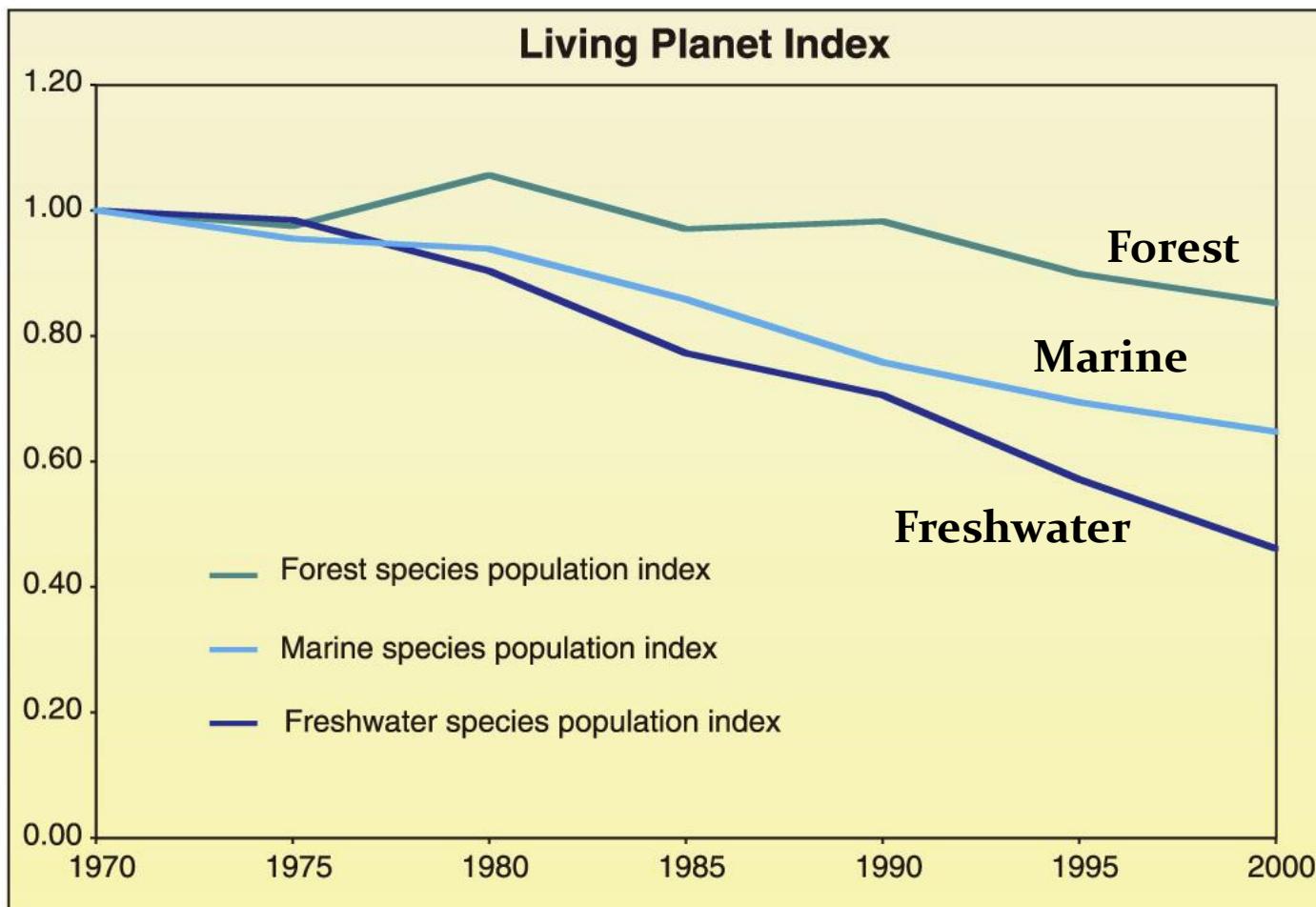
An aerial photograph of a river system in Japan. The river flows from the bottom right towards the top left, creating several sharp bends and small islands. The surrounding land is a mix of agricultural fields (brown and green patches), forested areas (dark green), and some developed land with buildings and roads. In the far distance, a town is visible at the confluence of the river with other water bodies.

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)



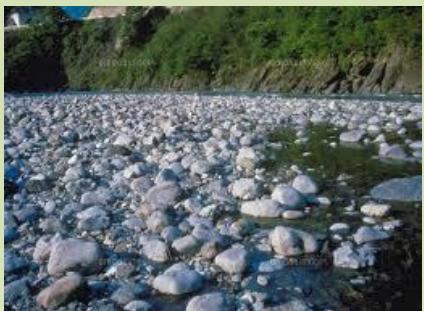
Flow Regime

Flow diversity
Hyporheic flow

Bar & floodplain
formation

Sediment Regime

Bank protection
Sediment storage
Microtopography



Flow diversity
Hyporheic flow

Moisture subsidy
Disturbance
LW Distribution

Riparian Forest Large Wood Regime

Disturbance
Germination bed



Channelization

1947

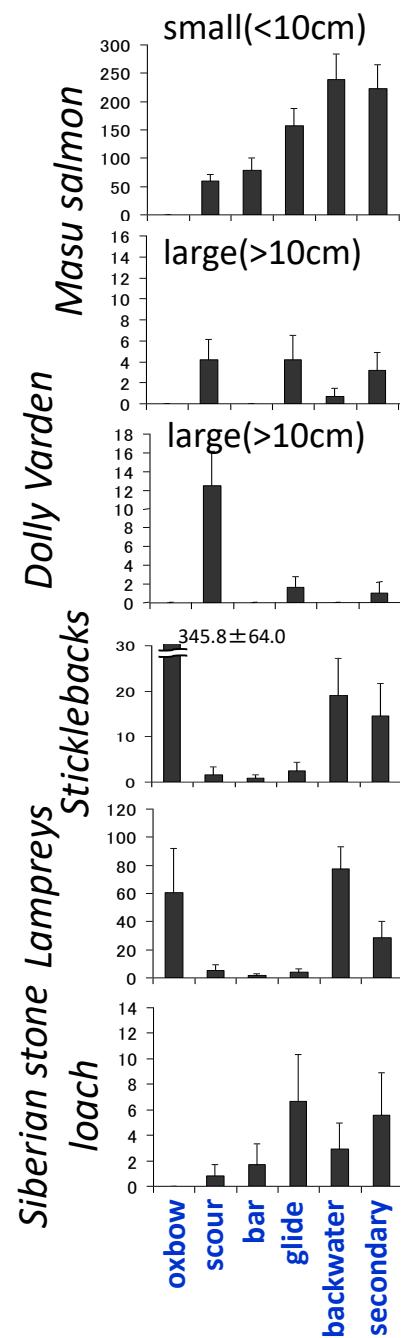
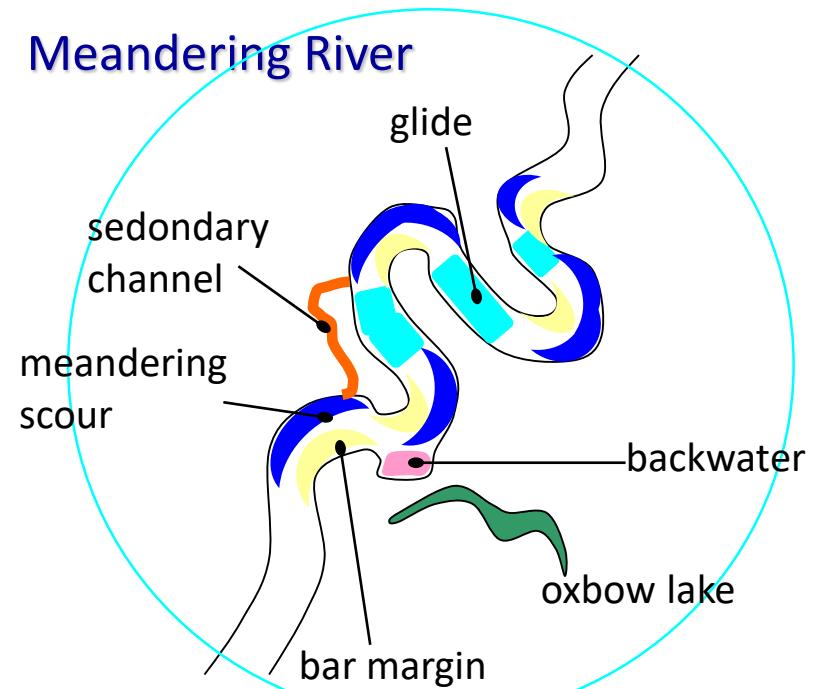


Channelization

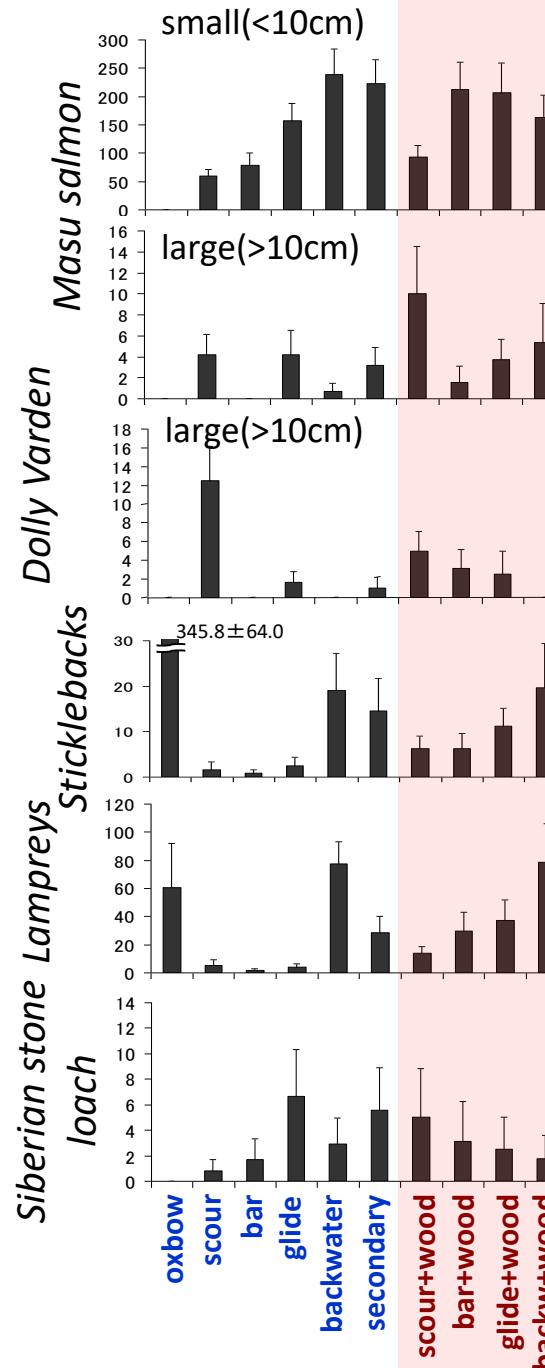
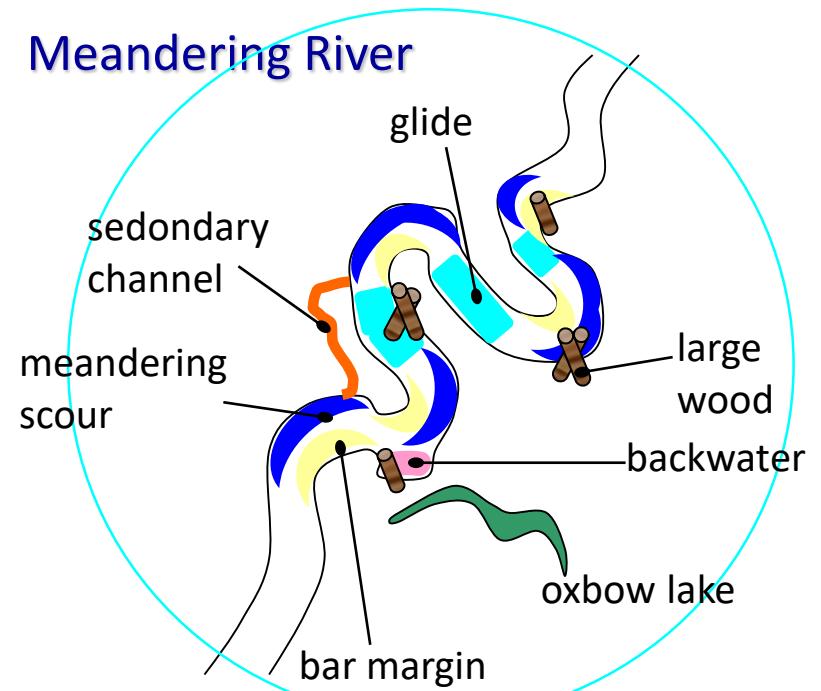
2005



