

Santa Barbara Coastal LTER & California's Marine Protected Areas

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Santa Barbara Coastal LTER





Santa Barbara Coastal Long Term Ecological Research

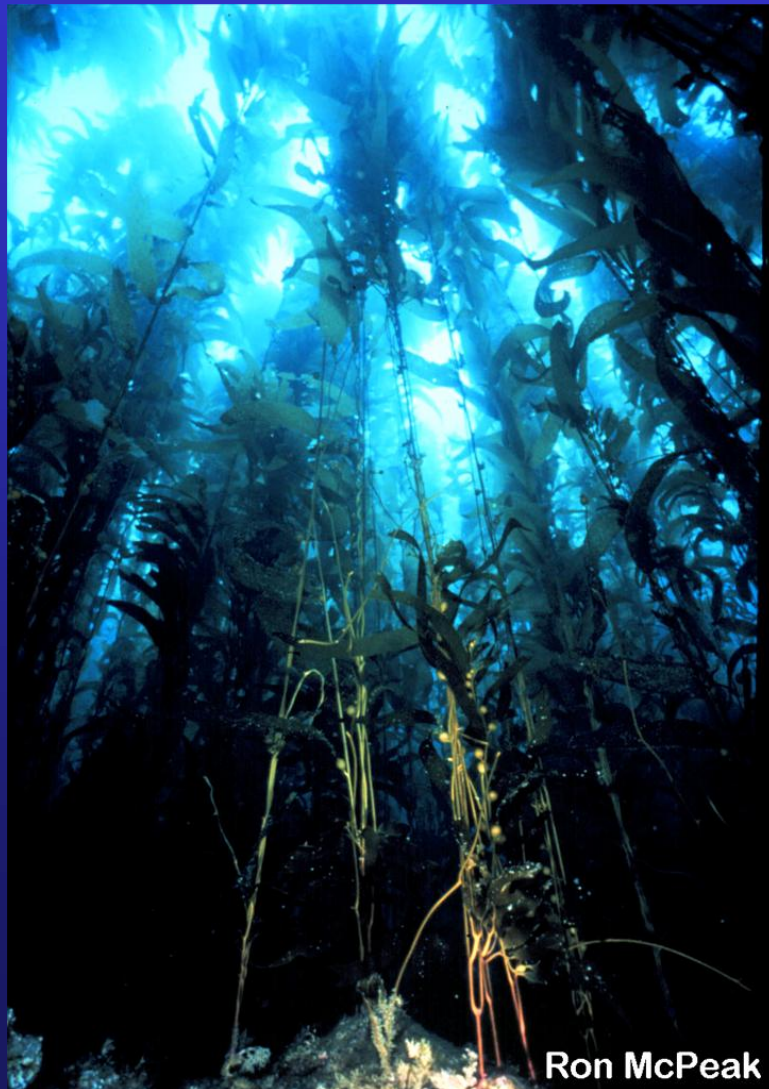


- ~ 10,000 km²
- Steep coastal mountains
- Small estuaries
- Shallow rocky reefs
- Deep ocean basin
- Offshore islands

- Mediterranean climate
- Strong ENSO signal
- Major biogeographic boundary



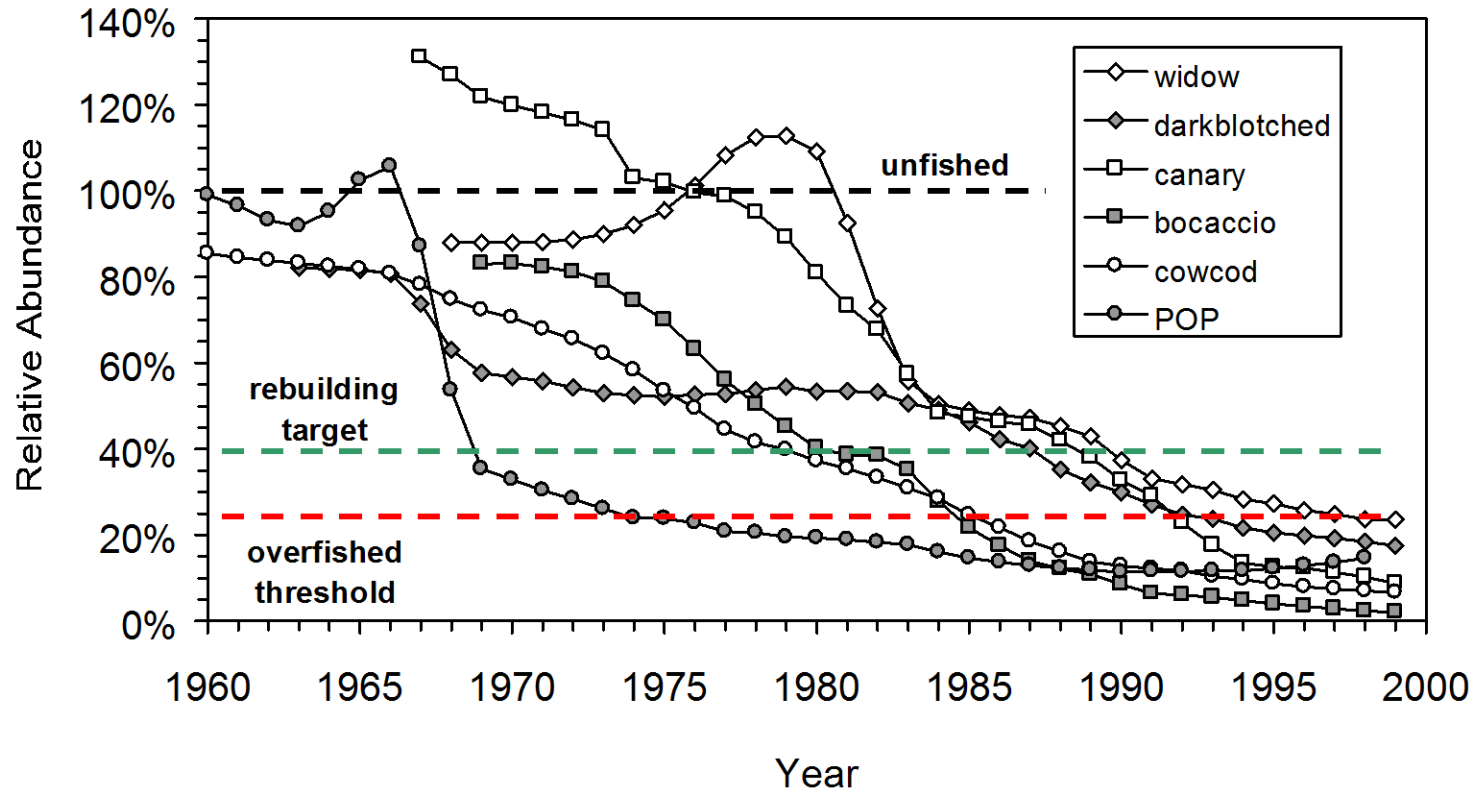
Giant Kelp Forests



Ron McPeak

- High primary production
- Biological habitat formation
- Support high species diversity
- Complex trophic interactions
- Worldwide distribution on shallow temperate reefs
- High economic importance

