Linking stable isotope analysis with skeletochronology to determine life history patterns in sea turtles

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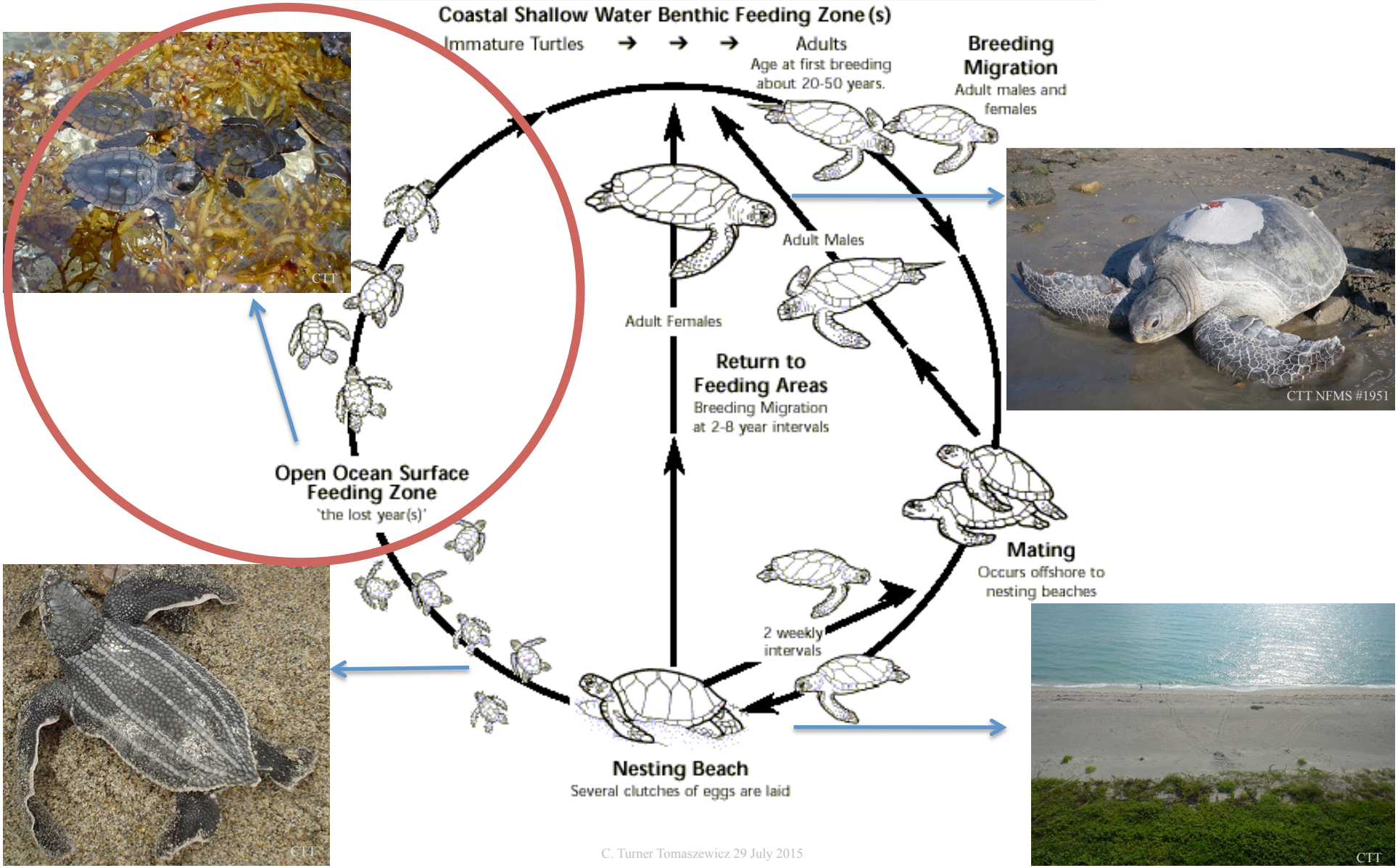
Review of NOAA Fisheries' Science on Marine Mammals & Turtles

Southwest and Northwest Fisheries Science Centers

27-31 July 2015

La Jolla, CA

Where do they go?
How long are they there?



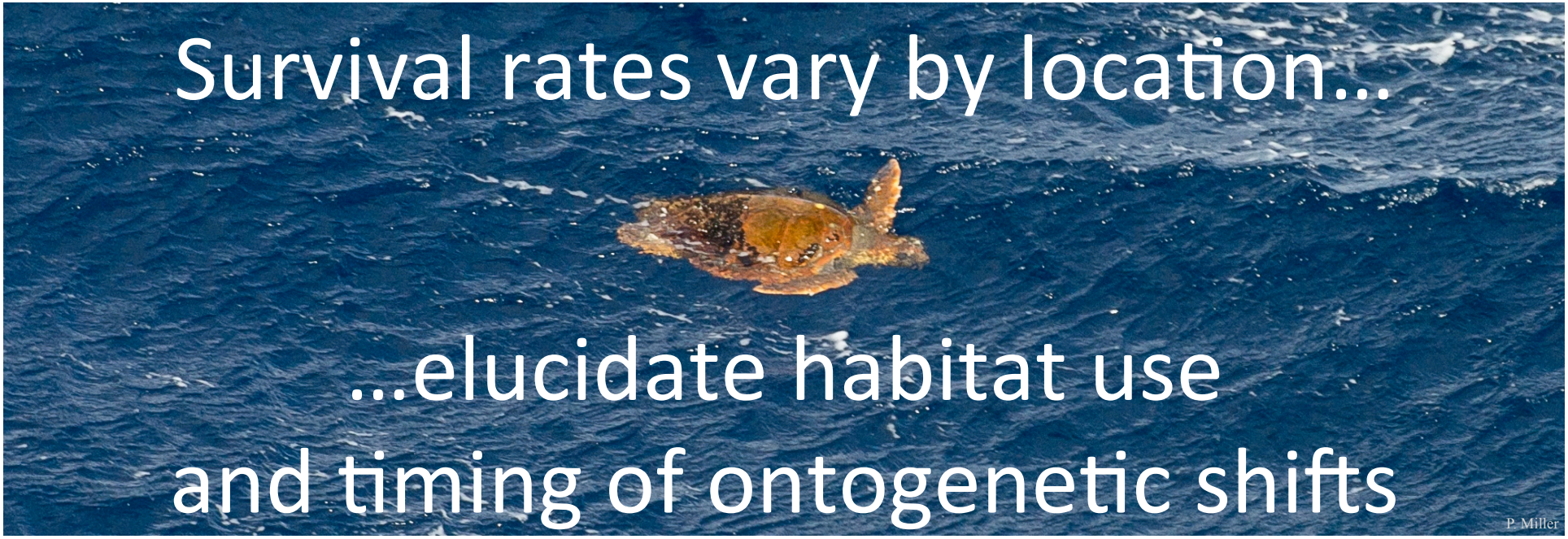
Differential threats

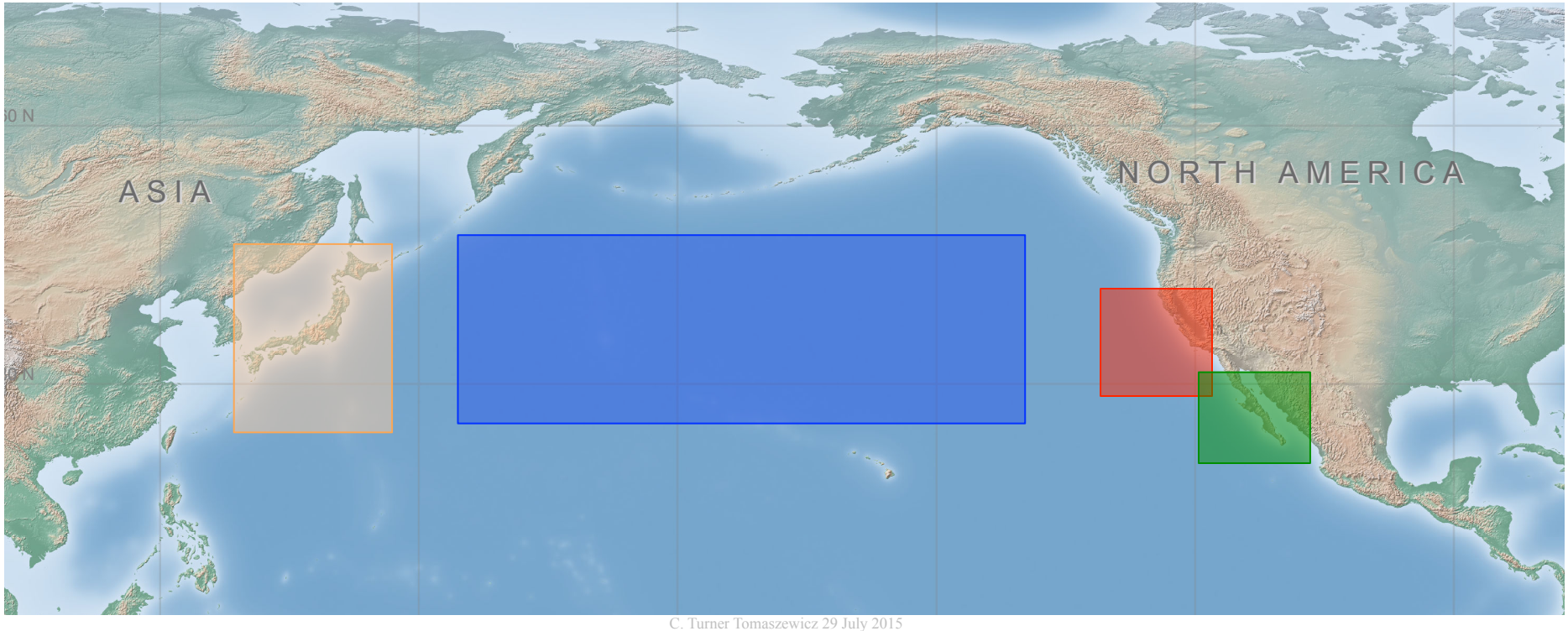
Offshore

i.e. Industrial Longline Fishery

Nearshore

i.e. Trawl Fishery





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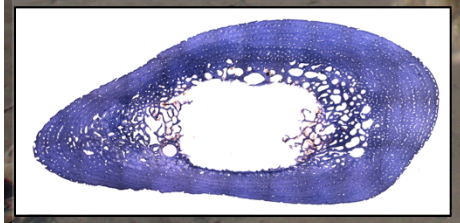
Track individual turtles for multiple years

