Modeling of Alligator Nest-Sighting for Resource Management in Everglades National Park

Dilip Shinde[1], Leonard Pearlstine[1], Amy Nail[2], and Mark Parry[1]

[1]South Florida Natural Resources Center, National Park Service, Everglades National Park

[2]Honestat Statistics & Analytics, LLC

GEER 2019
Greater Everglades Ecosystem Restoration
April 22-25, 2019
Coral Springs, Florida

A multivariate logistic-regression generalized additive model (GAM) of the probability that an alligator nest will be built and sighted in a given spatial grid cell within Everglades National Park in a given year was developed. Data of nest sighting from the annual systematic reconnaissance flight (SRF) surveys, with other independent predictor variables which are classified into alligator hole variables, distance variables (from canals and roads), hydrological variables (water depths during breeding cycle), meteorological variables (rain and temperature), and habitat variables (canals, water edge, marsh, upland etc.) were used to develop this model.

Unlike other existing HSI models, which relied heavily on expert judgment, provided a deterministic response (0-1 index) of productivity and habitat suitability, and did not establish the relationship between a specific score and expected number of nests, this model is based on extensive data analysis and provides probability of nesting. ***The objective was*** *to investigate the influence of predictor variables on alligator nest sighting in the Park over the period of record. This provides insight on the changes Park has experienced during the restoration efforts, the influence of predictor variables on alligator nest sightings, and also quantifies uncertainty.*

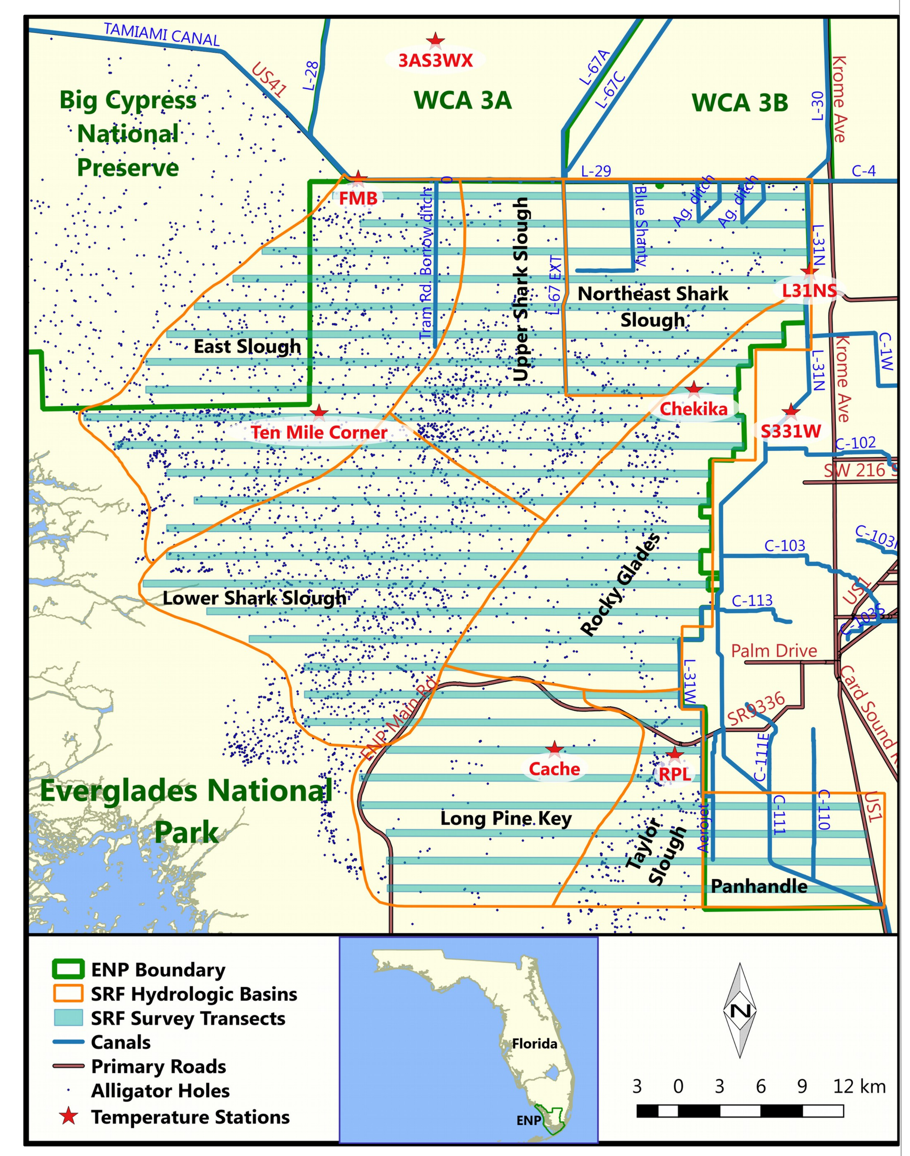


Figure 1: Location of SRF survey transects in the model domain.

