Marine Life Protection Act Initiative

Preliminary Size & Spacing Evaluations North Central Coast Proposals

Presentation to the MLPA Blue Ribbon Task Force

Nov 19, 2007 • San Rafael, CA

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Goals 2 and 6

1. To help **sustain, conserve, and protect marine life populations**, including those of economic value, and rebuild those that are depleted.
2. To ensure that the state's **MPAs are designed and managed**, to the extent possible, **as a network**.

→ Size and Spacing Guidelines in the Master Plan

Master Plan Guidelines

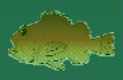
- Size Guideline #1
  - "For an objective of protecting adult populations, based on adult neighborhood sizes and movement patterns, MPAs should have an **alongshore span of 5-10 km** (3-6 m or 2.5- 5.4 nm) of coastline, and **preferably 10-20 km** (6-12.5 m or 5.4-11 nm). Larger MPAs would be required to fully protect marine birds, mammals, and migratory fish."

0 – 1 km	1 – 10 km	10 – 100 km	100 – 1000 km	> 1000 km
Invertebrates	Rockfishes	Invertebrates	Fishes	Invertebrates
Abalone	Black	Dung. Crab*	Big Skate	Jumbo Squid*
Mussel	Brown	Rockfishes	Pacific Halibut	Fishes
Octopus	Copper	Bocaccio	Sablefish*	Sharks*
Sea Star	Greenspotted	Canary	Salmonids*	Tunas*
Snail	Olive	Yellowtail	Sturgeon	Turtles*
Urchin	Vermilion	Widow	Whiting*	Birds
Rockfishes	Other Fishes	Other Fishes	Birds	Albatross*
Blk. & Yellow	Cabezon Ca.	Anchovy	Gulls*	Pelican*
China	Halibut	Herring	Mammals	Shearwater*
Gopher	Lingcod	Sardine	Porpoises	Shorebirds*
Kelp		Birds	Sea Lions*	Terns*
Other Fishes		Gulls		Mammals
Gobie		Cormorants		Dolphins
Sculpin		Mammals		Sea Lions*
		Harbor Seal		Whales*
		Otter		

* Seasonal Migration

Minimum Guideline

0 – 1 km	1 – 10 km	10 – 100 km	100 – 1000 km	> 1000 km
Invertebrates	Rockfishes	Invertebrates	Fishes	Invertebrates
Abalone	Black	Dung. Crab*	Big Skate	Jumbo Squid*
Mussel	Brown	Rockfishes	Pacific Halibut	Fishes
Octopus	Copper	Bocaccio	Sablefish*	Sharks*
Sea Star	Greenspotted	Canary	Salmonids*	Tunas*
Snail	Olive	Yellowtail	Sturgeon	Turtles*
Urchin	Vermilion	Widow	Whiting*	Birds
Rockfishes	Other Fishes	Other Fishes	Birds	Albatross*
Blk. & Yellow	Cabezon Ca.	Anchovy	Gulls*	Pelican*
China Gopher	Halibut	Herring	Mammals	Shearwater*
Kelp	Lingcod	Sardine	Porpoises	Shorebirds*
Other Fishes		Birds	Sea Lions*	Terns*
Gobie		Gulls		Mammals
Sculpin		Cormorants		Dolphins Sea Lions* Whales*
		Mammals		
		Harbor Seal		
		Otter		

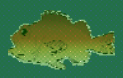


* Seasonal Migration

Limited Benefit

Preferable Size Benefits Many More Species

0 – 1 km	1 – 10 km	10 – 100 km	100 – 1000 km	> 1000 km
Invertebrates	Rockfishes	Invertebrates	Fishes	Invertebrates
Abalone	Black	Dung. Crab*	Big Skate	Jumbo Squid*
Mussel	Brown	Rockfishes	Pacific Halibut	Fishes
Octopus	Copper	Bocaccio	Sablefish*	Sharks*
Sea Star	Greenspotted	Canary	Salmonids*	Tunas*
Snail	Olive	Yellowtail	Sturgeon	Turtles*
Urchin	Vermilion	Widow	Whiting*	Birds
Rockfishes	Other Fishes	Other Fishes	Birds	Albatross*
Blk. & Yellow	Cabezon Ca.	Anchovy	Gulls*	Pelican*
China Gopher	Halibut	Herring	Mammals	Shearwater*
Kelp	Lingcod	Sardine	Porpoises	Shorebirds*
Other Fishes		Birds	Sea Lions*	Terns*
Gobie		Gulls		Mammals
Sculpin		Cormorants		Dolphins Sea Lions* Whales*
		Mammals		
		Harbor Seal		
		Otter		



* Seasonal Migration

Master Plan Guidelines

- Size Guideline #2
  - "For an objective of protecting the diversity of species that live at different depths and to accommodate the movement of individuals to and from shallow nursery or spawning grounds to adult habitats offshore, MPAs should **extend from the intertidal zone to deep waters offshore**."

