Comprehensive Seabird Monitoring for the Characterization and Future Evaluation of Marine Protected Areas in California's North Coast Study Region

Presented by: Dan Barton, Humboldt State University

Acknowledgments

HUMBOLDT STATE UNIVERSITY

Point Blue Conservation Science

UNIVERSITY OF CALIFORNIA SANTA CRUZ

U.S. DEPARTMENT OF THE INTERIOR BUREAU OF LAND MANAGEMENT

CALIFORNIA STATE PARKS SINCE 1864

oceanSPACES

Co-PIs Rick Golightly (HSU), Dan Robinette, Jaime Jahnke (PBCS), Breck Tyler (UCSC)

Collaborators Eric Nelson, Ken Griggs, Gerry McChesney (USFWS), Harry Carter

Indispensable staff & students Phil Capitolo (UCSC), Steph Schneider (Moss Landing), Shannon Murphy (HSU), Betsy Elkinton (HSU), Derek Harvey (HSU), Eric Irvin (HSU), Julie Howar (PBCS), Crystal Shore (HSU)

Partners California State Parks, Bureau of Land Management, HSU-CNRS, CDFW, Tolowa Dee-ni'

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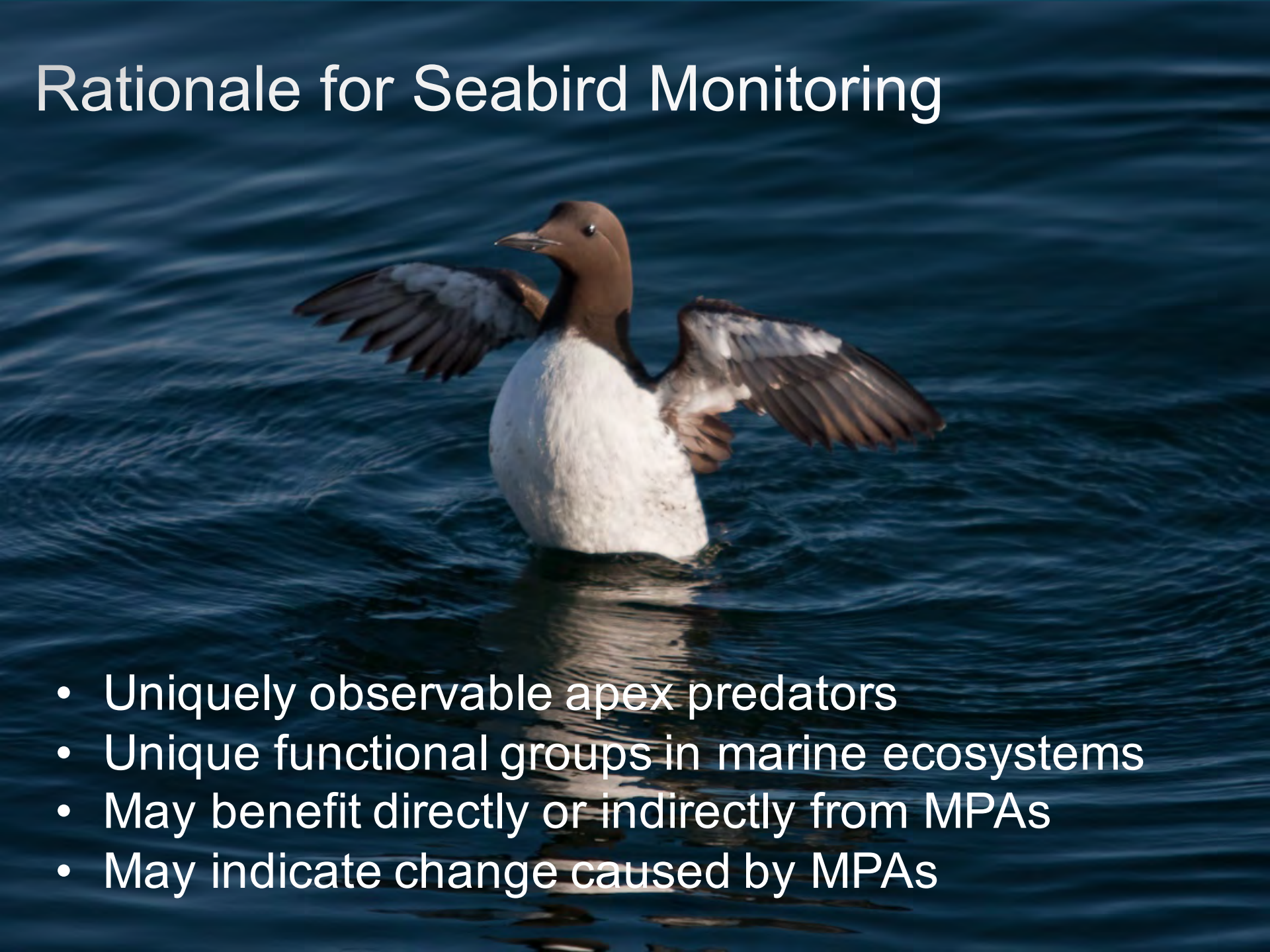
Rationale for Seabird Monitoring



- Uniquely observable apex predators
- Unique functional groups in marine ecosystems
- May benefit directly or indirectly from MPAs
- May indicate change caused by MPAs

North Coast Seabirds 101

- 4 seabird species account for the vast majority of the North Coast's nesting seabirds:
  - **Brandt's Cormorant**
  - **Western Gull**
  - **Common Murre**
  - Cassin's Auklet
- Other breeding species:
  - Fork-tailed Storm-Petrel
  - Leach's Storm-Petrel
  - **Pelagic Cormorant**
  - **Double-crested Cormorant**
  - **Pigeon Guillemot**
  - Rhinoceros Auklet
  - Tufted Puffin
  - Marbled Murrelet (odd one)
  - **Black Oystercatcher (odd one)**

Nesting substrates

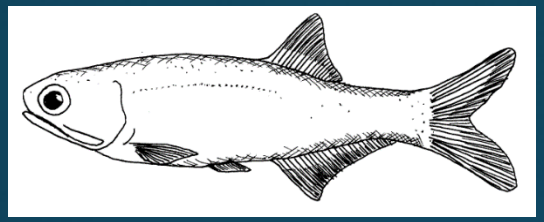
Cliff ledges:
Pelagic Cormorant

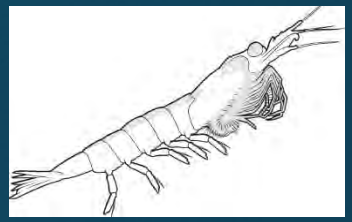
Ledges through flats:
Western Gull
Common Murre

Flat rocks/soil:
Double-crested Cormorant
Brandt's Cormorant

Subterranean:
Fork-tailed Storm-Petrel
Leach's Storm-Petrel
Rhinoceros Auklet
Cassin's Auklet
Pigeon Guillemot
Tufted Puffin

Diet and foraging locations





Offshore

Brandt's Cormorant
Tufted Puffin

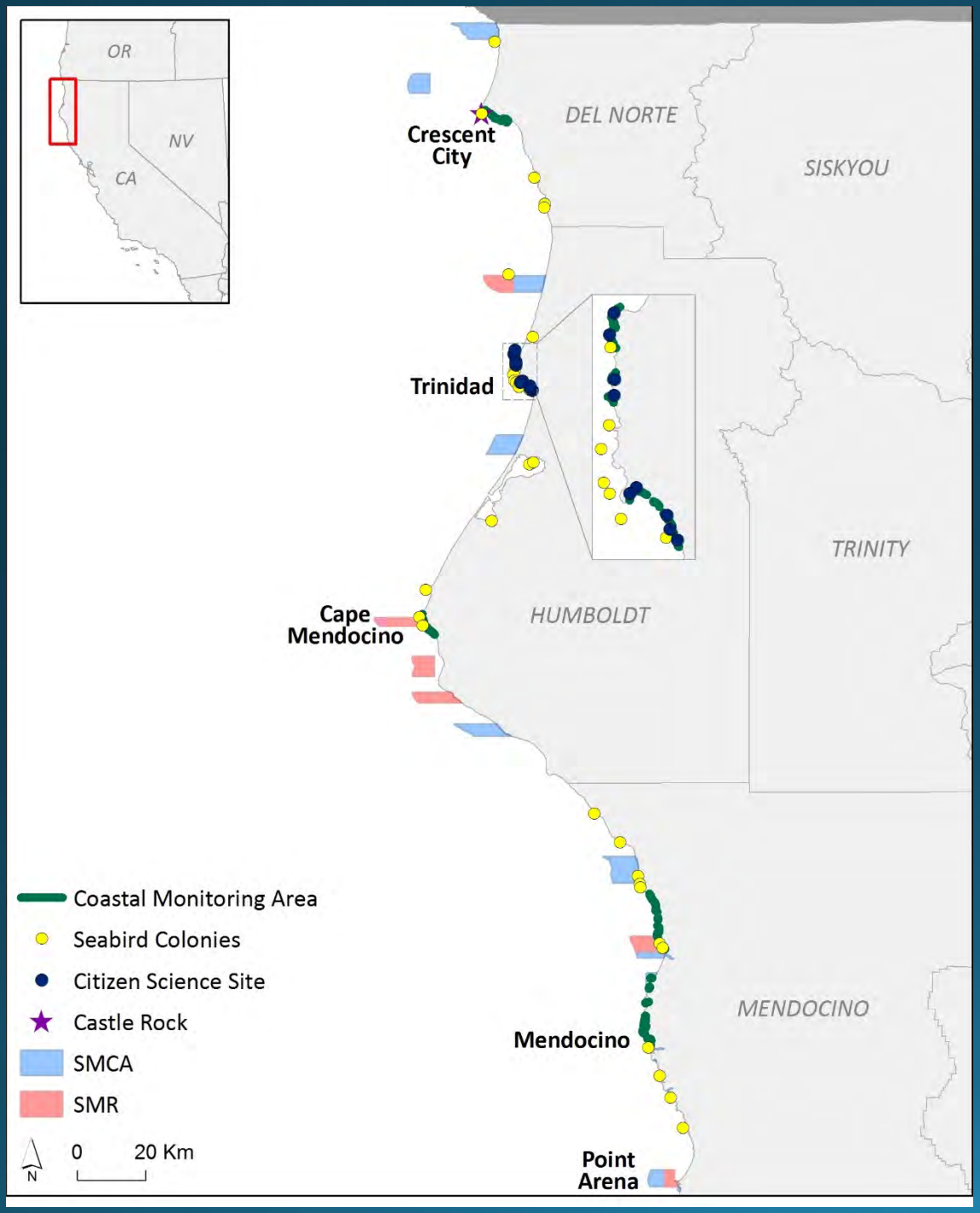
Cassin's Auklet
Fork-tailed Storm-Petrel
Leach's Storm-Petrel

Both/either

Common Murre
Pigeon Guillemot
Rhinoceros Auklet

Nearshore

Pelagic Cormorant
Double-crested Cormorant
Marbled Murrelet



Design, Sites, and Methods

Three complimentary methods:

1) Trends in seabird abundance via aerial colony counts: 1989-2014 (14 murre, 8 brandt's)

2) Shore-based monitoring: 2014-2015 (and citizen-science cross-validation)

3) Intensive productivity and diet monitoring at Castle Rock via remote camera: 2014 (stay for the next presentation)

