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Invasive American Mink (*Neovison vison*): Status, ecology and control strategies

Scientific basis for action plan against American Mink in Norway

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ABSTRACT:

This study is the scientific basis for an action plan against American mink, from now on just called mink. It presents the current status on knowledge about the distribution, ecological role of mink and results from eradication programs against mink in Northern Europe. The main volume of knowledge is from Great Britain. The following aspects regarding the status of mink and mink ecology are the most important regarding damage to indigenous fauna and the possibility of implementing successful measures against mink:

Habitat and preferred prey: The mink is generalist species and even though aquatic prey are preferred by mink, rodents may be important prey too.

Demography and dispersal ecology: There are few European studies on demography, but the population densities seem to be density dependent. Mink generally disperse along waterways such as lake shores, rivers, small streams and marine coast lines. Major mountain ranges and large stretches of open water seem to act as barriers for dispersing mink. The main period for dispersal is in the fall.

The mink, relation to competitors and enemies: Mink can outcompete mustelids smaller than itself. The presence of otter is on the other hand negative for mink densities, although the two species coexist. White-tailed eagle, Golden Eagle and Eagle owl prey on mink.

Effects on sea birds: Data and general experience document negative impact from mink presence on a number of species. Negative impact from mink is particularly severe on the medium sized to small sea bird species.

Indirect interactions: Mink influence prey species important to other predators. This may be detrimental to populations of these species. Severe negative effects from mink predation have been documented on water voles in Scotland. Studies from Finland also document the same effects on island populations of field voles there. Combining these two results gives reason to suspect that mink may have negative indirect impact on Eagle owl populations on the coat through negative effect on island populations of water vole.

Effects of eradication programs: There is little data available on this except the data from Great Britain. In Great Britain they have succeeded in eradicating mink from a number of small relatively isolated islands. It seems impossible to eradicate mink on a large scale. In Scotland there has however been recorded success in making an impact on the population of mink through systematic efforts based on involvement of local communities.

Adaptive management strategy: The success of this kind of strategy is based on a well developed communication between researchers/managers and local stakeholders. This kind of strategy is based on well designed monitoring and assessment of effects of the efforts made.

Content

Sammendrag og anbefalinger

Amerikansk mink (*Neovison vison*): Status, økologi og forvaltning

Som faggrunnlag for en handlingsplan mot Amerikansk mink (heretter benevnt mink) i Norge gis det i denne rapporten en kunnskapsgjennomgang av om artens nåværende utbredelse og økologi (med fokus på relasjon til andre arter) i N-Europa, samt hvilke erfaringer som har blitt høstet gjennom tiltak for å bekjempe mink. Det har etter hvert blitt publisert mange vitenskaplige artikler om mink i Europa, til dels av svært god kvalitet, både i den grunnleggende og mer anvendte faglitteraturen. Denne rapporten har for en stor del bygget på disse. Flest publikasjoner stammer fra Storbritannia, hvor det har blitt drevet flere omfattende bekjempelsestiltak. Også fra Finland har det kommet en rekke nye publikasjoner som har særlig dokumentert effekter av mink på byttedyrarter i Bottenviken. Fra Norge er det derimot er det få systematiske undersøkelser på minkens utbredelse og effekter, særlig fra de seneste år. Selv om arten nå er utbredt over hele Norge og det er liten tvil om at den har like betydelige effekter på bl.a. sjøfugl, i hvert fall lokalt. I tillegg til litteraturgjennomgangen, bygger denne rapporten også på et besøk hos et fagmiljø i ved Universitetet i Aberdeen ledet av professor Xavier Lambin, som har drevet forskning knyttet til minkbekjempelse i 10 år, samt andre samtaler med fagfolk innen og utenfor landet.

Følgende aspekter ved minkens status og økologi har særlig betydning for skadevirkninger på stedegen fauna og muligheter for implementere effektiv bekjempelse:

Habitat og næringsvalg: Minken er et akvatisk dyr som finnes i tilknytning til vann og vassdrag og i marine miljøer. Populasjonstetthet og leveområdestørrelse varier mye avhengig av byttedyrtilgang og noen grad tilstedeværelse av andre rovdyr (som konkurrenter og predatorer). Minken er en utpreget generalist i næringsveien, og selv om akvatiske byttedyr ofte dominerer, kan populasjonen være subsidiert av terrestre byttedyr, som for eksempel smågnagere. Dietten til mink kan variere meget fra lokalitet til lokalitet.

Demografi og spredningsøkologi: Det har blitt gjort meget få demografiske studier, men data og erfaringer som har blitt gjort i bekjempelsesprogrammer, og det faktum at enkelte bestander har avtatt noe etter et bestandsmaksimum etter invasjonsbølgen, tyder på at populasjonene er tetthetsregulert. Det produseres allikevel et overskudd av mink i mange populasjoner (kildepopulasjoner). Det er derfor sannsynlig at spredning er også tetthetsavhengig (selv om data på dette er mangelfull) og at dette skjer fra tette til mindre tette populasjoner. Når det gjelder spredningsveier, følger disse vesenlig vann, vassdrags -og kystlinjer, men mink kan også bevege seg store avstander over land. Større fjellkjeder og lange avstander over åpent hav ser imidlertid ut til å fungere som barrierer eller i det minste "filtre". En viktig periode for spredning er høsten.

Relasjon til konkurrenter og fiender: Minken kan utkonkurrere mindre mårdyr, men er samtidig selv negativt påvirket av oter. Minken kan imidlertid sameksistere med oter, særlig i kystområder hvor terrestre næringsressurser er tilgjengelig. Større rovfugler, slik som havørn, kongeørn og hubro har mink som byttedyr. Et par nye studier fra Finland viser at tilstedeværelse havørn påvirker minkens habitatvalg og aktivitetsmønstre, på slik måte at havørn kan gi en "paraplyeffekt" på enkelte byttedyrbestander. Det er ikke data på om andre konkurrenter og predatorer har en tilsvarende effekt.

Effekt på sjøfugl: Det er påvist at mink har en negativ effekt på en rekke arter. Dette gjelde særlig flere små- til mellomstore sjøfuglarter, både gjennom predasjon på unger og egg, men også i noen grad på voksne, rugende fugl. I Norge gjelder dette særlig ande-, måke- og alkefugl. For enkelte arter slik som ærfugl, kan det se ut som om minken har varierende effekt fra region til region. Årsakene til denne variasjonen er ukjent, men kan være styrt av tilstedeværelse av konkurrenter og predatorer. Likeledes er det liten kunnskap om andre predatorer har en kompenserende effekt på bytterpopulasjoner hvis mink bekjempes.

Indirekte interaksjoner: I den grad mink har effekter på viktige byttedyr for andre rovdyrarter, kan effekten av ressurskonkurranse gi negative effekter på populasjoner av andre rovdyr. For eksempel er det godt dokumentert at mink har sterke negative effekter på populasjoner av den akvatiske økotypen av vånd i Skottland. Det er ikke kjent om det tilvarende effekter på terrestrisk øypopulasjoner av vånd.

Dette er imidlertid sannsynlig da finske studier har påvist slike negative effekter på øypopulasjoner av markmus. Dette gir dermed muligheter for negative effekter av mink på hubropopulasjoner som er avhengig av vånd. Dette er en aktuell problemstilling i og med at en stor andel av den norske populasjonen av hubro finnes i tilknytning til (og er delvis avhengig av) øypopulasjoner av vånd. Det vil imidlertid kreve et ny forskning for å verifisere om slik "trekantinteraksjoner" mellom mink, vånd og hubro er viktige.

Når det gjelder **effekter av bekjempelsesprogram** har man høstet flest erfaringer fra Storbritannia, hvor dette har blitt prøvd ut i både svært stor og liten målestokk. I flere tilfeller har man klart å utrydde mink fra mindre og ganske isolerte øyer. Utryddelse av mink ser ut til å være umulig på større skalaer. Dog kan man ha betydelig effekter også på en stor skala, hvis tiltaket utføreres systematisk med stor felletetthet i kildehabitater og langs spredningsveier, og med høy intensitet særlig på tider av året hvor spredning skjer. Fellefangst har vist deg å være spesielt effektiv der man bruker systematisk overvåkning som viser om mink er tilstedeværende eller ikke. Et viktig suksesskriterium i Skottland har vært langsiktig deltagelse fra lokalsamfunn, representert ved næringsinteresser, grunneiere eller NGOer. Dette fungerer best der dette skjer etter en **adaptiv forvaltningsstrategi** hvor de positive effektene av tiltaket kommuniseres godt mellom forskere/forvaltere og de lokale interessentene. En slik strategi krever et godt opplegg for overvåkning og effektvurdering. Størst suksess har man hatt i form av effektiv fangst – og overvåkningsmetodikk, aktiv samfunnsdeltagelse og positive effekter på sårbar fauna i vassdragssystem i Skottland.

