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PRBO Conservation Science

Photos by Peter LaTourrette and PRBO

Modeling the Effects of Restoration on South San Francisco Bay Bird Communities

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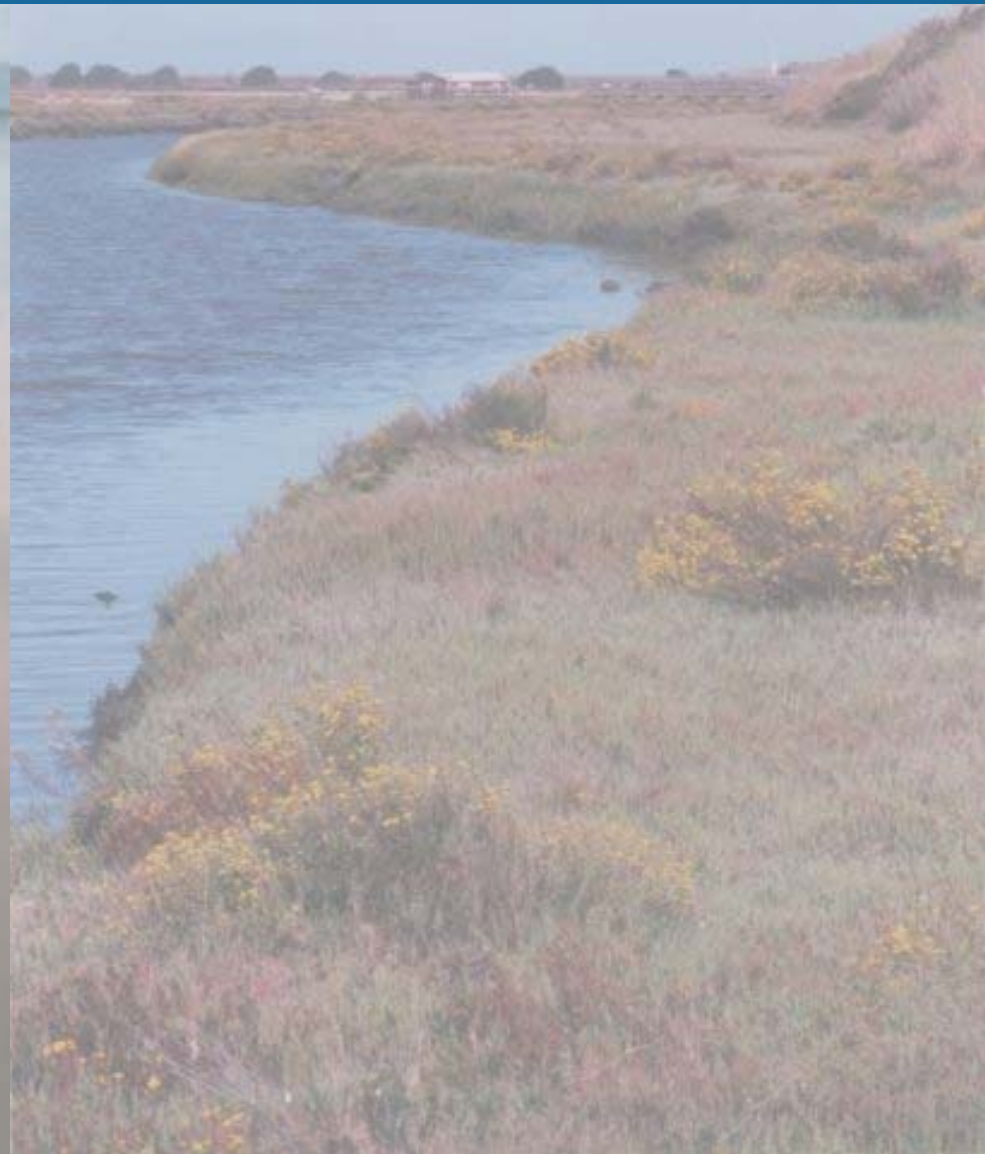
Salt Pond Restoration

- **Restoration and management decisions will involve trade-offs for birds.**
- **Habitat-based models can be useful to compare and evaluate future scenarios**



Phase II Habitat Conversion Model

- **Identification of focal species / seasons / behaviors**
- **Incorporation of salt pond water depth data**
- **Explicit consideration of marsh microhabitats (pond/pan, channel, vegetation)**
- **Incorporation of intertidal mudflats**
- **Use of robust statistical methods to incorporate model uncertainty**
- **Evaluation of realistic restored marsh alternatives (from PWA)**
- **Evaluation of optimally managed pond alternatives (from HT Harvey)**

Phase II Model Steps

1. **Determine focal species / seasons / behaviors**
2. **Develop habitat relationship models for each species / season / habitat**
3. **Predict bird abundance and density for specific restoration alternatives (from PWA / HT Harvey) using GIS-based tool**
    1. **“No action” (Alt. A)**
    2. **Intermediate (50%) restoration (Alt. B)**
    3. **Maximum (90%) restoration (Alt. C)**

Focal Species

Shorebirds (feeding)

- American Avocet
- Black-bellied Plover
- Black-necked Stilt
- Dunlin
- Greater Yellowlegs
- Willet
- Least Sandpiper
- Semipalmated Plover
- Western Sandpiper
- Snowy Plover
- Red-necked Phalarope

Waterfowl (feeding)

- Gadwall
- Mallard
- Northern Pintail
- Northern Shoveler
- Ruddy Duck
- Scaup

Other Waterbirds (feeding)

- American White Pelican
- Eared Grebe
- Forster's Tern

Landbirds / Rails (breeding)

- Common Yellowthroat
- Song Sparrow
- Marsh Wren
- Clapper Rail

Data Sources

Salt Ponds

- **1999-2001 fall/winter/spring area surveys (PRBO)**
- **2002-2004 fall/winter/spring area surveys (USGS)**

