Rijkswaterstaat
Ministerie van Infrastructuur en Waterstaat

CONNECTIVITY ON THE RIVER MEUSE

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ATKB voor natuur en leefomgeving

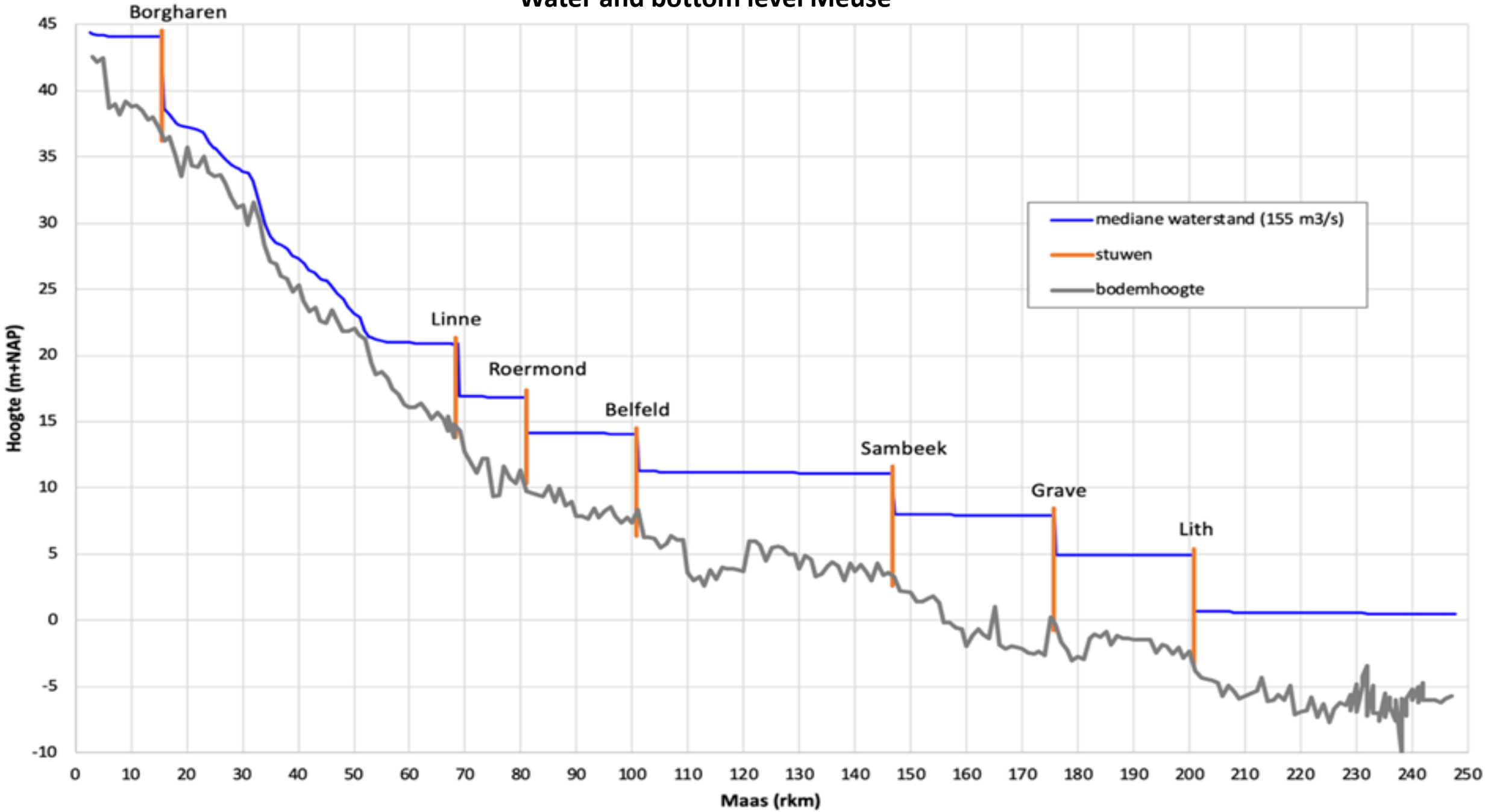
THE MEUSE, A HEAVILY IMPACTED RIVER

Research was done to analyse the current situation of the river Meuse, to find out what the bottlenecks are and to formulate measures to improve the ecological condition of the river.

It focused on connectivity problems for fish and the availability of flowing habitats for fish and macrofauna.

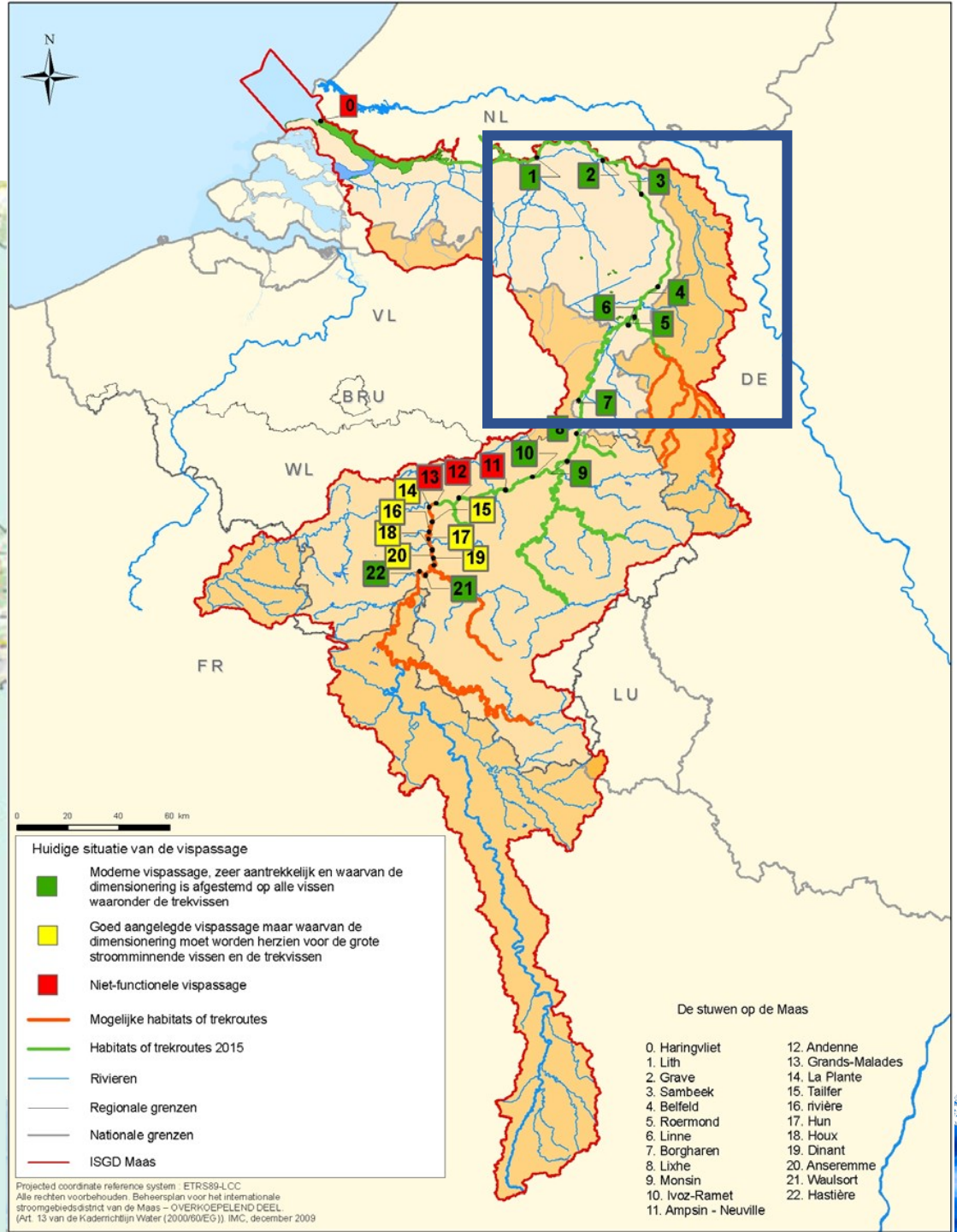
This presentation will primarily address the connectivity for long distance migrants like salmon and eel.

