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Coastal
Ecosystem
Complex

High fishery production supported by complex coastal ecosystems

Aki Kasai

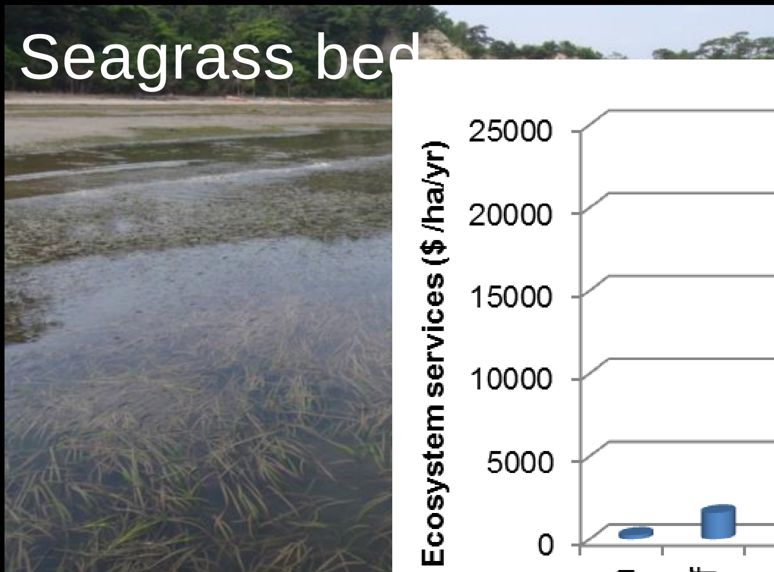
Kyoto University

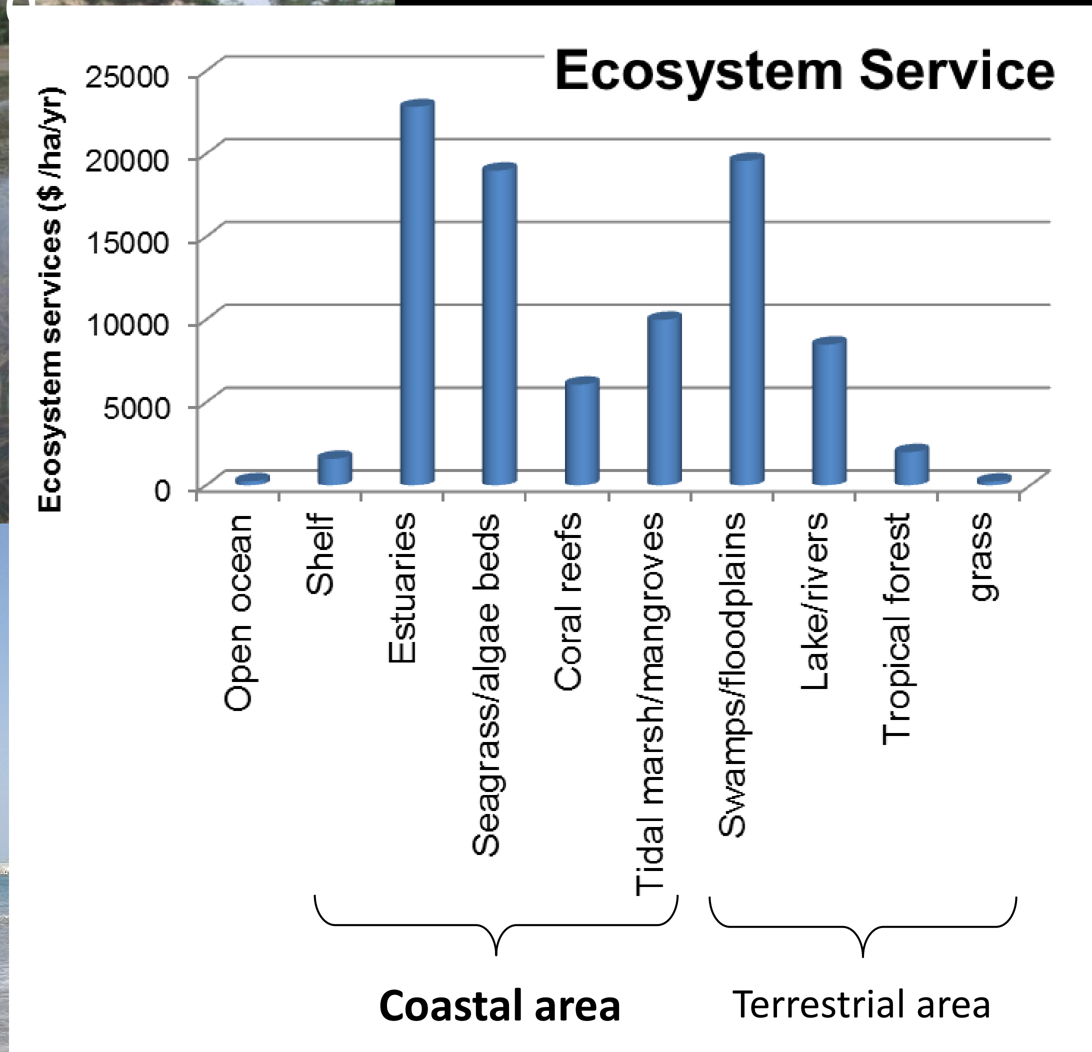
京都大学フィールド科学教育研究センター
Field Science Education and Research Center, Kyoto University

文部科学省
MINISTRY OF EDUCATION, CULTURE, SPORTS, SCIENCE AND TECHNOLOGY-JAPAN

Back ground ~Coastal area

Coastal area:
- covers 6% on the earth
- produces 38% of ecosystem services



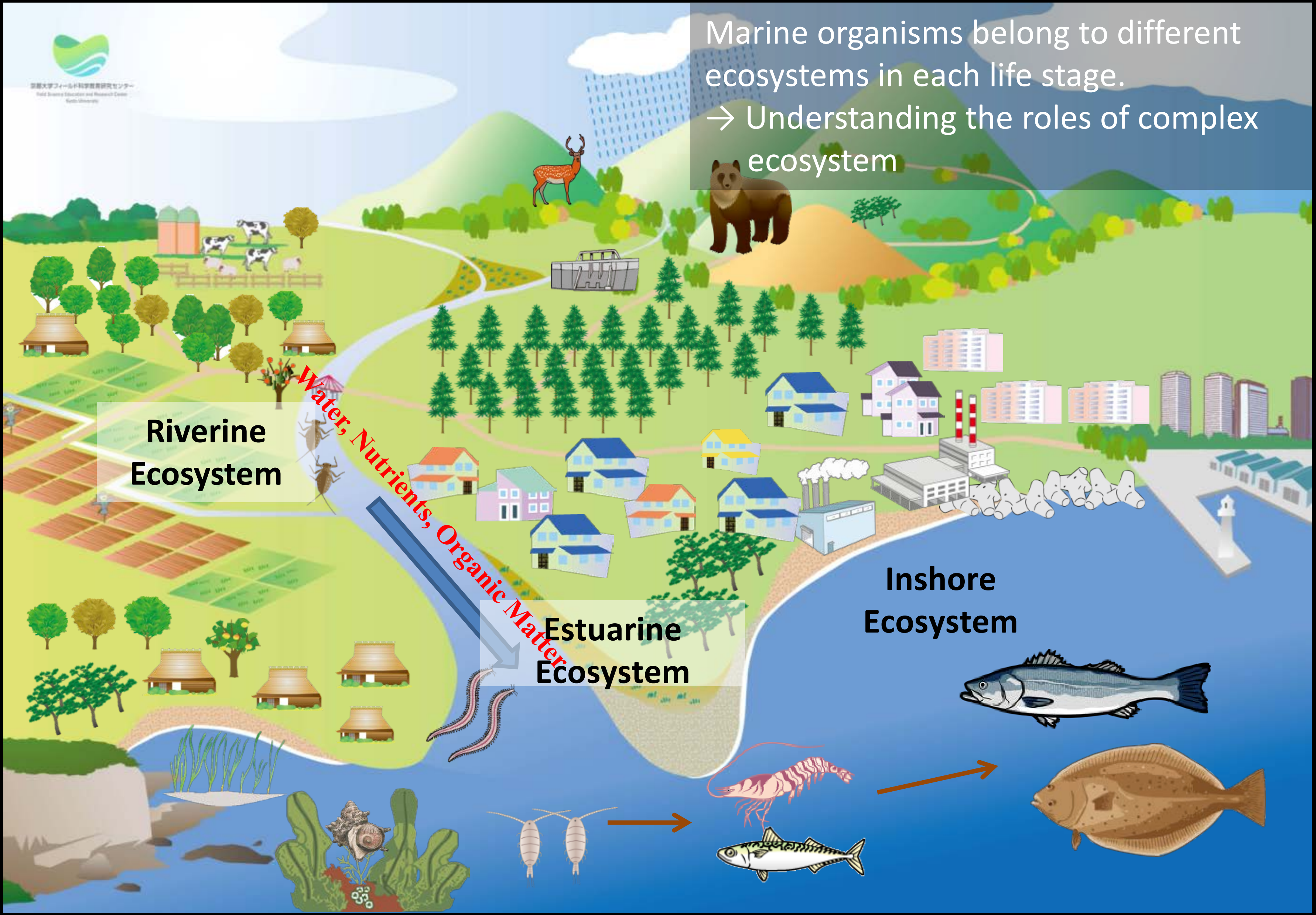


Costanza et al. (1997)

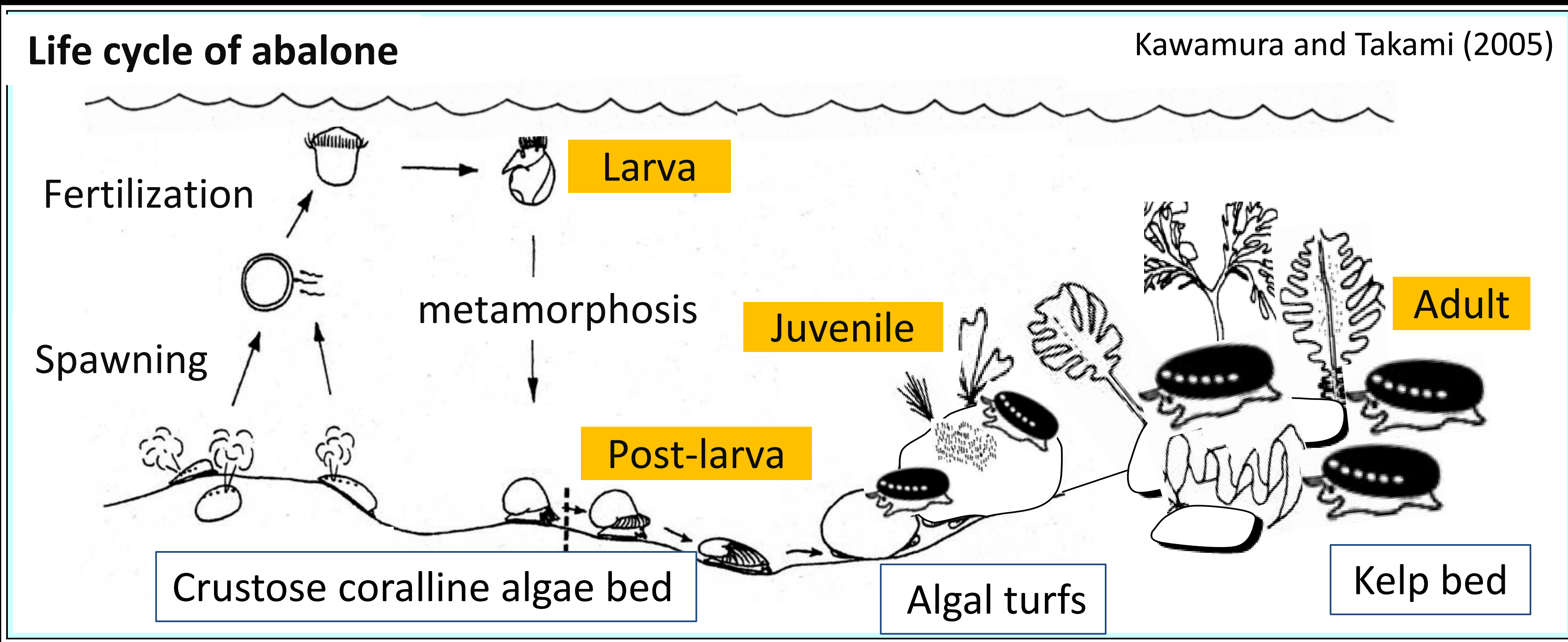
Back ground ~Coastal area

- 40% of population by the sea
- Host to industrial activities
  → burden on ecosystems
- A billion people rely on seafood
- 200 million people are involved
  in Fisheries and associated works.
  → Clear policies are required to
  maintain ecosystem functions

