





The Herting project

Olle Calles¹, Sam Shry¹ & Anders Nilsson^{1,2}

¹ River Ecology and Management (RivEM), Karlstad University

² Aquatic Ecology, Lund University



Fiskevårdsteknik AB



LÄNSSTYRELSEN
HALLANDS LÄN

Havs
och Vatten
myndigheten



Politecnico
di Torino



Upstream and downstream passage of migrating fish

- Remedial measures to improve passage performance at hydropower dams

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Sweden → Karlstad → Ätran



Image IBCAO
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image U.S. Geological Survey
Image Landsat / Copernicus

Google Earth

visningshöjd 14168.89 km



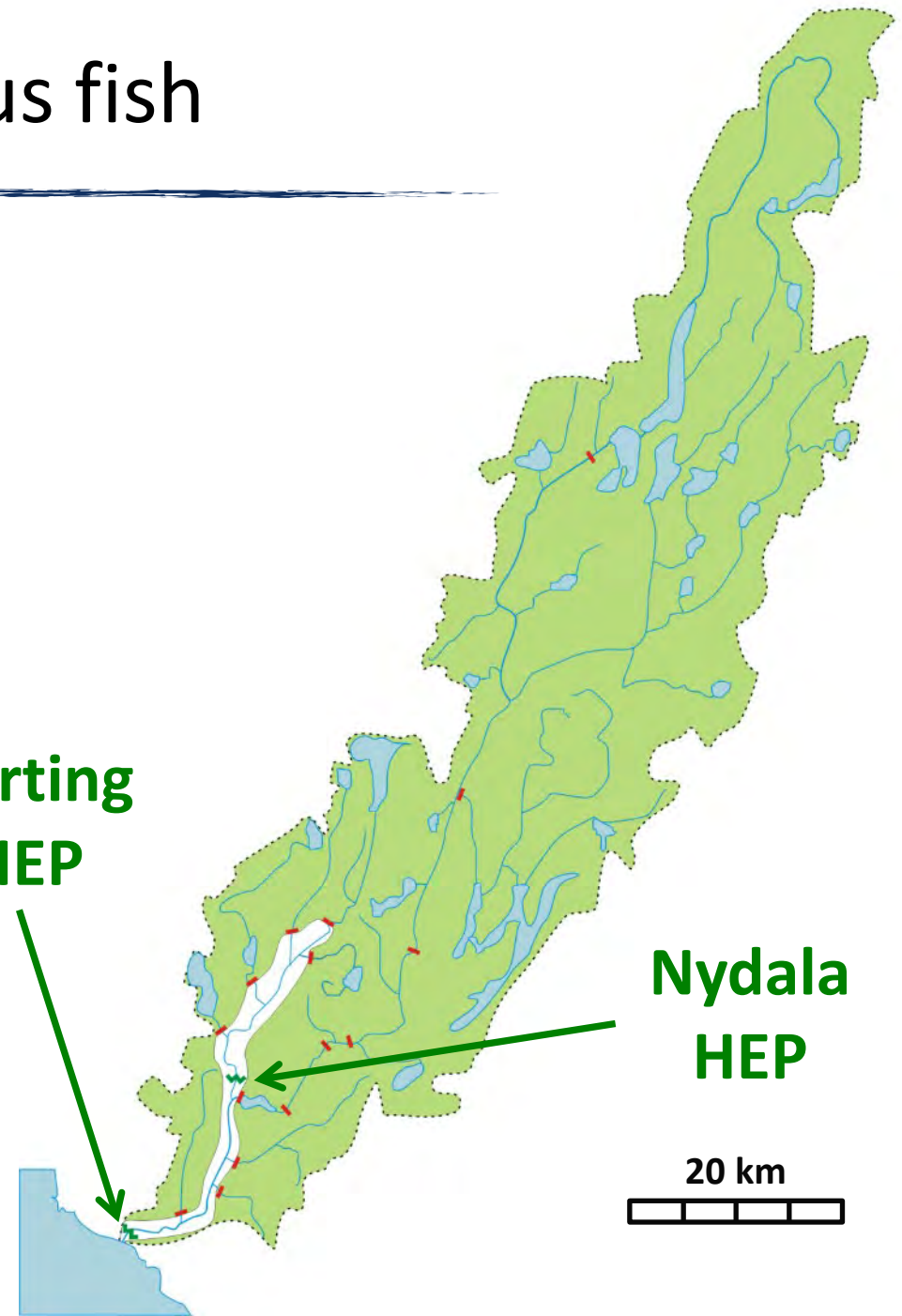
River Ätran & diadromous fish



Herting
HEP

Nydala
HEP

20 km

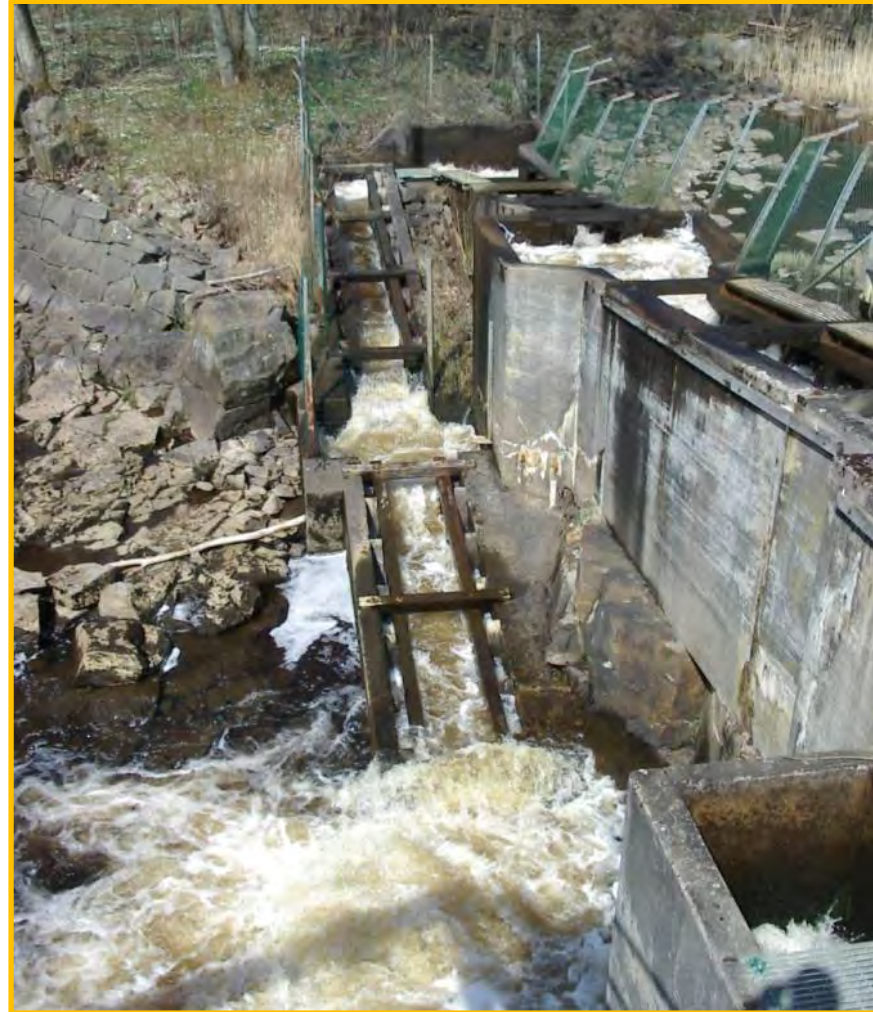


Herting
before
2013



H2

H1



The Herting project goals

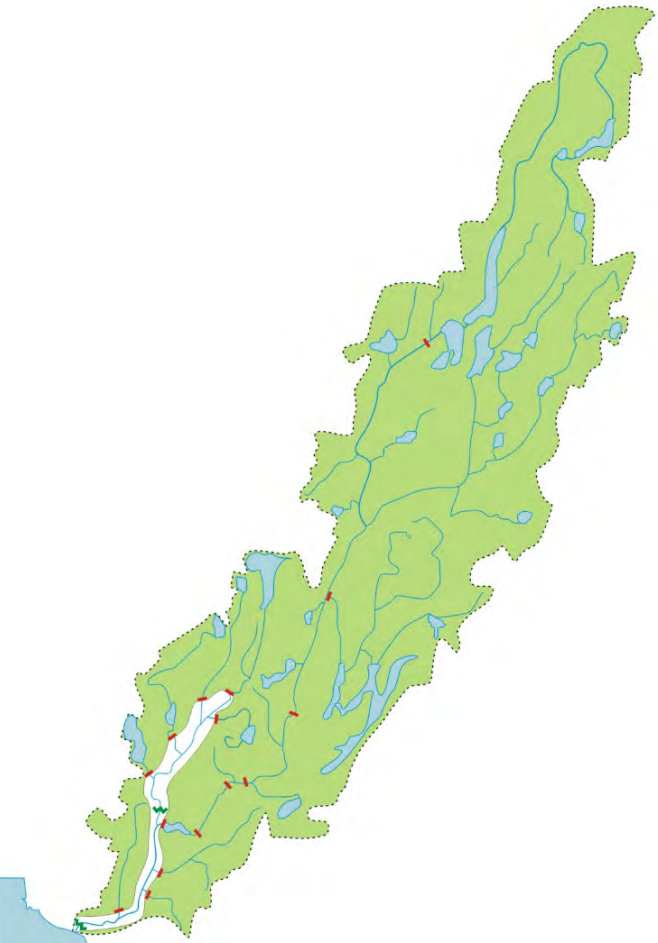


- Strengthen diadromous fish populations:
 - Atlantic salmon
 - European eel
 - Sea lamprey