U.S. West Coast Rockfish



Source: Pacific Fisheries Management Council, 2001

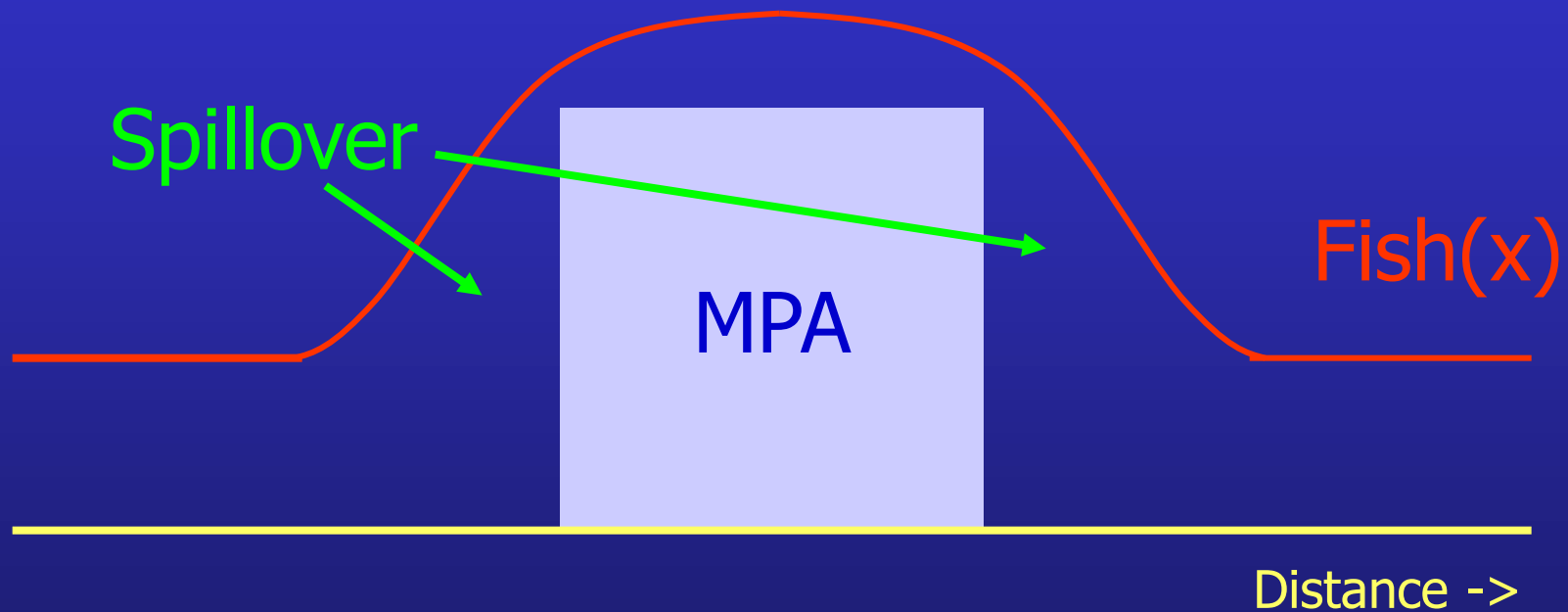
MPA's in Channel Islands

- State-federal process to implement Marine Protected Areas around the Channel Island National Marine Sanctuary
- Stakeholder driven goals:
 - *protect biodiversity*
 - *maintain fishery yields & incomes*

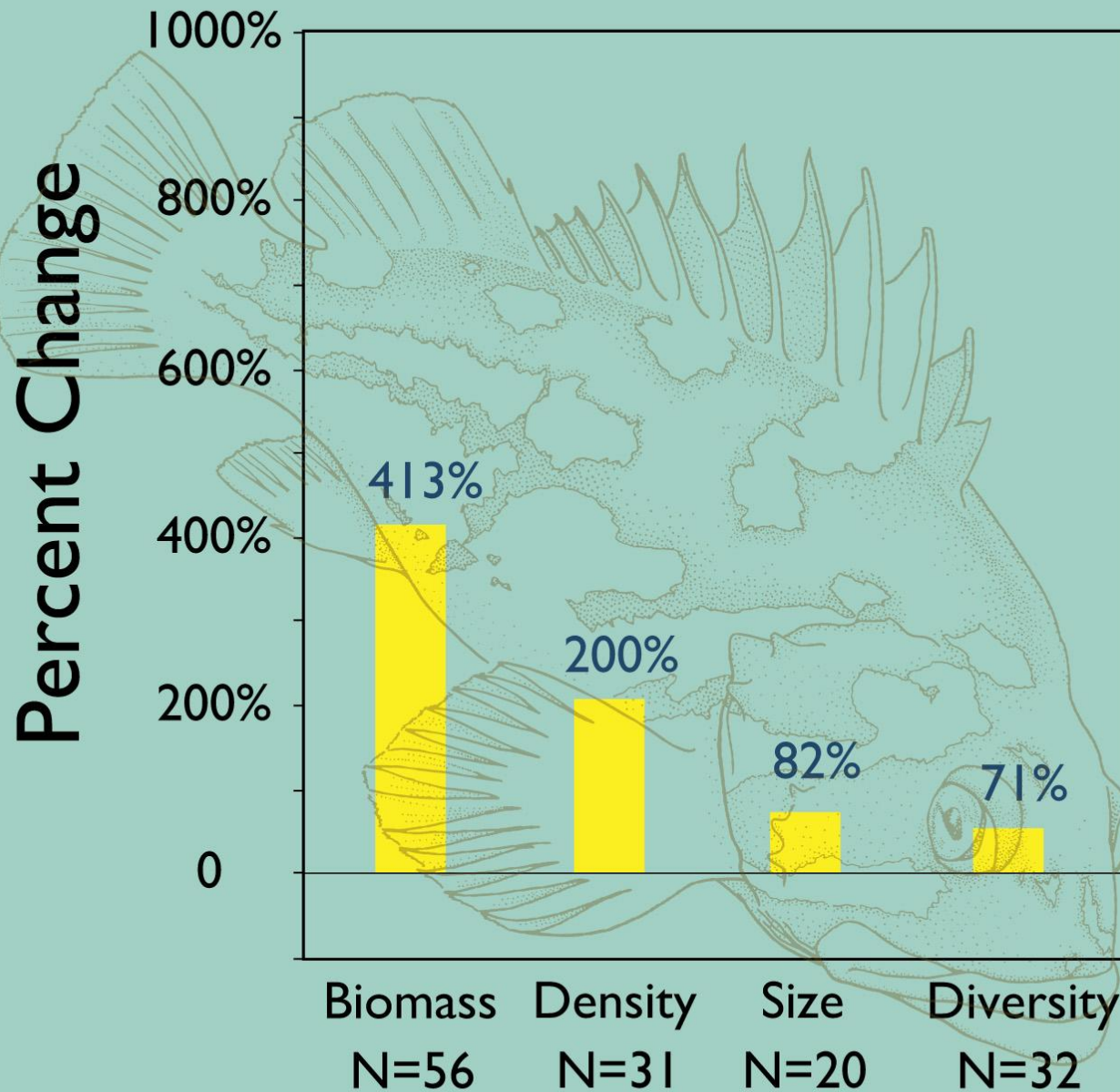
How a MPA might work

- MPA's allow adults grow to maturity (especially for sedentary fish & inverts)
- Elimination of harvest enables more "natural" communities & food webs to exist
- Fecundity often increases with age
- Fishery benefits if progeny disperse broadly *or* adults "spill out" of the MPA