Use stranded animals, inherently focus on at-risk populations and critical habitats

- Habitat use and connectivity
- Identify ontogenetic habitat shifts
  - At what age? (i.e. age at settlement, maturation)
  - At what size?
- Determine residency duration
- Monitor changes after events (i.e. Fukashima, oil spill)

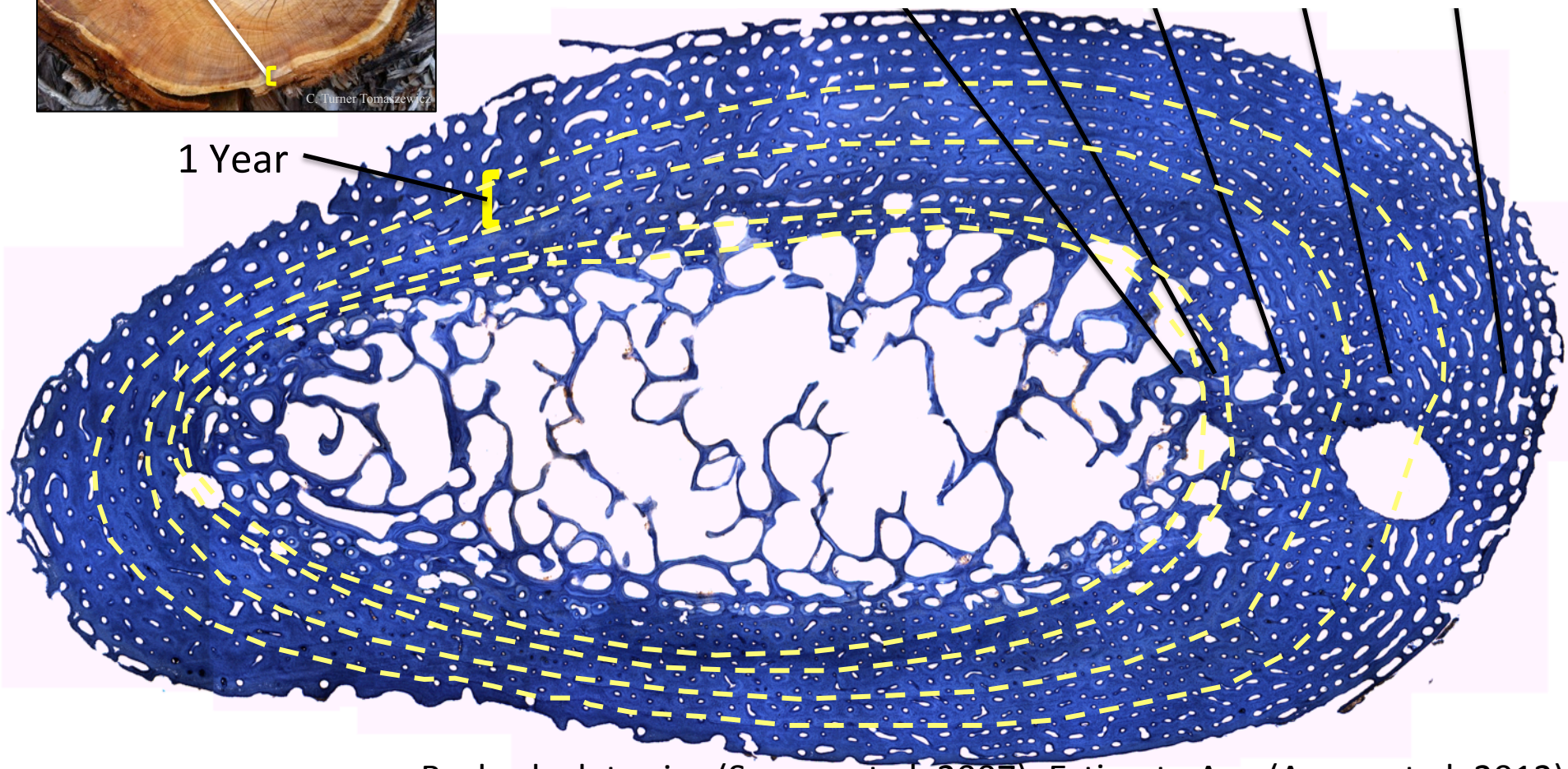


Skeletochronology

Stable Isotope Analysis

Skeletochronology: Multi-year demographic data

	2005	2006	2007	2008	Stranded: 2009
Est. CCL:	32 cm	33 cm	38 cm	43 cm	50 cm
Est. Age:	4 yrs	5 yrs	6 yrs	7 yrs	8 yrs

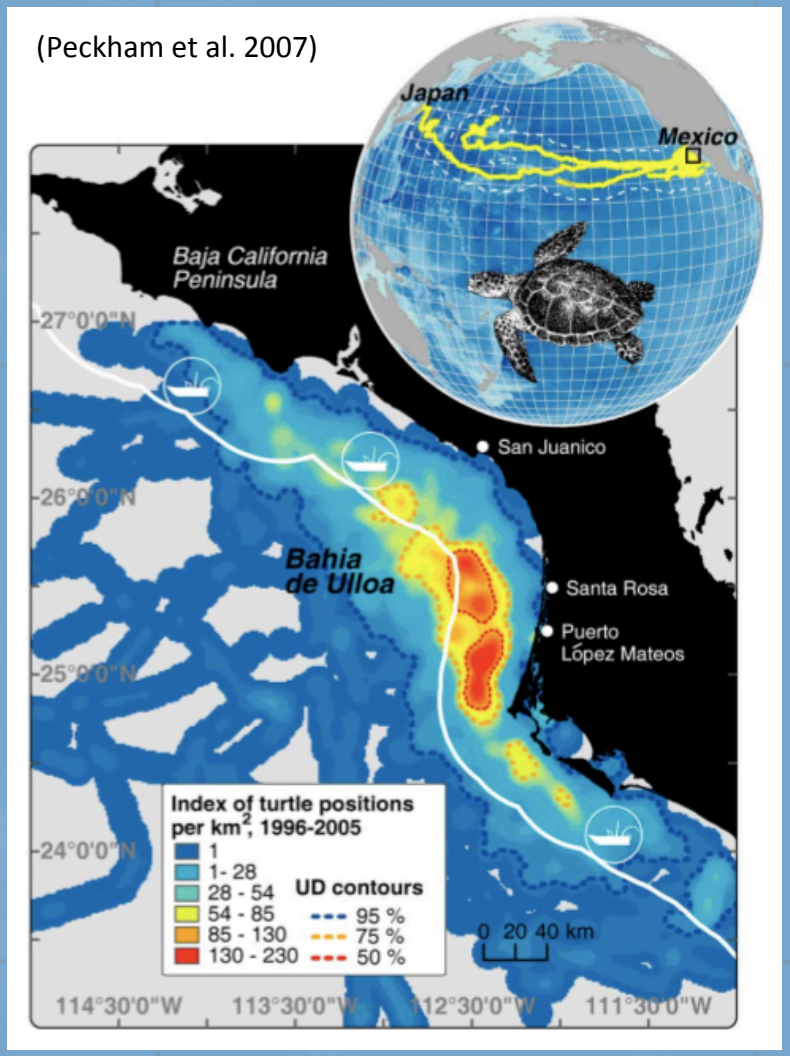


Backcalculate size (Snover et al. 2007); Estimate Age (Avens et al. 2012)

Estimate survivorship in eastern Pacific juvenile foraging habitat

~ 43,000 loggerheads

Est. 11 % annual mortality rate



~1,000 mortalities annually

(Seminoff et al., 2014, Koch et al., 2013, Peckham et al., 2008)

