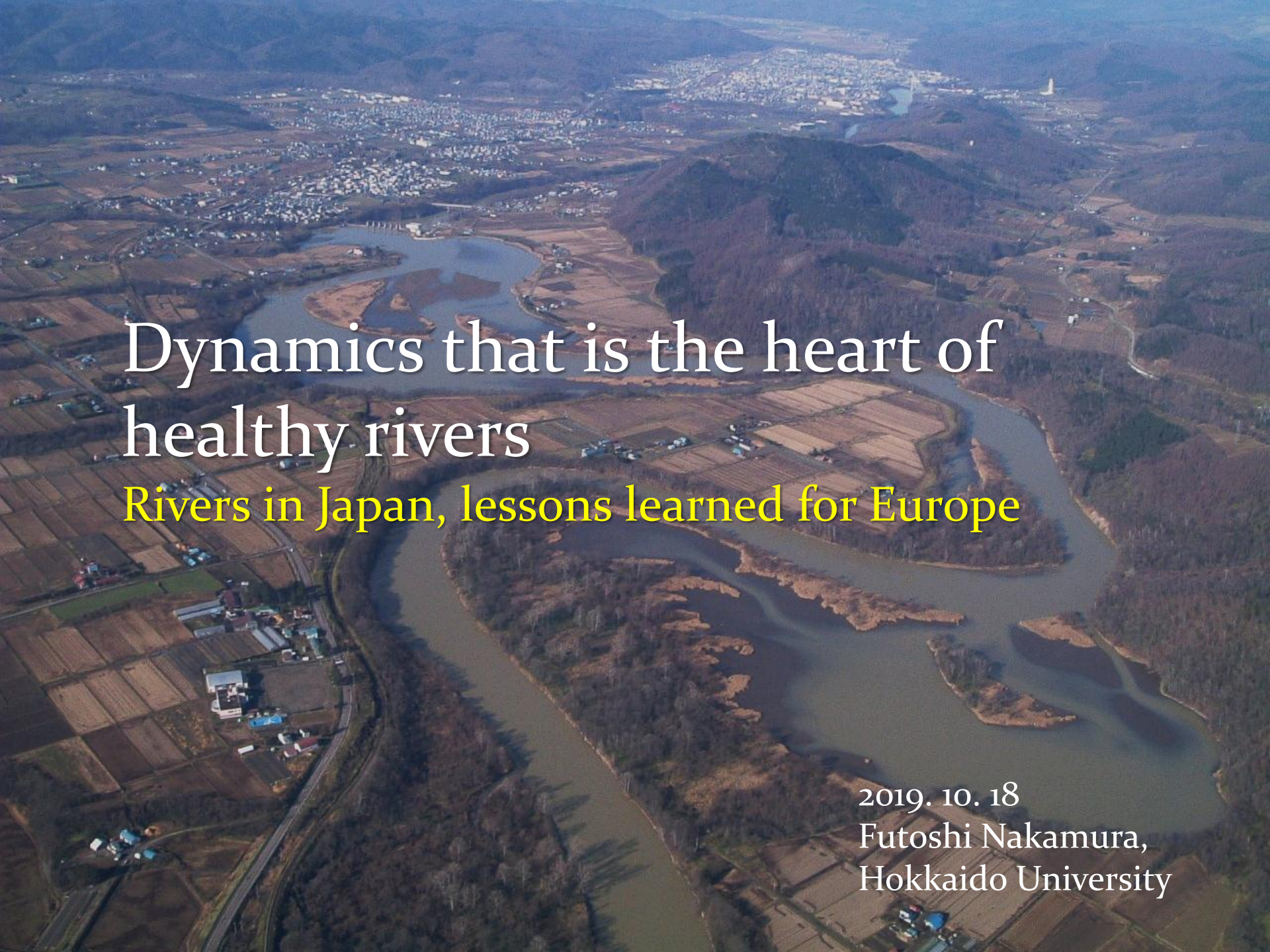
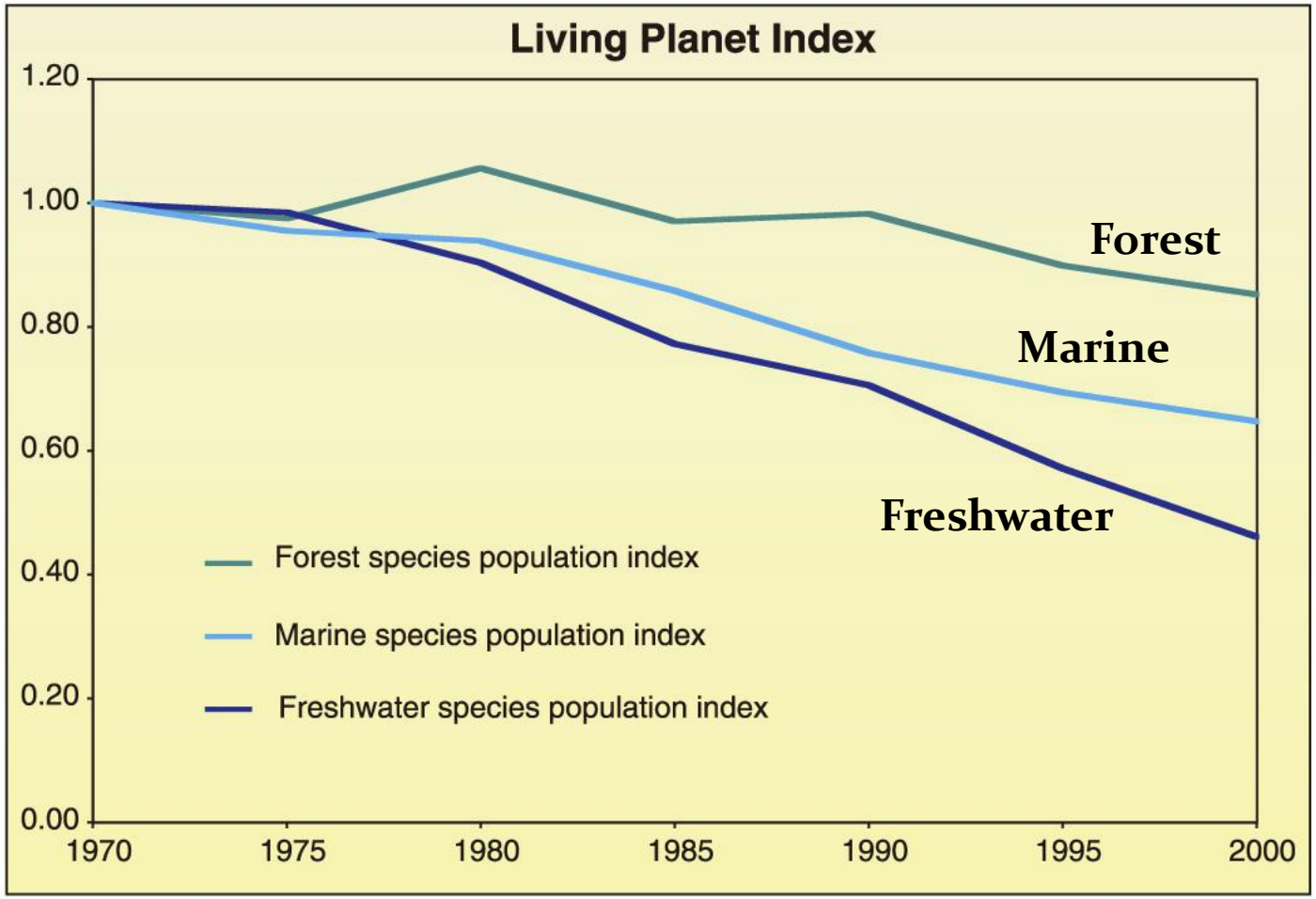


Dynamics that is the heart of healthy rivers

Rivers in Japan, lessons learned for Europe

2019. 10. 18

Futoshi Nakamura,
Hokkaido University



Species population indices from 1970 to 2000 for forest, marine, and freshwater ecosystems, as included in the 2002 WWF Living Planet Index. Data for 1996 to 2000 are drawn from small samples (Jenkins, M. Science Vol. 302, 2003)

Nakamura et al. (2017) Geomorphology

Flow Regime

Flow diversity
Hyporheic flow

Flow diversity
Hyporheic flow

Moisture subsidy
Disturbance
LW Distribution

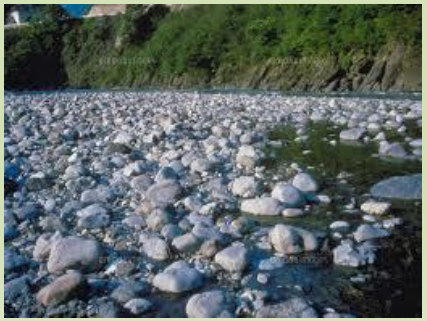
Bar & floodplain formation

Sediment Regime

Riparian Forest Large Wood Regime

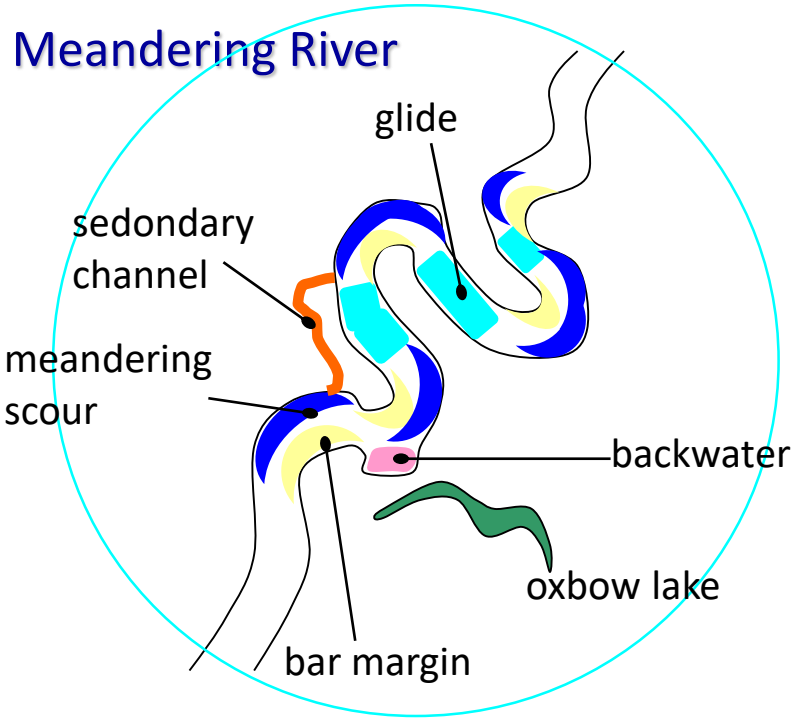
Bank protection
Sediment storage
Microtopography