...with contrasting life-cycles and behavior → acting as umbrella species
- Evaluation of Fish Passage Solutions, *before and after modifications*, by quantifying passage performance and passage time



Herting – the gateway to River Ätran



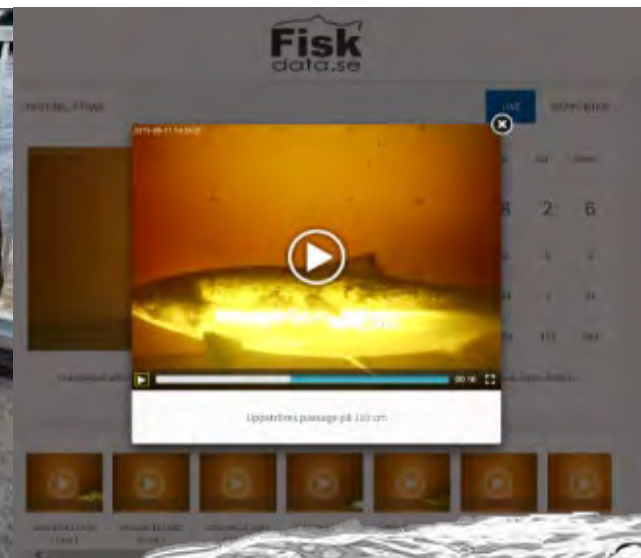
Before 2013
- Pre-study 2007-2010



After 2013
- Evaluation 2014-2017



Methods





Sea
lamprey
capture

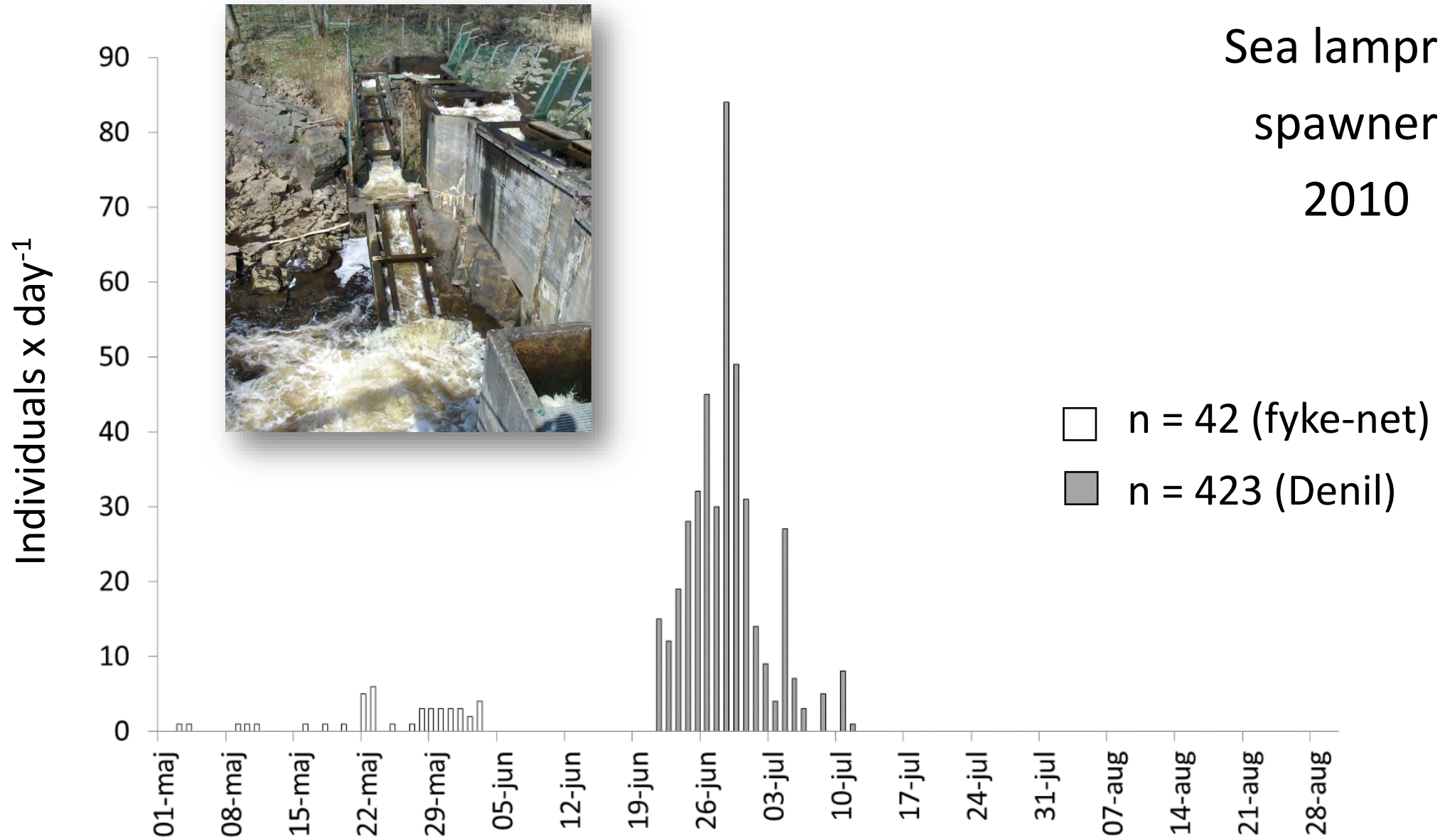




Sea
lamprey
capture
...?



