Assessing the role of larval connectivity on a kelp forest fish across the California MPA network

Mallarie E. Yeager, Dan P. Malone, Chris M. Free, Tom W. Bell,
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Moving to Juneau this summer!

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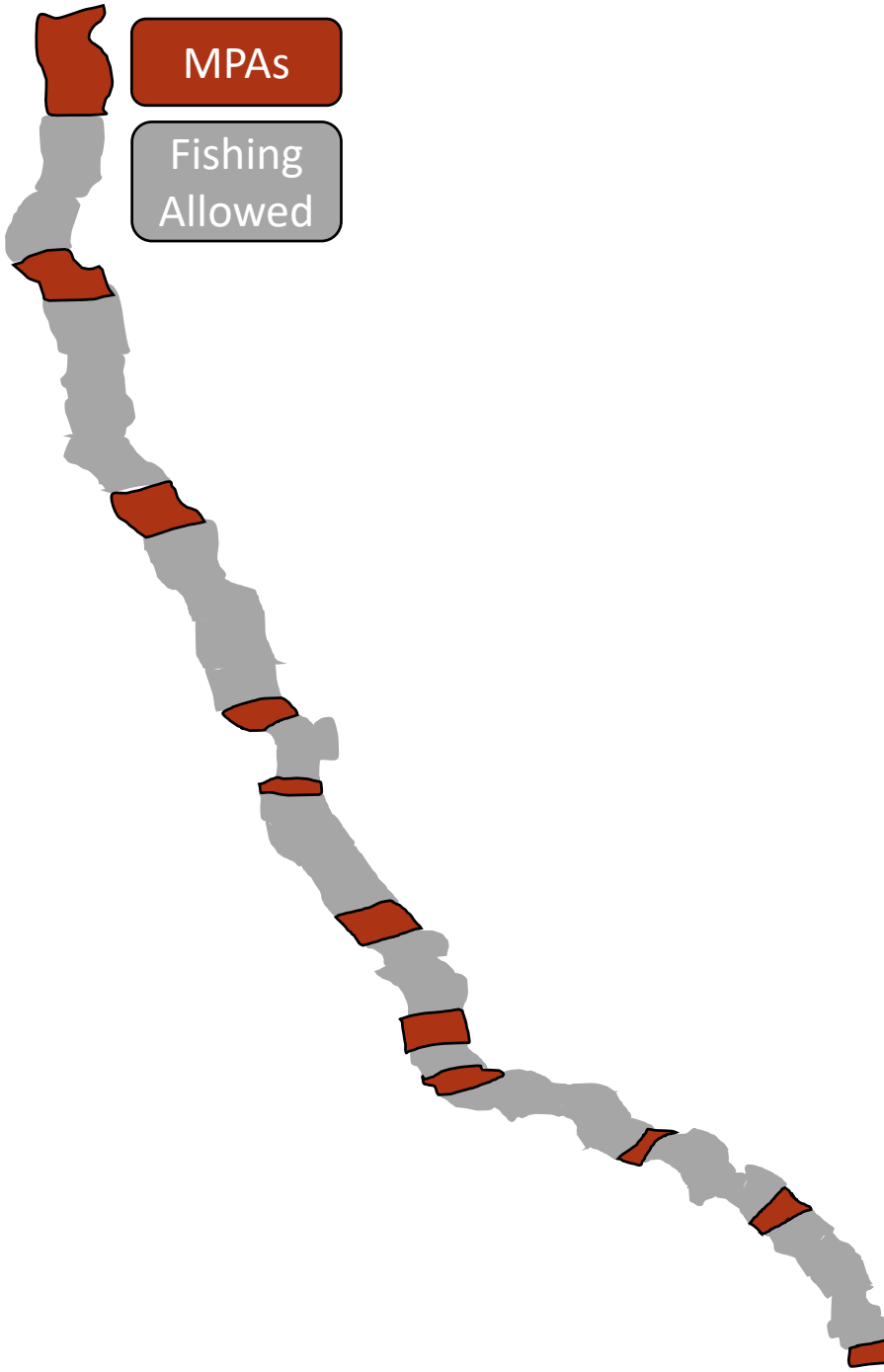
California MPA Network

- 124 Marine Protected Areas (MPAs)



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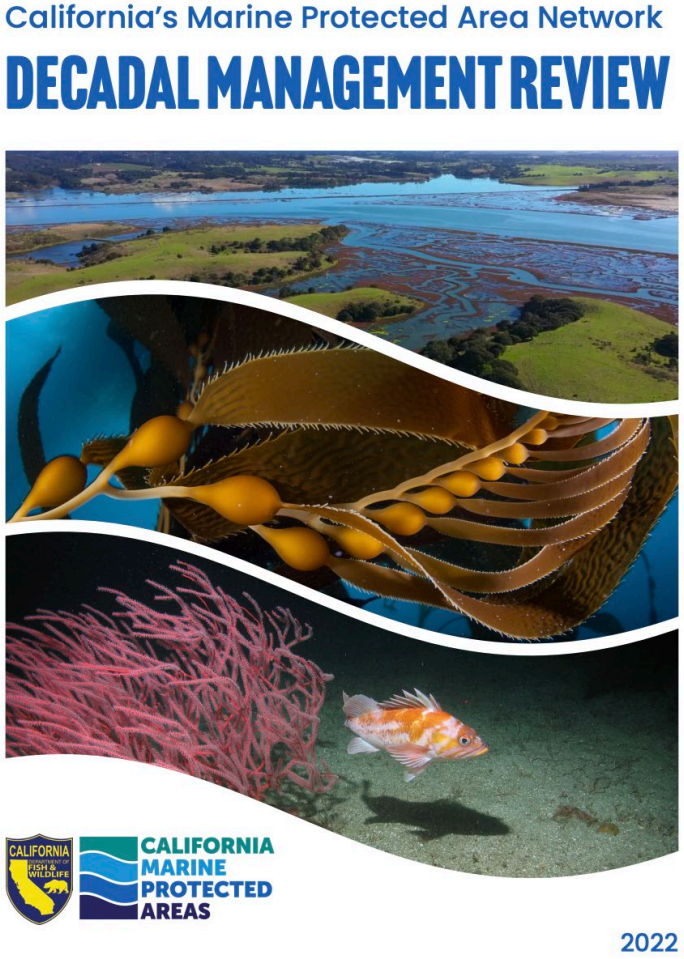
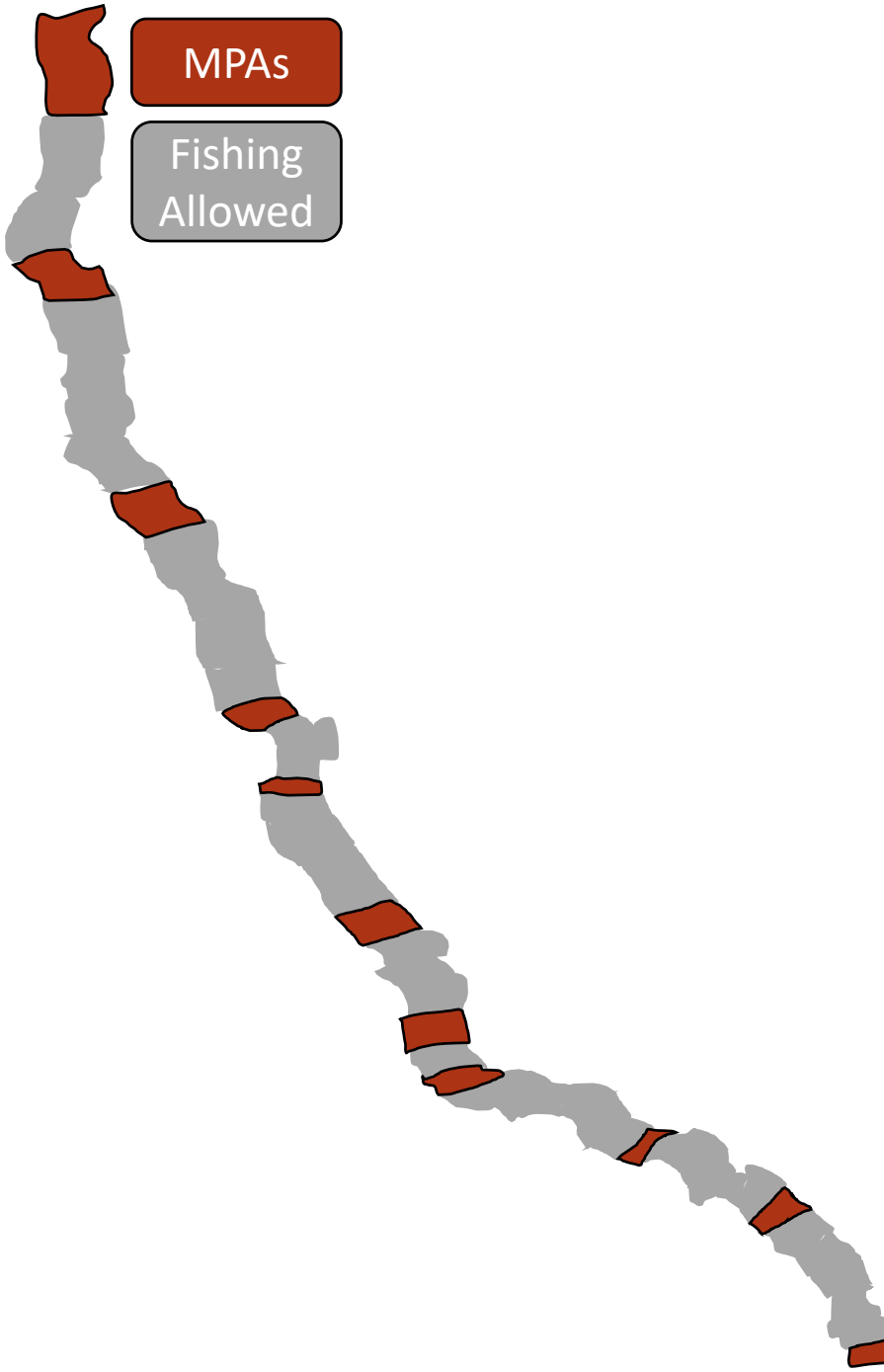
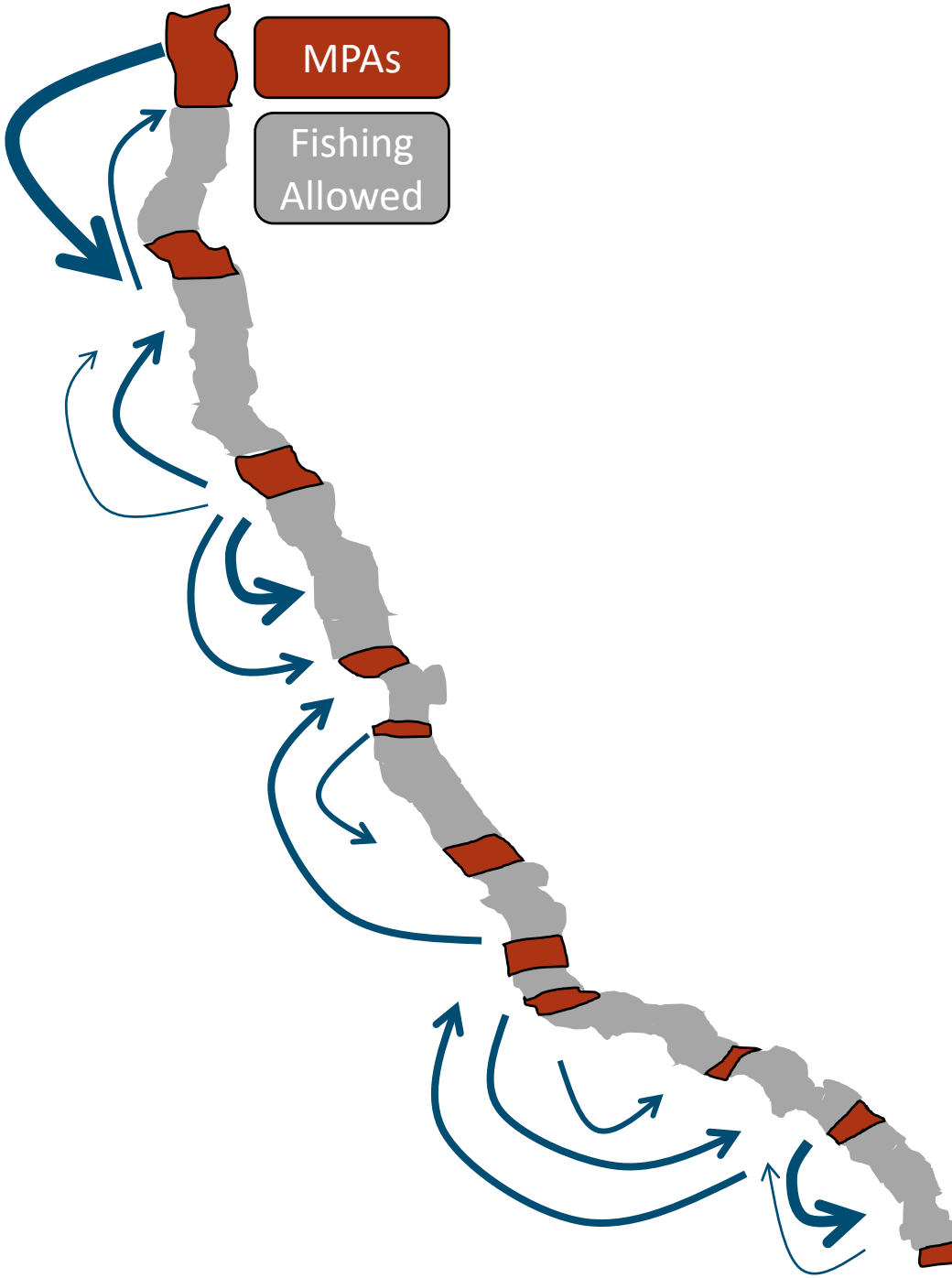


Report link here



MPA Network Connectivity

MLPA Goal: To ensure that the state's MPAs are designed and managed as a network



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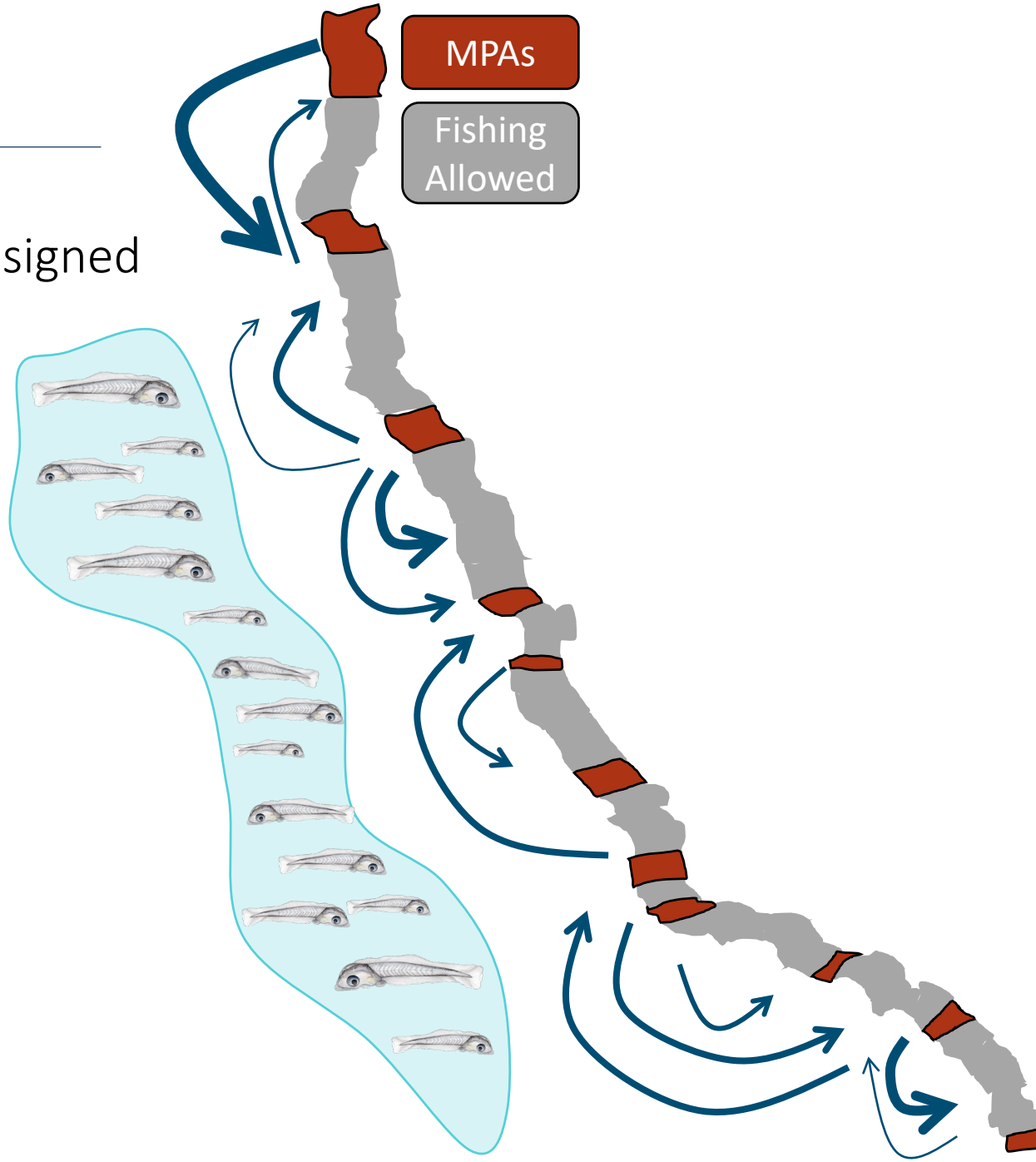

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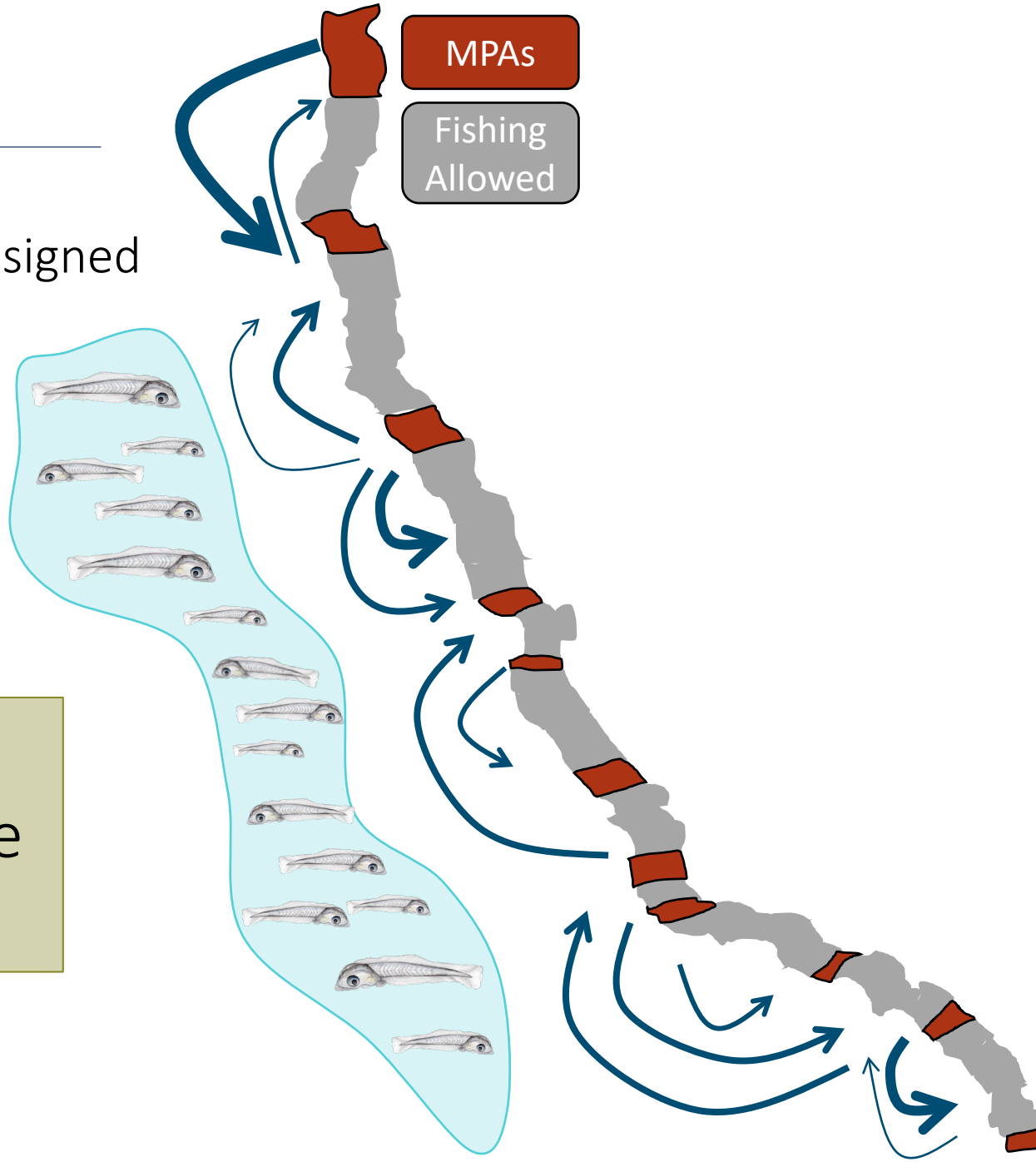
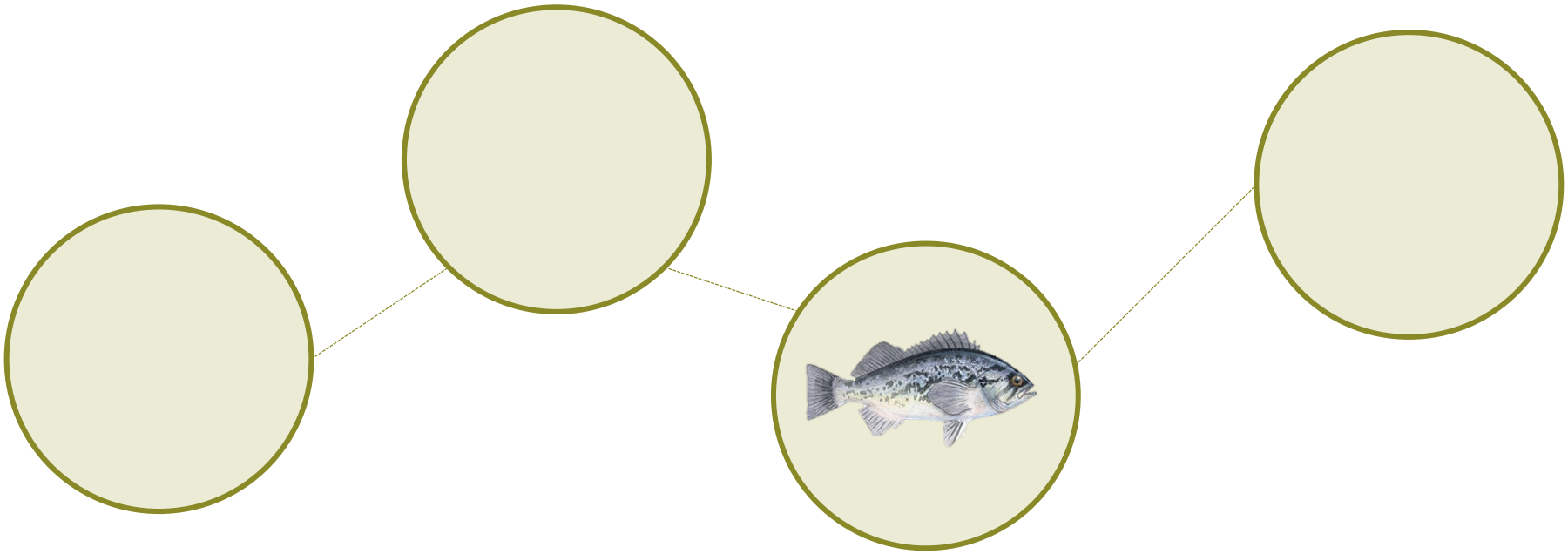


Evaluate whether the California MPAs are operating as an effective ecological network