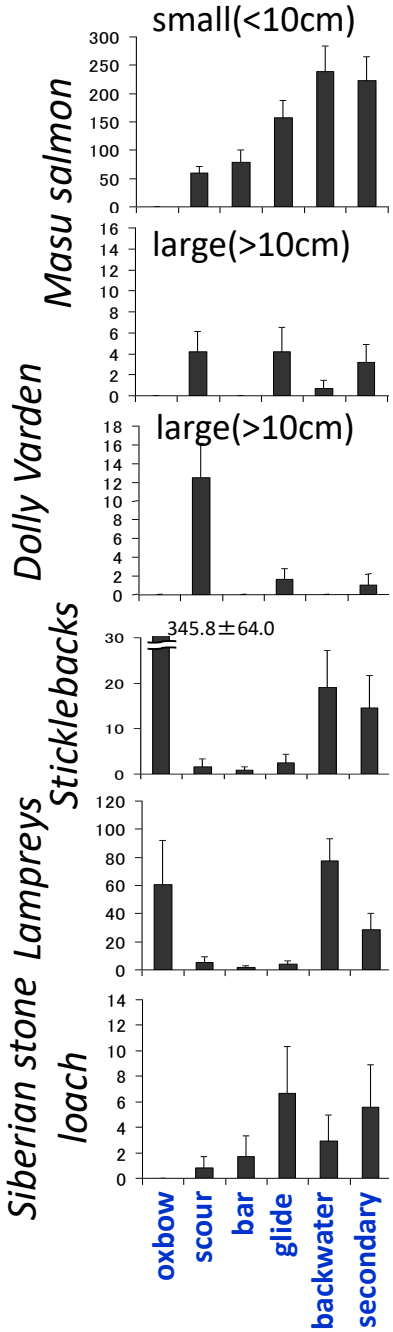
Disturbance
Germination bed



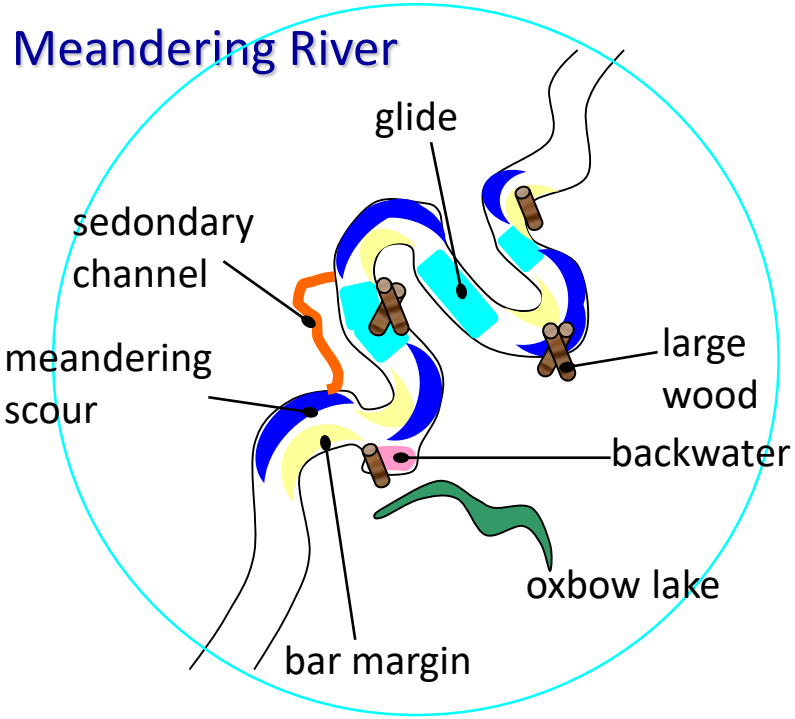
Channelization

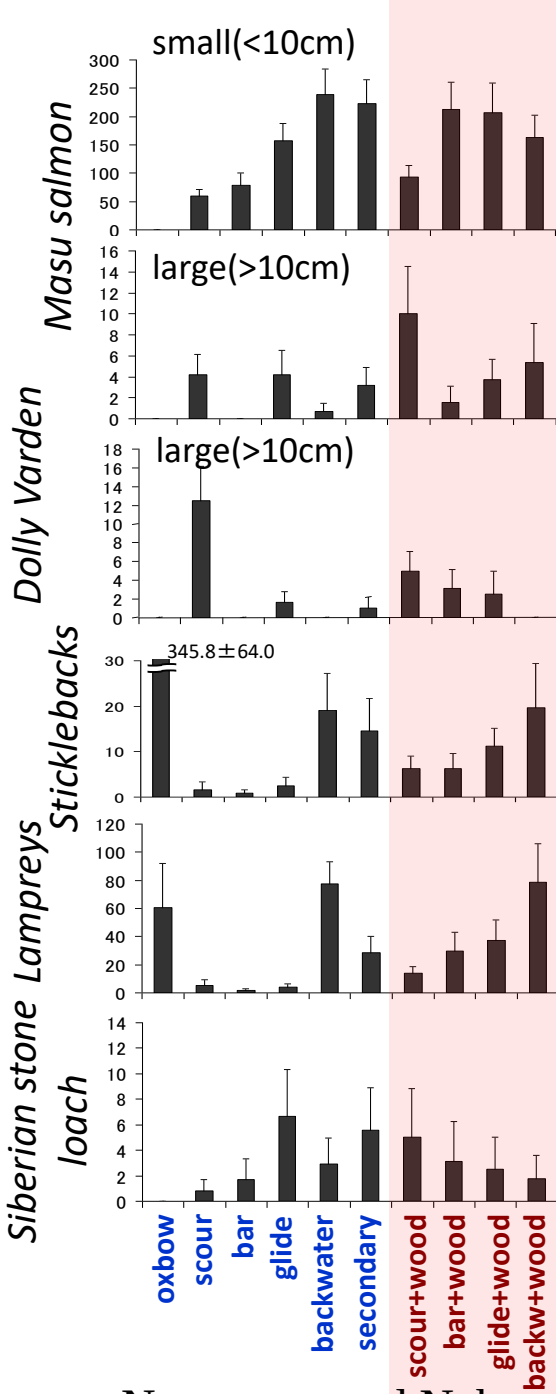
Channelization



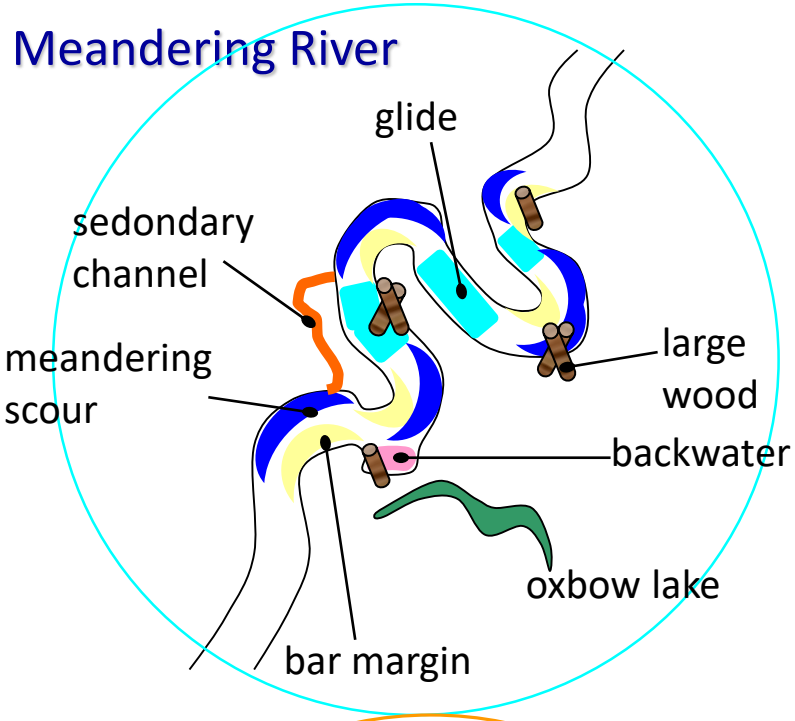


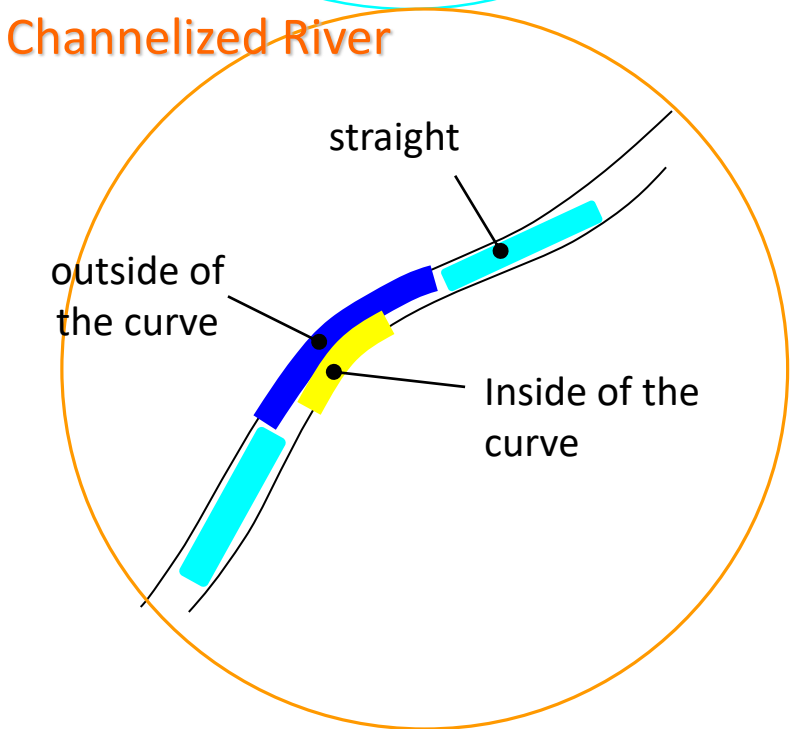
Nagayama and Nakamura (2018) Limnology

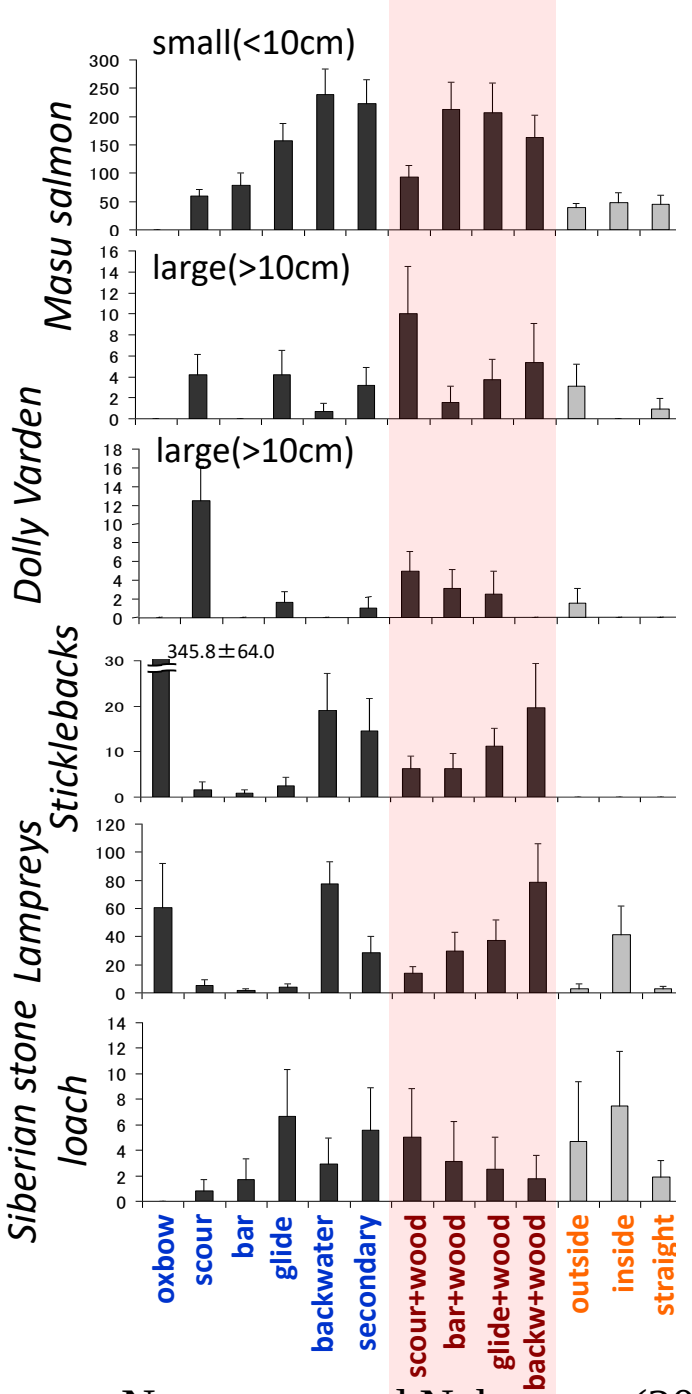




Nagayama and Nakamura (2018) Limnology



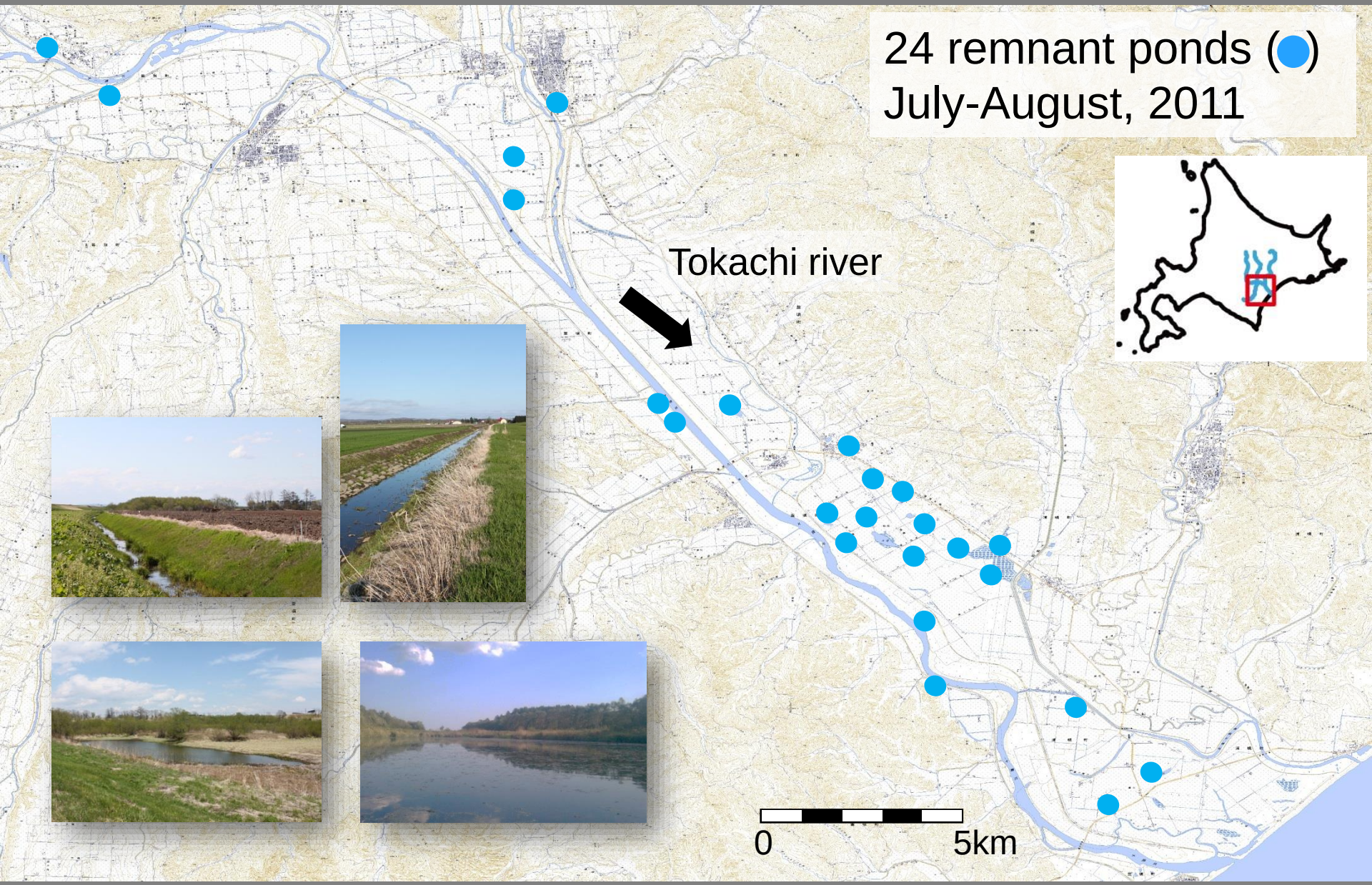




