesting, mining or large-scale hydro-electric development, and exist for the expressed purpose of protecting biodiversity or because they lack harvestable resources due to high elevation. Other Public lands not included in these specially managed areas have been zoned through the Sea-to-Sky Land Resource Management Plan for a management priority on the retention of high scenic values and recreational opportunities. This zoning would place constraints on the access on and activities in these lands by resource industries. Municipal owned lands adjacent to one of the parks is also managed through municipal zoning for the purpose of protecting the natural environment and sensitive habitat.

From an enforcement perspective, the BC Conservation Officer Service is a leading natural resource law enforcement agency specializing in public safety as it relates to human/wildlife conflict, managing complex commercial environmental and industrial investigations and compliance and enforcement services. The public can contact the Service to report violations or conflicts.

BC is committed to considering cumulative effects as an integral component of natural resource decision-making. Improving cumulative effects assessment and management will be a vital part of sustainable and integrated resource management. The Cumulative Effects Framework (CEF) includes policy, procedures and decision-support tools that complement current land management achieved through BC's legislative framework, land use plans and various best practices and processes. The framework provides important foundational information that can be used in a number of ways, including the potential to inform consultation with First Nations where a proposed decision or activity by the Province may affect claimed or proven Indigenous or treaty rights. Transparently reporting on cumulative effects assessment information and management considerations will enable coordinated, consistent management of cumulative effects across the natural resource sector. (Prov. BC Interim Policy, 2016). AHSBR supports the intended protections of the Cumulative Effects Assessments in the region as intended to reduce harm from growing pressures of development.

In the marine environment, the protection of marine ecosystems within AHSBR's Core Area is focused on protecting the globally significant glass sponge reefs. The marine Core Area is comprised of eleven Glass Sponge Reef Refuges established under by Fisheries and Oceans Canada under the *Fisheries Act* to protect these internationally significant reefs. Fisheries restrictions apply to both the marine Core areas and Buffer Zones surrounding these Sponge Reefs.

The marine Buffer Zone five Rockfish Conservation Areas (RCAs) overlay the Glass Sponge Reef Marine Refuges created by Fisheries and Oceans Canada, also under the *Fisheries Act*.

Fisheries and Oceans Canada (DFO) enforces the *Fisheries Act* and other regulations and legislation such as Canada's marine mammal regulations to ensure minimum vessel approach distances from whales while in the area. Enforcement activities are carried out by Fishery Officers across Canada. They conduct regular patrols on land and sea as well as in the air. Fisheries Officers patrol the marine areas in the Sound and the public are encouraged to Observe, Record and Report to the Fisheries and Oceans Canada (DFO) hotline.

Quillback Rockfish, photo: A. Taylor

14.1.4 Which indicators or data are used to assess the efficiency of the actions/strategy used?

There are numerous monitoring programs in place throughout Átl'ka7tsem/Howe Sound to assess the effectiveness of several initiatives over the recent past to improve the environment of the region as described in Section 16. There are four air quality monitoring stations in the Howe Sound area alone, in addition to many in Metro Vancouver, to measure progress following the closure or remediation of historic sources of air pollution. Annual fish counts are held through Fisheries and Oceans Canada to monitor the recovery of depleted fish populations such as rockfish and lingcod. A water quality monitoring system known as Pollution Tracker, was launched In Howe Sound in 2018 by Fisheries and Oceans Canada and the Vancouver Aquarium's OceanWise to observe chemical pollution such as the presence of mercury, dioxins and furans, still lingering from historic sources, as well as more recently derived pharmaceuticals, pesticides and micro plastics (Seyd, 2018; Pollution Tracker, 2019).

The Ocean Health Index is also being applied to Howe Sound by a team of local scientists and researchers to measure the condition of marine related species and habitats in the Sound. The research used highly productive environments including salt marshes, sponge reefs and soft-bottomed habitats as a measure of both habitat quality and the status of marine life that occupy them.