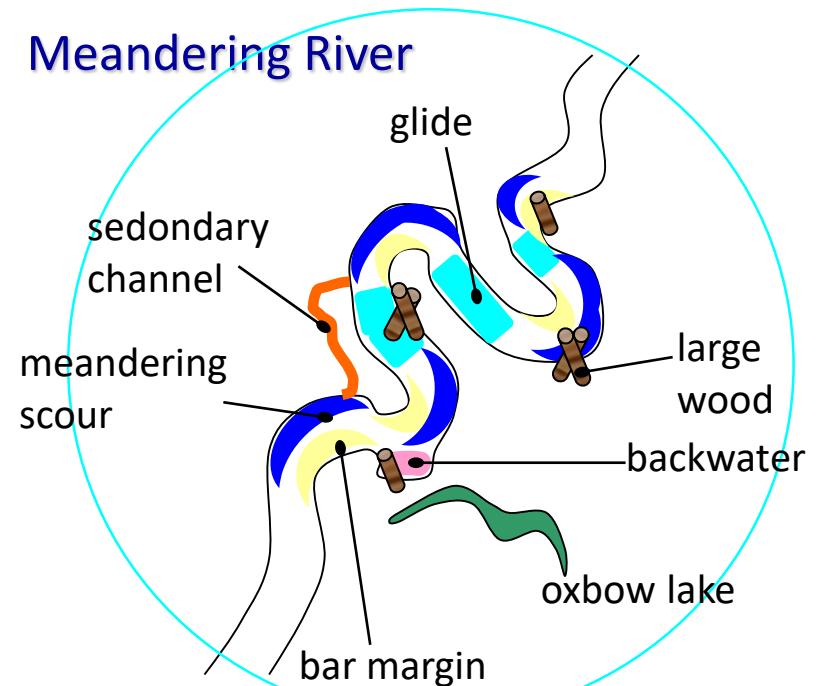
Meandering River



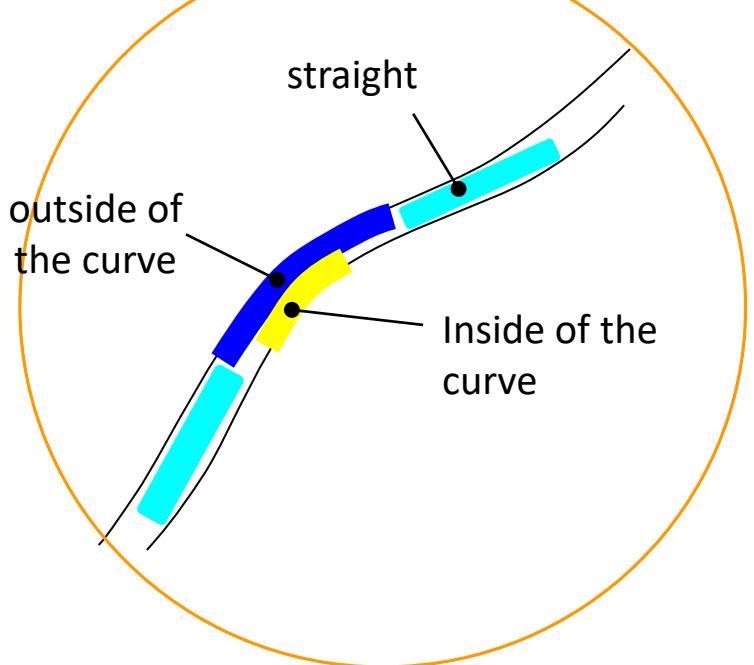
Meandering River



Meandering River



Channelized River



small(<10cm)

Musu salmon

large(>10cm)

Dolly Varden

large(>10cm)

Sticklebacks

Siberian stone Lampreys

loach

oxbow
scour
bar
glide
backwater
secondary

scour+wood
bar+wood
glide+wood
backw+wood

outside
inside
straight

Nagayama and Nakamura (2018) Limnology

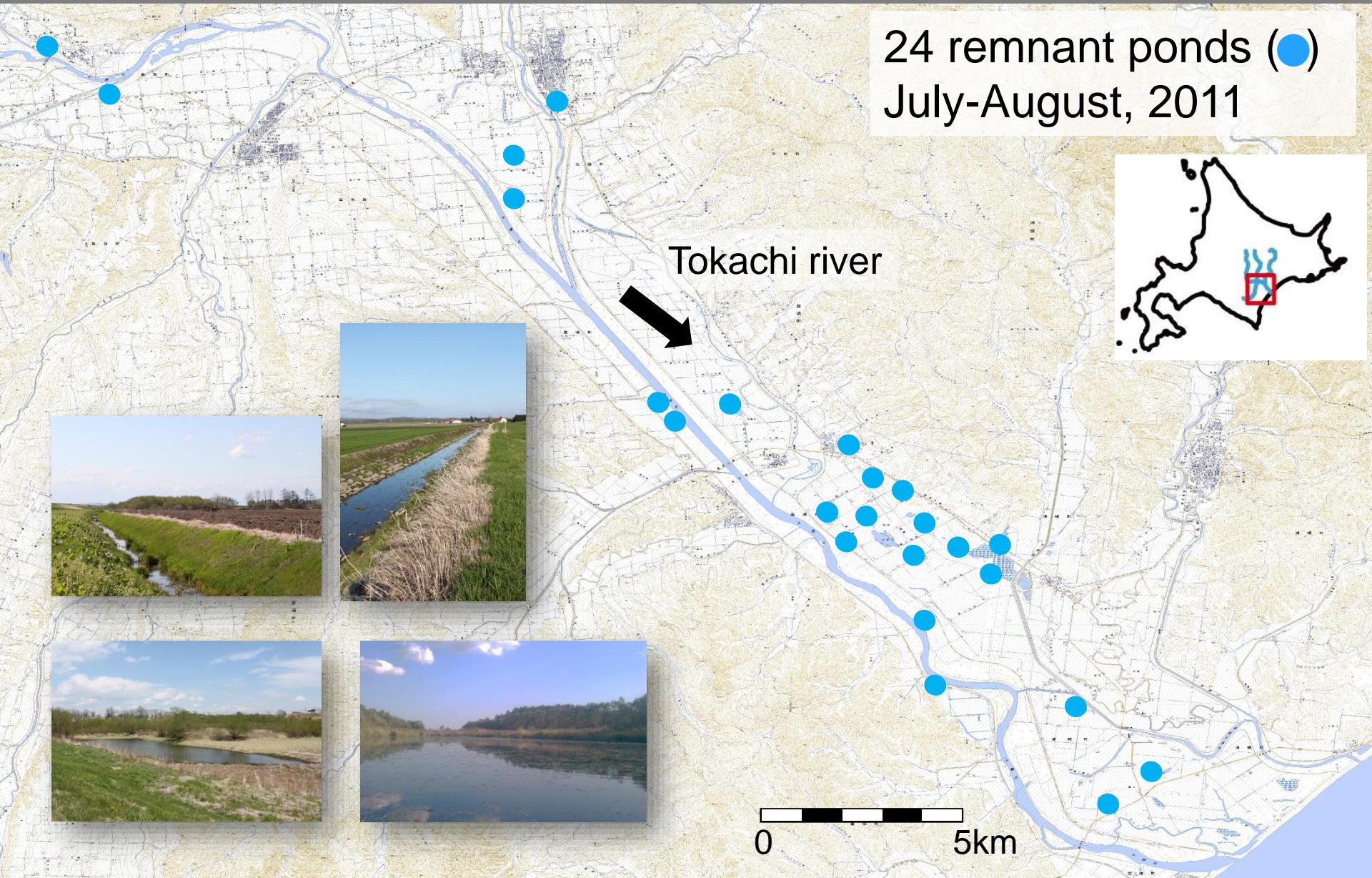


An aerial photograph of the Ishikari River delta, characterized by its extensive, winding network of water channels and backwaters. The river flows from the bottom right towards the top left, creating numerous loops and connecting various small lakes and fields. The surrounding terrain is a mix of green agricultural land and some developed areas with buildings and roads. In the far background, a range of mountains is visible under a clear sky.

Ishikari River

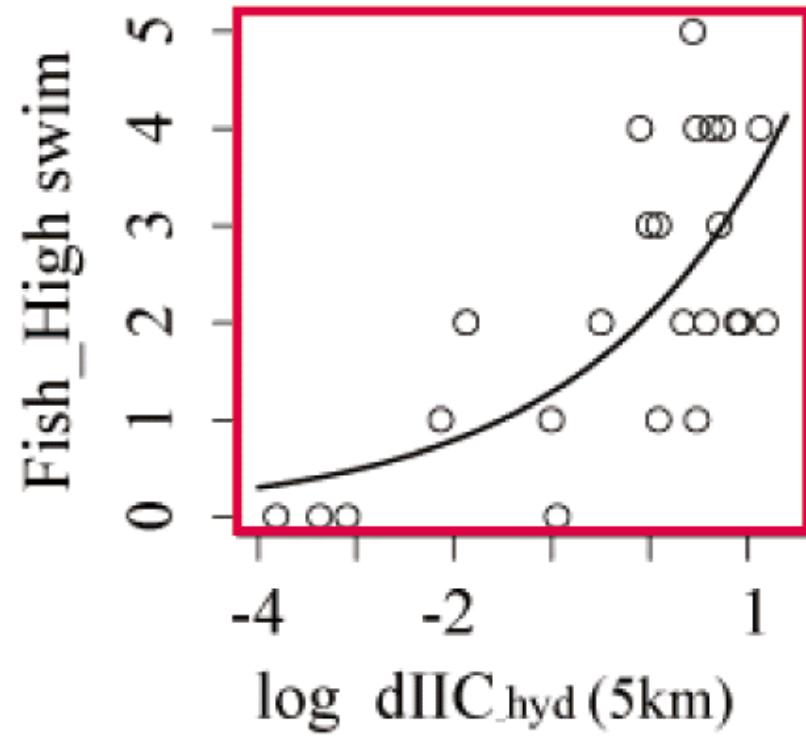
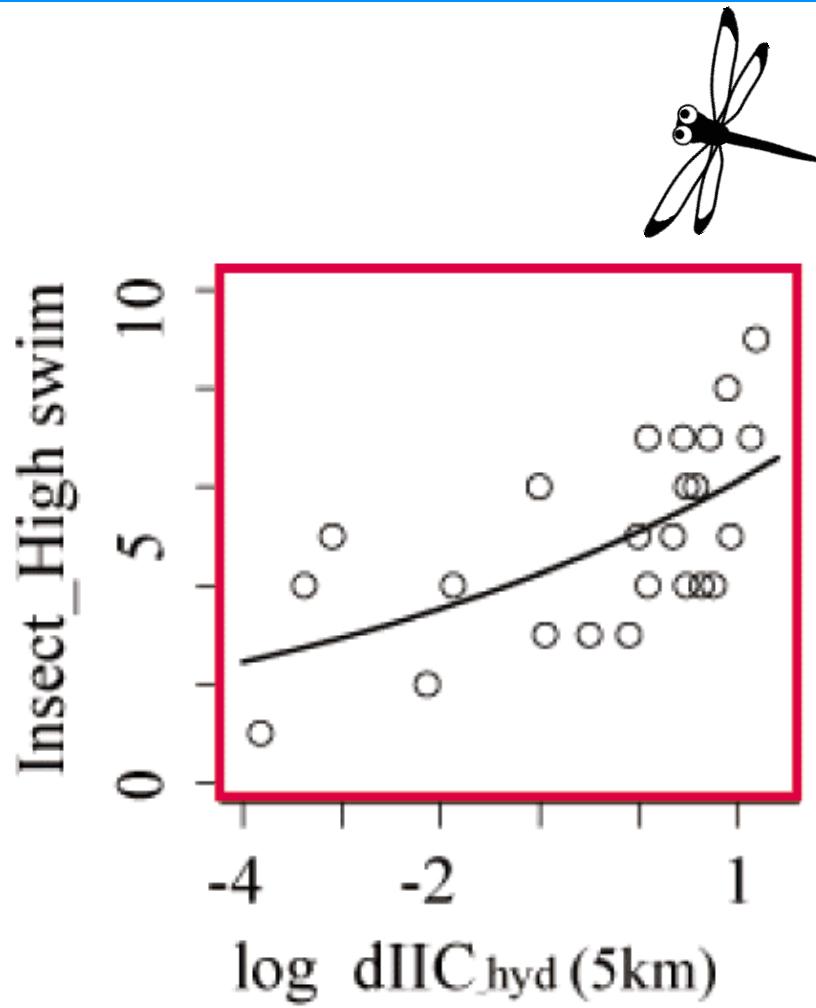
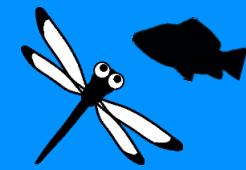
364 km → 268 km

