Nederlands-Vlaamse vereniging voor ecologie

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# 15th anniversary meeting on CONNECTIVITY towards ensuring a future for biodiversity


**8 april 2014 Golden Tulip Hotel Central Den Bosch**

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# Programma

# Programma NecoV lezingendag

# 8 april 2013 in Den Bosch

| hour | title | Speaker | Affiliation |
|---|---|---|---|
| **9:00-10:00** | **Registration, Coffee** | | |
| 10:00-10:10 | Welcome | Maurice Hoffmann | NecoV-INBO |
| 10:15-10:45 | Connectivity issues in marine environments: beyond biotic exchange | Tjeerd Bouma et al. | NIOZ- RUG-RUNijmegen |
| 10:45-11:15 | Identifying connectivity requirements for the Nature 2000 network | Joachim Mergeay | INBO |
| 11:15-12:00 | Flash presentations of posters | | |
| **12:00-13:30** | **Lunch -posters** | | |
| 13:30-13:40 | Presentation of Aquatic Ecology | Piet Spaak | Eawag - Aquatic Ecology |
| 13:40-14:00 | Connectivity as a missing link in marine project monitoring: lessons learned? | Arjen Boon | Deltares |
| 14:00-14:20 | Body size and dispersal mode as key traits determining meta-community structure of aquatic organisms | Steven Declerck | NIOO-KNAW |
| 14:20-14:40 | Colonization dynamics and adaptation as structuring factors in population genetic structure ? | Luc de Meester | KULeuven |
| 14:40-15:00 | Comparative population genetics of flatfish reveal a common structuring oceanic front | Sara Vandamme | ILVO-KULeuven |
| **15:00-15:30** | **Tea and Coffee Break** | | |
| 15:30-15:50 | Do ecoducts contribute to the coherence of Veluwe habitats? | G.J. Brandjes et al. | Bureau Waardenburg |
| 15:50-16:10 | Spatial and temporal extent of the effectiveness of simulated wildlife passages on metapopulations | Maud Segal | KULeuven |
| 16:10-16:30 | Integrated ecological modeling to predict migration processes in support of river restoration and protection management. | Peter Goethals et al. | UGent- INBO |
| 16:30-16:50 | The Grayling butterfly along the Belgian coast: patch characteristics and landscape connectivity | Dirk Maes & Dries Bonte | INBO-UGent |
| 16:50-17:10 | The fish migration river Afsluitdijk: connecting the IJsselmeer with the Waddenzee | Roef Mulder | Dienst Landelijk Gebied |
| **17:10-18:00** | **15th Anniversary Drink** | | |

**Scientific committee**: Peter Goethals, Maurice Hoffmann, Joachim Mergeay, Luca van Duren

**Organizing committee**: Hanneke Baretta-Bekker, Annette Bisseling, Gerda Bolier, Francisca Sival

# Abstracts of Presentations

**Tjeerd Bouma[a], Johan van de Koppel[a,b], Lucy Gwen Gillis[a], Tjisse van der Heide[c], Marieke van Katwijk[c], Han Olff[b] & Peter Herman[a,c] ([a]NIOZ, [b]RUG, [c]RUNijmegen)** *Connectivity issues in marine environments: beyond biotic exchange*

Ecological studies on connectivity have traditionally strongly focused on the exchange of organisms and gene pools. Recent studies in the marine environment indicates that physical aspects may be at least as important, by generating facilitative interactions by spatially extended ecosystem engineering. These interactions can work over long-distance, and can have a strong control over long-term ecosystem dynamics. We will provide a concise overview of recent insights obtained from reviews and experimental work in the Netherlands.

