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Session A2: Fish Migration Facilities on the Salt-Fresh Water Border of the Wadden Sea

George Wintermans
Wintermans Ecologenbureau

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WINTERMANS ECOLOGENBUREAU
george@wintermansecologenbureau.nl

FISH MIGRATION FACILITIES ON THE SALT-FRESH WATER BORDER OF THE WADDEN SEA

George Wintermans

Fish Passage Conference 2015, Groningen 22-24 June

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george@wintermansecologenbureau.nl

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- thematic introduction
- general design demands migration facilities
- local design issues salt-fresh water migration facilities
- applied constructions on the salt-fresh water border

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Thematic introduction 1

In the mid 80's research into the food ecology of spoonbills in the Wadden Sea region revealed that three spined sticklebacks are an important prey species. Not only for spoonbills but also for other fish eating birds and predatory fishes in both fresh and salt waters.

At the same time research into the stocks of Eel indicated that the supply of glass eel along the coast was strongly decreasing.

Rik Beentjes

Gonnie van der Schans

PP Schollema

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Thematic introduction 2

This led to the notion that in the 20the century in the Netherlands almost all migration routes from the sea to inland waters were blocked by hydraulic constructions like dikes, weirs, sluices and pumping stations.

As the Ministry of Infrastructure and Environment (RWS) at that time was the owner of most of the dikes and discharge facilities, it was adressed for solving the problem.



https://beeldbank.rws.nl, Rijkswaterstaat / Joop van Houdt

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Thematic introduction 3

Within the RWS program “Gradients” in the 90's the restoration of estuarien gradients and fish migration routes is persued and in the mid 90's the first fish migration facilities on the salt-fresh water border are realized on the island of Texel (fish siphon and fish ladder).

Hereafter the development, construction and monitoring of salt-fresh water migration facilities rapidly increased together with research into the supply of migratory fishes along the Dutch coast.

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SBB-Texel

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General design demands

- noticable
  (attraction flow / discharge volume)

- accessible

- passable
  (both upstream and downstream)

and preferably

- continuous operational

- long lifespan

- cheap

Straight forward list of demands/wishes but....................................

we are are dealing with ca 10 different migratory species; each with its specific physical, psychiological and behavioural capacities and limitations regarding:

- swimming capacity (passive and active migrants)
- abiotic water conditions (turbulence, temperature)
- disturbance sensitivity (noise, light)
- water quality (fresh/salt water tolerance, sensitivity for eutro/toxification)

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Local design issues 1

In the Netherlands, we are facing some relevant country specific issues:

- almost all the mainland along the coast behind the dikes and dunes lies lower than the average sea level and only temporary (during low tide) above mean low water level.

- almost all 'superfluous' water is discharged via hydraulic constructions like weirs, sluices, and pumping stations (in Wadden Sea area alone up to 45 locations!)

