Multi-Tissue Stable Isotope Analysis of Kemp Ridley, Green and Loggerhead Sea Turtles

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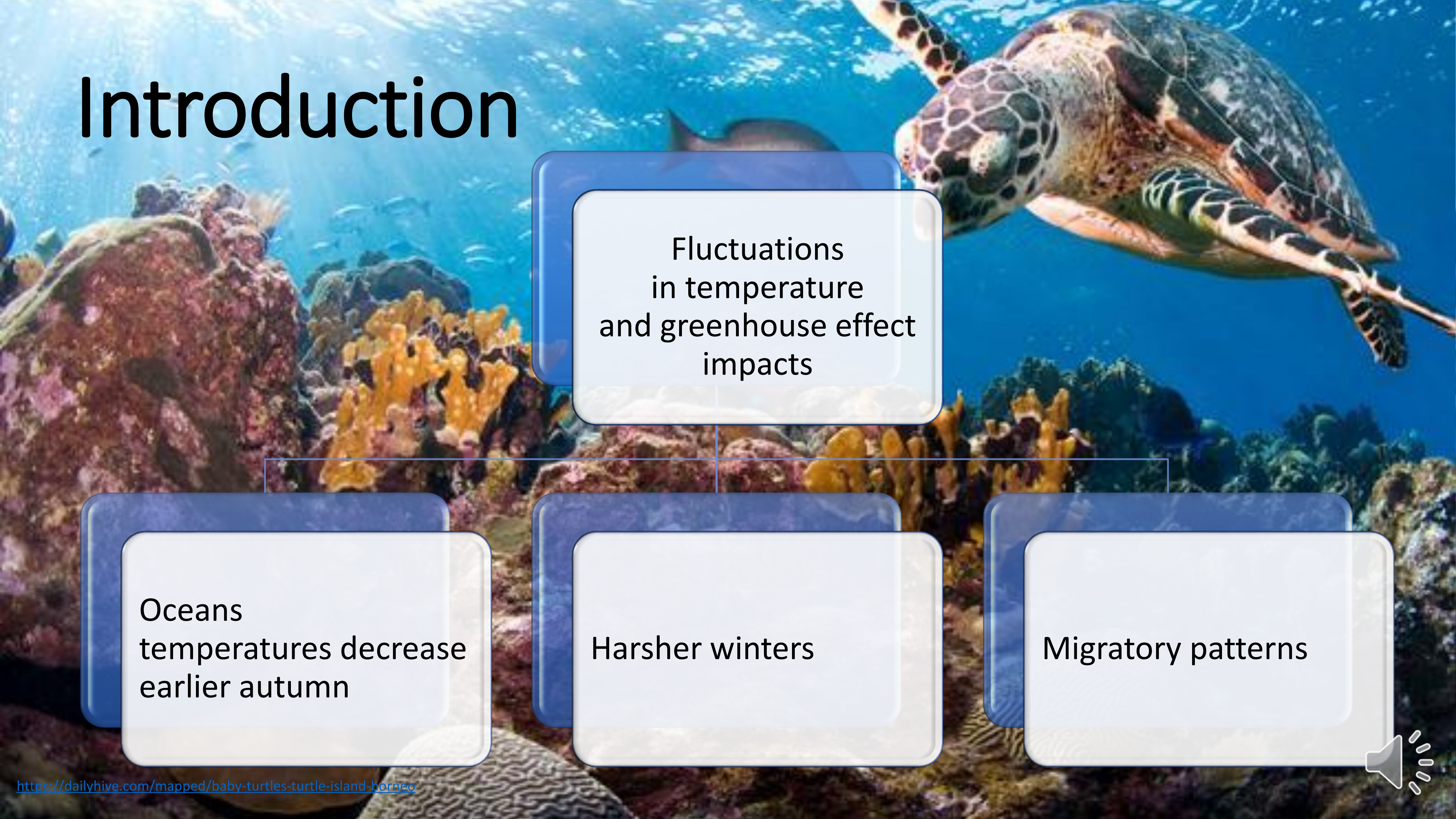
https://www.nwf.org/Educational-Resources/Wildlife-Guide/Reptiles/Sea-Turtles

Introduction

- Fluctuation of environmental factors caused by buildup of pollutants
  - Fossil Fuels
  - Carbon dioxide
  - Temperature
  - Atmospheric pressure
- Greenhouse effect- traps solar radiation in atmosphere
- Increased greenhouse gases- increases global climate change (Ottersen, G. 2001)

