Restoration of Sand Mined Wetlands in the Wild Duck Lake Natural Reserve, Beijing: Approaches and Evaluation

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Location

China

Beijing Municipality
Location

- 10 kilometers to the west of Yanqing County
- A small village
- Inside Wild Duck Lake Nature Reserve
- About 56 ha

The project area (Google Earth Sep. 2007)
Baseline analysis

Site selection

- Recommended by Beijing Municipal Bureau of Landscape and Forestry & Yanqing County Forestry Bureau.

- Confirm with the land ownership

- Confirm the tenure

Potential risks
Baseline analysis

Human activities

- Sand Mining

Disturbance statement
- Native vegetation
- Sandy soils
- Organic matter content

Severely damaged

Declining biodiversity
Erosion
Baseline analysis

Ecological Condition

- Gravel soil with poor water-retention capacity.

- Native vegetation:
  - reed, sedge and cattail community, Nymphoides communities;
  - tree species are Populus, Salix, Ulmus and other.
Baseline analysis

Climate condition

- The Temperate continental monsoon climate
- The average temperature is 8 °C
- The Annual precipitation is 493 mm with large annual variation (274mm-747.1mm), Annual evaporation is more than 1700mm.
Baseline analysis

Hydrological conditions

- A group of separated water bodies of different sizes,
- Water supply is mainly from natural precipitation and underground seepage.
- Low-lying area
### Baseline analysis

## Hydrological conditions

<table>
<thead>
<tr>
<th>Land covers</th>
<th>Area (ha)</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare soil</td>
<td>15.13</td>
<td>27.0</td>
</tr>
<tr>
<td>Sand mining slash</td>
<td>10.70</td>
<td>19.1</td>
</tr>
<tr>
<td>Wetland vegetation</td>
<td>1.36</td>
<td>2.4</td>
</tr>
<tr>
<td>Open water</td>
<td>10.56</td>
<td>18.9</td>
</tr>
<tr>
<td>Terrestrial vegetation</td>
<td>11.26</td>
<td>20.1</td>
</tr>
<tr>
<td>Agricultural land</td>
<td>7.01</td>
<td>12.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>56.02</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
Baseline analysis

Potential risk analysis

Disturbance analysis

Ecological status analysis

It is feasible!
Design Principles

- **Artificial promotion and the ecological restoration**
  - Habitat transformation, self-design, mainly select native species

- **From nature, beyond nature**
  - Function optimization, landscaping, assisting update

- **Be suitable for local conditions, cost savings**
  - Abide by the natural conditions, water storage, adaptive management

*Be ecological, natural and economical*
Design ideas

Base repairing

Hydrology adjustment

revetment strengthening

vegetation reconstruction

adaptive management
Design objective and target

- The overall objective of restoration:
  - Normal ecological functions of wetlands;
  - Symbolic function selection (water bird habitat);
  - Abundant biodiversity

- Target ecosystems:
  - Vegetation (artificial promotion) + Animals (natural recovery)
  - Shrubs (Artificial) - Herbal (Natural) Wetland
  - Simulation of natural wetlands succession process

Achieve functional restoration through structure restoration
Restoration Technique

- Restored hydrological regimes
- Micro-topography modeling
- Soil organic matter recovery
- Vegetation planting
- Construction of ecological revetments
Restored hydrological regimes

- Small water body enlarging
- Small water body connection
- Partial deep digging
- Partial impede water flow
Restoration technique

**Micro-topography modeling and reshaping**

*Shoal Construction*

*Small water surface regulation*

*Habitat island creation*
Restoration technique

Soil organic matter recovery

- Layered backfill
- Plant hole backfill
- Plant trough backfill

Volume of earthwork: 10,000 Cubic meter loam soil
Restoration technique

Vegetation planting

- Small water surface vegetation planting
- Large water surface vegetation planting
- Vegetation exposed from beach in normal water level
- Vegetation planting below Normal water level
Vegetation planting

- Waterfront vegetation planting
- Buffer zone vegetation planting
- Slope protection vegetation planting
Restoration technique
Restoration technique

Construction of ecological revetments

- Timber pile slope protection
  - Willow timber pile

- Rock slope protection
  - Difference size

- Eco-bags slope protection
  - Long-life (anti ultraviolet rays)

- Ecological concrete slope protection
Management and monitoring

- After the basic completion of restoration project, certain signs points should be set according to the monitoring requirements to regularly collect water samples and soil samples, and to monitor the effectiveness of restoration project implementation.

- Set a number of sample plots, to observe the biodiversity of wetlands, plant growth, the number of animals (including soil fauna), plant water use data, and to assess the ecological functions of vegetation.

- Use the mobile weather station to observe the specific periods of meteorological data (including precipitation and wetland water level changes).
Evaluation

Soil organic content significantly increased after the restoration

Through the investigation of soil organic matter content in the recovery area and the contrast area in 2009, the soil organic matter content of 0-10cm is higher than that in the control area.