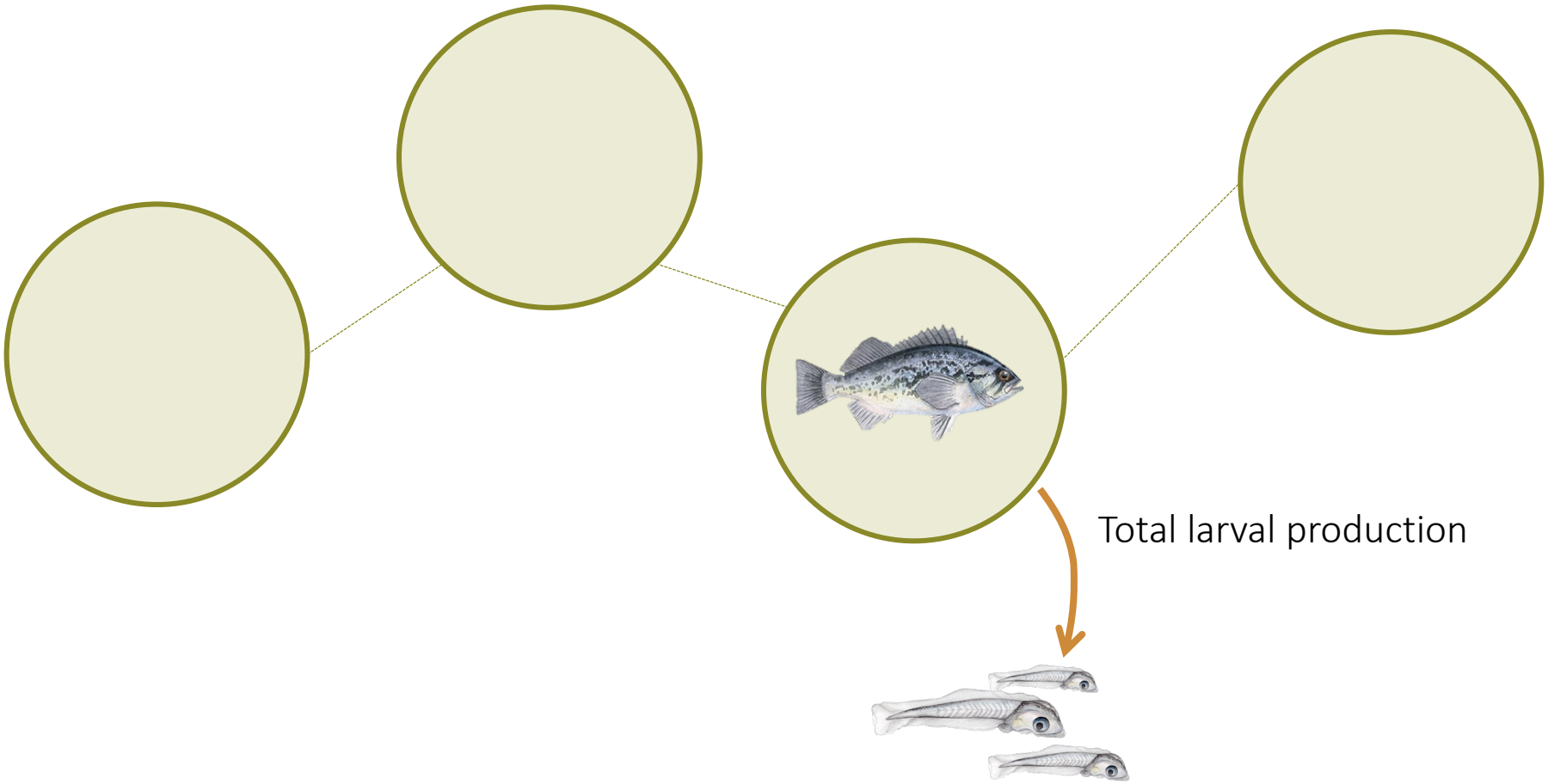
NETWORK PERSISTENCE



Network Persistence =

Hastings and Botsford, 2006

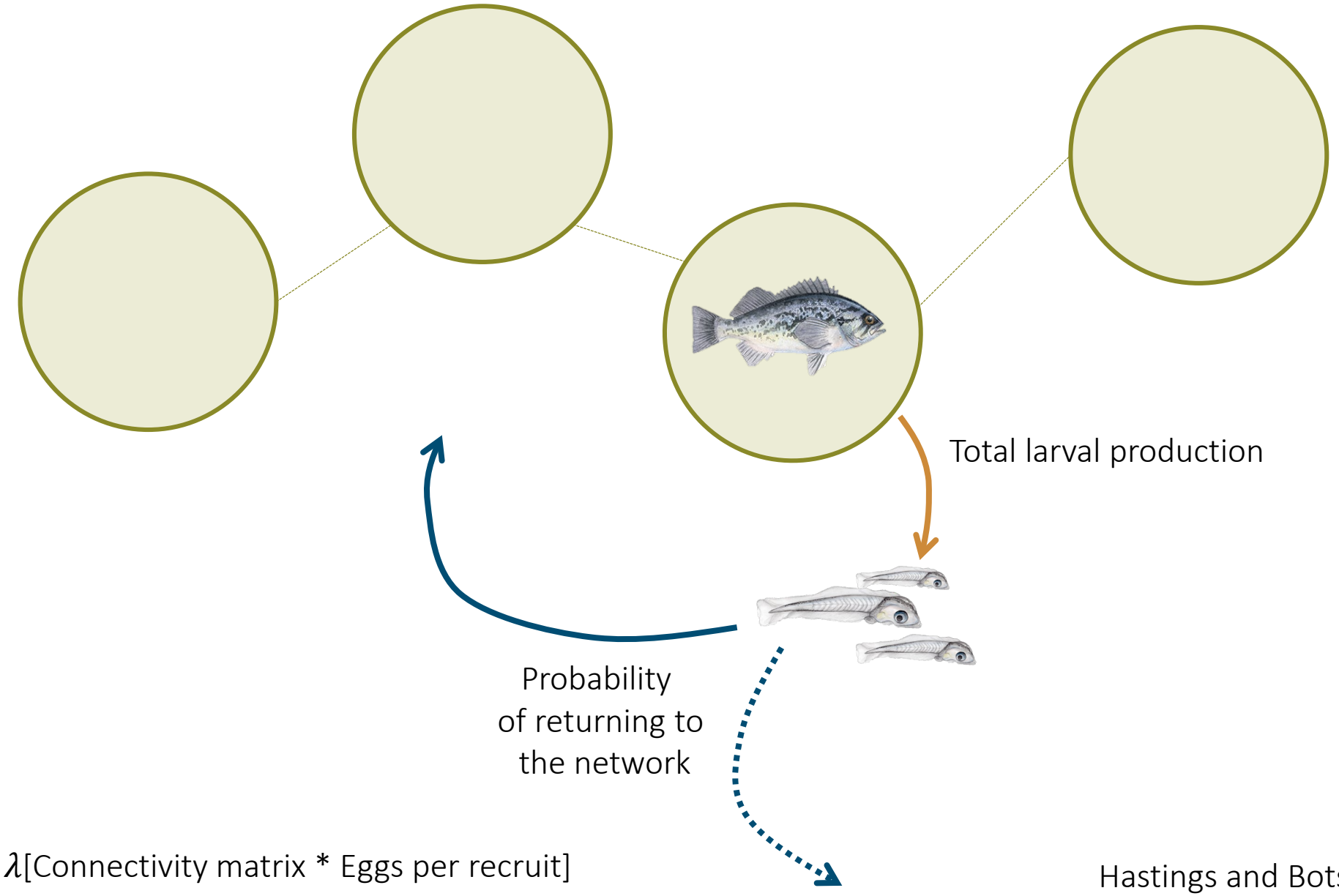
NETWORK PERSISTENCE



Network Persistence = Eggs per recruit

Hastings and Botsford, 2006

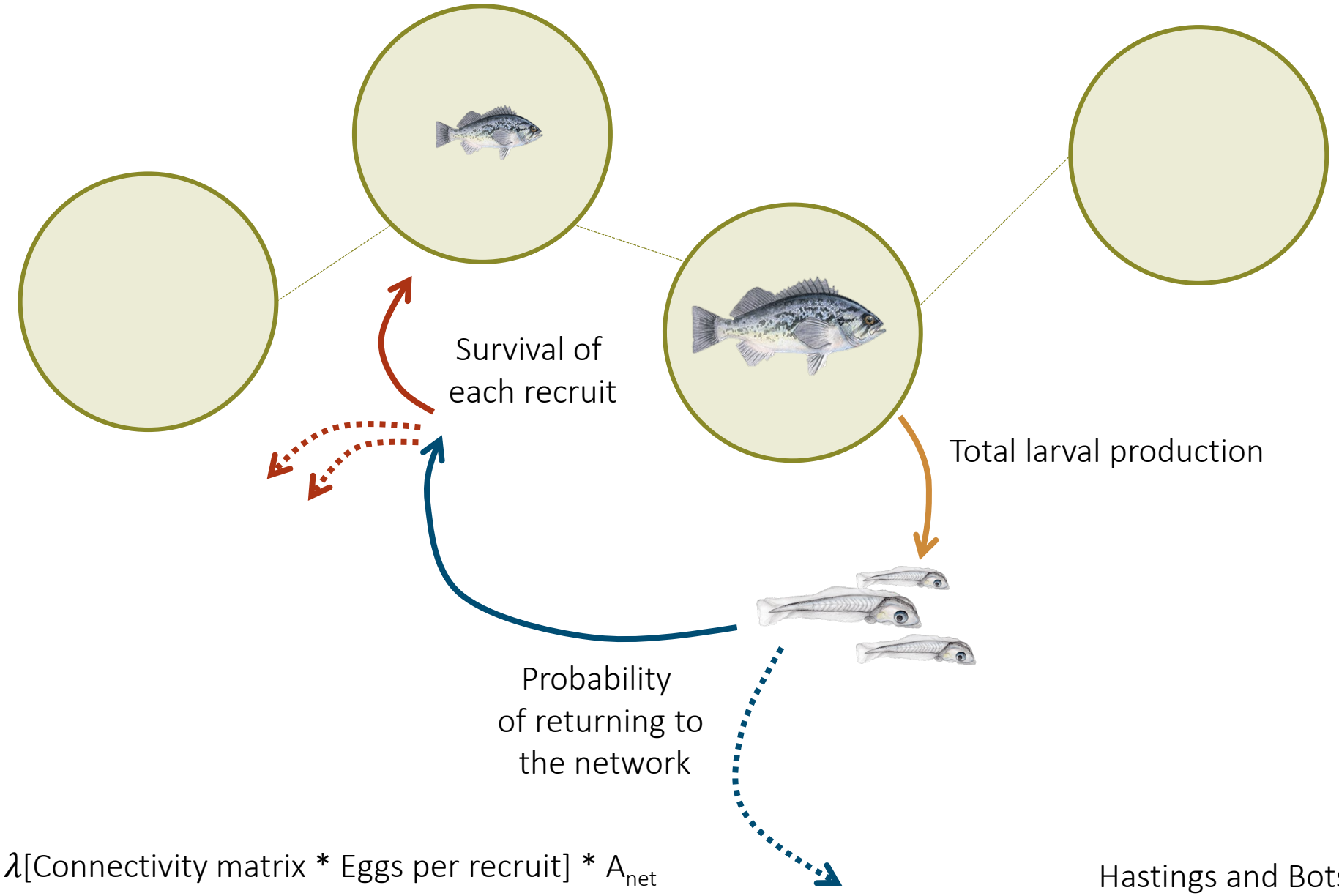
NETWORK PERSISTENCE



Network Persistence = λ[Connectivity matrix * Eggs per recruit]

Hastings and Botsford, 2006

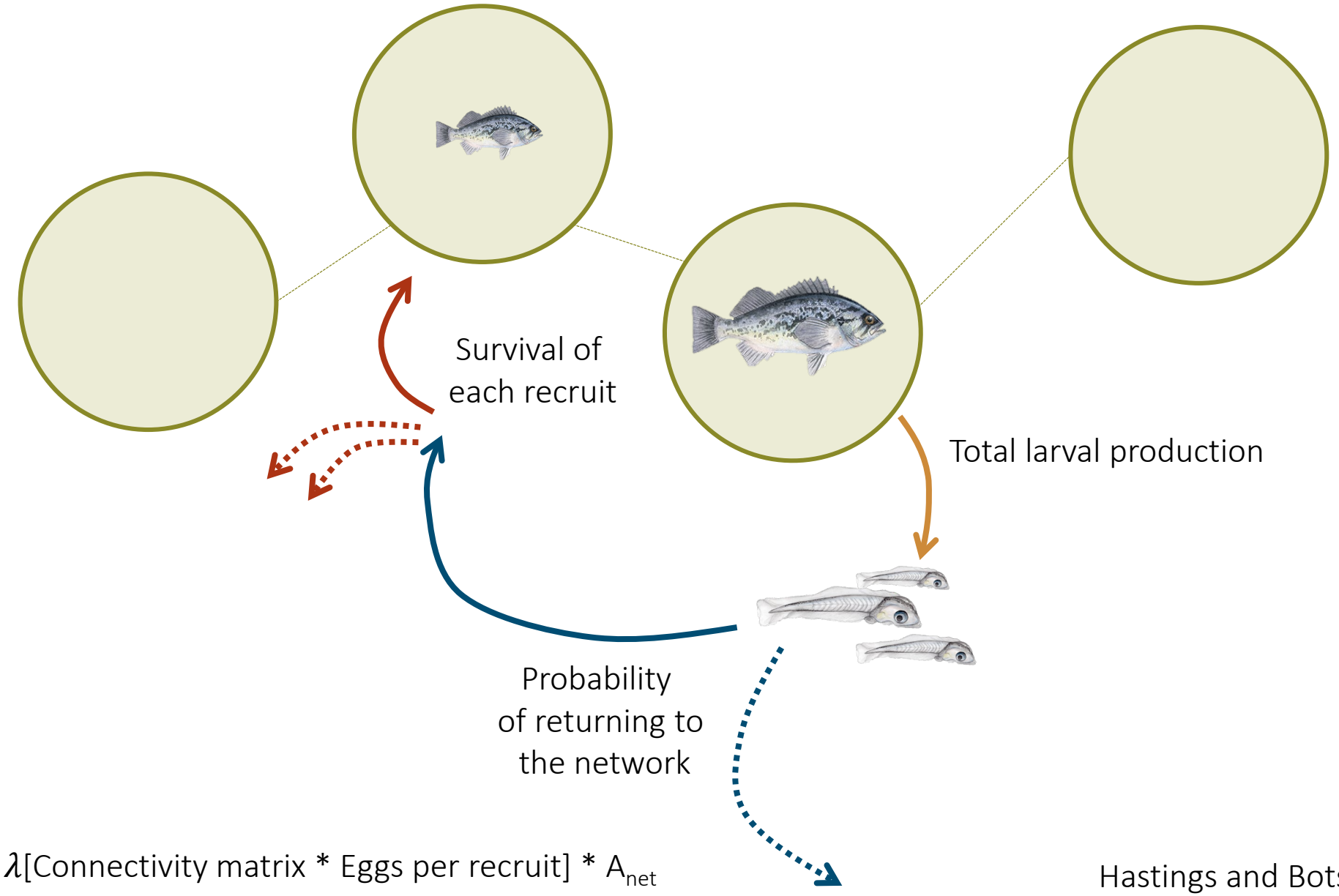
NETWORK PERSISTENCE



Network Persistence = λ[Connectivity matrix * Eggs per recruit] * A_{net}

Hastings and Botsford, 2006

NETWORK PERSISTENCE $\geq$ 1



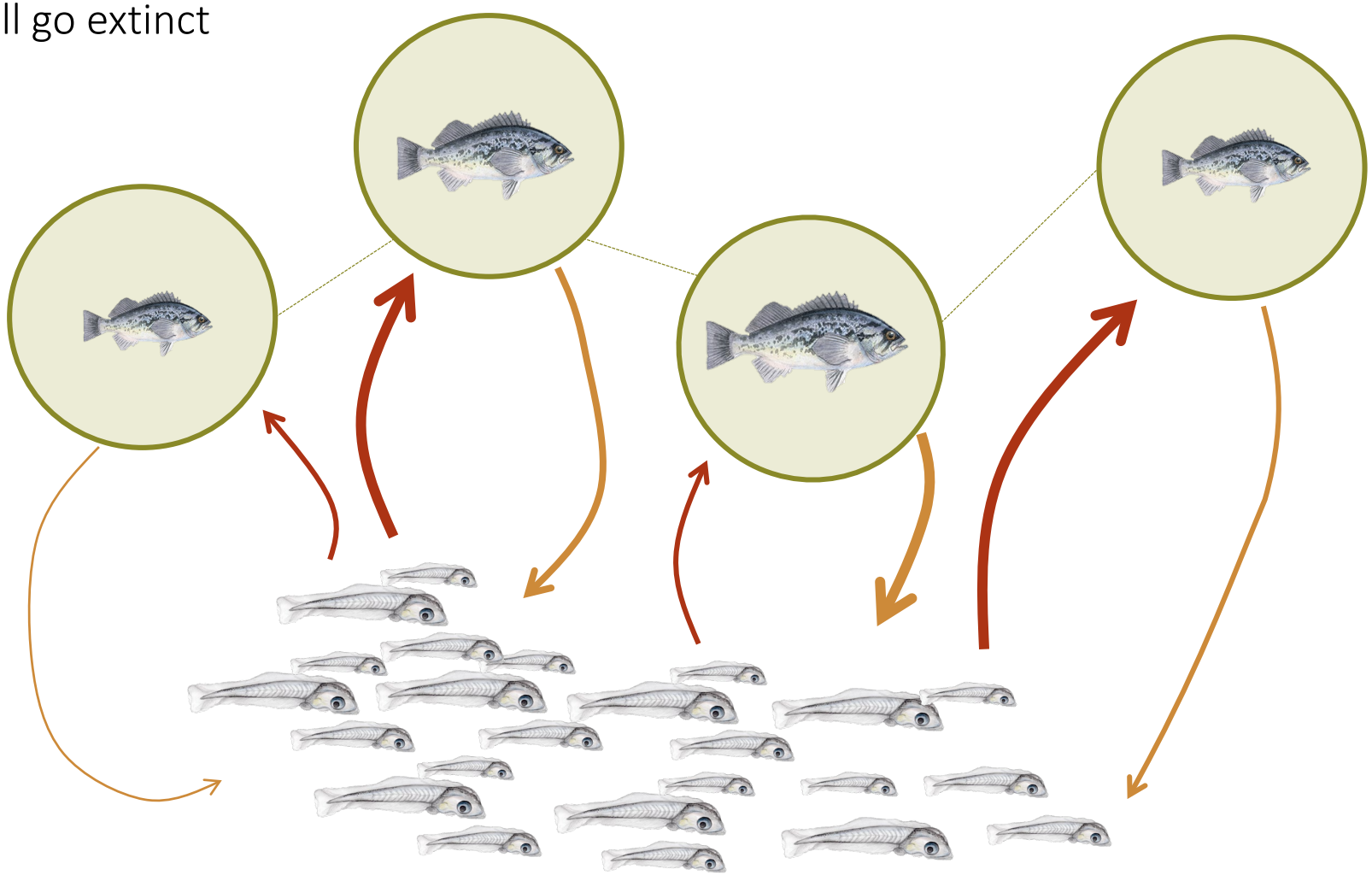
Network Persistence = λ[Connectivity matrix * Eggs per recruit] * A_{net}

Hastings and Botsford, 2006

NETWORK PERSISTENCE = MAX REPLACEMENT CAPACITY

If the value is:

- $\geq$ 1 = the network is persistent, and
  - level of the value is the replacement capacity the network receives
- < 1 the network is not persistent and will go extinct



Blue rockfish demographic population model

- Blue Rockfish (*Sebastes mystinus*)
  - 40+ years
  - 3-5 month larval/pelagic juvenile duration
  - Inhabit shallow- to mid-deep (90m) rocky reefs

- Integral Projection Connectivity Model
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  - Integrated size-based population structure
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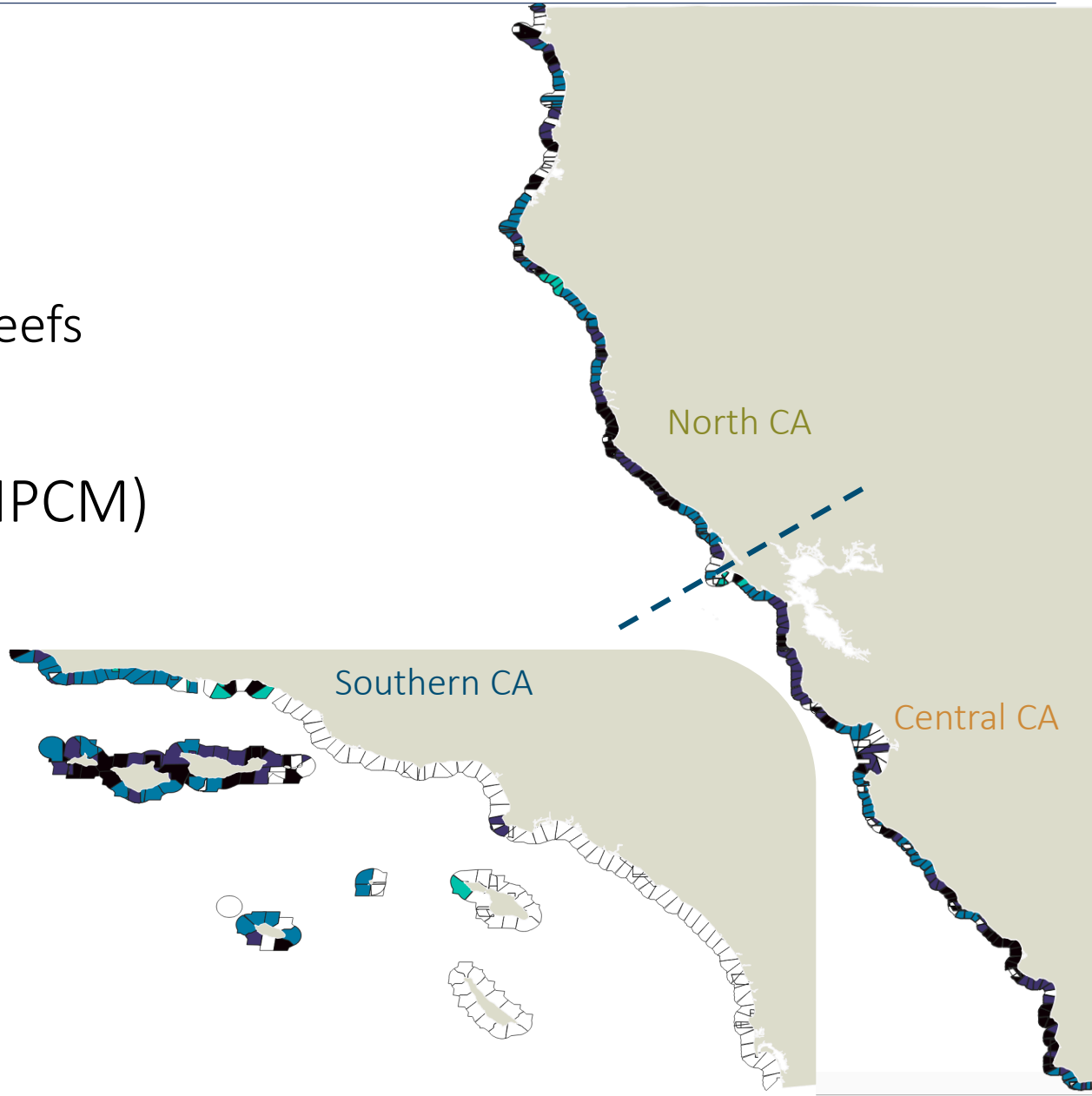
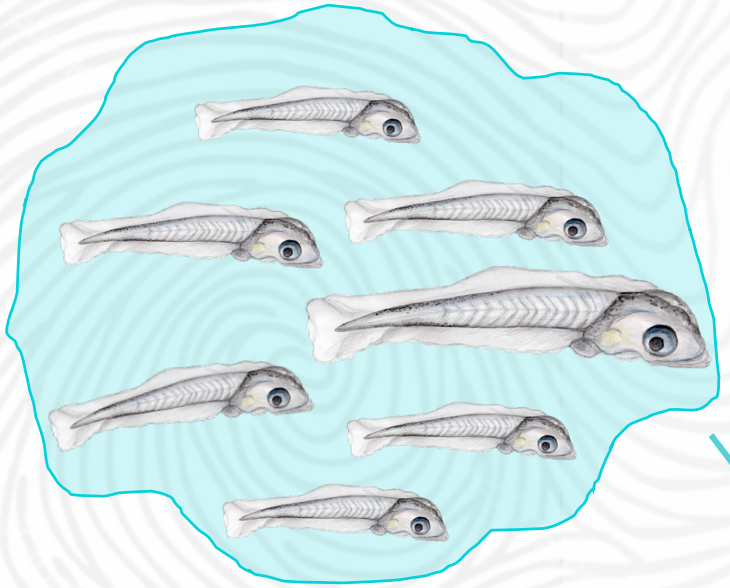
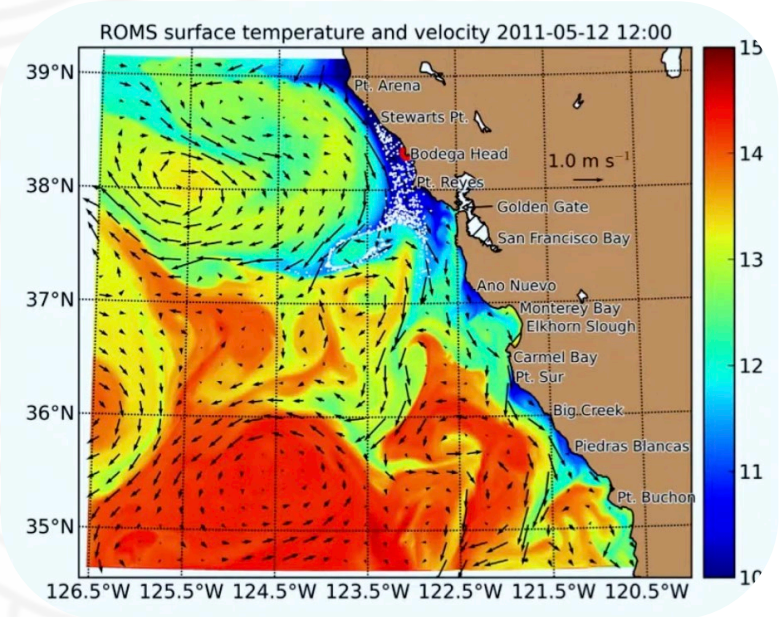
  - Range – western Channel Islands up to OR