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 →

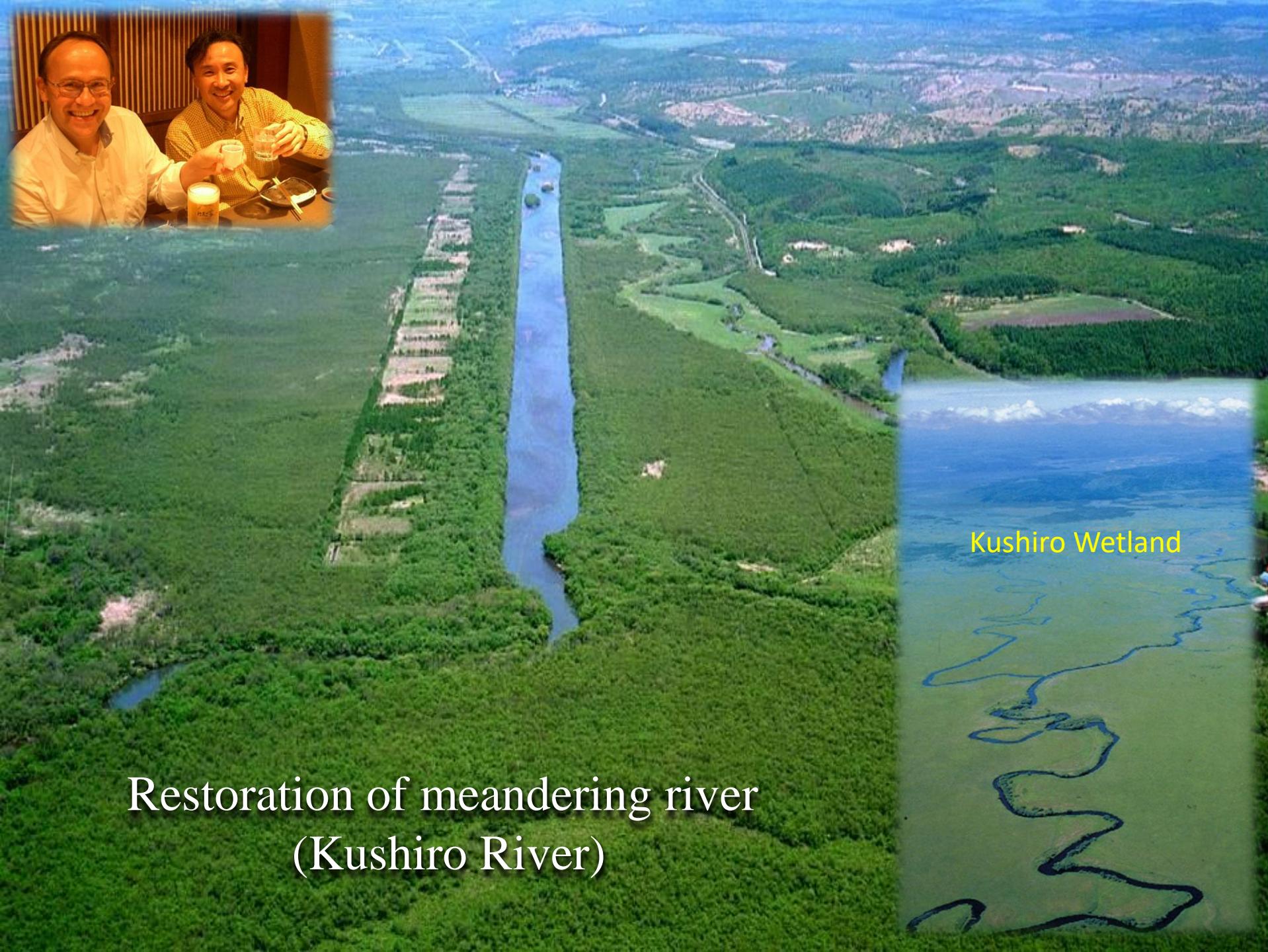


Restoration of meandering river
(Kushiro River)

Restoration of meandering river (Kushiro River)



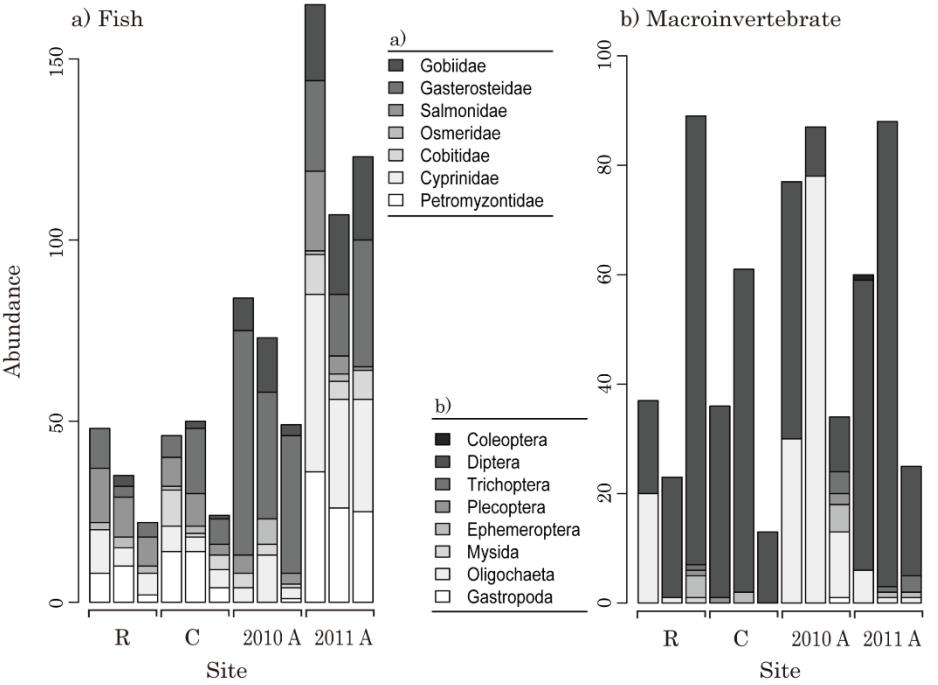
Kushiro Wetland



Restoration of meandering river
(Kushiro River)