With respect to the forests of AHSBR, BC's forest management agency, FLNRORD, is committed to the long-term conservation of forest biodiversity in the region (FLNRORD, 2019b). Under BC's Howe Sound CEF project, the current condition of forest biodiversity is determined using the distribution of forest age classes as a surrogate for estimating wildlife habitat and biological diversity. Forest biodiversity risk ratings are assessed to estimate the likelihood of reduced forest biodiversity as compared to historic natural forest conditions, utilizing the following five indicators: old forest amount; old and mature forest amount; early seral forest amount; old and mature interior forest amount; and area undisturbed by roads and linear features (FLNRORD, 2019b). The results of this assessment provide a general estimate of the condition of forest biodiversity which then helps identify appropriate management responses to retain or improve biological and habitat diversity in the region.

15 LIFE ON LAND

There are more than 40 non-government organizations and citizen scientists contributing to the conservation work in the region.

For example the Squamish River Watershed Society monitors the status of its work on amphibian wetlands, restoration and removal of barriers in salmon creeks and channels, eelgrass plantings, brownfield site restoration and actively takes part in various fish studies.

Consolidation of the available data and support to identify gaps in information in order to effectively monitor cumulative effects is an important role AHSBR and HSBRIS will provide is the community. Universities, prospective developers and many other agencies often search for information in multiple locations. Through being a consolidator of the resources, time and effort can be spent on research and monitoring of the gaps in information.

14.2 Status and Trends at the level of species and ecosystem diversity

14.2.1 Identify main groups of species or species of particular interest for the conservation objectives

(especially those that are endemic to this biosphere reserve, and provide a brief description of the communities in which they occur).

While there are no known species that are endemic to AHSBR or the surrounding region, there are several species for which there are conservation concerns that will be addressed specifically in the management objectives for AHSBR. As discussed in Section 4.2.1, the Roosevelt elk, grizzly bear and mountain goat are of particular conservation interest due to historically declined populations that have either only recently stabilized or have a considerable way to go before becoming stable. The Roosevelt elk populations are stable or increasing and have ample habitat in younger and maturing seral stage forests, some of which are now protected through Wildlife Habitat Areas (WHAs) to protect critical winter ranges. Similarly, mountain goat populations at higher elevations appear stable and also have much of their critical winter ranges protected in WHAs. Grizzly bears had been extirpated from much of south-western BC and are still considered threatened throughout AHSBR and the surrounding area. In the absence of a comprehensive recovery strategy for grizzlies, the focus of non-government efforts is to safeguard their habitat through science-based planning and community involvement.

In the marine environment, marbled murrelets are the primary species of concern in Átl'ka7tsem/Howe Sound. The Sound is known as an important location for these birds, particularly in that portion of the Sound within the English Bay, Burrard Inlet and Howe Sound Important Bird Areas, since they still have access to old or older growth forests necessary for nesting and rearing their young. Below the surface, species of rockfish as well as lingcod, and the glass sponge reefs, are the primary species of concern.

Chinook salmon is an important keystone species on Canada's west coast. It is a vital food source for a diversity of wildlife, including killer whales, bears, seals and large birds of prey. The fish hatcheries on Bowen Island and in Squamish focus on enhancing coho, pink, chum and chinook salmon stocks. The hatcheries releases more than 3.3 million smolts each year.

Transient Bigg's killer whales prey on mammals and Northern Resident killer whales prey on Chinook and Chum salmon. Both are regular visitors to Howe Sound and considered Threatened by Canada's Species at Risk Act.

In BC, new legislation is under development that will protect species and ecosystems at risk. In the interim, BC and Canada are working collaboratively through a federal-provincial accord and agreement on species at risk using Canada's *Species at Risk Act* and BC's *Wildlife Act* to identify and protect species at risk. The terrestrial and marine species of concern in AHSBR are discussed in detail in Section 4.2.1.1.