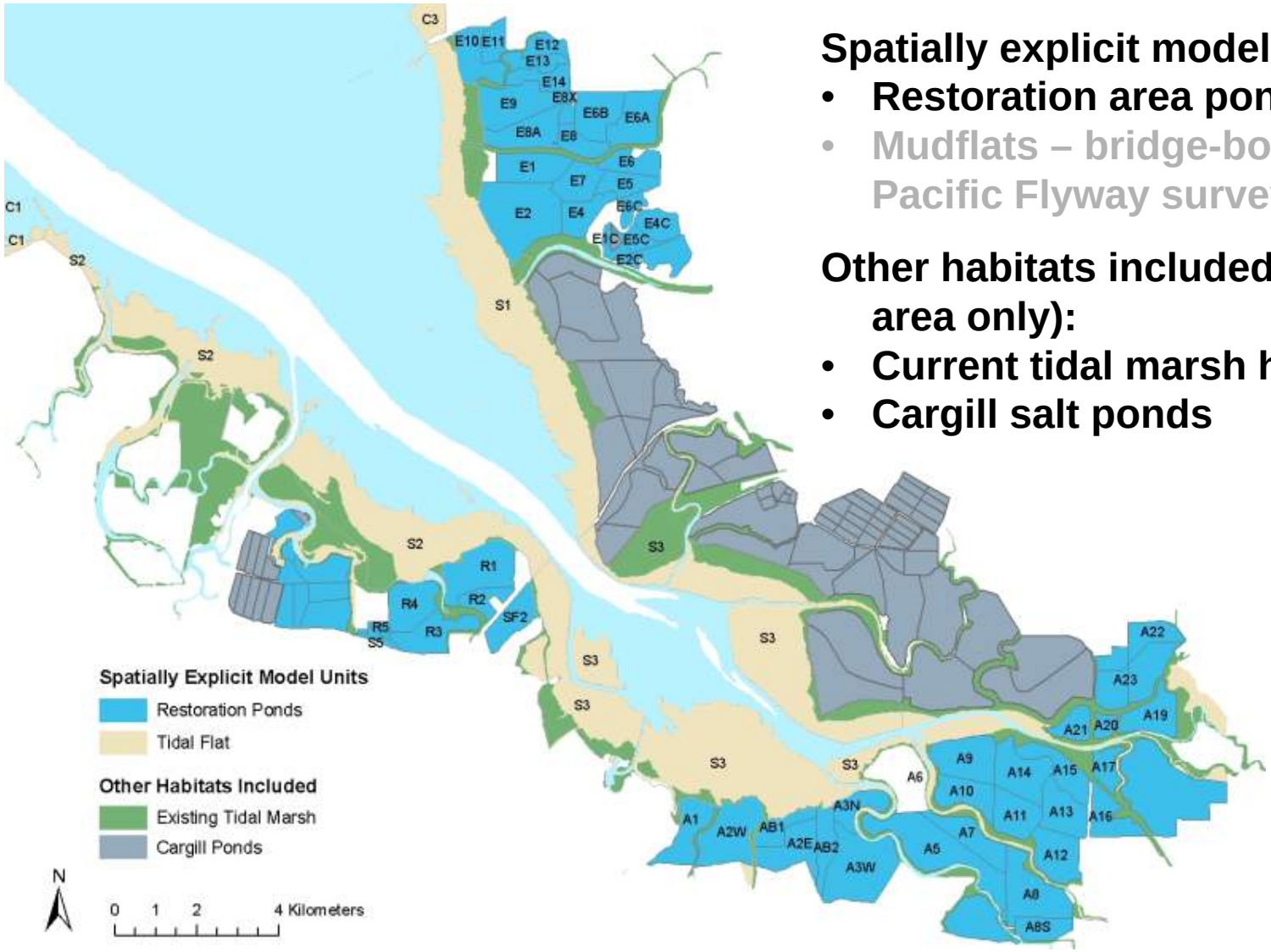
Tidal Marsh

- **1996-2003 breeding season point count surveys (PRBO)**
- **1999-2001 fall/winter/spring area surveys (PRBO)**

Mudflats

- **1988-1993 Pacific Flyway fall/spring mudflat surveys (PRBO)**

Habitats Modeled



Spatially explicit model units:

- **Restoration area ponds**
- **Mudflats – bridge-bounded Pacific Flyway survey units**

Other habitats included (total area only):

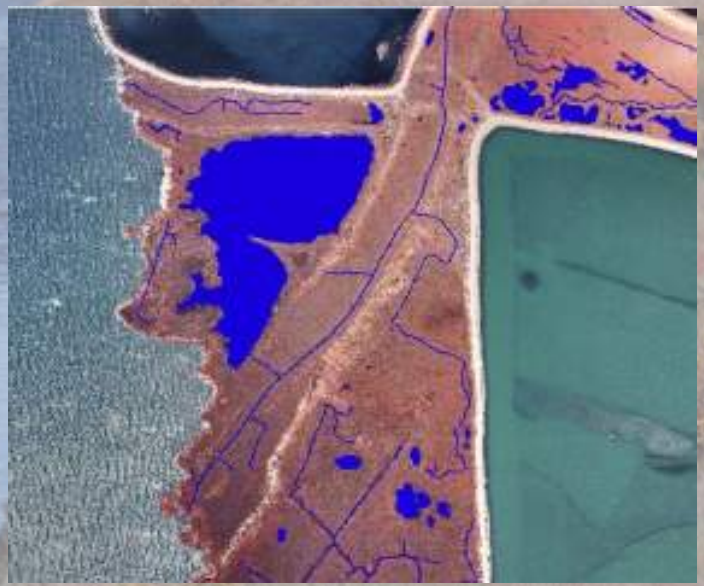
- **Current tidal marsh habitat**
- **Cargill salt ponds**

Salt Pond Site Variables

- **Pond area (ha)**
- **Measured salinity (ppt)**
- **Mean pond depth (m) ***
- **Shallow (<15 cm) pond proportion ***
- **Deep (>1 m) pond proportion ***

