A **SYSTEMATIC MAP** OF **TRANSLOCATIONS** INVOLVING **PROTECTED AREAS** WORLDWIDE

Summary :

This work was carried out as part of LIFE Natur'Adapt project, to support managers in their choices for the adaptation plan. Following the systematic map method and based on the analysis of 498 articles, 841 experiences of translocations (manual species movements), animal, plant and sponge, involving a protected area in the world between 1969 and 2020, were compiled in a database (Langridge et al., 2021). This catalog shows that translocation is a frequently used tool within protected areas. Protected areas can be the source of individuals to be translocated, but they are also the destination of these translocations. Translocations primarily concern animals, and mammals in particular. They are mainly reintroductions, sometimes accompanied by reinforcement, of species originally present in protected areas, but which have declined there for various reasons. According to our analysis of the literature, very few translocations have been motivated by climate change; the main reason for these translocations being the conservation of a previously present species in decline. Finally, it would be interesting to evaluate the success of all these translocations, a task that has not been carried out as part of this systematic map.

Highbush knapweed

To remember : This work has resulted in a catalog of 841 translocation experiences involving protected areas (different IUCN categories). It shows that, for the moment, protected areas are hardly using translocation as a tool for adapting to climate change; however, there are no obstacles to doing so, and we can expect this type of experimentation to become more widespread in the near future. At this stage, our work has not examined the probability of success of these experiments (survival of displaced individuals).

1. Background

As part of LIFE Natur'Adapt project, three management measures were studied through literature reviews (map and systematic review, meta-analysis) in order to better understand how these measures can be used to adapt protected area management to the context of climate change. Translocation is one of the three measures studied.

Translocation is the manual movement of plant or animal species. It may involve introduction, reintroduction or reinforcement. Not only is translocation a tool for species conservation, it is also increasingly presented as a potentially interesting tool for adapting to climate change. Indeed, by taking strong action, individuals can be moved to an area where the climate will remain or become favorable for the species in question, thus ensuring its survival. This intervention can help overcome the difficulties faced by certain species in migrating on their own (physical barriers, speed of climate change, etc.).

2. Method

The exercise was based on the systematic mapping method proposed by the Collaboration for Environmental Evidence. A bibliographical search was carried out using 2 databases, 4 search engines, 5 websites and a call for literature. 6354 documents were collected and sorted. In the end, 498 articles were retained and 841 unique translocation operations were extracted. The relevant information (location, species, protection status, etc.) was compiled into a detailed database (see link at the end of the document). This work has been published in open access in the *Environmental Evidence Journal (Langridge et al., 2021)*. Upstream, a methodological protocol was also published in the same journal, as required by the systematic review method *(Langridge et al., 2020).*

➢ Hermann tortoise - ©By Orchi

3. Main results

841 translocations were recorded, from 1969 to 2020. They concern animals (82%) much more than plants (18%). Mammals are by far the most concerned group among animals (56% of operations, corresponding to more than 70,000 individuals across 383 operations). It should be noted that very few marine organisms were involved in translocation operations.

The majority of translocations took place in North America and Oceania, although 69 countries around the world were involved, including France (see box on page 4).

Most translocations were one-off reinforcements or reintroductions followed by reinforcements. In the case of animals, more than a quarter of translocations (176 out of 686 translocations, or 25.7%) were «reintroductions + reinforcements». The classic case concerns a species that has disappeared from its past range, which is reintroduced, with a first group of individuals in the first year, then with new individuals reinforcing the new population in subsequent years. As far as plants are concerned, around a third of the operations (44/155, 28%) are one-off reinforcements, involving fragile but still existing populations.

An average of 529 individuals are translocated per operation, but this figure varies greatly depending on the translocation, with a median of 20 individuals. Similarly, the stage of individuals translocated (adults or juveniles for animals; seeds, seedlings or plants for plants) is quite variable, and there is often a combination of several stages for a single operation. As a result, practices vary considerably, which is probably detrimental to communication on this subject.

When it comes to monitoring translocated individuals, operations are primarily concerned with survival parameters (proportion of individuals still alive or mortality level «x» years after translocation), demographics (e.g. growth rate of the translocated population) and land use (dispersal of individuals from the release site, distribution of the population after release, etc.).

White-clawed crayfish

Focus on France

Within the systematic map, 16 translocations were recorded in France (see table opposite). None were motivated by climate change. Half of these translocations concern the same species, the European pond turtle *(Emys orbicularis*). This turtle was the subject of reintroductions, sometimes followed by reinforcements, between 2000 and 2012, in 3 different localities and involving a total of over 330 translocated individuals. In particular, 5 translocations took place in the Bagnas National Nature Reserve, involving 271 individuals from the wild or captivity.

