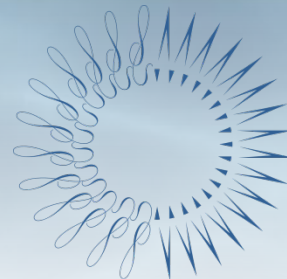


# Literature Review

# Oyster Reef Connectivity

Gulf States Marine Fisheries Commission  
Molluscan Shellfish Subcommittee  
October 12, 2021

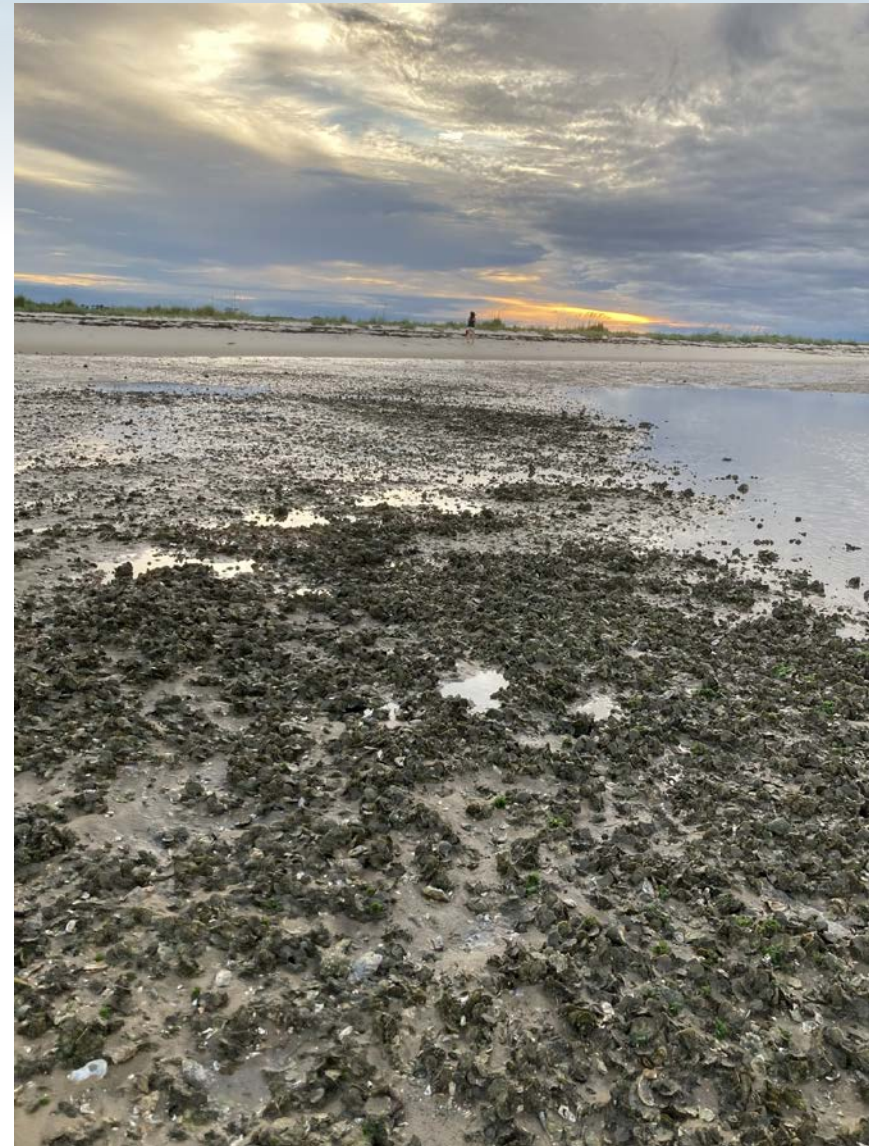
Chad Hanson, Science and Policy Officer  
Conserving Living Marine Life in the U.S.  
[chanson@pewtrusts.org](mailto:chanson@pewtrusts.org)



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# Presentation Overview

- **Conducting literature review**
  - why, how, what
- **Summary description of results**
- **Snapshot of papers by region**
- **Observations / takeaways**
- **Recommendations**



# Literature Review Project



**Question: What does the latest research show on reef connectivity with oysters?**



**Why?**

- **Effects of restoration**
- **Successful management strategies**
- **Quantify or address broader application of restoration**
- **What methods best establish/quantify connectivity**
- **Any observations or recommendations for future restoration**