Anbefalinger: På dette grunnlaget gis det følgende anbefalinger i forkant av en handlingsplan for mink i norsk sammenheng:

- **Kunnskapsgrunnlaget:** Selv om det har blitt etablert mye kunnskap om minkproblemet gjennom ny forskning i sammenheng med bekjempelsestiltak i Europa så viser denne forskningen at effektene av mink på lokal fauna avhenger svært mye av lokale økologiske forhold, spesielt hva angår alternative habitater og byttedyrarter, og hva som er mulige konkurrenter og predatorer (på mink). *Derfor, må kunnskap om lokale økologiske forhold framskaffes og legges til grunn for valg av lokaliteter, bekjempelses – og overvåkningsmetodikk. Dette kunnskapsgrunnlaget er enda svært mangelfullt for Norge. Et bedre kunnskapsgrunnlag vil spesielt kunne oppnås hvis tiltak på ulike lokaliteter skjer på en koordinert måte etter en adaptiv forvaltningsstrategi (se nedenfor).*

- **Valg av lokaliteter og arter:** Ut fra forutsetning om at sjø- og kystfugl er den mest utsatte faunaen for negative effekter av mink i norsk sammenheng, er aktuelle lokaliteter *verneområder/reservater som har vist nedgang i kolonistørrelse og hekkesuksessparametere hos sjøfugl og hvor det er sannsynlig at reirpredasjon er en utslagsgivende faktor.* Dette impliserer at det har vært eller blir gjennomført overvåkning av aktuelle fuglearter, f. eks. formalisert gjennom SEAPOP eller tilsvarende overvåkningsprogram. I og med at det har vist seg at aktiv samfunnsdeltagelse har vært et vesenlig suksesskriterium utenlands *bør tilstedeværelse av lokale interessenter være et tilleggskriterium for valg av lokaliteter og fugleart. Spesielt vil vi peke på at ærfugl vil være en gunstig art ut fra nåværende kunnskap og overvåkningsparametere, og positiv lokal interesse for eksempel gjennom dunsanking.* Ærfugl et også en gunstig art ut fra en rekke andre henseender og kan ha en viktig indikatorfunksjon for andre arter som er vanskeligere å overvåke. *En konkret kartlegging av aktuelle lokaliteter for kontrollerte minktiltak for ærfugl bør være en viktig oppgave for en handlingsplan for Amerikansk mink. En slik systematisk kartlegging har det ikke vært mulig å gjennomføre i arbeidet med denne faggrunnlagsrapporten. Lokaliteter som bør vurderes er ærfuglkolonier som allerede er gjenstand for forskning og overvåkning, samt kolonier hvor det skjer sanking av dun av lokalbefolkning og hvor det dermed vil være stor samfunnsinteresse for slike tiltak. Med hensyn på muligheten for en "trekantinteraksjon" mellom mink, vånd og hubro ville det være spesielt gunstig inkludere ærfugllokaliteter, f.eks, på Helgelandskysten, med nærhet til øypopulasjoner av vånd og hubro*.

- **Metodikk for gjennomføring av minkbekjempelse:** Det kan være gode muligheter for å utrydde, i det minste temporært, mink fra enkelte isolerte sjøfuglkolonier som finnes på mindre øyer langt til havs. Dermed anbefales gjennomføring av kortvarige, intensive fellefangstkampanjer i slike kolonier hvor betydelig minkpredasjon har vært observert. Slike kampanjer vil ikke kreve store kostnader. I denne rapporten gis det en detaljert beskrivelse av fangstutstyr og metodikk til hjelp for tiltak som skal settes i gang snart. Men selv etter vellykket utryddelse må man forvente at mink med tid og stunder kommer til å re-kolonisere selv isolerte sjøfuglkolonier slik at en viss grad av overvåkning bør gjennomføres i etterkant av kampanjetiltak. For større og kystnære verneområder kreves metodikk og oppfølging etter en mer omfattende og varig strategi. Tidligere erfaringer viser at kortvarige innsatser for å fjerne mink i større sammenhengende natursystemer stort sett er bortkastet arbeid og ressursbruk. Det hensiktmessige strategiske rammeverk i denne sammenheng er ***adaptiv bekjempelse** hvor overvåkning, effektvurdering og metodetilpasning skjer sammenhengende*. Dette krever medvirkning av relevante forskningsmiljøer, utøvende forvaltere (f. eks. SNO) og lokale interessenter. Hvis flere slike tiltak gjøres på ulike lokaliteter bør disse også være koordinert slik at de ulike tiltakene "lærer av hverandre". Spesielt kan mye lærdom ligge i hvor/når tiltak virker og hvor/når de ikke gjør det. Hvis slike tiltak iverksettes burde derfor et egnet fagmiljø gis en koordinerende funksjon hvor en "meta-vurdering" av tiltakene blir en sentral oppgave.

- **Begynnende tiltak:** Vi anbefaler følgende tiltak som kan iverksettes før det foreligger en mer omfattende handlingsplan:

  - *Kampanjetiltak:* Det bør gjøres umiddelbare kampanjetiltak ved hjelp av feller i sjøfuglkolonier hvor minkpredasjon allerede er identifisert som et betydelig problem. Personer/institusjoner som får i oppgave å utføre disse tiltakene bør protokollføre metode (felletype, åte, og plassering), innsats (antall feller og fangsperiode) og resultat (antall mink fanget og eventuell bi-fangst av andre arter). Så langt det lar seg gjøre bør fanget mink innsamles (fryses). Dette materialet kan brukes til analyse av demografi og diett (stabile isotoper). Det bør pekes ut et fagmiljø som samler innsamlet materiale og informasjon med hensyn på en omforent analyse.

  - *Etablering av metode:* Med tanke på implementering av mer langvarig bekjempelse i komplekse og sammenhengende kystverneområder bør det startes med tiltak som gir kunnskap for å etablere effektive bekjempelsesstrategier under typiske norske forhold. Viktige aspekter er optimal plassering av feller rom og tid, effektiv dokumentering av reirpredasjon på sårbare fuglearter og/eller arter med gode indikatorfunksjoner, og ikke minst metodikk for overvåkning av mink. Minkovervåkning er viktig både for å optimalisere fangsinnsats og for å måle effekter av bekjempelsestiltakene. Disse første forsøkene bør gjøres i områder med god forhåndkunnskap om viktige økologiske forhold; spesielt bestandsforhold for relevante sjøfugl og potensielle alternative ressurser, og andre predatorer som enten konkurrenter med eller predaterer mink.

  - *Tiltak i ærfuglkolonier:* Ærfuglkolonien på Grindøya naturreservat i Tromsø kommune har vært gjenstand for forskning og overvåkning i en årrekke og gir dermed et unikt kunnskapsgrunnlag for tiltak. Denne kolonien har også vært i nedgang over de siste 10 årene trolig på grunn av en høy predasjonsrate på reir. Tidligere forsøk har utelukket at bekjempelse av kråkefugl alene har en positiv virkning på ærfuglens hekkesuksess. Ut fra gode logistiske (nærhet til forskningsinstitusjoner) og kunnskapsmessige forutsetninger, foreslår vi at man starter opp tiltak for utprøving av metodikk for overvåkning av minkpredasjon og minkbekjempelse på Grindøya allerede i 2009 (jmf. metodepunktet ovenfor). Det foreslås også at det gjøres forberedende undersøkelser med tanke på utvikle tiltak med sterkt innslag av samfunnsdeltagelse (grunneiere, næringsinteresser). Vega på Helgelandskysten foreslås som et utgangspunkt for dette. Her pågår det sanking av ærfugldun, og det har også vært organisert tiltak for å bekjempe mink nær ærfuglkoloniene. Det foreligger allerede en handlingsplan på dette for tidsrommet (2004-2009), men som kan utvikles til en "adaptiv forvaltning strategi" basert på vitenskaplige kriterier. En slik konkret forvaltingsstrategi for Vega kunne utarbeides i forbindelse kommende handlingsplanen for mink.

1 Background

1.1 Introduction history

American mink (*Neovison vison*) (hereafter mink) is a medium size mustelid native to North America. It was introduced to many parts of Europe in the late 1920's and early 1930's for fur farming and in parts of Russia additionally for game hunting (Macdonald & Harrington 2003). In Norway, the first mink farm was set up in 1927 in Vestlandet (Bevanger & Aelbu 1986; Braanaas 1997). In the next 30 years it established populations in most of Norway and by 1993 it was established in the whole of the country excluding some offshore islands (Bevanger & Henriksen 1995). A similar rapid spread is seen over most of the rest of its introduced range and it is now found in established populations in 28 European countries, including Fennoscandia, Russia, British Isles, Ireland and Iceland (review in Bonesi & Palazon 2007). Abundance is variable at both local and national scales (Bonesi & Palazon 2007).

1.2 Present distribution

Mink are found in semi-aquatic habitats including coastal mainland and archipelago, inland river catchments, lakes, canals and wetlands (Ahola et al. 2006; Halliwell & Macdonald 1996). It is more common in prey rich systems and is most abundant in mainland coastal habitats (Dunstone & Davies 1993; Helyars 2006). Focal points of distribution were found initially from escapees round the location of fur farms (Bonesi et al. 2000; Hammershøj et al. 2005; Wildhagen 1949) with distribution thereafter being influenced by topographical features. Mink move along wetland corridors (Birks & Linn 1982; Gerell 1970) with dispersal being hindered and/or greatly reduced by mountain ranges and/or open stretches of water (Craik 1997; Zalewski et al. 2008). Colonisation to offshore islands may be aided by winter ice (Kauhala 1996) and incidental transportation, for example in boats (Manchester & Bullock 2000). In Norway there are currently approximately 170 mink farms. These are located mostly in Rogaland, with the most northerly farms found in northern Trøndelag (A. Martinsen, pers. comm.). Farms are mostly located in rural areas with each farm having on average 550 vixens (Norges Pelsdyraslag 2009). In 2006, 680,000 pelts were produced from Norwegian mink farms (SSB 2008), indicating that the potential escapee population is large. No national scale systematic surveying has been undertaken for mink, but it is clear that mink are currently present along the length of the country in all aquatic environments both coastal and far inland (Bevanger 1990, J. A. Hendersen pers. comm.; Heggberget 2007). A survey of coastal mink activity along the southern two thirds of the Norwegian coast between Østfold and northern Nordland during 1989 and 1990 found that mink were positively associated with settlements and agricultural land, with preference for agricultural habitat in the presence of otter, whilst exhibiting no preference between agricultural land, wild habitat or developed habitat in the absence of otter (Christensen 1995).