Sea lamprey spawners 2010



Sea lamprey spawner summary

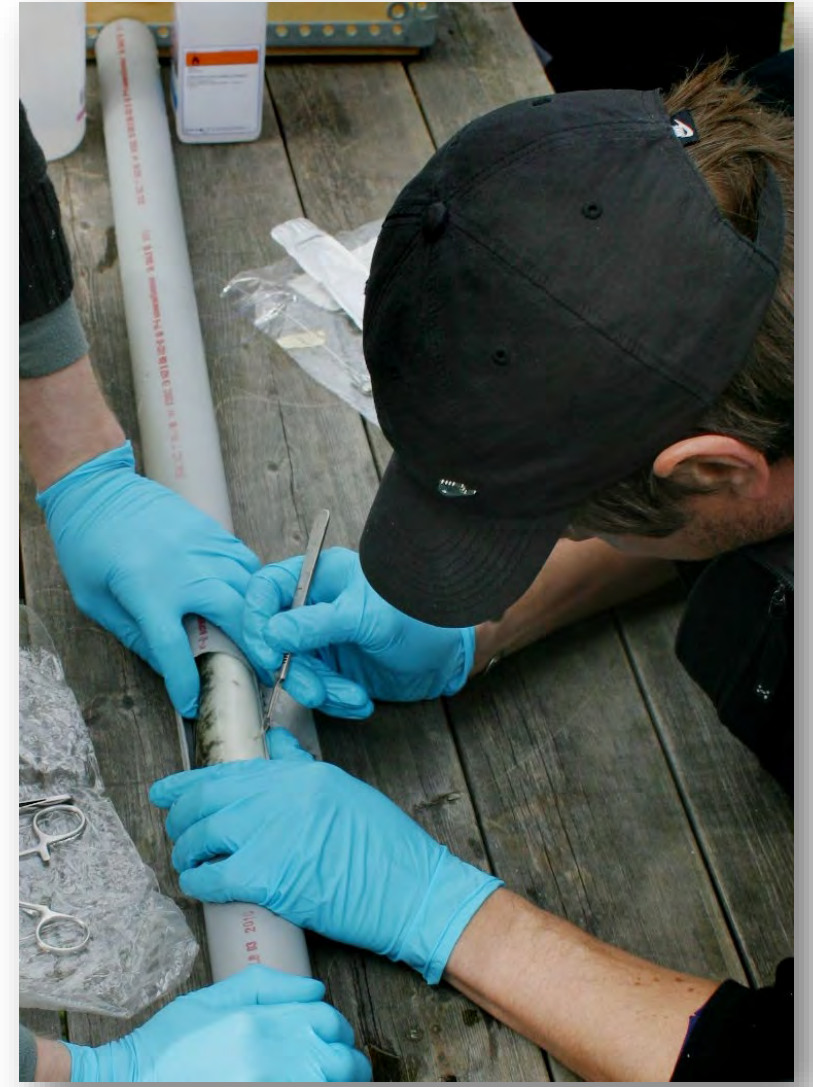
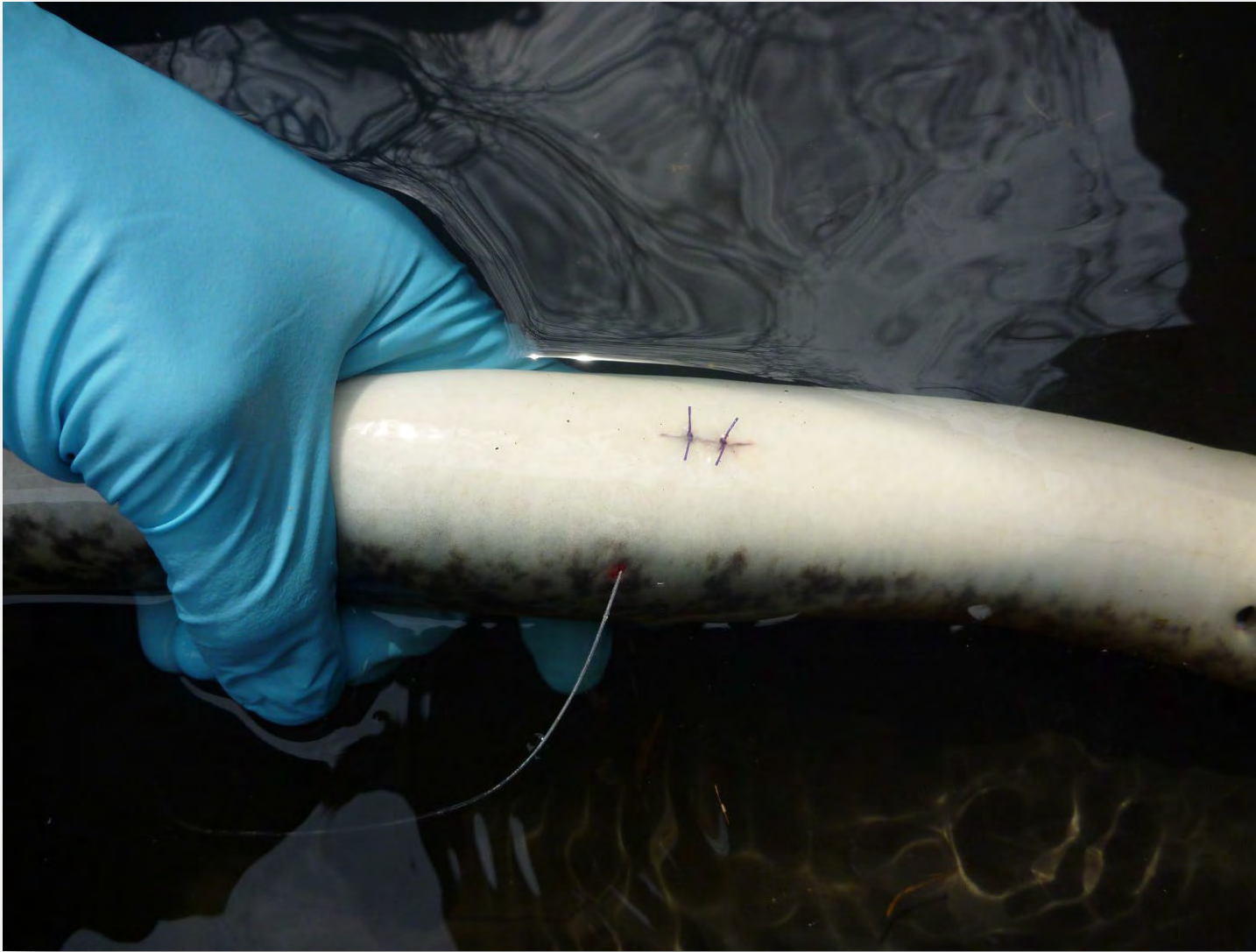
| Info | Before (2010) |
|----------------|---------------|
| FPS | Denil |
| Fyke-nets | 2 |
| Fyke-net catch | n = 42 |
| Telemetry | n = 20 + 11 |



Radio telemetry



Radio telemetry



Herting
before
2013

0%
passage
success

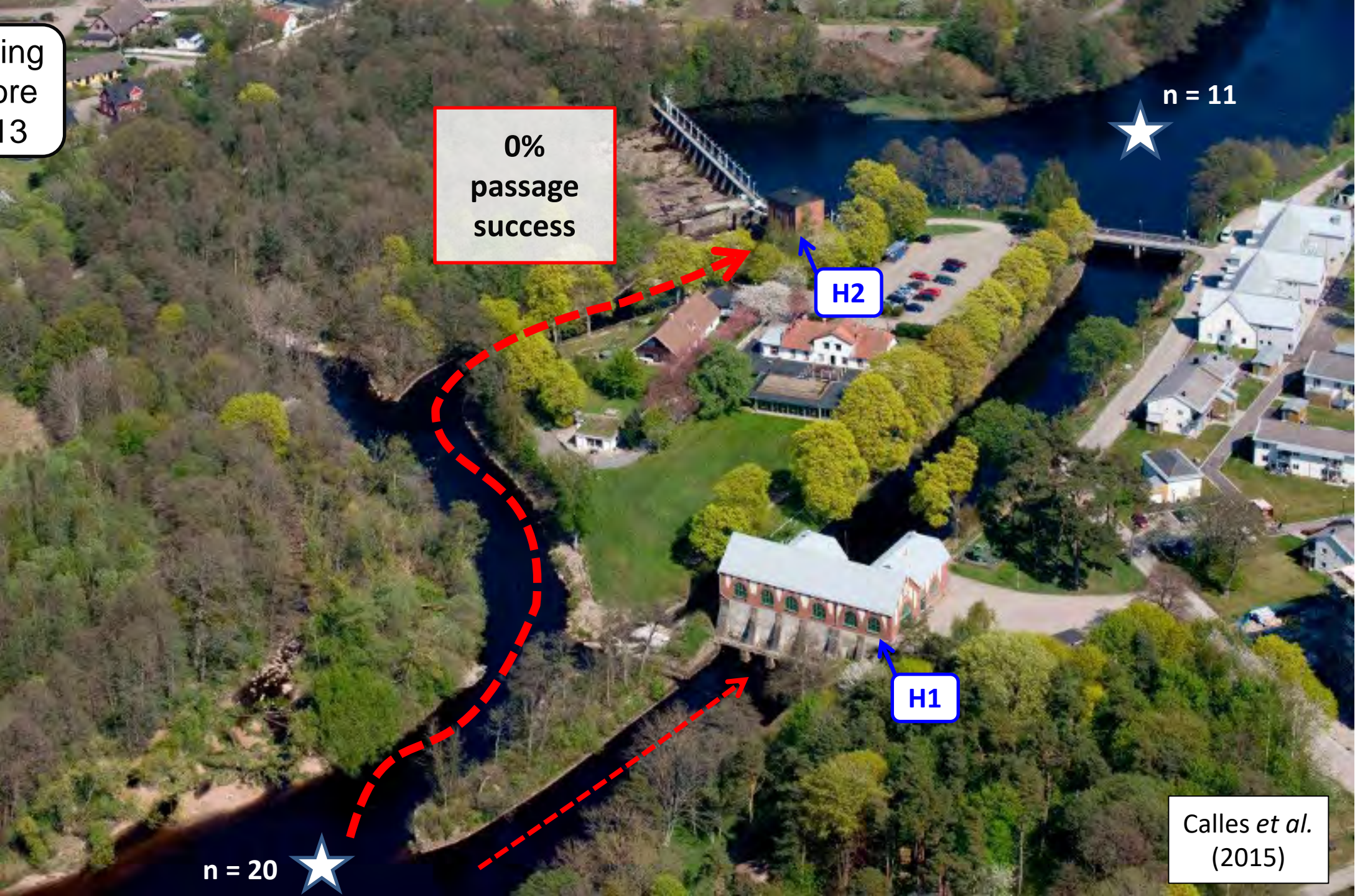
n = 11
★

H2

H1

n = 20
★

Calles *et al.*
(2015)