Water and bottom level Meuse



STUDY AREA


Legenda
Maas trajecten
Bergsche Maas
Beneden Maas
Bedijkte Maas
Zandmaas
Grensmaas
Bovenmaas
Stuwen
0 10 20 30 40 50 km


N
NL
VL
BRU
WL
FR
LU
DE
0 20 40 60 km
Huidige situatie van de vispassage
Modeme vispassage, zeer aantrekkelijk en waarvan de dimensionering is afgestemd op alle vissen waaronder de trekvissen
Goed aangelegde vispassage maar waarvan de dimensionering moet worden herzien voor de grote stroomminnende vissen en de trekvissen
Niet-functionele vispassage
Mogelijke habitats of trekroutes
Habitats of trekroutes 2015
Rivieren
Regionale grenzen
Nationale grenzen
ISGD Maas
Projected coordinate reference system : ETRS89-LCC
Alle rechten voorbehouden. Beheersplan voor het internationale stroomgebiedsdistrict van de Maas – OVERKOEPELEND DEEL (Art. 13 van de Kaderrichtlijn Water (2000/60/EG)). IMC, december 2009
De stuwen op de Maas
0. Haringvliet
1. Lith
2. Grave
3. Sambeek
4. Belfeld
5. Roermond
6. Linne
7. Borgharen
8. Lixhe
9. Monsin
10. Ivoz-Ramet
11. Ampsin - Neuville
12. Andenne
13. Grands-Malades
14. La Plante
15. Tailfer
16. rivière
17. Hun
18. Houx
19. Dinant
20. Anseremme
21. Waulsort
22. Hastière

Weirs and hydropower stations in the Meuse

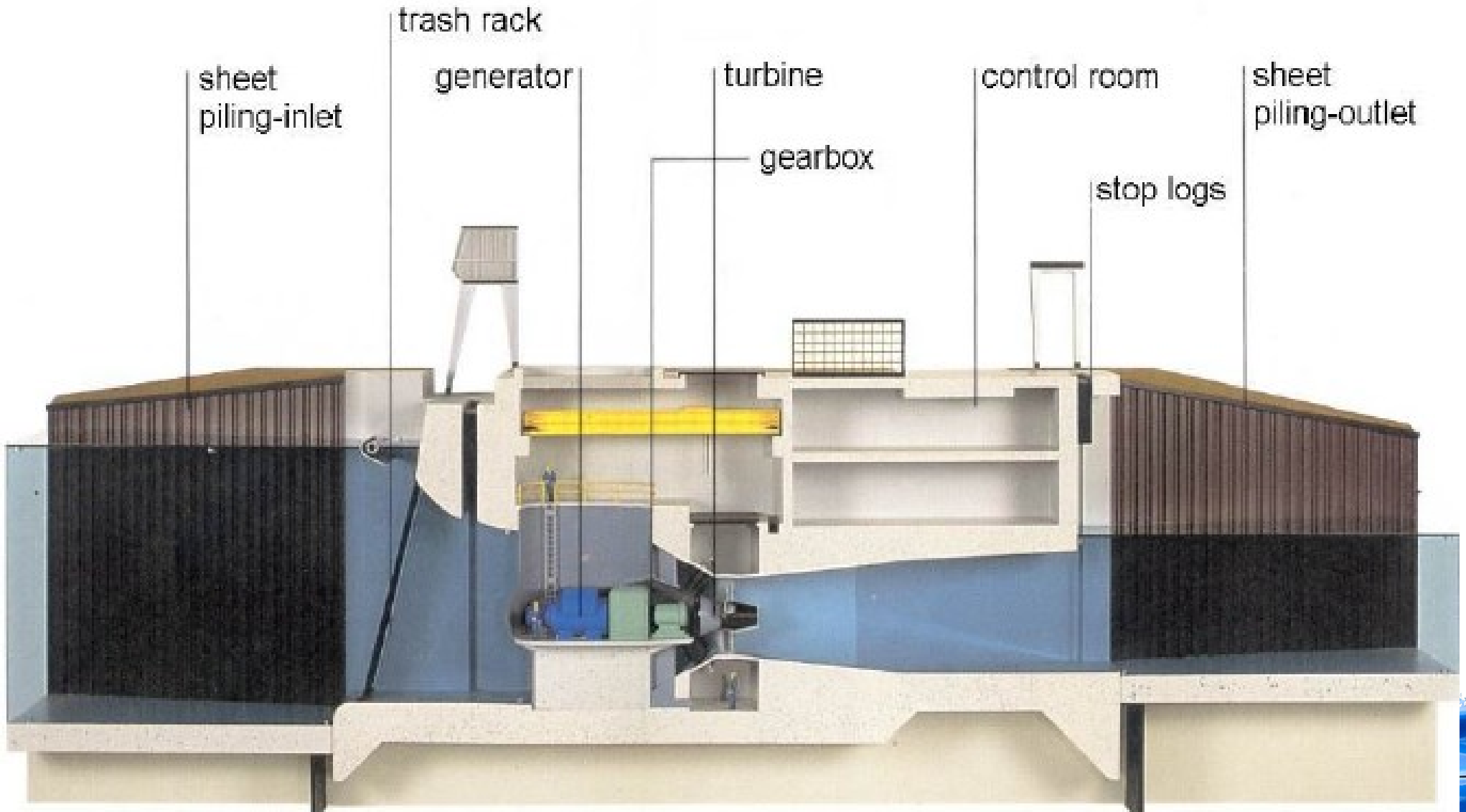
North Sea

★ = hydropower station

● = weir


Maas
Stuw Linne
Maas
Maas
Waterkrachtcentrale
Linne
Verbindingsweg
Verbindingsweg
Fish way

HYDROPOWER STATION (4 HORIZONTAL KAPLAN TURBINES)



FISH WAY BORGHAREN (POOL TYPE, V-SHAPED WEIR AND VERTICAL SLOT)

DEFINITION OF CONNECTIVITY

It is the degree of connection between various natural habitats in the Meuse river, between river sections, between the tributaries and between waterbodies in the river basin.

