Biodiversity

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Biodiversity

BACKGROUND

Global Biodiversity

Biodiversity, which comes from shortening the term "biological diversity," is defined as the number, variety, and interdependence of living organisms on the planet, as well as the ecosystems of which they are a part. The conservation of biodiversity, first recognized in the early 1980s (Wilson 1988), provides economic, scientific, cultural, and aesthetic values, but its greatest value is in maintaining the life-sustaining systems of the biosphere (UNEP 1992).

The first effort at assessing the global status of biodiversity produced a report in 1992 (World Conservation Monitoring Centre 1992). In 2005, another global assessment conducted by many of the same organizations reported that humans have depleted 60% of the world's grasslands, forests, farmlands, rivers, and lakes (MEA 2005a). They also reported that human activity is putting such a strain on the natural ecological functions that the ability of the planet's ecosystems to sustain future generations can no longer be taken for granted (MEA 2005a). In terms of the global state of organisms, 33% of amphibian species (Stuart et al. 2004), 12% of birds (Birdlife International 2004), and 23% of mammals (IUCN 2003) are considered vulnerable, endangered, or critically endangered. Estimates of the global rate at which organism are becoming extinct range from 100 to 1000 times the historically "normal" rate of extinction, and scenarios for the future suggest this may increase a further 10 times (UNEP 2001; MEA 2005b). This accelerated extinction is the result of human activities such as altering and destroying habitat, pollution, over-harvesting species, introducing non-native species, and producing greenhouse gases that are causing a changing climate (Wilson 1992). Globally, the pressures on biodiversity are expected to continue or increase, further compromising the ability of these ecosystems to support human life (MEA 2005a, 2005b).

Coastal Biodiversity in BC

Marine coastal ecosystems are among the most productive and diverse communities in the world (Poore and Wilson 1993). It is not surprising that British Columbia, with its extensive coastline and complex glacial history, is one of the most biologically diverse provinces in Canada. British Columbia occupies 10% of Canada's land area while containing more than half of Canada's vertebrates and vascular plants and three-quarters of its bird and mammal species (BCMELP 1993).

Coastal BC is the most biologically diverse area of the province. An impressive 78% of all the mammal species in BC (D. Nagorsen, unpubl. data compiled for BC Ministry of Environment, 2004), 64% of the birds that regularly breed in BC (R. Cannings, unpubl. data compiled for BC Ministry of Environment, 2004), 64% of BC's amphibians (Green

1999), 69% of BC's reptiles (Gregory and Gregory 1999), and 67% of BC's freshwater fish species (McPhail and Carveth 1994) are found on the coast. Even more compelling is the extent to which endemic (meaning locally unique and native) species occur on the coast:

- Two-thirds of the mammal species and subspecies that are found only in BC occur nowhere else in the province but the coast (D. Nagorsen, unpubl. data compiled for BC Ministry of Environment, 2004).
- Three-quarters of the subspecies and significant populations of freshwater fish found only in BC are exclusive to the coast (McPhail and Carveth 1994; BC Ministry of Environment, unpub. data, 2004).
- All of the bird subspecies that breed only in BC do so exclusively on the coast (R. Cannings, unpubl. data compiled for BC Ministry of Environment, 2004).
- Approximately 10% (238 of a total 2316) of the province's vascular plant taxa, including subspecies and varieties, occur only on the Pacific coast between Alaska and Mexico (Douglas et al. 2002).

The rugged BC coast, with its characteristic fiords and islands, provides an environment that hastens the divergence of species by separating and isolating populations. As time goes by, isolated populations grow more adapted to their local environment and, in doing so, diverge in appearance or behaviour from other populations of their species. It is not surprising that 44 of the 62 vertebrate subspecies and significant populations endemic to coastal British Columbia occur on coastal islands (including Vancouver Island). In the Queen Charlotte Islands alone, 8 of the 12 coastal endemic breeding birds occur, including local variants of Stellar's jay.

The biodiversity of coastal British Columbia is of global importance. The province's remaining old-growth coastal rainforest represents approximately one-quarter of all remaining coastal temperate rainforests worldwide (BCMOF 2004). These forests are rare globally, yet they have exceptionally high biological production and biological diversity. In addition, the province bears some of the global responsibility for at least 19 coastal species that, in addition to being at risk in BC, are also at risk globally (CDC 2005). Examples include the Oregon spotted frog (*Rana pretiosa*), an aquatic native of the Fraser Valley; the Cowichan lake lamprey (*Lampetra macrostoma*), a primitive fish found only in two lakes on Vancouver Island; and Keen's long-eared myotis (*Myotis keenii*), a small bat that occurs in hot springs on the Queen Charlotte Islands.

Conserving Biodiversity

Several key organizations provide information on biodiversity conservation in British Columbia. At the national level, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is an independent body of experts who use scientific, aboriginal, and community knowledge to classify species as extirpated (extinct in a local area, province, or country), endangered, threatened, or of special concern (see text box). COSEWIC has listed more than 450 plant and animal species as being at risk in Canada,

meaning that their continued existence in this country is in danger (Environment Canada 2004). Of the 450 species listed by COSEWIC, 119 occur in coastal British Columbia. Four of these species are extirpated: the Island marble butterfly (*Euchloe ausonides*), Puget Oregonian snail (*Cryptomastix devia*), Pacific gophersnake (*Pituophis catenifer catenifer*), and Pacific pond turtle (*Actinemys marmorata*).

COSEWIC CLASSIFICATIONS FOR WILD SPECIES IN CANADA

- Extinct: A species that no longer exists.
- Extirpated: A species that no longer exists in the wild in Canada, but occurs elsewhere.
- Endangered: A species facing imminent extirpation or extinction.
- Threatened: A species expected to become endangered if limiting factors are not reversed.
- Special concern: A species that may become threatened or endangered for a combination of reasons, such as biological characteristics, or particular threats.
- Data deficient: A species for which there is inadequate information to make an assessment of its risk of extinction (COSEWIC 2004).

The BC Conservation Data Centre (CDC) is a government body that annually publishes the provincial lists of species considered by provincial biologists to be endangered or threatened (red list), or of conservation concern (blue list) (see text box). As of 2005, the red list contained 237 organisms and the blue list, 203 organisms. This includes vertebrates, vascular plants, freshwater fishes, and a small number of invertebrates (butterflies, dragonflies, some gastropods, and molluscs). Species on the red or blue lists may also be legally designated as extirpated, endangered, or threatened under the Wildlife Act. CDC is housed within the provincial government, but is also part of NatureServe, an international organization of cooperating conservation data centres and natural heritage programs, all using the same methodology to gather and exchange information on the threatened elements of biodiversity.

SPECIES AT RISK IN BRITISH COLUMBIA

The **Red List** includes species that are:

- legally designated as threatened or endangered under the provincial Wildlife Act. As of 2005, legally designated species included the sea otter (*Enhydra lutris*), which is threatened, and the following endangered species: American white pelican (*Pelicanus erythrorhyncos*), burrowing owl (*Athene cunicularia*), and Vancouver Island marmot (*Marmota vancouverensis*).
- candidates for such designation. These are the vast majority of species on the list.
- extirpated or extinct.

The **Blue List** includes species not immediately threatened but of concern because of characteristics that make them particularly sensitive to human activities or natural events.

The **Yellow List** includes uncommon, common, declining, and increasing species—all species not included on the red or blue lists, but tracked by the Conservation Data Centre.

As a signatory to the 1996 Accord for the Protection of Species at Risk, British Columbia committed to supporting the recovery of threatened and endangered species in the province. Until the federal Species at Risk Act (SARA) was proclaimed in June 2003, however, no legislation specifically protected Canadian species at risk. SARA has three goals: (i) to prevent Canadian indigenous species, subspecies, and distinct populations from becoming extinct or extirpated (locally extinct); (ii) to provide for the recovery of endangered or threatened species; and (iii) to encourage the management of other species to prevent them from becoming at risk. To list a species under SARA, COSEWIC recommends it to the Minister of Environment based on a status assessment. After a period of public consultation, the federal Cabinet considers the recommendation, taking into account social, political, and economic factors, and decides whether the species should be added to the legal list of species at risk (Government of Canada 2005). SARA requires that a recovery strategy and an action plan be prepared for any extinct, endangered, or threatened species listed under the act; management plans, which are less stringent in terms of content, are necessary for species of special concern. The federal minister is required to report on the progress of implementing each strategy and plan.

This paper presents indicators of biodiversity on the coast of British Columbia. It focuses on the status and population trends of coastal species and on progress in recovery planning for species at risk. Indicators showing the impact of specific human activities on ecosystems and wildlife are discussed in the other project papers.

INDICATORS

1. Key Indicator: Changes in the conservation status of threatened and endangered vertebrates of the BC coast

This is a state or condition indicator. It addresses the question: What is the status of key coastal species?

Conservation status of species, usually summarized as the proportion of native species that are at risk, is widely used as the basis for tracking biodiversity. It is used nationally and internationally by Canada (Environment Canada 2003), the United States (Heinz Center 2002), Denmark, Japan, Italy,England, and other countries (cited in Saunders et al. 1998), and by global organizations such as the World Conservation Union (IUCN 2003). Despite their widespread use, however, indicators that summarize conservation status have been criticized, primarily because changes in knowledge of a species and how its status is assessed can mask actual changes in the status of the species (Possingham et al. 2002; Keith and Burgman 2004).

Changes in the number of species at risk, or the percentage of known species that are on the BC red list, occur as a result of changes in:

- organism taxonomy (e.g., single species are "split" into multiple species, or multiple species are "lumped" into one);
- methods for assessing risk or assigning risk categories (e.g., the procedure for assessing status is changed);
- knowledge of a species status (e.g., new information about a species may show that it is at greater or lesser risk than had been previously assumed);
- actual species status (e.g., the real abundance or distribution of a species has changed).

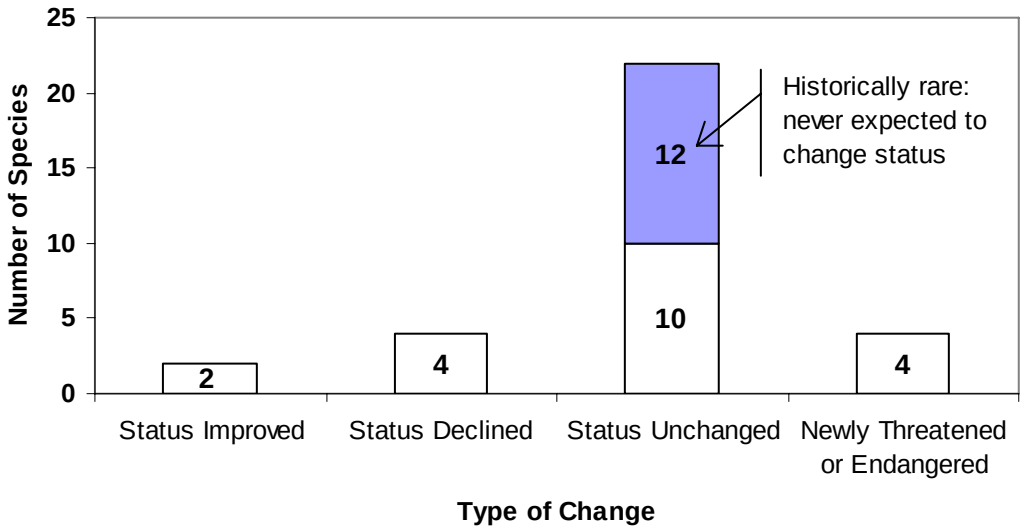
It is commonly assumed that a change in conservation status is primarily a product of changes in the actual species status. However, a BC study has shown that the first three factors listed above are more significant determinants of change in the numbers of species at risk than real changes in the actual status of the species (Quayle and Ramsay 2005). To address this problem and improve on previous indicators, a new indicator was developed for threatened and endangered species in British Columbia. The indicator corrects for changes in taxonomy, assessment methods, and increased knowledge. It lists only the actual change in the status of the red-listed species.

