



LAYMANS REPORT



Management of the invasive Raccoon Dog (*Nyctereutes procyonoides*) in the north-European countries

LIFE09 NAT/SE/000344





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LIFE is the EU's financial instrument supporting environmental and nature conservation projects throughout the EU. Within the LIFE+ Nature and Biodiversity strand, specific funding is targeted at Biodiversity, a LIFE+ project category for innovative or demonstration projects that tackle wider biodiversity issues, such as removal of invasive alien species.

Page 2-3: *In rich wetlands with high densities of raccoon dogs the annual production of ducks can be decreased with more than 50%. Rare bird species as Marsh Harrier (*Circus aeruginosus*), Bittern (*Botaurus stellaris*) and Bearded Reedling (*Panurus biarmicus*) can be affected even more with zero nesting success. High density population of raccoon dogs are a severe threat towards amphibian fauna. If the species would establish in Southern Sweden species already at risk like European tree frog (*Hyla arborea*), Natterjack toad (*Epidalea calamita*) and Northern crested newt (*Triturus cristatus* page 20) would struggle even more to survive.*





Introduction

INVASION BY NON-NATIVE (ALIEN) species has been recognized as one of the main threats to global biodiversity. Among introduced species, predators have had the largest effect on native fauna globally, driving many indigenous species without any natural defense against the new predator to extinction.

Today, the impact of invasive alien species (IAS) is a major concern throughout the world and their management and control will continue to be a huge challenge for conservation biologists and managers during the coming decades.



The raccoon dog (*Nyctereutes procyonoides*) is an omnivorous generalist predator that was introduced from the eastern parts of Asia to the European parts of former Soviet Union during the years 1929–1955 to enhance the number of fur producing game species in the area.

Since then the raccoon dog has spread like a wildfire over large parts of Europe, threatening European biodiversity, (mainly rare ground nesting sea birds and

amphibians), animal and human health and thereby straining affected states economies with a need to manage its effects.

Before our project started in 2008 the raccoon dog was common in large parts of central Europe. It had invaded Finland early in its expansion process and could be found over the whole country, although only common and reproducing in the south and mid parts of the country. A few individuals had been found in Southern Denmark (Jylland). In Sweden single individuals had been seen occasionally for some years in the area bordering to northern Finland and was getting increasingly more common.

The first known reproduction of raccoon dog in Sweden was found on the Island of Haparanda-Sandskär close to the Finnish border in northern Sweden in 2006. Haparanda-Sandskär is a national park and a Natura 2000 area and a very important Island for ground nesting sea birds. The raccoon dogs were culled and shortly after this the work to find funding for a raccoon dog project started.

In 2008 the first national funding was approved for a project aiming to improve our knowledge about the biology and behavior of the raccoon dog in its expansion zone, and based on this knowledge to suggest tools to manage the invasive alien species.

The first study was followed by other national research and management projects where the tools were tested with promising results. We however soon realized that Sweden alone would not be able to stop the raccoon dog from establishing. Some raccoon dogs moved up to 400 km in a few months and a country border on a map was no dis-



persal barrier. For a highly mobile species such as the raccoon dog it is absolutely necessary with a transnational project, where neighboring countries in which the species already exists fulfill their ratified conventions from the Rio- and Bern convention and tries to stop the invasive species from spreading to other countries.

We applied for, and were approved, this LIFE+ project where we have shared our knowledge and tools with Finland and Denmark and where they have tried to stop further spread of the raccoon dog to Sweden and Norway.

In Finland a lot of knowledge and experience about raccoon dog management already existed after many years of raccoon dog research and hunting, for example regarding hunting with dogs and trapping, which were also incorporated in the application.

In Denmark the raccoon dog was only present on Jylland (the mainland bordering to Germany), and they also, besides from helping Sweden and Norway, wanted to stop it from spreading further to the rest of their country (the Islands Fyn and Sjælland).