*** From USGS bathymetry data**

Tidal Marsh Site Variables *



From tidal marsh data:

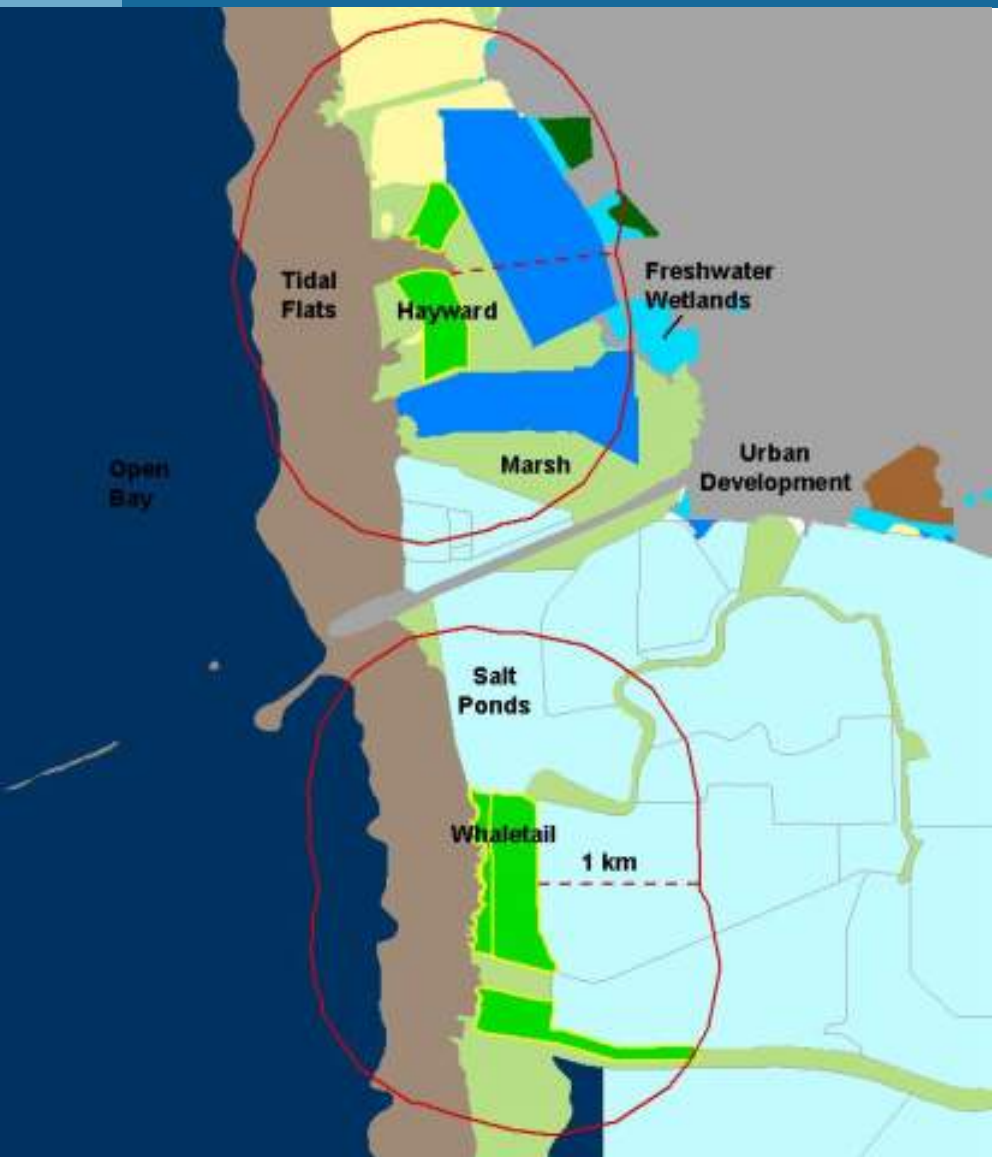
- **Vegetated area**
- **Pond/panne area**
- **Channel area**
- **Linear channel density**
  - **Overall**
  - **Small channels**

From low salinity pond data:

- **Intertidal mudflat area**
- **Subtidal area**

*** From PRBO aerial imagery**

Landscape Variables *



Proportion within 1 km:

- **Tidal marsh**
- **Non-tidal marsh**
- **Salt ponds**
- **Mudflats**
- **Open water**

*** From EcoAtlas & USGS GIS data**

Model Selection

For each species-season-habitat :

- **Identify all possible linear models containing *a priori* habitat variables**
- **Average model predictions based on AIC weights**

