Modelling fish dispersal and settlement in the Mediterranean Sea

Consequences for Hjort's aberrant drift hypothesis, and connectivity among MPAs
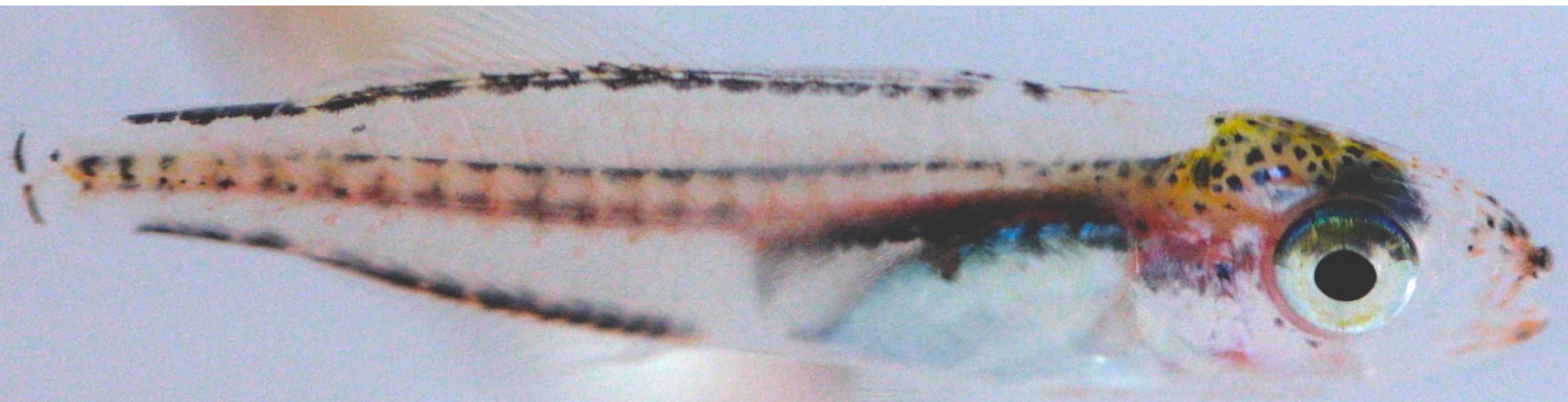
RAPPORTS ET PROCÈS-VERBAUX

VOLUME XX

FLUCTUATIONS IN THE GREAT FISHERIES OF NORTHERN EUROPE

VIEWED IN THE LIGHT OF BIOLOGICAL RESEARCH

BY

JOHAN HJORT

WITH 3 PLATES

3 4 5 6 7 8 9 10 11 12 13 14 15 16

1908.

1909.

1910.

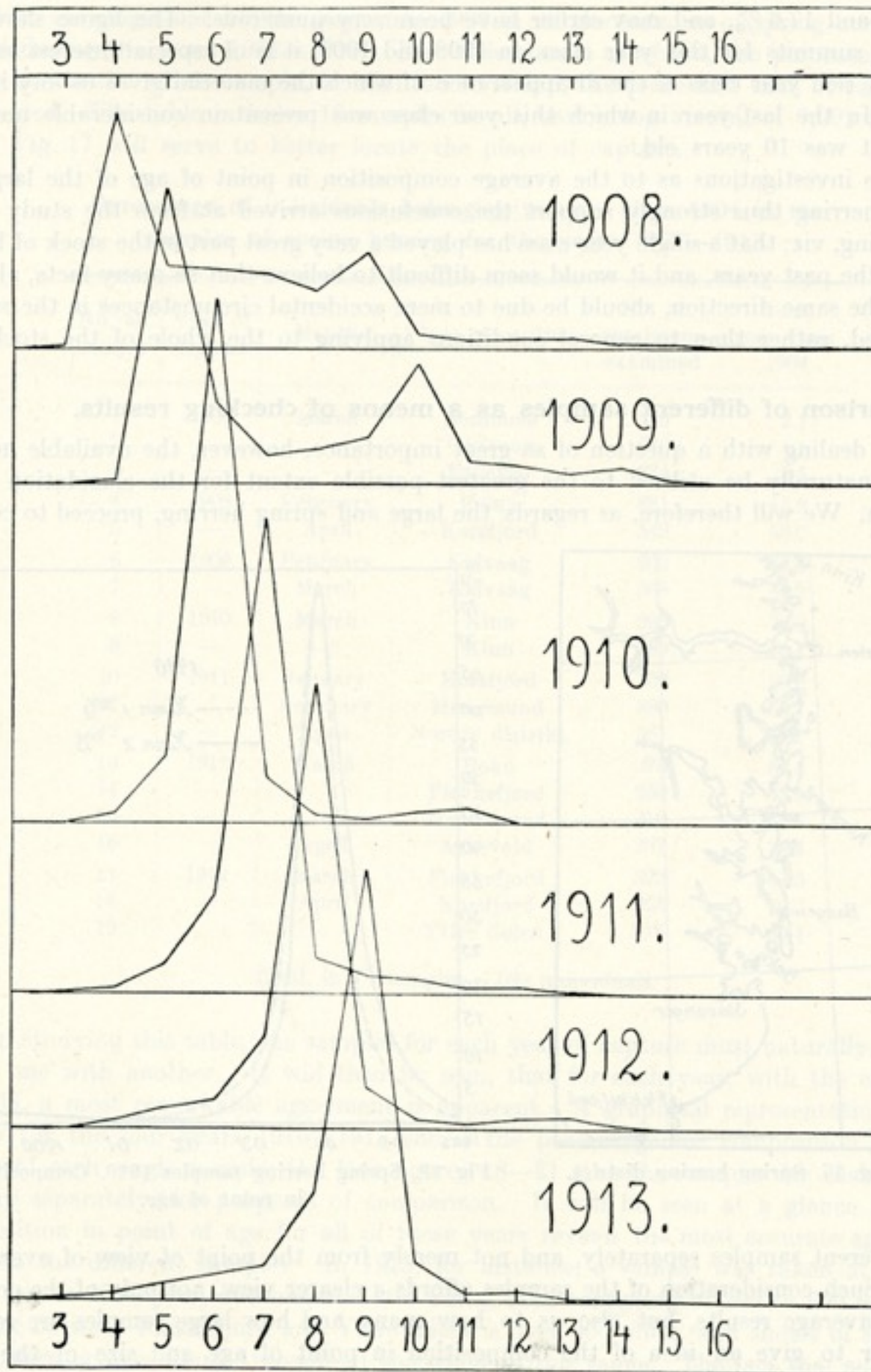1911.

1912.

1913.

3 4 5 6 7 8 9 10 11 12 13 14 15 16

Fig. 16. Composition in point of age of spring herring, 1908—1913.
4 = 4 years old (scales showing 4 winter rings).

Why study fish larvae?

