



Spatial trends of polybrominated diphenyl ethers (PBDEs) in loggerhead sea turtle eggs and plasma

Jennifer M. Keller, Juan J. Alava, Katrina Aleksa, Brianna (Young) Carlson, John R. Kucklick



Outline

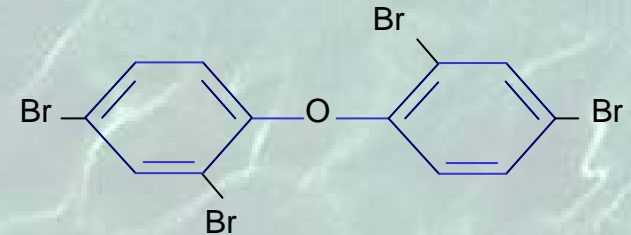
- **Why polybrominated diphenyl ethers (PBDEs)?**
- **Why sea turtles?**
- **Methods**
 - **Sampling techniques and locations**
 - **Analytical methods**
- **PBDE concentrations**
 - **compared to PCB concentrations**
 - **compared to human plasma and bird eggs**
 - **PBDE patterns**
 - **Spatial trends**



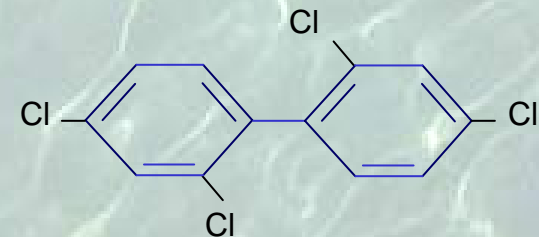
Polybrominated diphenyl ethers (PBDEs)

- Similar in structure to PCBs
- Flame retardant used primarily in foam & electronic plastics
- Bioaccumulate because lipophilic
- Persistent
- Toxicity
 - Nervous system
 - Thyroid system
- Increasing concentrations

PBDE 47



PCB 47

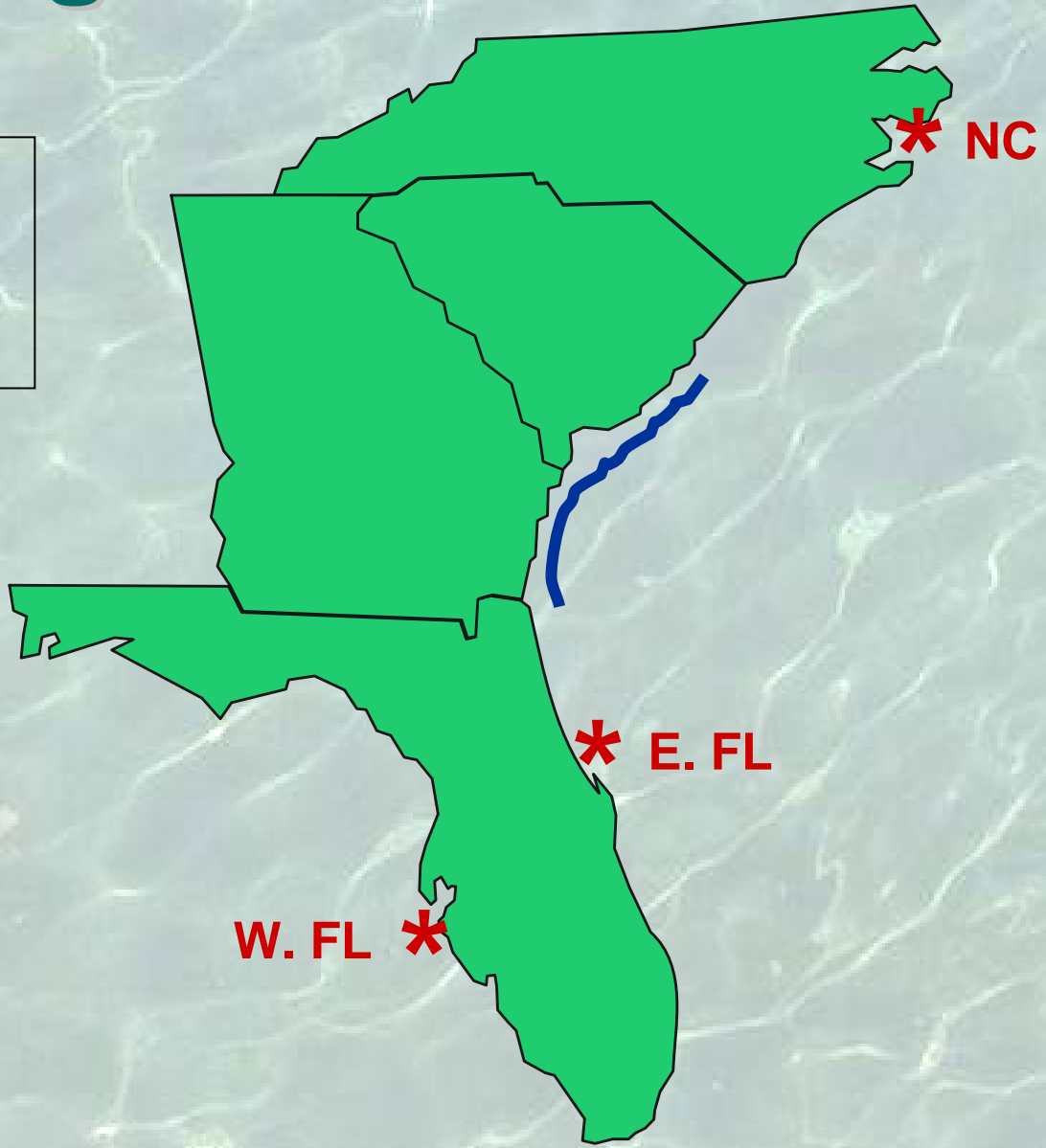
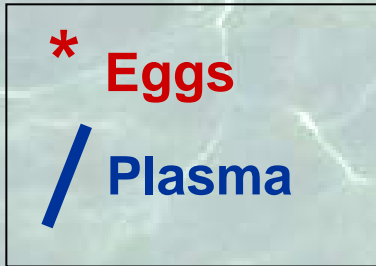