Fish species depend on connectivity in a different way:

Potadromous species: migrate within the river system;

Diadromous species: migrate through the river system from sea to fresh water and vice versa.

CONNECTIVITY VISUALIZED

Dendritic Connectivity Index (DCI)

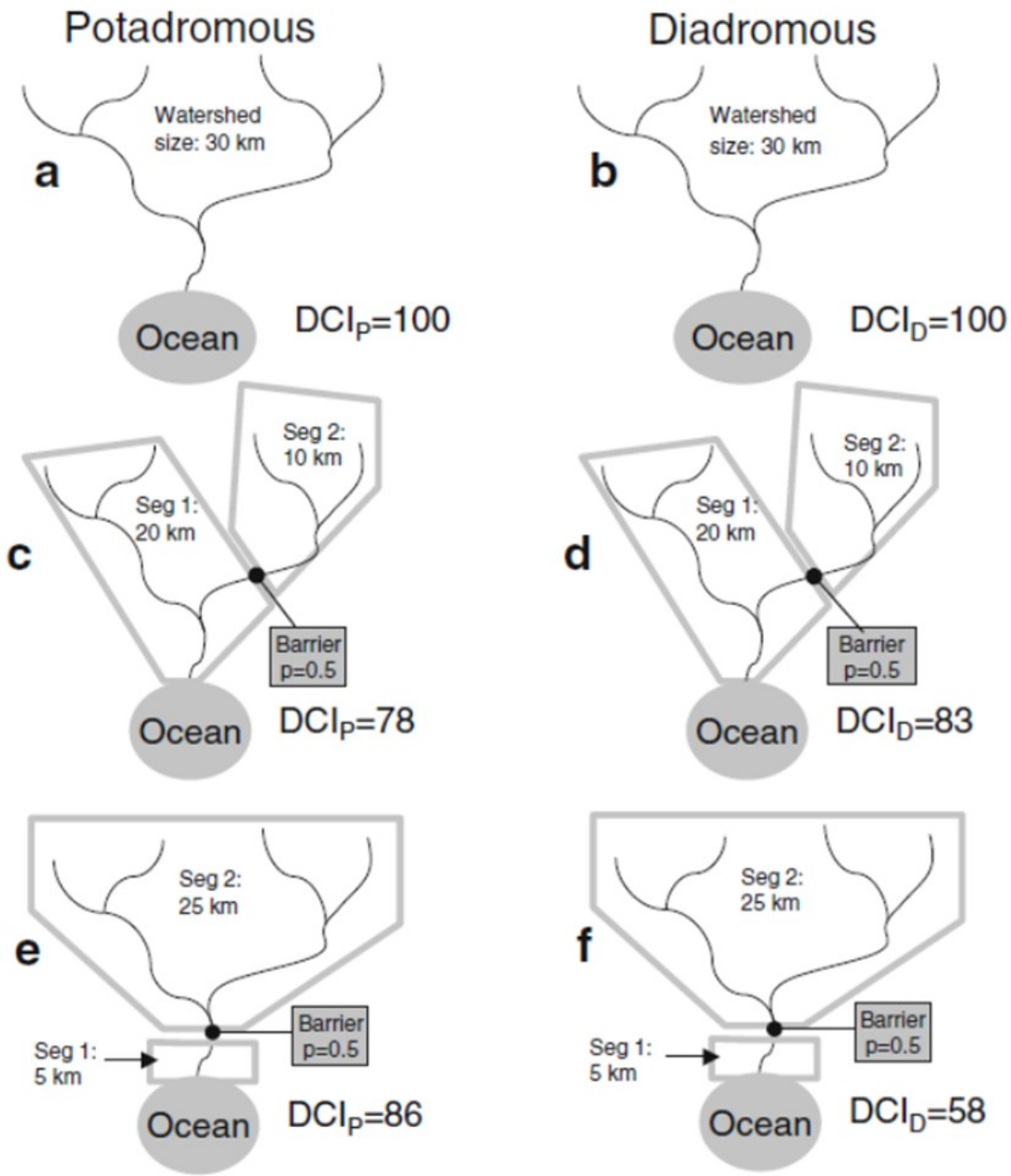
(Cote *et al.,* 2009) based on:

- Passibility of barriers (P-value);
- Length of the river (stretch).

P-values between 0 en 1:

0 = impassable;

1 = completely passable.



CONNECTIVITY FOR DIADROMOUS FISH CALCULATED

Dendritic Connectivity Index (DCI_D)