Trends in Seabird Abundance: Methods

Region-wide baseline counts of all colonies conducted in 2014

Available raw photos from 1989-2014 counted for “index colonies” at Castle Rock and Cape Vizcaino/Rockport Rocks

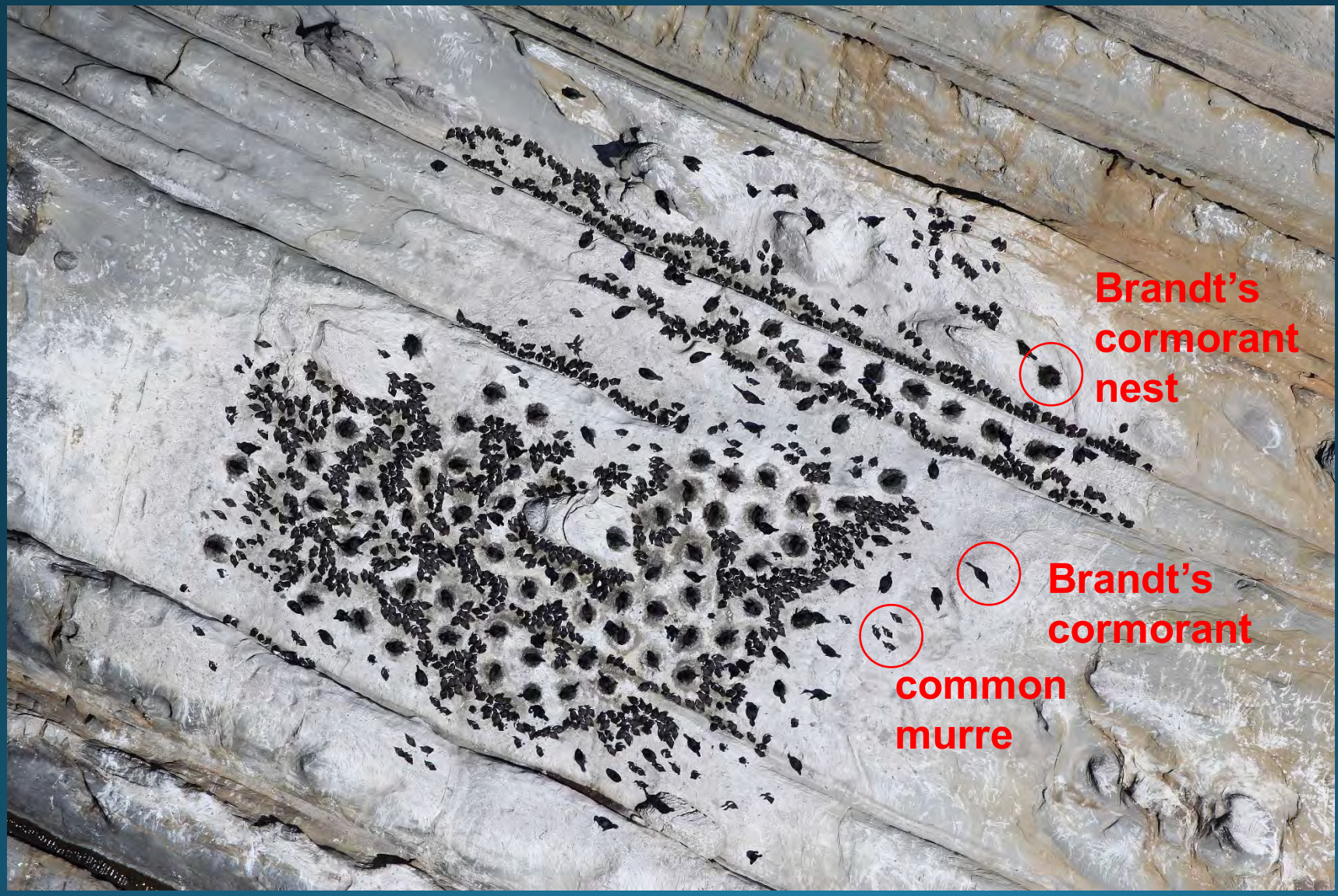
Additional data shared by collaborators

Aerial photographs (digital and, back in the day, slides) collected at elevations of 650-1000’ in a CDFW Partenavia P-68

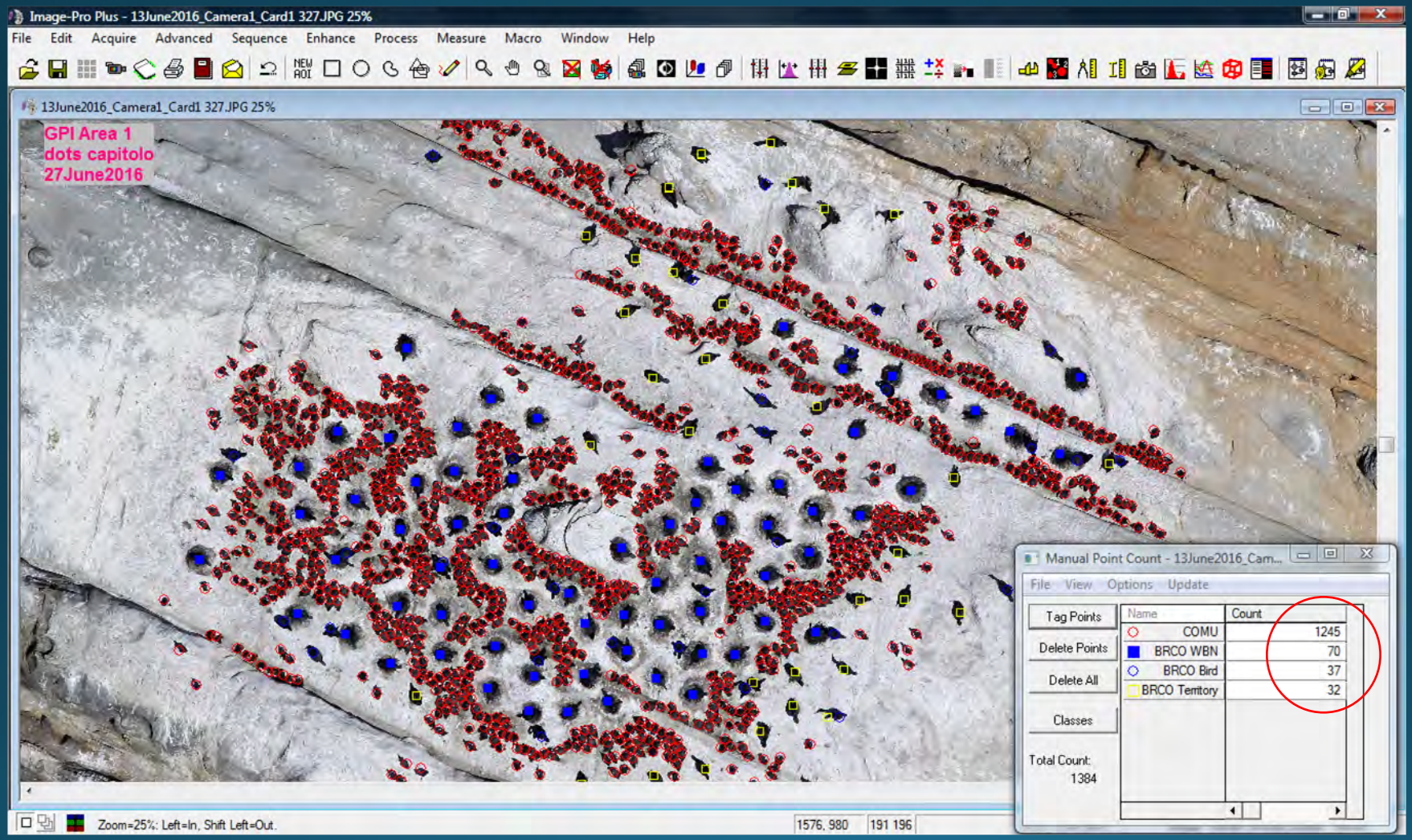
Observers: Phil Capitolo, Michael Parker, Allison Fuller

Complete counts of all birds in photos: Phil Capitolo, Steph Schneider, Crystal Shore

Audience participation: how many murres?



Audience participation: how many murres?