Nagayama and Nakamura (2018) Limnology

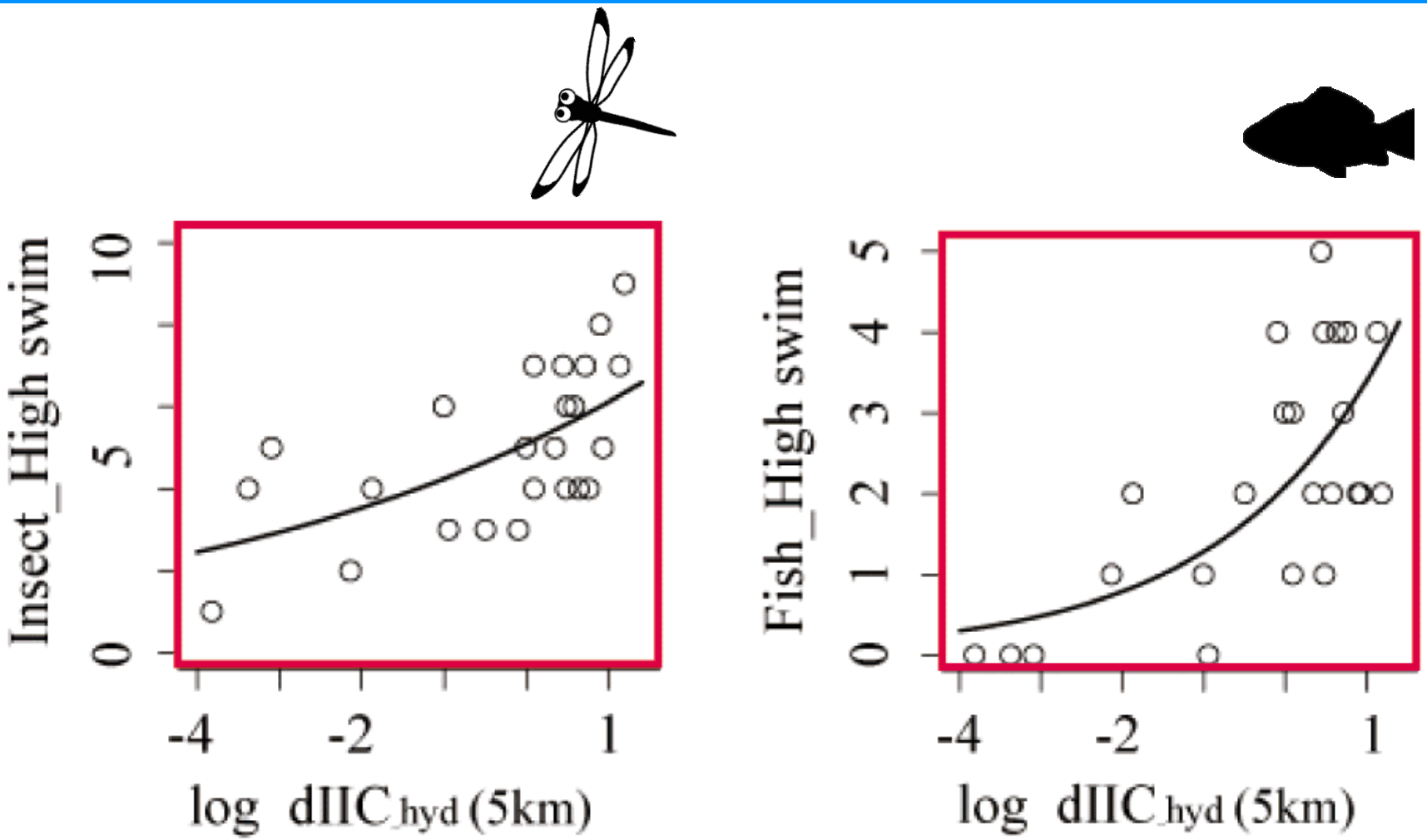

Ishikari River
364 km → 268 km

Importance of pond network to maintain fish assemblages



Response of species diversity to a wetland network

Ishiyama et al. (2014) Aquatic Science



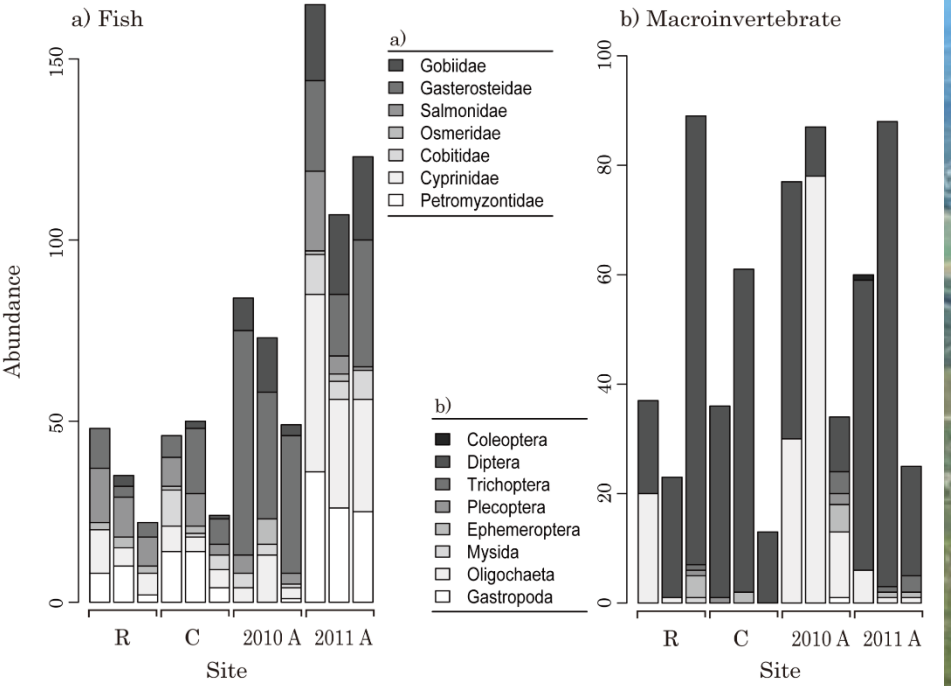
Increase of connectivity


Restoration of meandering river
(Kushiro River)

Restoration of meandering river (Kushiro River)

Restoration of meandering river (Kushiro River)