Systematic Reconnaissance Flight Alligator Nesting Data:

- Annual flights in July, 1992—2015
- Nest counts for the Alligator
- 2,332 grid cells of dimension 400 m x 500 m
- 26 reconnaissance flight survey transects (Fig. 1)

Table 1: American alligator (*Alligator mississippiensis*) breeding cycle time periods.

Periods*		Year t-1									Year t						
Start	Finish	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Apr 16, t-1	Apr 15, t	BP Period															
Apr 16, t	May 31, t	CM Per.															
Jun 01, t	Jul 15, t	NB Per.															
Jul 16, t-1	Jul 15, t	WY Period															
Seasons		DRY		WET					DRY							WET	
* BP: Breeding Potential, CM: Courtship and Mating, NB: Nest Building, WY: Whole Year, and t: Year																	

Figure 2: Water depths (cm) during Breeding Potential (BP) period in a wet year (1996), a dry year (2012), and typical years (1993 & 2003).

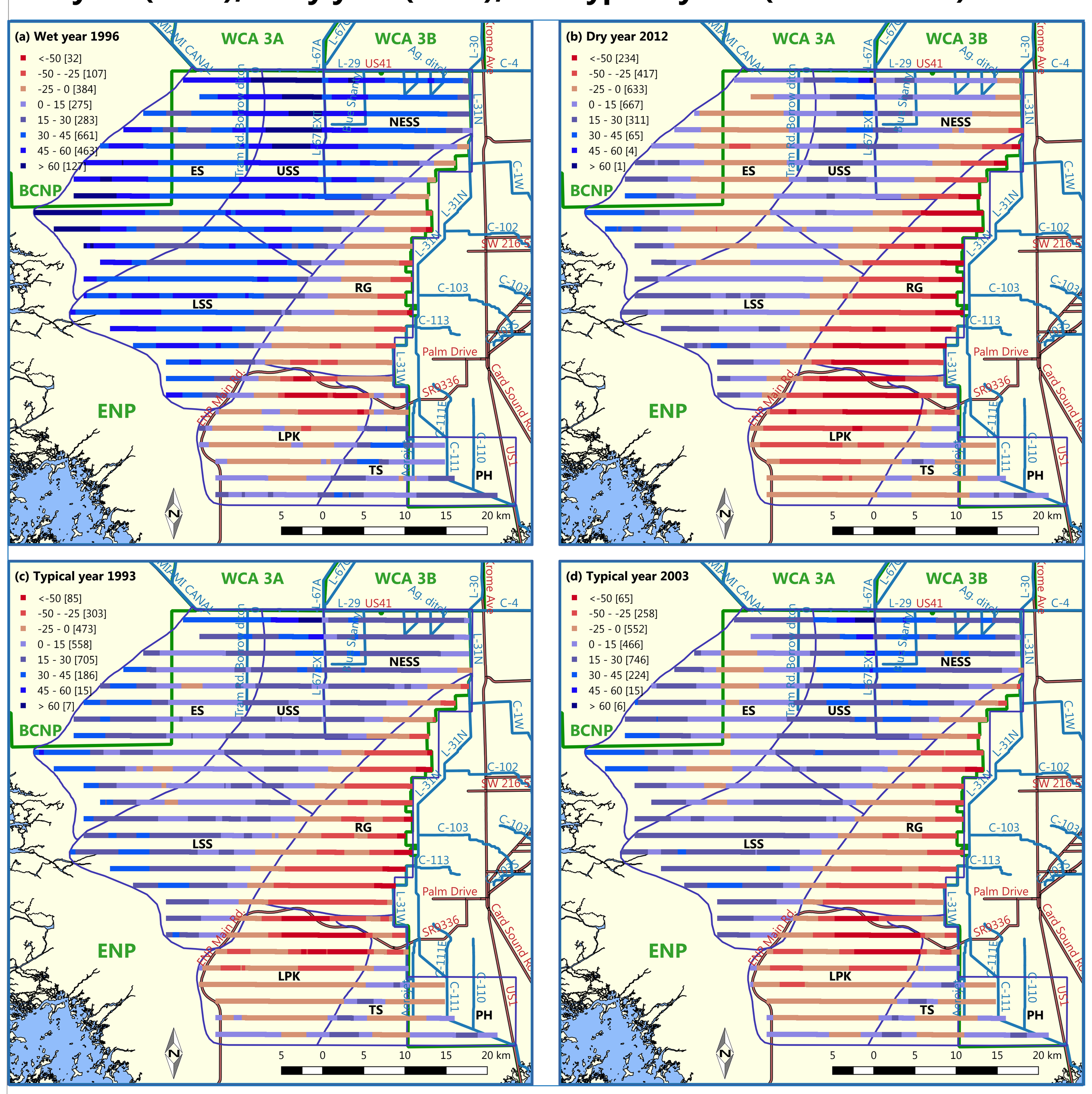


Figure 3: Predicted probability in % of nest presence and prediction interval widths.