How a MPA might work



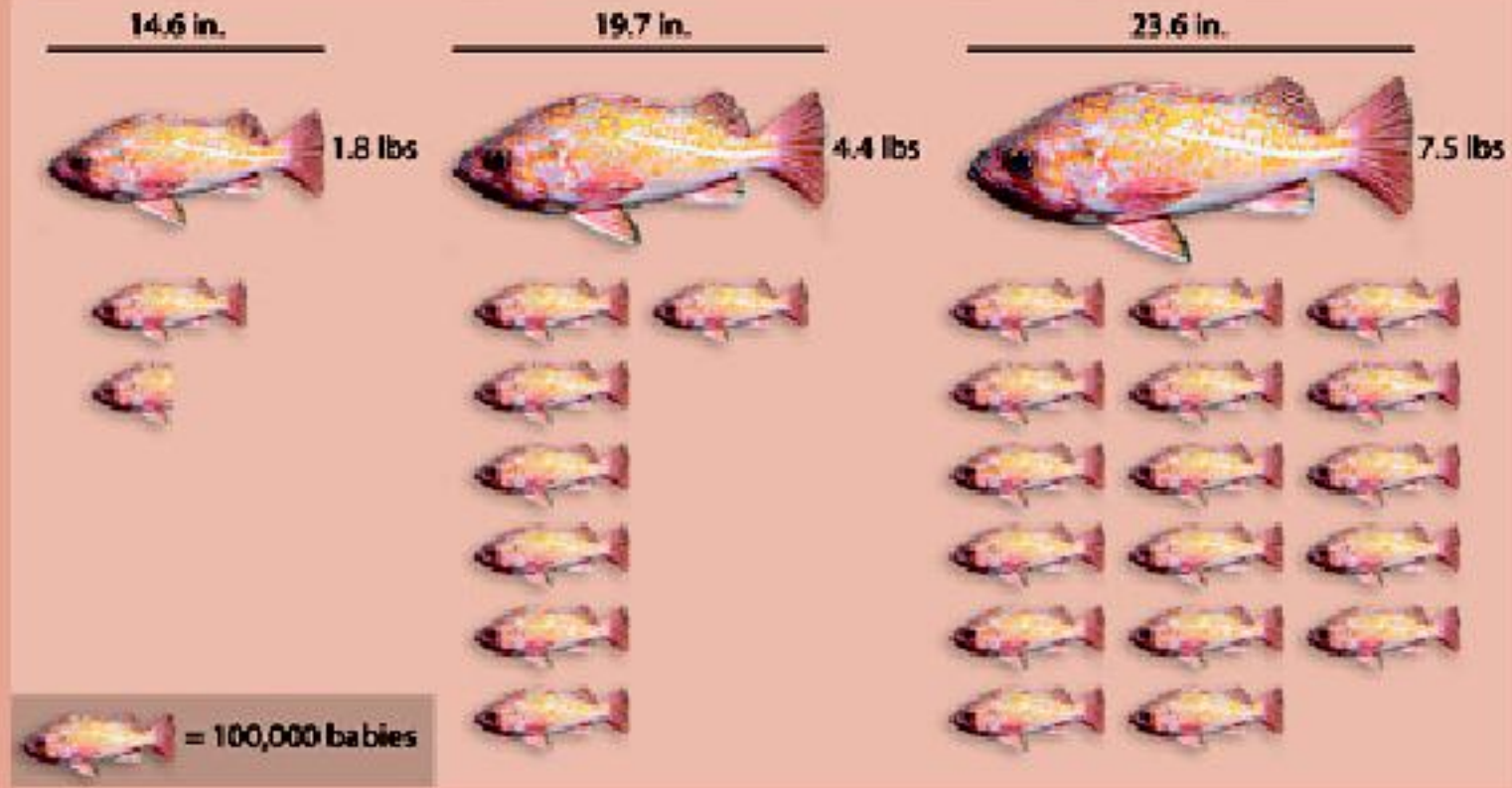
Key: Spatial Management of a Fishery



MPA's
Work
Within
Their
Borders

From Halpern [2002]

A Benefit of Getting Old & Fat



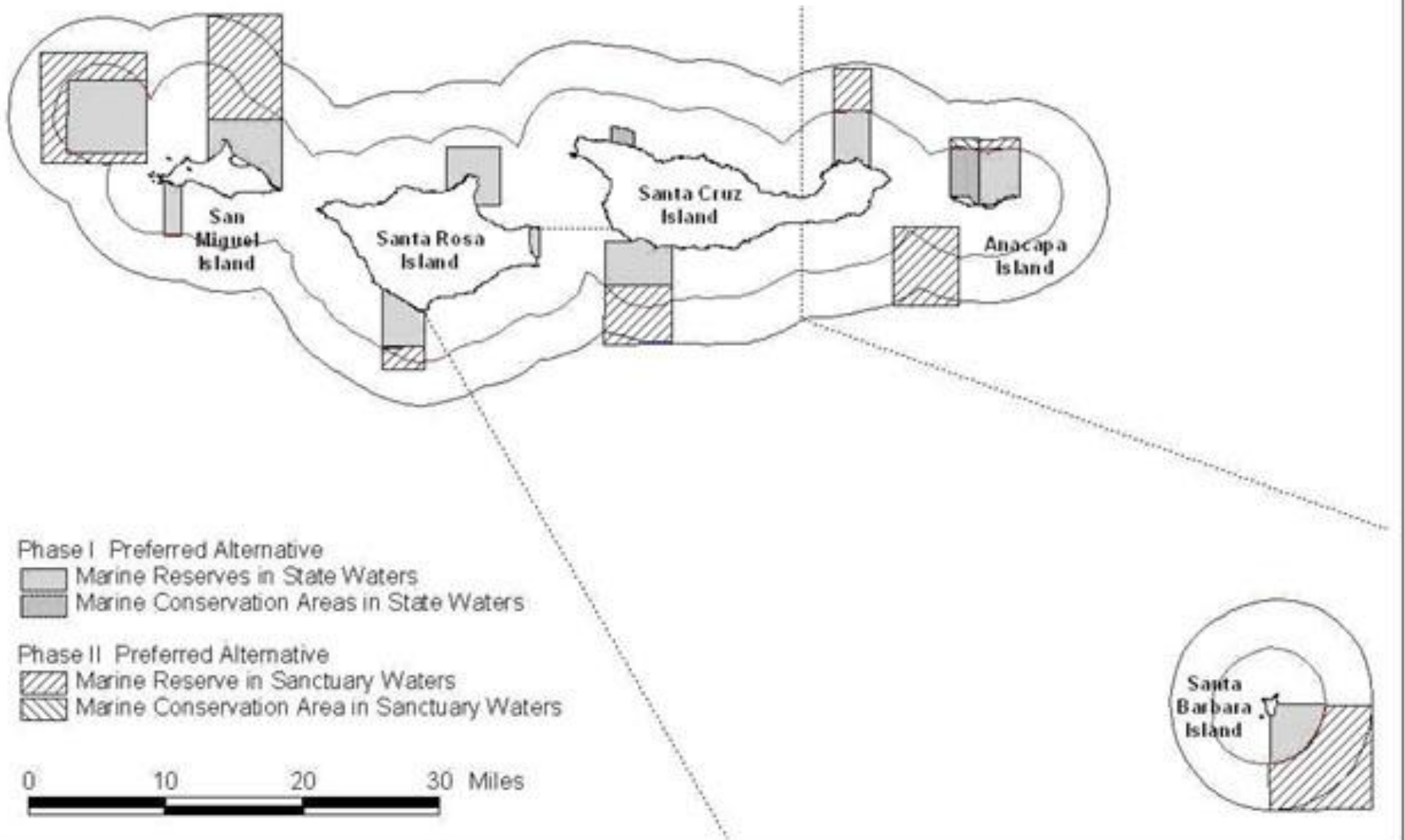
Average numbers of eggs produced by three different sizes of vermilion rockfish.

We were victims of public service...

