Icelandic Programs related to the Circumpolar Biodiversity Monitoring Program

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Undanfarin ár hafa Norðurskautslöndin átta verið að þróa tillögu að vöktunarkerfi fyrir líffræðilega fjölbreytni á norðurslóðum (*Circumpolar Biodiversity Monitoring Program*, CBMP). Hefur Ísland leitt þessa vinnu innan CAFF (*Conservation of Arctic Flora and Fauna*), sem er einn af vinnuhópum Norðurskautsráðsins (*Arctic Council*).

Vöktun er talin ein af mikilvægustu aðferðum við verndun og hóflega nýtingu lífríkis í anda sjálfbærrar þróunar. Með vöktun fást samfelldar upplýsingar um breytingar á lífríkinu. Vöktun varpar ljósi á framvindu lífríkisins og gefur tilefni til frekari rannsókna eftir því sem þörf krefur. Vöktun gefur mikilvægar upplýsingar sem nýtast til ákvarðanatöku í málum sem snerta lífríkið, bæði vegna auðlindanýtingar og umhverfisverndar. Samræmt vöktunarkerfi fyrir norðurslóðir gefur möguleika á að skoða niðurstöður í mun víðara samhengi en unnt er í hverju landi fyrir sig.

Á vinnufundi, sem haldinn var í Reykjavík 2000 (CAFF/AMAP 2000), var ákveðið að fikra sig í átt að samræmdu vöktunarkerfi fyrir norðurslóðir með því að byrja á nokkrum velþekktum lífríkisþáttum. Urðu eftirtaldar tegundir, tegundahópar, vistkerfi og verkefni fyrir valinu: hvítabjörn *Thalarctos maritimus*, hringanóri *Phoca hispida,* hreindýr *Rangifer tarandus*, bleikja *Salvelinus alpinus*, gæsir, vaðfuglar, sjófuglar og vísindaverkefnið International Tundra Experiment (ITEX) sem rannsakar viðbrögð ákveðinna háplöntutegunda við loftslagsbreytingum. Einn eða tveir vísindamenn voru fengnir til að samhæfa vinnu innan hvers hóps. Einnig var votlendi valið sem viðfangsefni, en því verkefni hefur enn ekki verið hleypt af stokkunum.

Í þessari skýrslu er gefið stutt yfirlit yfir stöðu vöktunarmála hérlendis á þeim sviðum sem tengjast vinnu ofangreindra hópa. Sex þeirra hafa mikla skírskotun til Íslands, þ.e. hreindýr, bleikja, gæsir, vaðfuglar, sjófuglar og ITEX en tveir, hvítabjörn og hringanóri, minni enda lifa þau dýr alla jafna ekki hér við land. Einnig er lítillega minnst á ýmis íslensk vöktunarverkefni á öðrum sviðum, sem munu vonandi tengjast vöktunarkerfi á norðurslóðum er fram líða stundir. Gert er ráð fyrir að vöktunarkerfið hljóti blessun ráðherra umhverfis- og utanríkismála í norðurslóðaløndunum og í framhaldi af því verði það hluti af skipulegri umhverfisstefnu landanna.

Upplýsingum um komur hvítabjarna og hringanóra hingað er haldið til haga. Hreindýr eru talin árlega og bleikja er að nokkru leyti vöktuð. Íslenskir gæsastofnar eru aðallega taldir á vetrarstöðvunum. Vaðfuglar eru líklega sá hópur fugla sem verst er settur varðandi vöktun hér á landi, þar sem segja má að aðeins ein tegund sé skoðuð að einhverju gagni. Talsverðar upplýsingar eru til um sjófuglastofna og breytingar á þeim, þótt ýmsar tegundir hafi orðið útundan og vöktun yfirleitt ekki fullnægjandi. Unnið er að ITEX-verkefninu á tveimur stöðum á landinu, einu hálendis- og einu láglendissvæði.

Vöktun er langt frá því að vera fullmótuð hér á landi í neinum af ofangreindum sex hópum. Viðkomandi stofnar eru ekki vaktaðir á nægilega mörgum stöðum til þess að hægt sé að segja að niðurstöður gefi nægilega góða mynd af ástandi þeirra á landinu í heild. Helstu undantekningar eru hreindýr og ITEX, en síðarnefnda verkefninu er ekki ætlað að ná til landsins í heild. Tillögur hafa verið mótaðar fyrir einstöku tegundir eða tegundahópa, svo sem gæsir, æðarfugla, stormmáf, langvíu, stuttnefju og teistu, þótt þær hafi ekki allar komist í framkvæmd. Vonast er til að vinnan innan CAFF á komandi árum muni nýtast til að þróa samræmt vöktunarkerfi fyrir Ísland.

