GAM Modeling of Alligator Nest-Sighting as Affected by Hydrologic, Habitat, Meteorological, and Anthropogenic (Canals and Roads) Variables

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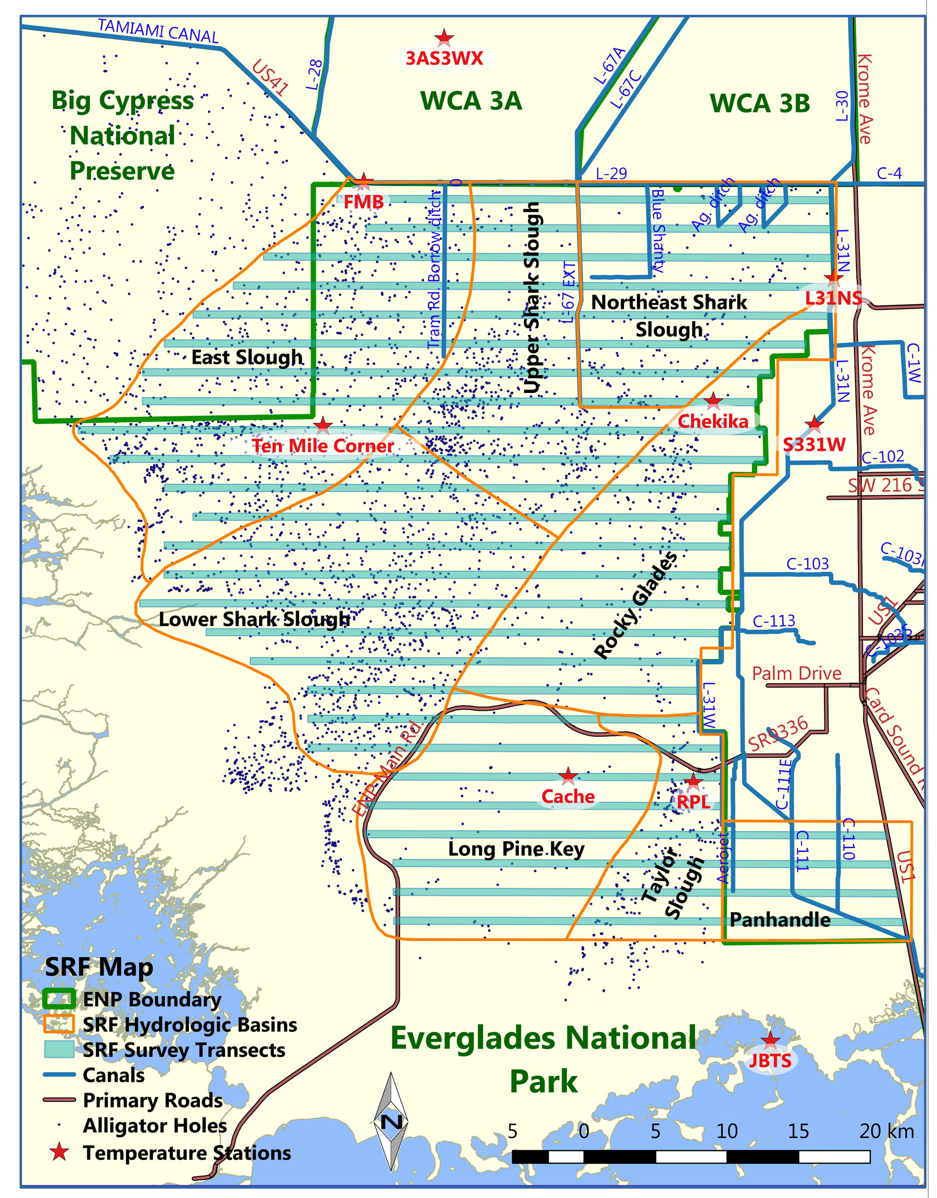
A multivariate logistic-regression generalized additive model (GAM) of the probability that an alligator nest will be built and sighted in a given spatial grid cell within Everglades National Park in a given year as a function of predictor variables which describe hydrology, habitat, meteorology, and structural elements of the landscape was developed. Data of nest sighting from the annual systematic reconnaissance flight (SRF) surveys with other independent predictor variables classified into alligator hole variables, space-time variables, distance variables (from canals and roads; anthropogenic effects), hydrological variables (water depths during breeding, courtship and mating, nest building periods, hydroperiod, and several others derived from water depths), meteorological variables (rain and temperature), and habitat variables (canals, water edge, marsh, upland etc.) were used to develop this model.

