Marine Life Protection Act Initiative

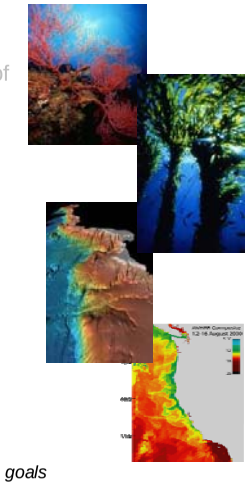
MPA Size and Spacing Guidelines and Evaluations for the MLPA North Coast Study Region

Presentation to the MLPA Master Plan Science Advisory Team
December 17, 2009 • Eureka, CA

Dr. Will White • MLPA Master Plan Science Advisory Team

MLPA Goals*: Populations

1. To protect the natural diversity and function of **marine ecosystems**.
2. To help sustain and restore **marine life populations**.
3. To improve **recreational, educational, and study opportunities** in areas with minimal human disturbance.
4. To protect representative and unique **marine life habitats**.
5. Clear objectives, effective management, adequate enforcement, sound science.
6. To ensure that MPAs are designed and managed as **a network**.

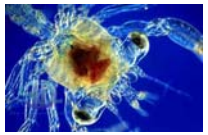


** Note that this language represents a summary of the MLPA goals*

Protecting Populations: Goals 2 & 6

General requirements

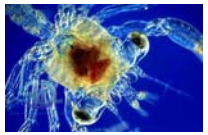
- Marine protected areas (MPAs) should be large enough that adults do not move out of them too frequently and become vulnerable to fishing
- MPAs should be close enough together that sufficient larvae can move from one to the next:
  - Demographic connectivity
  - Genetic connectivity



Protecting Populations: Goals 2 & 6

Evaluation approaches

- Proxy evaluations
  - MPA size and spacing guidelines (this presentation)
  - All habitats, wide suite of species
- Direct evaluations
  - Demographic effects: Bioeconomic models (next presentation)
  - Genetic effects: New supplemental model evaluation (next presentation)

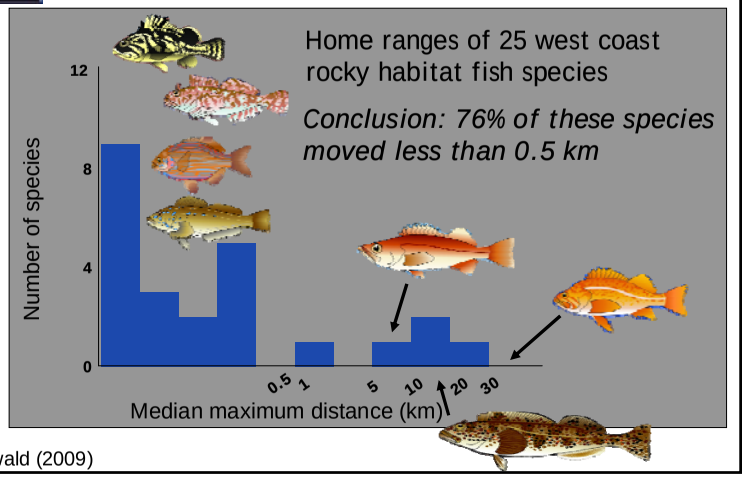


Protecting Populations: Goals 2 & 6

MPA Size

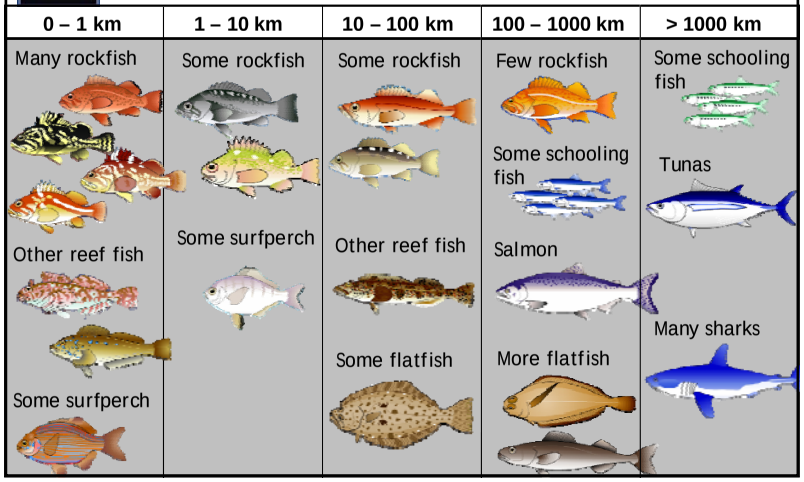
- MPAs should be large enough that adults do not move out of them too frequently and become vulnerable to fishing
  - Effective MPAs have size greater than average adult home range size (Moffitt et al. 2009)