For discussion purposes, the term "species" is used interchangeably with the term "taxon" (pl: taxa) to include the full scope of species, subspecies, and significant populations that are the focus of conservation listing in British Columbia and Canada.

Methodology and Data

The BC Conservation Centre (CDC) published its first red list in 1992. The analysis for this indicator therefore covered the 12 years from 1992 to 2004. Changes in the red list were based on changes in the subnational rankings (S rank) of individual species, as tracked by the CDC. The S ranks generally range from S1 (critically imperilled) to S5 (secure) (Figure 1). Species with an S rank of S1, S2, or S1S2 are considered threatened or endangered in British Columbia. The analysis was limited to mammals, birds, amphibians, reptiles, and freshwater fishes that occur in the Georgia Depression and Coast and Mountains ecoprovinces of British Columbia. Although assessed by CDC as threatened or endangered, species on the provincial red list are not necessarily legally designated as such. Quayle and Ramsay (2005) contains a detailed description of how data were compiled and analyzed.

Figure 1. Changes in the status of red-listed mammals, birds, reptiles, amphibians, and freshwater fishes for coastal British Columbia, 1992-2004. Data exclude four taxa already known to be extirpated as of 1992.



Source: Original data from CDC, Ministry of Sustainable Resource Management 2004. Adapted from Quayle and Ramsay (2005).

Note: Twelve of the 22 species with Status Unchanged are historically rare (i.e., never expected to change status for the better). Status Declined includes two new subspecies extinctions.

Interpretation

This indicator focused on vertebrates because they are the best understood taxa in the province and are possibly less subject to artificial fluctuations in status resulting from changes in our knowledge of their status (Possingham et al. 2002). Although plants and invertebrates make up most of the province's biodiversity, the vertebrate results are likely to be indicative of coarse changes in other taxonomic groups. This is because the same

type of pressures that affect vertebrates—such as habitat destruction or climate change—would also affect other organisms.

Of the 10 red-listed species that experienced a real change in status, only two showed improvement. These were the sea otter (*Enhydra lutrus*) and the purple martin (*Progne subis*), a migratory swallow that suffers from competition for nest cavities with invasive birds. The martin increased in numbers as a result of nest box construction programs; it remains threatened in the province because of its dependence on these human-made structures (Pridgeon 1997).

Four coastal species that were already red-listed experienced a further decline in status between 1992 and 2004. All four species appear to have been vulnerable because they were isolated. Two subspecies of stickleback (*Gasterostereus* spp.) confined to Hadley Lake are now extinct because non-native catfish, which prey on stickleback eggs, were introduced to the lake (Backhouse 2000). The Vancouver Island wolverine (*Gulo gulo vancouverensis*), a subspecies of wolverine exclusive to Vancouver Island, went from imperilled (S2) in 1992 to historic (SH) in 2002, because it has not been seen for decades (Cannings et al. 1999). The Vancouver Island marmot, a large rodent endemic to alpine areas of Vancouver Island, moved from imperilled (S2) to critically imperilled (S1); only 30 individuals were living in the wild in 2004 (Environment Canada 2005).

Four coastal taxa were added to the provincial red list between 1992 and 2004. Two are populations of killer whales (*Orca orcinus*) and two are bird species. Marbled murrelets (*Brachyramphus marmoratus*) have suffered from loss of their old-growth forest breeding habitat (Hull 2000). Double-crested cormorants (*Phalacrocorax auritius*) have declined recently, apparently because disturbance by bald eagles is causing the adults to flee their nesting sites, leaving the nests vulnerable to predatory gulls and crows (Moul and Gebauer 2002). This pattern may result from an increase in bald eagle numbers or a reduction in fish stocks on which the eagles prey.

Most striking about these results is how little change there has been in actual status of coastal vertebrate species since 1992. Taxa that are naturally rare may account for some of this, because historically they have had populations or distributions in BC that would make them red-listed species even in a pristine landscape. Of the 22 species that experienced no change in status, 12 of these (>50%) appear to be naturally rare. Most of these 12 are confined by very specific and rare habitats. For example, 7 fish taxa are found only in one BC lake and a subspecies of Townsend's vole (*Microtus townsendii cowani*) is found only on Triangle Island. Although modern threats to these 12 species might be mitigated, barring their extirpation or a historically unprecedented change in distribution or numbers, these 12 species will remain on the BC red list indefinitely.

Incorporating the concept of natural rarity shifts the baseline for this indicator away from zero to approximately 12 coastal vertebrate species that are unlikely to show improvement in status. It does not diminish the importance of the 10 remaining species that now appear on the red list because of their unnaturally small numbers or contracted distribution. For example, populations of the spotted owl (*Strix occidentalis*), which was on the red list in both 1992 and 2002, have declined by half over that time (Blackburn et

al. 2002). Population trends are unknown for most other species that have been on the red list since 1992, although absolute population numbers are low (Cannings et al. 1999). Population recovery is a slow process, however, particularly for the many vertebrates that produce only a few young each year. Even for most species that have shown improvement, the 12-year period covered by this indicator is not long enough for the degree of recovery that would enable them to be removed from the red list. This may also explain why the indicator does not yet show an effect of the 1996 federal Accord for the Protection of Species at Risk.

Analysis shows that only 10 of the 30 (33%) changes in the rankings of red-listed vertebrates in coastal BC between 1992 and 2004 represented actual changes in species status. The remainder were due to changes in taxonomy, knowledge, or assessment methods. Although this bias was removed in the calculations for this indicator, the large proportion of change that was found to be due to external factors—unrelated to the real status of the species—emphasizes the need for better quality data. The strength of the indicator relies on high-quality monitoring data about the species considered for, and included on, the red list (Quayle and Ramsay 2005; Heinz Center 2002).

Supplementary Information: Species at Risk and Rare Invertebrates

Species at Risk on the Pacific Coast

In 2005, 119 of the animal and plant species that occur on the BC coast were listed as nationally at risk by COSEWIC (Table 1). In addition, 357 species on the provincial red and blue lists (equivalent to endangered or threatened, and special concern, respectively) were also found on the coast.

National and provincial status assessments are not complete over the full range of species. Most notably, only a portion of the invertebrates and non-vascular plant species have been assessed. Assessment of vascular plants is also limited at the national level. For the first time the status of all Pacific marine fishes is due for publication later in 2006.

Provincial red and blue lists include 119 ecological communities at risk in the province that potentially occur on the coast. Ecological communities are assemblages of plant species that can occur together and have the potential to interact with one another. Ecological communities include natural plant communities and plant associations and the full range of ecosystems that occur in British Columbia (for more information, see: *www.env.gov.bc.ca/cdc/ecology/index.html*).

Table 1. The status of species at risk on the Pacific coast in Canada and British Columbia.

	Listed in Canada				Listed in British Columbia		
	Endan-gered	Threat-ened	Special concern	Canada total	Red list (endangered threatened)	Blue list (special concern)	BC total
Amphibians	1	1	3	5	2	2	4
Butterflies/ dragonflies	3	1	1	5[a]	7	12	19
Birds	2	5	8	15	18	20	38
Freshwater fishes	10	2	3	15	14	5	19
Marine fishes	4	1		5[b]	–	–	–
Mammals	6	7	8	21	14	11	25
Molluscs[b]	2	2	2	6	1	0	1
Reptiles	2		1	3	3	1	4
Vascular plants	21	8	2	31[b]	102	145	247
Species total	**51**	**27**	**28**	**106**	**161**	**196**	**357**
Ecological communities	–	–	–	–	69	50	119[c]
Grand total	**51**	**27**	**28**	**106**	**230**	**246**	**476**

Source: Canadian data: COSEWIC 2005. British Columbia data: CDC 2005.

Note: Data on the status of algae, mosses, and marine invertebrates are not reported.

[a]Assessment limited to butterflies.

[b]Assessment of species group is largely incomplete.

[c]Analysis of ecological communities in BC limited to Coastal Douglas Fir, Coastal Western Hemlock, Mountain Hemlock, and Alpine Tundra biogeoclimatic zones.

– indicates Not Assessed.

Rare invertebrates

Invertebrates include insects, molluscs, spiders, crustaceans, millipedes, and centipedes. In an analysis of the province's freshwater and terrestrial invertebrates, Scudder (1996) lists the Georgia Basin, Vancouver Island, Queen Charlotte Islands, and the Lower Mainland as the highest priority areas for conservation of rare and endangered invertebrates. In a separate analysis in the same report, the Coastal Douglas Fir biogeoclimatic subzone was ranked as the province's highest priority ecological zone for conserving rare and endangered invertebrates.

In an analysis of marine invertebrates, Austin (2000) identified 50 species of rare marine invertebrates (i.e., known from five or fewer provincial records) on the British Columbia coast (Table 2). The list includes species that occur at the edge of their range in BC, but

are common elsewhere, and species that are rare in BC waters as well as in other seas. This was not an exhaustive list, but approximately 30% of the species were found in places that are designated or proposed for some type of protection (the extent of protection varies). Two species, a sand dollar and a sea star, that were collected from the coast in the early 1900s, have not been reported since and may now be extirpated from BC waters.

Table 2. Taxonomic distribution of 50 species of marine invertebrates identified as rare along the BC coast, by phylum.

Phylum	Description	Number of rare species identified
Porifera	Sponges	7
Cnidaria	Stinging thread animals (hydroids, corals, anemones)	4
Platyhelminthes	Flatworms	1
Echinodermata	Spiny skinned animals (stars, cucumbers, urchins)	9
Hemichordata	Acorn worms and allies	1
Brachiopoda	Lamp shells	2
Chordata	Vertebrates and allies	4
Mollusca	Soft bodied animals (cradles, limpets, snails, sea slugs, mussels, scallops, clams)	13
Pogonorpha	Beard worms	1
Annelida	Segmented worms	1
Arthropoda	Joint legged animals (centipedes, spiders, barnacles, crabs, shrimp)	7

Source: Austin (2000).

2. Secondary Indicator: Trends in abundance of killer whale populations along the BC coast

This is a status or condition indicator. It addresses the question: What is the status of a key coastal species?

