Jun 10th, 3:10 PM - 3:30 PM

Towards a Healthy Danube - Fish migration at the Iron Gate dams

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Towards a healthy Danube

Fish migration at the Iron Gate Dams I & II

Wilco de Bruijne – June 10th 2014

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Outline

1. Project objectives
2. Situation Iron Gate Dams
3. Design criteria for up- and downstream migration of sturgeon and other species
4. Acoustic telemetry study sturgeon behavior
5. Preliminary conclusions
6. Initial design for upstream passage at Iron Gates I and II

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1. Project objectives

- This project is a continuation of the initial FOA scoping mission, carried out in 2011.
- The project objective is to extend the opportunities for different fish species, including sturgeon, to migrate 800 km further upstream in the Danube River system.
- Activities:
  - Tagging and monitoring of sturgeons in order to determine the correct location for an upstream fish way at the Iron Gates II;
  - Preliminary design of fish ways at Iron Gates I and II for upstream fish migration, including a cost estimate;
  - Preliminary study for downstream fish migration possibilities.
- Downstream solutions are disregarded in this presentation because of limited time.

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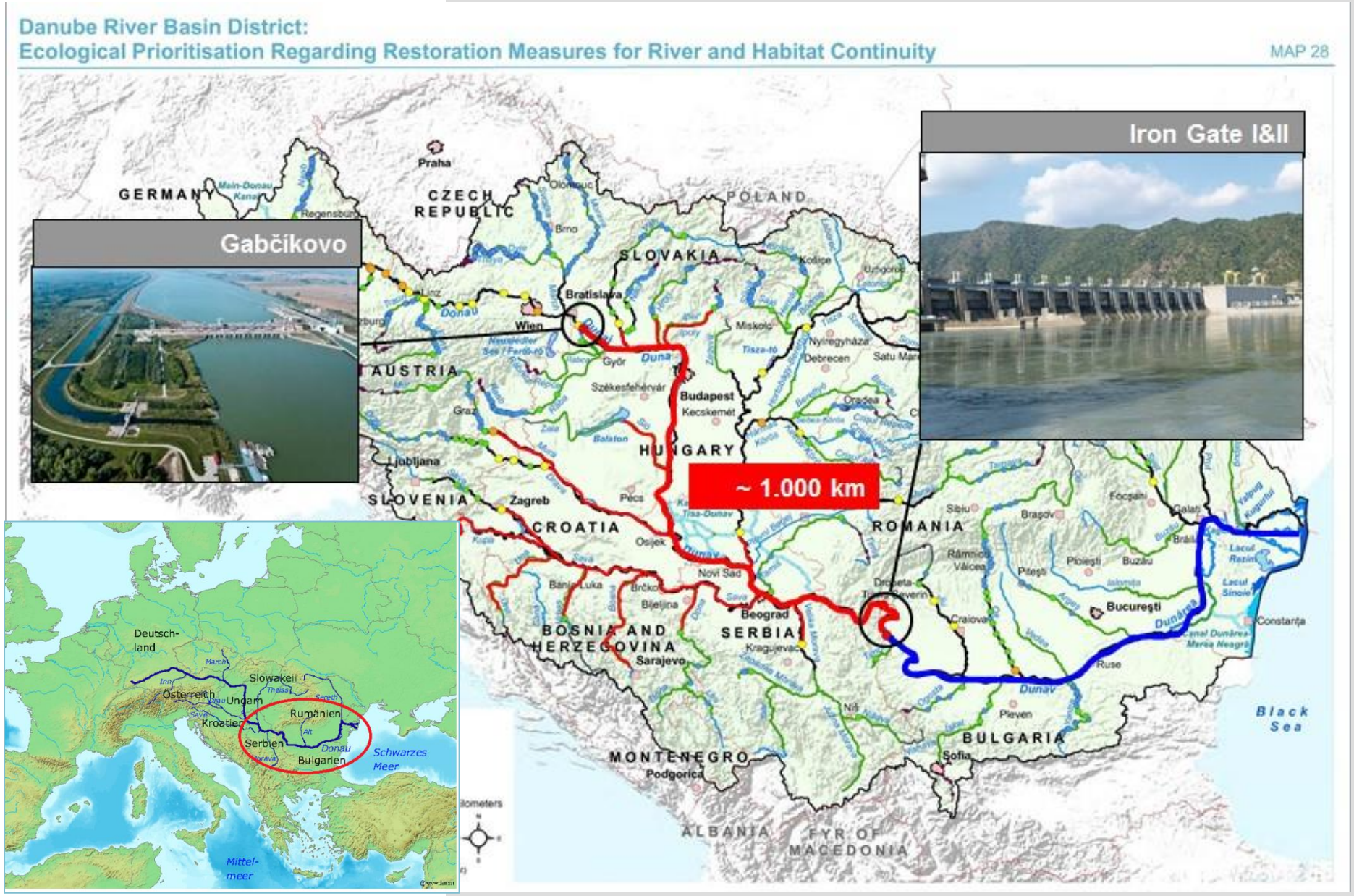
2. Situation Iron Gates

