

# **Culvert restoration and stream connectivity in the Teno river system**

– earlier experiences and achievements

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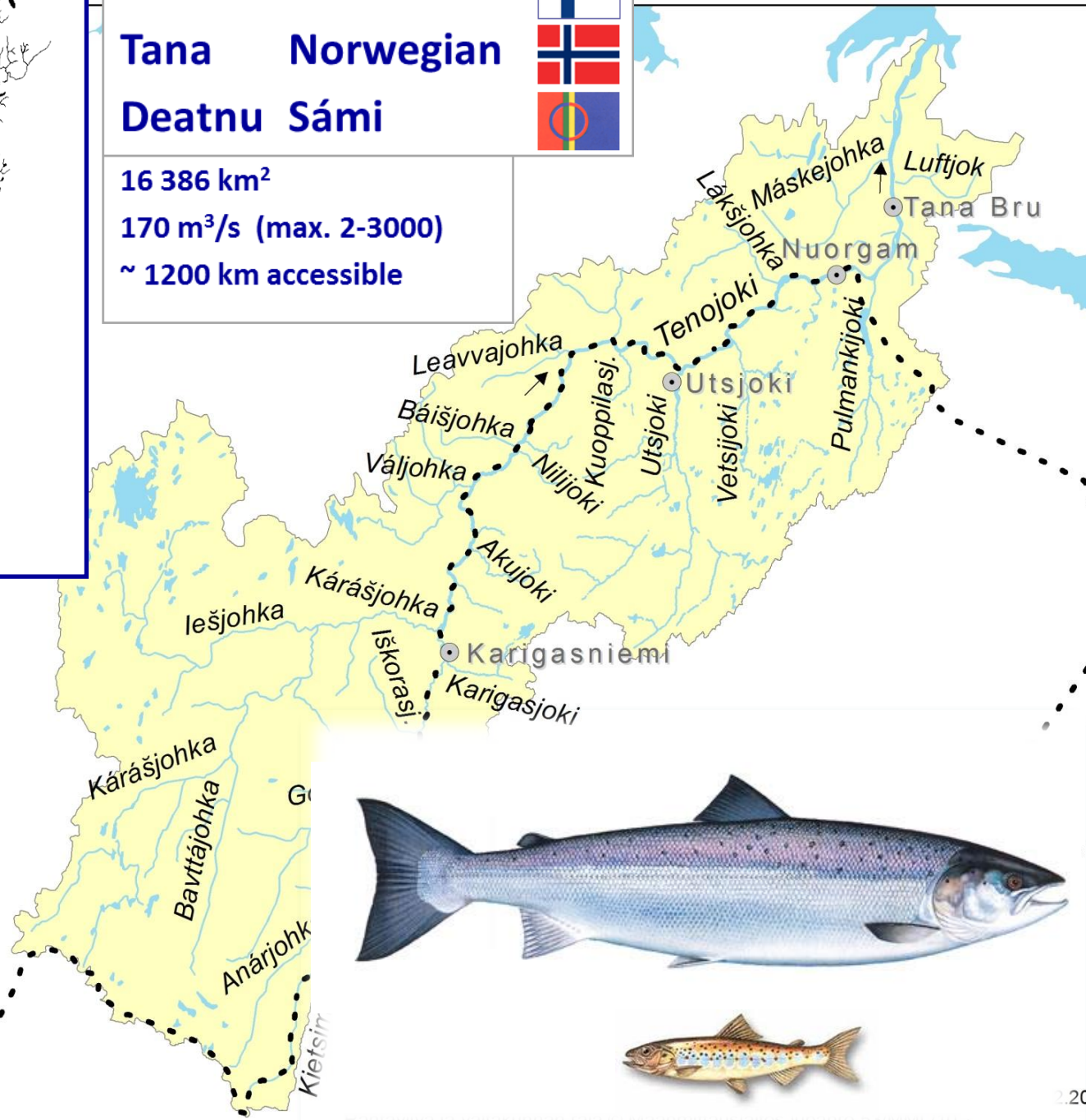
Teno Finnish  
Tana Norwegian  
Deatnu Sámi



16 386 km<sup>2</sup>

170 m<sup>3</sup>/s (max. 2-3000)

~ 1200 km accessible



# Juvenile salmon movement from main stem rivers into small streams



**Juveniles (1+ and older)  
move from spawning areas  
into small streams**

- ✓ Huntsman (1945) NB  
Canada
- ✓ Niemelä (1979) River  
Näätämojoki /Neidenelva
- ✓ Rikstad (1980), Aarseth  
(1982) River Teno
- ✓ Erkinaro (1995),  
Erkinaro & Niemelä  
(1995), Erkinaro et al.  
(1998), Johansen et al.  
(2005) etc. etc.  
River Teno