The killer whale (*Orcinus orca*) is only one of 25 species of cetaceans (whales, dolphins, and porpoises) found along the BC coast (Nagorsen 2003), but it is a particularly high-profile species. Because of their relatively large size, distinctive appearance, and the publicity they receive, killer whales are widely known and recognized. Watching killer whales is now a multimillion dollar industry in Johnstone Strait, Juan de Fuca Strait, Strait of Georgia, and Puget Sound. The status of killer whale populations is an indicator of the health of coastal ecosystems because whales need clean water, healthy prey populations, and an environment that is large and quiet enough for them to maintain communication, locate and capture prey without disruption, and maintain other vital life functions (Killer Whale Recovery Team 2005).

Although the killer whale is generally considered one species, three distinct forms or ecotypes inhabit the coast of BC: transient, offshore, and resident (Killer Whale Recovery Team 2005). There are two different populations of the resident whale ecotype: southern residents and northern residents. One of the most important differences between ecotypes is diet: resident whales appear to feed almost entirely on fish, and transients appear to feed almost entirely on marine mammals (Ford et al. 1998). Less is known about offshore killer whales, but they are also thought to feed on fish (Ford et al. 2000; Heise et al. 2003, cited in Killer Whale Recovery Team 2005). Offshore and resident whales travel in large groups, using frequent echolocation and social calls. Transients rely on stealth to catch their prey and travel alone or in small, quiet groups (Killer Whale Recovery Team 2005).

The southern residents appear to be the most endangered, but all killer whale populations along the BC coast are considered to be at risk according to both federal and provincial criteria (see Table 3). A species recovery strategy has been drafted for the northern and southern resident populations.

Table 3. Status of killer whale groups on the Pacific coast.

Population / ecotype	Federal status	BC provincial status
Southern resident	Endangered	Red list
Northern resident	Threatened	Red list
Transient	Threatened	Red list
Offshore	Special concern	Blue list

Methodology and Data

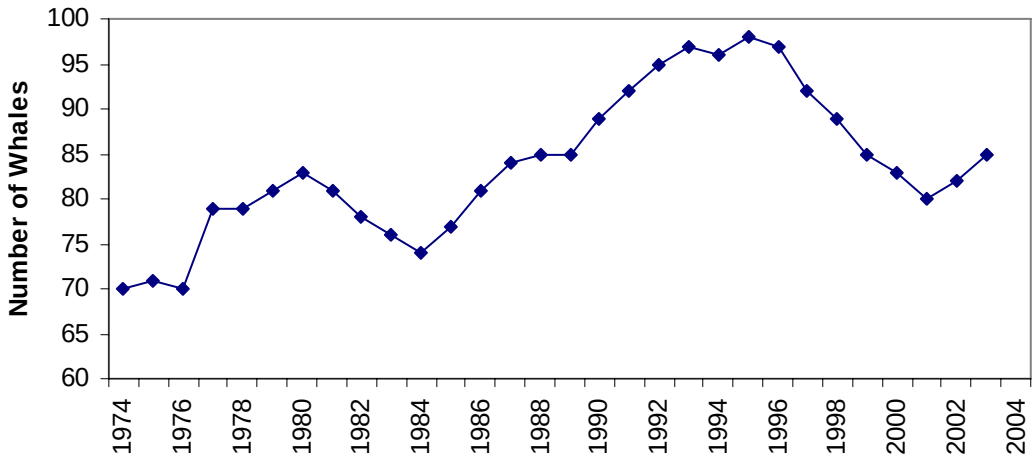
Population counts of killer whales are made annually. The Center for Whale Research, San Juan Island, carries out the census for the southern residents; the Cetacean Research Program, Department of Fisheries and Oceans Canada (DFO), Nanaimo, carries out the census for the northern residents. During vessel surveys, photographs are taken of all whales encountered. Individual whales are identified by program staff from a database of photographs. Each whale is identified by its uniquely shaped dorsal fin and saddle patch, as well as by scars.

The southern resident count includes all whales that are seen during a calendar year, and mortalities may be included in the count, depending on when they occur. For example, a whale that is not seen after March in a given year is assumed to be dead. However, because whales may leave inshore waters in winter, it is not certain that whales not counted in November or December are dead; therefore, such whales may still be included in the count for that year (Killer Whale Recovery Team 2005). In recent years, observer effort has been high and members of the southern resident population are photographed annually, so that the count is expected to be reasonably accurate. There are small discrepancies in the southern resident counts in the literature due to different methods of

recording when whales are considered to enter or leave the population (e.g., Krahn et al. 2004 reported 83 southern residents in 2003, whereas Figure 2 shows 85.)

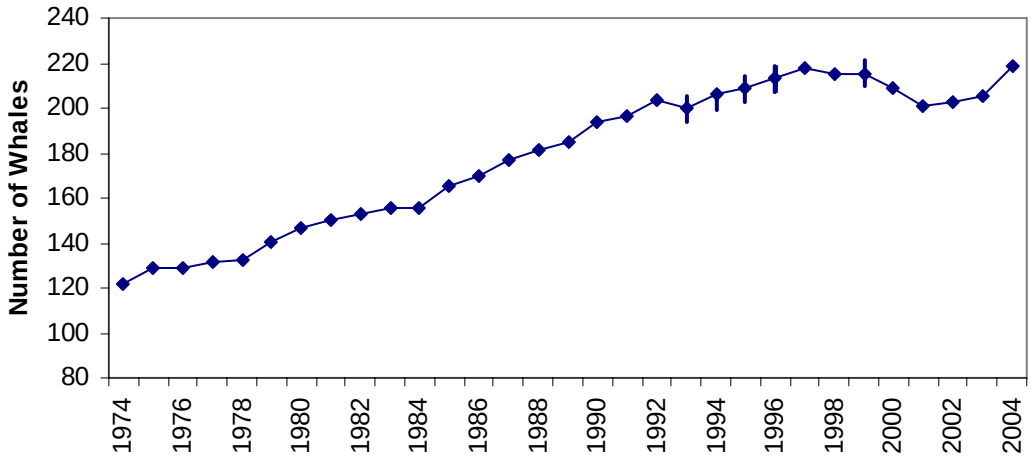
The northern resident count includes all whales that are known to be alive in July-August of each year, and the annual population is estimated from that number (Killer Whale Recovery Team 2005). However, not all members of the northern resident community are seen each year because they travel widely along the BC coast, so the counts are generally less accurate than for the southern residents.

Figure 2. Population size and trend for southern resident killer whales of the BC coast, 1974–2004.



Source: Center for Whale Research, Friday Harbor, Washington, USA, unpubl. data.

Figure 3. Population size and trend for northern resident killer whales of the BC coast, 1974–2004.



Source: Cetacean Research Program-DFO, Nanaimo, unpubl. data.
Note: Bars represent uncertainty due to some groups not being seen in some years.

Interpretation

According to the Killer Whale Recovery Team (2005), in 2003 there were a total of 290 northern and southern resident killer whales, and approximately 220 transient and 200 offshore killer whales. Little is known about the historic abundance of killer whales, and there are no population estimates for killer whales in British Columbia before 1960. In the late 1960s and early 1970s, a total of 47 individuals that were known to be (or likely to have been) southern residents were captured and sent to aquaria (Bigg et al. 1990). This may have represented 40% of the total population at the time, calculated by adding the number of whales captured to the number counted in 1974.

After live captures ended in 1973, the population of southern residents increased to 83 by 1980 (Figure 2). However, the population declined in the early 1980s as a result of lower birth rates, higher mortality for adult females and juveniles, and lower numbers of mature animals, especially males, caused by the selective live captures before 1973 (Olesiuk et al. 1990; Killer Whale Recovery Team 2005). After a surge in the number of breeding individuals, the population increased 34% over the next decade to 99 animals. The latest decline, which began in 1996, now appears to be reversing in some groups within the population, but not in others. New research strongly linking the abundance of Chinook salmon to the population dynamics of resident killer whales suggests that prey limitation may be an important factor in recent declines (Ford et al. 2005).

Currently, the number of southern resident whales is still below the numbers estimated before the live captures occurred (Baird 1999). An analysis of population viability, taken from just the 1990 reproductive rates, would indicate that extinction of southern residents is inevitable. In contrast, analyses based on the longer 1974–2000 average indicate that the risk of extinction is much less (0–55% probability; summarized in Killer Whale Recovery Team 2005). The risk of extinction could be even lower if southern residents are part of a larger breeding population of northern BC and southern Alaska residents (Krahn et al. 2002), but current evidence suggests that the southern residents are genetically isolated (Barrett-Lennard and Ellis 2001).

At least 14 whales were known to have been taken from the northern resident population between 1964 and 1973; 12 of these were from one pod (Bigg et al. 1990). In contrast to the southern population, the northern population appears to have grown steadily from 1974 to 1991 (Figure 3). This may have been because the northern population was larger to begin with, because fewer individuals were captured, or because they are generally exposed to less disturbance (Killer Whale Recovery Team 2005). As with the southern residents, evidence suggests that population declines in the late 1990s are related to a reduction in overall numbers of a key prey species, the Chinook salmon, along the west coast (Ford et al. 2005).

The small size of both northern and southern resident killer whale populations makes them particularly vulnerable to threats, such as environmental contaminants (including oil spills), reduced availability of prey, disturbances, and noise pollution. Even under ideal conditions, killer whale populations tend to recover slowly because mature females calve only every 5–6 years (Killer Whale Recovery Team 2005).

3. Secondary Indicator: Observed abundance of coastal waterbirds

This is a status indicator. It addresses the question: What is the status of our coastal birds?

Globally, the conservation status of marine birds has declined sharply; nearly one-third of the bird species that depend on marine and coastal areas are currently considered to be threatened (Butchart et al. 2004; MEA 2005c). The coastal habitats of British Columbia support some of the highest densities of seabirds, waterfowl, shorebirds, and raptors in the eastern North Pacific (Butler and Vermeer 1994), including globally significant populations of breeding, migrant, and wintering species.

The Strait of Georgia is a key area for wintering and migratory species, particularly the Fraser Delta, including Boundary Bay and Roberts Bank, and the east coast of Vancouver Island from Nanoose Bay north to the Comox estuary. The Fraser River estuary—which supports well over 2 million migratory shorebirds and waterfowl annually—was recently designated as a Western Hemisphere Shorebird Reserve. Outside the Georgia Basin, Rose Spit at the northeastern tip of the Queen Charlotte Islands also supports significant winter concentrations of some shorebird and auk species.

Two-thirds of British Columbia's human population and three-quarters of its labor force live in and around the Georgia Basin. Waterbirds and their habitats in this region are subject to a wide range of anthropogenic influences including recreation, seashore industry, residential development, and marine vessel traffic (Vermeer 1994). Each influence has associated negative effects, including disturbance, effluent discharges from industry, sewage overflow, and oil spills from ships. Several internationally designated Important Bird Areas in the Strait of Georgia are close to major population centres with substantial industry and shipping activity, and many waterbird populations use habitats that lie along or adjacent to major oil shipping lanes and are therefore at risk from discharges of oil.