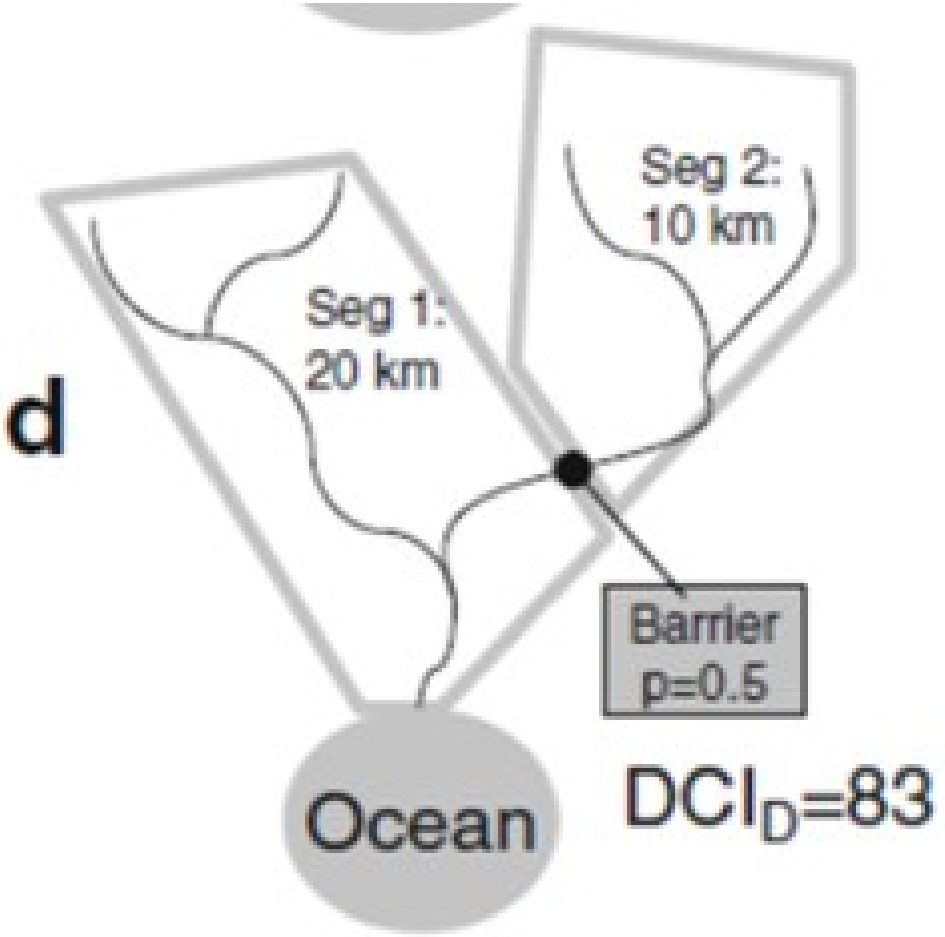
Segment 1: no barriers, P-value = 1

Segment 2: one barrier, P-value = 0,5

DCI_D = (1 x 20) / 30 + (0,5 x 10) / 30) =

20 / 30 + 5 / 30 = 0,83

100 x 0,83 = 83



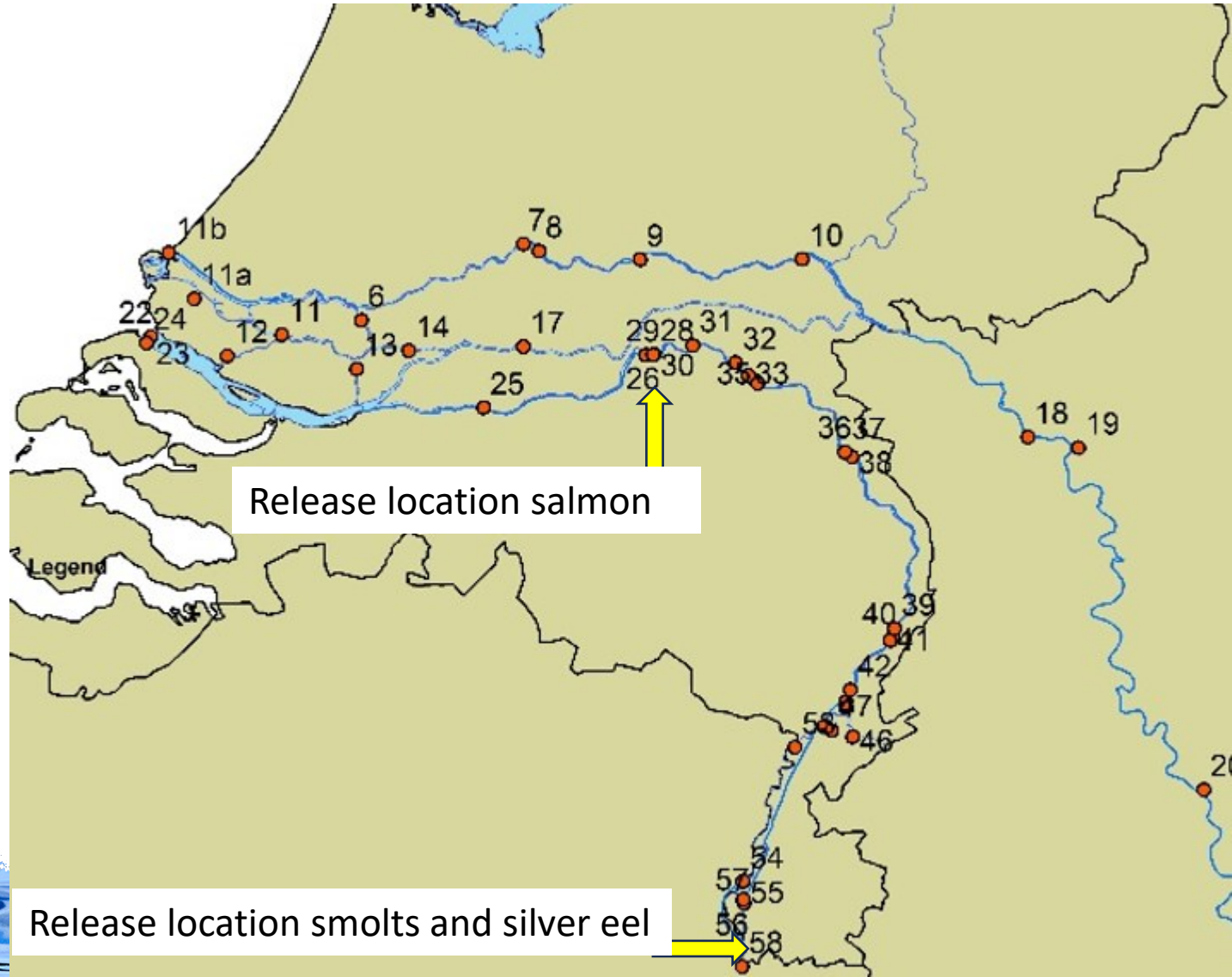
HOW TO ESTABLISH P-VALUES FOR BARRIERS ON THE MEUSE?

By using telemetry: NEDAP Trail System®.