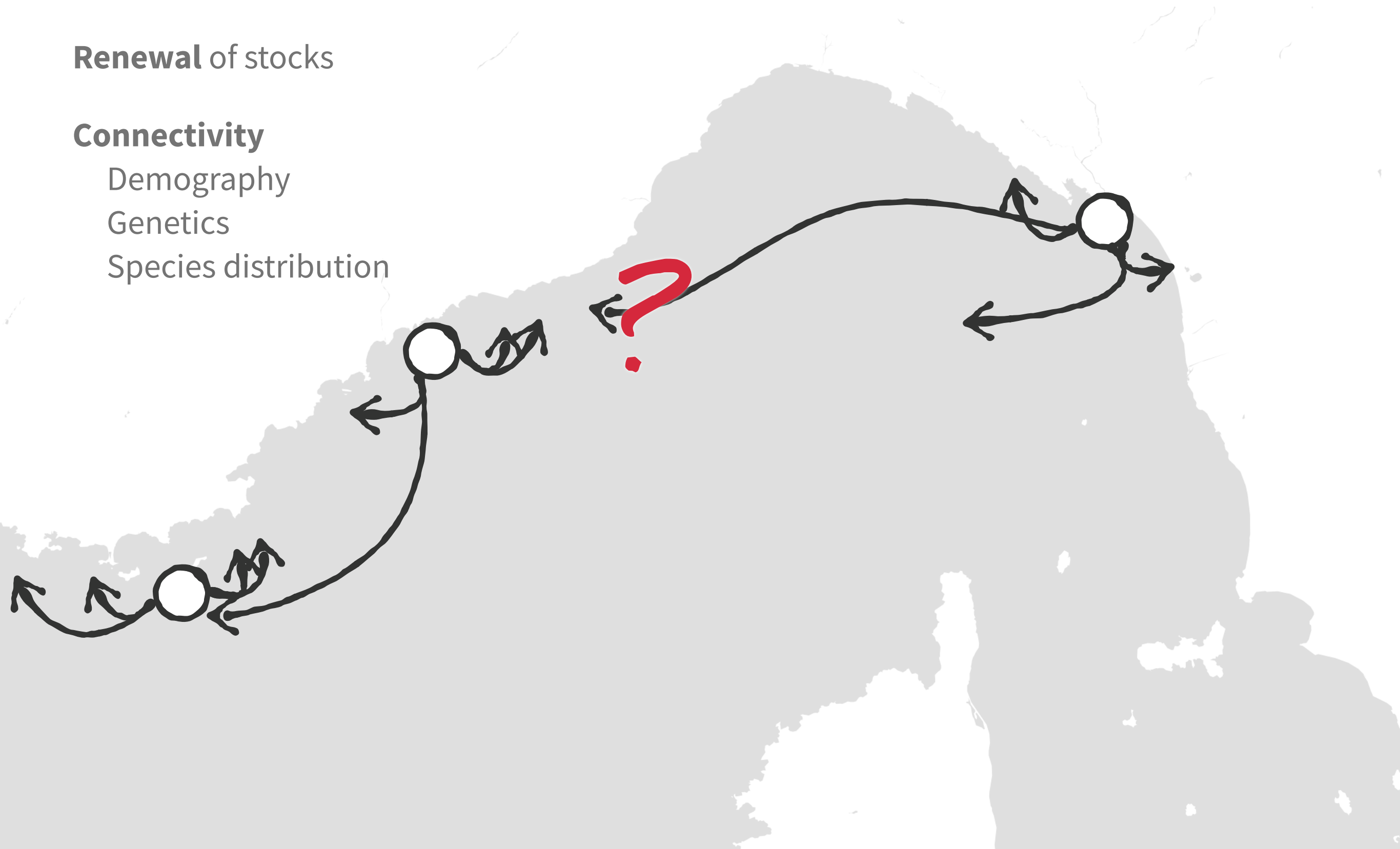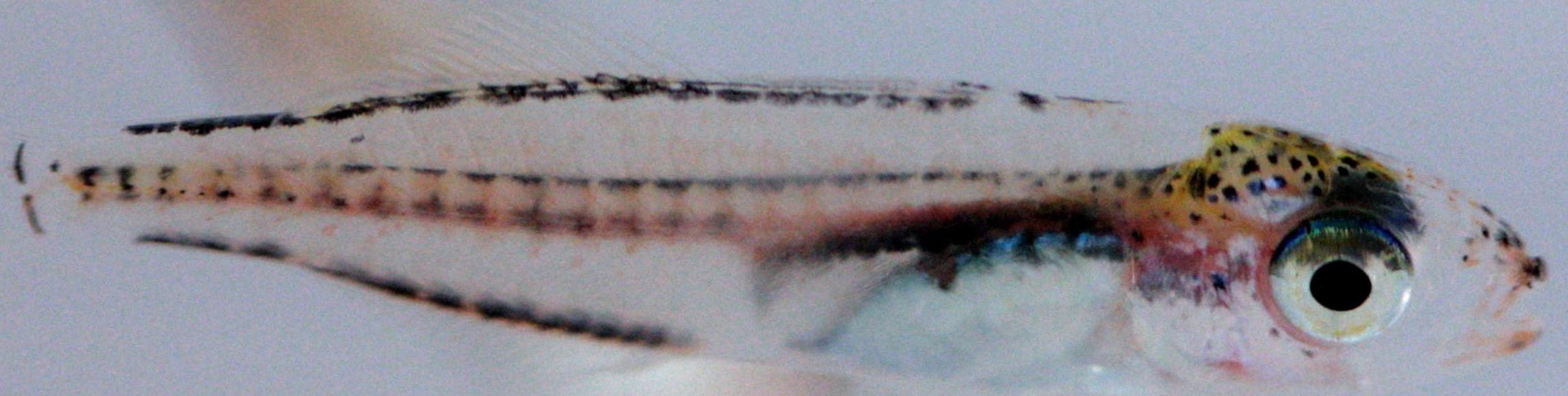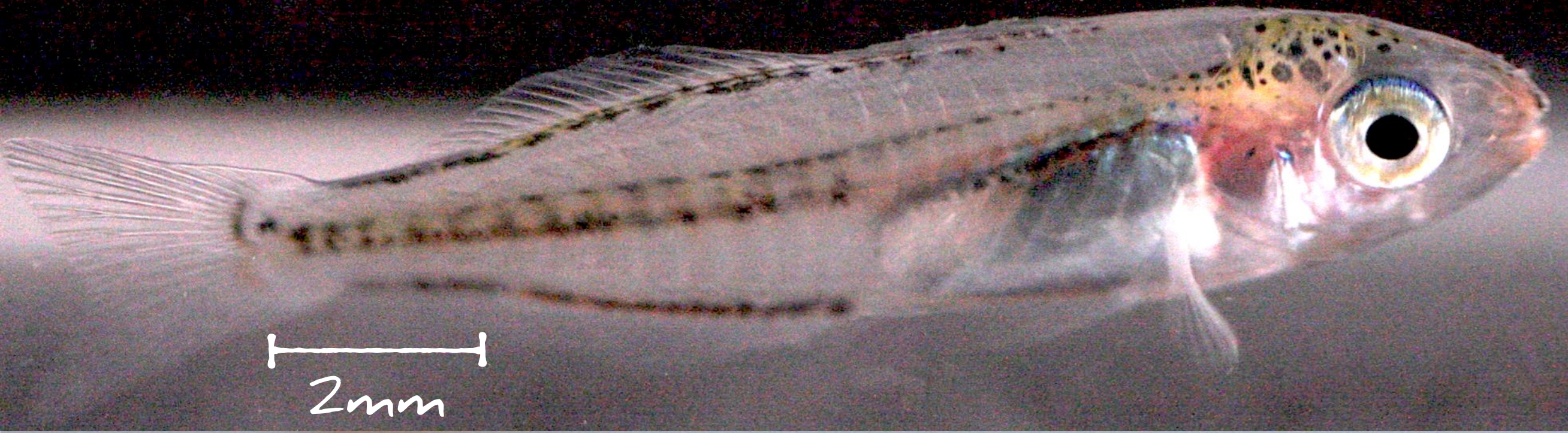**Renewal** of stocks

Connectivity
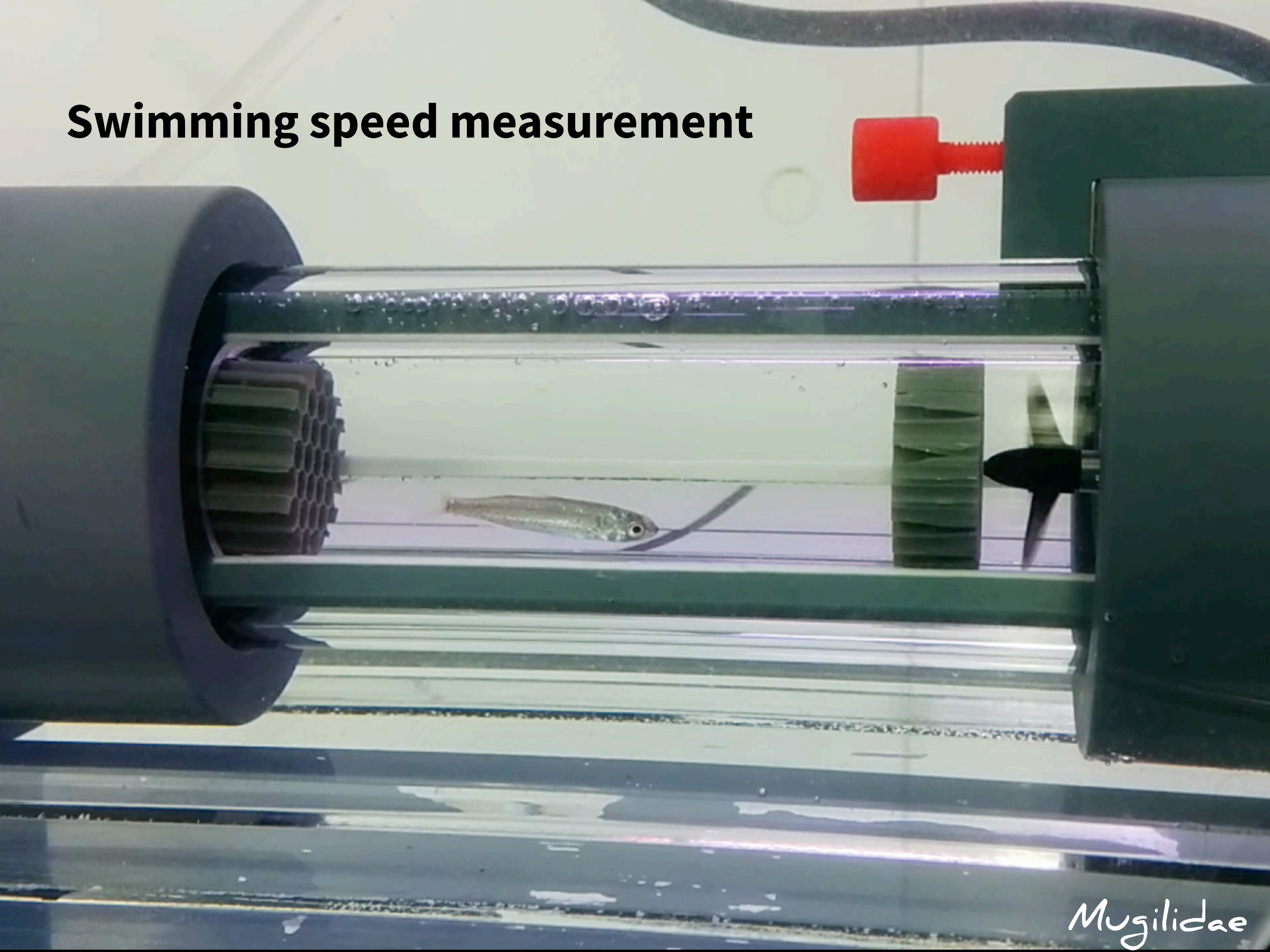   Demography
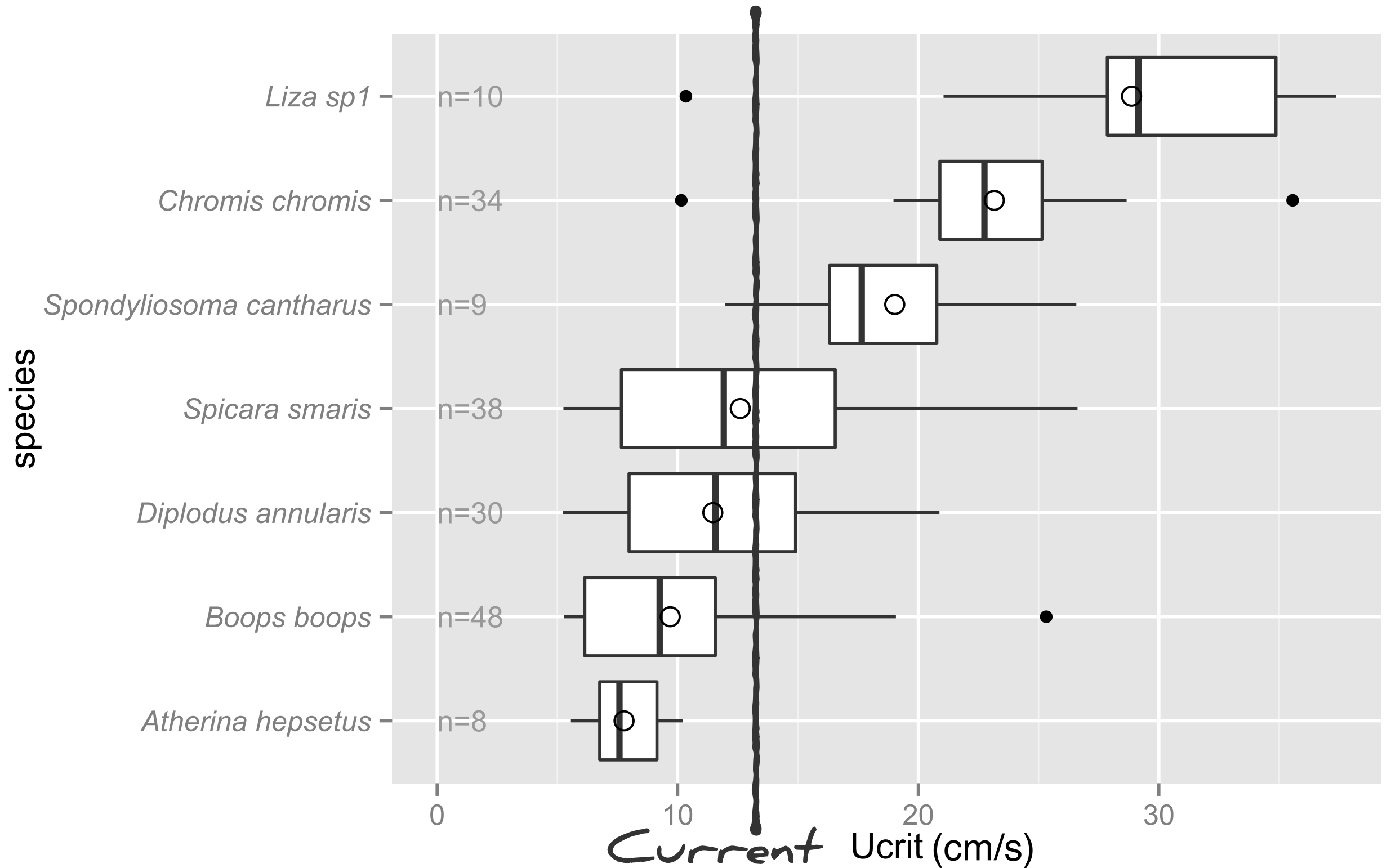   Genetics
   Species distribution