http://news.mit.edu/2017/explained-greenhouse-gases-0130



Introduction

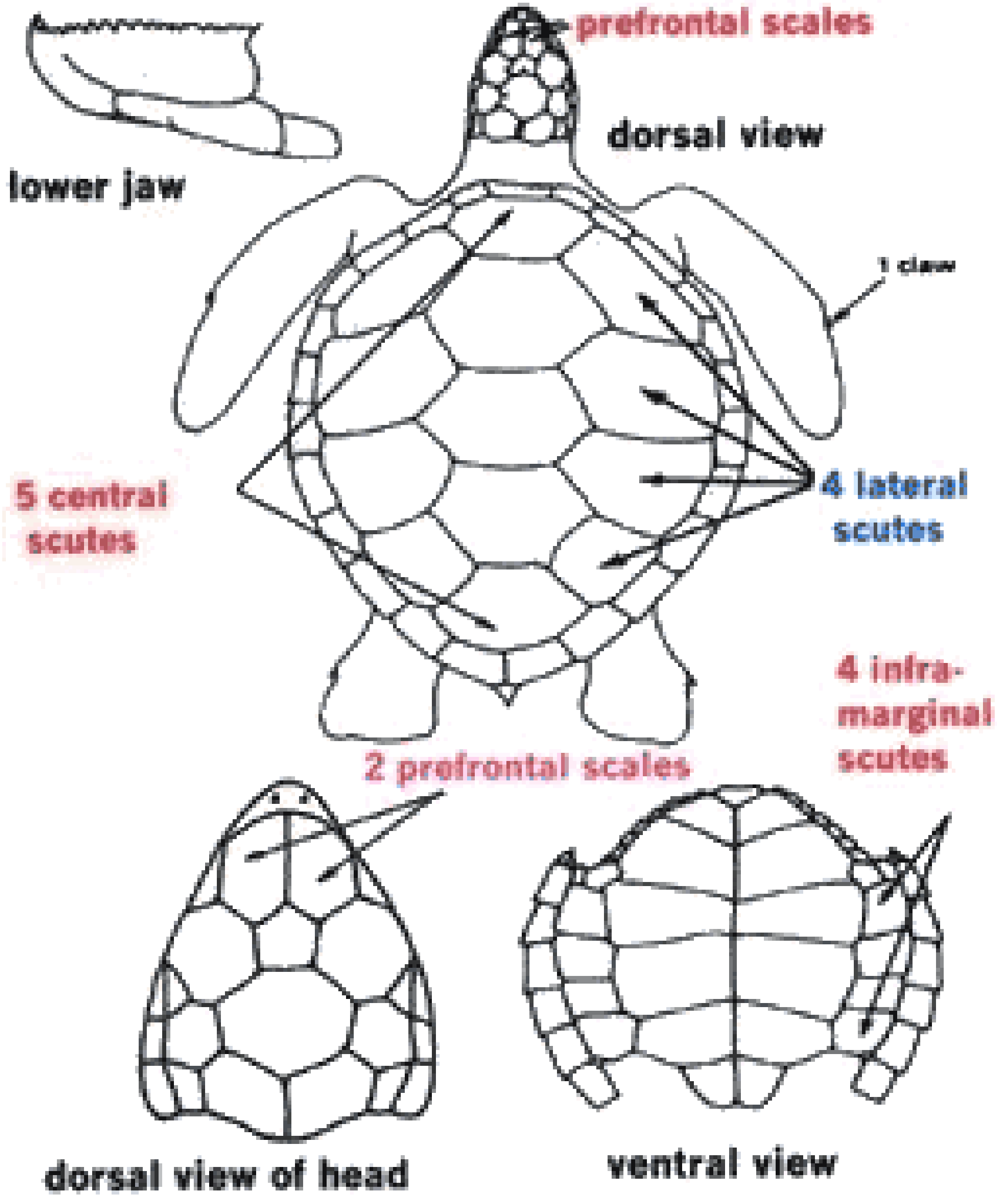
Fluctuations in temperature and greenhouse effect impacts

- Oceans temperatures decrease earlier autumn
- Harsher winters
- Migratory patterns

https://dailyhive.com/mapped/baby-turtles-turtle-island-borneo

Green Sea Turtles (*Chelonia mydas*)

- Small overall shell
- Brown/Yellowish color
- 4 pairs of lateral scutes
- 5 central scutes
- 2 prefrontal scales
- Serrated lower jaw



https://marinebio.org/species/green-sea-turtles/chelonia-mydas/

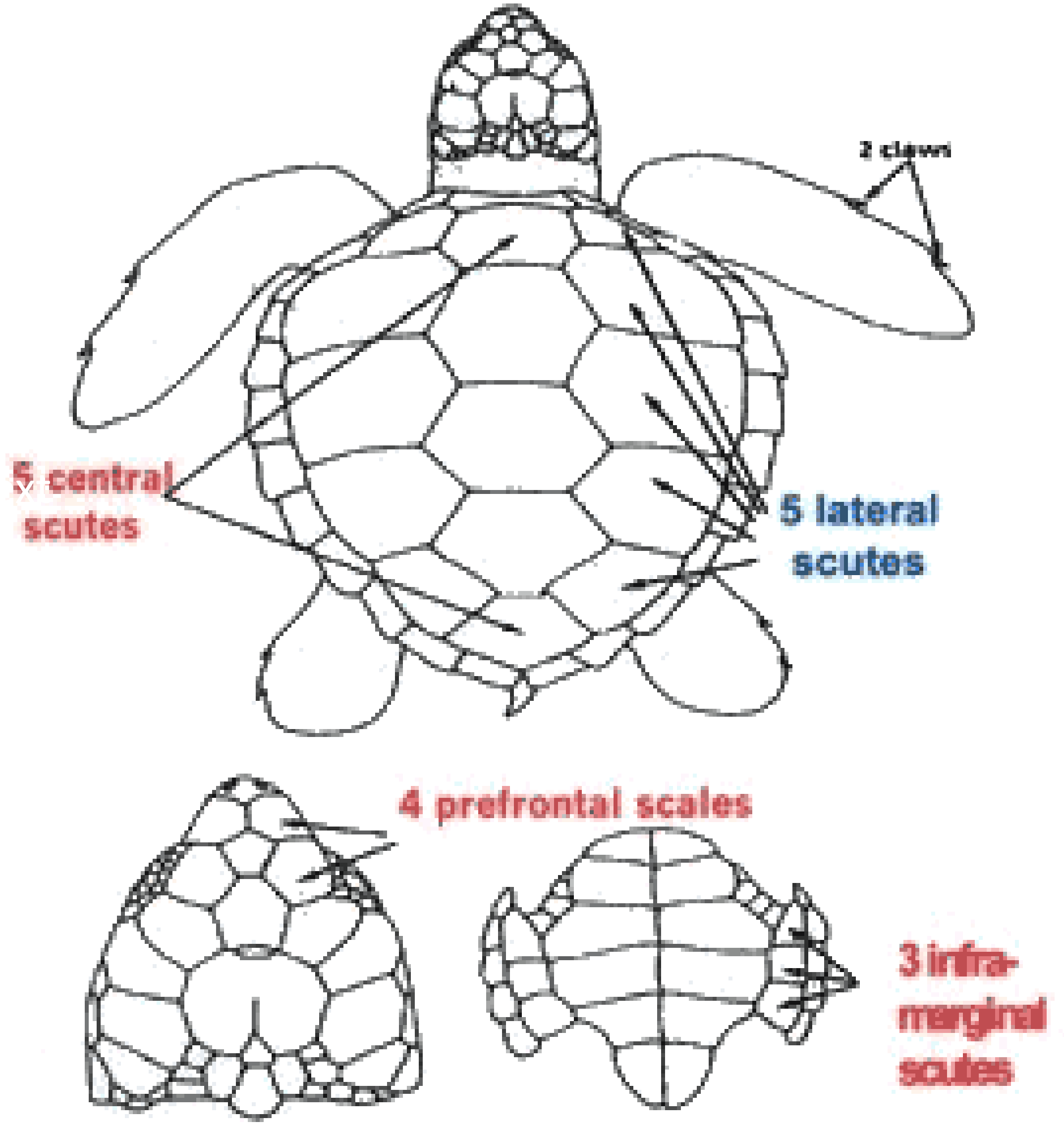
Green Sea Turtles (*Chelonia mydas*)