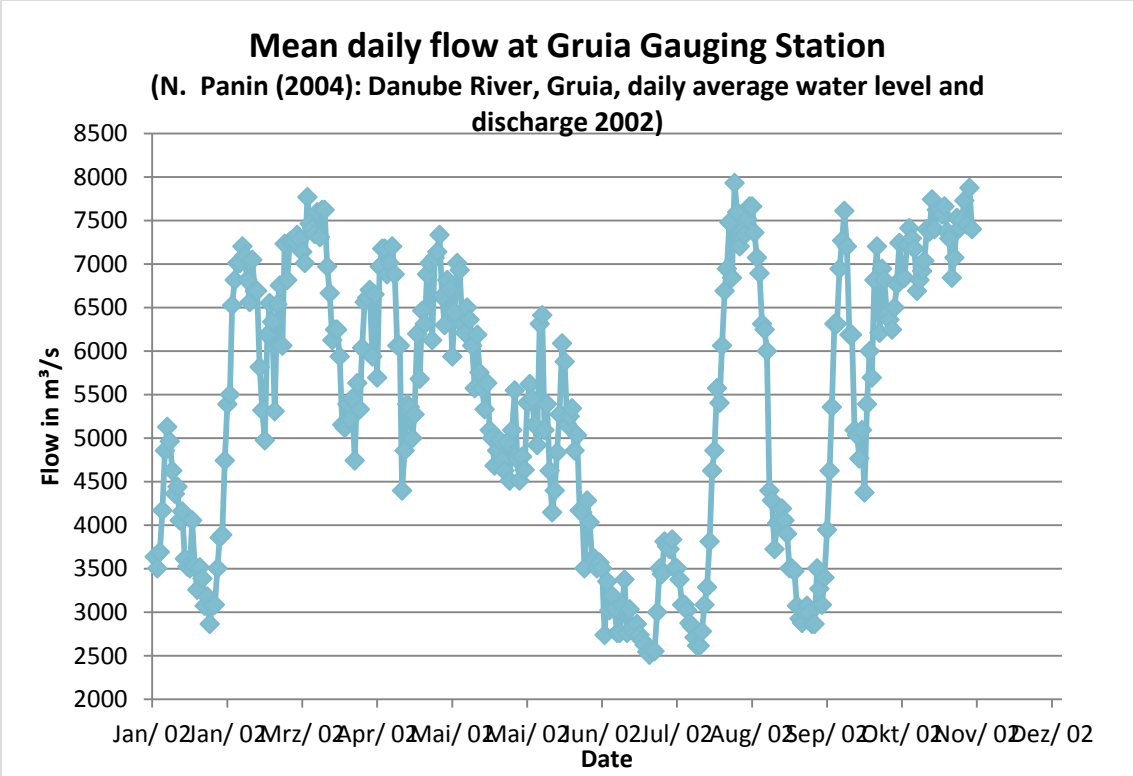



Orşova
Eşelniţa
Iron gates I
Drobeta-Turnu Severin
Izvoru Bârzii
Cazane
Korbovo (Корбово)
Hinova
Brza Palanka (Брза Паланка)
Devesel
Rogova
Bistreţu
Vânjuleţ
Jiana
Iron gates II
Jabukovac (Јабуковац)
Balta Verde
Pătulele
Dušanovac (Душановац)
Radujevac (Радујевац)
Negotin (Неготин)
Gârla Mare
Vrata
Novo selo