The BC Coastal Waterbird Survey was established by Bird Studies Canada and the Canadian Wildlife Service to provide baseline species distribution data and to monitor changes in waterbird populations throughout British Columbia. The survey is a volunteer-based program focusing on the populated areas of the Lower Mainland and on islands in the Strait of Georgia. The Georgia Basin Action Plan provided funding for analyses.

Methodology and Data

Skilled volunteers count the number of waterbirds and raptors at specific sites within two hours of the high tide. Volunteers follow a standard protocol and count on predetermined dates (or one day before or after these dates) each month from September through April, for a total of eight monthly visits per winter. Species groups surveyed include loons, grebes, cormorants, herons, swans, geese, ducks, shorebirds (sandpipers, plovers, etc.), gulls, alcids (murres, puffins, etc.), and raptors. The number of surveyed sites ranges from 171 to 207, with an average of 180 sites surveyed.

Indices of relative abundance were developed for the first five winters (1999/2000, 2000/01, 2001/02, 2002/03 and 2003/04), based on the mean count of each species at each survey site in each winter (Badzinski et al. 2005). Preliminary population trend assessments were conducted for the 58 most commonly recorded species, using linear regression models to estimate changes in relative abundance over the five-year period (Table 4). An analysis was also conducted on the five-year dataset to assess the survey's ability to detect annual population changes of less than 3% for each of the 58 species.

Table 4. Number of coastal waterbird species by species group, showing significant ($p < 0.05$) upward or downward trends between 1999/2000 and 2003/04.

	Five-year trend			
Species group	Significant upward trend	Significant downward trend	Trend not significant	Total
Cormorants	2	0	1	3
Grebes	1	1	1	3
Gulls	2	1	4	7
Herons	1	0	0	1
Loons	1	0	2	3
Raptors	0	2	2	4
Seabirds	0	1	2	3
Shorebirds	1	1	6	8
Waterfowl	5	5	16	26
Total	12	12	34	58

Source: Coastal Waterbird Survey, Badzinski et al. 2005.

Interpretation

The five-year trends shown in Table 4 should be considered as preliminary, given the short time over which the survey has been conducted, the non-random selection of survey sites and naturally wide fluctuations that occur in waterfowl populations (Wilkins and Otto 2003). Although it was not possible to detect trends for most of the species counted, the numbers of wintering long-tailed duck (*Clangula hyemalis*) showed one of the strongest declining trends of any species counted in the survey. This agrees with other species-specific surveys, which have shown substantial declines in some sea duck species, including scoters and long-tailed ducks, over the last 30 years (USFWS 1999).

Analyses of the data showed that with five years of data (six winter seasons), population trends could be adequately detected for only a few of the species most commonly recorded. By analyzing the statistical power of the results, it appears that after 10 years of data, it would be possible to detect significant population trends for about two-thirds of the most commonly recorded species. This would require maintaining high levels of volunteer coverage over 10 years and possibly other improvements to the survey

methodology. As it continues, the Coastal Waterbird Survey should fill a gap in bird population monitoring. It provides better coverage of coastal habitats than the Breeding Bird Survey (CWS 2004) and improves on the Christmas Bird Count, which does not differentiate coastal habitat within counts and does not test for significance of population trends (Audubon Society 2005).

4. Key Indicator: Number of alien species, by group, in coastal BC

This is a pressure indicator. It addresses the questions: How much of a problem are invasive species in BC? How many invasive species have been introduced to coastal BC?

Alien, or exotic, organisms live outside of their natural range usually because they have been deliberately or accidentally introduced there by humans. Because their natural predators or diseases are generally not present in the new environment, such introduced species can become established and reproduce quickly. According to one estimate, about 10% of introduced species become invasive (Menge and Branch 2001). Alien species are particularly effective at invading and becoming established in ecosystems under stress, such as those that are recently disturbed (Sorensen 1984).

Alien species may be second only to habitat destruction in causing the loss of biological diversity worldwide (Vitousek et al. 1997). Current efforts to manage alien species have generally not been effective in controlling the problem (Simberloff et al. 2005). Global trade provides an increasing number of opportunities to transport organisms into non-native habitats where they may prey on, compete with, or alter the value of habitat for native organisms (Simberloff 2002).

In addition to the cost of ecological destruction, managing alien species is expensive. Economic costs include lost agricultural production and ecosystem services, control or eradication programs, and exclusion programs to keep out possible invaders. Alien species in the United States are estimated to cause environmental loss and damage worth US$137 billion per year (Pimental et al. 2000).

Methodology and Data

Three separate datasets are presented in this indicator (Table 5).

1. Coastal Vertebrates: The Conservation Data Centre (CDC) of the BC Ministry of Environment tracks the occurrence of many animal species known to be introduced to coastal BC habitats from elsewhere in BC or Canada or from outside of Canada. The CDC's list of introduced species is not exhaustive because it excludes many marine organisms, as well as nonvascular plants (algae) and invertebrates other than butterflies, dragonflies, and damselflies. For this indicator, vertebrate species were included if they were present in coastal habitats. In some cases, a species was recorded as "introduced" if it is native to BC but now occurs in a coastal area (e.g., on an island) where it was not found historically. Insects were not included because data were only available on two species of butterflies, whereas many more alien insects are known.

2. Coastal Vascular Plants: Alien plant data were compiled from the UBC Herbarium Database (*www.botany.ubc.ca/herbarium/*), recent publications (Ceska 1997; Douglas et al. 1998-2002; Klinkenberg 2004), and expert knowledge (Roy Cranston, pers. comm.). Data include alien plant species that live in terrestrial, freshwater, marine, and estuarine habitats along the BC coast. All are believed to have become established on the coast. Alien plant species were categorized as either frequent (occurring widely in coastal habitats) or rare (known from five or fewer scattered sites). Rare species are those considered to be established although they are seldom found.

3. Strait of Georgia Species: Data on alien marine and estuarine plant and animal species just in the Strait of Georgia were extracted from Levings et al. (2002). These data were considered provisional and only the confirmed alien species were included in this indicator. Some of these species are known to be established; the long-term status of others is not known.

Interpretation

Plants are overwhelmingly the most common group of alien species documented in coastal BC (Table 5). About 65% of alien plants occur frequently and appear to be widely established. The number of alien plants is high, likely because they have been unintentionally imported along with livestock feed, as well as introduced for nursery and other agricultural purposes (Harding 1994). Others may have arrived on imports of equipment or on domesticated animals. Many of the most invasive plants (e.g., Scotch broom, purple loosestrife, baby's breath, Japanese knotweed) were intentionally planted as ornamentals and have escaped from gardens.

At least 35 of the 41 alien vertebrates established on the BC coast were introduced intentionally (Ministry of Environment, 2005, prelim. data). They may have been deliberately introduced for hunting and fishing (e.g., chukar, wild turkey, bass), intended to beautify the countryside (e.g., Eurasian skylark), set free from zoos (grey squirrel, European wall lizard), or released pets (e.g., red-eared slider turtle). Both federal and provincial governments continue to sponsor programs to stock alien species of sportfish in non-native habitats throughout coastal BC, despite research documenting this practice as a conservation threat to freshwater systems (e.g., Pilliod and Peterson 2001; Schindler and Parker 2002; Cambray 2003; Knapp 2005).

The figures in Table 5 do not include organisms native to other parts of the province that have been moved to areas where they did not exist previously. Such movement of vertebrates has caused severe problems in the Queen Charlotte Islands where introduced mainland species are causing ecological damage. Rats (*Rattus* spp.) and raccoons (*Procyon lotor*), the latter introduced from mainland BC in the 1940s to promote fur trapping, are a serious threat to populations of nesting marine birds (Harfenist and Kaiser 1997; Hartman et al. 1997). Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) were introduced to the Queen Charlotte Islands for hunting around 1900 (Foster 1989). In the absence of predators, they have multiplied to the point where their heavy browsing on several tree species has altered local plant communities (Pojar et al. 1980; Pojar 1999).

Table 5. Number of alien species established in coastal British Columbia (vertebrates and vascular plants) and recorded in the Strait of Georgia (marine and estuarine species).

Coastal British Columbia	Number of established introductions
Vertebrates[a]	
Freshwater fish	12
Amphibians	2
Reptiles	2
Birds	14
Mammals	11
Total vertebrates	41
Vascular plants[b]	–
Species occurring frequently	406
Species occurring rarely	223
Total Plants	629

Strait of Georgia Strait only[c]	Number of recorded introductions
Seaweed	5
Plants	18
Hydroids, Anemones (Cnidaria)	2
Worms (Polychaeta)	7
Snails, Slugs (Gastropoda)	8
Shellfish (Bivalvia)	11
Amphipods, Isopods (Crustacea)	6
Sea squirts (Tunicata)	4
Sponges (Porifera)	2
Finfish	5
Birds	2
Mammals	1
Other (Kamptozoa, Foraminifera, Platyhelminthes)	2
Total species	73

Sources: [a] Animal data (current to 2004): CDC. [b] Plant data (various dates): Ceska 1997; Douglas et al. 1998-2002; Klinkenberg 2004; UBC Herbarium Database; Roy Cranston, pers. comm. [c] Marine/estuarine data (current to 1999-2000): Levings et al. 2002.

Note: Atlantic salmon and American shad, both anadromous species, are counted twice: as "freshwater fish" under Coastal BC and as "finfish" under Strait of Georgia. Alien Coastal BC mammals includes feral cats and horses, but not other domesticated animals.

GREEN INVADERS: THREE NOTORIOUS PLANT SPECIES IN COASTAL BC

Scotch broom (*Cytisus scoparius*), considered one of the five most destructive alien plants in Canada (Mosquin and Whiting 1992), was introduced intentionally as an ornamental in 1850 to southern Vancouver Island. It has since spread along the east side of Vancouver Island, across the Gulf Islands, and into the Lower Mainland and Fraser Valley. Broom thrives on disturbed sites on poor soils, such as along rights-of-way, roadsides, and in new forestry sites (Prasad 2000). It lacks natural enemies, tolerates drought and cold, and produces many seeds that can lie dormant for decades (Peterson and Prasad 1998).

Purple loosestrife (*Lythrum salicaria*) was brought to North American 200 years ago. It was transported to Vancouver Island by the early 1900s and then spread to much of the Georgia Basin and Fraser Valley. Grown as a garden ornamental until the 1980s, it also spread along roadside ditches. Loosestrife outcompetes native vegetation in riparian and wetland habitats (Mal et al. 1992), altering ecosystem productivity and function (Grout et al. 1997) and displacing wetland animals and fishes, few of which feed on, or otherwise use, purple loosestrife (White and Haber 1992).

Cordgrasses (*Spartina* spp.) are salt-tolerant plants, native to the Atlantic coast. They were intentionally introduced to the Pacific Northwest to create duck habitat and stabilize shorelines. Aggressive eradication efforts are now being undertaken to halt their invasion of the Fraser delta (Williams 2004) because cordgrasses replace native vegetation in mudflats and marshes (Simenstad and Thom 1995). This increases the build-up of sediments (Thompson 1991) and causes declines in both benthic organisms (Gray et al. 1991) and bird habitat (Foss 1992).