CONTENTS

1 INTRODUCTION

The eight Arctic countries have since 1999 been developing a program for monitoring biodiversity in the circumpolar Arctic, termed the Circumpolar Biodiversity Monitoring Program (CBMP). This is presently one of the items on the work plan of CAFF (*Conservation of Arctic Flora and Fauna*), which is a working group of the Arctic Council, a cooperative initiative of the eight Arctic countries.

Developing a circumpolar monitoring program, which takes into account different aspects of biodiversity, is quite challenging. All levels of biodiversity cannot practically be monitored and choosing the most representative parameters for the Arctic environment is a difficult task as well as linking them into an integrated monitoring program. All the Arctic countries have also certain sets of on-going monitoring activities. They are neither likely to dispatch with these for new ones nor is it desirable since many already include data sets spanning decades. These studies have resulted in valuable information, which is likely to increase in value with time, although these may not necessarily be the most representative ones if an integrated monitoring program was being planned from the very beginning.

The present report gives an overview of those monitoring programs in Iceland, which are directly related to the present form of the CBMP. A short account is also given of other monitoring activities.

2 THE CIRCUMPOLAR BIODIVERSITY MONITORING PROGRAM

Monitoring, as a method of recording changes in selected parameters at intervals, has long been recognized by CAFF as being of great importance for the conservation of the Arctic environment. In 1995, CAFF compiled a preliminary overview of circumpolar monitoring activities but this task was never completed.

In 1996, when the Co-operative Strategy for the Conservation of Biodiversity in the Arctic Region was under development, one of its primary objectives related to monitoring, as follows:

"*Enhance efforts to monitor Arctic biodiversity, paying particular attention to species, populations, habitats and ecosystems which are of greatest ecological, cultural, social, economic or scientific value and those which are vulnerable and require urgent conservation measures*." (CAFF 1997a: 9)

It was recognized by CAFF that the fourteen objectives of the Co-operative Strategy for the Conservation of Biodiversity in the Arctic Region were too many and priorities had to be assessed. Hence, a small task force, led by Iceland, was charged with the task of narrowing the scope to a more manageable level and these would form the framework for the work of CAFF in the next five years. This work proceeded in the years 1996–1997, during which the task force engaged in a ranking exercise of the fourteen objectives of the strategy. The top five objectives were selected as priorities, of which one was monitoring. The other four were: conservation of species and their habitats; activities outside protected areas; integration of biodiversity conservation and sustainable use; protected areas.

These five objectives were published in the CAFF Strategic Plan for the Conservation of Biological Diversity (CAFF 1998), which has formed the framework for CAFF activities to

date. CAFF has presently finished revising its objectives, to establish a baseline for the conservation work as from 2003 (CAFF 2002).

In principle the Circumpolar Biodiversity Monitoring Program (CBMP) is intended to:

- detect changes in the natural environment, particularly its biodiversity;
- provide an early warning system, which could trigger more specific research and conservation measures;
- contribute to the development and evaluation of national and circumpolar conservation policies and programs, and
- provide for the timely and cost-effective sharing of information.

Monitoring is still recognised as one of the cornerstones of circumpolar conservation work. The plans presently under way are aimed at developing an integrated monitoring program for the circumpolar Arctic in the years to come. Much depends on the program being presented in an acceptable way to the ministers of the Arctic countries. In order for this to happen the program must, among other things, be well defined in scope and pragmatic, yet scientifically sound. If the program is to receive support its value as an important management tool needs to be recognised by politicians, bureaucrats and managers, both for conservation and resource utilisation. It has been made clear by the Arctic countries that a circumpolar monitoring initiative needs to be based on on-going national programs although efforts should be made to fill in obvious monitoring gaps.

3 THE CBMP NETWORKS

At the CAFF meeting in Yellowknife, Canada (CAFF 7) in April-May 1999, it was decided to launch the development of a monitoring network by holding an initial workshop to begin scoping the task ahead. Prior to this, and to address the objectives of a monitoring network, CAFF prepared a paper, which included a conceptual framework, cataloguing the goals, objectives, scope, planning considerations, approach, and information management of such a program (CAFF 1999). Iceland was charged with holding the Biodiversity Monitoring Workshop, which took place in Reykjavik in February 2000 (CAFF/AMAP 2000).

