Implications of Seasonal Shifts in Manatee Distribution: Integrated Coastal Zone Management for Belize

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Manatee photo here

ABSTRACT: Antillean manatees (*Trichechus manatus manatus*) potentially serve as an umbrella focal species for protection of biodiversity in coastal systems of the greater Caribbean. We examined the seasonal change in manatee distribution among habitats in the coastal zone of Belize. Aerial surveys were conducted in the dry and wet seasons (1997, 1999 to 2002). Manatee locations were classified by habitat: cay, coast, estuary, lagoon, and river. The survey route was buffered 1 km on both sides, with a 1-km grid classified by habitat type. Likelihood-ratio tests were used to determine interactive effects (season by habitat) on presence of at least one manatee in each cell. Manatee locations were significantly more likely in river habitat in the dry season and offshore cay habitat in the wet season. However, the use of specific sites was not consistent from year to year. Although manatee density was higher in near-shore (estuary, lagoon, river) compared to offshore habitat (cay, coast), the total number of manatee locations was higher offshore. We recommend coordinated site-specific surveys to determine how environmental factors influence seasonal shifts in coastal habitats for focal marine species, thereby providing a sound scientific basis for integrated coastal zone management in developing countries of Central America.

INTRODUCTION

Integrated coastal zone management in Caribbean

- ➢Safeguard marine ecological processes (Mokhtar & Ghani Aziz 2003).
  - •Shallow seagrass beds & littoral forests,
  - •Mangrove edges & wetland systems
- ➢Systems of marine protected areas (Roberts et al. 2001)
  - ▪Protect needs of all life stages of species (vertebrate & invertebrate)
  - ▪Water current transport between multiple sites
- ➢Apply similar principles to coastal zone systems (Auil 2004)
  - •Sustainable fisheries (nursery "sources" & catch-site "sinks")
  - •Ecotourism at sensitive sites protecting biodiversity

Manatees: an umbrella focal-species for coastal zones?

- ➢Feed on plants in marine, brackish & fresh waters
  - •Sensitive to salinity, depth, temperature, rough waters
  - •Need freshwater every 2-5 days (40-250 km range)
- ➢Use both offshore & near-shore habitat (Fig. 1)
  - •Offshore habitat: reefs & mangrove island edges
  - •Near shore habitat: rivers, estuaries, lagoons & coastline

OBJECTIVES

(1) More manatees in rivers/lagoons than coastline?
(2) Distribution nearshore vs. offshore cays?
(3) Seasonal influences on distribution (wet vs. dry)?

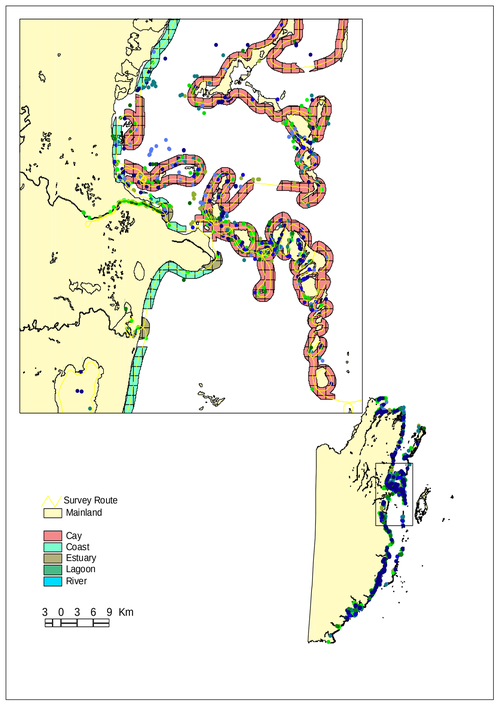

Fig. 1 Belize aerial survey route: habitat strata

METHODS

Aerial surveys: manatee sightings (calves & adults)

- ➢Standardized extended-area 2-day aerial surveys (Auil 2001)
- ➢Repeated annually: dry season (winter/spring) & rainy season (summer/fall)
- ➢ 5 years (1997, 1999-2002); entire coastal zone of Belize sampled

Spatial analysis: GPS locations in 1-km strip samples of 4 habitat types

- ➢Grid-cell approach adapted from analysis of dugong habitat (Preen 1992)
  - •Tallies of grid cells with manatee absence vs. presence (at least one manatee)
  - •Probability of presence was calculated by taking the ratio of presence given absence.
- ➢Geographic Information System (GIS) - Coastal Zone Management Institute
  - •National database archived using ArcView 3.2 software; integrated with other databases
  - •Attributes for each location: group size (1-19), age-class, year, season, near-shore strata (river, estuarine, lagoon, coast), offshore strata (reef/mangrove), coastal physiognomy (rocky, wetland)
  - •Themes; 1-km buffer along the survey route;1-km square grid clipped to this theme (unique value assigned to each cell); each habitat strata polygon file was adjusted using the grid route.