**Joachim Mergeay (INBO)** *Identifying connectivity requirements for the Nature 2000 network*

The Natura 2000 network combines the sites designated by the member states of the European Union to preserve species and habitats of the Habitats and Bird Directives. It is intended to function as a network and allow the movement of individuals and their genes, thereby also providing the green infrastructure necessary to connect ecosystems and populations in general. But is it truly a network? And for which species? In some cases at least, Natura 2000 sites were not designated based on spatial coherence, instead representing isolated remnants of nature. Some studies even point at a decrease in functional connectivity among Natura 2000 sites as a result of deterioration of the landscape matrix in between sites. Intensive landscape fragmentation further hampers functional connectivity, and well-meant mitigation measures may not be adequate. Furthermore, our view on biodiversity patterns in relation to environmental and spatial habitat traits is blurred by a potentially important but hard to quantify extinction debt, which in itself is a function of habitat size and connectivity. In general, there is a need for identification of green infrastructure needs tailored to meet the requirements of a variety of organisms, and a translation of these needs to biodiversity policy. Here I try to provide an overview of challenges for biodiversity research to identify connectivity requirements for the Natura 2000 network.

**Piet Spaak (Eawag - Aquatic Ecology)** *Presentation of Aquatic Ecology*

Aquatic Ecology is an international journal published quarterly and is the official journal of NECOV, having succeeded the Netherlands Journal of Aquatic Ecology in 1997. In 2010, I took over the position of Editor in Chief from Ramesh Gulati. Aquatic Ecology publishes the results of fundamental and applied ecological research carried out on all trophic levels. Studies of all inland waters, estuaries, and coastal environments are welcome, particularly those that (1) address observations made across scales of time and space, (2) use experimental approaches in either natural or laboratory settings, or (3) use a modelling approach. The journal is currently restructuring its Editorial Board and revising the editorial process, aiming for rapid reviews and timely publication including online early. In 2013, 264 papers were submitted of which 40 were published. With my presentation I hope to motivate more authors from Dutch and Belgian institutes to submit their high quality research to our journal.

**Arjen Boon (Deltares)** *Connectivity as a missing link in marine project monitoring: lessons learned?*

The last decade, extensive ecological impact monitoring has been carried out (and is being carried out) in projects in the marine environment, such as in offshore wind farms (OWEZ), nourishment studies (Sand engine, Ameland) and restoration project (Maasvlakte 2 in Voordelta). However, the results often do not supply the desired answers. In this presentation, a short overview will be given of the goals and set up of these projects, and the research questions asked. Next, the shortcomings in these monitoring strategies will be discussed following the set up used in offshore wind farm monitoring. Concluding, an overview will be given on the necessary improvements for project monitoring.

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**Steven Declerck (NIOO-KNAW)** *Body size and dispersal mode as key traits determining meta-community structure of aquatic organisms*

Metacommunity theory integrates the study of interactions between organisms and their local biotic and abiotic environment with spatial, dispersal-related dynamics at the regional scale and makes a variety of predictions about the spatial structure of biodiversity. The outcome of these predictions can be expected to be strongly contingent on traits of the organisms and features of the regional context. Relationships between traits of organisms and the structure of their metacommunities have so far mainly been explored with meta-analyses. We compared the structure of metacommunities of 12 aquatic organism groups in the same set of 99 ponds to minimize biases inherent to meta-analyses. The studied organism groups ranged from bacteria to fish and therefore differed widely in body size and dispersal modes. In the category of passive dispersers, large-bodied groups showed stronger spatial patterning than small-bodied groups suggesting an increasing impact of dispersal limitation with increasing body size. Metacommunities of organisms with the ability to fly (i.e. insect groups) showed a weaker imprint of dispersal limitation than passive dispersers with similar body size. In contrast, dispersal movements of vertebrate groups (fish and amphibians) seemed to be mainly confined to local connectivity patterns. Our results reveal that body size and dispersal mode are important drivers of metacommunity structure and these traits should therefore be considered when developing a predictive framework for metacommunity dynamics.