At the workshop it was decided to launch the CBMP with nine pilot monitoring networks. Meanwhile CAFF would continue to develop the overall scope of the program, as foreseeably this would take several years with all the meetings, necessary consultations and funding requirements. These are the main criteria whereby the pilot networks were chosen: ecological breadth; different ecosystem levels; economic relevance; and ongoing monitoring, all criteria not necessarily relevant to every network. It was also recognised that these networks only constituted the very beginning of a circumpolar monitoring program.

Coordinators (one or two) were selected to lead the development of each of the networks with the resulting dialogues. Coordinators have been successfully appointed for eight networks: Polar Bear *Thalarctos maritimus*; Ringed Seal *Phoca hispida*; Caribou/Reindeer *Rangifer tarandus*; Arctic Char *Salvelinus alpinus*; geese (Anatidae); shorebirds/waders (Limicolae); seabirds; and the plant-based International Tundra Experiment (ITEX). The ninth proposed network, wetlands, has not yet been launched. This differs from the others in being site-based rather than primarily species-based and, therefore, has a direct relevance to the work of CPAN, the Circumpolar Protected Areas Network (CAFF 1996).

Common terms of reference were drawn up for the networks but participation is on a voluntary basis. Each network was asked to come up with suggestions relevant for monitoring of their respective species or species group. The coordinators are responsible for soliciting cooperation with other experts in their field, preferably with as much national breadth as possible, from within and outside the circumpolar Arctic.

4 ICELANDIC PROGRAMS RELATED TO THE CBMP NETWORKS

Iceland has carried out various activities and data collecting, which are directly relevant to the CBMP and its present networks. These vary considerably between networks, as the parameters in question differ in relevance to the Icelandic biota. A summary of the main activities related to these networks is given below. Four of them deal with a single species while the others concern themselves with a group of species, one (shorebirds) even hundreds of species in the circumpolar Arctic. A short, but by no means complete, discussion is also given of other Icelandic monitoring program activities.

4.1 Polar Bear

The Polar Bear is not indigenous to Iceland but has often been recorded as a straggler, especially in years of heavy drift-ice (Petersen & Haraldsson 1993). A computer file of Polar Bear records has been kept at the Icelandic Institute of Natural History since 1982. Besides noticing new records, historical ones are continually being tracked down and added to the file as these become available. These records include descriptions of live animals or skeletal material, references to which are picked from various sources, for instance from literature, verbal sources etc.

It is believed that the records on file reflect reasonably well the occurrence of Polar Bears in Iceland, especially during the past two or three centuries. Towards the end of 2001 the computer file contained about 260 Polar Bear records, which represented around 550 animals. Most of the records relate to single animals while, exceptionally, up to 25 to 30 animals have been registered in the same year or winter in different parts of the country.

A Polar Bear was last recorded in Iceland in 1993. The year 1965 was the last one in which many Polar Bears was seen, 7 animals, while 27 were recorded in 1918.

4.2 Ringed Seal

The Ringed Seal is only an irregular straggler in Icelandic waters, especially off the North and East coasts. Apparently this species was generally more common in earlier times, i.e. 2–3 centuries ago, than at present (Hauksson 1982, 1986). Ringed Seals have been especially noticeable in years of heavy pack ice (Hauksson 1982, 1986), such as in 1896 (Guðmundsson 1944).

Records are kept of the occurrence of this species, but less than ten animals are recorded annually (Hauksson 1986). They are less common than two other vagrant Arctic seals, that is Hooded Seal *Cystophora cristata* and Harp Seal *Phoca groenlandica*, but more so than Bearded Seal *Erignathus barbatus* (Hauksson & Bogason 1995a, b). It is believed the Ringed Seal may have pupped in Iceland (unpubl. information, Icelandic Institute of Natural History).

4.3 Reindeer/Caribou

Reindeer were introduced to Iceland from Finnmark, Scandinavia, on several occasions during 1771–1787 (Þórisson 1993). They were taken to various parts of Iceland but have only survived on the Eastern Highlands.

The Reindeer population has been monitored near annually since 1940, during July-August. The surveys were initially carried out on horseback but later from airplane and by aerial photography. The population increased more or less steadily from the early 1940's till mid 1970's. In 1976 the population was considered to be a minimum of 4000 animals but has since declined to around 3000 (Þórisson 1993, Þórisson & Karlsdóttir 2001).