Components of the IPCM



Larval dispersal-
ROMS connectivity at 120-day PLD



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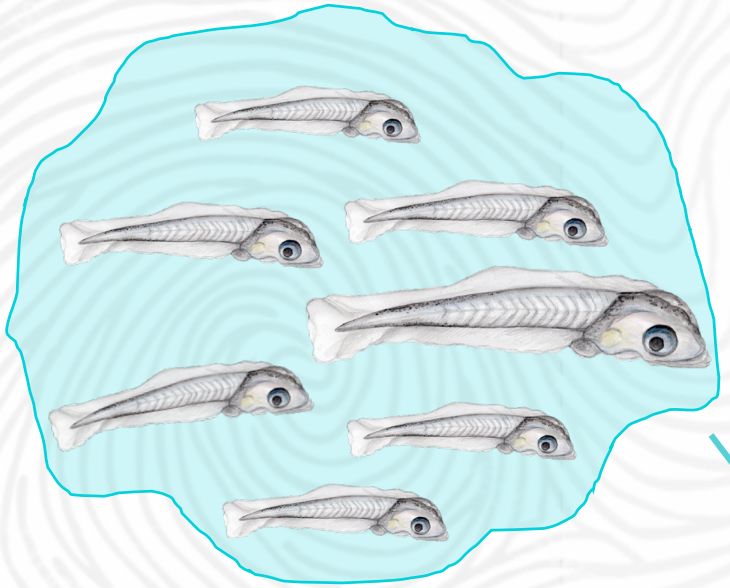

Larval dispersal-
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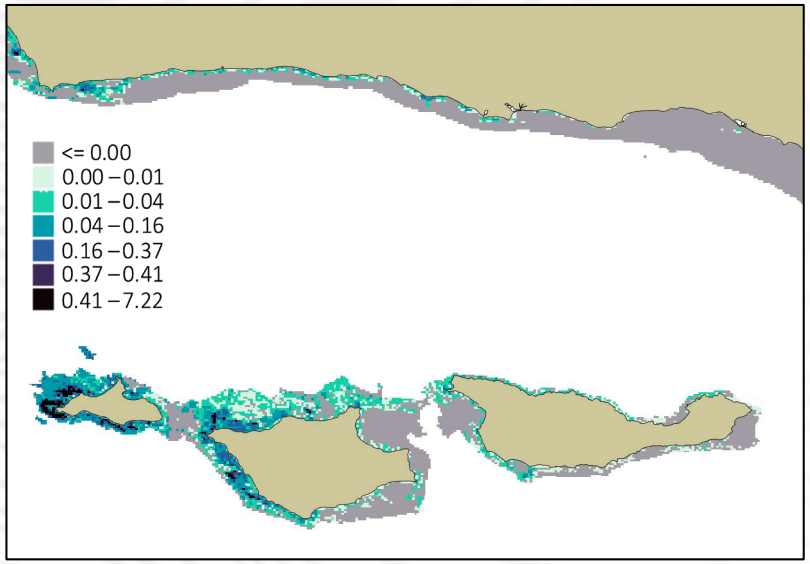
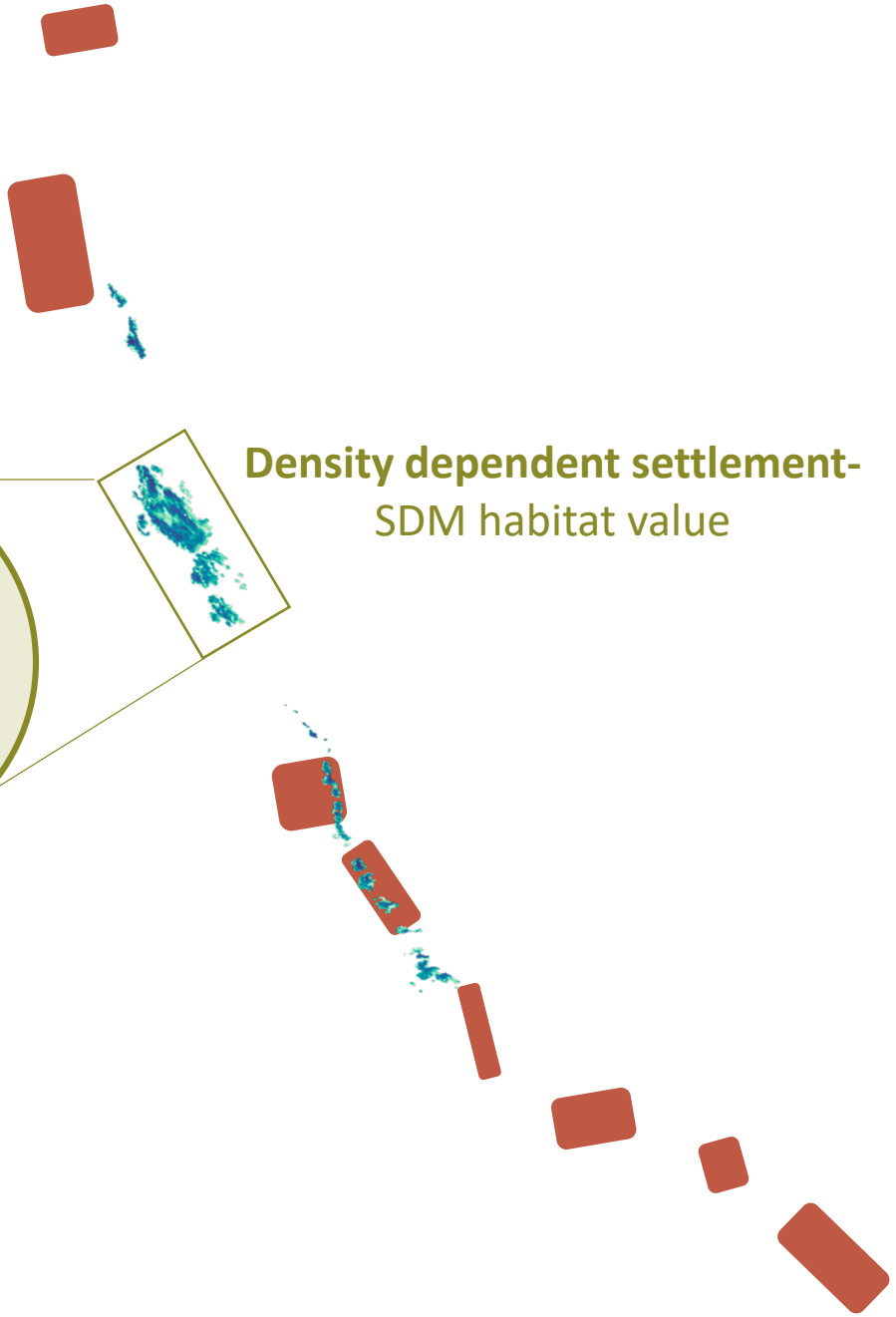
Density dependent settlement-
SDM habitat value



Biomass density

<= 0.00
0.00 – 0.01
0.01 – 0.04
0.04 – 0.16
0.16 – 0.37
0.37 – 0.41
0.41 – 7.22



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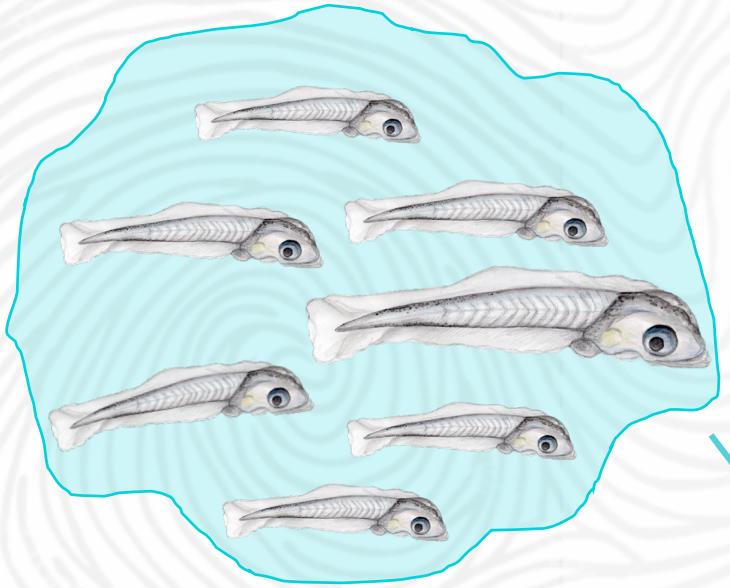

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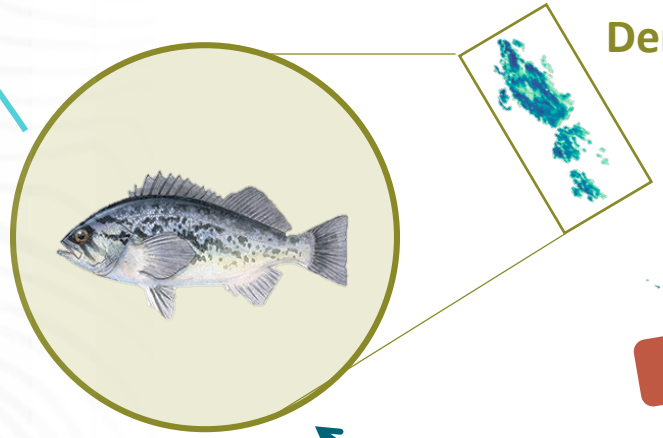

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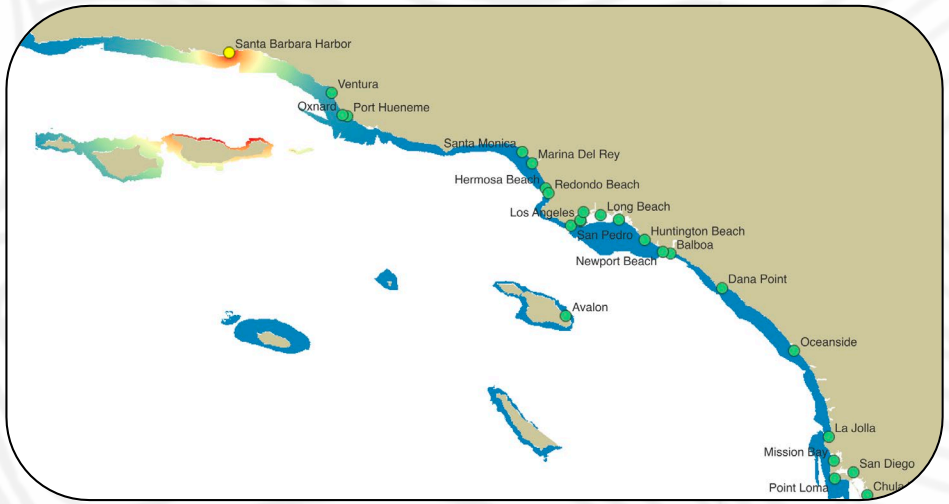
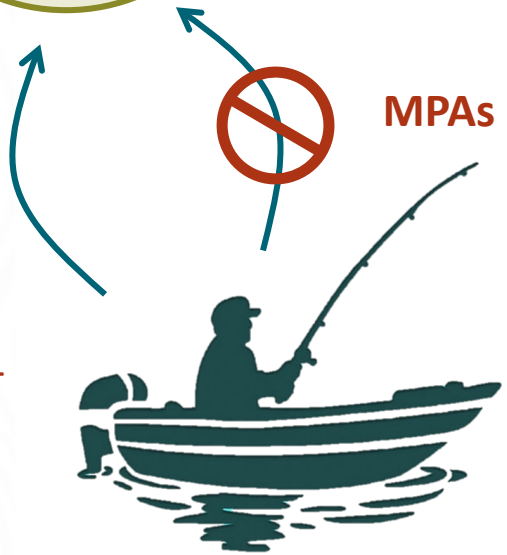
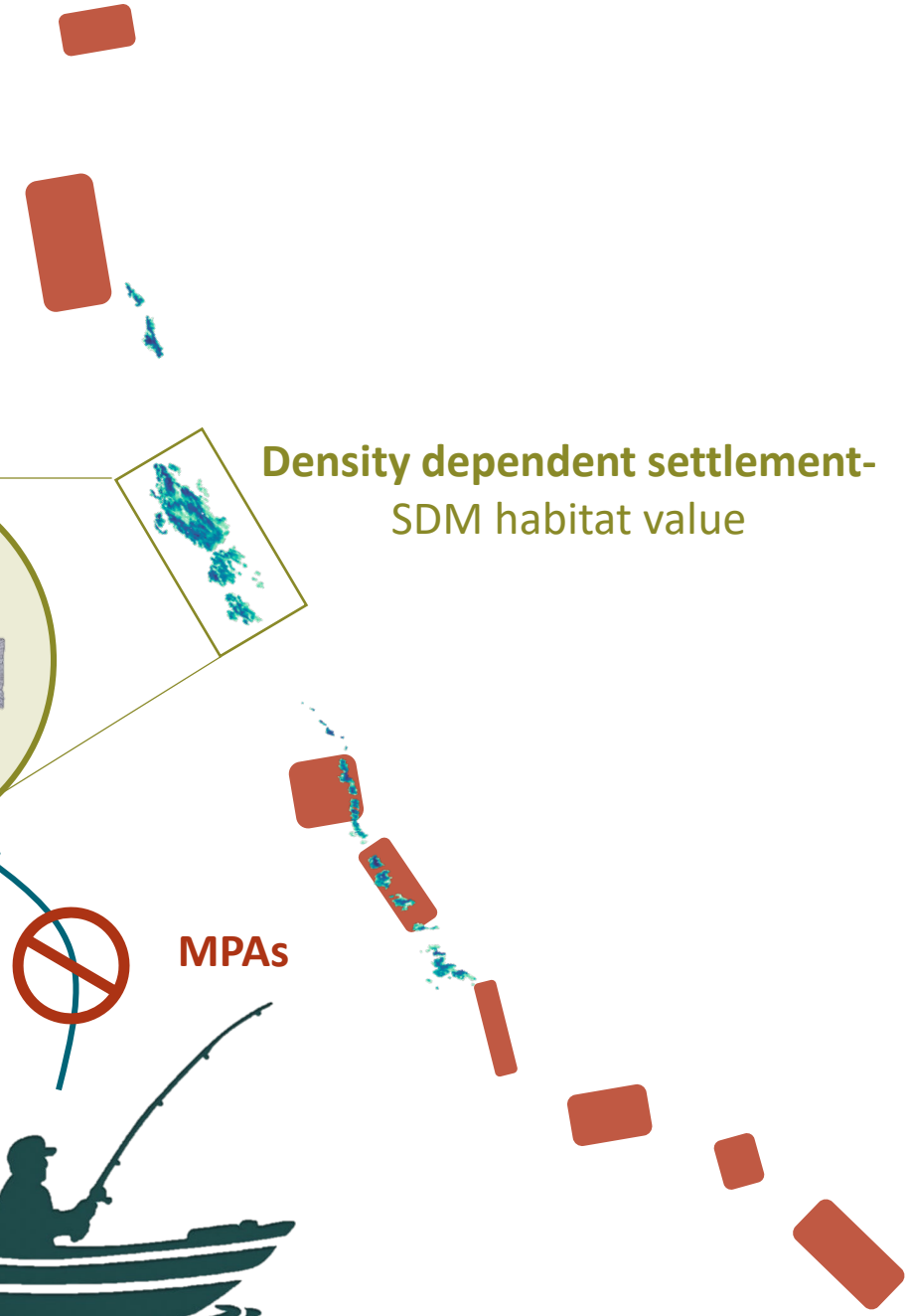


Spatial fishing effort –
Dynamic fleet model



MPAs



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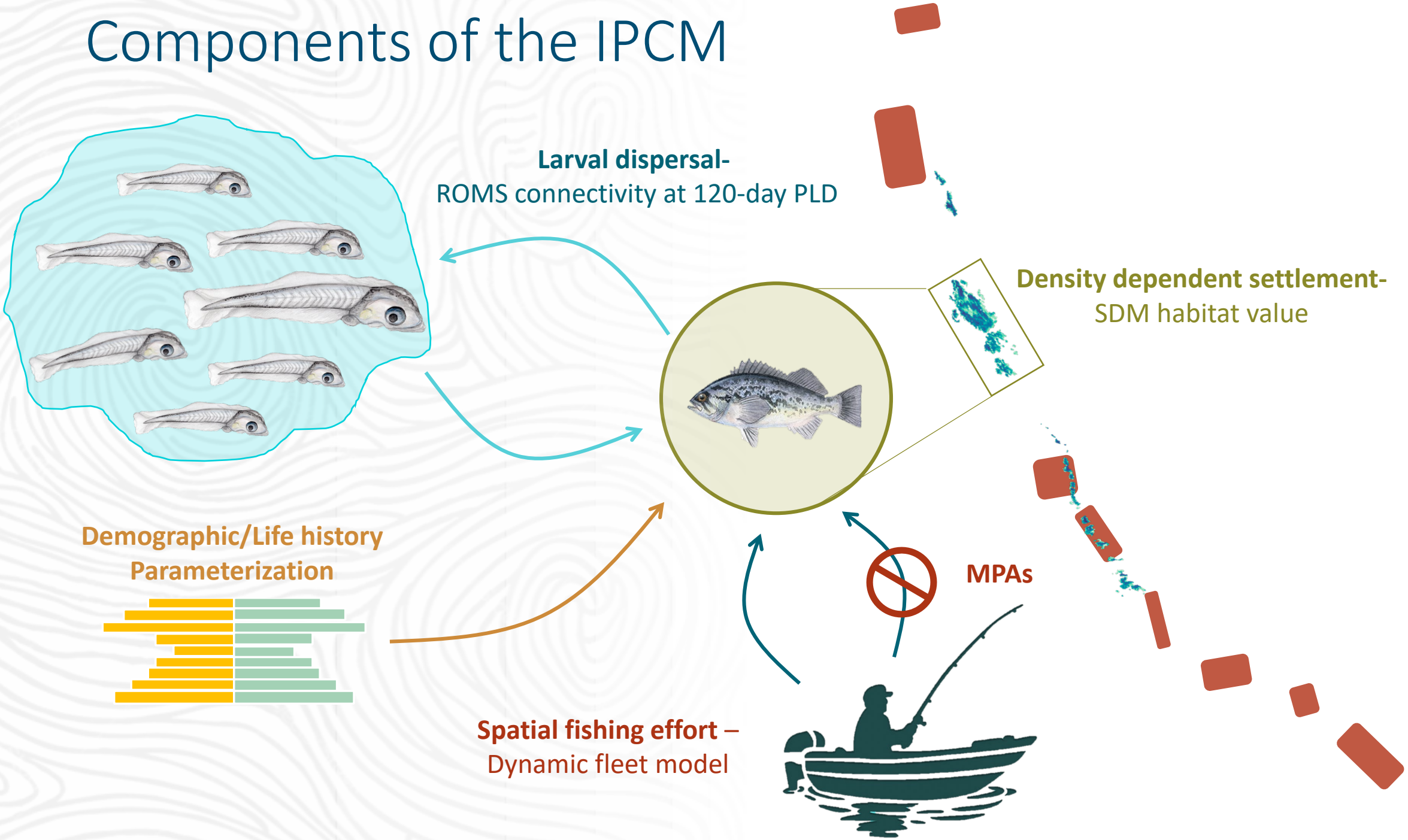
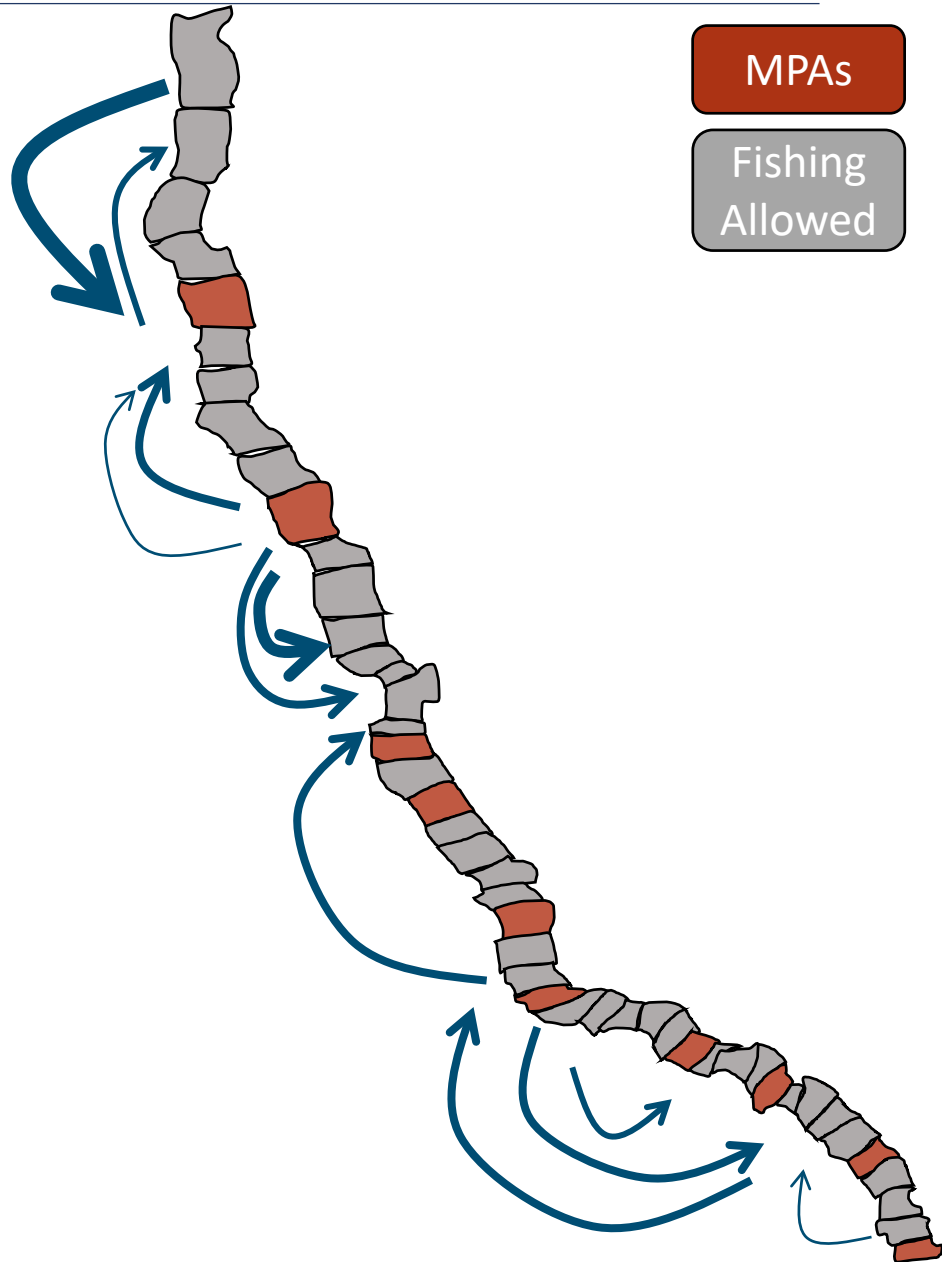