Participating countries: Sweden Denmark and Finland. Circles shows the location of the first known reproduction in Sweden and the location of the first confirmed observations in Denmark, before the project started.



Project objectives

- Prevent damages on biodiversity.
- Prevent the establishment of wild, free-living and viable population of raccoon dog in Sweden, Norway and Denmark.
- Limit further increase and dispersal of the target species in Finland.
- Use innovative methods to reduce and eradicate invasive species like Raccoon Dogs.
- Use tagging with GPS/VHF transmitters for effective culling.
- Use innovative methods to learn more about the social behaviour of invasive species.
- Spread the results from the efforts in the project among hunters, local communities, ornithologists and international stakeholders of invasive species.
- Improve the awareness among public to report presence of Raccoon Dogs.



Expected results

- Prevent further dispersal of raccoon dogs from Finland to other regions in Sweden and further to Norway.
- Stop the dispersal in Denmark and eradicate or at least reduce the population.
- The innovative methods for culling and management of the raccoon dog, developed and demonstrated in the project can be used in other countries and possibly also in the efforts to prevent dispersal from other invasive species.
- The structure and organisation of the cooperation between the countries will work as a showcase for other countries.
- Raccoon dog population will be quantified during the project time by capturing, tagging and re-capturing.
- The actions above will lead to unaffected areas in Sweden and Denmark and where a population is already established, have a positive influence on the species affected by raccoon dog which is proved by earlier studies in Finland.
- The information activities will improve awareness to report observations and indications of presence of raccoon dogs which will facilitate further elimination of the target species.
- A well visited International Conference at the end of the project where stakeholders get relevant information from the results in the project.



Techniques/methodology implemented

INTERNATIONAL COOPERATION

We have created and implemented a transnational management framework for invasive alien predators.

MANAGEMENT

- **Early warning systems consisting of game cameras directed toward scent lures at possible immigration routes.**

Game cameras and scent lures are very efficient tools when managing elusive invasive alien predators. In total the project are using up to 500 cameras to detect new raccoon dogs (figure 1).



Figure 1: Layout of the early warning system of permanent game camera systems in the project area at the raccoon dogs potential invasion routes. Larger systems allows for population estimates through capture/re-sight techniques of marked animals when enough raccoon dogs have been captured on picture.

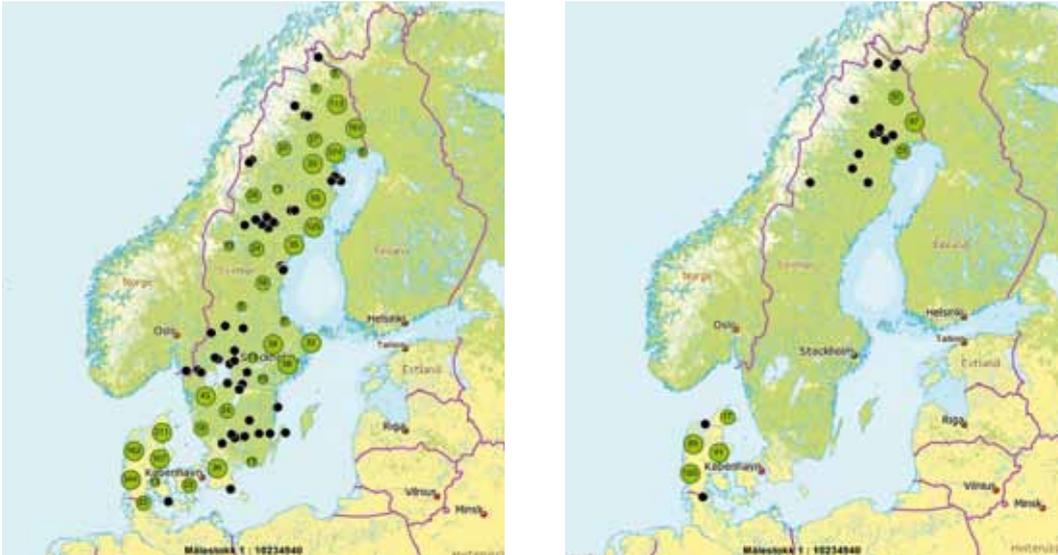


Figure 2: Citizens "raccoon dog" observations reported to the project and those that the project could confirm as actually being raccoon dog. Most common mistakes are badgers (*Meles meles*), red fox (*Vulpes vulpes*) and otter (*Lutra lutra*).