→ 3 miles offshore

Size Analysis Methods

- Measure individual MPA lengths and area
- Combine contiguous MPAs into single MPA complexes
- Consider level of protection
- Tabulate MPA lengths and areas relative to minimum & preferred guidelines

High Protection

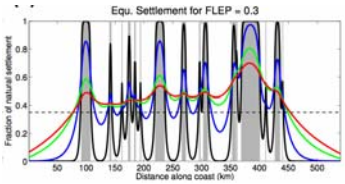
Pkg	# of Clusters	Below Min.	At Minimum	Pref Range
0	1	100%	0%	0%
EA	6	50%	33%	17%
EB	8	50%	38%	13%
JA	7	57%	14%	29%
JB	6	83%	17%	0%
TA	6	50%	50%	0%
TB	6	50%	33%	17%

High Protection

Pkg	# of Clusters	Below Min.	At Minimum	Pref Range
0	1	100%	0%	0%
A	7	100%	0%	0%
B	6	83%	17%	0%
C	10	20%	60%	20%
D	5	80%	20%	0%

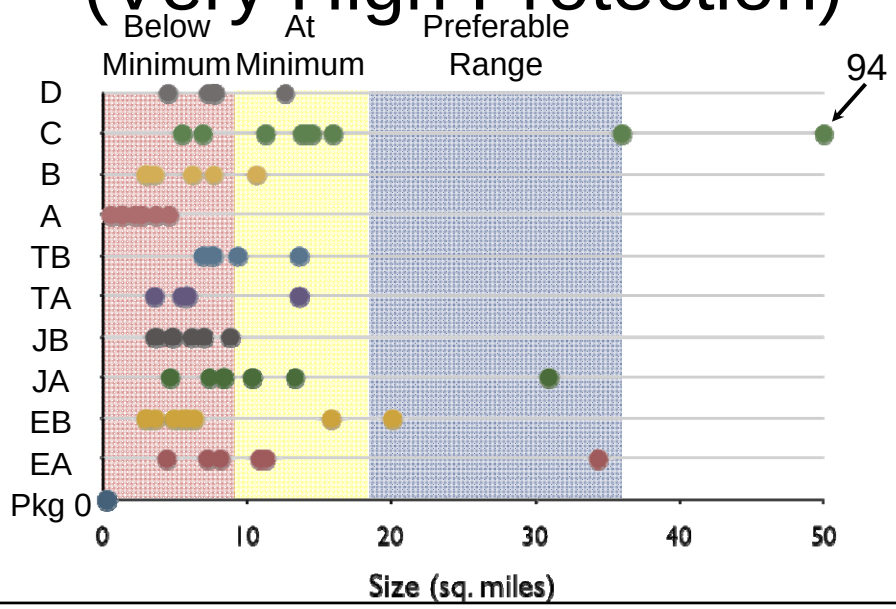
Models Quantify Benefits & Costs

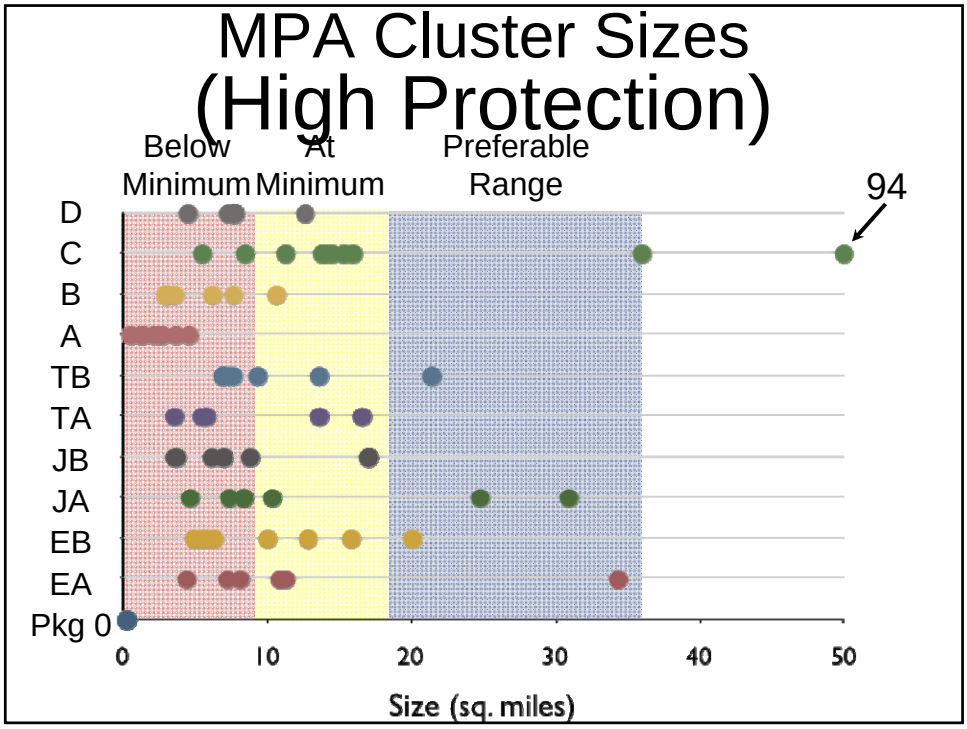
- Better assessment of the value of different sizes and spacing