Scales of Adult Movement



Freiwald (2009)

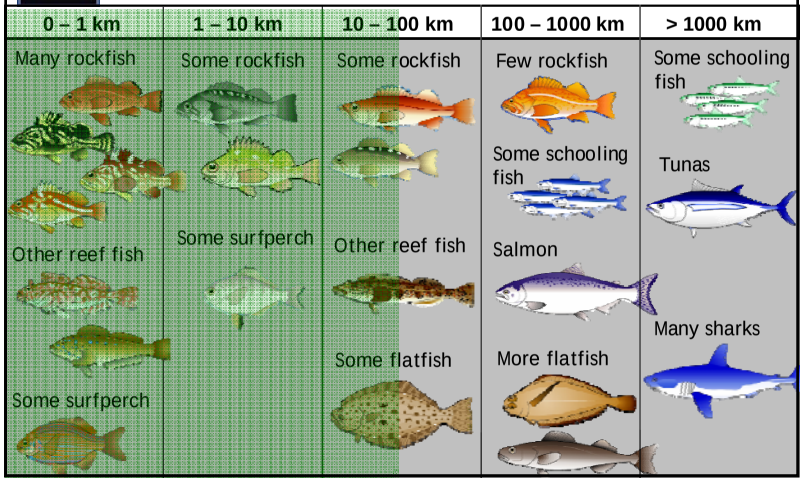
Scales of Adult Movement



MPA Size Guidelines

- **MPAs should have an alongshore span of 5-10 kilometers (3-6 miles) of coastline, and preferably 10-20 kilometers (6-12.5 miles)** to protect adult populations, based on adult neighborhood sizes and movement patterns. Larger MPAs should be required to fully protect marine birds, mammals, and migratory fish.
- **MPAs should extend from the intertidal zone to deep waters offshore** to protect the diversity of species that live at different depths and to accommodate the ontogenetic movement of individuals to and from nursery or spawning grounds to adult habitats.
- Combined and simplified, these two guidelines yield:
  Minimum range of 9-18 square miles
  Preferred range of 18-36 square miles

Scales of Adult Movement

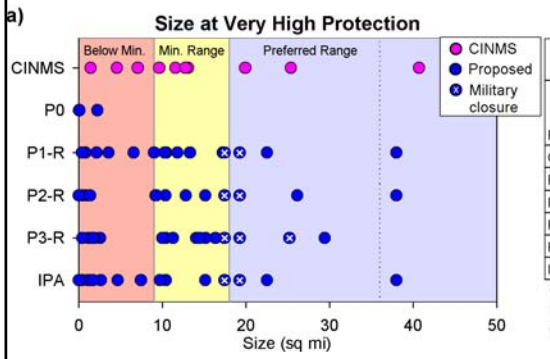


MPA Size Evaluation Methods

- Measure individual MPA areas
- Consider level of protection (LOP; moderate-high, high and very high)
- Combine contiguous MPAs of moderate high LOP or above into "MPA clusters"
- Tabulate MPA cluster areas relative to minimum and preferred guidelines
- Estuarine MPAs are not included in size evaluation

MPA Size: Very High Protection

Example from South Coast Study Region



Number of MPA Clusters* at Very High Protection

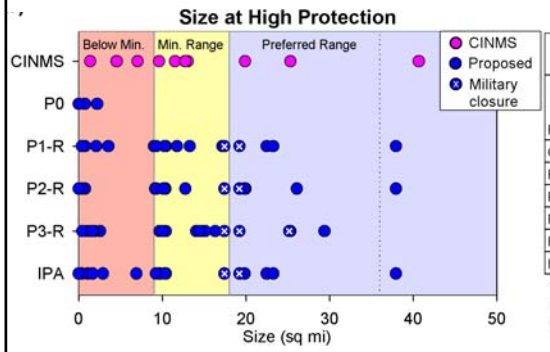
Proposal	Below Min. Size	Min. Size Range	Pref. Size Range	Total # Clusters
CINMS MPAs	3	5	3	11
Proposal 0	3	0	0	3
P1 Revised	5	6(1)	2(1)	13(2)
P2 Revised	4	5(1)	2(1)	11(2)
P3 Revised	5	7(1)	1(2)	13(3)
IPA	7	3(1)	2(1)	12(2)