• Citizen science systems in Sweden and Denmark.

Raccoon dog observations by the public are followed up with infra-red motion triggered game cameras directed at scent lures and by tracking by professional personnel to try to confirm or dismiss the observation.

The citizen science system is one of our most important tools to find new raccoon dogs, especially in areas outside the core areas which the project personnel do not have time to cover at all times.

Reporting is done to a 24h telephone hotline and the phone number is distributed on the project home page (www.mardhund.se) and in the press in connection to articles or information about the project in nature/hunting magazines and newspapers/radio/television.

It is however often difficult to identify an animal, especially for a layman and even within the project it is impossible to be sure sometimes, so the citizen

science system has to be used with some care and managed professionally.

The project never confirms observations that we are not 100% sure about and that have not been thoroughly controlled by our professional managers, not even pictures.

The risk with confirming observations that are not 100% safe is that we then would already have raccoon dog over all of Scandinavia, that is, animals that are believed to be raccoon dog but that in fact are something different. This in turn would be a serious threat against our work with trying to stop the raccoon dog since the authorities might then take the decision that the battle is a lost cause and stop the funding.

We know by previous experience that most observations of likely raccoon dogs are in fact other species (figure 2). Visit our homepage www.mardhund.se and search for observations.

• **Hunting with dogs and traps, both for culling and tagging.**

Sweden and Denmark have learnt a lot from our Finnish colleagues regarding hunting with dogs and trapping of raccoon dogs during the project.



Above: *Ebba (the dog) putting a raccoon dog at bay.* Below: *Raccoon dog outside cage trap.*



- **Transmitter (GPS/GSM) tagged animals that lead us to new individuals (Judas animals).**

- **Sterilisation of released transmitter animals so they will not be able to reproduce if we were to lose them through transmitter failure.**

The raccoon dog is monogamous and lives in life long pair relationships, if one of the partners dies the other one will start searching for a new partner. Juveniles will also start searching for a partner when they reach sexual maturity. This social behavior is used in the project.

Instead of culling all animals we capture, some are used to find other animals. This management method gets proportionally more efficient the lower

the population density get. At high density it is relatively easy for humans/dogs to find animals, but at very low densities it is very difficult. The raccoon dog is however very efficient in finding individuals of its own species.

Since all released raccoon dogs are sterilized (in Sweden and Denmark) no new pups will be born if they find a partner and the transmitter stop functioning.



Left: Raccoon dog fitted with ear tags and GPS collar transmitter. Right: A GPS collared and sterilized female raccoon dog photographed by one of the project game cameras showing that she has found a new unmarked male. This was the third male this female delivered to the project.

• Dissemination of results and education of hunters, ornithologists and the public leading to higher awareness of IAS among the public in general and higher quality tips about raccoon dog occurrences coming in to the project through the citizen science system in particular.

Dissemination of project experiences and results, on the web page, in local communities, in relevant magazines, newspapers, radio and television as well as short courses for hunters and other nature organisations and education from kindergarten to university level are all very important parts of the project.

All of these actions aims at a higher awareness and larger knowledge among the public about IAS in general and the raccoon dog in particular, and will lead to more observations being reported, and a higher quality of the observations which

will enable the project to put the efforts where most needed instead of hunting other species mistaken for raccoon dog.