Loggerhead Sea Turtles

- **Endangered Species Act**
 - Threatened
 - Northern nesting population declining
 - Debilitated, sick turtles increasing
- Long-lived with late age at maturity
- Circumnavigate the Atlantic Ocean, but older juveniles and adults have site fidelity along the coast
- Several recent health assessments
- PBDEs not yet measured in sea turtles or any other reptile

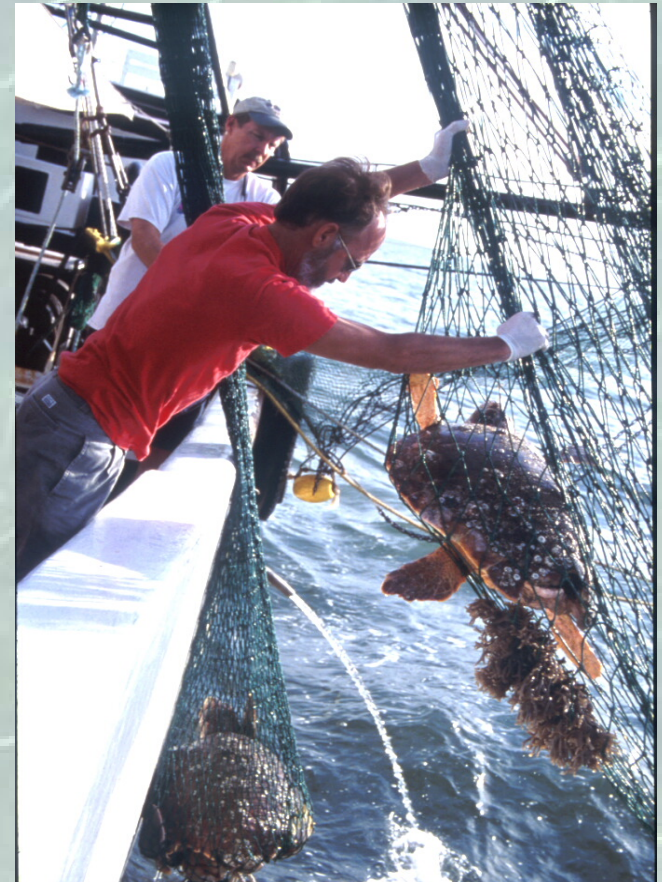


Sampling locations



Plasma sampling

- Coastal nearshore waters of South Carolina and Georgia
 - Trawl stations randomly selected (June and July 2003)
 - 30 min trawls without TEDs
 - 29 immature loggerheads
 - Turtles measured, tagged, blood sampled, released



