Baseline Characterization of Sandy Beach Ecosystems along the North Coast of California

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NCMPA Baseline Study Beaches
6 MPA**
6 Reference

Long beaches (>1 km)
1. Pyramid Point SMCA**
2. Kellogg Beach
3. Gold Bluffs
4. Reading Rock SMCA**
5. Mad River
6. Samoa SMCA**
7. Ten Mile
8. Virgin Creek SMCA**

Pocket beaches (<1 km: 120-690 m)
9. Jug Handle
10. Caspar
11. Russian Gulch SMCA**
12. Van Damme SMCA**
Sandy Beach & Surf Zone
Key Relationships

- Macrophyte wrack
- Amphipods
- Phytoplankton
- Sand Crabs
- Surfperch
- Birds

Resource/Habitat link:
- Forests
- Estuaries & Wetlands
- Rocky Intertidal
- Kelp Forest

Consumer link:
- Coastal Ocean Processes
NCMPA Beach Baseline Study

1. Monthly surveys of birds, people, dogs, fresh kelp plants, wrack & beach characteristics
   • Surveys of standard transects on 12 beaches
   • Sept 2014 – May 2015, n = 108

2. Intertidal biodiversity surveys
   • Summer 2014, 12 study beaches, 540 samples (5400 cores, 42 m², ~12 metric tonnes of sand sieved)

3. Surfperch abundance & diet, 9 beaches, 2 years

4. Night Smelt populations, 9 beaches, 2 years
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Beach Zones

- Coastal Strand
- Dry Sand
- Upper Intertidal
- Damp Sand
- Lower Intertidal
- Mid-Intertidal
- BERM
- Macrophyte Wrack
- Water Table Outcrop
- Saturated Sand
- Low Intertidal
- Surf Zone
Beach Characteristics: Zone Widths

Long Beaches

Pocket Beaches

**Pyramid Point
Kellogg Beach
Gold Bluffs
**Reading Rock
Mad River
**Samoa
Ten Mile
**Virgin Creek
Jug Handle
Caspar
**Russian Gulch
**Van Damme
Marine Wrack

- Macrophyte wrack (kelps, eelgrass, surfgrass)
  - 20 cm² to 1.3 m² per m
- Animal wrack (crab molts, by-the-wind sailors)
  - 180 cm² to 0.45 m² per m
Marine Wrack Subsidies

Macroalgal wrack, far more abundant on pocket beaches
Wrack Subsidies

- Kelps dominate on pocket beaches
- Seagrasses dominate on long beaches
Intertidal Invertebrates

- High Biodiversity > 70 species found
- High Abundance > up to 281,641 ind m$^{-1}$
- High Biomass > up to 15,334 g m$^{-1}$
Intertidal Invertebrate Richness & Abundance

- Species richness: no pattern with beach type
- Sand crabs & talitrid amphipods found on all beaches
- Composition differed with beach type
- Long beaches >> Pocket beaches = sand crabs
- Wrack invertebrates: higher abundance on pocket beaches
Intertidal Invertebrate Biomass

- Long beaches >>> Pocket beaches
- Sand Crabs
  - 78% Long Beaches
  - 2% Pocket Beaches
- Wrack Invertebrates
  - 0.5% Long Beaches
  - 58% Pocket Beaches
Intertidal Invertebrate Biomass

Macroinvertebrates

Biomass (g m⁻¹)

Long beaches

Pocket beaches

Endemic
Wrack-assoc.
Sand crabs
Non-endemic
Endemic
Wrack-assoc.
Sand crabs
Non-endemic

Reference
MPA
Birds

Monthly surveys for 9 months (September – May)

17,891 birds of 68 species
  8,714 shorebirds of 20 species
  4,984 gulls of 7 species
  3,559 seabirds of 19 species
Birds
Species Richness

- More shorebird species on long beaches
- More aquatic/wading birds on pocket beaches
Bird Abundance

- Shorebirds & seabirds prefer long beaches
- Terrestrial & aquatic/wading birds important on pocket beaches
Bird Abundance

Birds

Abundance (no. km$^{-1}$)

Long beaches  Pocket beaches

Shorebirds  Sea-birds  Gulls  Shorebirds  Sea-birds  Gulls

Abundance (no. km$^{-1}$)

Long beaches  Pocket beaches

Aquatic  Terr  Aquatic  Terr

Reference  MPA

[Graph showing bird abundance in different types of beaches and habitats]
Sandy Beach & Surf Zone
Key Relationships

- Macrophyte
- Wrack
- Amphipods
- Birds
- Phytoplankton
- Sand Crabs
- Surfperch

Resource/Habitat link
Consumer link

Forests
Estuaries & Wetlands
Rocky Intertidal
Kelp Forest

Coastal Ocean Processes
Beach Type
Wrack
Intertidal Invertebrates
Birds
-Composition
-Abundance
-Biomass
Beach Characteristics Influence Intertidal Biodiversity

![Graph showing the relationship between total macroinvertebrate species richness and active intertidal width. The equation of the line is y = 0.2277x + 2.6527, with R² = 0.72 and p = 0.007. The graph is labeled Long beaches and Beach Width.](image-url)
Wrack Subsidies & Invertebrates

**All Invertebrates**

- Richness
  - Long beaches
  - \( y = 0.4305x + 18.726 \)
  - \( R^2 = 0.63, p = 0.02 \)

- Abundance
  - Long beaches
  - \( y = 273.83x + 1219.6 \)
  - \( R^2 = 0.73, p = 0.007 \)

**Wrack Invertebrates**

- Richness
  - Long beaches
  - \( y = 4.0211x + 26.412 \)
  - \( R^2 = 0.77, p = 0.004 \)

- Abundance
  - Long beaches
Shorebirds Respond to Invertebrate Prey

**Long beaches**

\[ y = 0.9651x - 14.871 \]

\[ R^2 = 0.80, \ p < 0.01 \]

**Richness**

**All beaches**

\[ y = 0.0026x + 11.361 \]

\[ R^2 = 0.78, \ p < 0.001 \]
Surfperch CPUE & Prey Abundance

Graph showing the relationship between mean CPUE (no. redtail surfperch/angler hours) and sand crab abundance (no. m⁻¹ of swash zone). The equation of the line is y = 0.0001x + 0.0591, with R² = 0.5537 and p = 0.055.
Surfperch diet reflects intertidal prey availability
NCMPA Sandy Beach Highlights

- Diverse & Productive Ecosystems
- Striking Differences between Pocket & Long Beaches
- Strong support for Conceptual Framework
  - High Invertebrate Abundance & Biomass
  - High Bird Use
  - New Links with Surf Zone Fishes
- Robust Trophic Links:
  - Kelp Forests, Rocky shores, Estuaries & Surf Zones
- Implications for direct and indirect effects of MPAs
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Questions?