

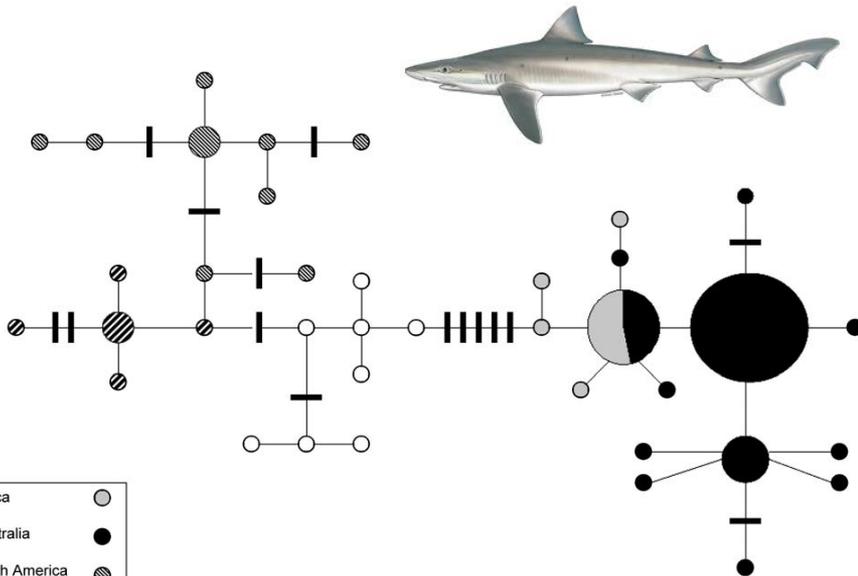
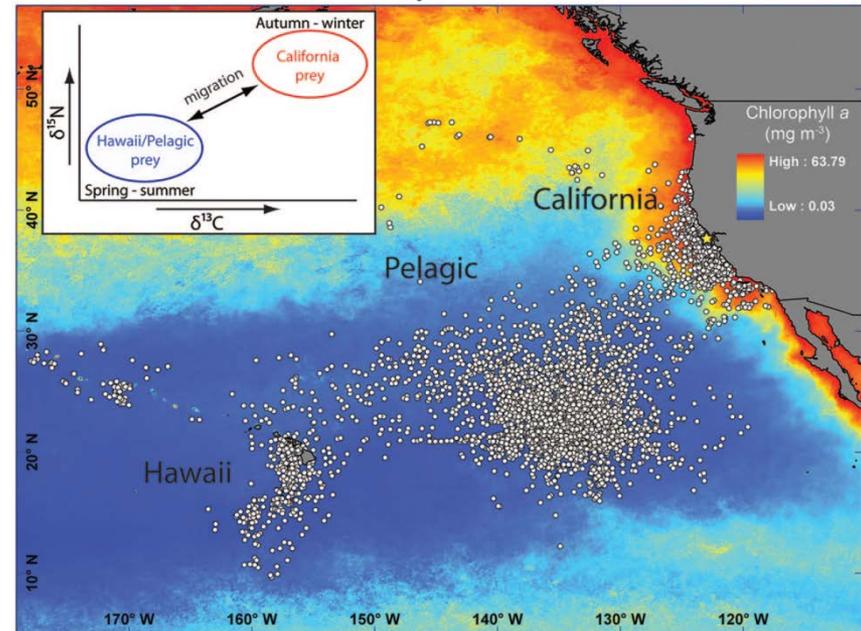
Movements and Ecology

- Important for understanding:
 - Population structure
 - Key for fisheries management
 - Location of important habitats (in space and time)
 - Feeding, mating, pupping areas
 - Marine Protected Area development
 - Potential interaction with fisheries
 - Effect of anthropogenic activities
 - Effect of environment on populations (temperature, salinity)
 - Effect of climate change
 - Interactions with other species (predator/prey dynamics)



Studying Movements and Ecology

- Tagging
- Stable isotope analysis
- Genetics
- Observational data
 - Surveys
 - Fishing catch records