1.3 Ecology of invasive American mink

1.3.1 Social organization and spacing behaviour

Mink are sexually dimorphic with males being up to twice the size of females (Thom et al. 2004). They have a polygamous mating system with males tending to disperse from their territories and travel large distances during the breeding season in order to mate with multiple females (Yamaguchi & Macdonald 2003). Outside of the mating season adult male mink are solitary, whereas females tolerate juveniles within their territories (Dunstone & Davies 1993). Home range and territories can overlap both between and within the sexes (Yamaguchi et al. 2003b) and male territories typically encompass one or more female territories (Yamaguchi et al. 2004). Linear home range sizes (along rivers and shore-lines) of between 0.5 km and 6.8 km have been recorded (table 1) with variation between individuals, the sexes, seasons and habitats apparent (Bonesi & Macdonald 2004b; Dunstone & Davies 1993; Yamaguchi et al. 2003a). For mainland sites, home range size is generally smaller for coastal habitat than riverine or lacustrine, suggesting that prey availability is higher in coastal habitat. Supportive evidence for the latter exists in that individuals from coastal populations are generally in better body condition than riverine populations (Clode et al. 1995; Helyars 2006). In comparison, archipelago home ranges appear to be larger than coastal ones. This could be an artifact of using a different measurement unit of home range (area cf. linear distance) or a real difference in prey densities determined by island effect dynamics.

Spatial behaviour appears to be related to resource availability in the form of food and dens (and for males during the mating period spacing behaviour reflects female abundance) (Dunstone & Birks 1987; Gerell 1970; Halliwell & Macdonald 1996). Individuals utilize several core areas within their home range (Birks & Linn 1982; Gerell 1970), spending several days at each with each core area containing at least one den (Bonesi et al. 2000). As mink rarely construct den sites themselves they are reliant on appropriate features in the landscape such as holes under large tree roots, rock cavities (Dunstone & Davies 1993). The presence of buildings and other animals may modify spatial use in otherwise unsuitable areas; with for example boat houses providing appropriate den areas. Similarly beaver (*Castor fibor*), otter (*Lutra lutra*) and rabbit provide additional den sites and in the case of beaver additional food resources in otherwise unsuitable locations (Bonesi & Palazon 2007). In contrast, mink home ranges becomes restricted by the presence of natural enemies such as otter and white tailed eagle (Bonesi et al. 2006b; Salo et al. 2008). Human hunting practice also affects local spatial dynamics with territory size being generally larger in hunted areas (Birks & Linn 1982; Dunstone & Birks 1985) and movement of mink from poor to vacated good quality habitat (Helyars 2006).

1.3.2 Life history, demography and population dynamics

Mink breed once a year with the mating season occurring between February and early April. Females exhibit delayed implantation giving birth between late April and June after 38-76 days, with active gestation varying between 34-38 days (Helyars 2006; Moore et al. 2003; Yamaguchi et al. 2004). Relatively little is known about the fecundity of wild mink as estimates are based on a few individuals and over a short time series. However, mean litter size for wild populations is recorded as being between 2.5 and 5.75 with an upper range of 8 kits per female (table 2). In an experiment using farm animals in Denmark, percentage of females which lost kits between conception and birth was 9.4% (Elmeros & Hammershøj 2006), thus the use of current kit estimates is likely to overestimate fecundity. Dispersal of juveniles occurs from July onwards with new home ranges being established during autumn and winter. Survival has not received detailed investigation but data based on culled populations shows variation between different age cohorts (Bonesi et al. 2006a). The presence of density dependence in animal populations makes control or eradication difficult as survival and dispersal increase with increasing removal efficiency. In common with other similar sized mustelids there is some evidence that mink display density dependant survival (Fryxell et al 1999, Barlow and Norbury 2001, Helyars 2006). There is no evidence to indicate whether individual cohorts vary in this aspect. Similarly, there is little information regarding density dependant dispersal. As competition for resources is a common characteristic of mammalian species which exhibit this (Matthysen 2005), mink would also expect to show density dependant dispersal with dispersal rate decreasing as density decreases. Helyars (2005) found no evidence for density dependant dispersal (including both immigration and emigration) but removal studies in a section of a river catchment in Scotland showed that replacement of mink occurred in a short space of time. Thus density dependant dispersal may be occurring. In Iceland, numbers of mink from several locations show a tendency to oscillate with a periodicity of roughly 7 years (Einarsson et al. 2006) also suggesting that there even may be delayed density dependence in some mink population dynamics.

Mink appear to be able to establish populations and increase their range rapidly after escape from captivity (Bevanger & Henriksen 1995; Bonesi & Palazon 2007). Indeed genetic fingerprinting studies of trapped mink from different regions of Scotland show that first order relatives are capable of moving large distances within short time intervals (Zalewski et al. 2008). Demography can further be influenced by national policy, with countries still operating fur farms providing a continuous source population for expansion and/or renewal of existing mink populations. In some European countries there now appears to be a decline in mink in some habitats following its rapid expansion (Bonesi & Palazon 2007). Causes are unknown but possible factors include inter-species competition, change in resources and/or disease and it is probable that these factors are site dependant and may interact.

There is no published quantitative data on wild mink population dynamics or size in Norway, however, qualitative data and hunting statistics exist. Bevanger and Aelbu (1986) reported that mink population trends appeared to differ depending on habitat and region, with coastal populations perceived to be increasing during the 1970's and 1980's, whilst southern and central populations were perceived to decrease. Similarly, Heggberget (2007) reported a decline in mink activity during 10 years of an otter monitoring programme along stretches of rivers in south and west Norway. Downward trends for inland areas were associated with acidification of inland water bodies and competition with the otter as it re-colonized part of its former range (Bevanger & Aelbu 1986; Heggberget 2007). No suggestion was put forward for the change in coastal populations. Hunting statistics indicate that there is currently a sizeable population of mink with between 5500 and 6800 reported mink felled annually during the last 10 years (SSB 2009).

1.3.3 Trophic ecology

The mink is a generalist predator with a catholic diet, feeding on birds, fish, small mammals, reptiles, amphibians and invertebrates as well as scavenging opportunistically on carcasses (Ahola et al. 2006; Dunstone & Birks 1987; Dunstone & Davies 1993; Erlinge 1969; Gerell 1967; Nordström et al. 2003; Padyšáková et al. 2009). Males tend to take larger prey than females although there is overlap (Birks & Linn 1982; Thom et al. 2004). Females in river habitats tend to be more reliant on aquatic prey than terrestrial (Bonesi & Macdonald 2004a). In coastal areas mink show a preference for foraging in the intertidal zone, making use of rock pools as a source of frequently replenished and easily available prey (Bonesi et al. 2000; Dunstone & Birks 1987).

Mink can have large negative effects on some of its prey species especially on islands or in fragmented mainland habitats (Bonesi & Palazon 2007; Aars et al. 2001). Species exhibiting habitat or niche shift, reduced breeding densities and success or disappearance from mink inhabited areas include ground and/or hole nesting seabirds and waterfowl, voles, frogs (Banks et al. 2008; Barreto et al. 2001; Craik 1997; Ferreras & Macdonald 1999; Fey et al. 2006; Macdonald & Harrington 2003; Moore et al. 2003) and possibly intertidal communities (Delibes et al. 2004). For bird species with archipelago breeding habitat it appears that relatively early breeding small-sized species are negatively affected by mink predation (Banks et al. 2008; Nordström et al. 2003; Nordström et al. 2004). Many seabird species breeding in easily accessible nesting places in dense colonies are particularly vulnerable to mink predation. In addition to inducing widespread breeding failure due to colony desertion, mink are capable of killing large numbers of adults and young in a short period of time (Clode & Macdonald 2002; Craik 1997; Craik 1995). Not all potential prey species show declines in the presence of mink populations (Bonesi & Palazon 2007). Some areas of southern England and Belarus show water vole and mink co-existence (Barreto et al. 2001; Macdonald & Harrington 2003), whilst large relatively late breeding bird species present on islands appear to be little affected (Banks et al. 2008). Moreover, the impact of mink on some waterfowl species is unclear (Einarsson et al. 2006).

Where mink control has appeared to have been accompanied with increased breeding success and population density in vulnerable prey species, it is unclear whether the system consists of just mink as a predator or multiple predators. Thus the role of compensatory predation has not received much focus. One exception showed no compensatory effects on artificial egg predation over a short timescale in a system which consisted of a large number of potential compensatory predators (table 3). Similarly the role of alternative prey including other non-native species, (rabbits, rats) allowing prey switching and suppression of identified key species of interest has received little focus.

In Norway mink have been reported to have negative effects on sea bird colonies and riverine trout (Anker-Nilssen et al. 2006; Bevanger & Henriksen 1995; Heggenes & Borgstrom 1988). Effects include killing incubating female common eider (*Somateria mollissima*) (Anker-Nilssen 2007) and both adult and puffin chicks (Anker-Nilssen et al. 2006). In contrast, on islands in the south of Norway, mink, in keeping with Banks et al. (2008), had no effect on greater black-backed gull (*Larus marinus*), lesser black-backed gull (*Larus fuscus*) or common eider hatching success (Udø 2005).