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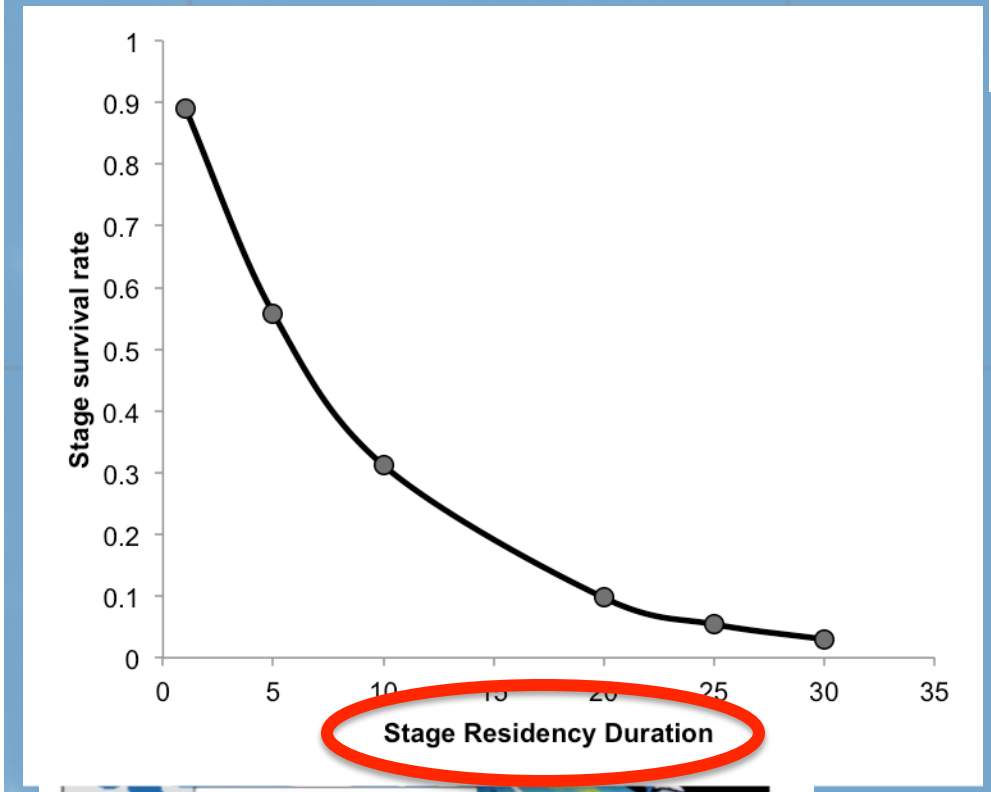
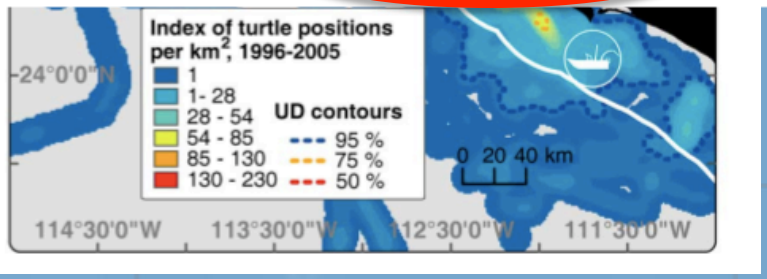
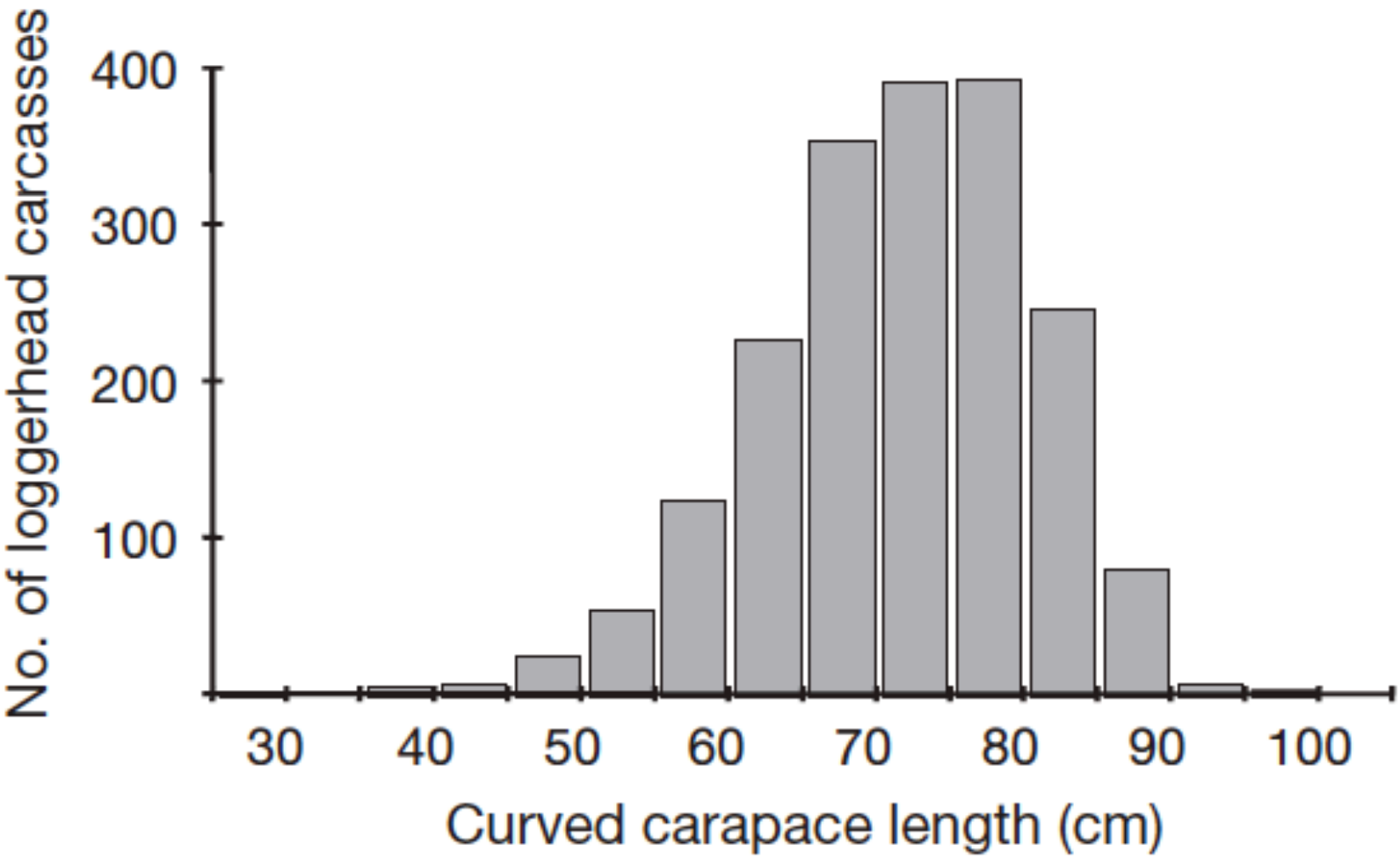




(Seminoff et al., 2014, Koch et al., 2013, Peckham et al., 2008)

~1,000 mortalities annually

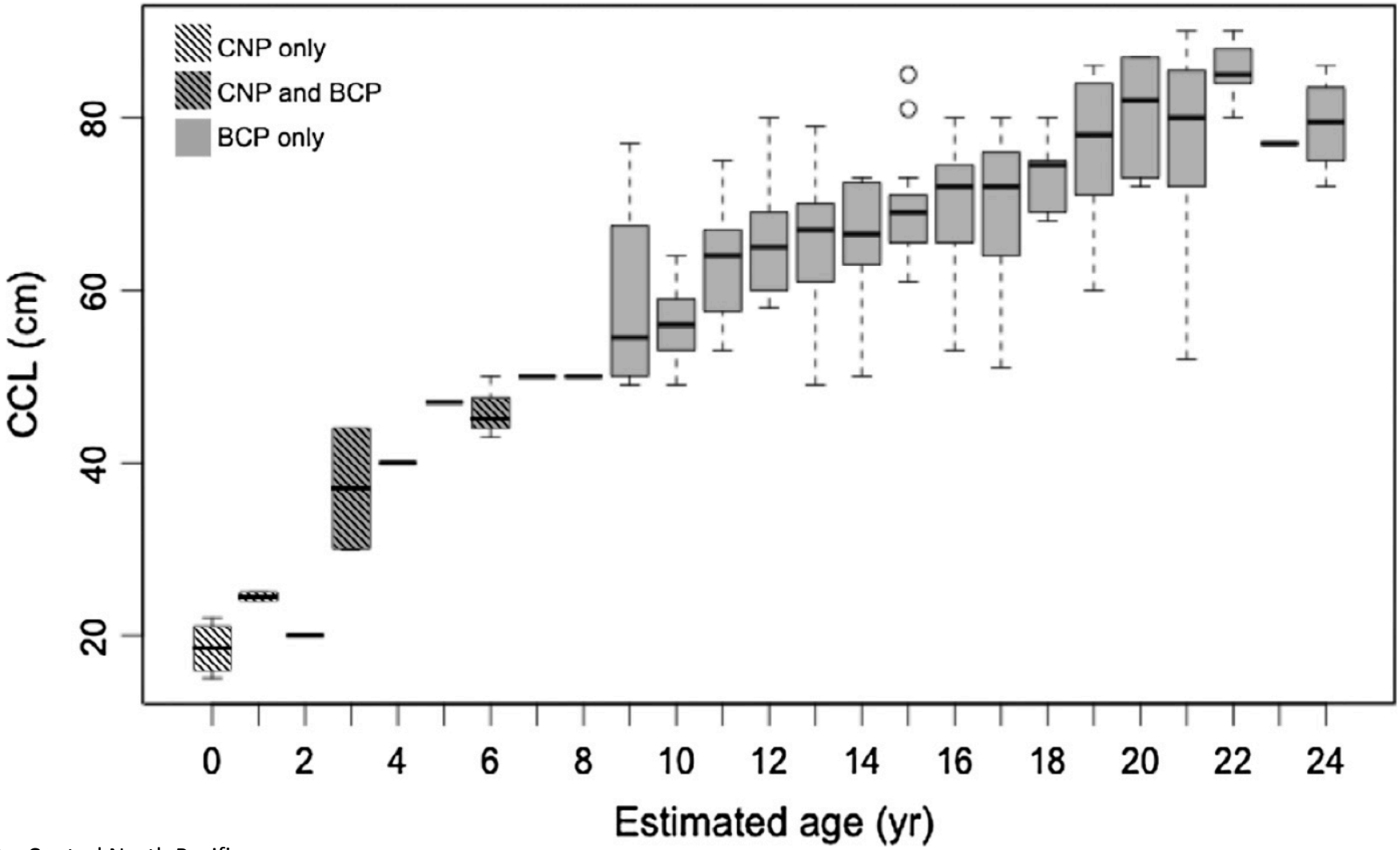
Size distribution of stranded turtles



Years 2003-2007
(n = 1918)