Questions

1. What is the *replacement capacity* of Blue Rockfish across the **entire California coastline?**



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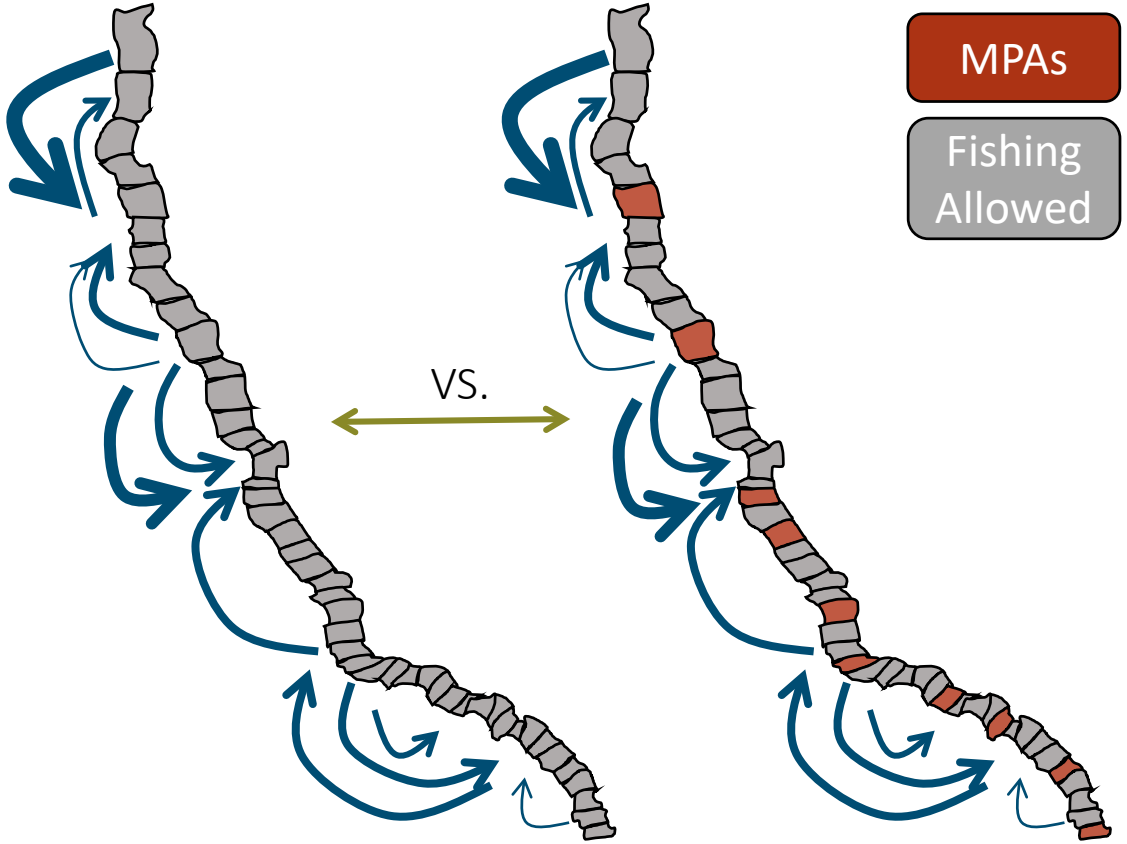

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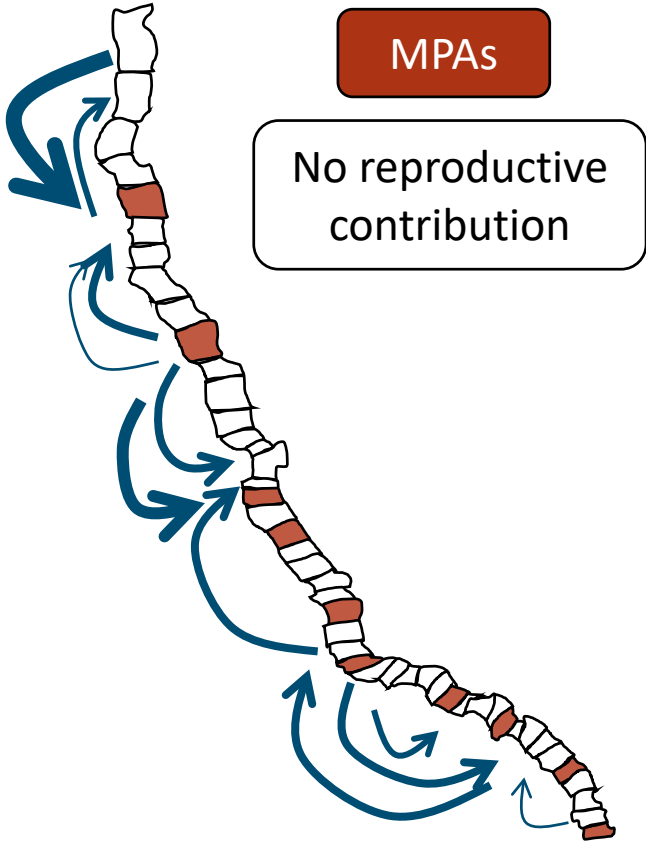

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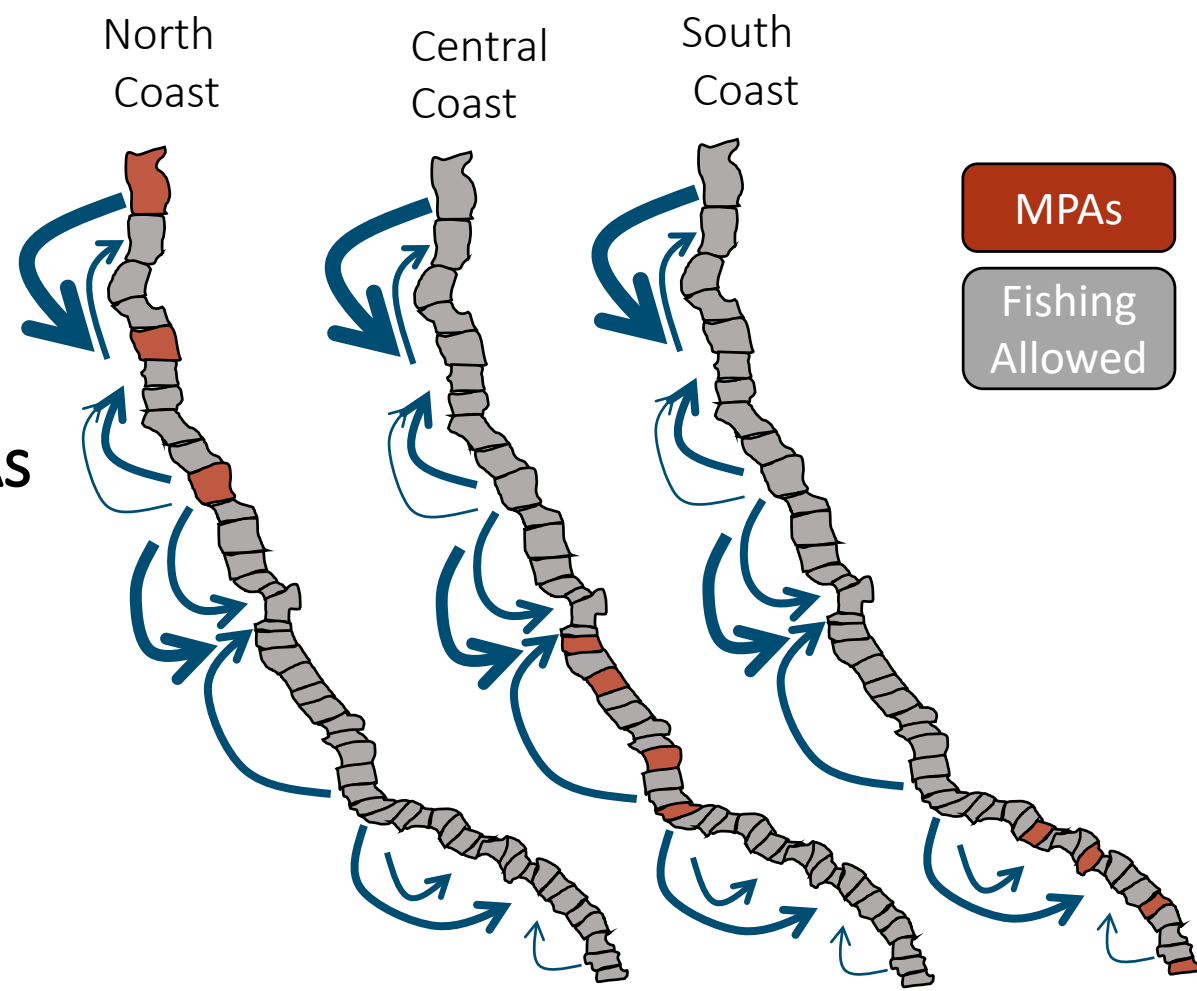

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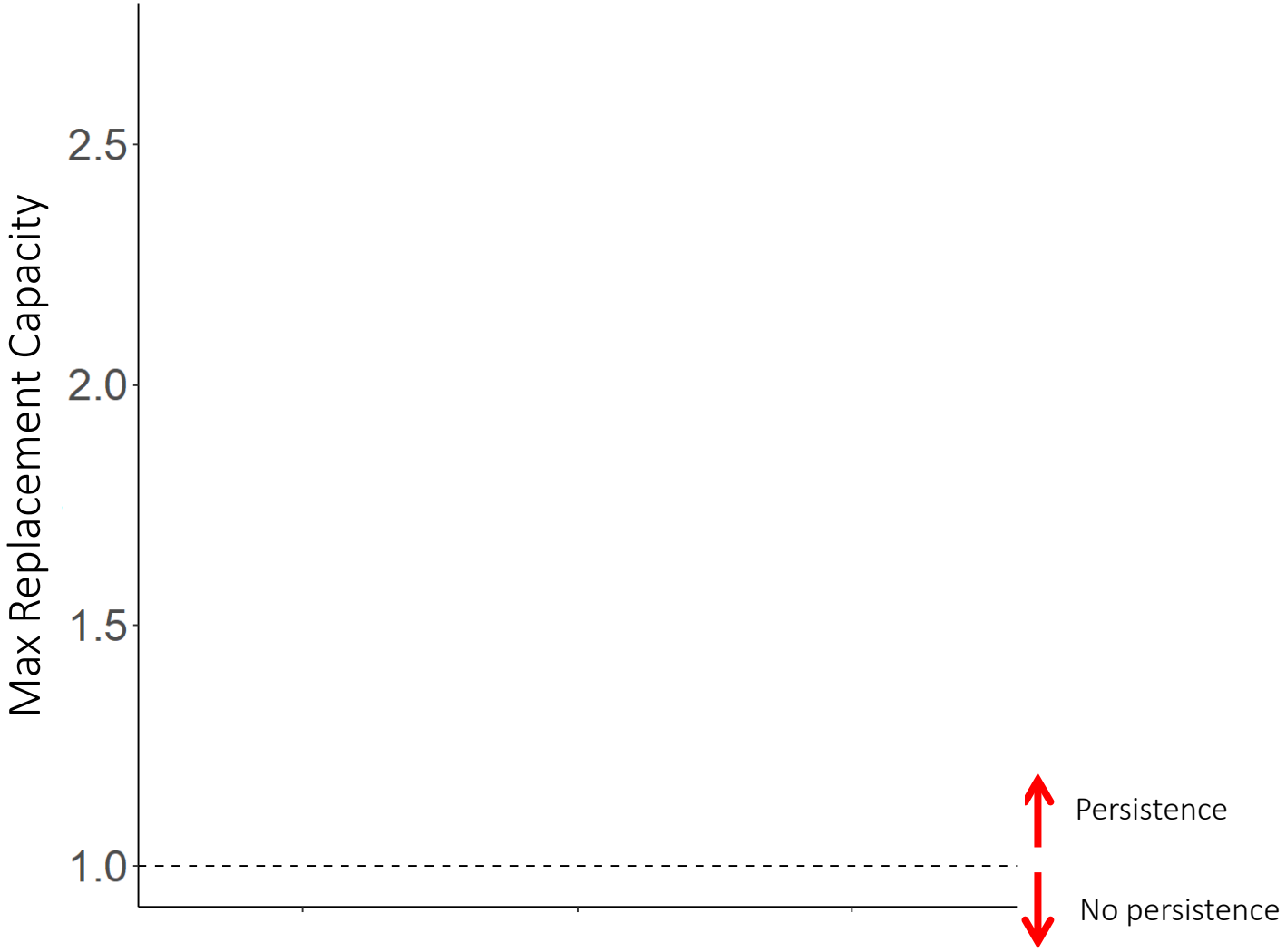
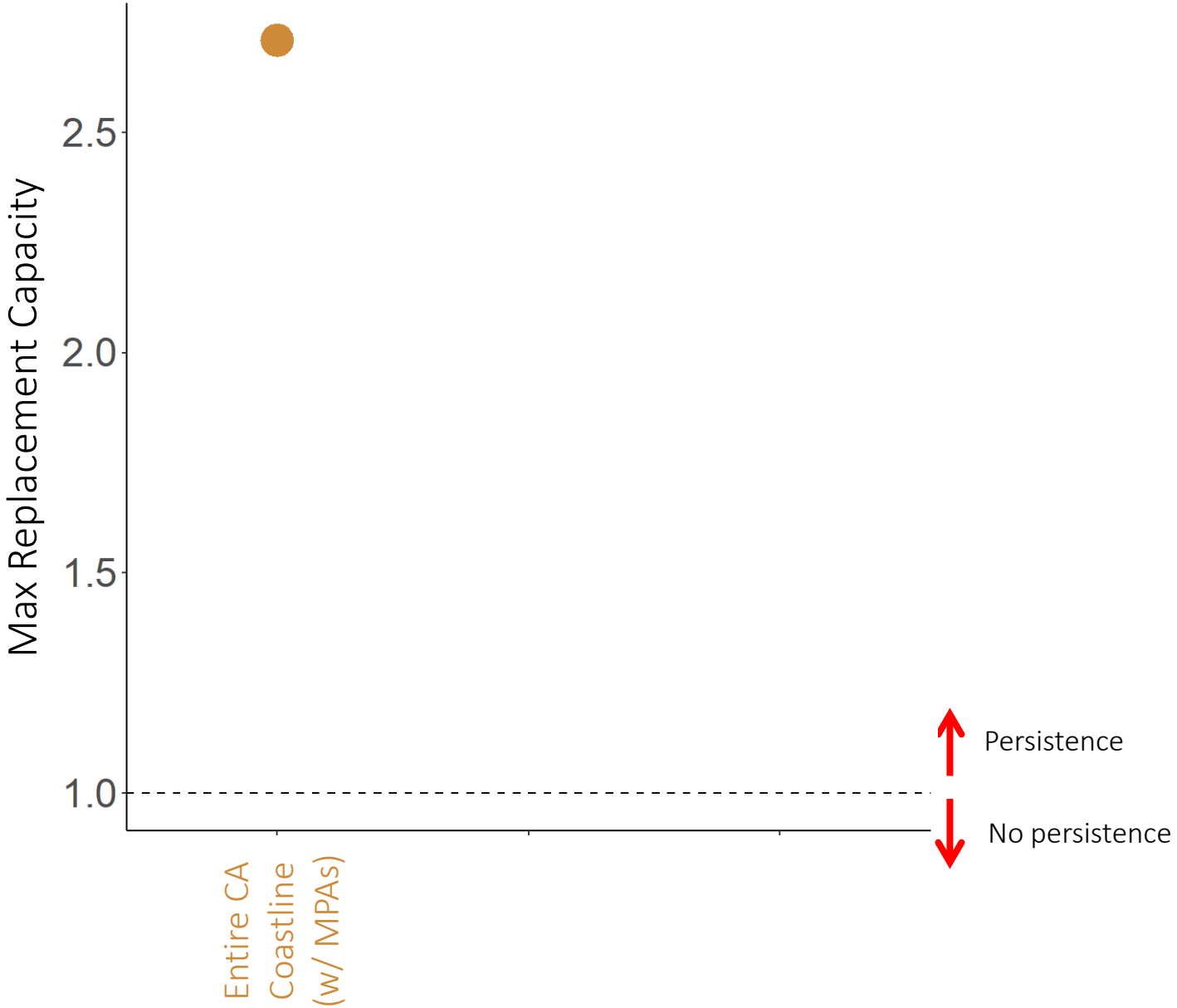
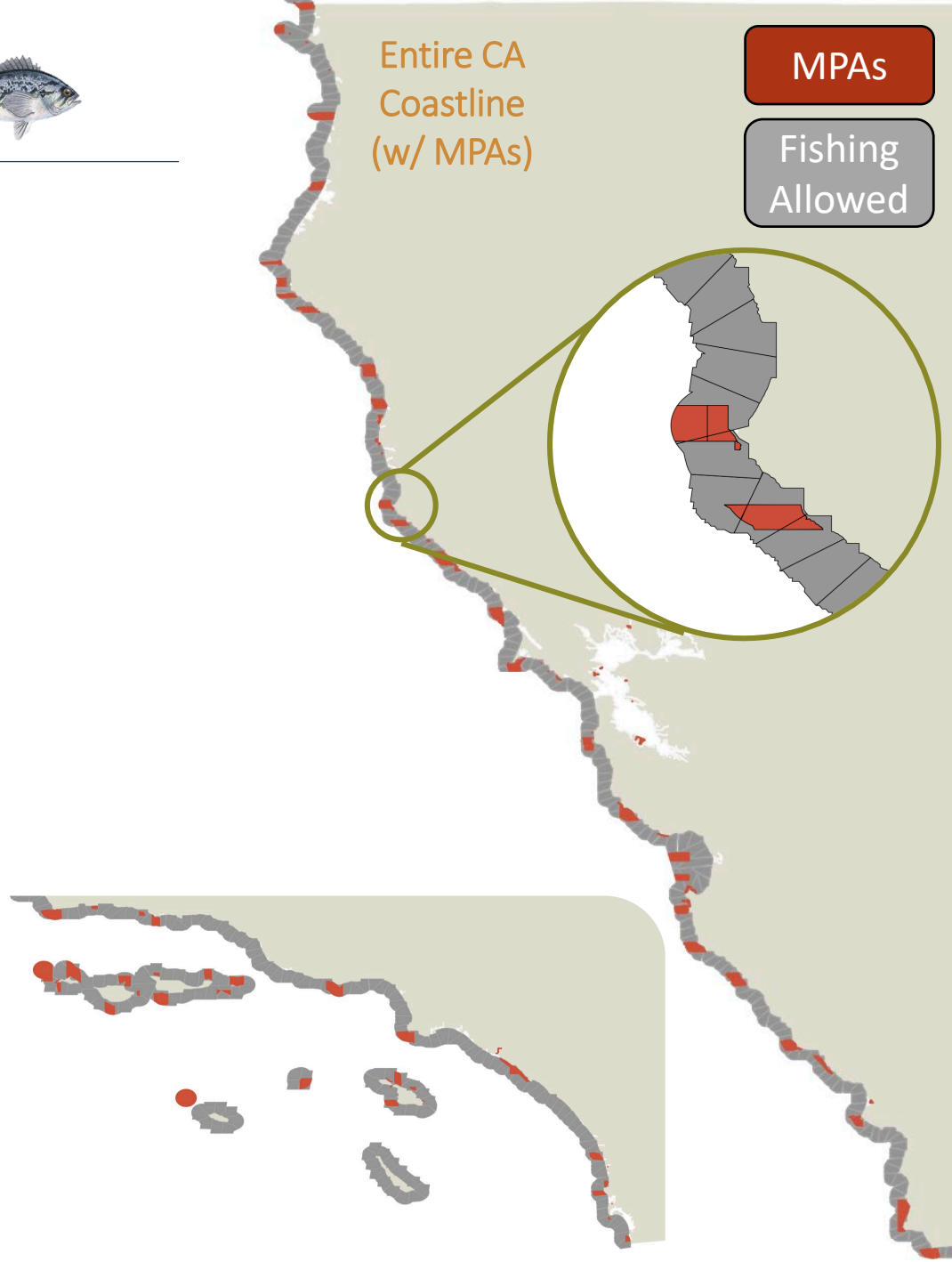
CONNECTIVITY



CALIFORNIA WIDE CONNECTIVITY





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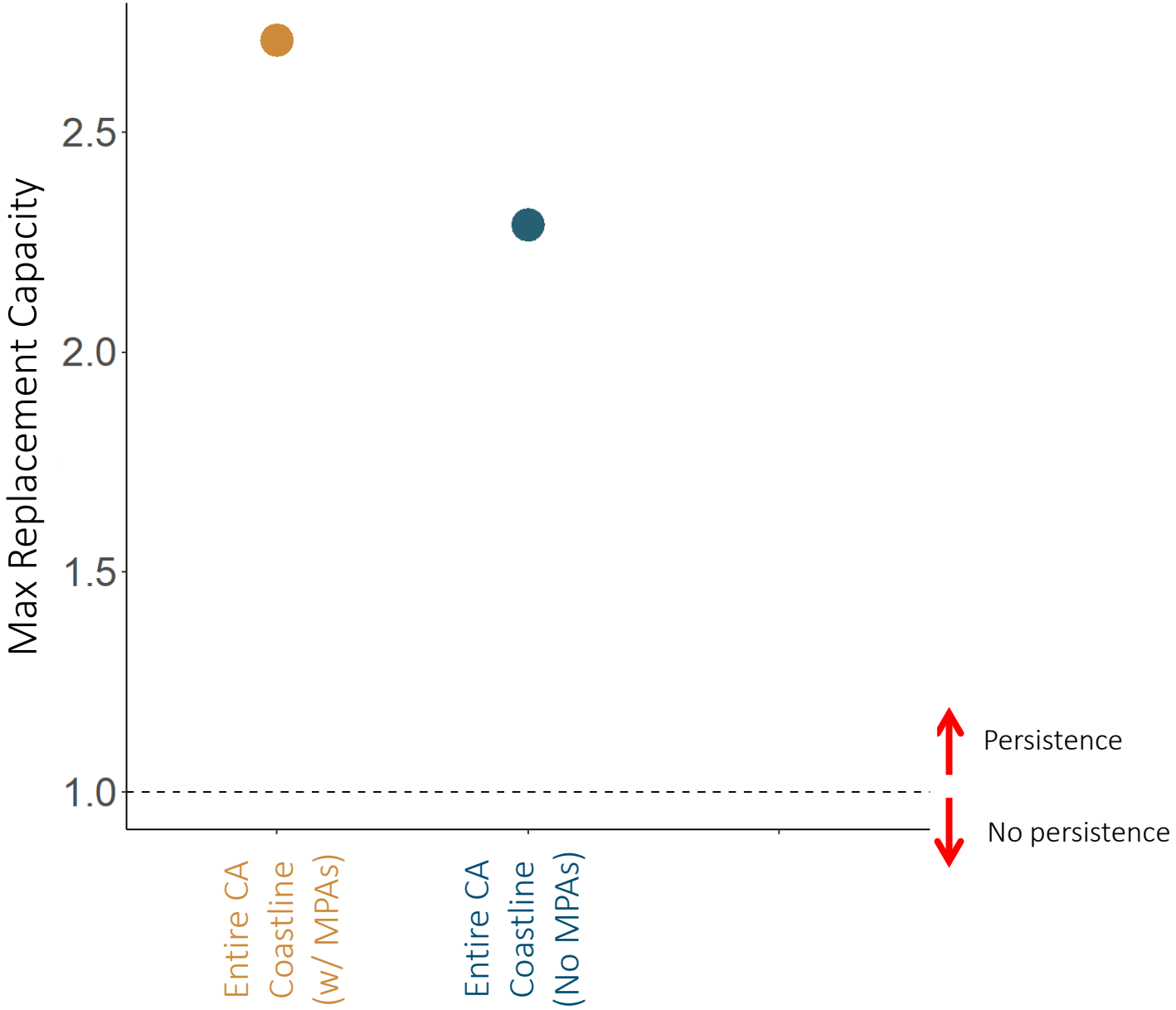

