### Appendix 1. Identified evaluation steps in major ecological restoration projects in the northern hemisphere.

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<th>Habitat restored and objectives</th>
<th>Identity of restoration project</th>
<th>Step 1 Within planning</th>
<th>Step 2 Between planning and implementation</th>
<th>Step 3 Within implementation</th>
<th>Step 4 Between implementation and monitoring</th>
<th>Step 5 Within monitoring</th>
<th>Step 6 Between monitoring and planning</th>
<th>References</th>
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<tr>
<td>Alpine heathland: removal of roads, military infrastructure, explosives and pollutants, restoring landscape structures and vegetation</td>
<td>Dovre Mountain, Norway</td>
<td>Interaction between Norwegian Defence Estates Agency (NDEA) and experts during the initial planning process resulting in more specific plans</td>
<td>NDEA planned and operated the project, and met with authorities, municipalities, tourist companies and hunters. NDEA evaluated the implementation and the outcome was used for further planning of subsequent project phases</td>
<td>Methods based on previous experiences. Collaboration between the project owner, ecologists and contractors led to some modification of procedures and logistic adjustment for large-scale application</td>
<td>Monitoring results reported back to people responsible for the implementation (ecologists, machine drivers, project owner) resulting in minor modifications and adjustments on site</td>
<td>Monitoring established as a pilot project 4 years before restoration. Vegetation data gave feedback on restoration methods (in particular the use of turfs, seeds and fertilizer). Data integrated into steps 3 and 4</td>
<td>The project owner posted annual reports on the web and distributed newsletters. Scientists reported on websites and conferences. Modifications were proposed to project owner. The cooperation procedure applied to related projects, e.g., hydropower and road construction</td>
<td>Martinsen and Hagen 2010, Hagen and Evju 2013, Forsvarsbygg 2015</td>
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<td>Alpine heathland: removal of structures on a former mine site</td>
<td>Nalunaq gold mine, Greenland</td>
<td>Evaluation of clean-up and restoration plans between the mining company and central authorities</td>
<td>Stakeholder meetings and public hearings processing original and revised documents. The Environmental Impact Assessment was revised when production procedures were changed after 2009</td>
<td>It was decided not to use non-native seeds or plants to avoid unnatural conditions and invasive plants; therefore only barren land was left to be colonized by local plants</td>
<td>Informal but good communication and support were supplied to the monitoring team from the mining staff at Nalunaq</td>
<td>Ten monitoring reports produced, evaluating elements in aquatic and terrestrial environments. Monitoring will continue at least 3 years after the closure and was planned to take place during 2014–2016</td>
<td>Monitoring program evaluated and changed due to changes in mining techniques, i.e., emphasizing cyanide after 2009. Based on monitoring results it was possible to change demands towards the mining company</td>
<td>Dominy et al. 2006, Bell and Kolb 2013</td>
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<td>Birch woodland: reforestation to enhance resilience to ash deposition</td>
<td>Hekluskógar, Iceland</td>
<td>Meetings with farmers and other stakeholders, presenting project ideas. Some areas excluded from the project due to farmers’ concern about continued use of grazing commons</td>
<td>Project implementation discussed in a stakeholder group and with a wider audience, resulting in amendments of plans</td>
<td>Internal follow-up of implementation, mostly regarding planting of seedlings by contractors and landowners and other practicalities. This often led to adjustments of implementation</td>
<td>Landowners, contractors and other practitioners reported planting and revegetation activities to project manager. Monitoring results provided feedback to implementation</td>
<td>Original plans included regular monitoring of ecosystem development and assessment of socio-economic impact. Lack of funding restricted monitoring to seedling survival</td>
<td>Simple annual reports posted on project website, and project information reported at conferences together with monitoring results. Plans adapted based on monitoring results if needed</td>
<td>Aradottir 2007, Óskarsson 2009, a, b, 2011, Berglund et al. 2013, Hunziker et al. 2014, Hekluskógar 2015</td>
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<td>Rangeland: Farmers Heal the land</td>
<td>Interaction between SCSI district officers and individual farmers</td>
<td>During annual or</td>
<td>The annual, subjective</td>
<td>Next year’s work</td>
<td>Schmidt 2000,</td>
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<td>Region</td>
<td>Action</td>
<td>Challenges</td>
<td>Monitoring</td>
<td>Results</td>
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<td><strong>Land, Iceland</strong></td>
<td>Revegetating eroded areas by adding seeds, fertilizer and mulch</td>
<td>Discussed and adjusted restoration plans based on farmers' feedback. Scenic district officers also evaluated whether activities were implemented as planned</td>
<td>Biannual visits farmers informed Scenic district officers about their restoration interventions, making revisions of subsequent interventions possible</td>
<td>Based on outcome of assessment. Results of questionnaires and informal interviews with participants have influenced project management</td>
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<td><strong>Forest</strong>: Burning, storm simulation, and cutting or wounding trees</td>
<td>Green Belt LIFE, Finland</td>
<td>Plans adapted after field conditions and research needs. Impact of reindeer grazing on plant regeneration included in the planning</td>
<td>Location of monitoring gear conveyed to practitioners to avoid damage during implementation. For practical reasons, such as space requirements for burning, or mistakes made by the harvester in the tree cutting sites, control and restoration monitoring sites had sometimes to be moved</td>
<td>Scientists made results available through meetings, seminars, and discussions in the Finnish Restoration Board. Modifications proposed by scientists could not be applied to this project, but have been considered for later restoration projects</td>
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<td><strong>Grassland</strong>: Decreasing cover of invasive plants and reintroducing native species</td>
<td>Northern Great Plains, Canada</td>
<td>Interested landowners or government agencies were chosen as partners. Funds including evaluation were raised</td>
<td>Methods were adjusted based on field experience, e.g., increasing soil-seed contact by removing extant vegetation improved the outcome of restoration</td>
<td>Different variables measured in different years, e.g., burning impact on trees not seen until after several years, but for the ground it was the opposite. Monitoring focused on species thought to respond to restoration. Research plots established to monitor new mineral soil patches after storm simulation</td>
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<td><strong>Montane grassland</strong>: Removal or reduction in grazing to favor grass cover and stop erosion</td>
<td>Trotternish, Skye, Scotland</td>
<td>Interaction between the Scottish Government, landowners and scientists during the initial planning process resulted in adjustments of fences</td>
<td>Methods involved two types of fences, excluding sheep and rabbits or just sheep. The project was like a trial, and monitoring was evaluated, but not</td>
<td>Results made available to Scottish Natural Heritage. Possible influence of climate change and social economic changes with reduction in sheep due to aging of</td>
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<td>Peatland: removal of redundant trees and blocking of ditches</td>
<td>Green Belt LIFE, Finland</td>
<td>Plans adapted to site conditions and, as far as possible, to research needs</td>
<td>Planners, practitioners and scientists discussed project practicalities. Meetings with local people informed about restoration actions. Technical evaluation carried out according to EU-LIFE standards</td>
<td>Location of groundwater wells for monitoring purposes conveyed to practitioners to avoid damage during tree harvest, blocking of ditches and placement of logging residue during project implementation</td>
<td>Monitoring established to respond to spatial questions in future even though there was no spatial expert in the monitoring group. New research plots established in restored ditches, as they served as new habitat types not existing before restoration</td>
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<td>Peatland: blocking of ditches</td>
<td>Caithness and Sutherland, Scotland</td>
<td>Landowners, scientists and conservationists collaborated to agree on plans and find funding sources. During preparation of a management strategy, also practitioners were involved</td>
<td>Planners and landowners discussed location and extent of restoration sites, restoration methods, and potential impacts of water level rise. Restoration plan changed when needed</td>
<td>No formal but probably unconscious evaluation during implementation, e.g., to check if drains were successfully blocked</td>
<td>Information of what drains were blocked where and what management was carried out was compared to original plans and communicated to monitoring teams</td>
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<td>River: removal of channelization structures and meadow drainage</td>
<td>Skjern River, Denmark</td>
<td>Landowners, NGOs and a stakeholder advisory committee were involved. Modifications were made, e.g., it was decided not to lead the river flow through a lake to protect migrating salmon and trout from predatory pike</td>
<td>An Environmental Impact Assessment was made and a construction law was adopted in Parliament. Public hearings gave input to work description, including technical evaluation. The advisory committee gave input and minor modifications were made</td>
<td>Tenders were requested in two steps, making changes possible in the second step. A soil movement program was modified and a planned lake was enlarged. Artificial grass mixtures were seeded to increase grass productivity and promote domestic cattle grazing contracts</td>
<td>A short term monitoring program began right after the construction work. Any important changes compared to the original plans are not known</td>
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<td>Scientists made results available through meetings, seminars and discussions in the Finnish Restoration Board. Modifications discussed for later projects. Practical reasons hindered whole-tree harvesting although monitoring indicated it to be more effective than current stem harvest</td>
<td>Laine et al. 2011, Tarvainen et al. 2013, Similä and Aapa 2014</td>
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<td>Monitoring, surveys and analyses led to scientific papers on project outcomes. Project boundaries adjusted due to wetness in nearby land and landowners compensated. Grazing strategies modified. Parts of project area set aside for open-ended succession. Conflicts among stakeholders continually addressed</td>
<td>Pedersen et al. 2007a, b, 2010, 2014, Feld et al. 2011</td>
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River: removal of timber-floating structures, creation of fish spawning beds and diversification of channel morphology

