California Coastal Wetlands Monitoring Venture

Landscape Profiles

1. Fragmentation Analysis

2. Cross-scale exploration of stressor-state correlations
Part 1: Bayland Fragmentation

Sponsors
USEPA Section 104b
USFWS San Francisco Bay Program
San Francisco Foundation

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Purpose

Start regional fragmentation studies

- Illustrate the scale-dependency of fragmentation analysis
- Develop hypotheses of habitat fragmentation that can be genetically tested at the landscape scale
Fragmentation Definition

Reduction in size and increase in separation between areas of like habitat, often with changes in patch shape.
smaller size

more isolation

more edge

simplified food web (McArthur and Wilson 1967)

reduced genetic variability (Freckleton and Watkinson 2002)

more disease, competition, predation, invasion (Quinn and Hastings 1987, Ambuel and Temple 1983)

increased risk of extinction

Conceptual Model
Steps in Fragmentation Analyses

Species-specific, so need to select species and develop heir rule sets.
Focus on Patch Type 1
resident rails rule set

✓ Upland areas > 200 ft wide
✓ Open water areas > 200 ft wide at low tide
✓ Tidal channels > 200 ft wide from bank-top to bank-top.
✓ Man-made levees on 1:24k scale USGS maps
✓ Paved Roads of any size
Distribution of Patch Type 1

Historical Distribution of Tidal Marsh (pre Euro-American contact)
Distribution of Patch Type 1

Map of the historical Type 1 patches

313 patches total
Distribution of Patch Type 1

Map of the modern Type 1 patches

412 patches total
Distribution of Patch Size

Distribution of Type 1 Patch Size

- Historical Patches (313 total patches)
- Modern Patches (412 total patches)
Small patches were historically abundant.

Historical small patches are gone; most small patches are relics of large patches.

Maximum patch size has been cut in half.
Distance between Patches

Distribution of Distance to Nearest Type 1 Patch

- Historical Patches (313 total patches)
- Modern Patches (412 total patches)
The frequency of close patches has increased 50%.

The frequency of moderately close patches has increased 200%.

The frequency of far apart patches has increased 100%.
Patch Type 1 Isolation

Distribution of Type 1 Patch Isolation Index
(combined area / nearest neighbor distance)

- Historical Patches (313 total patches)
- Modern Patches (412 total patches)

Number of Patches

Isolation Index

- 0-.001
- .001-.01
- .01-.10
- .10-.50
- >.50
Patch Type 1 Isolation

The frequency of minor isolation has not changed.

The frequency of moderate isolation has increased 50-75%.

The frequency of major isolation has increased 25%.
Patch Size and Isolation

Isolation Index Related to Patch Size

- Isolation Index
- Patch Size (in acres)

Historical Patches
Modern Patches
Patch Size and Isolation

Isolation is not related to patch size.
Patch Shape

Distribution of Type 1 Patch Shape Complexity

- **Number of Patches**
  - Historical Patches (313 total patches)
  - Modern Patches (412 total patches)

- **Shape Complexity Index**
  - 0-1.49
  - 1.5-1.9
  - 2.0-2.9
  - 3.0-3.9
  - 4.0-4.9
  - 5.0-5.9
  - > 6.0

The bar chart illustrates the distribution of Type 1 patch shape complexity, comparing historical and modern patches. The y-axis represents the number of patches, and the x-axis shows the shape complexity index.
Patch Shape

Shape complexity (perimeter:area) has generally increased.

The frequency of moderate complexity has increased about 75%.

The frequency of very complex patches has increased 100-200%.
Patch Shape

Shape Complexity Related to Patch Size

- Historical Patch 1
- Modern Patch 1

- $R^2 = 0.30$
- $R^2 = 0.40$

Patch Size (in acres)

Shape Complexity Index
Patch Shape

Patch shape complexity increases with patch size.
Wide patches exist between uplands and open water.
Narrow patches exist between uplands and levees.
Observations about Fragmentation

- Small patches were historically abundant.
- Maximum patch size has decreased.
- Proportion of small patches has increased.
- Complexity of patch shape has increased.
- Shape complexity increases with patch size.
- Isolation has increased for all patches sizes.
For rails and turtles, historical habitat array featured 3 areas of very large adjacent patches and many small patches between.
In the modern habitat array, the 3 areas are smaller, further apart, have fewer large patches, and fewer patches between.
Part 2: Cross-scale Exploration of Stressor-State Correlations

EMAP Estuaries
Intensification Project
SF Bay Inter-tidal

Collaborators

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Cross-scale Stressor-State Correlations

30 randomly chosen 1-m² EMAP Core stations in vegetated tidal marsh
Cross-scale Stressor Analysis

Nested Systems

EMAP Core Plot

Marsh Drainage Area
Cross-scale Stressor Analysis

Core Station Data
- Sediment Metals
- Sediment Trace Organics
- Sediment Nutrients
- Total Carbon
- Benthos
- Vascular Vegetation
Cross-scale Stressor Analysis

Five transects to characterize the drainage system plant community of each EMAP Core Station
Cross-scale Stressor Analysis

Stressors at Scales of Watersheds and Marsh Buffers

- Landcover
- Human Demographics
- Patch Shape (perimeter:area)
Patch Isolation Relates to Whole Watershed Development

\[ R^2 = 0.58 \]
Inter-patch Distance Relates to Buffer Development

Distance to Nearest Polygon (m)

Percent Development from Patch Border

$R^2 = 0.35$

$P = .046$
Patch Shape Relates to Buffer Development

Max $R^2 = 0.29$
$P = .062$

100 m Buffer
Immediate Boundary Quality in Relation to Human Population Density

Quality of Patch Boundary Relates to Number of People in Watershed
Drainage System Plant Species Richness Relates to Patch Shape

\[ R^2 = 0.27 \]
\[ P = 0.05 \]
Drainage System Plant Community Integrity Relates to Patch Shape

Shape Complexity Related to Native Plant Species Coverage of Transects

![Graph showing the relationship between shape complexity and native plant species coverage.](image)

R² = 0.69
Overarching hypotheses
From initial stressor-state analysis for Vegetation

Watershed development has led to unnaturally complex tidal marsh shapes ...
with an overabundance of upland edge ...
that tends to be disturbed by adjacent land uses ...
resulting in local decreases in plant community integrity.
Thank You