14.2.2 What are the pressures on key species?

In other words: what are the threats (example unsustainable management of forest), their immediate causes (drivers of change like forest change or habitat change), their underlying causes (example overgrazing, fire, pollution), and the main driving forces (example: economic, political, social, external, etc.) and the area(s) concerned?

In a forest dominated environment, the key pressure on both plant and animal species relates to the management of the forest and its impacts on forest and wildlife diversity. The analyses undertaken as part of the Cumulative Effects Assessment (CEA) for Howe Sound found that as a result of historic patterns of timber harvesting and urban development, there has been a decline in old (>250 years) and older and mature forests (>101 years) over the past 200 years, with a corresponding increase in the amount of forest currently in the early seral stages of forest renewal. The study concludes that this historic pattern has had a significant impact on species diversity over time, in particular those species dependent on old or older forests (ie. marbled murrelet). Recognizing the strong correlation between forest habitat diversity and forest and wildlife species diversity, the CEA seeks the restoration and maintenance of structural complexity in the forest to mimic historic conditions (FLNRORD, 2019). The extent to which new conservation lands, such as Old Growth Management Areas, other protected areas and forest management practices achieve this condition will require ongoing monitoring.

Herring, photo: B. Turner

Beyond the mid- to high elevation forests, the nature of land development often focuses on riparian areas, shorelines and wetlands at lower elevations. These habitats are the most critical for conservation of species at risk and of concern, in particular reptiles and amphibians. Where management efforts tend to focus on larger animals (eg. grizzly bear and elk), the smaller creatures in these low elevation habitats are often overlooked with their populations suffering the most by the cumulative effects of human land use and development (Knight, 2019).

In addition to forest and riparian management, other anthropogenic causes of disturbance include the following:

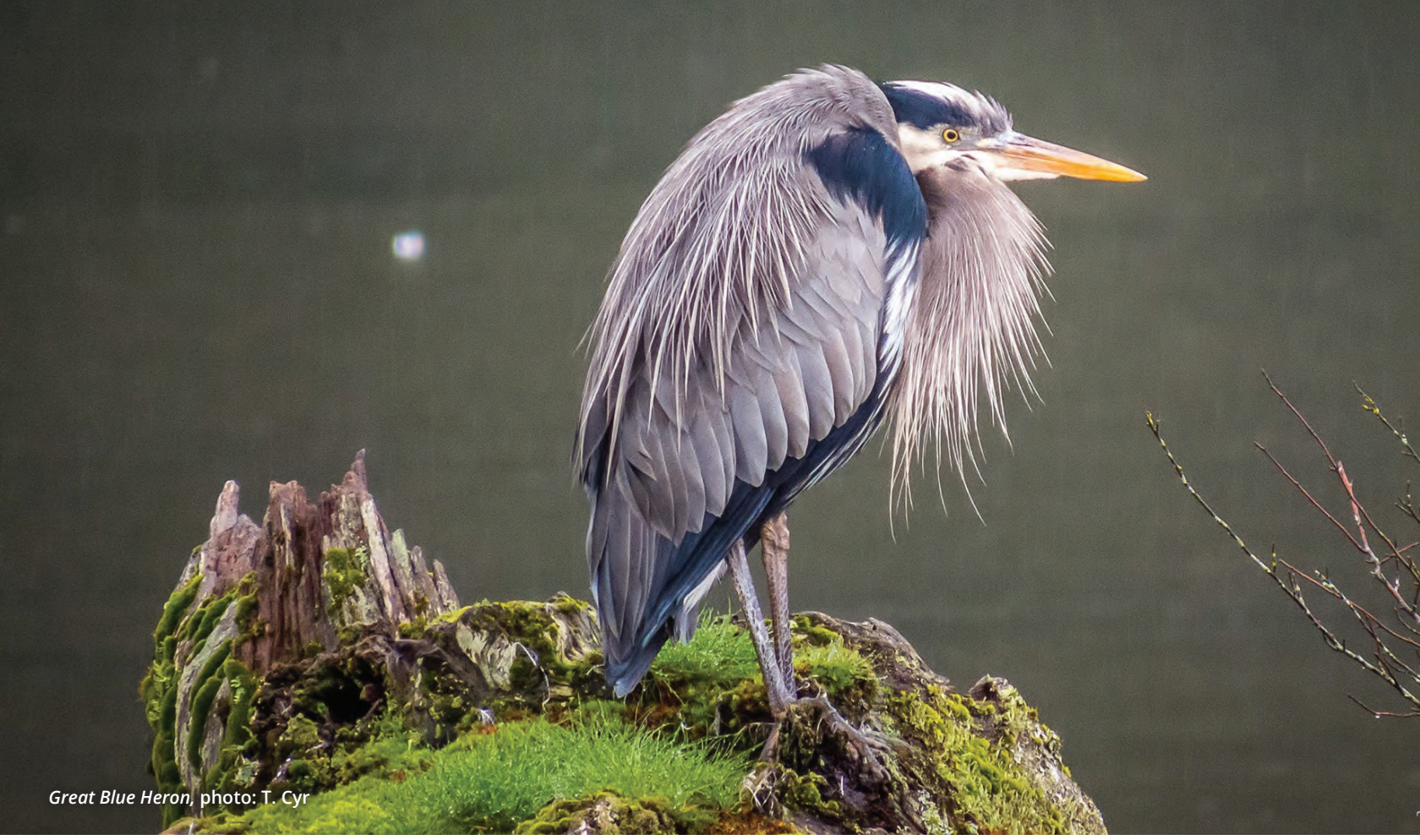
- **overfishing in the marine environment, with such declines in species abundance for salmon, rockfish, lingcod and other species that fisheries closures have been in effect for decades;**
- **pollution from a number of industrial sources over the past decades has contributed to ongoing fisheries closures and overall declines in marine biodiversity;**
- **land and marine use changes including urban, commercial and industrial development along the shores of the Sound and decades of log storage and inappropriate boat moorage and abandonment;**
- **modest changes due to climate change including sea level rise, sea warming and more frequent and severe storms;**
- **increasing outdoor recreational activity disturbing whales and seabirds and leading to increased poaching of rare and endangered species.**
- **hunting, the main activity that extirpated the Roosevelt Elk population by 1900, and has had significant impacts on other large mammals such as black and grizzly bears;**
- **increased populations of people recreating throughout the watershed and insufficient amount of enforcement officers; and**
- **spread of invasive species introduced to the region by settlers.**

Human population increase, and economics are the main drivers of these pressures.

14.2.3 What kind of measures and indicators are currently used, or planned to be used to assess both species groups and the pressures on them?

Who undertakes this work, or will do so in the future?

The work of assessing and managing populations of species at risk is undertaken primarily by Fisheries and Oceans Canada in the marine environment, and BC's forest management agency, FLNRORD and BC's Ministry of Environment and Climate Change (MECCS) on land and in freshwater. All agencies are aided by a capable cadre of citizen scientists



Great Blue Heron, photo: T. Cyr

and non-government organizations, many of whom are credited with significant discoveries and restoration efforts.

As mentioned above, FLNRORD's CEA is the leading effort in AHSBR for assessing species at risk using a number of measures and indicators that vary by species. For example, the current condition of marbled murrelets and estimates of the risk to population sustainability is measured using two nesting habitat indicators: suitable nesting habitat and suitable nesting habitat protected. Also, Roosevelt elk populations are managed on a population unit (PU) basis, using specific indicators to estimate their future sustainability risk: forest cover interspersion; winter range requirement; winter range availability and quality; forage cover availability; population resiliency; predation risk; and unregulated hunting (FLNRORD, 2019). Similar efforts are being made for other species such as grizzly bear and mountain goat.