1.3.4 Interactions with natural enemies

The mink has very few competitors or predators in Europe, something which has helped its rapid colonization after escaping from fur farms. It has managed to out-compete the native European mink (*Mustela lutreola*) in areas where the two species co-existed and there is evidence that it is linked to decline in polecat (*Mustela putorius*) (Macdonald & Harrington 2003; Sidorovich & Macdonald 2001). In addition its range expansion appears to have been helped by the coincidental decline of its main competitor in western Europe, the otter (*Lutra lutra*) (Bonesi & Palazon 2007). In both coastal and inland systems, the otter appears to be a dominant competitor over mink with increasing densities of otter being associated with decreasing densities of mink (Bonesi & Macdonald 2004b; Christensen 1995). Where co-existence between the two species occurs, it appears to be determined by the amount of habitat heterogeneity close to the water edge (Bonesi & Macdonald 2004a). Although mink require an aquatic habitat, being a more generalist predator than the otter they can utilise nearby terrestrial areas for foraging, promoting a shift in food niche to a more terrestrial diet (Bonesi et al. 2004).

Predators of mink include the large avian top predators white-tailed sea eagle (*Haliaeetus albicilla*), golden eagle (*Aquila chrysaetos*) and eagle owl (*Bubo bubo*) (Cramp & Simmons 1977). The presence of white-tailed sea eagle has been shown to modify the activity patterns of mink in Finland, reducing swimming activity in open water where eagle activity is high (Salo et al. 2008). Since mink have been shown to have negative impacts on frogs, voles and seabirds in this area (Ahola et al. 2006; Nordström et al. 2003), the presence of white-tailed sea eagle could provide some control on mink. Similarly, eagle owl in coastal systems and golden eagle in coastal and inland systems could provide a natural means of mink control but this has yet to be demonstrated.

Wild mink can be subject to the parvo viruses causing Mink Enteritis Virus (distemper) and Aleutian Mink Disease (Dunstone & Davies 1993; Manas et al. 2001). Distemper results in reduced fertility, whilst both can be fatal (Steinel et al. 2001). Mink can be vectors transmitting the viruses to unvaccinated cats and dogs (including feral populations), as well as being the recipient from the same source and from escapees from mink farms. In addition, wild mink can be subject to botulism (Dunstone & Davies 1993) via ingestion of contaminated carcasses. The bacterium, *Clostridum botulinum* is commonly found in decomposing organic matter and frequently causes periodic wide scale mortality in waterfowl and gulls (Ortiz & Smith 1994).

1.3.5 Knowledge gaps

As mink is a successful invasive species it should be able to tolerate high mortality without impacting on numbers recruiting to the breeding population. Targets need to be set for removal based on knowledge of population dynamics in order to achieve successful control and/or eradication rather than harvesting. Thus there is a general need for greater knowledge of the role of density dependence in mink population demography.

Other areas requiring greater knowledge generally are:

- Role of predators and competitors in suppressing mink movements and populations
- Interaction with potential competitors/predators and role of compensatory predation on vulnerable species when mink are successfully removed
  - For instance there are no studies on compensatory nest predation between mink and corvids (crow and raven)
- Influence of non-native prey communities (for instance common minnow (*Phoxinux phoxinus*, pheasant (*Phasianus colchius*), brown rat (*Rattus norvegicus*) in supporting mink numbers and allowing prey switching suppressing identified focal species of conservation
- Sensitivity analysis for negatively affected prey species

In order to assess the effect of mink, ecological studies should be based on well designed experiments. Purely observational studies are often confounded with other sources of variation in breeding success and demography in prey species. Experimental assessments should include evaluation of relevant scale for the study, control sites, replication, monitoring of mink population and focal prey populations before, during and after treatment.

Specific to Norway:

- Current distribution in Norway particularly:
  - relative use of coastal and inland habitats
  - coastal and inland habitats – are they sources or sinks?
- Seasonal use of coastal and terrestrial systems, especially in areas where snow cover is present for prolonged periods during winter months
- The diets of minks in different coastal habitats – what is the role of terrestrial and limnic subsidies?
- Home range size and dispersal distances: Important for deciding the scale of removal operation
- Den site characteristics – predictive tool for focusing removal
- Demographic parameters such as age and sex ratios, fecundity, individual population distributions: Important for establishing mink population resilience to control measures
- Vulnerable prey species and/ or areas

2 Controlling/ decimating invasive American mink

2.1 Overview of published control programs

Known control programs have been undertaken in 10 European countries with most occurring in the UK.

2.2 Method review

Control methods include general hunting, removal from small areas, or attempted eradication and have been attempted in riverine, coastal and archipelago systems. More detailed information regarding programme set up has been gathered where possible and is presented in appendix 1. Live trapping is a common technique of mink removal and appears to be the most humane method (Moore et al. 2003), while the use of dogs has been important in targeting individuals and /or females during denning time (Moore et al. 2003; Udø 2005, unpub.). Control programmes have been carried out over varying time periods and spatial scales, ranging from 2 months to more than 10 years (e.g. Craik 2008; Padyšáková et al. 2009) and from a 10 km linear range to more than 1000 km^2.(e.g. X. Lambin pers. comm., Padyšáková et al. 2009) Removal effort has varied from targeted seasonal periods to year round effort and success appears to be high if trapping is focused during dispersal periods (Bonesi & Palazon 2007, I. Maclennan pers. comm.). Most mink are often caught within a few days of trap initiation (Craik 2008; Roy et al. 2006). Where catch effort has been reported, intensity varies from strategic placements of traps ranging from 12 per 1000 km^2 (Maran 2000) and 2-5 per km^2 (Moore et al. 2003), to regular distances of 2 km along entire catchments (X. Lambin pers. comm.). Both strategies appear to work well and methodology is perhaps more reliant on whether removal occurs in an island or mainland system. Few studies report by-catch figures. Of those that do, similar sized mustelids, other mammals including cats, as well as some bird species have been reported (I. Maclennan, J. Urquhart pers. comm., Hammershøj et al. 2004). By-catch can be greatly reduced by placement of 2 thin wires vertically over trap entrances, thus making the entry hole too small for otter to enter, and by the use of commercial scent instead of food (Roy et al. 2006, J. Urquhart pers. comm.). Some large scale control programmes have involved community participation (Maran 2000; Moore et al. 2003, D. Maclennan, X. Lambin pers comm.). Careful planning is required in order to set achievable goals when communities are involved (Maran 2000) and feedback and motivation appear to be key factors in achieving successful long term community participation (D. Macleod, X. Lambin pers. comm.).

2.3 Effects of control efforts

Sex ratio biases exist when trapping mink on a yearly basis with more males being trapped than females (Gerell 1971). This has important consequences for trapping effectiveness as breeding females have the most negative effects on prey species (Dunstone & Davies 1993). Trapping during autumn dispersal enables trapping of equal ratios males and females (Craik 2008) and is therefore necessary in order to obtain optimal effect per effort in a removal program.

Studies on density dependence are time consuming as sufficient numbers of individuals must be caught, released and monitored over an appropriate timescale in addition to the removal of individuals in order to simulate a reduction in population density. There is some evidence that mink may exhibit density dependant survival (Helyars 2006), with post survival cull rates being higher than pre-cull rates for both adults and juveniles. Reasons were not investigated but reduction in competition for resources was suggested as the likely mechanism. Whether density dependant survival can occur is therefore likely to be specific to individual locations and be dependant not only on mink numbers, but mink numbers in relation to available resources. It is currently unclear what proportion of the population needs to be removed in order to see a decline in mink numbers, but culling of at least 70 to 80% of the natural population has been suggested (Helyars 2006, Sidorovich and Polozov 2002).

There appears to be a lack of systematic monitoring of mink numbers and/or activity before during and after removal takes place. The use of monitoring rafts into which traps can be placed when activity is observed appears to be an excellent way of ensuring low cost highly reliable year round monitoring and has been used in several British studies (e.g. Reynolds et al. 2004, X. Lambin pers comm.), and is being taken into use on increasing numbers of nature reserves. However, this kind of raft requires water for its placement and is easily flooded so is not applicable for use outside of inland water bodies. Monitoring of success is often constrained by time and monetary limitations. Less systematic monitoring of success has relied upon the skill of dog and fieldworkers in finding mink signs during trapping or dog searching (e.g. D. Macleod pers. comm.).

Bearing these facts in mind, eradication seems to be possible on small coastal islands, whilst control has appeared to be successful on targeted areas along mainland rivers and entire catchment areas of 1000 km^2 (Bonesi & Palazon 2007, X. Lambin pers. comm.). Wide scale hunting over large mainland areas seems to be generally unsuccessful (Bonesi & Palazon 2007). Mink removal has been shown to be beneficial in terms of breeding densities, reproductive output, and/or the re-colonisation of ground/ hole nesting birds species as well as common frog (Mayor et al. 2006; Nordström et al. 2003). Mink may act as one of a number of factors which can have a negative impact on populations e.g. mink were found to depress population densities of field voles (Microtus agrestis) during summer, but not spring or winter (Fey et al. 2008). Most studies do not focus on compensatory effects by other predators.

2.4 Knowledge gaps

Despite a number of well designed and reported studies showing trapping effort methodology and efficiency, information on risk of by-catch, potential compensation from other species are lacking. Use of Before and After Treatment comparisons of effects on prey and activity levels/ population estimates of mink at appropriate scales is necessary to assess success of control measures. Studies should feed into a system for adaptive management for species/ areas of conservation concern.