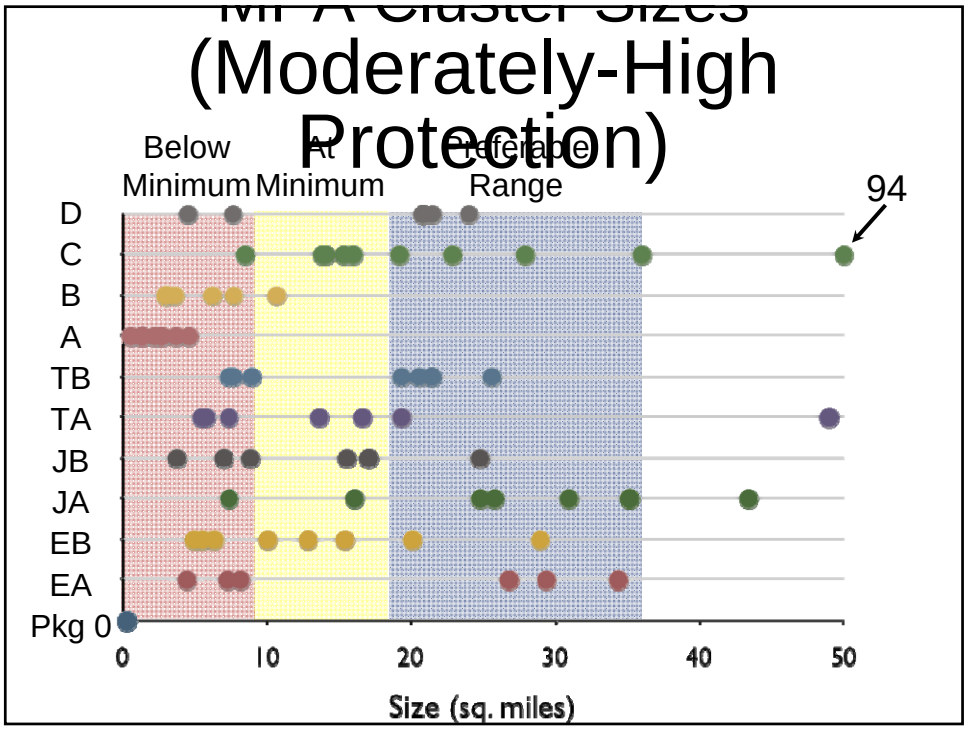


Spacing (km)	Size (km)	Coastline in reserves (%)	Coastline persistent at peak (%)	Maximum larval dispersal that leads to persistence (with no adult movement) (km)
100	5	4.8	6.5	6
100	10	9.1	12.7	12
100	20	16.7	23.5	28
50	5	9.1	12.4	6
50	10	16.7	23.3	14
50	20	28.6	100	∞

MPA Cluster Sizes (Very High Protection)




MPA Cluster Sizes
(High Protection)
Below Minimum
At Minimum
Preferable Range
94
D
C
B
A
TB
TA
JB
JA
EB
EA
Pkg 0
0
10
20
30
40
50
Size (sq. miles)


(Moderately-High Protection)
Below Minimum
At Minimum
Preferable Range
94
D
C
B
A
TB
TA
JB
JA
EB
EA
Pkg 0
0
10
20
30
40
50
Size (sq. miles)

MPA Size Conclusions

With **Very High or High Levels of Protection**:

- Pkg C is most consistent with size guidelines (80% of MPAs).
- Pkg JA has the largest fraction of MPAs in preferred size range
- Pkgs EA, EB, TA, TB had at least one MPA in the preferred size range and 50% > min size guideline
- Pkgs JB, A, B, D had few or no MPAs > min size guideline