# Habitat characteristics

## River Teno main stem

- Open, no shadow
- Slow flowing
- Large sandy areas

# Habitat characteristics

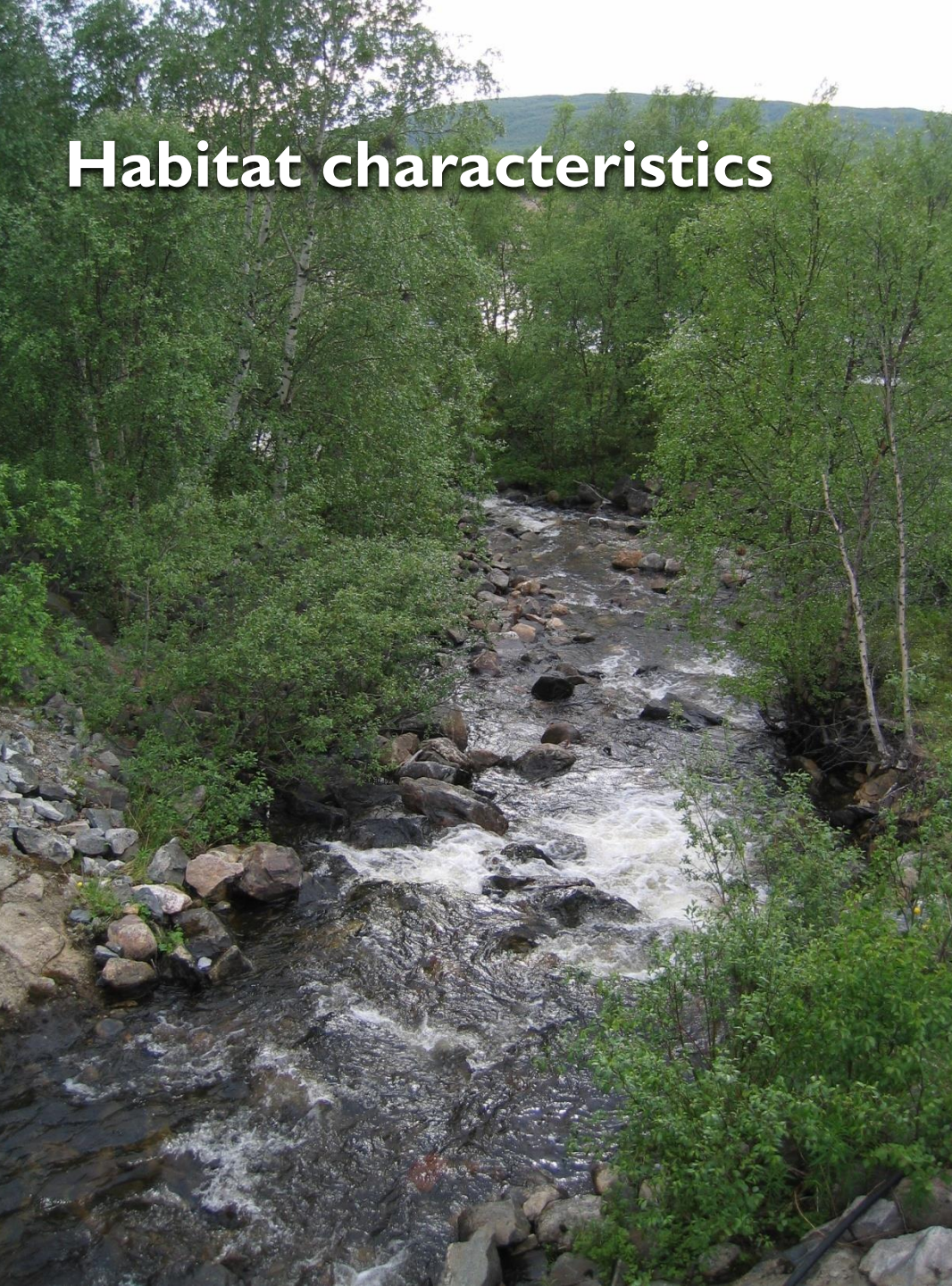
- ▶ Relatively homogenous substratum

# Habitat characteristics

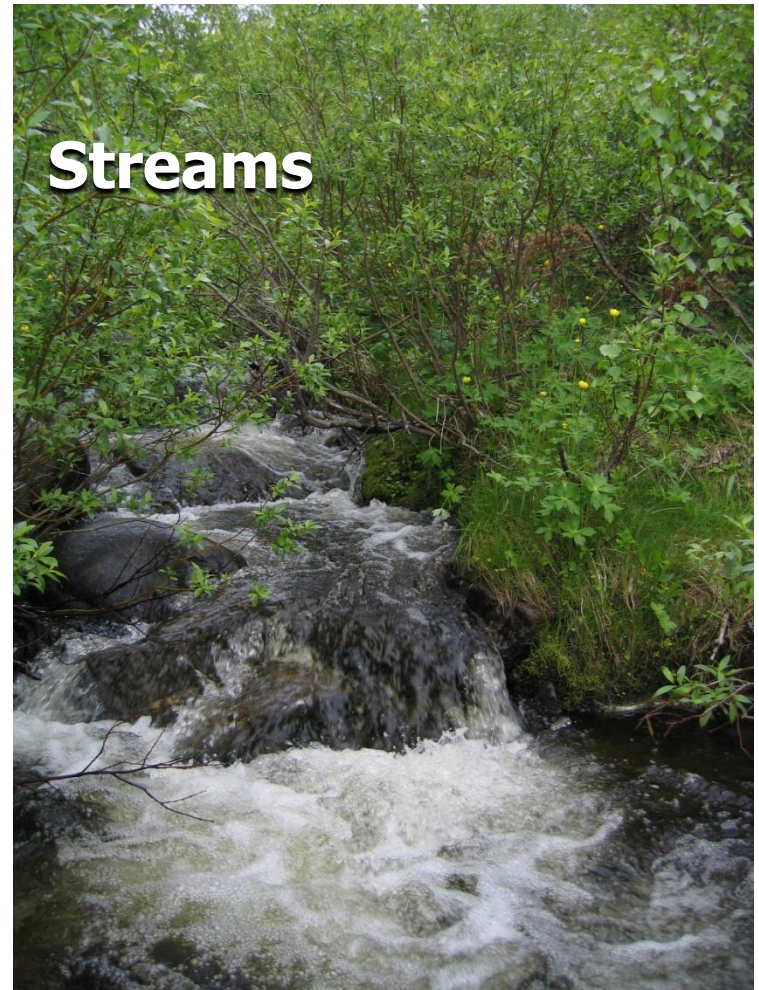


Heavily scoured by ice in  
the spring

# Habitat characteristics



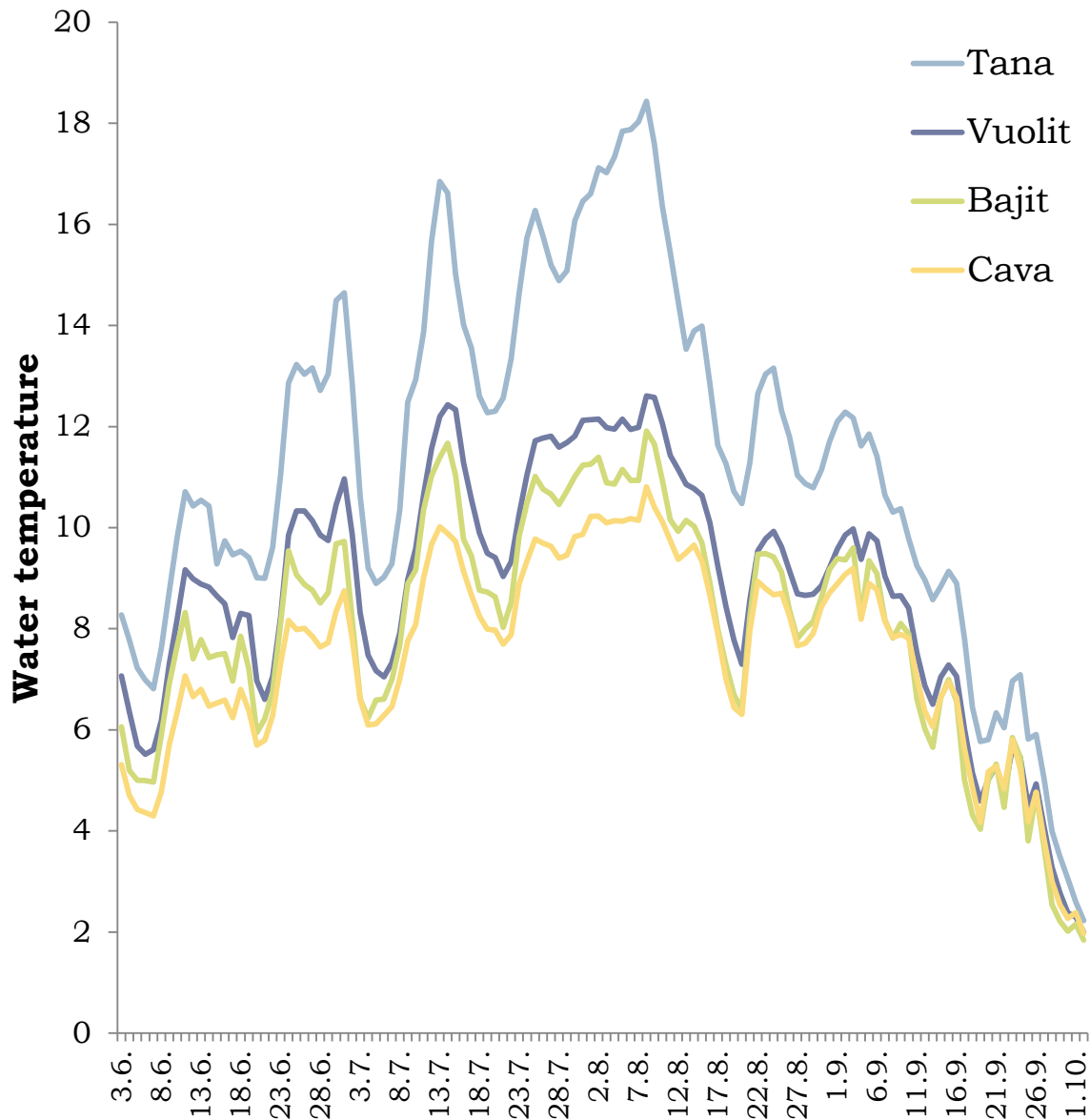
## Streams



- **Shaded by riparian vegetation**
- **Diverse substratum and flow**
- **Relatively stable**

# Habitat characteristics





## Water temperatures (2009)

Temperatures consistently highest in the Teno/Tana main stem

Differences up to 6 °C

*Why are the fish undertaking these extensive movements into what really is a pretty chilly place?*