- Stay in shallow waters until the breeding season
- Females make a long migration back to natal beach to breed
- Travel long distances across oceans to return to preferred breeding site

https://www.fisheries.noaa.gov/species/green-turtle

Loggerhead Sea Turtles (*Caretta caretta*)

- Heart shaped shell
- Reddish/Orange color
- 5 pairs of lateral scutes
- 4 prefrontal scales
- 3 inframarginal scutes



https://marinebio.org/species/loggerhead-sea-turtles/caretta-caretta/

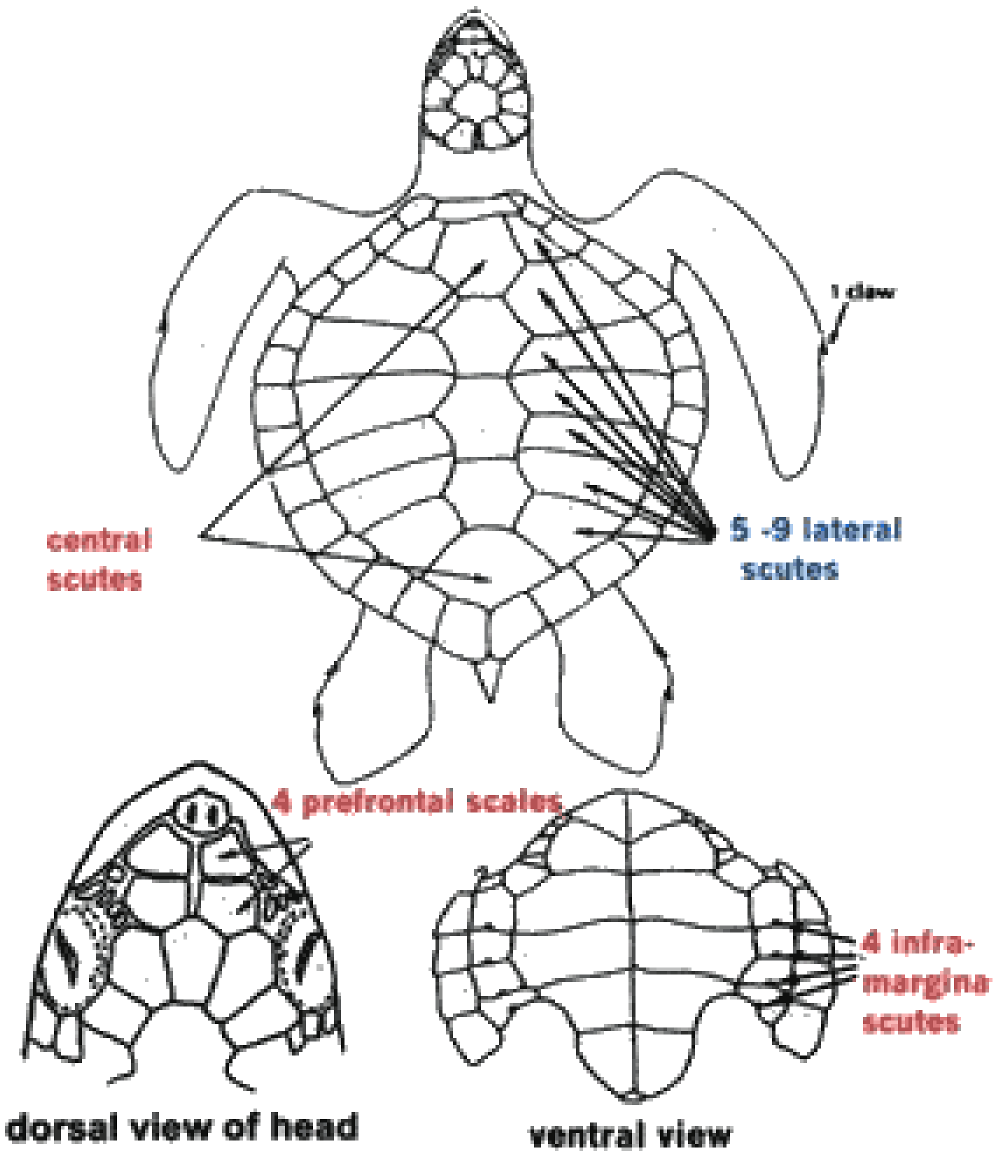
Loggerhead Sea Turtles (*Caretta caretta*)

- Migrate between nesting and foraging grounds
  - Travel thousands of kilometers during their lifetime
- Coasts of Florida to other side of Atlantic and back

https://www.fisheries.noaa.gov/species/loggerhead-turtle

Kemp's Ridley Sea turtles (*Lepidochelys kempii*)

- Oval carapace
- Olive-grey color
- 5 pairs of coastal scutes
- 4 inframarginal scutes
- 5-9 pairs of lateral scutes