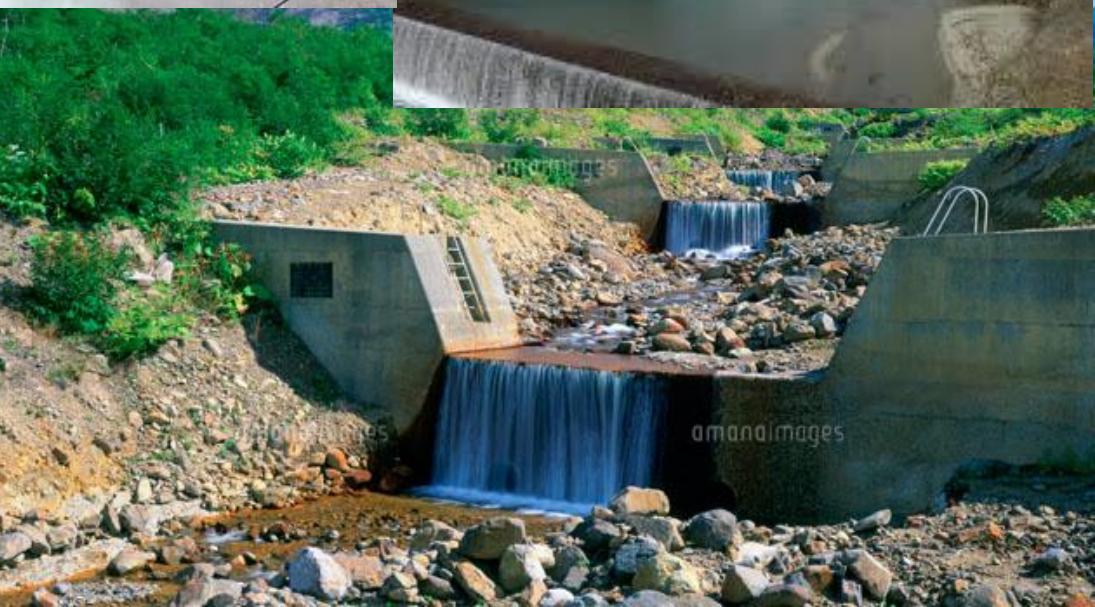


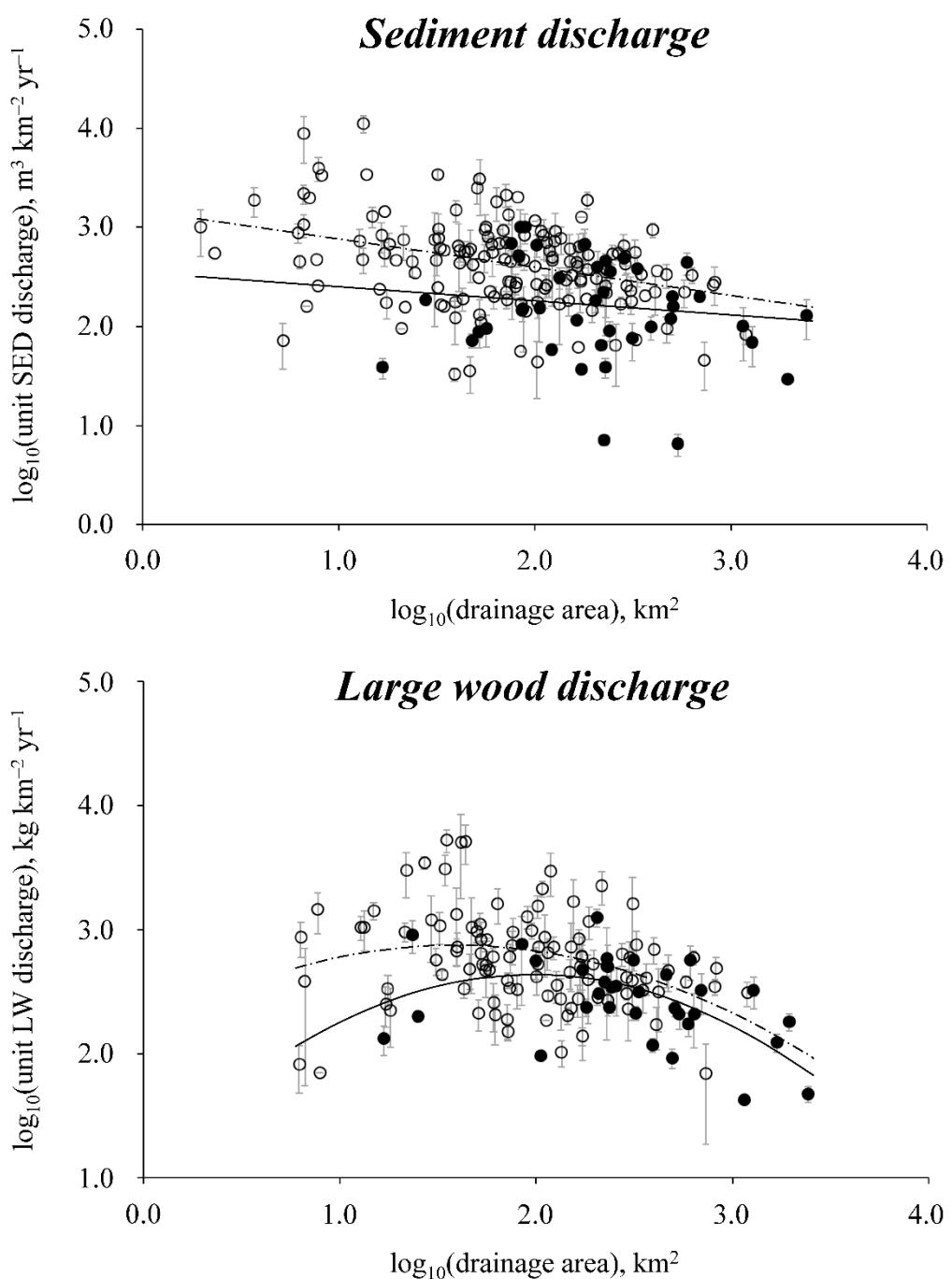
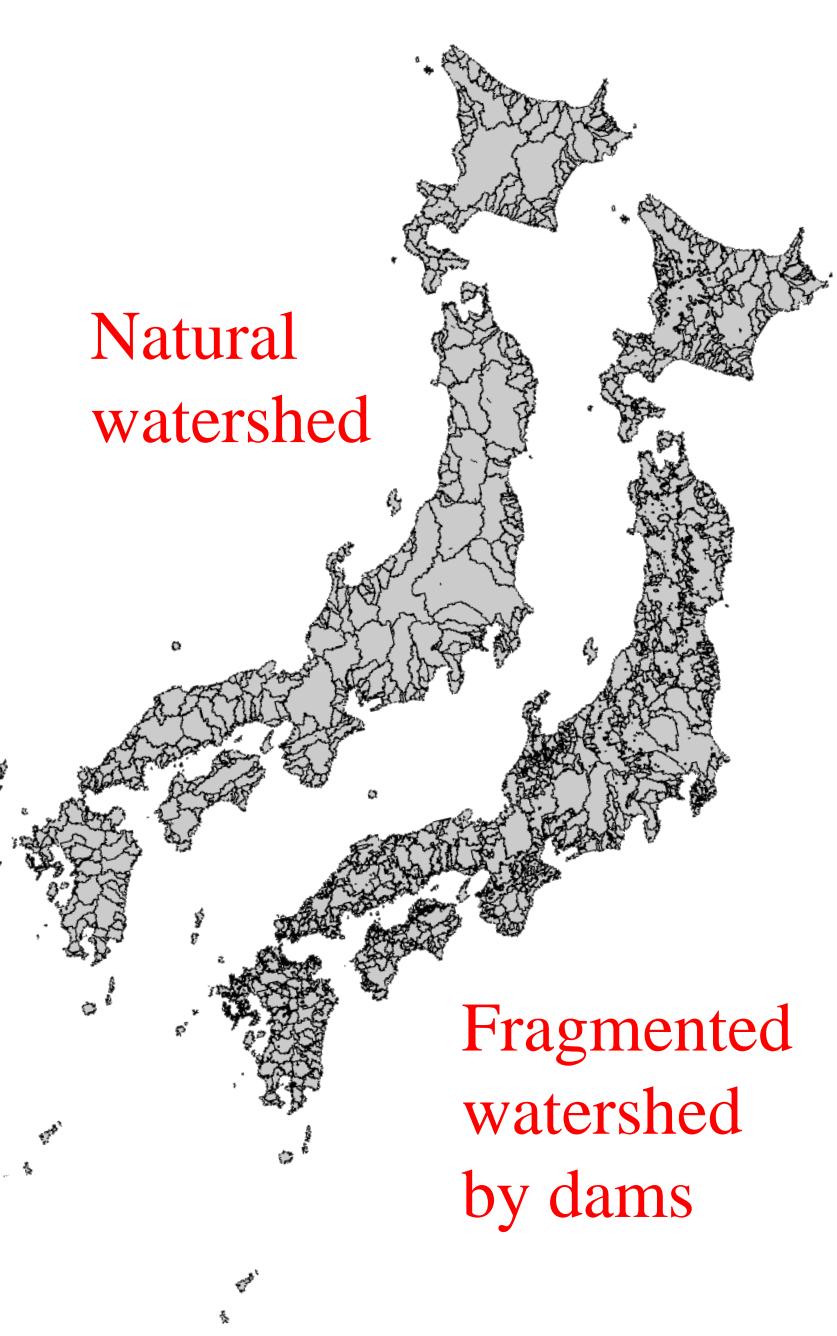
2011.8.3

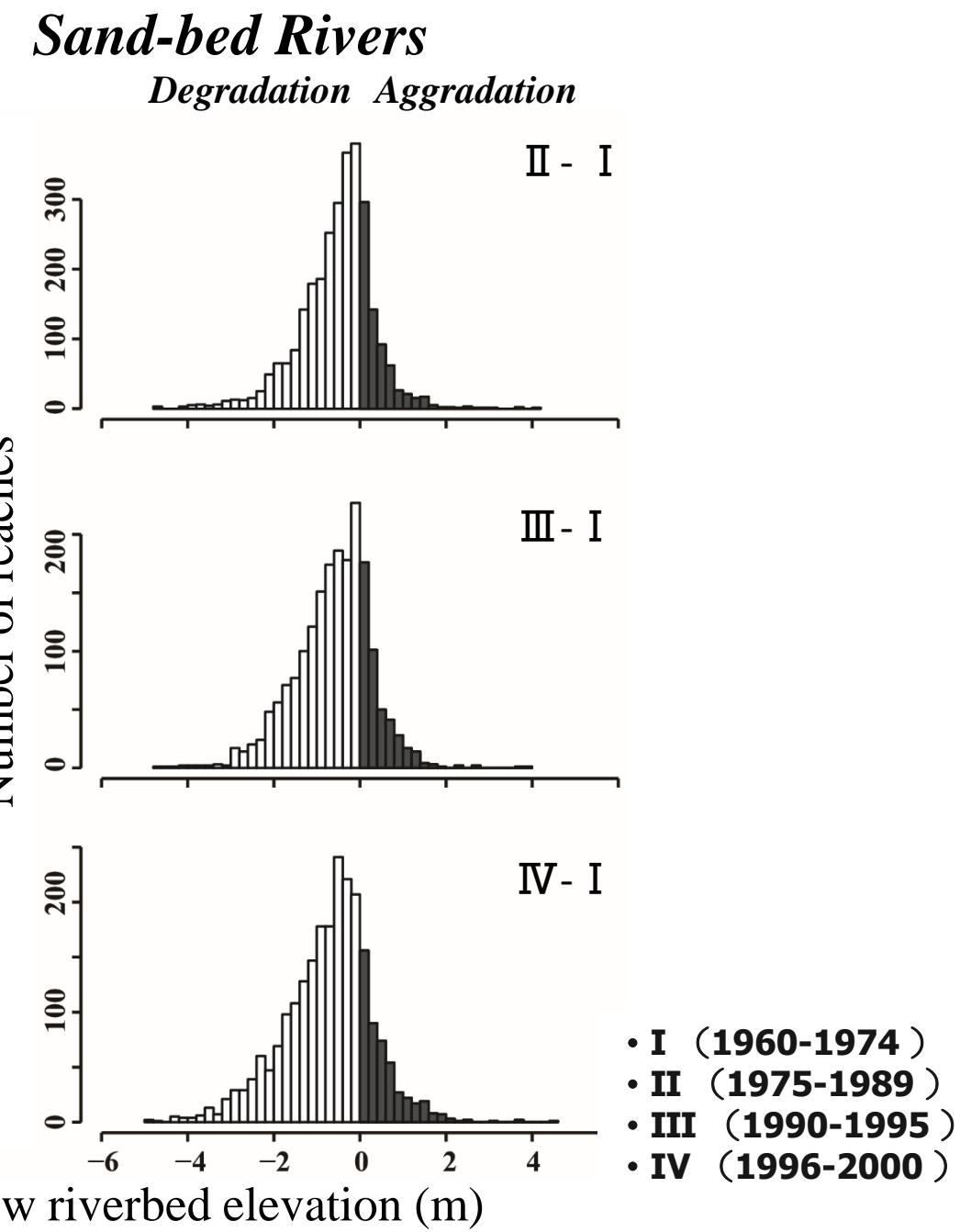
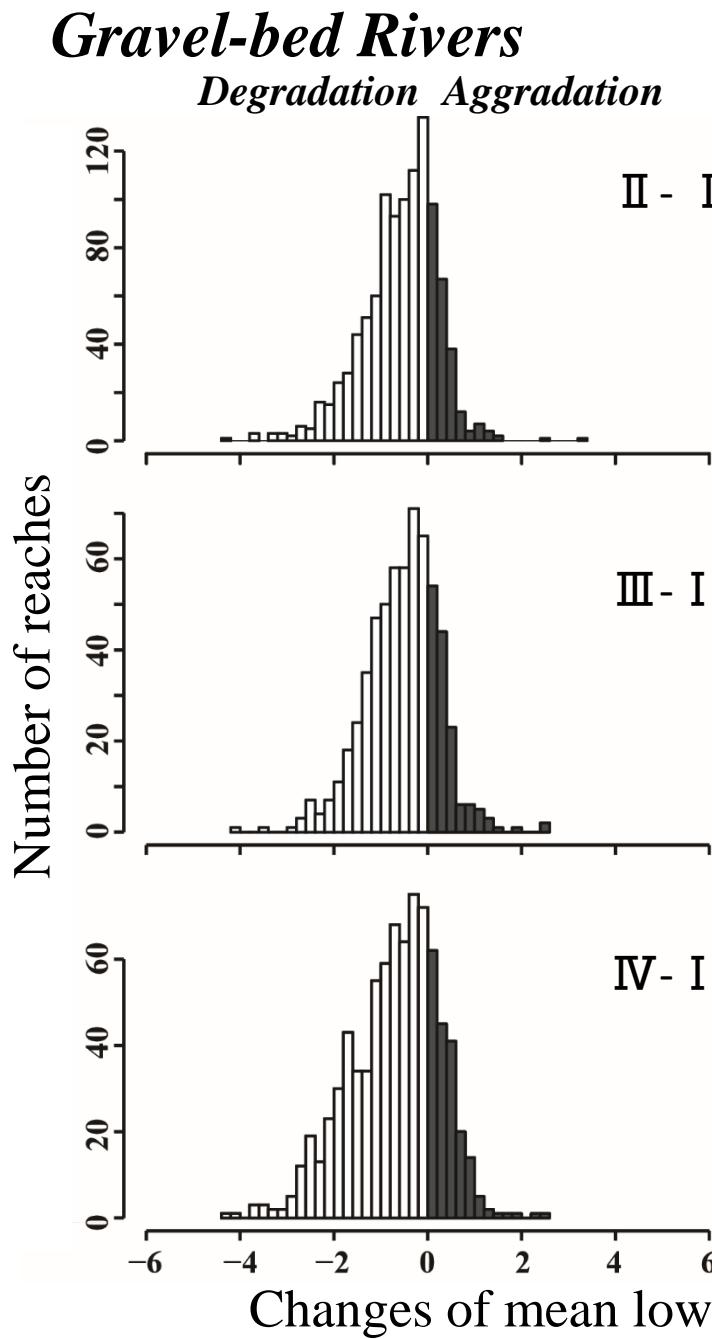