While actions directed towards e.g. local hunters will give a direct effect in the form of more animals culled, actions directed at small school children and university students will give an effect in the longer term since those persons are to take over nature management in our countries.

Visit our web page and have a look at our After-LIFE communication plan (www.mardhund.se).



Lesson for school kids on raccoon dog management in Finland.

- **International conference to disseminate our results and methods to other managers and scientists outside the Nordic countries.**

In the summer of 2013 the project hosted a much appreciated conference about invasive alien predators. The conference gathered approximately 100 participants from 13 countries and three continents.



Visit our home page www.mardhund.se and read the conference report.

MONITORING

- **Larger camera based monitoring systems at the main immigration routes of the raccoon dog in all countries allow us to follow the development of the populations.**
- **Combining the camera monitoring systems with marked transmitter animals allow us to calculate population estimates (mark-recapture techniques).**
- **A population model allow us to model the effect of our actions and future development of the population.**
- **A database where all management data are gathered has been implemented.**

Results achieved

Capture and culling

During the project, Sept 1 2010, to Aug 31 2013, 2 272 observations of likely raccoon dog were reported to the project in Sweden. Out of these, 364 were confirmed as raccoon dogs by the project, whereof 319 were captured and/or killed (culled by project personnel, hunters, traffic, found dead). 80 of the animals have been used as Judas animals.

In Denmark 962 observations of likely raccoon dogs were reported to the project, whereof 488 have been confirmed. Of these 402 were captured and/or killed (culled by project, hunters, cars, found dead). 46 of the animals have been used as Judas animals.

In Finland 680 animals has been culled in the northern management area closest to the Swedish border. Most of these have been killed by hunters involved in the project (with traps or dogs) and with the help from the Judas animals. 44 animals have been used as Judas animals in Finland.

There are no new confirmed raccoon dog observations outside the areas where they were already present before the LIFE+ project started.

No raccoon dog has during the project been confirmed in south or mid-Sweden, or on the Islands of Fyn or Själland in Denmark.

Table 1: Raccoon dog capture/culling in Scandinavia 1/9 2010 to 31/8 2013
Source: LIFE09 NAT/SE/000344 (2010-2013 project)

Country	Reported observations	Confirmed animals	Captured or killed	Judas animals used
Sweden	2 272	364	319	80
Denmark	962	488	402	46
Finland	N/A	N/A	680	44
Total	3 234	852	1 401	170



Population development

The number of unique individuals captured in the camera systems per time unit has been used as an index of the population development, i.e. a catch per unit effort index (CPUE). All countries CPUE show a decrease in photographed individuals per camera month. The populations are thus according to our population index decreasing (figure 3).

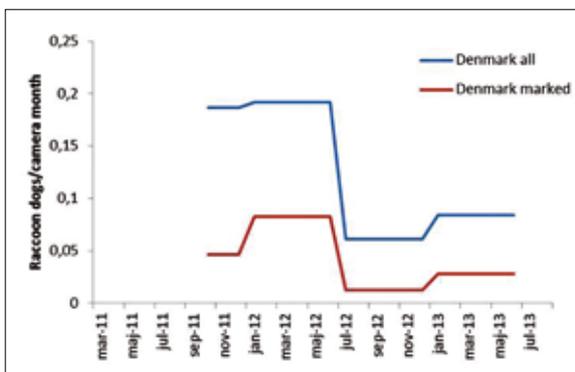
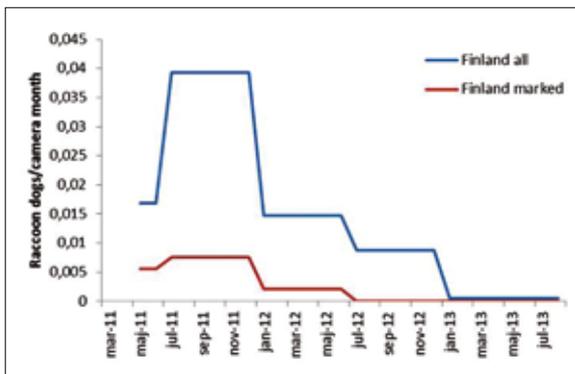
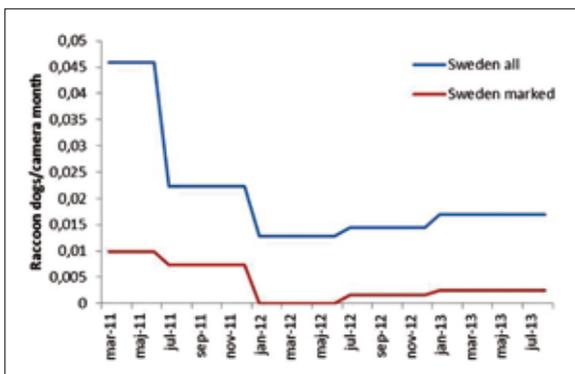