https://marinebio.org/species/olive-ridley-sea-turtles/lepidochelys-olivacea/

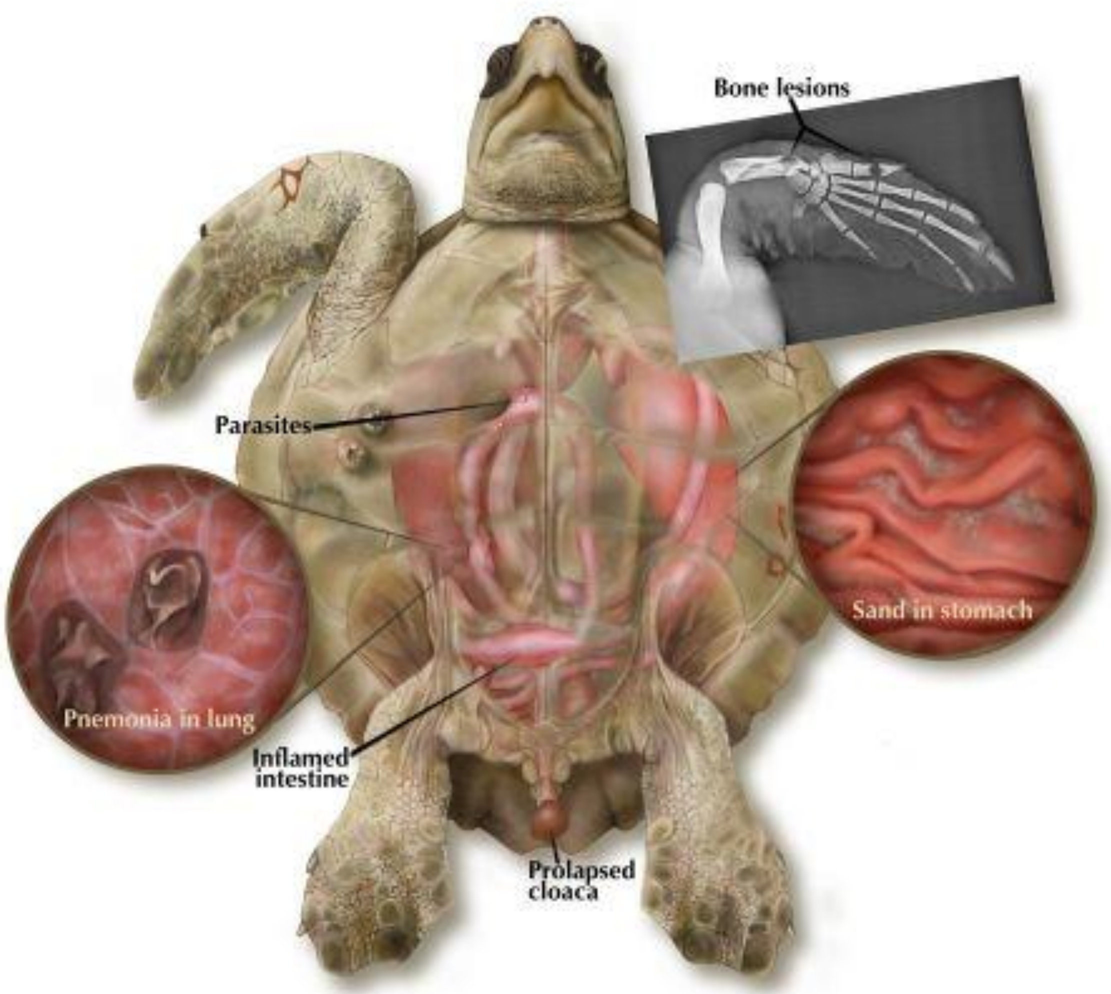
Kemp's Ridley Sea turtles (*Lepidochelys kempii*)

- Males typically stay within Gulf of Mexico
- Some males migrate annually between feeding and breeding grounds
- Others don't migrate at all
  - Mate with females found at feeding grounds or near nesting beaches
- Females migrate to and from nesting beaches off of Gulf of Mexico
- Females migrate to foraging areas from Yucatán Peninsula to southern Florida

https://www.fisheries.noaa.gov/species/kemps-ridley-turtle

Introduction

- Cold stunning
  - Hypothermic reaction when sea turtles exposed to prolonged cold water temperatures
- Cold stunning results
  - Lethargic sea turtles
  - Comatose sea turtles
  - Trapped on the shoreline
  - Risk of complications
  - Hypoglycemia
  - Pneumonia
  - Starvation
  - Bradycardia



https://nationalaquarium.wordpress.com/2014/02/11/illustrating-the-effects-of-cold-stunning-on-sea-turtles/

https://www.shutterstock.com/image-illustration/abstract-under-sea-background-white-sand-614496539

Introduction

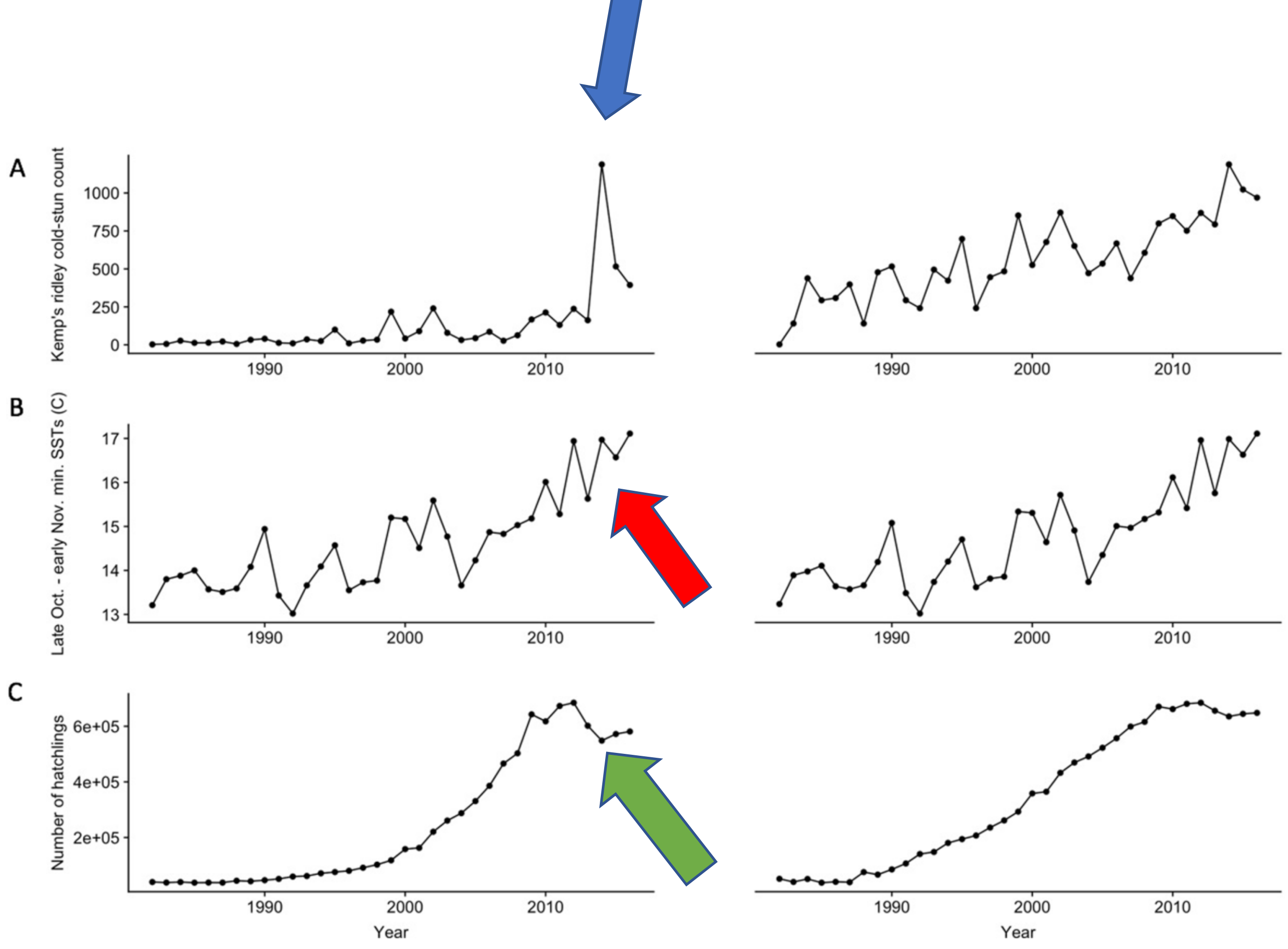
- Migration season shortened
- Turtles begin to cold stun at **higher latitudes** where **temperatures** are **lower**
- Kemp's Ridleys **most prone** species to **cold stunning** due to **small size**

