Justification and guidelines for genetic rescue of the endangered Saimaa ringed seal, conducted by University of Eastern Finland (UEF)

Photo: UEF

Action A1: Preparing a genetic rescue plan of Saimaa ringed seal

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Abstract

The endangered Saimaa ringed seal (*Pusa hispida saimensis*) population has low genetic variation and is fragmented. To enhance its genetic resilience, translocations have been recommended by geneticists for increasing the long term survival of the population. Due to the unique characteristics of the Saimaa ringed seal and unpredicted risks of pathogens or diseases, only within-lake translocations are considered. This report summarizes the translocation action covering the entire process, including planning, transfers, release, monitoring and post-release management. Permissions from several authorities are applied before the first field season. The translocation process is evaluated when applying required permits to conduct the translocations. Seal capturing and handling are done during the annual molting season in spring, starting in 2023. The current plan is to translocate around five adult seals (primarily target females) from a source area (Pihlajavesi) to recipient areas: Kolovesi (1-2 seals) and Etelä-Saimaa (2-3 seals) basins. The number of translocated individuals has been selected according to general guidelines in order to preserve the genetic diversity of the recipient population. The personnel have the required skills to capture the seals and wildlife veterinarians supervise the process and ensure animal welfare issues. The translocated seal individuals are equipped with telemetry tags, if possible, for immediate tracking of their behavior. In addition, the fur patterns are photographed and DNA-samples collected to monitor the individuals by photo-ID and genetic methods in the long term. Genetic data together with census data on population parameters are used for evaluating the long term success of the translocations.

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Hanke on saanut rahoitusta Euroopan unionin LIFE-ohjelmasta. Aineiston sisältö heijastelee sen tekijöiden näkemyksiä, eikä Euroopan komissio tai CINEA ole vastuussa aineiston sisältämien tietojen käytöstä.

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1. Introduction

Genetic rescue aims to improve the fitness of wildlife populations by increasing/restoring genetic diversity and reducing extinction risks by moving individuals between populations (Whiteley et al. 2015). Translocations are commonly used, and have been successful in the recovery programmes of many endangered species globally (IUCN 2012). Translocations have been typically carried out in small, isolated and inbred populations. For a number of genetically depauperate mammals, it has led to direct fitness benefits (e.g. Hoggs et al. 2006, Johnson et al. 2010, Hasselgren et al. 2017, Weeks et al. 2017) and especially when applied together with other measures such as habitat protection, it has the potential to be an effective conservation approach for the mitigation of the negative effects of the genetic variability loss.

The Saimaa ringed seal (*Pusa hispida saimensis*) is a typical example of a small and fragmented endangered population. As an endemic and landlocked subspecies, it has suffered from a variety of human induced factors such as habitat loss, environmental toxins and incidental by-catch mortality. As an ice and snow dependent species, the population is also increasingly affected by climate change (e.g. Kunnasranta et al. 2021). In addition, the genetic diversity of the Saimaa ringed seal is among the lowest ever detected in pinnipeds (Valtonen et al. 2012, Nyman et al. 2014, Stoffel et al. 2018, Peart et al. 2020). Moreover, the current population of some 400 individuals is divided into genetically semi-isolated subpopulations (Figure 1; Valtonen et al. 2012, 2014, Sundell et al. submitted). This is worrying, as it can make this rare population even more vulnerable to both stochastic demographic and genetic events such as inbreeding depression resulting from lack of gene flow, allelic fixation due to genetic drift and further loss of genetic diversity. With a low migration rate between the different water basins, the subpopulations further risk losing genetic variation (Löytynoja et al. 2023). Translocation within the lake has been proved to be successful as one female has already been translocated in the 1990s from Central to South Saimaa, where it has been observed to give births and survived till today. Moreover, Löytynoja et al. (2023) reported that this translocation had an effect on the genetic variation of the Southern local population. Based on concerning results from genetic studies (Palo et al. 2003, Valtonen et al. 2012; 2014, Nyman et al. 2014, Stoffel et al. 2018, Peart et al. 2020, Kunnasranta et al. 2021) and recent whole-genome sequencing of the Saimaa ringed seal, Sundell et al. (submitted) recommended additional within lake translocation of individuals between the different subpopulations to maintain the current genetic diversity and reduce the risk of losing local subpopulations.