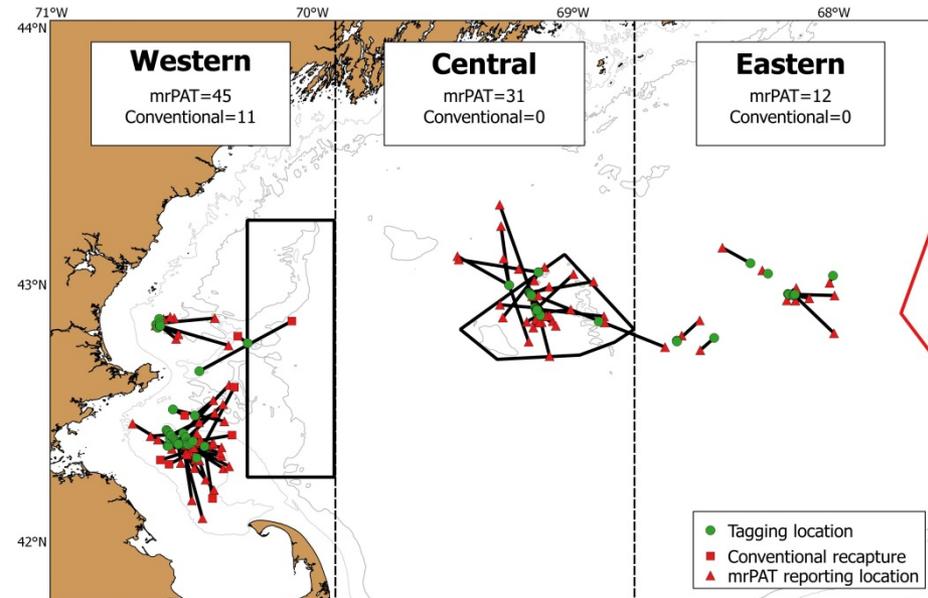
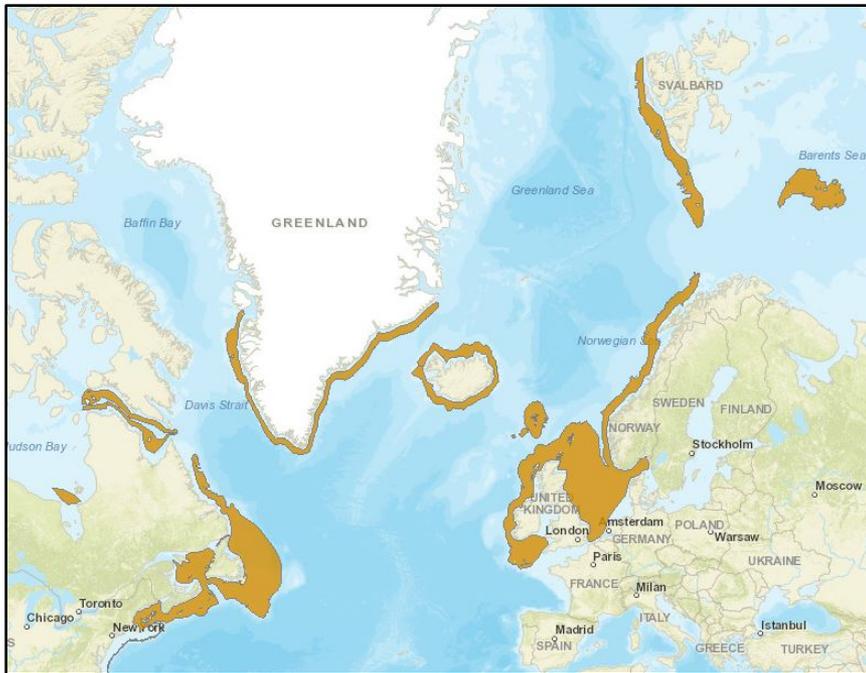
Africa	○
Australia	●
North America	◐
South America	○
UK	◑

Range (Geographic)

- Geographic extent of population in an area (e.g., global vs. ocean basin)
- Impacted by genetics, environment (temperature), oceanographic conditions

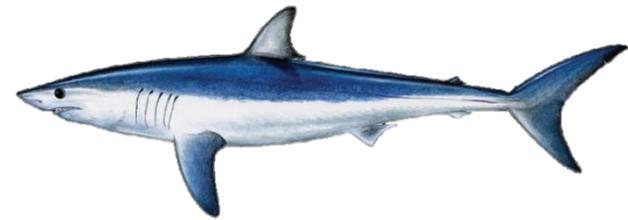


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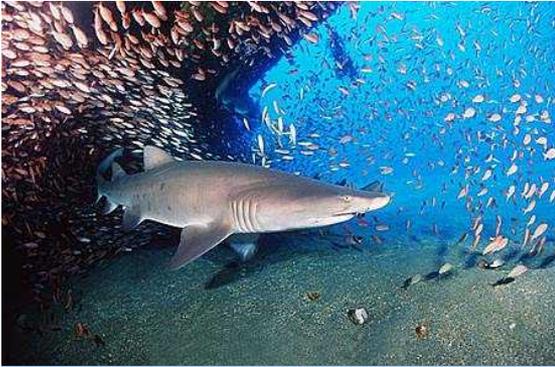
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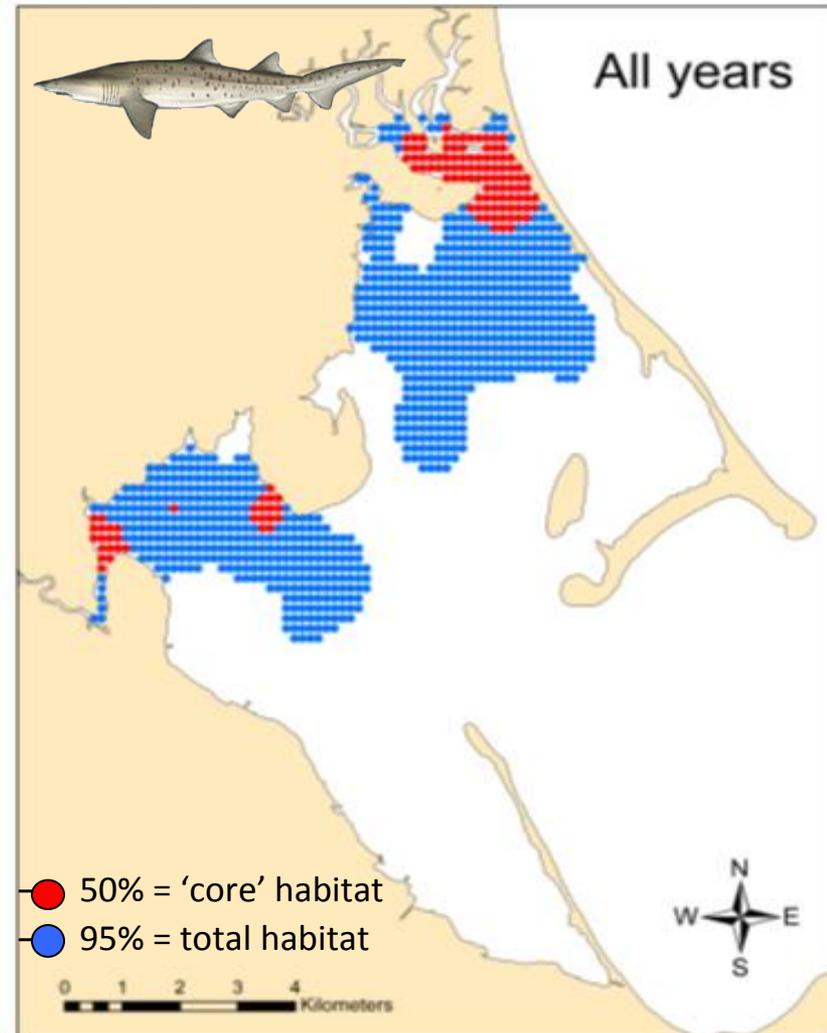
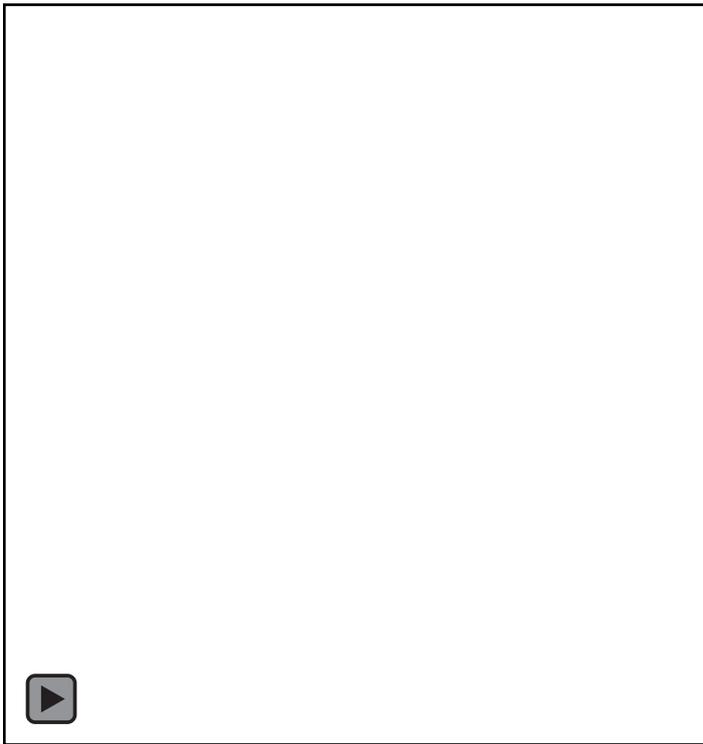
Habitat Use