3 Implementing mink control in Norway to mitigate population declines of vulnerable populations of sea birds

3.1 Ecological settings

Norway, situated between 58 and 71˚ N, experiences a range of climatic conditions, topographies, ecosystem productivity and density of human settlements. Thus mink, being distributed all over the country, experience a vast range of ecological circumstances. Norway has borders with three European mainland countries, Russia, Finland and Sweden which all currently have active mink farms and populations of feral mink (Bonesi & Palazon 2007).

Negative impacts of mink on a wide range of species have been recorded (table 3). All of these are present in Norway and so are under potential threat. In addition 4 of these are bird species on the Norwegian Red List (Kålås 2006) and several species have suffered population declines in recent years. There are quite certainly impacts on other species not yet reported in the literature. For instance, mink are regarded as a main threat to eider nesting success in Vega World Heritage Site (B. Sinsvål, pers. comm., Vega kommune - Lokal forvaltningsplan for Ærfugl 2004-2009). Additional coastal bird species which are also potentially negatively impacted include many wader species.

Norway has a diverse predator community consisting of both mammalian and avian species. Of these, eagle owl, white-tailed eagle and golden eagle are most likely to negatively affect mink in terms of actual predation and or change of spatial use as a predator avoidance strategy. Otter has been recorded as being dominant over mink, able to outcompete mink in terms of acquisition of aquatic prey, forcing it to change food niche to a more terrestrial diet. As mink are able to exploit a terrestrial food niche, relying mainly on small mammals, there is potential for food competition with a large number of other mammalian and avian species. In addition competition with generalist predators, red fox, crow and raven could affect mink population dynamics. There are currently no documented studies or reports involving competitive interactions other than with otter (Christensen 1995; Heggberget 2007).

Competition with the otter has been recorded in both coastal and riverine systems and in coastal systems the otter can limit dispersal of mink where both aquatic and terrestrial food is limited (Clode and MacDonald 1995, Bonesi et al. 2000). It could therefore be expected that terrestrial prey may be under a greater predation pressure where mink and otter interact in areas which have poor aquatic resources.

3.2 Seabird monitoring

Systematic standardized nationwide monitoring programmes for many bird species in Norway have been lacking (Anker-Nilssen et al. 2005; Lorentsen 2007; NOF 2009), thus impeding inter-site comparison of factors involved in demographic changes. A national seabird monitoring project (SEAPOP) has been recording breeding numbers of seabirds since 1988 (Lorentsen 2007). In addition, since 2005 eight key areas between Svalbard and Møre & Romsdal have been the source of demographic data collection (survival, reproduction and diet), from selected seabird species (Anker- Nilssen et al. 2005). Excluding Svalbard which so far lacks a mink population, seven mainland sites exist of which two, Hornøya and Hjelmsøya, both situated in Northern Finnmark, have reported negative effects from mink predation (Anker-Nilssen et al. 2006, A.P. Sarre pers. comm.). In addition the island of Grindøya which is also linked to the SEAPOP program has suffered from mink predation in recent years (Anker-Nilssen et al. 2006). A national bird censusing project was undertaken between 1977 and 1985 by The Norwegian Ornithological Society (NOS) which culminated in the publication of a national breeding bird atlas in 1994 (Gjershaug et al. 1994). NOS initiated a new scheme in 1995 (Norwegian Breeding Bird Census) which involved censusing of 58 key species chosen as indicators of biological change in mountain, forest and cultural landscape ecosystems (EBCC 2009). This scheme is now being replaced by a more wider ranging program (TOV-E, Terrrestrial Extensiv Overvåking; NOF 2009) with the aim of providing a more balanced coverage of important species through the designation of approximately 500 areas covering the entire country. The project was initiated over much of the country in 2008 and it is hoped that coverage will begin in the Troms and Finnmark in 2009.

Norway's nature conservation policy is to halt the loss of biodiversity within 2010. Within the memorandum outlining how this will be achieved, the influence of invasive species on the loss of biodiversity on island, coastal and inland waters over the last 100 years is assessed as very high, high and high respectively (St.meld.nr.26 2009). Conservation policy protects important areas by designation areas as national park, nature reserve or landscape reserve of which nature reserve is afforded the highest protection. The Directorate for Nature Management is responsible for implementing conservation policy with the practical aspects being undertaken by the states national monitoring body (Statens Naturoppsyn, SNO). The level of monitoring of these areas has historically been under individual county control and has varied greatly in coverage, methodology and reportage. In connection with Norway's conservation policy to protect important coastal areas, the The Directorate for Nature Management recently commissioned a feasibility study in order to assess the applicability of implementing wide scale county wide standardized monitoring of seabird species at nature and landscape reserves (Lorentsen 2007).

3.3 Current mink control efforts

Mink trapping currently appears to be carried out at a small-scale, uncoordinated individual site basis e.g. nature reserves, stretches of rivers administrated by fishing clubs, areas of traditional eider down harvesting and around fur farms. These organizations ranging from governmental to NGO's through to individual community groups and interested individuals form a huge potential resource base for carrying out the groundwork of an eventual control program in Norway. The Cairngorm's project in North East Scotland which largely relies on community participation and has created a mink free catchment area of 1000 km^2 within 4 years has shown that community involvement can make large scale clearance feasible at low cost. The scheme has now extended to cover an additional 5 catchment areas which in total cover 17500 km^2 (X. Lambin pers. comm.).

4 Recommendations

4.1 Knowledge requirements

As mink is a successful invasive species it should be able to tolerate high mortality without impacting on numbers recruiting to the breeding population. Targets need to be set for removal based on knowledge of population dynamics in order to achieve successful control and/or eradication rather than harvesting. Thus there is a general need for greater knowledge of the role of density dependence in mink population demography.

Other areas requiring greater knowledge about mink in Norway (we list the most important points from the sections about knowledge gaps above):

- Current distribution in Norway particularly:
  - relative use of coastal and inland habitats
  - coastal and inland habitats – are they sources or sinks?
- The diets of minks in different coastal habitats – what is the role of terrestrial and limnic subsidies
- Home range size and dispersal distances: Important for deciding the scale of removal operation
- Demographic parameters such as age and sex ratios, fecundity, individual population distributions: Important for establishing min population resilience to control measures
- Vulnerable prey species and/ or areas
- Interaction with potential competitors/predators and role of compensatory predation on vulnerable species when mink are successfully removed
  - For instance there are no studies on compensatory nest predation between mink and corvids (crow and raven)
  - Indirect interactions between mink and eagle owls could take place in coastal island systems where eagle owl breeding success is dependent on high density water vole populations. As mink has been found to be an efficient predator on terrestrial populations of field voles and aquatic (inland) populations of water voles, it is possible that mink may affect island population of terrestrial water voles to the extent that eagle owl breeding success is reduced. As a substantial proportion of the vulnerable Norwegian eagle owl populations is found in such an ecological setting, this possibility should be explored.

In order to assess the effect of mink, ecological studies should be based on well designed experiments. Purely observational studies are often confounded with other sources of variation in breeding success and demography in prey species. Experimental assessments should include evaluation of relevant scale for the study, control sites, replication, monitoring of mink population and focal prey populations before, during and after treatment.

4.2 Control strategies and methods

4.2.1 General requirements for an action plan for island and coastal areas

As the distribution of mink covers the entire region of Norway eradication on a national scale is unlikely. Choice of appropriate sites and spatial scale are vital if control efforts are to succeed. An action plan should identify key sites in terms of focal species for conservation based on criteria such as Norwegian IUCN Red List, BirdLife International, or negative population trends in recent years. In addition, common species which are locally vulnerable to heavy mink predation may have important ecological functions in wildlife reserves and national parks and should not be immediately discounted from mink control projects. Islands situated more than 2 km from neighbouring islands or mainland should be targeted first as the chance of re-colonisation will be greatly reduced. Mink control is labour intensive and the involvment of relevant industries, non-governmental organizations and the wider general public should be encouraged in order to make control low cost and feasible over large areas. The following specific recommendations for methodology for controlling mink are based largely on the successful mink removal projects in the Western Isles and North East Scotland.

4.2.2 Trapping equipment

Trapping effort in Britain uses cage traps of dimensions 18 x 15 x 60 cm. The use of traps with a solid metal door enables trapping success to be assessed from far away. Traps should be fitted with 2 vertical wires over the entrance in order to reduce entrance size and therefore reduce bycatch of otter. Tests in Western Isles indicate that traps should be baited with commercial lure (http://www.kishelscents.com/COMERSUS/store/comersus_viewitem.asp?idProduct=3272) NOT food, in order to reduce bycatch and maximise catching efficiency. It is enough to use a blade of grass dipped into the scent bottle and placed at the back of the trap (I. Macleod pers. comm.).

So called mink rafts are very efficient for use along inland pools, lakes or slow-medium flowing waterways of 1m or greater width (also potential for above high tide rock pools). This easily constructed raft allows monitoring of mink activity during above freezing conditions. When mink activity is noted, a trap is deployed in the tunnel. It has the advantages of providing a focal point for observation of sign location (hence monitoring), reduces the number of traps at any given time and man hours needed to check open traps. Tunnels can be checked less frequently over longer time periods for the same amount of labour time as intense trapping over short time intervals. Mink rafts have proved very popular when working with the community, especially when co-ordinated with general public training days (J. Urqhuart pers. comm.). A fact sheet for construction and usage can be obtained from The Game Conservancy Trust http://www.gct.org.uk/text01.asp?PageId=26).

