Cold Stunned Sea Turtle Diet Analysis in Cape Cod Bay from 2015-2020

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Introduction

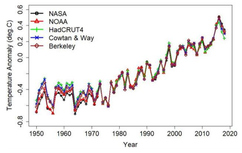
Fluctuations in temperature associated with climate change

Warmer fall SSTs

Delayed migrations

Sudden drop in SSTs

Cold Stunned Turtles

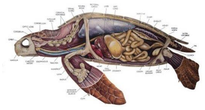


Cold-stunning: Hypothermic reaction when sea turtles exposed to prolonged cold water temperatures, results in stranding, lethargy, comatose, and starvation, can lead to hypothermia, pneumonia, and bradycardia

Turtles cold-stun at higher latitudes where temperatures are lower
Kemp's Ridleys- most prone to cold-stun: small size (Rainey WE 1981)

Keystone Species- if removed ecosystem would change drastically and suffer
- Nutrient cycling and grazing of seagrass beds
- Species rely on seagrass
  - Food and habitat

Gut Content Analysis:
- Visual identification of GI tract contents
- Used to identify food chains, food webs, trophic position, nutritional requirements, individual turtle's diets, material and energy dynamics within ecosystems



Stable Isotope Analysis:
- Identification of isotopic markers within a sample
- Turnover rates- differentiate between recent vs. past diet
- Fast- Recent Diet
  - Liver
  - Plasma
- Slow- Metabolic activity over longer time periods
  - Muscle
  - Whole Blood
- Data plotted using standard deviation from natural occurring values of isotope marker
- Different δ13C and δ15N values represent ecosystem baselines and species standards
- Used to identify habitat, diet, trophic position, Migratory Patterns, foraging ecology

$$\delta^{15}N = \left(\frac{\left(\frac{15N}{14N}\right)sample}{\left(\frac{15N}{14N}\right)standard} - 1\right) \times 1000$$

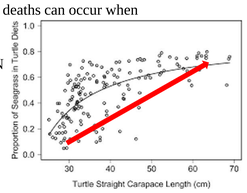
$$\delta^{13}C = \left(\frac{\left(\frac{13C}{12C}\right)sample}{\left(\frac{13C}{12C}\right)standard} - 1\right) \times 1000$$

Literature Review

1. Kemp's Ridley migrate from Gulf of Mexico to New England coastal waters with a Migration season ranging from late June through early December.
   -Lazell, J. (1980)

2. Cold Stunning begins when SSTs reach 10°C and deaths can occur when SSTs reach 5°C
   -Griffin et al (2019)

3. a)As turtles moved to Bermuda, diet shifted: δ15N and δ13C of turtle skin
b) Diet varied by size class and age
c) Seagrass represented less of total diet than predicted based on size
   -Burgett, C.M. et al (2018)

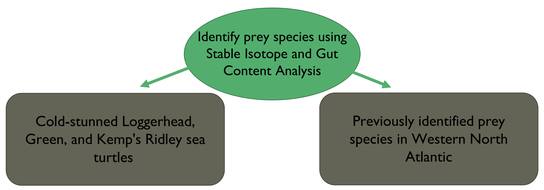


4.Loggerheads can be found in coastal, tropical and subtropical waters often extending to temperate waters in search of food and they will migrate between nesting and foraging grounds
   -Bass et al (2004)

Gap In Research

- 3 species of turtles with declining populations: Kemp's Ridley, Loggerhead, Green
- Little research surrounding pre-cold stunning foraging ecology
  - Empty stomachs when cold-stunned
- Investigate causes of population decline using new technologies such as Stable Isotope Analysis
- Learn more about their life cycle to develop mitigation strategies

Goals of Research



Methodology

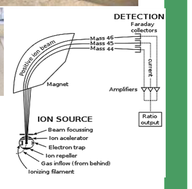
Tissue Collection

- Tissues collected from turtles necropsy session
- Frozen for storage and transportation

http://images.agoramedia.com/everydayhealth/gcms/Coping-With-Anxiety-and-Depression-722x406.jpg

Stable Isotope Analysis

- All samples dried at 50°C and individually homogenized
- Samples analyzed to determine stable isotope ratios for δ13C and δ15N
- Standard Elemental Analyzer and Isotope Ratio Mass Spectrometer techniques at UC Davis
- δ15N increasing with trophic level: Northern Ocean more enriched than Southern Ocean
- δ13C decreases with increasing latitude: Marine more enriched that terrestrial



Gut Content Analysis

- Placed under dissecting microscope
- Identify prey species within gut sample
- Pictures sent to lab for further analysis/ species conformation

Anticipated Results

Loggerheads

Bradley, et al. (1999). Kousta, et al. (2009). Gott, et al. (2014).