Statistical analysis: tested log-likelihood ratio models (G^2 : Preen 1992).

- ➢2-way interactions (Figs, 2-4): year, season, strata (x presence)
- ➢3-way interactions (Fig. 5): year x season, year x strata, season x strata (x presence)

RESULTS

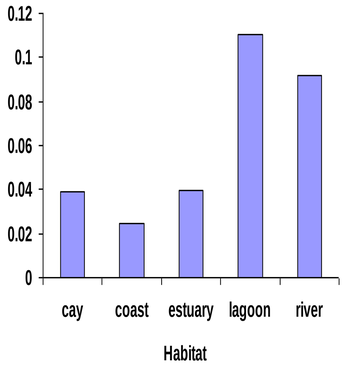

Fig. 2

Significant effect of habitat strata on probability of manatee presence

(G^2 = 224.71, df = 4, p < 0.001)

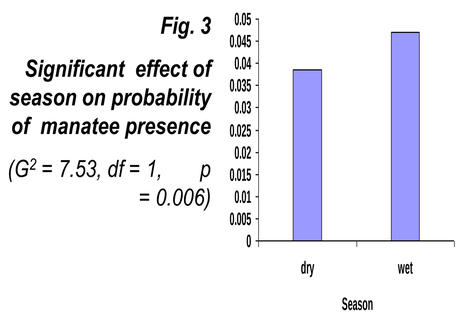

Fig. 3

Significant effect of season on probability of manatee presence

(G^2 = 7.53, df = 1, p = 0.006)

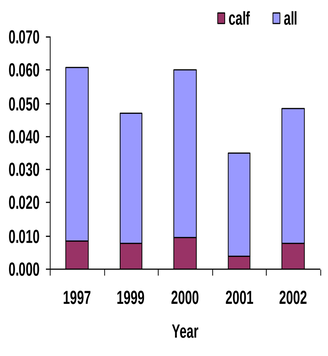

Fig. 4.

Significant effect of year on probability of manatee presence

(G^2 = 27.48, df = 4, p < 0.001)

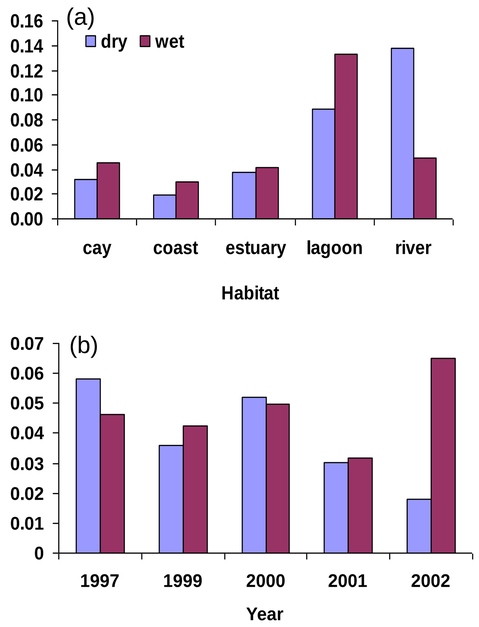

Fig. 5 Significant interactions for
(a) season by habitat strata *(G^2 = 39.41, df = 4, p < 0.001),*
(b) season by year *(G^2 = 49.94, df = 4, p < 0.001)*
(c) year by habitat strata *(G^2 = 49.27, df = 16, p < 0.001; not shown)*

DISCUSSION

- ➢Manatee sightings in lagoons & rivers were more likely than expected, in comparison to estuaries, cays and coastlines.
- ➢Near-shore systems have greater probability of manatee presence (density) compared to offshore systems (more total sightings distributed over a larger area).
- ➢Manatee sightings shifted from primarily river habitat in the dry season to primarily lagoon habitat (followed by estuary, cay and coast) in the wet season.
- ➢Seasonal manatee distribution among habitat strata was not consistent from year to year (major variation in 2002).

RECOMMENDATIONS

- ➢ Near-shore systems should be classified as primary habitat, providing a protective umbrella for other species.
- ➢ Significant interactive effects indicate no one protected area is sufficient for a given season, rather a system of multiple sites needs to be protected with adequate connectivity.
- ➢ Highest priority protection should be allocated to (a) rivers in the dry season and (b) lagoons in all seasons; lagoons are also documented nurseries.
- ➢Further research is needed on manatee sensitivity to salinity variation on a site-specific basis, as a potential indicator of anomalies affecting larval recruitment of other species.