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**Luc de Meester (KULeuven)** *Colonization dynamics and adaptation as structuring factors in population genetic structure ?*

We provide a short outline on recent evidence that environmental sorting and adaptation can influence landscape genetic structure in important ways. We present ways to interpret spatial and environmental signals in population genetic data and illustrate the importance of selection and evolution-mediated priority effects with data on zooplankton.

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**Sara Vandamme (ILVO-KULeuven)** *Comparative population genetics of flatfish reveal a common structuring oceanic front*

Identification of the genetic patterning of marine species is crucial for conservation management. Using landscape genetic analysis, we have identified common gene flow barriers in three co-occurring demersal fish that share various life-history traits: turbot (*Scophthalmus maximus* ), brill ( *S. rhombus*) and sole (*Solea solea*). By applying neutral loci, we were able to identify several subgroups across the Northeast Atlantic Ocean, although the level of differentiation varies among these species. While the integration of gene-linked markers showed that selection may overcome the homogenizing effect of gene flow, landscape

genetic analysis indicated that the level of explained adaptive genetic variation differs among the oceanographic basins of the North Sea and Baltic Sea.
According to our results, genetic differentiation in flatfish depends on two aspects: (i) the synergy between oceanographic fronts and species-specific spawning behavior, together with (ii) the different selection pressures within each basin that lead to relatively stronger local adaption. We conclude that in order to define biologically relevant population units and understand the connectivity between populations, multi-species comparison and investigation of environmental, spatial and life-history traits interactions highly important.

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**G.J. Brandjes, D. Emond, D. Wansink & G.F.J. Smit (Bureau Waardenburg B.V.)** *Do ecoducts contribute to the coherence of Veluwe habitats?*

The Veluwe is our largest forested area with a total of 91.000 hectare. Nature, forest and heath land, is fragmented by a dense network of infrastructure. Highways, regional roads and local road all contribute to a network of barriers for a wide variety of fauna. In the last decennia a large number of fauna passages are realised to counter the barrier effect. Badger tunnels, wildlife tunnels, stubb walls and ecoducts facilitate save crossings of animals. Also bridges and tunnels for local traffic are used by terrestrial fauna. Recently six ecoducts are added to the three that already function for more than ten years. Field research shows that these ecoducts are quickly accepted by a large number of species, from reptiles as the slow worm to large herbivores. Network Theory provides a method for quantifying the contribution of ecoducts in defragmenting the Veluwe. Besides a role in defragmenting nature, ecoducts have an intrinsic value, as we show with a Belgium ecoduct as example.

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**Maud Segal[a], Caroline Geeraerts[b] & Joachim Mergeay[b] ([a]VUB, [b]INBO)** *Spatial and temporal extent of the effectiveness of simulated wildlife passages on metapopulations*

Wildlife passages are increasingly constructed to mitigate habitat fragmentation by roads. There is little empirical evidence regarding the efficiency of wildlife passages to connect populations genetically, and at what temporal and spatial scales this happens. This is because such studies require time series over tens to hundreds of generations and statistical designs that are logistically very difficult to realize, let alone to get funded.
Here we used a simple simulation approach in a stepping-stone metapopulation model to test at what spatial and temporal scales a wildlife passage can be expected to have a measurable effect on levels of genetic structure. We simulated three types of metapopulations and replicated each one ten times: a positive control without effects of road fragmentation, a negative control with an impermeable linear barrier dividing the northern and the southern part into two distinct metapopulations, and finally a situation with a linear barrier and a centrally located wildlife passage connecting the northern metapopulation to the southern one by 1.6 effective migrants per generation. We then tested for significant differences in genetic structure among treatments at various time intervals (20, 100 and 1000 generations) within and among groups relative to the barrier and at various distances from the simulated passage (1, 3, 5 and 7 steps in the stepping stone model) at the subpopulation level.
Overall, we failed to find a significantly positive effect of the wildlife passage at the level of the entire metapopulation, even after 1000 generations. At the subpopulation level, only the most proximate subpopulations had a significantly positive influence of the passage, but which required more than 20 generations to become measurable.
Although only a simulation under a restricted parameter space, this study suggests that wildlife passages only have a positive impact over small spatial scales, while requiring a long time to develop.