Other species included another turtle, Hermann's Tortoise *(Testudo hermanni hermanni*), vultures (Bearded Vulture (*Gypaetus barbatus*), Black Vulture (*Aegypius monachus*), Griffon Vulture (*Gyps fulvus*)), European Deer *(Capreolus capreolus*) and White-clawed Crayfish (*Austropotamobius pallipes*).

Nine translocations involved moving animals taken from outside a protected area into a protected area, and only one experiment involved taking animals from within a protected area for translocation outside. One translocation also took place entirely within the same protected area.

Four translocations took animals more than 100 km from the collection point, 3 of which involved a change of climatic envelope.

The only experiment recorded, which is also the only introduction, concerns a plant species, the Highbush Centaurea (*Centaurea corymbosa*), a self-incompatible species (i.e. one whose fertilization within the same flower, between flowers of the same plant, or between genetically close plants is impossible).

This species was introduced from seed (around 2000), on an experimental basis in an unoccupied area of the Massif de la Clape, where it is endemic, in 1994-1995. A scientific study then compared the 10-year demographics of the two populations formed by this introduction and six natural populations.

Overall, survival rates were higher in the introduced populations (better site conditions) than in the natural populations, but the introduced populations had lower fecundity (limited by self-incompatibility). In the end, population dynamics between introduced and natural populations proved to be quite similar, as survival and fecundity offset each other.

This study shows that the creation of new populations by seed introduction is possible, even for species whose fecundity is limited by self-incompatibility. To maximize the chances of success, the authors recommend sowing seeds from different sources, at high densities and over several years, to increase the availability of partners and ultimately fecundity.

➛ European roe deer

Translocations recorded in France as part of the Natur›Adapt systematic map

Etude	Prog.	Période	Espèce	Action	Provenance	Aire protégée	Distance Capture/ Relaché (km)	Nombre d'individus	Age des individus	Milieu de relâché
1	C	2000 2002	Cistude d'Europe *Emys orbicularis*	R	MN	V	?	35	A	A
2	C	2007		R	MN	D-V+	?	29	?	ZH
3	C	2008		R	MN	V	?	26	?	ZH
4	C	2007 2012		R+Rf	MN, C	V+	?	71	A/J	ZH
5	C	2007 2012		R+Rf	MN, C	V+	?	74	A/J	ZH
6	C	2008 2009		R+Rf	MN	D-V	70,7	30	A	ZH
7	C	2008 2012		R+Rf	MN, C	D-V, ?-V, V	101,8	65	A/J	A/ZH
8	C	2008 2012		R+Rf	C	V	?	71	?	ZH
9	S	2013 2016	Tortue d'Hermann *Testudo hermanni hermanni*	S	C	V	?	24	A	F
10	C	1987	Gypaète barbu *Gypaetus barbatus*	R	C	V	?	39	?	F / O
11	C	1992 2004	*Vautour moine Aegypius monachus*	R+Rf	C	V	?	53	A/J	?
12	C	1993 1997	Vautour fauve *Gyps fulvus*	R	MN	V	126,4*	50	?	?
13	E	1995 1997	Chevreuil européen *Capreolus capreolus*	?	E	D-V	791,9*	104	A/J	F
14	E	1988		S	MN	D	703,5*	74	A	F
15	E	1994 1995	Centaurée en corymbe *Centaurea corymbosa*	I	MN	D-V	0	1950	G	?
16	C	2012	Ecrevisse à pattes blanches *Autropotamobius pallipes*	?	MN	Intra	0	60	?	A

Program : C = Improvement of a species' conservation status - E = Experimentation - S = Rescue of a species
Origin of individuals : C = Captivity - E = Semi-natural enclosure - MN = Natural environment
Protected area : D = From a protected area - V = To a protected area - D-V = From and to a protected - + = Relocated to a stronger protected area
Intra = Capture and release within the same protected area
Action : R = Reintroduction - R+Rf = Reintroduction + Reinforcement - Rf = Reinforcement - I = Introduction
Environment : ZH = Wetland - A = Aquatic environment - F = Forest - O = Open environment
Age of translocated individuals : G = Seeds - A = Adults - J = Juveniles - A/J = Adults/Juveniles
- * = Climatic zone change - ? = Data unknown

1) Cadi & Miquet, 2004 - 2) Bugot, 2009 - 3) Labouille, 2010 - 4) Deffontaines, 2015 - 5) Lemière, 2012 - 6) Mignet et al., 2014 - 7) Tankovic et al., 2018 - 8) Labouille, 2012 - 9) Pille et al., 2018
10) Bogliani et al., 2011 - 11) Mihoub et al., 2014 - 12) LeGouar et al. *In*: Ewen et al., chapt. 5 - 13) Maillard et al., 2010 - 14) Maillard et al., 1999 - 15) Colas et al., 2008 - 16) Beguier, 2016

4. Lessons for protected areas

We can see that protected areas can be both «sources» and «recipients» of translocated individuals, even if in reality their role is mainly to receive individuals. In fact, 70% of translocations involve transfers from unprotected to protected sites (either from captivity or from the wild), and almost 25% take place between protected sites. Translocations therefore appear to be a tool that mainly serves protected areas, with the aim of conserving species (see box on page 6).