- Specific areas where the animals are commonly found
 - Substrates: coral reefs, seagrass, rocky reefs, sandy bottom, open ocean
 - Environments: surface waters, thermocline, deep ocean
- Habitat use/choice impacted by season, environment, prey, predators, life stage



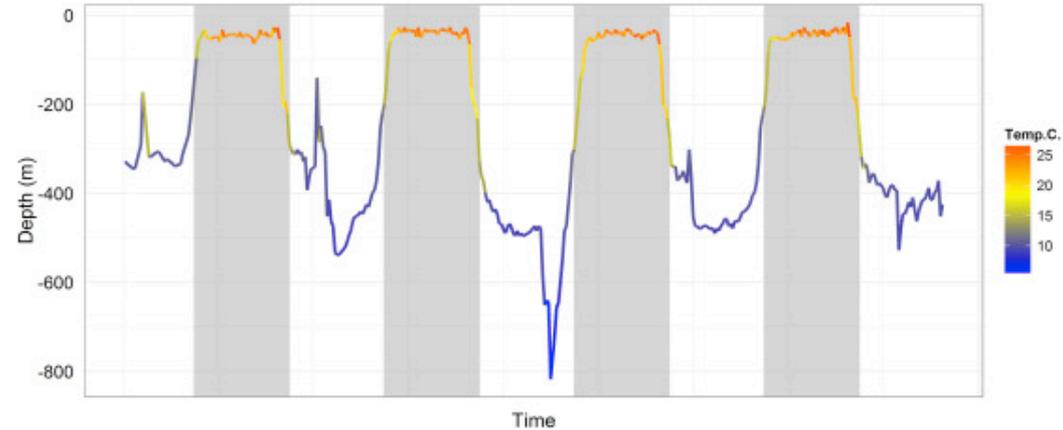
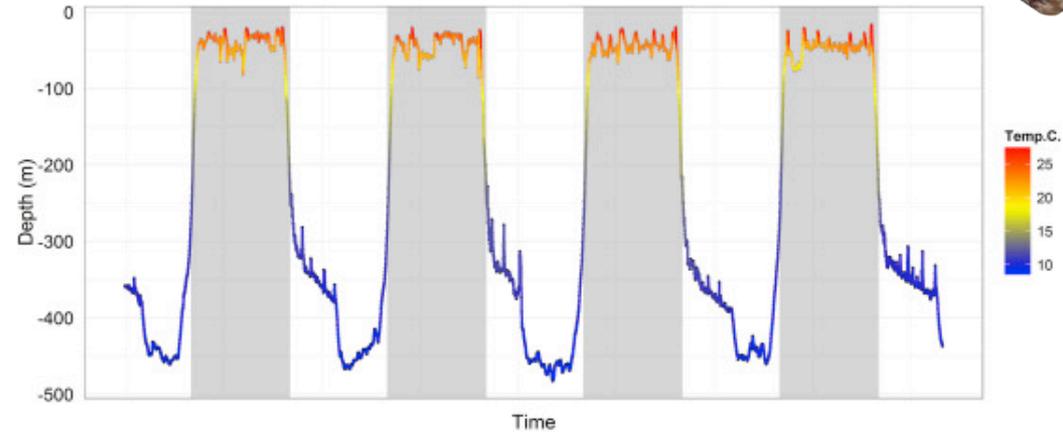
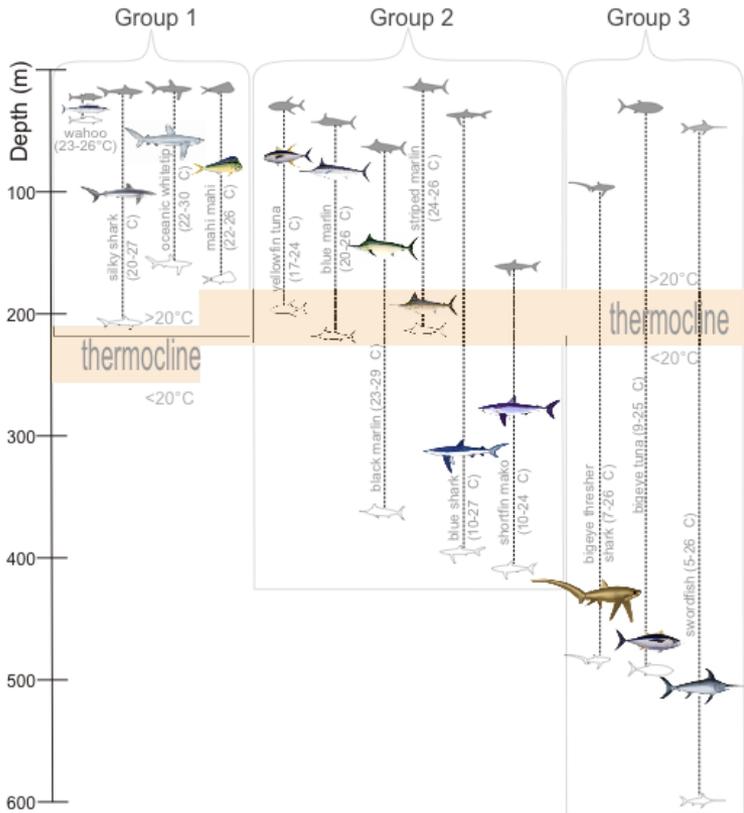
Movements: Small & Short Scale