- Carnivorous diet
- Forage for shellfish and invertebrates in deep ocean
- Horseshoe crabs, clams, mussels- based on availability in northern hemisphere
- Higher isotopic values of nitrogen levels than herbivores

Greens

- Diet shift from omnivore to primarily herbivorous as habitat changes
- Algae, sea grasses, invertebrates
- Lower isotopic nitrogen levels than carnivores

Kemp's Ridleys

- Carnivorous Diet
- Multiple fish species, sea urchins, squid, crabs, clams, mussels, shrimp, and jellyfish
- Higher isotopic nitrogen levels than herbivores

Anticipated Results

Horseshoe Crabs

- **Clams**
- **Crustaceans**
- **Worms**
- **Algae**

Sea Urchins

- **Kelp, algae**
- **Decaying Matter, Dead Fish**
- **Sponges, Muscles, Barnacles**

Shrimp

- **Algae**
- **Plankton**

Clams/ Mussels

- **Plankton**
- **Bacteria**
  - **Filter Feeders**

Squid

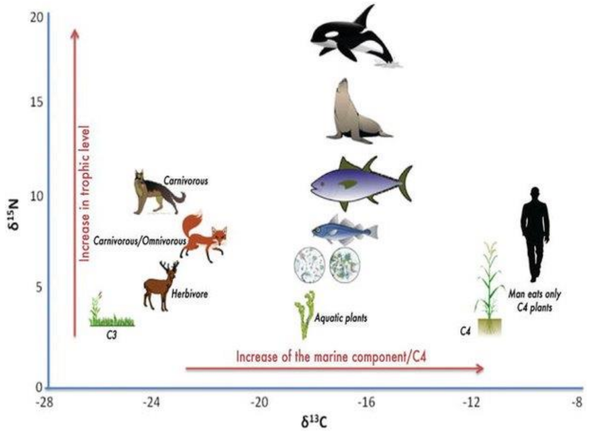
- **Fish**
- **Crabs**
- **Shrimp**

Jellyfish

- **Fish/ planktonic eggs and larvae**

Stable Isotope Species Standards

Berto, et al. (2019).



- Predicted results will closely mimic findings of previous studies conducted
- Empty stomach contents in Kemp's Ridleys due to starvation from cold-stunning
- δ15N increasing with trophic level: Northern Ocean more enriched than Southern Ocean
- δ13C decreases with increasing latitude: Marine more enriched that terrestrial

Discussion

- Adjustment for trophic discrimination and anterior scute carbon and nitrogen isotopic values represents recent feeding patterns
- Anticipated results reflect significant increase in δ15N values for scute edge interior samples
  - Local foraging prior to stranding and cold stunning
  - Slower tissue turnover
- Application/ Mitigation:
  - Contributes to overall understanding of these endangered species to help save them from extinction
- Limitations
  - Lethal sampling method- only representative of deceased turtles
  - Not always healthy
  - Empty stomachs due to starvation from cold-stunning

Conclusion

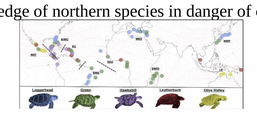
Research Goal
- Identify prey species of Loggerhead, Green, and Kemp's Ridley sea turtles using Stable Isotope and Gut Content Analysis and investigate diet and foraging ecology

Methods
- Stable Isotope Analysis of Tissue Samples
- Gut Content Analysis of GI tract

Results
- Higher Nitrogen values in Carnivorous Cold Stunned Turtle species
- Empty stomachs of Kemp's Ridleys due to starvation
- Variety of foraging strategies, migration patterns and trophic positions

Significance

- Cold-stunned population doesn't have homogenous migratory and/or trophic history
- Techniques could provide further insight into migratory, foraging, trophic and mitigation strategies
- Improve knowledge of northern species in danger of cold stunning



Future Research

- Connections between cold stunning rates, hatchling success rates, gender ratios, and chronic debilitation
- Covid-19: single use PPE pollution (masks & gloves) effect on sea turtles and ocean in general

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