Vindel River LIFE, Sweden

Restoration plans adapted to landowner reactions: planners started working with the most cooperative ones, leaving recalcitrant landowners to later

Planners and practitioners discussed plans with respect to site accessibility, personnel, machines and methods. Plans presented for landowners. Technical evaluation carried out according to EU-LIFE standards

Methods developed over years, e.g., methods for applying coarse sediment and large wood into channels and for constructing fish spawning beds. Methods modified based on gained insights. Discussions in the field with contractors, planners and scientists

Practitioners updated scientists on performed actions to facilitate monitoring. Scientists proposed modifications to implementation, e.g., that available sediment was not coarse enough for recreating channel structures

Fish populations and riparian vegetation monitored. Biotic responses found to be slow or absent. Biotic monitoring methods modified and extended to account for this slow response

Scientists made results available through websites and conference presentations. Modifications proposed by scientists to practitioners were also communicated to planners

LITERATURE CITED


Martinsen, O.-E., and D. Hagen. 2010. Tilbakeføring av Hjerkin skytefelt til sivile formål (Hjerkin PRO) [Restoration of Hjerkin firing range into nature conservation areas (Hjerkin PRO)]. Pages 35–37 in D. Hagen and A. B. Skrindo, editors. Restaurering av natur i Norge—et innblikk i fagfeltet,
fagmiljøet og pågående aktivitet [Restoration of nature in Norway—a glimpse into the thematic field, professional institutions and ongoing activity].

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