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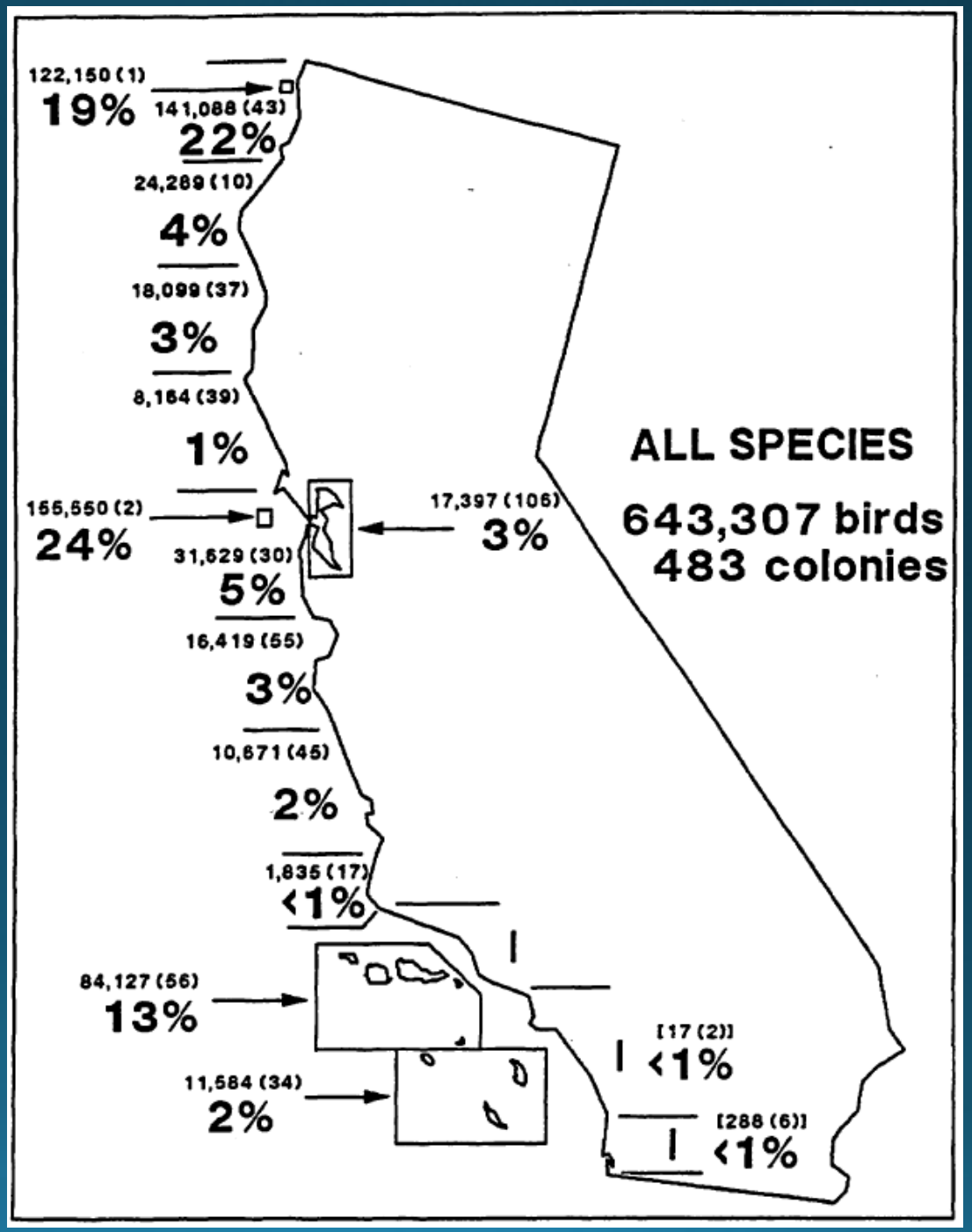
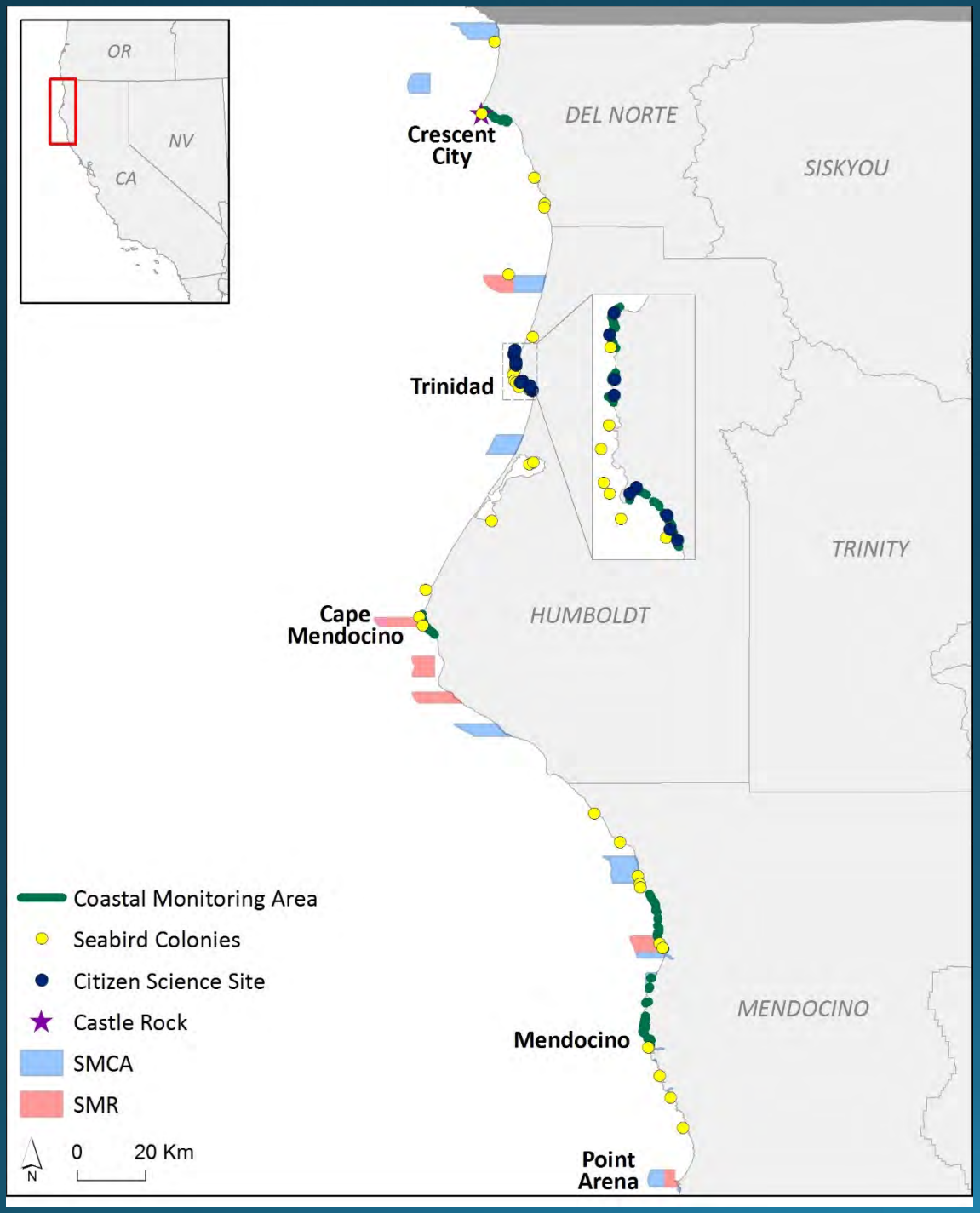
State-wide Baseline 1989

Along the North Coast:

1) A large portion of California's seabirds (Point Arena-Tolowa was 41% in the 1989-1991)
2) A large portion of that fraction is concentrated in two places:
   - Castle Rock
   - Trinidad-Patrick's Point





Region-wide Baseline 2014

Common Murre:
350,923 birds
19 colonies
41% at Castle Rock

Brandt's Cormorant:
6,689 birds and 4,583 nests
20 colonies (19 with nests)

Double-crested Cormorant:
2,589 birds and 1,825 nests
13 colonies

Brown Pelican:
1,060 roosting birds
14 sites

Trend Analysis

Common Murre:
173 obs. of attendance at 14 colonies during 1989-2014

Brandt's Cormorant:
123 obs. of attendance at 10 colonies during 1989-2014

'State-space' model of growth and observation:

First-order Markovian growth model $\log(N_{i.t+1}) = \log(N_{i,t}) + r_{i,t}$

Linear effect of SOI on annual growth $r_{i,t} = \beta_{0\,i,t} + \beta_1 soi_t$

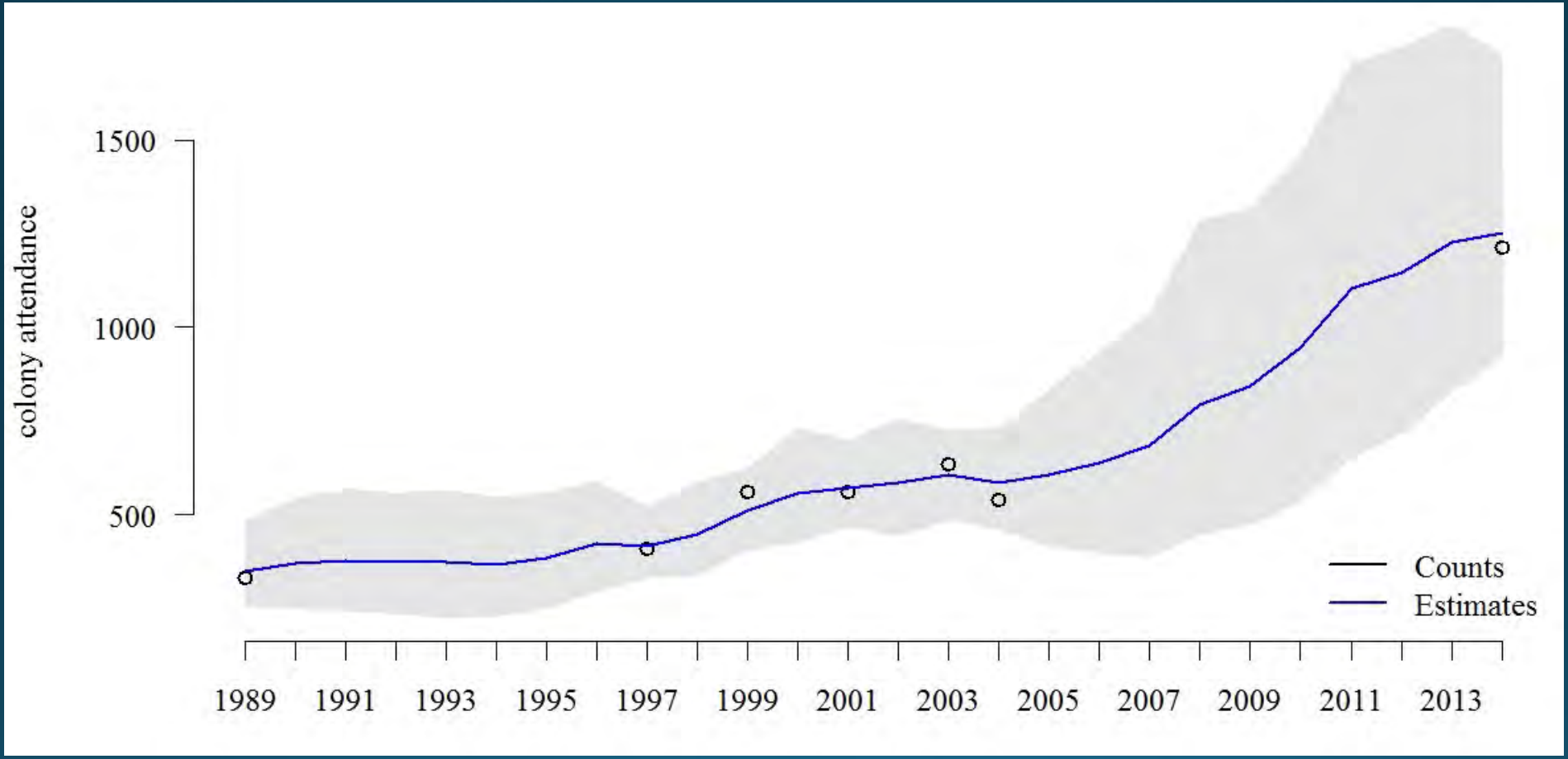
Variation among colonies normally distributed $\beta_{0\,i,t} \sim N(\overline{\beta_{0\,i}}, \sigma_i^p)$

Normally distributed observation error $y_{i,t} \sim N(\log(N_{i,t}), \sigma_i^o)$