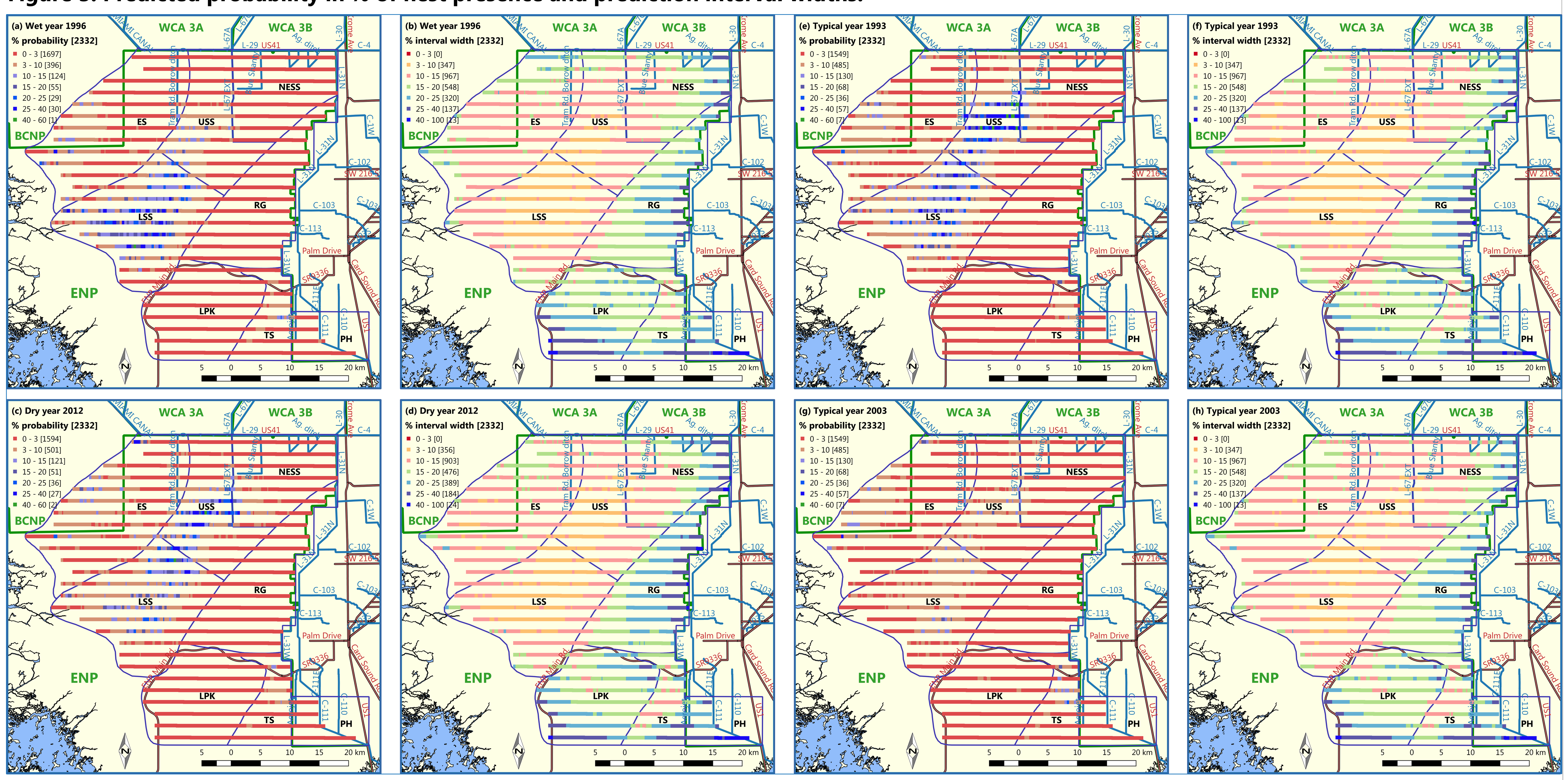
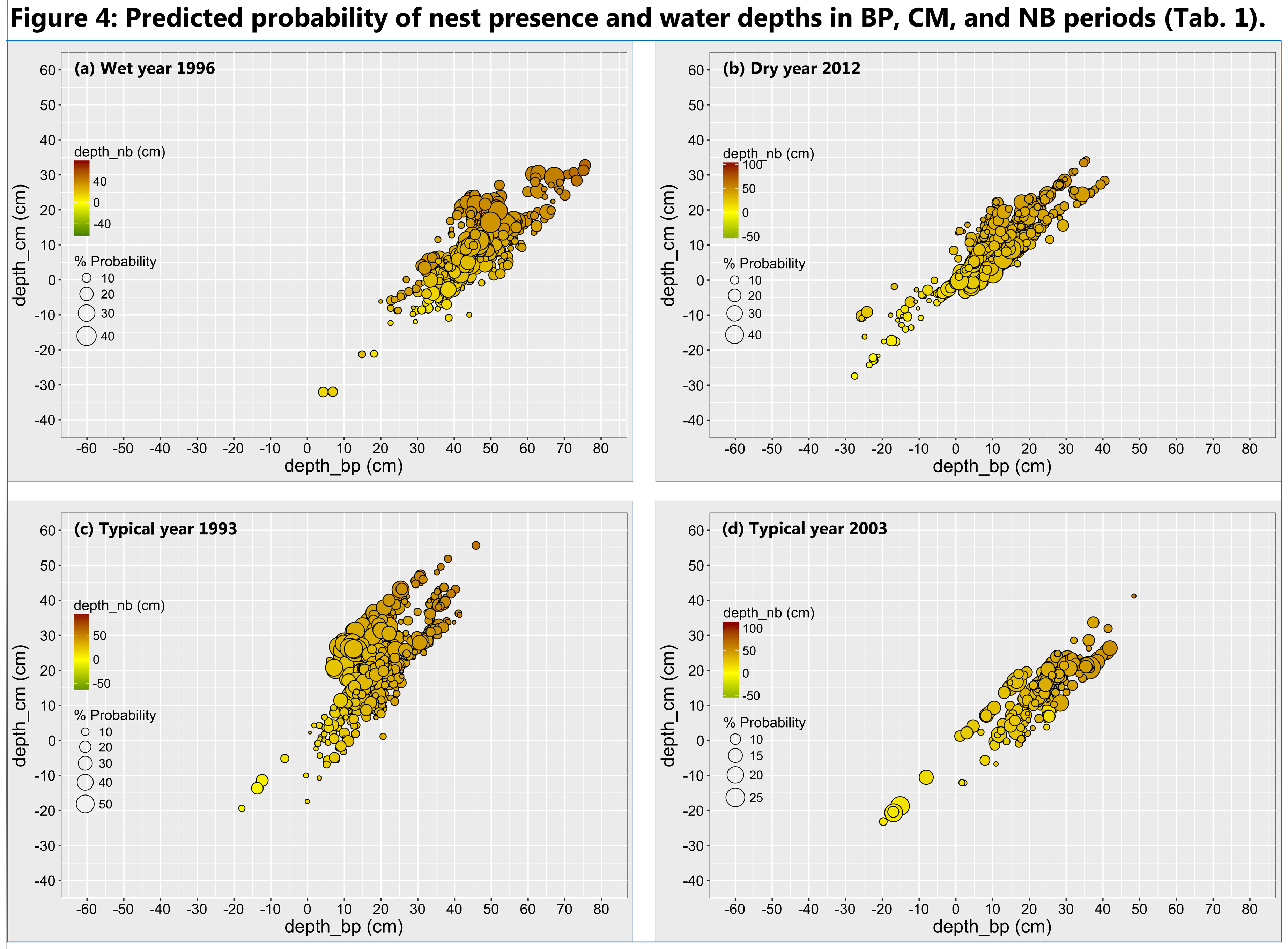


Figure 4: Predicted probability of nest presence and water depths in BP, CM, and NB periods (Tab. 1).