**Methods:**

**Electrofishing**

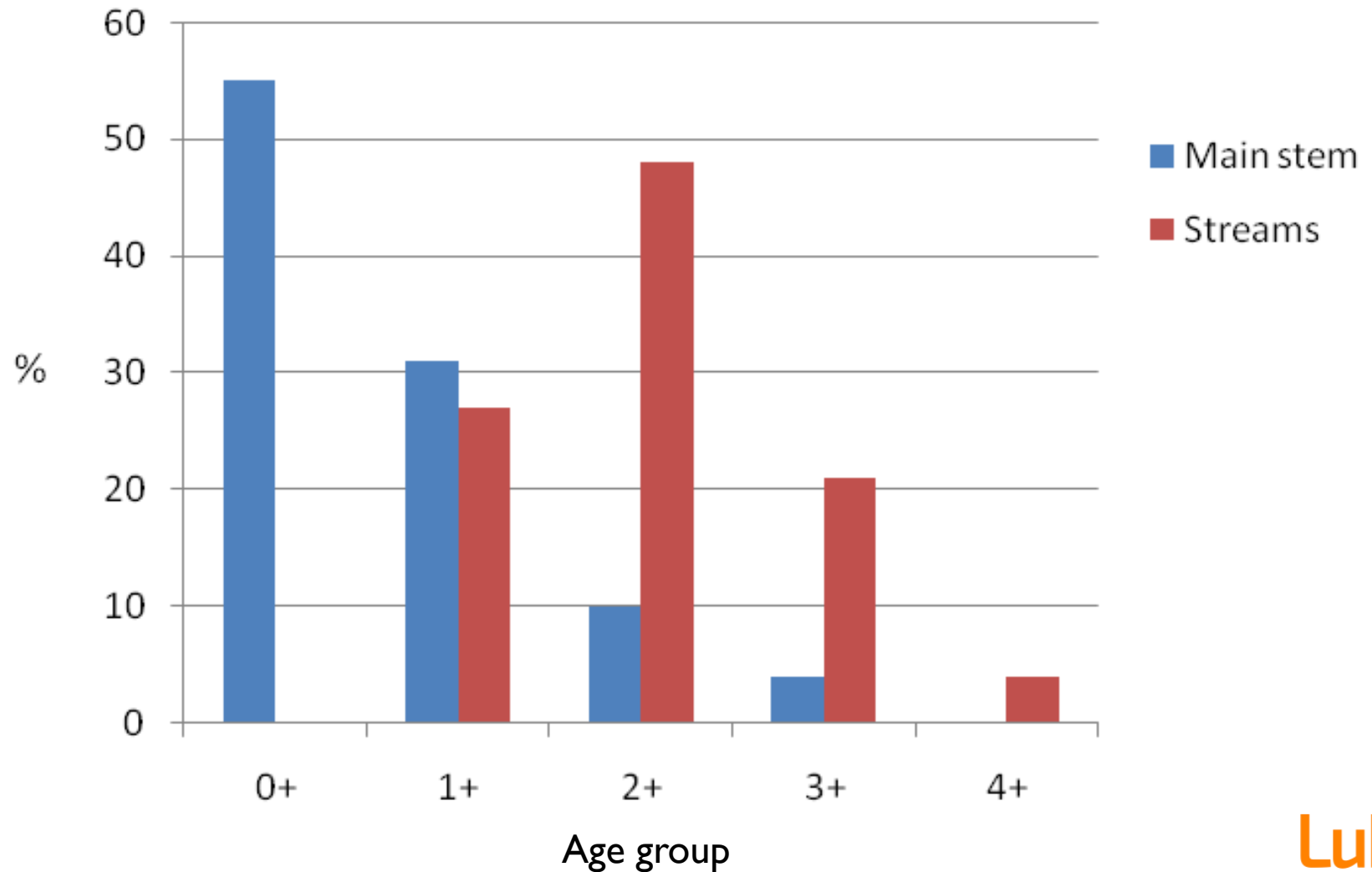


**Methods:**

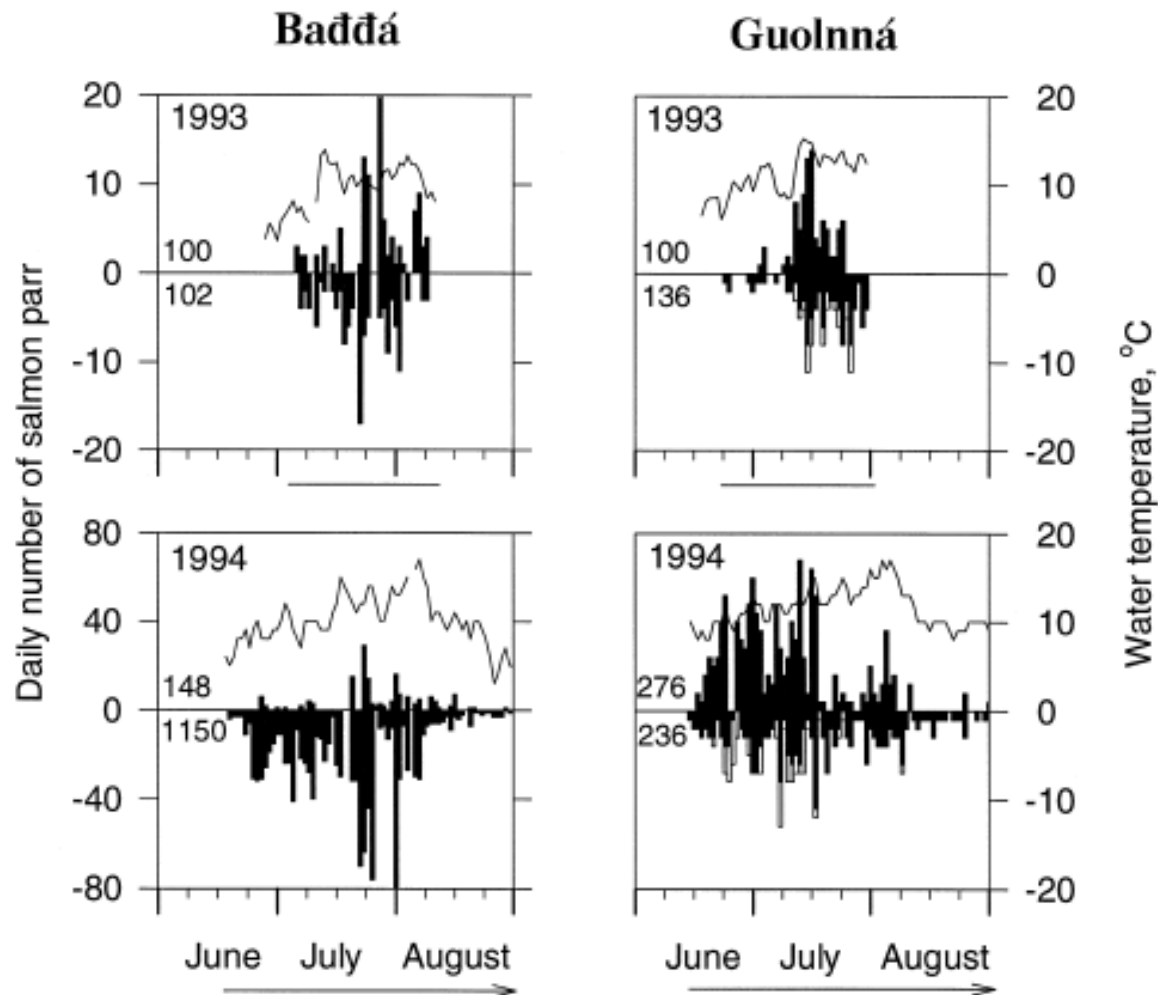
**PIT-tagging**  
**Trapping**



## Age distribution of salmon parr in the Teno main stem and in streams



# Movement into and out of streams – trapping



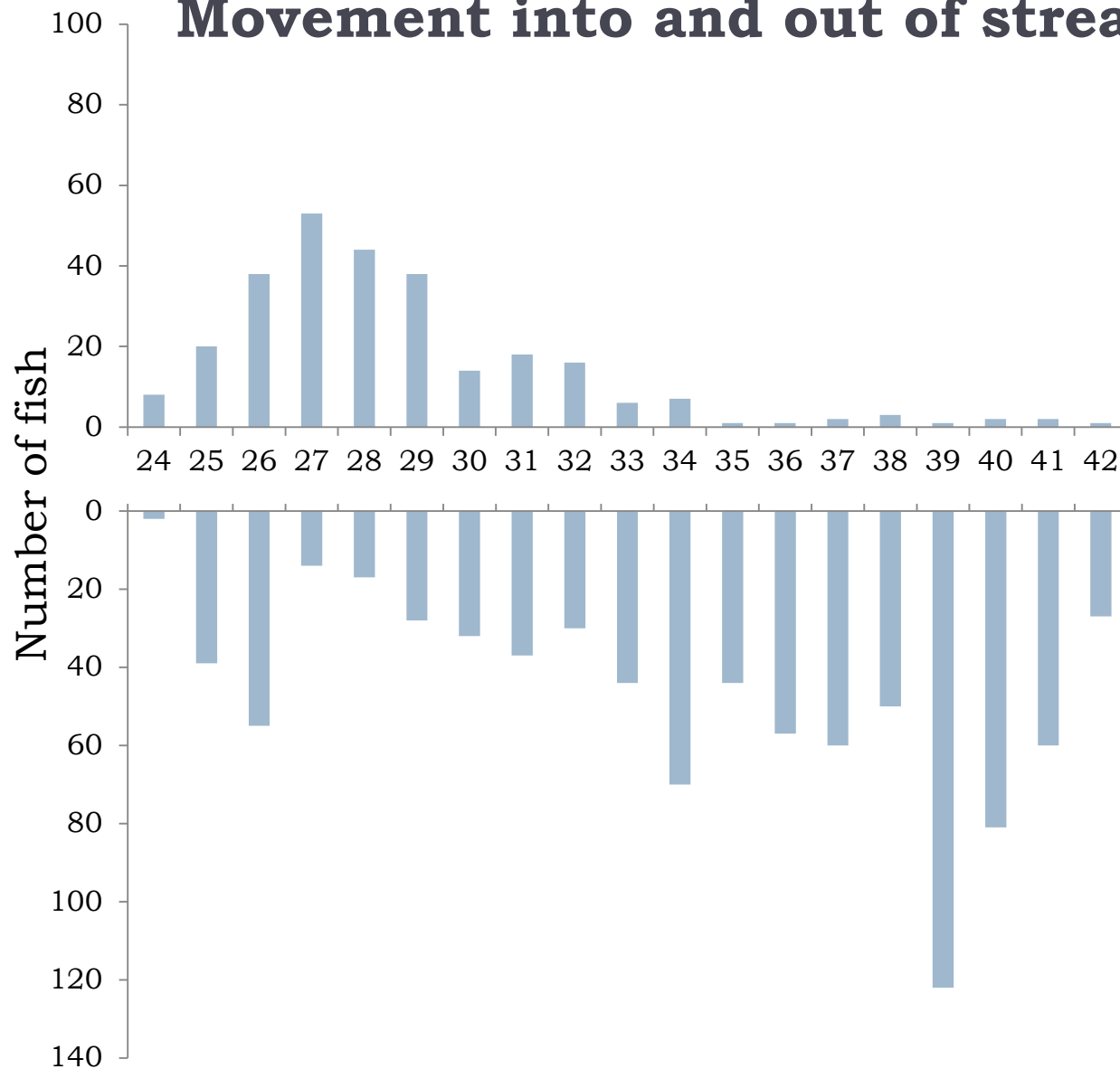
# Movement into and out of streams – PIT-tagging