Literature Review

- Kemp's Ridley sea turtles, *Lepidochelys kempii*, migrate from gulf of Mexico to New England coastal waters
  - Migration season from late June through early December
    - Lazell, J. 1980)(Griffin, L. P. 2019
- When sea surface temperature reaches 10°C, cold stunning events can begin
  - Deaths may occur when sea surface temperatures reach 5°C
    - Griffin, L. P .2019
    - Witherington, B. E. 1989
    - Schwartz, F. J. 1974

Raw Data

Logged Data

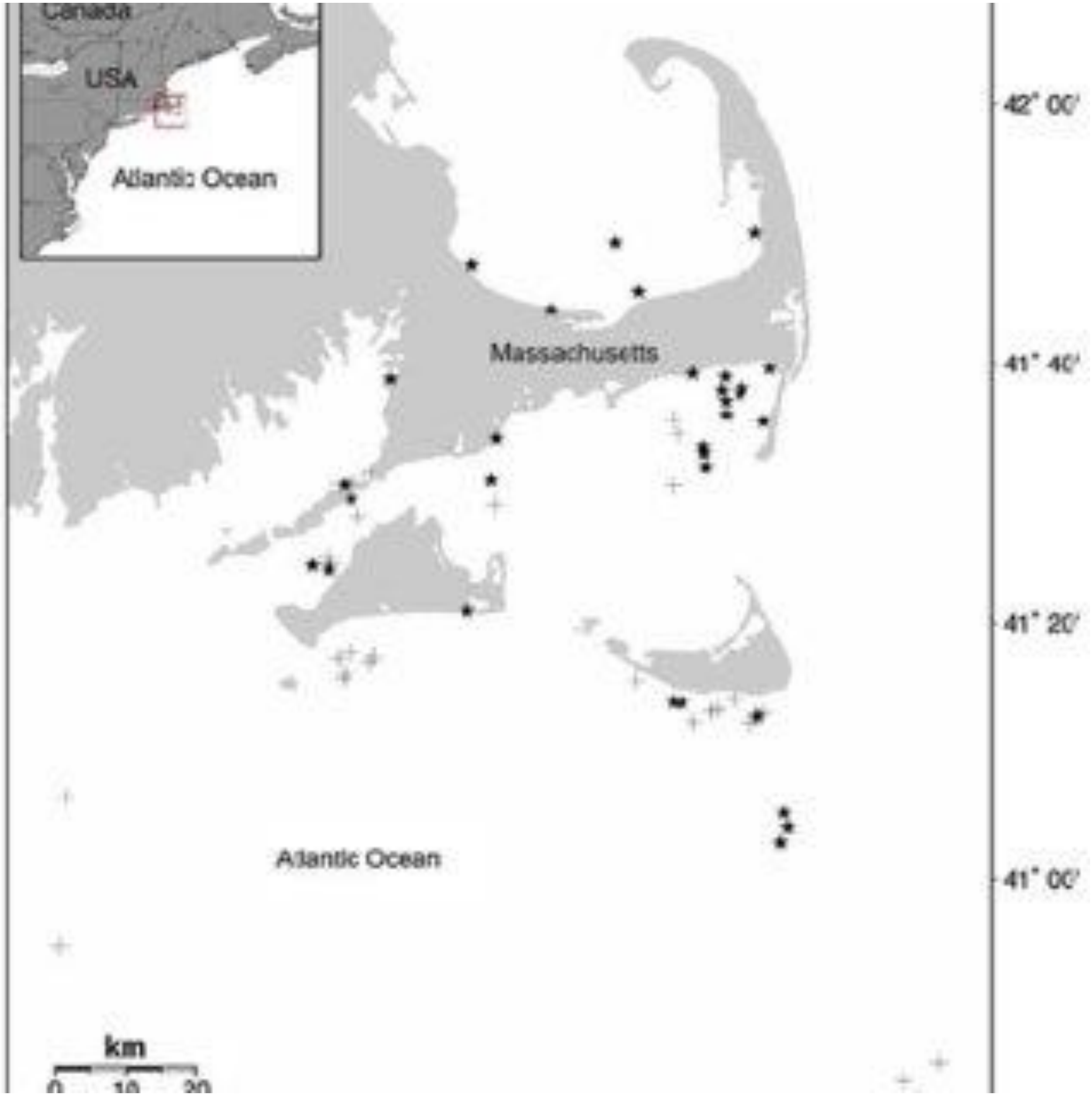


A. Kemp Ridley Cold Stunned Turtle Count
B. Sea Surface Temperatures
C. Number of Hatchlings of Kemp Ridley Sea Turtles

Griffin, L. P .2019

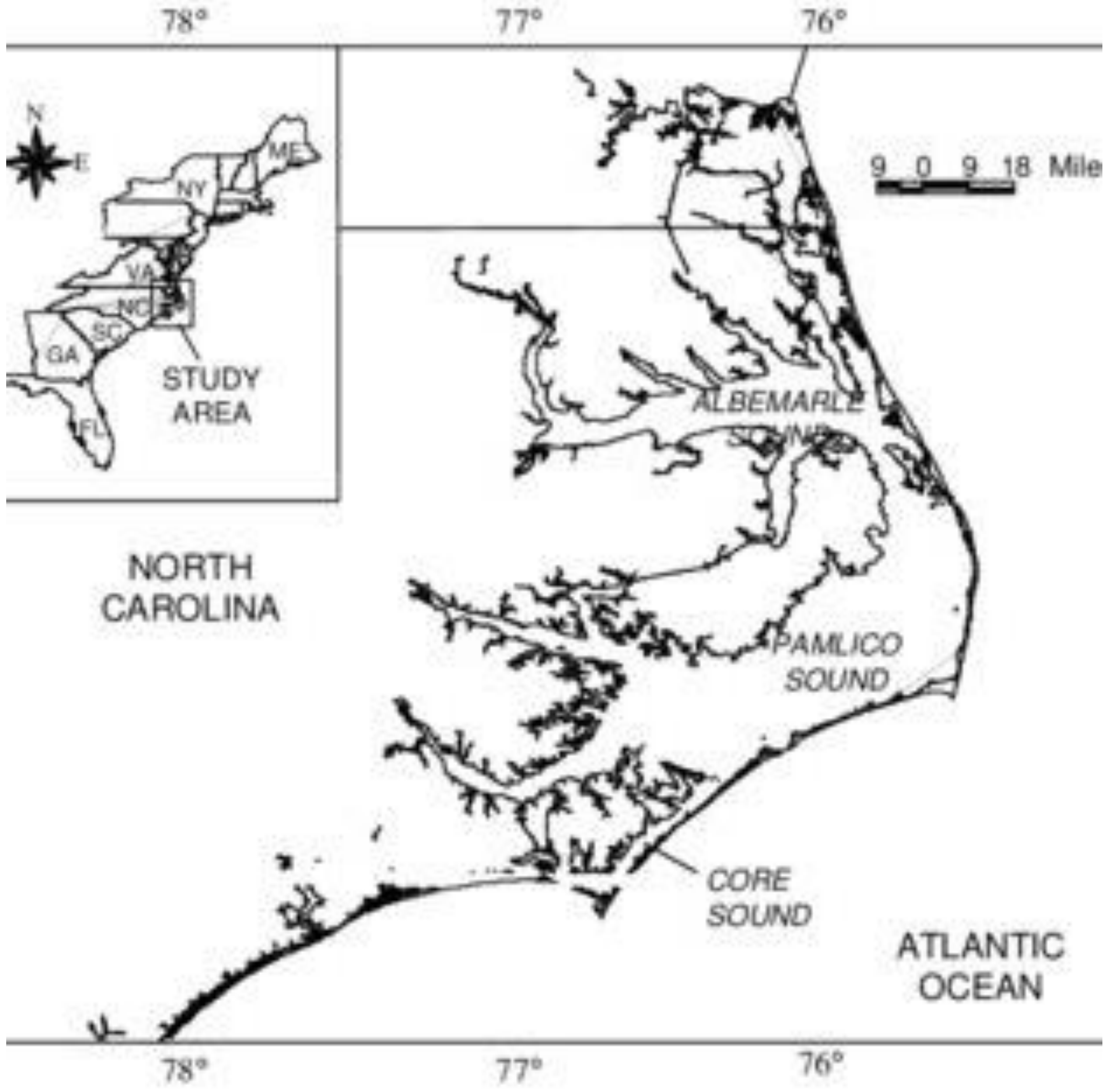
Literature Review

- Multi-tissue stable isotope of leatherback sea turtles in the western North Atlantic to analyze foraging ecology
- Found diet to consist primarily of scyphozoan jellyfish and ctenophores
  - Smaller portion of diet consists of holoplanktonic salps and sea butterflies
    - Logan J. M. 2011



Literature Review

- Loggerheads found in coastal, tropical and subtropical waters often extending to temperate waters in search of food
- Migrate between nesting and foraging grounds
- Migratory locations typically range from Coasts of Florida to other side of Atlantic and back
  - Bass, A. L. 2004



Gap in Research