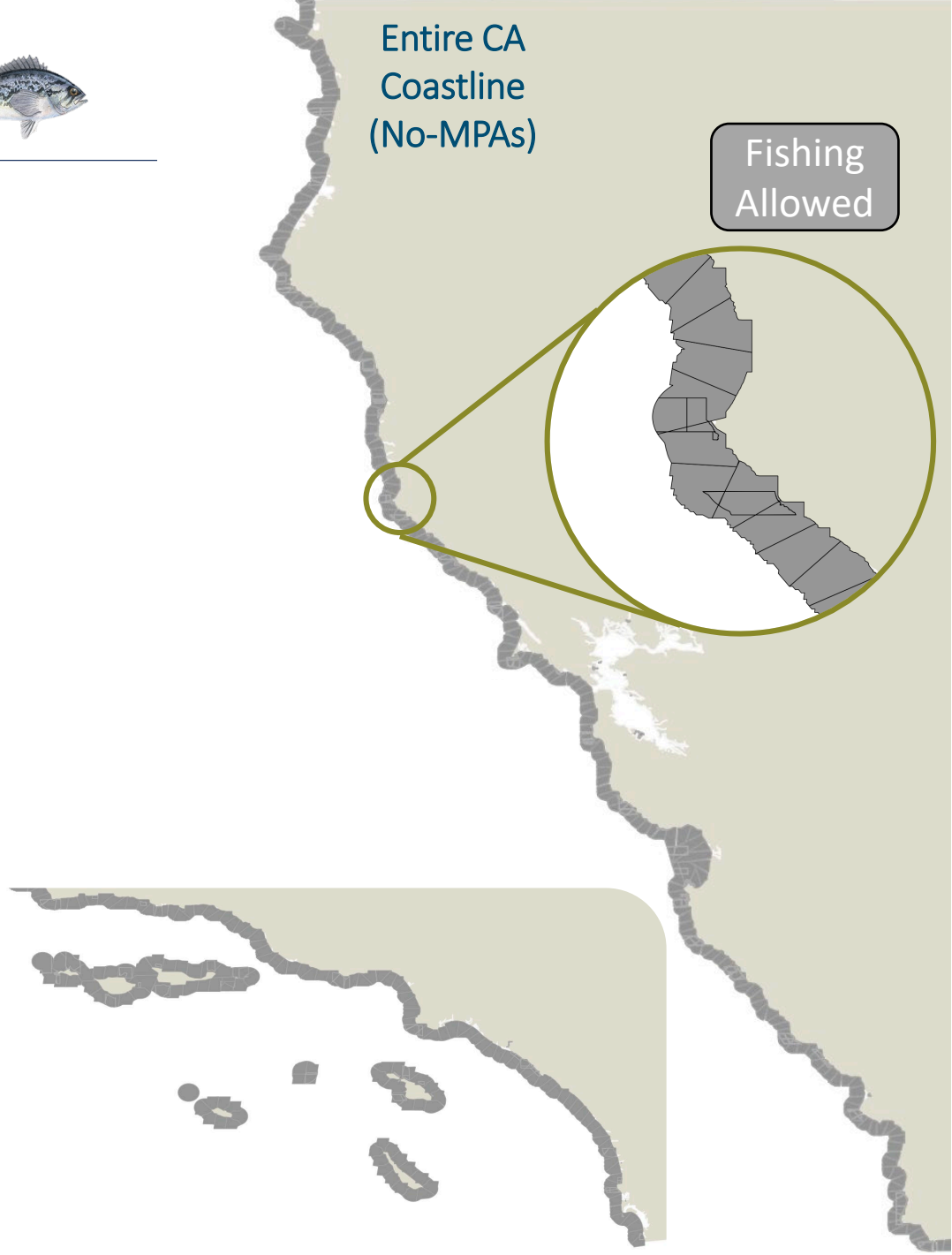

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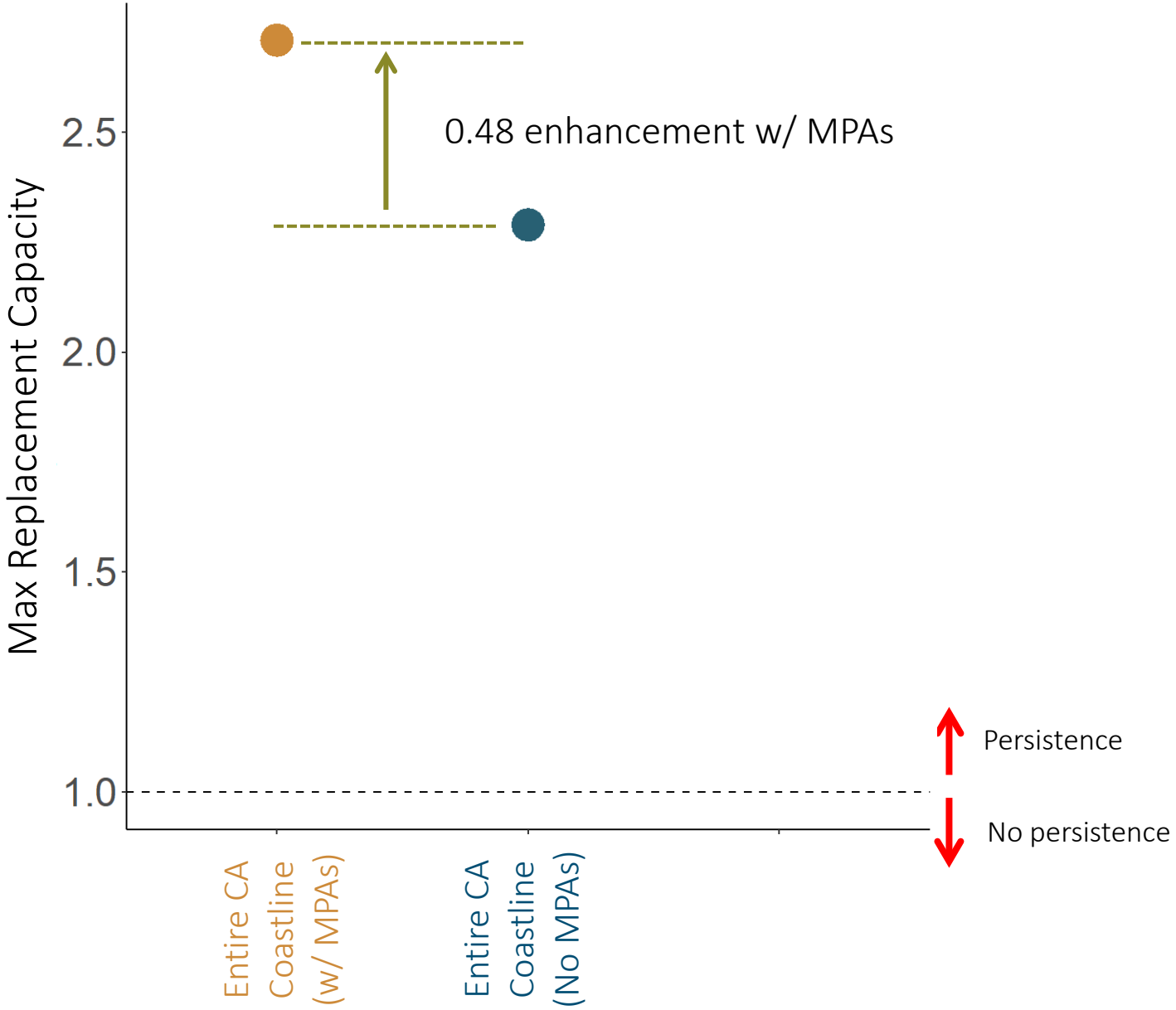

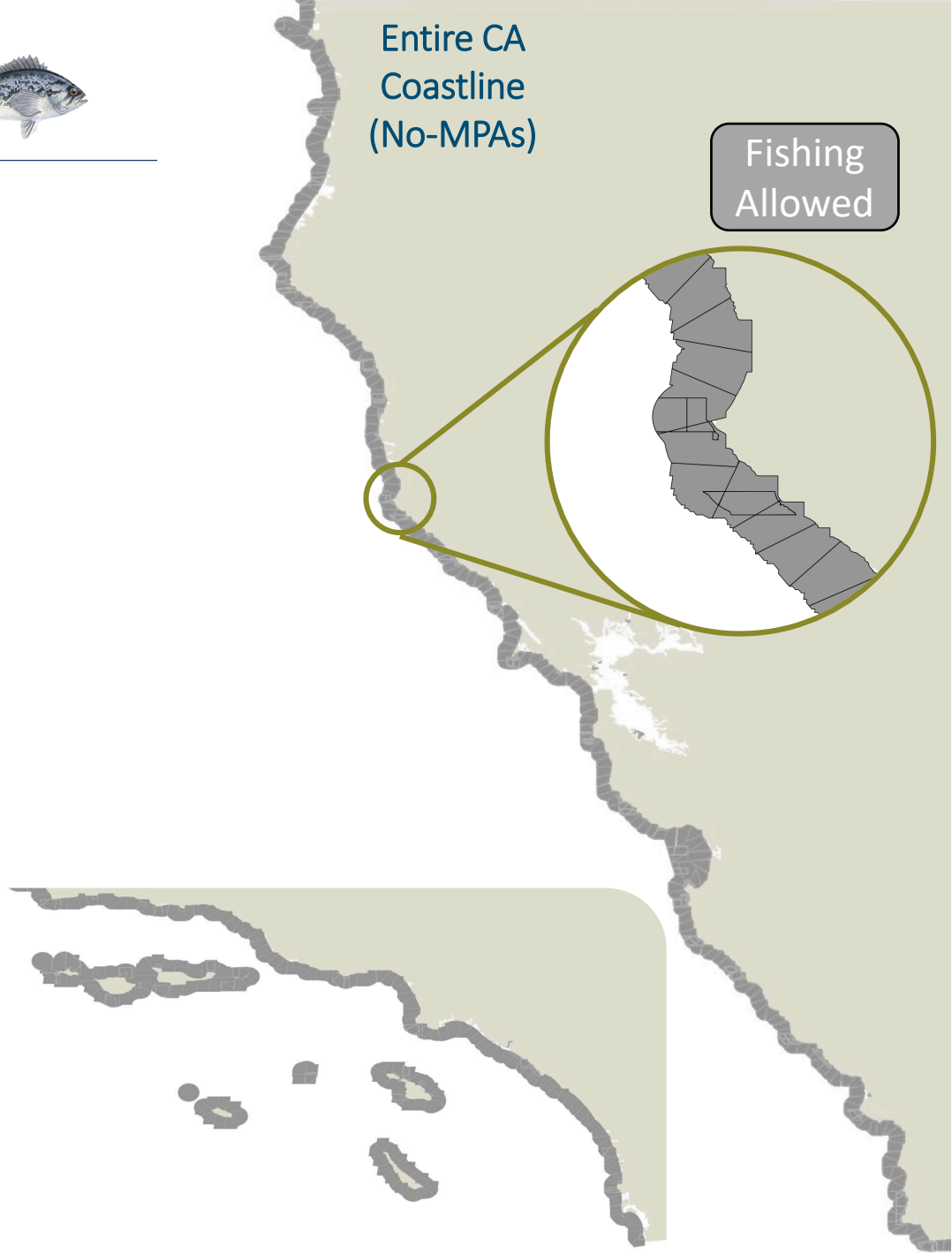

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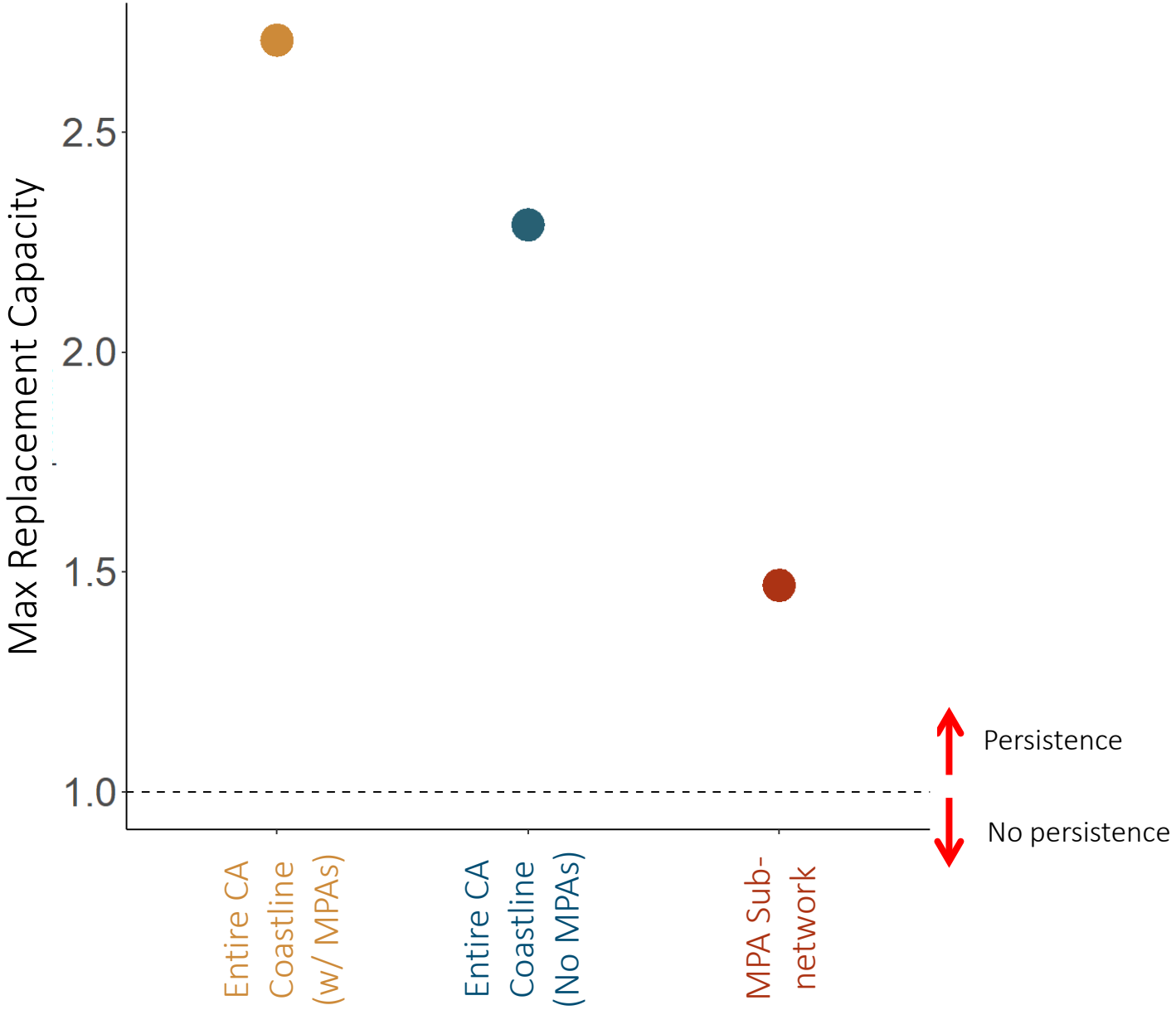
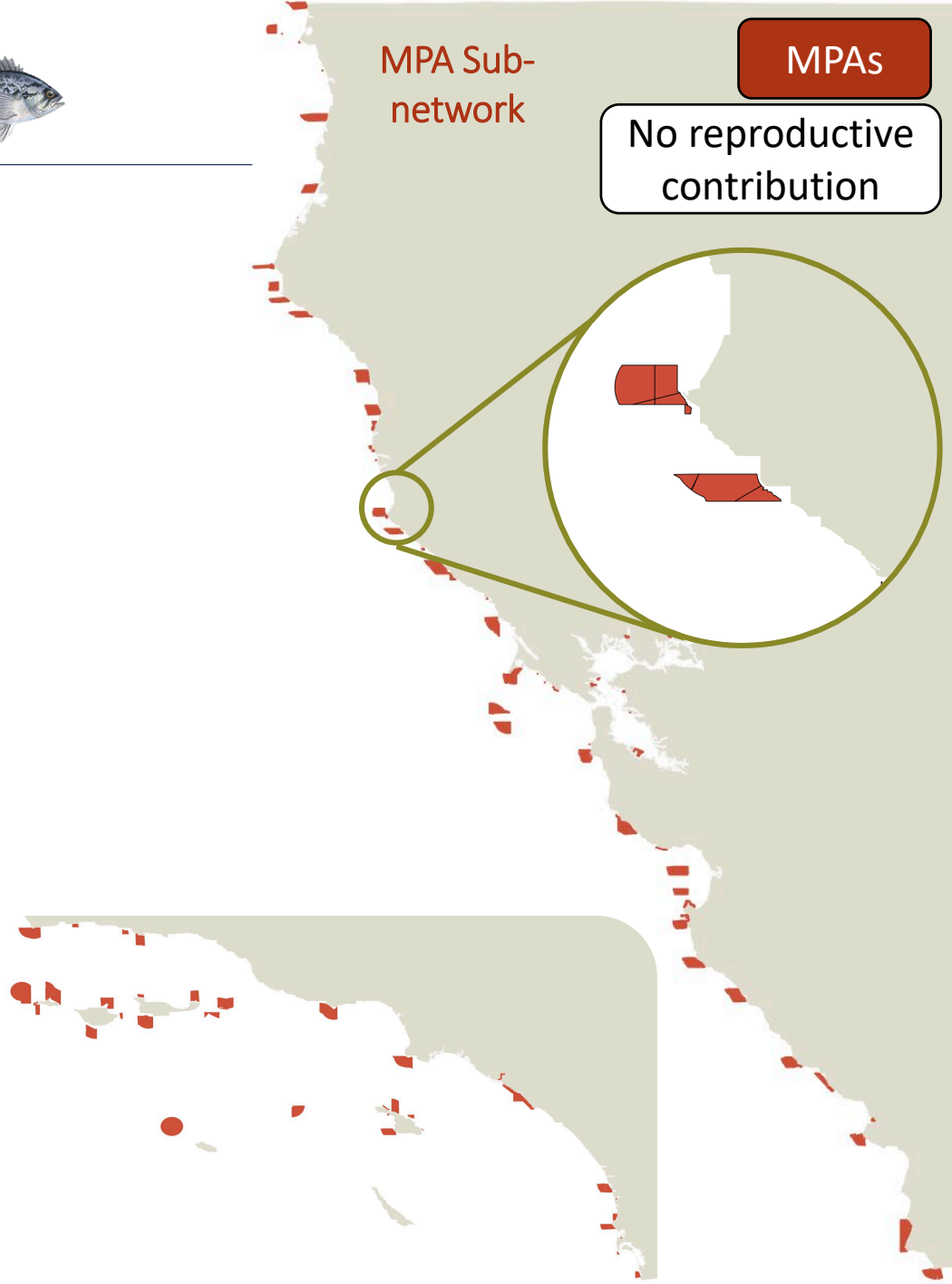
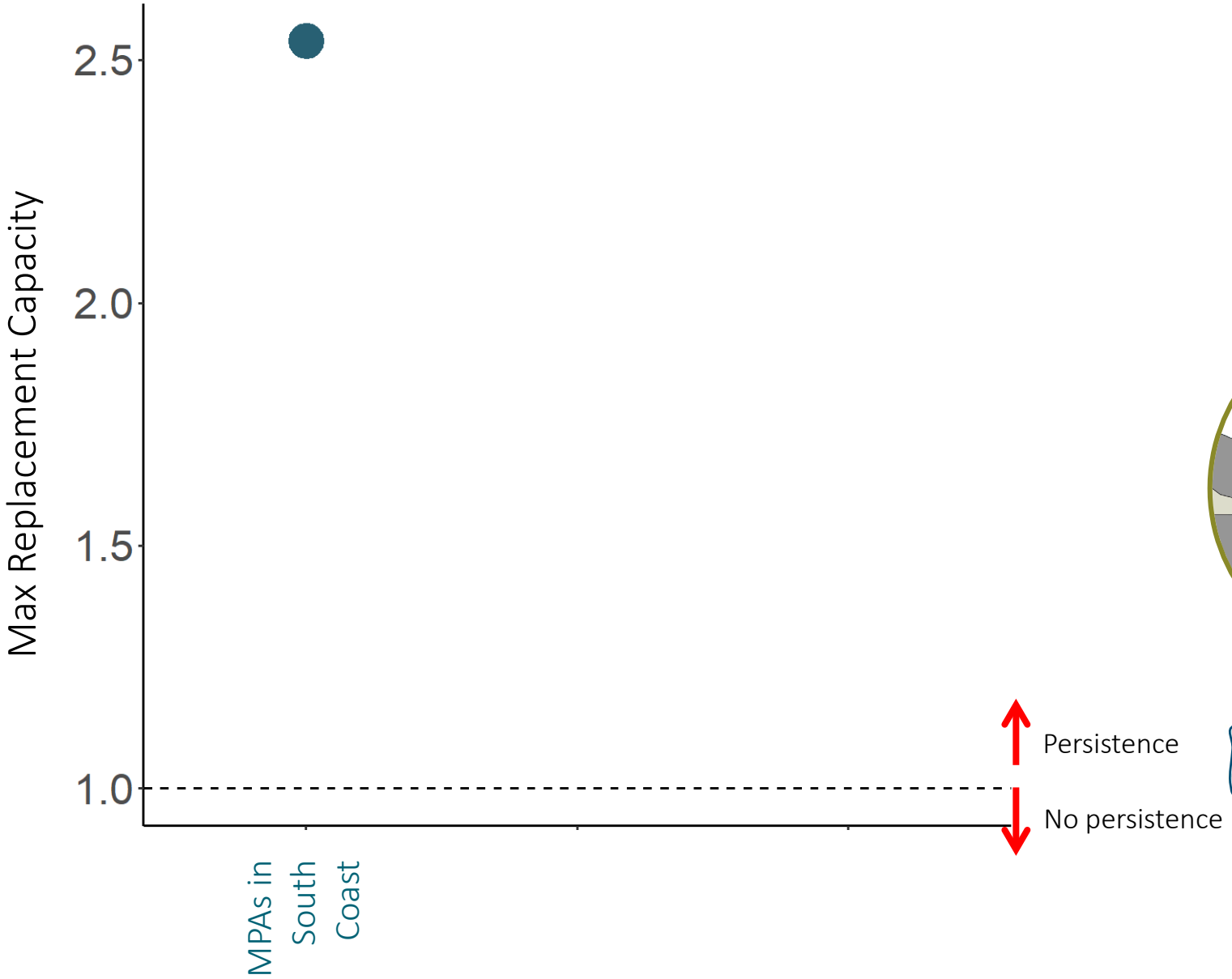
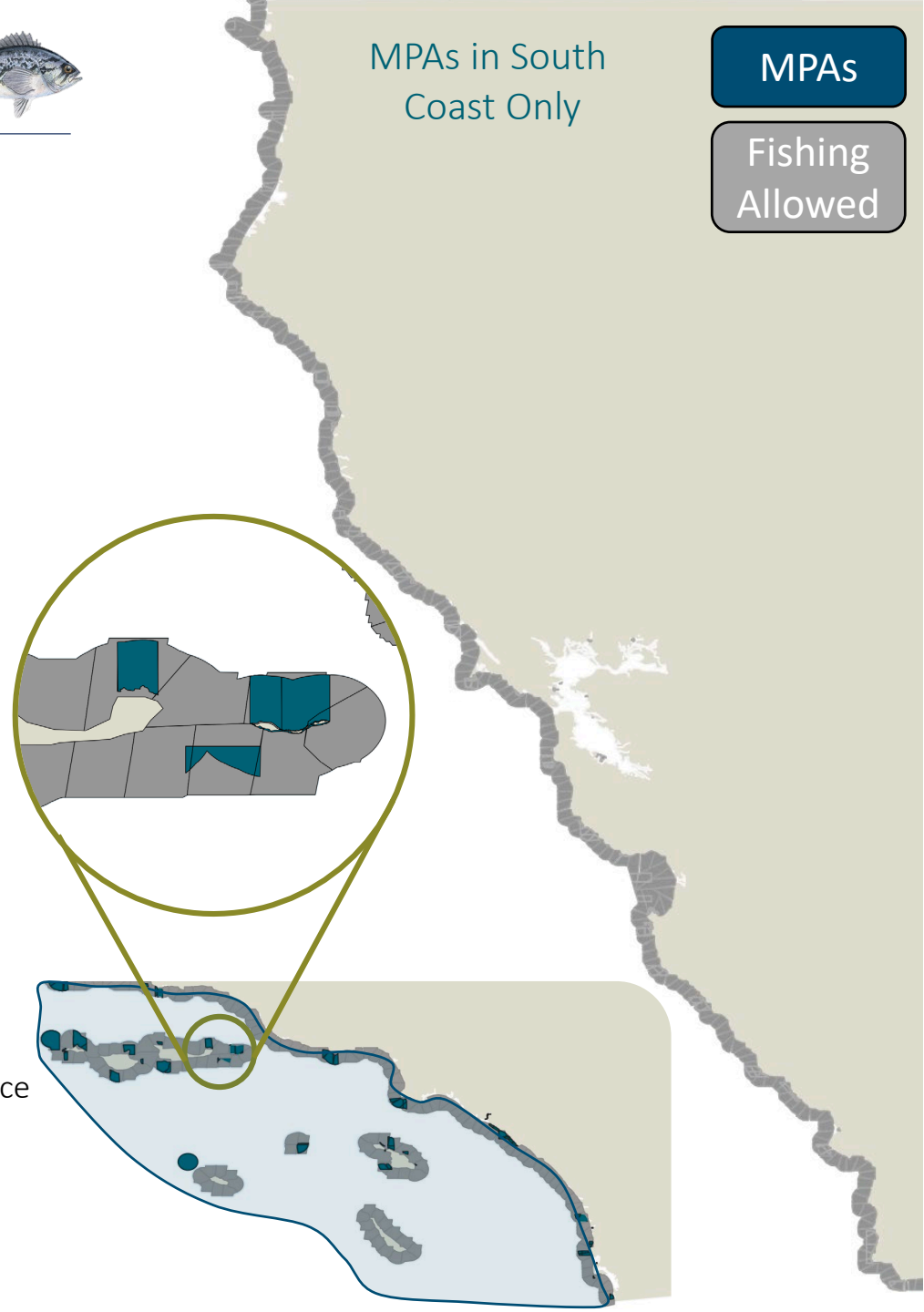