Iron gates II
Romanian turbines and weir
Ostrovu Mare
Mihajlovac (Михајловац)
Gogoşu
Balta Verde
Romanian shiplocks
Portile de Fier 2
Dušanovac (Душановац)
Main HPP and weir
Prahovo (Прахово)
Serbian shiplocks and turbines

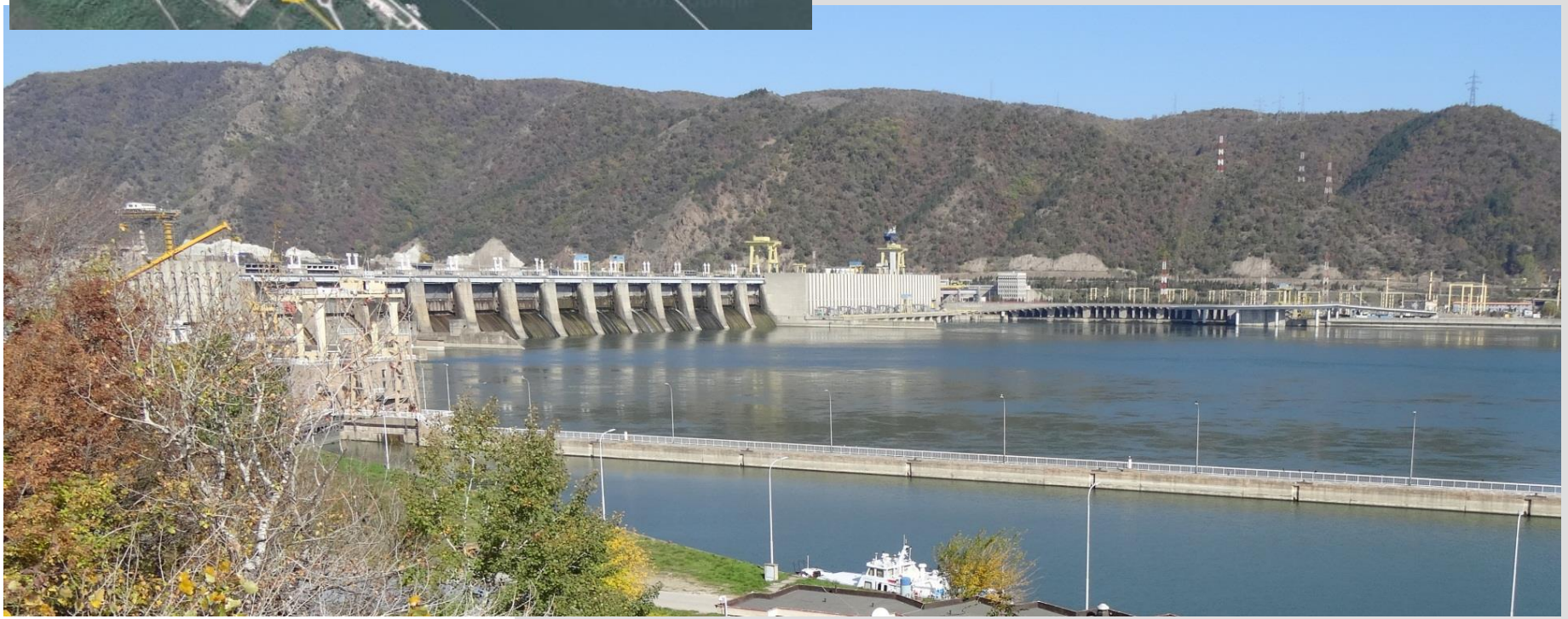
Iron Gates Hydrology

- Multi-annual flow (1840-2006) at Gruia is 5585 m³/s.
- Flow can vary from 990 m³/s (1985) to 15.900 m³/s (2006).
- High annual flow variation



Iron Gates I

- Head drop 20-28m
- high (daily) variation in upstream waterlevel. Tailwater constant due to Iron Gates II reservoir
- Will prove extremely challenging for pool-type pass because of upstream waterlevel fluctuations and limited space.