(Peckham et al., 2008)

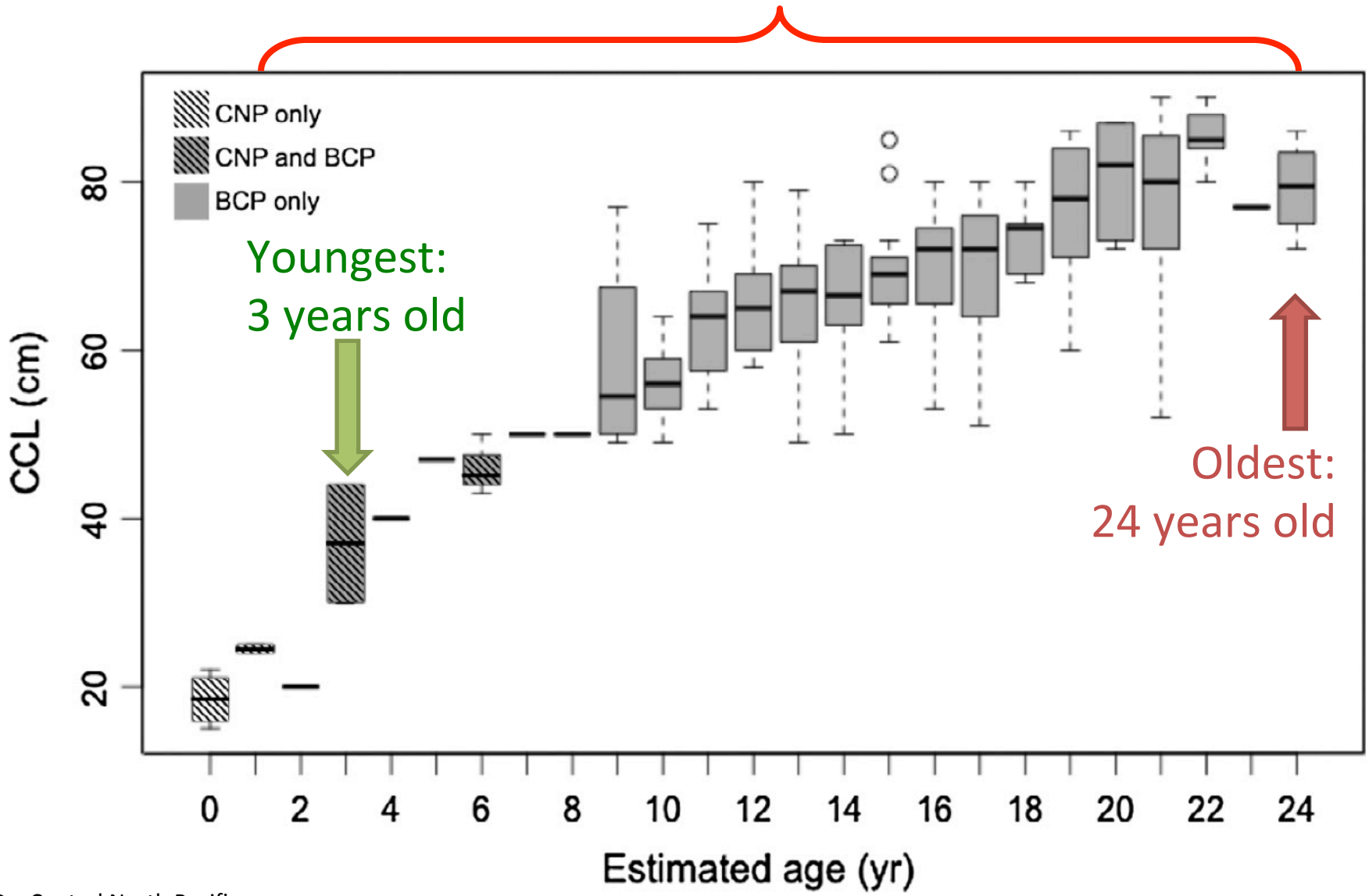
Body size at age of stranded turtles



CNP = Central North Pacific
BCP = Baja California Peninsula
CCL = Curved Carapace Length

(Turner Tomaszewicz et al., 2015)

Spend ~20 years in high-bycatch area



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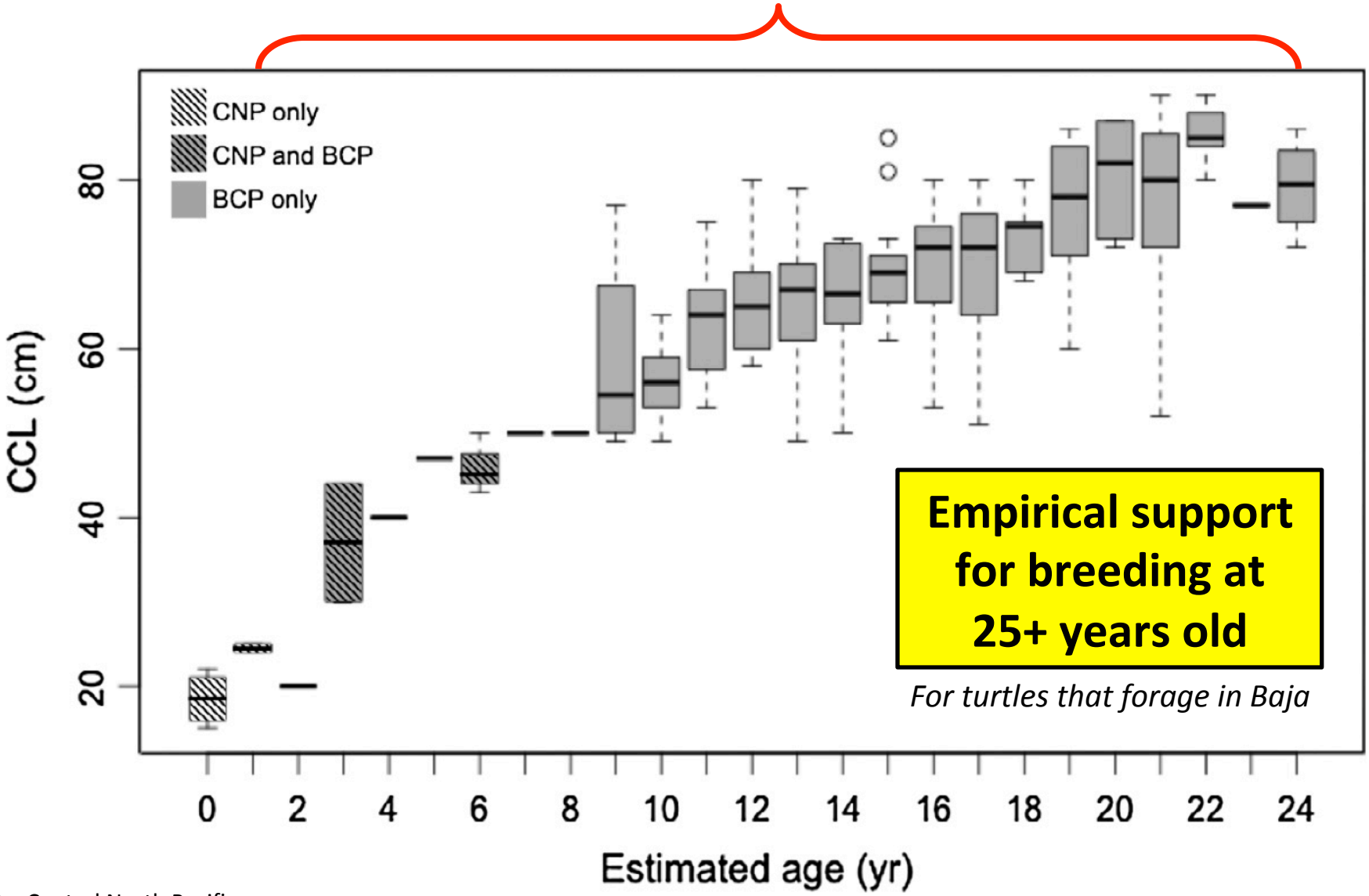