- Six SBC-LTER PI's served on the Science Panel for the Channel Islands Marine Reserve process
- Helped the stakeholder working group arrive on a "preferred alternative" MPA plan
- This plan has been implemented by the State

Preferred Alternative Marine Protected Area Network
For the Channel Islands National Marine Sanctuary

Approved Oct. 24, 2002 for
state waters
Federal approval in the works



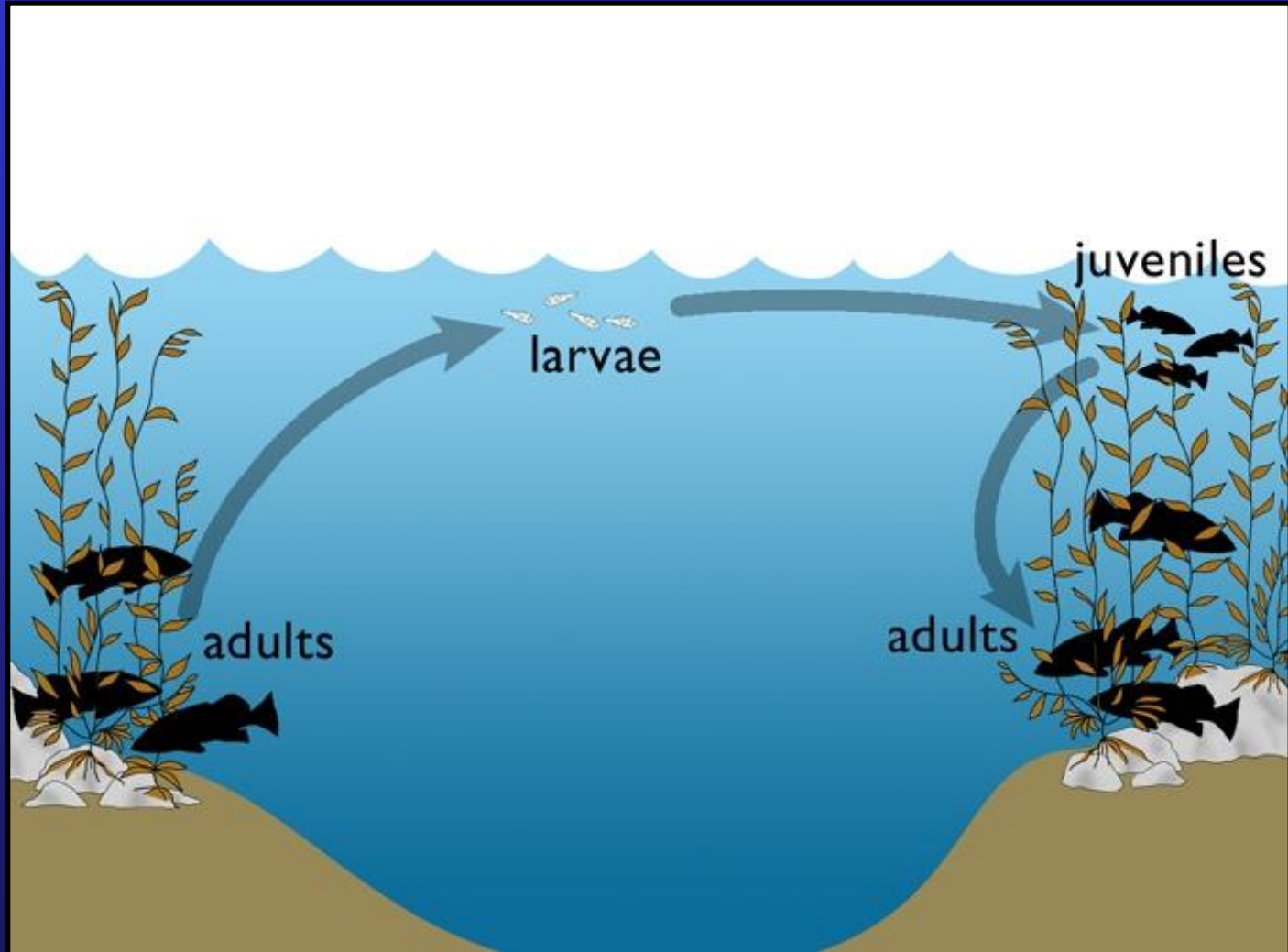
MPA's in California

- Marine Life Protection Act (AB993)
 - Implement a state-wide MPA network
 - Take a regional approach to siting marine reserves
 - SBC-LTER participants are part of this process
 - On hold due to state budget
 - ... but it is the law!!

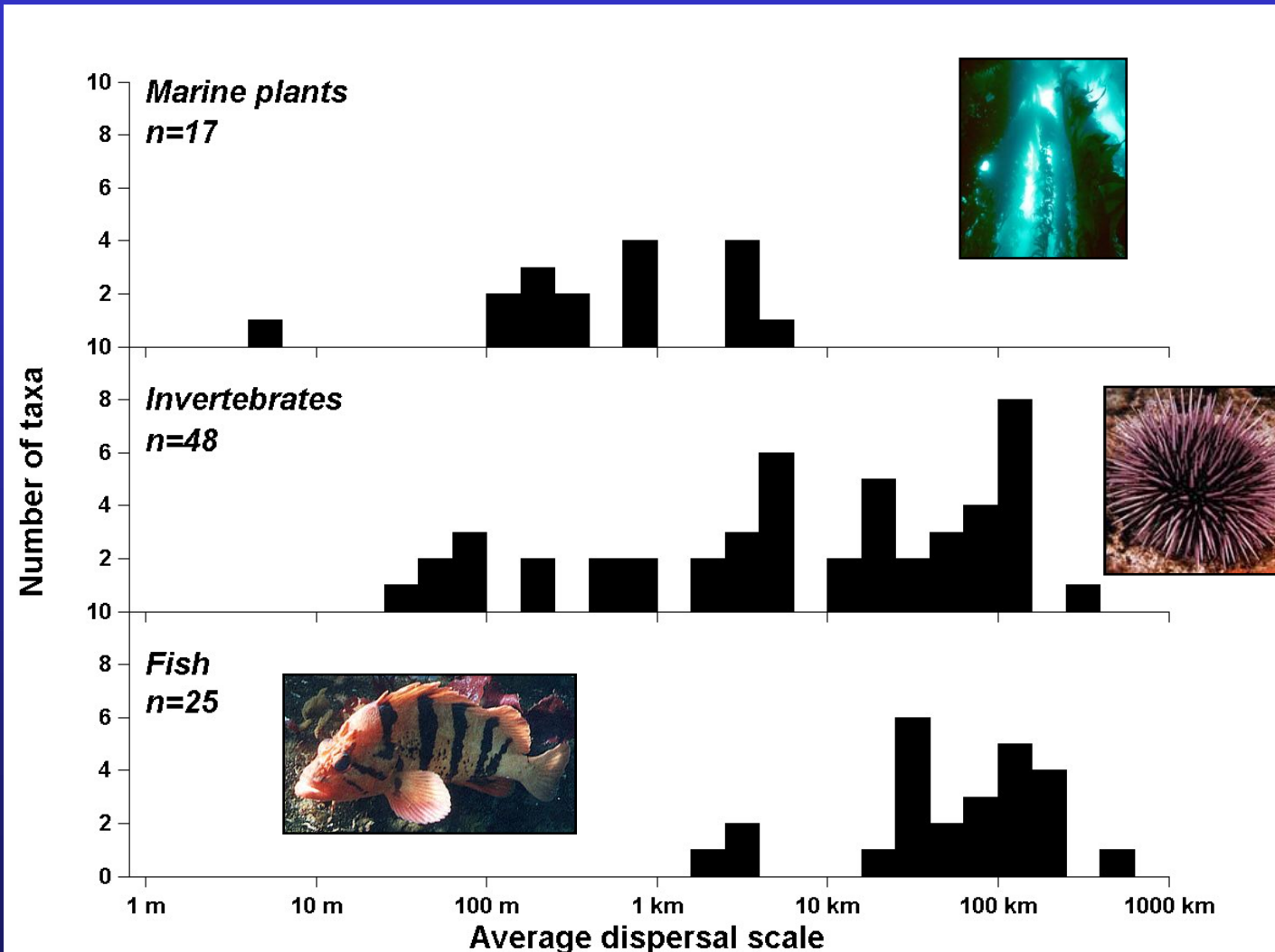
What did/will SBC-LTER contribute?