* Clusters tabulated above do not include CINMS MPAs in proposals, () indicates military closures

- **All proposals have 3 state marine reserve clusters in the preferred size range**
- **Most MPAs in all proposals are below preferred size range**

MPA Size: High Protection

Example from South Coast Study Region



Number of MPA Clusters* at High Protection

Proposal	Below Min. Size	Min. Size Range	Pref. Size Range	Total # Clusters
CINMS MPAs	3	5	3	11
Proposal 0	4	0	0	4
P1 Revised	4	7(1)	3(1)	14(2)
P2 Revised	3	6(1)	4(1)	13(2)
P3 Revised	5	8(1)	2(2)	15(3)
IPA	6	5(1)	4(1)	15(2)

* Clusters tabulated above do not include CINMS MPAs in proposals, () indicates military closures

- **All proposals increase the proportion of clusters above minimum size when high protection MPAs are included in analyses**

Evaluated for all open coast MPAs at or above high protection

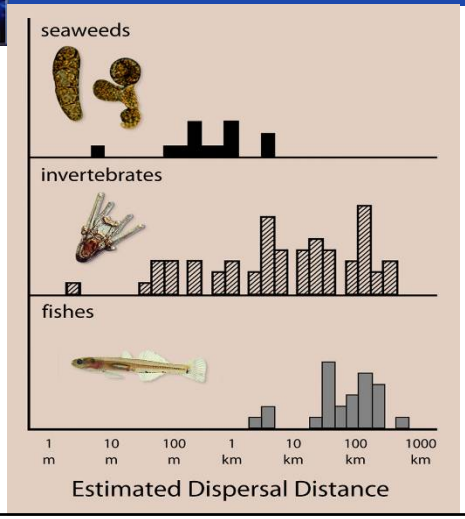
Protecting Populations: Goals 2 & 6

MPA Spacing

- MPAs should be close enough together that sufficient larvae can move from one to the next
- Two paths to population persistence:
  - MPA size matches average larval dispersal distance (self-contained, "self persistent" MPAs), or
  - MPAs are spaced closely enough that sufficient larvae are exchanged among them ("network persistence")

Botsford et al. 2001, Hastings and Botsford 2006, White et al. *in press*

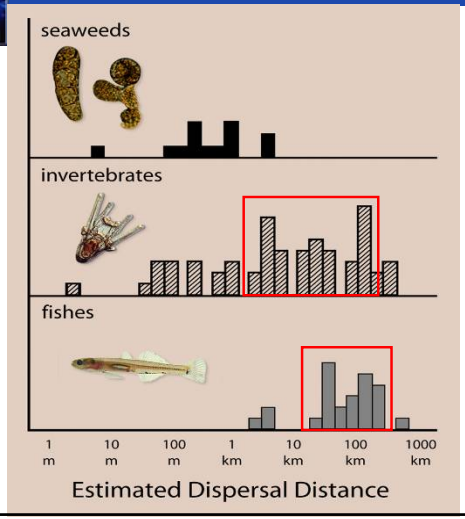
Scales of Larval Dispersal



- Based on observed patterns of isolation-by-distance (IBD)
- Theoretical relationship between IBD and dispersal distance

Palumbi (2003)
Kinlan and Gaines (2003)

Scales of Larval Dispersal



Inverts: < 100 km

Fish: 10 - 200 km

Kinlan and Gaines (2003)