**Peter Goethals[a], Andy Dedecker[a], Pieter Boets[a], Ine Pauwels[a,b] & Ans Mouton[b] ([a]UGent, [b]INBO)** *Integrated ecological modeling to predict migration processes in support of river restoration and protection management.*

During the past decennia, habitat suitability modeling methods have been developed to analyze and predict species in rivers. A major limitation of most of these models is their lack of dynamics needed to describe for instance migration related processes. This presentation will illustrate several integrated models, which combine habitat suitability and migration modeling. The models are illustrated on case studies predicting river restoration effects on macroinvertebrates (Dedecker 2006, 2007), the potential distribution of invasive invertebrates (Boets 2014) and spawning related migration of pike (Baetens 2013; Pauwels 2013, 2014).

Related references


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Boets P., Pauwels I.S., Lock K., Goethals P.L.M. (2013). Using an integrated modelling approach for risk assessment of the 'killer shrimp' Dikerogammarus villosus. River Research and Applications: doi: 10.1002/rra.2658

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**Dirk Maes[a] & Dries Bonte[b] ([a]INBO, [b]UGent)** *The Grayling butterfly along the Belgian coast: patch characteristics and landscape connectivity*

In NW-Europe, habitat loss (both in quantity and in quality) and fragmentation (causing a possible reduced connectivity among patches) are two important causes of declines in biodiversity. Many species are nowadays unable to persist in increasingly smaller habitat patches with a declining habitat quality. In a densely populated region such as Flanders (N Belgium), this hampers the conservation of a large number of typical and often rare species and their habitats.

The dunes along the Belgian coast are a good model system to investigate the effect of fragmentation and deteriorating habitat quality in a metapopulation context. As model organisms, we use three specialised dune invertebrates (two butterflies: the Grayling *Hipparchia semele* and the Queen of Spain fritillary *Issoria lathonia* and the Blue-winged grasshopper *Oedipoda caerulescens*). During four different years (2003, 2004, 2012 and 2013), we mapped the presence of these species in 115 potentially suitable dune patches with blond and/or grey dunes between De Panne and Nieuwpoort. For all patches, we measured the area, the distance to the nearest patch, the amount of Marram (*Ammophila arenaria* – the host plant of *Hipparchia semele*), Dune pansey (*Viola curtisii* – the host plant of *Issoria lathonia*) and mosses, trampling intensity (of both tourists and grazing animals), sand dynamics and the distance to the sea.

The probability to find Grayling butterflies increased with patch size, a large amount of Marram, proximity to the sea and to the nearest suitable dune patch. Trampling intensity negatively affected the presence of the butterfly. Colonization events of the Grayling mainly occurred in large patches with a relatively high trampling intensity that were close to the nearest dune patch and close to the sea. Trampling, however, showed an interaction with area in the sence that colonization occurred in both large patches with a limited trampling intensity and in small patches with a high trampling intensity. Extinction events, on the other

hand, occurred in patches that were far from the nearest dune patch, at a larger distance from the sea and in patches with a high trampling intensity. Small patches with a high trampling intensity thus have a high oaacupancy turnover resulting in repeated colonizations and extinctions.
Finally, we calculated yearly connectivity measures for each patch in the metapopulation taking distance, area and the mobility of *Hipparchia semele* into account. Since 2003, some of the central patches in the Grayling metapopulation along the Belgian coast showed a strong decline in connectivity value which could eventually lead to the split of the present metapopulation into two separate and smaller metapopulations. Conservation measures should, therefore, focus on restoring the habitat quality of these patches, on enlarging small habitat patches and on creating new suitable patches in the vicinity of these patches to facilitate colonization.