- Home range: 'area traversed by an animal in its normal activities'
- Normal activities: prey searching (hunting), mating
- Environmentally driven
 - Temperature, salinity, oxygen
 - Tide, time of day, moon phase
- Time scale: hours to months
- Site fidelity: remain or return to same area



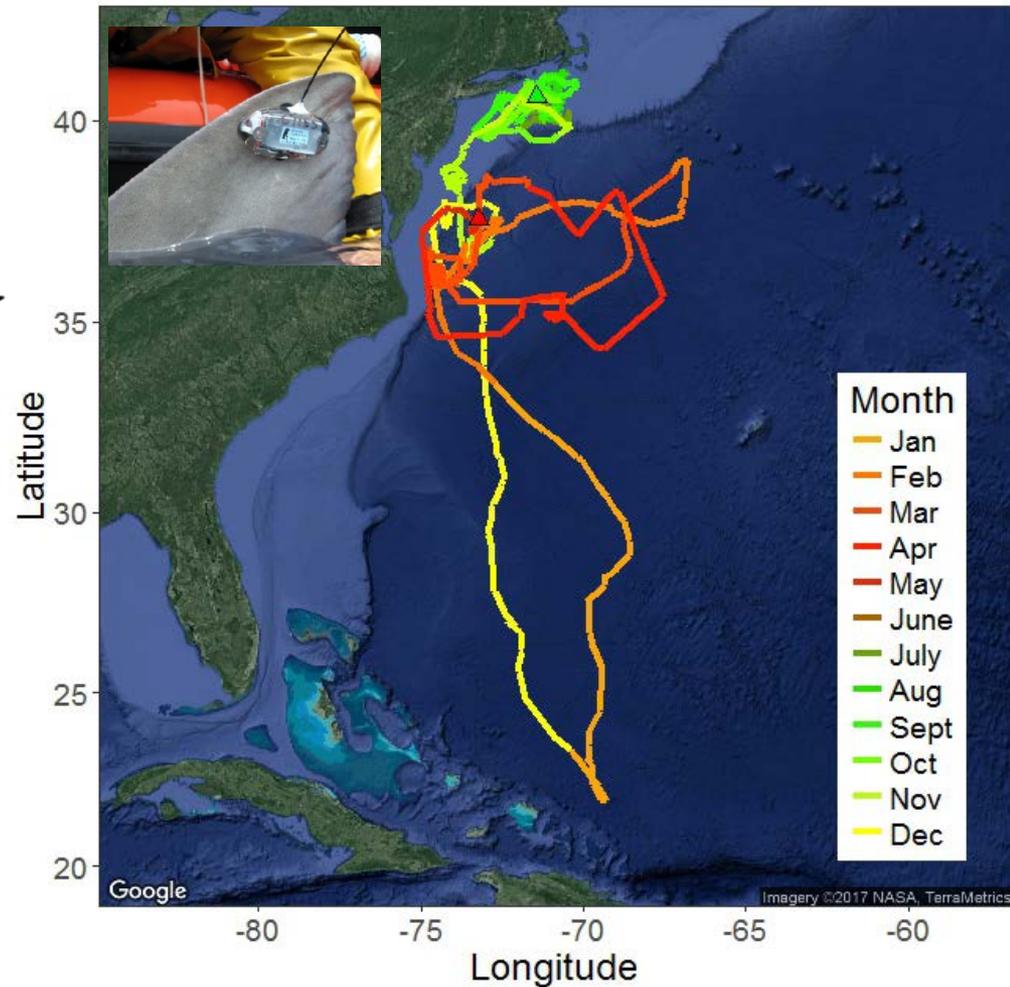
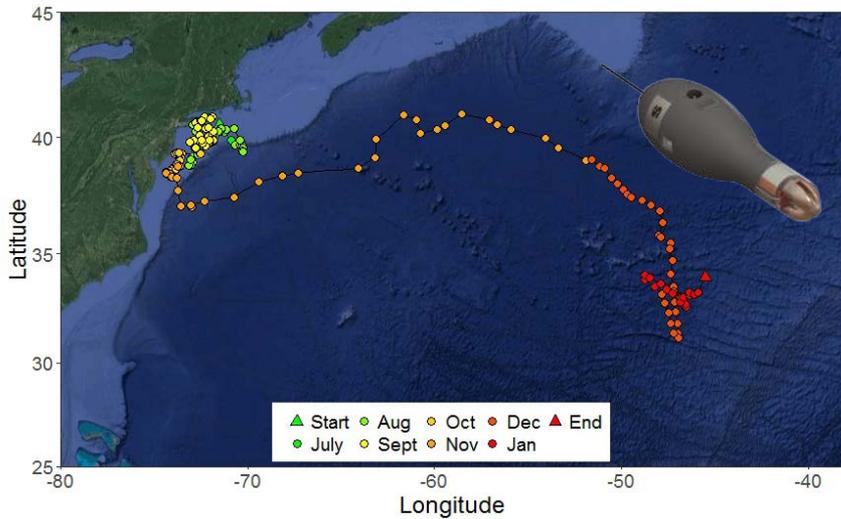
Vertical Movements