In the marine environment, Fisheries and Oceans Canada, with the assistance of citizen scientists, employs regular surveys of abundance for such species as rockfish and lingcod, both good indicators of ecosystem health. Detailed counts of sightings for cetaceans and pinnipeds have been kept by the BC Cetacean Sightings Network (BCN) and have documented the recovery of marine mammal populations for decades (BCN, 2019).

Where information indicates a need for stronger enforcement or work to improve, conservation groups at work in the region make recommendations to government. Such as the current work on management plans for high use recreation areas, i.e. the Shannon Basin Recreation Plan and the nomination of marbled murrelet nesting habitat for Wildlife Habitat Area (WHA) designation. There are many example where research and monitoring have resulted in investments in restoration, protections and implantation of special designations, such as important bird areas and refuges for glass sponge reefs.

14.2.4 What actions are currently undertaken to reduce these pressures?

The most significant action terrestrially to manage pressures on wildlife populations is the relatively recent emphasis by FLNRORD on conserving forest biodiversity and protecting habitat, especially for grizzly bear and ungulate populations: Roosevelt elk, black-tailed deer and mountain goat. Wildlife Habitat Areas have been established to protect critical winter ranges; Old Growth Management Areas (OGMAs) have been created to protect critical nesting habitat for marbled murrelets and to add forest diversity for all species. Hunting is being more stringently managed to reduce poaching pressures. The grizzly bear hunt was terminated completely in 2017.

Other significant actions in the Sound include decades of habitat restoration work in the Squamish Estuary, the replanting of eel grass and kelp beds, the improvements to drainage and stream crossing culverts to remove barriers for fish, extensive work to remove or manage invasive species and new habitat mapping to identify priority areas for conservation.

In the marine environment, Fisheries and Oceans Canada has closed most commercial fisheries in Howe Sound due to concerns over species abundance, with only limited prawn and crab and some finfish fisheries remaining. Fisheries and Oceans Canada has also designated 11 Rockfish Conservation Areas to protect important habitat and enable population recovery for the many species of rockfish and for lingcod. In addition, Marine Refuges were established to protect the globally significant populations of glass sponge reefs.

14.2.5 What actions do you intend to take to reduce these pressures?

As discussed in Section 13, the main goal of a Biosphere Region in Átl'ka7tsem/Howe Sound is to support, reinforce and coordinate the network of governments, First Nations and non-government organizations who collectively are undertaking the conservation and restoration in, and the sustainable development of, this important region.

The AHSBR Roundtable Governance will be instrumental in the development of a long term strategy that provides the logistic support through HSBRIS to achieve the stated objectives.

This effort will go beyond the scope of existing measures to embrace a strategy for the future that builds on the results of the CEA to develop best practices and a suite of management measures that learns from and reverses past mistakes.