The Reindeer population is subject to hunting, and a quota is set each year by the Ministry for the Environment. During the years 1995–2000 the numbers of animals killed varied between 260 and 406. The Wildlife Management Institute compiles the hunting statistics. Hunters are required by law (no. 64/1994) to fill in annual hunting reports to renew their hunting licence.

4.4 Arctic Char

There are two basic varieties of Arctic Char in Iceland; one variety primarily lives in the ocean but migrates upstream to spawn, while the other is entirely confined to freshwater lakes. The general distribution of Arctic Char is well known in Iceland. The freshwater variety is found in most lakes and pools from the lowland areas well into the highlands while the sea variety is most common along the North and East coasts (Jónsson 1983). Local forms or morphs (phenotypes) are present in some of the bigger lakes. These are best described in Lake Þingvallavatn (SW-Iceland), in which there are four morphs (Sandlund *et al*. 1992). Different sympatric morphs have given rise to speculations on speciation.

There is a long-standing tradition of monitoring freshwater fish in Iceland (Malmquist *et al.* 2001). Monitoring of Arctic Char has mainly been carried out through catch statistics, some of which extend as far back as a century (Aðalsteinsson 1975). Since 1974 the Institute of Freshwater Fisheries has carried out a monitoring program of selected lakes and rivers, using catch statistics and trapping of up-river migrating stocks (Malmquist 1997). The University of Iceland and the Kópavogur Nature Centre have undertaken net monitoring in Lake Þingvallavatn since 1983 (Malmquist 1997). At Lake Mývatn (NE-Iceland), the Mývatn Research Station and the Institute of Freshwater Fisheries have carried out assessments of population and biomass changes since 1986 (Guðbergsson 1994, Malmquist 1997).

4.5 Geese

Three species of geese breed in Iceland, Greylag Goose *Anser anser*, Pink-footed Goose *A. brachyrhynchus*, and Barnacle Goose *Branta leucopsis*. The last species breeds only in very small numbers while birds of the Greenland breeding population regularly stage here on migration, as do those of the Greenland White-fronted Goose *Anser albifrons* and the Canadian-Greenland population of the Brent Goose *Branta bernicla*.

Since the 1950's, goose populations of importance to Iceland have been monitored on the wintering grounds in the United Kingdom (e.g. Madsen, Cracknell & Fox 1999). These programs have basically covered the total populations although the representativeness of these counts for Greylag and Pink-footed Geese has recently been contested (Frederiksen 2001).

Breeding atlas and various other ornithological work, including that of numerous amateur birders and environmental impact assessments, have provided information on the general distribution of geese breeding in Iceland (see for instance Skarphéðinsson *et al*. 1994, Skarphéðinsson & Þórisson 2001, Jóhannsson & Guðjónsdóttir 1995, Petersen 1998, Frederiksen & Sigfússon 2002). These observations are neither detailed nor regular enough for monitoring, especially considering the fact that the population numbers have changed considerably over a relatively short time span.

Monitoring has taken place in small local areas, which are by no means representative of the total respective Icelandic populations. The longest-running series is provided by spring counts of Greylag and Pink-footed Geese in the Lake Mývatn district (N-Iceland), while a series of spring counts are also available from the Hérað district (E-Iceland). Estimates of breeding populations of Greylags are provided for smaller areas; on the island group of Hvallátur (W-Iceland) and the delta area of river Eyjafjarðará (N-Iceland). A review of these programs is found in Frederiksen & Sigfússon (2002).

Breeding bird surveys at multiple sites have provided valuable foundations for future monitoring. Some areas have been censused on more than one occasion, hence provide some information on population changes over time (e.g. Skarphéðinsson & Guðmundsson 1990).

Of the three staging goose species, the Brent and Barnacle Geese have hitherto been censused at irregular intervals (Garðarsson & Guðmundsson 1997, Percival, Mitchell & Paynter 1987, Percival & Percival 1994). White-fronted Geese, as well as Brent and Barnacle, are monitored on the wintering grounds in the UK (e.g. Madsen, Cracknell & Fox 1999).