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**Roef Mulder (Dienst Landelijk Gebied)** *The fish migration river Afsluitdijk: connecting the IJsselmeer with the Waddenzee*

In early ages the 'Zuiderzee' was an open, tidal estuary. In 1932 it was closed off and separated from the Wadden Sea by the Afsluitdijk. This dike became a barrier between salt and fresh water and closed off one of the main doors for fish migration into the Ijsselmeer and further upstream. The sluices only open to release superfluous freshwater in the rainy season and most of the time water currents are too high to allow fish to migrate from sea into the IJsselmeer. It is widely accepted that opening the Afsluitdijk will greatly improve local and migratory fish populations, and both biologists and engineers have proposed several solutions in the past. The major challenge in design remains the fact that IJsselmeer needs to remain fresh at all times. The FishMigrationRiver is an innovative plan to construct an artificial river that will connect the tidal Wadden Sea with the Ijsselmeer. The river is designed to buffer the saltwater flowing in during high tide. It opens the dike for a wide range of migratory fish, including tidal migrants, and provides a gradual habitat for physiological adaptation.

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# Posters with abstracts

**Jan H. Wanink[1], Guus Kruitwagen[2], Marit Meier[3], Jos de Bijl[4] & Pui Mee Chan[5]** *Mitigating pumping stations as major fish migration barriers in the lower Netherlands*

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The Water Framework Directive (WFD) commits EU member states to achieve good ecological status of surface waters by 2015. Fish is one of the biological quality elements for which standards for a good status have been set. Migration barriers are serious obstacles in meeting these standards. In the lower Netherlands, the creation of many polders has resulted in fish habitat fragmentation. Polder-draining pumping stations cause high passage mortality during downstream migration, and block upstream migration. Removal of the stations is no option. Their negative effects on fish migration can only be mitigated, but not at the expense of pump efficiency. We evaluate mitigation measures taken by two water boards at five locations. Two conventional pumps were replaced by innovative fish-friendly alternatives: one axial pump and one screw pump. At the third location a newly built pumping station was equipped with a fish-friendly screw pump and a one-way (upstream) bypass fishway. Efficiencies of the new pumps are equal to or greater than those of the old pumps, and meet predefined requirements. At the final two locations two-way siphon fish ladders were installed as bypasses for the conventional pumps. All adjustments were made in 2011. We monitored fish passage and mortality during upstream (spring) and downstream (autumn) migration in 2009 ($T_0$) and 2011/12 ($T_1$). Species and numbers attempting to negotiate the barriers were estimated from fyke-net catches near pump inlets. Actual passage and mortality rates were assessed using fyke nets, set up behind the pump and fishway outlets. Overall pump passage mortality ($T_0$: 27.0%; n=2349) declined after installing fish-friendly pumps ($T_1$: 0.1%; n=37178). This was most pronounced for European eel, as compared to the perch (Percidae) and carp (Cyprinidae) families. Mortality among large Cyprinidae (>15 cm) was higher than among smaller fish in all pump types. No passage mortality was observed in the fishways. Except for European eel, higher numbers of fish passed the pumps at $T_1$ than at $T_0$. Although most species present used the fishways, numbers were relatively low during downstream migration. More fish used the route via the adjacent pump. For three out of the five polders concerned, we expect the mitigation measures to cause higher scores on the WFD fish metrics. Irrespective of this, by restoring interconnectivity between water bodies, the measures contribute to gene flow and local biodiversity.