Egg sampling

- **Three geographical regions**
 - **Cape Lookout National Seashore, North Carolina (NC)**
 - **Several beaches along eastern Florida (E FL)**
 - **Sarasota, FL – western Florida (W FL)**
- **Unhatched eggs from 37 nests in summer 2002**
- **Stage of embryonic development and abnormalities noted**
- **Yolks of only earlier stages of development pooled per nest**

Analytical Methods

- Spiked with internal standards
- Extracted
 - Plasma: liquid:liquid with formic acid, hexane and dichloromethane (DCM)
 - Yolk: pressurized fluid extraction with DCM
- Cleaned up with size exclusion chromatography & alumina columns
- Quantified
 - 13 PBDE congeners (PBDE 17, 28, 47, 66, 71, 85, 99, 100, 138, 153, 154, 183, 190) by GC/EI-MS
 - 85 PCB congeners and 20 pesticides by GC-ECD and GC/MS
 - Screened a subset for PBDE 209 using GC/NCI-MS with 15 m column

Health Parameters

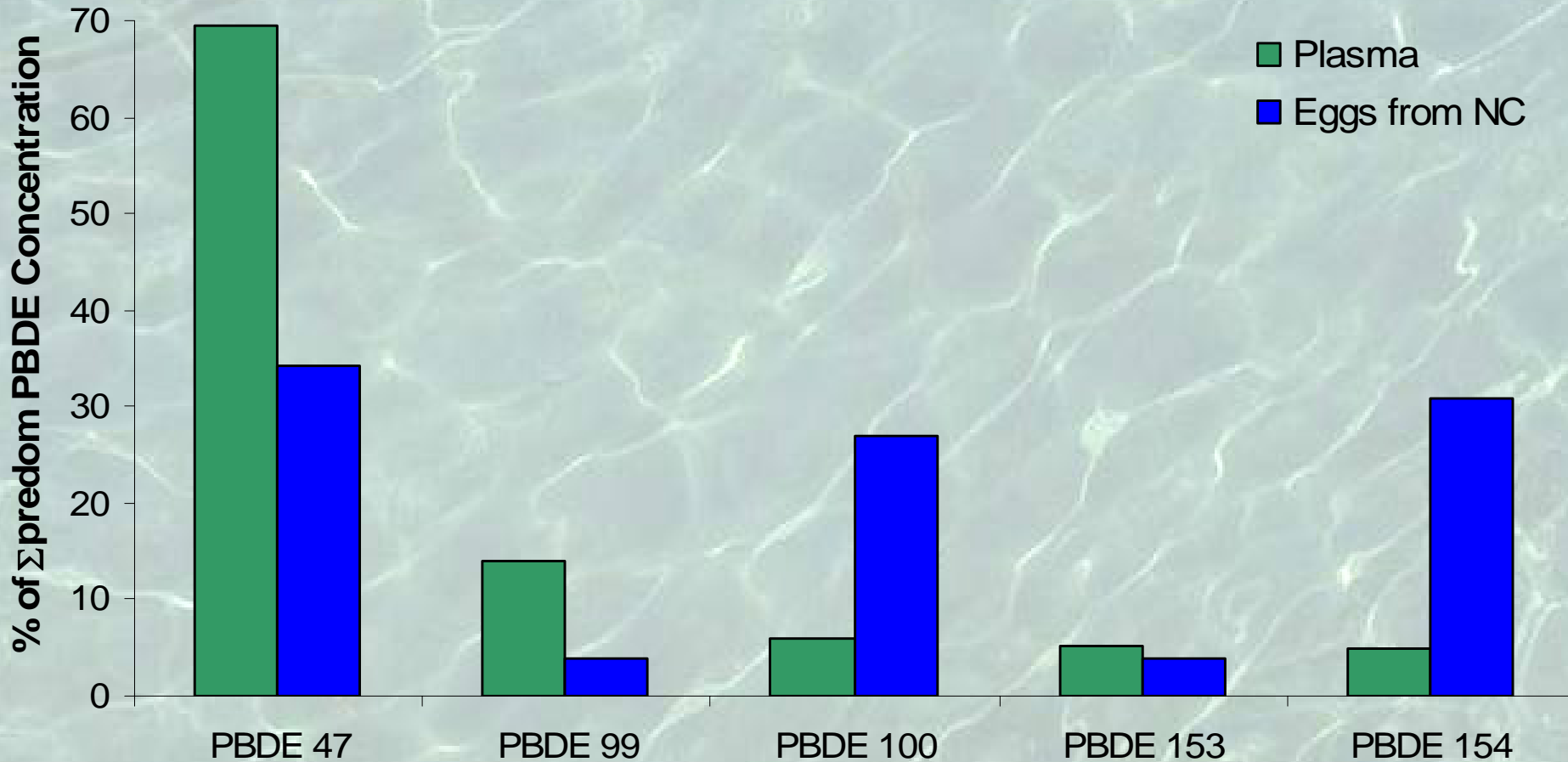
- **Immature loggerheads (plasma)**
 - White blood cell count
 - Plasma chemistry panels
 - Hematocrit
 - Body condition
 - Immune function assays
- **Nests (egg yolk)**
 - Hatching success
 - Embryonic abnormalities
 - Hatchling survival, growth rates, and sex ratios
- **To be compared to contaminants in future studies**