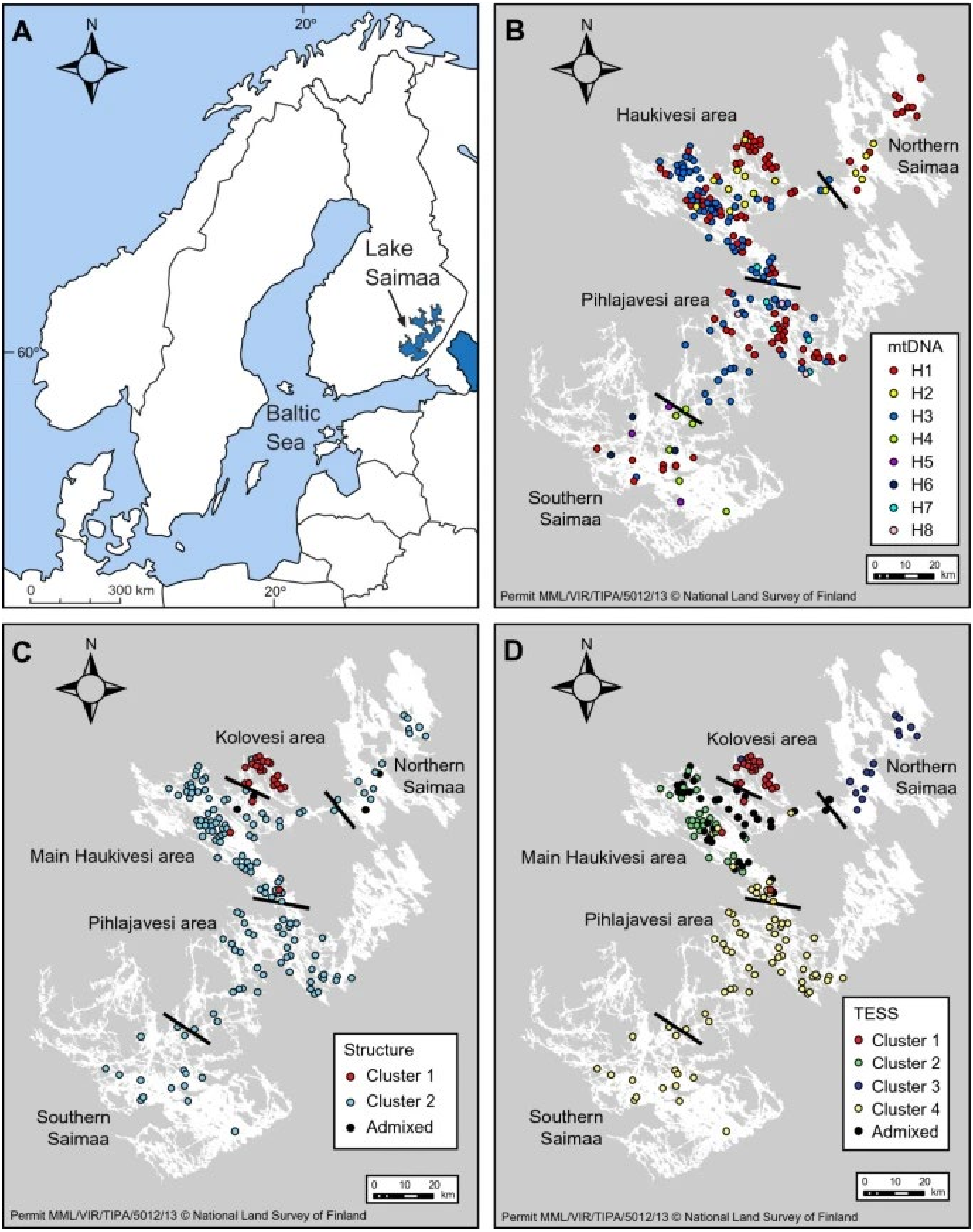

Figure 1. Fine scale population substructure of the Saimaa ringed seal based on mitochondrial (B) and nucleic (C and D) DNA. Capture from Valtonen *et al.* (2014).