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# Mitigating pumping stations as major fish migration barriers in the lower Netherlands

## European Water Framework Directive (WFD)

- Good ecological status of surface waters to be achieved by 2015
- Fish migration barriers are serious obstacles in meeting the standards

## The Netherlands >> many polders

- Fish habitat fragmentation
- Polder–draining pumping stations as barriers

## Pumping stations

- Passage mortality at downstream migration
- Upstream migration blocked completely

## Mitigation measures at five locations in 2011

- Two conventional pumps replaced by fish-friendly axial or screw pump
- New station with fish-friendly screw pump and upstream bypass
- Two two-way siphon fish ladders as bypasses for conventional pumps (predefined requirement new pumps: efficiency ≥ conventional pumps)

## Monitoring fish passage and mortality

- $T_0$ – spring and autumn 2009
- $T_1$ – autumn 2011 and spring 2012

## Pump passage mortality

- $T_0$ – 27% (n=2349)
- $T_1$ – 0.1% (n=37178)
- Mortality decline in European eel greater than in perch and carp families
- All pump types: highest mortality among Cyprinidae > 15 cm



## Fish passage

- Pumps: higher numbers at $T_1$ (except eel)
- New fishways: already used by most species but numbers relatively low during downstream migration; most fish still via the adjacent pump

## Conclusions

- Mitigation measures expected to cause higher scores on WFD fish metrics in three out of the five polders
- Restored interconnectivity between water bodies contributes to gene flow and local biodiversity

**An Vanden Broeck*, Wouter Van Landuyt[§], Karen Cox*, Luc De Bruyn[§,°°], Ralf Gyselings[§], Gerard Oostermeijer[§§], Bertille Valentin[¥], Gregor Bozic[++], Branko Dolinar[+], Zoltán Illyés°, Joachim Mergeay***

*Long-distance seed dispersal blurs ecotypic divergence in a terrestrial orchid*

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Gene flow and adaptive divergence are key aspects in ecological speciation. Long-distance gene flow is hard to detect and few studies estimate gene flow in combination with adaptive divergence. The aim of this study was to investigate long-distance dispersal and adaptive divergence in fen orchid (*Liparis loeselii* (L.) Rich.). We used amplified fragment length polymorphism (AFLP)-based assignment tests to quantify long-distance dispersal at two different regions in Northwest Europe. In addition, genomic divergence between fen orchid populations occupying two distinguishable habitats, wet dune slacks and alkaline fens, was investigated by a genome scan approach at different spatial scales (continental, landscape and regional) and based on 451 AFLP loci. We expected that different habitats would contribute to strong divergence and restricted gene flow resulting in isolation-by-adaptation. Instead, we found remarkably high levels of gene flow and low levels of adaptive divergence. At least 15% of the assigned individuals originated from among-population dispersal events with dispersal distances up to 220 km. Six (1.3%) 'outlier' loci, potentially reflecting local adaptation to habitat-type, were identified with high statistical support. Of these, only one was an outlier in multiple independent dune-fen population comparisons and thus possibly reflecting truly parallel divergence. Signals of adaptation in response to habitat type were most evident at the scale of individual populations. These findings suggest that the homogenizing effect of gene flow may overwhelm divergent selection associated to habitat type in fen orchids in Northwest Europe.

An Vanden Broeck*, Wouter Van Landuyt , Karen Cox*, Luc De Bruyn*, Ralf Gyselings*, Gerard Oostermeijer**, Bertille Valentin*, Gregor Bozic**, Branko Dolinar*, Zoltán Illyés , Joachim Mergeay*

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Research Institute for Nature and Forest

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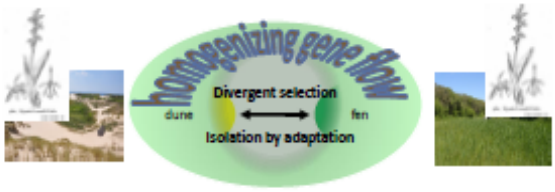
# Long-distance seed dispersal may blur ecotypic divergence in a terrestrial orchid

## Long-distance dispersal & adaptive divergence

The family Orchidaceae is well known for its exceptional diversity, with approximately 26 000 species. It is argued that realized long-distance dispersal (LDD) combined with local adaptation to different environments is a possible mechanism underlying this species diversity (e.g. Phillips et al. 2012). However, empirical data about LDD combined with local adaptation are scarce and completely lacking for orchids.