2mm

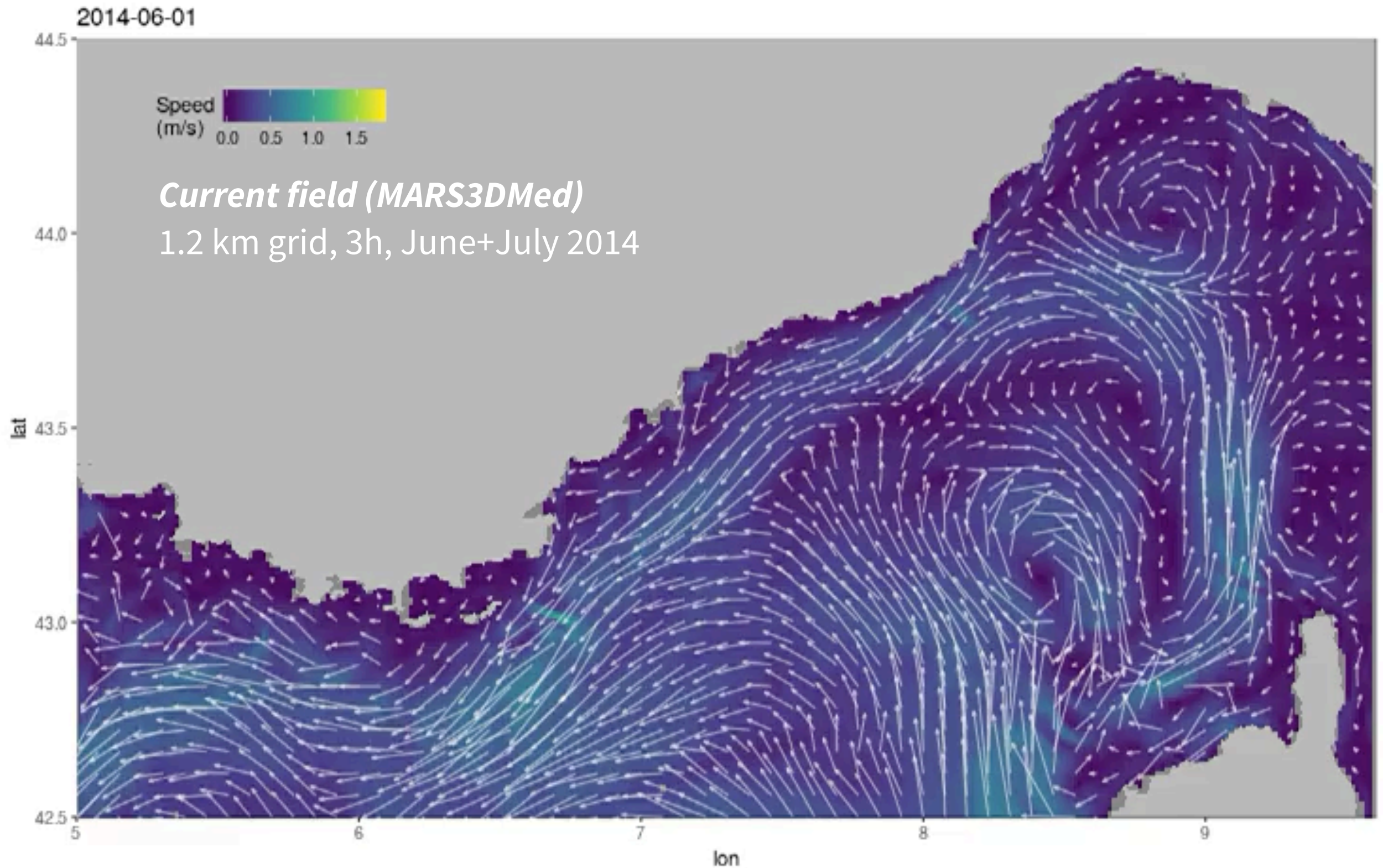© R. Crech'riou

Sarpa salpa

Swimming speed measurement

Yes, they swim fast

Fun comparisons!
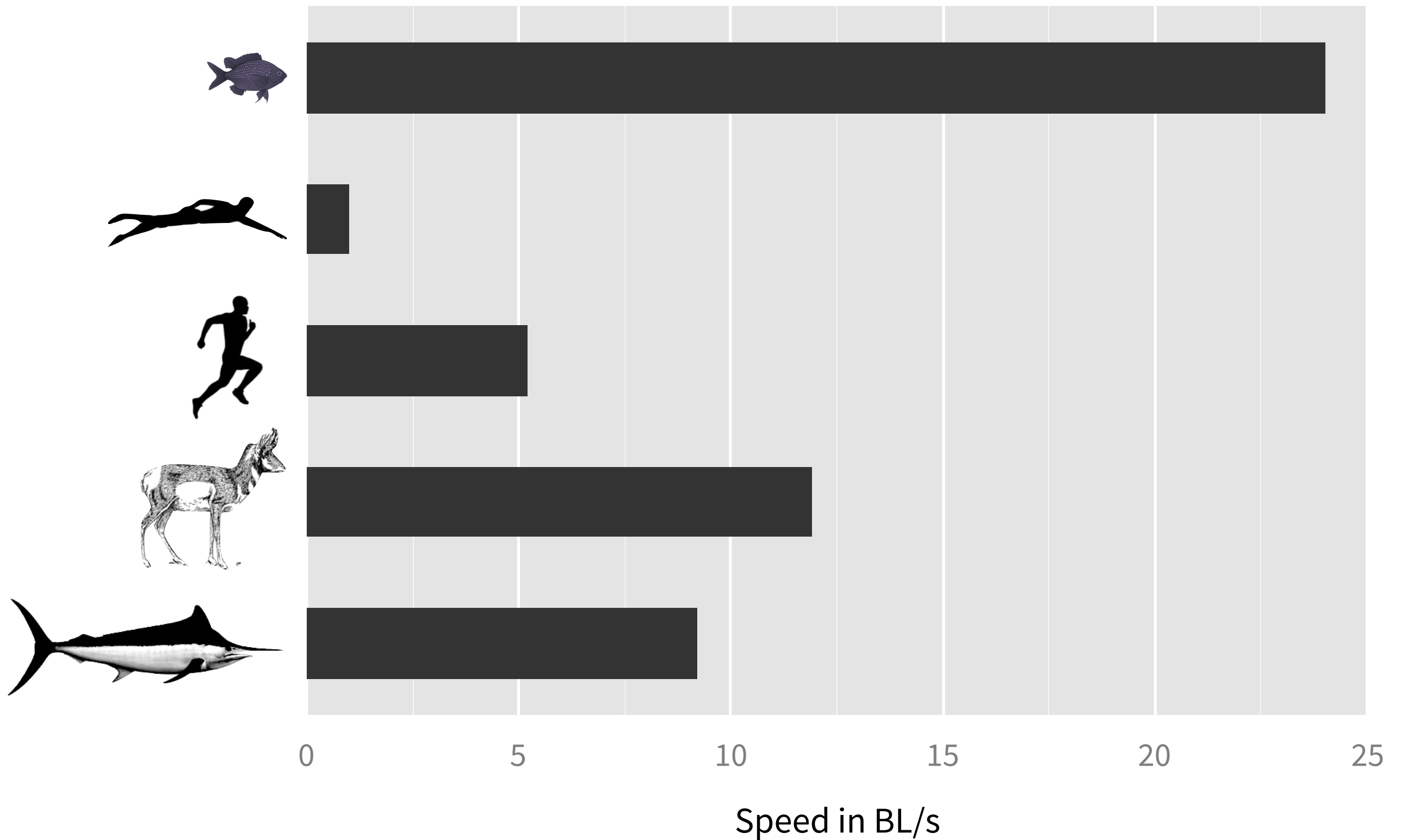
Ecological consequences:
model advection + swimming