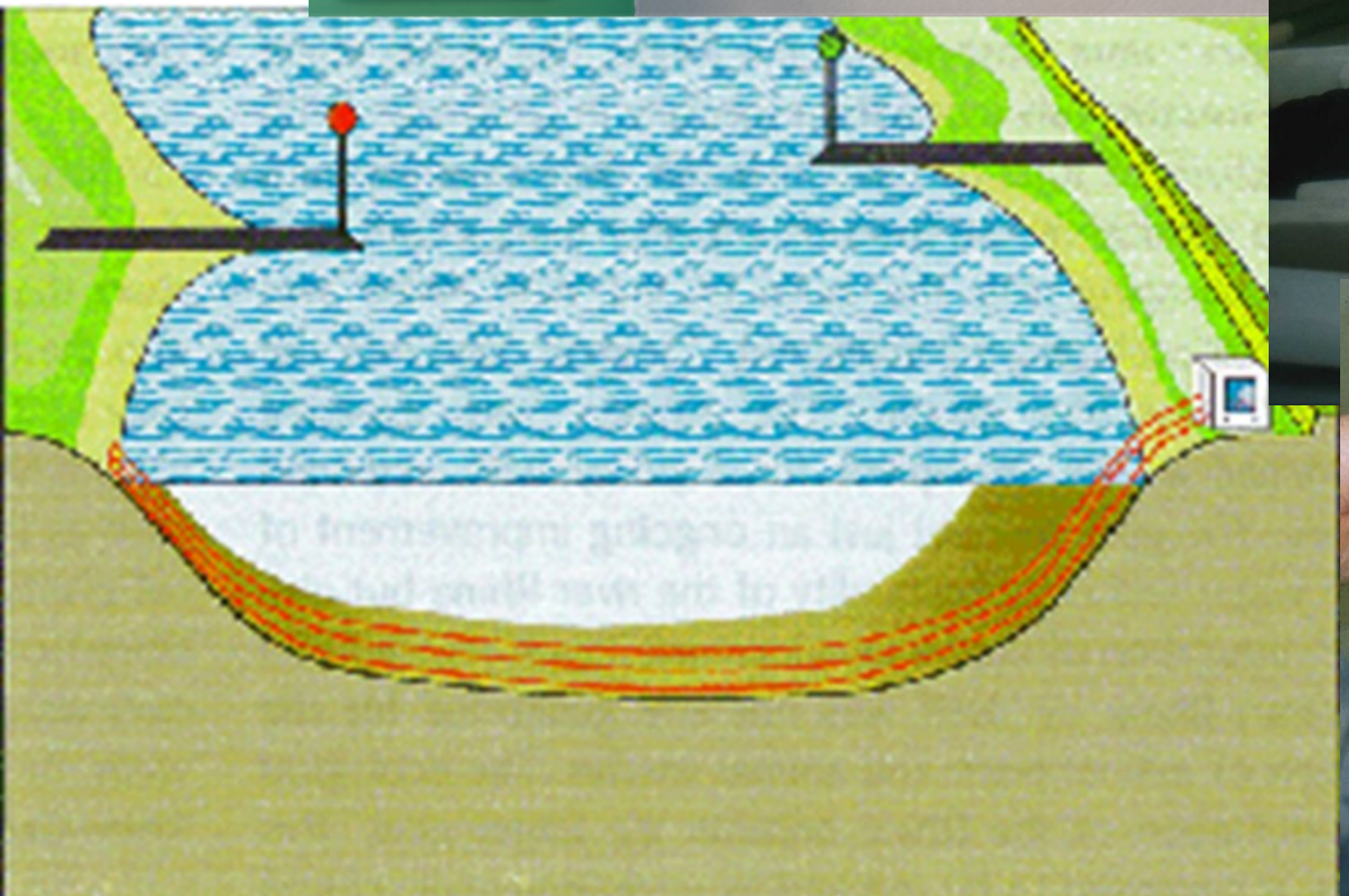
<u>Upstream migration</u>: adult salmonids were tagged downstream of Lith.

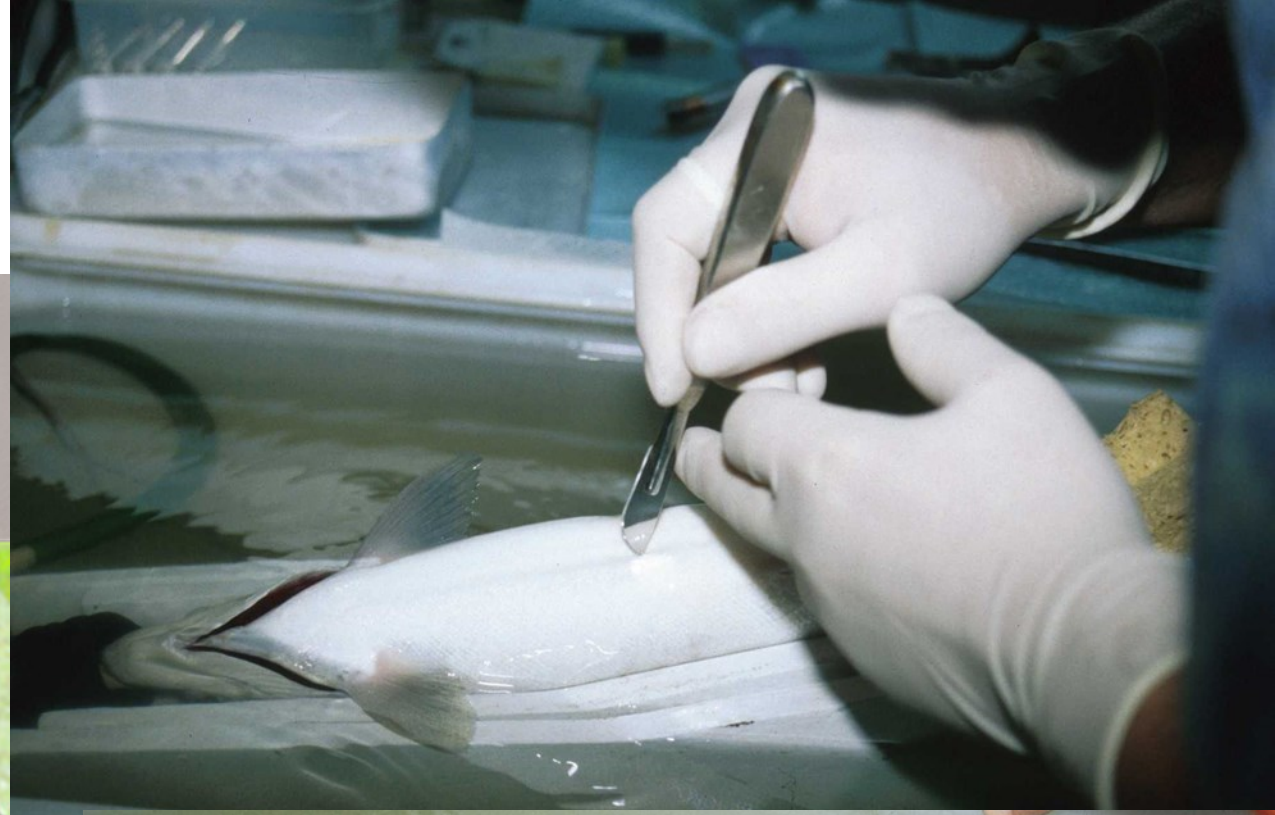
<u>Downstream migration</u>: Salmon smolts and Silver eel upstream Borgharen.

During several years hundreds of fish were tagged and released.