- Related to feeding or metabolism/physiology
- Diel vertical migration
 - Deep during day, shallow at night (vice versa)
 - Following prey?
 - Assists with digestion



Movements: Large Scale

- Broad movements over extended time
- Related to:
 - Feeding
 - Reproduction (mating/pupping)
 - Environmental conditions
 - Population structure (genetics)

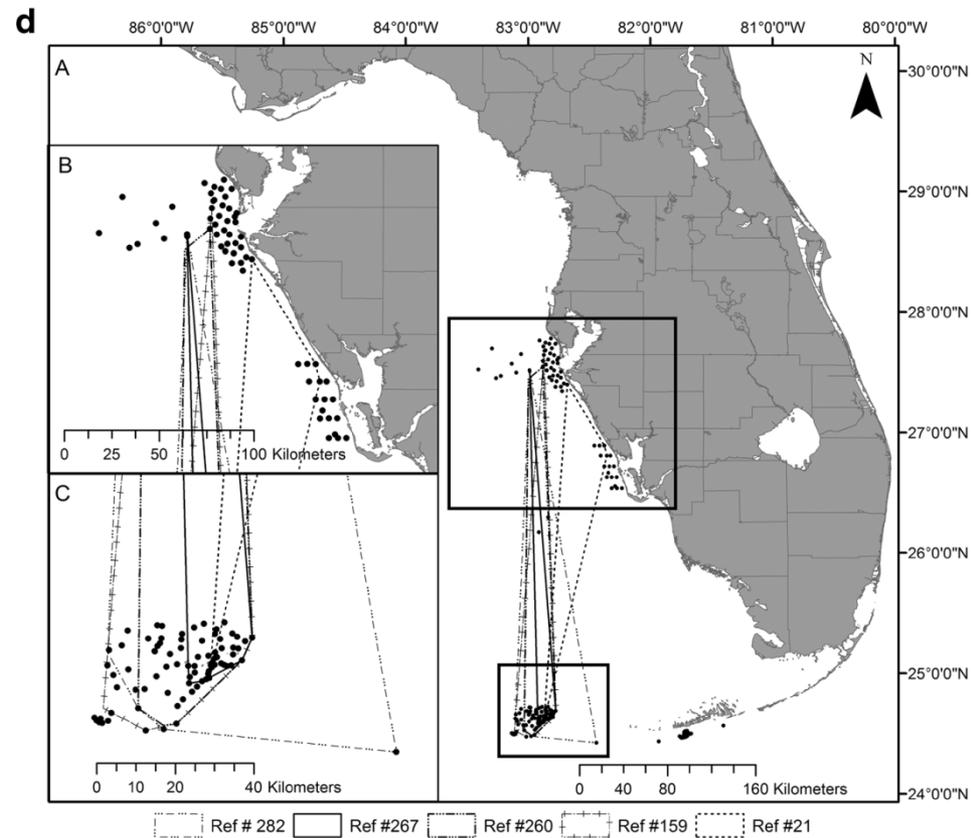
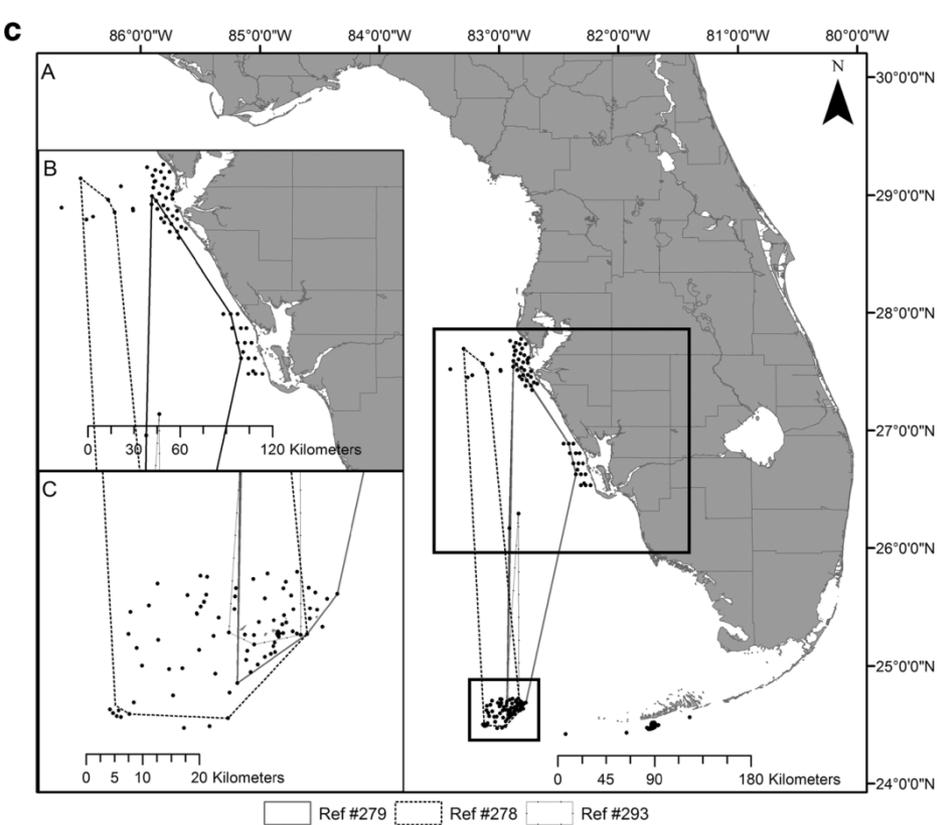