Coastal area as a complex system



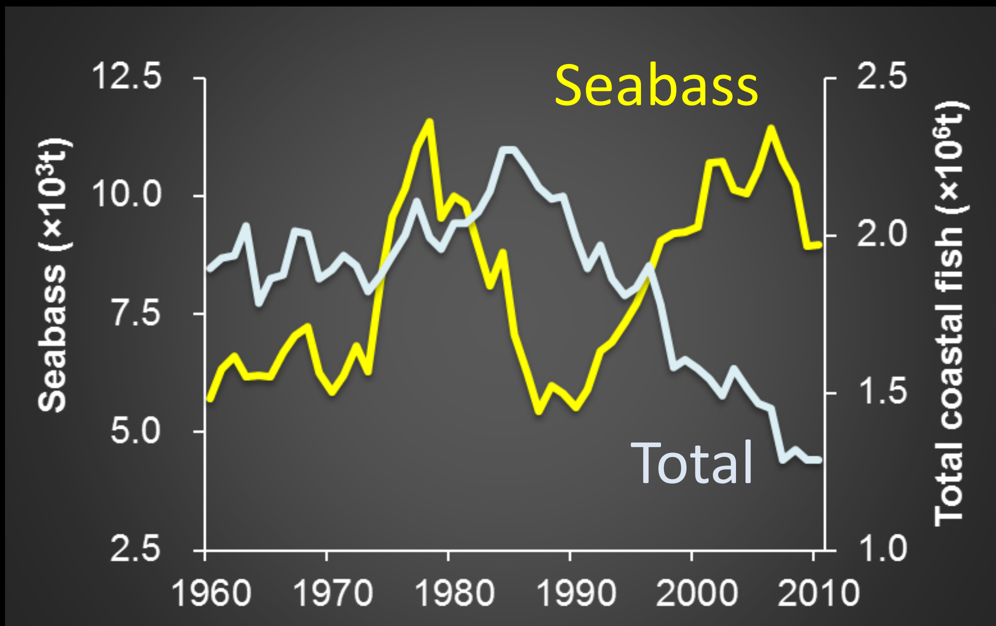
Ontogenetic habitat shifts in abalone *H. discus hannai*



Settlement - 2 cm SL | Juveniles (2 - 4 cm SL) | Adults (> 4 cm SL)

Temperate seabass *Lateorabrax japonicus*

Coastal fish landings in Japan



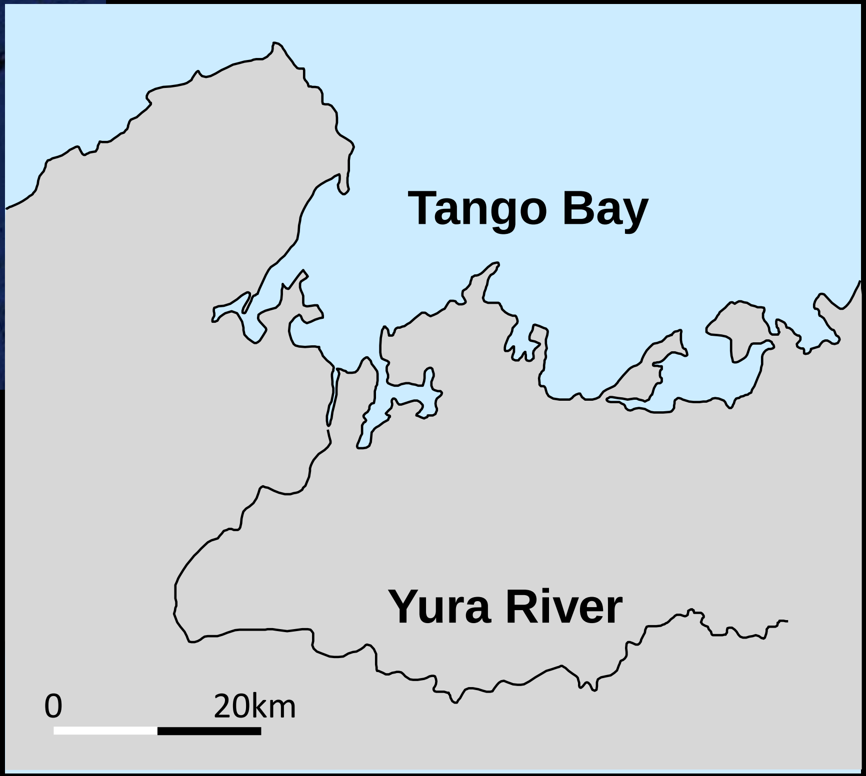
Seabass: Increasing biomass

⬍

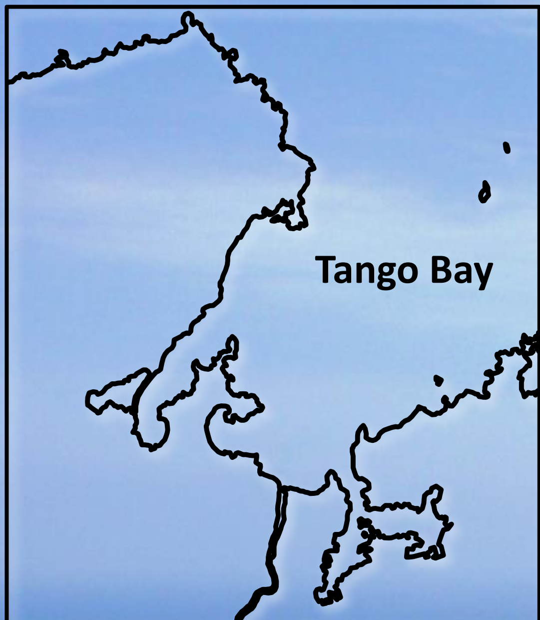
Many fishes: decreasing

A Joyful student with seabass

Study field: Tango Bay & Yura River Estuary

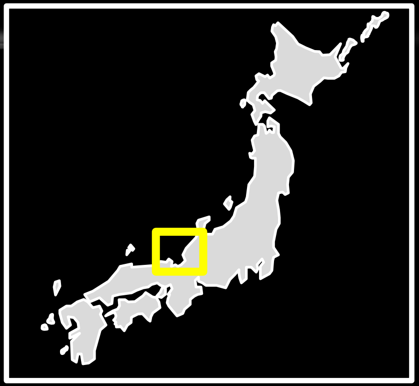


Study field: Tango Bay & Yura River Estuary



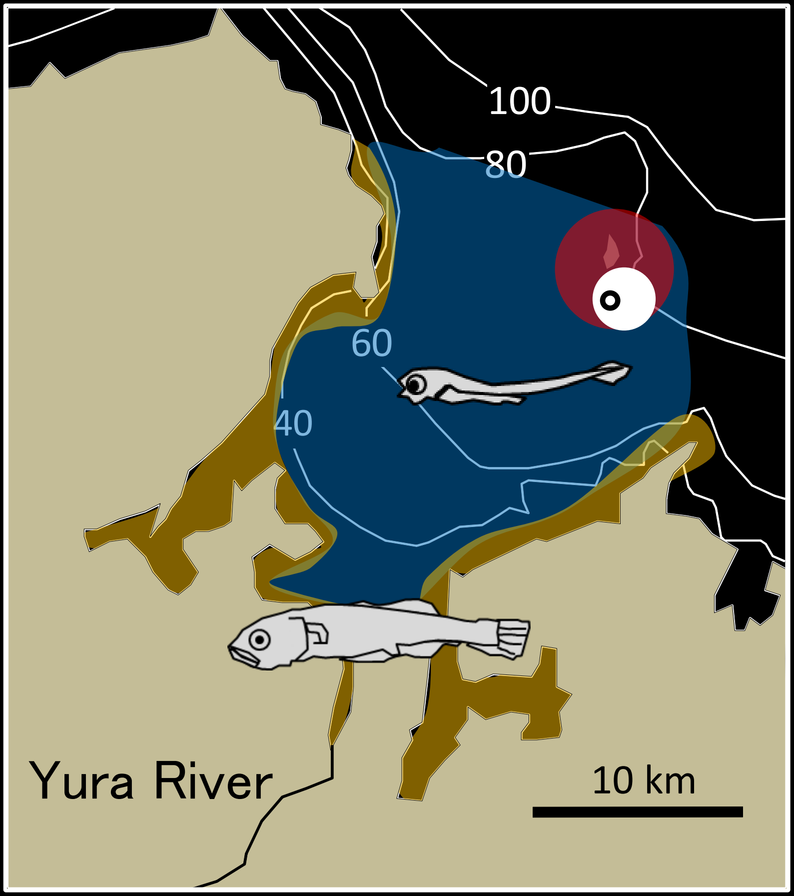
- Tides are small.
  → The estuary is stratified.
- Heavy snow in winter
  → Large freshwater discharge in winter.
  Salt wedge intrudes into the river in summer.
- Spawning and nursery for coastal fishes and benthos

Early life history of seabass in Tango Bay

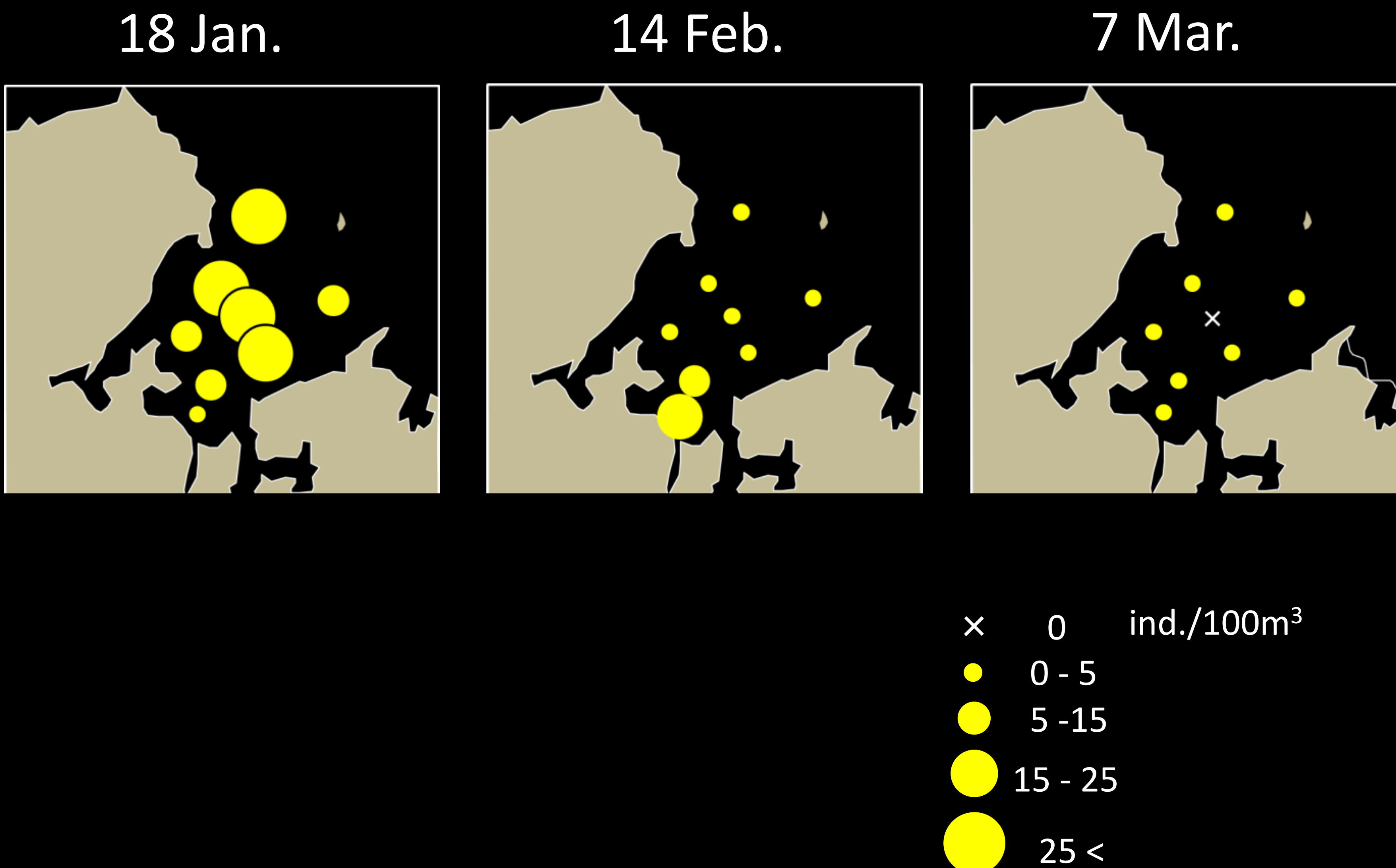


Seabass uses different habitats, according to their life stages.