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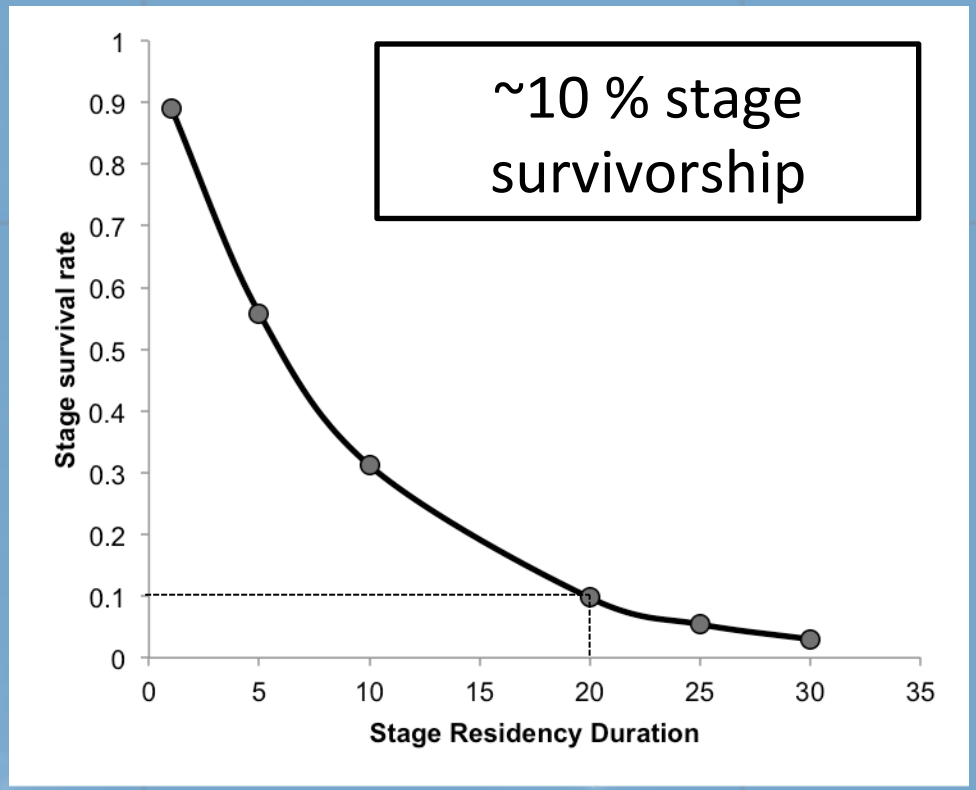
(Turner Tomaszewicz et al., 2015)

Survivorship in Baja juvenile foraging habitat

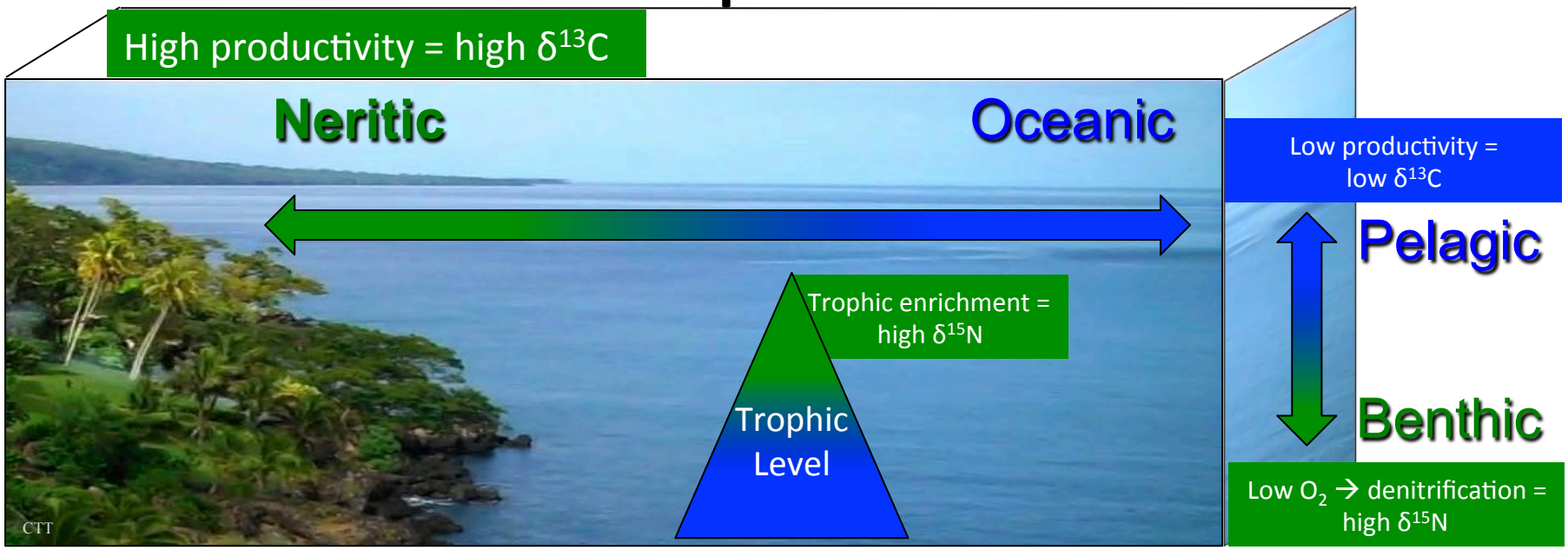
~ 43,000 loggerheads
11 % annual mortality rate



(Seminoff et al., 2014, Koch et al., 2013, Peckham et al., 2008, Turner Tomaszewicz et al., 2015)

Skeletochronology = TIME
LOCATION = ?
Skeletochronology
Stable Isotope Analysis

Stable Isotope Gradients



Carbon ($\delta^{13}C$)

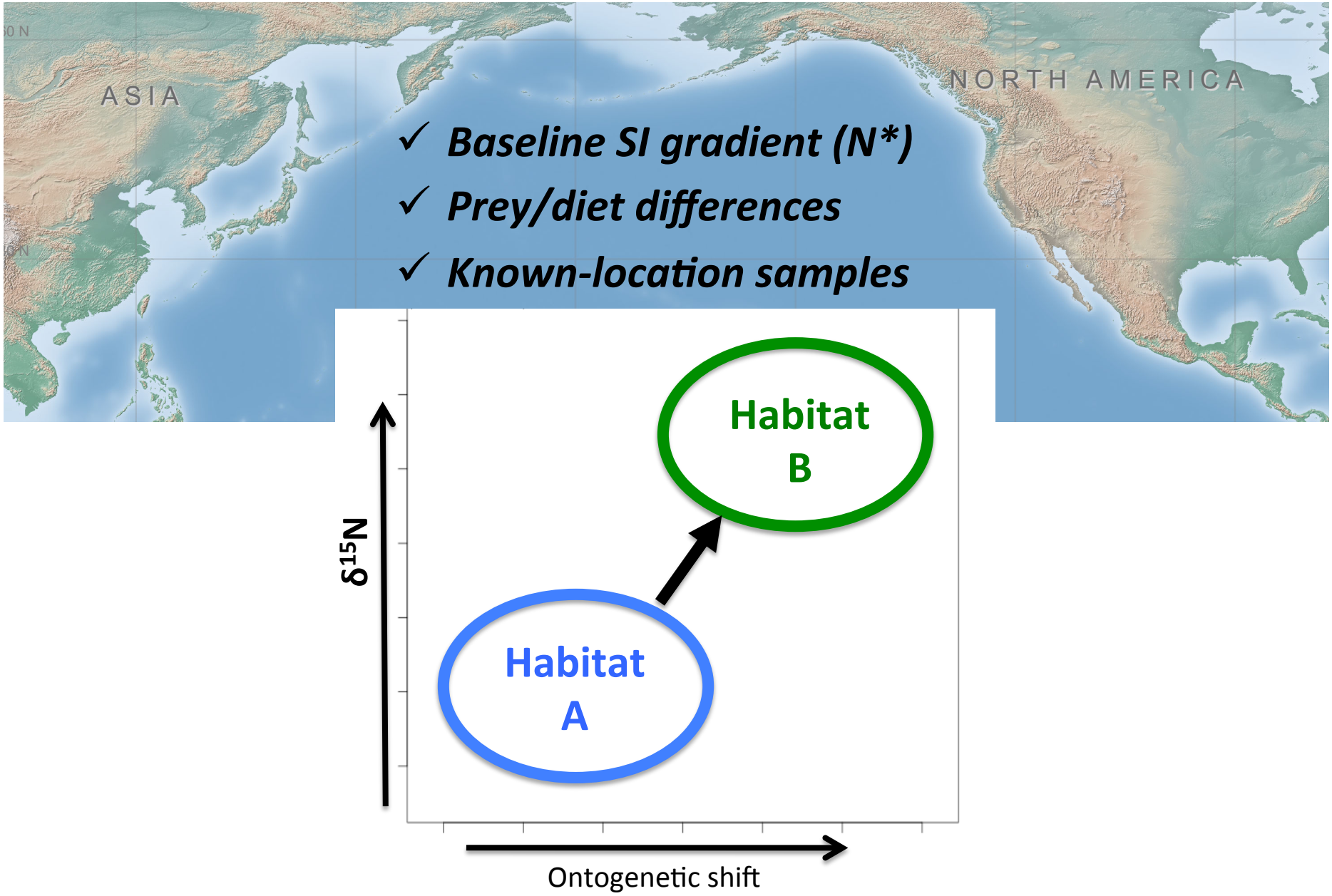
Depleted $\delta^{13}C$	Enriched $\delta^{13}C$
Oceanic	Neritic
Pelagic	Benthic
High latitudes	Low latitudes