2014-06-01

Speed (m/s): 0.0 0.5 1.0 1.5

Current field (MARS3DMed)
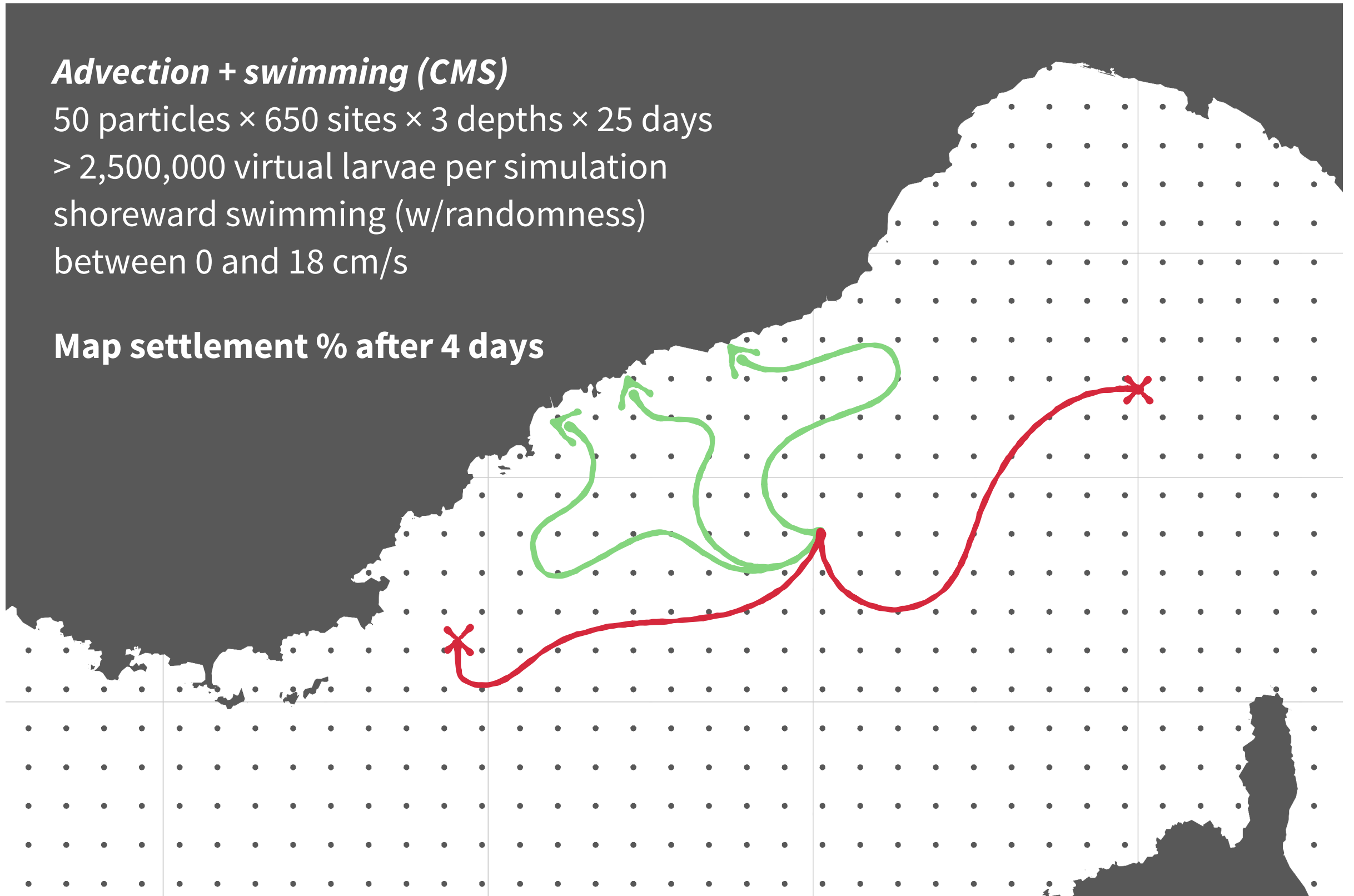1.2 km grid, 3h, June+July 2014
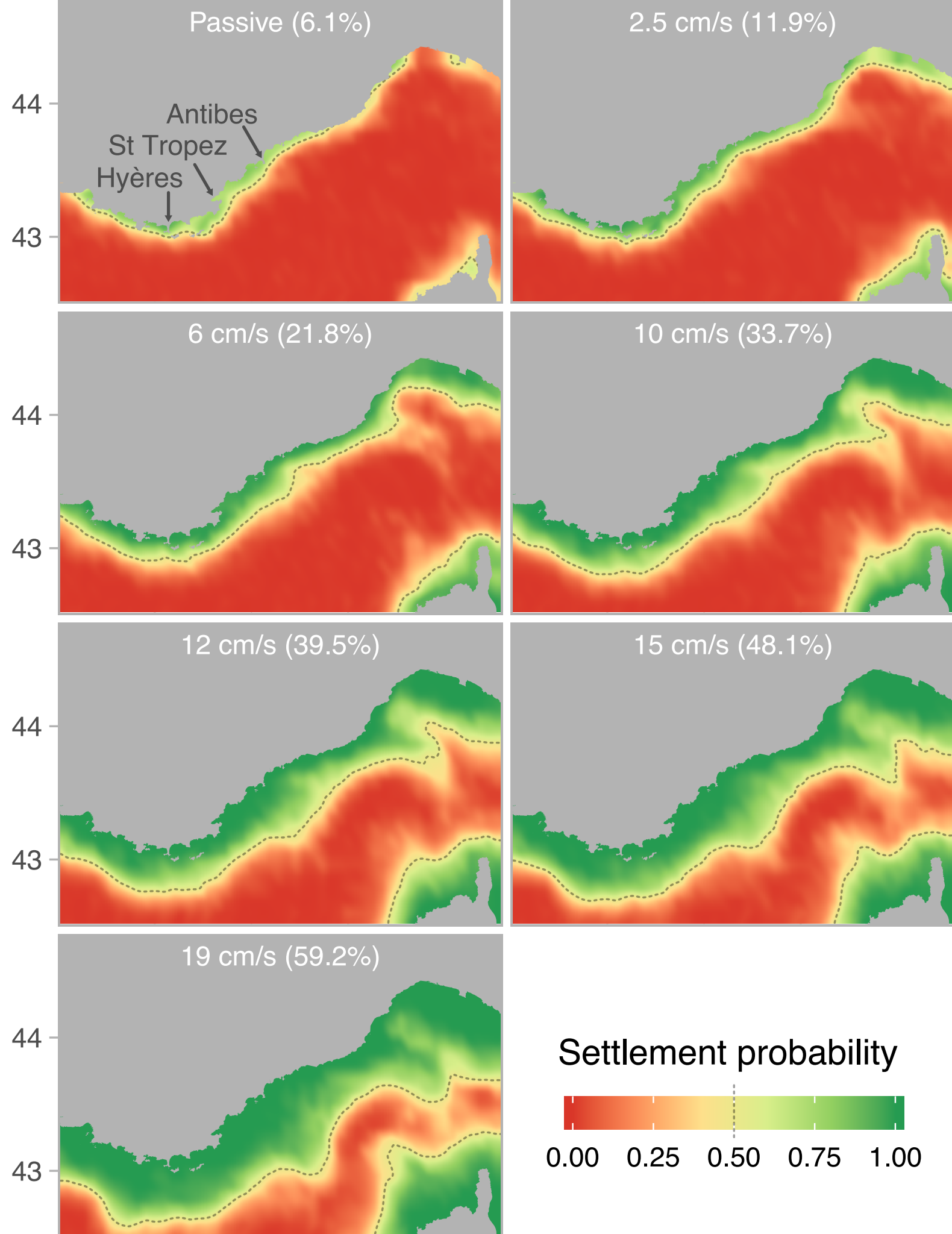
Config 1: Settlement phase