# Literature Review Details

**Question: What does the latest published research show on reef connectivity with oysters?**

**Search query:**

→ **Focused just on oysters**

→ **Gulf, Atlantic, Pacific, Outside US**

→ **2000 to present**

→ **Search terms examples with various combinations:**

larvae connectivity of oyster reefs, productivity of oyster sanctuary on nearby reefs, oyster sanctuaries, oyster recruitment, oyster restoration, broodstock reefs, spawning reefs, larvae connectivity, productivity

→ **Annotated Bibliography, summary of each paper**



# Literature Review Query



**Question: What does the latest published research show on reef connectivity with oysters?**

**Search query:**

- **Pew's Research Review and Support team**
- **Concluded early August (2021)**
- **Resulted in ~30 papers / reports**
- **Trimmed down to 18 most applicable (testing connectivity)**
- **Surely missed some (e.g., search terms, species/time limitations)**



Katie Orlinsky The Pew Charitable Trusts

# Literature Review Summary

| <u>Study Type</u> | <u>#</u> |
|-------------------|----------|
| Modeling          | 6        |
| Field Sampling    | 2        |
| Combined          | 5        |
| Genetics          | 2        |
| Geochemical       | 3        |

- Modeling: hydrodynamics, larvae transport, biophysical
- Field: Oyster collections, plankton tows
- Genetic: phenotypes / strains
- Geochemical: trace elements (Manganese, Strontium, etc)

# Literature Review Summary



| <u>Region</u>  | <u>#</u> |
|----------------|----------|
| Gulf of Mexico | 2        |
| Atlantic       | 12       |
| Pacific        | 3        |
| Outside US     | 1        |
|                | 18       |

- Pamlico Sound, NC
- Chesapeake Bay, MD/VA
- Southern California (Olympia oyster, *Ostrea lurida*)
- Mobile Bay / Eastern Mississippi Sound