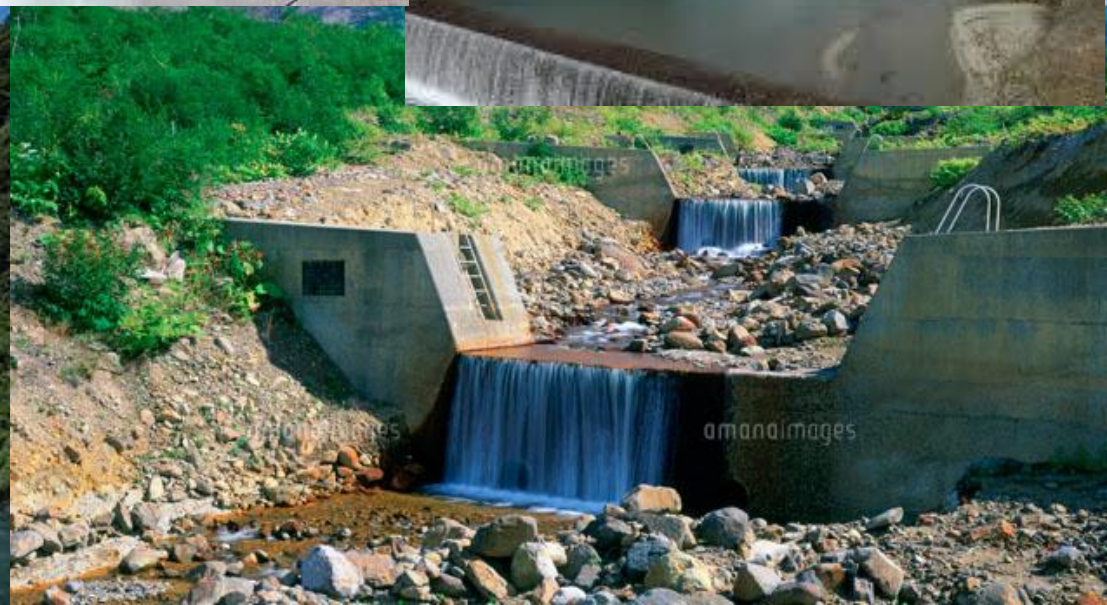

2011.8.3

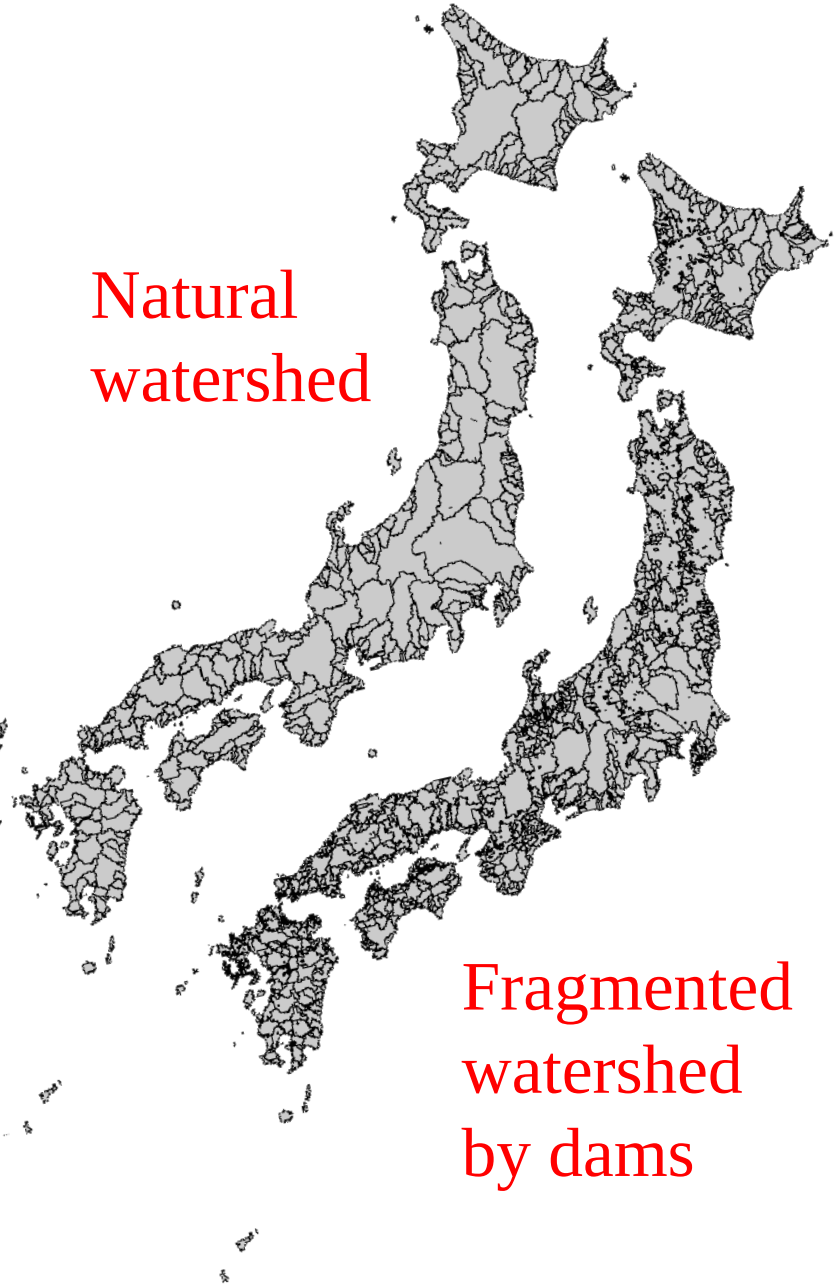


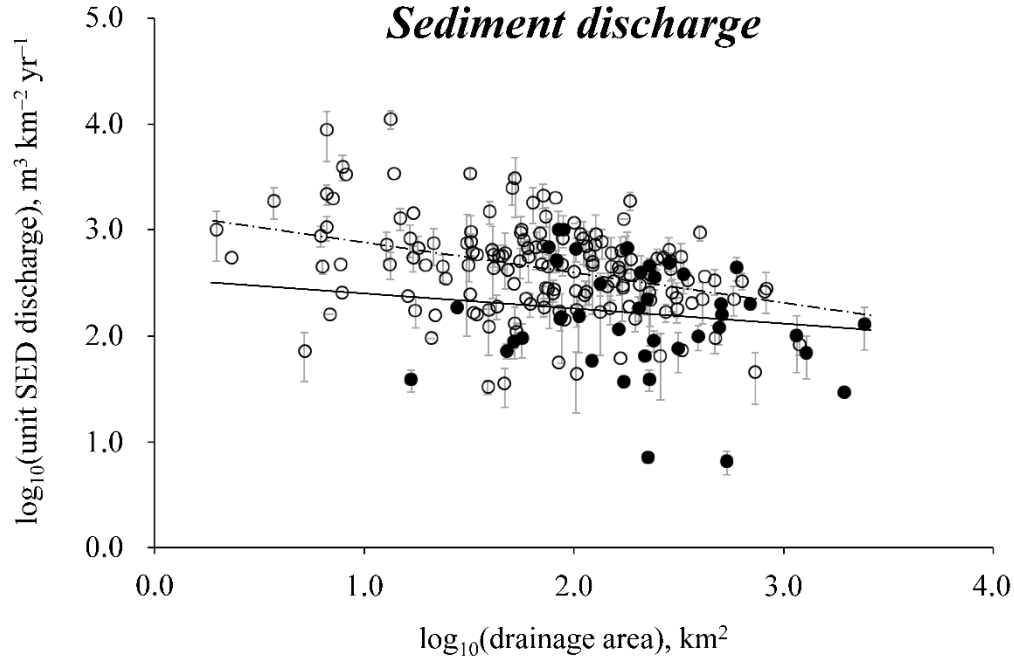
Increase in fish species and abandance

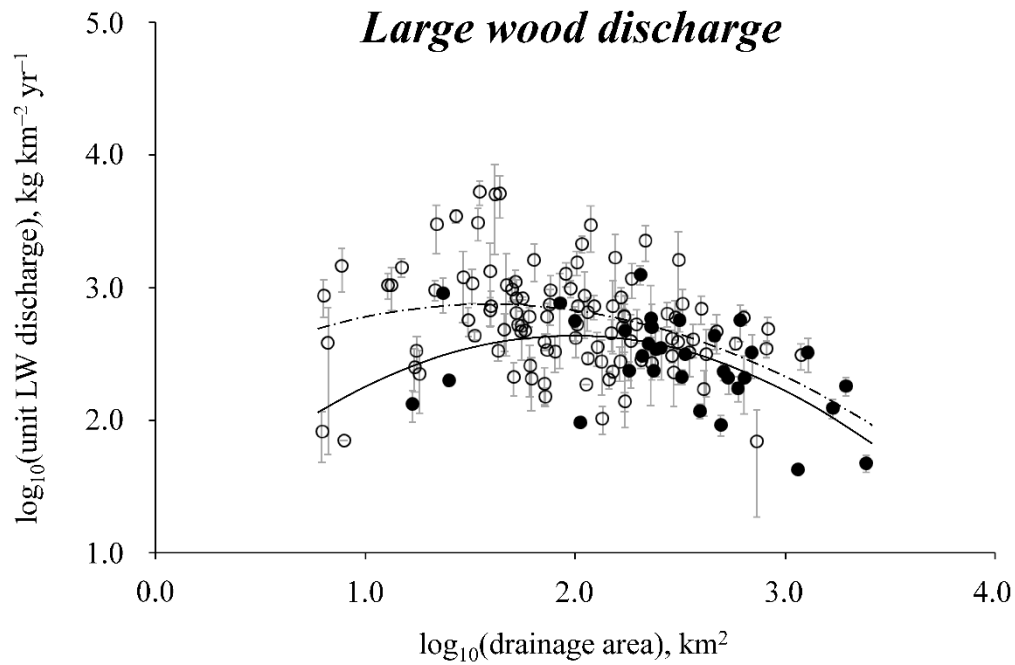
2011.8.3

Restoration Ecology (2014)