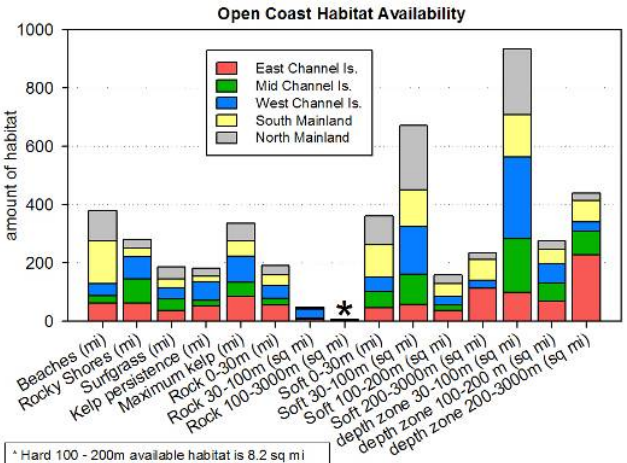
MPA Spacing Guidelines

- **MPAs should be placed within 50-100 kilometers (31-62 miles) of each other** to facilitate dispersal and connectedness of important bottom-dwelling fish and invertebrate groups among MPAs
- Because many populations are habitat-specific, spacing is evaluated **for each habitat**

MPA Spacing Evaluation Methods

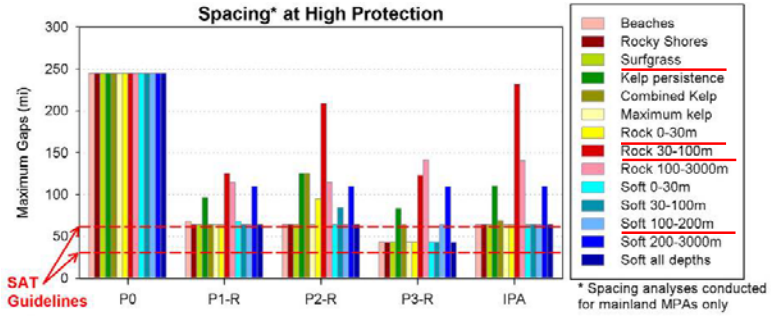
- MPAs or clusters must meet the minimum size guidelines (9 square miles) to be included in the spacing analysis
- Identify the habitats included in sufficient amounts to count as a "replicate" within each MPA cluster at moderate-high LOP or above
- Measure gaps between adjacent MPA clusters that contain a given habitat

Habitat Availability and Spacing



Example from South Coast Study Region

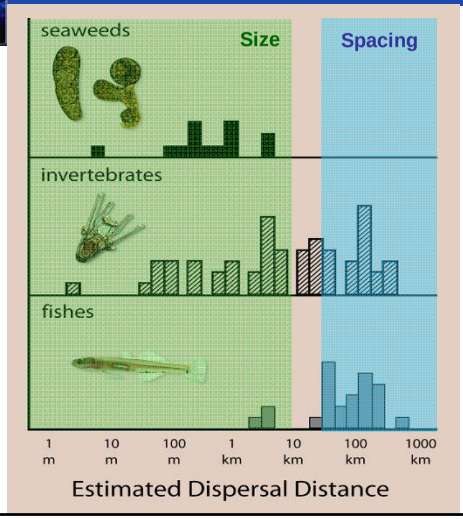
Maximum Gaps: High Protection



- **Was not possible to meet spacing guidelines for all habitats**
- **Proposals evaluated on how well guidelines were met across all habitats**

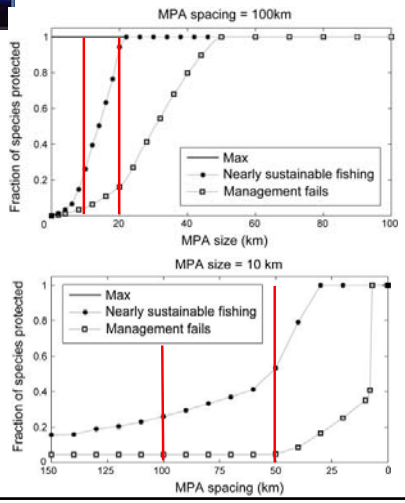
Example from South Coast Study Region

Scales of Larval Dispersal



Kinlan and Gaines (2003)

Consequences of MPA Size & Spacing



Population models run for range of combinations of size, spacing, and fishery management

Size guidelines:

- Steady increase in fraction of species protected as MPA size increases

Spacing guidelines:

- No benefits of decreased spacing beyond spacing guidelines (> 100 km)
- Sharp increase in benefit at closer spacing

Moffitt et al. (in review)