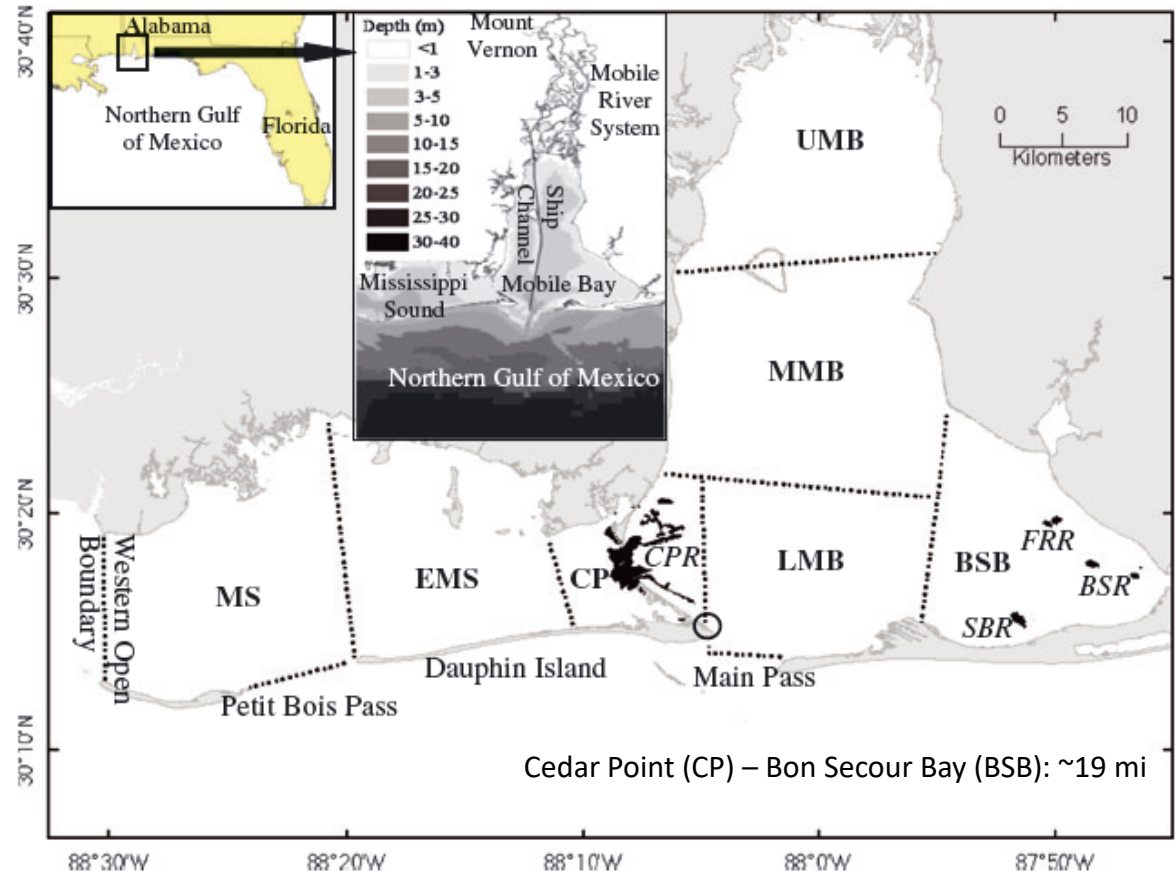
# Literature Review – Mobile Bay

## Kim et al 2013

- Modeling dispersal
- 63% CP → MS
- BSB mostly self-recruit
- BSB-CP mostly isolated
- Restoring EMB – replenish larvae

## Gancel et al 2021

- Trace elements
- Hydrodynamics
- Natal site v settlement
- Distinguish sites 1-7 mi
- EMS – important source area for CP?





# Literature Review – N. Carolina

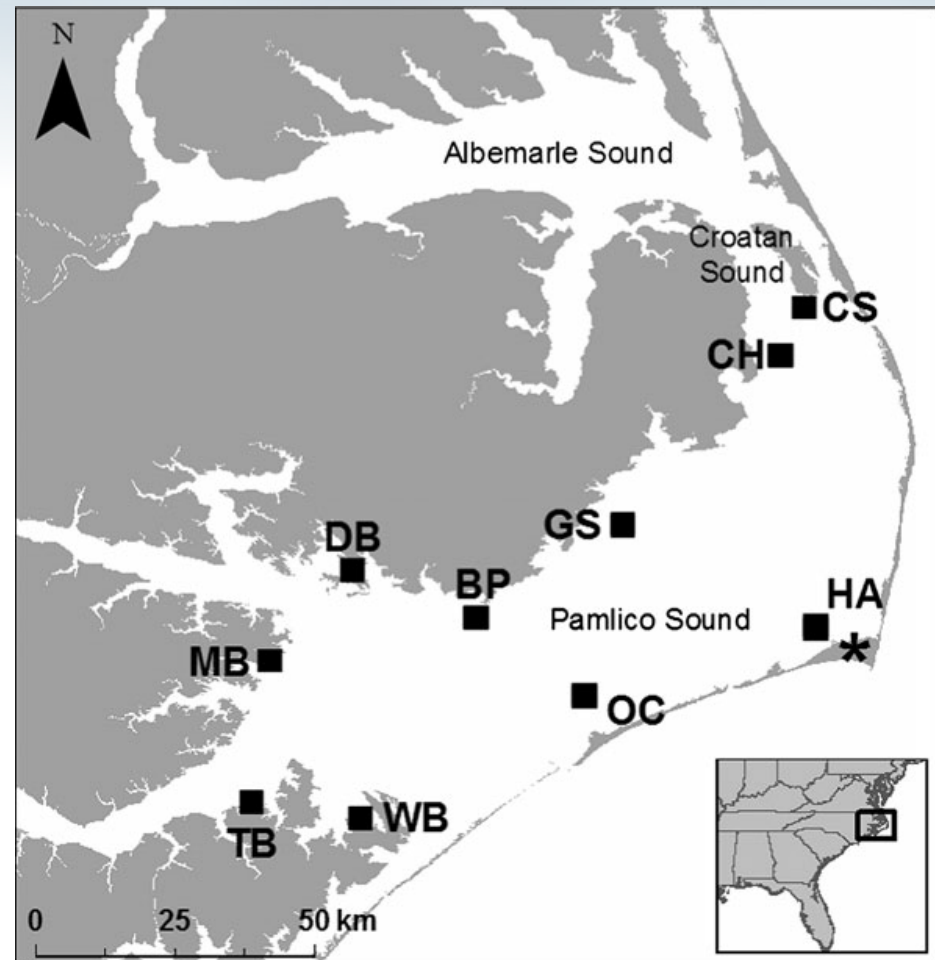


## Haase et al 2012

- Modeling larvae transport across 10 reefs
  - ~5 – 50 acres
- 24% connected, up to 40 mi
- 8/10 reefs with 1 or more connections
- 2 reefs highest recruitment (expand)
- 9/10 self-recruit
- Evidence of connected sanctuary system