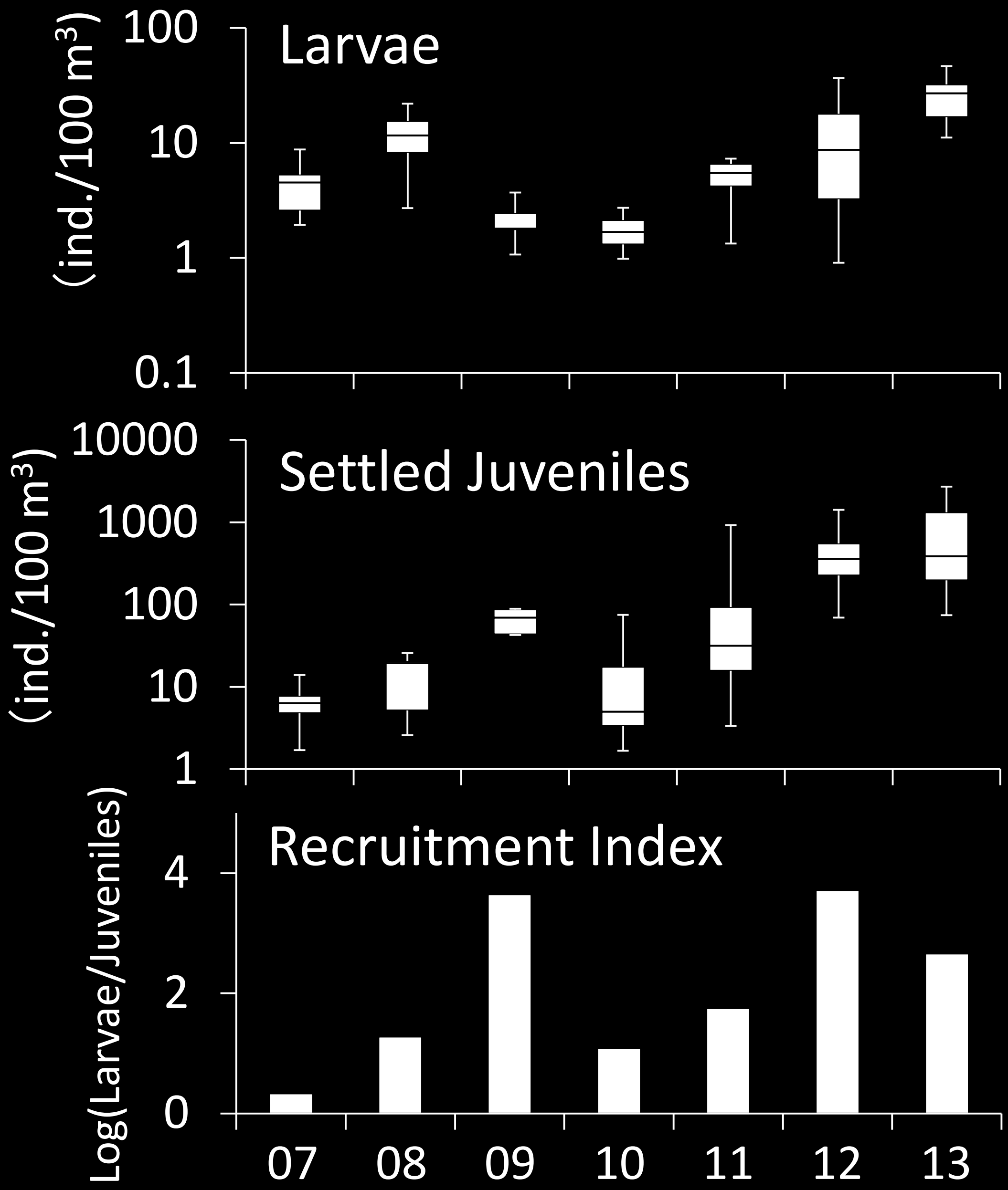
- **Spawning ground: offshore, late Dec. - early Feb.**
- **Larvae : pelagic life and inshore transport, Jan. - early Mar.**
- **Settling larvae and early juvenile : benthic life in coastal shallows, Feb. - Mar.**
- **Juvenile : benthic life in coastal shallows and lower reaches of rivers, Apr. -**



Larval distribution (2012)



Yearly changes in larvae and settled juvenils



Possible environments affecting recruitment

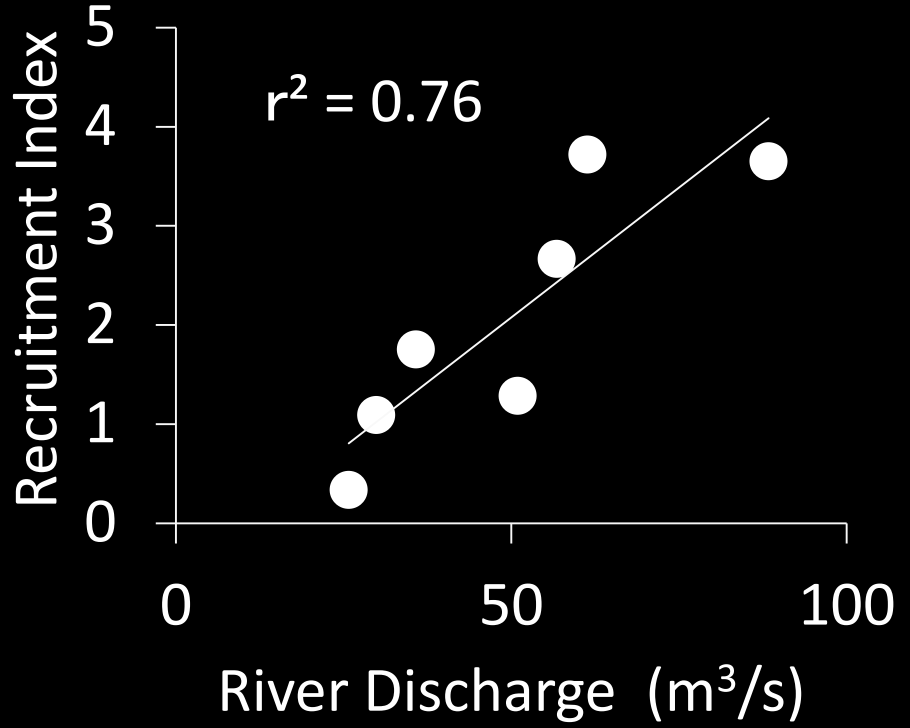
- Wind
- Temperature
- River discharge

Large variation in recruitment

Recruitment and environment (2007 - 2013)

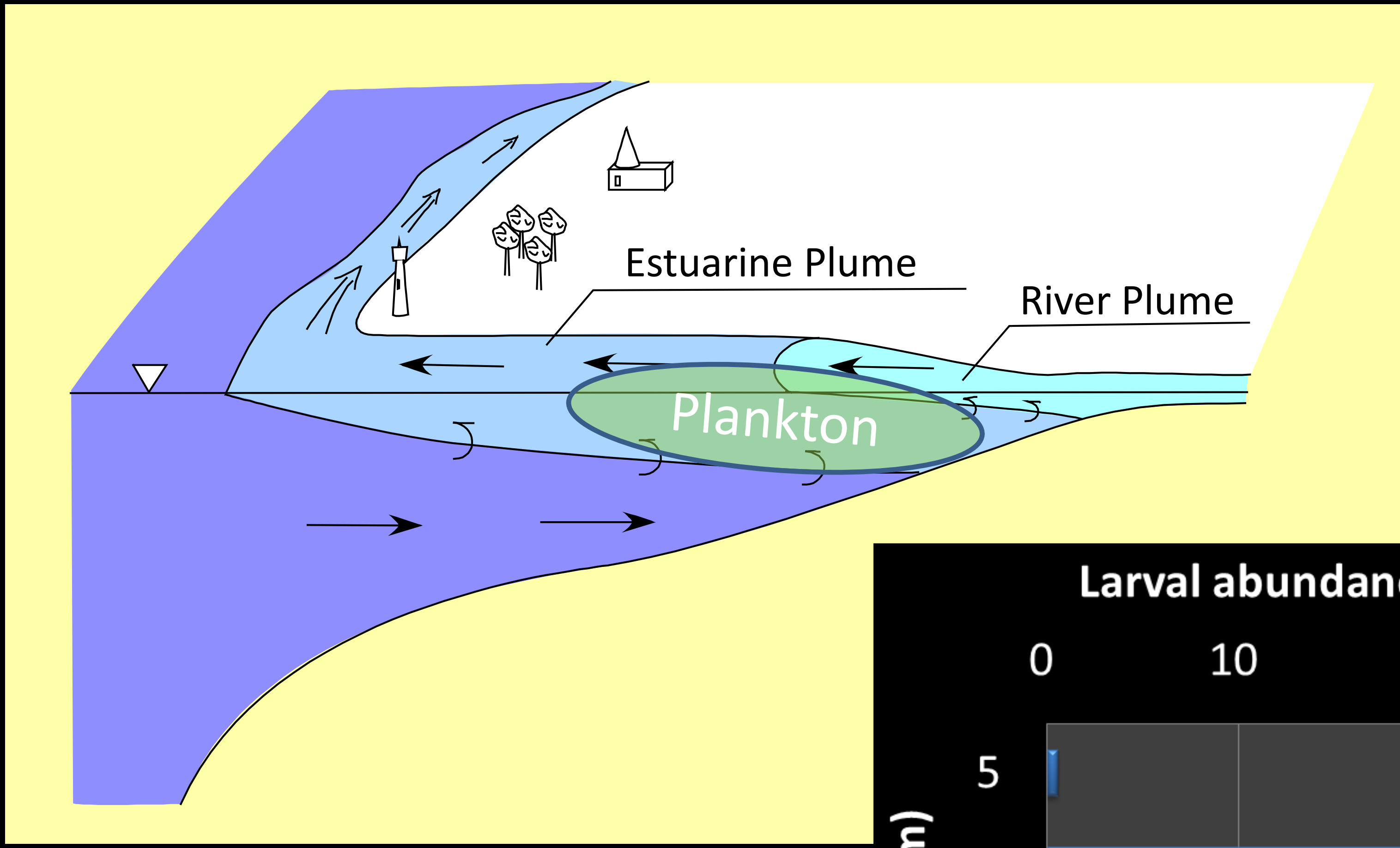
Factor	*r*
River discharge	0.872*
Temperature	-0.073
Northerly wind	-0.026
Westerly wind	0.075

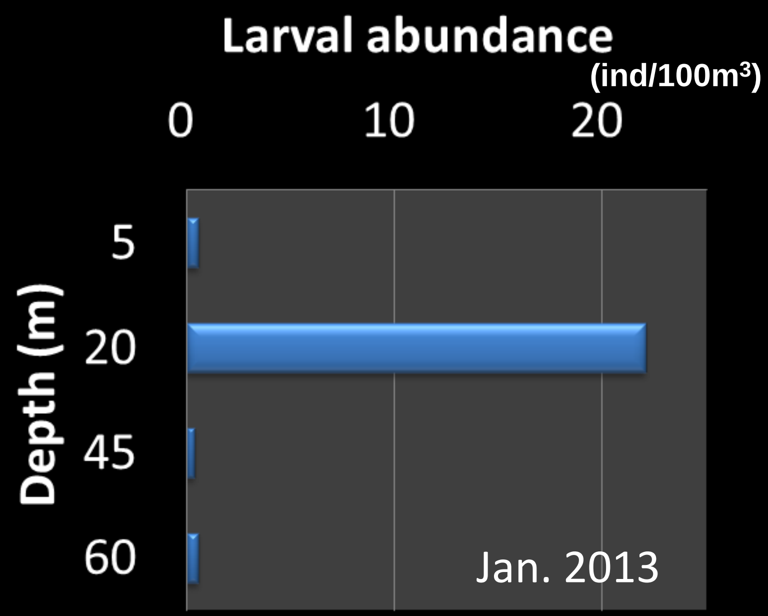
* $p<0.05$



Recruitment is correlated with river discharge.

