3.7 ECOSYSTEM-BASED MONITORING AND REPORTING

Arctic ecosystems are inherently interwoven, with numerous shared interactions (Schmidt et al. 2017). Recognising this, the CBMP–Terrestrial Plan takes an ecosystem approach, encompassing all taxonomic groups and their likely interrelationships. This includes both monitoring FECs and linking results to the main drivers of change, abiotic as well as biotic.

As outlined in Section 2.1.1, FECs were selected based on their ecological significance, value of the ecosystem services to Arctic Indigenous and non-Indigenous Peoples, and usefulness for management and legislation needs. The START draws upon expert knowledge to report on the status and trends of FECs individually and by taxonomic group; however, each section in Chapter 3 also includes information about relevant biotic interactions that might act as drivers for a particular taxon. Reconnecting the system through the inclusion of biotic interactions is pivotal for our ability to understand changes in Arctic terrestrial biodiversity and must permeate current and future monitoring and reporting.

The threats to global biodiversity and its subsequent decline are highlighted by various international biodiversity conservation conventions (see Section 1.3). Two important recent reports, the ***Global Assessment Report on Biodiversity and Ecosystem*** Services of the Intergovernmental Platform on Biodiversity and Ecosystem Services (2019) and the ***fifth Global Biodiversity Outlook*** of the CBD (2020), describe the most recent decline in biodiversity on a global scale and predict a dire future based on current trends. ***The Arctic Biodiversity Assessment*** and its accompanying summary for policymakers (CAFF 2013) highlights the particular threats to Arctic biodiversity.

Consistent with these reports, the START also finds that the overwhelming driver of change in terrestrial Arctic ecosystems is climate change. There is evidence of this in for instance the correlation between increasing temperatures and earlier onset, longer duration and increase of plant growth (see Section 2.2). Warming temperatures also contribute to the increased frequency of boreal and tundra wildfires as well as unprecedented intense rainfall and heat wave events. Examples of where these climate-related drivers can be linked to changes in diversity, abundance, composition, and structure of Arctic terrestrial vegetation, include:

- increased growth and encroachment of shrubs and trees in parts of the low Arctic (Bjorkman et al. 2020);
- increase in woody plants and expansion of their distribution into drier tundra communities (Hinzman et al. 2005);
- increases in cover of some graminoids and forbs (Bjorkman et al. 2020); and
- decreases in moss and lichen cover (Bjorkman et al. 2020).

Changes in landscape level vegetation, that are of particular concerns for endemic Arctic species, have led to phenological mismatches between herbivores and vegetation and changes in trophic level interactions (Post et al. 2008, Fauchald et al. 2017). Some examples include: reproductive failures in ***Rangifer*** (phenological mismatch with food plants); reproductive failure in predators of lemmings and their alternative prey (resulting from collapse of cycles, see Box 3-3); spread of new insect pest species and plant pathogens north to the forest-tundra transition zone; and warm periods in tundra areas causing massive outbreaks of blackflies affecting productivity of some Arctic birds (Franke et al. 2016).

Box 3-6 provides some examples of the complex relationship between top avian predators and other FECs and how this is influenced by changing Arctic conditions.

Of fundamental importance to an ecosystem approach to monitoring Arctic biodiversity is the relationship between Arctic Indigenous Peoples and the natural environment and they are thus included in CBMP–Terrestrial Plan conceptual models. Nevertheless, they are often not considered in biodiversity baseline assumptions nor in monitoring programmes. In our ecosystem-based approach to monitoring and reporting, it is important to include Arctic Indigenous Peoples.

Arctic lichens and bearberry. Photo: Roger Asbury/Shutterstock.com

BOX 3-6. TOP PREDATORS AND FEC INTERACTIONS

Most Arctic top bird predators rely on prey bases with cyclic abundance patterns. The snowy owl, rough-legged buzzard, and long-tailed jaeger, for example, are highly dependent on small mammals with highly cyclic occurrence, as shown in Figure 3-30; the predators either do not breed, or have very low productivity, in areas and years with lemming population lows. In areas with several rodent species (lemmings and voles), the buzzards do not utilize prey according to relative abundance but prefer lemmings—revealing complex interactions in a relatively simple ecosystem. It emphasises that lemmings and voles should be treated separately in Arctic monitoring and ecosystem studies to better understand the predator–prey interactions under changing Arctic conditions (Hellström et al. 2014).

For the gyrfalcon, ptarmigan species are the only prey available in the Arctic in the pre-breeding and early breeding season. The falcon is, therefore, highly dependent on these herbivores to initiate breeding. The links have been well studied in Iceland (Nielsen 2011) where the prey–predator cycles show a clear match with falcon territory occupancy and relative ptarmigan abundance, but with a 4–year lag (Figure 3-32). The lag was due to prey-mediated effects on adult gyrfalcon survival and juvenile recruitment into the breeding population. However, even in low ptarmigan years the gyrfalcon could have good breeding success; weather factors explained much more of the variation in breeding success than spring ptarmigan density. A shorter study in Alaska showed a more direct effect—a ptarmigan six-fold decline was mirrored by a significant decline in gyrfalcon breeding success (Barichello & Mossop 2011). In Sweden, high numbers of juvenile willow ptarmigan in autumn was linked to high breeding success of gyrfalcons the next spring (Falkdalen et al. 2011).