## Puckett et al 2014 and 2016

- Metapopulation connectivity
- Biophysical / larvae modeling
- 10 small sanctuary reefs
- Too small for self-recruit (2%)
- Too far for connectivity (2%)
- Only four function as source
- Smaller reefs source > sink
- Connectivity out to 68 mi
- Add several small and few large reefs
  - spaced ~10-20 miles



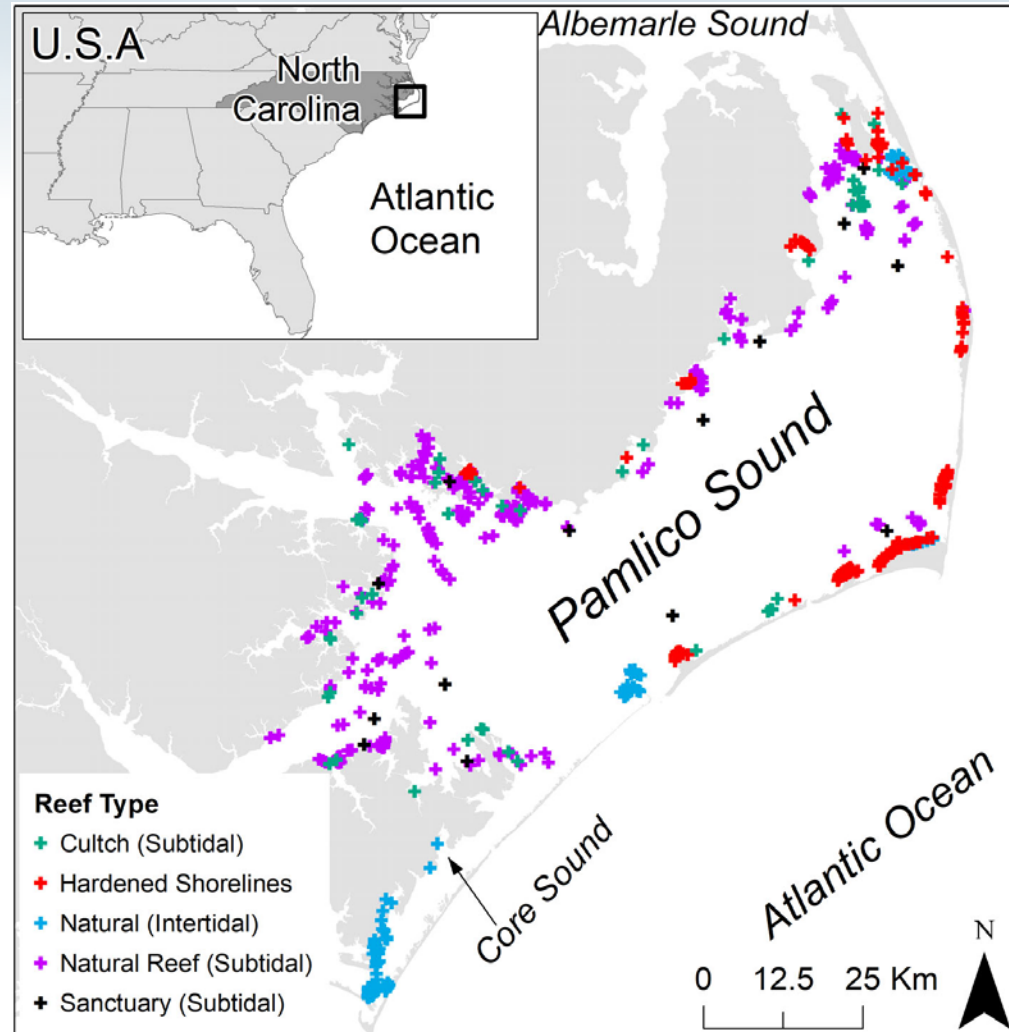
# Literature Review – N.C. cont'd

## Kroll et al 2016

- Geochemical tracing
- Signatures can distinguish natal reefs, if far enough apart (~20 mi)

## Theuerkauf et al 2021

- Metapopulation dynamics model
- 646 reefs, 5 reef types, size, distance
- 18% avg connectivity, out to 25 mi
- Small protected reefs (6% area) = 26% larvae
- Intertidal reefs only 5-7% larvae