Nitrogen ($\delta^{15}N$)

Depleted $\delta^{15}N$	Enriched $\delta^{15}N$
Low Trophic Level	High Trophic Level
West & Central Pacific - Nitrogen fixation	East Pacific - Denitrification
Oceanic pelagic prey	Neritic benthic prey

(Figure adapted from Reich et al. 2010. Post 2002; Olson et al. 2010; Snover et al. 2010; Somes 2010; review in McMahon et al. 2013)

Isotopically distinct habitats



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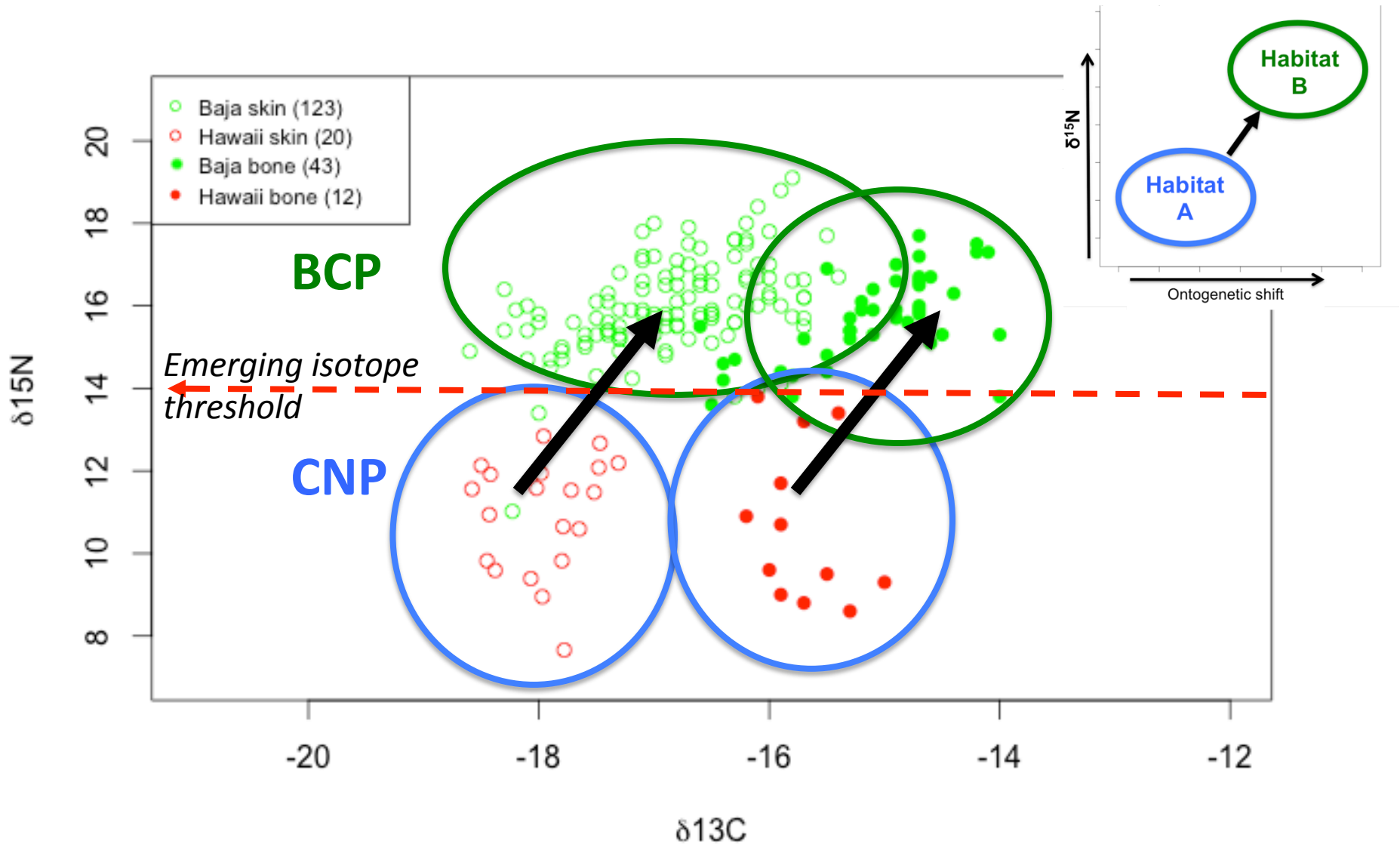
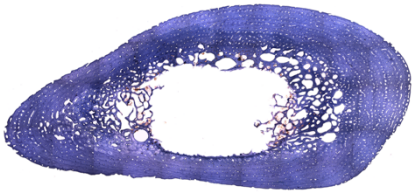
Validate isotopically distinct locations



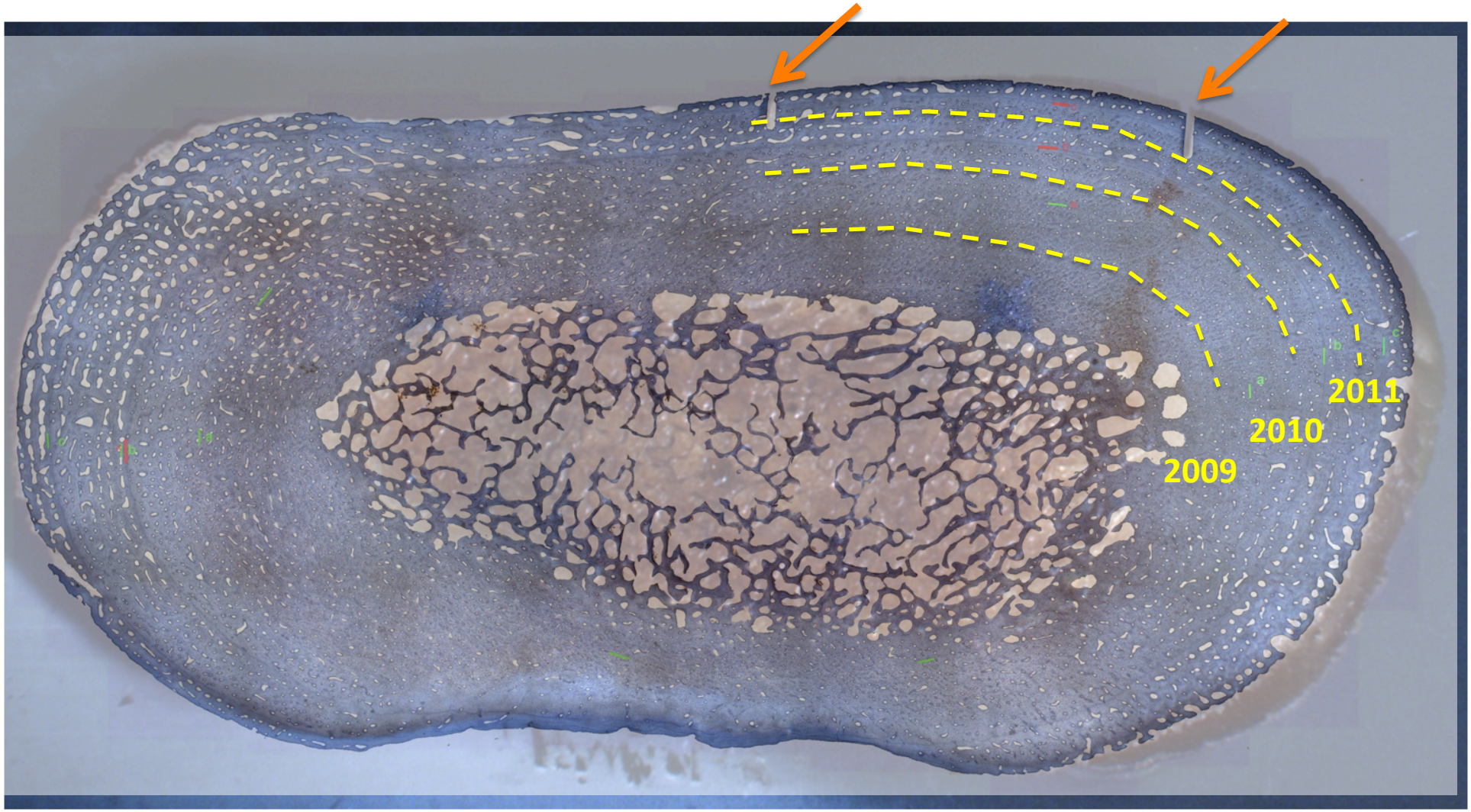
(Allen et al., 2013, Seminoff et al., NOAA, Turner-Tomaszewicz, unpub.)