MPA Size Conclusions

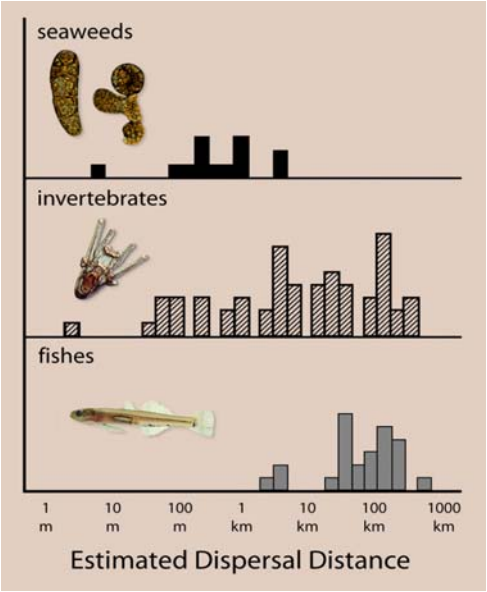
With **Moderately High Levels of Protection**:

- For 6 Packages, more than half of the MPAs meet minimum guidelines.
- Within this group, the fraction of MPAs decreases in the following order C > JA > EB > TB > TA > D
- 5 packages have at least half of their MPAs in the preferred size range: JA, D, TB, C, EA
- Two packages meet the minimum size guidelines for half of their MPAs: EA, JB
- Two packages have few or no MPAs that meet size guidelines: A, B

Master Plan Guidelines

- Spacing Guideline
  - "For an objective of facilitating dispersal of important bottom-dwelling fish and invertebrate groups among MPAs, based on currently known scales of larval dispersal, **MPAs should be placed within 50-100 km** (31-62 m or 27-54 nm) of each other."

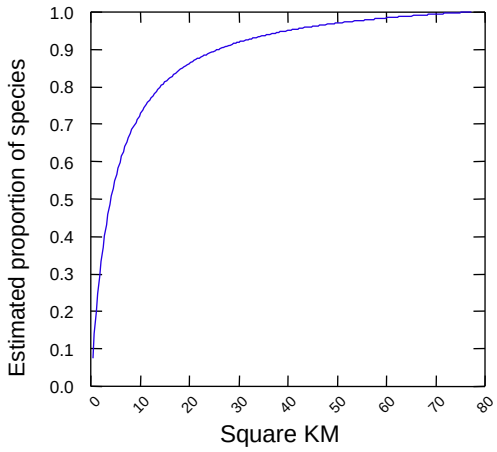
Source of the Spacing Guideline



Spacing Analysis Methods

- Characterize each MPA by the habitats included
- For each habitat, measure the gaps between adjacent, high protection MPAs

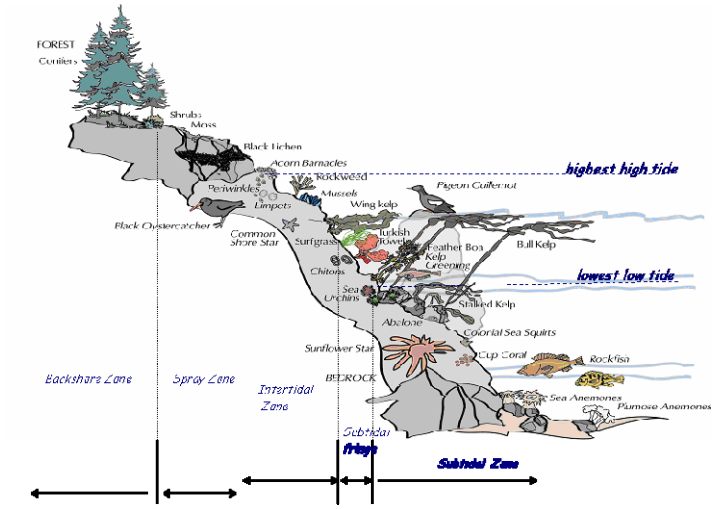
How Much Habitat is Needed?



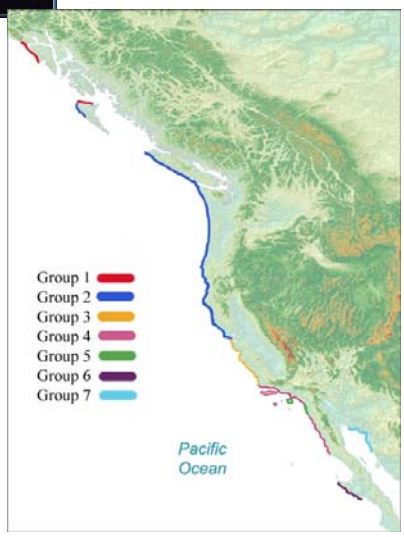
What we need is a relationship like this