# Literature Review – Chesapeake

## Lipcius et al 2008

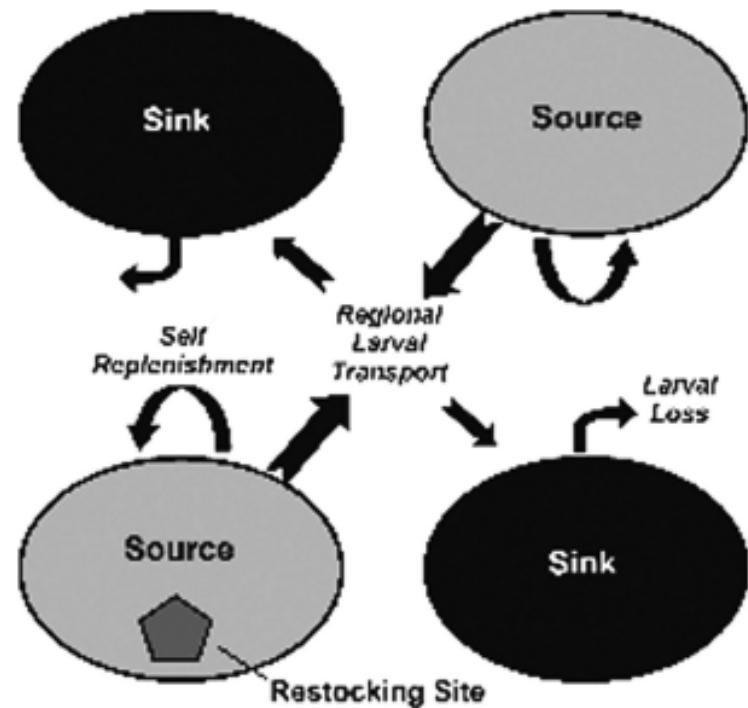
- Modeling for source/sink by reef type
- Source reefs (7/45, 15%) > 50% larvae
- Inconsistence source (14/45, 30%)
- Sink reefs (27/45, 60%)

## Sisson and Shen 2012

- Modeling larvae transport
- Connectivity throughout study area
- 11 sites captured larvae, sources / sinks

## Turley et al 2019

- Modeling transport of planted genetic strains
- Minimal connectivity within 44 mi
- One of two reefs recruitment



# Literature Review – Atlantic

## Munroe et al 2014 (Delaware Bay)

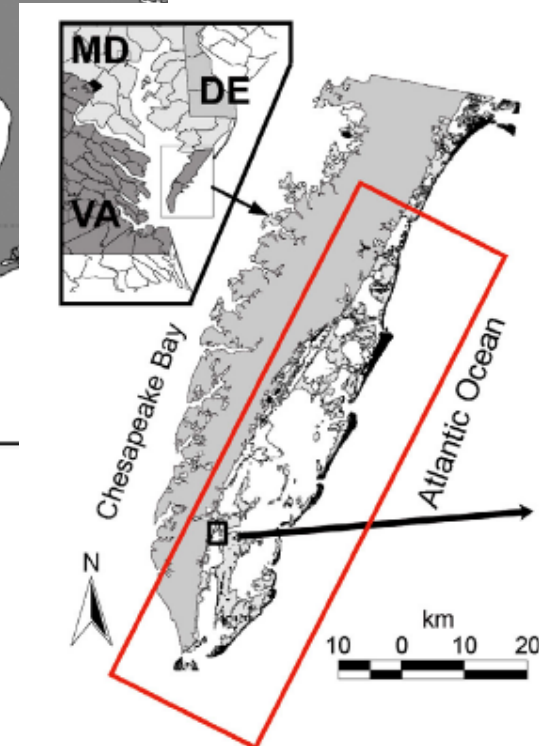
- Modeling connectivity using genetics
- 1 MPA and 3 fished reefs
- Salinity/river flow alter genetic connectivity
- MPAs upstream could supply less disease-resistant strains

## Hubbard & Reidenbach 2015 (VA Coast)

- Hydrodynamic model, larvae behavior
- Settlement velocities significant
- Low velocity → self-colonization
- High velocity → depend on connectivity
- Field data: agree with modeling
- Settlement 1.5 – 3 X greater over reefs with higher relief / complexity

## Jaris et al 2019 (Rhode Island)

- Genetic connectivity of wild/hatchery brood
- Exchange at small scale (1-6 mi)
- Changes in genetic diversity → evaluate restoration effects