Figure 3: Catch per unit effort in the Swedish, Finnish and Danish EWS systems, all animals (blue) and marked animals (red). The index cannot be used to compare densities between countries.

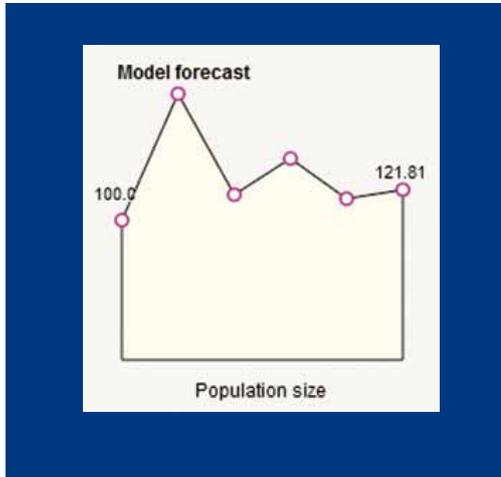


Figure 4a. Population development during five years including our efforts in culling and sterilisation.

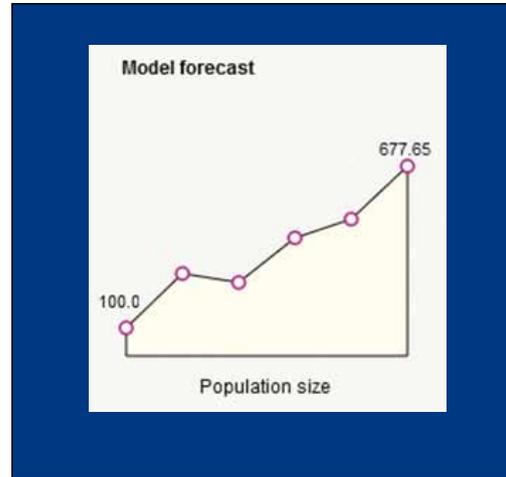


Figure 4b. Population development during five years without our efforts in culling and sterilisation.

Population modelling

We have constructed an individual based population model for the raccoon dog. The model has been demonstrated in Sweden where we have sufficient knowledge of the population dynamics of the population to use it properly.

A capture-recapture estimate (based on the EWS camera system and proportion of marked animals in the catch) in Sweden gave an approximate number of 100-150 raccoon dogs in winter population in Sweden during the project.

By using 100 individuals as initial population size (i.e. approximately the size of the adult population in Sweden during the project) and the parameter estimates estimated from the project data in Sweden our population model suggest that the population will be kept at a constant size during the first five years with our management actions and thereafter it will start decreasing (figure 4a and 5a).



So far this prediction seems close to the real outcome according to our results. However, if no effort had been done to limit the population there would have been well over 650 individuals after five years according to the model (figure 4b).