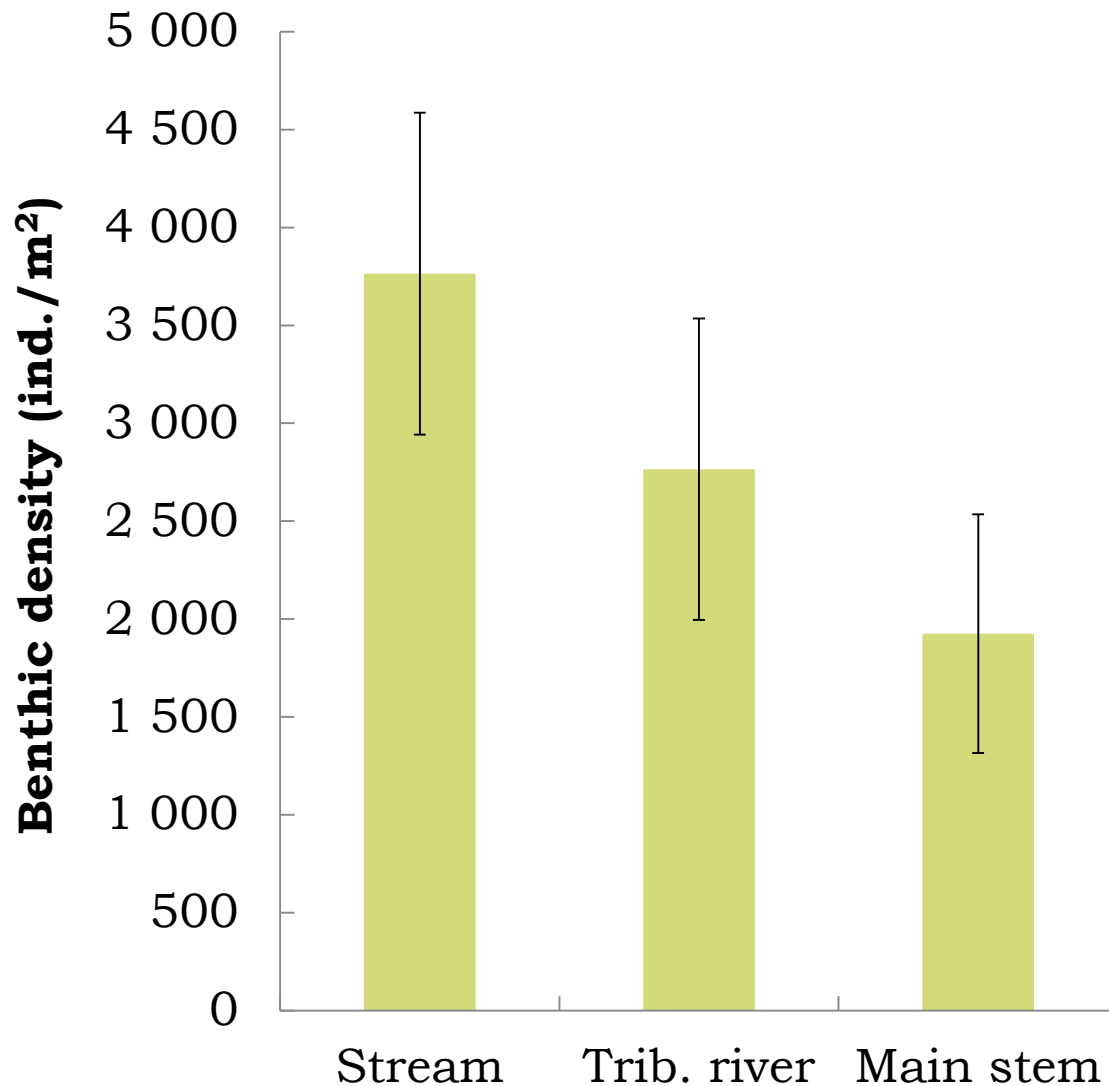
**Number of juveniles passing the PIT-antennas**