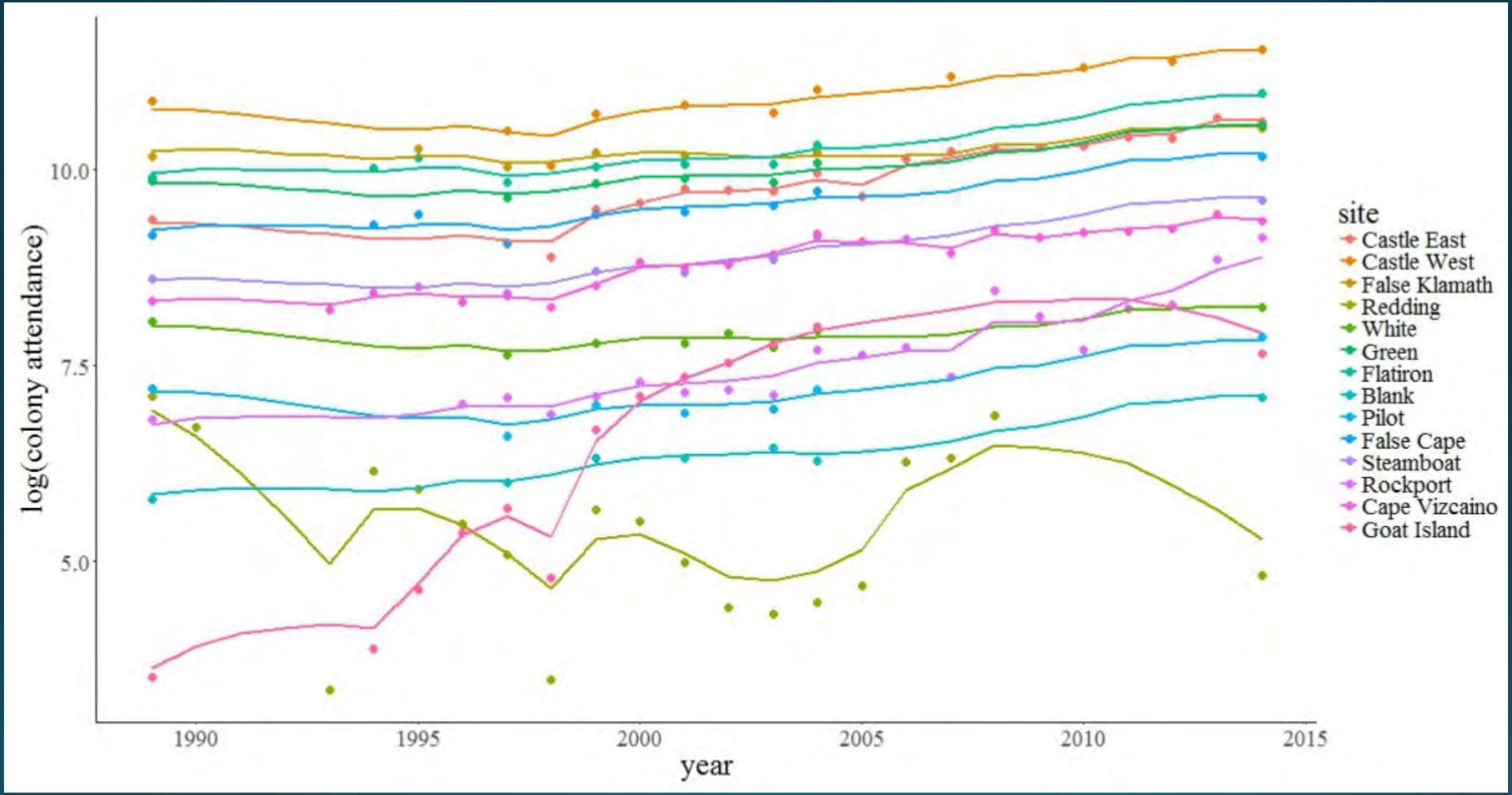
Common Murre Cape Vizcaino “Index”