– there are data that can be used to produce such relationships

Sample Many Small Areas



Example – Rocky Intertidal



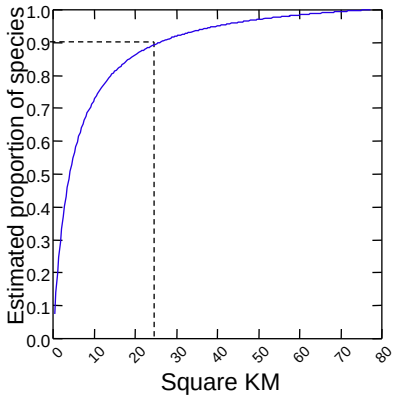
PISCO Biodiversity surveys

Data

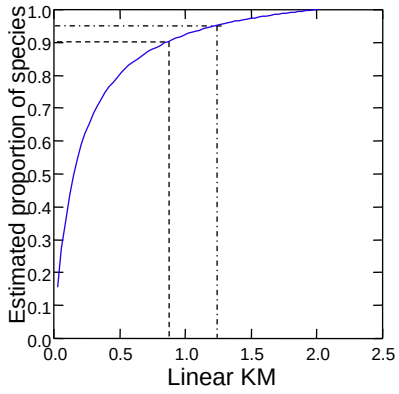
METHOD	FINAL_CLASSIFICATIC	VALUE	sitecode		final_classification	kingdom	phylum_dr	class	order	family	genus	species	tax_group	func_grou	trophic_gr	web_level1	web_level2
Density	littorina plena/scutulata	328.8485		1	littorina plena/scutul	Animalia	Mollusca	Gastropod	Neotaenio	Littorinidae	littorina	plena/scut	mobileinve	snail	herbivore	invertebrat	snail
Density	lottia austrodigitalis/digit	65.09091		1	lottia austrodigitalis/	Animalia	Mollusca	Gastropod	Patellogast	Lottiidae	lottia	austrodigit	mobileinve	limpet	herbivore	invertebrat	limpet
Density	smallimpet	35.87879		1	smallimpet	Animalia	Mollusca						mobileinve	limpet	herbivore	invertebrat	limpet
Density	littorina spp	22.42424		1	littorina spp	Animalia	Mollusca	Gastropod	Neotaenio	Littorinidae	littorina	spp	mobileinve	snail	herbivore	invertebrat	snail
Density	nucella emarginata/ostri	19.75758		1	nucella emarginata/	Animalia	Mollusca	Gastropod	Neogastro	Muricidae	nucella	emarginat	mobileinve	whelk	carnivore	invertebrat	whelk
Density	tegula funebralis	10.06061		1	tegula funebralis	Animalia	Mollusca	Gastropod	Archaeogi	Trochidae	tegula	funebralis	mobileinve	snail	herbivore	invertebrat	snail
Density	littorina keenae	9.818182		1	littorina keenae	Animalia	Mollusca	Gastropod	Neotaenio	Littorinidae	littorina	keenae	mobileinve	snail	herbivore	invertebrat	snail
Density	lottia scabra/conus	8.363636		1	lottia scabra/conus	Animalia	Mollusca	Gastropod	Patellogast	Lottiidae	lottia	scabra/co	mobileinve	limpet	herbivore	invertebrat	limpet
Density	pisaster ochraceus	4.606061		1	pisaster ochraceus	Animalia	Echinoder	Asteroidea	Forcipulati	Asteriidae	pisaster	ochraceus	mobileinve	seastar	carnivore	invertebrat	seastar
Density	mopalia spp	1.818182		1	mopalia spp	Animalia	Mollusca	Polyplaco	Neoloricat	Mopaliidae	mopalia	spp	mobileinve	chiton	herbivore	invertebrat	chiton
Density	leptasterias spp	0.727273		1	leptasterias spp	Animalia	Echinoder	Asteroidea	Forcipulati	Asteriidae	leptasteria	spp	mobileinve	seastar	carnivore	invertebrat	seastar
Density	pachygrapsus crassipes	0.727273		1	pachygrapsus crass	Animalia	Arthropod	Malacostra	Decapoda	Grapsidae	pachygrap	crassipes	mobileinve	crab	omnivore	invertebrat	crab
Density	pugettia producta	0.727273		1	pugettia producta	Animalia	Arthropod	Malacostra	Decapoda	Epialtidae	pugettia	producta	mobileinve	crab	omnivore	invertebrat	crab
Density	strongylocentrotus purp	0.727273		1	strongylocentrotus p	Animalia	Echinoder	Echinoidea	Echinoida	Strongyloc	strongyloc	purpuratus	mobileinve	urchin	herbivore	invertebrat	urchin
Density	lottia limatula	0.606061		1	lottia limatula	Animalia	Mollusca	Gastropod	Patellogast	Lottiidae	lottia	limatula	mobileinve	limpet	herbivore	invertebrat	limpet
Density	tonicella lineata/lokii	0.363636		1	tonicella lineata/lokii	Animalia	Mollusca	Polyplaco	Neoloricat	Ischnochit	tonicella	lineata	mobileinve	chiton	herbivore	invertebrat	chiton
Density	amphissa versicolor	0.242424		1	amphissa versicolor	Animalia	Mollusca	Gastropod	Neogastro	Columbelli	amphissa	versicolor	mobileinve	snail	carnivore	invertebrat	snail
Density	cancer spp	0.242424		1	cancer spp	Animalia	Arthropod	Malacostra	Decapoda	Cancridae	cancer	spp	mobileinve	crab	carnivore	invertebrat	crab
Density	lepidochitona hartwegii	0.242424		1	lepidochitona hartw	Animalia	Mollusca	Polyplaco	Neoloricat	Ischnochit	lepidochit	hartwegii	mobileinve	chiton	herbivore	invertebrat	chiton
Density	pachycheles spp	0.242424		1	pachycheles spp	Animalia	Arthropod	Malacostra	Decapoda	Porcellanic	pachychel	spp	mobileinve	crab	filter-feede	invertebrat	crab
Density	acanthinucella spp	0.121212		1	acanthinucella spp	Animalia	Mollusca	Gastropod	Neogastro	Muricidae	acanthinuc	spp	mobileinve	whelk	carnivore	invertebrat	whelk
Density	anisodoris nobilis	0.121212		1	anisodoris nobilis	Animalia	Mollusca	Gastropod	Nudibranc	Discodoric	anisodoris	nobilis	mobileinve	seaslug	carnivore	invertebrat	seaslug