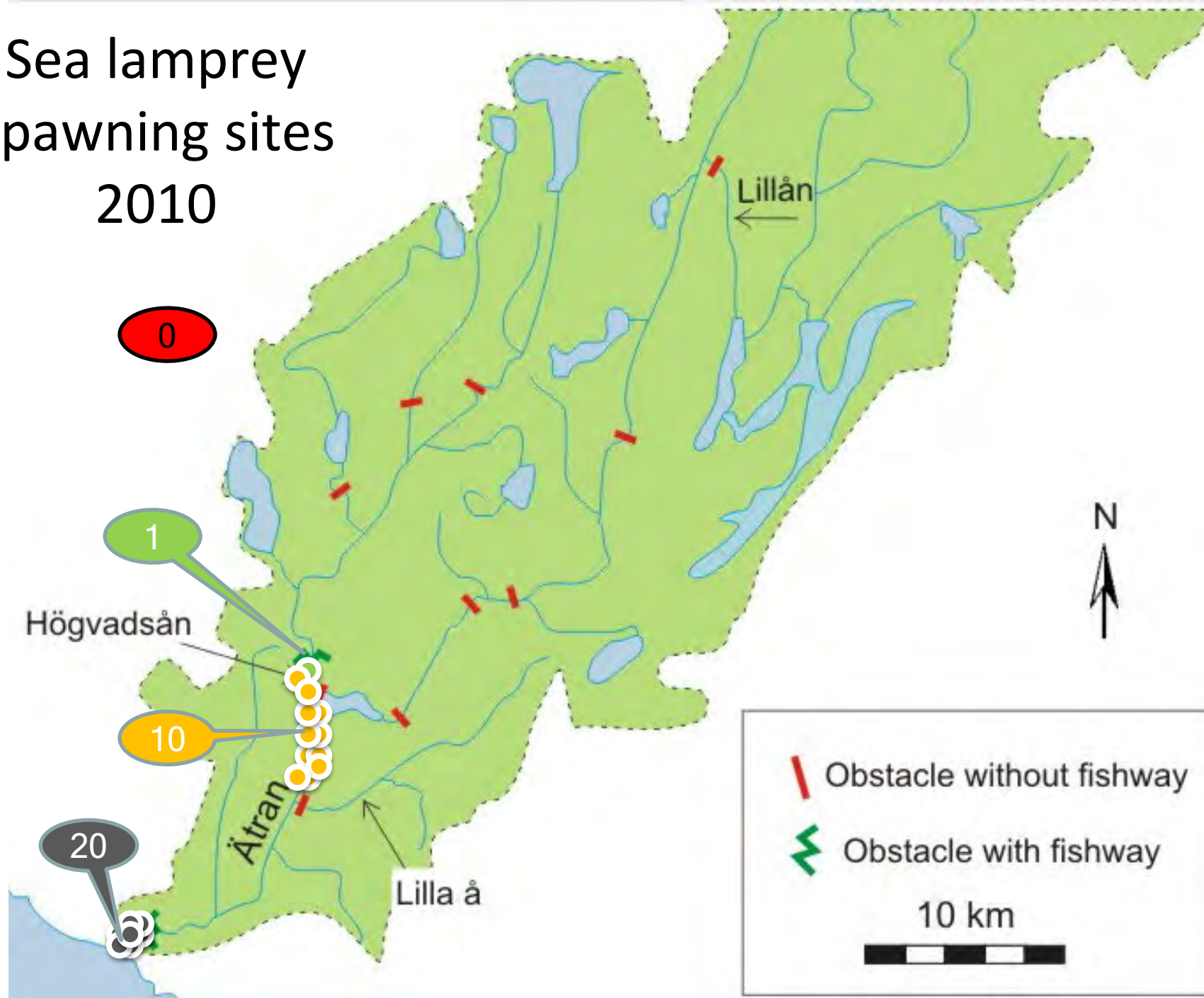


Sea lamprey spawner summary

| Info | Before (2010) |
|----------------|------------------|
| FPS | Denil |
| Fyke-nets | 2 |
| Fyke-net catch | n = 42 |
| Telemetry | n = 20 + 11 |
| Control group | 11 of 11 = 100 % |
| Passage group | 0 of 20 = 0 % |