- Local data & expertise
 - SBC-LTER & its partner programs
- Theoretical & synthetic analyses
 - How big, how many, how connected?
 - How hard will it be to assess MPA efficiency??
- Next steps
 - Flow, Fish & Fishing (F³) Biocomplexity Project
 - MLPA, California-wide MPA designation legislation

Fished Organism Life Cycle is Important



Dispersal Scales for Marine Organisms



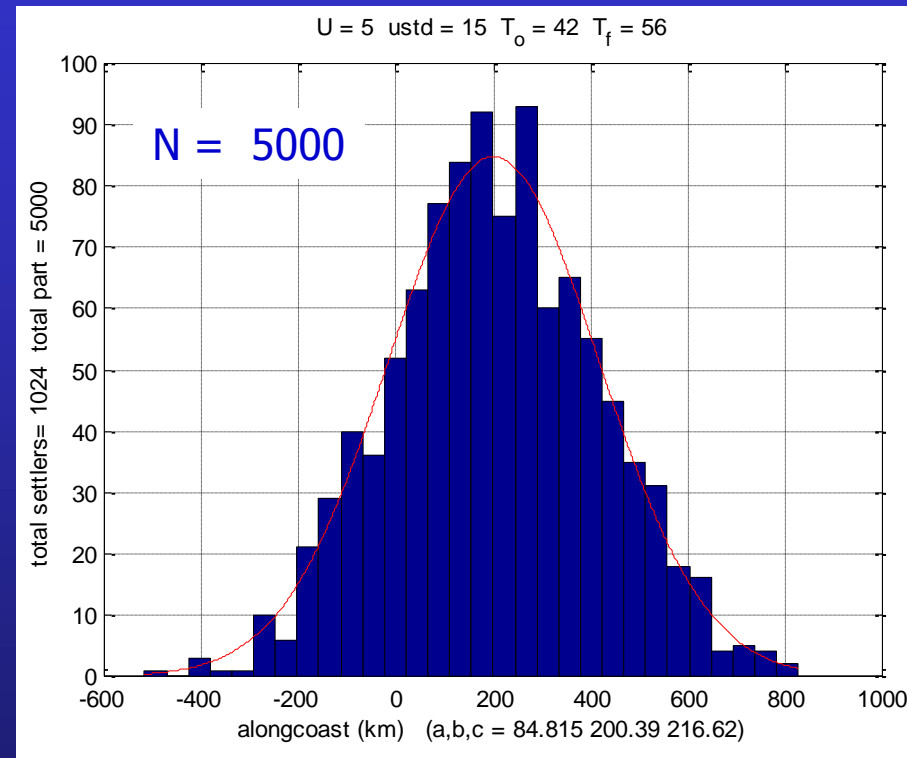
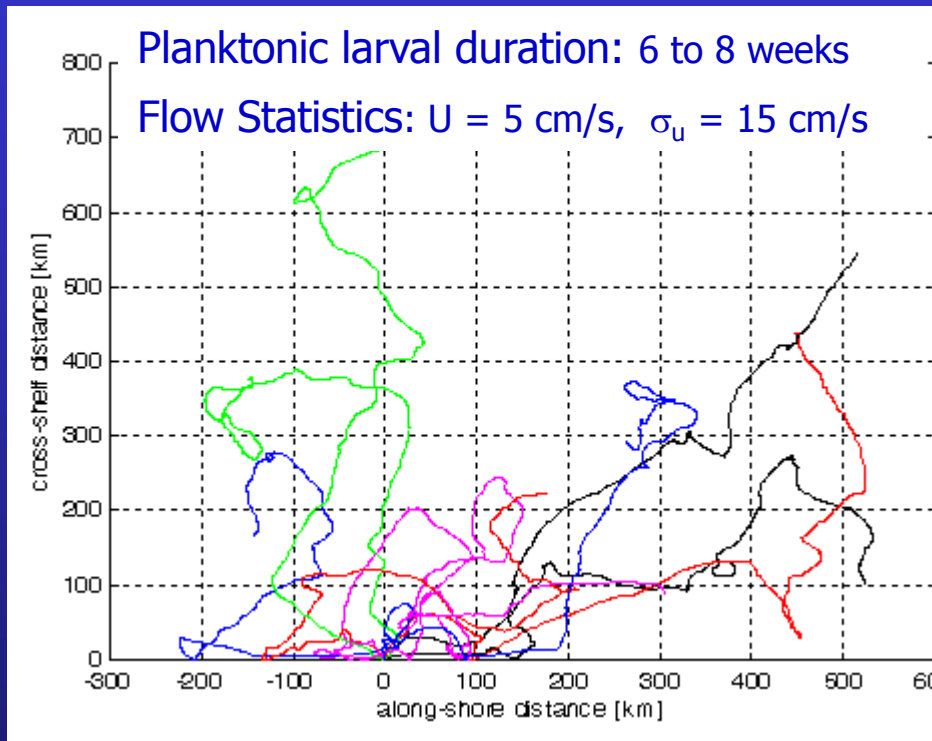
Kinlan & Gaines [2003; *Ecology* 84: 2007-2020].

Larval Transport Modeling

- Provide a metric for *source-to-destination* exchanges among nearshore populations
- Incorporate important oceanographic & organism life history characteristics
- Constrain using easily obtained field observations
- Useful for modeling spatial population dynamics

Siegel et al. [2003; Marine Ecology Progress Series 260: 83-96]

Larval Transport Modeling



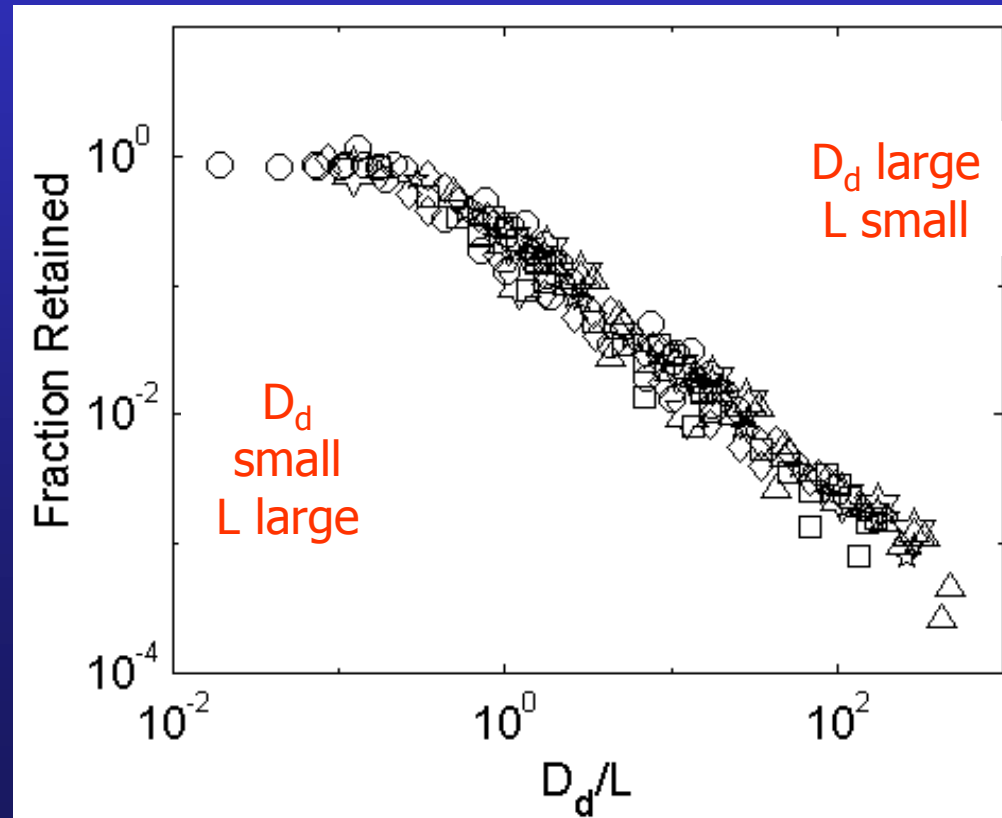
- Many trajectories are simulated to produce the settling probability distribution (the kernel)

Regional Scale Self Seeding

What fraction of larvae settle within a region of size L ?