Advection + swimming (CMS)
50 particles × 650 sites × 3 depths × 25 days
> 2,500,000 virtual larvae per simulation
shoreward swimming (w/randomness)
between 0 and 18 cm/s
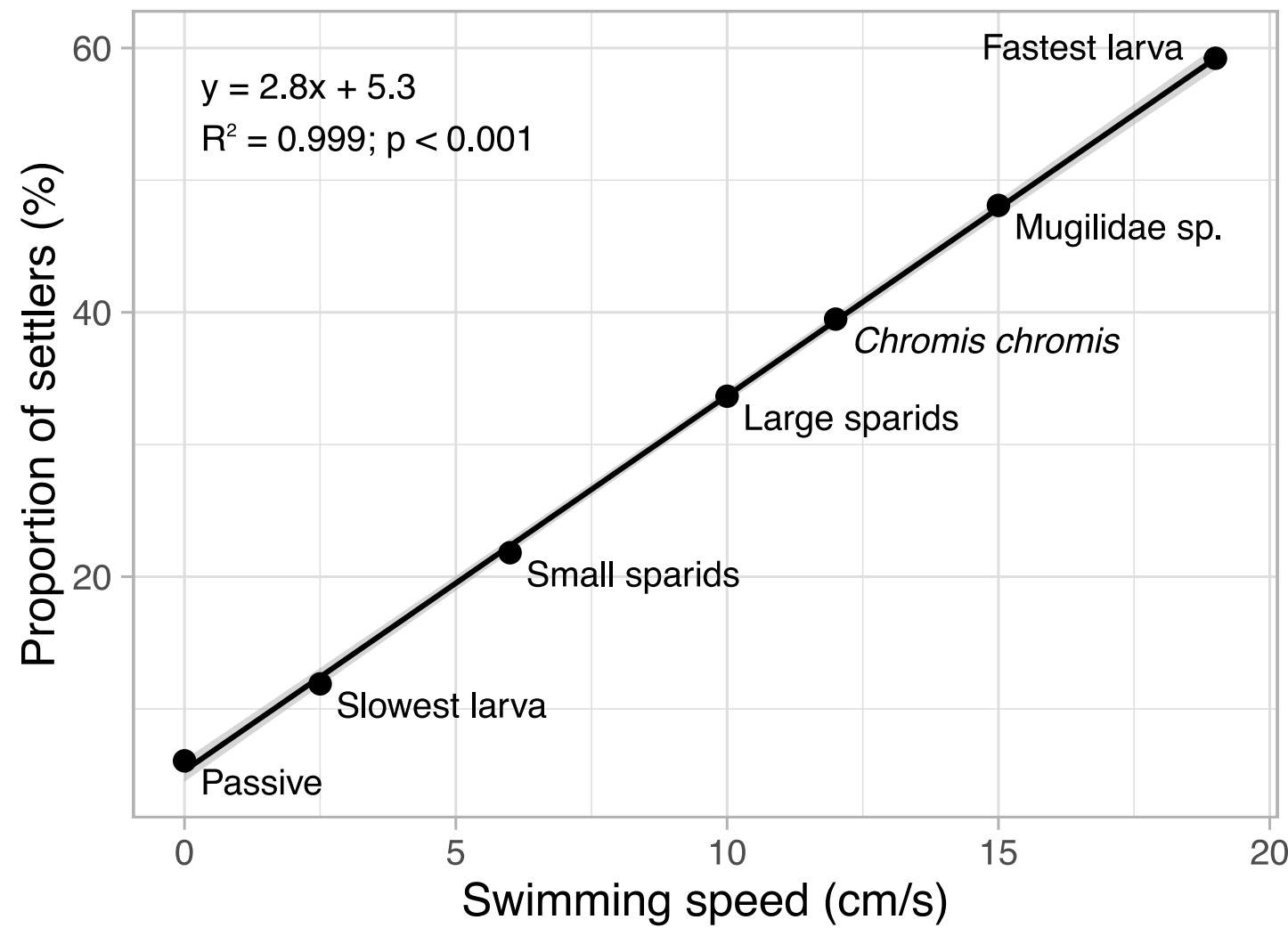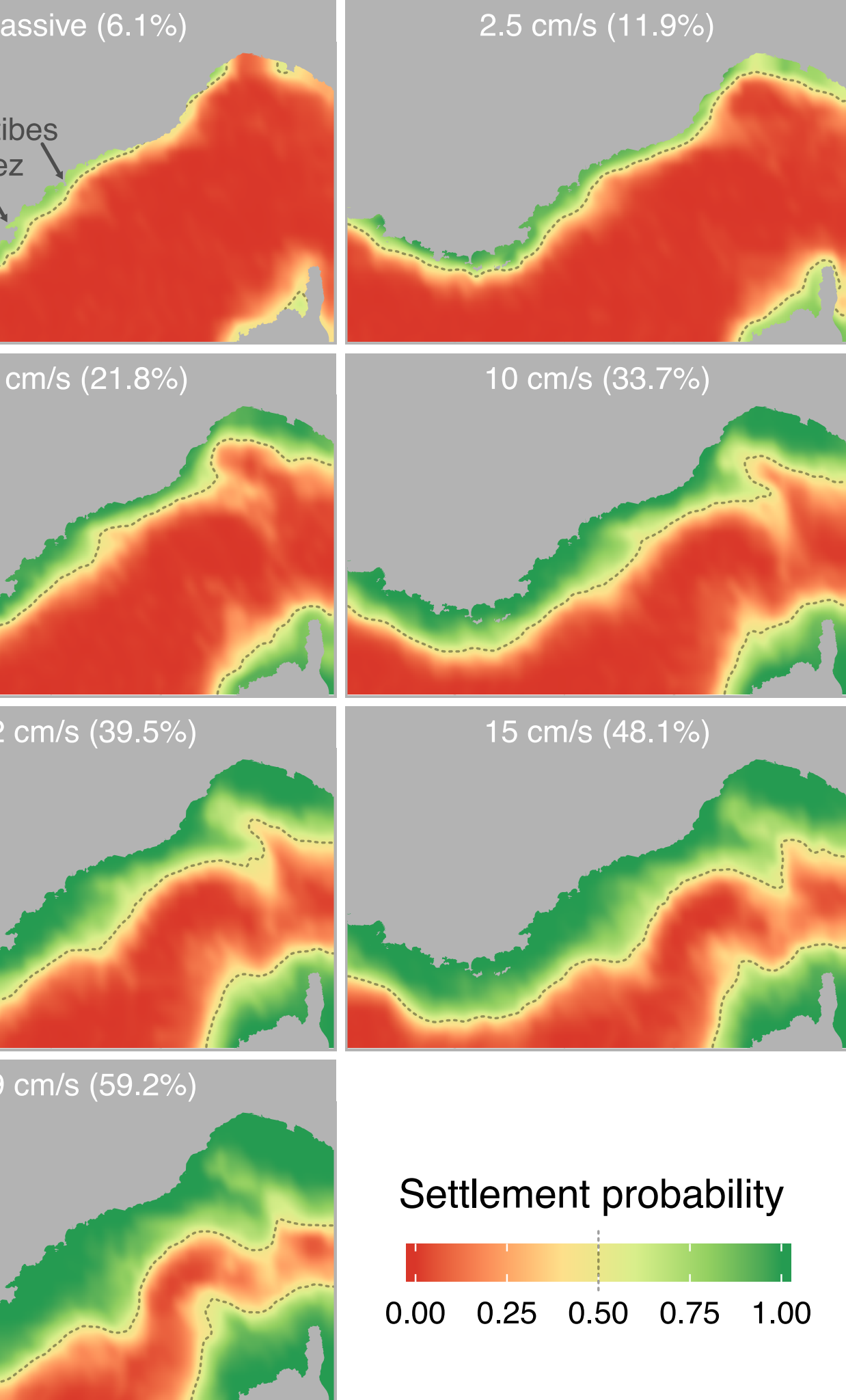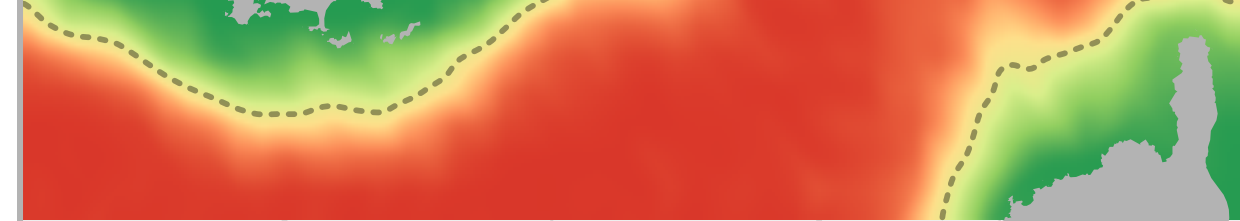
Map settlement % after 4 days
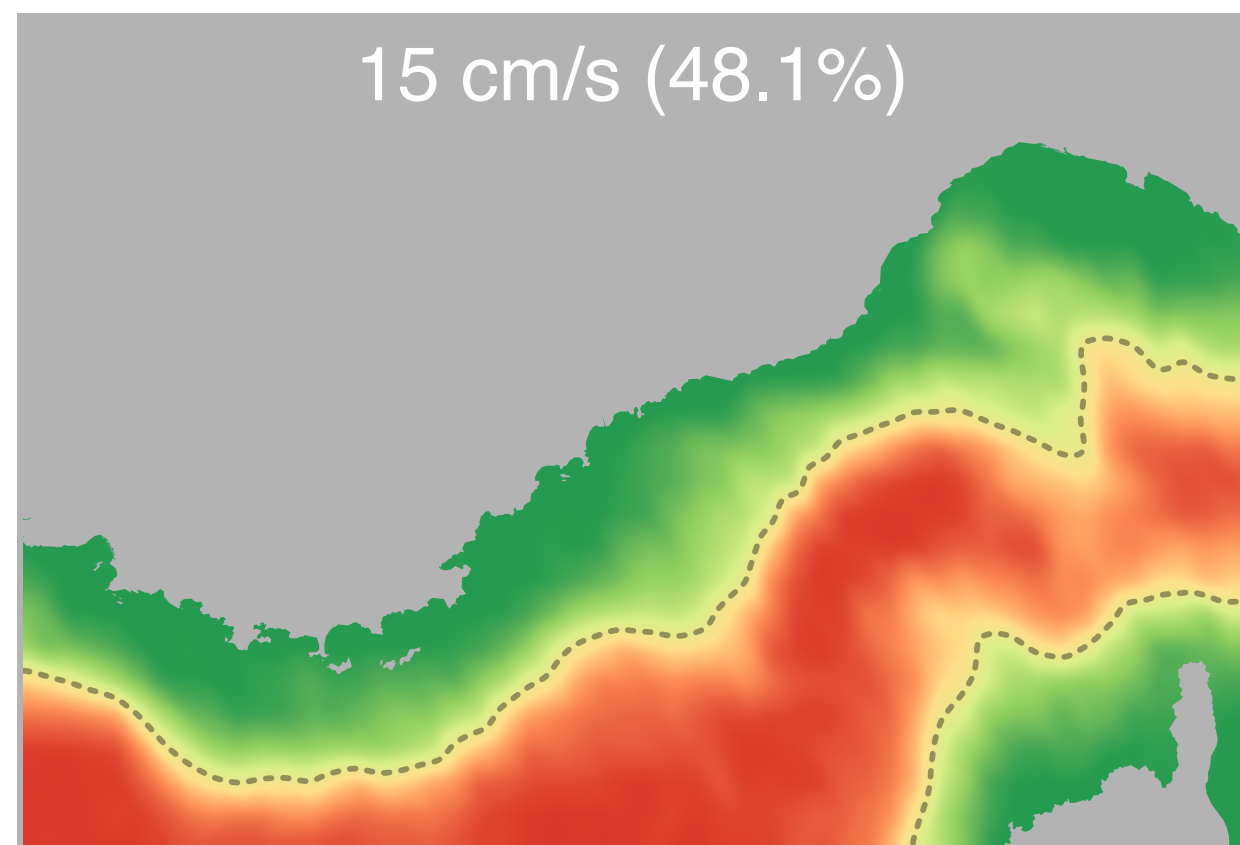
Settlement probability map

Settlement possible from
>20km away in only 4 days

Settlement **proportion** ⟶ ×10

Passive (6.1%)

2.5 cm/s (11.9%)

ibes
ez

cm/s (21.8%)

10 cm/s (33.7%)

2 cm/s (39.5%)

15 cm/s (48.1%)

9 cm/s (59.2%)

Settlement probability

0.00 0.25 0.50 0.75 1.00

$y = 2.8x + 5.3$
$R^2 = 0.999$; $p < 0.001$

Fastest larva

Mugilidae sp.

