Preliminary Plan for Conservation of Sturgeon Populations in the Middle Danube

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Historical sturgeon fishery

7000-9000 years ago, Paleolithic Age

11-15. cent. fishery flourished

Great sturgeon (*Huso huso*)

2633 ind. within 30 years (1552-1581),
77 ind. in one day at one site (1553)
Decline of sturgeon catch in Hungary

18th century. Regular sturgeon fishery ended in the Hungarian Danube section
20th century. anadromous sturgeon species are at risk of extinction

46 ind. in 100 years (20th cent.)
Difference: 5-6 order of magnitude
77 ind. in one day at one site (1553)

Paks, May 16, 1987
Occurrence of 3 sturgeon species in the 20th century

**Acipenser gueldenstaedti**

- Dunakiliti, 1999
- 36 ind.
- 18 sites

**Acipenser nudiventris**

- Mohács 2010
- 27 ind.
- 18 sites

**Acipenser stellatus**

- Tiszajenő, 2005
- 6 ind.
- 6 sites

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*Note: Images of individuals holding sturgeon specimens are shown for each species.*
Occurrence of *Acipenser ruthenus* in Hungary

Annual catch (1000 kg)

- **Median:** 5.5 t
- **Max:** 37.2 t
- **Min:** 5.5 t

From database of the Hungarian fish fauna
„Conservation measures”

Species are on verge of extinction
High economic value

Development of breeding and farming technologies

Stocking actions are applied
Popular events

Efficiency for rehabilitation?

caviar price:
6,000-12,000 €/kg
Main reasons of decline of sturgeon populations

- **Overfishing**
- **Habitat degradation, fragmentation**
- **Population, decline of genetic integrity**

Regulation and control of fishery

Restoration and continuity

- From second half of the 20th cent.
- Hybridization
- Introduction of non-native sturgeons by uncontrolled stocking
- Intense sedimentation
- Fragmentation of migratory way
- Change of bedload transport
- Bed incision
- Intense sedimentation
Main reasons of decline of sturgeon populations

- Overfishing
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- Population, decline of genetic integrity

- Regulation and control of fishery
- Habitat protection, restoration, continuity
- Species and population conservation
Sturgeon conservation in consideration of holistic approach

Fish fauna – indicator of environmental changes

200 out of 522 of Europe’s freshwater fish species are at risk for extinction

60% of riverine species are endangered

Sturgeons are best indicator of ecological integrity of the Danube

Consider as ‘flagship species’ in assessment of ecological status

Develop a benchmarking system to complement biotic evaluations of the WFD
Social and economic benefits of large rivers

- Land use in floodplain
- Navigation way
- Domestic water
- Hydropower
- Industrial water
- Irrigation
<table>
<thead>
<tr>
<th>Human activity – decline ecological integrity of rivers</th>
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<tbody>
<tr>
<td>interruption of lateral connectivity – channelization</td>
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<tr>
<td>fragmentation of longitudinal connectivity – damming</td>
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<tr>
<td>river bed incision</td>
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<tr>
<td>increasing floodplain sedimentation</td>
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<tr>
<td>pollution (eutrophication, pesticides, heavy metals ...)</td>
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<tr>
<td>invasion of non-native species</td>
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Sustaining of ecosystem integrity

By recognition of human dependence on ecosystems (Millennium Ecosystem Assessment 2005)

Restoring ecological integrity policy goal

Human population density – restoring pristine state is impossible

Integrative policy is needed with consideration:
- Degradation of ecosystems
- Economic needs of growing human population
- Social needs of human population

What types of measures can provide sustainable ecosystem integrity, in the context of balancing social, economic and environmental needs?
Restoration strategy of large rivers – (according to Jungwirth et al. 2002)

Status quo assessment
- Water management
  - Flood protection
  - Navigability improvement
  - River engineering, …
- Ecology
  - Hydro-morphology
  - Landscape, habitats
  - Flora, fauna, …

Status quo evaluation
- Assessment of ecosystem deficits

Target vision
- Delineation environmental objectives
- Consideration existing constraints

Restoration program

Monitoring program
- Evaluation of restoration or rehabilitation measures

Historical reference conditions
- Pre-regulation system, ecology

Framework conditions
- Land use
- Water utilization
- Urban areas
- Legal aspects

EU WFD
Iron Gate Dam – fragmentation of river system

Generate high mortality of migratory fish to downstream direction - particularly for large adult fish