2. Description of genetic rescue as a conservation tool for the Saimaa ringed seal

The isolated Saimaa ringed population (~400 individuals) is genetically, morphologically and behaviorally different from other ringed seal subspecies (e.g. Kunnasranta et al. 2021, Löytynoja et al. 2023, Sundell et al. 2023). Serious concerns about conservation status of the population have been raised due to its extremely narrow gene pool and its division into genetically isolated subpopulations. The genetic rescue action for the Saimaa ringed seal aims to improve gene flow in order to maintain the current genetic diversity by the introduction of new individuals (and genes) into a target subpopulation from a source subpopulation within Lake Saimaa. Due to the unique genetic and ecological characteristics of the subspecies and unpredicted risks of pathogens or diseases, only within-lake translocations will be considered.

According to the IUCN (2013), the proposed translocation plan for the Saimaa ringed seal falls into the **reinforcement** category, which is *''the intentional movement and release of an organism into an existing population of conspecifics. Reinforcement aims to enhance population viability, for instance by increasing population size, by increasing genetic diversity, or by increasing the representation of specific demographic groups or stages*''. However, in the case of the Saimaa ringed seal, the aim is to maintain rather than increase the genetic diversity of the population.

3. Authorizations and enforcement of translocation actions

Translocation actions meet the regulatory requirements at national and regional levels. Actions need permissions from the Animal Experiment Board in Finland: a permit related to Animal welfare Act and from the regional Centre for Economic Development, Transport and the Environment (ELY)-centres that provide permits related to the Nature Conservation Act. Furthermore, a permit from Metsähallitus is needed for conducting research based actions in the areas owned by the government and to depart from the regulations concerning the national parks.

4. Source and recipient areas

The scientific paper of Sundell et al. (2023) describes the genetic background for the translocation needs of the Saimaa ringed seal population. According to them, the potential source areas are Pihlajavesi and Haukivesi basins. These areas showed the highest proportion of unique Single Nucleotide Polymorphisms (SNPs). SNPs are modifications in the DNA sequence and can be considered as an estimator of the level of genetic diversity. However, due to the extensive variation in the sample sizes between the different regions of Saimaa, caution should be used in the choice of source population as the reported SNP level might not reflect the actual inbreeding level. Moreover, this choice cannot be based on genetic aspects alone. The current demography of each subpopulation needs to be considered. Although South Saimaa seals also had a high number of unique SNPs, this southern population is much smaller and therefore should not be considered. Pihlajavesi (130 seals) and Haukivesi (90 seals) basins contain more than half of the entire population and are therefore the best candidates. Based on the most recent population growth report, Pihlajavesi has been selected as the source population for the translocation plan.

The most suitable recipient area would be Kolovesi basin as its subpopulation is the most genetically isolated (Valtonen 2014). Moreover, it is estimated that Kolovesi subpopulation has been declining despite the overall demographic increase in Lake Saimaa, and only hosts between 8 and 16 individuals, with only one reproducing female per year. Thus, if gene flow is not enhanced in this region, its genetic diversity will be lost within one or two generations. Besides, Kolovesi would provide suitable habitat for the seals due to its national park status with strict regulations. Although translocation should be primarily done in Kolovesi basin, other regions could be considered as recipient areas to preserve the overall diversity present in Lake Saimaa. For instance, North Saimaa showed one of the lowest levels of unique SNPs (Sundell et al. 2023). However, the habitat in North Saimaa is more subject to human disturbance (e.g. higher human density around the lake in this region) and thus is not suitable. South Saimaa, on the other hand, is a region where the seal population has increased, and more area-wise protection is provided making it suitable for the population expansion.