## Fen orchid

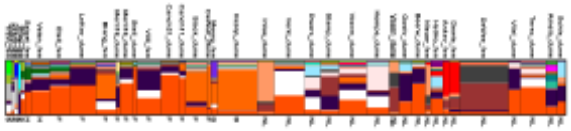
We studied realized LDD and adaptive divergence in fen orchid (*Liparis loeselii* (L.) Rich.), a small green-flowered orchid of fens and dune systems. Two varieties are sometimes distinguished: a narrow-leaved variety occurring in fens, and a shorter, broader-leaved variety (var. ovata Ridd. ex Godfery) occurring in dune slacks (Wheeler et al, 1998). Genetic differentiation may exist between the two habitats to the extent that hybrid offspring suffers from marked outbreeding depression, i.e. isolation-by-adaptation.




*"We expected that different habitats would contribute to strong divergence and restricted gene flow resulting in isolation-by-adaptation. "*

## High levels of long-distance dispersal

Our results suggest remarkably high levels of between-population dispersal (15% ) with dispersal distances up to 220 km. Populations were admixed and gene flow frequently occurred between populations occupying different habitats. We observed no significant relationship between genetic and geographic distance and a low genetic differentiation among populations ($F_{ST}$ = 0.09, $\Phi_{PT}$ = 0.13).



## Low signals of adaptive divergence

Six (1.3%) 'outlier' loci, potentially reflecting local adaptation to habitat-type, were identified with high statistical support. Of these, only one (0.22%) was an outlier in multiple independent dune-fen population comparisons and thus possibly reflecting truly parallel divergence. Signals of adaptation in response to habitat type were most evident at the scale of individual populations.

*"Contrasting the expectations, we found remarkably high levels of effective long-distance seed dispersal and low levels of adaptive divergence.*

*The homogenizing effect of realized long-distance seed dispersal may overwhelm divergent selection associated to habitat type in fen orchids in Northwest Europe."*

## Methodology

We analyzed 451 polymorphic AFLP-loci on a total of 422 individuals from 23 dune and 16 fen populations. Assignment tests were performed with AFLPOP within two independent sites in which we are quite certain to have allocated all fen orchid populations: A) Northwest France and B) Belgium and the Netherlands (Fig. 2). Furthermore, we sampled one population in the French Alps in the Marsh of Les Etelles, five populations in Slovenia located in the pre-alpine hills and north-western Dinaric Mountains, and two populations in Hungary.

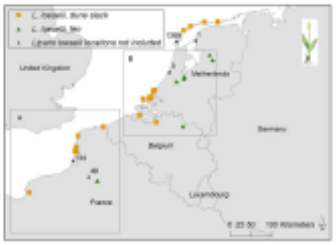


*Fig. 2. Locations of Liparis loeselii along the coast of the North sea over a distance of 600 km from Normandy in northern France up to the Dutch Wadden Sea islands in the north of the Netherlands. All known locations, except the ones indicated with a black triangle , are included in this study.*

Adaptive divergence was investigated by a genome scan approach at different spatial scales (continental, landscape and regional) with the programs BAYESCAN and MCHEZA.

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**Sofie Depauw[1] & Barend de Jong[2]** *Building with Beavers*

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Beavers are key ecological agents that shape riverine landscapes by influencing the hydrogeomorphic processes which connect floodplain ecosystems to streams (Gurnell, 1998). They are even ecosystem engineers because they increase the species richness at landscape scale (Justin P. Wright, Clive G. Jones and Alexander S. Flecker, 2002)

Based on literature, articles (natuurbericht.be) and observations (waarnemingen.be) we constructed the migration routes of the beaver in Flanders. The beaver in Flanders became extinct since 1848 but returned in 2000 in the valley of the Dijle, south of Leuven. The second population was found along the Grensmaas and its tributary streams. The beaver shows to be an opportunist passing busy cities (Leuven) and ship canals (Albertkanaal). Nowadays more than 100 beavers are found in Flanders. In the Netherlands, the beaver is reintroduced in 1988. Nowadays there are five growing populations. Reintroduction is no longer needed for a healthy population. Exchange with populations in Flanders take place via the Grensmaas.