Influence of river water on the larval survival





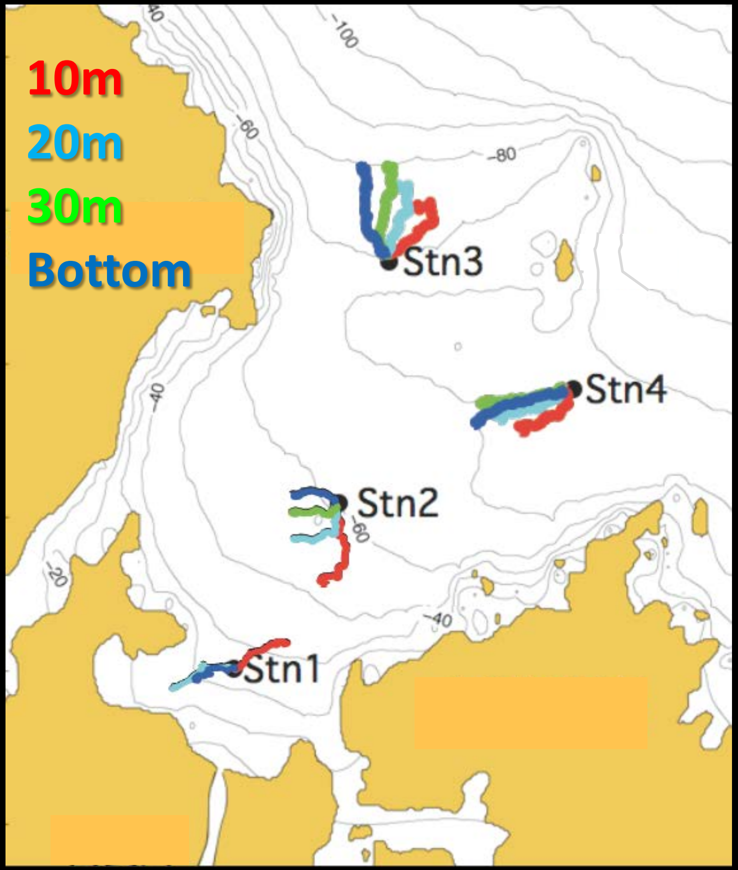
Large river discharge enhances

- Estuarine circulation
- Production

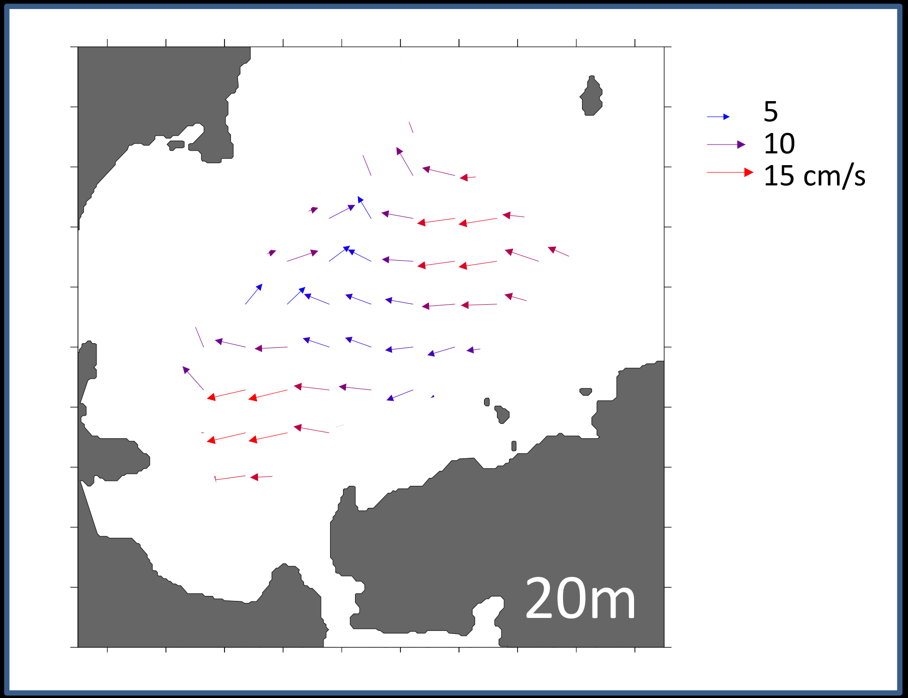
Current fields in Tango Bay

Onshore-ward current at 20 m depth

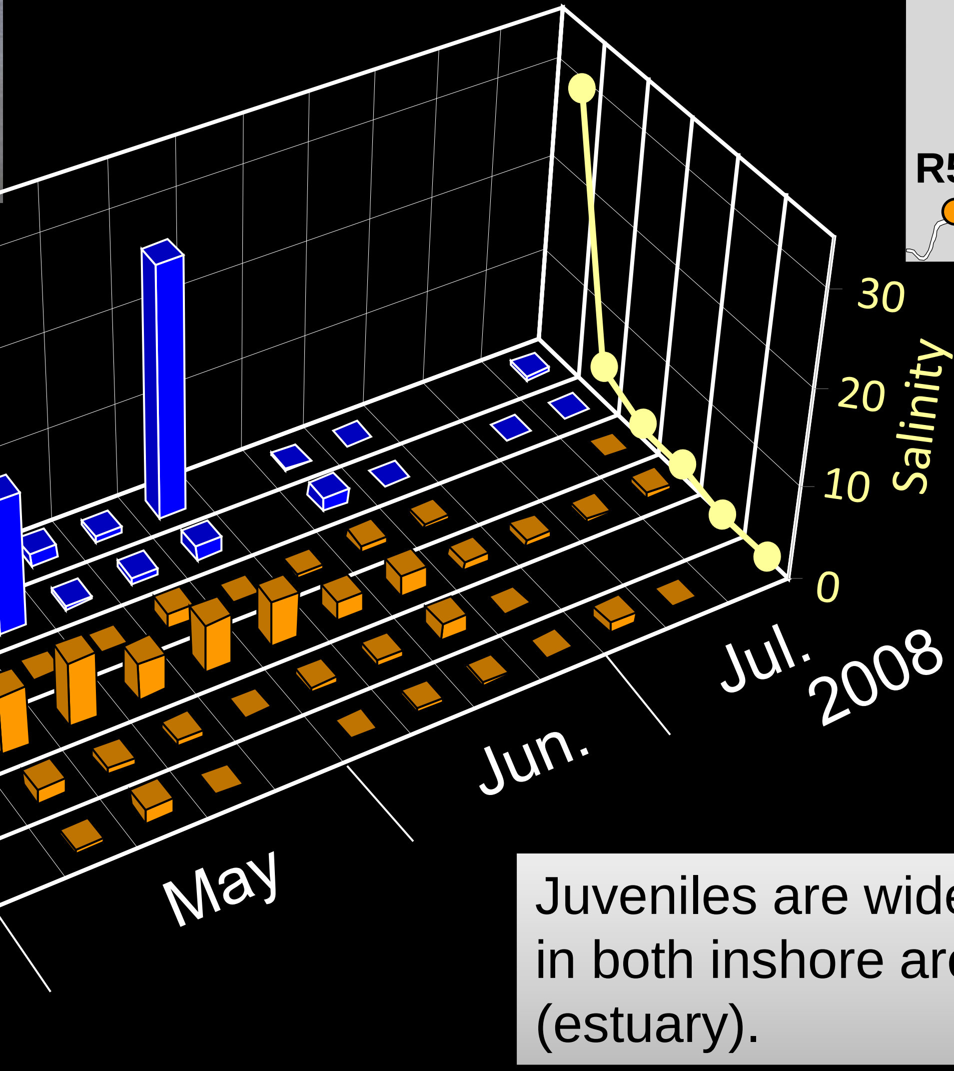
Progressive vectors
(Jan. – Mar 2012)

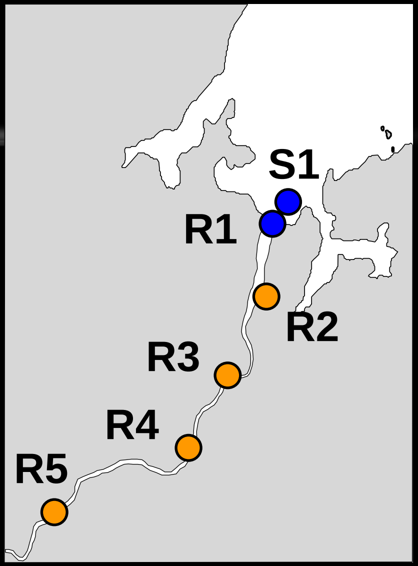


Wide ADCP observation
8 Jan. 2013



Distribution of seabass juveniles

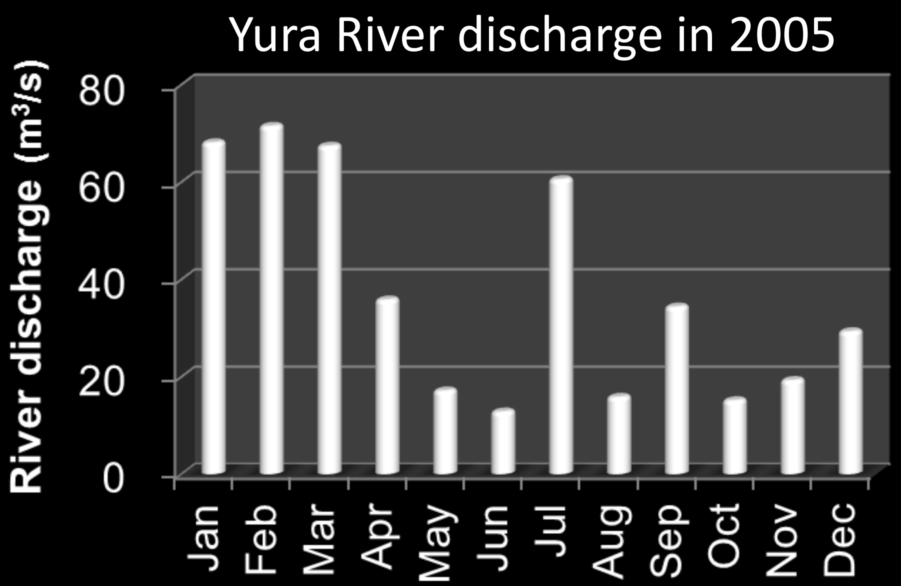


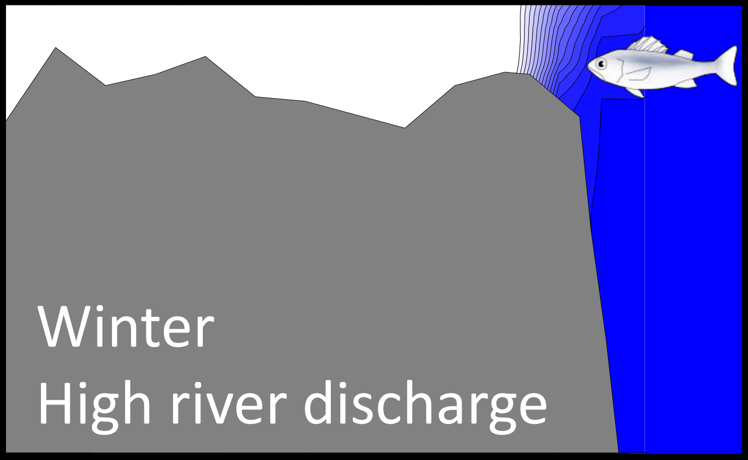


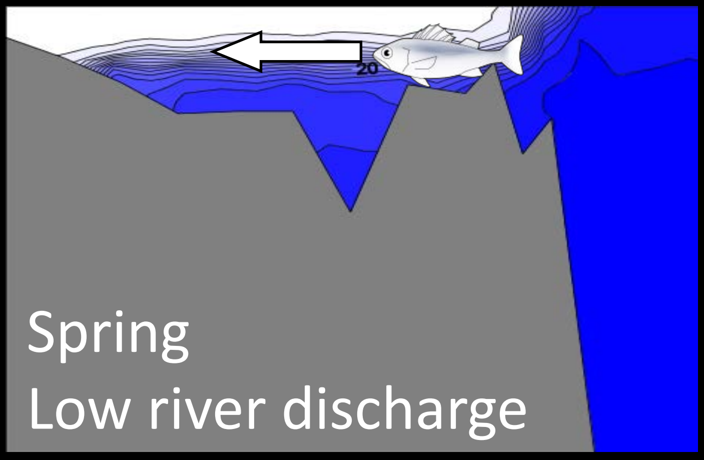
Juveniles are widely distributed in both inshore area and river (estuary).