5. Number and sex of individuals that are candidates for translocation

The mortality rate of Saimaa ringed seals is especially high in the first year of their lives. Thus, we recommend to target exclusively adult individuals to optimize the success of the translocation. As a general guideline, the number of translocated individuals should not exceed 20% of the gene flow in the recipient population in order to preserve its original genetic diversity (Hedrick 1995). However, the demographic situation of Kolovesi basin is such that the introduction of even one reproducing individual will be beneficial and help to preserve at least some of its genetic diversity. We recommend the translocation of two individuals in this area to optimize the success of reproducing without replacing the whole genetic diversity in Kolovesi. Also, these two individuals should be of same sex to prevent mating between the two translocated seals, which would not directly help in the preservation of Kolovesi genetic diversity. If more individuals are captured, they will be translocated to South Saimaa. However, a maximum of 2-3 individuals should be considered to preserve the original genetic diversity of South Saimaa while maintaining the breeding dynamic in Pihlajavesi region.

Niemi et al. (2019) reported mutual avoidance in breeding females. However, the recipient area of Kolovesi is suffering from a demographic deficit and the introduction of such a low number of females should not disrupt the basin's dynamics. Moreover, it is possible to confirm the success of the translocation if the translocated females are observed with pups, however, the long-term success would need to be assessed by continued genetic monitoring of indices such as the inbreeding coefficient. Monitoring the success of males, translocation is also possible through genotyping of placentas in the recipient area. A previous translocation of a female to South Saimaa (Kunnasranta et al. 2021), which was succeeded by several observations of her with pups through the years, speak in favor of female translocation. The male breeding system is relatively unknown in Lake Saimaa. If some male sexual dominance exists, the translocation of a male might not be successful as it would not necessarily reproduce in the new area due to poorer ability to compete over females. Although the capturing of seals is challenging and might not enable us to actively target preferred individuals, we recommend to primarily target adult females.

6. Field protocols for capturing, handling/transfer and release

The design and implementation of translocation actions follow standard stages of project design and management. Practical goals and processes for the translocation actions (including logistics, risk assessment, feasibility, implementation, monitoring and evaluation) will be determined before the commencement of field work, based on permit requirements and the up to date genetic status. In addition, suitable individuals for translocation (age class, sex, body condition) will be selected by non-invasive monitoring methods (photo-ID and genetic) in the source area(s). Suitable locations for release will be identified in the recipient area(s). Equipment for seal capturing, handling, and tagging will be ordered and tested. Staff will receive training for animal capturing and handling.

The translocation field work will commence in spring 2023. Chosen seals are captured from haul-out sites during the annual molting season in May-June with tangle nets that are constantly monitored. Seals are transported immediately from the source area to the recipient area (distance max 100 km) by a powerboat. The seals are individually transported in captivity, involving a prolonged restraint in a custom-made box that prevents injury to the seal and to the personnel. Seals are released into their new environment after tagging (flipper tag, GPS-device) and sampling (hair, saliva, and blood samples, see Appendix 1). In addition, pelage patterns on both sides of the seals are photographed for later identification purposes. During the handling, the weight and other measurements will be taken. Ringed seals are manually restrained during handling and no sedation is needed. In case the molting process of the individual is not completed, no tracking device will be glued onto the pelage.

7. Animal welfare

Translocations will be performed according to the accepted international standards for animal welfare, and all possible efforts are taken to reduce stress or suffering. As stress is inevitable, it needs to be considered during the capture and handling, captivity, transportation and release. However, there are many ways to reduce it and avoid chronic stress (Dickens et al. 2010). The welfare of the individuals is monitored during capture and transport, and handling is performed by experienced staff. The group has previous experience on capturing seals and keeping them in captivity for a short period of time (maximum of a few hours). Any new personnel will be appropriately trained. The personnel responsible for the animal handling are licensed to conduct animal experiments. The possible rise in body temperature of the captured seals is mitigated by cooling the animals during transport and handling. Protocols related to animal welfare issues are supervised by a wildlife veterinarian. The captivity and transportation time is minimized and the translocation is conducted during the capture day, as the degree of stress is also dependent on the distance and time in transit (Dickens et al. 2010). Furthermore, possible capture and release sites will be monitored beforehand (starting in field season 2022) to find the most suitable individuals (as seals shows moulting site fidelity (Biard et al. 2022)) and habitats for translocation, while aiming to avoid proximity of human constructions and other possible sources of disturbance for the translocated animals.