Upper part: Number of juveniles entering the stream

Lower part: Number of juveniles leaving the stream

Calendar weeks:  
24 = middle of June,  
42 = middle of October





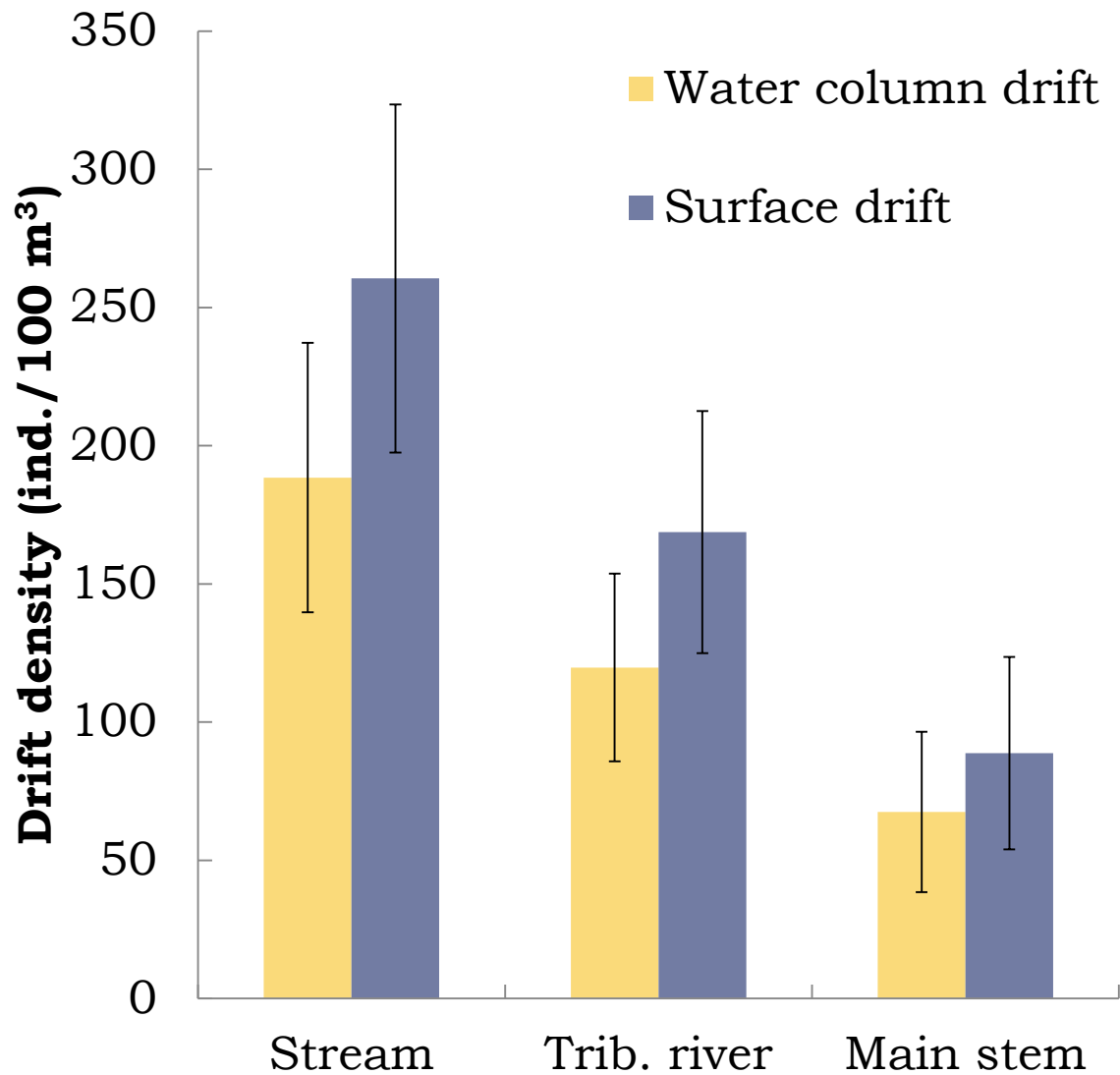
## Benthic food availability

**Small streams:** High benthic density, many large-sized benthic species (mayflies, stoneflies, caddis)



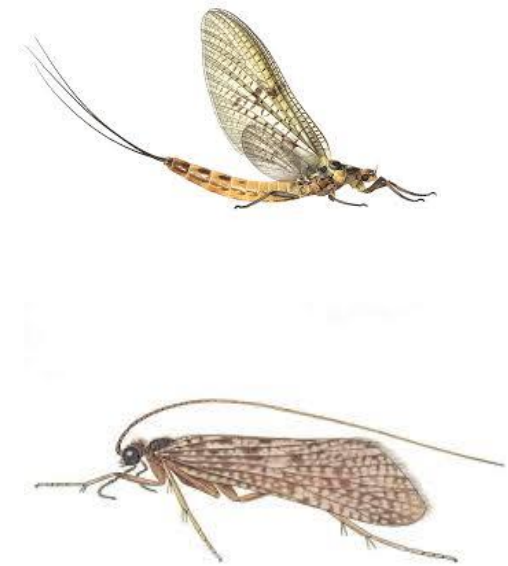
**Main stem:** Low density, dominated by small chironomid larvae