Gray ribbon is the 95% credible interval of population size estimate

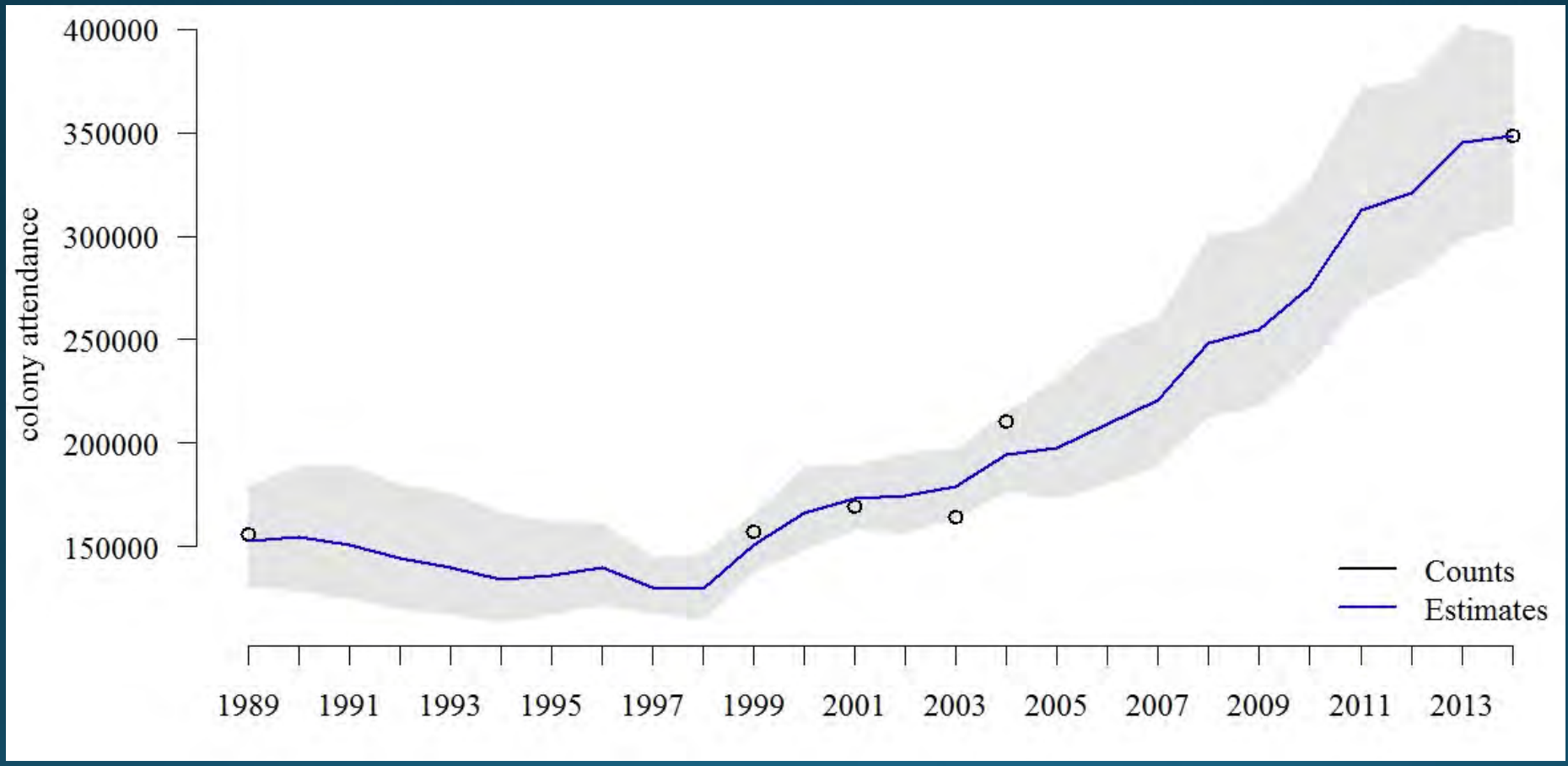
Common Murre – Blank Rock



Common Murre by colony



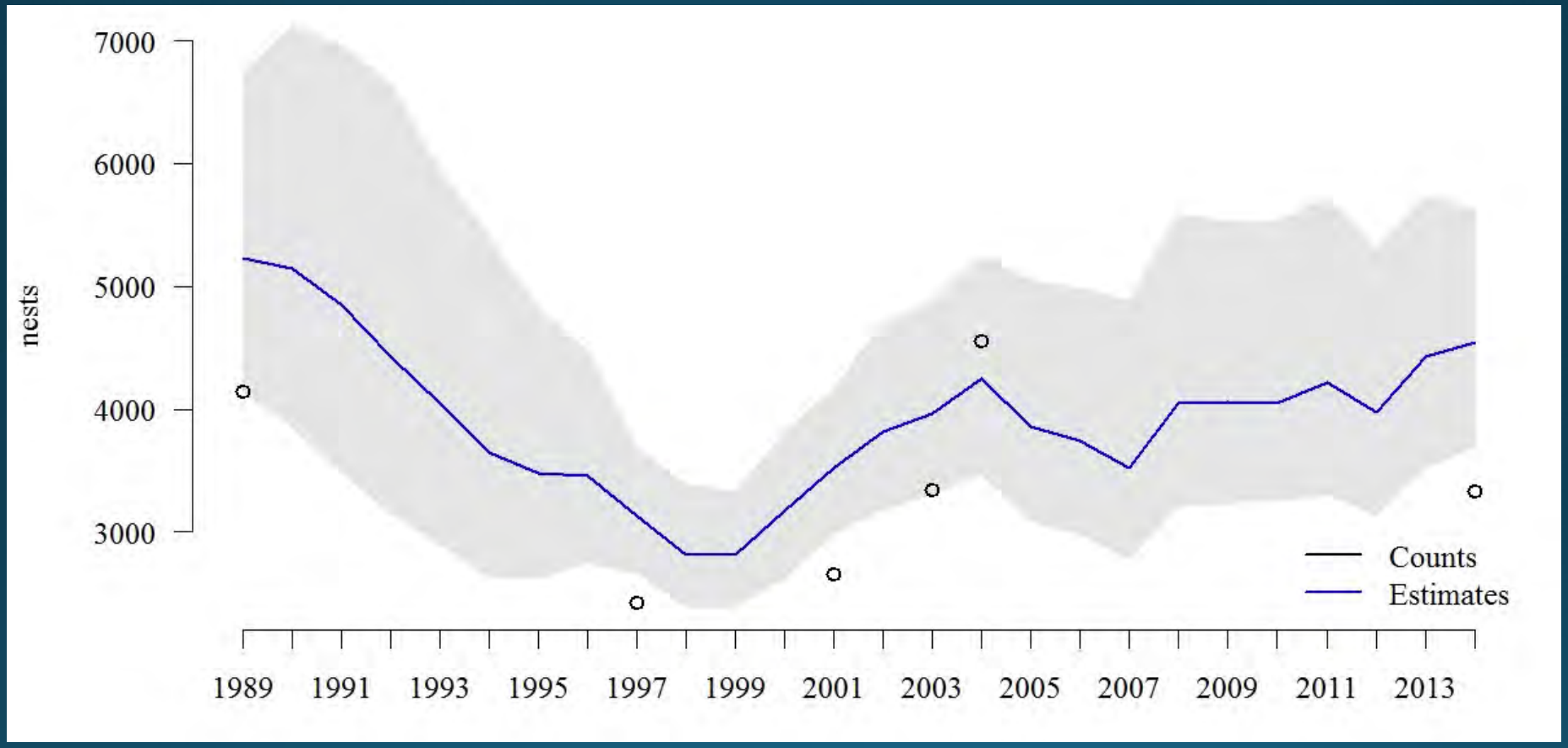
Common Murre Region-wide



Region-wide mean annual growth rate was 4.0% per year

Colony-specific mean annual growth rates varied from -6.9% to 16.9%

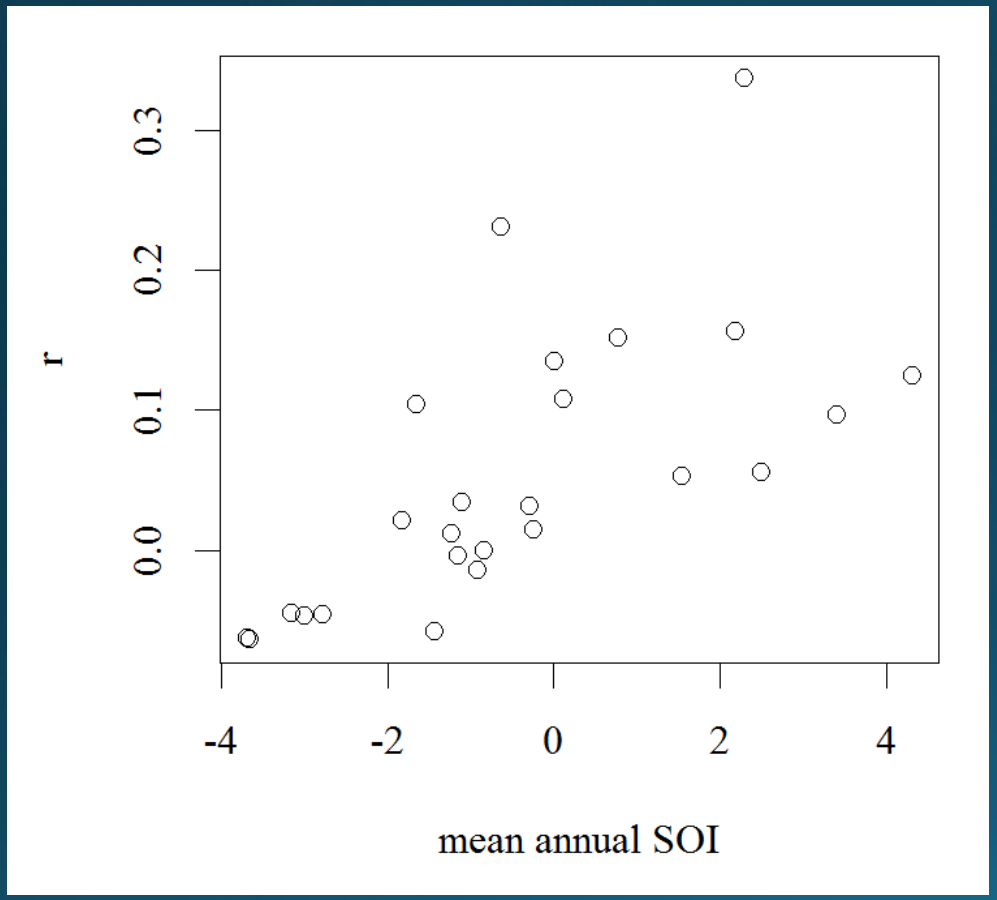
Brandt's Cormorant Region-wide

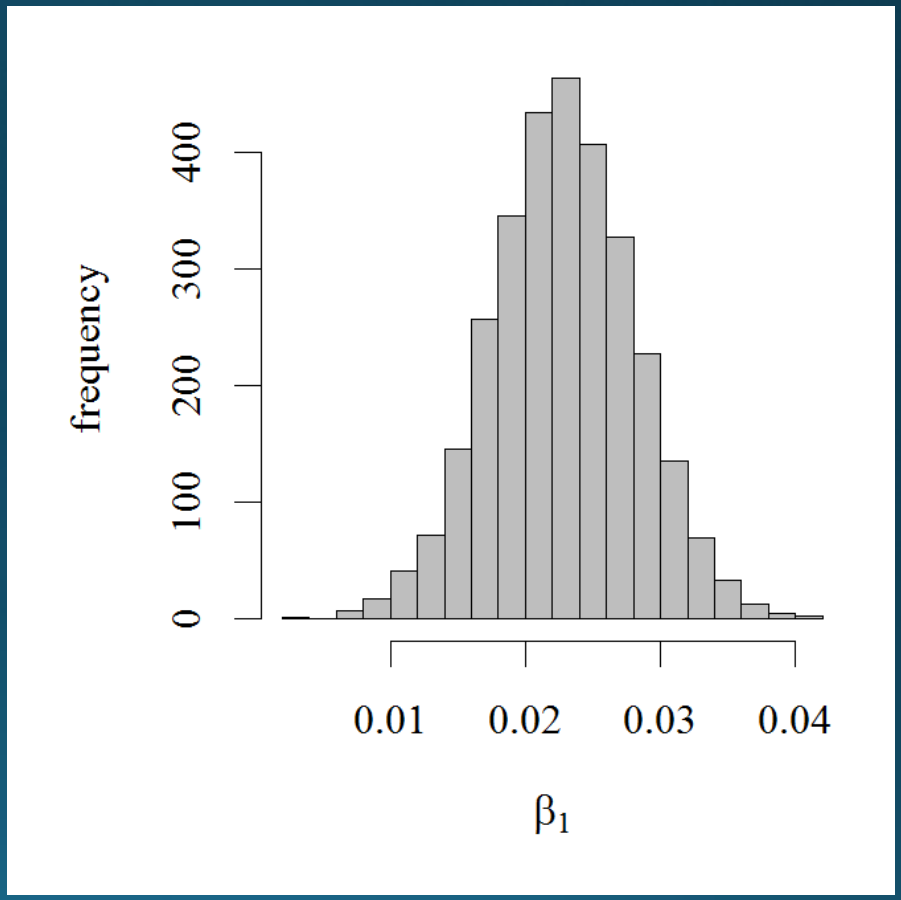


Region-wide mean annual growth rate was -0.9% per year

Colony-specific mean annual growth rates varied from -4.4% to 3.6%

El Niño and murres

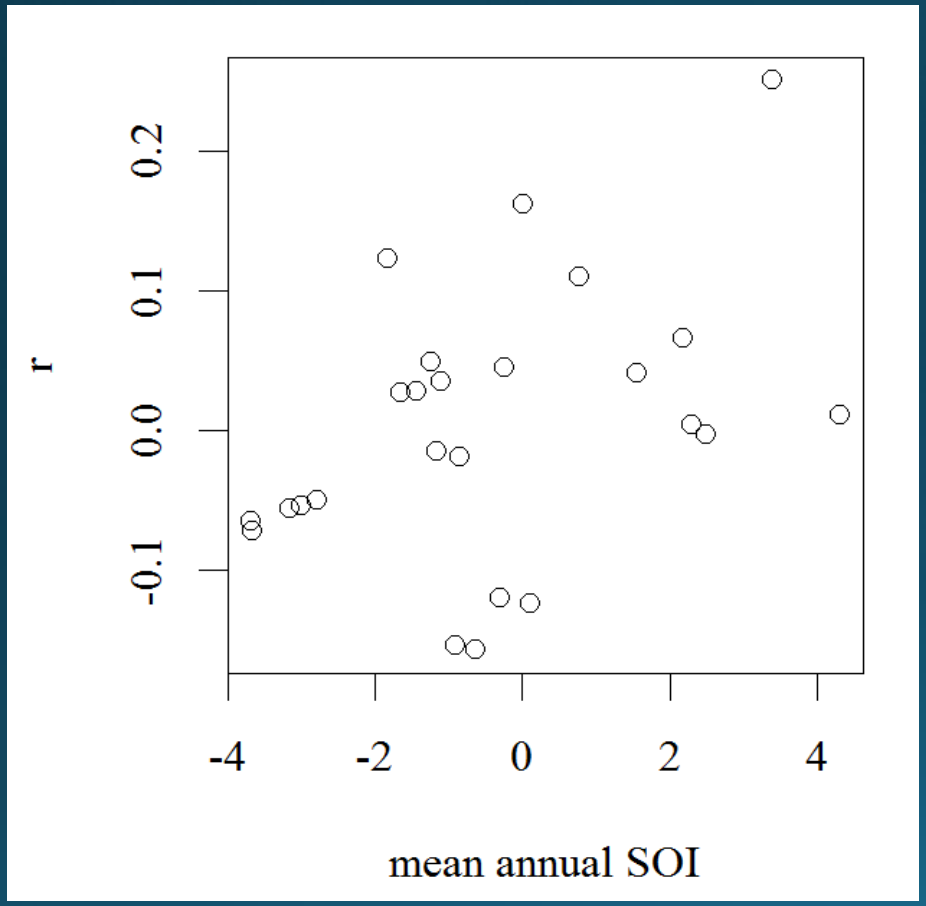


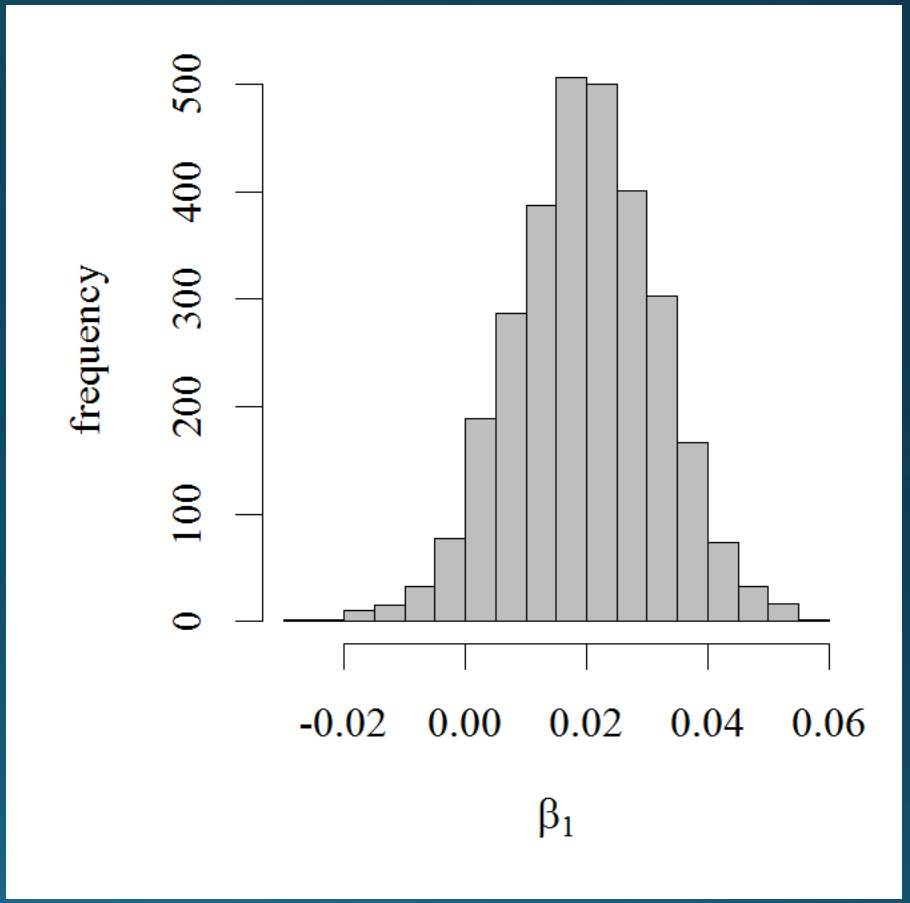


Estimated slope of effect of SOI on r = 0.0228

Posterior probability of positive effect of SOI ~ 1

El Niño and cormorants





Estimated slope of effect of SOI on r = 0.0198

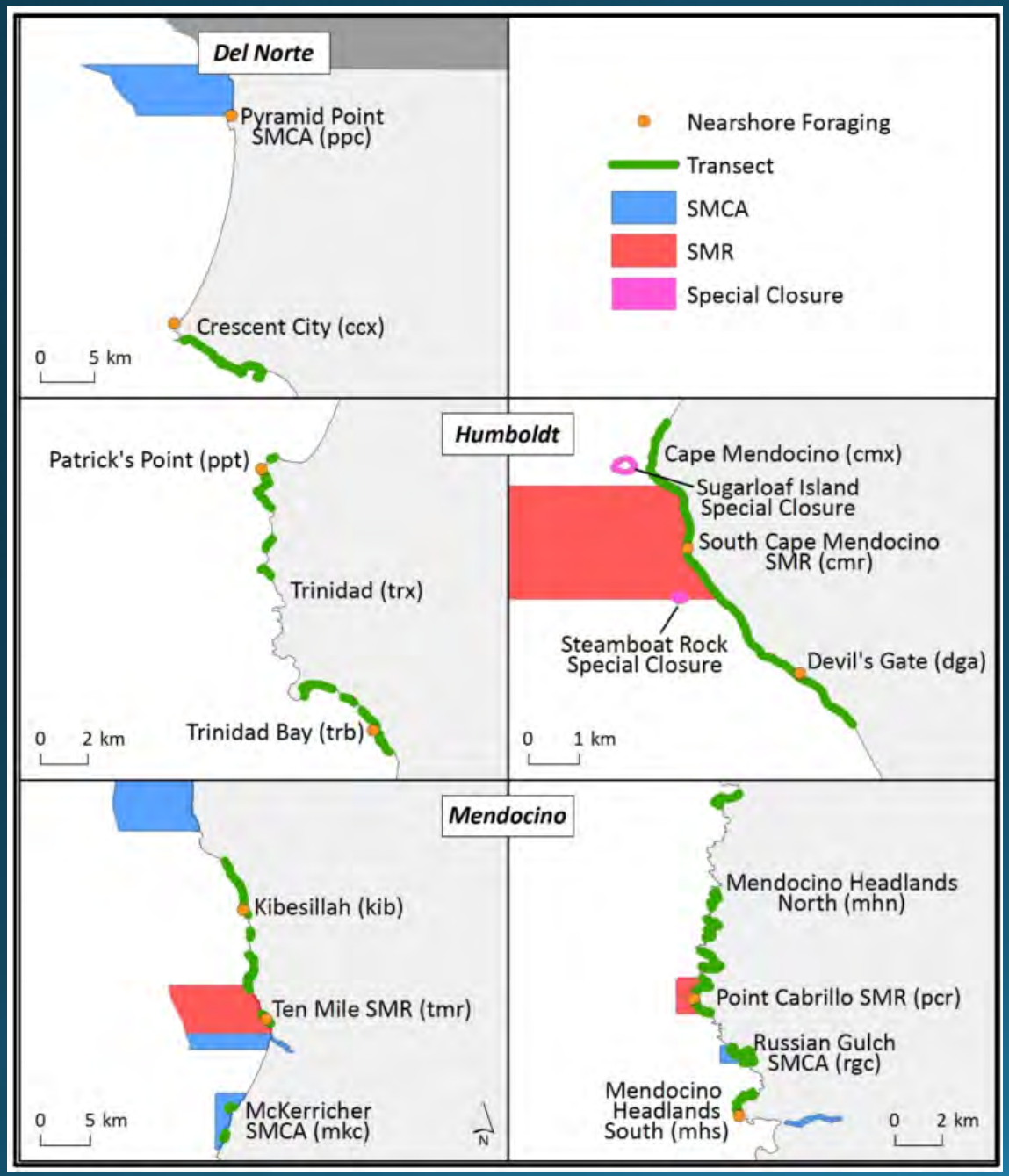
Posterior probability of positive effect of SOI = 0.954

Trend Monitoring Effectiveness

		observation variance				process variance			
site	$\bar{r}$	σ_i^o	lower CI	upper CI	CV	σ_i^p	lower CI	upper CI	CV
Castle East	**0.053**	0.123	0.014	0.234	0.015	0.141	0.026	0.273	2.66