8. Monitoring and evaluation

Monitoring the behavior of newly translocated individuals can be a valuable, early indicator of translocation success (IUCN 2013). Therefore, after the release, the behavior of translocated seals is monitored for the short term (less than one year) with GPS-tags that are glued to dorsal pelage (see e.g. Niemi et al. 2012). Tags provide detailed, daily information on movement and activity patterns for a maximum of 9 months. Long term monitoring are carried out by lair censuses (Sipilä 2003), photo-ID (Koivuniemi et al. 2016) and genetic approaches (Valtonen et al. 2015), which provide information on survival, health, breeding success, site fidelity, growth, spread and genetic diversity of the local populations.

9. Risk assessment

The worst-case scenario is the death of or injury to an individual during the translocation process. To minimize the risk of this happening, the individuals will be monitored closely during all the steps of the translocation. Moreover, the translocations will be performed under the supervision of a wildlife veterinarian. In addition, the team is composed of experienced staff that have successfully captured and deployed seals with telemetry devices without any events of mortality or injury.

Chronic stress can lead to reproduction failure, diseases (due to inhibited immune function), starvation and movement away from the release site (Dickens et al. 2010) thus resulting in translocation failure. Stress factors will be taken into consideration and minimized in all stages of the translocation (see chapter 7). It is also possible that individuals are able to return to their capture area.

10. Conclusions

The conservation target for genetic rescue of Saimaa ringed seals aims to preserve and maintain the genetic diversity of the subpopulations within Lake Saimaa. This is suggested to have long-term benefits for the survival of this endangered population. At the moment, the population is fragmented to small subpopulations and shows high levels of inbreeding; thus the risk of losing further genetic differentiation can lead to reduced fitness. The action aims to augment gene flow by translocating seals within the lake, preferably adult females from the source population of Pihlajavesi to the recipient area of Kolovesi (N=1-2) (and possibly South Saimaa, N=2-3). The capturing methods and equipment have been developed and used successfully in previous telemetry studies. Furthermore, one female has been translocated successfully in the 1990s from Haukivesi basin to South Saimaa, where it has been observed to give birth to several pups and is still alive. Translocation is an invasive method, thus the risks will be evaluated externally by the permit process applied from conservation and animal welfare authorities. The risks include the death of the translocated individuals as the worst-case scenario. However, if successful, the genetic rescue by translocation would offer clear improvement for the present situation and enhance the fitness of the whole Saimaa ringed seal population.

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Appendix

1. Handling form to be filled after capturing the seal.

Käsittelykaavake Saimaannorppa/UEF

PVM	Nimi & Phs-koodi	Sukupuoli	Ikäluokka

Pyyntipaikka	klo	Koordinaatit

Vapautuspaikka	klo	Koordinaatit

Käsittelijät

Pyyntitapa

O Verkko
O Muu, mikä?

Mitat

Paino: ______________ kg

Nenä-anus: ______________cm

Nenä-häntä: ______________cm

Nenä-takaräpylä: ______________cm

Max ymp. mitta: ______________cm

Karvanvaihto

O Ei aloittanut
O Vaihtunut
O Kesken
O Ei osaa sanoa

Näytteet

O Karva
O Sylki
O Nahka
O Veri
O Täi _______kpl
O Muu, mikä?

PhotoID-kuvat ja erikoistuntomerkit

O Vasen
O Oikea
O Maha
O Selkä

Seurantalaitteet (takaselkä)

Räpylämerkki

Numero:_____________
O Vasen O Oikea

Väri:________________

Muistiinpanoja

Hyvinvoinnin seuranta

Klo	Lämpö	Pulssi	Hengitys frek.