Insurmountable barrier to upstream

\[ H_{\text{max}} = 35.46 \text{ m} \]
\[ H_{\text{g}} = 27.16 \text{ m} \]
\[ H_{\text{baff}} = 17.50 \text{ m} \]
\[ Q = 725 \text{ m}^3/\text{s} \] (800, 840)
\[ P = 175 \text{ MW} \] (190, 200)
\[ n = 71.5 \text{ min}^{-1} \]
Iron Gate Dam – Rehabilitation of longitudinal connectivity

emphasized goal, high priority measure in significant action plans

SAP - 2005
DRBMP - ICPDR 2006

Ship lock as fish lock
Iron Gate Dam – Prediction of impact of fish pass

Historical catch of great sturgeon

- 16th century: 2633 ind./30 year
- 18th century: 25000 ind./year
- 18th century: End of regular sturgeon fishery
- 1930s: 2 ind./10 year
- 1930s: >500 t/year
- 40 years before Iron Gate dam

Are there any migrating specimens at the Iron Gate?

High priority measure?

Lower Danube has priority in conservation of anadromous species

2 order

3 order

3 order
Estimation of impact of sterlet stocking in Hungary

Artificial propagation was developed in the 1970s and 1980s
Stocking of juveniles in the 1980s (regular):
Stocking in the 1990s (became occasional):
Stocking from 2000 (regular):

Stocking does not have significant impact on recruitment

Influence of stocking can be estimated by population dynamical parameters

Artificial propagation was developed in the 1970s and 1980s
Stocking of juveniles in the 1980s (regular):
Stocking in the 1990s (became occasional):
Stocking from 2000 (regular):

Succes story?

Sterlet catch 1947-1988

protected species

stocking

Estimated biomass:

Sterling catch

Biomass: 175 kg

Yield: 35 kg (25-55)

Cost of surplus:

120 €/kg

Survival rate: S=0.54

Stocking does not have significant impact on recruitment

Influence of stocking can be estimated by population dynamical parameters
Long-term seasonal water level fluctuation of the Danube at Budapest

Monthly average 1935-2005

Seasonal water level fluctuation is a key factor of the fish production in the large lowland rivers.
Long-term seasonal water level fluctuation and annual sterlet catch in the Hungarian section of the Danube (1950-1977)
Relationship between monthly water levels and annual catch analysed by cross-correlation (1950-1977)

- Sign. negative correlation annual catch monthly water lev. in previous 1-4 y.
- Negative retarded effect of floods on sterlet catch
- Reproductive success depends on water level, increasing bed shear stress
Correlation: 5 year average of monthly mean water levels  
5 year average of commercial catch

Sterlet Szigetköz (1967-1991)

Barbel Szigetköz (1967-1991)

Carp Szigetköz (1967-1991)

Pike Szigetköz (1967-1991)
Habitat degradation – Szigetköz case study

Anabranching system
Historical spawning habitat

19th century:
River engineering
navigation way, flood protection works

1992
Discharge diversion (85%), Hydrower station

Intense human modifications

main arm (end 19th c.)

floodplain sidearms

Gabčikovo hydroelectric power station (1992)
bypass canal (end 20th c.)
dike (end 19th c.)
Sterlet catch - Szigetköz (1950-2005)

- Acipenser ruthenus

400,000 m³ soft sediment accumulated in a 4 km long section

sterlet – important indicator of the habitat change
Improvement of habitats – key element of rehabilitation

Reliable information need to target vision
localisation of key habitats - telemetry

Sonar image processing

2D and 3D hydraulics models

Description of local hydro-morphological processes

Delineation of environmental objectives for habitat restorations

Bedrock or impermeable material

sand, silt
gravel
seepage
EU Danube Region Strategy

Improvement of habitat quality is relevant to EDRS

EU – Danube – Black Sea – Central Asia

New opportunities for development of sectoral policies

- socio-economic development
- competitiveness
- environmental management
- modernisation of transport corridor

Decline of biodiversity
Alteration of natural ecosystem

Environmental protection
Sustainable utilization approach

To achieve goal of sustainable utilization
Need to investment in environmental research to identify new tools for

- improvement ecosystem integrity
- reduce human pressure on river ecosystem
Principle of ecological restoration (according to Williams et al. 1997)

Increasing ecosystem structure

Increasing ecosystem function

Replacement replaced function but not structure "ecological gardening"

Replacement replaced structure but not function "ecological husbandry"

Degradation

Historic condition

Restored system

Existing condition

Increasing ecosystem structure