Increase in fish species and abundance







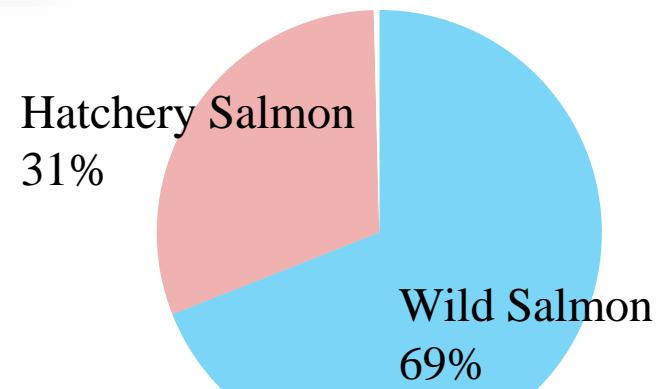




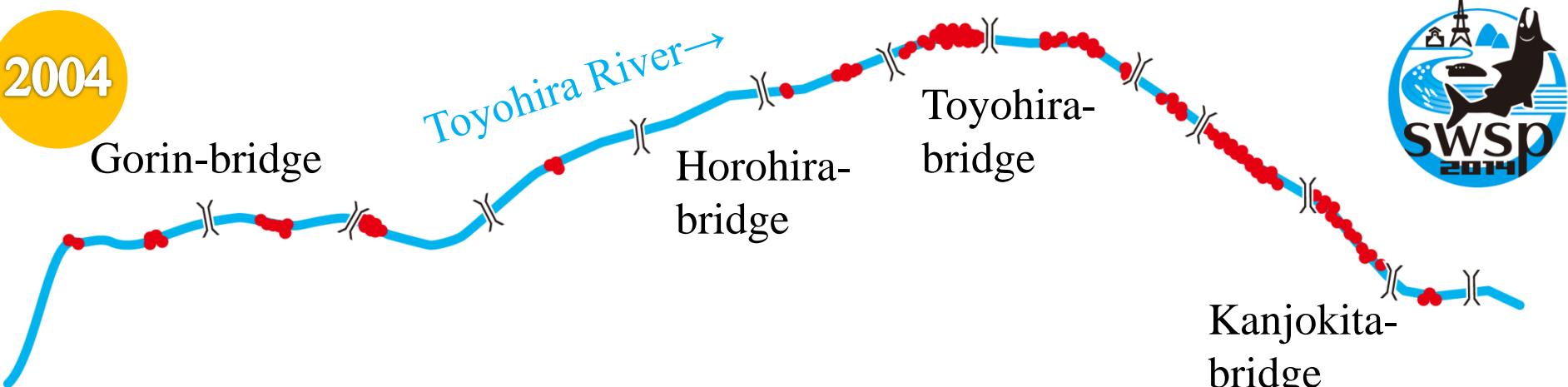
Channel incision of
Toyohira River



Chum salmon



2004



2012



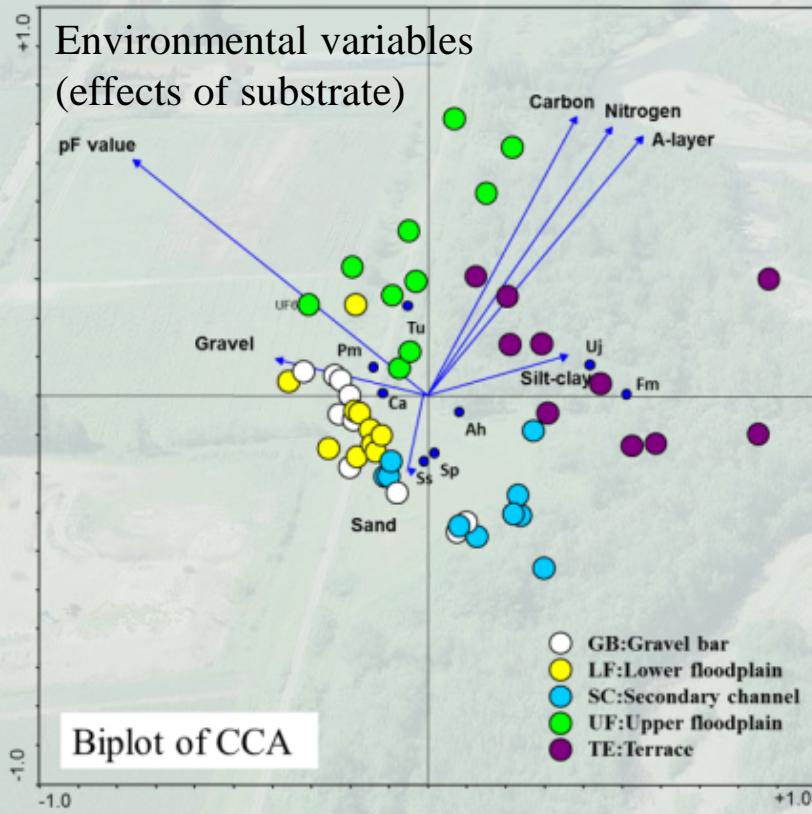
Changes of spawning beds
due to sediment depletion

An aerial photograph of a river flowing through a rural area. The river is light brown and meanders through a narrow strip of dark green riparian vegetation. This vegetation is surrounded by larger agricultural fields, some of which are green and some appear to be fallow or planted with crops like corn. In the background, there are more fields and a few small clusters of buildings, possibly farmhouses or barns. The overall scene illustrates the dynamic relationship between the river and its surrounding land.

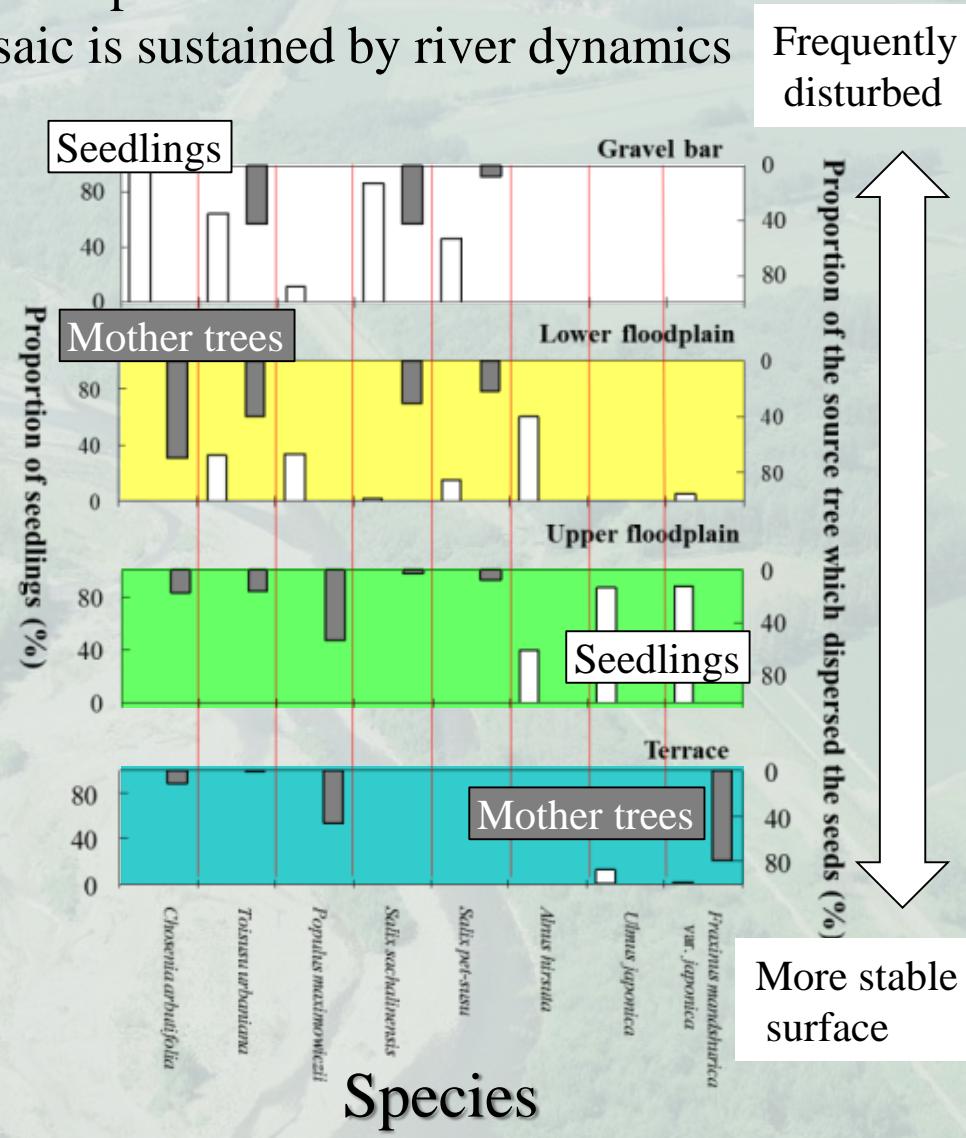
Dynamics of riparian vegetation

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**

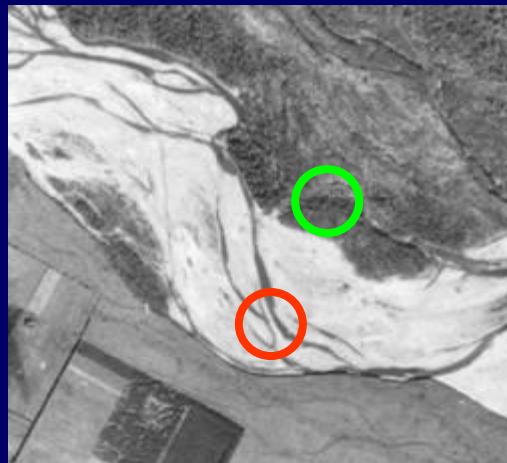


Shin and Nakamura (2005) *Plant Ecology* 178: 15-28

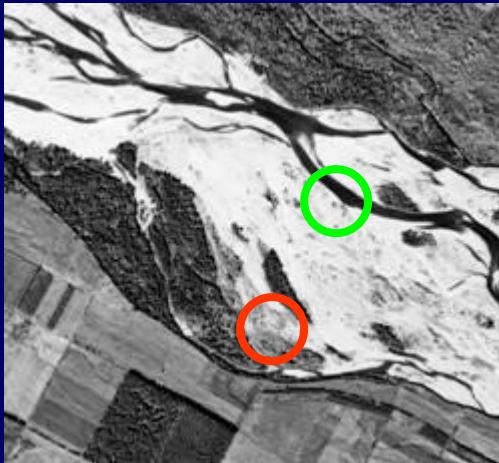


Nakamura et al. (2007) *Forest Ecology and Management* 241: 28-38

1947



1963



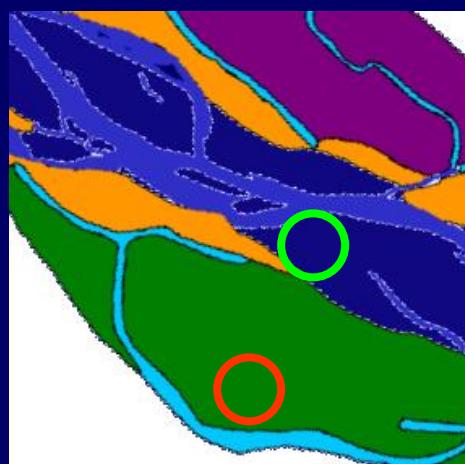
1977



1997



1997 Geomorphic surfaces



- █ Channel
- █ Gravel bar
- █ Lower floodplain
- █ Secondary channel
- █ Upper floodplain
- █ Terrace