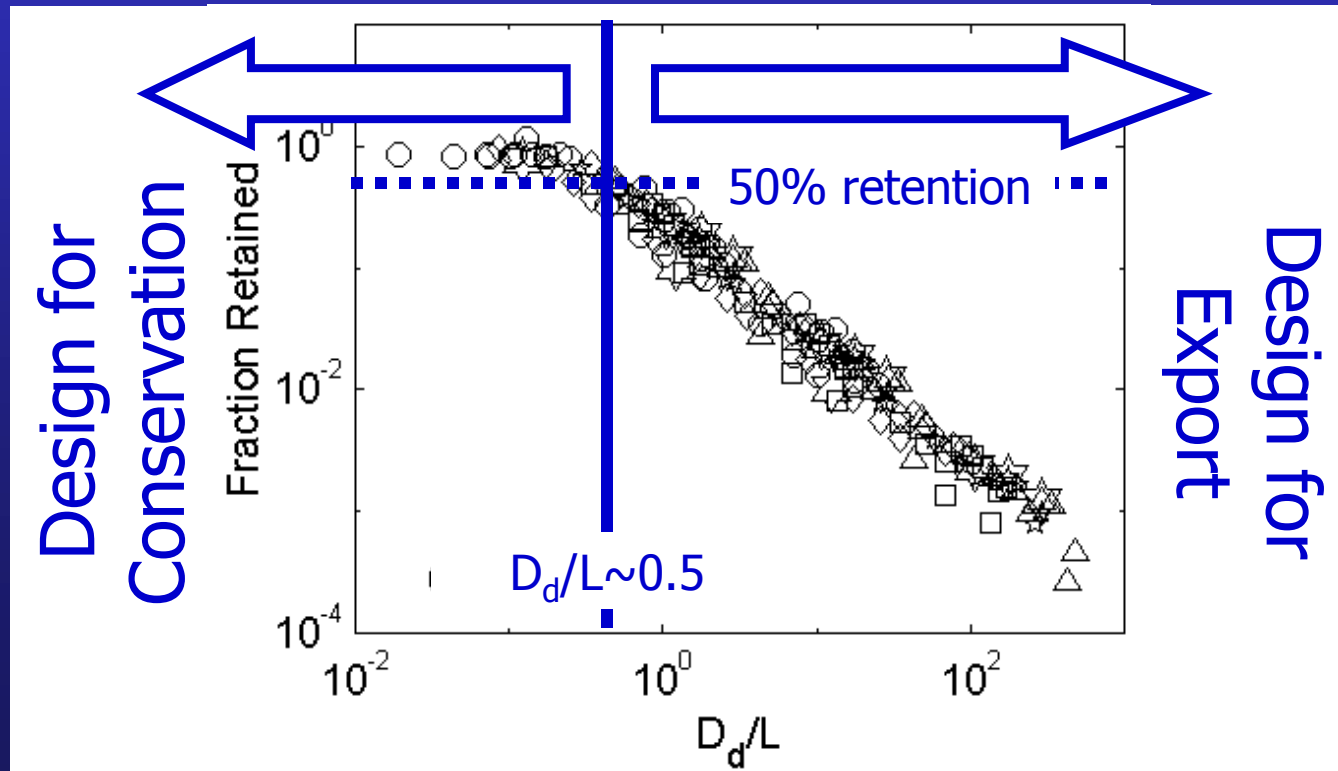
Will a MPA seed itself or its surroundings?

Scales as D_d/L

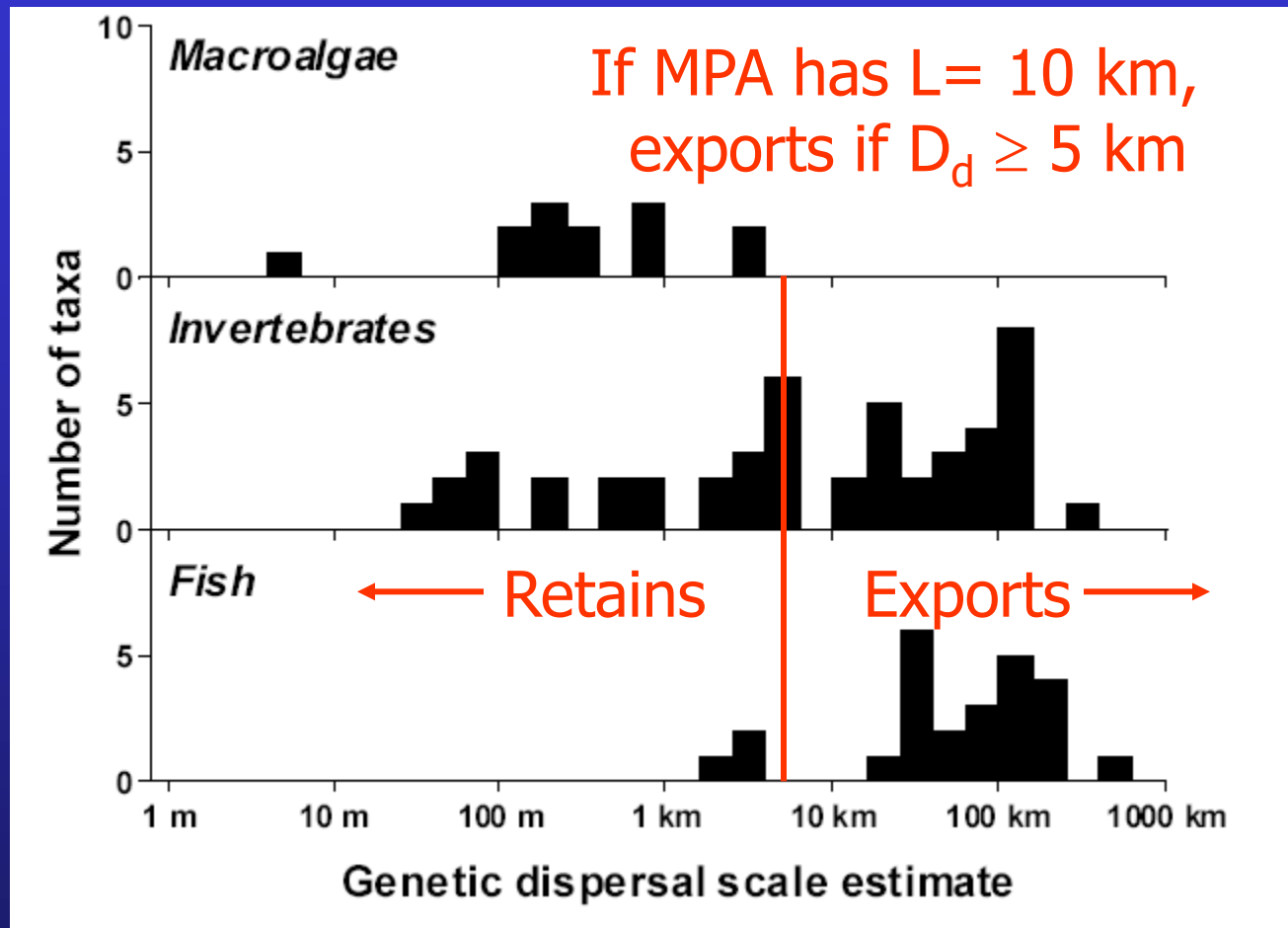


Will a MPA Retain or Export??