Wikipedia.org

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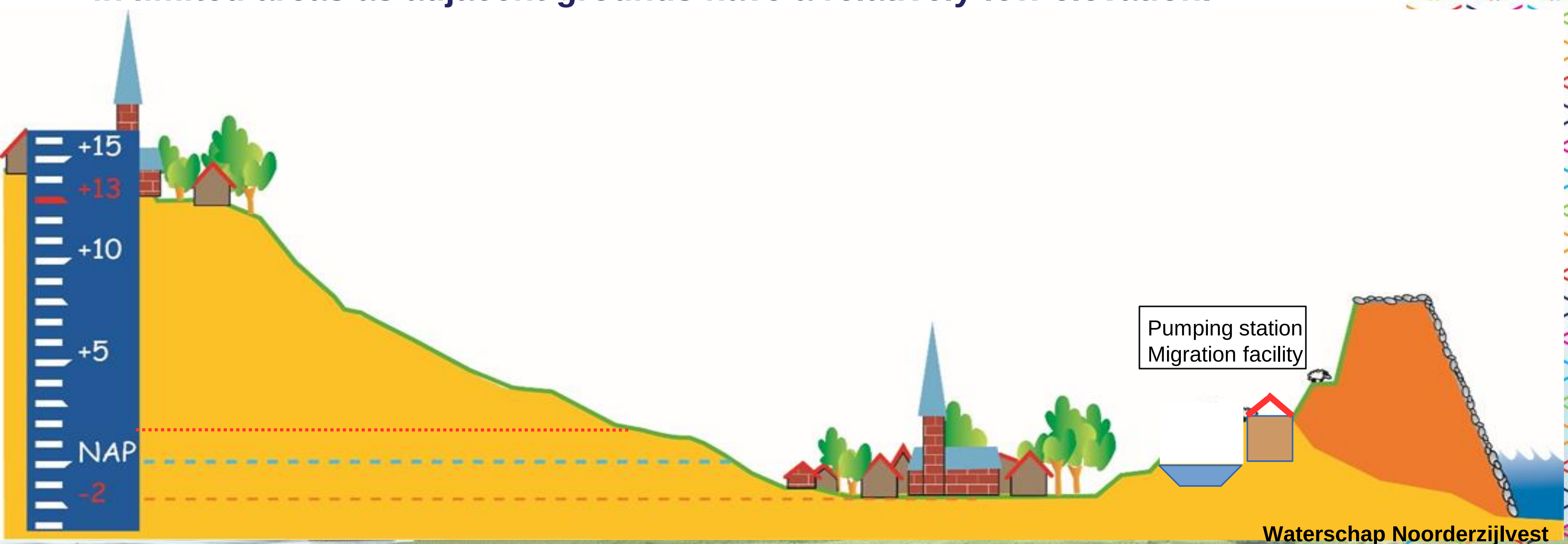
Local design issues 2

This implies for salt-fresh water migration facilities that they have to operate:

- **close to and in conjunction with discharge facilities (attraction flow)**
- **when the sea level is higher and lower than the fresh water level and elevation of the discharge facility.**
- **in limited areas as adjacent grounds have a relatively low elevation.**



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Local design issues 3
Ad noticability / attraction flow

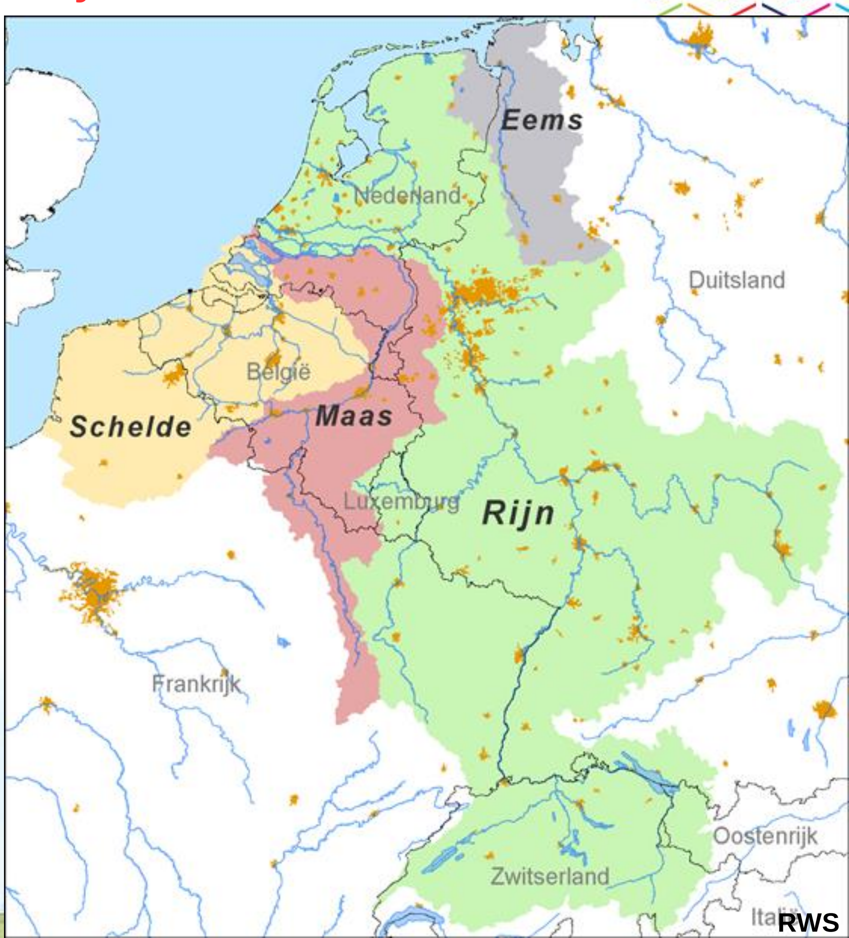
The noticability of migration facilities depends mainly on the available discharge volume and therefore on:

– the size and quality of the catchment area (water supply)

– the elevation and capacity of the discharge facility (discharge time)

Discharge Facilities in large rivers and lakes generally have enough water avaible but may be limited in discharge time (depending on elevation and capacity of the facility).

Facilities of reclaimed and natural lands along the coast are relatively small, numerous and often limited in both discharge volume and time.



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Local design issues 4
Ad accessibility

The accessibility of a migration facility is determined by a variation of physical, psychiological and behavioral parameters.

Downsteam migration:
– often hindered at weirs and sluices but possible depending on regular or fish-friendly discharges and migration facilities like valves in lock gates and 'by passes'.

– severely limited at pumping stations and to a lesser degree also at locks.
NB: Fish friendly pumps may solve (part of) the problem but replacing all conventional pumps is no sinecure.

Upstream migration:
– severely limited at nearly all discharge facilities (high current speeds, absence of open water connection, presence of moving obsticals) with lock gates possibly more or less as an exception (accessibility poorly studied!).

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Local design issues 5
Ad passability

The degree in which a migration facility is passable depends meanly on the applied construction, besides the physical, physiological and behavioral parameters that also determine the accessibility.

In principle all constructions used on the salt-fresh water border, aim to realize a more or less permanent water connection between the sea and inland waters, that can be used by all migratory fish species during all tidal cycles.

Applied constructions

On the salt-fresh water border of the Wadden Sea roughly 4 different constructions are applied:

- **classical fish ladder: artificial waterfall (cascade, vertical slot, eel gutter) in open connection with the sea (no primary dike and/or sufficient elevation). In Wadden Sea region seldom used; only applicable in relatively small isolated areas like dune valleys and salt marshes.**

- **fish siphon: (small) pumping station with a temporary siphon connection between an outside basin and inland water over a primary dike.**

- **discharge fish passage:**
  Small: discharge facility via an outside basin with a return discharge option through a primary dike.
  Large: discharge facility via an inside basin and stormgate in a primary dike with a return discharge option through a secondary dike.

- **artificial fish migration river: in principle open but sealable connection between the sea and inland water in a primary dike.**