0 500m

Temporal changes of riverbed morphologies

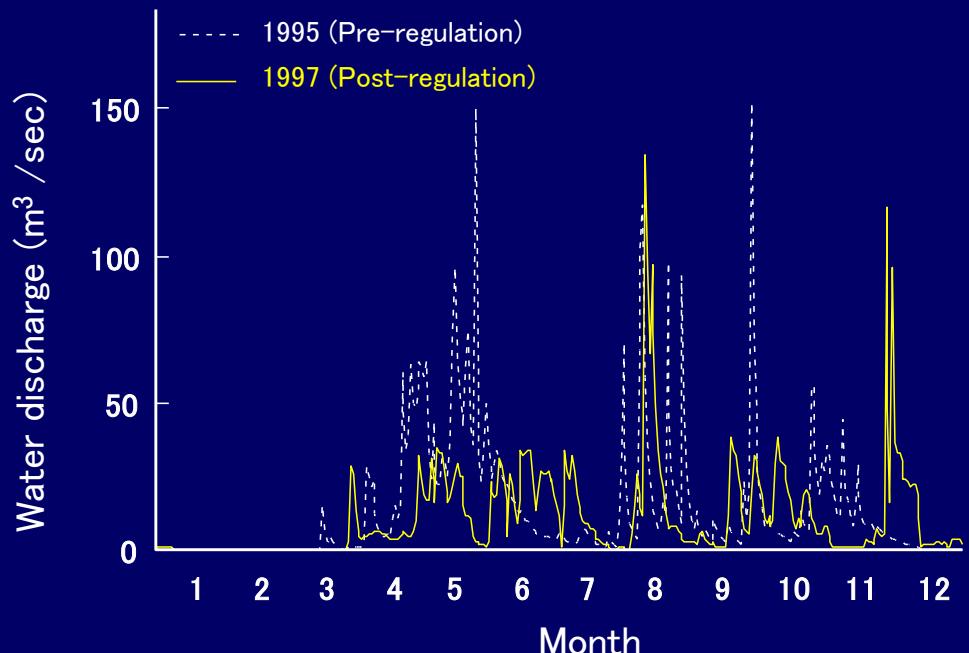
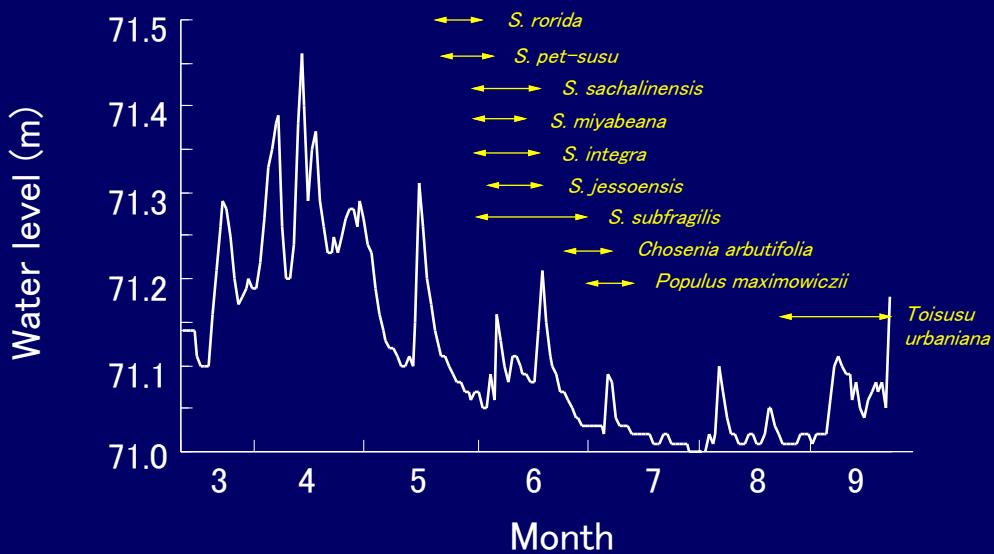
Nakamura et al. 2007
Forest Ecology and Management

Seed dispersal period of willow species and hydrograph

Satsunai River Dam



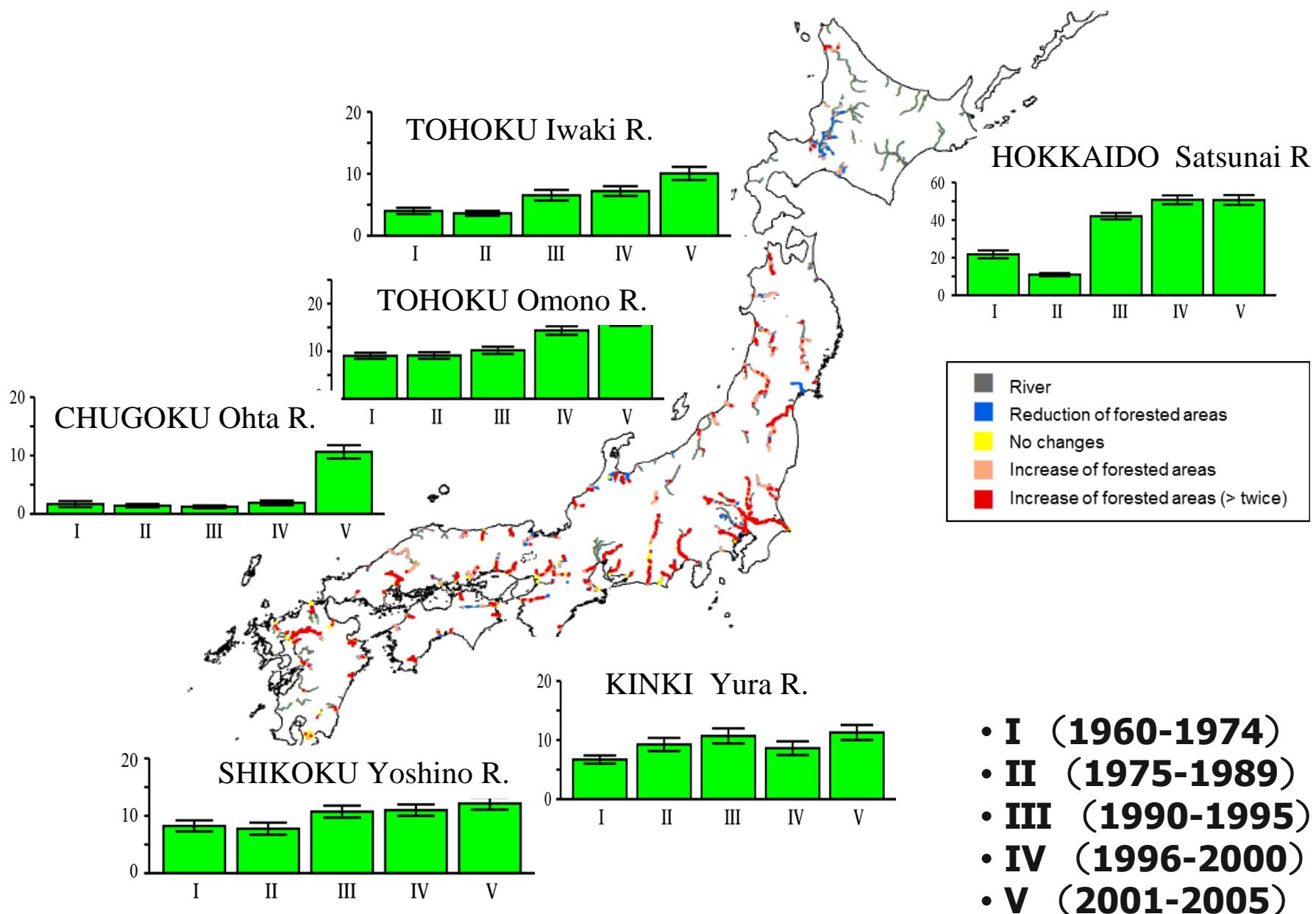
Differences of water discharge before and after dam construction

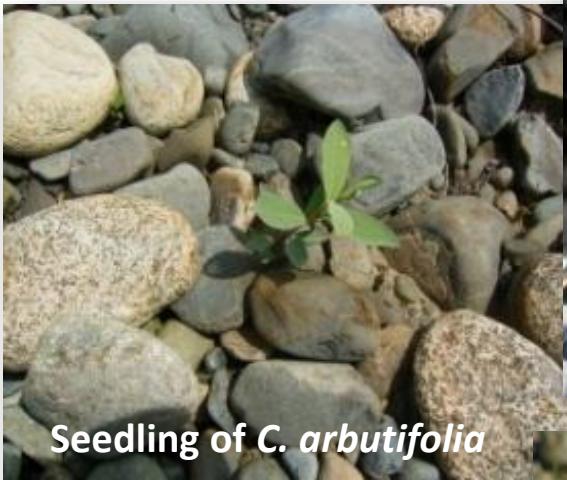


Changes in floodplain environment from gravel bars to forests in Satsunai River, one of the tributaries of Tokachi River



Forest expansion in Japanese rivers





Seedling of *C. arbutifolia*



Motacilla grandis

Species dependent on
gravel bed



Sphingonotus japonicus



Charadrius placidus



Charadrius dubius



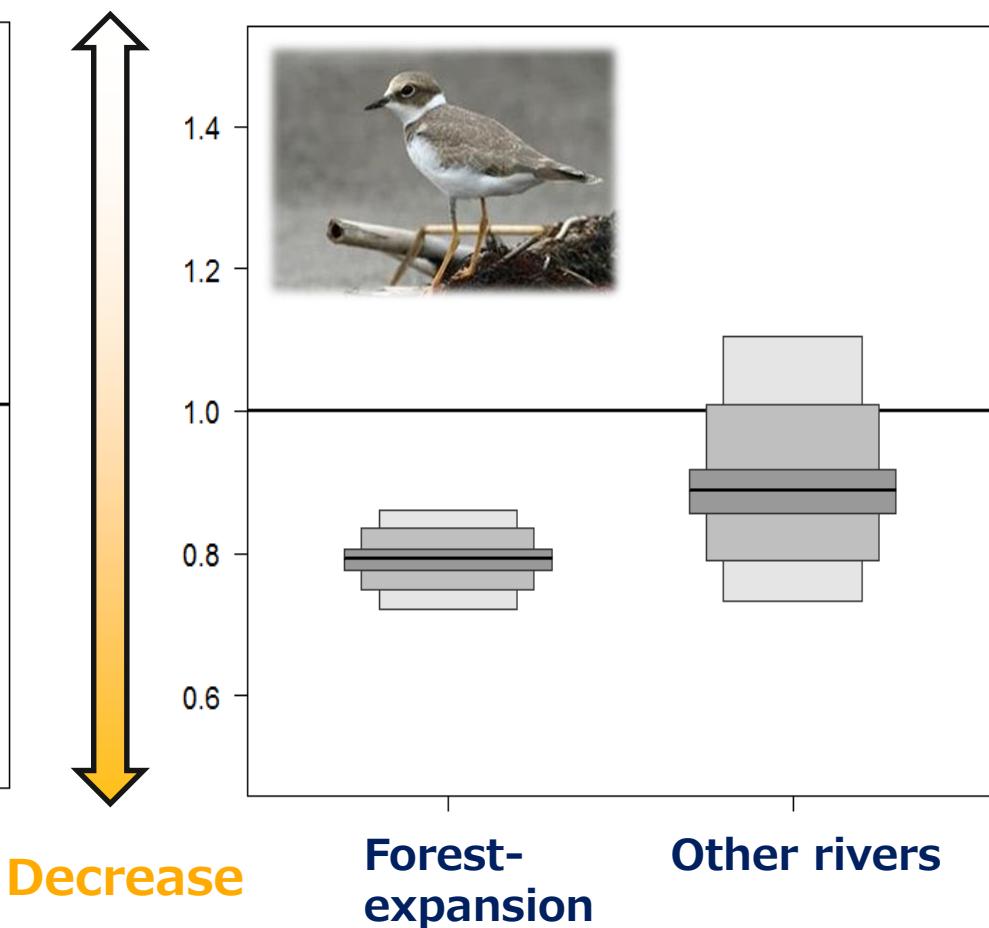
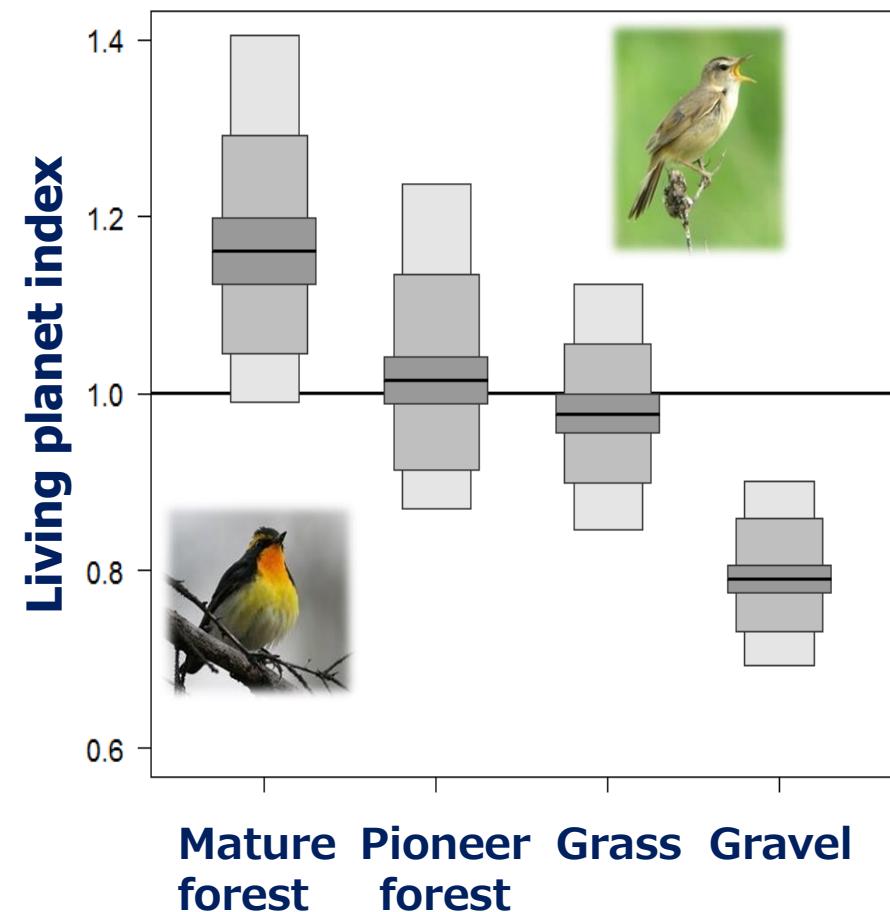
Changes of bird species in Japanese rivers