Castle West	**0.031**	0.223	0.058	0.431	0.027	0.136	0.006	0.384	4.38
False Klamath	**0.012**	0.130	0.012	0.343	0.016	0.091	0.003	0.279	7.58
Redding	**-0.069**	0.690	0.159	0.984	0.084	0.664	0.141	0.985	9.62
White	**0.009**	0.125	0.022	0.310	0.015	0.082	0.002	0.290	9.11
Green	**0.029**	0.132	0.015	0.384	0.016	0.081	0.003	0.283	2.79
Flatiron	**0.04**	0.145	0.010	0.362	0.018	0.118	0.006	0.314	2.95
Blank	**0.051**	0.136	0.010	0.404	0.017	0.100	0.005	0.315	1.96
Pilot	**0.028**	0.221	0.011	0.673	0.027	0.192	0.012	0.577	6.85
False Cape	**0.039**	0.150	0.011	0.355	0.019	0.108	0.002	0.317	2.76
Steamboat	**0.042**	0.182	0.016	0.512	0.023	0.138	0.008	0.452	3.28
Rockport	**0.085**	0.254	0.045	0.408	0.031	0.163	0.012	0.425	1.91
Cape Vizcaino	**0.042**	0.081	0.008	0.158	0.010	0.116	0.044	0.203	2.76
Goat Island	**0.169**	0.348	0.024	0.824	0.041	0.605	0.289	0.941	3.57

Estimated coefficient of observation variance small

Estimated coefficient of process variance large



Near-shore Monitoring – Sites and Methods

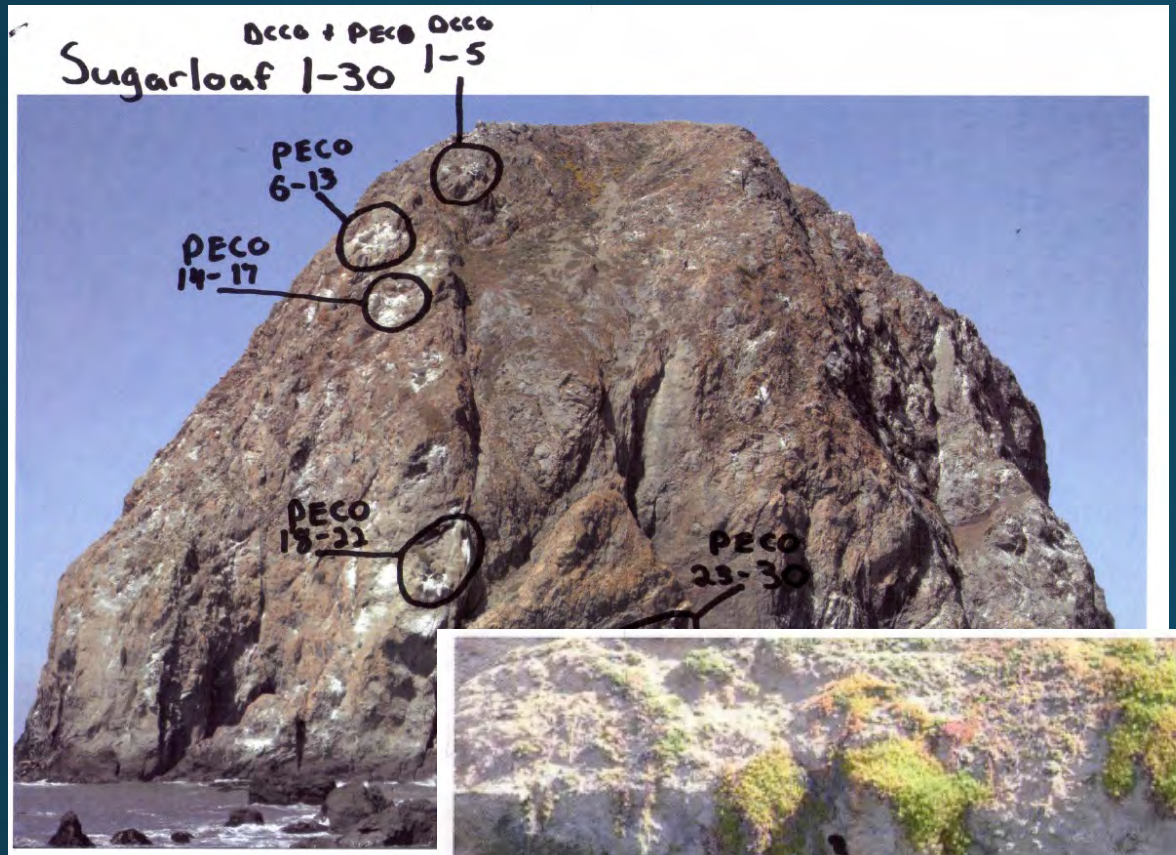
6 MPAs in Treatment-Control Design

Nest monitoring

Nearshore foraging

Rocky habitat use (+ citizen science x-valid.)