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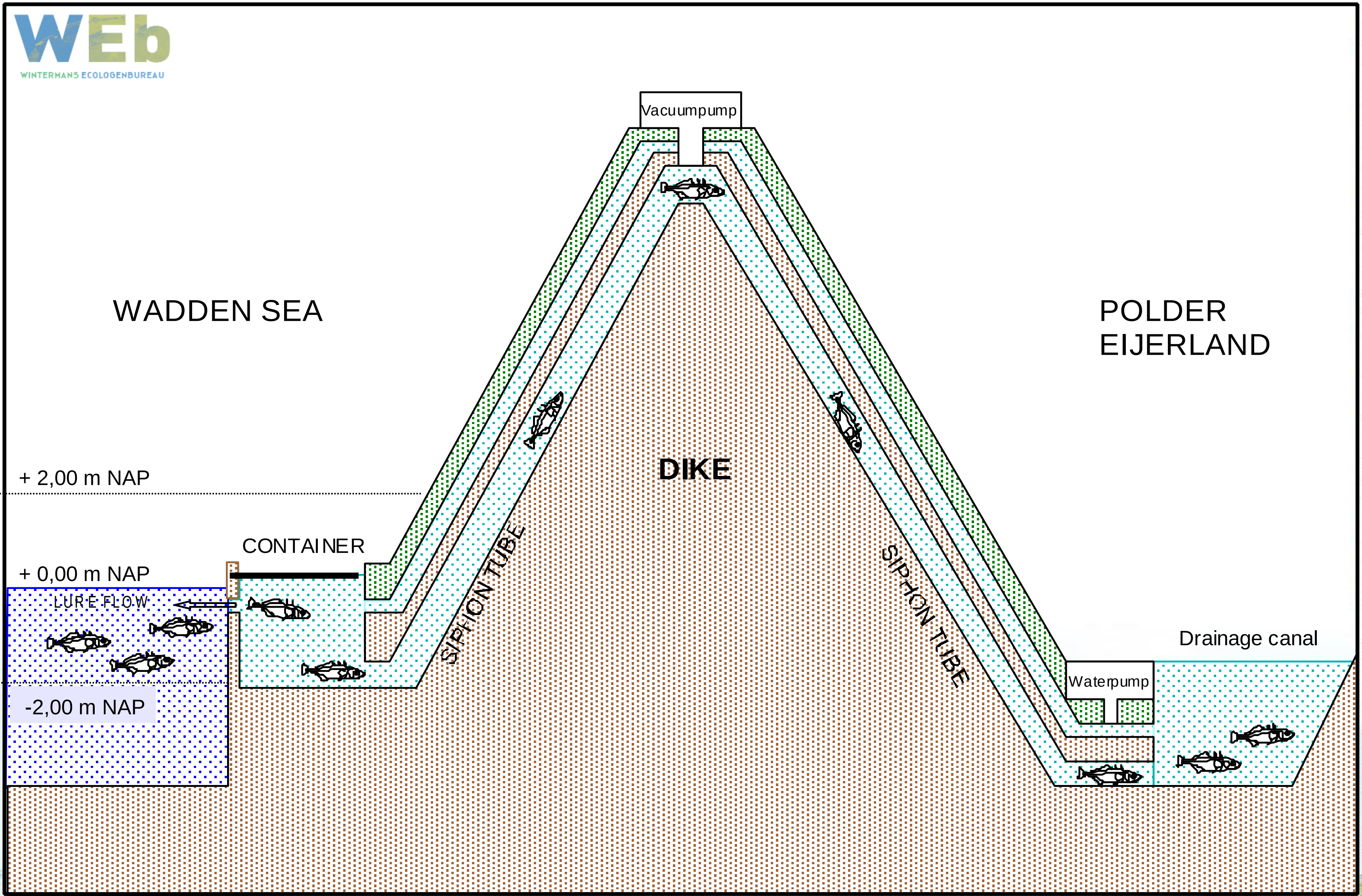
Fish siphon 1



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Fish siphon 2

Pros:
- feasible in combination with existing discharge facilities.
- no impact on salinization (agricultural and water management issue).
- no impact on coastal defence.

Cons:
- artificial hydraulic construction.
- costs and maintenance: water and vacuum pump; vacuum detection. mechanism; fish assemble basin with valves, cellars.
- limited efficiency (active migration, relaps volume, limited siphon volume and discharge time).
- limited fish friendly (relaps volume).

Important parameters for functioning:
- carry up height (pressure; relaps volume).
- water level ratio (siphoning; transport speed).
- available discharge volume in time (operation time; upper half of tidal cycle).
- tidal amplitude (operation time; upper half of tidal cycle).

