The influence of habitat restoration and management on animal communities

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Outline

Introduction
• On the role of animal studies in restoration ecology
• The importance of habitat diversity

Methods and principles of restoration
• Design and implementation of a large-scale, near-natural restoration, Egyek-Pusztakócs marshes, Hortobágy National Park, E Hungary

Results and lessons learned for restoration theory and practice
• Part 1: Grassland restoration
• Part 2: Grassland management by grazing
• Part 3: Wetland/marsh restoration
• Part 4: Restoration and ecological resilience

Summary and conclusions
Why focus on animals?

- Animals are rarely used in restoration studies
  - plants and not animals are targeted
  - animals are elusive or use habitats at scales that are difficult to study
  - limited spatial/temporal scales of restoration
  - limited taxonomic expertise

Brudvig (2011)  
*Am. J. Bot.*
Why focus on animals?

• Animals are fundamental in many ecological processes
  – maintenance of soil structure and productivity
  – biogeochemical processes e.g. decomposition
  – seed dispersal
  – regulation of plant-plant relationships and community assembly
  – ...

• Full evaluation of restoration success needs to integrate higher trophic levels → calls for including animals in restoration studies
  (e.g. Young 2000, Longcore 2003, Woodcock et al. 2008, Brudvig 2011)
Checklist of information necessary for designing restoration

• Landscape/habitat history
  – Past land use
  – Past spatial connectivity
• Understanding of the reasons for the unfavourable changes occurring
• Exploration of threat factors
• Definition of target status:
  – General aim: establishment of factor composition judged favourable for recovery
• Clarification of options for regeneration:
  – Sources of propagula, distances, connectivity
• Options for avoiding invasion by non-native species
• Landscape-level restoration: separately for each habitat targeted

Modified from Groom et al. (2006) *Principles of Conservation Biology*
Habitat diversity

• What determines the number of species (SR)?
  – Area: SR vs. Area relationship (SAR)
  – Habitat diversity (HD): SR vs. Habitat diversity relationship

• Aspects of HD:
  – Composition (number/identity of elements)
  – Structure (3-D spatial arrangement/architecture of elements)
  – Process/function (interactions/fluxes among elements)

• e.g. birds on islands in Finland and Greece:

How can we maximize species diversity?

- Area to be restored: usually given
- How does habitat diversity influence the number of species?
- Baseline survey of natural, target habitat types
Habitat diversity – species diversity relationships

Lengyel et al. (2016) *PLOS ONE*
Our understanding of habitat diversity

• Not as clear theory and measurement as SAR
• No general framework or central descriptive model
• Confusion over terms used to describe HD
• Different taxon groups show relationships with different aspects/measures of HD

• HD is generally important for many animal groups
• SR-HD relationship is positive across taxa → restoration should target HD

Lengyel et al. (2016) *PLOS ONE*
Restoration for diversity: the Egyek-Pusztakócs project

- 4000 ha, 33% arable land
- Iterative participatory process (10-12 participants)
- General principles:
  - **large-scale** restoration = target multiple habitat types
  - **near-natural** restoration = minimize human impact/control, allocate large role to natural ecological processes
Restoration for diversity: the Egyek-Pusztakócs project

- **Good conditions for restoration**
  - Many semi/natural grasslands and wetlands
  - Few invasive species, little chance for invasion
  - Public lands in project area: 85%

- **Limitations by socio-economic constraints (rental contracts with farmers)**

- **Vision:** landscape before large-scale transformation by humans
  - Map of potential habitat types
  - Understanding of drivers influencing biodiversity patterns
History of Egyek-Pusztakócs marshes: potential open habitats and drivers

Main drivers
- **floods** by river Tisza
- **grazing** by large herbivores
- **fire**
History of Egyek-Pusztakócs marshes: changes through time

Remaining threats: high proportion of arable land, grassland fragmentation, agrochemical pollution, lack of conservation management
Threats, objectives and actions in the Egyek-Pusztakócs LIFE programme

**THREATS**

1. Grassland fragmentation
2. Grassland degradation
3. Degradation by goose farms
4. Suboptimal grassland management
5. Marsh homogenization
6. Chemical load on marshes
7. Lack of feeding and nesting sites for birds of prey

**OBJECTIVES**

1. Ecological corridors
2. Buffer zones with restored grasslands
3. Elimination of goose farming
4. New grazing system
5. Imitate natural disturbances
6. Buffer zones with afforestation of cropland edges
7. Improve food base for raptors

**RESTORATION AND MANAGEMENT**

A1. Preparation of farm and land purchase
A2. Baseline monitoring
A3. Management plans
B1. Land purchase
B2. Farm purchase for sheep grazing
C1. Grassland restoration
C2. Afforestation
C3. Purchase livestock
C4. Grazing infrastructure
D1. Grazing on grasslands
D2. Grazing and burning in marshes
D3. Forest maintenance
D4. No-input croplands
Grassland restoration in Egyek-Pusztakócs, Hortobágy NP

**Targets** (Natura 2000 ‘priority’):
- Pannonic alkali steppes
- Pannonic loess steppic grasslands

**Soil preparation + sowing:**
- Alkali mixture:
  - *Festuca pseudovina* 67%
  - *Poa angustifolia* 33%
- Loess mixture:
  - *Festuca rupicola* 40%
  - *Bromus inermis* 30%
  - *Poa angustifolia* 30%

**Post-restoration management:**
- Mowing once in June

**Near-natural restoration:**
initial ‘push’ + local conditions/filters

Grassland restoration: implementation

- **18.45 t** seeds harvested
- **7.95 t** seeds purchased
- **20-25 kg/ha** sown

- loess grassland foundation species: *Festuca rupicola, Poa angustifolia*
- alkali steppe foundation species: *F. pseudovina, Poa angustifolia*
Early vegetation development

Year 1:

Year 2:

Year 3:
Monitoring system

**Vascular plants:** permanent plots

**Orthoptera, vegetation-dwelling Araneae:** standardized sweep-netting

**Apoidea:** yellow plate traps

**Carabid beetles, ground-dwelling Araneae:** Barber pitfall traps

**Amphibians:** pitfall traps

**Birds:** point counts, Danish system

**Small mammals** (mice, voles, shrews): live trapping
Species richness and cover of vascular plants, 2009

Changes in species composition

Vegetation development: summary

- **Year 1**: weed dominance; **Year 2**: perennial grass cover; **Year 3**: perennial grass dominance

<table>
<thead>
<tr>
<th>Effect</th>
<th>Pattern</th>
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<tbody>
<tr>
<td>Last crop</td>
<td>fewer weeds on former alfalfa than on cereal or sunflower fields</td>
</tr>
<tr>
<td>Seed mix</td>
<td>alkali restorations are more diverse and show faster progress to target species composition than loess restorations</td>
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<tr>
<td>Restoration age</td>
<td>diversity of common species and cover of target species increasing from Year 1 -4</td>
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<tr>
<td>Distance to target</td>
<td>no significant effect</td>
</tr>
<tr>
<td>Spatial variability</td>
<td>significant variability in vegetation development</td>
</tr>
</tbody>
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Török et al. (2010) *Biol. Cons.* – restoration of alfalfa fields: rapid changes
Török et al. (2011) *Biodiv. & Cons.* – review of grassland restoration methods, their applicability and costs