4.2.3 Trap deployment

Efforts to remove mink should be concentrated during natural dispersal periods i.e. January – March, June – September. The autumn dispersal period is the most successful period for catching adult females and should not be discounted due to the time period in part occurring as an 'after bird breeding event'. Traps should be left open for 4 consecutive days each month. ie. traps are checked every 24 hours for 4 consecutive days. During the dispersal trapping campaigns, mink rafts should also be fitted with traps in order to maximise trapping effort. Trapping can be continued at a lower intensity during the breeding season in order to remove missed individuals. Target areas can be identified using the mink raft in monitoring mode i.e. without a trap.

Trap density and placement should be carefully planned BEFORE placement in the field in order to maximise workforce efficiency and safety. Co-ordinates and routes can be loaded onto gps with fieldworker setting out traps within a given radius of position e.g. 50 m. Deployment of workforce should also be planned carefully (see below). The Western Isles removal project works on a saturation principle for densely spaced populations, whilst the North East Scottish river removal project works on less densely spaced populations. Since the literature indicates that coastal population home ranges are smaller than inland, with a minimum range of 0.5km, trap density should initially be set to a minimum of 2 traps per km with modification after experience where necessary. Riverine populations at least in Scotland are less densely situated, and here a density of 1 trapping tunnel per 2 km covering the entire catchment area has proved very successful (X. Lambin pers. comm.). We recommend that lacking knowledge of Norwegian mink densities the same trap density and placement is used along Norwegian inland systems. Definition of inland and coastal boundaries must be arbitrary but can be based on the maximum recorded home range movement. Accordingly coastal areas are then defined as coast line and 500 m inland, whilst inland areas are defined as all areas greater than 500 m from the coastline.

Islands situated more than 2 km from neighbouring islands or mainland should be targeted first as the chance of re-colonisation will be greatly reduced. This not only achieves the target of mink removal but also keeps moral high within the workforce (I. Macleod, pers. comm.). Where islands are less than 2km from neighbouring land masses buffer trapping zones should be set up on these. Length of zone can be determined beforehand by determining the maximum buffer coastline covered by drawing two 2 km lines from the island which intersect the buffer zone coastline.

Location of traps should follow natural water features such as streams, coast line, and lake / pool edge. Presence of mink signs such as tracks (in snow or mud), runs through vegetation, dens and spraints can be used to pinpoint trap placement at fine scale. Use of snow tracking can be an efficient way of locating active dens during winter months. Location of traps in vicinity of roads and planning of circular routes greatly increases trapping efficiency as a greater area can be covered in a given amount of time. Similarly, use of boat taxi to deploy workers in different areas of an island greatly increase efficiency, improves safety and not least moral.

The Western Isles Project trapping effort which has eradication as its goal covers between 30 and 40 km^2 per week, with the aim of covering a larger piece of ground than mink are likely to traverse. Areas too large to be covered in one session should be targeted according to topographical features so that removal occurs by catchment area. Starting points should be high ground where observations have shown that mink density is lower, with trapping progressing downstream against the direction of natural dispersal (J. Urquhart pers. comm.). This provides a front of clearance behind which it has proved easy to monitor mink activity.

Traps should be anchored securely to prevent instability or loss. If traps are to be placed out permanently they can be dug into the ground if possible. Assessment must be made of durability of traps in coastal environments i.e. traps can rust, and decisions taken in accordance with workforce trade off. In addition if areas are snow covered during winter trapping it is more feasible to have semi permanent traps that can be deployed where necessary.

Placement of traps should enable trap status (empty or occupied) to be assessed from a distance (e.g. with binoculars from boat in calm seas) where possible in order to reduce work effort.

Traps must be checked daily when set. Research shows that mink are caught very quickly when in the vicinity of a set trap. It should be enough to have traps open for 4 nights. Signs of mink should be recorded along trapping routes. Dispatch can be undertaken using shotgun (but one must be aware of ricochet and destroying traps) or air gun to the base of the skull (Air guns are not legal for killing game in Norway, a .22 long rifle gun with .22 short ammunition would however clearly do) . In the case of use of air gun, special ammunition must be used (for example Prometheus pellets 22/5.5 mm) as normal air gun ammunition will not penetrate the skull. Dead animals should be collected and stored by freezing in order to supply samples for demographic studies by University of Tromsø.

In order to keep trapping participation high, trappers must be regularly informed regarding results and shown the consequences of poorly collected data. Where the community are involved they should be informed about the reasons for the program and given regular updates through open days and or websites. Individuals may be unwilling to despatch caught animals, therefore co-ordination is needed in order to have suitable coverage of despatchers in areas whilst traps are active.

4.2.4 Other means of mink control

The use of tracking dogs should be employed in order to locate denning females and for dens of individuals during dispersal time or when population densities are low. Dogs have a greater capacity to track scent than humans and cover a greater area, resulting in a more efficient coverage of area. Western Isles use many different breeds as mink leave a strong scent and are easy for a dog to source (I. Macleod pers. comm.). Training must occur in accordance with a professional dog trainer in order to maximise success. Local dog clubs often have scent trail training and may even be willing to undertake the task with their own dogs. Western Isle project use lure as training method. The dog search window in the Western Isles is from May-mid July (main window mid May to mid June) and this timing should also be followed in Norway. 'Best dogs' can be used for specific areas. Dogs can also be fitted with gps and their tracks downloaded to obtain overview of area coverage.

Where dens are located, several traps can be deployed adjacently, close to the den entrance(s) in order to trap both females and young. If dogs are not used to locate females monitoring tunnels should be deployed in key areas which can be checked during breeding bird monitoring visits

4.3 Monitoring

4.3.1 Mink

The monitoring plate of the mink raft consists of a clay/ sand mixture which is kept damp and thus functional by a reservoir provided by continual saturation of an underlying sponge (hence the requirement for placement of raft on a water source). Footprints are formed on the damp plate when mink enter the tunnel. After activity on the plate has been recorded, the plate is simply wiped smooth using hand and water.

Mink footprints are easy to identify on boards. Prints have 5 toes, are roughly 2.5cm wide and have a characteristic spread toe pattern with claw marks often visible. Confusion can initially occur with stoat and otter. Excellent descriptions and pictures of prints on different substrates can be found in the following websites: http://www.watervolescotland.org/#/footprints/4527033405

http://www.skullsite.co.uk/prints/Mink/mink.htm

http://www.norton-green.com/gallery.html_floranfauna10.htm

http://www.bear-tracker.com/mink.html

http://animaltracksandsign.blogspot.com/2008/01/mink-tracks-in-snow.html

Mink scats are black and shiny and smaller than otter, and are often twisted at one end. They often contain fur and feathers and generally have a rank smell. Otter scats contain fish bones and scales and have a sweet musky smell. For photos see

www.sussexotters.org/pdf/Mink%20Control%20for%20Wildlife%20Conservation.pdf

Once mink activity has been established and traps deployed, capture normally occurs very rapidly (within the first 4 days). Few active traps catch mink after one week. Thus capture efficiency is a trade off between manpower and proportion of population to be trapped. Removal studies indicate that it is feasible to remove the majority of the population in a relatively short time.

4.3.2 Seabirds

Detailed coverage of nesting success is time consuming and therefore impractical when manpower is limited. In addition it can cause nesting failure if not carried out with due care and consideration. As eider nesting survival is proposed to be limited by mink predation, nesting survival and therefore nesting density should increase in the absence of mink (assuming no compensatory predation occurs). The common eider is well placed to be the indicator species for mink trapping success since it is a ground nester, susceptible to mink predation, easy to monitor and is distributed along the entire length of the Norwegian coast. It has perhaps the greatest capacity of all Norway's breeding birds to engage public participation being considered with great affection due to Norway's history of eider down production. In addition, the presence of hidden compressed eggshells in down laid nests at the end of a breeding attempt provides a low impact simple method of assessing successful hatching and could prove to be a good indicator of success of mink trapping. (However it must be remembered that success of mink removal can only be measured by monitoring of mink activity). We recommend that between 3 and 4 evenly spaced visits should be made during the eider breeding season between 10th and 30th June(assuming birds begin nesting 17 May and have an incubation period of 24 days) in order to record number of successful nests. The first visit may also be used to map active incubators in order to allow easy location of empty nests on subsequent visits. Use of simple hand held cameras may provide an efficient way of nest mapping where topography allows.

4.4 Recommendations on immediate actions

Based on our general review we proposed that the following immediate actions could be made before a more detailed and specific Norwegian action plan has been completed.

4.4.1 Short term campaigns in seabird colonies on remote islands

Short-term campaign-like actions should be initiated in seabird colonies on remote offshore islands where a substantial mink problem has been identified. Hjelmsøy and Hornøy in Finnmark are two such colonies. Owing to the remoteness of such islands it could be expected that immigration events of mink are much less frequent than in more connected coastal systems and for this reason short-term campaigns may be effective. However, because new immigration will certainly take place in the future such campaign should be accompanied with long-term monitoring. Mink are thought to require freshwater in order to maintain their coat (Bonesi et al. 2000) and so placement of rafts for monitoring in limnic habitat is likely to be successful in terms of recording activity where mink are present. Inland waterbodies are likely to be few or non existent on such small islands. However, if rock pools are available a raft can be placed in each, thus fulfilling a monitoring function (raft dimensions are 1.2 x 0.6 m). In addition, mink signs can be searched for and recorded ideally along 1 km transects situated along the high water line, but where this is not possible, other predetermined and logged distances can be used. The transects should be chosen at random along the trap deployment route to make efficient use of manpower. Trials to develop a suitable low technology monitoring tunnel not requiring a water source should be conducted at a suitable locality (see below). In addition the presence of seabird monitoring plots allows a direct systematic assessment of the level of mink predation on seabird species. Recording of predation rates of the different species (and age groups within species) can potentially be undertaken by the relevant researchers carrying out productivity and survival studies on SEAPOP sites.