The numbers of alien species reported here are only from some of the better known groups of organisms and are not the total number established in coastal BC. Alien microorganisms, insects, and other invertebrates are not well documented but are likely abundant. For example, ballast water in cargo ships may contain thousands of tiny organisms, including algae and zooplankton, in each cubic metre of water (Levings et al. 1998). More than 3000 species of animals and plants are estimated to be transported around the world daily in ballast water (NRC 1996); some, such as zebra mussels in the Great Lakes system, have had devastating impacts.

With respect to insects, Smith (1994) identified more than 300 alien insect species in British Columbia. Some are serious economic pests and others were introduced intentionally as part of biological control programs for pests. More comprehensive monitoring would likely find more species, especially among classes of organisms that are hard to find or identify as aliens.

Aliens from Neighbouring Jurisdictions

Some alien species reach BC under their own locomotion after being intentionally or accidentally released in neighbouring jurisdictions. Lower Mainland populations of opossum (*Didelphus virginiana*) may be descendants of opossums intentionally introduced to Washington State in the 1920s (Nagorsen 1996). European green crab (*Carcinus maenas*) is rapidly expanding its range along the coast. It was first found along the coast of California in 1989, Oregon in 1997, Washington in 1998, and west Vancouver Island in 1999 (DFO 1999). Since then, green crabs have been found along the west side of Vancouver Island from Esquimalt Harbour to Port Eliza (Kieser 2004). It is a voracious predator on invertebrates and, because it shreds eelgrass, is the leading cause of declining eelgrass beds in Nova Scotia (Garbary et al. 2004). It is feared that it could damage Dungeness crab and shellfish fisheries, and reduce the food supply for shorebirds and other species (Jamieson et al. 1998).

Twenty-four non-native species (all but one are invertebrates) reported as established in Puget Sound are not found in the shared waters of the Strait of Georgia (Cohen 2004); all are potential invaders north along the BC coast.

Valuable Aliens

Although they carry potential (or realized) costs to ecosystems and to native commercial species, lucrative industries have sprung up around some coastal aliens. Alien marine invertebrates account for 58% (40 species) of the non-native species in waters of the Strait of Georgia (Table 5). Among these are commercially valuable mussels, oysters, scallops, and clams. The Manila clam (*Tapes philippinarum*), unintentionally introduced in the 1930s, has colonized much of the province's south coast where it apparently co-exists with native clams (DFO 2001; BCSGA 2004) and supports a commercial clam industry valued at $7.6 million in 2003 (DFO 2004). The introduction of Atlantic salmon aquaculture to the BC coast has simultaneously fuelled an industry worth $250 million annually (BCMAL 2003) and controversy over threats to wild salmon fisheries from this alien species and the net-pen rearing methods (e.g., Senate Standing Committee on Fisheries 2001).

WATCHING THE BORDERS: ECONOMICALLY DESTRUCTIVE SPECIES

The Canadian Food Inspection Agency regulates and inspects plant products that could bring alien species into Canada. Provincial governments and industries also have monitoring and eradication programs aimed at keeping out alien species. Some of the economically costly invaders BC is working to keep out include:

- **European and Asian gypsy moths** (both *Lymantria dispar*) threaten the province's forestry, agriculture, and nursery sectors as well as the native Garry oak forests (Agriculture Canada 1986; Humble and Stewart 1994). If the moths become established, expensive quarantines and export embargoes will be needed. Because the European gypsy moth is widely established in eastern North America, constant monitoring and inspections are required to prevent them from becoming established in BC. A network of gypsy moth traps is monitored every year in BC by the Canadian Food Inspection Agency to give early warning of new gypsy moth introductions. Monitoring and eradication costs up to $1 million annually, depending on whether treatments are required to prevent them from becoming established (Forest Practices Branch, BC Ministry of Forests).

- **Sudden oak death** (*Phytophthora ramorum*) is a fungus that threatens both the forestry and horticulture sectors. It can infect, and in some cases kill, many plant species that are found on the west coast, including Garry oak, arbutus, manzanita, big leaf maple, alder, salmonberry, Douglas-fir, and a variety of nursery species, such as rhododendron and camellia (BCMAFF 2004; CFIA 2005). Sudden oak death has entered BC twice in recent years, resulting in the imposition of quarantines on imports of nursery stock as well as lost sales and regulatory costs (Allen et al. 2003; CFIA 2005). Although BC is currently free of sudden oak death, the presence of this pathogen elsewhere in the world has resulted in an estimated national economic impact within Canada approaching $1 million (Allen et al. 2003).

- **Ballast water organisms**: Many alien species in both Strait of Georgia and Puget Sound arrived in ballast water or on hulls of ships (Levings et al. 1998, 2004; Cohen 2004). To reduce the risk of foreign introductions, the Vancouver Port Authority, as of 1997, requires most ships arriving in port to exchange ballast water in mid-ocean, rather than in port (VPA 2002). This is not a complete solution as some coastal organisms may remain in ballast water in Vancouver (Levings et al. 2004) and ships travelling from other Canadian and American ports along the west coast do not have to abide by the mid-ocean exchange regulation. With more technological development, treating ballast water with ultra-violet radiation may become an alternative to mid-ocean exchange.

5. Secondary Indicator: Change in area of sensitive ecosystems on eastern Vancouver Island and the Gulf Islands

This is a status indicator. It addresses the question: What is the current condition of key natural ecosystems in BC?

In 1993, Environment Canada, the BC government, and other partners began the Sensitive Ecosystems Inventory, a project to classify, identify, and map ecosystems that were considered rare or particularly fragile on eastern Vancouver Island and the Gulf Islands. McPhee et al. (2000) emphasize the value of these "sensitive" ecosystems to coastal biodiversity because they are:

- rare, either naturally or because of human activities, and often occur in conjunction with rare species of animals and plants;
- specialized, providing unique habitats that are often in low supply;
- small and occur within a mix of different ecosystem types, resulting in a general association with high numbers of species and individuals.

Sensitive ecosystems may be fragile when they occur in small patches, even if relatively common, or they may be sensitive to forces of disturbance, such as land development, invasive species, and climate change. This indicator shows the trend in the area of sensitive ecosystems in a populated region of BC.

Methodology and Data

Work focused on a 412,000-ha study area stretching from just north of Campbell River south to Sooke and including the Gulf Islands (Figure 4). Seven sensitive ecosystems and two human-modified ecosystems were mapped; these initially occupied 7.9% and 11.6% of this study area, respectively (Table 6). The two modified ecosystems were included because of their value to wildlife and for biodiversity in general (McPhee et al. 2000).

Specific details about inventory methods are available in Ward et al. (1998). Data were collected from air photos (taken 1984–1992, with most from 1992), most of which were at a scale of 1:10,000 or 1:15,000. Nearly 7400 sites were identified from these photos; 30% of the sites were visited to check the accuracy of photo interpretations. A Geographic Information System was used to construct 66 maps. Changes in the area of the ecosystems mapped from 1992 air photos were determined by overlaying the mapped sensitive ecosystems on recent 2002 photos. Changes were documented as the total area disturbed or lost (Axys 2005).

Disturbance was classified into types, including agricultural, cleared/logged, industrial (e.g., gravel pits, dams, fish farms), rural use, trails/recreational, urban use, and "other." Not all types of disturbance could be identified (notably invasive species).

Figure 4. Study area for sensitive ecosystem inventory and mapping project.
Sensitive ecosystems occupied 7.9% of the study area in 1992.

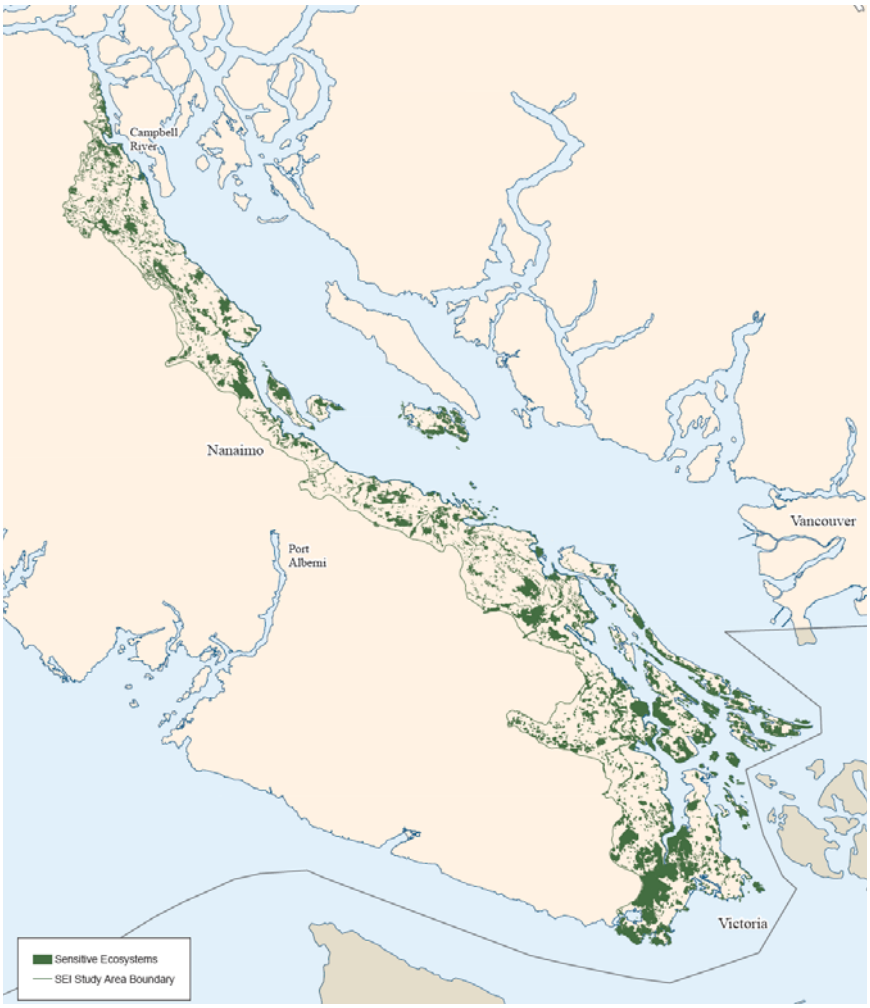


Table 6 lists the seven types of sensitive ecosystems and shows the net change in the area of each type in the study area between 1992 and 2002. The table also shows the changes in area of two types of human-modified ecosystems that have important values for wildlife: seasonally flooded agricultural field and older second-growth forest (i.e., 60–100 years old). The remaining, unclassified land in the study area was made up of modified urban or rural lands and recently logged forest (i.e., younger than 60 years).

One of the modified ecosystems, older second-growth forest, occupied more area than any other ecosystem. The sensitive ecosystems with the greatest extent were older forest (older than 100 years), followed by wetland and riparian ecosystems. The ecosystem with the smallest total area was the sparsely vegetated type, with only 326 hectares in 1992, or one-third of a square kilometre.

Table 6. Change in the area of seven types of sensitive ecosystems and two human modified ecosystems on eastern Vancouver Island and the Gulf Islands between 1992 and 2002.