River ascending mechanism of juveniles

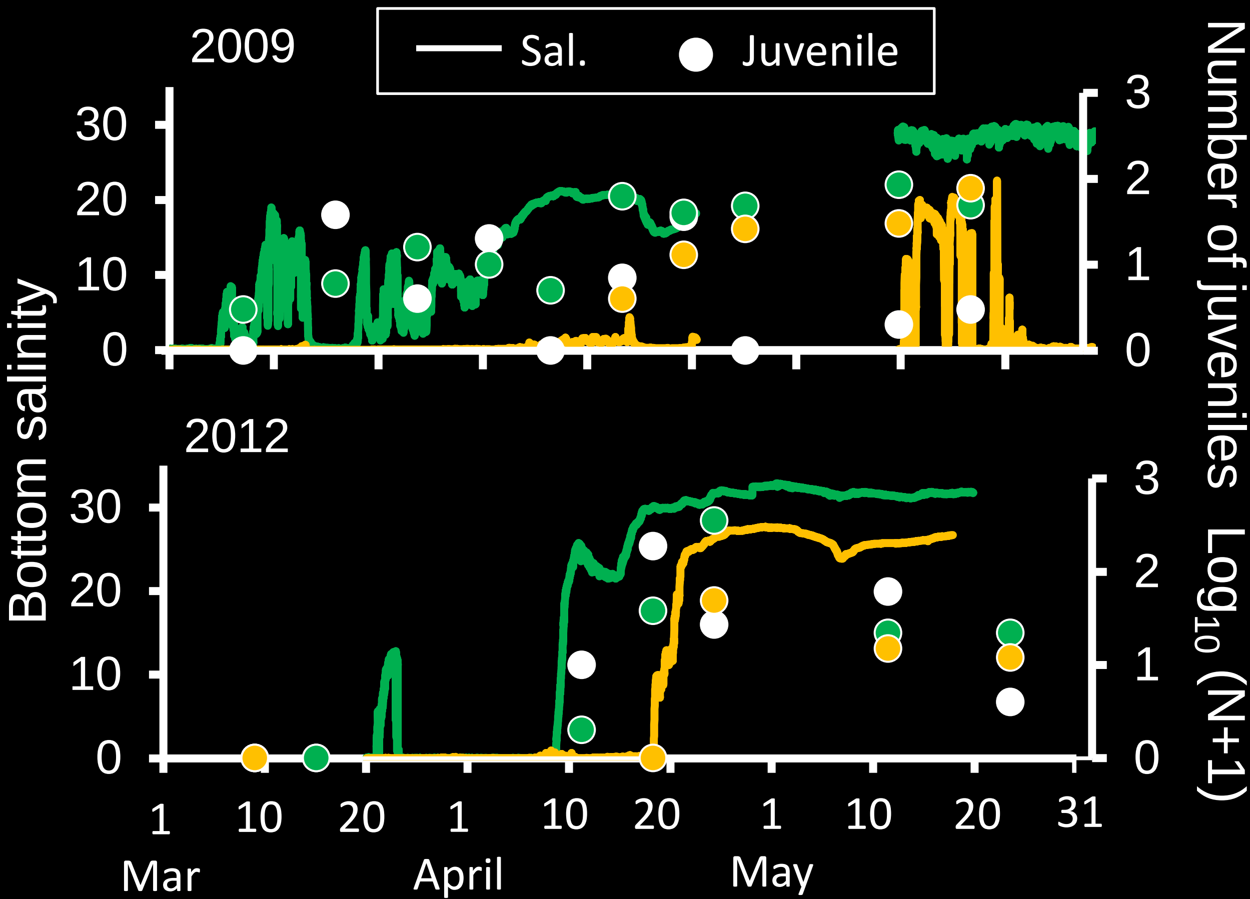
- Small Tide
  → Tidal transport ×
- Low river discharge in spring
  → Salt wedge intrusion √

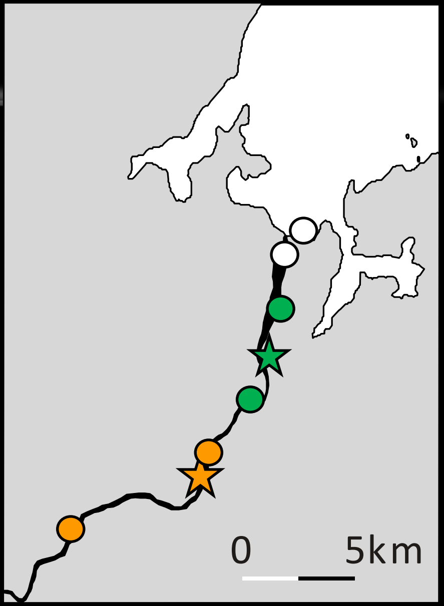






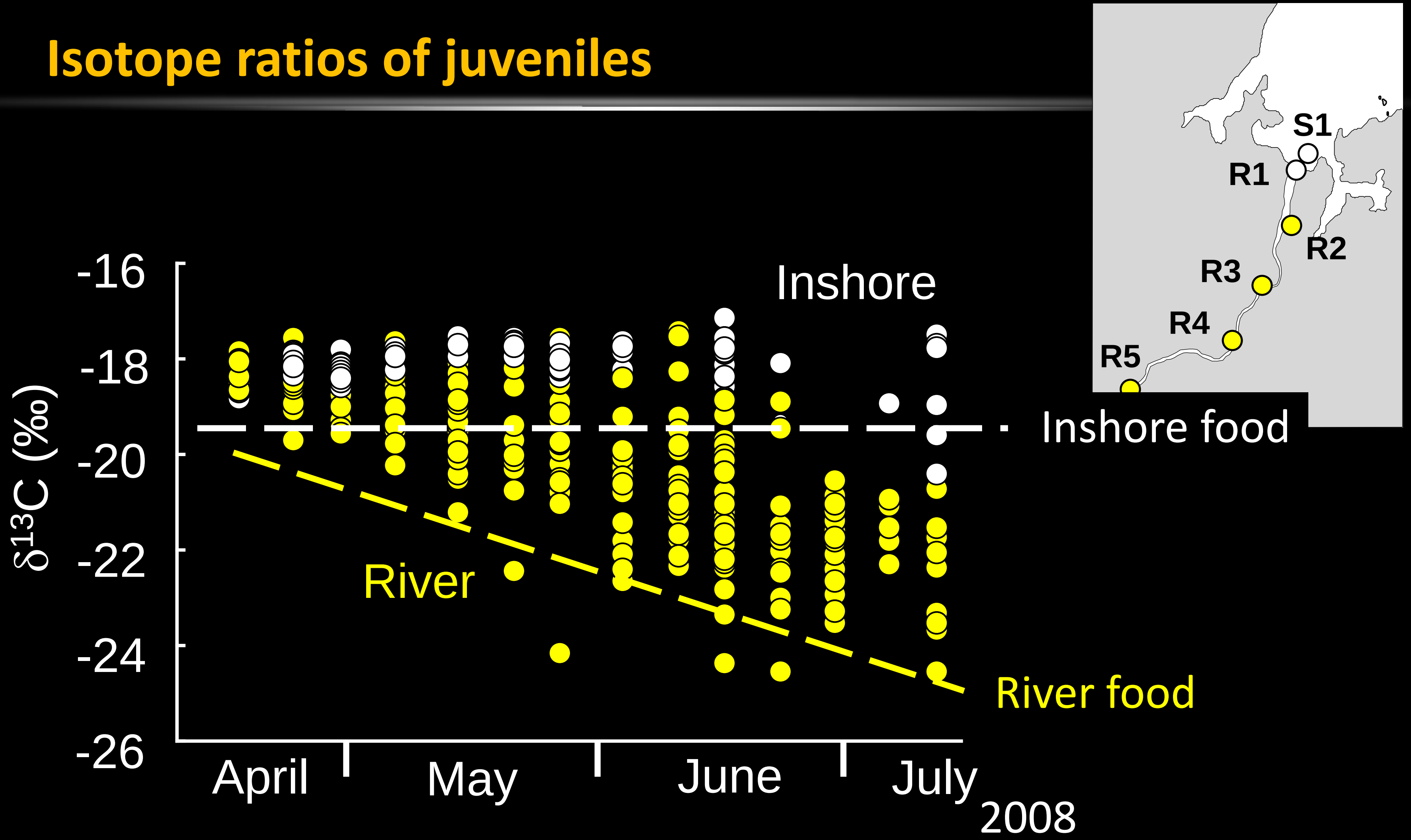
River ascending mechanism of juveniles





Large salinity changes must be a disadvantage for juveniles
→ Why do juveniles ascend the river?