Chromis chromis

Large sparids

Small sparids

Slowest larva

Passive

Proportion of settlers (%)

Swimming speed (cm/s)

15 cm/s (48.1%)

Settlement probability

0.00 0.25 0.50 0.75 1.00

$y = 2.8x + 5.3$
$R^2 = 0.999; p < 0.001$

Fastest larva

Mugilidae sp.

Chromis chromis

Large sparids

Small sparids

Slowest larva

Passive

Proportion of settlers (%)
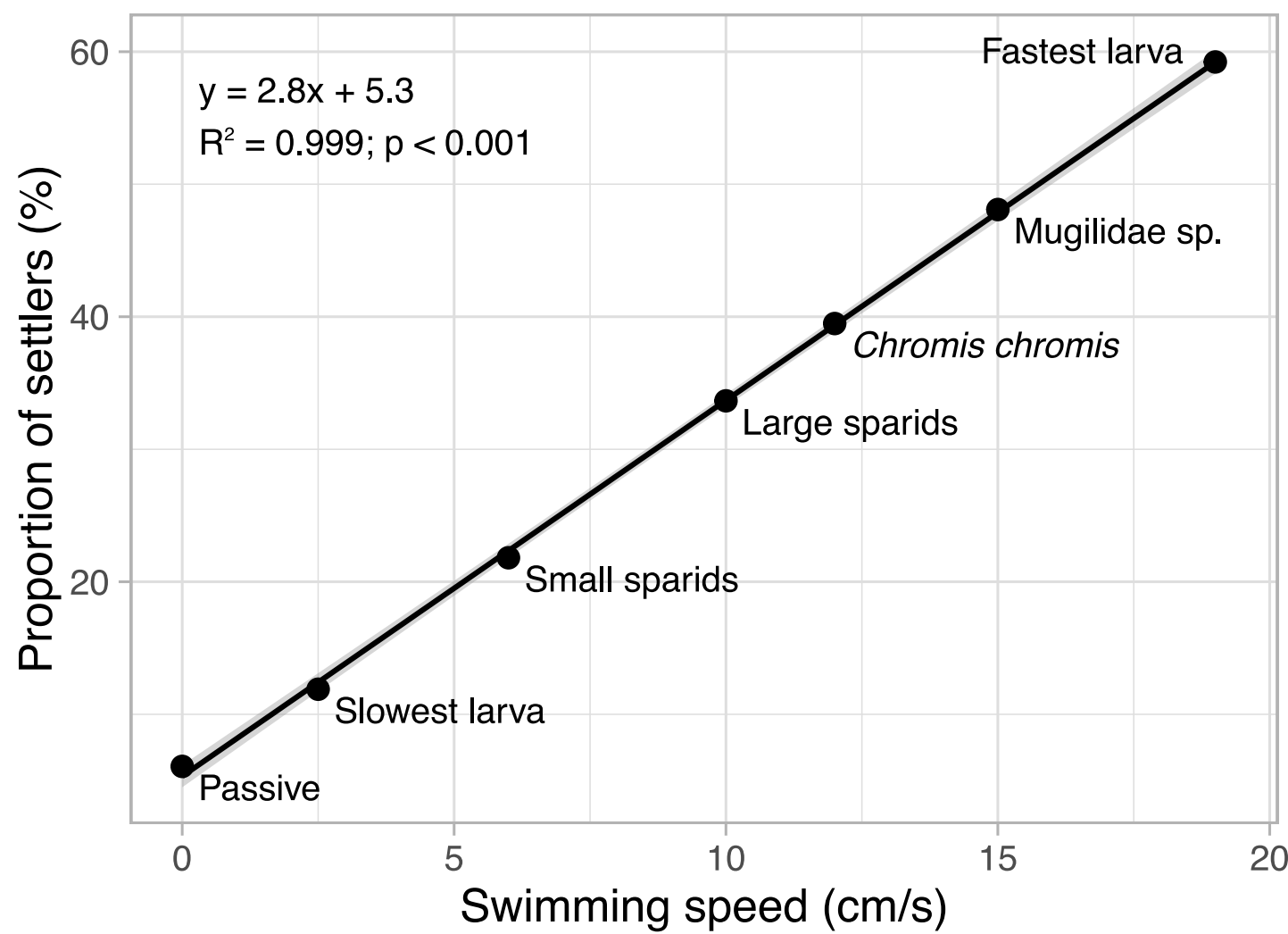
Swimming speed (cm/s)
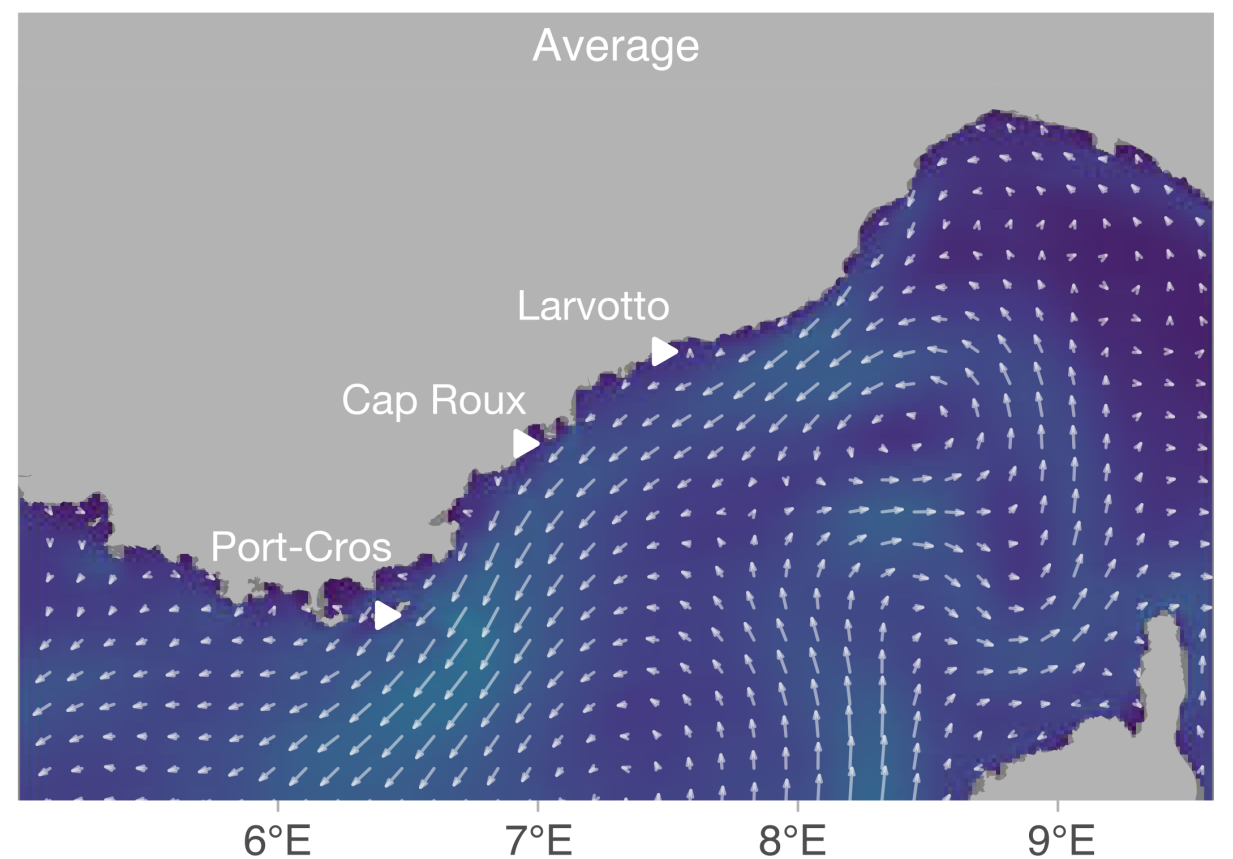
Config 2: Connectivity among MPAs
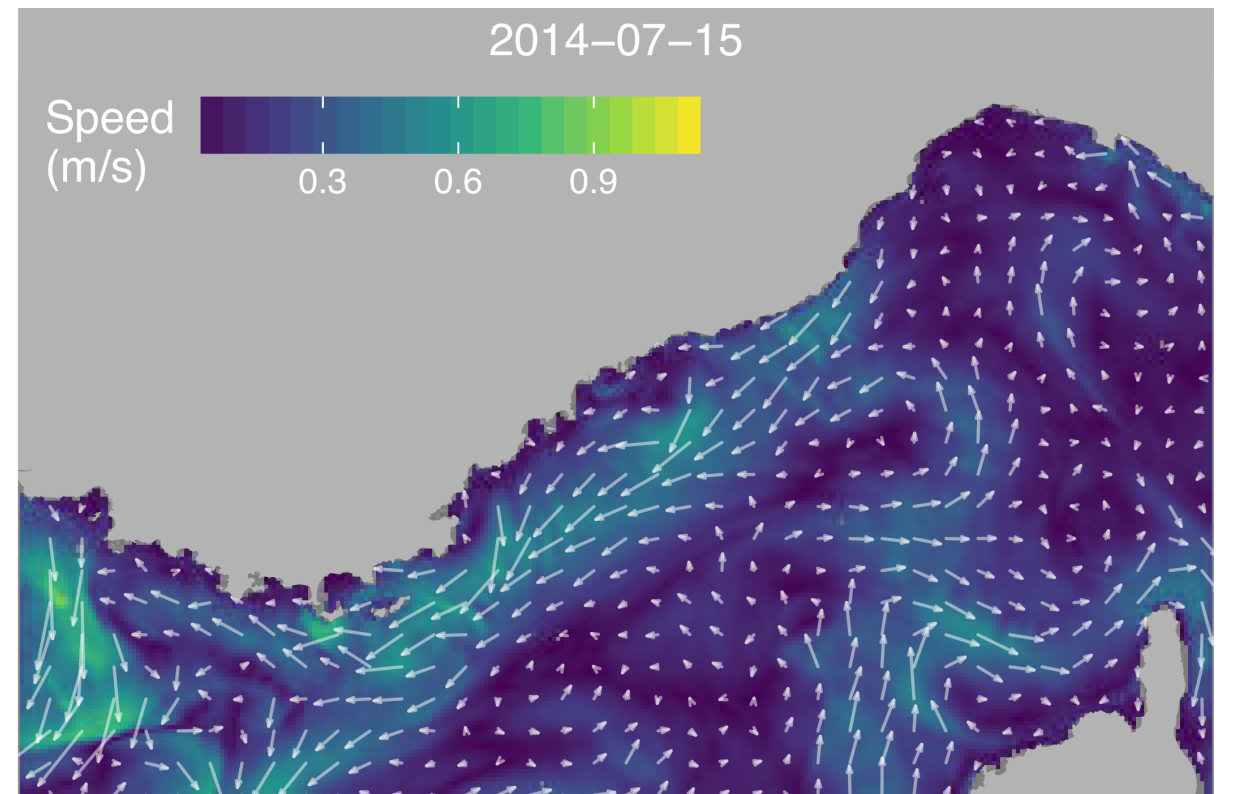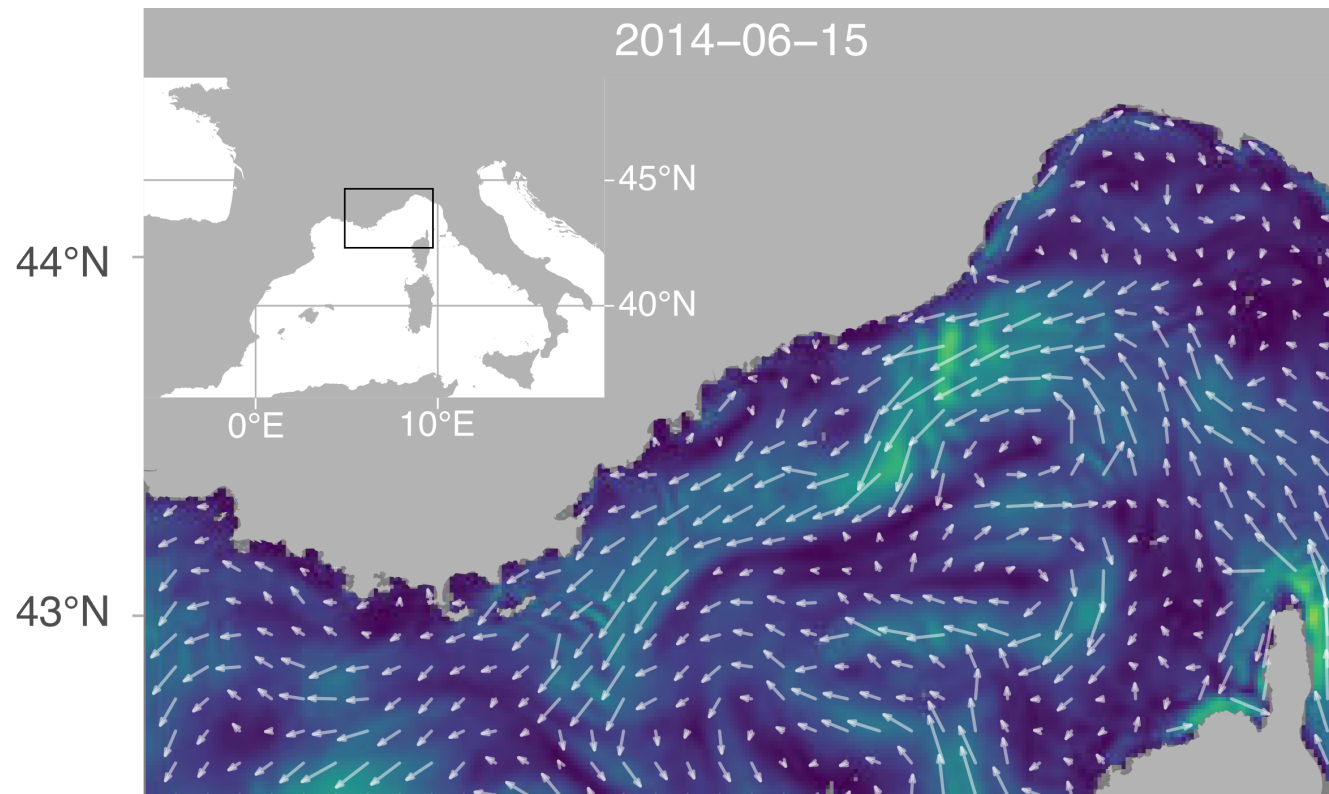
1500 larvae/site, 2×/day

