Water level variability control of invasive plant cover and water bird populations in Palo Verde, Costa Rica: Implications for wetland restoration

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Water birds in wetlands

- A conservation target
- An ecological indicator
- Varying abundances
- Sensitive to water depth
Palo Verde priority species:

Black-bellied Whistling-duck

(Dendrocygna autumnalis)

• Preferred water depth: 5-25 cm
• Seasonality: all year (non-breeding)
• Ramsar + IBA criteria: ≥1% of global population
Palo Verde priority species:

Blue-winged Teal
(Spatula discors)

• Preferred water depth:
  5-25 cm

• Seasonality:
  migratory (Sep – Apr)

• Ramsar criteria:
  vulnerable species
Preferred water depth: 0-30 cm
Seasonality: all year (breeding)
Ramsar criteria: locally threatened + critical life stage

Palo Verde priority species:

Jabiru
(Jabiru mycteria)
• Preferred water depth: \( \geq 25 \text{ cm} \)
• Seasonality: all year
• Ramsar + IBA criteria: \( \geq 1\% \text{ of global population} \)

Palo Verde priority species:

Wood stork
(Mycteria americana)
Palo Verde priority species:

White ibis
*(Eudocimus albus)*

- Preferred water depth: \(\geq 25\) cm
- Seasonality: all year
- Ramsar + IBA criteria: \(\geq 1\%\) of global population
Water depth

Time Series of Hourly Water Levels (Depth) at Palo Verde - OTS
Wetland extent

Alonso, 2017
Bird abundances

- Time of the observation
- Duration of the observation
- Space covered by the observation
- Number of participants in the observation

Population effects:
- Spatial autocorrelation
- Temporal autocorrelation

Data collection effects

Mean counts by location, date, species

Community effects
- Habitat use and availability

Data

• Waterfowl
  - Black-bellied Whistling-Duck
  - Blue-winged Teal

• Waders
  - Jabiru
  - White Ibis
  - Wood Stork

Abundance (p)

Date
Species-specific relationships:
Species-specific relationships:
Species-specific relationships:
Species Abundance Model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
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<tbody>
<tr>
<td>Species counts</td>
<td>Response variable</td>
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<tr>
<td>All water bird species counts</td>
<td>Habitat use covariate</td>
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<tr>
<td>Species counts in the region</td>
<td>Spatial autocorrelation covariate</td>
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<td>Cumulative day since 1st observation</td>
<td>Temporal autocorrelation covariate</td>
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<td>Day of the year (seasonality)</td>
<td>Temporal autocorrelation covariate</td>
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<td>Time of birding (start)</td>
<td>Observation effort covariates</td>
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<td>Time of birding (duration)</td>
<td>Observation effort covariates</td>
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<td>Distance travelled by birders</td>
<td>Observation effort covariate</td>
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<tr>
<td>Number of birders</td>
<td>Observation effort covariate</td>
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<tr>
<td>Water depth</td>
<td>Environmental covariate</td>
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<tr>
<td>Fraction wet</td>
<td>Environmental covariate</td>
</tr>
</tbody>
</table>

Pearson correlation coefficients

Random Forests

Mean decrease in accuracy (%)

all species counts

regional counts

fraction wet

effort distance

water depth
Scaling prediction

1. Poza Verde 4. Palo Verde
2. Varillal 5. Nicaragua
3. Piedra Blanca 6. La Bocana
Invasive vegetation cover

Legend
- Foliar samples
- Plots marked
- Planned stations

Typha
Parkinsonia
Thalia
Eichhornia
Preliminary conclusions & Implications for wetland restoration

• Role of hydrology in controlling water bird populations

• Greater quantitative understanding of avifaunal trends can inform current practice of *fangueo*

• First step for subsequent and parallel analyses on:
  • spatial configuration of ecosystem services and values in the wetland system
  • sensitivity of alternate restoration decisions to uncertainty
  • climate extremes, system resilience, and water governance narratives