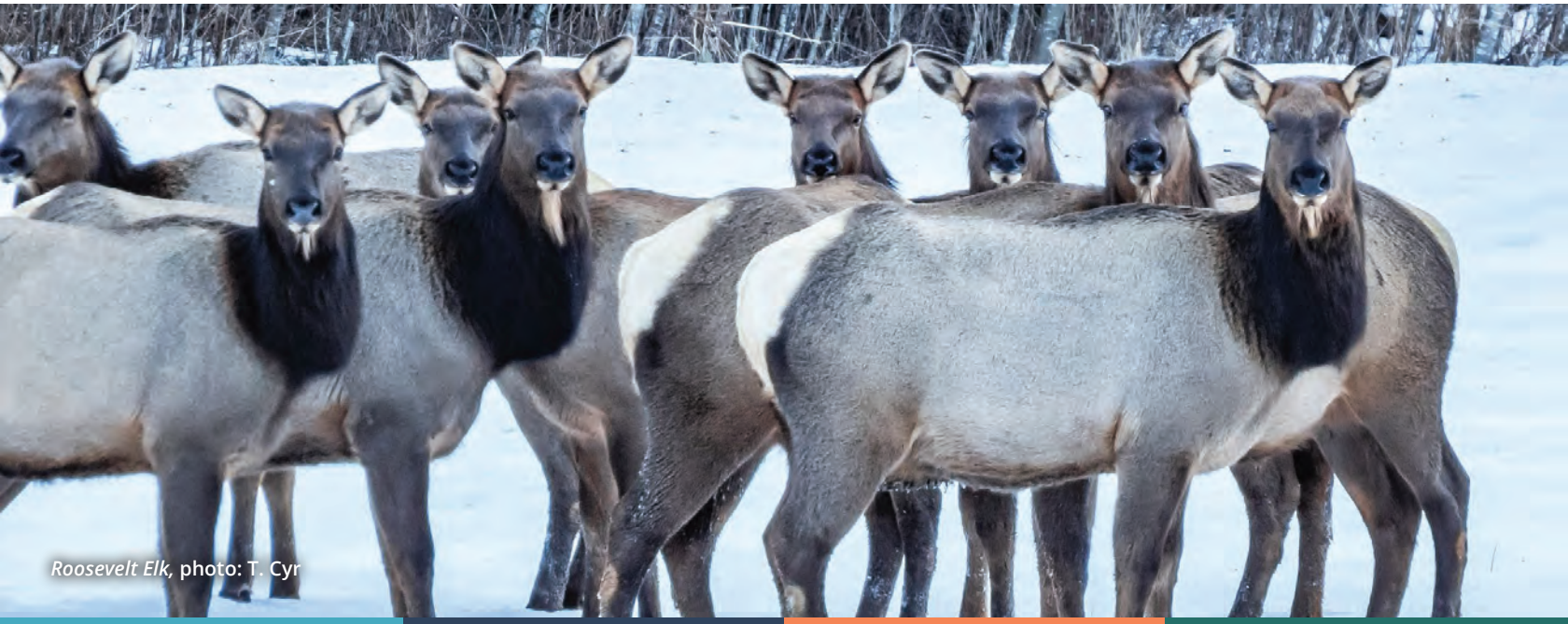
The coordination of research, monitoring, education and communication programs will be the hallmarks of the Biosphere Region's efforts to lead the pursuit of a model region for conservation and sustainable development.

14.3. At the level of genetic diversity:

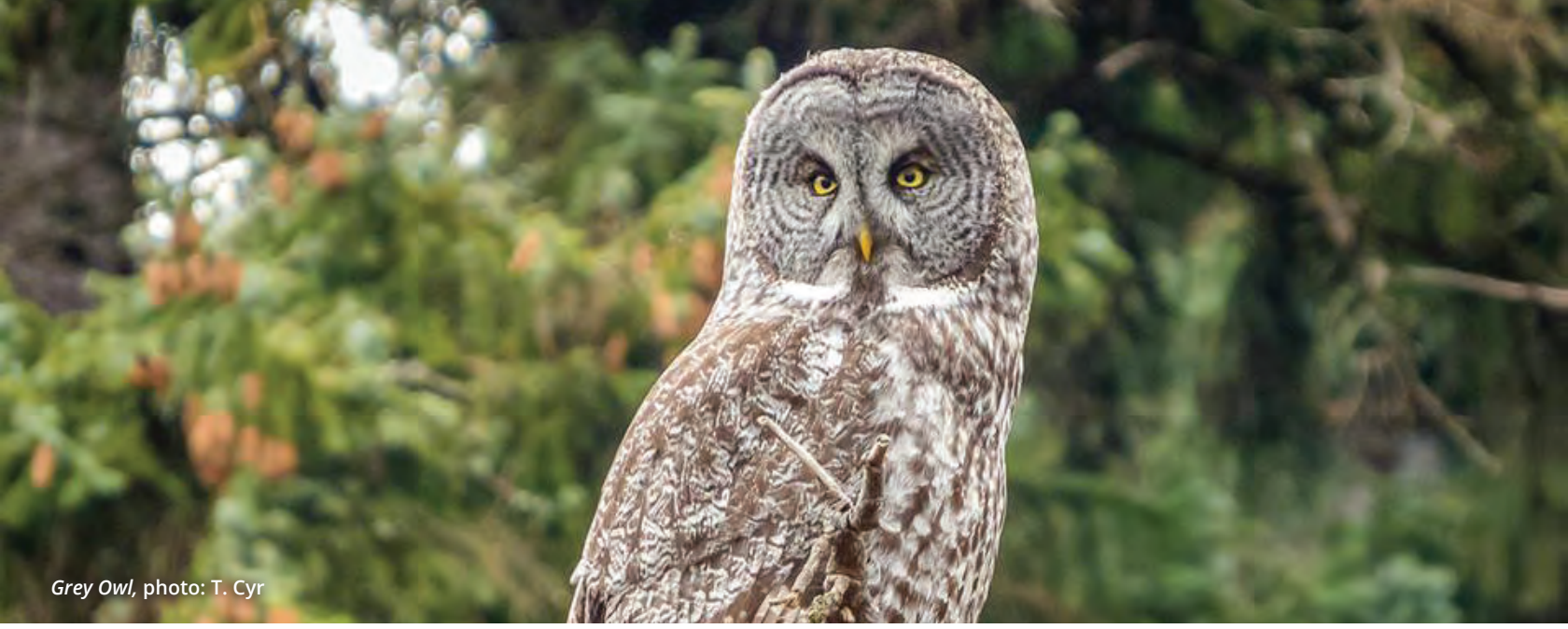
14.3.1 Indicate species or varieties that are of importance