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)

Sika deer



HCO ScoutGuard

07.16.2011 03:43:56

Sika deer



HCO ScoutGuard

07.13.2011 12:46:47



Red fox

HCO ScoutGuard

05.17.2011 17:03:37

Brown bear



HCO ScoutGuard

07.14.2011 21:11:12

Artificial flood project in the Satsunai River

Glen Canyon Dam, USA



ダム放流ピーク時 (6/25 14:30頃)



Before the flood

放流前(25日09:00)

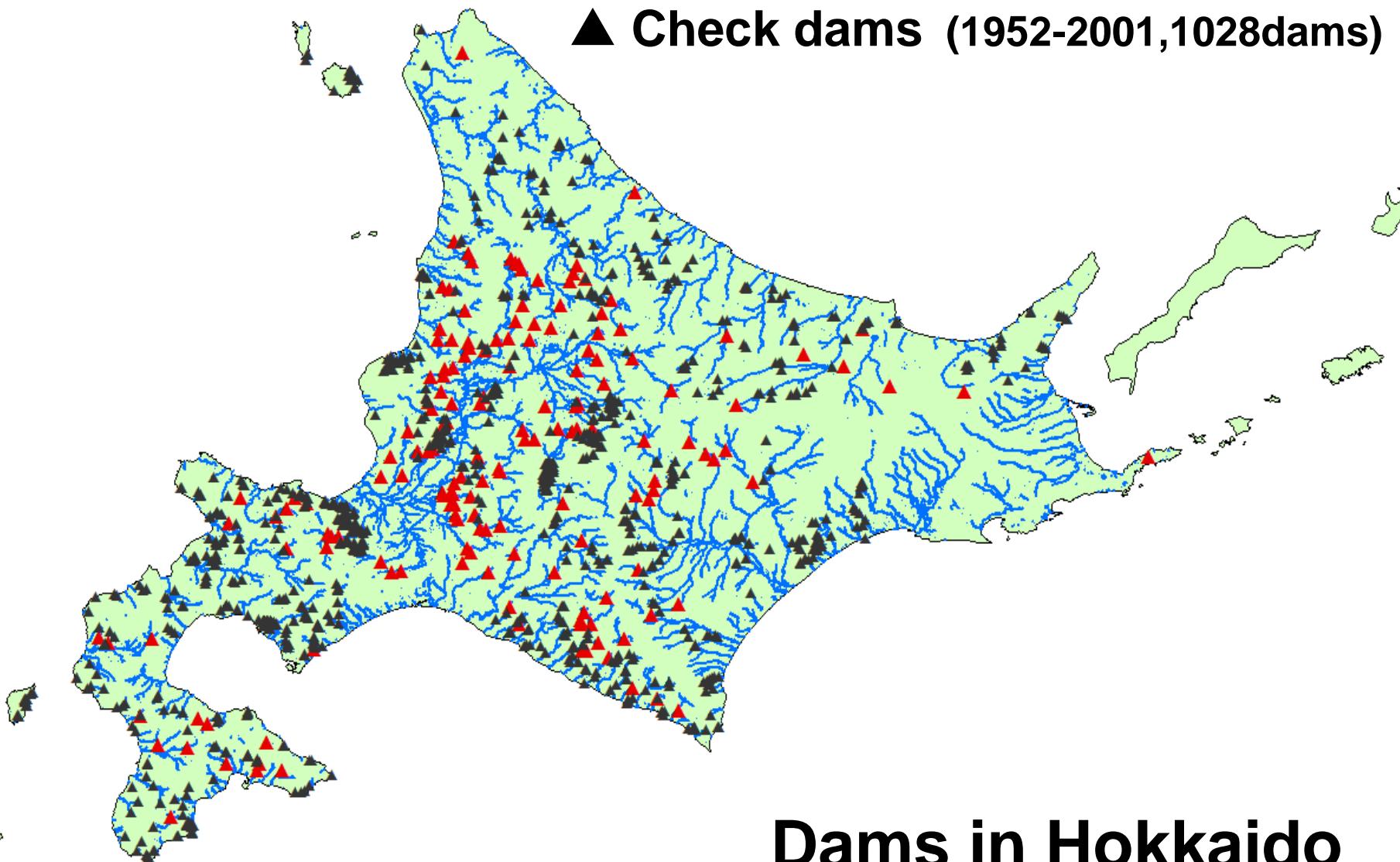


During the flood

放流ピーク付近(25日18:30)

▲ Reservoirs (1913-2002, 167dams)

▲ Check dams (1952-2001, 1028dams)



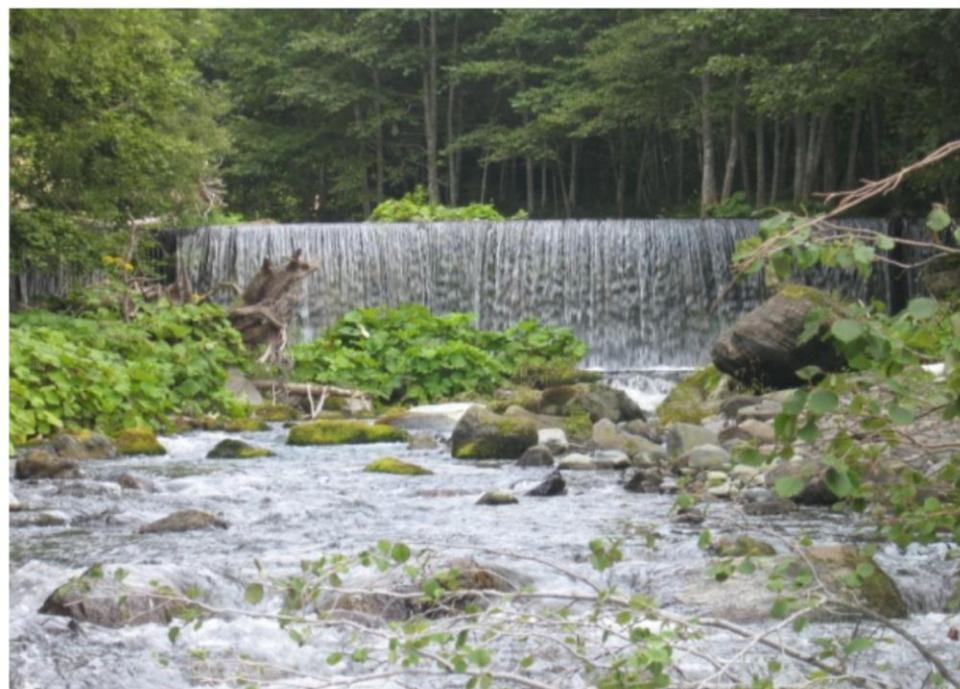
Dams in Hokkaido

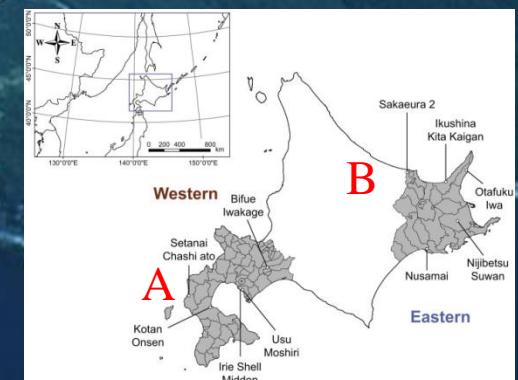
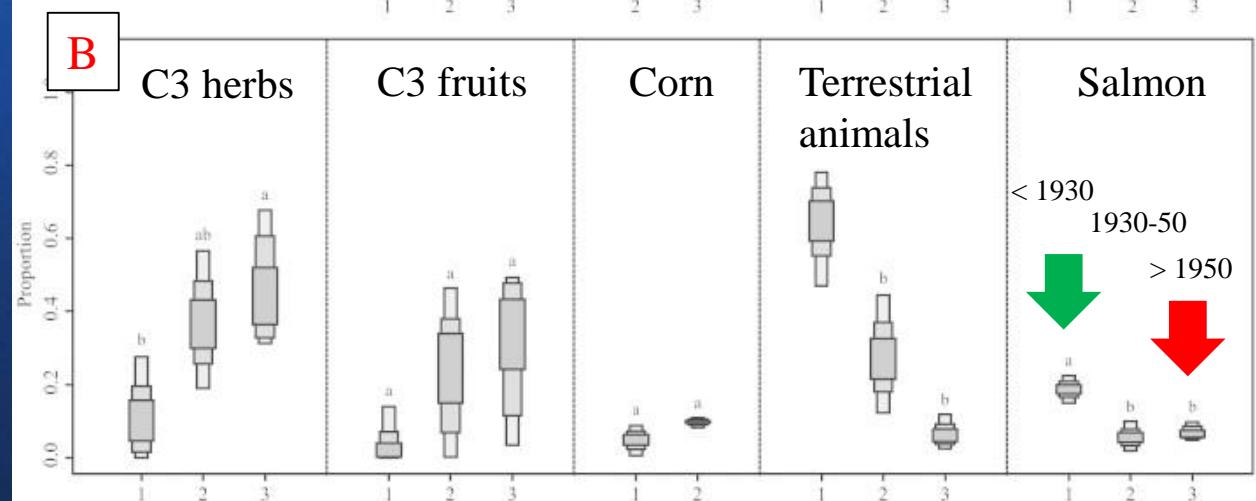
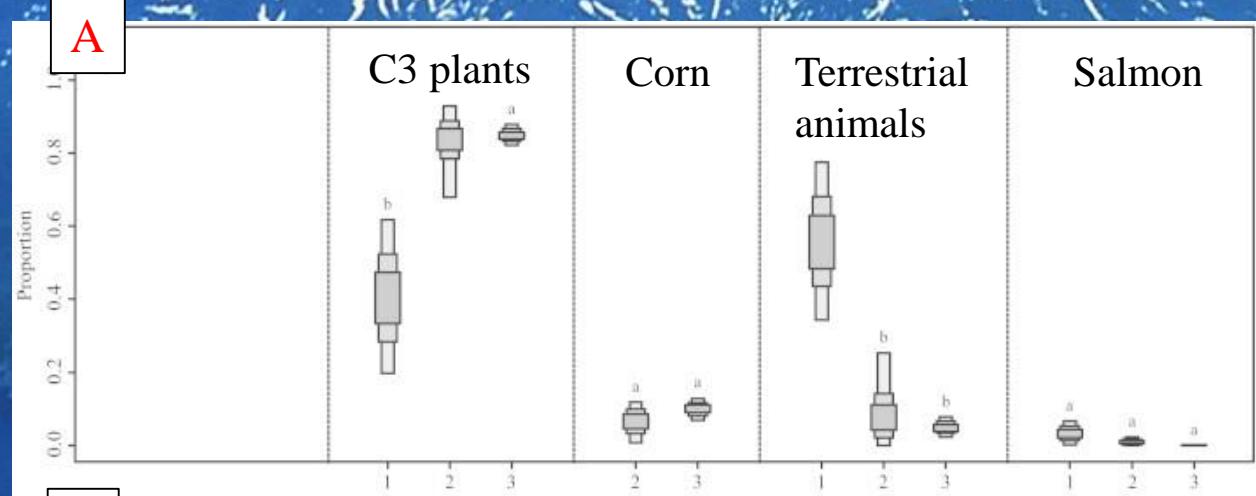