For nature conservation alongside streams and rivers, the beaver can't be missed. The beaver creates a local ecosystem, connects landscape elements and creates habitats for other species. Furthermore it increases water retention in watersheds which is important for preventing floodings. Therefore, good reasons to work on the migration of the beaver and remediation of beaver habitats.

Working with the beaver himself to build new habitats for his own family is a new opportunity for the ecological engineers. Therefore we need to observe and understand the threats of the beaver habitat and the tools they use to create their habitat. We can learn from the vast experience with remediation of habitats in Canada, for example by building starter dams in appropriate areas. We name it "Building with Beavers".

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The return of the beaver

# Building with beavers


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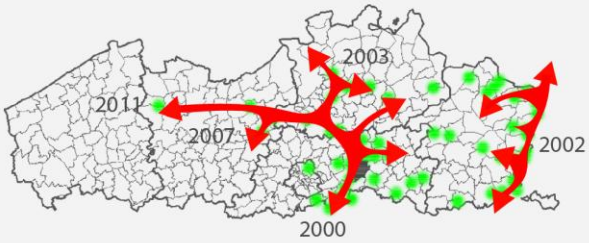
## Return of the beaver in Flanders

- Became extinct since 1848 in Flanders.
- First observation in 2000 in the Dijlevallei.
- Second population along the Grensmaas and tributary streams.
- Nowadays more than 100 specimens in Flanders.




bron: beverwerkgroep.be, waarnemingen.be, Alterra-rapport 1996

## Building with nature

- Beavers (Castor canadensis and C. fiber) are key ecological agents that shape riverine landscapes by influencing the hydrogeomorphic processes that connect floodplain ecosystems to streams. (Gurnell, 1998)
- Beavers, the ecosystem engineers, increases species richness at the landscape scale. (Justin P. Wright · Clive G. Jones and Alexander S. Flecker, 2002)



## Threats for the beaver habitat

- Loss of wetlands by diking, canalization and regulation of river levels.
- Loss of wetland by reclamation for agriculture and urbanism.
- Migration barrier by railroads, highways and steep shoreline banks.
- Increasing pressure from recreation.

## Remediation of the beaver habitat: 'working with beavers'

- Starter dams (1) :
  a wire with woven willow branches filled with rocks and loam
- Post lines with wicker weaves (2) :
  a wire with woven tissue and willow branches
- Post lines (3) :
  a wire without tissue or branches
- Re-inforce abandonned dams (4):
  inforce the dams with willows and loam



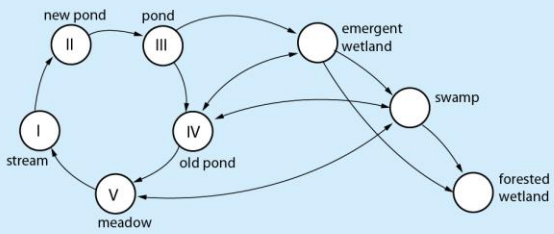


## The beaver as an ecological connector/connection is in his genes

The beaver creates a global ecosystem in which it supports different subsystems by creating specific water related areas. These areas are habitats for other species as well. These species are important for the beaverto survive.

Requirements for the beaver habitat:

- Wetlands with slight shoreline s and presence of alluvial forest (e.g. Salicaceae spec., Alnus glutinosa) and shoreline plants for food and nesting materials.
- Minimal suitable shoreline lengt is 1-2 kilometers with a width of 10-20 meters.
- No disturbance of beaver lodge by recreationists and dogs.
- Dam buiding when water depth is less than 50-90 centimeters.



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