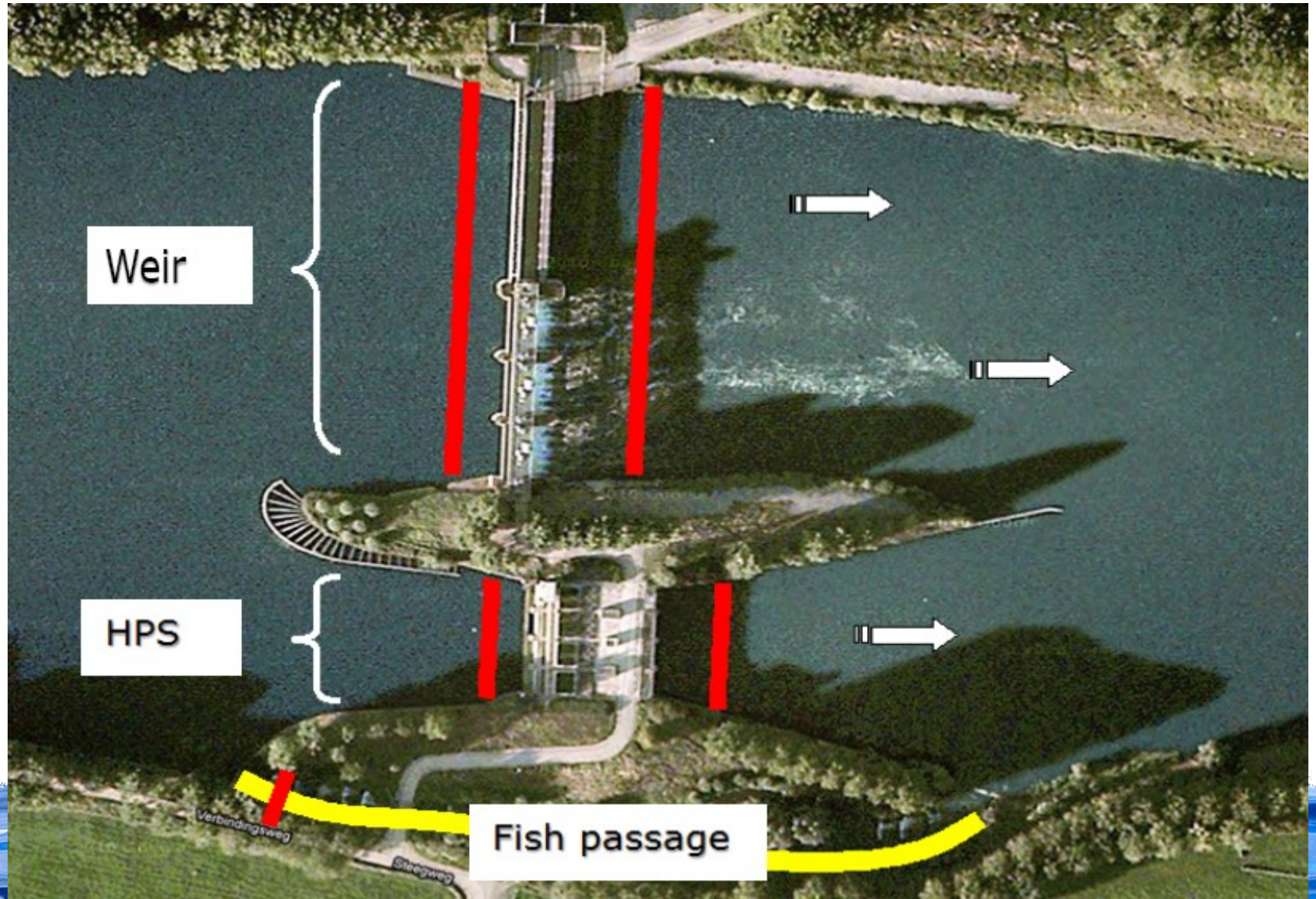


NEDAP Trail system®





DETECTION STATIONS NEDAP TRAIL SYSTEM® AT LINNE.



DETECTION STATIONS OTHER WEIRS

Detection stations downstream and upstream of weir and in the fish way

Individual migration routes can be tracked in detail.

P-values can be calculated from the number of ID's downstream, upstream and in the fish way.

EXAMPLE DOWNSTREAM MIGRATION FOR SMOLTS

River stretch				Smoltmigration study 2009, 2010 en 2013			
Nr.	*Upstream*	*Downstream*	*Distance (km)*	***N Upstream***	***N Downstream***	***Losses***	**P**
1	Maas_Linne_boven	Maas_Linne_beneden	0,2	303	303	0	
2	Maas_Linne_beneden	Maas_Linne_dorp	1,5	303	281	22	
3	Maas_Linne_dorp	Maas_Roermond_bov	9,3	281	250	31	0,83
4	Maas_Roermond_bov	Maas_Buggenum	3,7	250	229	21	0,92
5	Maas_Buggenum	Maas_Belfeld_bov	13,7	229	219	10	
6	Maas_Belfeld_bov	Maas_Steyl	2,5	219	212	7	0,97
7	Maas_Steyl	Maas_Afferden	42,1	212	194	18	
8	Maas_Afferden	Maas_Sambeek_ben_stu	1,8	194	192	2	0,99
9	Maas_Sambeek_ben_stu	Maas_Grave_bov	26,2	192	184	8	
10	Maas_Grave_bov	Maas_Balgoij	2,5	184	182	2	0,99
11	Maas_Balgoij	Maas_Megen	13,6	182	180	2	
12	Maas_Megen	Maas_Lith_boven	9,8	180	176	4	
13	Maas_Lith_boven	Maas_Lith_beneden	0,3	176	170	6	
14	Maas_Lith_beneden	Maas_Lith_dorp	1,3	170	146	24	0,83

P-VALUES RIVER MEUSE BASED ON TELEMETRY, LOSSES PER RIVER STRETCH.

P -values for connectivity						
	River stretch	**km**		**Adult salmonids**	**Smolts**	**Silver eel**
	Length river Meuse in the Netherlands	244		Upstream migration	Downstream migration	
1	Length up to Lith	50	P Lith	0,7	0,83	0,76
2	Length Lith-Grave	25	P Grave	0,62	0,99	1
3	Length Grave-Sambeek	27	P Sambeek	0,5	0,99	0,99
4	Length Sambeek-Belfeld	45	P Belfeld	0,88	0,97	0,98
5	Length Belfeld-Roermond	17	P Roermond	0,9	0,92	0,99
6	Length Roermond-Linne	12	P Linne	0,83	0,83	0,77
7	Length Linne-Borgharen	54	P Borgharen	1	0,92	0,98
8	Length Borgharen-Eijsden	13				

Independent P-values:

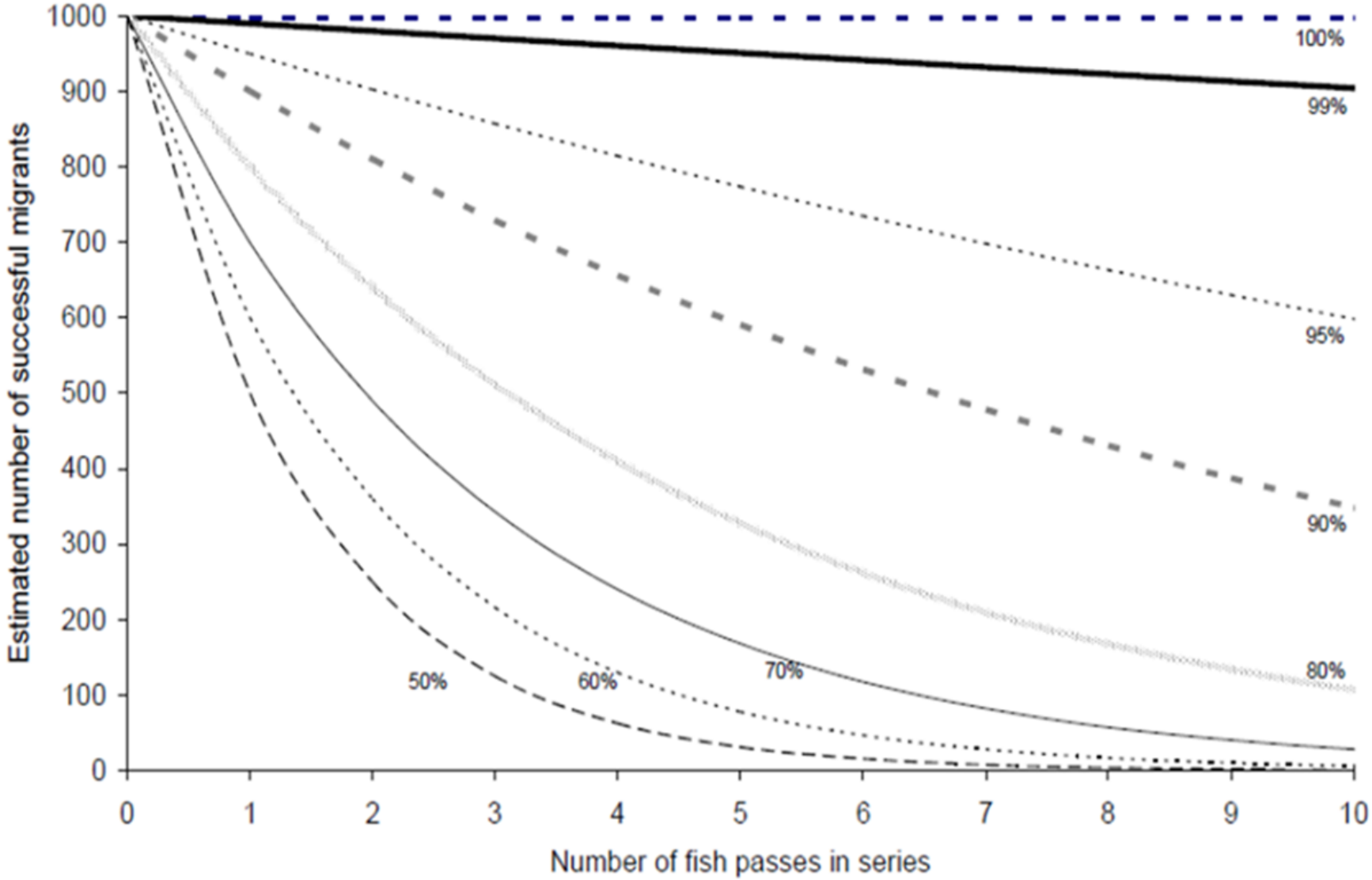
$DCI_{potadromous} = 87;$

$DCI_{salmonids\ upstream} = 78;$

$DCI_{smolts} = 93;$

$DCI_{silver\ eel} = 92$

P-VALUES ARE NOT INDEPENDENT!!!



P-VALUES ARE NOT INDEPENDENT!!!

When salmon arrive downstream of Lith it faces:

P-Lith: 0,70;
P-Grave: 0,62;
P-Sambeek: 0,50;
P-Belfeld: 0,88;
P-Roermond: 0,90;
P-Linne: 0,83;
P-Borgharen: 1,00.

When 1.000 salmonids arrive downstream of Lith, only 143 salmon reach the Meuse river upstream of Borgharen. The most important breeding grounds lay upstream of Borgharen.

Conclusion: effectivity current fish ways is insufficient!

P-VALUES ARE NOT INDEPENDENT!!!

Same calculations can be made for smolts and silver eel, although the causes for the losses are different (predation at weir complexes and, more important, mortality due to hydropower stations).

When 1.000 silver eel start their migration upstream of Borgharen, only 551 individuals will arrive downstream of Lith.

When 1.000 salmon smolts start to migrate at Borgharen, 554 individuals will arrive downstream of Lith.

More or less, half of the population is lost in the heavily modified stretch of the river Meuse.

MEASURES THAT WILL BE IMPLEMENTED

IMPROVEMENT OF CURRENT FISH WAYS

Inventory of fish ways was done:

Barely any maintenance;

Construction faults:

Pool size to small;

Water level differences to high;

Current velocity to high;

No resting pools;

Entrance of the fish way to far from the barrier;

To little attraction flow;