Personnel that are engaged in mink control campaigns ought to describe their methods (trap type, bait, trap placement) and effort (number of traps) and result (number of mink caught and by-catch of other species if relevant). The catch should be preserved (frozen) to allow for investigation of demographic parameters and diets (stable isotopes). An institution/person that coordinates and synthesizes this information should be elected.

4.4.2 Refining methods of control and monitoring

Control of mink in coastal system with high connectivity between islands and/or mainland requires permanent control actions according to a well planned strategy. There is an immediate need to tailor such control strategies for typical Norwegian coastal ecosystems, where mink is likely to be a problem. Important aspects to consider are development of optimal control efforts in time and space, efficient/reliable documentation of nest predation in vulnerable bird species and efficient/robust methods for monitoring of mink populations. These methodological issues should be developed in localities with "easy logistics", and where there is a good general knowledge about the ecological community (including demographics of bird colonies and presence of relevant predators).

4.4.3 Immediate actions in selected colonies of the common eider

As pointed out in our review the common eider possessed several characteristics which make this species a particularly useful target for research and monitoring in connection with mink control. We recommend that immediate actions could be made in two localities from 2009.

For trials aimed at refining methods of mink control and monitoring as well as monitoring of eider breeding success we propose Grindøya-Tistnes Nature reserve in Tromsø. The island of Grindøya is ideally placed for the study of mink predation on eiders as mink predation of both eggs and incubating females has been apparent in recent years (Anker Nilssen et al. 2007, J Stien unpub.), the colony is the source of the longest continuous time series on eider population dynamics (population size, adult survival and reproduction) outside of Svalbard (Anker Nilssen et al. 2008) and is logistically easy to access at all times of the year. It is surrounded by 3 neighboring islands and the mainland, all of which have mink activity, allowing both source-sink dynamics to be investigated and expansion of scale of removal trials. It also contains an array of other eider nest predators and or potential mink competitors including crow and otter, raven and white tailed sea eagle providing suitable conditions for the investigation of compensatory predation and resource competition.

As another focal point we suggest Vega World Heritage Site on the coast of Helgeland. This is a main site for the remaining traditional eider down industry in Norway. In a recent action plan for maintaining and developing the down industry at this site mink predation has been recognized as a major problem and some actions appear to have been implemented. We suggest that actions should be taken to improve on the scientific base of mink control in Vega with focus on community involvements according to detailed adaptive management protocol. This should be initially developed in the full action plan for American mink in Norway.

Table 1. *Size of home ranges of American mink three main classes of habitat in Europe (lacustrine, riverine and coastal), Data recorded from radio tracked individuals. All home ranges estimates are in linear metric (km), except for archipelago ranges which are also presented by the respective authors in both hectares and km^2.*distances are mean lengths, ranges not given. **from Dunstone (1993).*

Season	Sex	Habitat						Reference
		Lacustrine	n	Riparian	n	Coastal and or archipelago	n	
Breeding	ad M			2.5 (1.6 – 4.4)	?			**Chanin (1976), Birks and Linn (1982)
				6.5 (4.5 - 8.6)	3			Yamaguchi & MacDonald (2003)
	ad F			2.1 (1.2 - 3.2)	?			**Chanin (1976), Birks and Linn (1982)
				2.7 (0.8 – 4.3)	6			Yamaguchi & MacDonald (2003)
Non-breeding	ad M			(5.9-8.6)	2			Yamaguchi & MacDonald 2003
						5.3 (22.0 ha)	1	Niemimaa (1995)
	ad F			(0.8 – 4.1)	4			Yamaguchi & MacDonald 2003
						4.2 (17.0 ha)	1	Niemimaa (1995)
	Juv. M					6.51 (31.0 ha) (2.8-10.1) (6.0-56.0 ha))	2	Niemimaa (1995)
	Juv. F					2.79 (6.5 ha) (2.1-3.4 (6-7 ha))	2	Niemimaa (1995)
						(Upper range 1.80)		Dunstone and Birks (1983)
All seasons	ad M			2.6 (1.8 -5.0)	4			Gerell (1970)
				6.8*	5			*Yamaguchi & MacDonald 2003
		1.9*	4	2.5*		1.5*	9	*Dunstone and Birks (1985)
				2.7*	8			Yamaguchi & MacDonald 2003
	ad F			1.8 (1.0 - 2.8)	2			Gerell (1970)
		1.46*	4	2.1*		1.09* (lower range 0.75)	11	*Dunstone and Birks (1983,1985)
May-August	ad M					28.2ha (5.0-53.0)	5	Salo et al. (2008)
	ad F					27.4 (4.5-53.0)	13	Salo et al. (2008)

Table 2. *Recorded litter size of wild mink.*

Type of reference	Mean litter size	n	Location	Reference
Live kits	2.5	4	England	Yamaguchi and Macdonald 2003
	3.8 (3-6)	10	Sweden	Gerell (1971)
	(5-8)			Dunstone and Davies (1993)
	2-2.8	15	Scotland	Helyars (2006)
Active teats	1.8-3.7 (-)	39	Scotland	Helyars (2006)
Embryo	5.75 (2-5)	4	Scotland	Récapet (2008)
Placental scar	4.33 (2-5)	6	Scotland	Récapet (2008)

Table 3. *List of species documented as being negatively affected by mink (adapted from Bonesi et al. 2007). Red List refers to placement on the Norwegian Red List of conservation concern. Predation has been documented for grass snake (Natrix natrix) and therefore it is likely that the Red Listed sooth snake could also be affected.*

Prey species	Red list
Bank vole (*Clethrionomys glareolus*)	
Field vole (*Microtus agrestis*)	
Water vole (*Arvicola terrestris*)	
Arctic skua (*Stercorarius parasiticus*)	
Arctic tern (*Sterna paradisaea*) Finland	
Black guillemot (*Cepphus grylle*)	√
Black-headed gull (*Larus ridibundus*)	
Common eider (*Somateria mollissima*)	
Common gull (*Larus canus*)	
Common tern (*Sterna hirundo*)	
Coot (*Fulica atra*)	
Gadwall (*Anas strepera*)	√
Mallard (*Anas platyrhynchos*) Finland	
Moorhen (*Gallinula chloropus*)	
Northern shoveler (*Anas clypeata*)	√
Razorbill (*Alca torda*)	
Ringed plover (*Charadrius hiaticula*)	
Rock pipit (*Anthus petrosus*)	
Shelduck (*Tadorna tadorna*)	
Slavonian Grebe (*Podiceps auritus*)	
Tufted duck (*Aythya fuligula*)	
Turnstone (*Arenaria interpres*)	
Velvet scoter (*Melanitta fusca*)	
Water Rail (*Rallus aquaticus*)	
Wheatear (*Oenanthe oenanthe*)	
Pintail (*Anas acuta*)	√
Red-breasted merganser (*Mergus serrator*)	
Common frog (*Rana temporaria*)	
Stone crayfish (*Austropotamobius torrentium*)	
Smooth snake (*Coronella austriaca*)	√

Appendix

Summary of available background data for known mink removal studies

Country and Reference	Removal success	Prey / competitor species	Effect on prey	Actors
Belarus MacDonald and Harrington (2003)	Reduced by 80%	European mink	Unspecified	Local hunters aided by 1 expert
	Reduced			Unspecified
	Reduced			Unspecified
Czech Republic Padysakova (2009)	Reduced	Artificial nests of waders	Increased nest success compared to control areas	Unspecified
Denmark Hammershjø et al. (2004),	Unspecified	Unspecified	Unspecified	Danish Forest and Nature Agency
England Reynolds (2004)	Reduced	Water vole	Unspecified	Game Conservancy Trust
Estonia Maran (2000)	Removed	Removal before re-introduction of European mink	Beaver, otter, bird	Local hunters used in winter 1998/1999. Failed due to inexperience 1999-2000 – team of experts
Finland Nordström et al. (2003)	Not measured	Several seabirds, waders, passerines	White-tailed eagle, eagle owl	Research team
Norway Udø (unpub.2005)	Reduced	Gulls, common eider	Crow	Not specified
Scotland (Western Scotland) Craik (2008)	Reduced	Arctic tern Common tern	Predicted increased breeding density	Unspecified
Ratcliffe et al. (2008)	Reduced	Arctic tern Common tern	Predicted increased breeding density	Unspecified
Outer Hebrides Moore et al. 2003;	Reduced	Not measured	Unspecified	SNH/ research team, and residents (rapid reporting of mink observations)
Outer Hebrides Roy et al. (2006)	Not measured	Not measured	Unspecified	SNH/ researchers
Ratcliffe et al. (2008)	Reduced	Arctic tern Common tern	Predicted increased breeding density	Research paper based on data from Western Isles and West coast removal projects
North East Scotland Lambin (unpub)	Reduced	Water vole	Re-colonisation of parts of catchment area	6 biologists, c.160 volunteers from local community