4.6 Shorebirds (waders)

As with geese, the general breeding distribution of shorebirds (waders) is known from breeding atlas and various other ornithological work (Petersen 1998). Twelve shorebird species breed in Iceland: Oystercatcher *Haematopus ostralegus*; Ringed Plover *Charadrius hiaticula*; Golden Plover *Pluvialis apricaria*; Purple Sandpiper *Calidris maritima*; Dunlin *C. alpina*; Snipe *Gallinago gallinago*; Black-tailed Godwit *Limosa limosa*; Whimbrel *Numenius phaeopus*; Redshank *Tringa totanus*; Red-necked Phalarope *Phalaropus lobatus* and Grey Phalarope *P. fulicarius.* While the Curlew *N. arquata* is a newcomer with only a few pairs, the other species, except the Grey Phalarope, are quite common. Additional three species are common and regular through-migrants; Knot *Calidris canutus*, Sanderling *C. alba* and Turnstone *Arenaria interpres*.

The size of the breeding populations of shorebirds is rather incompletely known (see Petersen 1998). The main exception is the very rare Grey Phalarope. For no other bird group in Iceland is monitoring lacking more consistently as for shorebirds. A countrywide monitoring program for the breeding population does not exist for any of the species, perhaps with the exception of the Grey Phalarope, which has been censused at irregular intervals (Náttúrufræðistofnun Íslands 2000).

The most comprehensive monitoring program, in which shorebirds are included, is a winter survey program. The Christmas Bird Counts have been carried out annually at around 80 localities countrywide since 1951 (Petersen 1983, Petersen & Hjartarson 1989, 1991, 1993). The Purple Sandpiper is by far the most dominant shorebird species in winter, with much smaller populations of Oystercatcher, Redshank and Turnstone, and smaller still of Snipe, Curlew and Knot.

Hundreds of shorebird transects have been conducted in various parts of the country during the breeding season, not the least in the highlands of Iceland (see e.g. Guðmundsson *et al*. 2001), primarily as one-time affairs. Potentially, these censuses provide good baseline data for future monitoring activities, although they do not form a representative country network.

Presently, monitoring of the breeding populations is only carried out at two sites, on Flatey Island (W-Iceland) since 1974 and the delta areas of river Eyjafjarðará (N-Iceland) since 1987. At the former site data is available for Oystercatcher, Ringed Plover, Dunlin, Redshank, Snipe, Red-necked Phalarope, and Grey Phalarope (Petersen 1979). At the delta area the shorebird species monitored are Dunlin, Snipe, Black-tailed Godwit, Whimbrel, Redshank, and Red-necked Phalarope (Petersen & Thorstensen 2001).

4.7 Seabirds

Only a couple of Icelandic seabird species are monitored in a fully representative way; the Cormorant *Phalacrocorax carbo* (Garðarsson 1996a, 1999) and perhaps the Gannet *Sula bassana* (Garðarsson 1995a). Other seabird species breeding in Iceland are: Fulmar *Fulmarus glacialis*, Shag *Phalacrocorax aristotelis*, Leach's Petrel *Oceanodroma leuocorrhoa*, Storm Petrel *Hydrobates pelagicus*, Manx Shearwater *Puffinus puffinus*, Common Eider *Somateria mollissima*, Great Skua *Stercorarius skua*, Arctic Skua *S. parasiticus*, Arctic Tern *Sterna paradisaea*, Black-headed Gull *Larus ridibundus*, Common Gull *L. canus*, Lesser Black-backed Gull *L. fuscus*, Great Black-backed Gull *L. marinus*, Glaucous Gull *L. hyperboreus*, Herring Gull *L. argentatus*, Kittiwake *Rissa tridactyla*, Puffin *Fratercula arctica*, Razorbill *Alca torda*, Common Guillemot *Uria aalge*, Brünnich's Guillemot *U. lomvia* and Black Guillemot *Cepphus grylle*. The Little Auk *Alle alle* has recently stopped breeding in the country.

The breeding distribution of Icelandic seabirds is known in general terms, through irregular data-collecting, and more recently organized breeding bird atlas work and environmental impact assessments (see e.g. Skarphéðinsson *et al*. 1994, Jóhannsson & Guðjónsdóttir 1995, Petersen 1998, Petersen & Egilsson 1998). Detailed colony registration and one-time total population estimates have been carried out for Shag (Garðarsson 1979, Petersen & Ingvarsson 1995), Great Skua (Lund-Hansen & Lange 1991), Kittiwake (Petersen 1993, Garðarsson 1996b), Razorbill, Common Guillemot, and Brünnich's Guillemot (Garðarsson 1995b).