Ecosystem	Description	1992 area (ha)	2002 area (ha)	Loss (ha)	% Loss
Sensitive ecosystems					
Coastal bluff	Vegetated rocky islets, shorelines, and coastal cliffs	1,042.9	1,041.7	1.2	0.1
Terrestrial herbaceous	Mosaics of coastal grassland meadows and moss-covered rock outcrops	4,242.9	4,218.5	24.4	0.6
Older forest	Forests older than 100 years	10,613.8	9,698.4	915.4	8.6
Riparian	Vegetated floodplains, stream and lakeshores, and gullies	6,712.3	6,401.5	310.8	4.6
Sparsely vegetated	Dunes, spits, and inland cliffs	325.6	321.1	4.5	1.4
Woodland	Open forests dominated by deciduous trees with canopy cover generally less than 50%	2,518.7	2,452.6	66.1	2.6
Wetland	Marshes, fens, bogs, swamps, shallow water, and wet meadows	7,053.9	6,912.1	141.8	2.0
Total		32,510.1	31,045.9	1,464.2	4.5
Modified ecosystems of importance to wildlife					
Seasonally flooded agricultural field	Agricultural fields flooded in winter for use by migratory birds	2,778.6	2,763.3	15.3	0.5
Older second growth forest	Large stands of conifers 60–100 years old	44,890.6	37,527.5	7,363.1	16.4
Total		47,669.2	40,293.9	7,378.4	15.5
Total sensitive and modified ecosystems					
		80,179.3	71,342.6	8,836.7	11.0

Source: Axys 2005.

Interpretation

Nearly 1500 hectares of sensitive ecosystems on the east coast of Vancouver Island and the Gulf Islands were disturbed or lost between 1992 and 2002 (Table 6). Most of the loss was due to logging and clearing. Older forests, which are favoured by many wildlife species for their structural complexity, were hardest hit, losing 8.6% of their area. Riparian ecosystems were reduced in area by 4.6%. This is a concern because these areas support disproportionately high numbers of species per unit area and provide travel corridors for some species (McPhee et al. 2000). Woodlands lost 2.6% of their area, and wetland, sparsely vegetated, terrestrial herbaceous, and coastal bluff ecosystems each lost less than 2%. The rate of loss of sensitive ecosystems on eastern Vancouver Island and the Gulf Islands averaged almost 150 hectares per year. The remaining area of sensitive ecosystems in the study area in 2002 was just over 31,000 hectares.

The main type of disturbance for ecosystems in the study was "cleared/logged," which removed a total of 1176 hectares of sensitive ecosystems, as well as 6833 hectares of older second-growth forest (Axys 2005). About 16% of older second-growth forest was disturbed or lost in the 10-year period. Such older second-growth forest can support a broad range of wildlife species depending on stand size, vegetation structure, and connectivity (McPhee et al. 2000). These maturing forests are also important because they will eventually become older forest. Most of the recent harvest of second-growth forest has taken place in low-elevation stands near Nanaimo and Comox (McPhee et al. 2000; Axys 2005). The fact that there has been rapid urban growth in the Nanaimo Regional District during the early 1990s suggests that at least part of the land was cleared for conversion to other uses, such as rural subdivision (RDN 2003). Such total conversion of forested land has more serious impacts on biodiversity than logging for continued forestry, because converted habitat is essentially lost forever.

The loss of sensitive ecosystems on eastern Vancouver Island is not an isolated example. Wetlands in the Lower Mainland now cover only 10% of the area they once did (Boyle et al. 1997). Many were drained and converted into agricultural land in the early 1900s. Between 1986 and 1993, 435 hectares of wetlands were also lost in the Greater Vancouver Regional District (BCMSRM 2004). Farther north, along the central and northern coasts of BC, industrial forestry has reduced the amount of old forest in high productivity ecosystems to a level that is "much lower" than would be expected from natural disturbance (Holt and Sutherland 2003, 2004).

Supplementary Information: Two Sensitive Marine Ecosystems in Coastal BC

Kelp forests and eelgrass meadows are two vital marine ecosystems on the Coast. They provide intertidal and subtidal habitat for many invertebrates, fish, birds, and mammals, as well as for plants that cling to seaweed fronds. Herring, a key forage fish for other species, spawn their eggs directly onto eelgrasses, and several other fish species use eelgrass meadows as nurseries (Butler 2003). Eelgrass and kelp ecosystems cover 13%

and 29% of the total BC coastline, respectively (based on 1995–2001 air photos; Corporate Information Services, Ministry of Agriculture and Lands 2005).

Both eelgrass and kelp occur close to shore and are therefore particularly sensitive to impacts from human activities on land and along the shoreline. These activities include discharge of pollution that reaches marine waters, construction activities for docks and other shoreline structures, and coastal dredging. Other threats include global climate change (rising temperature and sea levels) and invasive species such as the European green crab, which destroys eelgrass shoots (Garbary et al. 2004).

Several mapping and monitoring projects to assess the health and extent of these ecosystems are in progress (e.g., Wright 2002; Dunster 2003).

6. Key Indicator: Progress toward completing recovery strategies for species at risk in BC

This is a response indicator. It addresses the question: What is being done to protect threatened species and biodiversity? The indicator shows the progress being made in one type of societal response to the issue of threatened species—the development of species recovery strategies.

As signatory to the 1996 Accord for the Protection of Species at Risk, British Columbia is committed to action that will enable threatened and endangered species to recover. Recovery planning for species listed as extirpated, endangered, or threatened involves the collaboration of government, industry, academia, and individuals. Planning involves preparing two documents: a recovery strategy and a recovery action plan (see text box). Because is it unlikely that species would recover without human intervention, tracking the listed species that have recovery strategies and action plans is one measure of societal effort and commitment toward species recovery. Taylor et al. (2005) recently demonstrated that in the United States, the status of species that had a dedicated action plan for at least two years was more likely to improve than for species without recovery plans.

This indicator measures progress in preparing recovery strategies for species that have been assessed by COSEWIC as extirpated, endangered, or threatened. The timeline for completion of recovery strategies is one year for endangered species and two years for threatened species. A management plan, which has less stringent content and format requirement, is required within three years of listing for species designated as special concern. This indicator reports only the status of recovery strategies; there was insufficient information to report on the current status of action plans. The indicator does provides an indirect measure of recovery action, however, because most recovery teams actively engage in implementation of recovery action even before the strategy is complete.

RECOVERY PLANNING

Recovery planning in Canada involves preparation of two types of documents:

- Recovery strategy: Details the information known about a species, its habitat, and threats to its survival. The document also outlines objectives and identifies additional information on species status and different recovery approaches that will help teams plan the recovery of the species.
- Recovery action plan: Includes specific projects or activities needed to meet the objectives outlined in the recovery strategy. The plan evaluates the socio-economic costs and benefits of improving the species' status.

An action plan together with a recovery strategy is often called a "recovery plan."

Methodology and Data

This indicator focuses on coastal BC species at risk as listed federally by COSEWIC. Each species underwent a formal status assessment as a prerequisite for COSEWIC listing. Data on the progress of recovery strategies are compiled and tracked by the Biodiversity Branch, BC Ministry of Environment. The BC Ministry of Environment is the lead agency on recovery strategies for many BC terrestrial species and it is a co-leading agency for recovery teams working on freshwater fish and molluscs. The Canadian Wildlife Service is responsible for recovery strategies for migratory birds, and Fisheries and Oceans Canada is responsible for many marine mammals, fish, and invertebrate species; it also co-leads the recovery teams for freshwater fish and molluscs.

For COSEWIC data, the term "species" also includes subspecies and even specific populations of a single species where COSEWIC has deemed it necessary to rank these separately. For example, two subspecies of peregrine falcon, the *anatum* and *pealei* subspecies, are counted separately in the dataset. Four populations of Pacific killer whales are also recognized. There is not necessarily a one-to-one relationship between COSEWIC-listed species and recovery strategies because recovery strategies may include multiple subspecies or populations, or even multiple species that inhabit the same ecological region (e.g., the Garry oak ecosystem).

Interpretation

Recovery strategies for extirpated, endangered, or threatened species are in progress across the full range of taxonomic groups and political jurisdictions (Table 7). Strategies have been started for 86% of species and 26% have been completed and are under review. Recovery planning in general appears to be in mid-process: as of 2005, no strategies had been approved and published.

Although writing and implementing a recovery plan does not guarantee improvement in the status of a species, it is a necessary step toward coordinating a recovery effort that has the greatest possible chance of being successful (Taylor et al. 2005). In addition to producing a plan, the process of recovery planning may produce interim recovery measures. There are also less obvious benefits from regularly bringing together species experts, interest groups, industry representatives, and others to discuss the welfare of a species at risk. Most recovery teams are also involved in implementing recovery actions, even before completing the recovery strategy or action plan.

Table 7. Progress, by taxonomic group, on development of recovery strategies for west coast species listed by COSEWIC as extirpated, endangered, and threatened.

Taxonomic group	No. listed species	Not yet started	In process	Draft in review[a]
Amphibians	2	–	1	1
Arthropods	5	1	4	–
Birds	7	2	2	3
Fishes, freshwater	12	1	3	8
Fishes, marine	5	2	3	–
Lichens	1	–	1	–
Mammals, marine	9	2	5	2
Mammals, terrestrial	4	–	3	1
Molluscs, aquatic	2	–	1	1
Molluscs, terrestrial	3	–	–	3
Mosses	3	–	3	–
Reptiles	4	–	2	2
Vascular plants	29	4	24	1
Total	86 (100%)	12 (14%)	52 (60%)	22 (26%)

Sources: Species status: COSEWIC website: *www.cosewic.gc.ca/eng/sct5/index_e.cfm*. Progress in recovery: Biodiversity Branch, BC Ministry of Environment.

[a] This category includes strategies for which there is an update in progress.

Notes: Data as of May 2005. Species listed as "special concern" by COSEWIC are excluded because they do not require recovery strategies. No recovery strategies have yet been published.