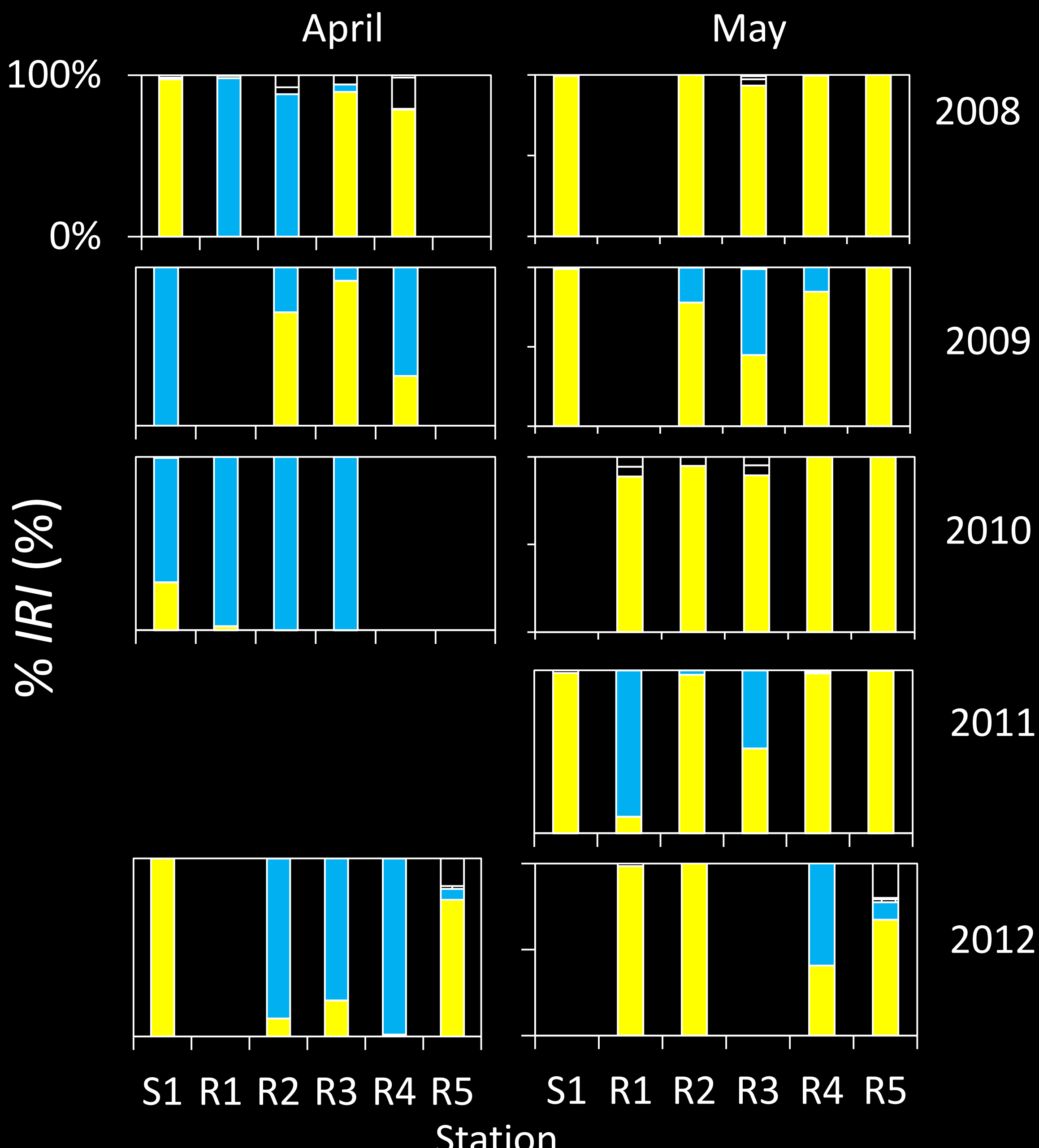
Isotope ratios of juveniles

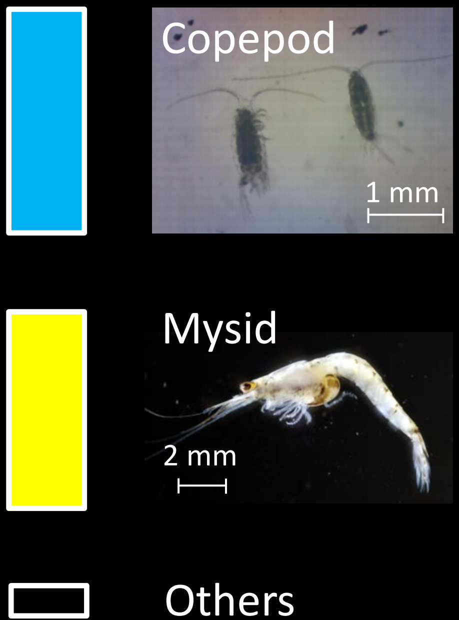


$\delta^{13}C$ values reflect foods

Inshore: Kept enriched value
River: Decreased with time
→ Bimodal migration

Stomach content analyses



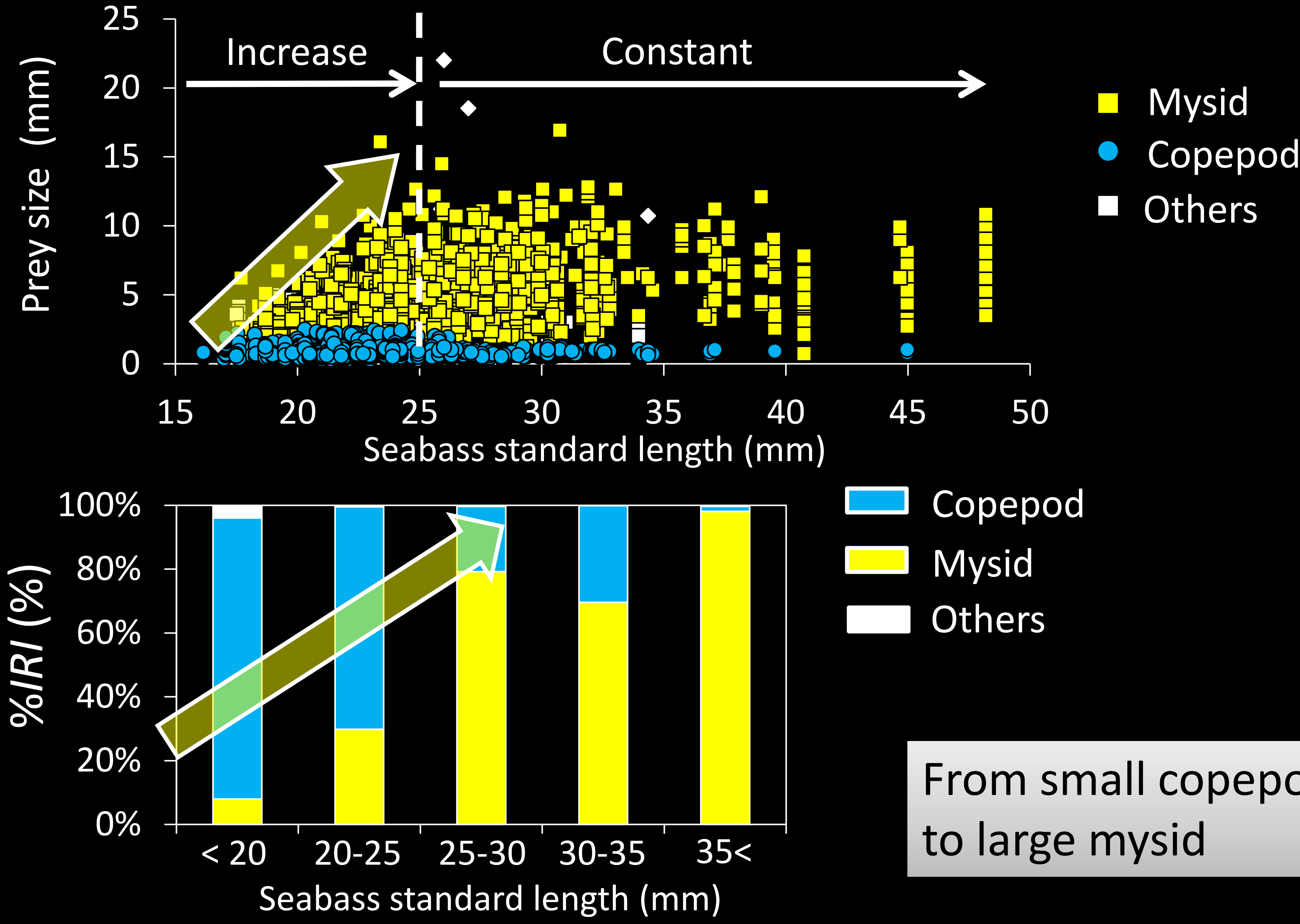


Important Prey

April
Copepod & Mysid

May
Mysid

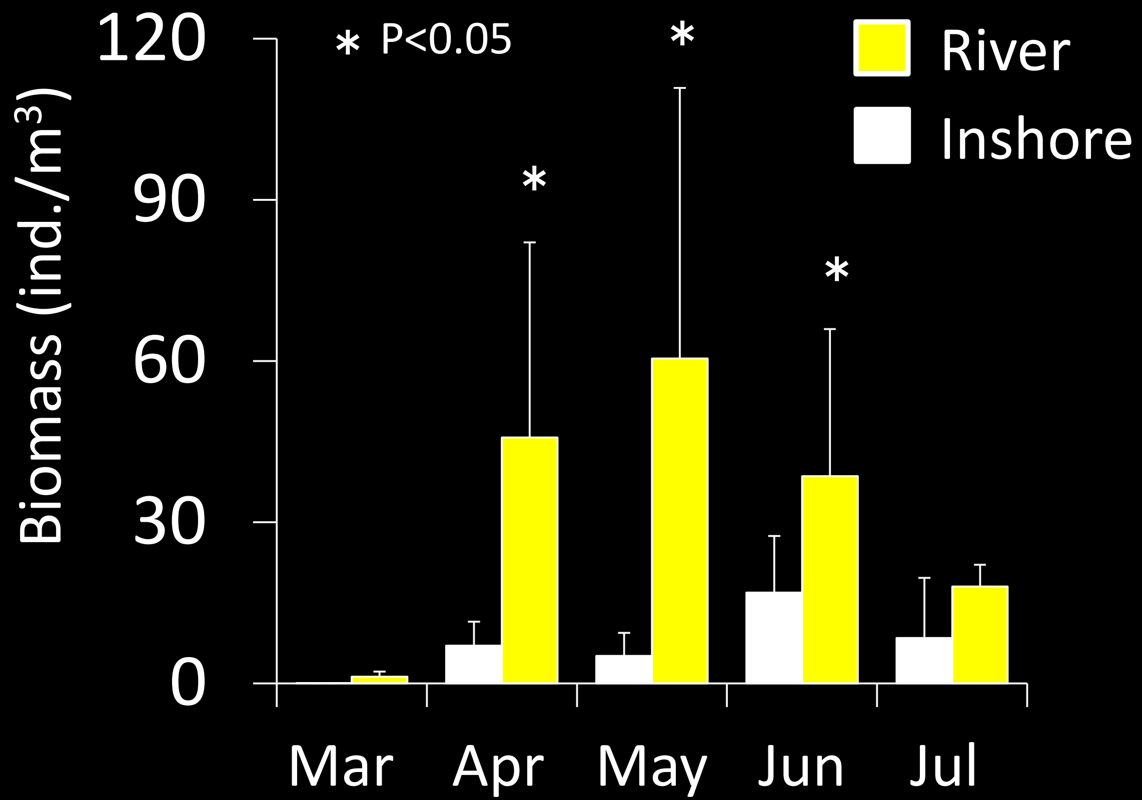
Size and importance of prey items

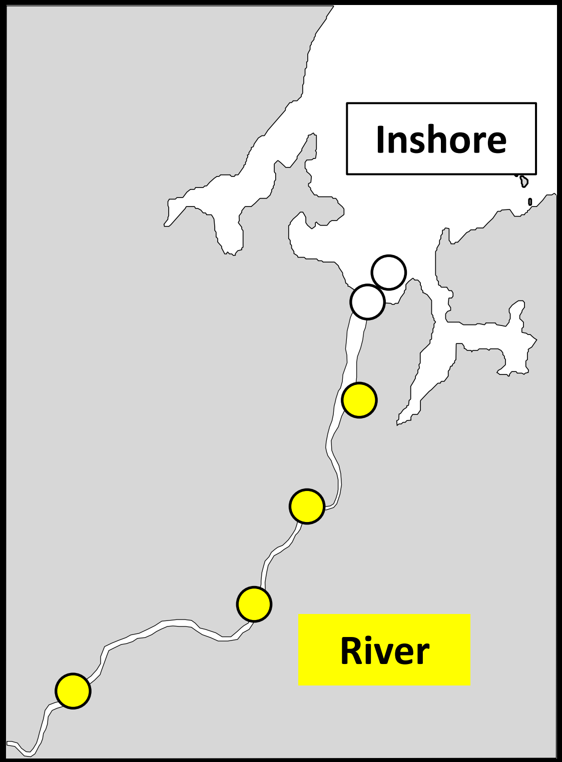


From small copepod to large mysid

Bimodal nurseries: River and Inshore area

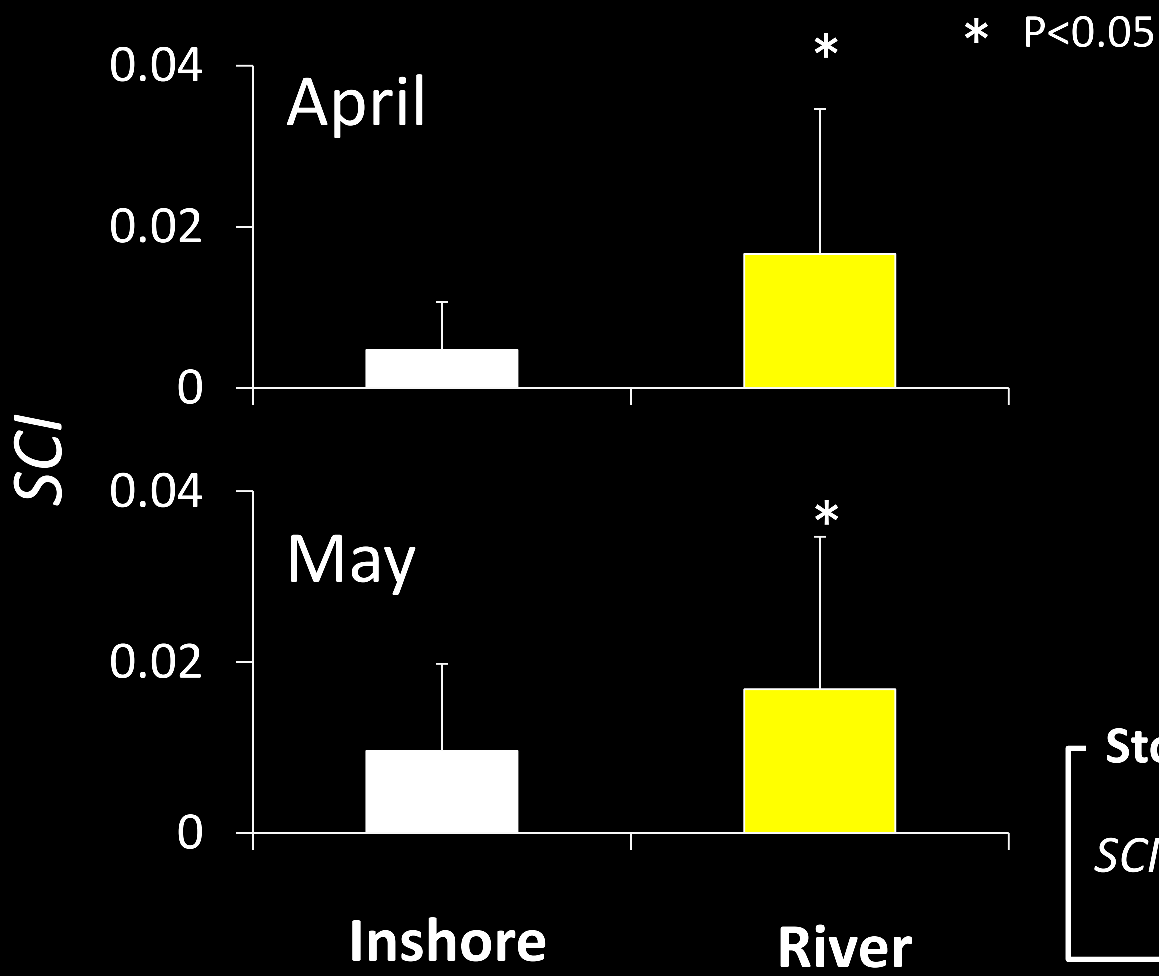
Biomass of mysid （2009-2012）

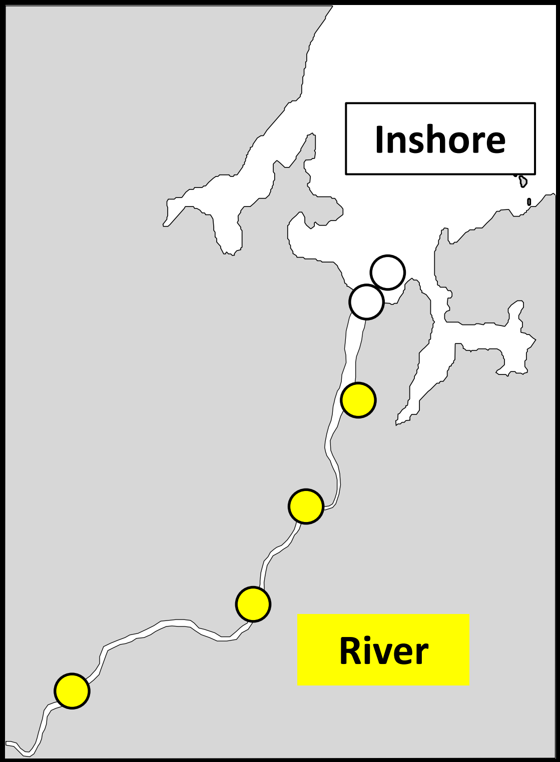




There are more abundant foods in the river than the sea.