Several seabird species are monitored locally, but in no way do these cover the respective Icelandic populations in a representative way. These include Fulmar, Shag, Cormorant, Kittiwake and Arctic Tern in the Breiðafjörður Bay and islands around Flatey, NW-Iceland (Petersen 1979). More extensive monitoring of Black Guillemots has taken place on about twenty little islands in Breiðafjörður for nearly 30 years (Petersen 1979, 1981, 2001a, Frederiksen & Petersen 1999a, b, 2000). Black-headed and Common Gulls are censused every fifth year in the Eyjafjörður region, N-Iceland (Petersen & Thorstensen 1990, 1993, 2001, 2002a, b).

Work is progressing to further the monitoring of seabirds in Iceland in general. A Seabird Colony Registry has been under development for several years, collating as much information as possible on the whereabouts of seabird colonies and their sizes at various times (cf. Petersen 2000). Incidental information from various times has been collected into a database giving an overview of the trend at some colonies, although the area coverage is not representative of the respective Icelandic populations, nor is the full suite of species at some of these colonies monitored.

Wintering seabirds are monitored within the annual Christmas Bird Counts (Petersen 1983, Petersen & Hjartarson 1989, 1991, 1993). Best coverage is of the Common Eider, Shag, Cormorant, 5–6 gull species and Black Guillemot, as well as the Iceland Gull *Larus glaucoides*, which is a regular and common winter visitor. Razorbill, Common Guillemot, and Brünnich's Guillemot are poorly represented on account of their more pelagic habits as the census areas are either along the coast or inland.

The Common Eider holds a very special role in Iceland being economically the most important wild bird species (Petersen 1997, 2001b,c). The size of the majority of the Icelandic Eider colonies is known, in many cases also colony trends going back as far as a century. Each farmer or landowner where a colony is located holds this information, but this has only been partially compiled. A monitoring program was set up in 2001 to collect at regular intervals data for a representative sample of Icelandic colonies, as part of the Circumpolar Eider Conservation Strategy (CAFF 1997b).

Many areas, large or small, have been censused for seabirds as part of general surveys of breeding birds of these areas. Certain small areas that have been visited on two or more occasions, including the recently-formed island of Surtsey (S-Iceland), lake Tjörnin in mid Reykjavík, lake Ástjörn and Seltjarnarnes peninsula (SW-Iceland), many Breiðafjörður islands (W-Iceland), the nature reserve Skógar in Skagafjörður, the island of Hrísey and the delta area of Eyjafjarðará (N-Iceland).

As part of continued work to fill gaps in regions with little or non-existent colony data, censuses have been carried out over such larger areas as the Reykjanes peninsula, islands off Reykjavík (SW-Iceland), many of the islands off Mýrar and those in the Breiðafjörður bay (W-Iceland), the regions of Jökulfirðir and Hornstrandir, Strandir and Ísafjarðardjúp (NW-Iceland), Vatnsnes, Látraströnd and Keflavík, Tjörnes peninsula and nearby islands, and Þistilfjörður (N-Iceland), Hérað and Víkur (E-Iceland), Dyrhólaey peninsula (S-Iceland), etc. Some of this work has been carried out as part of environmental impact assessments, other as part of general breeding bird surveys.

Some species, lacking detailed distribution overviews, let alone breeding numbers, have also been targeted over larger areas. These poorly covered species are also among the most common and highly dispersed seabird species in Iceland, such as Fulmar, Arctic Tern, the gulls, Puffin, and Black Guillemot.

The hunting intensity on seabirds is monitored by the Wildlife Management Institute, which annually compiles reports from hunters, in accordance with the hunting legislation (Act No. 64/1994). Preliminary analysis of the effects of hunting on seabird populations has been undertaken (Petersen 2002a).

4.8 International Tundra Experiment (ITEX)

The circumpolar ITEX program has been in place since 1990, with the initial objective of monitoring phenology, growth and reproduction in selected Arctic plant species and their response to climate change (Henry & Molau 1997). Further objectives have been added as the program has developed.

With a network of around 30 sites spread throughout the circumpolar Arctic, two are located in Iceland, one at Þingvellir (SW-Iceland) and the other at Auðkúluheiði (Northern Highlands). These two sites have been monitored since 1984. Research as part of the ITEX

project was initiated in 1990 while the first vegetation measurements were carried out in 1995 and 1996 (Borgþór Magnússon pers. comm.).