MPA subregion Connectivity





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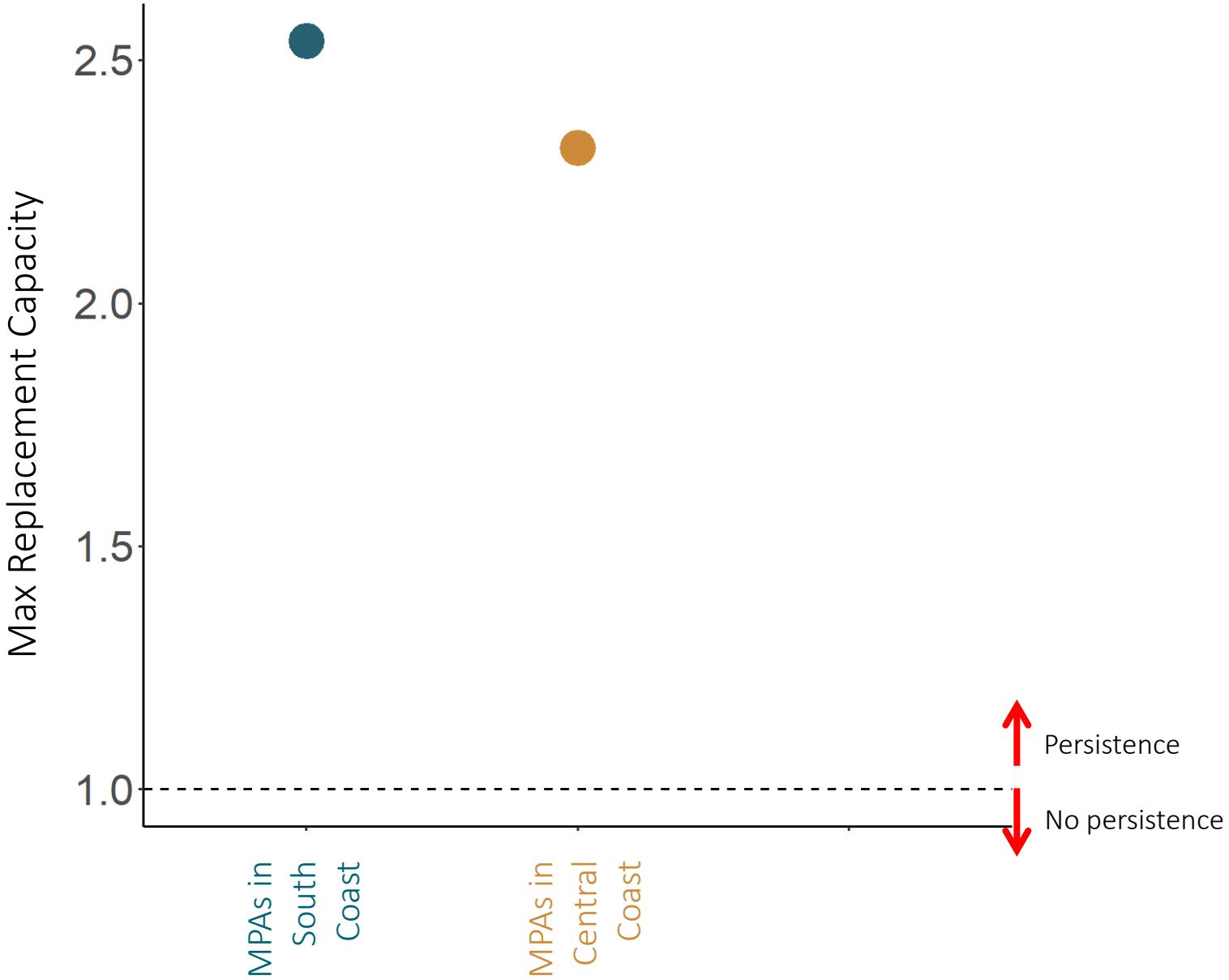

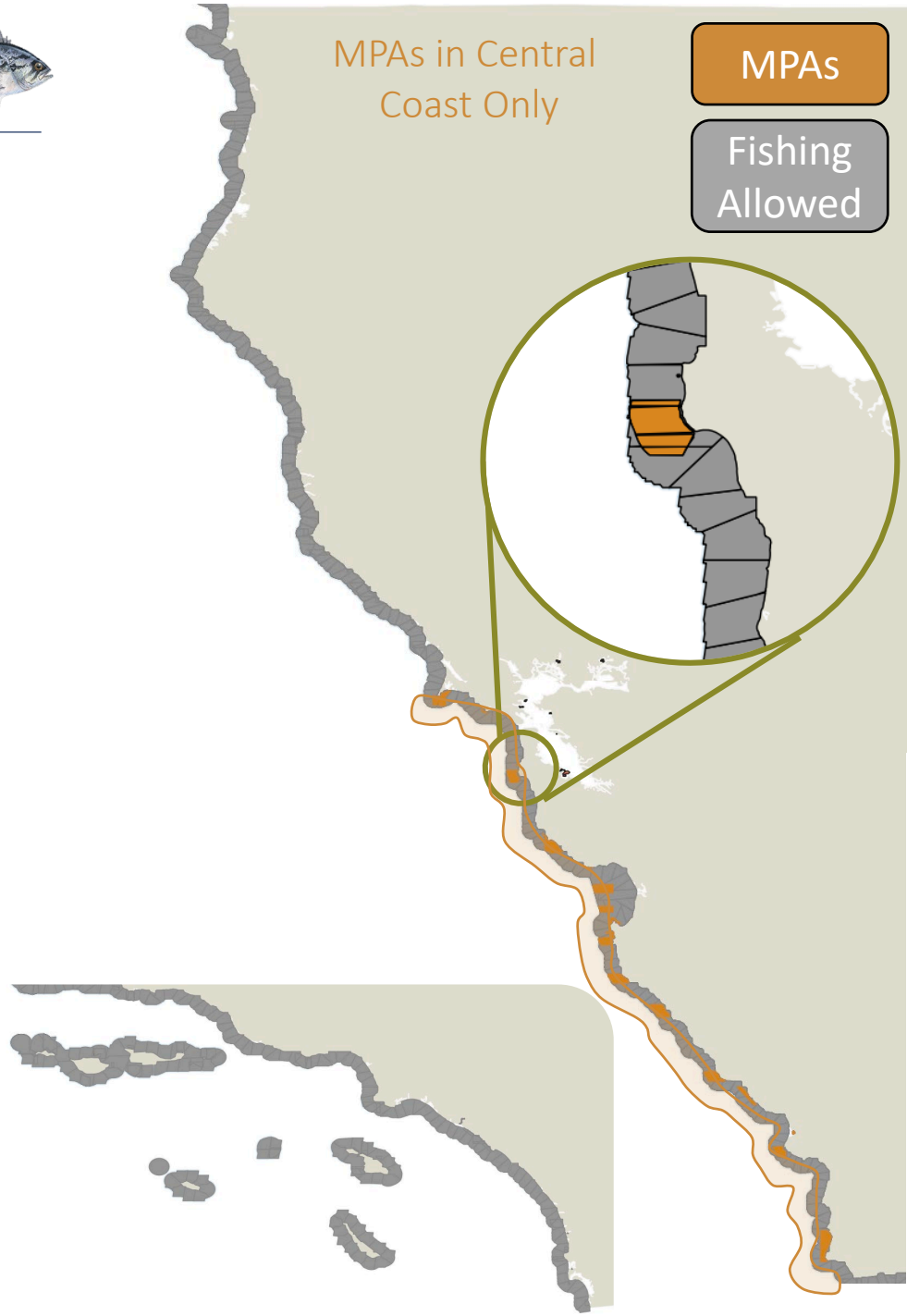

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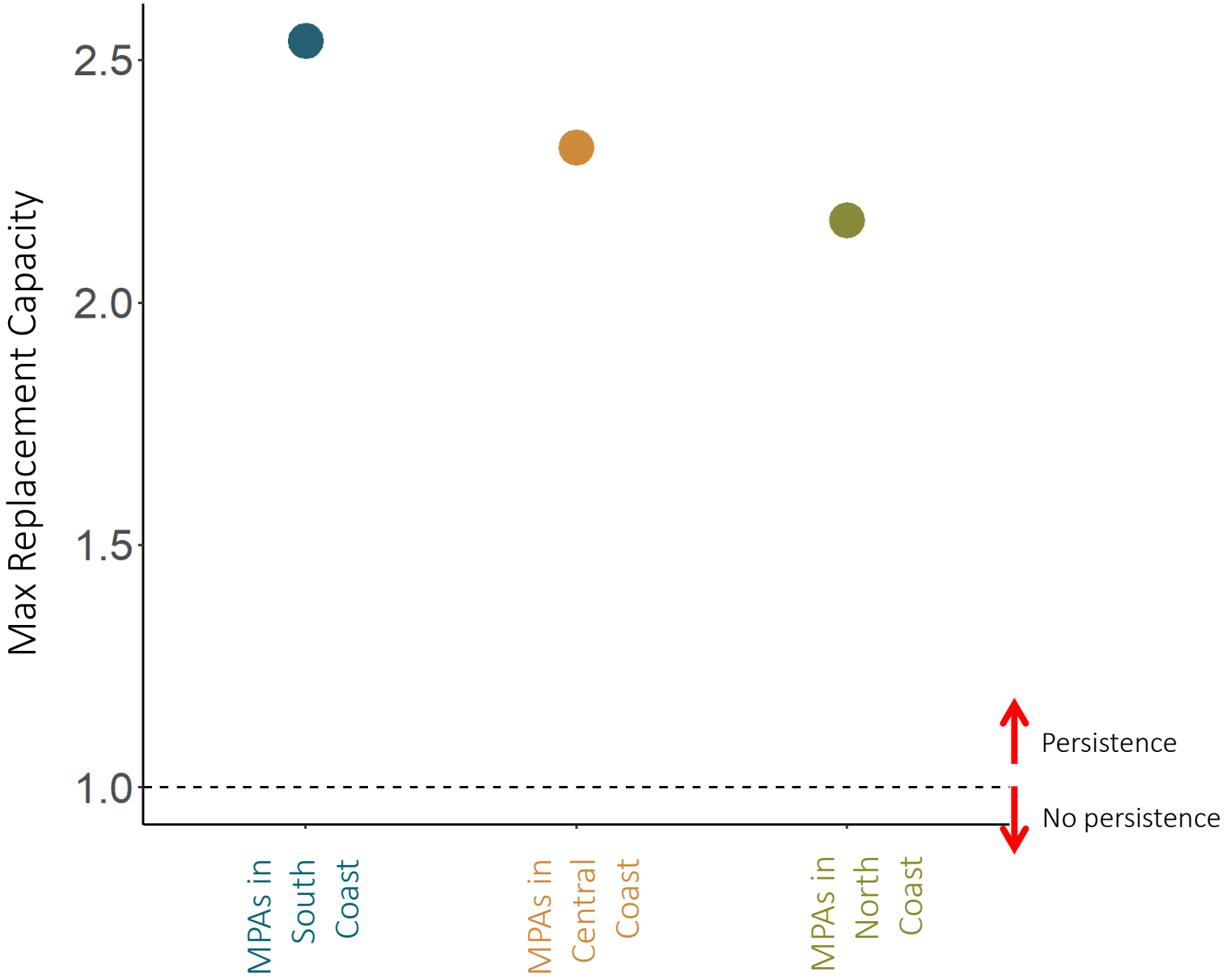
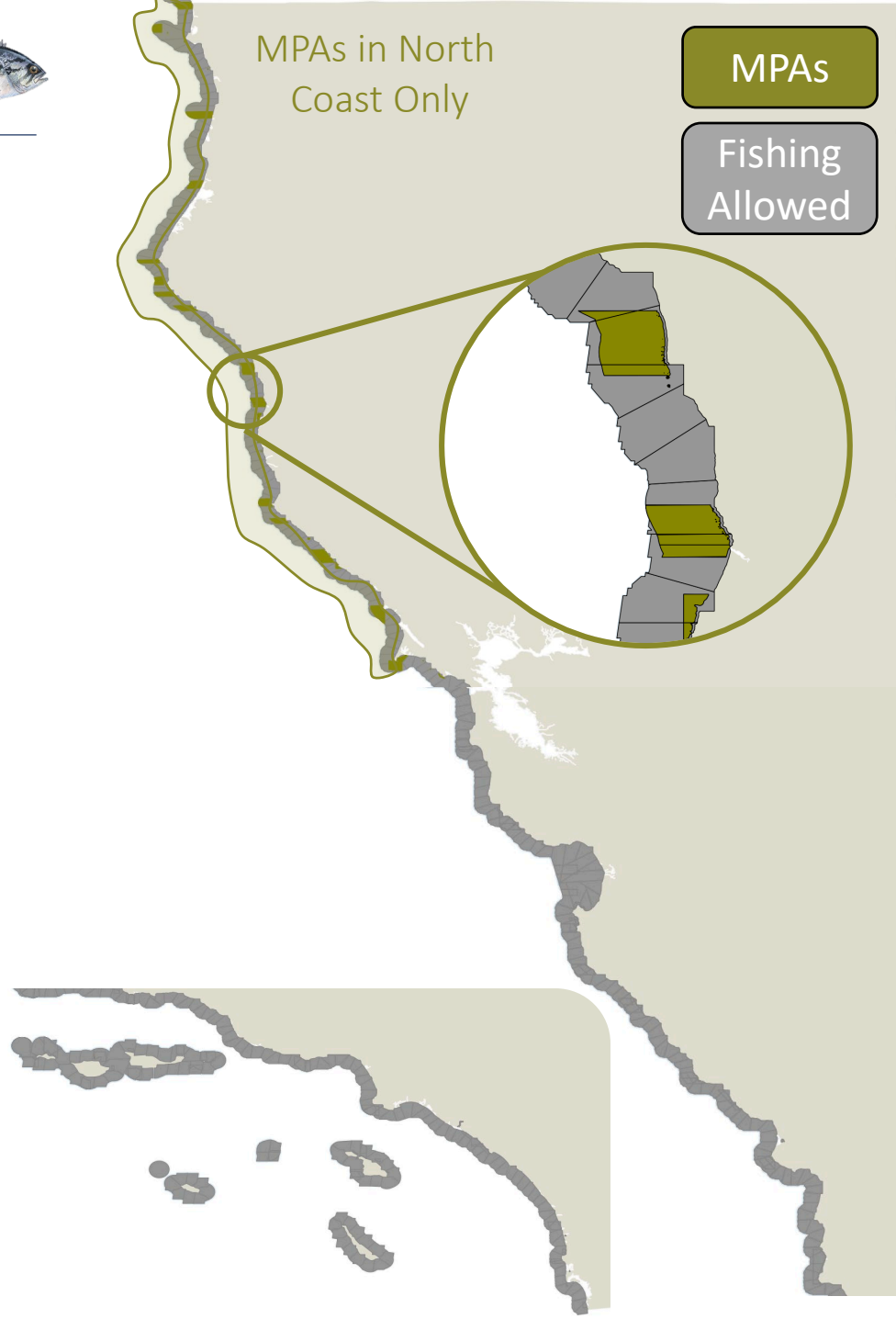




Network connectivity -Replacement Capacity

All Persistent

Full Coastline (with MPAs)	↑
Full Coastline (with no MPAs)	↑
MPA sub-network	↑
Full Coastline (with North MPAs)	↑
Full Coastline (with Central MPAs)	↑
Full Coastline (with South MPAs)	↑

Network connectivity -Replacement Capacity

All Persistent

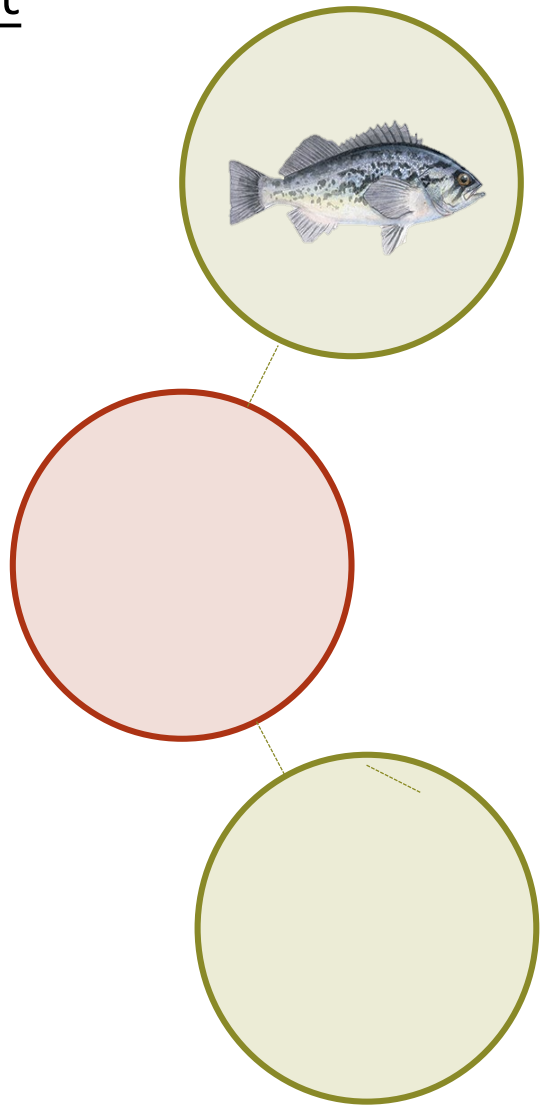
Full Coastline (**with MPAs**)	↑
Full Coastline (**with no MPAs**)	↑
MPA sub-network	↑
Full Coastline (**with North MPAs**)	↑
Full Coastline (**with Central MP**As)	↑
Full Coastline (**with South MPAs**)	↑

Not all MPAs are created equal

- ID high value MPAs via 2 metrics:
  1. Realized Export
  2. Patch importance

MPA VALUE METRICS

1. Realized Export



Non-MPA

MPA

MPA VALUE METRICS

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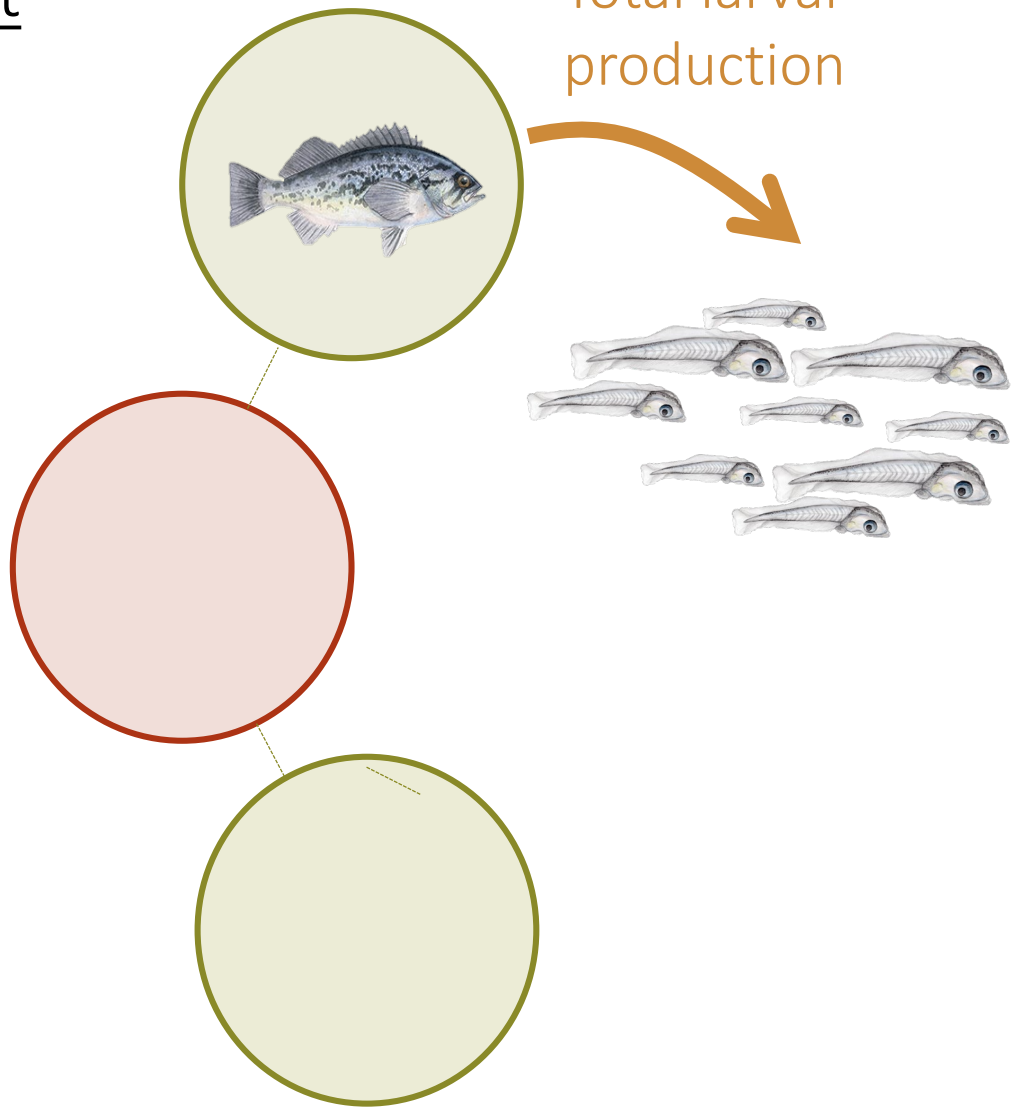