Iron Gates II main HPP

- Head drop 2.5-12.8 m, designed head 7.5 m
- Comparatively low annual upstream and downstream water fluctuations.
- Many space because of flood plains.

Turbines

Iron gate I turbines

- 2 x 6 double regulated vertical Kaplan units, 194.5 MW each.
- Design discharge 840 m³/s per Turbine.

Iron gate II turbines

- 2 x 8 bulb turbines in main HPP.
- 2 each in Gogosu branch and Serbian HPP.
- Design discharge 425 m³/s per Turbine

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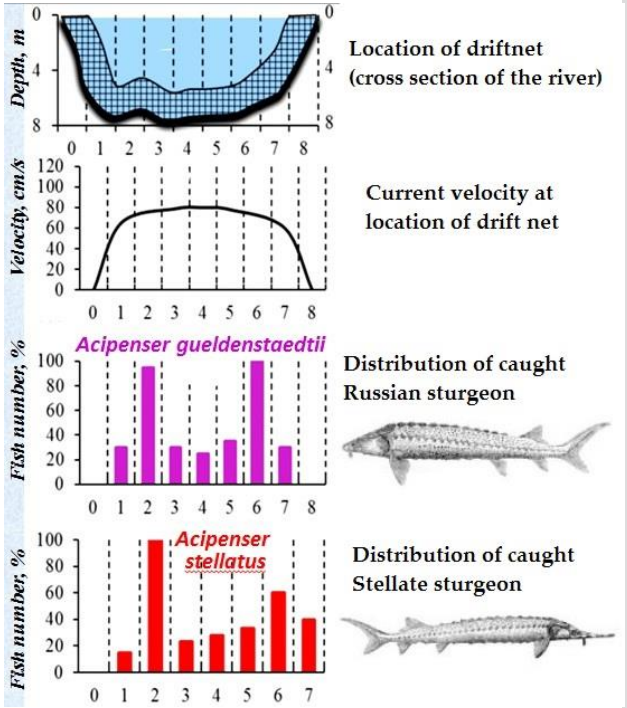
3.Design criteria: Migratory behaviour and swimming capacity

- 6 species of sturgeon, Beluga Sturgeon up to 6m.
- Very little know on Danube sturgeons, Russian studies used as reference (Volgograd river).
- Bottom dwellers, migration patterns along the shores in deep parts.
- Nocturnal behaviour.



Building code for i.e. Fishways – State buildig committee of the USSR (1989):

- Flow velocity characteristics for Acipenseridae:
  - $V_{threshold}$ = 0.15 - 0.20 m/s
  - $V_{attraction}$ = 0.70 - 1.20 m/s
  - $V_{drift\ adults}$ = 0.90 - 1.40 m/s
  - $V_{drift\ juveniles}$= 0.15 - 0.20 m/s

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3.Design criteria: Geometric criteria pool type fish ways and collection galleries

- Fishways for sturgeons are in operation in the former U.S.S.R. and North America. Only experience with fish lifts and fish locks.
- Building code for Fishways – State building committee of the USSR (1989):
  - Head drop < 10m: Bypass channels/ pool-type fishways:
    - Width: 3.0 – 10.0 m
    - Depth: 1.0 – 2.5 m
    - Slope: 1:8 – 1:20
  - Head drop > 10m: Hydraulic or mechanical fish lifts with collection gallery:
    - Length: 60.0 m
    - Width: 6.0 m
    - Depth: 1.5 m
- Geesthacht fish way in germany is designed (acc. DWA-M 509) to be suitable for sturgeon. Two *Acipenser baerii* (Siberian sturgeon) passed successfully (size not mentioned).