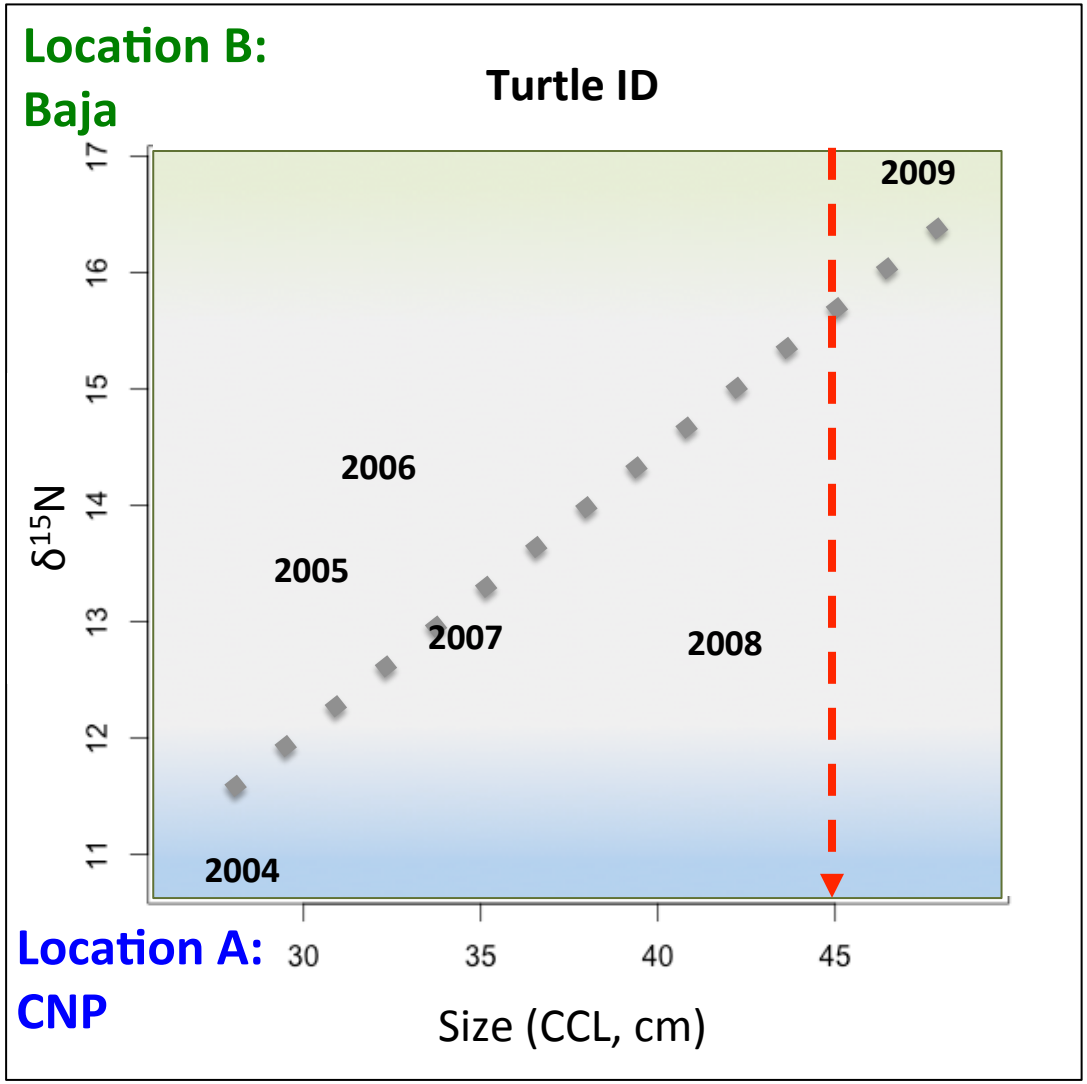
Skeletochronology
TIME

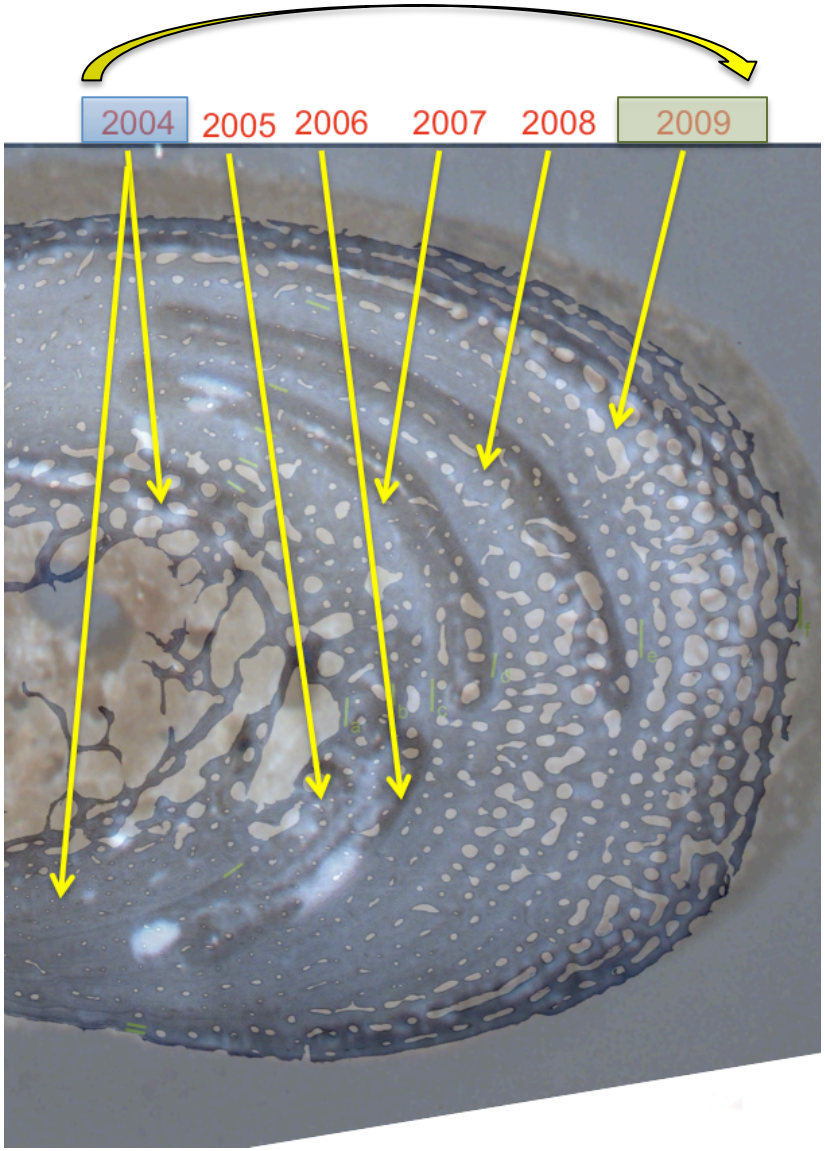
Stable Isotope Analysis
LOCATION

Skeletochronology + Stable Isotopes



Skeletochronology + Stable Isotopes





Example:

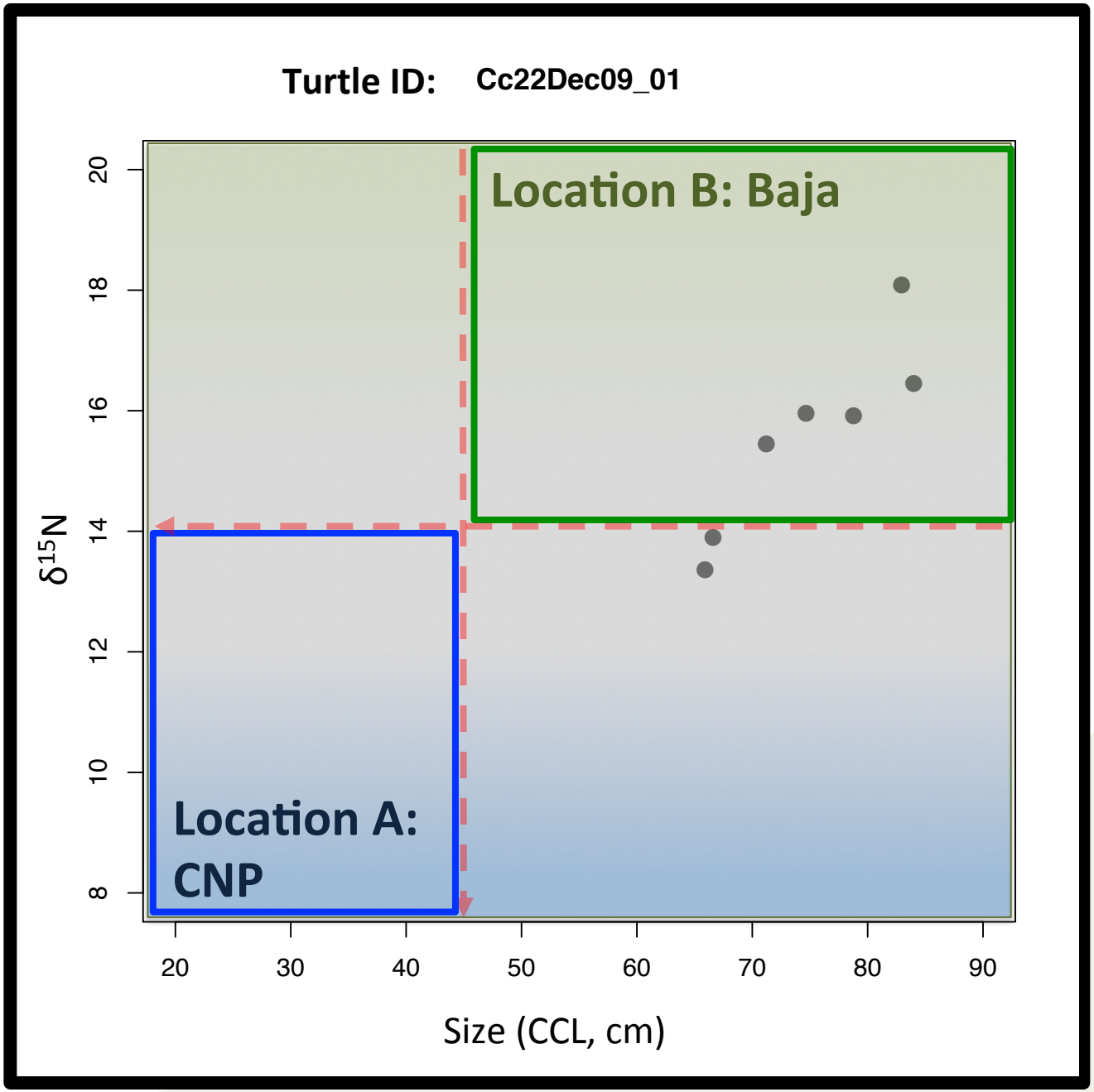
North Pacific Loggerhead (*Caretta caretta*)