Notes from informal discussions with recovery teams show that action plans are in preparation for many listed species. Although there is still some breadth of opinion as to how recovery actions will be implemented, there appears to be a growing consensus that multi-species or ecosystem-level action plans are desirable, even if recovery strategies themselves may be species-specific. Action plans that already exist for certain species, because they were part of previous processes, include:

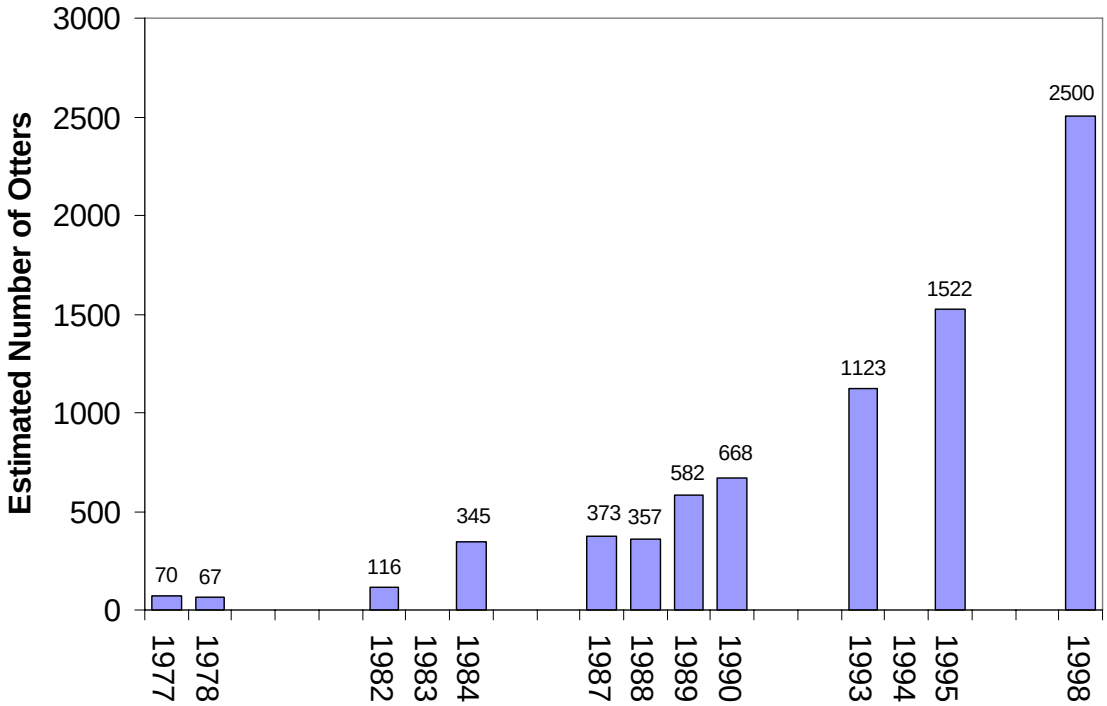
- Marbled murrelet (*Brachyramphus marmoratus*)—a small seabird that requires old-growth coastal forests for nesting. An action plan was developed in 1993 (Kaiser et al. 1994) and recovery efforts continue.
- Peregrine falcon (*Falco peregrinus*, ssp. *anatum*)—threatened by habitat loss and small population size (Environment Canada 2004). An action plan was first developed in 1987 (Erickson et al. 1988). Initial goals have been met and an update is under way.
- Vancouver Island marmot (*Marmota vancouverensis*)—lives exclusively in alpine and subalpine habitats on a few Vancouver Island mountains. The first action plan was written in 1994; it was reassessed in 2000. Recovery efforts include research, monitoring, captive breeding, and reintroduction to the wild (Vancouver Island Marmot Recovery Team 2000).

As older plans, such as these, are revised they will better meet the requirements of SARA Action Plans. Recovery efforts for some species are initiated before recovery planning is completed, or even before the species is listed by COSEWIC. For example, a purple martin nest box program initiated in 1986 has increased the population of this swallow in BC from fewer than 10 to more than 300 pairs (GBEARS 2004).

Supplementary Information: Recovery of the Sea Otter

The sea otter has the distinction of being one of the few Canadian species to be re-introduced after extirpation. Historically 150,000–300,000 sea otter ranged the Pacific Rim, from northern Japan to Baja California (Watson et al. 1997). By 1900, fewer than 2000 animals remained as a result of a global interest in sea otter fur. The sea otter was extirpated from BC by 1929 (Kenyon 1969). Between 1969 and 1972, 89 Alaskan otters were reintroduced to northwest Vancouver Island (Watson et al. 1997). Sea otter populations have since increased from 70 animals in 1977 to more than 2500 animals in 1998 (Figure 5). Approximately 80% of these animals occur on the west coast of Vancouver Island, with remainder along the BC central coast (Watson 2000). Sea otter numbers continue to increase and in some areas the population is likely at equilibrium (J. Watson, pers. comm.), meaning it has reached a state where numbers remain fairly steady.

Figure 5. Total number of sea otters from surveys of seven otter populations on the BC coast, 1977 to 1998.



Source: 1977–1995 data from Watson et al. 1997; 1998 data from Watson 2000.

Notes: Data are absent for years where conditions did not permit surveys of all seven groups. The count in 1995, although included in the indicator, was considered incomplete for one of the seven otter groups.

Originally listed as endangered in 1978, the sea otter status was revised in 1996 to threatened, a status it retains under SARA (Sea Otter Recovery Team 2003). The relatively small population remains vulnerable to catastrophes such as oil spills, the single biggest threat (Watson et al. 1997; Sea Otter Recovery Team 2003). Other potential threats include disease and parasites, low genetic diversity, marine biotoxins, contaminants, entanglement in fishing gear, collisions with vessels, illegal kills, and human disturbance (Sea Otter Recovery Team 2003). In 2002, Fisheries and Oceans Canada took the lead in developing a new national recovery strategy for sea otters in Canada consistent with the requirements of the federal Species at Risk Act (Sea Otter Recovery Team 2003). The next COSEWIC status report on sea otters is due in 2006.

Sea otters are a keystone species: their reintroduction had a profound effect on recovering nearshore communities of species in BC (Sea Otter Recovery Team 2003). Sea otter predation reduces the abundance, size, and distribution of invertebrate prey species, including sea urchins. In the absence of otters, the urchins dominate the rocky nearshore and graze kelp. Where sea otters are present, sea urchin biomass decreases, often dramatically. This relieves pressure from sea urchins grazing on local kelp and increases the abundance of kelp forest (Estes and Duggins 1995). Kelp forests provide important

habitat for many organisms by dampening wave surges, shading the sea floor, and adding structure above the benthic boundary (Steneck et al. 2002).

A particularly interesting twist in recovery of the sea otter comes from its position in the marine food chain, sandwiched between two other species at risk. Sea otters feed on one threatened species, the northern abalone (*Haliotis kamtschatkana*), and they may be fed upon by a second, the killer whale (*Orcinus orca*), both of which are federally designated as at risk. Where otters are present, northern abalone occur at low but stable densities in crevices that provide refuge from predation (Watson 2000).The removal of the sea otter from the BC coast allowed an artificial increase in the biomass of northern abalone, creating the basis for lucrative commercial and recreational fisheries (Estes and VanBlaricom 1985; Watson and Smith 1996). The recent collapse of many abalone fisheries along the west coast has created controversy over the sea otter's recolonization of its historic range (Estes and VanBlaricom 1985; Wendell et al. 1986; Estes 1990; Wendell 1994; Watson and Smith 1996). The collapse of abalone fisheries in BC is unlikely to be solely because of sea otter predation (Sloan and Breen 1988; Davis et al. 1996), but it is difficult to distinguish the effects of otter predation from those of human harvesting.

Although killer whale predation has not been extensively documented in BC, information from southwestern Alaska suggests that the whales may have a profound effect on sea otter numbers. The Alaskan otter population declined by 75% from 1965 to 2000 (Doroff et al. 2003), a change attributed to predation by killer whales (Estes et al. 1998).

WHAT IS HAPPENING TO COASTAL BIODIVERSITY?

Indications are that biodiversity on the BC coast appears to be declining, particularly in the most populated areas of the south coast. Biodiversity in BC is also poorly understood, as it is globally. The international Convention on Biological Diversity, of which Canada is a signatory, identified an urgent need worldwide to develop a basic understanding of biodiversity as a basis for implementing effective conservation measures (UNEP 1992). For most coastal organisms in BC, fundamental information, such as provincial distribution, is incomplete or nonexistent, which makes it difficult to form conclusions about the status of much of the province's biodiversity. The status of only a small number of species is regularly monitored, and the state of knowledge of communities and ecosystems is even less complete than the understanding of single species. Given this state of knowledge, it is hard to define meaningful indicators of biodiversity, and most of the existing indicators of the overall state of biodiversity in BC are not well validated. Indicators used in this report are an advance on previous reporting, but still represent a compromise between ideal indicators and those for which data are currently available.

Summary of results from the indicators show the following:

- The status of coastal vertebrates as a group has declined over the past 14 years, as shown by an increase from 18 to 22 red-listed species of coastal vertebrates in the conservation status indicator. In addition to the appearance of new species on the red

list, there has been no real improvement in status for most threatened and endangered coastal vertebrates that were on the red list in 1992.

- After 20 years of increasing population size, killer whales were added to the provincial and federal lists of species at risk after entering a period of population decline.
- More than 600 species of alien plants have become established on the BC coast; some of these have become formidable invaders. At least 41 species of alien vertebrates and 44 species of invertebrates have been introduced. Left uncontrolled, some alien species could have large negative impacts on coastal ecosystems and some commercial industries.
- Despite the relatively small areas they occupy, the rare and sensitive ecosystems of eastern Vancouver Island lost 5% of their area (1464 ha) over the past 10 years. At this rate, they could be gone in 20 years. Two human-modified ecosystems (seasonally flooded agricultural fields and older second-growth forest), both of which offer value to wildlife, were lost at three times this rate.

In terms of societal response to these changes, species recovery began for many species along coastal BC before the Species at Risk Act was proclaimed. Federal accords and legislation around species at risk have instigated the development of recovery strategies for more than 80% of the COSEWIC-listed species in the province. As necessary as species recovery programs may be, they are generally reactive, occurring once a species has declined to the point of near endangerment. Recovery is also generally slow and very expensive: in the time it takes to improve the status of one species, several more may become at risk. Of the 21 known species that have become extinct or extirpated from the province in recent history, 15 used to occur on the BC coast (BCMELP 2000). Only one of these—the sea otter—has since been successfully reintroduced. Although the story of the sea otter is a positive one, during the time of its recovery, an additional 15 species observed historically on the coast apparently disappeared. These species, which include 12 plants and 3 mammals, have not been seen anywhere in the province for more than 20 years (BCMELP 2000).

WHY IS IT HAPPENING?

Coastal ecosystems are uniquely characterized by a union of freshwater, saltwater, and terrestrial realms, and the intermingling of a wide variety of life forms that exploit the rich resources that result. Most British Columbians live on the coast, however, and the human population and activity is placing stress on the natural environment from transportation, industry, resource harvest, urbanization, and agricultural development. The combination of these numerous pressures can perturb natural ecosystems to the point where local populations are extirpated and natural processes are impaired (e.g., Solan et al. 2004).

Steep elevation gradients, abrupt changes in habitats, and high levels of productivity on the coast result in a large number of organisms and species occupying a relatively small amount of space. The coastal landscape is naturally fragmented into small pieces by

islands, inlets, bays, and peninsulas. Over time, geographically separated populations have produced unique local ecotypes, varieties, and subspecies. Although many of BC's ecosystems are relatively intact, ecosystem loss is greatest in the province's southwest corner along its coast. The southwest coast formerly contained some of the highest levels of biodiversity in the province; however, it has been severely altered ecologically and is now characterized by a regional concentration of threatened and endangered species and subspecies, and extirpated populations (BCMWLAP 2002). Biodiversity on the coast is particularly susceptible to human pressures and even localized development can have disproportionate effects on locally unique taxa.