- 3 types of endangered turtles (Loggerhead, Green and Kemp Ridley's)
- Scientists need to investigate causes of their population decline
- Learn more about their life cycle to develop mitigation strategies

https://seaturtles.org/what-happens-when-sea-turtles-are-cold-stunned/

Goal of Research

Identify **prey species** of Loggerhead, Green, and Kemp's Ridley sea turtles in Western North Atlantic Ocean using **Isotope** and **Gut Content Analysis**

Identify **diet** and **foraging** ecology of prey species

Methodology

Stable
Isotope Analysis

Gut
Content Analysis

https://www.youtube.com/watch?v=L4x4bJI5mdo

Methodology -Stable Isotope Analysis

Identification of isotopic markers within a sample

- Turnover rates differentiate between recent vs. past diet
  - Faster turnover rates
      - Liver
      - Plasma
    - Recent diet
  - Slower turnover rates
        - Muscle
        - Whole blood
      - Metabolic activity over longer time periods

https://www.seeturtles.org/why-are-sea-turtles-important

Methodology

Stable Isotope Analysis

- Species migrate a lot SIA approach difficult
- Aquatic ecosystems have different carbon and nitrogen level baselines
  - Find these levels in turtles to find feeding areas

https://www.animalstown.com/animals/s/sea-turtle/wallpapers/sea-turtle-wallpaper-04.php