Disturbance monitoring



Cabrillo

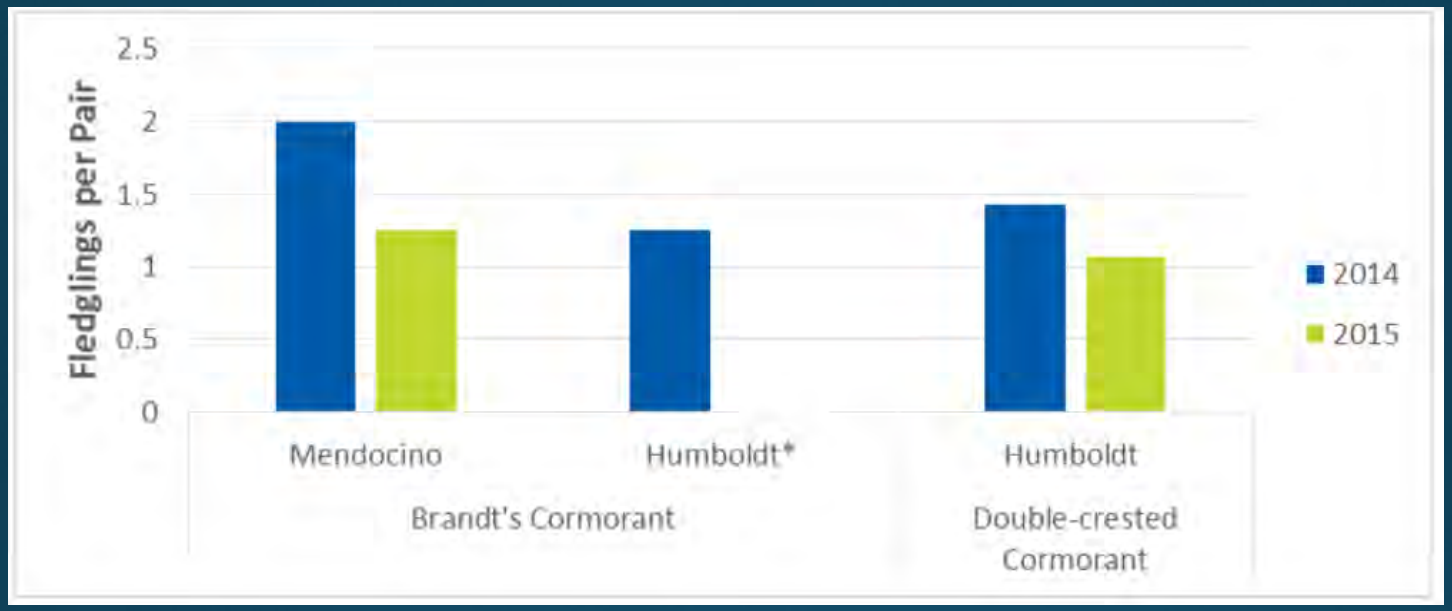
Point Cabrillo

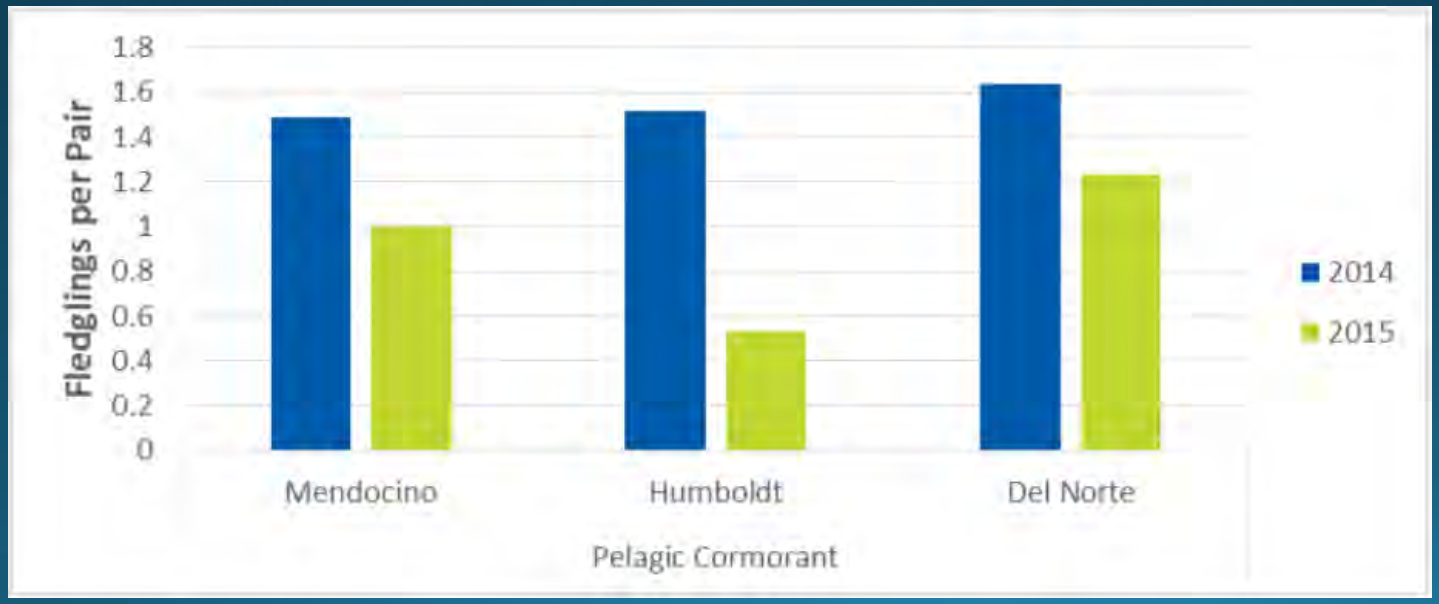
Near-shore monitoring: MPA use

Table 1. Marine bird species for which at least small breeding populations and/or moderate foraging habitat (foraging rates are close to average for the species) are being protected by each the six MPAs monitored during the 2014-2015 baseline period.

MPA	Breeding Population	Foraging Habitat
Pyramid Point SMCA		Double-crested Cormorant Pigeon Guillemot Marbled Murrelet
South Cape Mendocino SMR	Black Oystercatcher Pigeon Guillemot	Common Murre
Ten Mile SMR	Black Oystercatcher Pigeon Guillemot Western Gull	Pigeon Guillemot
McKerricher SMCA	Black Oystercatcher Pigeon Guillemot	
Point Cabrillo SMR	Black Oystercatcher Pigeon Guillemot Pelagic Cormorant	Pelagic Cormorant Common Murre
Russian Gulch SMCA	Pigeon Guillemot Pelagic Cormorant	

Near-shore monitoring: Nest success





Near-shore monitoring: Disturbance Rates

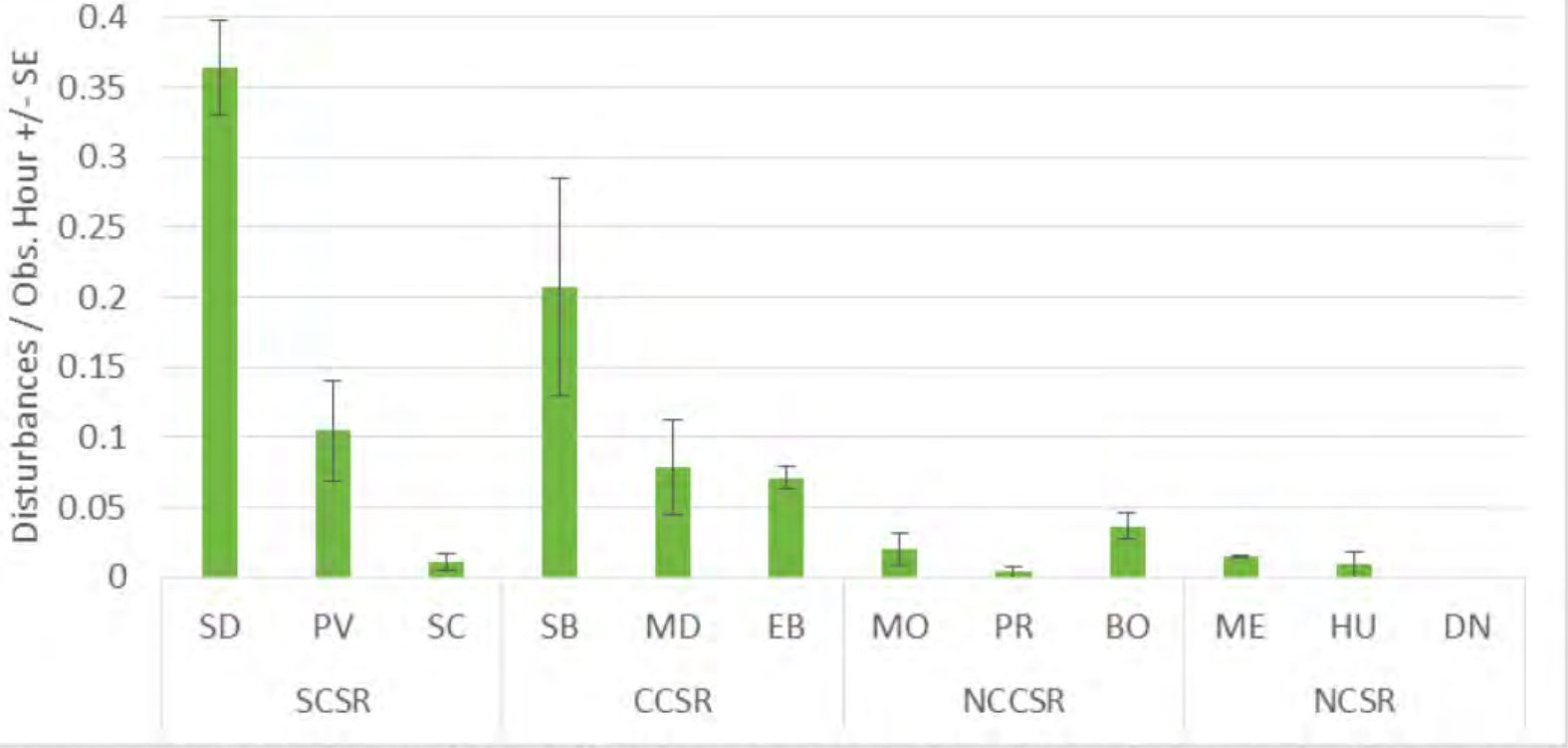
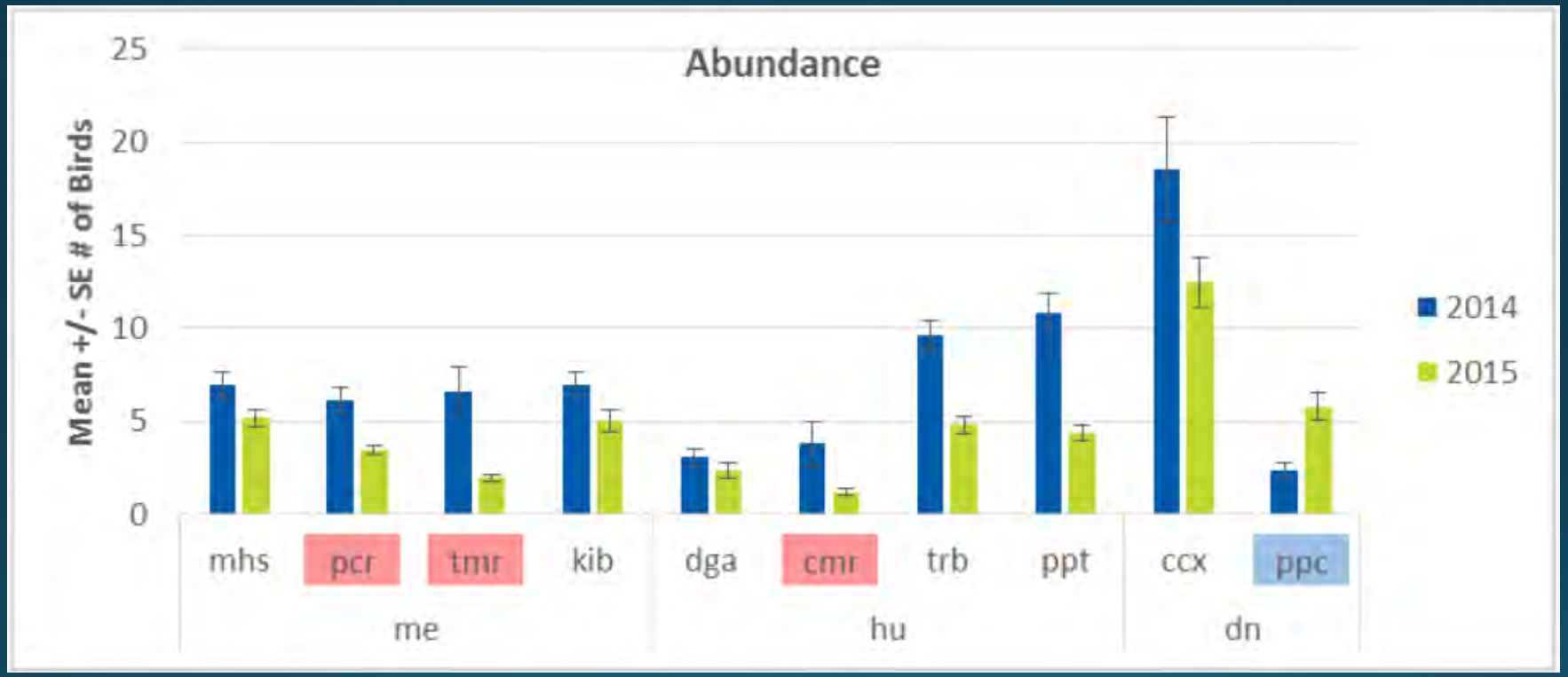
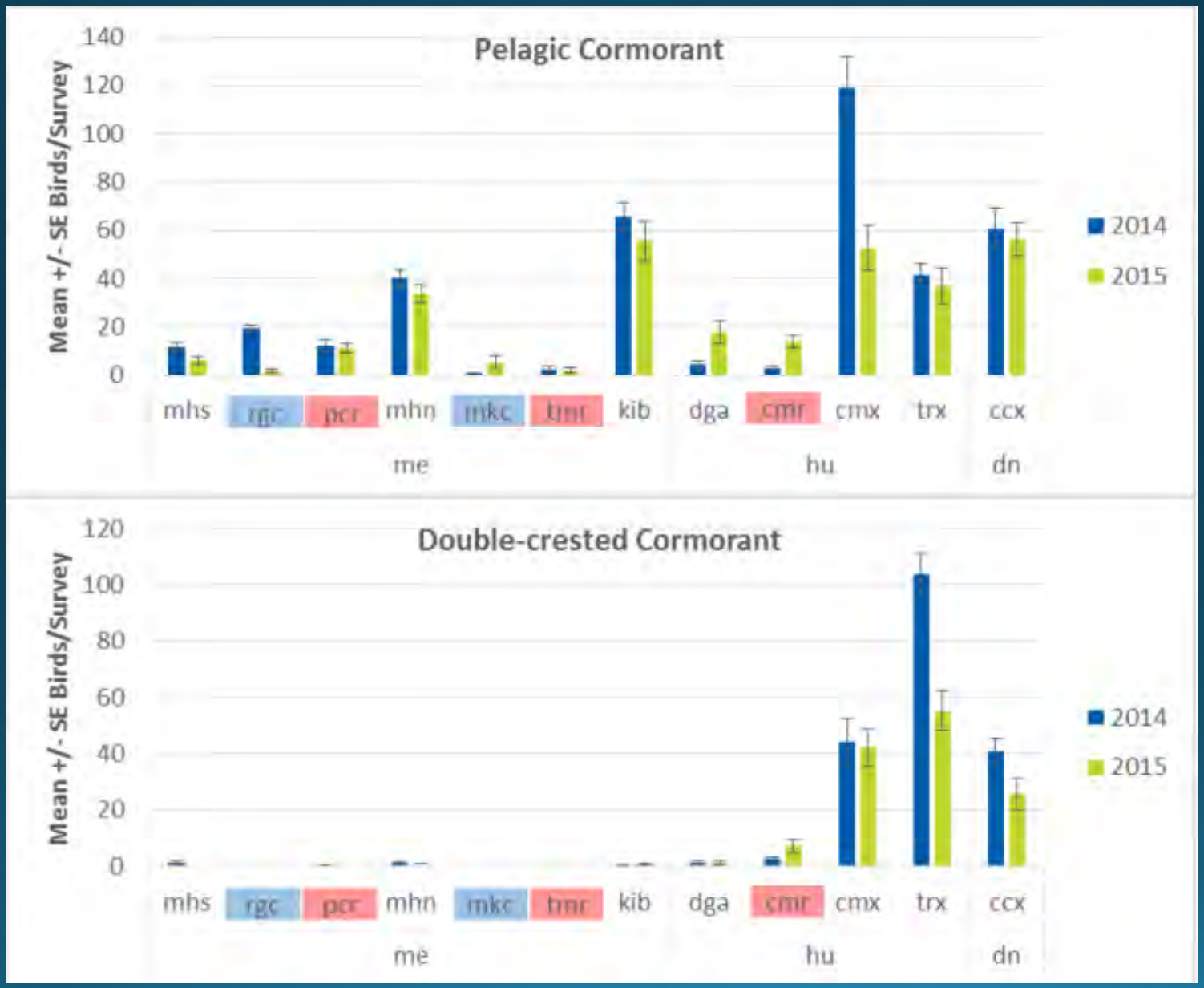