***The objective was** to investigate the influence of these variables on alligator nest sighting (presence/absence) in the Park on SRF grid cells over the period of record. This will provide useful insight on the changes Park has experienced during the restoration efforts and the influence of predictor variables on alligator nest sightings over the Park's spatial domain and also quantify uncertainty.*



Systematic Reconnaissance Flight Alligator Nesting Data:

- Annual flights in July, 1992—2015
- Nest counts for the American Alligator (*Alligator mississippiensis*)
- 2,332 grid cells of dimension 400 m x 500 m
- 26 transects (SRF Map)

Fig. 1: American alligator 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.											CM Per.			
Jun 01, t	Jul 15, t			NB Per.												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

Fig. 2: Water depths (cm) during BP Period (Fig. 1) in a very wet year (1996), a very dry year (2012), and typical years (1993 and 2003).

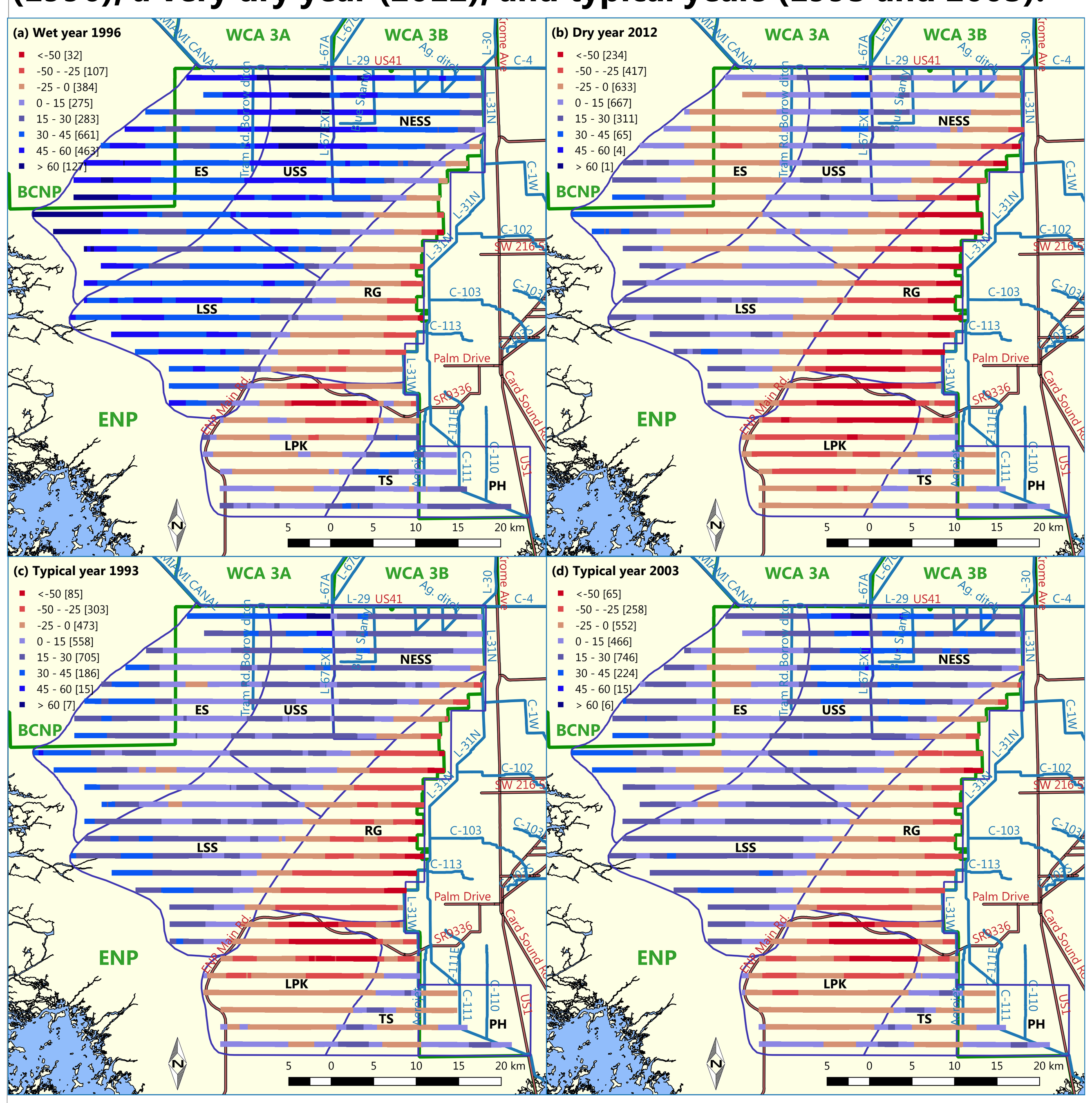


Fig. 3: Predicted probability (nest = 1) and prediction interval widths corresponding to Fig. 2 conditions.