Results

Soft Bottom (Trawl Data)



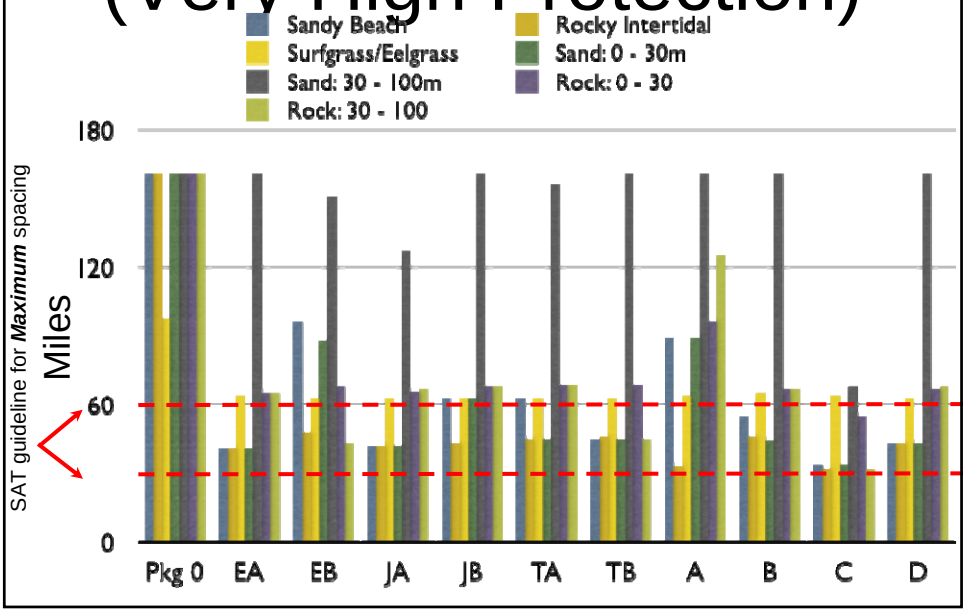
Intertidal (PISCO data)