PBDE Concentrations (ng/g lipid)

	Plasma			Egg Yolk		
	Mean	SD	Median	Mean	SD	Median
PBDE 47	33.2	43.6	20.6	1.25	1.82	0.689
PBDE 99	11.6	21.6	<LOD	0.390	0.659	<LOD
PBDE 100	9.35	27.2	<LOD	1.33	3.10	<LOD
PBDE 153	6.65	21.1	<LOD	0.298	0.531	<LOD
PBDE 154	7.12	17.9	<LOD	1.26	3.02	<LOD
Σ predomBDEs	67.9	75.5	28.0	4.52	8.56	1.45
Σ predomPCBs	2920	6150	1030	331	638	78.9
4,4'-DDE	367	550	163	204	435	43.3
% lipid	0.195	0.106	0.198	7.60	2.15	7.41

Recent human serum Σ predomBDEs
Commonly reported bird egg Σ predomBDEs
 median = 37 ng/g lipid (Mazdai et al., 2003)
 range of means = 8.2 - 7510 ng/g lipid (reviewed by Hites, 2004)

PBDE Patterns

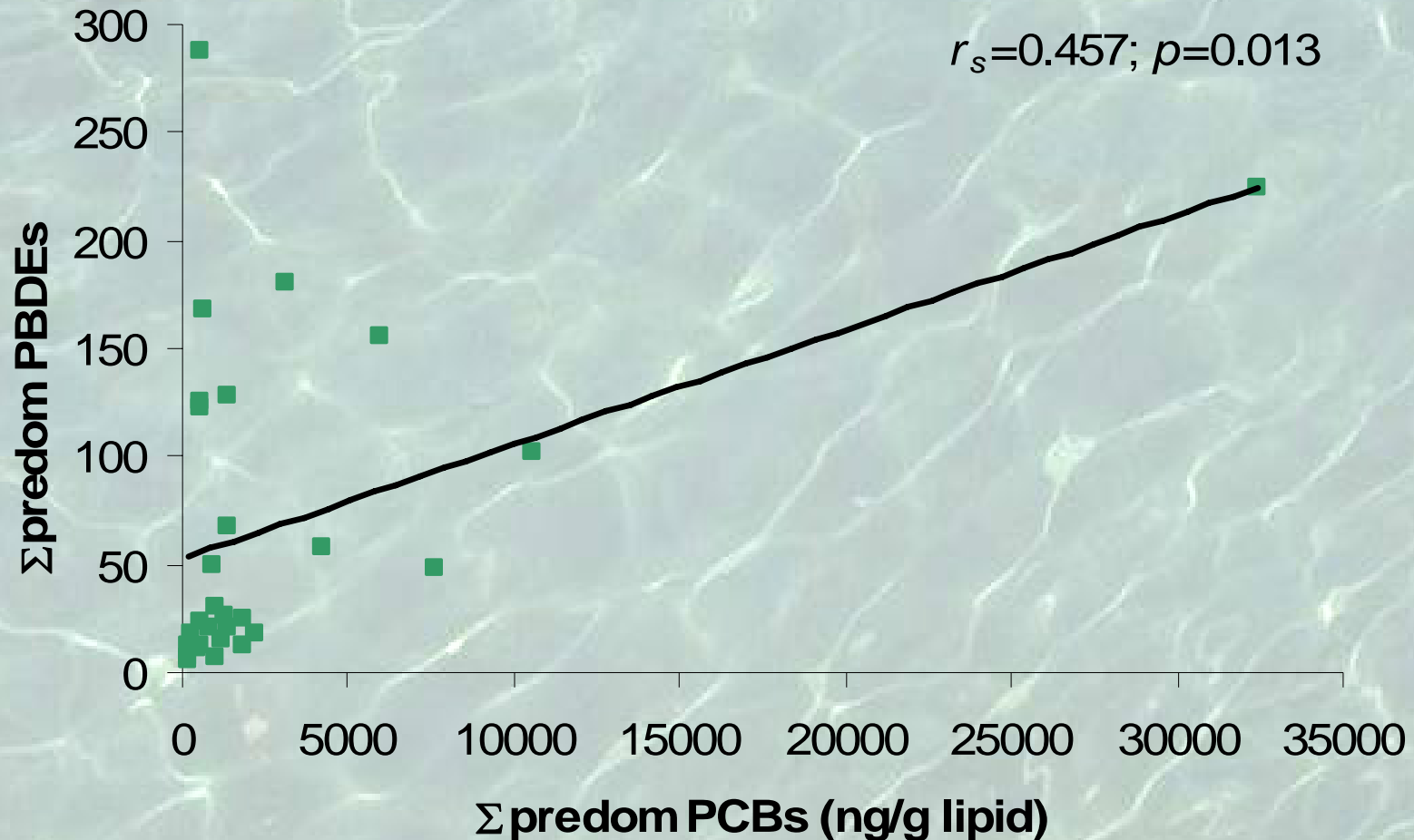


Plasma pattern similar to fish tissue and human plasma patterns.

Egg pattern is unique compared to bird eggs and turtle plasma.

(comparisons based on Hites, 2004)