amanaimages

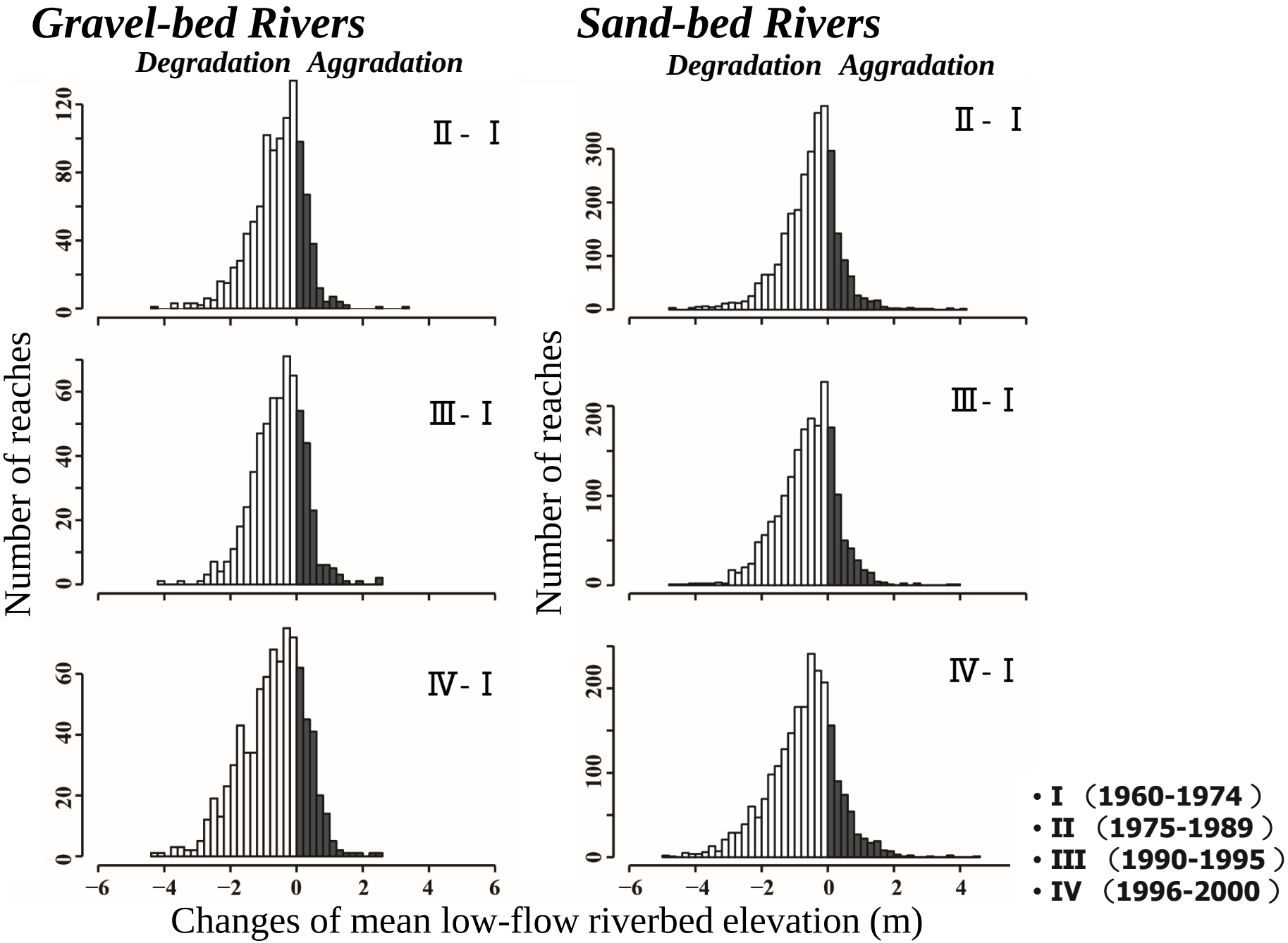






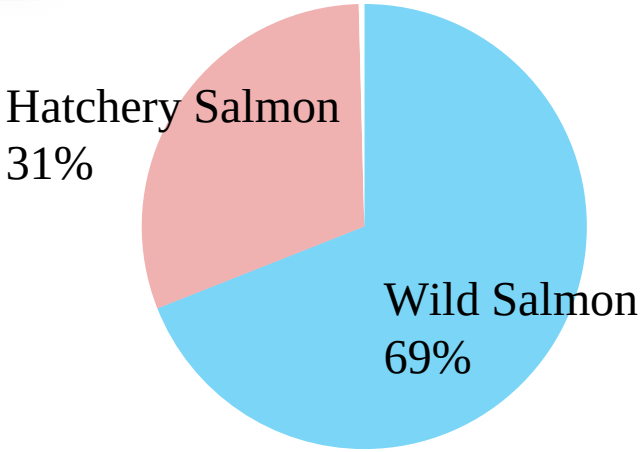
Nakamura et al. (2017) Geomorphology

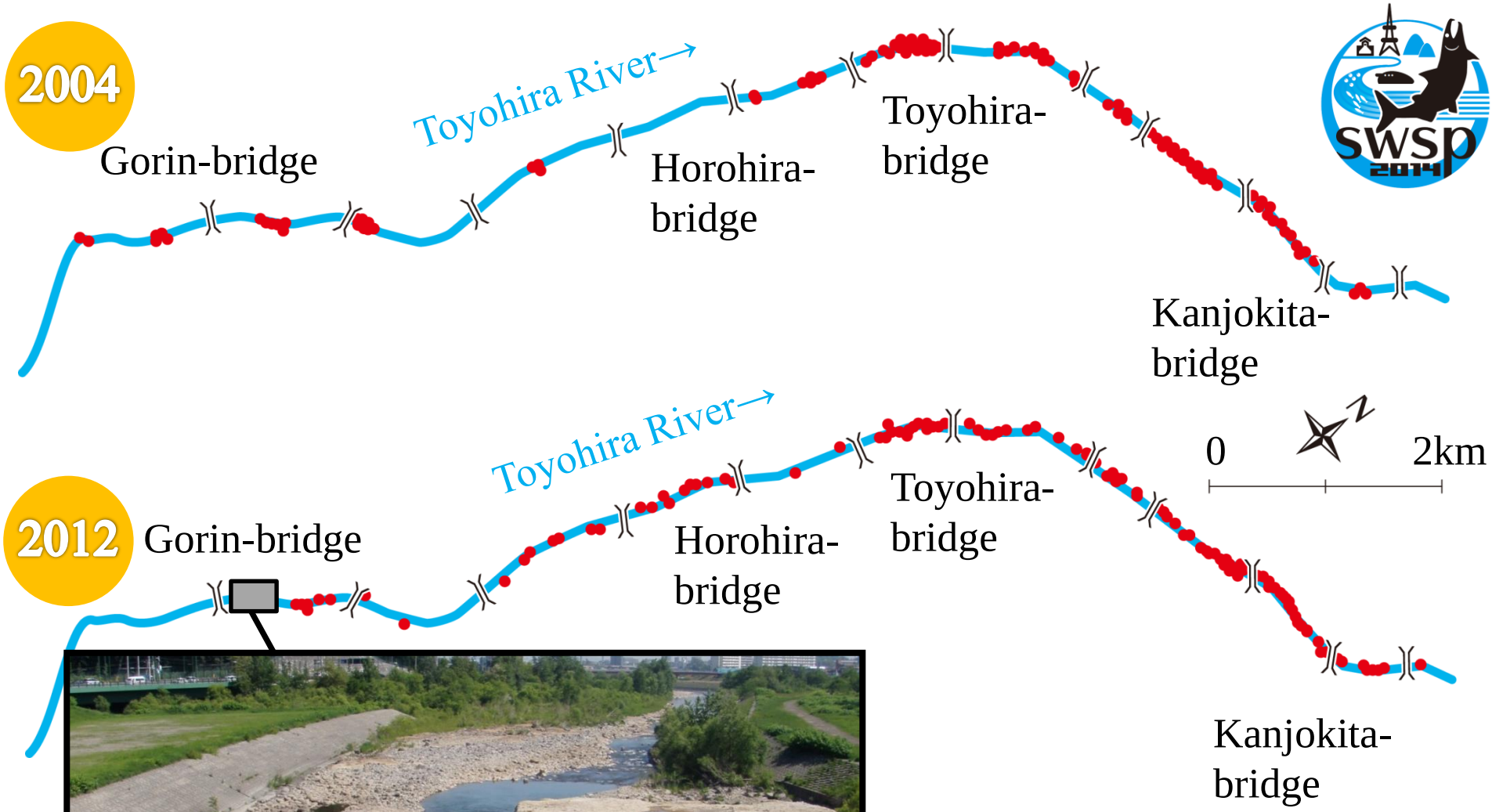
Nakamura et al. (2017) Geomorphology




Channel incision of
Toyohira River

Chum salmon



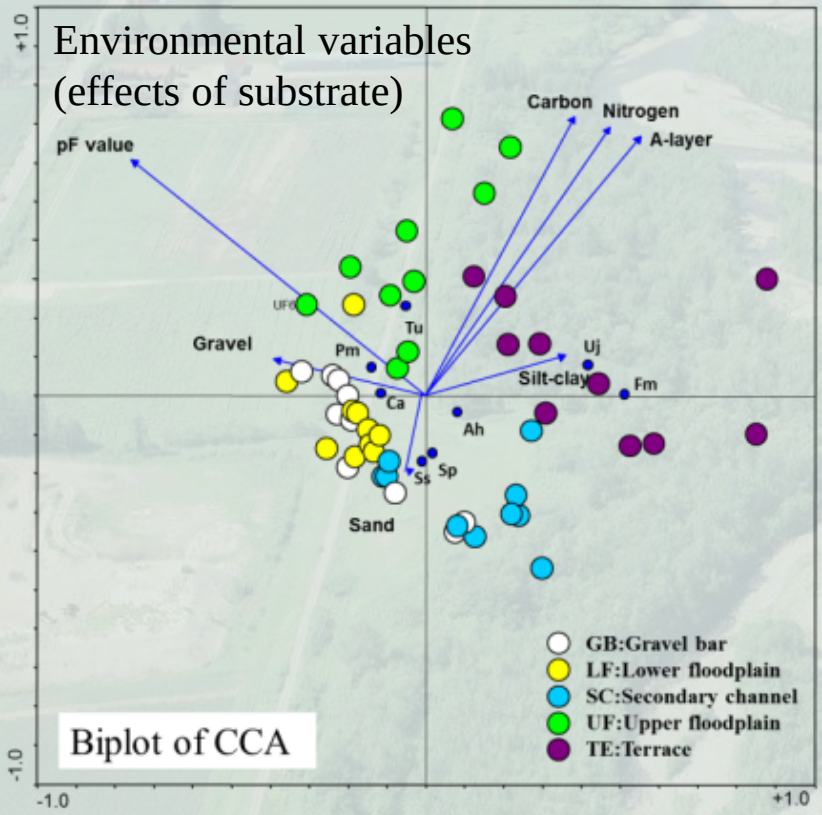


Changes of spawning beds due to sediment depletion

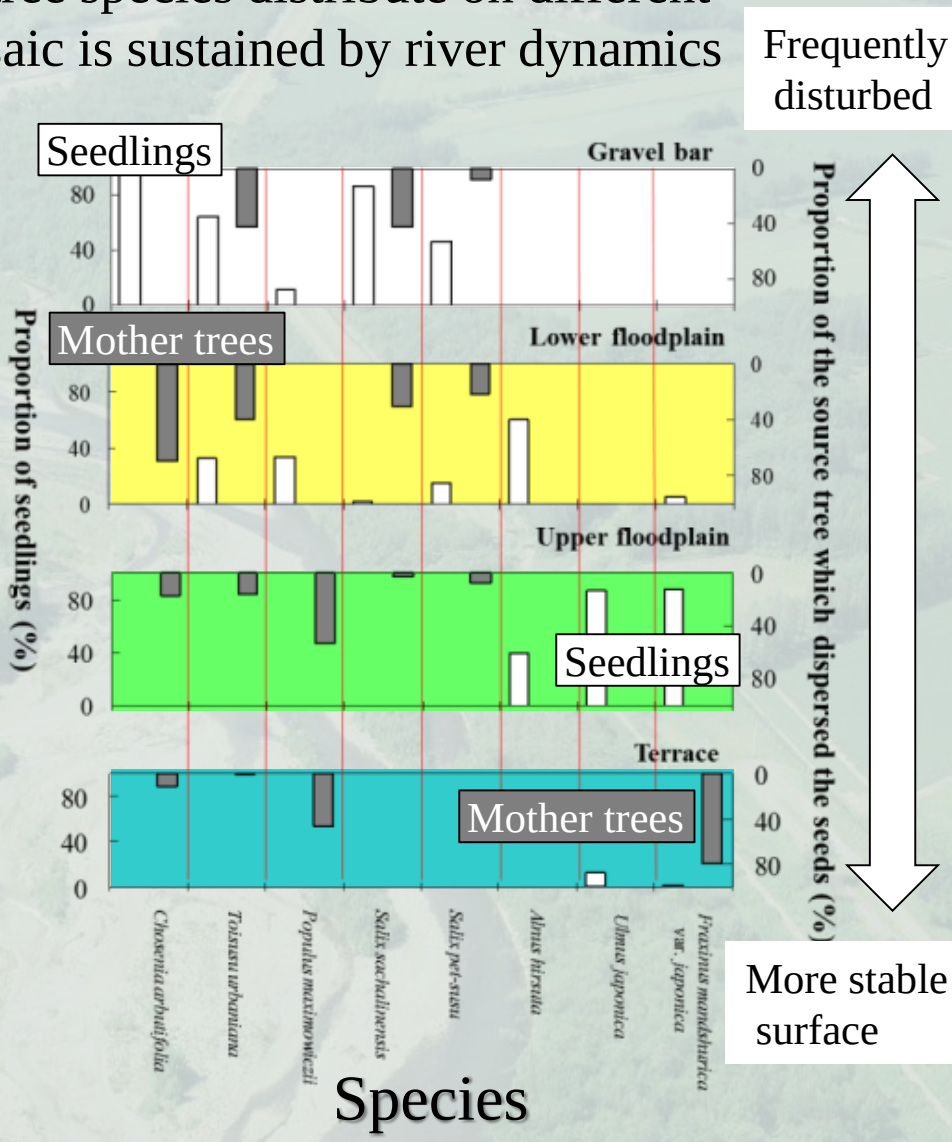
Dynamics of riparian vegetation

Shifting mosaic

- Composition of riparian forests can be explained by flood disturbance frequency (left)
- Mother trees and seedlings of the same tree species distribute on different geomorphic surfaces, thus forest patch mosaic is sustained by river dynamics (right) → Shifting mosaic

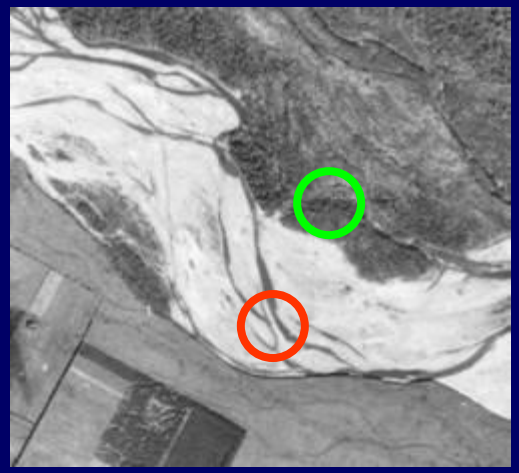


Shin and Nakamura (2005) *Plant Ecology* 178: 15-28

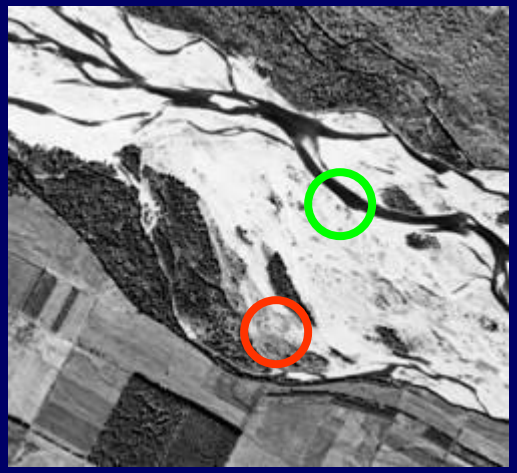


Nakamura et al. (2007) *Forest Ecology and Management* 241: 28-38

1947



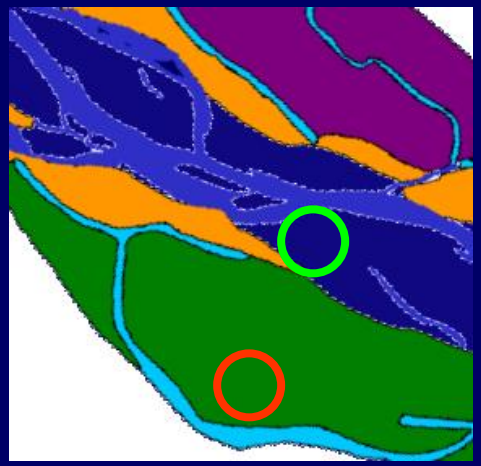
1963



1977

1997

1997 Geomorphic surfaces



N

Channel
Gravel bar
Lower floodplain
Secondary channel
Upper floodplain
Terrace

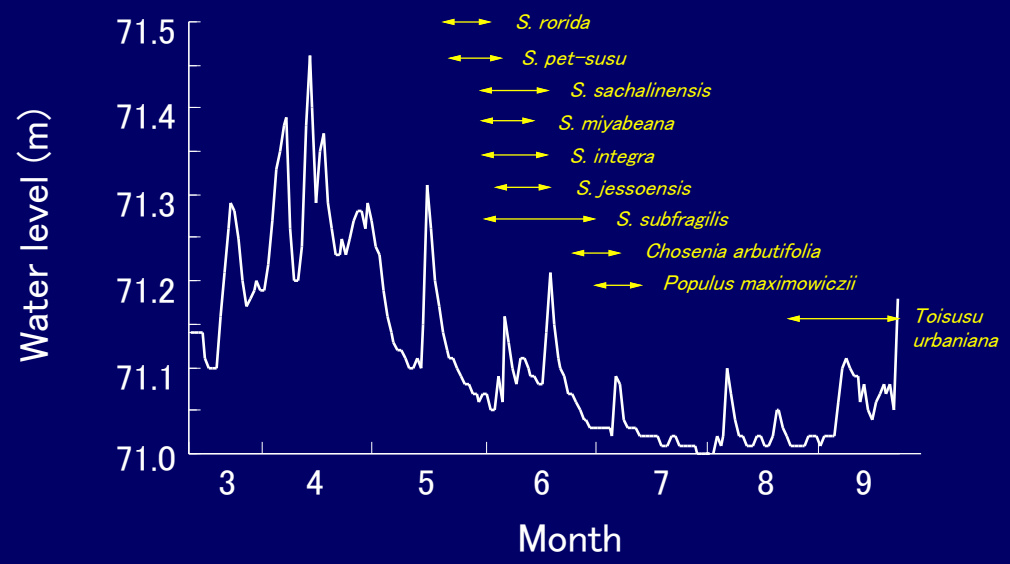
0 500m

Temporal changes of riverbed morphologies

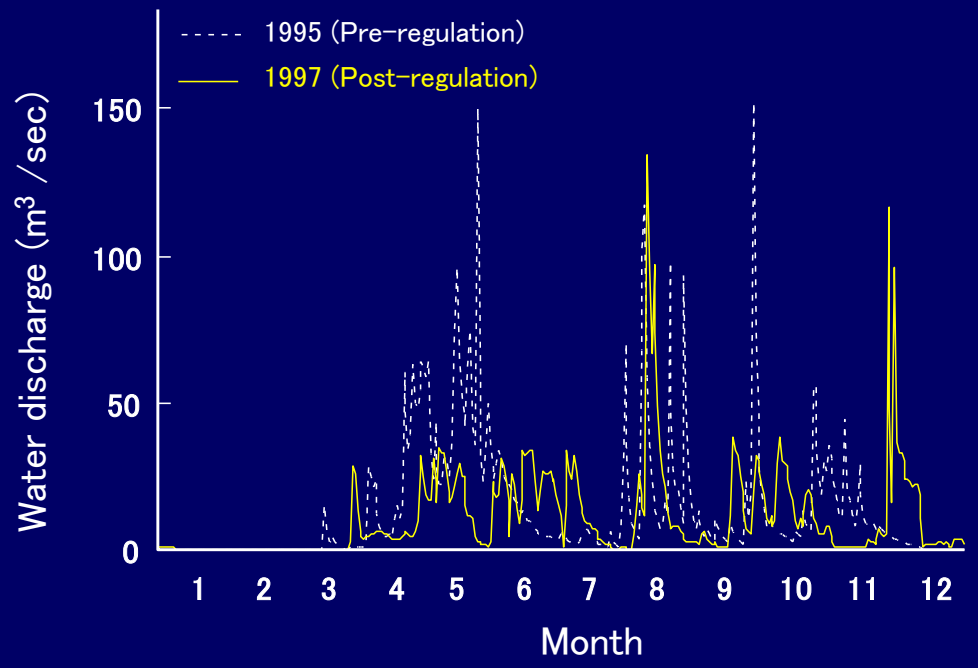
Nakamura et al. 2007
Forest Ecology and Management

Nakamura, F. and Shin, N. (2001)
AGU Water Science and Application Volume 4: 173-181