(e.g. for conservation, medicine, food production, agrobiodiversity, cultural practices, etc).

While more than 60 species in BC have been the subject of genetic research, only a few have been genetically classified below species level. Most research in BC has been undertaken in areas of historic isolation, on the edges of species' known ranges, and on islands and glacial refuges. Several species that are important in AHSBR's ecosystems have been studied genetically in other parts of the province, especially for population differentiation, including species of northern goshawk, wolverine, western painted turtle, Roosevelt elk, salmon, grizzly and black bears and marbled murrelet (Wilson et al, 2007; Todd, 2019). That data cannot, however, be readily extrapolated from one region to another (Wilson et al, 2007).



Roosevelt Elk, photo: T. Cyr



Grey Owl, photo: T. Cyr

As discussed in Section 4, those species assessed federally by COSEWIC and listed on SARA, and/or listed provincially as at–risk, have consideration given to conserving genetic diversity for these species, especially those with recovery plans (see Section 4.2.1.1). These include, for example, the coastal tailed frog, painted turtle, northern goshawk, Roosevelt elk and grizzly bear (Todd, 2019). The only genetically unique species in AHSBR known at this time is the Kokanee salmon (a non-anadromous form of sockeye salmon), found in Killarney Lake and Grafton Lake on Bowen Island, important refugia for this genetically unique population of the species (Todd, 2019; Knight, 2019). It may also be possible, though not yet confirmed, that genetically unique populations of western painted turtle and coastal northern goshawk may occur within AHSBR (Todd, 2019).

14.3.2 What ecological, economic or social pressures or changes may threaten these species or varieties?

As noted above and in previous sections, there are a number of ecological, economic or social pressures or changes that could affect species important for conservation at this time. At the *genetic* level, the two most serious threats to diversity are inappropriate development, particularly in riparian zones, and the issue of invasive species. Too often, human development focuses on riparian areas at lower elevations, such as along shorelines and wetlands, the preferred habitat of several smaller species-at-risk (Knight, 2019). The monitoring of invasive species is critically important to the future of native species, especially given that many species of concern in AHSBR are on the edge of their home ranges (Knight, 2019; Todd, 2019).

Additional threats to the genetic diversity of species and communities in AHSBR include altered trophic ecologies and direct impacts to survivorship within native populations (affecting genetic selection), habitat loss and modification (with impacts on survivorship, movement and gene flow) and potential cross-breeding (Todd, 2019).