Methodology -Stable Isotope Analysis

- Tissues collected from turtles
  - Necropsies

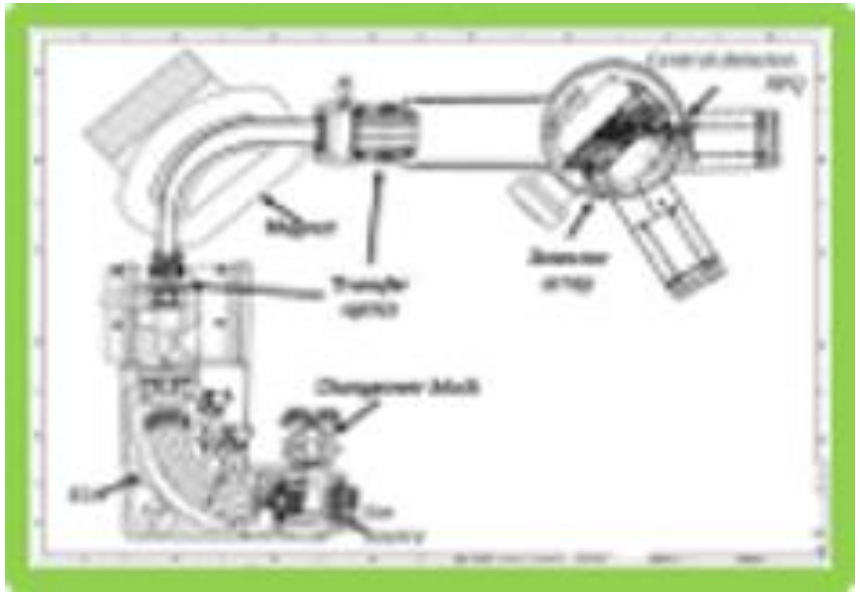
- Tissue samples frozen for storage and transportation to lab

- Samples
  - Thawed
  - Rinsed
  - Dried in drying oven
  - Weighed
  - Grinded to uniform composition

https://photodune.net/item/sea-turtle-swims-under-water-on-the-background-of-coral-reefs/22827296

Methodology
Stable Isotope Analysis

- Isotopic values collected using an elemental analyzer and an isotope ratio mass spectrometer
- Elemental analyzer
- Isotope ratio mass spectrometer
  - Analyze tissue samples for isotope markers
  - Find stable isotope values



https://www.youtube.com/watch?v=A0f6ong2eLY https://www.sciencedirect.com/science/article/pii/S1387380612003818

Methodology

Stable Isotope Analysis

- Data plotted using standard deviation from natural occurring values of isotope markers
- Isotope values compared to species standards community baselines
  - Identify
    - Trophic position
    - Migration patterns
    - Diet
    - Habitat
  - Evaluate specific turtle sampled

https://wallpapercave.com/sea-turtles-wallpaper

Methodology -Gut Content Analysis

- Provides insight into:
  - Nutritional requirements
  - Trophic position
  - Material and energy dynamics
  - Food webs
  - Food chains
  - Material and energy transfers between and within ecosystems

https://pxhere.com/en/photo/981853

Methodology
Gut Content Analysis

- Gut samples collected from turtles
  - Necropsies
- Stored in ethanol
- Placed under Dissecting Microscope
  - Identify prey species within gut sample
- Can be done remotely and pictures sent to lab for further analysis

https://fineartamerica.com/featured/sea-turtle-underwater-mm-sweet.html

Previous Results

- Loggerhead-
  - Carnivorous diet
  - Forage for shellfish and invertebrates in deep ocean
    - Horseshoe crabs, clams, mussels
      - (Tomas, J. 2006)
- Green-
  - Herbivorous diet
    - Algae and sea grasses
      - (Seminoff, J. 2006)
- Kemp's Ridley-
  - Carnivorous diet
    - Multiple fish species, sea urchins, squid crabs, clams, mussels, shrimp, and jellyfish
      - (Burke, V. J. et al. 1993)

http://www.hunterandliz.com/albums/belize/attachment/dcim100goprog0036703/?uploaded_to=5447