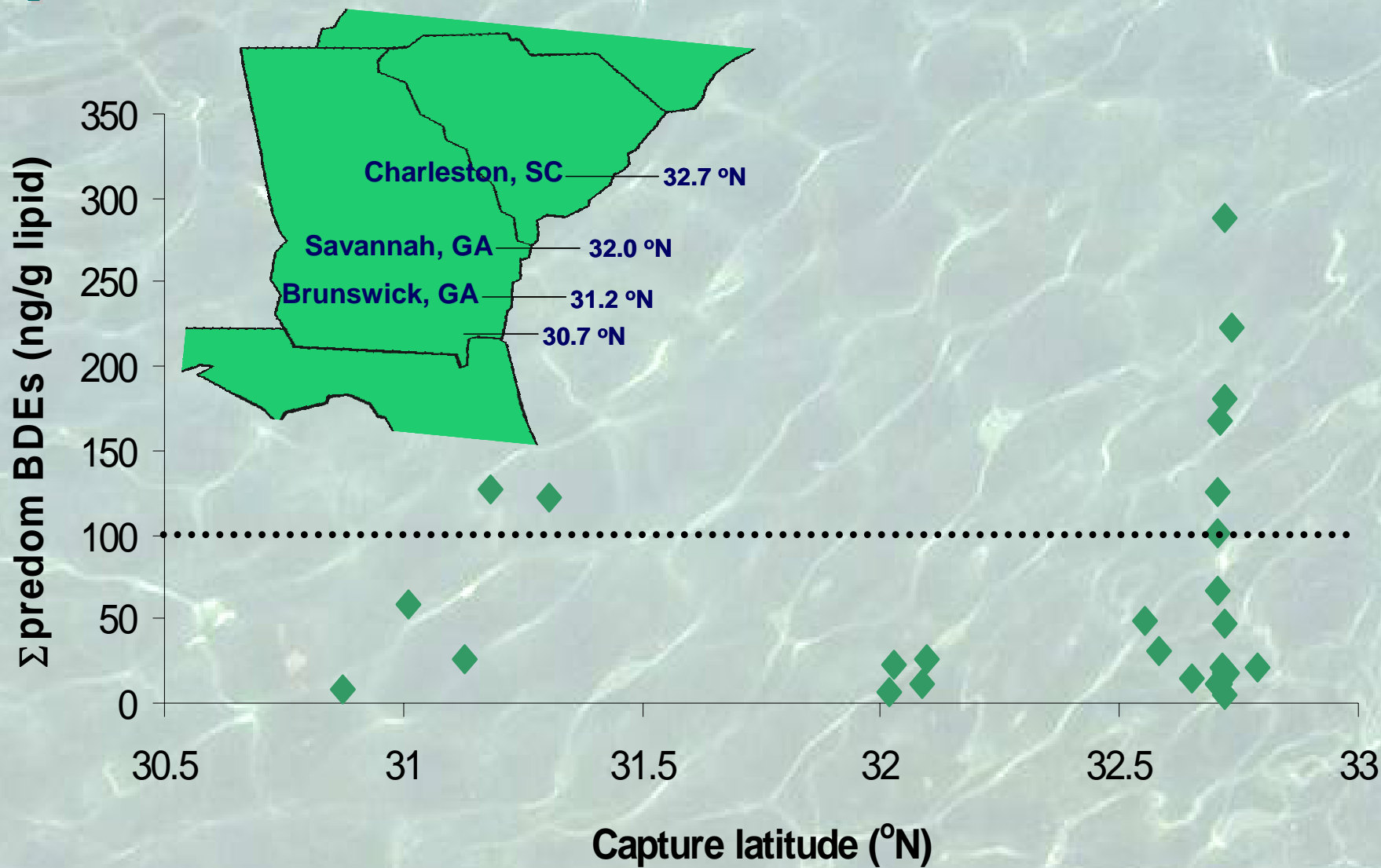
PBDEs versus PCBs – Plasma



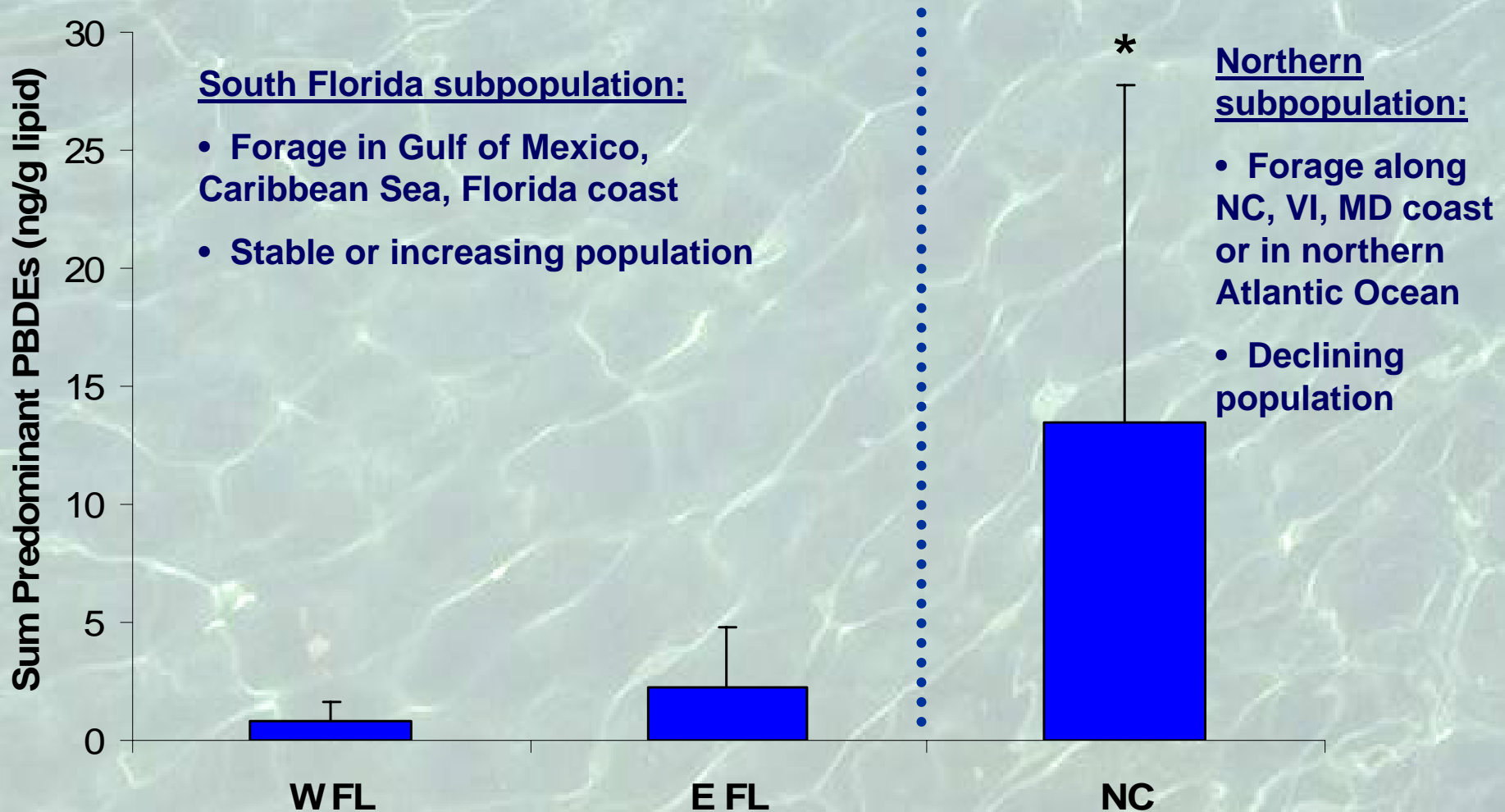
PBDEs were significantly correlated to PCBs when data are lipid normalized.

Not correlated with wet mass concentrations ($r_s = 0.303; p = 0.111$).

Spatial trends – Plasma



Spatial trends – Egg yolk



Satellite tagging studies: Plotkin and Spotila (2002); Hopkins-Murphy et al (in press); Foley et al (in press).

* ANOVA $P < 0.001$

Conclusions

- **Loggerhead PBDE concentrations were slightly lower than humans and birds.**
- **Concentrations in plasma were higher than in eggs.**
- **Egg PBDE pattern is unique and warrants further study.**
- **Turtles captured near Brunswick, GA and Charleston, SC had higher PBDE concentrations than turtles captured near Savannah, GA or the FL border.**
- **Nesting beach location strongly influenced the egg PBDE concentrations, suggesting that turtles nesting in NC forage in areas with higher contamination.**

Future Directions

- **Confirm the absence of PBDE 209 and screen for HBCD**
- **Compare PBDE concentrations to health parameters**
 - **Plasma comparisons to be presented by Brianna Young Carlson at SETAC 2005**
 - **Egg comparisons to be presented by Juan J. Alava at SETAC 2005**

Acknowledgements

- **Al Segars, David Whitaker, Phil Maier, and Mike Arendt from SC DNR for the plasma samples**
- **Jesse Marsh, Catherine McClellan, Matt Rush, Kim Blair, Lesley Stokes, Kelly Stewart, Matthew Godfrey, Jeff Cordes, Jerris Foote, Kirt Rusenko, Chris Johnson, Michael Bresette, Rick Herren, Stacy Kubis, Kelly Roberts, and Dean Bagley for egg collection.**
- **Larry Crowder, Jeanette Wyneken, Geoffrey Scott, Paul Becker, Stacy Vander Pol, and Bob Swarthout for their helpful contributions.**
- **Funding from NMFS to SC DNR (JDW)**
- **Funding from EPA to Larry Crowder and Jeanette Wyneken**
- **Funding from Fulbright (JJA)**



Asaf Senol