Reference	Study length	Habitat	Important cohabiting species
Belarus MacDonald and Harrington (2003)	1 year (1992-1993)	Nature Reserve. No habitat details	unspecified
	9 months (1998)	Reserve. No habitat details	unspecified
	1999 onwards	Reserve. No habitat details	unspecified
Padysakova (2009) Czech Republic	54 days	River, low lying ground, bankside trees, mosaic fields, forests, grassland	Jay (*Garrulus glandarius*), black-billed magpie (*Pica pica*), carrion crow (*Corvus corone*), common raven (*Corvus cornix*), stone martin (*Martes foina*), pine martin (*Martes martes*), polecat (*Putorius putorius*), red fox (*Vulpes vulpes*), wild boar (*Sus scrofa*)
Denmark Hammershjø et al. (2004)	3 years (1998-2000)	Thy island: inland: agricultural/spruce plantations, many streams and lakes coastal: sandy beaches	Polecat plus other mustelids, otherwise unspecified
	3 years (1999-2001)	Bornholm island: inland: agricultural/spruce plantations, cliffs coastal: rocky shores	No other mustelids, otherwise unspecified
England ***Reynolds (2004)	4 months	River, Itchen	Unspecified
Estonia Maran (2000)	17 months (1998-2000)	Island divided into 9 hunting regions	Beaver, otter, bird
Finland Nordström et al. (2003)	108 months (1992-2001)	Sparse vegetation with patches of grass or juniper	White-tailed eagle, eagle owl
	36 months (1998-2001)		
Norway Udø (unpub.2005)	8 months (2003-2004)	3 islands have reserve status. All islands include rocky shores, main vegetation juniper, heather, grass	Crow
Scotland (Western Scotland) Craik (2008)	10 years (1997-2006)	Archipelago (5 islands) ≤500m from mainland	unspecified
	3 years (2003-2005)	Archipelago (5 additional islands) ≤500m from mainland	unspecified
Outer Hebrides Roy et al. (2006)	2 years (2002-2003)	6 islands in the sound of Harris	Ferret
	1 year (2003)	2 additional islands	
Outer Hebrides Moore et al. 2003; Scotland	16 months (2001-2003)	Varied , blanket bogs, lakes and streams, hilly area,	Otter, ferret (Mustela putorius furo.), golden eagle, white tailed eagle
Lambin (pers comm.) North East Scotland	4 years	River, 1 catchment	Otter, crow, pine martin
	2 years	River, 3 additional catchments	

Reference	Trapping time	Place	Technique	Area	Pre-trapping population size	Catch per unit effort (no. caught/ no. trap nights)	Trap placement and/ or number
Belarus MacDonald and Harrington (2003)	All seasons	Gorodok Nature Reserve	trapping, type unspecified	20 x 30 km Unspecied	Max. 100	70-80/unspecified	'intensive'
	March - December					73/unspecified	unspecified
	Autumn and spring					40 total/unspecified	unspecified
Czech Republic ****Padysakova (2009)	Summer, 14 days	River	Live trap with fish bait	10 km (4 x 2.5 km transects) (Trapping along 2 transects)	Not measured	8/14	12/2.5 km²
Denmark Hammershjø et al. (2004)	Winter (Sep-March)	Thy	Instant kill traps	Unspecified	Unspecified	~187/~504	Strategic
	All year	Bornholm				~24/~1095	Strategic
England Reynolds (2004)	Summer, autumn, winter	River bank	Live trap with monitoring raft	12 km (linear)	30-148 adult females 90-740 young	Unspecified	10 per km²
Estonia Maran (2000)	Winter 1998/1999	Hiiumaa	Leg hold traps/live traps;	1000 km² island	74	12/42	Strategic (number unspecified);
	all seasons 1999-2000		Modified leg traps			38/105	Strategic (40-60)
Finland Nordström et al. (2003)	Mainly autumn / spring	Removal	Dogs, leaf blower, weapon	1.15 km² (60 islands)	Unspecified	98/~126	-
	Control		none	35 km² (37 islands)			
	Removal		Dogs, leaf blower, weapon	1.08 km² (62 islands) plus buffer trapping on neighbouring islands		≥50/unspecified	-
	Control	none		130 km² (64 islands)			
Norway Udø (unpub.2005)	Mainly winter, summer when required	Archipelago	Tracking Dog	Total area 25daa-170daa plus unspecified buffer area. Removal: (3 islands) Control: (4 islands)	Unspecified	5/unspecified	-
Scotland (Western Scotland) Craik (2008)	All year	Western Isles	Live trapping	unspecified	Unspecified	307/~1325	10 per island, 1 per km; unbaited
						154/~3650	
Scotland Outer Hebrides Roy et al. 2006	April and August	Western Isles	Live trapping	9 – 188 ha	Unspecified	20/ >810	5 – 9 per island
				900 km²		55/22525 (4 nights per trap)	'intensive'
Scotland Outer Hebrides Moore et al. 2003;	All year	Western Isles	Live trapping*, Dogs**	1114 km² archipelago -S. Harris, N&S.Uist, Benbecula,	487	224/62000	≤5 traps/km² (mean 2.25 – 3.1 km²)
Lambin (pers comm.)b	All seasons	River Ythan	Live trap with monitoring raft	1000 km²	From both projects >400 adult and young	unspecified	Initially every km, reduced to 1 per 2km
		River Spey, Don, Dee plus lowland areas		Additional 16500 km²			1 per 2km

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DN-utredning

oversikt

2011

6-2011: Invasive American Mink (Neovison vison): Status, ecology and control strategies
5-2011: Supplerende kartlegging av biologisk mangfold i jordbrukets kultulandskap, inn- og utmark i Troms med en vurdering av kunnskapsstatus
4-2011: Supplerende kartlegging av biologisk mangfold i jordbrukets kultulandskap, inn- og utmark i Finnmark med en vurdering av kunnskapsstatus
3-2011: Genbank 2008 og 2009
2-2011: Utbredelsesmodellering av fremmede invaderende karplanter langs veg
1-2011: The Norwegian Nature Index 2010

2010

9-2010: Evaluering av «Program for terrestrisk naturovervåking» (TOV 2000-2010)
8-2010: *Overvåking av fjellvegetasjon på Stortussen/Snøtind* - et pilotprosjekt innenfor GLORIA Norge
7-2010: Etablering av nye laksestammer på Sørlandet. Erfaringer fra arbeidet i Mandalselva og Tovdalselva etter kalking
6-2010: Supplerende kartlegging av biologisk mangfold i jordbrukets kulturlandskap, inn og utmark i Oslo og Akershus, med en vurdering av kunnskapsstatus
5-2010: Supplerende kartlegging av biologisk mangfold i jordbrukets kulturlandskap, inn- og utmark i Vestfold, med en vurdering av kunnskapsstatus
4-2010: Datagrunnlag for Naturindeks 2010
3-2010: Naturindeks for Norge 2010
2-2010: Spredning av fremmede karplanter fra veganlegg – kartlegging og metodeutvikling
1-2010: Mulige effekter av etablering av stillehavsøsters (*Crassostrea gigas*) i Norge

2009

6-2009: Overvåkning av fjellvegetasjon sommeren 2008 (GLORIA-prosjketet)
5-2009: Bleka i Byglandsfjorden – bestandsstatus og tiltak for økt naturlig rekruttering 1999-2008
4-2009: Moderne hjorteviltforvaltning med ny virkemiddelbruk mot 2015
3-2009: Utvikling av tradisjonelle kulturlandskaper i Barentregionen – KNP-modellen
2-2009: GMO Assessment in Norway as Compared to EU Procedures: Societal Utility and Sustainable Development
1-2009: Supplerande kartlegging av biologisk mangfald i jordbrukets kulturlandskap, inn- og utmark, i Hordaland med en vurdering av kunnskapsstatus
Nasjonalt program for kartlegging og overvaking av biologisk mangfald

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10-2008: Klima og effekter på økosystemer og biologisk mangfold -scenario stølslandskapet i Valdres
9-2008: Nå eller aldri for Vossolaksen - anbefalte tiltak med bakgrunn i bestandsutvikling og trusselfaktorer
8-2008: Reetablering av laks på Sørlandet. Årsrapport fra reetableringsprosjektet 2007
7-2008: Evaluering av bekjempelsesmetoder for *Gyrodactylus salaris*. – Rapport fra ekspertgruppe
6-2008: Supplerande kartlegging av biologisk mangfald i jordbrukets kulturlandskap, inn- og utmark, i Sogn og Fjordane
Nasjonalt program for kartlegging og overvaking av biologisk mangfald
5-2008: Bestandsstatus for laks i Norge. Prognoser for 2008. Rapport fra arbeidsgruppe
4-2008: Supplerende kartlegging av biologisk mangfold i jordbrukets kulturlandskap, inn- og utmark, i Vest- og Aust-Agder, med en vurdering av kunnskapsstatus
3-2008: Supplerende kartlegging av biologisk mangfold i jordbrukets kulturlandskap, inn- og utmark, i Buskerud med en vurdering av kunnskapsstatus
Nasjonalt program for kartlegging og overvåking av biologisk mangfold
2-2008: Nasjonal overvåking av marint biologisk mangfold i havområder og Arktis
– Forslag til overvåkingselementer, lokalisering og kostnadsoverslag
1-2008: Supplerende kartlegging av biologisk mangfold i jordbrukets kulturlandskap, inn- og utmark, i Midt-Norge; Møre og Romsdal og Oppdal, med en vurdering av kunnskapsstatus
Nasjonalt program for kartlegging og overvåking av biologisk mangfold

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The Norwegian Directorate for Nature Management has central, national tasks and responsibilities in managing the natural environment of Norway. These entail preserving biodiversity and paving the way for outdoor recreation and the use of resources provided by nature.

The Directorate is an advisory and executive agency under the Norwegian Ministry of the Environment. We are authorised to manage natural resources through various Acts and Regulations adopted by the Norwegian Parliament.

In addition to tasks fixed by law, the Directorate for Nature Management is also responsible for identifying, preventing and solving environmental problems. It works together with other authorities, and gives advice and information to the general public.