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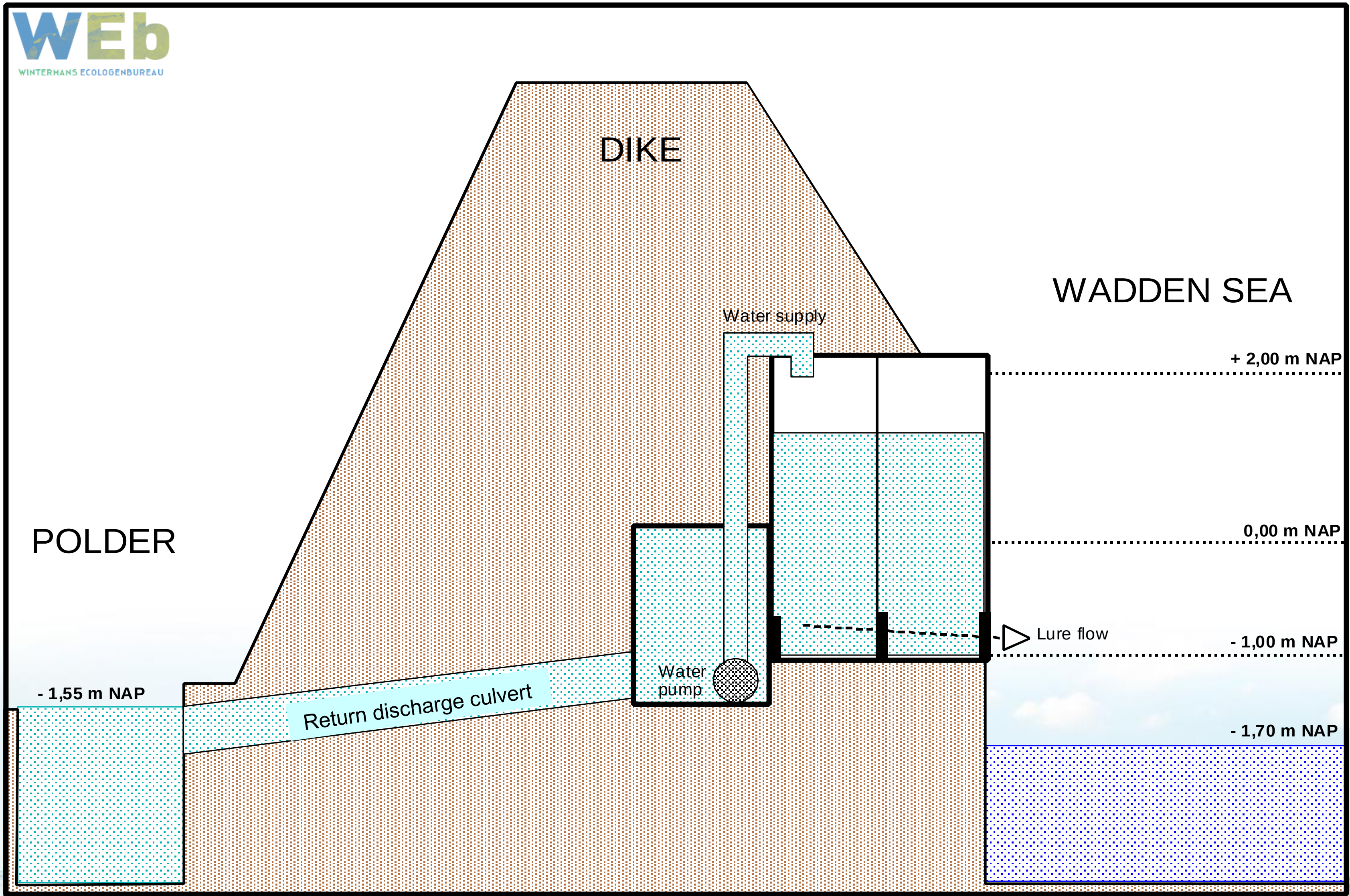
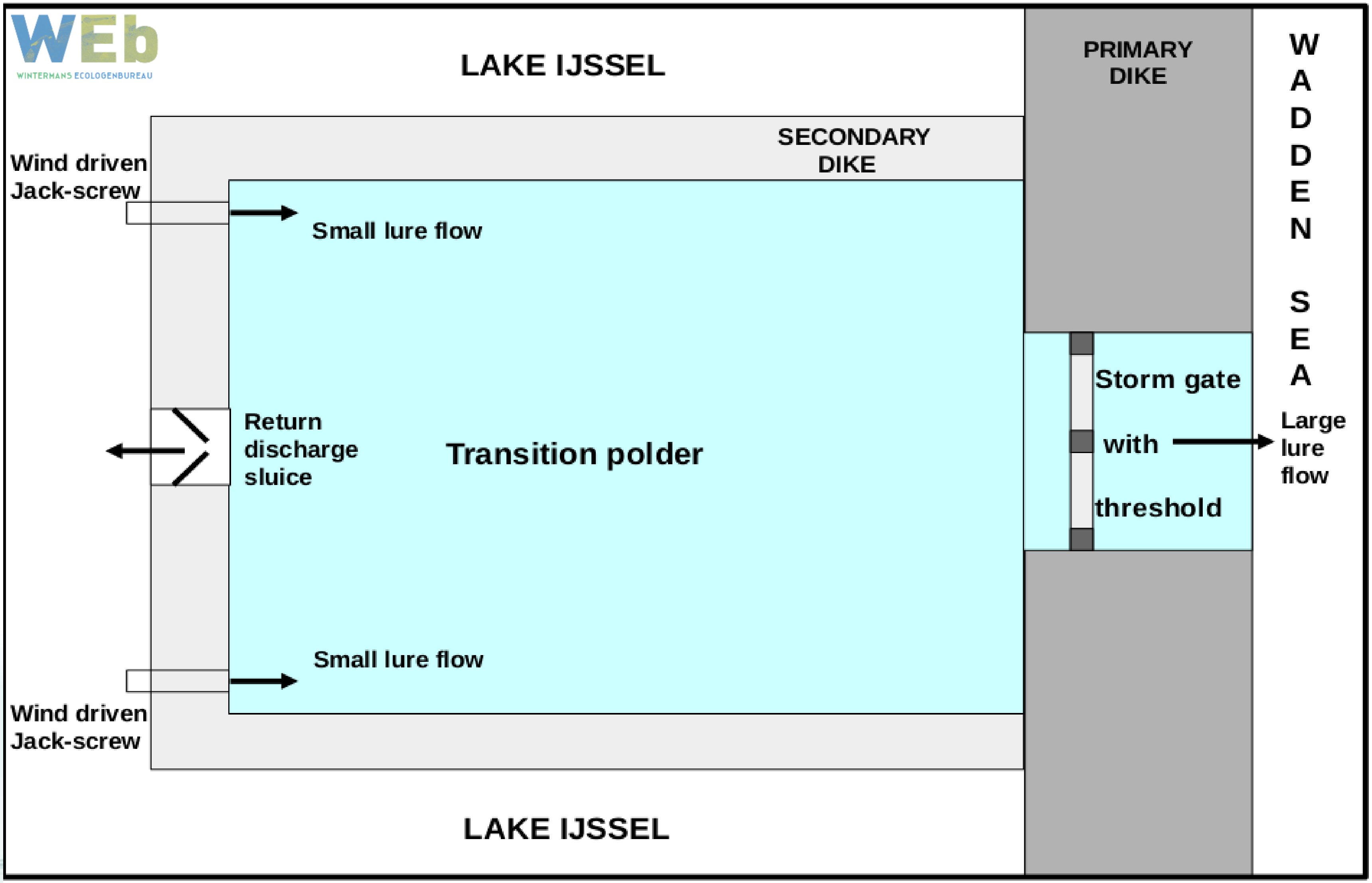
Discharge fish passage small



Discharge fish passage, large, topview



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Discharge fish passage

Pros:

- feasible in combination with existing discharge facilities or independently with own discharge facility (large option)

- no impact on salinization (agricultural and water management issue)

- manageable impact on coastal defence (tube or storm gate in dike)

- high(er) efficiency (no relapse volume; in large option: larger transport volume; longer operation time, passive migration)

- fish friendly (no relapse volume; in large option: transition area)

Cons:

- artificial hydraulic construction

- costs and maintenance (size dependent)

small: water pump, tube in dike, fish assemble basin with valves, cellars

large: stormgate in primairy dike, secondary dikes, extra dicharge facility and sluice

- space consuming (large option)

Important parameters:

- available space (small or large option)

- available discharge volume in time (operation time, upper half of tidal cycle)

- tidal amplitude (operation time)

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Fish Migration River

Latest initiative, complex construction, huge challenge, many goals (migration, nature, recreation, watermanagement).
Mind: eventual functioning as migration facility!

The last 3 constructions have to operate with a limited water volume to facilitate (passive) migration. Therefore its is important to:
– concentrate migratory fishes close to the inlet of the facility
– transport this accumulation of fishes into the facility

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