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>Types</th>
<th>Sample plots</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Surface soil</td>
<td>Contrast area*</td>
<td>12.85</td>
</tr>
<tr>
<td>0~10</td>
<td>Contrast area*</td>
<td>12.94</td>
</tr>
<tr>
<td></td>
<td>Recovery area</td>
<td>13.16</td>
</tr>
<tr>
<td>10~20</td>
<td>Contrast area*</td>
<td>13.04</td>
</tr>
<tr>
<td></td>
<td>Recovery area</td>
<td>13.04</td>
</tr>
</tbody>
</table>
Soil animal diversity significantly increased after the restoration

<table>
<thead>
<tr>
<th>Period</th>
<th>Samplt plots</th>
<th>Shannon Wiener Index (H')</th>
<th>Hmax</th>
<th>Uniformity index (J')</th>
<th>Dominance index (D)</th>
<th>1/D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>Contrast area</td>
<td>0.588</td>
<td>0.602</td>
<td>0.976</td>
<td>0.253</td>
<td>3.960</td>
</tr>
<tr>
<td></td>
<td>Natural wetlands</td>
<td>0.790</td>
<td>1.146</td>
<td>0.690</td>
<td>0.223</td>
<td>4.477</td>
</tr>
<tr>
<td></td>
<td>Restoration area</td>
<td><strong>0.718</strong></td>
<td><strong>0.954</strong></td>
<td><strong>0.752</strong></td>
<td><strong>0.218</strong></td>
<td><strong>4.579</strong></td>
</tr>
<tr>
<td>Winter</td>
<td>Contrast area</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td></td>
<td>Natural wetlands</td>
<td>0.391</td>
<td>0.477</td>
<td>0.819</td>
<td>0.393</td>
<td>2.545</td>
</tr>
<tr>
<td></td>
<td>Restoration area</td>
<td><strong>0.359</strong></td>
<td><strong>0.602</strong></td>
<td><strong>0.596</strong></td>
<td><strong>0.560</strong></td>
<td><strong>1.786</strong></td>
</tr>
</tbody>
</table>
Vegetation types and cover significantly increased after the restoration

Wetland vegetation cover: 3% → 49%
Water surface area: 18.9% → 26%
Plant species: 74 → 204
(38 kinds of aquatic plants, 90 kinds of wetland plants 90)
The species and quantity of wetland birds significantly increased

<table>
<thead>
<tr>
<th>Chinese name</th>
<th>scientific name</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>戴胜</td>
<td><em>Upupa epops</em></td>
<td>+</td>
<td>++(2009)</td>
</tr>
<tr>
<td>灰斑鸠</td>
<td><em>Streptopelia decaocto</em></td>
<td>+</td>
<td>+ (2009)</td>
</tr>
<tr>
<td>灰椋鸟</td>
<td><em>Sturnus cineraceus</em></td>
<td>+</td>
<td>++(2009)</td>
</tr>
<tr>
<td>小鹀</td>
<td><em>Emberiza pusilla</em></td>
<td>+</td>
<td>++(2009)</td>
</tr>
<tr>
<td>苍鹭</td>
<td>Grey heron (<em>Ardea cinerea</em>)</td>
<td>−</td>
<td>+(2009)</td>
</tr>
<tr>
<td>大白鹭</td>
<td>Great Egret (<em>Ardea alba</em>)</td>
<td>−</td>
<td>+(2009)</td>
</tr>
<tr>
<td>灰鹤</td>
<td>Common crane (<em>Grus grus</em>)</td>
<td>+</td>
<td>++(2009)</td>
</tr>
<tr>
<td>绿头鸭</td>
<td>Mallard Duck (<em>Anas platyrhynchos</em>)</td>
<td>+</td>
<td>++(2009)</td>
</tr>
<tr>
<td>赤麻鸭</td>
<td>Ruddy shelduck (<em>tadorna ferruginea</em>)</td>
<td>+</td>
<td>++(2009)</td>
</tr>
<tr>
<td>白腰草鹬</td>
<td>Green Sandpiper (<em>Tringa ochropus</em>)</td>
<td>-</td>
<td>+(2011)</td>
</tr>
<tr>
<td>小鸊鷉</td>
<td>Little Grebe (<em>T. ruficollis</em>)</td>
<td>-</td>
<td>+(2011)</td>
</tr>
<tr>
<td>红脚隼</td>
<td>Amur Falcon (<em>Falco vespertinus</em>)</td>
<td>-</td>
<td>+(2011)</td>
</tr>
<tr>
<td>扇尾沙锥</td>
<td>Common Snipe (<em>G. gallinago</em>)</td>
<td>-</td>
<td>+(2011)</td>
</tr>
</tbody>
</table>
2007.9

2011.5
This case study on the post-mining restoration techniques and success can provide a suitable guide for the restoration of other similar degraded wetlands.
Thank you for your attention!