ACKNOWLEDGMENTS: We sincerely thank all field researchers for their tireless efforts collecting and analyzing SRF data. Much of the improved understanding of alligator ecology was made possible by studies funded as part of the Restoration Coordination and Verification (RECOVER) and Monitoring and Assessment Plan (MAP).

Table 2: Probability in % and 95% prediction interval width for nest=1.

Predicted maximum and median probabilities																
Basin*	ES		USS		LSS		NESS		RG		TS		LPK		PH	
Year	max	Q-50	max	Q-50	max	Q-50	max	Q-50	max	Q-50	max	Q-50	max	Q-50	max	Q-50
1993	33.3	2.6	59.2	6.2	37.4	6.8	37.9	1.1	2.0	0.1	16.4	0.7	2.1	0.1	2.7	0.1
1996	31.5	1.5	20.5	1.4	40.6	9.1	5.7	0.3	3.5	0.0	23.4	0.9	2.0	0.1	5.1	0.2
2003	26.6	1.7	19.4	2.0	19.1	2.7	11.7	0.8	2.2	0.1	20.3	1.4	4.1	0.3	4.7	0.1
2012	27.3	2.7	46.7	3.6	41.3	5.5	27.1	0.9	2.3	0.1	12.8	0.8	2.6	0.2	2.5	0.1
95% prediction interval width																
Year	Q-25	Q-75	Q-25	Q-75	Q-25	Q-75	Q-25	Q-75	Q-25	Q-75	Q-25	Q-75	Q-25	Q-75	Q-25	Q-75
1993	27	40	23	36	21	38	36	54	53	69	45	64	52	68	67	81
1996	33	45	25	39	21	33	39	58	53	67	48	64	57	72	67	80
2003	29	40	25	37	24	33	34	52	53	67	43	61	50	67	66	82
2012	29	42	23	37	21	34	37	61	58	74	45	65	53	70	69	83

* ES: East Slough, USS: Upper Shark Slough, NESS: Northeast Shark Slough, LSS: Lower Shark Slough, RG: Rocky Glades, TS: Taylor Slough, LPK: Long Pine Key, and PH: Panhandle

APPLICATION:

Indicator years (Fig. 2), based on BP period (Tab. 1) water depths affecting alligator body condition over the SRF domain, were selected for wet, dry, and typical years to investigate probabilities of nest sighting and uncertainty.

Period of record quartiles of BP period water depths over the entire SRF domain were compared with individual years to determine dry year (2012), wet year (1996), and typical years (1993 & 2003).

Figure 2 shows distribution of water depths during dry, wet, and typical years.

Figure 3 shows estimated probabilities in % of nest sighting and prediction interval widths for indicator years. Figure 4 shows combined influence of water depths in BP, CM, and NB periods (Tab. 1) on estimated probability (in %) of nest sighting.

Table 2 summarizes the results over basins (Fig. 1) and elucidates differences on a basin scale.

OBSERVATIONS:

- Spatial distribution of probabilities look visually similar (Fig. 3) in the wet, dry, and one typical (1993) year.
- Table 2 shows that differences do exist in probabilities at a basin level for these three years.
- In typical years (1993 & 2003), Fig. 3, probabilities are not visually similar.
- Table 2 also shows that typical years (1993 & 2003) are different on a basin level comparison.
- Not shown here, differences exist in water depths between typical years (1993 & 2003) on a basin scale.
- Both wet and dry years, Fig. 4, have a maximum probability of ~40%, but wet year has more grid cells in higher probability range.
- In typical years, Fig. 4, 1993 had a maximum probability of ~50% as compared to ~25% in 2003.
- Also, the typical year 1993, Fig. 4, shows more grid cells in higher probability range compared to 2003.
- Influence of other habitat, meteorological, and anthropogenic (canals and roads) variables has not been shown here.
- This application shows that scale should be considered while selecting indicator years as differences were observed between typical years on a basin level.