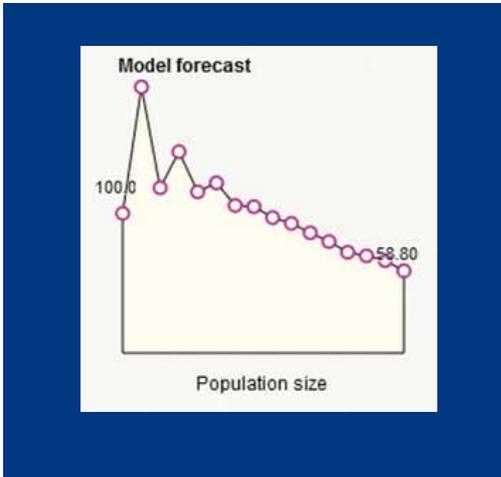


Figure 5a. Population development during 15 years including our efforts in culling and sterilisation.

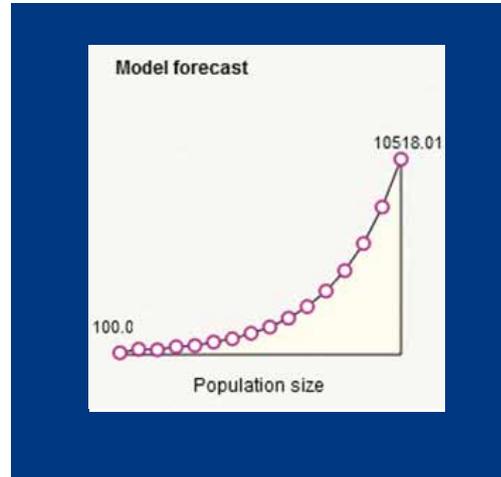


Figure 5b. Population development during 15 years without our efforts in culling and sterilisation.

Continuing the management with the same intensity, given that the input data reflects the reality reasonably well over time, would mean that the population start decreasing after about five years, and within 10-20 years only a few raccoon dogs remain (figure 5a).

On the contrary, stopping the management would mean that we would have at least 2500 raccoon dogs in Swe-

den in ten years' time and over 10 000 in 15 years' time, i.e. the population would increase exponential as it has done in Finland and other countries invaded by the raccoon dog (figure 5b).

In Finland they shot 800 raccoon dogs in year 1980. In year 2000 they shot 85 000 individuals and in year 2011 they shot close to 180 000 raccoon dogs.



Discussion

Cost-benefit discussion of the management

Costs associated with management of invasive species are substantial. Our project is seemingly rather expensive with a budget of 5.3 million Euros over three years for our three countries.

However, given the alternative of 10 000 raccoon dogs to start manage in Sweden in 15 years' time this cost is in fact rather modest.



The difficulty is to comprehend that even though the species is doing very little harm at low densities the costs associated with a neglected management will also increase exponentially with time if nothing is done right from the start.

In our case the raccoon dog populations in Sweden and Denmark are too small to give a measurable effect on biodiversity at the moment.

Even if 100 raccoon dogs would eat only eggs and amphibians, it would be impossible to pick up any measurable effect over the whole area. Locally a few individuals may do large harm on for

example an island, but to find that particular island is like looking for a needle in a haystack. In Finland there has been found effects on biodiversity in important bird recruitment areas and possibly on amphibian populations in the archipelago, however, even there, with their large raccoon dog populations, it is not strait forward to prove the effect over larger areas, yet.

Often it takes many years before an effect becomes evident, and then it is usually too late to do much about it.

Logic reasoning however tell us that if we get a new predator in an ecosystem, in some areas increasing the predator density from 0.5–0.8 predators (red fox and badger) to 20–30 predators (red fox, badger and raccoon dog) per Km², there will be effects.

In Finland they are today trying to stop new outbreaks of rabies, which were essentially found in raccoon dogs in their last outbreak in the late eighties.

The cost of this preventive management in the form of medicating immigrating predators from Russia and vaccination of dogs cost approximately one million Euros per year.