Comparison of feeding between the two habitats





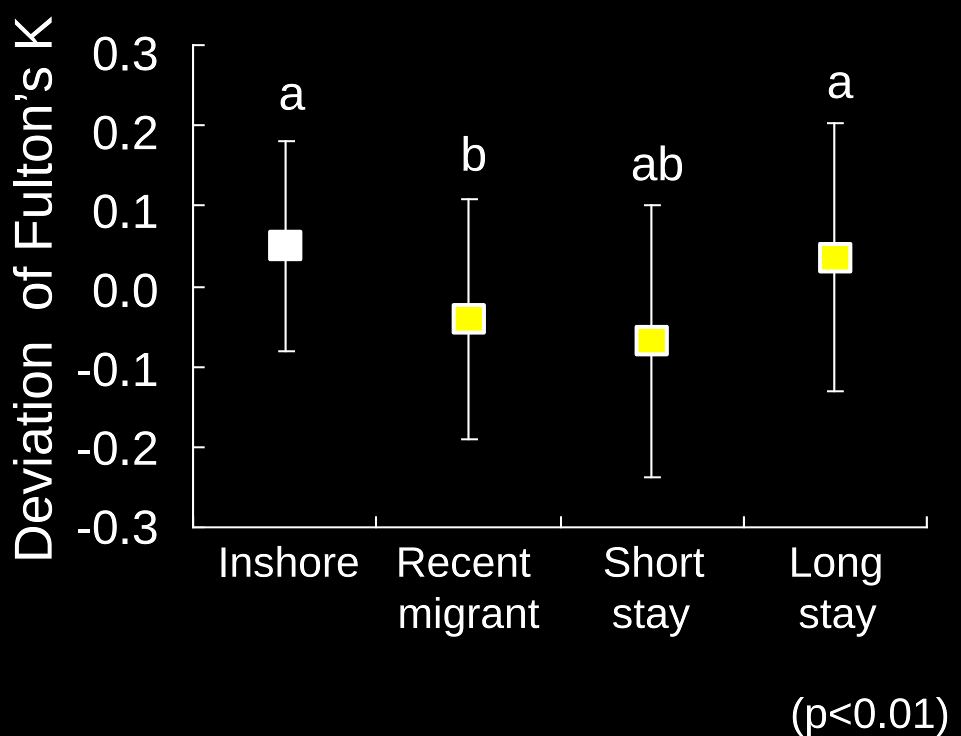
Stomach Content Index

$$SCI = \frac{\text{Stomach contents weight}}{\text{Fish body weight}}$$

Juveniles ascended the river consumed more foods than residents in the inshore area.

Fulton's Body Condition Index

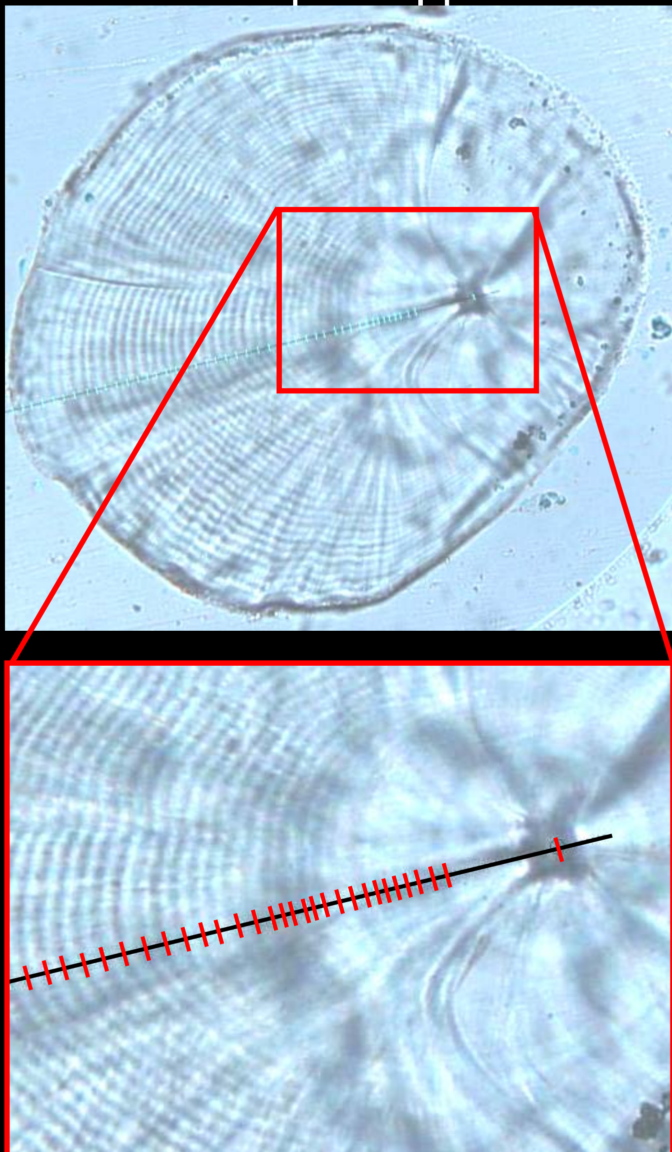
$$\text{Fulton's K} = \frac{\text{Body weight} \times 100}{\text{Body length}^3}$$



- Recent migrants show significantly lower K than inshore residents.
  → Poor conditioned juveniles migrate to the river.
- Differences in K were not significant between inshore residents and long staying juveniles in the river.
  → Body condition recovered during their stay in the river.

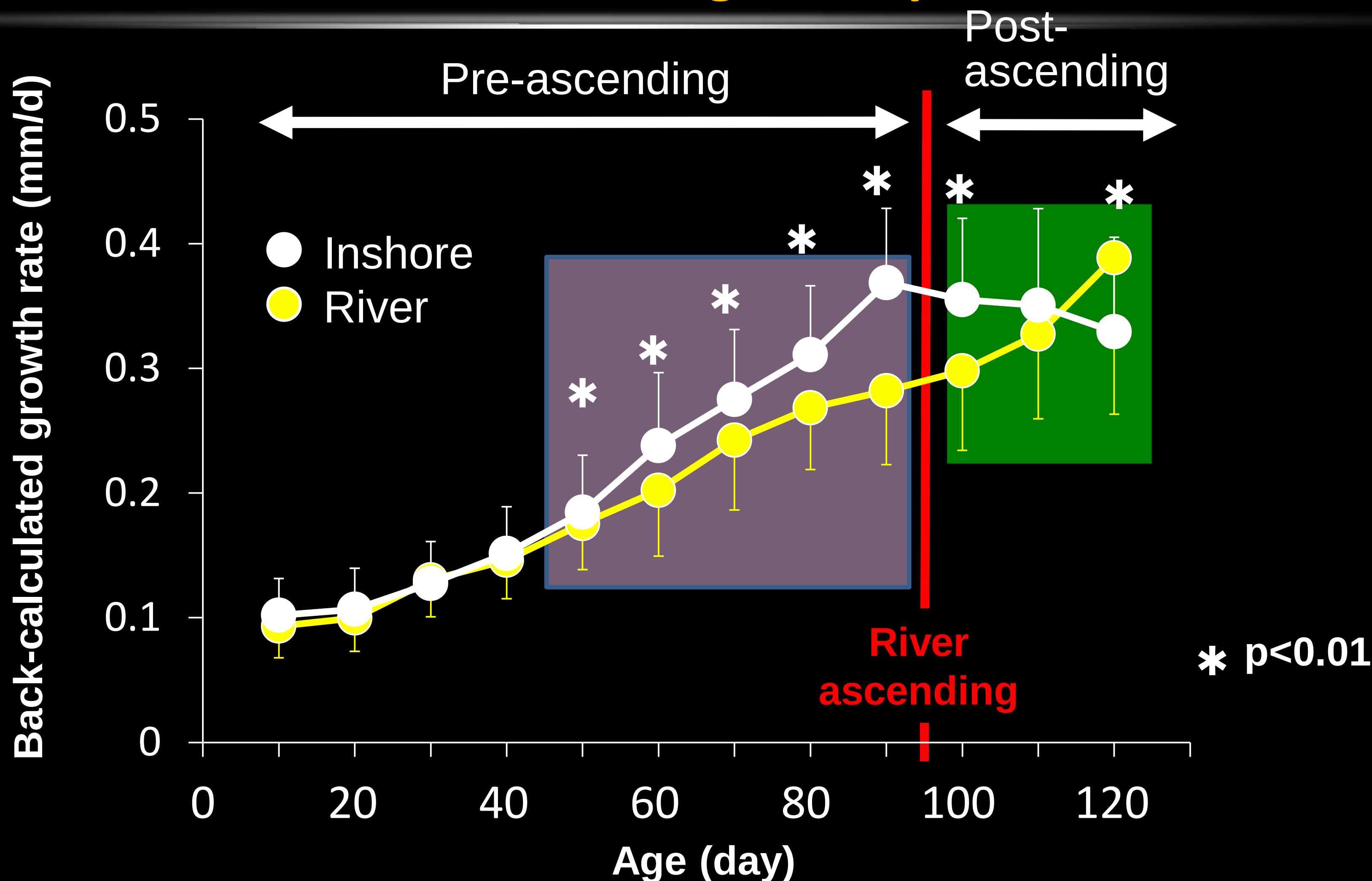
Otolith as a record of individual history

Otolith (lapillus) of seabass at 49



- Number of rings
  → Estimates of age
- Otolith increment width
  → Back-calculation of the body lengths
- Sr/Ca analysis
  → Estimates of habitat

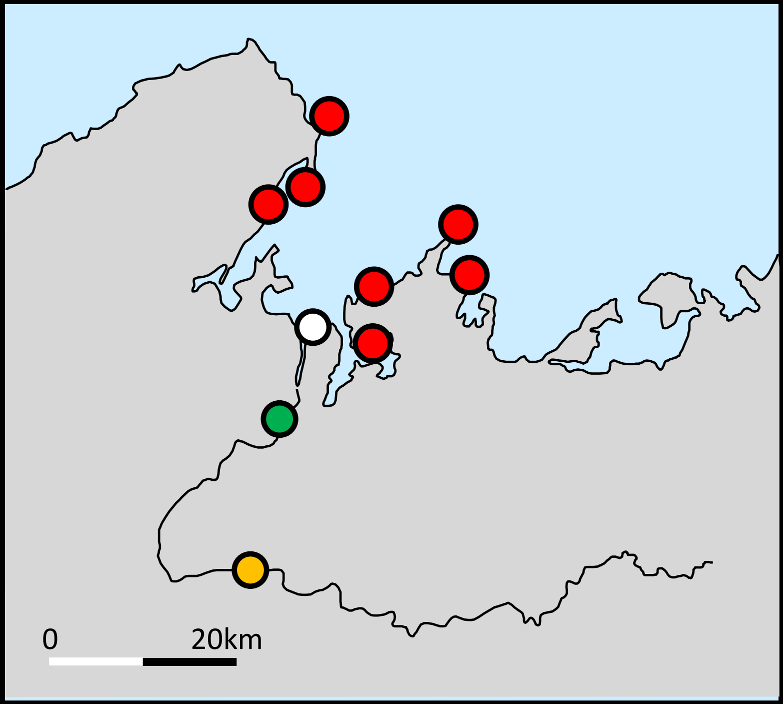
Growth records in different migration pattern



- Worse growth juveniles tend to migrate into river
- Juveniles in the river grow faster than inshore fish after ascending the river

Otolith (sagitta) Sr/Ca showing migration pattern

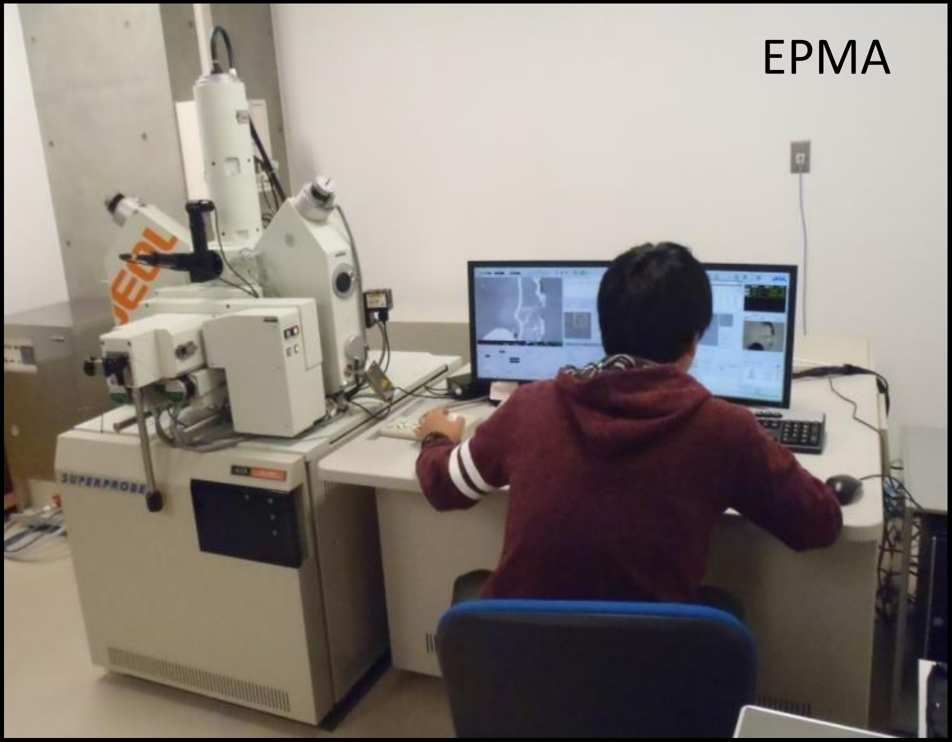
Sampling points



Otolith Strontium concentration decreases when fish are exposed to freshwater.