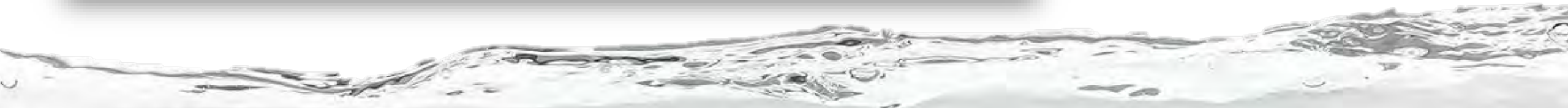


Sea lamprey spawning sites 2010



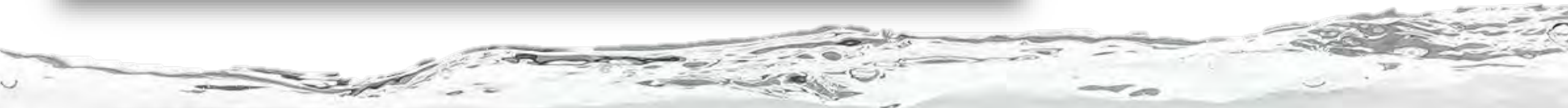


Sea lamprey spawners 2010





Sea lamprey spawners
2010



Sea lamprey spawners
2010



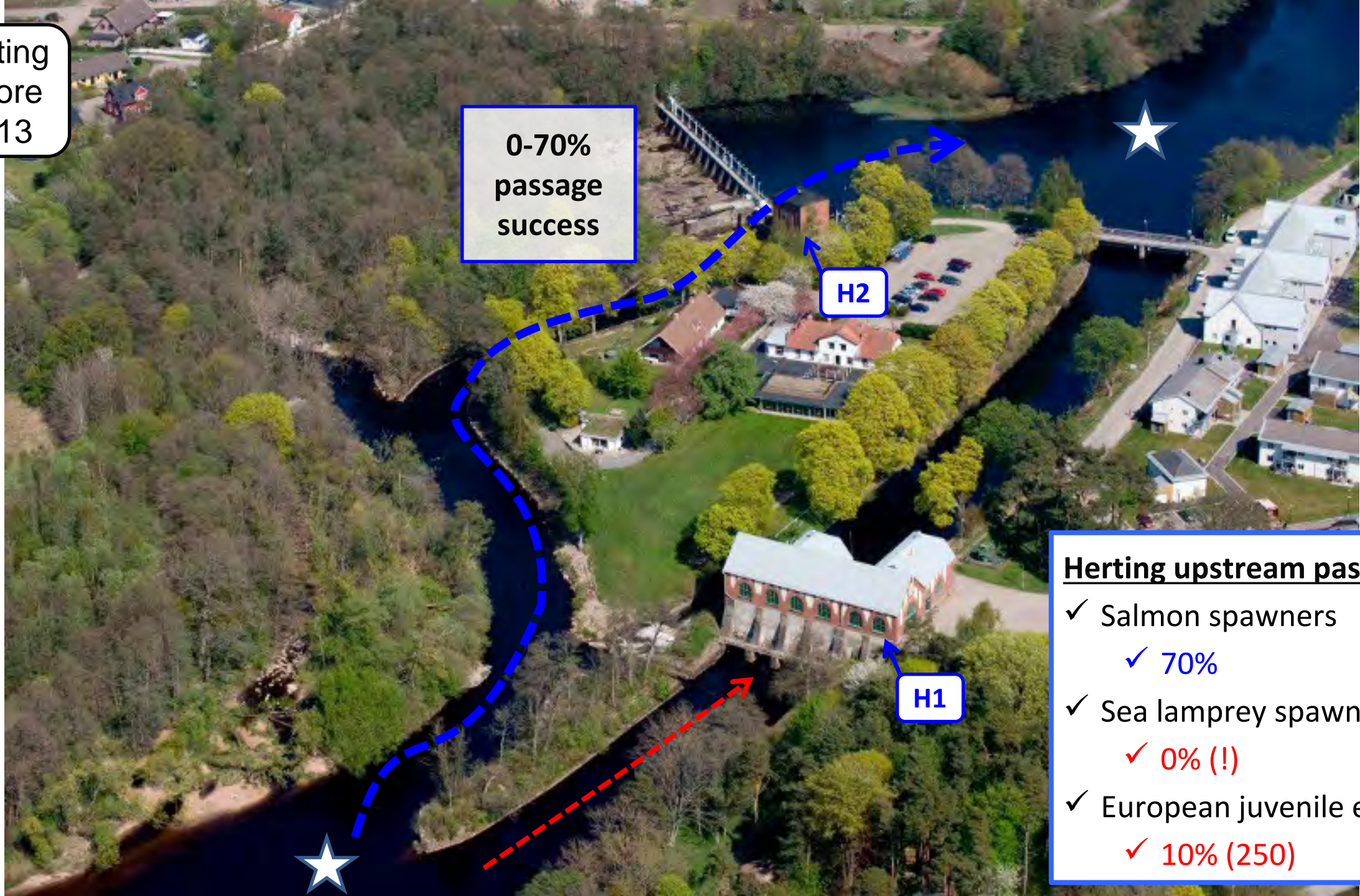
Herting
before
2013

0-70%
passage
success

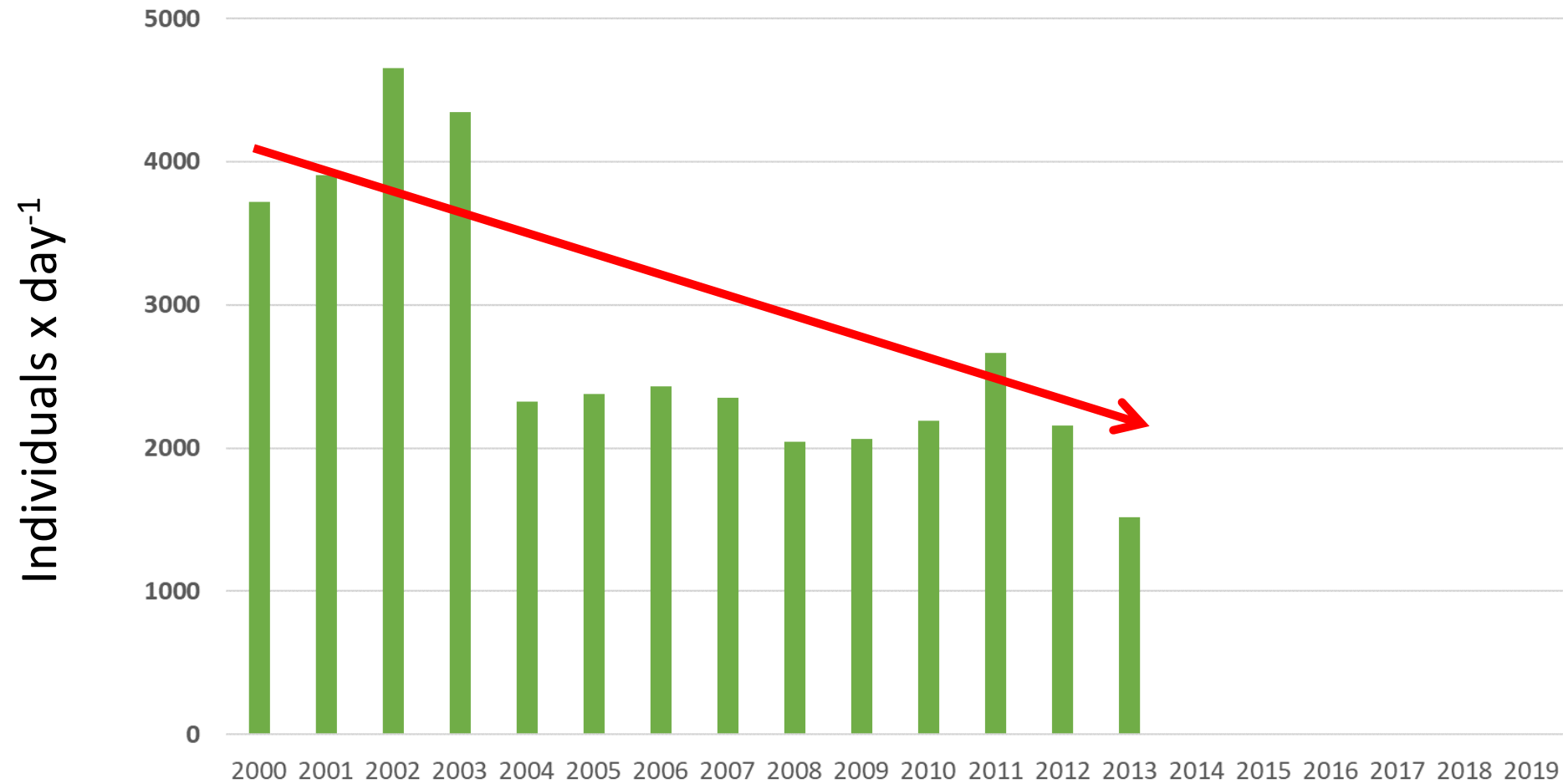
H2

H1

- Herting upstream passage**
- ✓ Salmon spawners
 - ✓ 70%
 - ✓ Sea lamprey spawners
 - ✓ 0% (!)
 - ✓ European juvenile eels
 - ✓ 10% (250)



Herting – Salmonid spawner count 2000-2013



Herting
2013



*Photo:
Ingemar
Alenäs*

Herting
after
2013



Downstream passage solution

- Conventional rack \rightarrow Angled rack



Old conventional bar rack

1. Vertical steel bars - 90 mm
2. $\alpha = 60^\circ$
3. Surface bypass (2.0 cms)



New angled bar rack

1. Horizontal composite bars - 15 mm
2. $\beta = 30^\circ$
3. Full-depth bypass (0.6 cms)

Herting
after
2013

Info Herting

✓ Capacity:

✓ H1 = 40 m³/s

✓ H2 = 25 m³/s

✓ MQ = 60 m³/s

✓ 4.65 m head (- 11%)

✓ 3.0 MW (+/- 0)

✓ 8.5 GWh / yr (-35%)

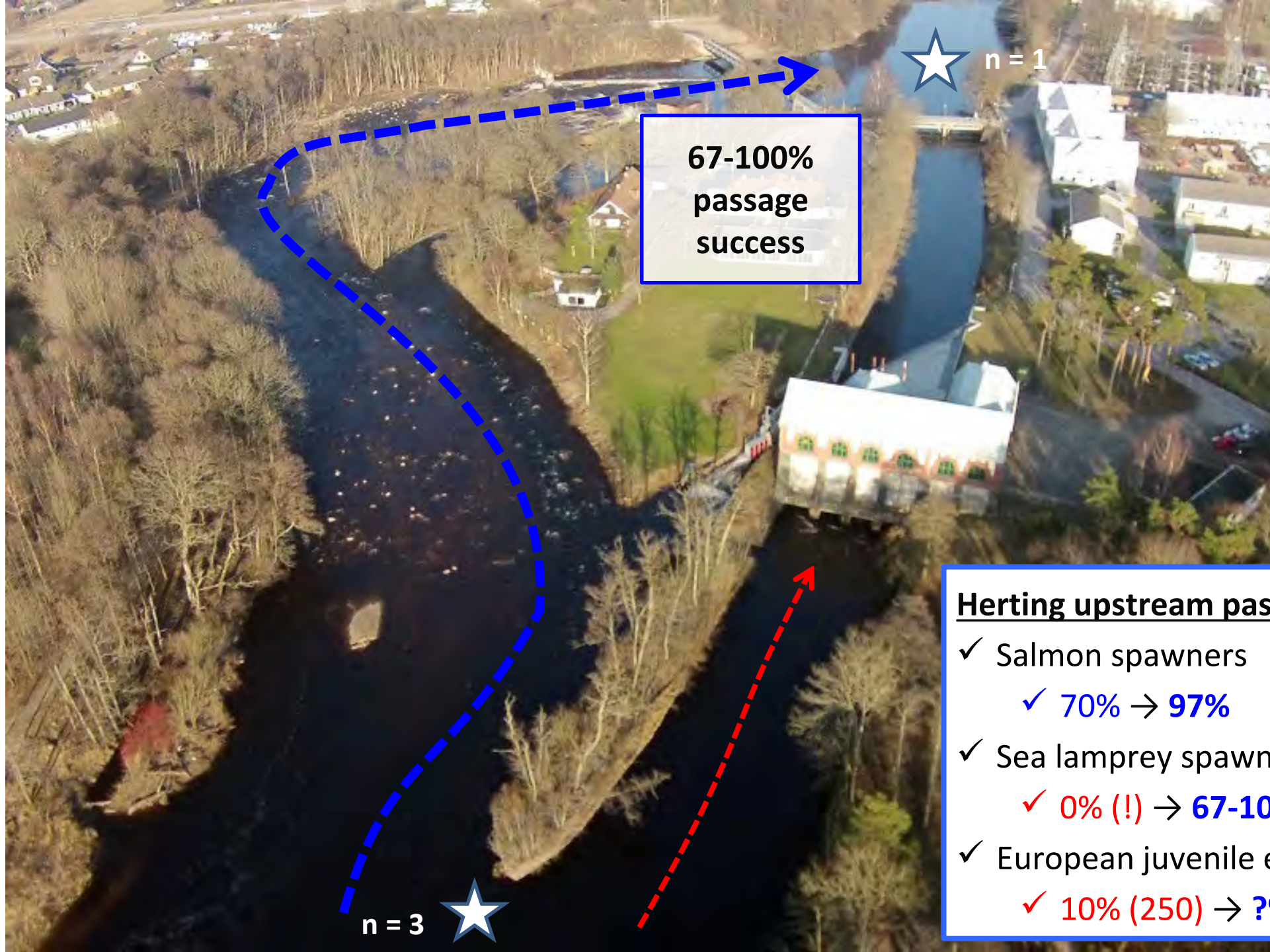


Sea lamprey spawner summary

| Info | Before (2010) | After (2014-2015) |
|----------------|------------------|-------------------|
| FPS | Denil | Nature-like |
| Fyke-nets | 2 | 4 → 14 |
| Fyke-net catch | n = 42 | n = 3 + 4 |
| Telemetry | n = 20 + 11 | n = 3 + 1 (!) |
| Control group | 11 of 11 = 100 % | |
| Passage group | 0 of 20 = 0 % | |