Species	Season	Habitat	AIC Weight	Cum. Weight	Landscape Variables 1……n			Pond Variables 1……n			Marsh Variables 1……n		
AMAV	W	SP	0.10	0.10	0.5	0	2.3	3.2	0.3	0	0	0	0
AMAV	W	SP	0.05	0.15	0.3	0	2.8	3.0	0	0	0	0	0
AMAV	W	SP	0.03	0.18	0	-0.1	2.0	3.8	0.1	-0.2	0	0	0
:	:	:	:	:	:	:	:	:	:	:	:	:	:
AMAV	W	SP	0.001	0.90	3.0	-0.2	0	0	0	-0.4	0	0	0
AMAV	W	TM	0.08	0.08	0.7	0	0	0	0	0	-0.3	0.8	0
AMAV	W	TM	0.04	0.12	0.8	-0.2	0	0	0	0	-0.2	0.7	0
AMAV	W	TM	0.03	0.15	0.8	-0.1	0	0	0	0	-0.4	0	0
:	:	:	:	:	:	:	:	:	:	:	:	:	:
AMAV	W	TM	0.001	0.90	1.2	0	0	0	0	0	0	0	0
:													
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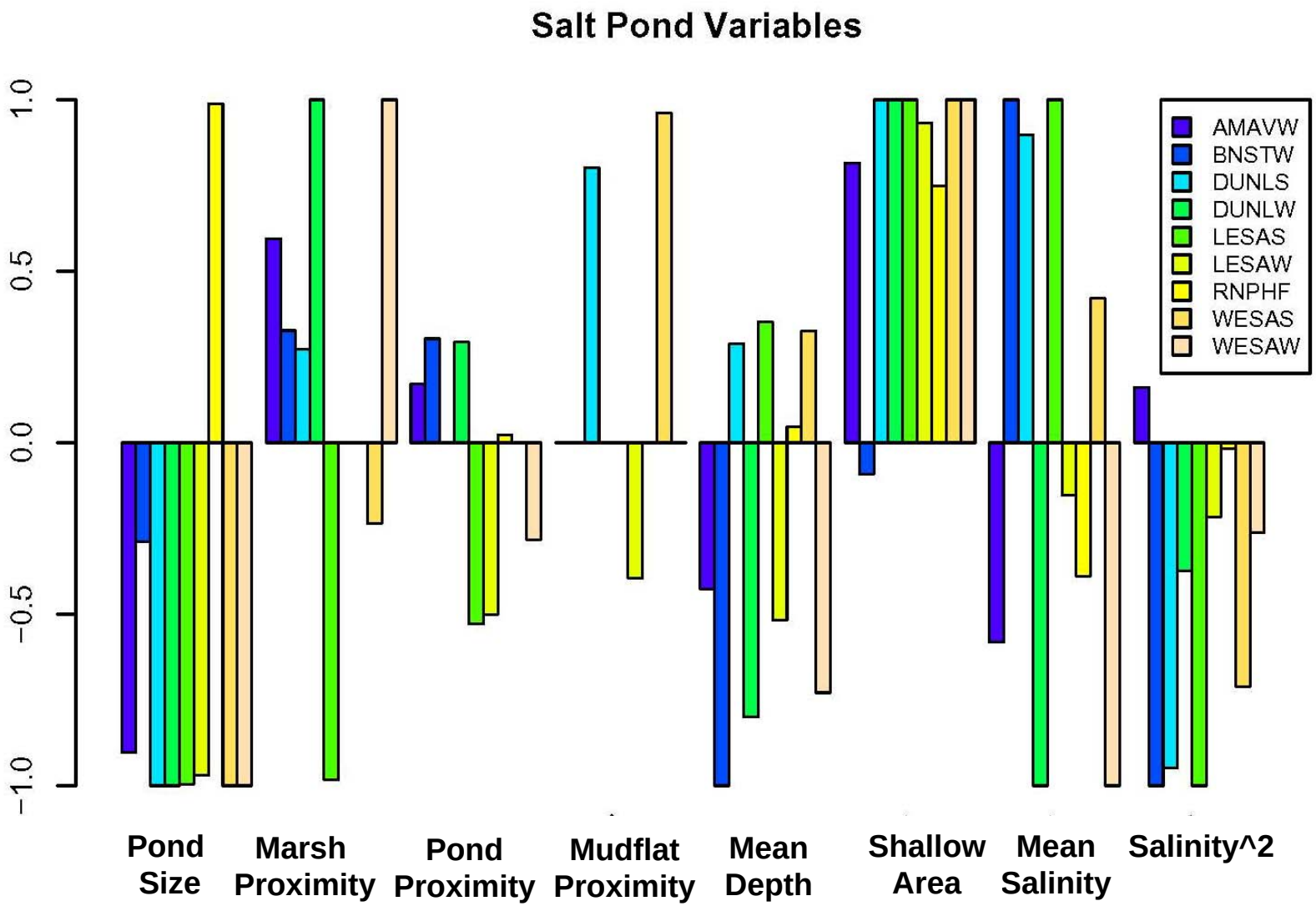
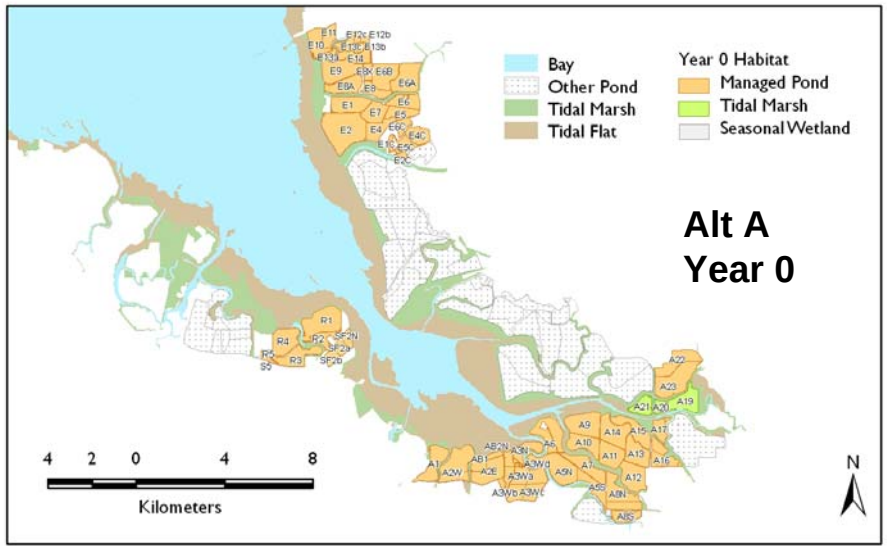
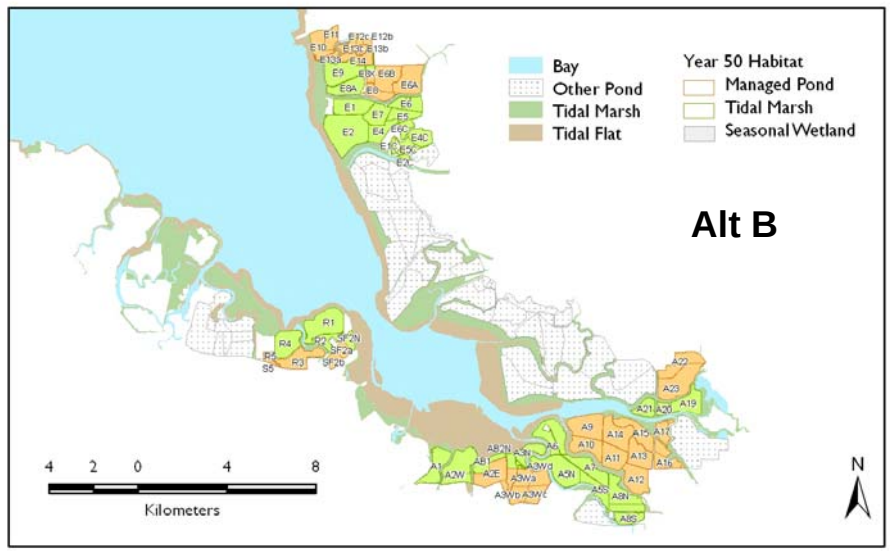
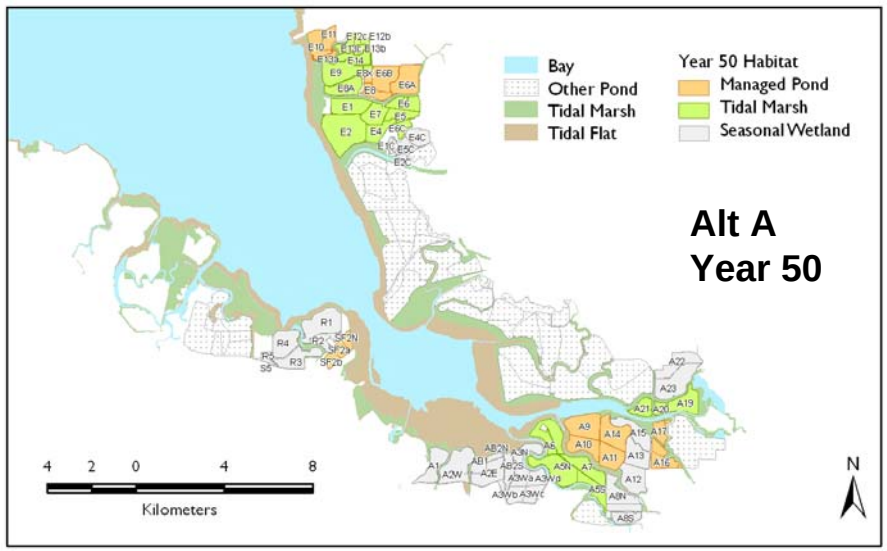
Salt Pond Shorebirds – Variable Importance