At the study sites, research is conducted on growth and development of several key plant species, both vascular plants (six species) and bryophytes (two species), using standardized experimental covers. The study also includes measuring the total plant community at selected plots as well as taking measurements of vegetation cover, species composition and plant heights. Furthermore, the chemical composition of the soil is measured and the microclimate. Automatic weather stations are located at the sites.

5 OTHER MONITORING PROGRAMS

Defining what is a monitoring program and what isn't can be quite tricky. A too rigorous definition of the term may result in throwing away valuable data sets, e.g. regarding the regularity of the data collection. A full review of the monitoring activities of wild fauna and flora carried out in Iceland has not yet been undertaken. A preliminary review was undertaken by CAFF in 1995 but never completed. A more recent compilation lists around one hundred biodiversity monitoring programs in Iceland, many of which have been initiated as part of individual research programs, rather than as part of a national monitoring network *per se*.

Overviews of monitoring activities have been undertaken at the regional level in the circumpolar Arctic. Relevant to the present overview are three Nordic compilations, which deal with certain aspects of monitoring activity; these include a list of bird monitoring programmes (Larsson 1992), terrestrial and freshwater monitoring schemes in the Nordic countries (Sögård & Jensen 1993) and monitoring programs in rivers and lakes (Friberg 1997).

Some of the most extensive and long-term monitoring programs in Iceland are carried out at the Marine Research Institute. These relate principally to commercial fish and invertebrate stocks, but also marine plankton and marine mammals. Monitoring programs are undertaken at other institutions, such as the Mývatn Research Station (midges, waterfowl populations, freshwater benthos, etc.), Wildlife Management Institute (hunting statistics), the Freshwater Research Institute (freshwater fish), the University of Iceland (various bird species, freshwater biota) and the Kópavogur Nature Centre (freshwater fauna and flora). Amateurs make valuable contributions to various monitoring programs, especially those related to birds.

In general, monitoring of wild fauna and flora is most extensively undertaken by the Icelandic Institute of Natural History (IINH), which has a general responsibility for biological monitoring of wild biota. Up until now, monitoring at the IINH has primarily been related to birds and plants, including rare and endangered species, but selected insects (such as moths, wasps and accidentals), vagrant mammals (especially Walrus *Odobenus rosmarus*, Polar Bear and bats), and whale strandings can also be mentioned. Certain sites have also been monitored by the IINH, such the islands of Surtsey and Flatey in Breiðafjörður, Litla-Skarð (which is the Icelandic counterpart of the Scandinavian network of monitoring sites, SCANNET), the Vatnajökull nunataks, Lagarfljót, and Jökulsárgljúfur and Skaftafell National Parks.

Monitoring of contaminants is carried out by several institutes, while coordination with AMAP (*Arctic Monitoring and Assessment Program*), another Arctic Council program, is secured by the Environment and Food Agency (Egilson *et al*. 1999).

6 DISCUSSION

Of the eight pilot networks, which have been established within the Circumpolar Biodiversity Monitoring Program (CBMP), six are the most relevant to Iceland. These are Reindeer, Arctic Char, Geese, Shorebirds, Seabirds and ITEX. The further two, that of Polar Bear and Ringed Seal, incorporate species which are only occasional stragglers, but records are kept of their occurrence.

None of the six networks, except perhaps that of Reindeer and ITEX, include fully representative monitoring schemes in Iceland. The ITEX does not monitor all plants but a selection of few species well suited for climate change studies. However, more than two monitoring and experimental sites would be desirable for this project. It is hoped that developments within individual circumpolar networks, led by specialists in each field, will lead to practical suggestions, which can be used to formulate the national programs or develop existing ones more fully. For geese, most of the baseline work has already been scoped for Iceland (Frederiksen 2001, Frederiksen & Sigfússon 2002). The same has been done for certain seabird species, i.e. Common Eider (Petersen 2001b), murres (Petersen 2002b), Black Guillemot (Petersen 2002c) and Common Gull (Petersen & Thorstensen 2002a).

In general, monitoring, as part of the organized conservation policy in Iceland, needs to be scoped in detail. This relates to the intensity of individual programs, filling obvious gaps, and the integration of different programs as necessary. Many of the current monitoring programs lack countrywide representation and need to be reviewed in this respect. It is hoped that the efforts undertaken by CAFF for an integrated circumpolar Arctic monitoring program will facilitate the development of a national monitoring program and its future implementation.

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