Herting
after
2013



67-100%
passage
success

☆ n = 1

n = 3 ☆

Herting upstream passage

- ✓ Salmon spawners
 - ✓ 70% → **97%**
- ✓ Sea lamprey spawners
 - ✓ **0% (!)** → **67-100%**
- ✓ European juvenile eels
 - ✓ **10% (250)** → **?% (1800)**

Sea lamprey spawner summary

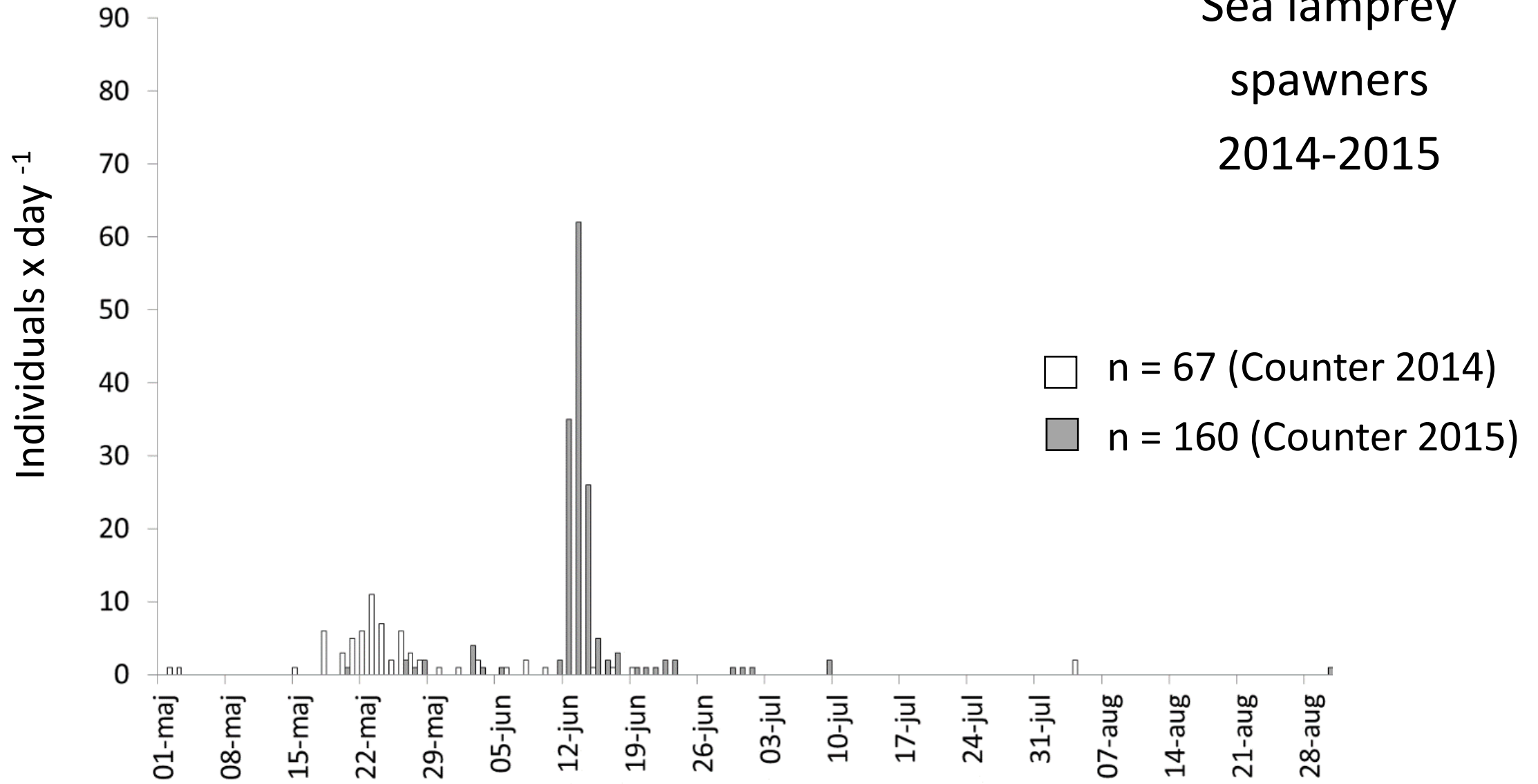
| Info | Before (2010) | After (2014-2015) |
|----------------|------------------|-------------------|
| FPS | Denil | Nature-like |
| Fyke-nets | 2 | 4 → 14 |
| Fyke-net catch | n = 42 | n = 3 + 4 |
| Telemetry | n = 20 + 11 | n = 3 + 1 (!) |
| Control group | 11 of 11 = 100 % | 100 % (n=1) |
| Passage group | 0 of 20 = 0 % | 2 of 3 = 67 %* |

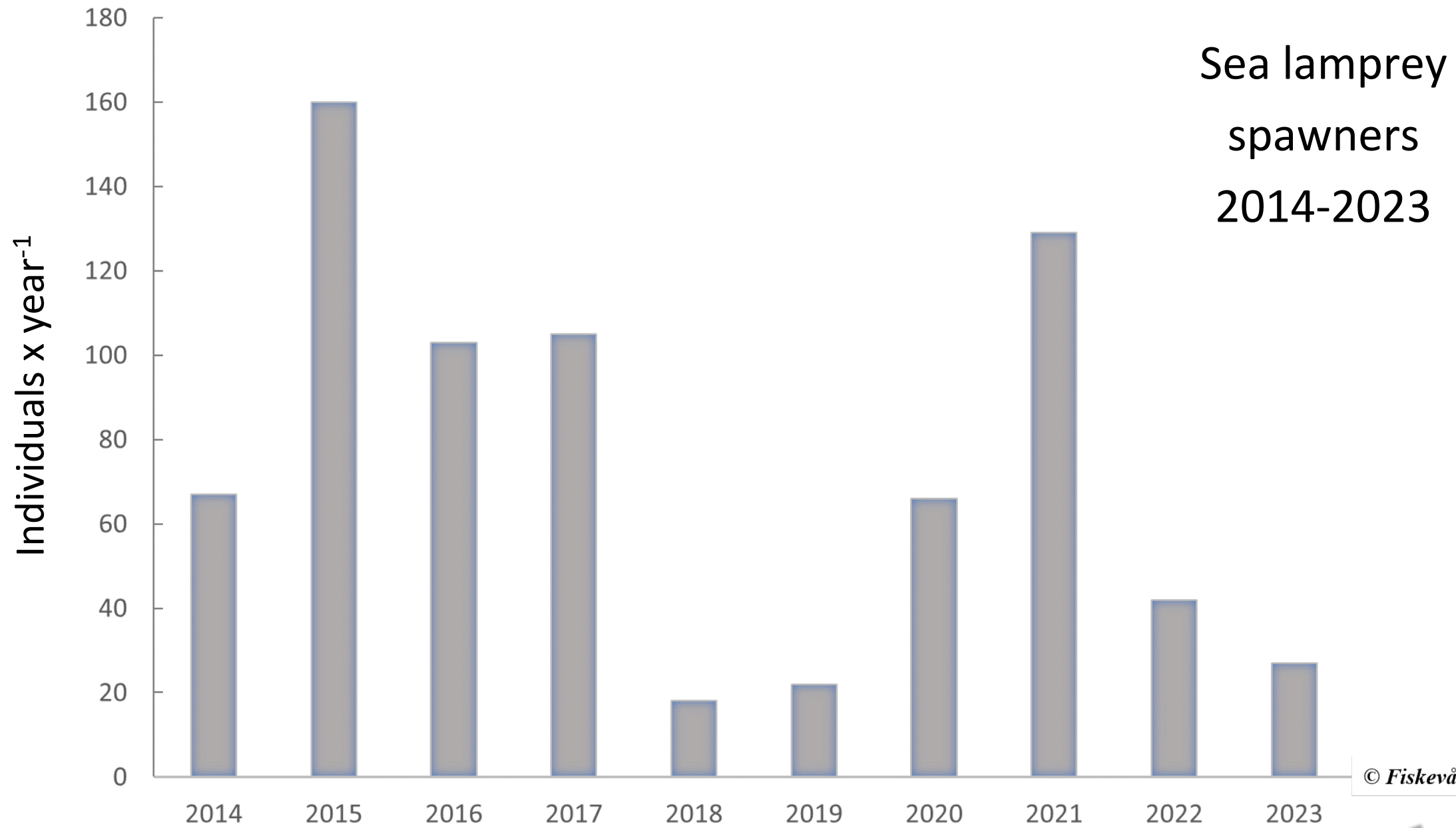
!
?