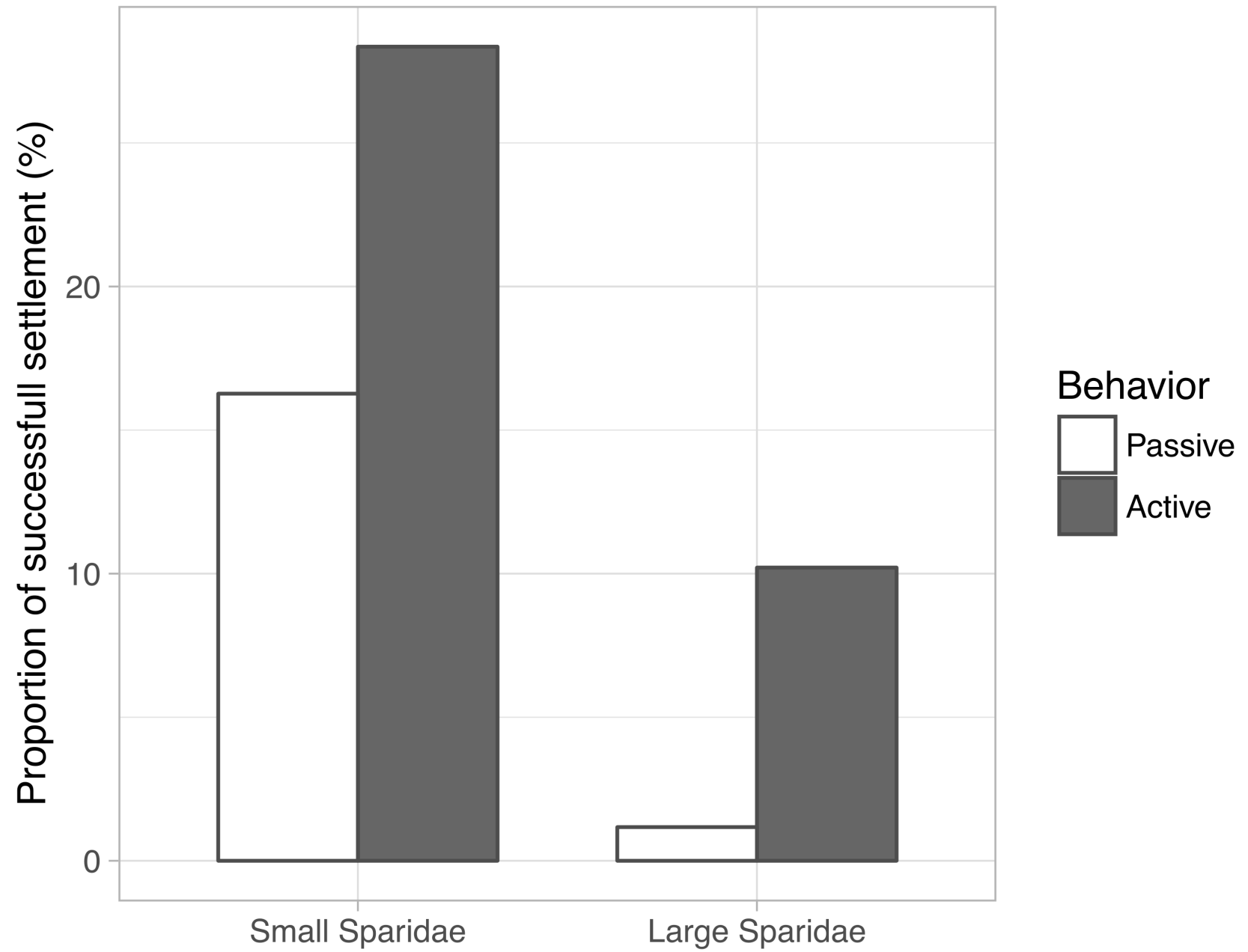2 types of larvae (small and large Sparidae) with different larval duration, swimming abilities

shoreward swimming (w/ randomness)