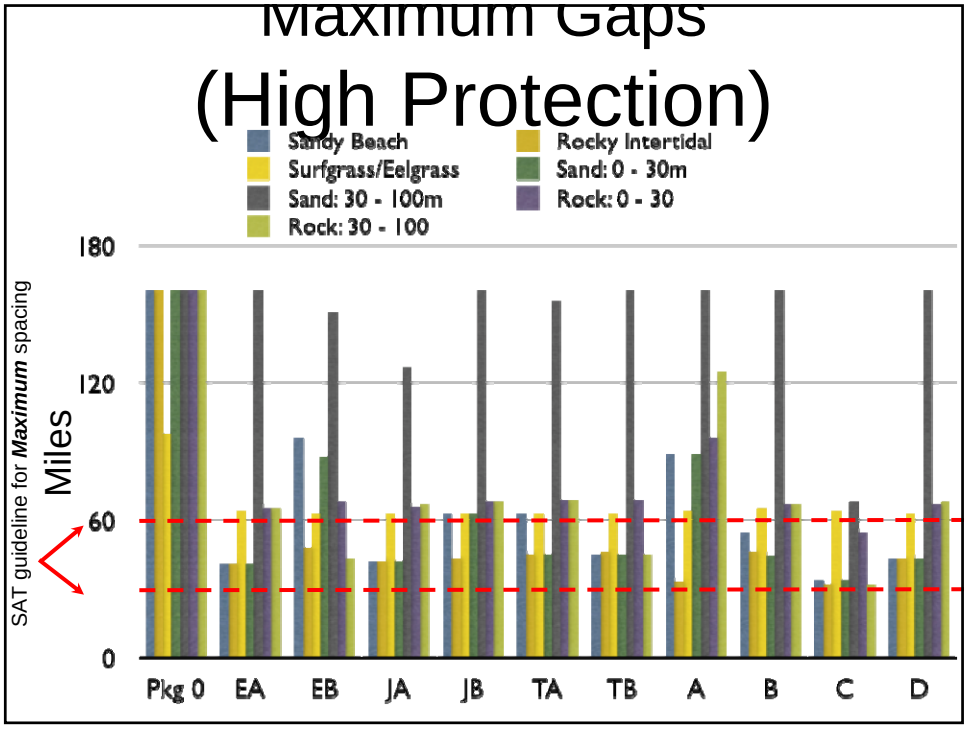


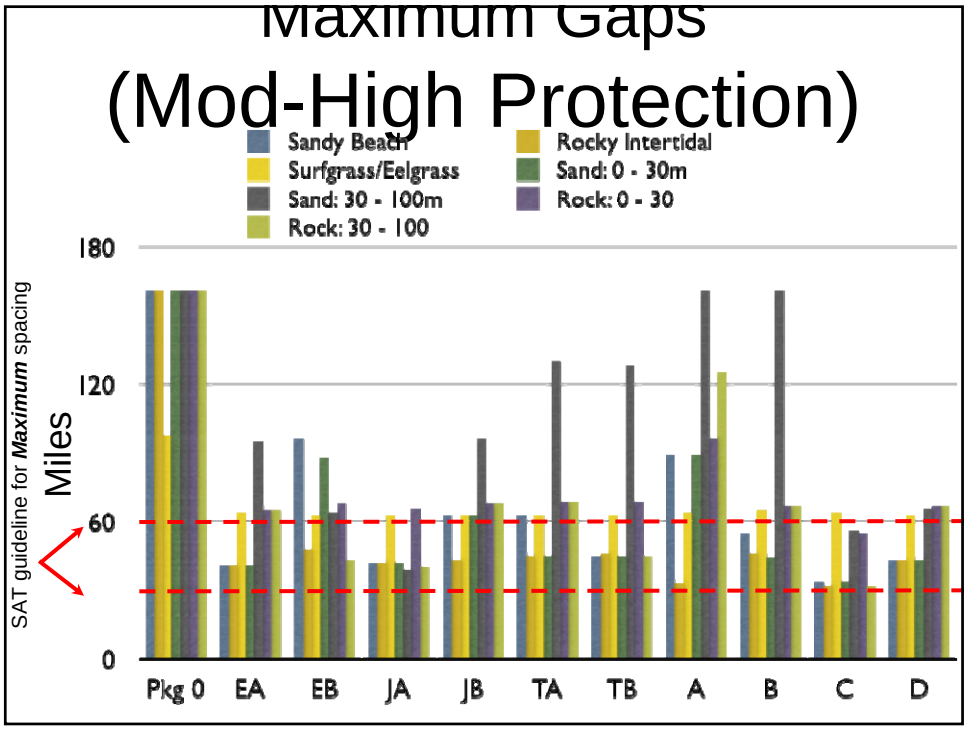
Habitat representation

Habitat	Representation needed to encompass 90% of biodiversity	Data Source
Rocky Intertidal	~0.6 linear miles	PISCO Biodiversity
Shallow Rocky Reefs/Kelp Forests (0-30 M)	~1.1 linear miles	PISCO Subtidal
Deep Rocky Reefs (30-100 M)	~0.2 square miles	Starr surveys
Sandy Habitat (30-100 M)	~10 square miles	NMFS triennial trawl surveys 1977-2007
Sandy Habitat (0-30 M)	~1.1 linear miles	Based on shallow rocky reefs
Sandy Beaches	~ 1 linear mile	

Maximum Gaps (Very High Protection)




Maximum Gaps
(High Protection)
Sandy Beach
Surfgrass/Eelgrass
Sand: 30 - 100m
Rock: 30 - 100
Rocky Intertidal
Sand: 0 - 30m
Rock: 0 - 30
180
120
60
0
Miles
SAT guideline for Maximum spacing
Pkg 0
EA
EB
JA
JB
TA
TB
A
B
C
D


Maximum Gaps
(Mod-High Protection)
Sandy Beach
Surfgrass/Eelgrass
Sand: 30 - 100m
Rock: 30 - 100
Rocky Intertidal
Sand: 0 - 30m
Rock: 0 - 30
180
120
60
0
Miles
SAT guideline for Maximum spacing
Pkg 0
EA
EB
JA
JB
TA
TB
A
B
C
D

MPA Spacing Conclusions

With **Very High or High Levels of Protection**:

- Pkg C was close to meeting the guidelines for all habitats. Half of the habitats had maximum spacing near the lower end of the guideline.
- Pkgs EA, JA, JB, TA, TB, B, and D all greatly exceeded the spacing guidelines for 1 habitat (Sand: 30-100m). All were close to meeting the guidelines for all other habitats.
- Pkgs EB and A greatly exceeded the spacing guidelines for several habitats.