** One individual spent 34 days in the fishway and then migrated to sea*



Sea lamprey spawners 2014-2015





Herting
after
2013

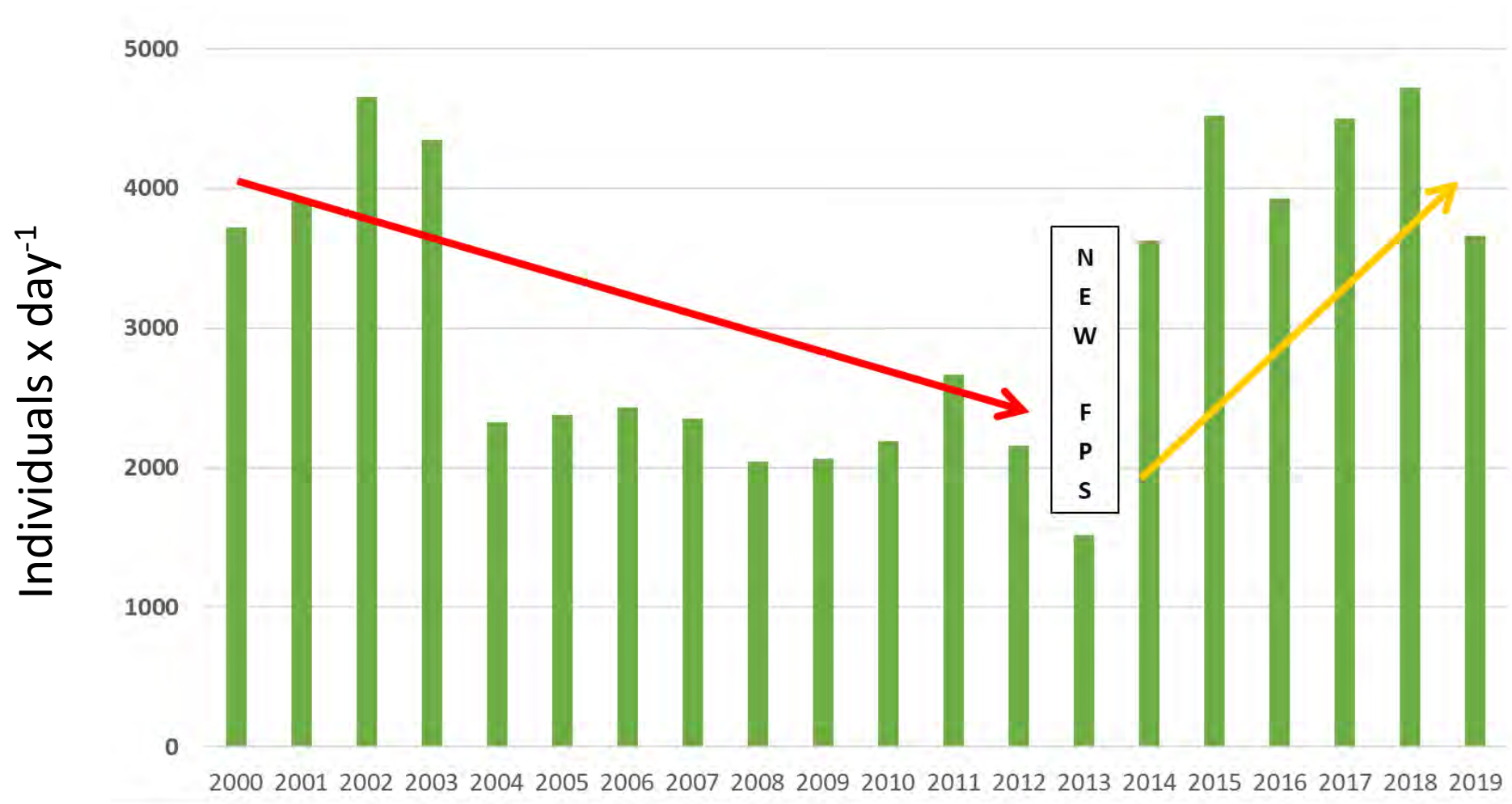


**91-100%
survival**

Herting downstream passage

- ✓ Salmon kelts
 - ✓ 33-80% (S) → **96% (S)**
- ✓ Salmon smolts
 - ✓ 90% (T) → **91% (S)**
- ✓ European silver eels
 - ✓ 70% (T) → **95-100% (S)**

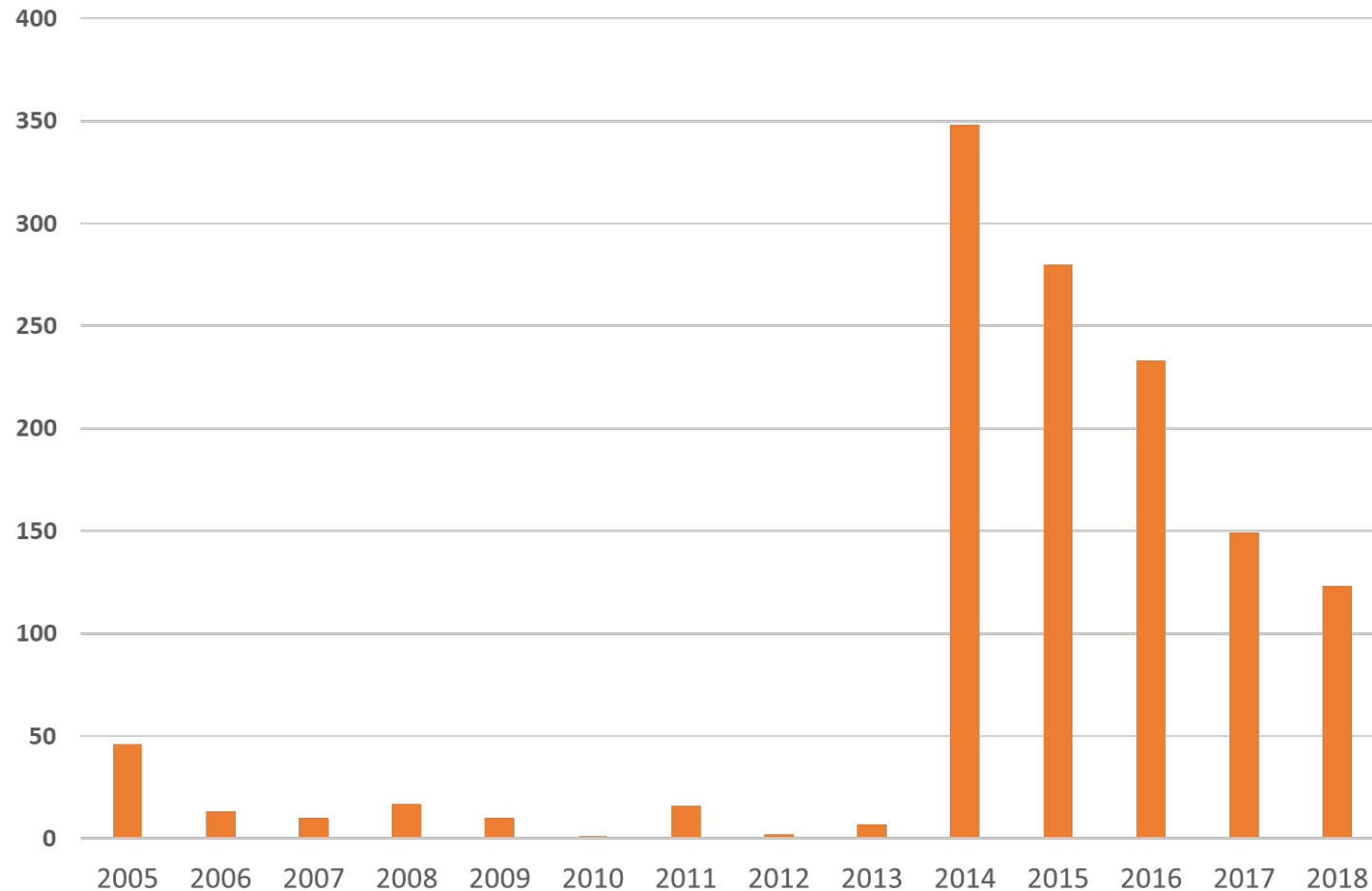
Herting – Salmonid spawner count 2000-2019