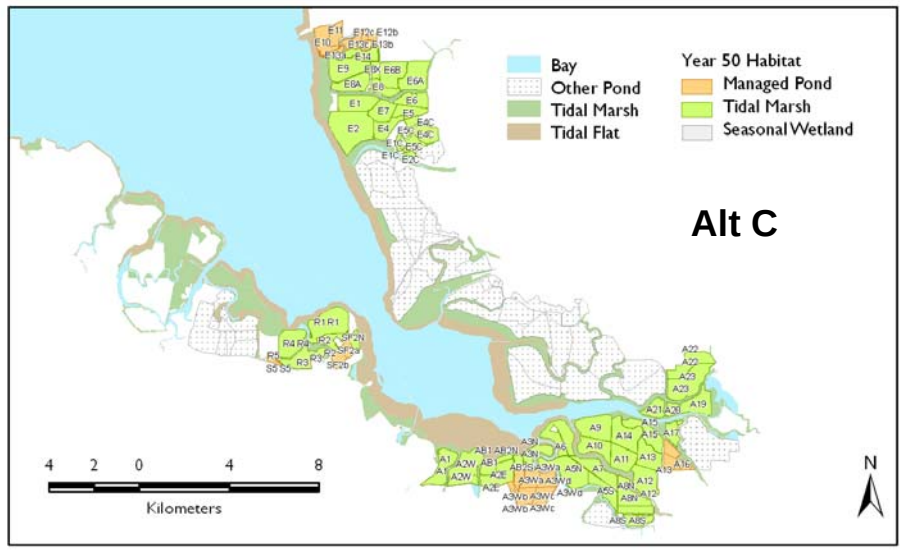


Alternatives Evaluated







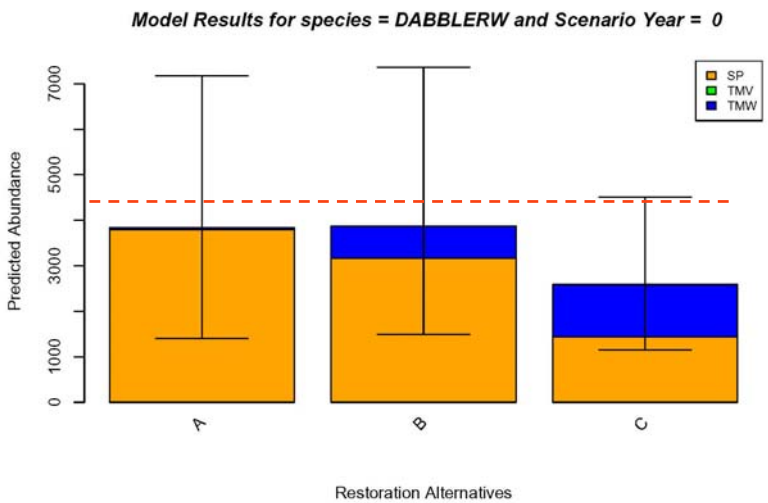


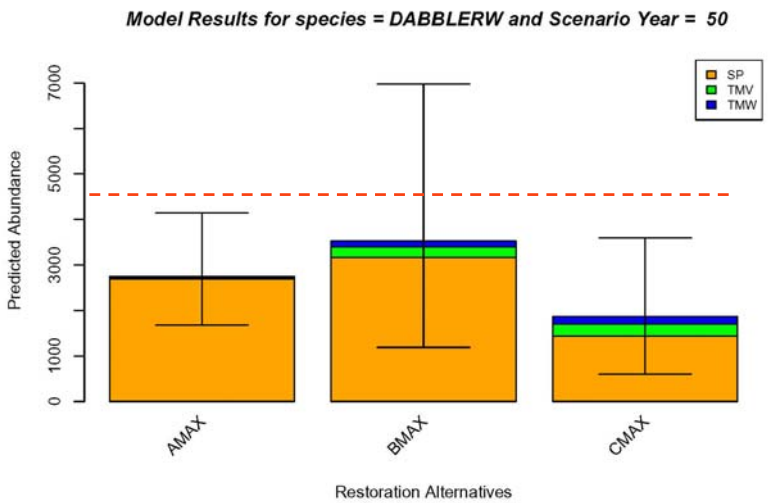
Alternatives – Pond / Marsh Characteristics

Alternative	**A**	**A**	**B**	**B**	**C**	**C**
Year	**0**	**50**	**0**	**50**	**0**	**50**
# Managed Ponds	64	14	35	35	19	19
Total Pond Area (Ha)	5130	1209	2474	2474	696	696
Mean Pond Size (Ha)	80.2	86.4	70.7	70.7	36.6	36.6
Mean Pond Depth (m)	0.43	0.43	0.34	0.34	0.19	0.19
Mean Pond Salinity (ppt)	45	40	62	62	65	65
# Restored Ponds (Tidal Marsh)	3	24	32	32	48	48
Total Marsh Area (Ha)	193	1814	2849	2849	4627	4627
Total Vegetated Area (Ha)	0	1372	0	2149	0	3507
Total Channel Area (Ha)	0	225	0	356	0	587
Total Pond/Panne Area (Ha)	0	192	0	291	0	470
Total Mudflat Area (Ha)	189	0.0	2676	0	4312	0
Total Subtidal Area (Ha)	4	20	173	50	315	61