Shiretoko World Natural Heritage Site



Shiretoko World Natural Heritage Site

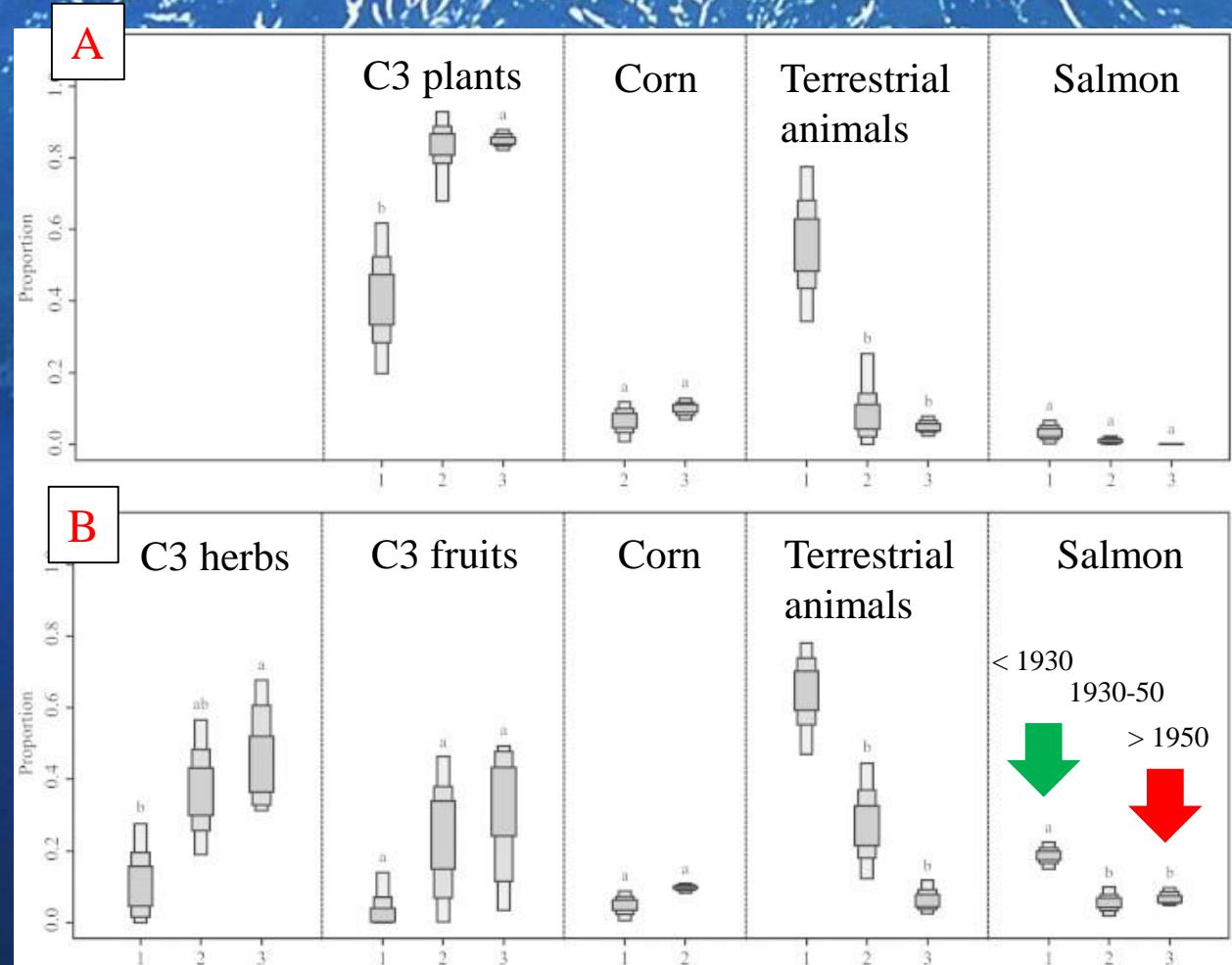




Historical variation of diet components of Hokkaido brown bears as illustrated by SIAR distributions
Matsubayashi et al. Scientific Reports (2015)

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

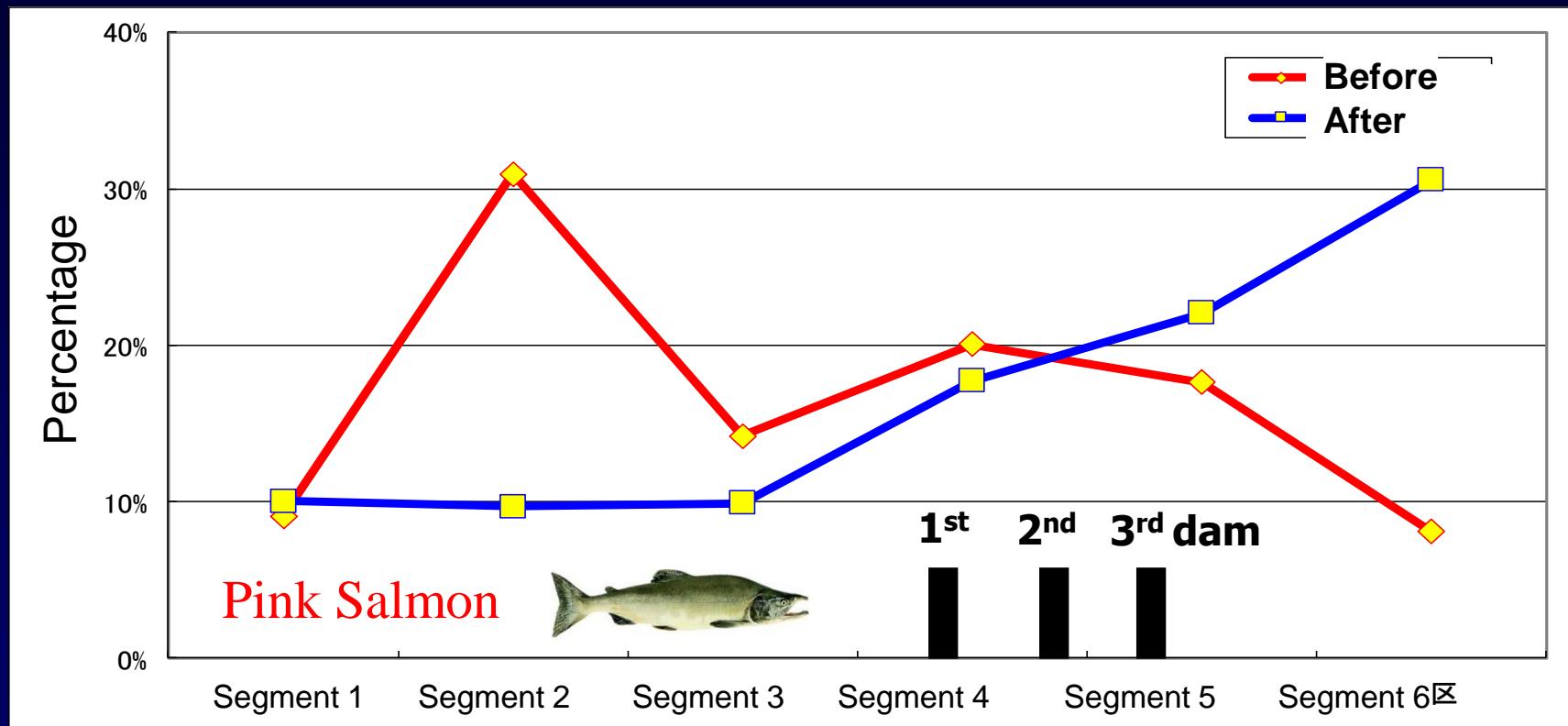


Before

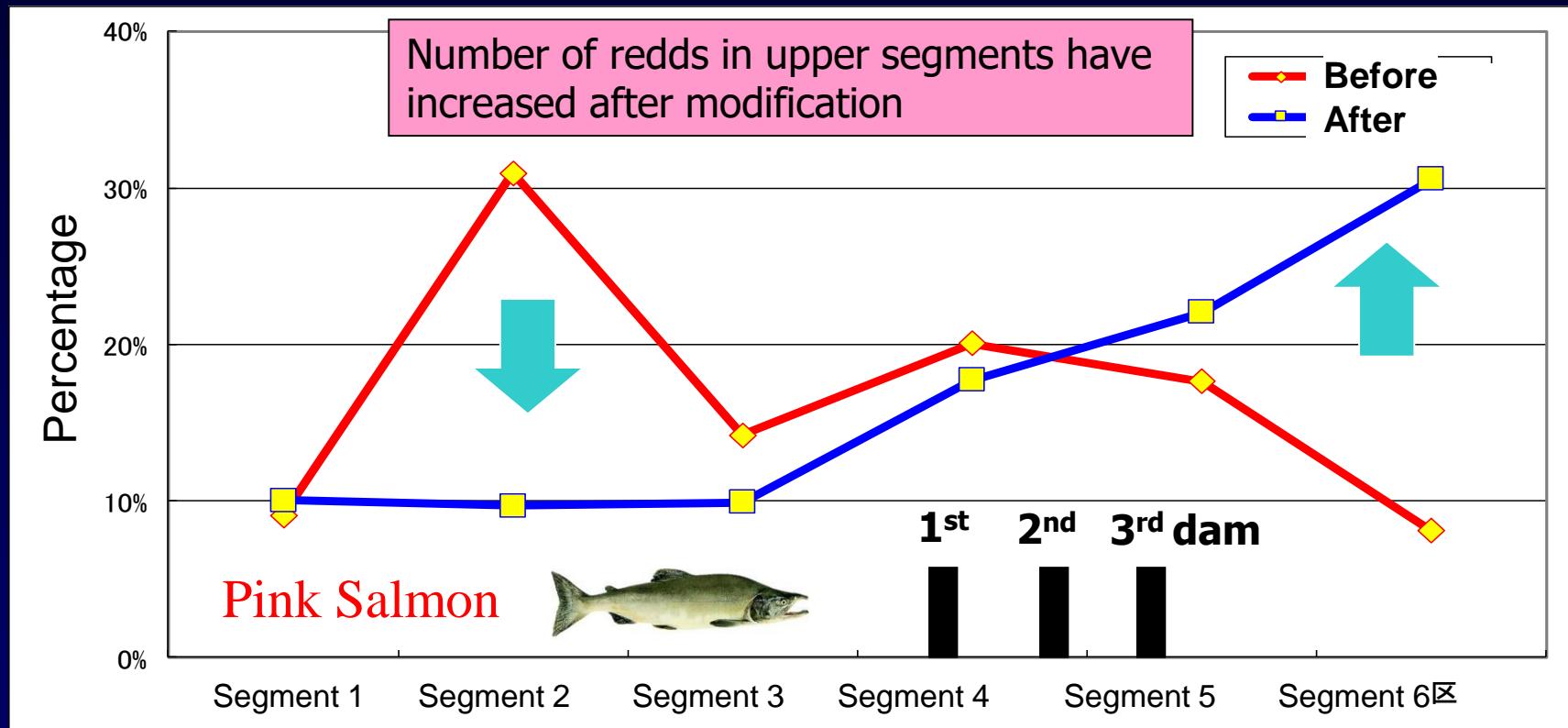
After



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



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





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.