The cost of management (predator control) of valuable wetlands (bird recruitment areas) cost 3.3 Euros annually per hectare, and then the work has to be done voluntarily. Neither the cost for general hunting of raccoon dogs are reimbursed, the cost for culling 180 000 raccoon dogs per year would be tremendous.

In for example Sweden we have 9 million hectares of wetlands, not all of this land is of course of certain consi-



deration, but only managing the most important wetlands would mean a very high cost if we had the same population size of raccoon dogs as in Finland, and we will have in the future if we do not stop them from establishing now.

After LIFE management

The Nordic governments have understood the long term threats that are potentially facing our countries in the future. It has, on Swedish initiative, been written and signed a state secretary intent between the Swedish, and Norwegian ministries of environment and the Finnish ministry of agriculture and forestry, stating that the countries want to develop their cooperation to stop the raccoon dog from spreading between countries.

They argue that it is a common and prioritized question to take action to prevent raccoon dog establishment and to stop its dispersal within and between countries.

They further argue that it is a common prioritized question to secure funding to be able to take those actions. This intent has however just been signed and no decisions regarding the funding have yet been taken in the time of writing.

The Danish ministry of environment was not part of the intent, however, the Danish Nature Agency has approved funding at least until the end of 2015, where after the project and the management plan shall be evaluated before possible continuation.

At the time of writing the funding for the next year is also secured in Sweden and Norway. Norway was as a non-EU country not allowed to participate in the LIFE project. They were however a financier and part of our LIFE+ project steering group. Norway is now a full partner of the transnational management cooperation. Visit our web page www.mardhund.se and have a look at our After-LIFE conservation plan.



Transferability of project results

We have during the LIFE+ MIRDINEC project demonstrated that our innovative methods for culling and management of the raccoon dog work very well in many different habitats from northern Sweden to southern Denmark.

We have also been able to confirm that our tools work on other invasive predators; several raccoons (*Procyon lotor*) have been culled within the project in Denmark and Sweden.

We have further demonstrated a successful cooperative management of invasive predators between several countries which is an absolute necessity when trying to manage especially highly mobile species, but the common framework is also very useful when it comes to share new methods and tools that will enhance the management of other invasive alien species in all involved countries.

Lessons learnt

- Use efficient methods, be innovative.
- Cooperate between neighboring countries, national agencies and projects for cost-efficient management.
- Disseminate results and involve the public, citizen science can be very helpful.
- Involve, educate and cooperate with local stakeholders such as hunters.
- Cooperate with applied research to improve methods as new data are produced.
- Monitor the population in some way, even though it may be difficult, otherwise you will not know how you are doing and what needs for improvements there are.



Project detaljs

LIFE09 NAT/SE/000344

Management of the invasive Raccoon Dog (*Nyctereutes procyonoides*) in the north-European countries (MIRDINEC)

Duration of the Project: 01-09-2010 – 31-08-2013

Total budget of the project: € 5 318 278 (Of which the major part € 2 659 139 is provided by the European Commission LIFE+ fund and € 2 331 000 by the Swedish Environmental Protection Agency. The rest is provided by the beneficiaries and external financiers).

Coordinating Beneficiary:

Swedish Association for Hunting and Wildlife Management



Associated Beneficiaries:

Swedish University of Agricultural Sciences (SLU), Swedish Environmental Protection Agency, Finnish Wildlife Agency, Danish Nature Agency.



Miljøministeriet
Naturstyrelsen



Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

External cooperation:

National Veterinary Institute (Sweden), Swedish Institute for Communicable Disease Control (Sweden), Norwegian Environment Agency (former Directorate for Nature Management) (Norway), County Administrative Boards of Västerbotten, Norrbotten and Skåne (Sweden), Danish Hunters Association (Denmark), Federation of Associations for Hunting and Conservation of the EU (FACE, Belgium).

Co-financiers other than beneficiaries:

LIFE+ and Norwegian Environment Agency (former Directorate for Nature Management) (Norway).