swimming speed increases with time

Increased settlement

Like before, swimming **increases settlement**
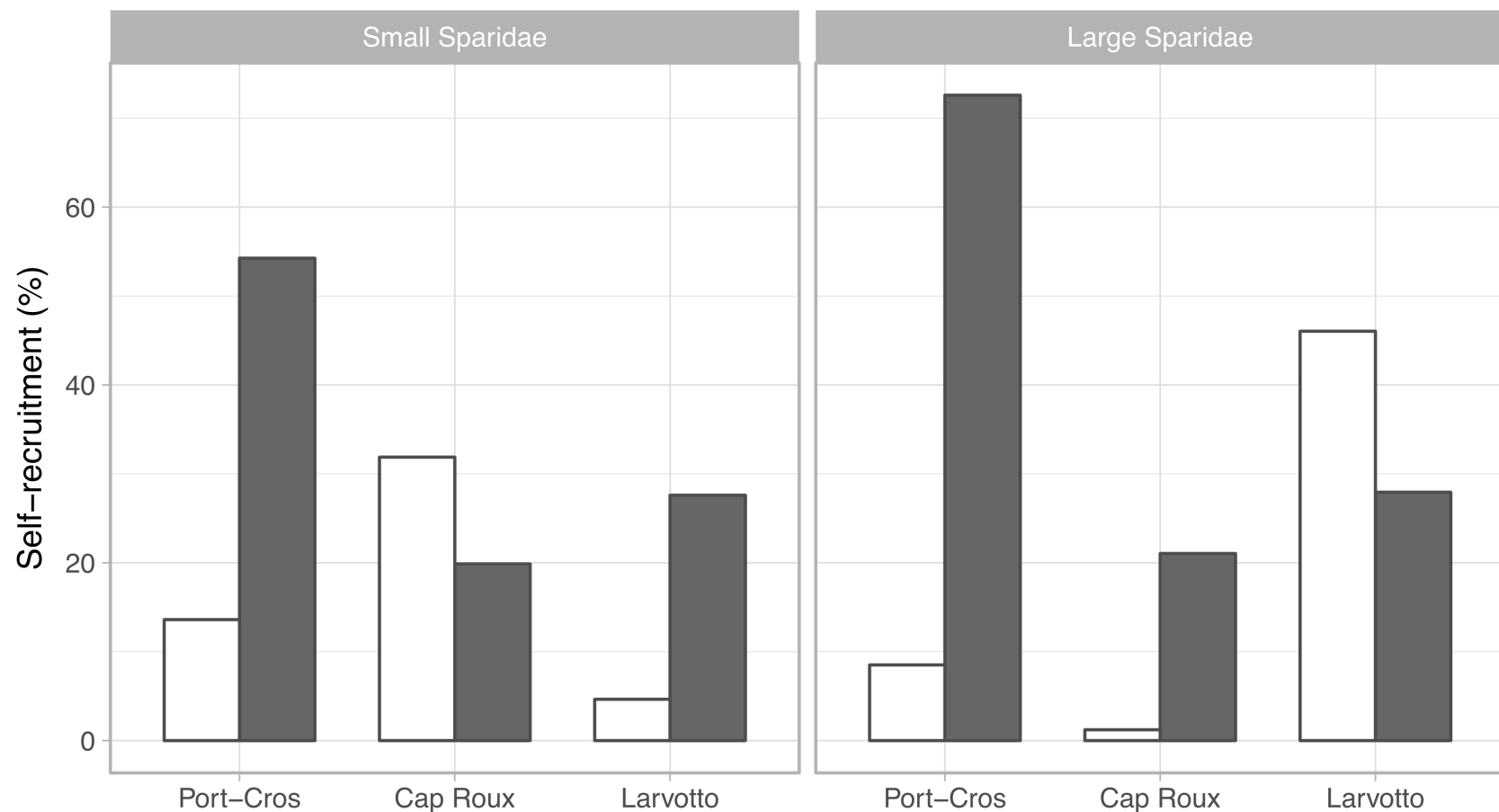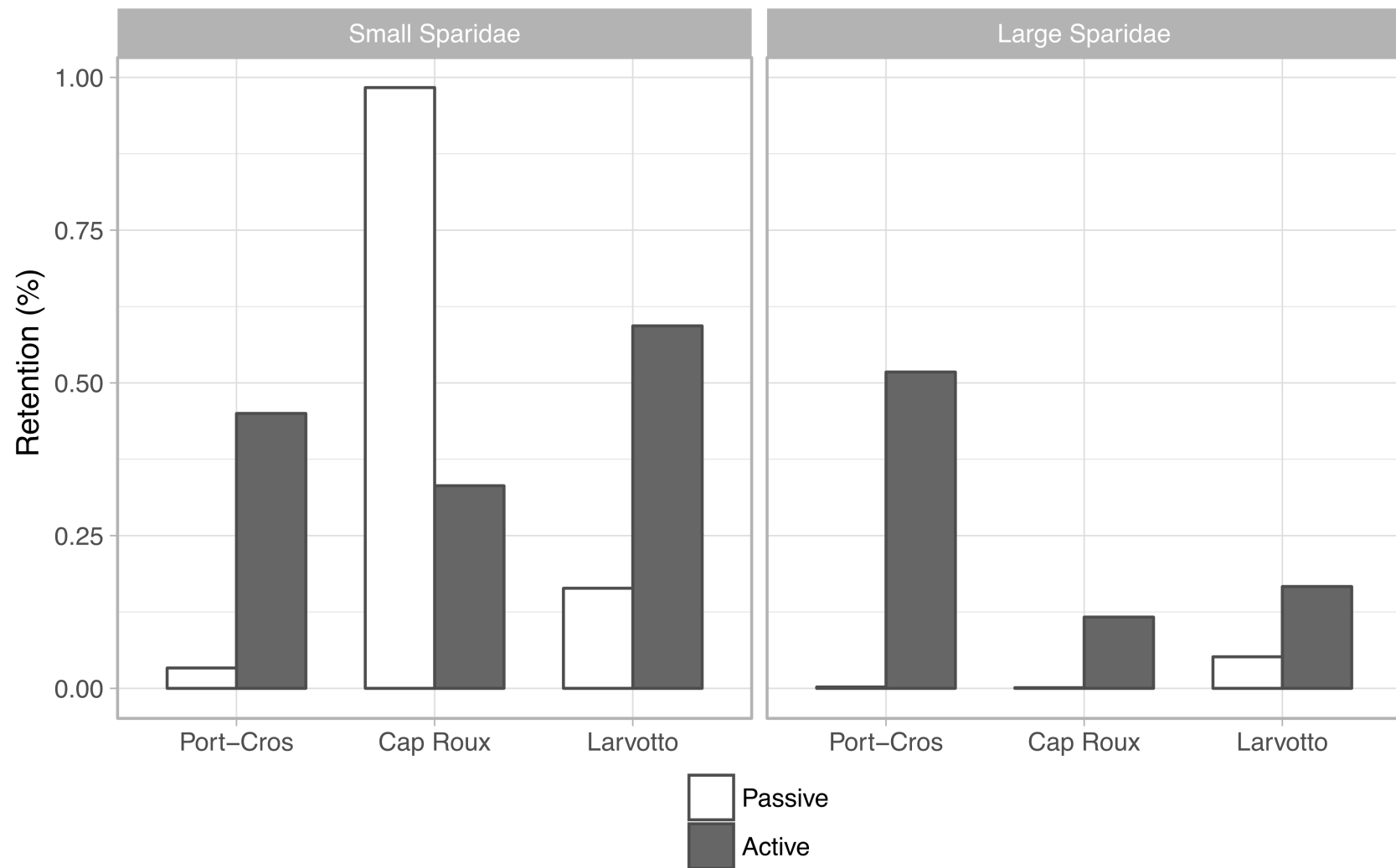
Connectivity scale

Retention:

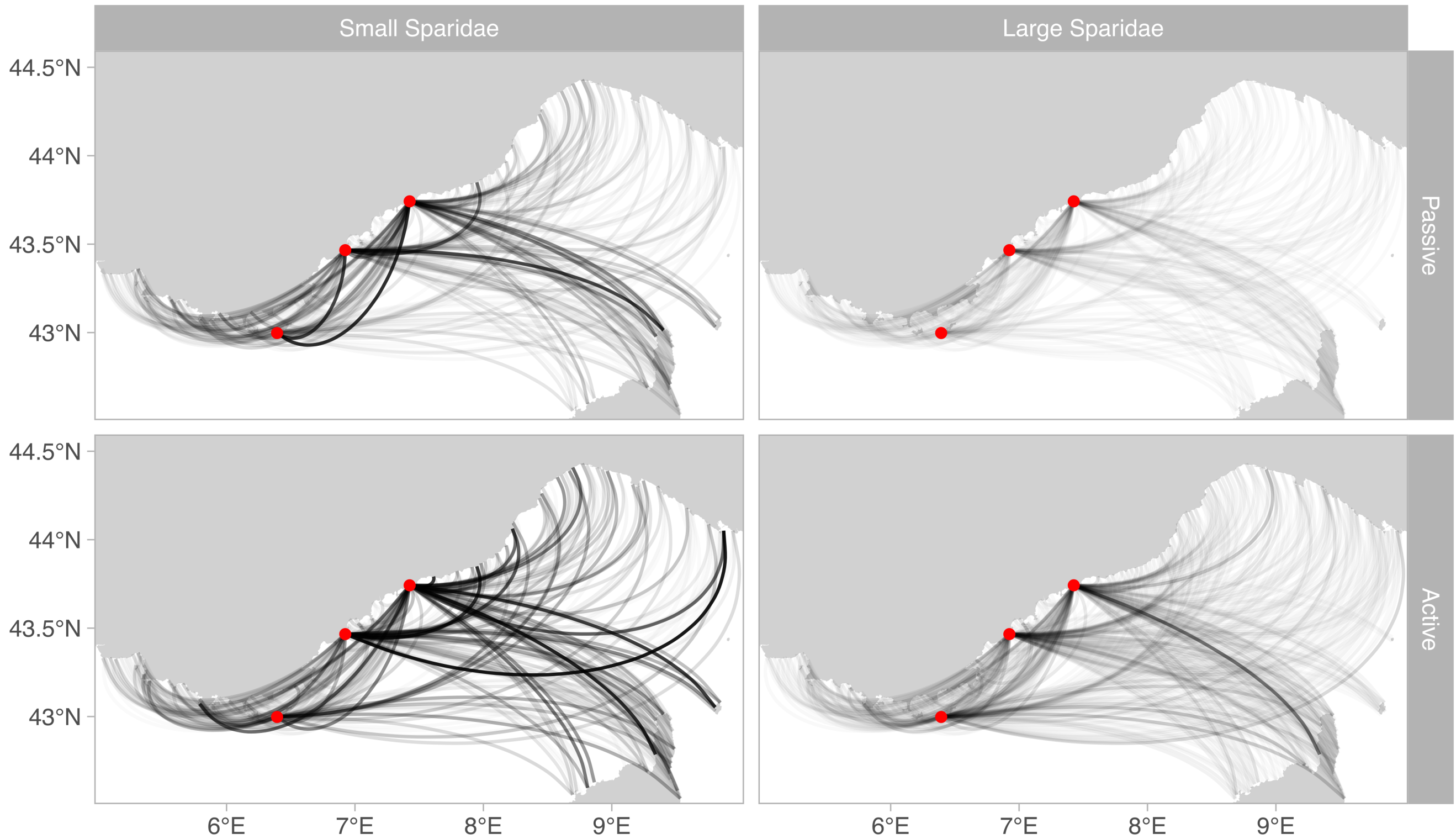$$\frac{n_{from+to\ MPA}}{n_{from\ MPA}}$$

Self recruitment:

$$\frac{n_{from+to\ MPA}}{n_{to\ MPA}}$$

Swimming most often
increases retention

Diminishes connectivity
scales?

Dispersal pathways

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It would be especially desirable to ascertain the extent of such movement, and **how far the young fry are able to return, of their own volition**, to such localities as offer favourable condition; for their further growth.

We ascertained, and the answer is: "from **very far**"!

Swimming

    can strongly **increase settlement** rates

    often **increases retention**, but also **spillover**

Merci