Years: 7

Size: 65-84cm

Ages: 16-22

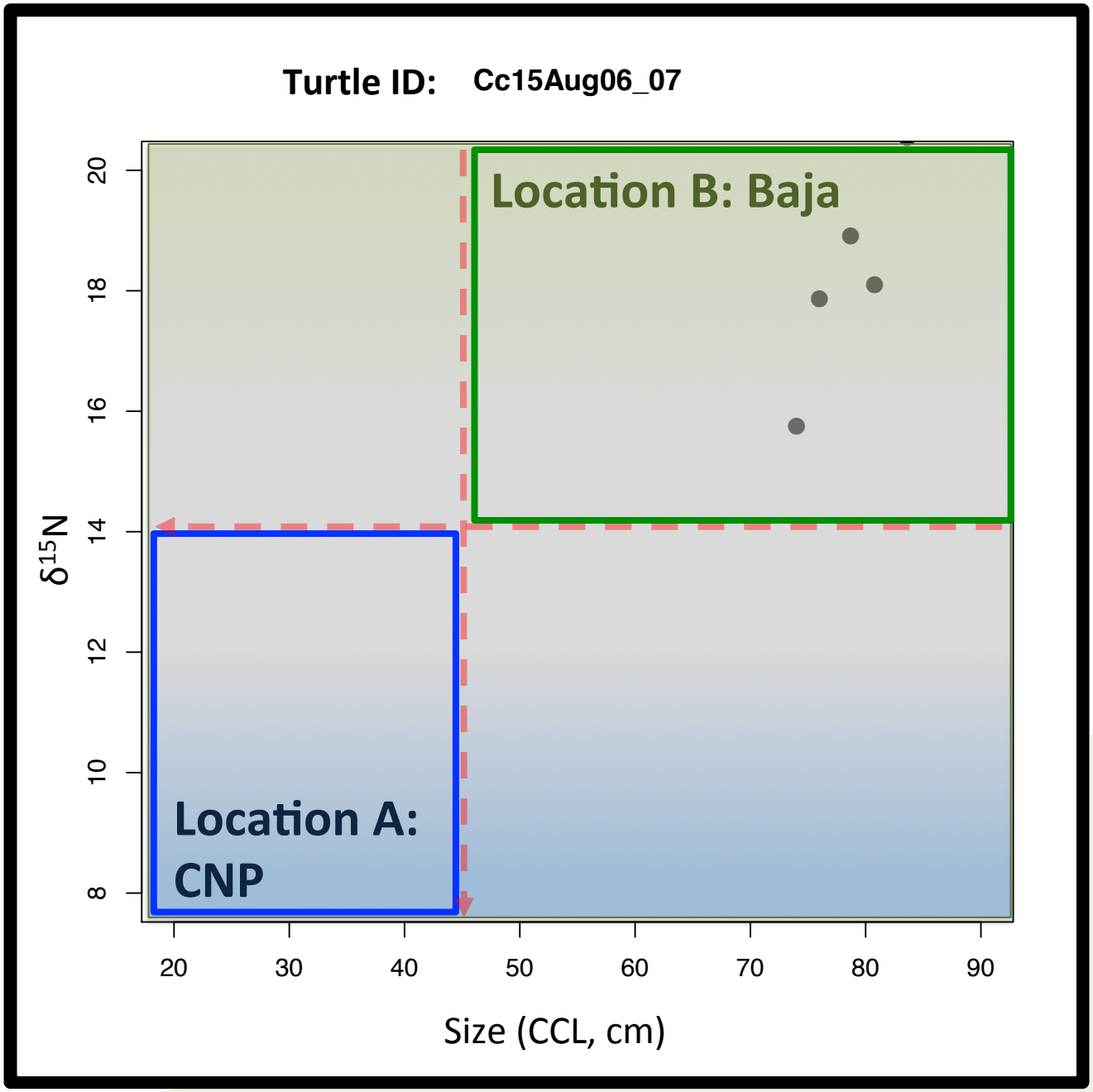
Duration in BCP: 7+ years



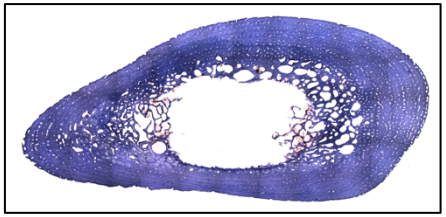
Larger size → higher $\delta^{15}N$

Expected from ontogenetic shift:

- ✓ Coastal area
- ✓ More prey variety
- ✓ Higher trophic level prey
- ✓ Benthic prey

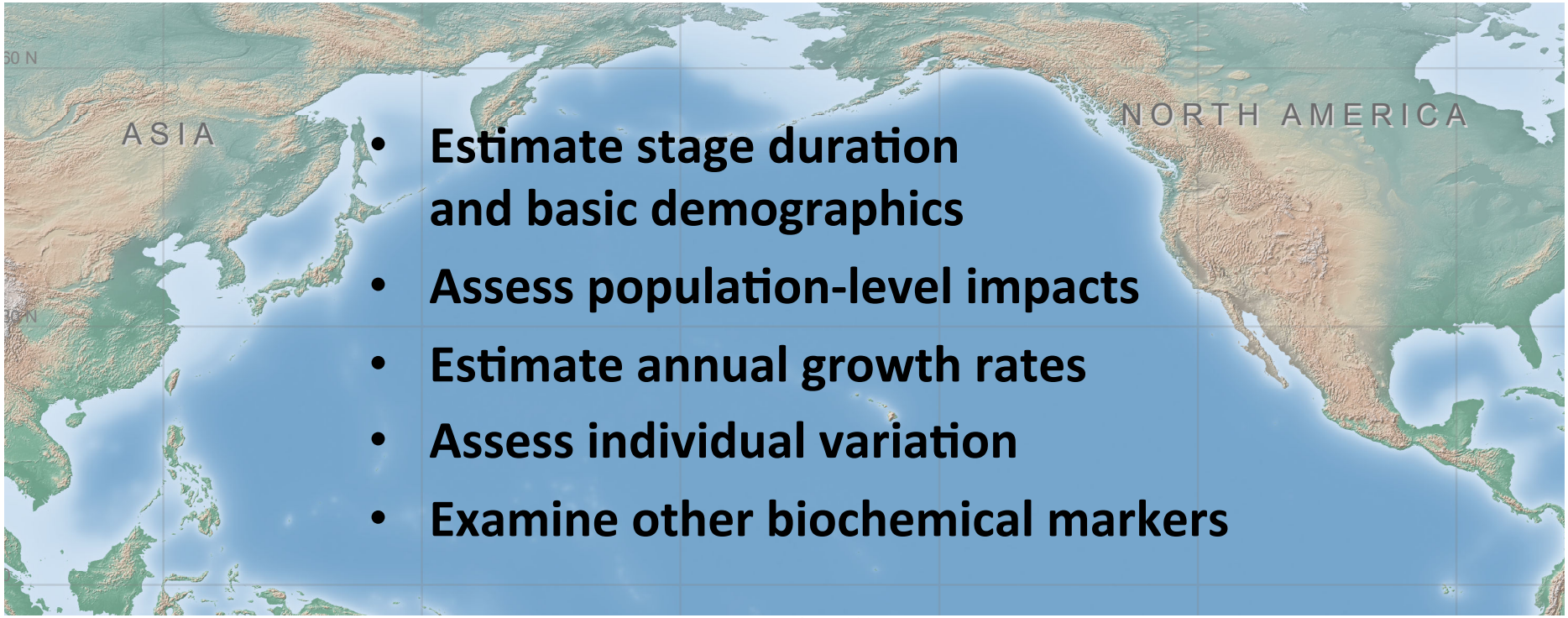


Possibilities for all Cheloniidae (hard-shelled) sea turtle populations



Skeletochronology
TIME

Stable Isotope Analysis
LOCATION



- **Estimate stage duration and basic demographics**
- **Assess population-level impacts**
- **Estimate annual growth rates**
- **Assess individual variation**
- **Examine other biochemical markers**

Thank you

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