Seed dispersal period of willow species and hydrograph



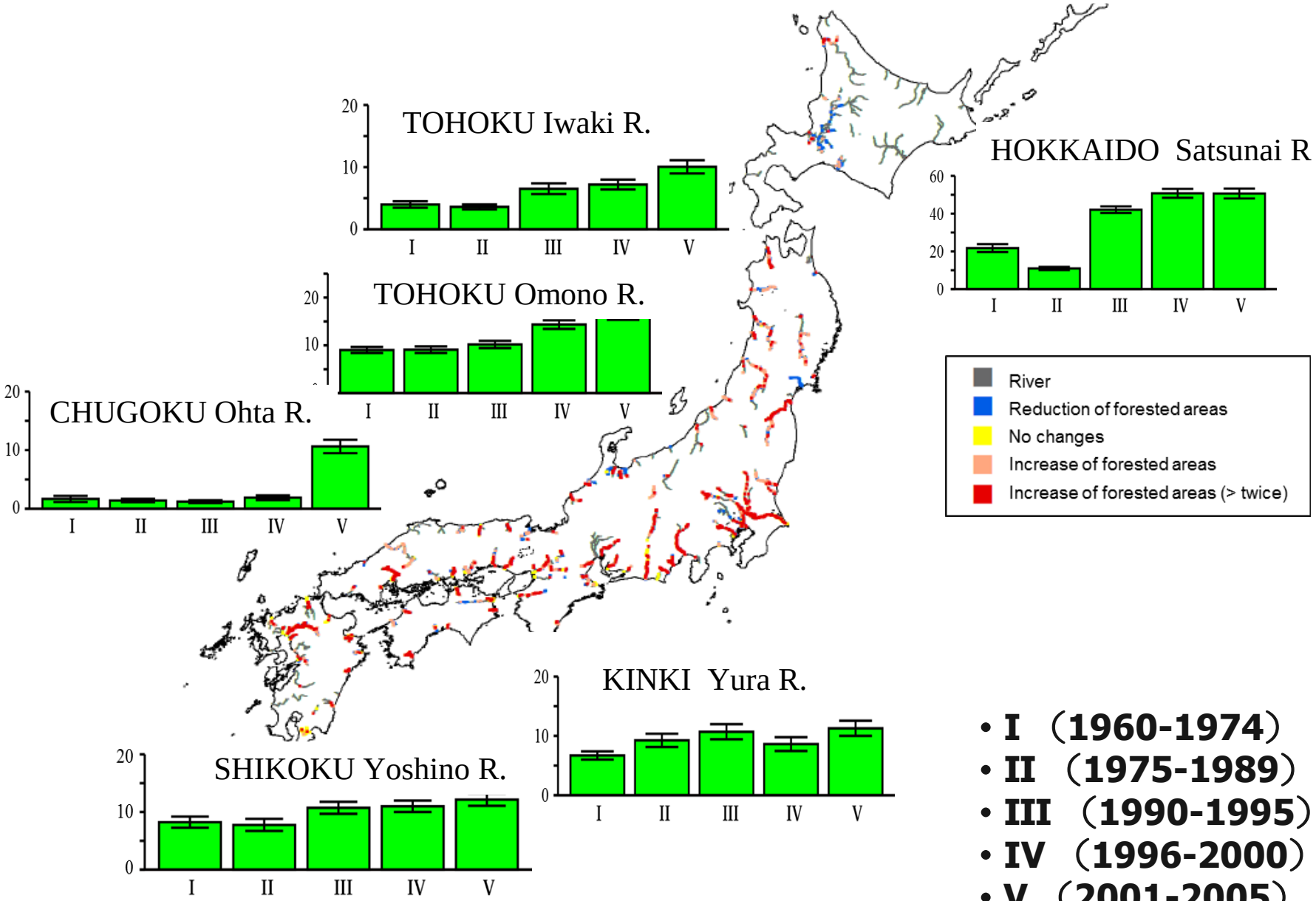
Satsunai River Dam



Differences of water discharge before and after dam construction

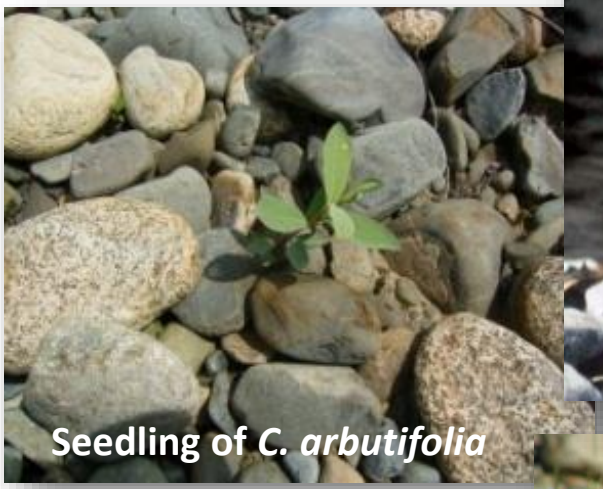
Changes in floodplain environment from gravel bars to forests in Satsunai River, one of the tributaries of Tokachi River

Forest expansion in Japanese rivers



- **I （1960-1974）**
- **II （1975-1989）**
- **III （1990-1995）**
- **IV （1996-2000）**
- **V （2001-2005）**

Species dependent on gravel bed



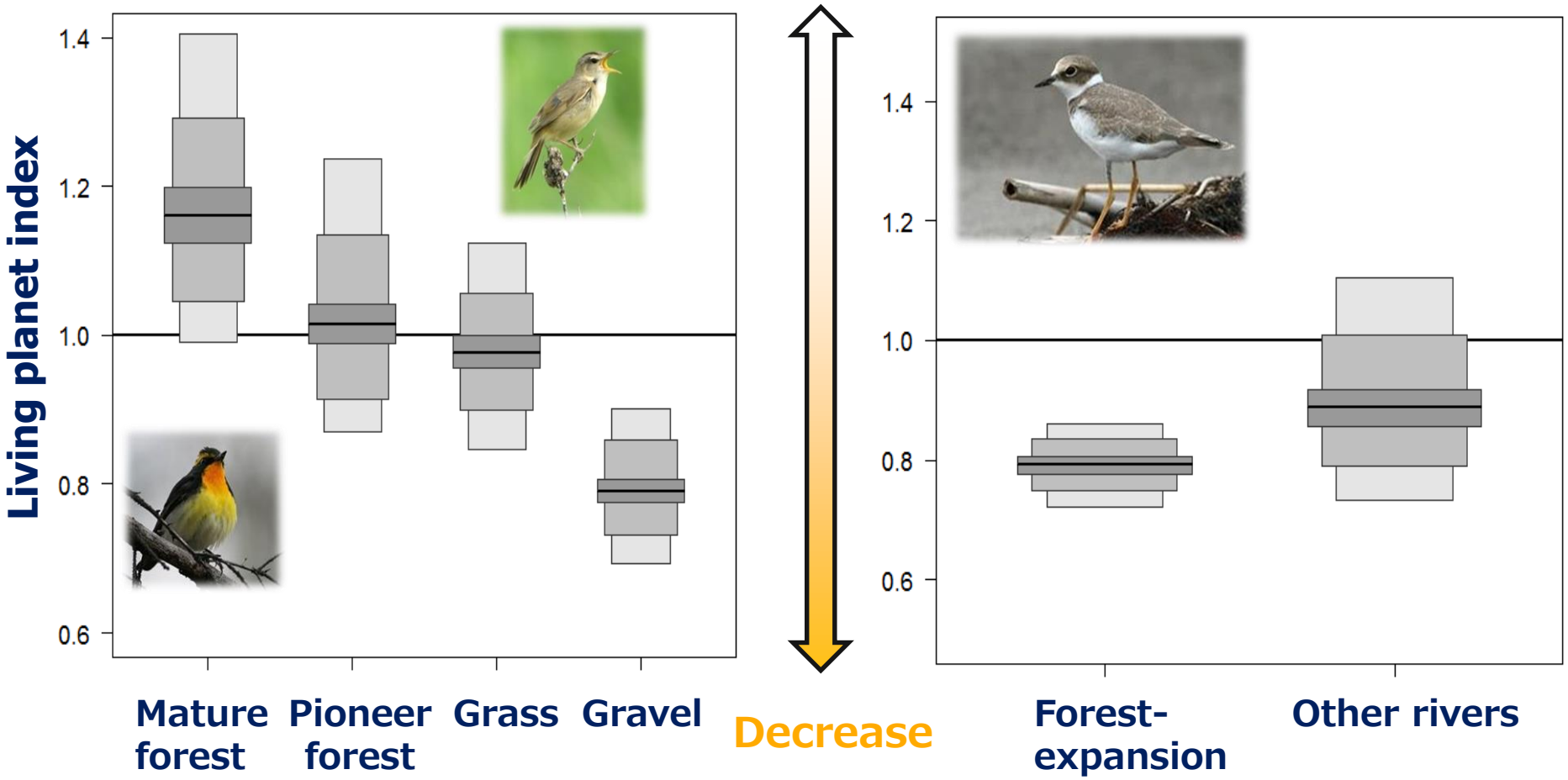
Changes of bird species in Japanese rivers

Changes of bird species with forest expansion

Changes of gravel-nesting birds between forested and other rivers

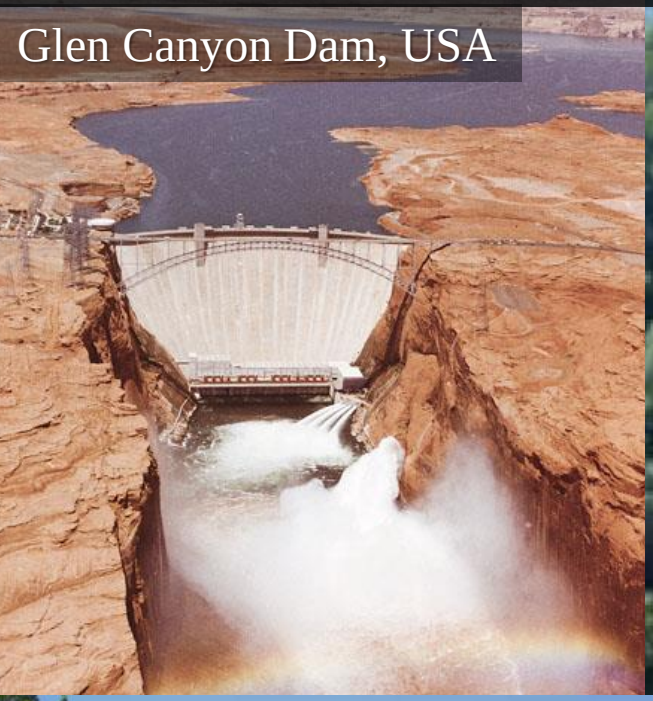
Comparison between 2nd (1996-2000) and 3rd round (2001-2005)