Non-MPA

MPA

MPA VALUE METRICS

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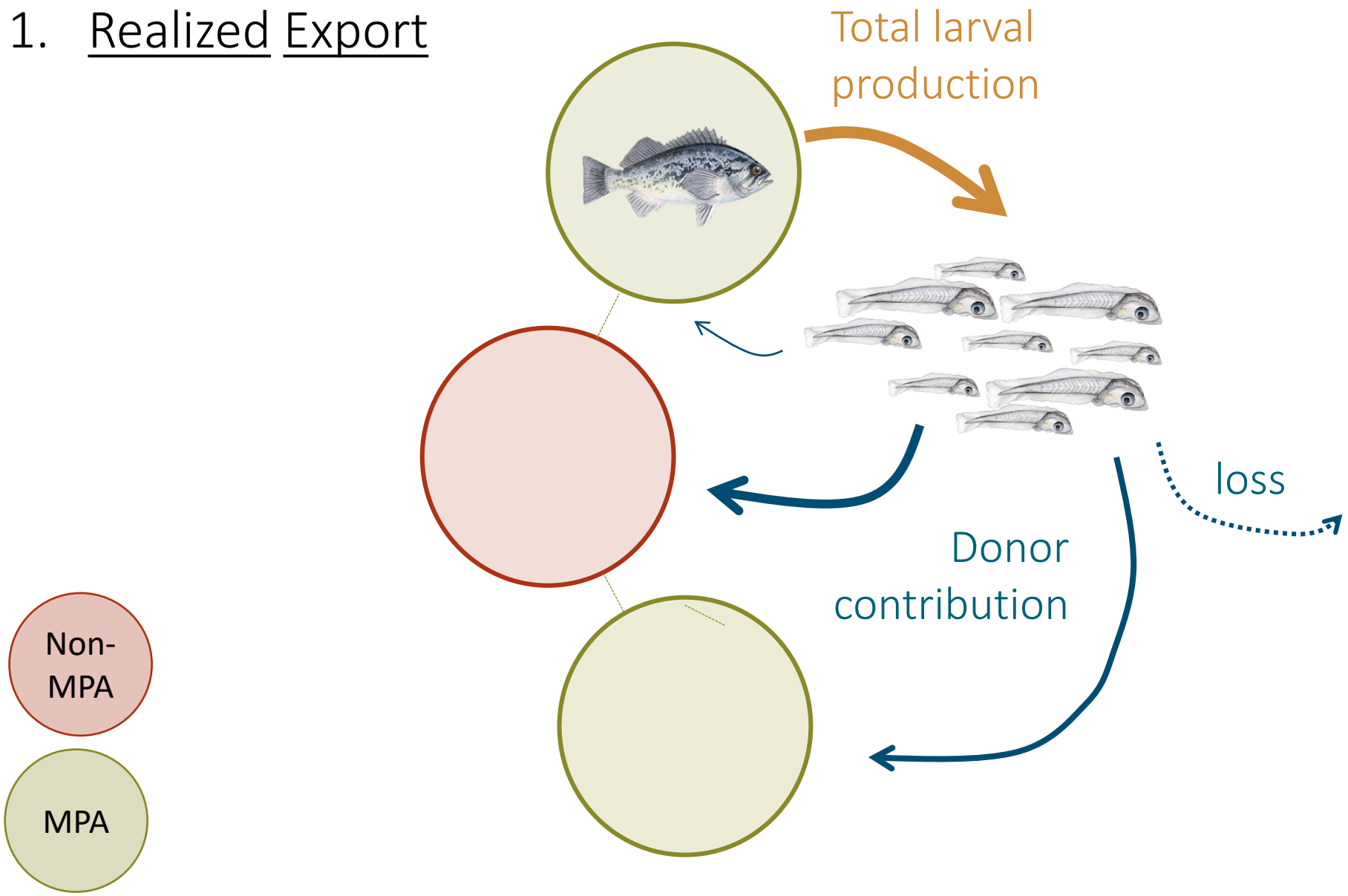
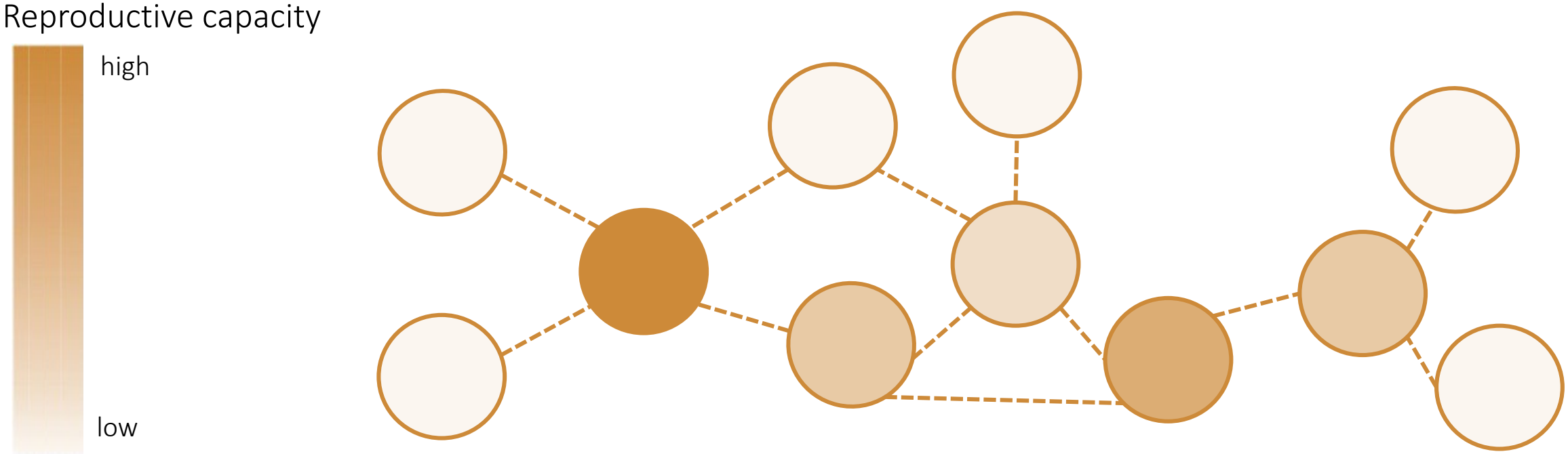


MPA VALUE METRICS

1. Realized Export
2. Patch importance

Metric which combines:

- Reproductive capacity (size structure)
- Connectedness



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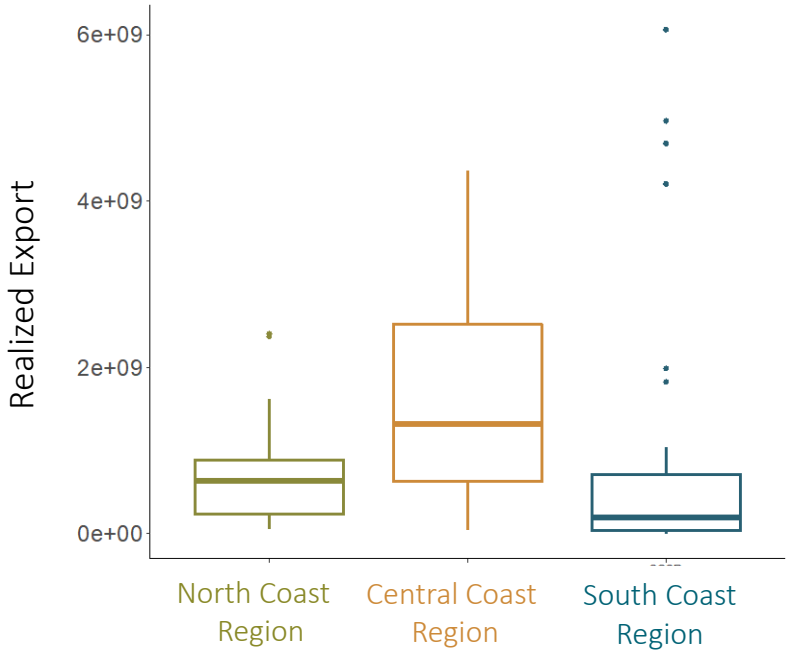

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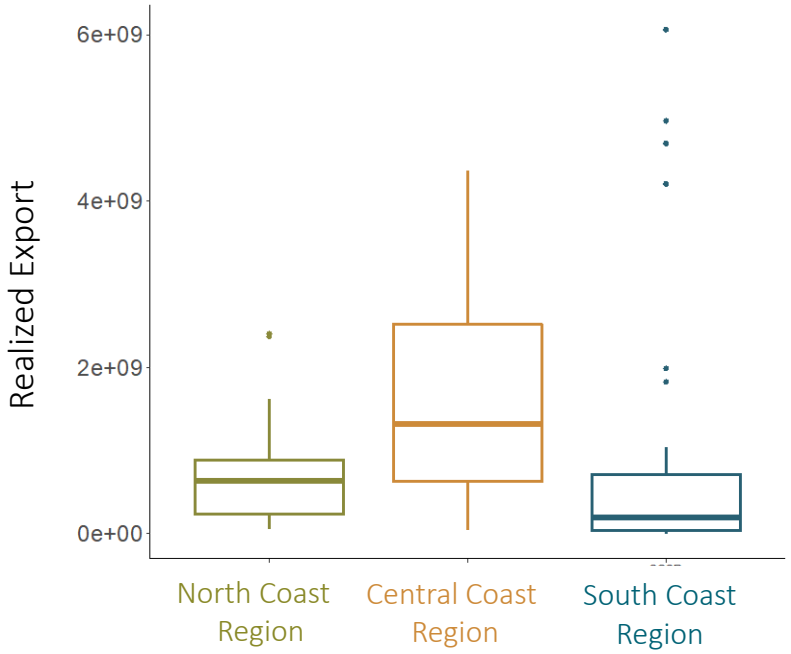
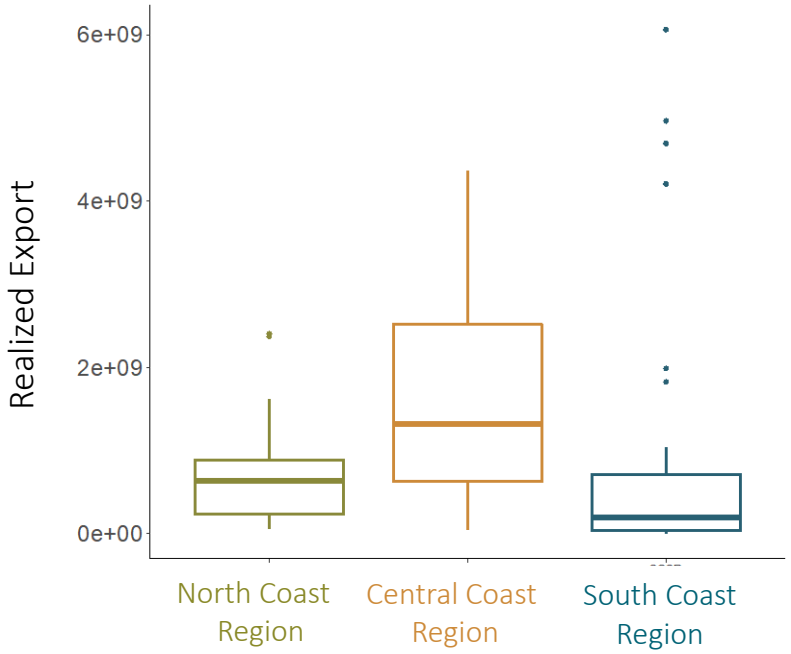
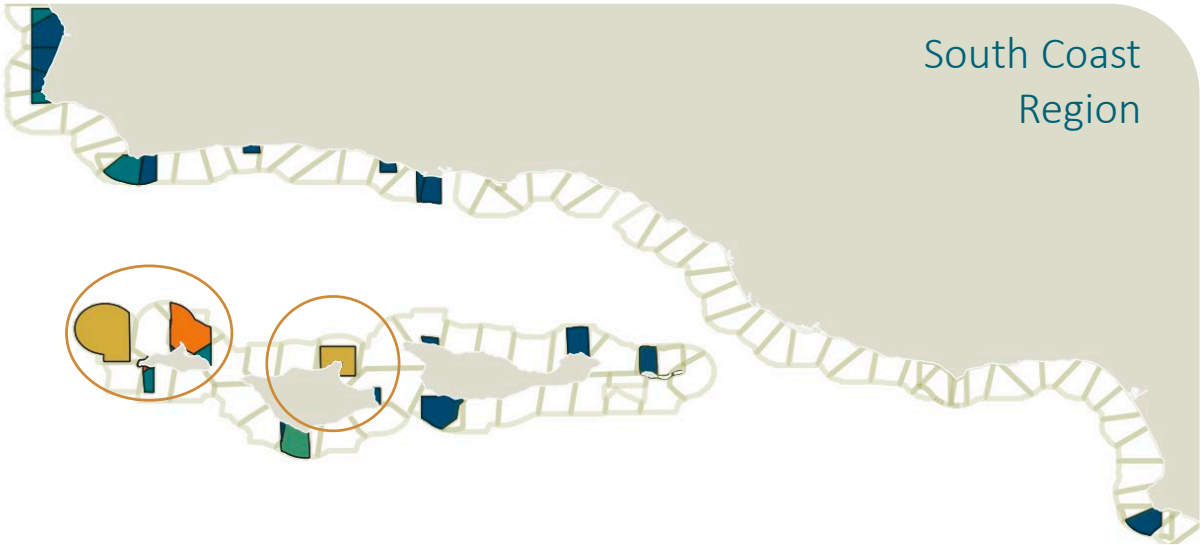
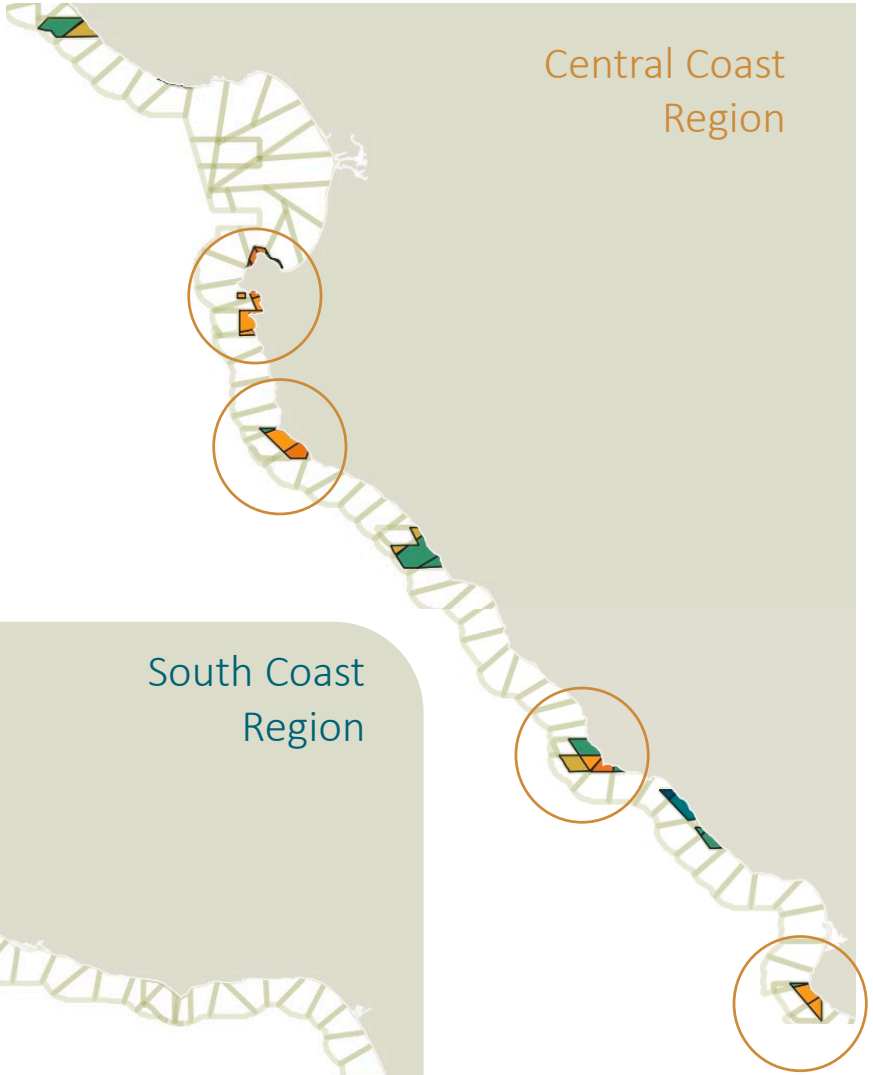


Realized Export







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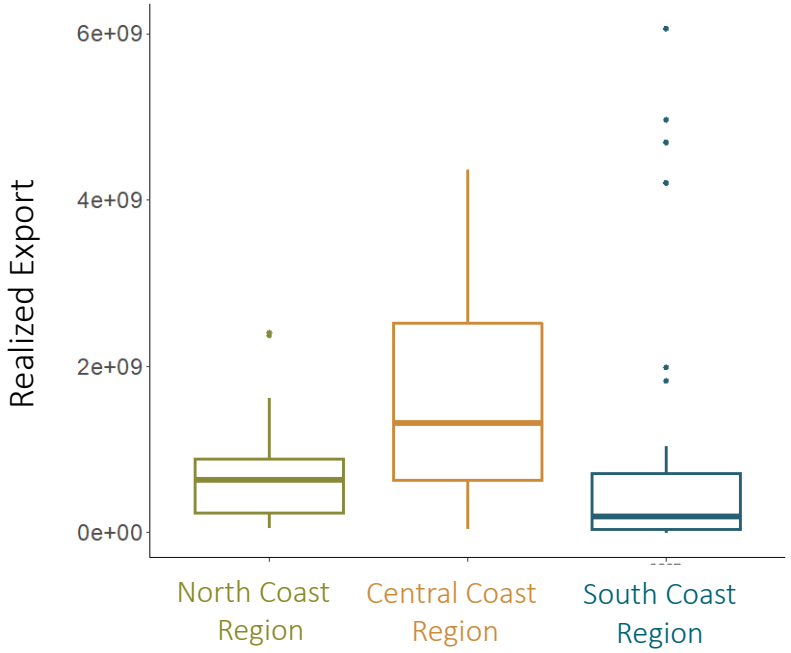
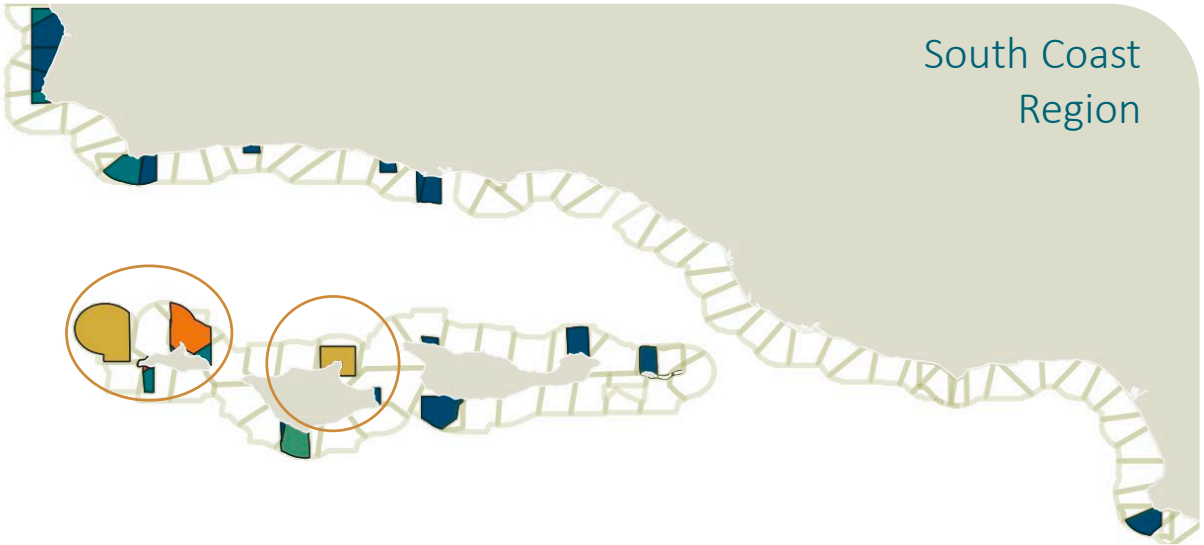
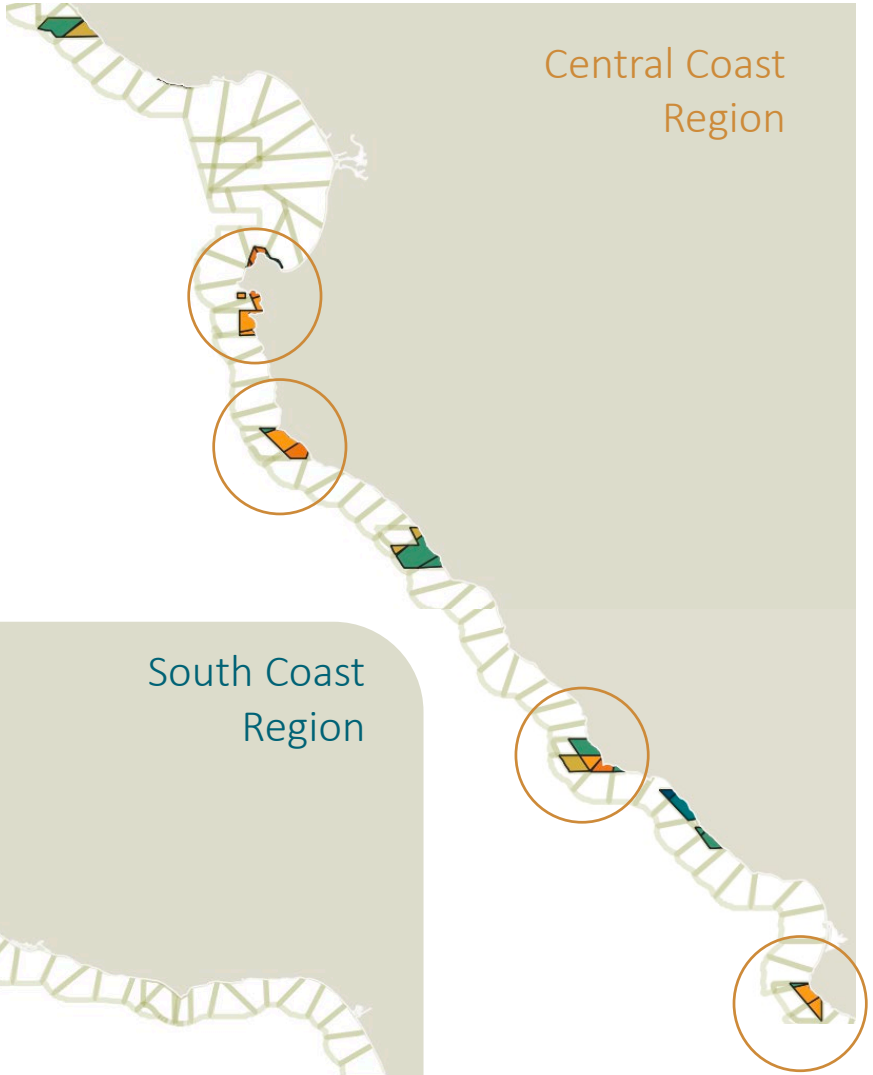
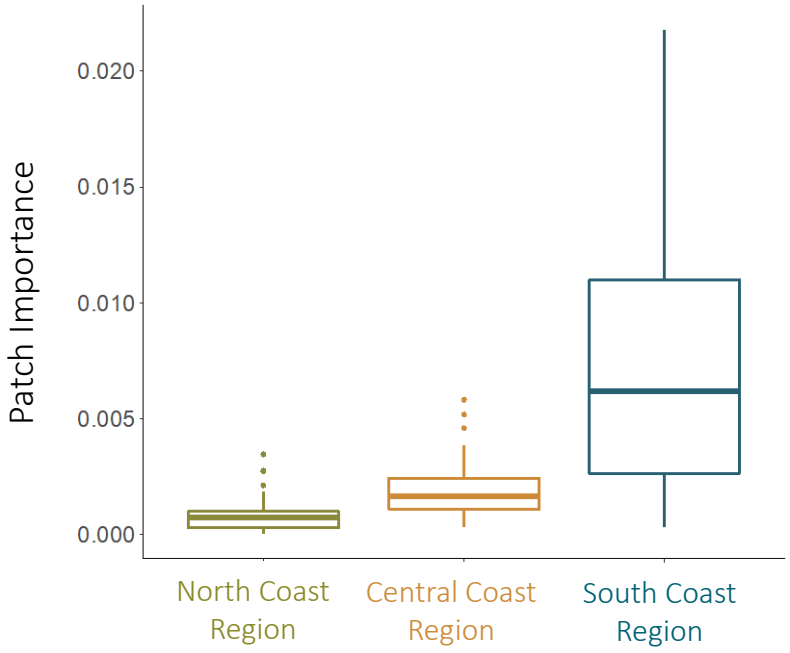