It is not just the growing human population on the coast that is putting pressure on BC's coastal biodiversity. Global climate change is likely to become the greatest threat to biodiversity in many regions of the world, resulting in severe impacts and extinctions as it compounds the impact from local threats (Thomas et al. 2004). Climate change has the potential to increase the frequency and extent of disturbance, such as fire and insect outbreaks (McKenzie et al. 2004), to create favourable conditions for invasive species, and to produce ecological shifts that may occur faster than species can adapt (Opdam and Wascher 2004). Although it is not possible to predict how much climate change will affect biodiversity on the BC coast, it is likely that it will create additional pressure in ecosystems that are already stressed in many ways.

WHY IS IT IMPORTANT?

From a purely human standpoint, the ecological processes maintained by biodiversity provide a host of "ecosystem services" upon which humanity is entirely dependent.

Although ecosystem services provide life support for the planet, their value is poorly understood, rarely articulated, and generally ignored in decision-making (Emerton and Bos 2004). In one analysis of the value of ecosystem services in BC's lower Fraser Valley, the authors conclude that protecting this ecosystem may save society hundreds of millions of dollars every year (Olewiler 2004).

Biodiversity is an essential component of four main categories of ecosystem services (e.g., MEA 2005a):

- Providing food, water, timber, and fibre. In 2004, agriculture, forestry, fishing, and hunting accounted for more than $4.9 billion of BC's gross domestic product (BC Stats. 2005);
- Regulating climate, floods, disease, water quality, and waste treatment. Regulating services have been systematically undervalued even though they are irreplaceable;
- Supporting ecosystem functions, such as soil formation, pollination, and nutrient cycling; and
- Supporting cultural activities, such as recreation, aesthetic enjoyment, and spiritual fulfilment.

In terms of the contribution of biodiversity to ecosystem services, research shows that the composition and richness of ecosystems may be dramatically changed by the loss of just one species (e.g., Paine 1974). Also, the order in which species are lost from an ecosystem appears to influence ecosystem integrity. Loss of certain key species leads to rapid, systematic loss of others (Raffaelli 2004), and can result in reduced ecosystem function and stability because surviving species may not adequately replace the function of those lost (Solan et al. 2004). A damaged ecosystem becomes increasingly vulnerable to threats that it may formerly have been able to resist, such as invasive plants (Zavaleta and Hulvey 2004).

Globally, human use of all ecosystem services is growing rapidly, and yet recent research shows that approximately 60% of the Earth's ecosystem services are being degraded or used unsustainably (MEA 2005a). In marine coastal ecosystems, these ecosystem processes are of global importance to climate, nutrient budgets, and primary productivity (Field et al. 1998), but can be compromised by human-induced stresses (Vitousek et al. 1997). The continued provision of ecosystem services relies on healthy ecosystems, of which biodiversity is a major and vulnerable part (MEA 2005b).

WHAT IS BEING DONE ABOUT IT?

Biodiversity is affected by many areas of policy because it is directly and indirectly influenced by a variety of pressures from human activity, including industrial processes, land conversion, forestry, fishing and other harvesting, agriculture, environmental contamination, and climate change. Because it is not possible to describe all policies that affect the pressures on biodiversity, the following summary focuses on initiatives most relevant to coastal biodiversity.

Key Federal Initiatives

- UN Convention on Biological Diversity (CBD): In 1992, Canada, with support from provincial and territorial governments, was the first industrialized nation to sign this convention. The main objective of the CDB is to achieve, by 2010, a significant reduction in the current rate of loss of biodiversity at the global, national, and regional level. The Canadian Biodiversity Strategy, published in 1996, is intended to guide implementation of the CBD in Canada. (*www.biodiv.org/default.shtml*)
- Species at risk agreements and legislation: In 1996, British Columbia and all other Canadian jurisdictions endorsed the Accord for the Protection of Species at Risk that commits the provinces and territories to work with the federal government to protect and recover species at risk. The federal Species at Risk Act (SARA), which came into force in June 2004, is the federal government's legislative response to the Accord. SARA is intended to prevent Canadian indigenous species, subspecies, and distinct populations from becoming extirpated or extinct; to provide for the recovery of endangered or threatened species; and to encourage the management of other species to prevent them from becoming at risk. SARA has prompted recovery planning for species at risk all across the country. British Columbia and the federal government

have endorsed a bilateral agreement to work cooperatively on the implementation of SARA. (*www.sararegistry.gc.ca/*)

- Committee on the Status of Endangered Wildlife in Canada: COSEWIC is an independent body of experts who use scientific, aboriginal, and community knowledge to classify species in Canada as extirpated, endangered, threatened, of special concern, data deficient, or not at risk. COSEWIC includes representation from British Columbia. Under the Species at Risk Act, the government of Canada will take COSEWIC's recommendations into consideration when establishing the legal list of species at risk. (*www.cosewic.gc.ca/index.htm*)
- Invasive Alien Species Strategy for Canada: British Columbia was a participant in this strategy, which was published in 2004, to address the threat of invasive species to Canada's wildlife, forests, fisheries, and other resource sectors. It prioritizes key actions and identifies the need for action plans on aquatic invaders, invasive plants, and introduced terrestrial animals. (*www.cbin.ec.gc.ca/primers/ias_invasives.cfm*)
- Canada's Oceans Strategy: Announced in 2002, the strategy is based on the principles of sustainable development, integrated management, and the precautionary approach. Its main objectives are understanding and protecting the marine environment, supporting sustainable economic development, and providing international leadership and oceans governance. It involves collaboration between the federal government, provinces, First Nations, oceans industries, academia, and the general public, as well as with other nations. In 2004, the federal and provincial governments signed a Memorandum of Understanding Respecting the Implementation of Canada's Oceans Strategy on the Pacific Coast of Canada to formalize the commitment of both governments to achieve the objectives. (*www.cos-soc.gc.ca/dir/cos-soc_e.asp*)

Key Provincial Government Initiatives

- BC Conservation Data Centre: The CDC systematically collects and disseminates information on plants, animals, and ecosystems (ecological communities) at risk in British Columbia. This information is compiled and maintained in a computerized database that provides a centralized and scientific source of information on the status, locations, and level of protection of these organisms and ecosystems. (*www.env.gov.bc.ca/cdc/*)
- Strategic land use planning: Strategic land use plans, which include identifying key areas for management and conservation of biodiversity, are under way and at various stages of completion in five coastal areas, including the central coast, the north coast, the Queen Charlotte Islands, Vancouver Island, and the Sea-to-Sky Highway. (*ilmbwww.gov.bc.ca/ilmb/lup/*)
- Revisions to the Wildlife Act: In 2004, this act was amended to allow cabinet to designate the full range of species provided for in the federal Species at Risk Act, including plants and invertebrates at risk. The Wildlife Act regulates wildlife harvest, establishes wildlife management areas and critical wildlife areas, and designates endangered species.

- Species at risk under the Forest and Range Practices Act: In 2004, the Minister of Environment identified 39 species, all previously listed by COSEWIC, as Species at Risk under this act. These species now require a greater level of consideration when planning forestry and range activities.

Other Initiatives

There are many other initiatives by international bodies, municipal governments, community groups, and volunteers.

- Georgia Strait Alliance was originally formed in 1990 by concerned citizens with the purpose of protecting and restoring the marine environment and promoting the sustainability of the Strait of Georgia and its adjoining waters and communities. The GSA has several program areas including marine protected areas, clean air and water, and intertidal stewardship. (*www.georgiastrait.org*)
- The Greater Vancouver Regional District Biodiversity Strategy is a collaborative effort to engage the public, land use planners, and decision-makers in conserving the ecosystem components, functions, and services that remain in the district, which is expected to reach nearly three million people by 2021. (*www.gvrd.bc.ca/growth/biodiversity.htm*)
- Garry Oak Ecosystem Recovery Team (GOERT) partners government, First Nations, non-governmental organizations, academic institutions, and private enterprises in the development and implementation of a recovery strategy for the endangered Garry oak ecosystem. Garry oak and associated ecosystems are home to 104 vertebrate species and more plant species than any other terrestrial ecosystem in coastal British Columbia. (*www.goert.ca/*)
- Nature Canada and Bird Studies Canada work as Canadian partners with BirdLife International to designate Important Bird Areas (IBA) to protect and monitor a network of vital habitats for the conservation of bird populations and biodiversity around the world. Seventy sites have so far met the criteria for Important Bird Areas in BC: 36 islands with seabird colonies, 23 wetland and inland sites, 7 marine sites, 2 heron rookeries, and 2 shorebird migration sites. One tiny island has 55% of the world's population of Cassin's auklets—nearly two million birds. (*www.naturalists.bc.ca/projects/iba/iba_intro.htm*)
- Habitat Stewardship Program (HSP) for Species at Risk is a funding program established in 2000 as part of the National Strategy for the Protection of Species at Risk. The goal is to contribute to the recovery of species by engaging the public in conservation actions that benefit wildlife. The HSP provides funding stewardship projects that protect or conserve habitats for species designated by COSEWIC as endangered, threatened, or of special concern. The HSP is one of the three main federal funding programs centred on protection and recovery of species at risk that are being implemented by Environment Canada, Fisheries and Oceans Canada, and the Parks Canada Agency. (*www.cws-scf.ec.gc.ca/hsp-pih/default.asp*)

- M3, Marine Mammal Monitoring, is one of many ongoing HSP projects (see above) that promotes stewardship of marine mammals, birds, and critical habitat by providing a comprehensive outreach, education, and monitoring program for recreational and commercial ecotourists. To reduce potential impacts of vessel traffic, which can disrupt the natural activities of marine animals, M3 is also developing best management practices guidelines for viewing marine mammals and birds. (*salishsea.ca/m3/M3home.html*)
- BC Trust for Public Lands was established in 2004 to secure and manage ecologically sensitive lands and to plan for biodiversity conservation across the province. The Trust is delivered through the BC Conservation Lands Forum, a partnership between government and the conservation sector. An independent committee under the Forum is developing a provincial biodiversity strategy to inform policy and decision-making. Provincial government news release at *www2.news.gov.bc.ca/nrm_news_releases/2004SRM0036-000815.htm*.

WHAT CAN YOU DO?

British Columbians make many personal choices that affect the natural environment. For example, choosing to consume less resources and produce less waste relieves some of the pressure on the ecosystems that contain BC's biodiversity. The effect of this can be multiplied many times if everyone makes choices that reduce the pressure on the planet's ecosystems. Here are some other things you can do:

- Learn more about the animals and plants in British Columbia. Local natural history societies, as well as national and provincial parks, offer opportunities for learning about flora and fauna in their natural environment. The Federation of BC Naturalists acts as the hub for a network of natural history societies in towns and cities across British Columbia. Find a local club at *www.naturalhistory.bc.ca/VNHS/index.htm*.
- Encourage backyard biodiversity by providing habitat for native animals and plants. Naturescape British Columbia is a program that helps people bring human communities closer to living in harmony with nature, by providing information on how to restore, preserve, and enhance wildlife habitat in urban and rural landscapes and yards. (*www.hctf.ca/nature.htm*)
- Share your knowledge of, and passion for, biodiversity with friends, children, and co-workers. Project WILD provides wildlife-focused conservation education for K–12 teachers and their students. (*www.projectwild.org/*)

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