Migration: Feeding and Mating

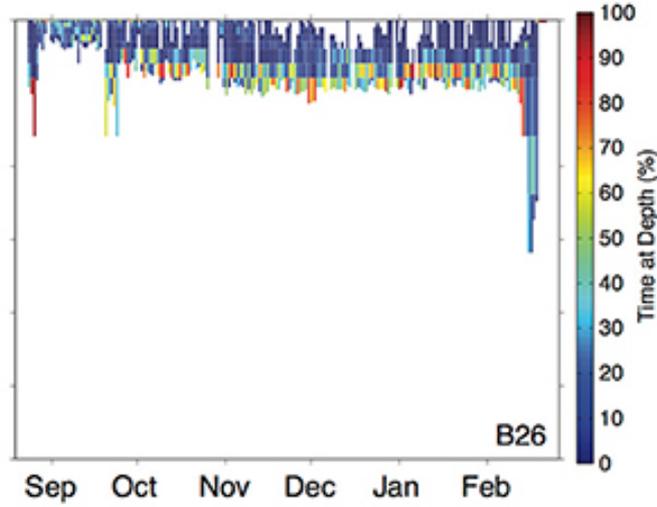
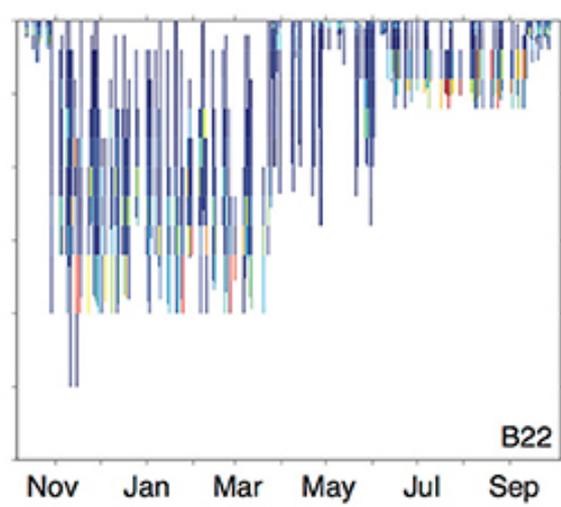
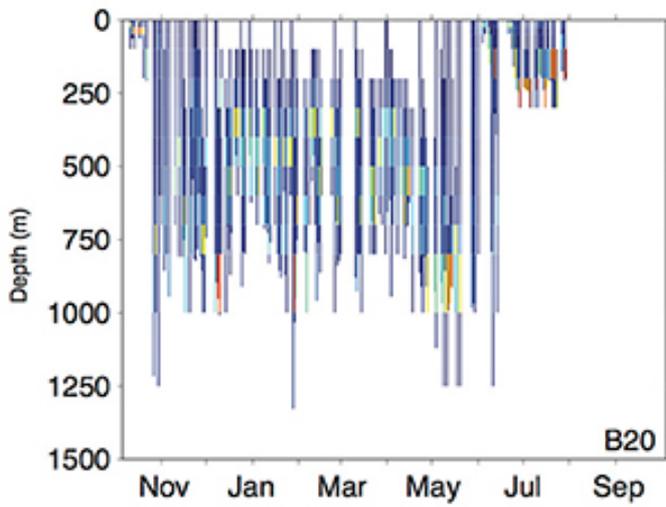
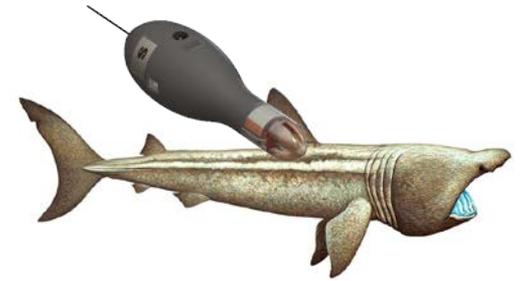
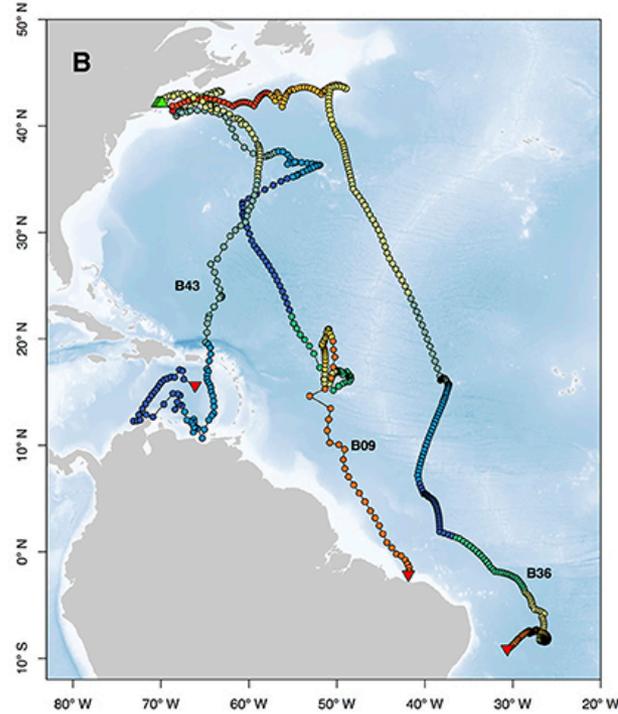
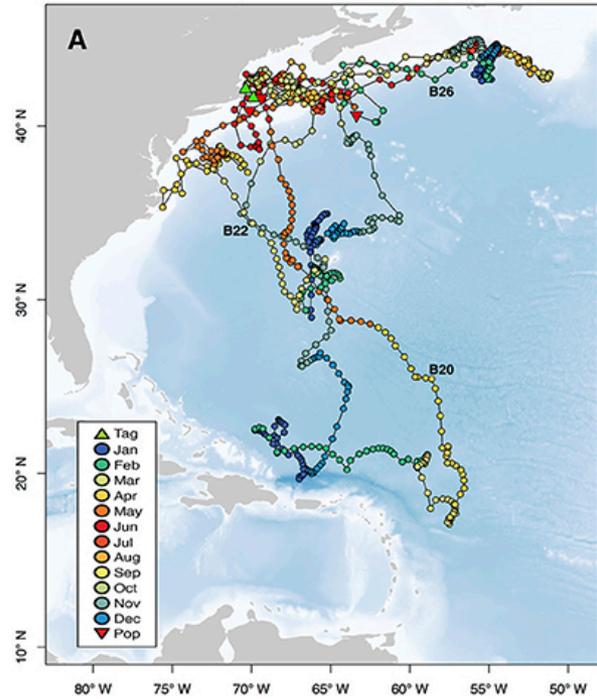