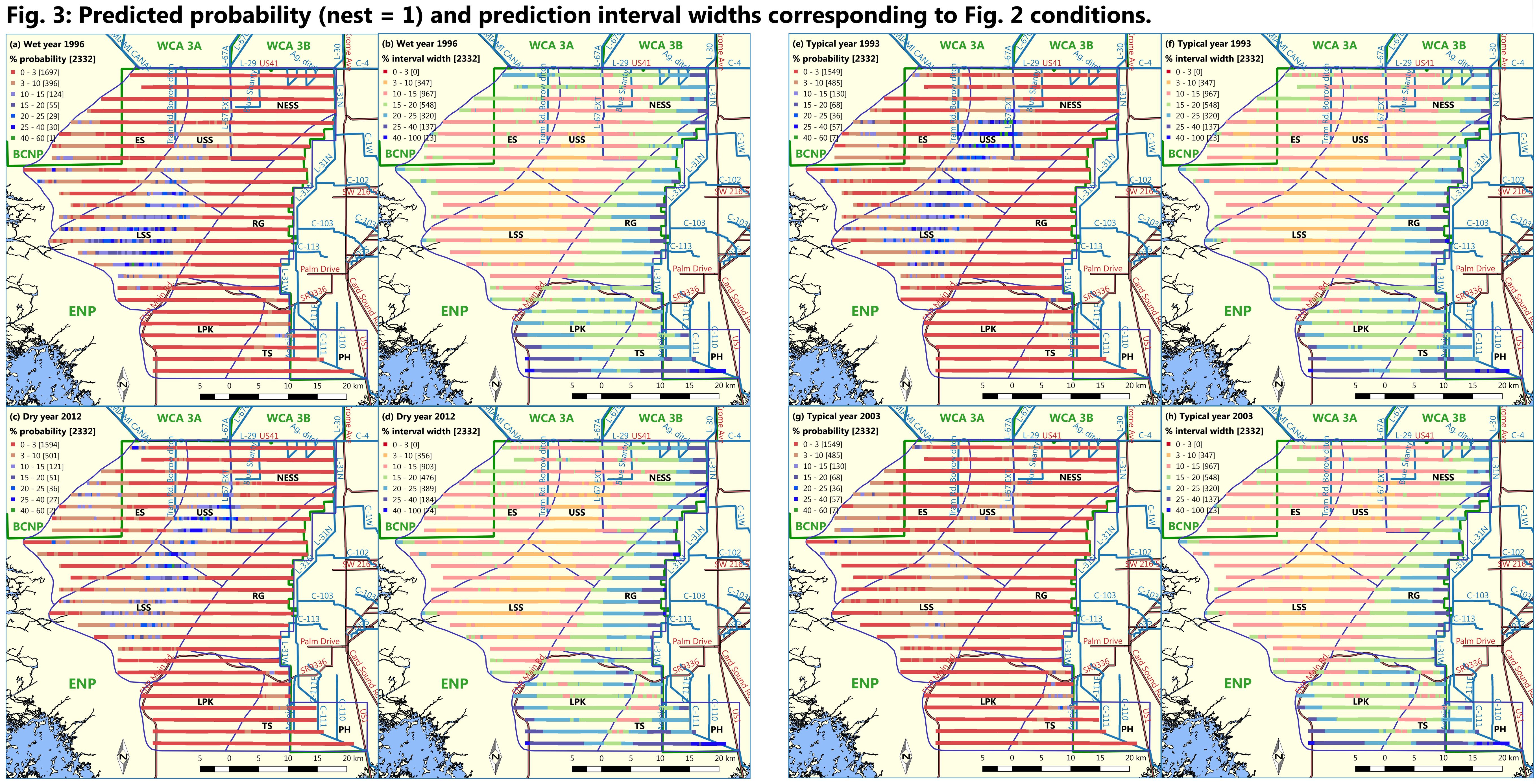
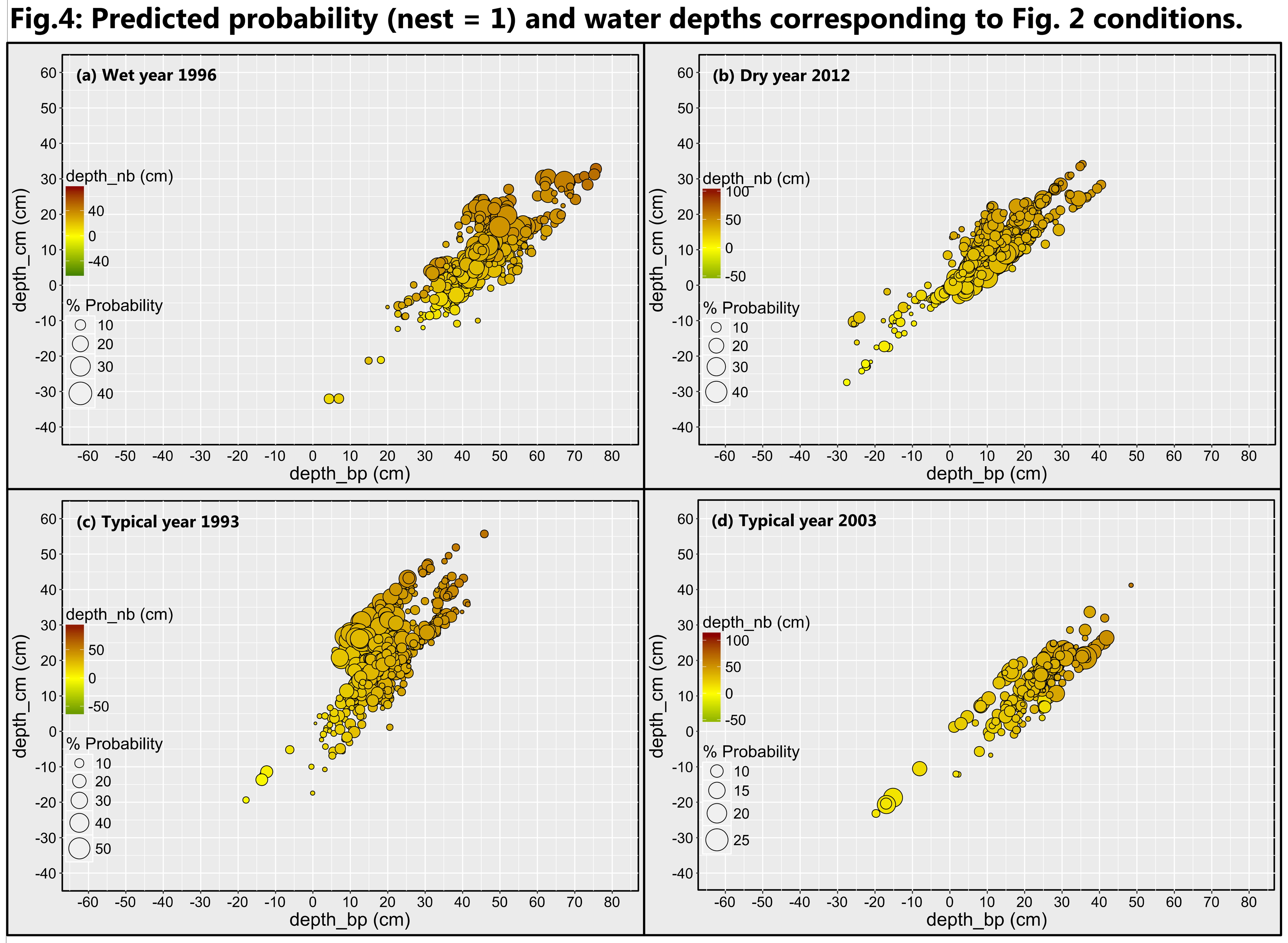