In 567 translocations, the IUCN protection status of the protected area was not known. For the other operations between protected areas for which this information was known, the majority of transfers appear to be to a site with the same or higher protection status.

Focus on climate change

One of the main questions this map was intended to answer was whether translocation is already being used today to adapt species' ranges in the context of climate change, particularly within protected area networks. However, of all the translocations recorded, only 4 were motivated by climate change, 3 in China and 1 in Mexico (see details below). Conversely, over 70% of translocations (622 out of 841) were undertaken for conservation purposes, but without any link to climate change. This systematic map therefore shows that, **for the time being**, translocations are mainly used in response to current problems (endangered or extinct species, human/wildlife conflicts) and not in anticipation of future climate challenges. Also, among cases where the climatic zones (of capture and release) were known (358 translocations), only 11% of translocations involved a change of climatic zone between the capture and release sites. What's more, the majority of translocations took place over short distances, from 0 to 100 km (only 54 animal translocations were carried out over distances of more than 1,000 km).

Four recorded translocations motivated by climate change:

- The species *Paphiopedilum dianthum* was **introduced** into the «Yachang National Orchid Reserve» (China, year unknown) from 5 individuals (seeds?) collected from an unknown natural site (Downing et al., 2017)
- The species *Paphiopedilum hirsutissimum* was introduced into the «Yachang National Orchid Reserve» (China, year unknown) from one individual (seed?) taken from an unknown natural site (Downing et al., 2017)
- The species *Manglietia longipedunculata* was **introduced** into the «Tianxin nature reserve» (China) in 2009 from 45 seeds from a nursery (Ren et al., 2015)
- The species *Abies religiosa* (720 individuals) was planted as two-year-old seedlings at two sites (open air + shaded situation) in the «*Monarch Butterfly Biosphere Reserve*» (Mexico) in 2017 *(Carbajal-Navarr et al., 2019*)

In the latter experiment, the aim was to reinforce an existing population in the face of climate change by sowing these seeds a few tens of kilometers higher up the current range (assisted migration to higher altitudes), while remaining in the same climatic zone. Three and a half years after planting at the Las Palomas site (5.5 years from germination), seedling survival was 72% in the shade, but only 18% in the open. At the Los Ailes site, 1.5 years after planting (3.5 years after germination), survival was 94% and 10%, respectively.

Carbajal-Navarro A. et al. (2019). Ecological restoration of Abies religiosa forests using Nurse plants and assisted migration in the Monarch Butterfly Biosphere Reserve, Mexico. *Frontiers in Ecology and Evolution*. 7: 13606-. https://doi.org/10.3389/fevo.2019.00421

Downing J. et al. (2017). Contrasting changes in biotic interactions of orchid populations subject to conservation introduction vs. conventional translocation in tropical China . *Biological Conservation*. 212, Part A , 29-38. http://dx.doi.org/10.1016/j.biocon.2017.05.021

5. Limits and prospects for improvement

This systematic map only covers the catalog. Also, we have not analyzed the success of the translocations recorded, nor the factors of success/failure. This work deserves to be carried out, in particular by focusing on European species, and even if the notion of «success» remains complex to grasp.

6. How to make practical use of the deliverables produced

The database is available to all, and can be used in particular by managers of natural areas. It makes it easy to find the existence of translocations for a given biological group, in a given country, in a given year, and so on. A flow chart (see link at end of document) is provided to help managers navigate the database (Excel file).

➤ Bearded vulture ©Raoul Feignoux

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Find out more

LANGRIDGE J., SORDELLO R., REYJOL Y., 2021. Existing evidence on the outcomes of wildlife translocations in protected areas: a systematic map. Environmental Evidence Journal. 10(29). https://doi.org/10.1186/s13750-021-00236-w

LANGRIDGE J., SORDELLO R., REYJOL Y., 2020. Outcomes of wildlife translocations in protected areas: what is the type and extent of existing evidence? A systematic map protocol. Environmental Evidence Journal. 9(16). https://doi.org/10.1186/s13750-020-00199-4

Database of identified translocations : https://static-content.springer.com/esm/art%3A10.1186%2Fs13750-021-00236-w/MediaObjects/13750_2021_236_MOESM7_ESM.xlsx

Database consultation help flowchart :
https://naturadapt.com/groups/communaute/documents/617/get

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