These regionally different and complex interactions may be affected by changing climate and habitat conditions in the future. A modelling study of gyrfalcon and two ptarmigan species in Alaska (Booms et al. 2011) concluded that the spatial extent of the fundamental niche of each of the three species will contract and become more heterogeneous and discontinuous and the amount of spatial overlap of the gyrfalcon's and ptarmigan's fundamental niche will decline. Coordinated monitoring projects should be following those changes in the Arctic.

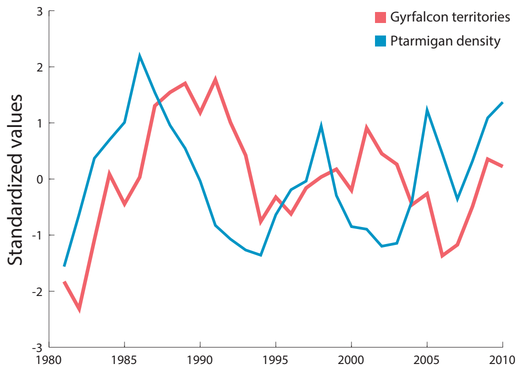

Figure 3-34. Rock ptarmigan density and occupancy rate of gyrfalcon territories. Modified from Nielsen 2011. Used with permission from the Peregrine Fund

Counting prey remains–mostly ptarmigan–at gyrfalcon breeding sites in Iceland. Photo: Daniel Bergmann

*Snowy owls feeding a grey-sided vole (*Myodes rufocanus*) to their chicks. Photo K.-O. Jacobsen*

BOX 3-7. AMPHIBIANS AND REPTILES OF THE ARCTIC

Amphibians and reptiles inhabit the Arctic but not in the abundance and diversity of the other taxa covered in this document. These species are unique as they occur in climatic conditions not normally associated with amphibians and reptiles and possess highly specialised adaptations to survive in the Arctic. Data on the distribution, status, and trend of these six species are generally lacking, but each can be locally and seasonally abundant. While not widespread in the high Arctic, these species are well distributed in the low Arctic and even more widespread and abundant in the sub-Arctic. All species are widespread south of the Arctic regions. According to IUCN classification, all have the range wide status of Least Concern and their trends are Stable, except the viviparous lizard, which is Unknown (Table 3-16). These species are predators of invertebrates and adults and larva serve as a food source for larger terrestrial, avian and aquatic predators. Amphibians serve as valuable indicators of changes to ecosystems. Threats such as climate change, habitat alterations, diseases and pollution do exist, but opportunities for range and population expansion may also present themselves as climate and habitats change. No FECs have been established for amphibians and reptiles. Monitoring should focus on obtaining a better understanding of the distribution, status, and trends within the Arctic, as well as on disease presence and climate change induced habitat alteration. For more information, see Chapter 5 of the Arctic Biodiversity Assessment (Kuzmin et al. 2013).

*Wood frog (*Lithobates sylvaticus*). Photo: Casey Burns/BLM*

Table 3-16. Arctic amphibian and reptile species, their habitats and status. For the purposes of this table, 'Arctic' species are found in the high– or low Arctic zones (see Figure 1-2)

COMMON NAME	SCIENTIFIC NAME	ARCTIC DISTRIBUTION	HABITAT AND THREATS (IUCN)	RED LIST STATUS/ TREND (IUCN)
wood frog	*Lithobates (Rana) sylvaticus*	United States, Canada	Habitats: forest, pond/stream edges, willow thickets and grass/ willow/aspen associations. Hides in logs, humus, leaf litter or under logs and rocks. Threats: include intensive timber harvesting in areas surrounding breeding sites.	Least Concern/ Stable (2015)
Siberian wood frog	*Rana amurensis*	Russia	Habitats: open and wet places in coniferous, mixed, and deciduous forests, shrublands and grasslands. Threats: general habitat loss (e.g., dams), drainage and pollution of breeding pools and overharvesting for food.	Least Concern/ Stable (2008)
moor frog	*R. arvalis*	Norway, Sweden, Finland, Russia	Habitats: tundra, forest, steppe, swamps, peatlands, moorlands, meadows, fields and bush lands, gardens. Threats: destruction and pollution of breeding ponds and adjacent habitats, drought, and predation of tadpoles by waterfowl. Chytrid fungus was detected in this species outside the Arctic.	Least Concern/ Stable (2008)
common frog	*R. temporaria*	Norway, Sweden, Finland, Russia	Habitats: coniferous/deciduous forests, forested tundra, and steppe, shrublands, glades, grasslands, meadows, marshes temporary and permanent ponds, lakes, and rivers. Threats: no major threats but locally by pollution, drainage of breeding sites and collection.	Least Concern/ Stable (2008)
Siberian newt	*Salamandrella keyserlingii*	Russia	Habitats: wet coniferous, mixed, deciduous forests in the taiga zone and riparian groves in tundra and forest steppe. Threats: no major threats to this species, but locally threatened by desiccation of wetlands, loss of terrestrial habitat, pollution, and urbanization.	Least Concern/ Stable (2008)
viviparous (common) lizard	*Zootoca (Lacerta) vivipara*	Norway, Sweden, Finland, Russia	Habitats: grassland, meadows, humid scrubland, open woodland, woodland edges, peat bogs, stream edges and coastal areas. Threats: locally from habitat loss from agricultural, urbanization and development of tourism facilities.	Least Concern/ Unknown (2018)