Males

Females



Migration: Vertical Component



Nursery Areas

- Areas that foster juvenile growth and survival
- Ecologically sensitive and important for population maintenance
- Considered Essential Fish Habitat (EFH)
 - Essential areas for feeding, breeding, growth to maturity
- Criteria for nursery areas (Heupel et al. 2007)
 - 1) sharks are commonly encountered
 - 2) remain or return for extended periods (site fidelity)
 - 3) area is repeatedly used across years (sometimes by the same individuals)



Nursery Areas (Where and When)

- Where....
 - Females go to give birth
 - Sharks spend the first part of their lives
 - Birth places
 - Where they move to after being born
 - Variable habitats (physically and environmentally)
 - Shallow areas
 - Coastal bays
 - Estuaries
 - Open ocean
- When.....
 - Tropical climates (year round)
 - Temperate climates (seasonal)
 - Variable residence times
 - Weeks
 - Months (Sand tigers: 1 – 4 months)
 - Years (Up to 5)



Nursery Areas (Why and How)

- Why.....
 - Provide access to prey resources
 - Provide protection from predators
 - Optimal temperature for metabolism/growth
- How....
 - Ecological tradeoffs
 - Many sharks in same area = intraspecific competition (slower growth?)
 - Vs.
 - Low risk of predation = higher probability of survival



Do all species use nurseries?

- Nurseries particularly important for species with small pups
- Species with large pups?