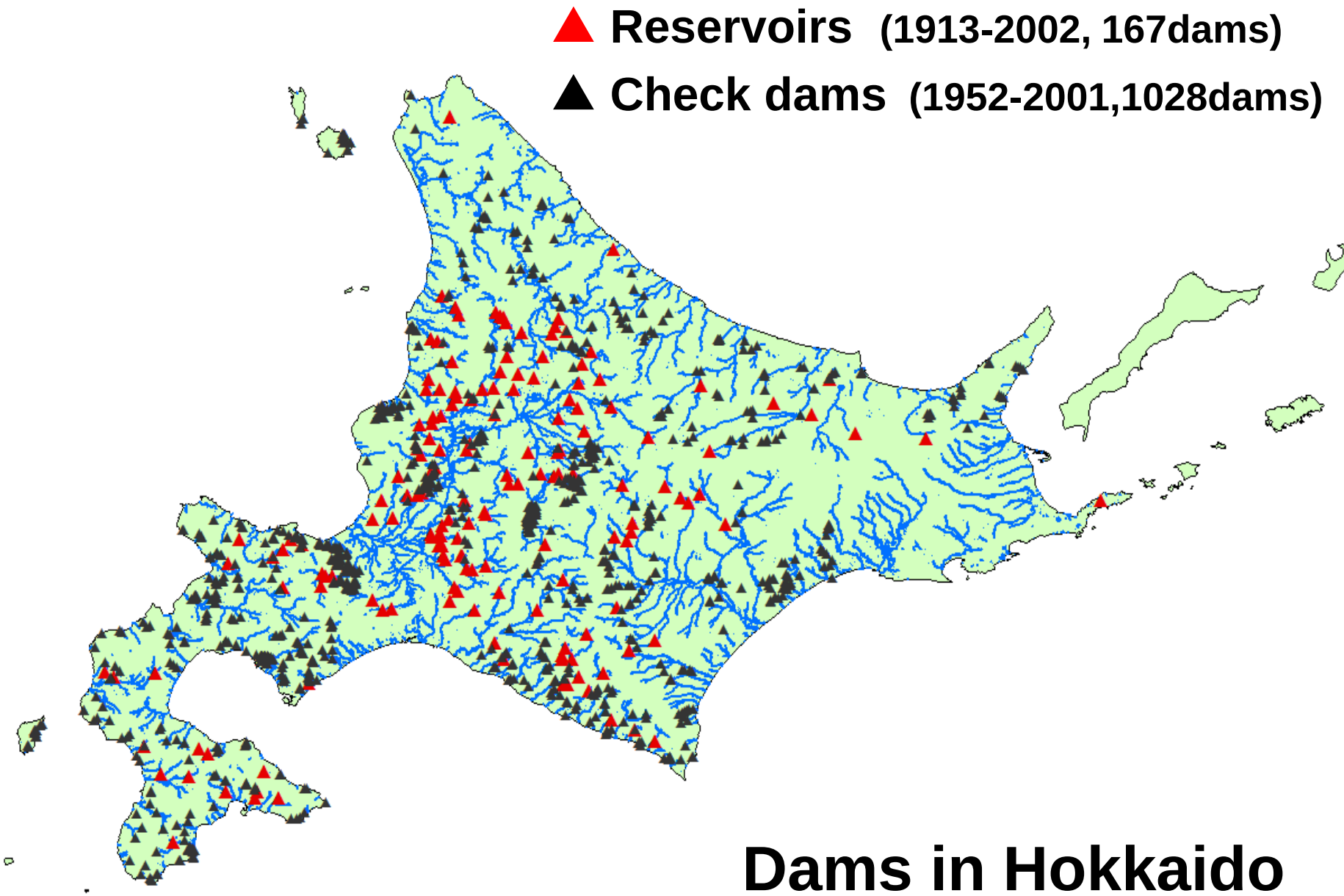
Increase



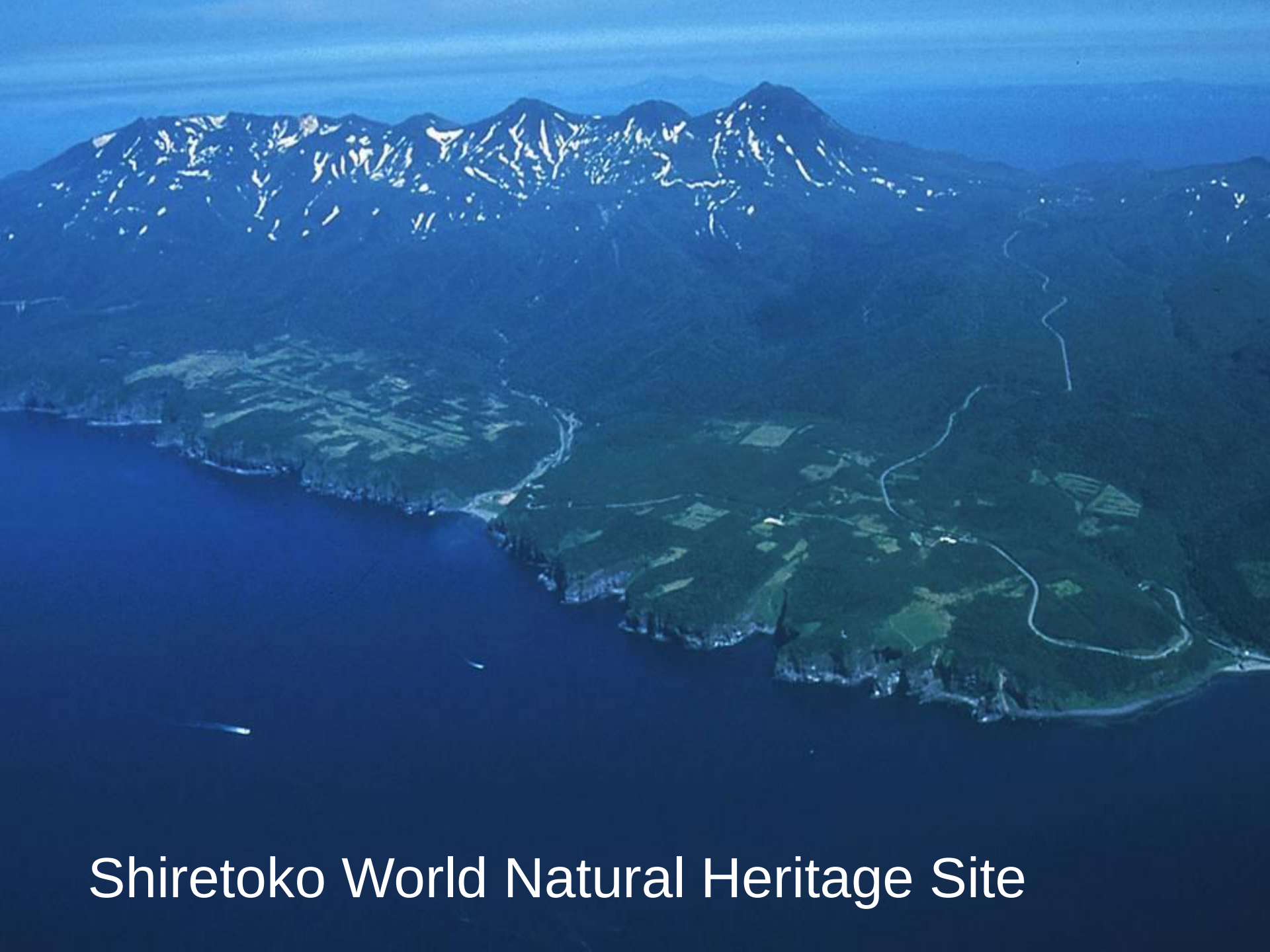
Mammals found in the riparian zone（photos provided by Dr. Mayura Takada)

Artificial flood project in the Satsunai River



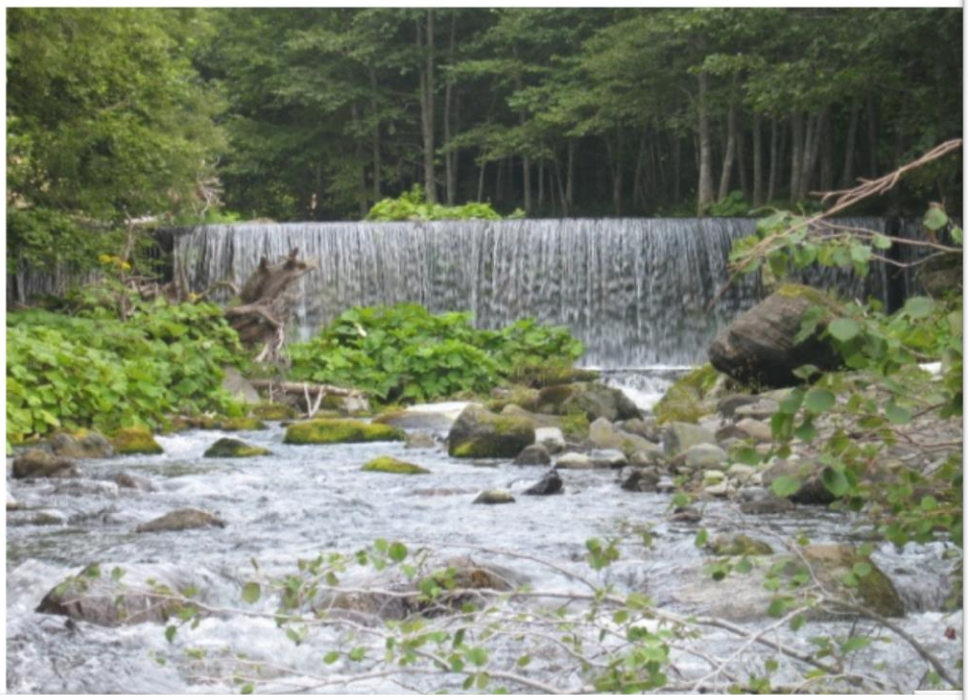


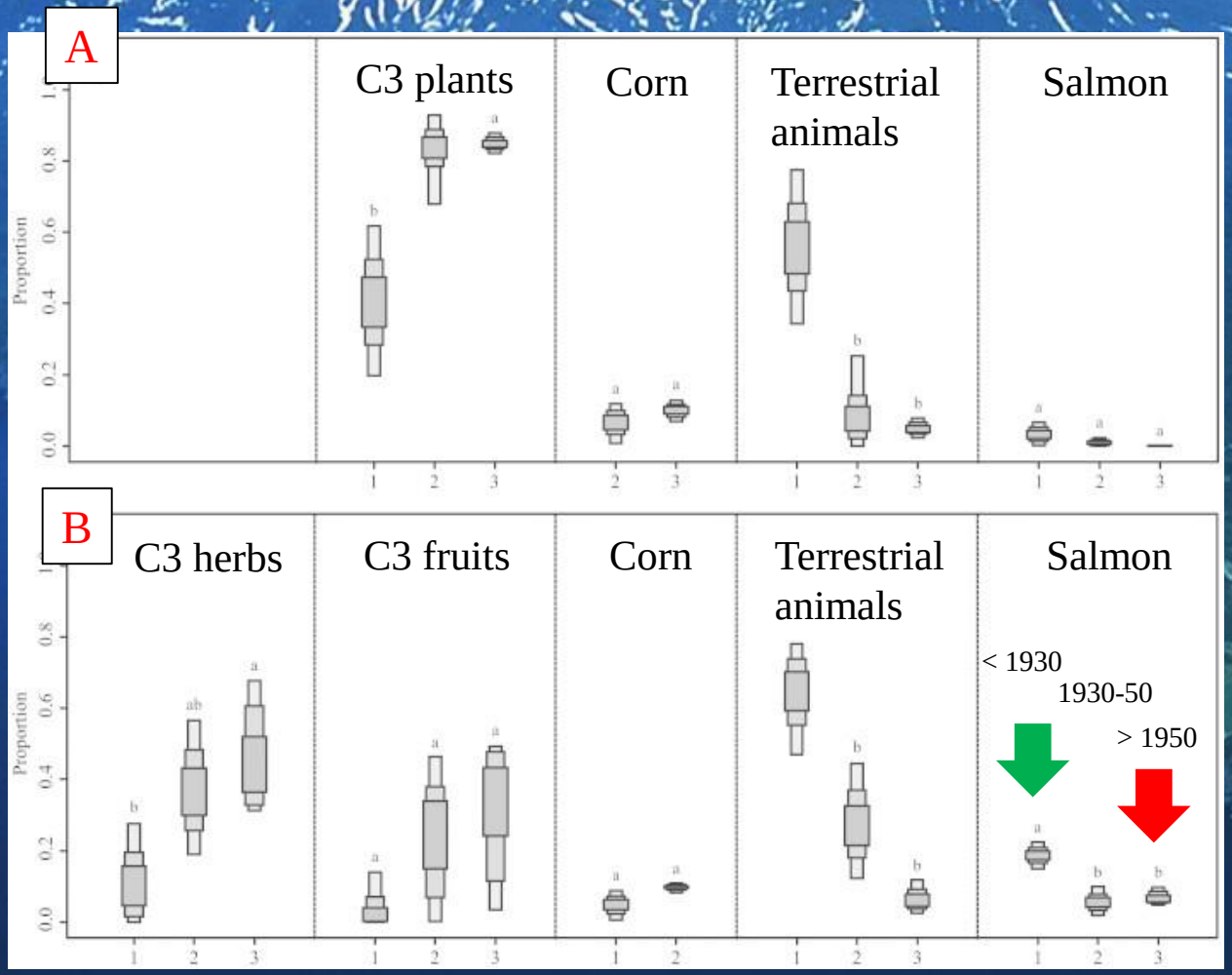
Dams in Hokkaido

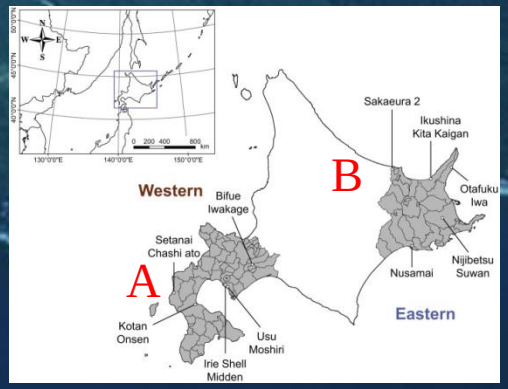


Shiretoko World Natural Heritage Site

Shiretoko World Natural Heritage Site





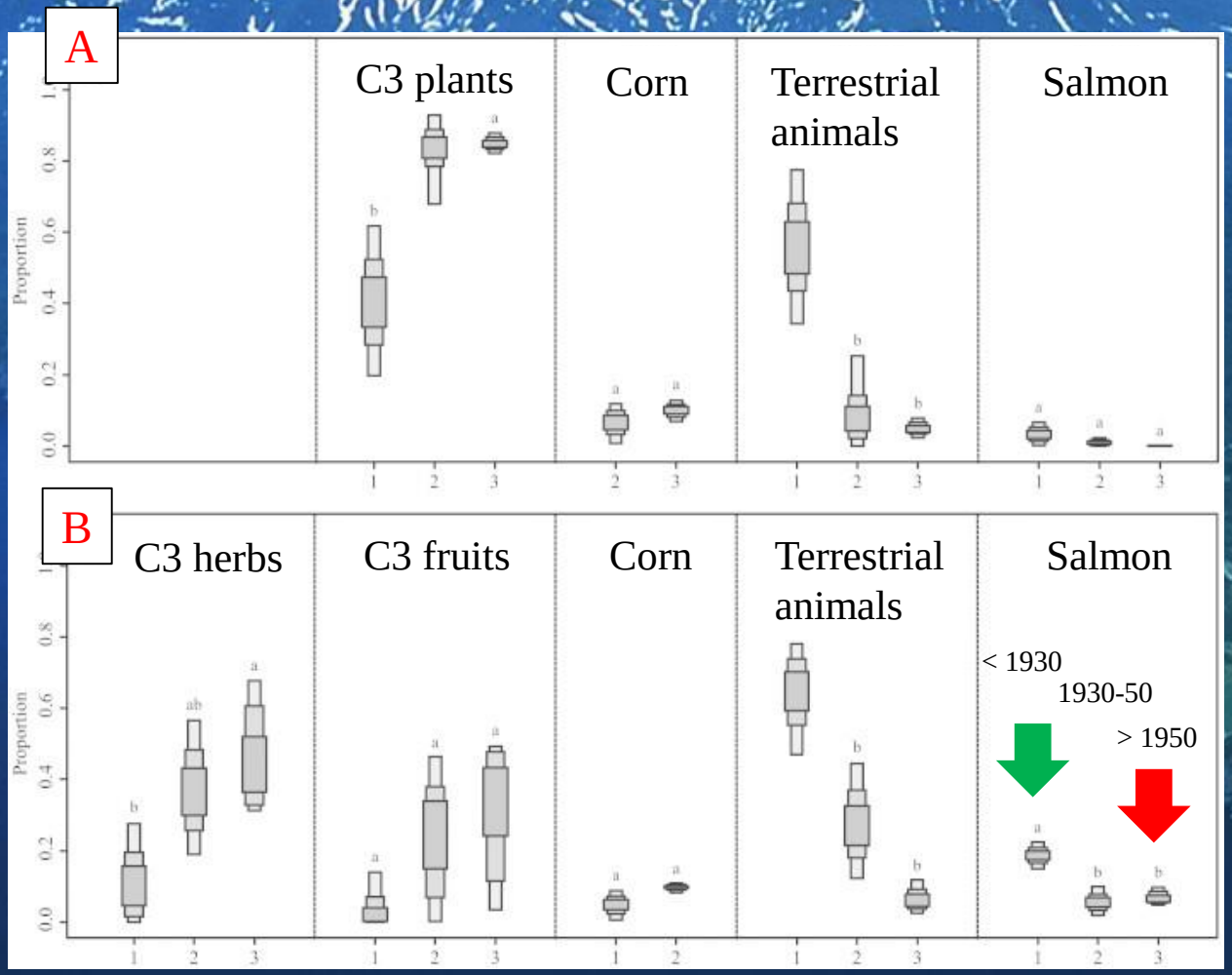


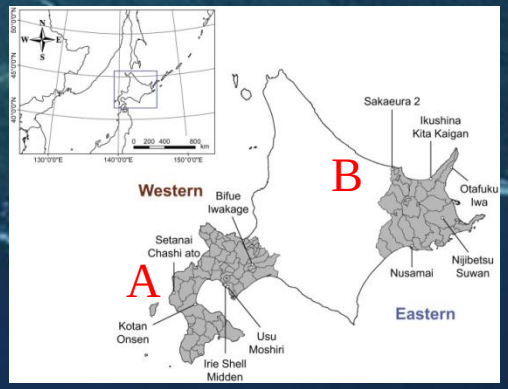
Historical variation of diet components of Hokkaido brown bears as illustrated by SIAR distributions

Matsubayashi et al. Scientific Reports (2015)

The skeletal size of bear subpopulations in eastern Hokkaido was estimated to have decreased by 10%–18% for males and 8%–9% for females.