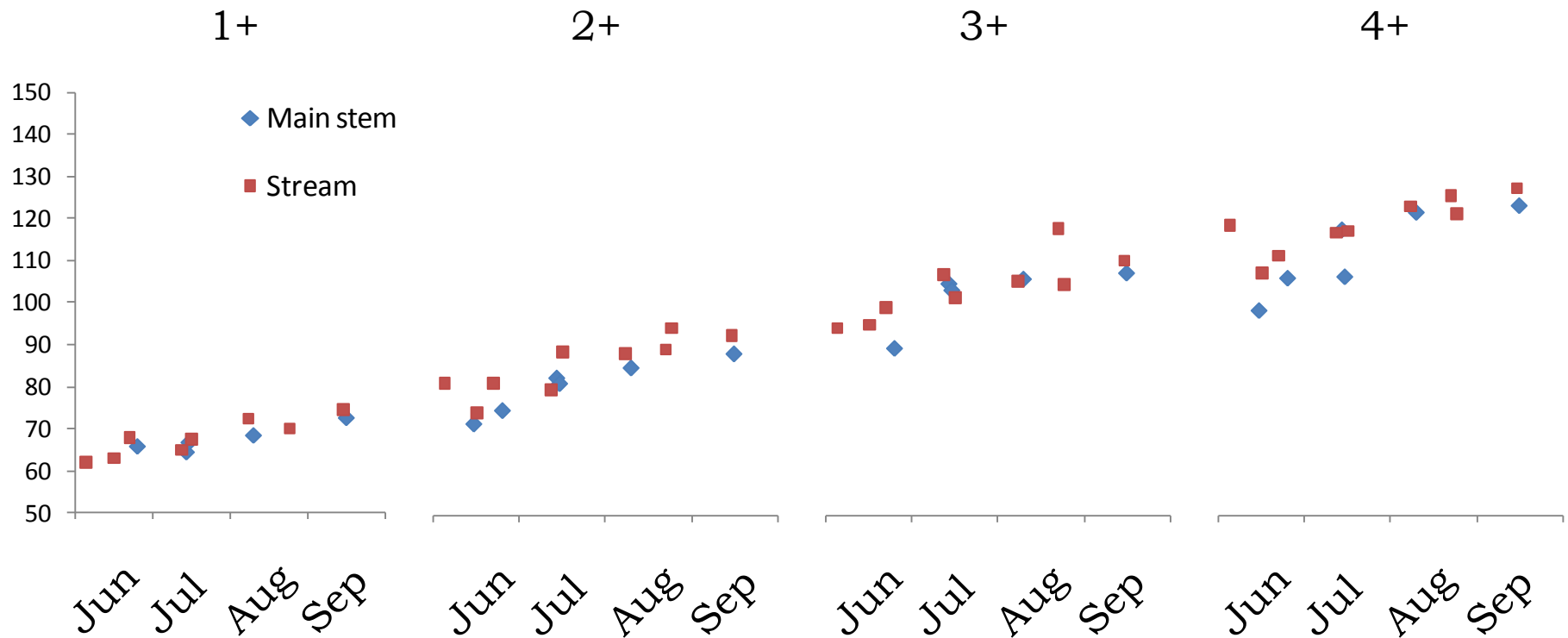


## Drift food availability

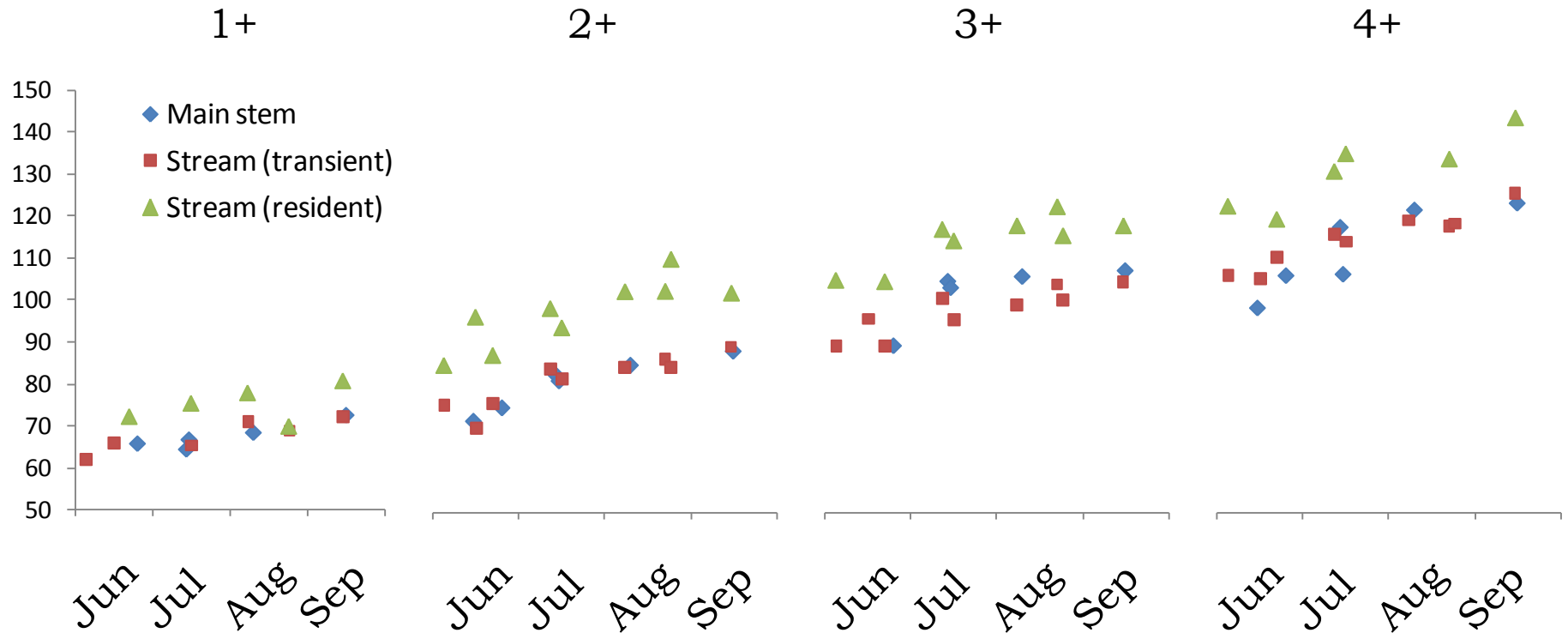
Early August samples



# Size (length, FL) of salmon parr in the Teno main stem and in a stream



# Size (length, FL) of salmon parr in the Teno main stem and in a stream



# Freshwater habitat shifts vs. life histories

Scale analyses: juvenile habitat use vs. years at sea

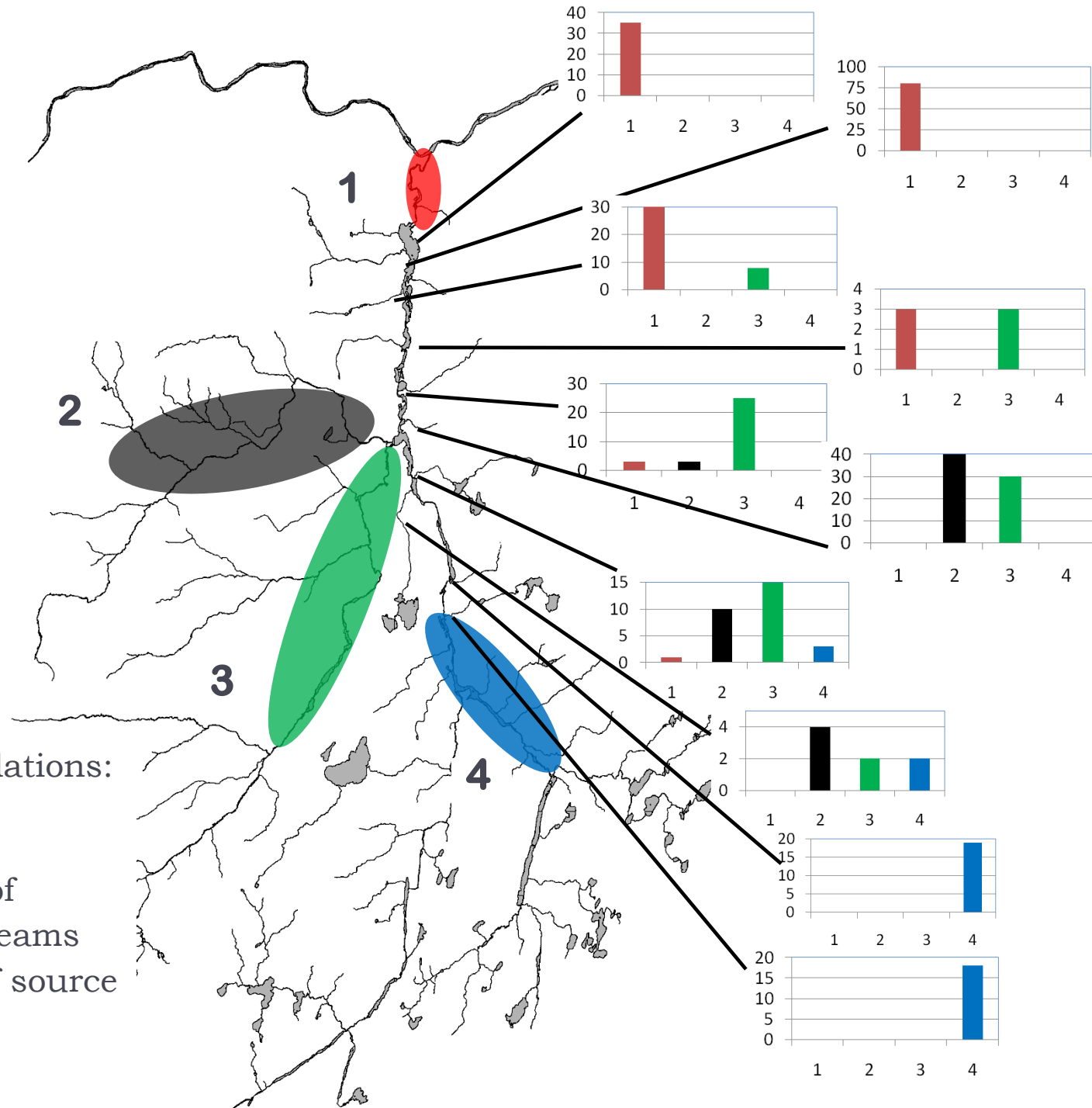
Migrant parr → Larger, older smolts  
Higher proportion of 1SW returns  
Higher proportion of repeat spawners

# Genetic origin of stream-migrant salmon parr in the River Utsjoki system

Four spawning populations: 1,2,3,4

Distribution of parr of different origin in streams reflect the location of source populations

Erkinaro et al., unpublished



# Migration of salmon parr in small streams

- Sometimes extensive, up to 10-15 km
- Several kilometres in large number of streams
  - significant production area at use in the River Teno system
  - significant production of smolts, up to 1 – 1.5 smolts/100m<sup>2</sup>



Problems in habitat connectivity?



# Activities towards improving connectivity in the Tana

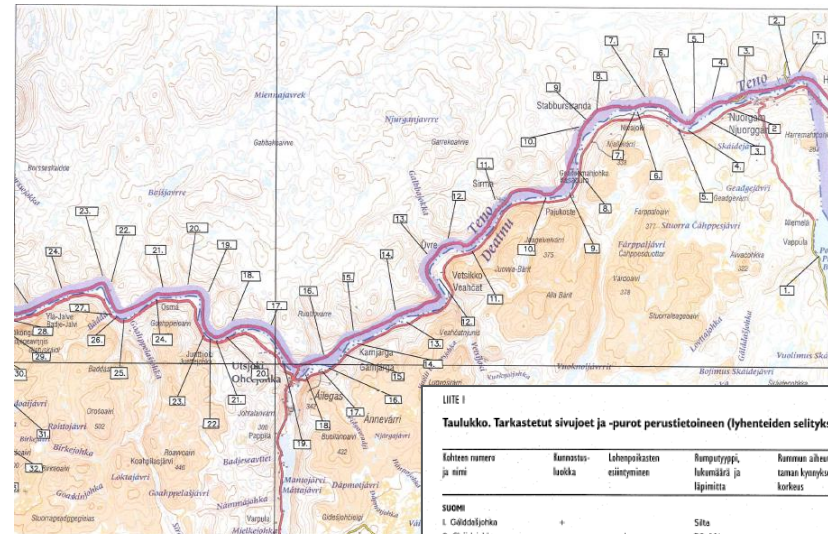
## Constructing and re-shaping bridges



# Activities towards improving connectivity in the Tana

## Restoring road culverts

- Lundvall et al. (2001) survey of culverts in the Tana system



LIITE I  
Taulukko. Tarkastetut sivujoet ja -purot perustietoineen (lyhenteiden selitykset taulukon lopussa).