→ habitats of juveniles

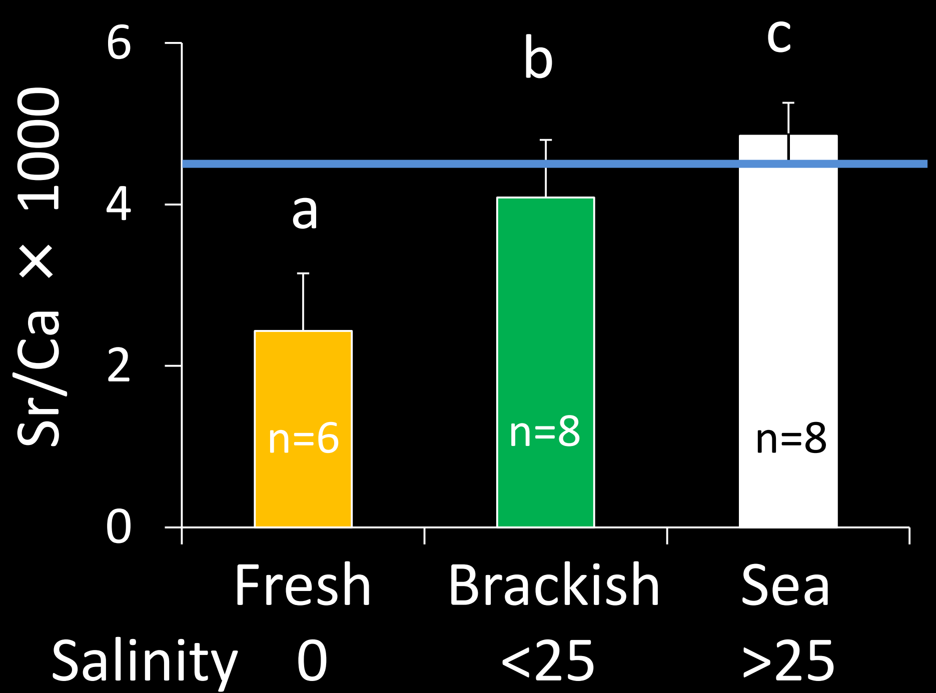
→ Contribution of each nursery area as a nursery

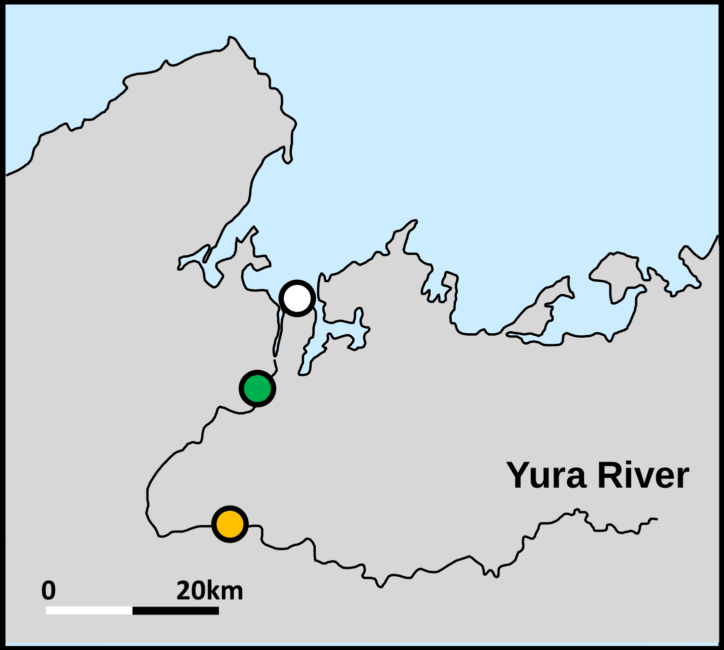


- Juveniles → Criterion
  - ○ Seawater
  - ● Brackish water
  - ● Freshwater
- Adults ● → Contribution

Threshold criterion of Sr/Ca to define the nursery type

Juveniles





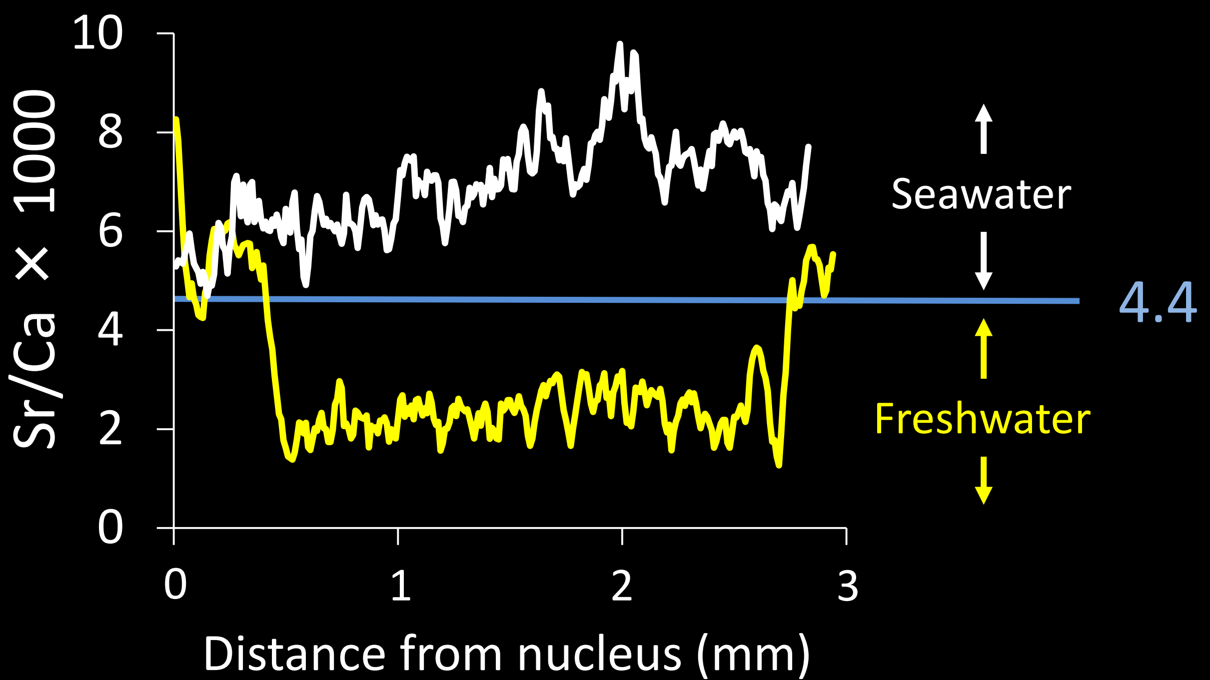
Sr/Ca of otolith in the river were significantly low.

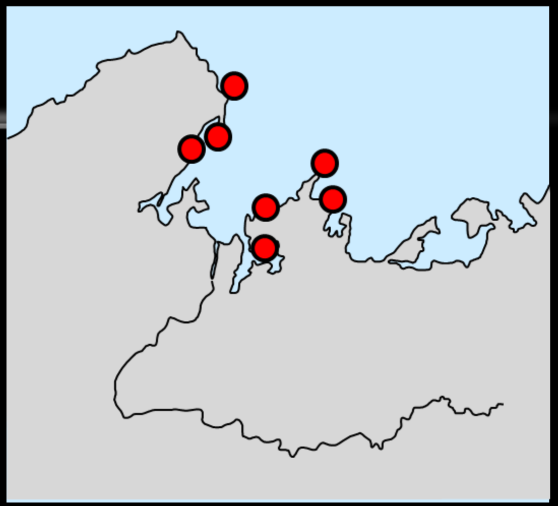
➡ River migrants: $< 4.4 \times 10^{-3}$

Inshore residents: $< 4.4 \times 10^{-3}$ (average – SD)

Sr/Ca of adult seabass otolith

Adults Sr/Ca





- ➢ Individuals with higher Sr/Ca than the criterion
  → Inshore resident group
- ➢ Individuals with lower Sr/Ca than the criterion
  → River migrant group

Contribution of rivers for recruitment of seabass

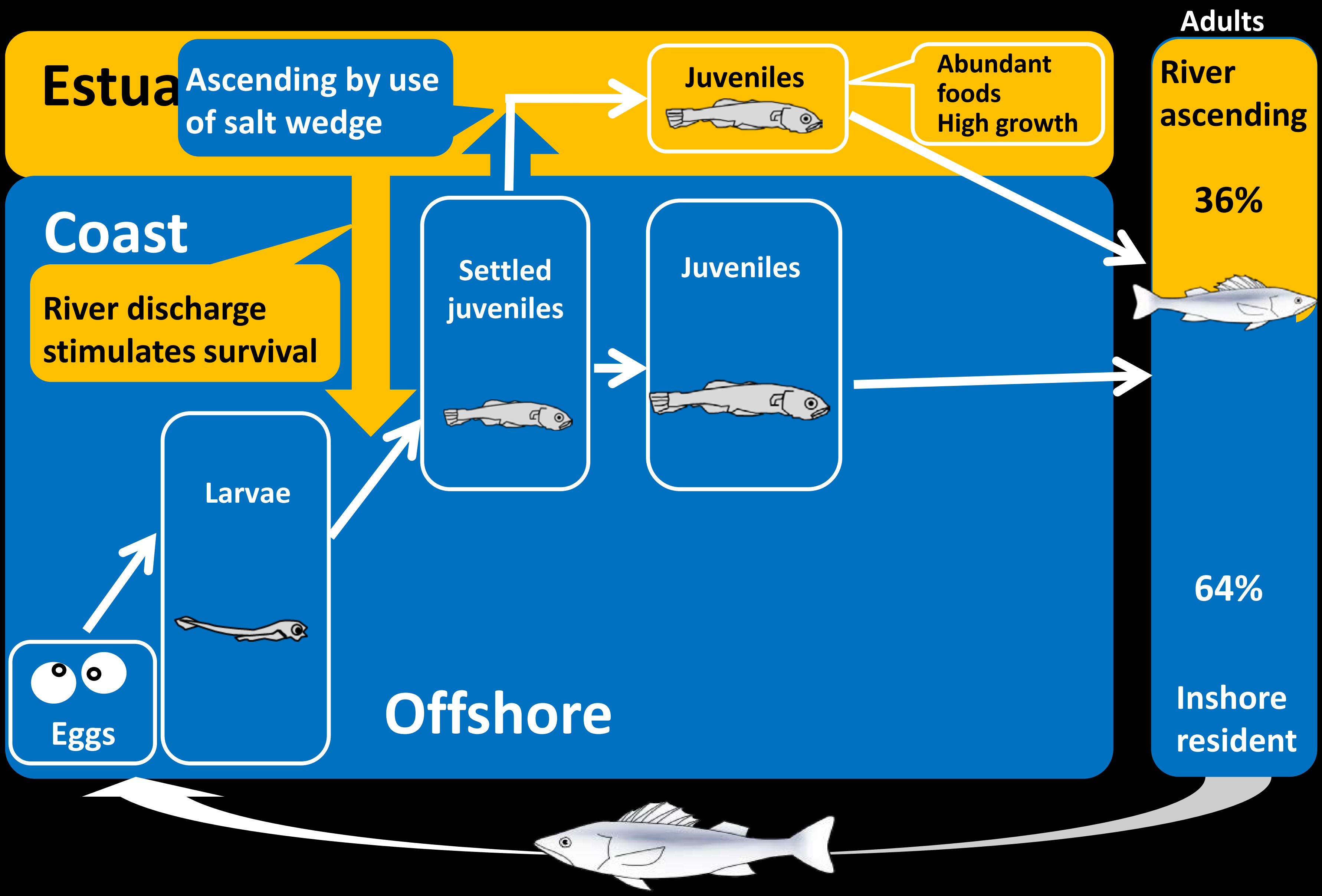
Among 107 adult samples

- Freshwater signal : 39
- Seawater signal : 68

	River	Inshore
Used as a nursery (%)	36	64
Length of water front (km)	31	153
Contribution/Length (%/km)	1.16	0.42

Rivers would be more valuable as seabass nurseries than inshore areas

Unique life history of seabass

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