Fig.4: Predicted probability (nest = 1) and water depths corresponding to Fig. 2 conditions.



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 (Fig. 1) water depths affecting alligator body condition over the SFR domain, were selected for wet, dry, and typical years to investigate probabilities of nest sighting and uncertainty.

Period of record quartiles were compared with individual years to determine a dry year (max{abs[Q1(t) – Q1(POR)]}; Q1[t] < Q1[POR]), a wet year (max[Q3(t) – Q3(POR)]; Q3[t] > Q3[POR]), and a typical year (min{abs[Q2(POR) – Q2(t)]}). These criteria showed 1996- wet, 2012- dry, and 1993 plus 2003- to be typical years.

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

The table summarizes the results over basins (see SRF map) and elucidates differences on a basin scale.

OBSERVATIONS:

- Spatial distribution of probabilities look somewhat similar in wet (1996), dry (2012), and typical (1993) years.
- The table elucidates that differences exist in probabilities at basin level for these three years.
- For typical years (1993, 2003), probability spatial distribution is not similar.
- Table also shows that typical years are different on a basin level comparison.
- Not shown here though, difference exists in water depths during typical years (1993, 2003) when summarized on a basin scale. See Fig. 2 (c) & (d).
- Figure 4 shows both wet and dry years have maximum probability ~40%, but wet has a higher concentration of larger dots.
- During 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 a higher concentration of larger dots compared to 2003.
- Though other habitat, meteorological, and anthropogenic (canals and roads) variables also have influence, it has not been elucidated here.
- It is clear from this application that scale effects should be considered while selecting indicator years.

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