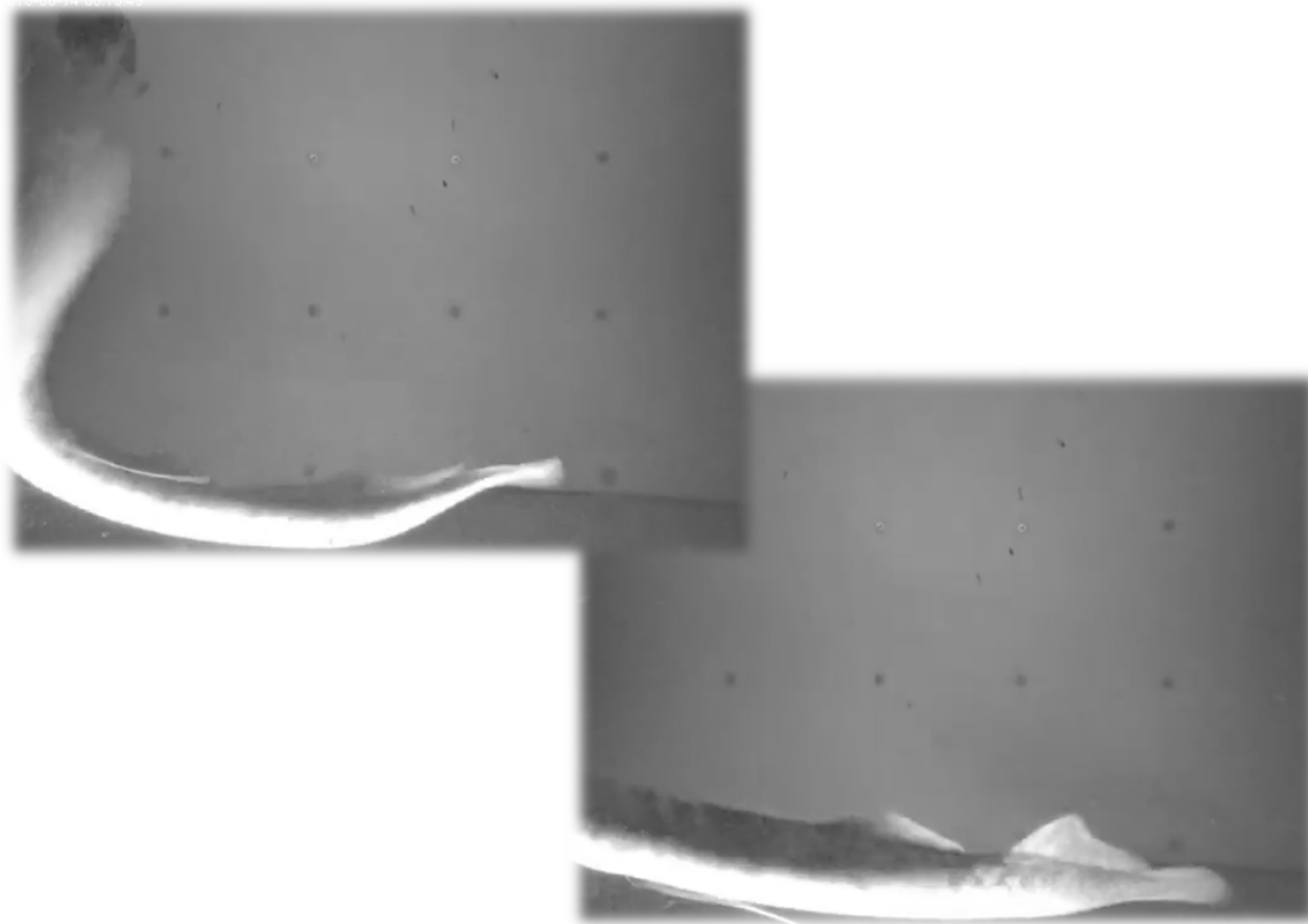
4-6 weeks
earlier arrival
at Nydala in
Högvadsån!

Herting – Non-salmonid count 2005-2018

- 1) Perch
- 2) Ide
- 3) White bream
- 4) Bleak
- 5) Common bream
- 6) Shad
- 7) River lamprey
- 8) Roach
- 9) Chub
- 10) Dace
- 11) Pike
- 12) Tench
- 13) Sea lamprey
- 14) European eel
- 15) Pink salmon
- 16) Rainbow trout
- 17) Mitten crab...



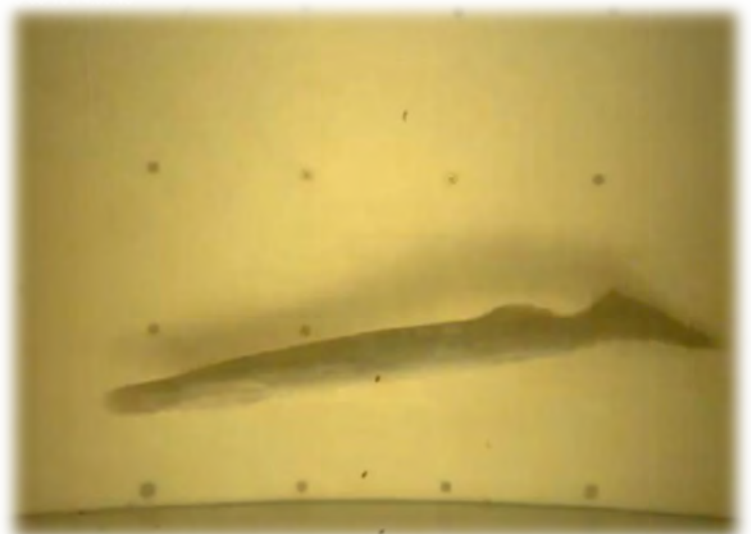
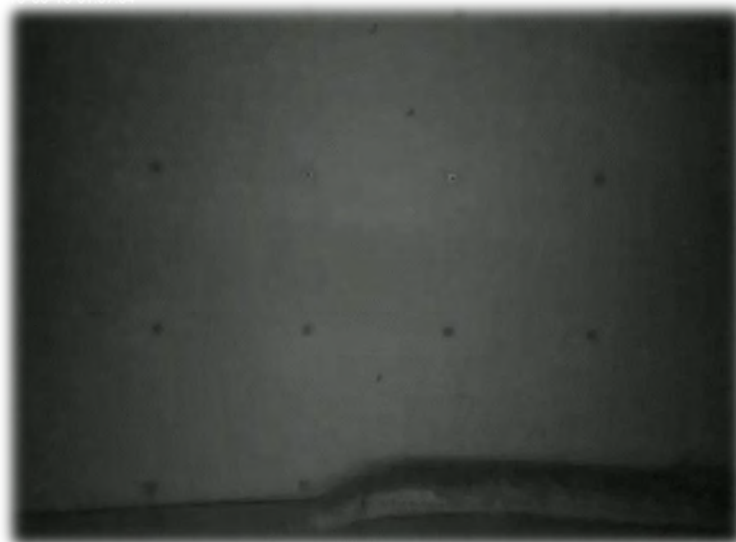
Sea lamprey
spawners
2014-2023



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Sea lamprey
spawners
2014-2023



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Herting HEP - A functional two-way passage facility

PLOS ONE

RESEARCH ARTICLE

Technical fishway passage structures provide high passage efficiency and effective passage for adult Pacific salmonids at eight large dams

Matthew L. Keefer *, Michael A. Jepson, Tami S. Clabough, Christopher C. Caudill

Department of Fish and Wildlife Sciences, College of Natural Resources, University of Idaho, Moscow, Idaho, United States of America

*mattkeefe5@gmail.com



An exception was a recent radiotelemetry study of Atlantic Salmon *Salmo salar* in Sweden by Nyqvist et al. [35], where fishway attraction efficiency estimates (≥ 0.97) were equivalent to the CRB estimates reported here.

3 YEAR POSTDOC OPPORTUNITY!



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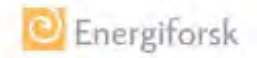


Using machine learning for improved eel downstream passage design

Olle Calles & Stefanos Georganos - Karlstads universitet

Ana Silva, Benjamin Cretois, Kim Magnus Bærum & Torbjørn Forseth - NINA

David Aldvén & Stephanie Müller - Vattenfall





Thanks for your attention!



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