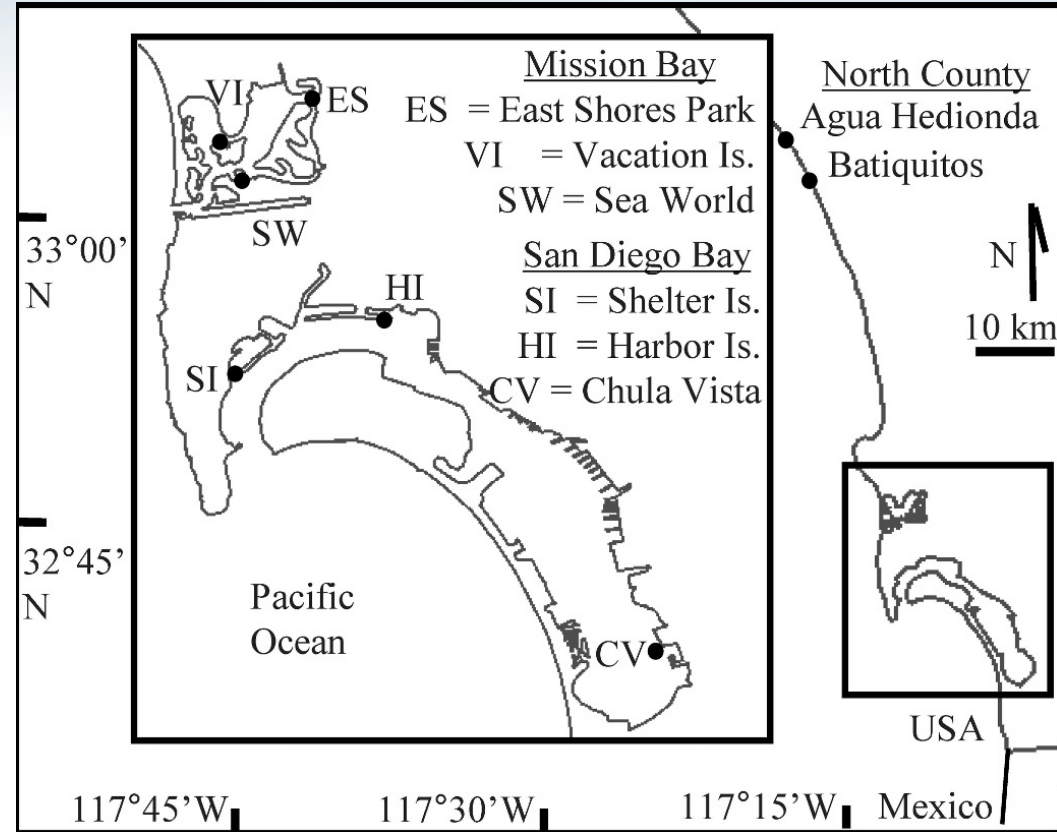
# Literature Review – So Cal

## Carson 2010 / López-Duarte et al 2012

- Olympia oysters
- Trace elements across Bays
- Larvae exchange ~50 mi / avg 11mi
- 2 of 3 estuaries – 80% larvae
- Significant self-recruit

## Peteiro & Shanks 2015

- Field sampling larvae (tows)
- Noted connectivity within estuary
- High isolation, self-recruitment
- Larvae release in conducive conditions best for connectivity



# Observations

## Some observations and takeaways

- Connectivity studies are hard!
- Varying techniques
- Demonstrated connectivity
- Mostly involve modeling with field work
- Environment has big effect
- Consistently inconsistent
- Growth, mortality, pop dynamics
- Small healthy reefs > larvae, connectivity
- Big reefs > settlement
- Max connectivity ~50 mi
- Close to mid range <20 mi best connectivity
- Network of spawning reefs can contribute to metapopulation



# Recommendations

## Some recommendations for research and restoration

- Include in restoration strategies
  - Factor in connectivity into objectives
  - Study directly, demonstrate
  - Appropriate spacing
  - Small, dense, abundant, high relief
    - source reefs
  - Diversify approach: small/big high/low
- Couple modeling with field validation
- Multi-year research/monitoring
  
- Protected reefs strategically placed → replenish larvae
- Know each system → modeling platform

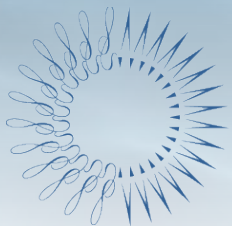


# Questions/Feedback?

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