A MPA will retain or export progeny based on the organism's dispersion scale & the size of the MPA

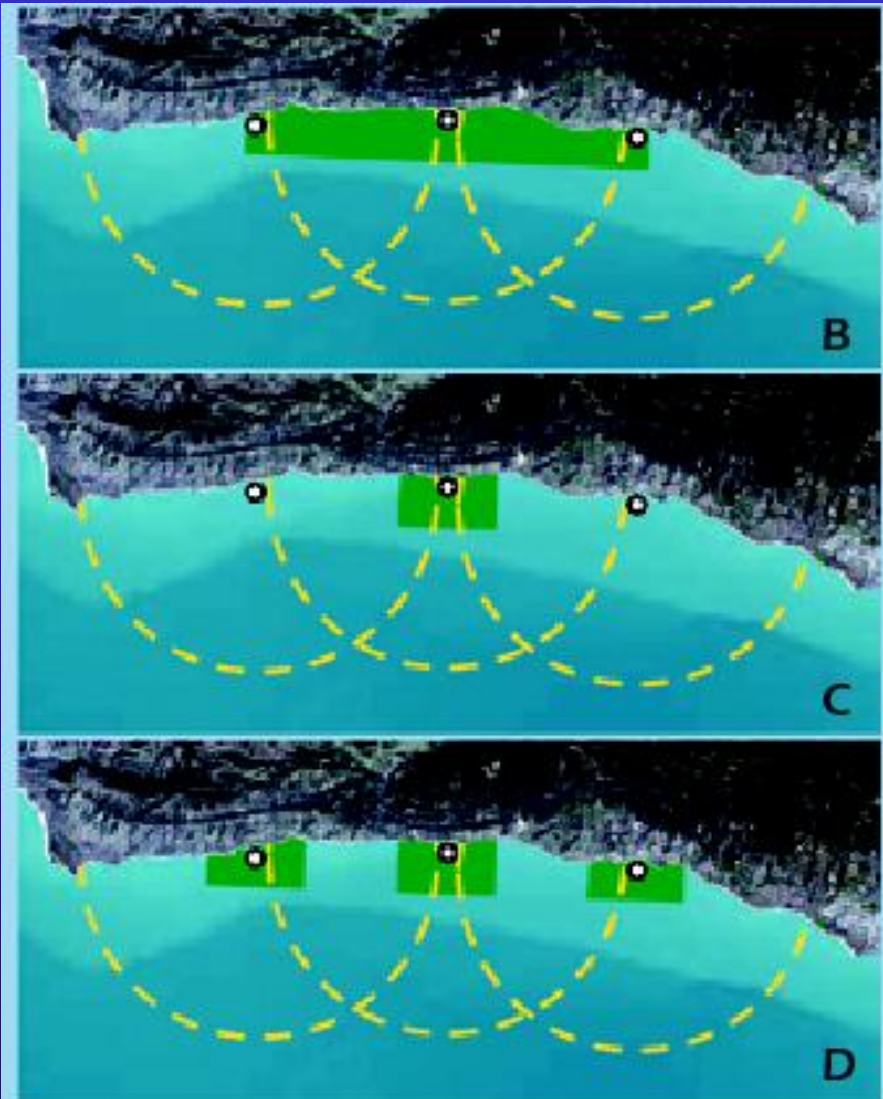


Is a MPA a Source or Sink?



- A single MPA will be both a larval source & sink
- Points to networks of reserves for conservation

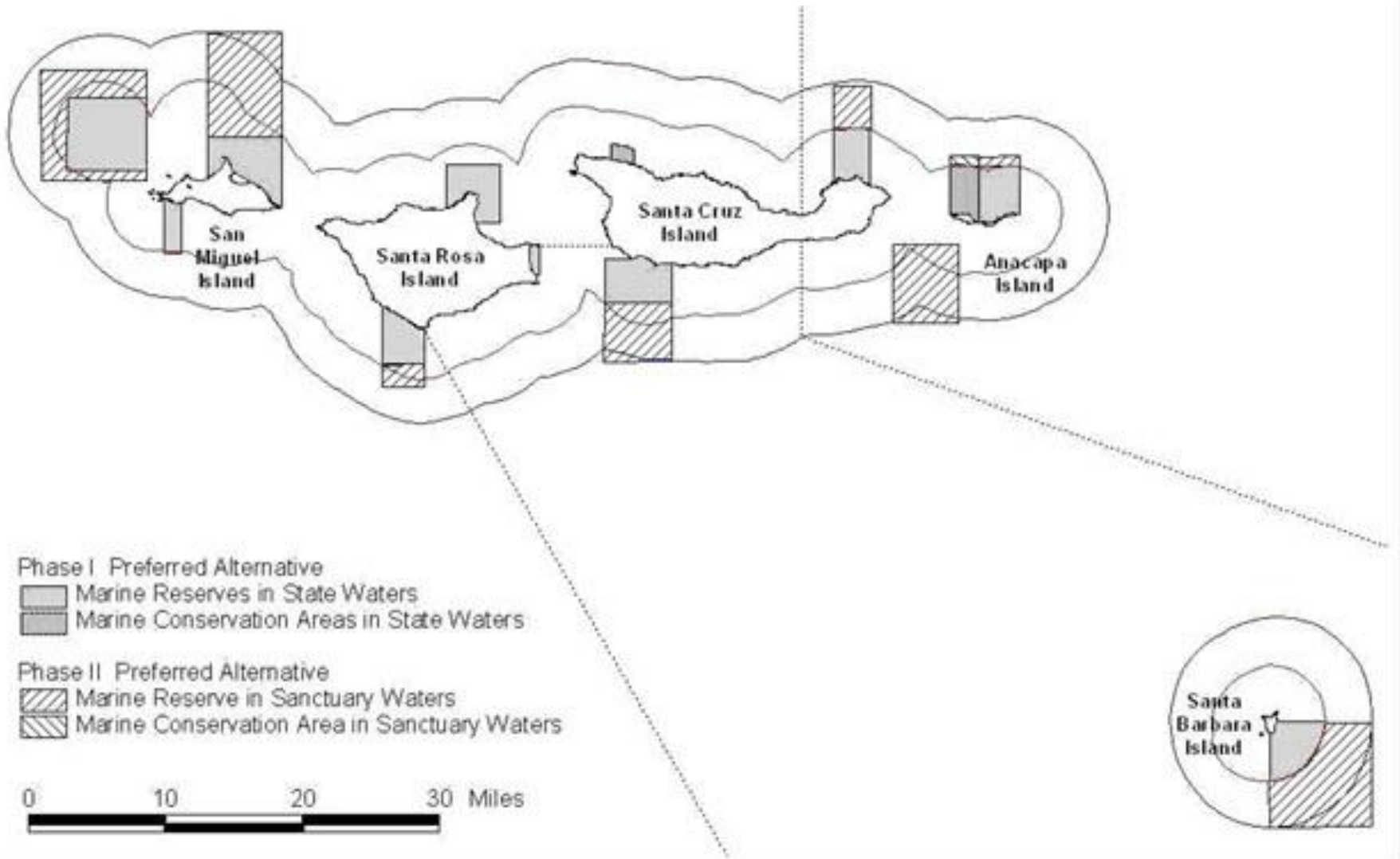
Reserve Networks



- Conserves organisms with both far & short larval dispersal
- Should contribute to fishery goal as well

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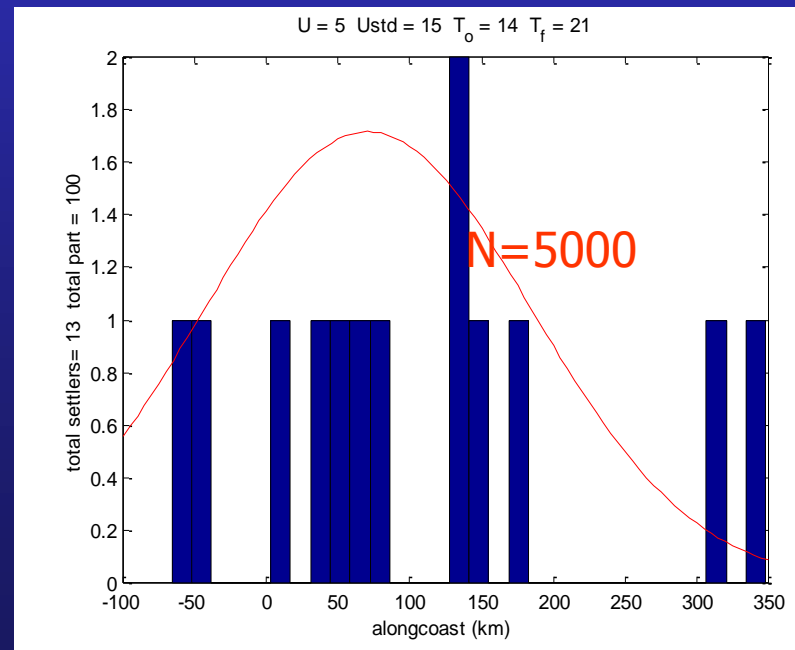