Patch Importance



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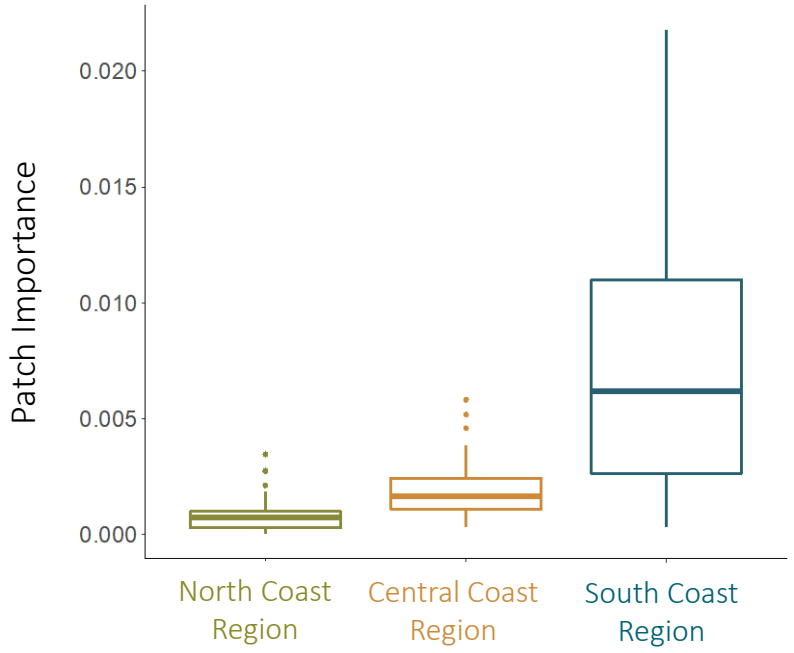

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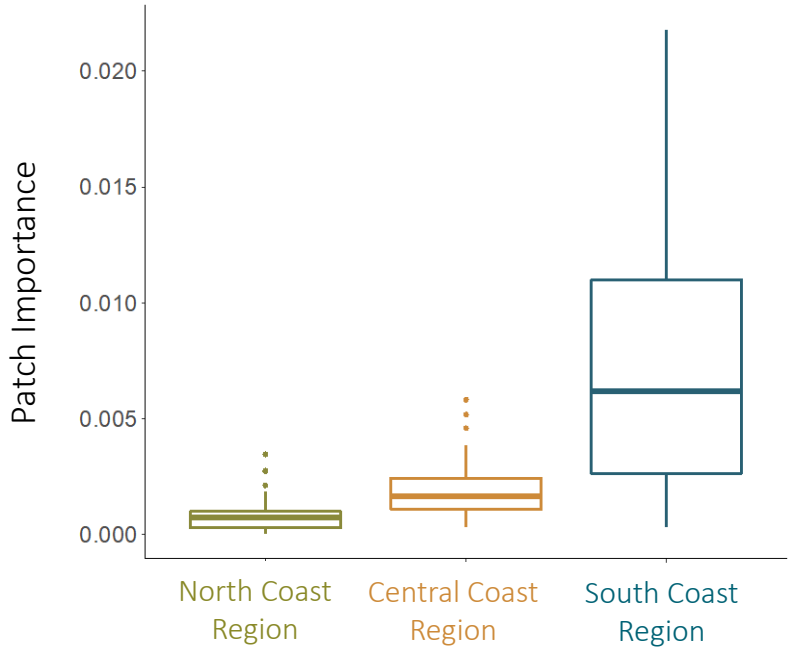

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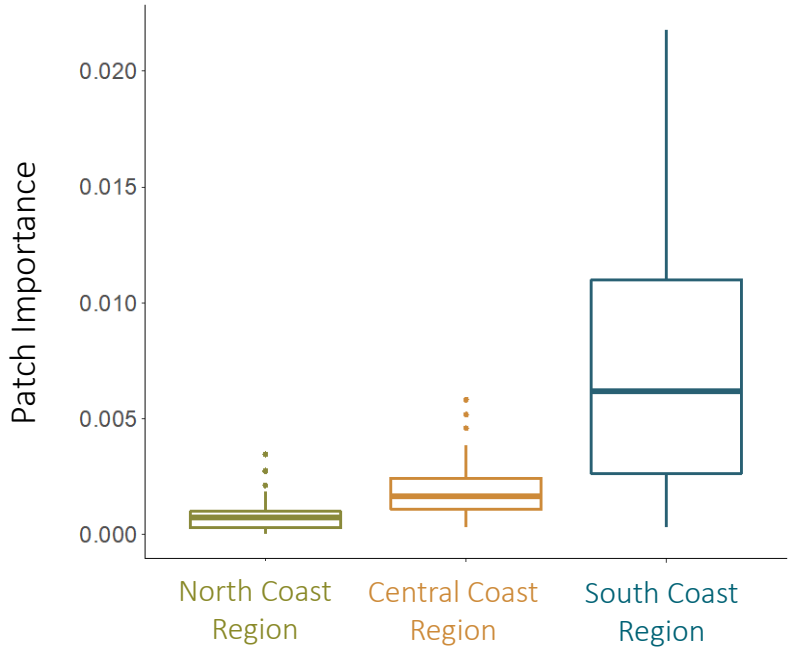
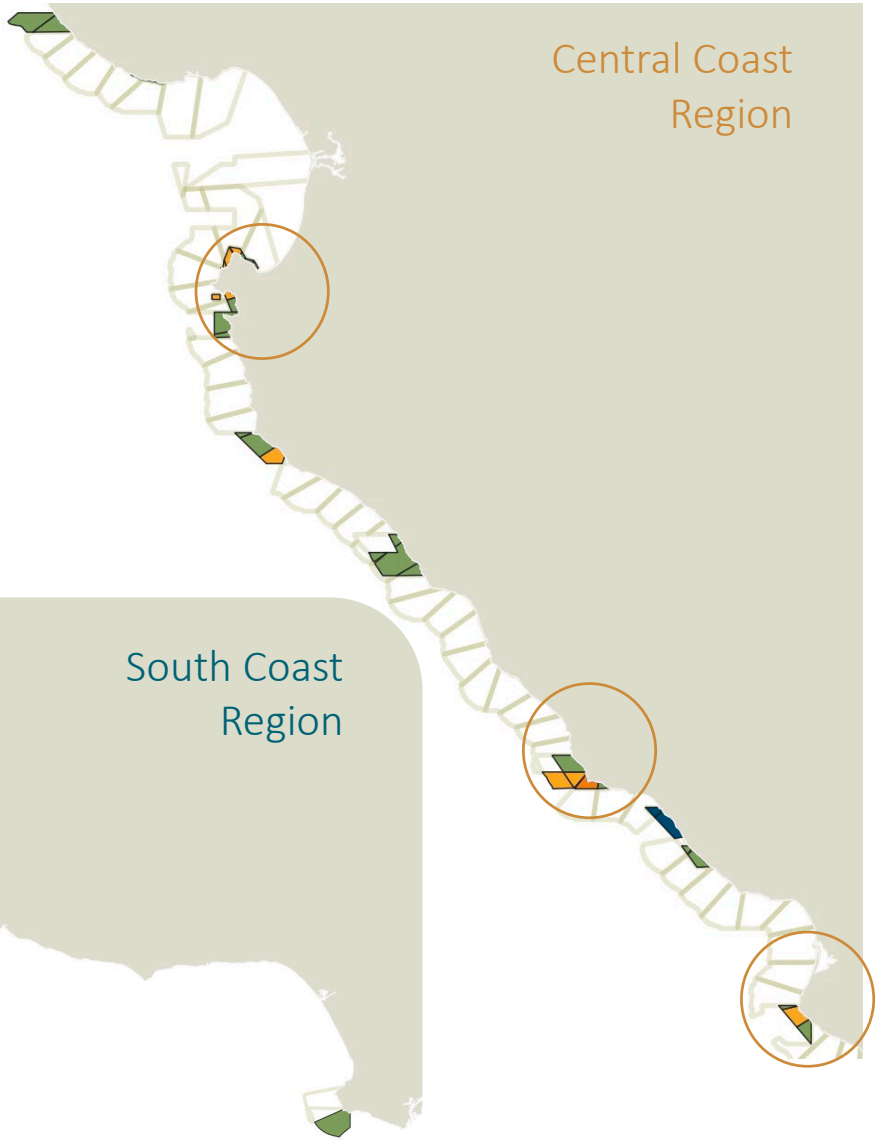
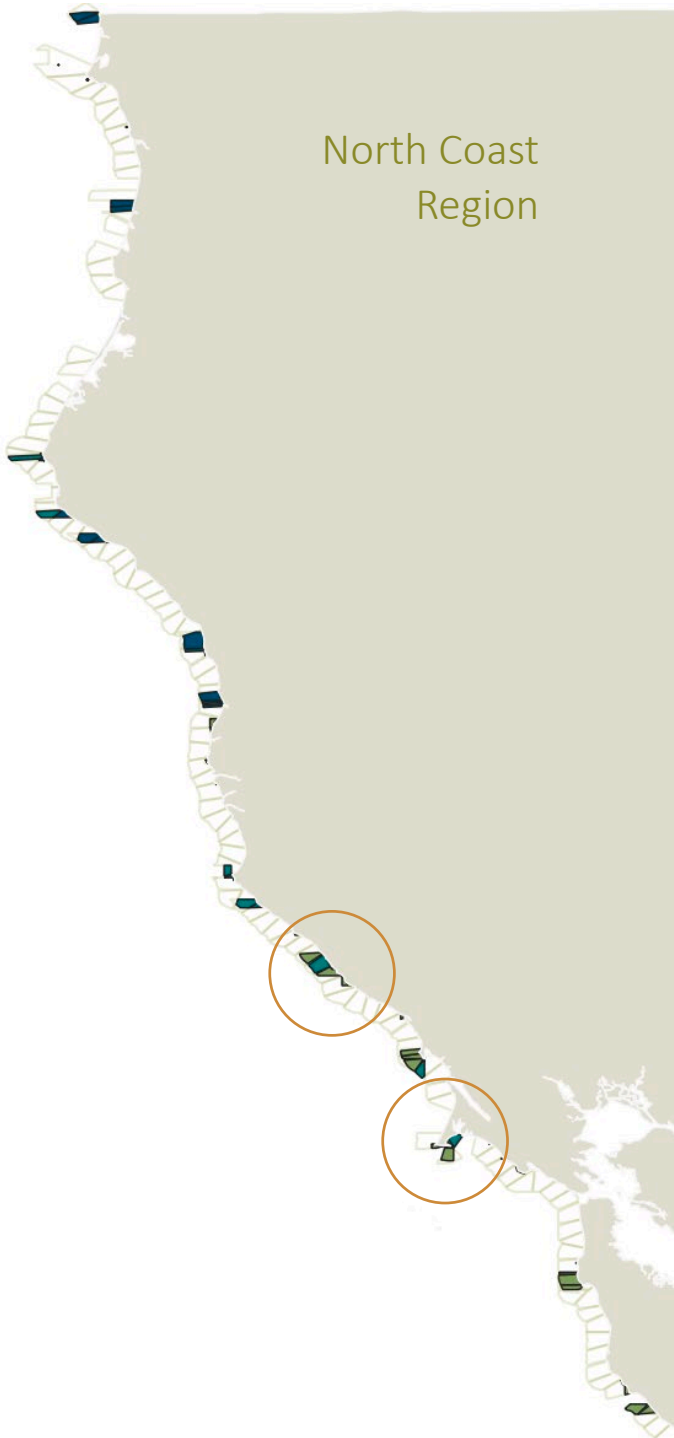
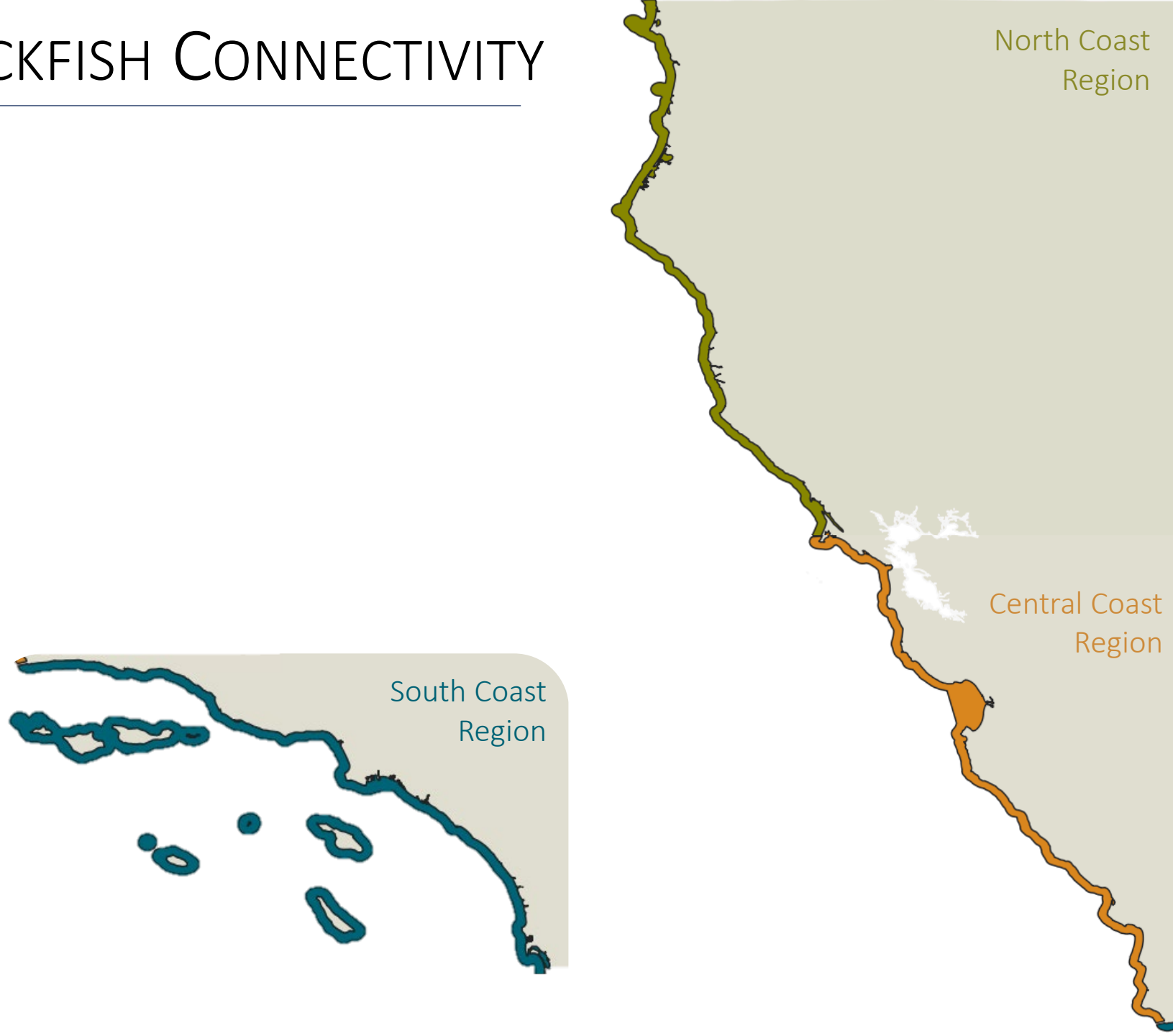






Conclusions: Blue Rockfish Connectivity

Full Coastline (with MPAs)	↑
Full Coastline (with no MPAs)	↑
MPA sub-network	↑
Full Coastline (with North MPAs)	↑
Full Coastline (with Central MPAs)	↑
Full Coastline (with South MPAs)	↑



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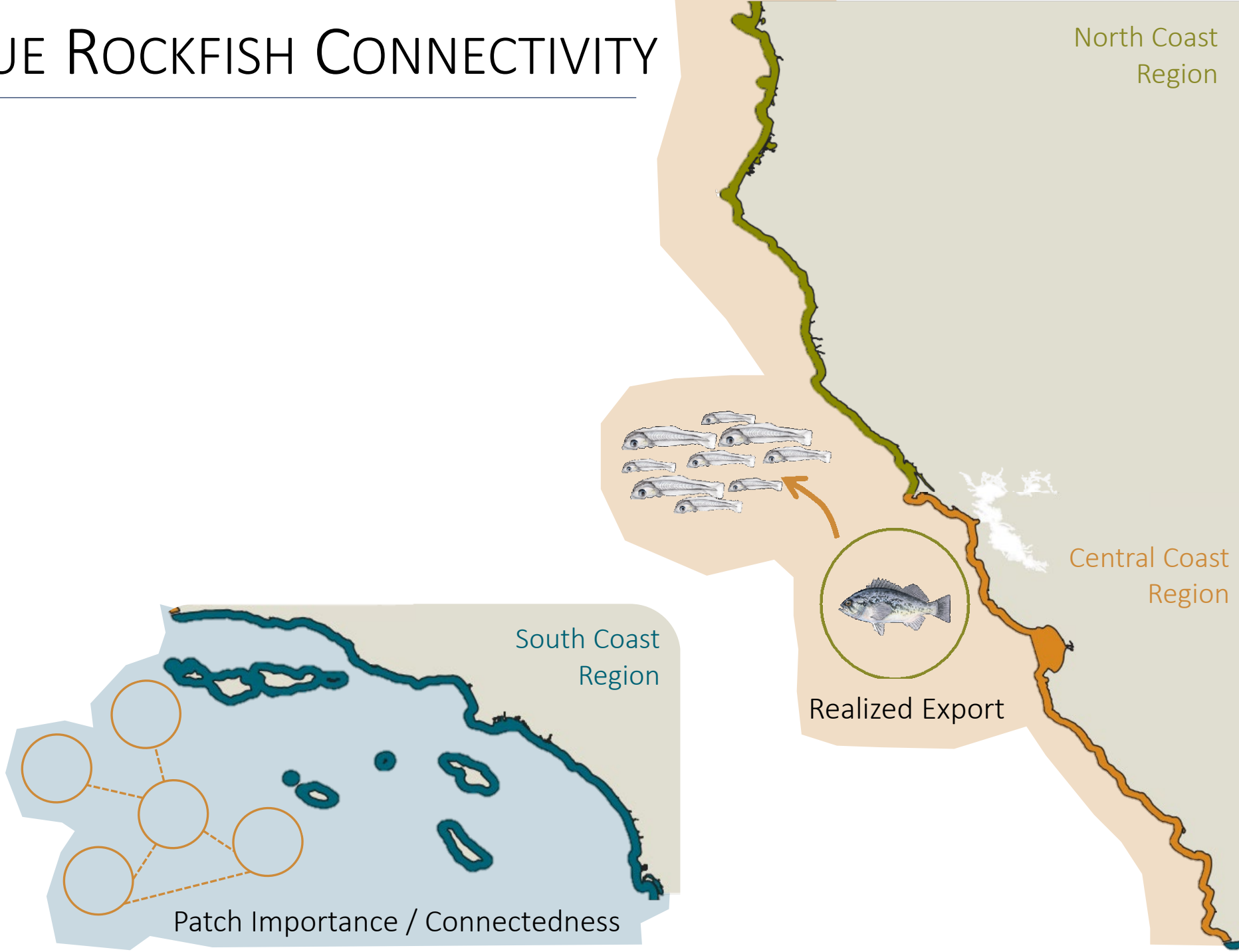
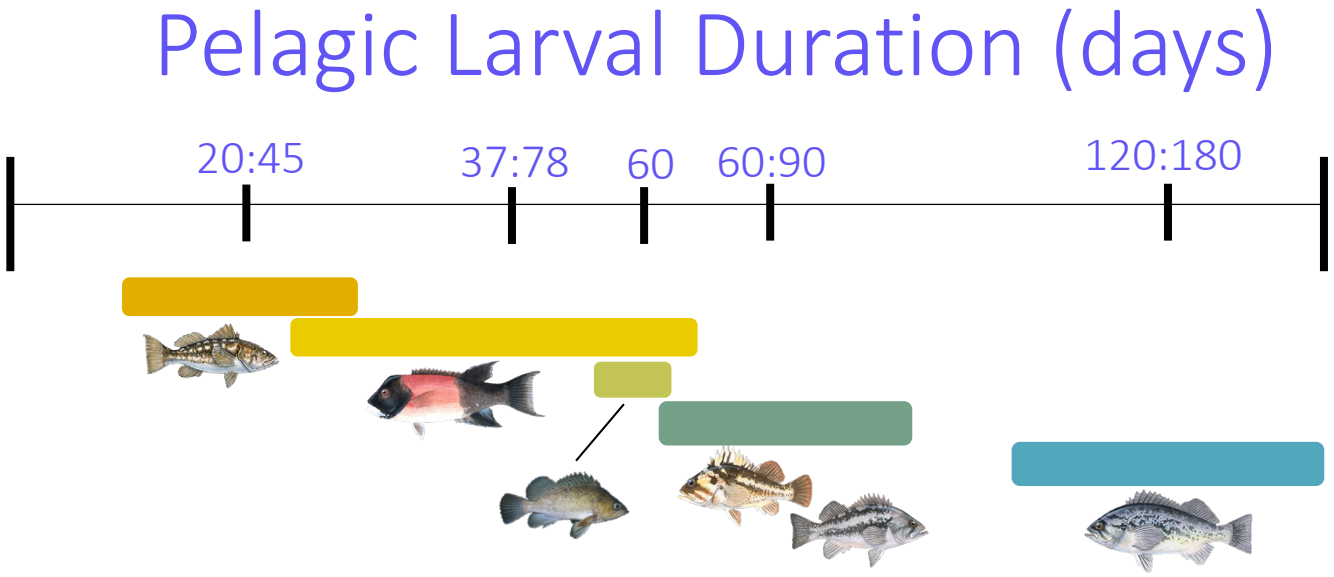
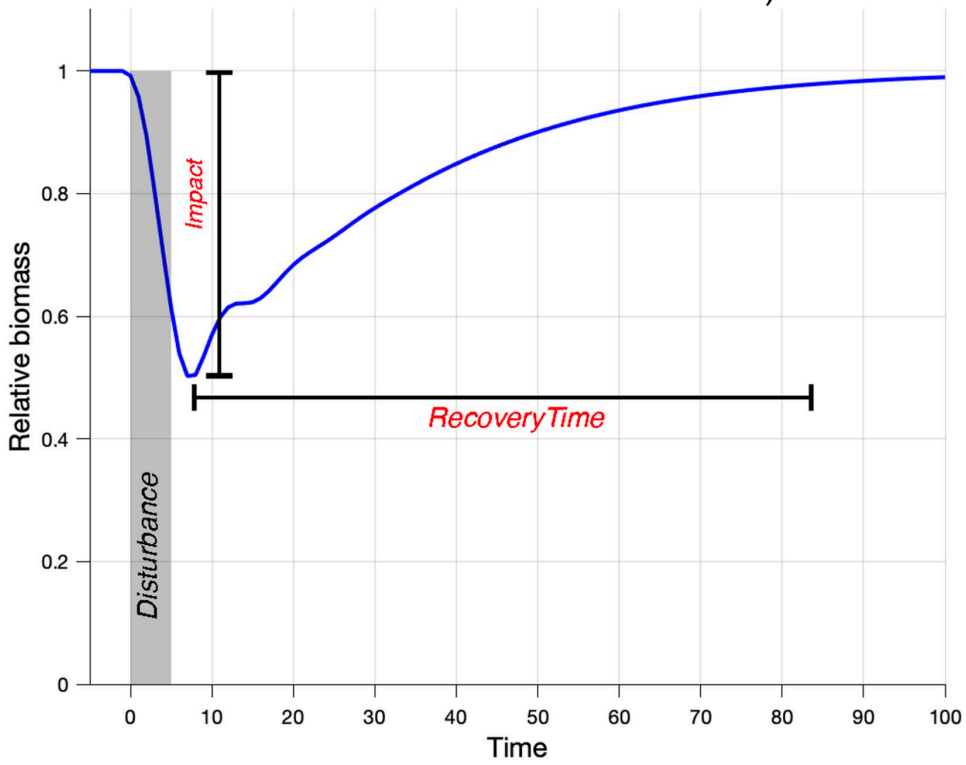


Next Steps

- More species
- Pulse disturbance: impact and recovery



White et al., 2022 JAE



Thank you

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