14.3.3 What indicators, at the level of the species, are used, or will be used, to assess the evolution of population status and associated use?

Natural populations require genetic diversity in order to evolve and adapt to new environmental conditions, especially due to climate change, but also from insects and diseases. Because it is not possible to measure all ecological processes or species, indicators are used to reduce the complexity of natural systems into simpler parts. The use of indicators has become a globally accepted practice in describing, reporting and monitoring progress towards ecologically sustainable development (Innes et al, 2009).

Indicators of genetic diversity are usually applied in conservation management to address two primary monitoring objectives: to safeguard the genetic diversity of a species on which the continued evolution of the species depends; or to conserve genetically distinct or unique populations of a species. The former relates to ecosystem health and services and the need to keep landscapes, ecosystems, and species representative and diverse. The latter is more a conservation status issue where a particular subspecies or variant, and the integrity of this genetically unique population, requires conservation attention (Todd, 2019).

There is a considerable amount of work being undertaken in BC on forest genetic conservation research both within the BC government at FLNRORD and at the Centre of Forest Conservation Genetics (CFCG) at UBC in Vancouver. Both theoretical and applied research is used to advise on forest resource management issues such as seed supply, timber supply analysis and planning, and the benefits of protected areas. FLNRORD is also advised by the Forest Genetics Council of BC (FGC) that coordinates research activities on the conservation, resilience and value of BC's forests, seeking knowledge on population, ecological and quantitative genetics, comprehensive inventories of genetic resources and identifying priorities for conservation (FGC, 2019).

The following 16 indicators are included in a monitoring framework utilized in BC for assessing the status of or trends in forest species, under three categories: Biodiversity; Natural Disturbances and Ecosystem Drivers:

Biodiversity:

- **Ecosystem Distribution and composition**
- **Ecosystem productivity**
- **Species diversity**
- **Genetic diversity**
- **Ecosystem connectivity.**

Natural Disturbances:

- **Insects and diseases**
- **Wind throw**
- **Fire**
- **Mass movements**

Ecosystem Drivers;

- **Precipitation**
- **Snowpack**
- **Stream flow**
- **Water temperature**
- **Water quality**
- **Glaciers**
- **Unseasonable or unexpected weather conditions (Innes et al, 2009).**

Indirect or surrogate indicators can also be used to monitor the conservation of genetic diversity and the associated genetic processes that support it (e.g., genetic differentiation, gene flow), including, for example, ecosystem and tree species diversity, floral and faunal community and species diversity, habitat diversity or landscape connectivity (addressing gene flow) (Todd, 2019).

14.3.4 What measures will be used to conserve genetic diversity and practices associated with their conservation?

Measures utilized by management authorities to further the conservation of genetic diversity will include the implementation of monitoring and adaptive management actions to address the threats to the conservation of genetic diversity, as discussed in 14.3.2 above. AHSBR's partners will assist management authorities to design and develop a monitoring framework for the AHSBR region that employs both direct and indirect indicators of genetic diversity. This framework will include existing monitoring and research programs, such as FLNRORD's Forest and Range Evaluation Program and the Stewardship Objectives Baseline Tool (SBOT) initiative to monitor cumulative effects on populations of key species, including genetically unique and designated populations (FLNRORD, 20xx). In addition, provincial and federal species management plans (e.g., for tailed frogs and western toads) and recovery strategies (e.g., for northern goshawks) already contain strategies and practices which will address genetic conservation, as well as recommendations for future research needs to improve the level of understanding of genetic differentiation, isolation and population status (Todd, 2019). For example, BC, in collaboration with local universities, has completed genetic research into western painted turtle and is currently undertaking similar genetic research into coastal goshawk, western toads and coastal tailed frogs, to support their recovery strategies and management plans. The study areas for this research all overlap with the AHSBR region, and future research will continue.