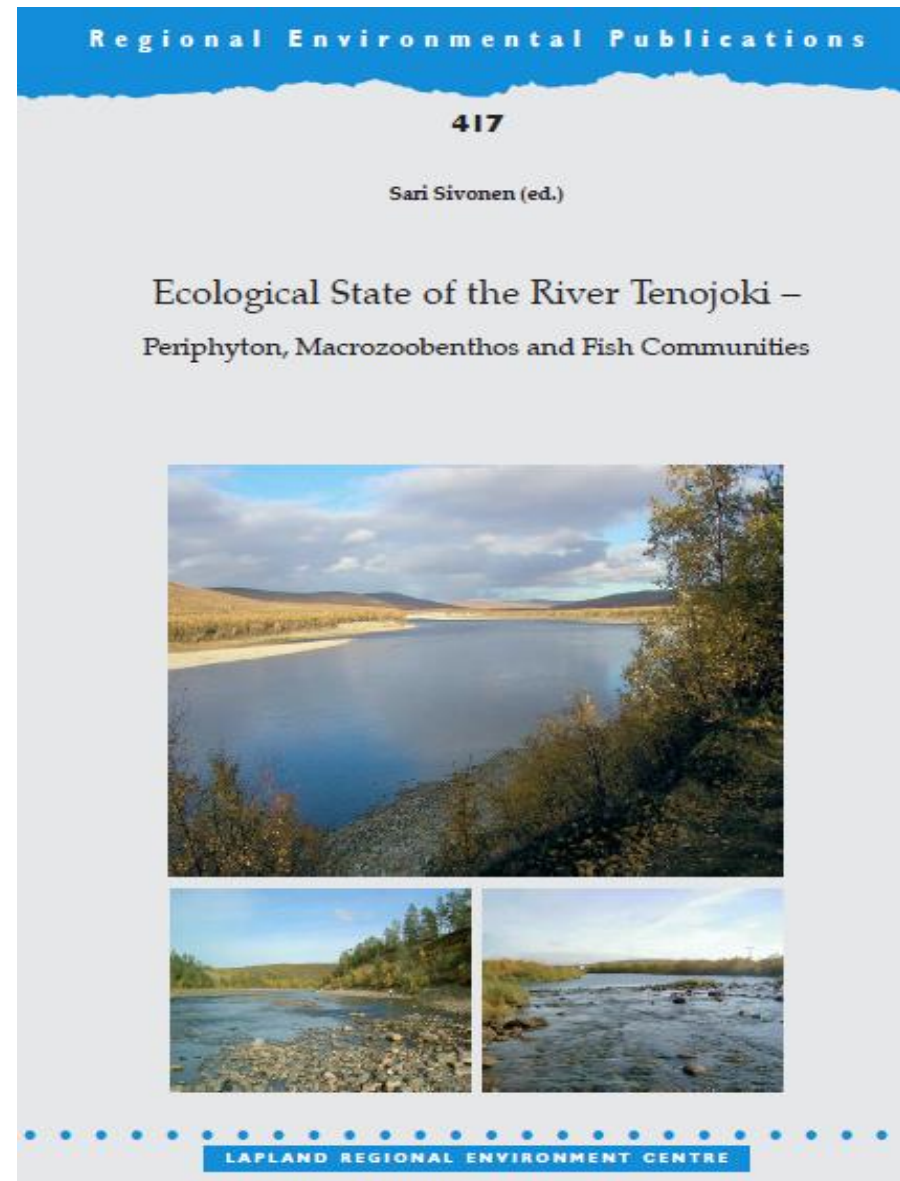
| Laajennus<br>numero<br>ja nimi | Kunnos-<br>tustila | Laajennuksen<br>erittely | Rakennustyyppi,<br>laajuus ja<br>päämäärä | Kunnon alen-<br>nustas<br>korkeus | Järjestys<br>tila | Huomautuksia        |
|--------------------------------|--------------------|--------------------------|-------------------------------------------|-----------------------------------|-------------------|---------------------|
| <b>SUOMI</b>                   |                    |                          |                                           |                                   |                   |                     |
| 1. Galdelajärvi                | +                  |                          | Silta                                     |                                   | ok                | Törmäpöytä tehty    |
| 2. Saldelajärvi                | +                  | L                        | B2, M1                                    |                                   |                   | Jyrkkä, kello       |
| 3. Aasajärvi                   | -                  |                          |                                           |                                   |                   | Jyrkkä              |
| 4. Vuoksi Boratkoajärvi I      | -                  | L                        | B2                                        | 0,9 m                             |                   | Kalvenna silta      |
| 4b. V. Boratkoajärvi II        | ***                | L                        | B2                                        | 0,5 m                             |                   | Kalvenna silta      |
| 5. Baji Boratkoajärvi          | ***                | L                        | B2                                        | 0,9 m                             |                   | Kalvenna silta      |
| 6. Gessamajärvi                | +                  | L                        | T2                                        |                                   |                   |                     |
| 7. Gessamajärvi                | -                  | K                        | B1                                        | 0,5 m                             |                   | Pieni               |
| 8. Oksajärvi                   | -                  | L                        | B1                                        | 1 m                               |                   | Pensekko            |
| 9. Vuoksi Jaagelajärvi         | +                  | L                        | Silta                                     |                                   | ok                |                     |
| 10. Baji Jaagelajärvi          | +                  | L                        | Silta                                     |                                   | ok                |                     |
| 11. Oksajärvi                  | +                  |                          | B1                                        | 0,4 m                             |                   | Ahdas rumpu         |
| 12. Vuoksi Jaagelajärvi        | +                  | L                        | Silta                                     |                                   | ok                | Törmäpöytä tehty    |
| 13. Nyläjäjärvi                | +                  | L                        | B2                                        |                                   |                   | Yksityinen          |
| 14. Oksajärvi                  | **                 | L                        | B2                                        | 0,6 m                             |                   | Nosta vedensatas    |
| 15. Vildemajärvi               | +                  | L                        | Silta                                     | ?                                 |                   |                     |
| 16. Radeborjokki               | -                  | L                        | B2, M1                                    | 0,5 m                             |                   | Yksityinen          |
| 17. Aalejokki                  | +                  |                          | Kaasik                                    |                                   |                   |                     |
| 18. Oksajärvi                  | +                  |                          | Silta                                     |                                   | ok                | Törmäpöytä tehty    |
| 19. Aalejokki                  | +                  | L                        | Silta                                     |                                   |                   | Yksityinen          |
| 20. Vuoksi Radeborjokki        | -                  |                          | B1                                        | 0,5 m                             |                   | Erittäin jyrkkä     |
| 21. Baji Radeborjokki          | -                  |                          | B1                                        | 0,5 m                             |                   | Erittäin jyrkkä     |
| 22. Vuoksi Radeborjokki        | +                  | L                        | B2                                        | 0,3 m                             |                   | Jyrkkä, kunnostettu |
| 22b. Baji Radeborjokki         | +                  | L                        | B2                                        |                                   |                   |                     |
| 23. Juntajokki                 | -                  | L                        | B1                                        | 0,3 m                             |                   | Jyrkkä, kunnostettu |
| 24. Kauppalajokki              | **                 |                          | T1                                        | 0,2 m                             |                   | Nosta vedensatas    |
| 25. Gessamajärvi               | +                  |                          | Silta, 2 sika                             |                                   | ok                | Törmäpöytä tehty    |
| 26. Vuoksi Jaagelajärvi        | +                  | K                        |                                           |                                   |                   |                     |
| 27. Baji                       | +                  | L                        | Silta                                     |                                   | ok                |                     |
| 28. Oksajärvi                  | +                  |                          | Kaasik                                    | Louhikko                          |                   | Pieni               |
| 29. Oksajärvi                  | +                  | L                        | T2                                        |                                   | ok                | Matala              |
| 30. Juntajokki                 | +                  |                          |                                           |                                   |                   | Jyrkkä              |
| 31. Gessamajärvi               | +                  |                          |                                           |                                   |                   | Jyrkkä              |
| 32. Gessamajärvi               | +                  | L                        | Kaasik                                    |                                   | ok                | Jyrkkä              |
| 33. Baji                       | +                  |                          | T1                                        |                                   |                   | Jyrkkä              |
| 34. Gessamajärvi               | -                  | K                        | B1, 0,9 m                                 |                                   |                   | Jyrkkä              |
| 35. Hämäläjäjärvi              | -                  | K                        | Silta                                     |                                   |                   | Jyrkkä              |
| 36. Suopajärvi                 | -                  | L                        | B2                                        | 0,8 m                             | ok                | Jyrkkä              |
| 37. Nuonajärvi                 | +                  |                          | Silta                                     |                                   | ok                | Matala              |
| 38. Nyläjäjärvi                | +                  |                          | Silta, 2 sika                             |                                   | ok                | Matala              |
| 39. Hämäläjäjärvi              | -                  | K                        | B1, M1                                    |                                   |                   | Jyrkkä, pieni       |
| 40. Vuoksi Jaagelajärvi        | -                  | L                        | B2                                        | 0,1 m, Louhikko                   | ok                | Erittäin jyrkkä     |
| 41. Aalejokki                  | -                  | L                        | B2+1                                      | 0,6 m                             | ok                | Erittäin jyrkkä     |
| 42. Oksajärvi                  | -                  |                          | B1                                        | 0,5 m                             | ok                | Jyrkkä, pieni       |
| 43. Jaagelajärvi               | +                  | L                        | Silta                                     |                                   | ok                |                     |