Larval Transport, Time & Fish Stock Uncertainty

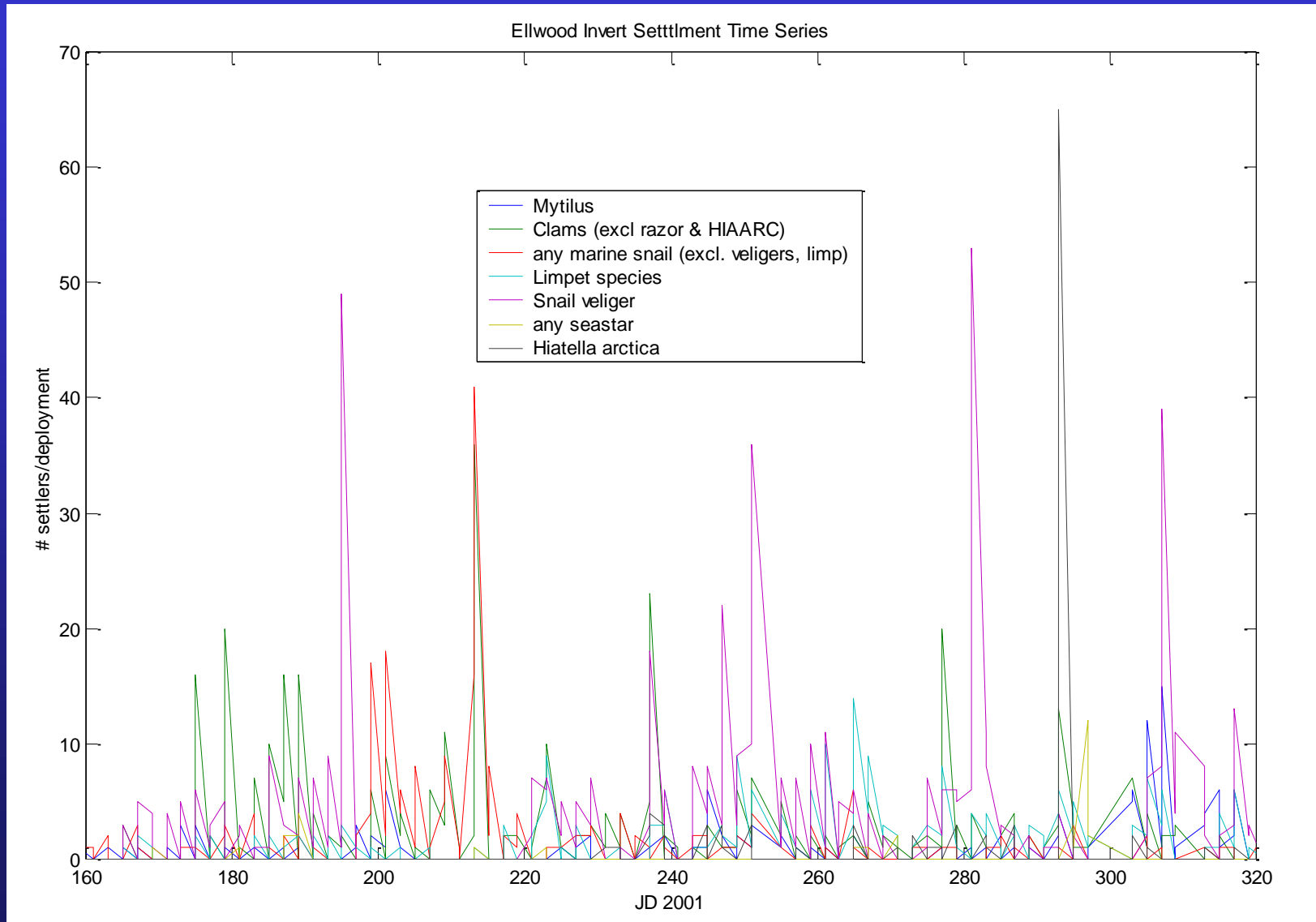
- Larval dispersal measured or modeled represents *ensemble mean* conditions
- The implied time to construct similar mean estimates is 10 to 50 years!!
- However, fish recruitment and fishery management time scales are much shorter

Time, continued...

- Annual recruitment may be a small sampling of a dispersal kernel ($N = 10?$, or less!!)
 - $(300 \text{ releases / year}) * (10\% \text{ survival}) / (3 \text{ day } \tau_L)$
- Implies that connections among sites are stochastic & intermittent
- Critical for assessing the “success” of a MPA as a fishery instrument



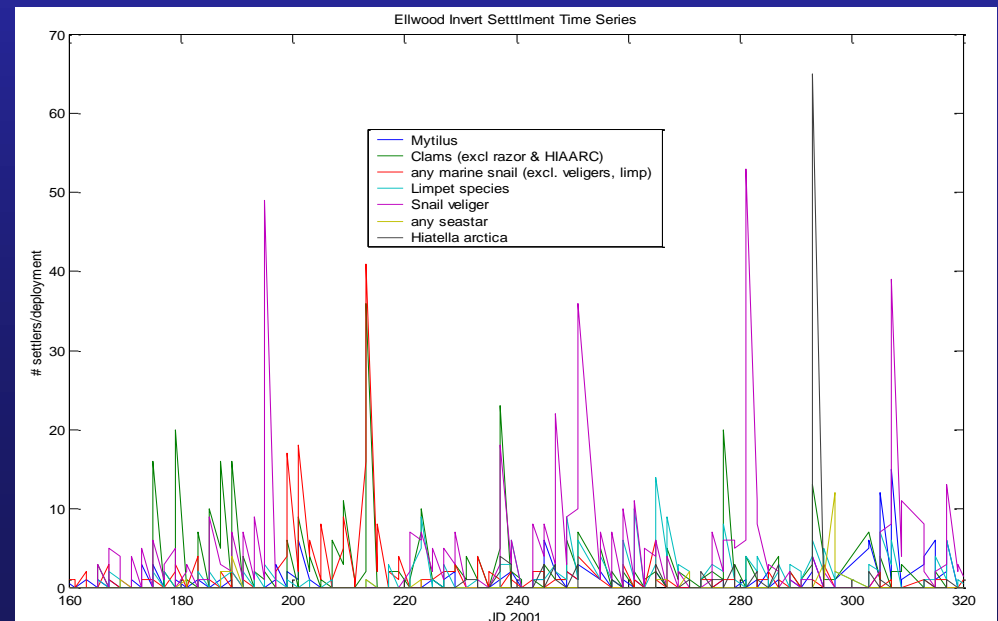
Invertebrate Settlement – SBC-LTER/PISCO



Time series sampling – $\Delta t = 2$ d

Interpreting Settlement Time Series

- Stochastic, quasi-random time series
- No correlation of settling among species
- Few settlement events for each species
- Events are short (≤ 2 days)



Implications for MPA Assessment

- MPA affects on fishery yields will be difficult to assess due to inherent recruitment variability
- A variable fishery response *is* expected
- Proper MPA assessment needs to be done over some long time (not really known yet)
- Need *real* predictive tools (including space, dispersal stochasticity, fisherman dynamics, economics, etc.)

Flow, Fish & Fishing - www.ices.ucsb.edu/~davey/F_cubed

SBC-LTER & the MPA Process

- Theoretical & synthetic analyses for MPA
 - How big, how many, how connected?
 - Assessment of MPA efficiency??
- Other relevant SBC work
 - Long-term observations of the kelp ecosystem
 - Terrestrial inputs of nutrients, sediments, etc.
- We expect to continue our “broader impacts” contributions as part of the MLPA process

Thank You!!