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3.Design criteria: Operation time

- Fish migration calendar present migratory species (Radu Suciu - DDNI)
- ≥ 300 d/yr fishway operation time

English name	Romanian name	Scientific name	Habitat-directive	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Beluga sturgeon	morun	*Huso huso*	V												
Russian sturgeon	nisetru	*Acipenser gueldenstaedtii*	V												
Stellate sturgeon	pastruga	*Acipenser stellatus*	V												
Sterlet	cega	*Acipenser ruthenus*	V												
Ship sturgeon	viza	*Acipenser nudiventris*	V												
Pontic shad	scrumbia de Dunare	*Alosa imaculata*	V												
Black Sea salmon	somon de Marea Neagra	*Salmo labrax*	V												
Sichel	sabita	*Pelecus cultratus*													
Vimba bream	morunas	*Vimba vimba*													
European catfish	somn	*Silurus glanis*													
Pike-perch	salau	*Sander lucioperca*													
Burbot	mihalt	*Lota lota*													
Eel	anghila	*Anguilla anguilla*													
Ide	vaduvita	*Leuciscus idus*													
Asp	avat	*Leuciscus aspius*													
Volga pikeperch	salau vargat	*Sander volgense*													
Zingel	pietrar	*Zingel zingel*	V												
Barbel	mreana alba	*Barbus barbus*	V												
Common nase	scobar	*Chondrostoma nassus*													
Wild carp	crap slabatic	*Cyprinus carpio*													

	Diadromous species
	Potadromous species
	Anadromous species
	Important period for **upstream migration**
	Important period for **downstream migration** of adults
	Important period for **downstream migration of juveniles**
	Important period for **spawning** in the Danube River

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4. Acoustic telemetry study sturgeon behavior

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First results

- One 2m young beluga male sturgeon caught. Tagged already Nov. 2013.
- Four juvenile stellate sturgeons (too small to tag).
- Beluga was released upstream of Gogosu Branch and was detected one day later at 800m downstream of the main HPP at 6.5 m depth.
- Later several detections at the mouth of the Gogusu Branch, leaving the IG II site.
- First tagged beluga sturgeon detected at the IG II site ever

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5. Preliminary conclusions for fish way design

- Limited design criteria for locks & lifts from Russia, France, USA
- State-of-the-art design criteria pool-type fishways for anadromous and potamodromous species
- Limited design criteria for pool-type fishways for Sturgeon
  - entrance location and water depth
  - passability, i.e. hydraulic & geometric criteria

  Very limited criteria as to surplus attraction flow.
- Good info on migration periods/ operation time
- Recommendation for upstream passage restoration:
  Iron Gates I: fish lift (or lock)
  Iron Gates II: pool-type fishway
- Downstream passage restoration:
  IG I & II: no viable technology for this size/ discharges

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6. Initial design for upstream passage at Iron Gates II

Double Vertical Slot Fishway designed acc. to DWA-M 509 (adopted by EIFAAC)

- located on left bank at HPP
- clear pool length: 9 m
- clear pool width: 13.50 m
- min. water depth: 2.50 m
- 2 slots 1.20 m wide
- head drop per baffle: 0.09 m
- max. flow velocity in slot: 1.35 m/s
- fish pass design flow: 7.50 m^3/s
- 3 entrances in tailwater (at turbine outflow/ turbulent zone, below turbulent zone, and in calm river bank zone) parallel to main current and connected to river/ bank bottom

Attraction flow

- provided by a SHPP (Q_{max} ~45 m^3/s, P_{el} ~3 MW, Output ~ 25,500 MWh)
- attraction flow: 30 - 53 m^3/s (= 3x 10 - 17.5 m^3/s per entrance depending on downstream water level)
- attraction flow velocity: 0.8 - 1.0 m/s at entrance

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Initial design for upstream passage at IGII

Initial design for upstream passage at Iron Gates I

Mechanical or hydraulic fish lift

- located on left bank next to lock in former sluice section
- overall dimensions: ~43 x 20 m
- Lift height: +30 m
- Facility includes: outlet with gate, crowding device, holding pool, 2 side pools for attraction flow separated with fine screens, lift shaft, supply pool for lift, 2 dissipation chambers for attraction flow, shute or canal to reservoir
- Hopper dimensions: ~7 x 9 m (V ~ 100 m^3)