# Restoration of road culverts in the Tana system

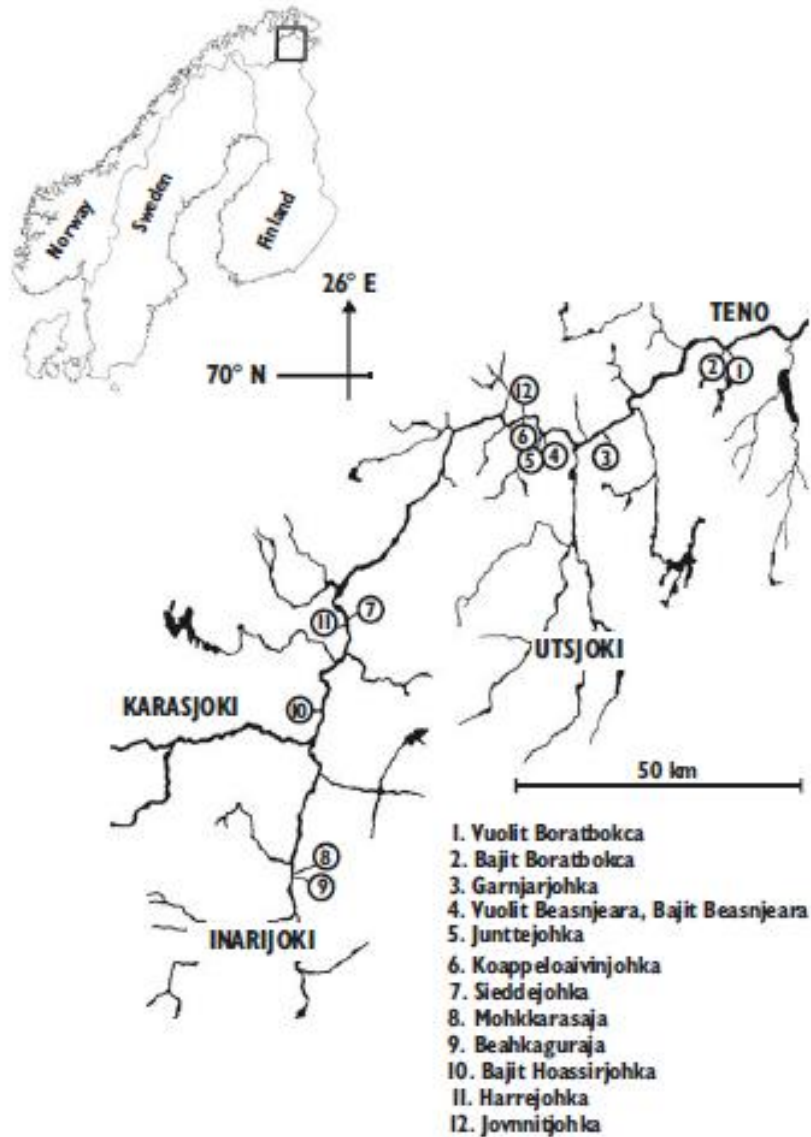
- EU- Interreg project 2003-2005
- Final report 2006:

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- Road culverts of 12 small streams were restored in 2000-2005





# Road culvert restoration expands the habitat connectivity and production area of juvenile Atlantic salmon in a large subarctic river system

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# Results



- Expansion of distribution of juvenile salmon
- Colonization mostly after 2-3 years after restoration
- In total c. 1 km new production area in seven streams in total
- In most cases natural migration barriers close to the road crossing

**Vuolit Boratbokcájohka lower branch (restored 2003)**

| Site | 1988 | 1991 | 1995 | 2003 | 2004 | 2005 | 2007 | 2010 |
|------|------|------|------|------|------|------|------|------|
| 1    | 27   | -    | -    | 53   | 29   | 31   | 43   | 38   |
| 2    | -    | -    | 22   | 35   | -    | -    | -    | -    |
| 3    | 0    | -    | -    | 0    | 0    | 4    | 5    | 8    |

**Vuolit Boratbokcájohka upper branch (restored 2001)**

| Site | 1988 | 1991 | 1995 | 2003 | 2004 | 2005 | 2007 | 2010 |
|------|------|------|------|------|------|------|------|------|
| 1    | 35   | 42   | 27   | 41   | 33   | 40   | 26   | 28   |
| 2    | 5    | 3    | 5    | 8    | 2    | 4    | 4    | 8    |
| 3    | -    | -    | -    | 0    | 0    | 0    | 3    | 3    |

**Bajit Boratbokcájohka (restored 2004)**

| Site | 1988 | 1991 | 1995 | 2003 | 2004 | 2005 | 2007 | 2010 |
|------|------|------|------|------|------|------|------|------|
| 1    | 36   | 40   | 39   | 50   | 44   | 42   | 52   | 66   |
| 2    | -    | -    | -    | 74   | 53   | 41   | 64   | 43   |
| 3    | 0    | 0    | 0    | 1    | 0    | 0    | 1    | 4    |
| 4    | -    | 0    | 0    | 0    | 0    | 0    | 0    | 0    |

**Vuolit Beasšnjeará (restored 2000)**

| Site | 1987 | 2003 | 2004 | 2005 | 2010 |
|------|------|------|------|------|------|
| 1    | 45   | 34   | 36   | 20   | 36   |
| 2    | 27   | 43   | -    | -    | 40   |
| 3    | 0    | 13   | 19   | 21   | 15   |
| 4    | -    | 0    | 0    | 0    | 6    |

**Bajit Beasšnjeará (restored 2000)**

| Site | 1988 | 2003 | 2004 | 2005 | 2010 |
|------|------|------|------|------|------|
| 1    | 36   | 48   | 39   | 48   | 42   |
| 2    | -    | 31   | 45   | 46   | 35   |
| 3    | 0    | 87   | 262  | 87   | 87   |
| 4    | -    | 0    | 0    | 0    | 0    |

**Junttejohka (restored 2000)**

| Site | 1988 | 1991 | 2003 | 2004 | 2005 | 2010 |
|------|------|------|------|------|------|------|
| 1    | 41   | 50   | 53   | 39   | 42   | 51   |
| 2    | -    | -    | 52   | -    | -    | -    |
| 3    | 1    | 0    | 14   | 11   | 21   | 7    |
| 4    | -    | 0    | 0    | 0    | 0    | 0    |

**Juovnnitjohka (restored 2002)**

| Site | 1991 | 2004 | 2005 | 2007 | 2010 |
|------|------|------|------|------|------|
| 1    | 13   | 20   | 9    | 15   | 7    |
| 2    | 0    | 0    | 1    | 1    | 4    |

# Other salmonid fish species also benefit from culvert restoration!

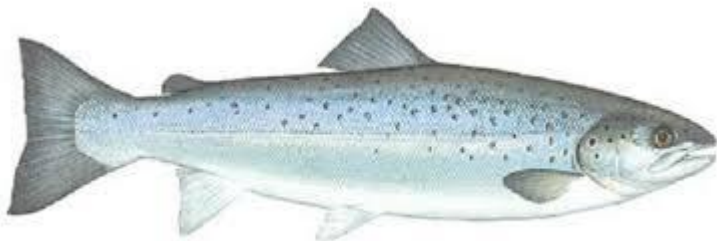
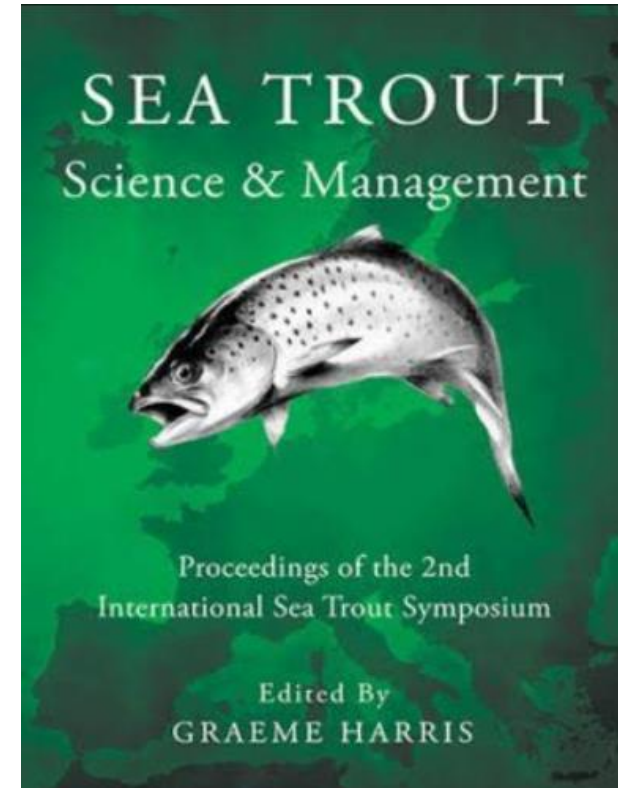
Migration behaviour of sea trout (*Salmo trutta*, L.) in a large sub-arctic river system: evidence of a two-year spawning migration.

P. ORELL<sup>1\*</sup>, J. ERKINARO<sup>1</sup>, T. KANNIAINEN<sup>1</sup> & J. KUUSELA<sup>2</sup>

<sup>1</sup>Natural Resources Institute Finland, P.O.B. 413, FI-90014 Oulu, Finland.

<sup>2</sup>Natural Resources Institute Finland, Nuorgamintie 7, FI-99980 Utsjoki, Finland.

Harris, G.S. (ed) 2017  
Sea trout: Science & Management.  
Proceedings of 2<sup>nd</sup> International Sea Trout Symposium



# JOINT ENVIRONMENTAL MANAGEMENT OF THE RIVER TANA

## TANA RIVER INTERREG PROJECT 2017-2019

### WP 2. Removing migration barriers and estimating the effectivity of earlier restoration efforts

- Still remaining problems with culverts in the Tana system?
- Recent work on the Norwegian side: some room for improvement
- Any remaining restoration needs on the Finnish side?
- Further evaluation of some of the earlier restored sites – first time since 2010

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et al.