Figure 14. Mean +/- SE number of disturbances observed per hour of observation for areas within each of the four MLPA study regions. SCSR = South Coast Study Region, CCSR = Central Coast Study Region, NCCSR = North Central Coast Study Region, NCSR = North Coast Study Region, SD = San Diego, PV = Palos Verdes Peninsula, SB = Shell Beach, MD = Montaña de Oro, EB = Estero Bluffs, MO = Montara, PR = Point Reyes, BO = Bodega, ME = Mendocino, HU = Humboldt, and DN = Del Norte.

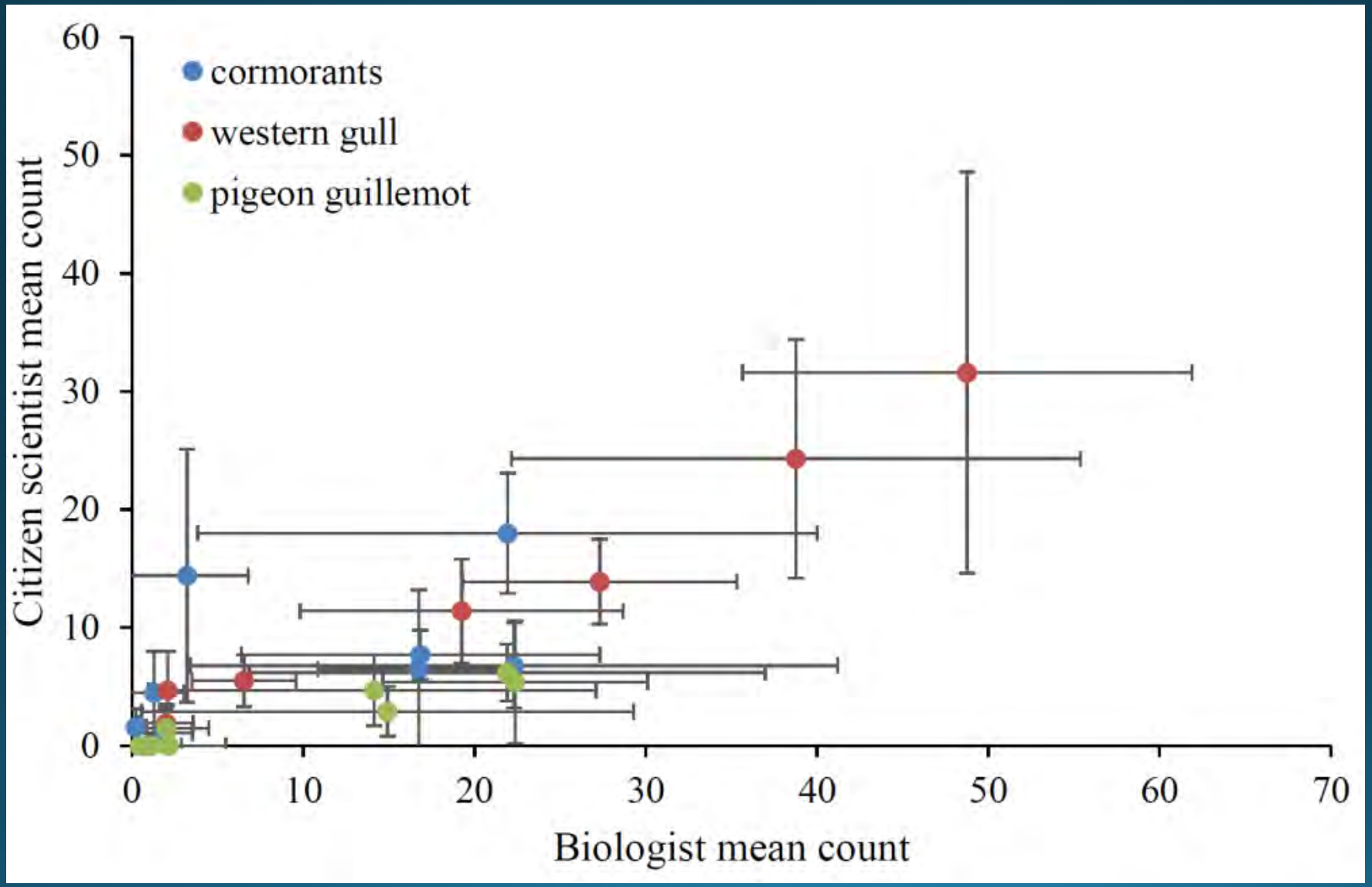
Near-shore monitoring: Foraging Observations

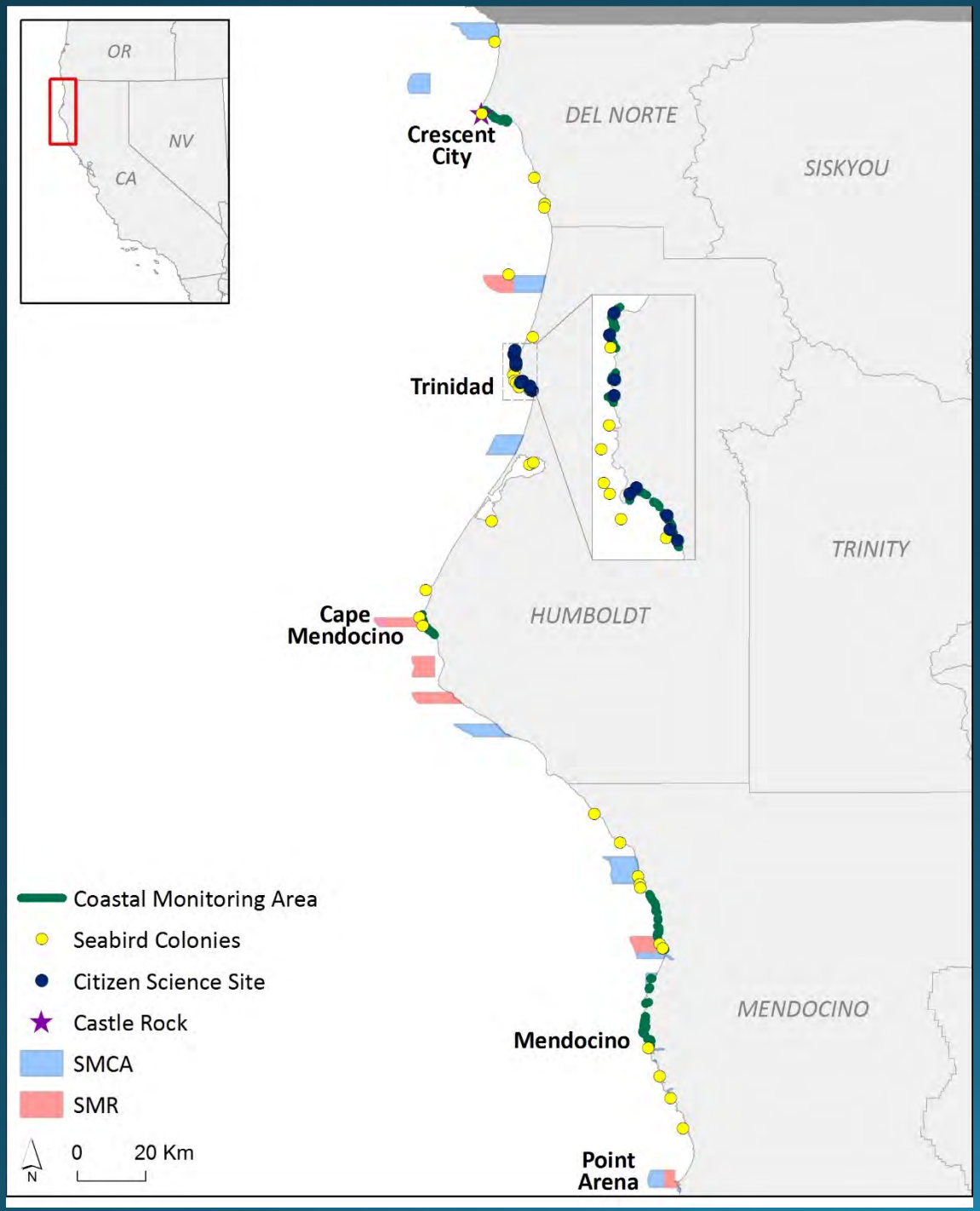


Near-shore monitoring: Roosting



Trinidad citizen science cross-validation





Future and integration

Uniquely observable apex predators – especially population growth, reproductive success, diet

Opportunity to continue to establish historic baseline from pre-existing data

Opportunity for strong treatment-control designs (shore-based) or BACI designs (aerial surveys)

Additional contextual data beyond SOI (help.)