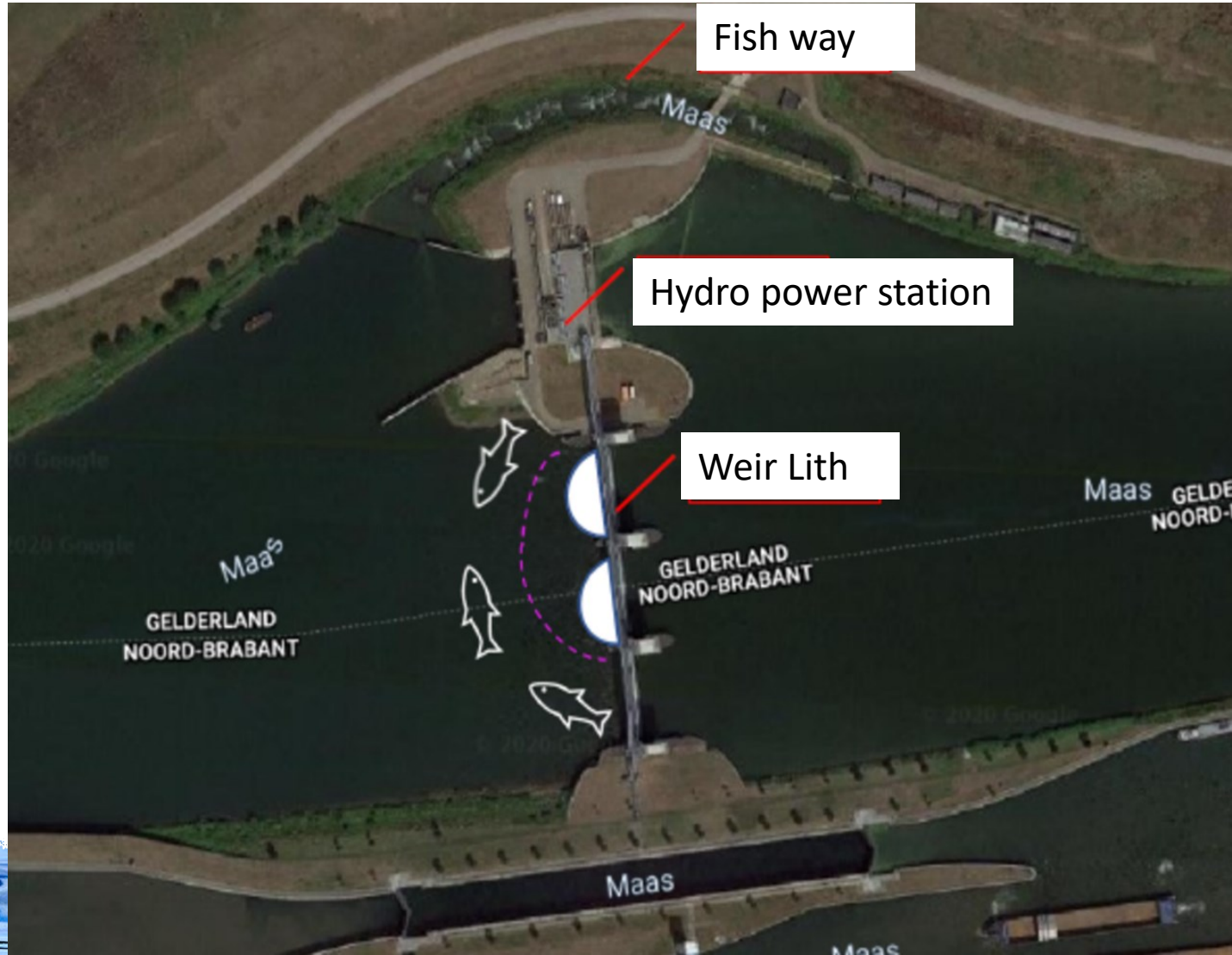
Lots of debris in the fish way etc.

When improved, connectivity will rise.

CONSTRUCTION OF NEW FISH WAYS

It became clear that the migration speed at locations with weir, sluices and hydropower stations (Lith and Linne) is much lower than at the other locations. Fish have difficulty to locate the entrance of the fish way especially when there is a lot of discharge over de weir and the hydropower station is not working (no discharge at the side of the fish way).

New vertical slot fish way will be developed.



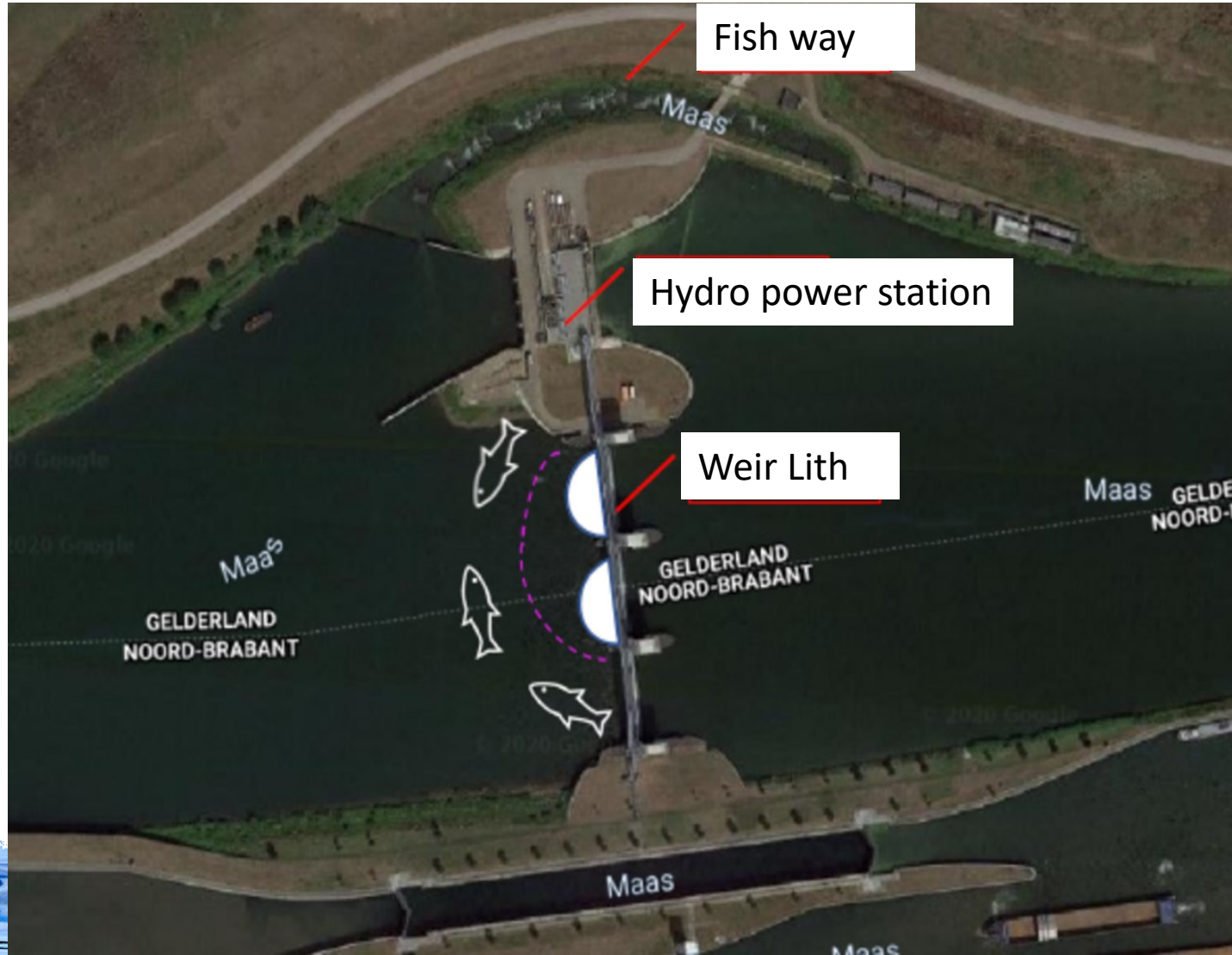
OTHER MEASURES TO BE TAKEN

Fish friendly weir management:

Weirs will be operated in such a way that the attraction of the fish way is optimal.

Measures at hydropower stations:

During the period of smolt and silver eel migration, HPS's will be (by permit) be obliged to shut down during the night. This measure is already in effect.



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Thanks for the attention!