MPA Spacing Conclusions

With **Moderately High Levels of Protection**:

- Pkgs JA, C and D were close to meeting the guidelines for all habitats. Several habitats in each pachage had maximum spacing near the lower more stringent end of the guidelines.
- Pkgs EA, JB, TA, TB, and B all greatly exceeded the spacing guidelines for 1 habitat (Sand: 30-100m). All were close to meeting the guidelines for all other habitats.
- Pkg EB greatly exceeded the spacing guidelines for 2 habitats. Pkg A greatly exceeded the spacing guidelines for 5 habitats.

Replicates Per Habitat (Very High Protection)

Pkg	Sandy or gravel Beaches	Rocky intertidal and cliff	Surfgrass	Soft 0 - 30m	Soft 30 - 100m	Hard 0 - 30m	Hard 30 - 100m	Average Kelp	Average
0	0	0	0	0	0	0	0	0	0
EA	2	3	1	2	0	3	3	1	1.8
EB	2	2	2	2	1	2	2	0	1.6
JA	3	3	2	3	1	3	3	1	2.4
JB	0	0	0	0	0	0	0	0	0
TA	1	2	1	1	1	2	2	1	1.4
TB	1	2	1	1	0	2	2	1	1.3

Replicates Per Habitat (High Protection)

Pkg	Sandy or gravel Beaches	Rocky intertidal and cliff	Surfgrass	Soft 0 - 30m	Soft 30 - 100m	Hard 0 - 30m	Hard 30 - 100m	Average Kelp	Average
0	0	0	0	0	0	0	0	0	0
EA	2	3	1	2	1	3	3	1	2
EB	2	3	2	2	2	3	4	0	2.3
JA	3	3	2	3	2	3	3	1	2.5
JB	0	1	0	0	0	1	1	0	0.4
TA	1	3	1	1	1	3	3	1	1.8
TB	1	3	1	1	1	3	3	1	1.8

(Moderate-High Protection)

Pkg	Sandy or gravel Beaches	Rocky intertidal and cliff	Surfgrass	Soft 0 - 30m	Soft 30 - 100m	Hard 0 - 30m	Hard 30 - 100m	Average Kelp	Average
0	0	0	0	0	0	0	0	0	0
EA	2	3	1	2	3	3	3	1	2.3
EB	2	4	3	2	3	3	5	1	2.8
JA	4	6	3	4	5	5	6	2	3.8
JB	1	3	1	1	2	3	2	1	1.8
TA	1	4	1	2	3	4	4	2	2.6
TB	3	5	2	3	3	4	4	2	3.3

Replicates Per Habitat (Very High Protection)

Pkg	Sandy or gravel Beaches	Rocky intertidal and cliff	Surfgrass	Soft 0 - 30m	Soft 30 - 100m	Hard 0 - 30m	Hard 30 - 100m	Average Kelp	Average
0	0	0	0	0	0	0	0	0	0
A	0	0	0	0	0	0	0	0	0
B	0	1	0	0	0	1	1	1	0.5
C	6	7	5	6	4	6	7	2	5.4
D	1	1	1	1	0	1	1	0	0.8

Replicates Per Habitat (High Protection)

Pkg	Sandy or gravel Beaches	Rocky intertidal and cliff	Surfgrass	Soft 0 - 30m	Soft 30 - 100m	Hard 0 - 30m	Hard 30 - 100m	Average Kelp	Average
0	0	0	0	0	0	0	0	0	0
A	0	0	0	0	0	0	0	0	0
B	0	1	0	0	0	1	1	1	0.5
C	6	8	5	6	4	7	8	3	5.9
D	1	1	1	1	0	1	1	0	0.8

(Moderate-High Protection)

Pkg	Sandy or gravel Beaches	Rocky intertidal and cliff	Surfgrass	Soft 0 - 30m	Soft 30 - 100m	Hard 0 - 30m	Hard 30 - 100m	Average Kelp	Average
0	0	0	0	0	0	0	0	0	0
A	0	0	0	0	0	0	0	0	0
B	0	1	0	0	0	1	1	1	0.5
C	7	9	6	7	6	7	8	3	6.6
D	2	3	2	2	3	3	3	1	2.4