Attraction flow

- provided by pipes from upstream
- Turbined attraction flow
- attraction flow velocity: 0.8 m/s at entrance (may be variable depending migration times of on target species)

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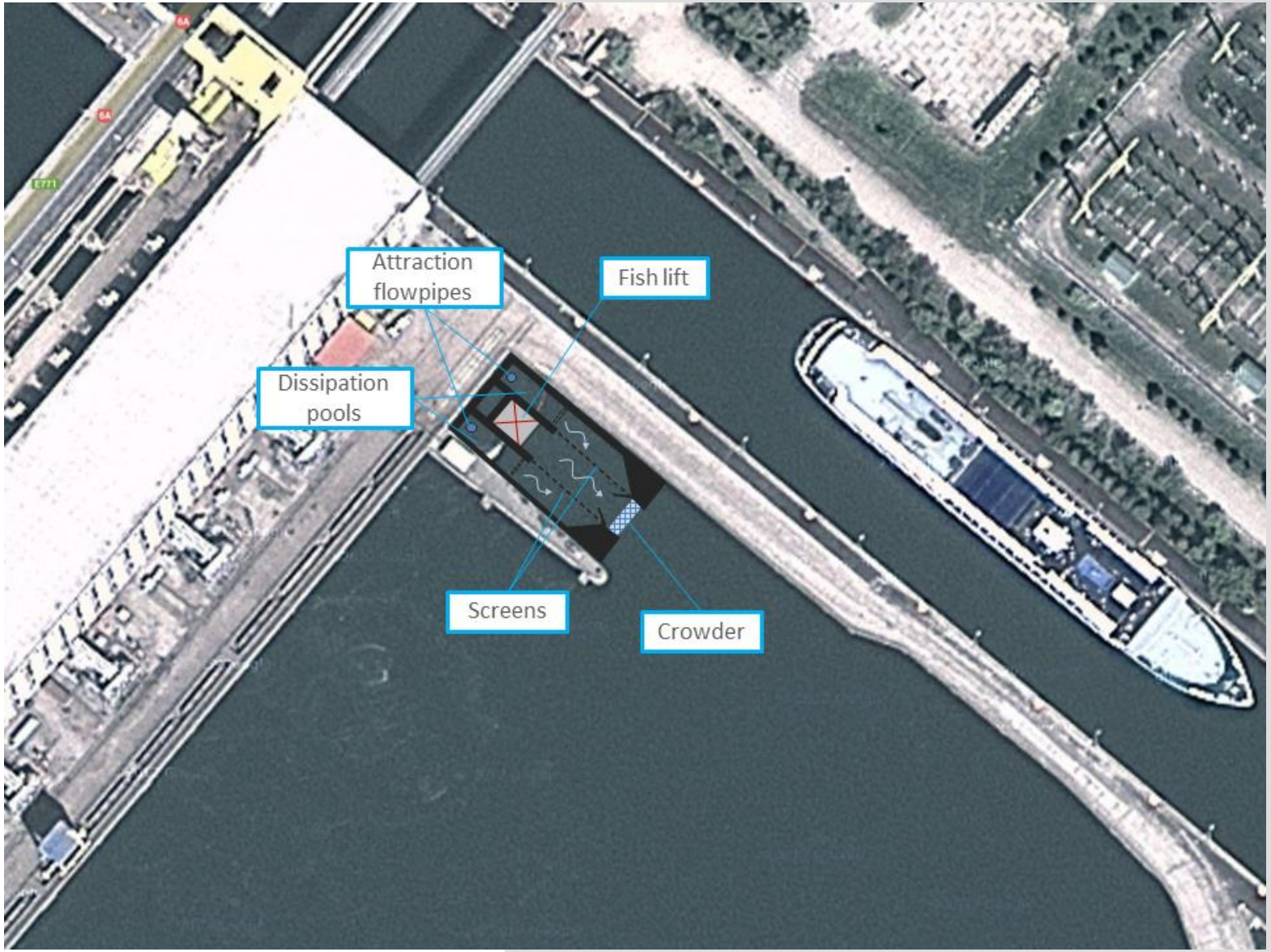
Initial design for upstream passage at Iron Gates I



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Imagine the result

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