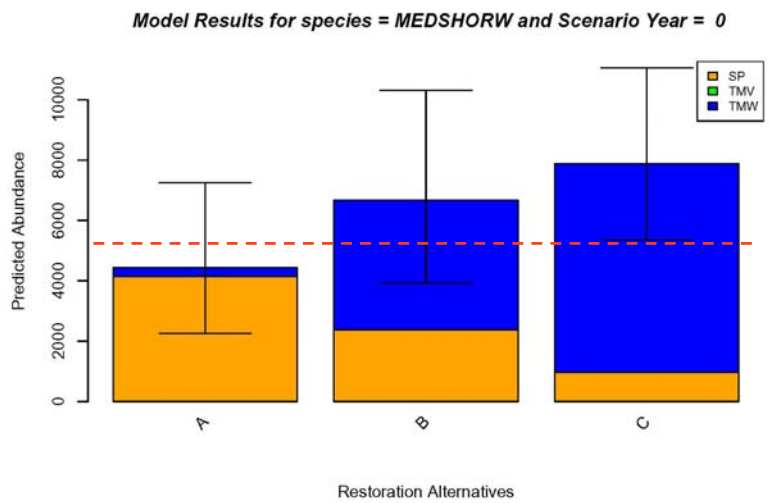
Selected Group Predictions

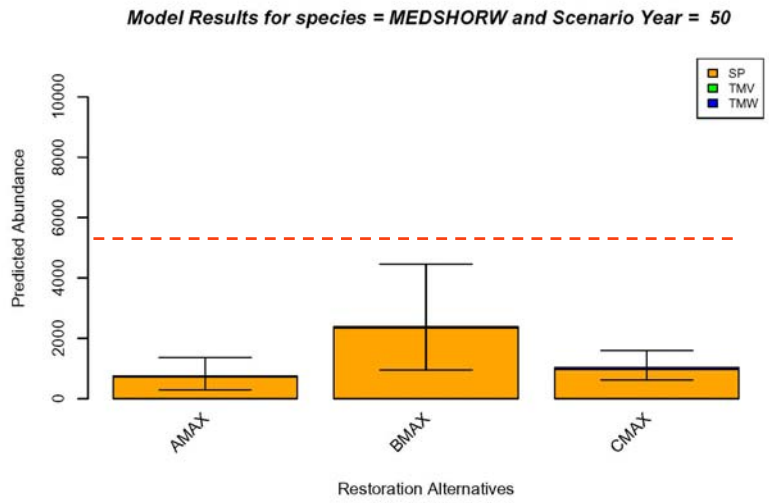
Dabbling Ducks





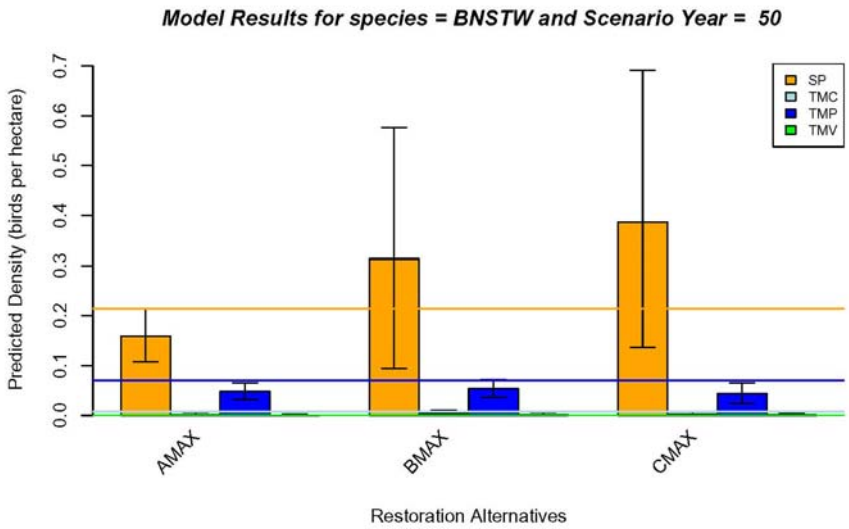
Medium Shorebirds



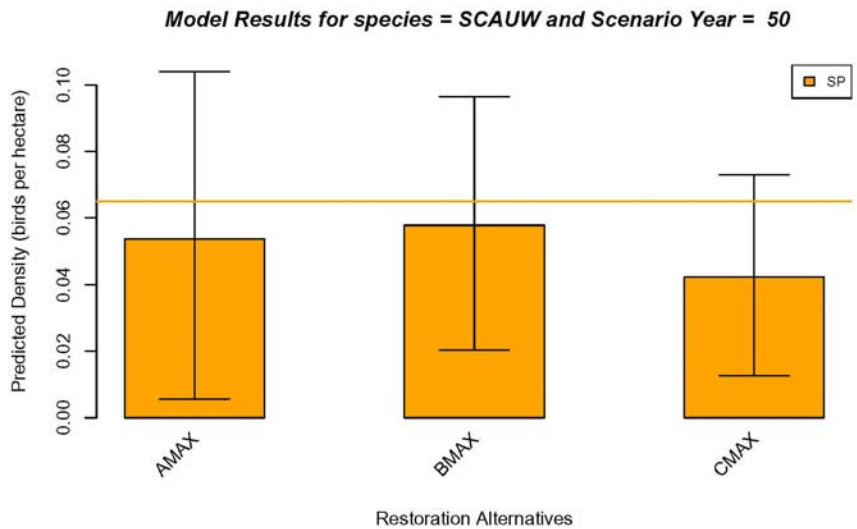


Selected Species Density Predictions

Black-necked Stilt

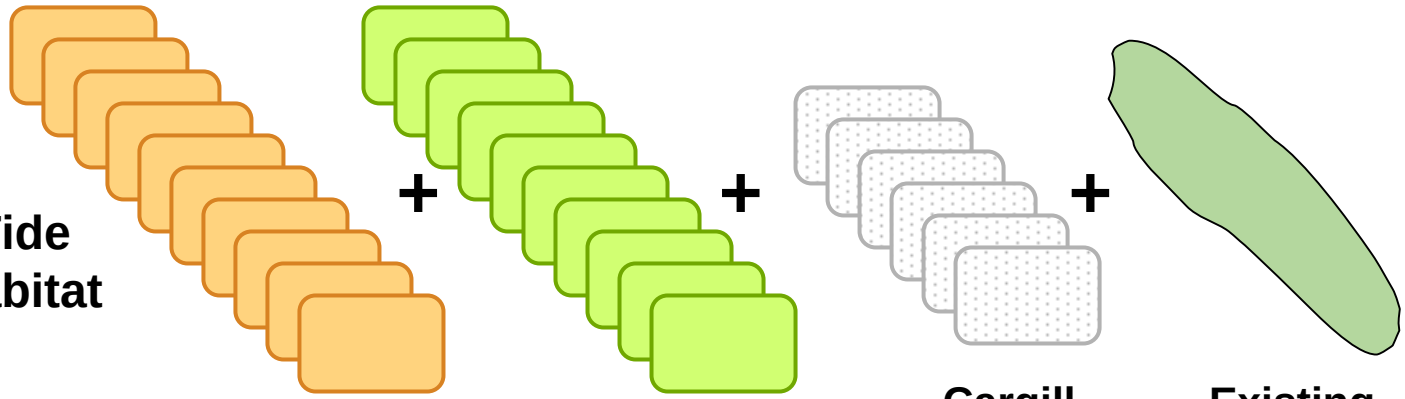


Greater and Lesser Scaup



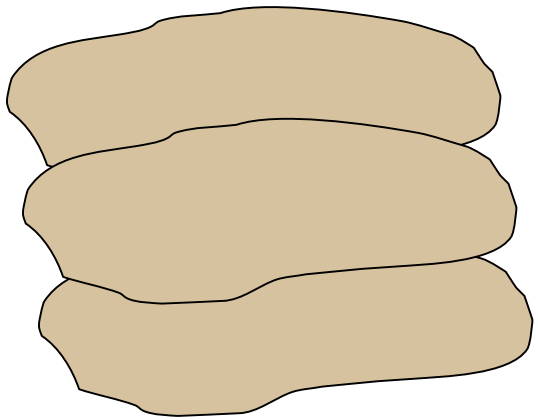
South Bay-wide Predictions

High/Low Tide Feeding Habitat



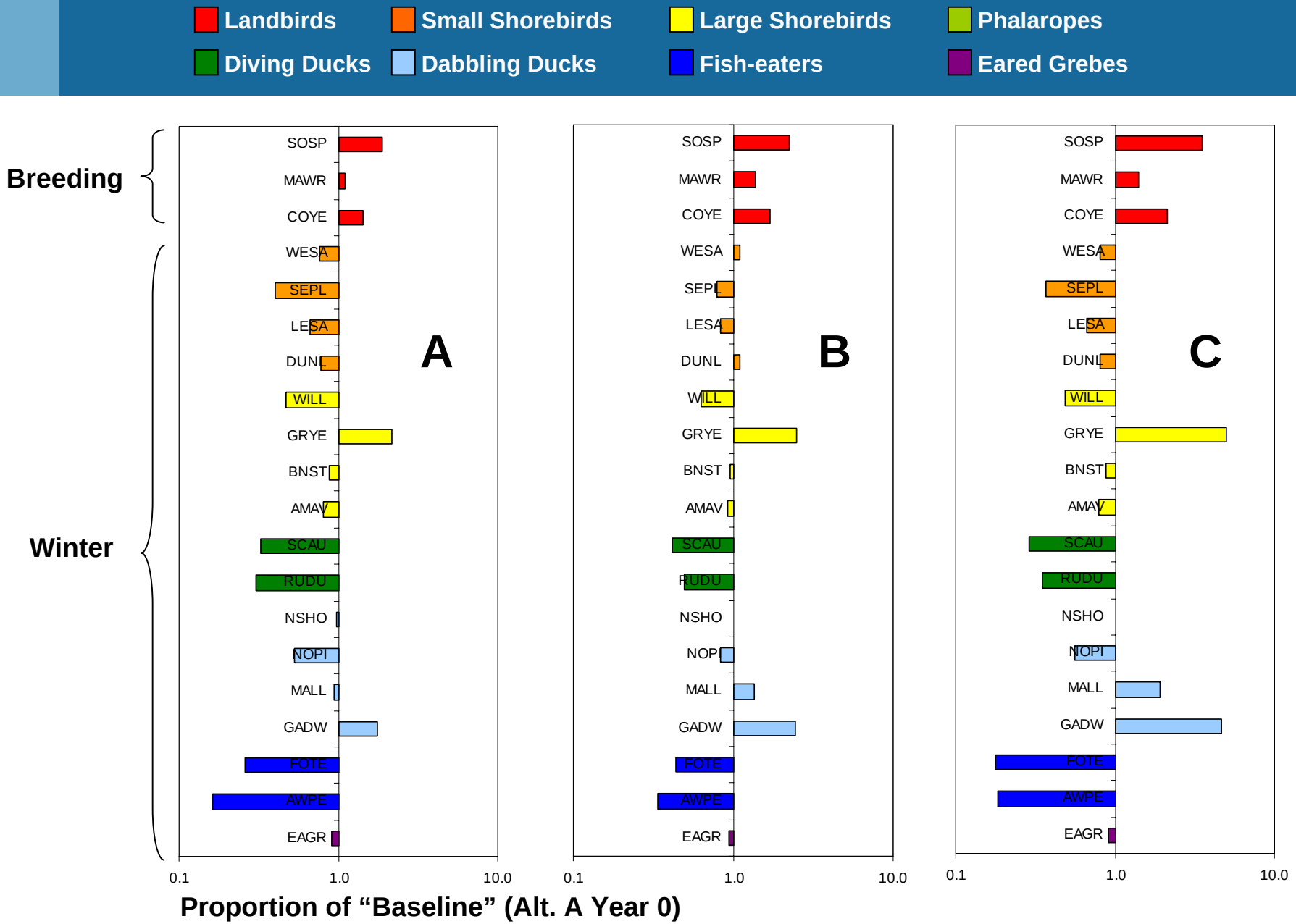
Managed Ponds **Restored Marshes** **Cargill Ponds** **Existing Tidal Marsh**

Low Tide Feeding Habitat



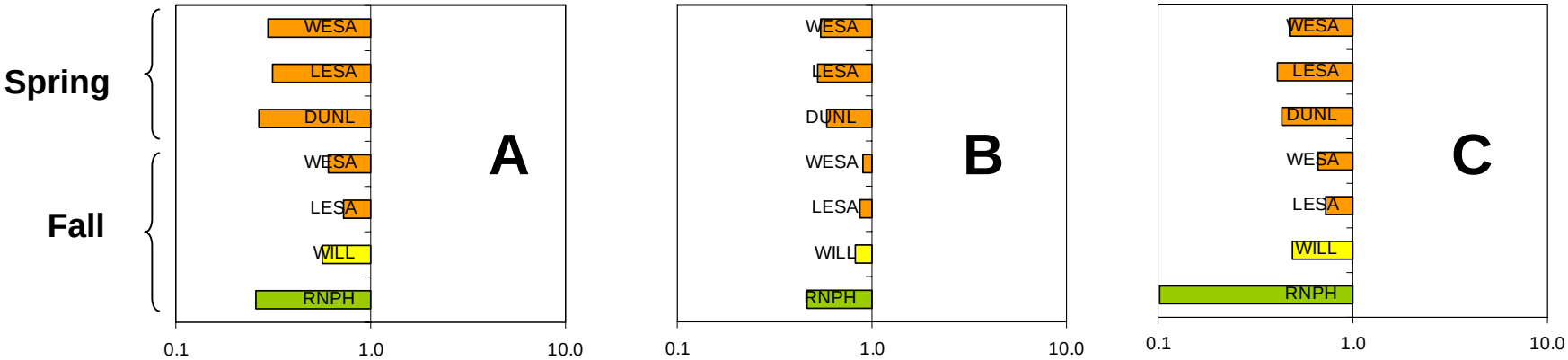
Mudflats

Proportional Change – South Bay Wetlands – Year 50



Proportional Change – South Bay Wetlands – Year 50

Landbirds | Small Shorebirds | Large Shorebirds | Phalaropes
Diving Ducks | Dabbling Ducks | Fish-eaters | Eared Grebes



Proportion of "Baseline" (Alt. A Year 0)

Conclusions

1. **Increased habitat potential for many waterbird species immediately following levee breaches**
2. **Over 50 years, intermediate pond/marsh habitat balance provides most habitat benefits across a broad range of species**
3. **Potential habitat bottleneck for shorebirds during fall and spring migration**
4. **Mudflat decline may make other shallow water habitats more important for shorebirds**
5. **Great opportunity to increase habitat potential of managed ponds**

Model Limitations / Caveats

1. **Habitat assumed to be limiting factor**
2. **Current ponds / marshes assumed to be at carrying capacity**

   → **Population indices represent relative habitat value, not actual bird numbers**

3. **Pond habitat relationships based on current (pre-ISP) data**
4. **Marsh habitat relationships based on few, small, existing marshes**

   → **Greater uncertainty when predicting outside range of conditions used to build models**

Acknowledgements

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HT Harvey, Phil Williams and Associates

Site Access:
Don Edwards National SF Bay NWR
California Department of Fish and Game
Numerous other South Bay landowners