Matsubayashi et al. (2016) Can. J. Zool.





Historical variation of diet components of Hokkaido brown bears as illustrated by SIAR distributions

Matsubayashi et al. Scientific Reports (2015)

Dam modification in Iwaubetsu Stream

Before

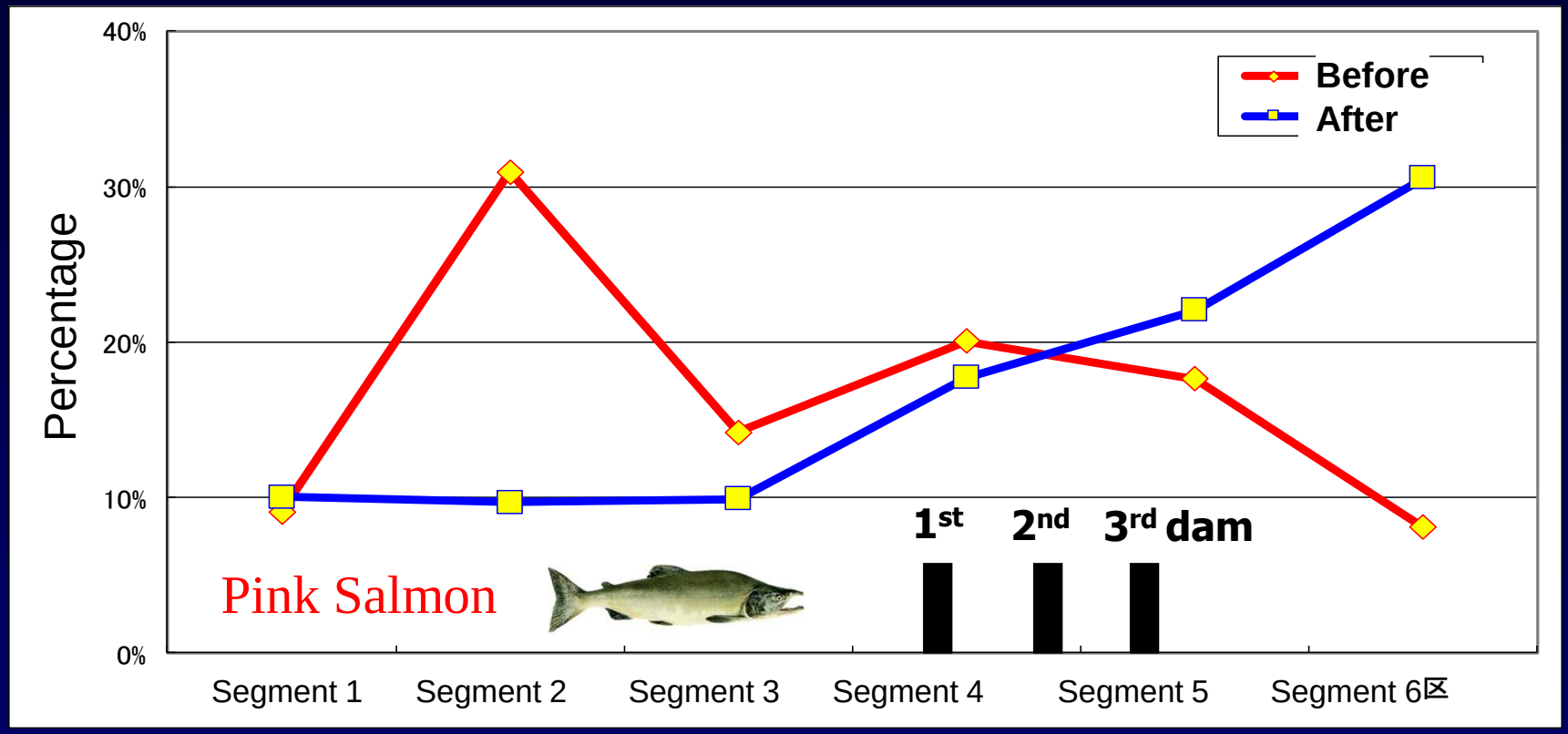
After

Dam Modification in Rausu Stream

Before

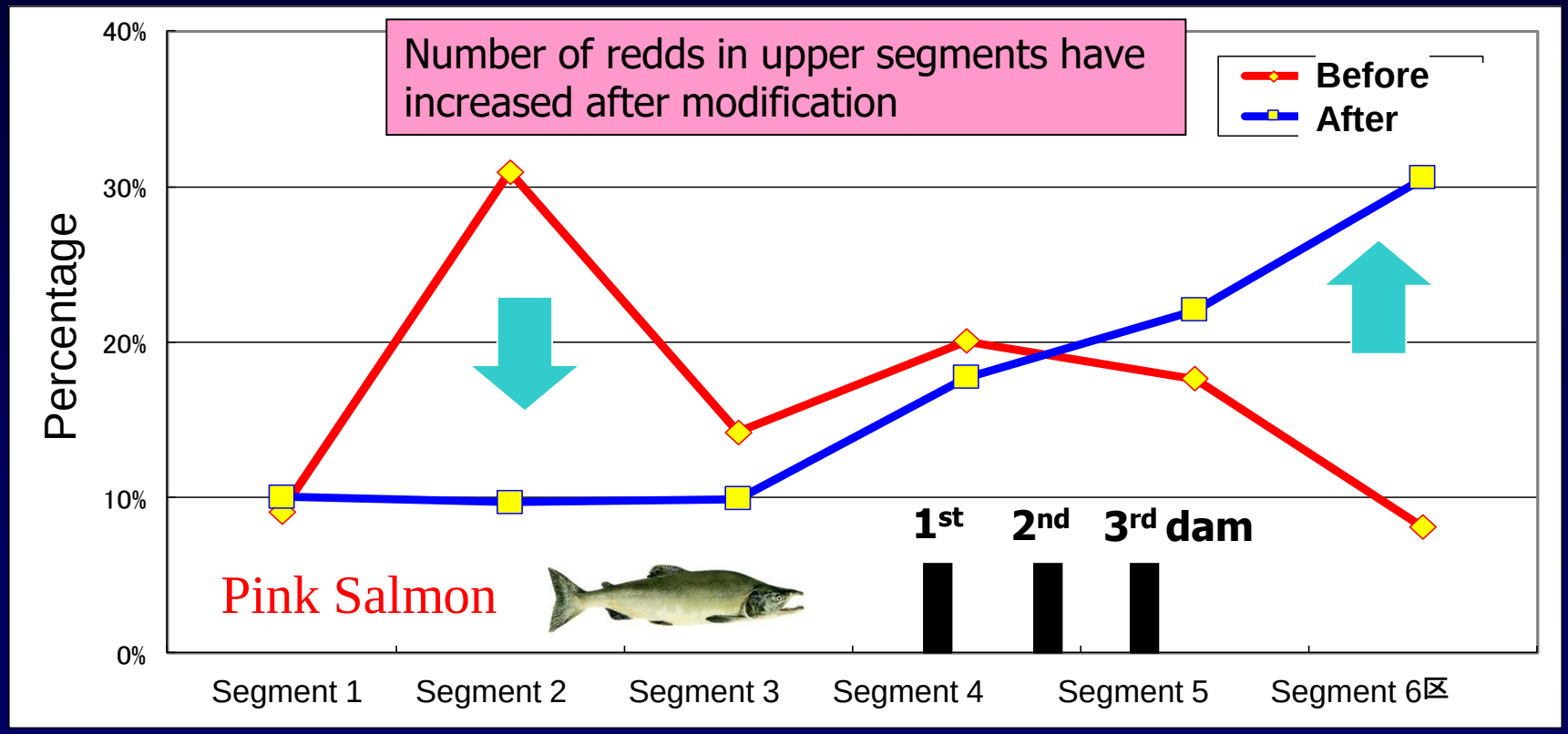
After

Distribution of redds before and after dam modification (Rusha Stream)



Landscape and Ecological Engineering 6: 143-152

Distribution of redds before and after dam modification (Rusha Stream)

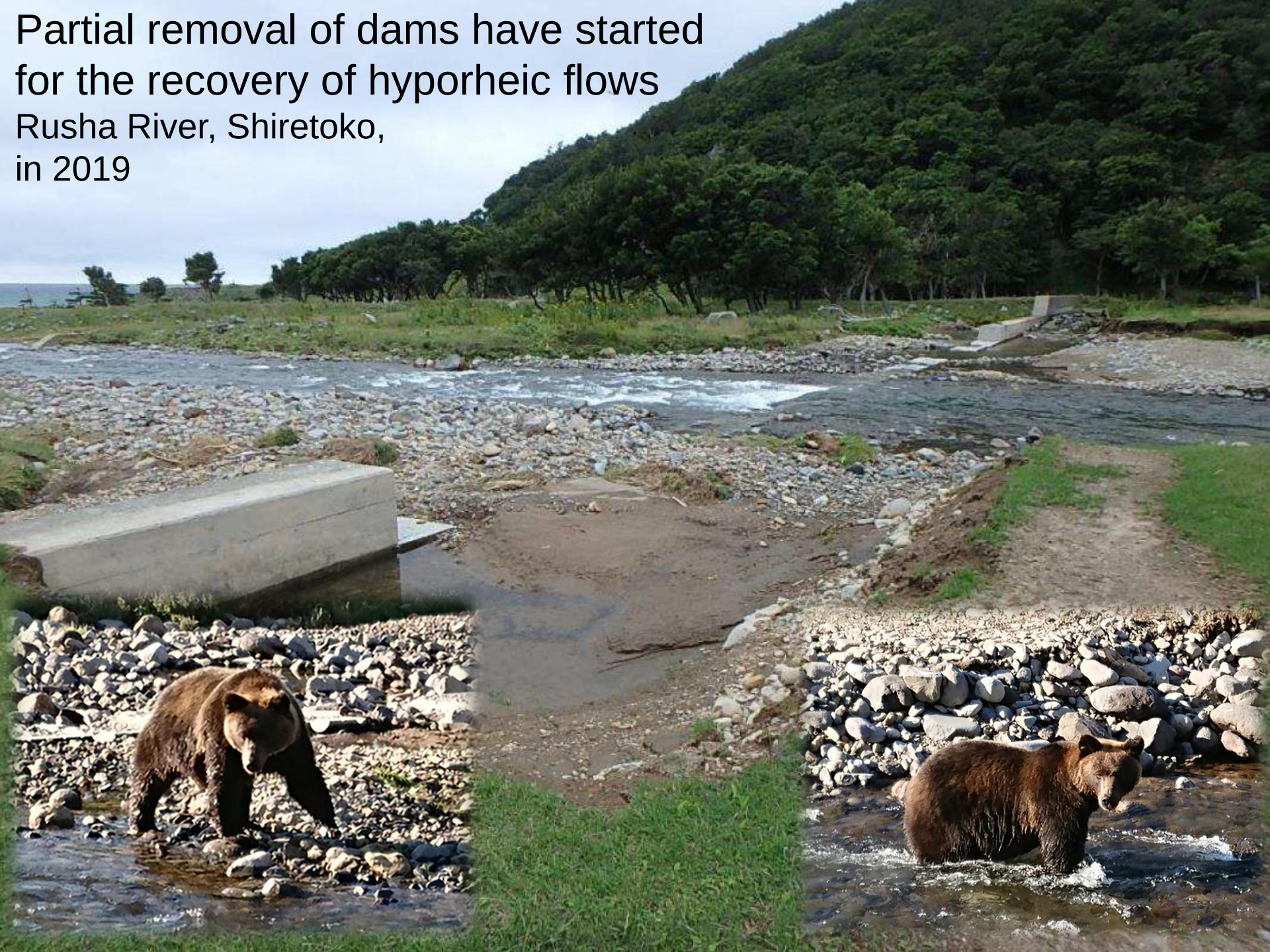


Landscape and Ecological Engineering 6: 143-152


Thanks for dam
improvement !

Partial removal of dams have started for the recovery of hyporheic flows

Rusha River, Shiretoko,
in 2019



Take-home message

1. Dynamics is the heart of healthy rivers.
2. Flow and sediment regime, and riparian vegetation are key components which provide templates for river-floodplain ecosystem.
3. Conservation of present wild rivers is always preferable and more economical than their subsequent restoration.
4. Restoration cannot create similar conditions to those of pristine wild rivers.