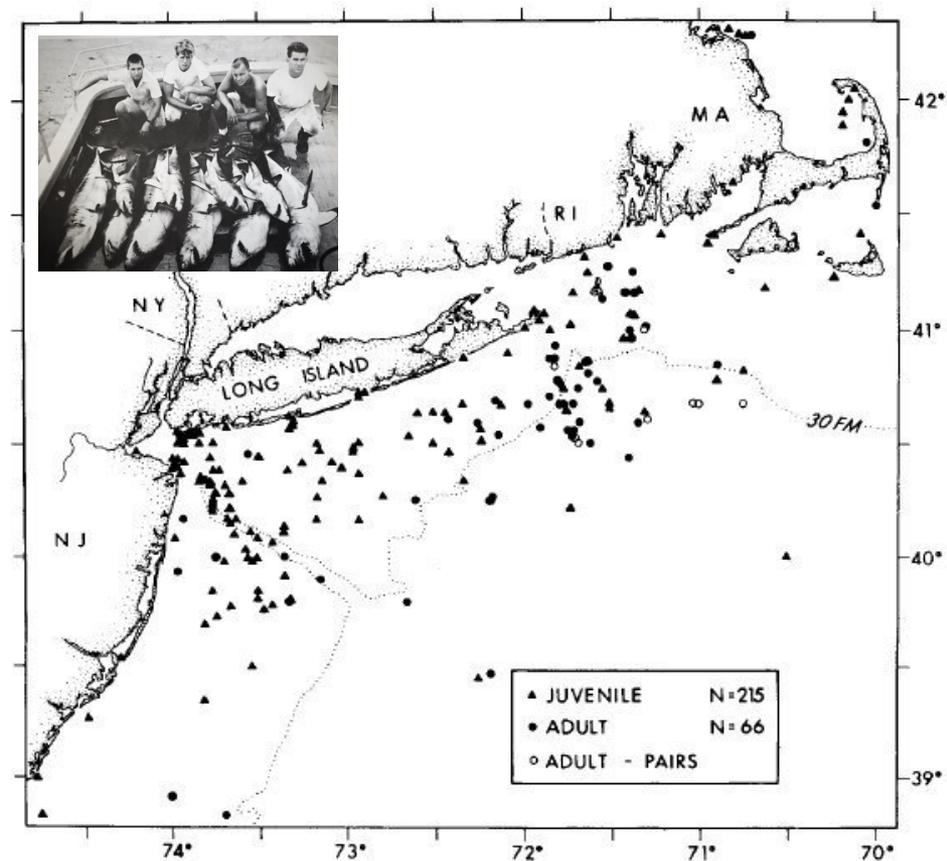
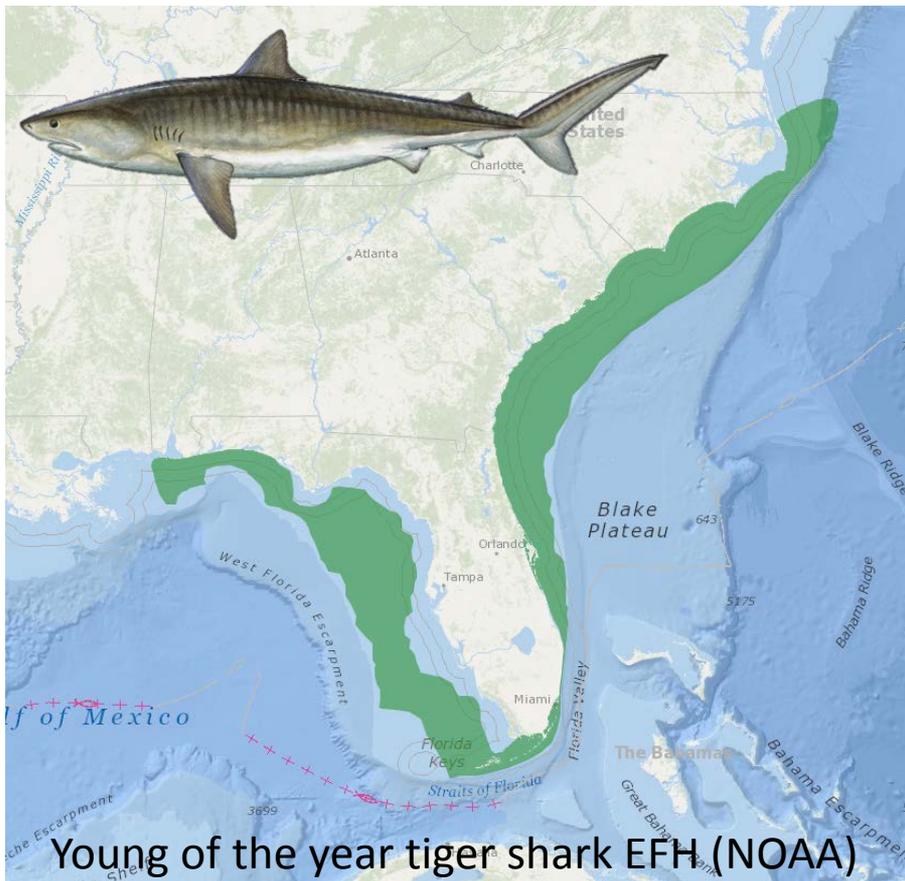
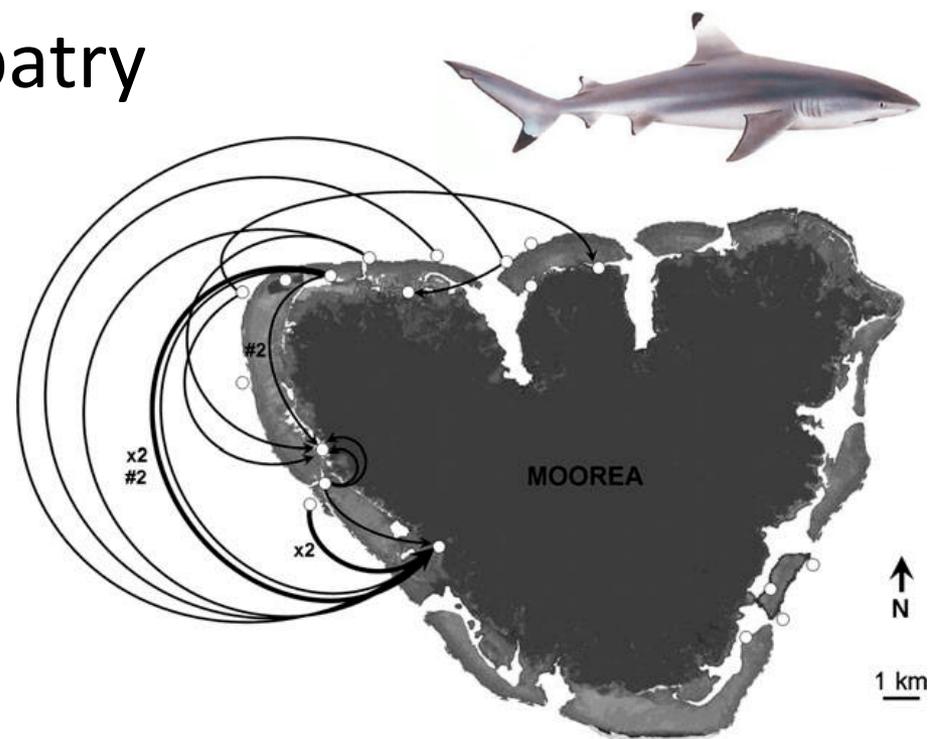


Fig. 2. Distribution of adult and juvenile white sharks between New Jersey and Massachusetts. All sources pooled n = 281.

Philopatry

- Tendency to return to one place
- Natal philopatry = return to birth place
- Females return to give birth over years
- Males often less philopatric



Female	2005	2006	2007	2008	2009	Other
F06		*10 J5A J7A J1A				
F11			M09 J2B		*1 J1D J3D J4D J16D J9D	*3
F21				*5 J1C	*6 J2C	
F30			M04 J6B J6C		*3 J7D J8D J11D J12D J14D J15D	*4 J10D J13D J17D
#1			M04 M09 J1B J5B		*2 J2D	*2 Tet1
#2	*10 Sub1		M12 J7B		M05 J5D	
#3				*6 J4C	*2 J6D	
#4				M05 J3C		
#5				*7 J5C		