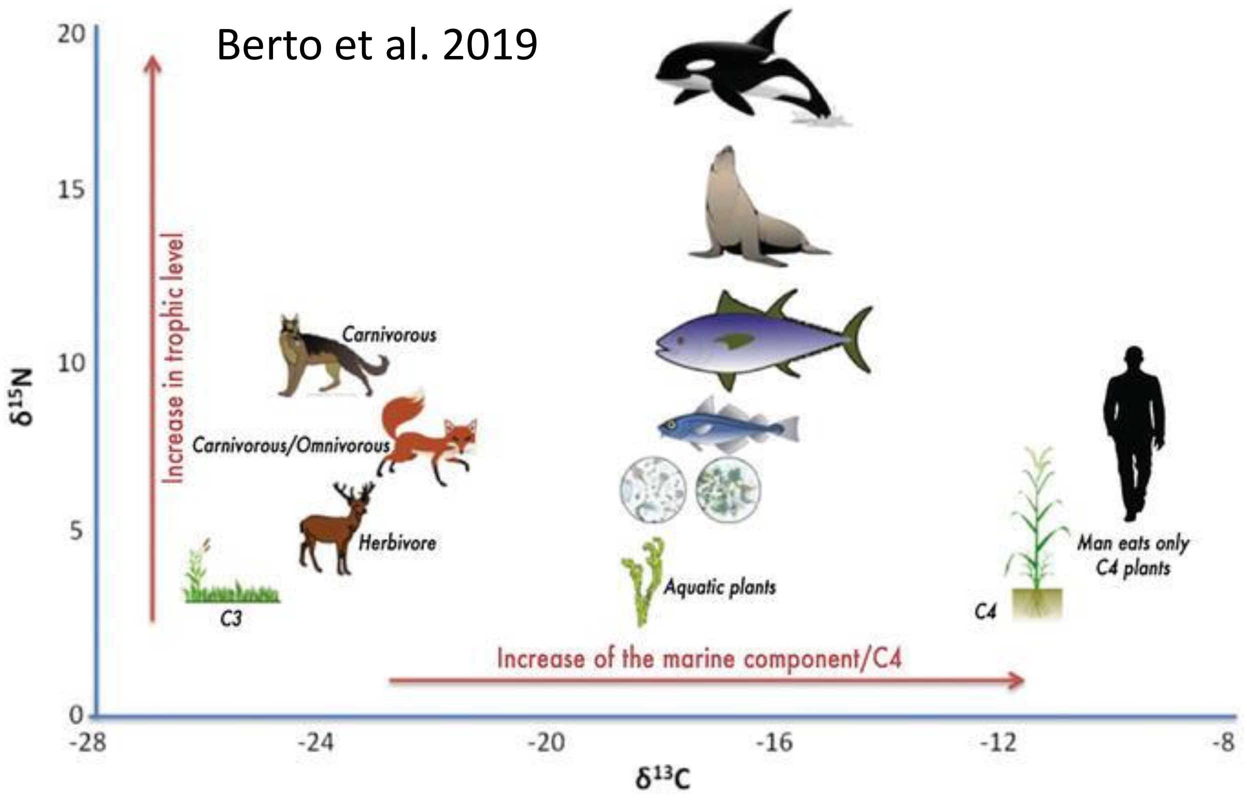
Previous Results

- Horseshoe crabs-
  - Clams, crustaceans, worms, algae
    - (Botton, M.L. 1984)
- Clams/ Mussles-
  - Filter Feeders
    - Plankton, detritus, and bacteria
      - (Mamat, N.Z. 2014)
- Sea urchins-
  - Kelp, decaying matter, algae, dead fish, sponges, mussels, and barnacles
    - (Larson, B.R. 1980)
- Squid-
  - Fish, crabs, and shrimp
    - (Pierce, G. J. et al. 1994)
- Shrimp-
  - Algae and plankton
    - (Fry, B. et al. 1982)
- Jellyfish-
  - Fish eggs and fish larvae; they also eat planktonic eggs and plankton larvae
    - (Underwood, A. H. (2007)

https://www.thesuperfins.com/do-turtles-eat-jellyfish/

Anticipated Results

- Predicted results will closely mimic findings of previous studies conducted
- Empty stomach contents due to starvation from cold-stunning



Berto et al. 2019

- Loggerhead- Carnivorous diet
  - Larger amounts of Clams and Mussels based on availability in northern hemisphere
  - Higher isotopic nitrogen levels than herbivores
- Green- Herbivorous diet
  - Increased amounts of algae
  - Lower isotopic nitrogen levels than carnivores
- Kemp's Ridley- Carnivorous diet
  - Larger amounts of fish, clams, mussels and shrimp
  - Higher isotopic nitrogen levels than herbivores

Discussion

- Adjustment for trophic discrimination and anterior scute carbon and nitrogen isotopic values
  - Represent recent feeding patterns
- Anticipated results reflect significant increase in δ15N values for scute edge relative to scute interior samples
  - Suggest local foraging prior to stranding and cold stunning
- Cold-stunned population doesn't have homogenous migratory and/or trophic history
- Techniques could provide further insight into migratory, foraging, trophic and mitigation strategies to improve knowledge of northern species in danger of cold stunning

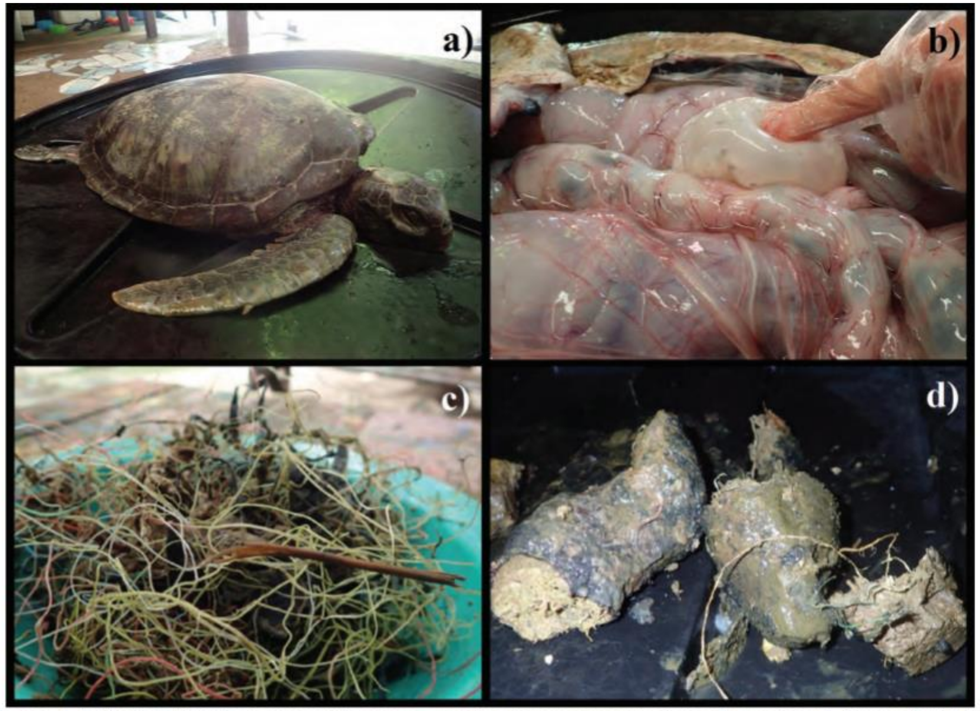


Figure 1. A. Turtle before the necropsy. The area surrounding the eyes suggests signs of starvation. B. Gas pocket in the blocked digestive tract. C. Detail of contents recovered from the digestive tract after rinsing. D. Contents before rinsing.

Marine Turtle Newsletter No. 158, 2019 - Page 14

Discussion

- Application/Mitigation
  - Contributes to the 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 stomach contents due to starvation from cold-stunning

https://www.chron.com/neighborhood/bayarea/news/article/Stranded-sea-turtle-rescued-from-Bolivar-Beach-14909739.php

Conclusion

Research Goal	Identify **prey species** of Loggerhead, Green, and Kemp's Ridley sea turtles in Western North Atlantic Ocean using **Isotope** and **Gut Content Analysis and investigate diet and foraging ecology**			
Methods & Results	Stable Isotope Analysis of Tissue Samples and Gut Content Analysis	Higher Amounts of Nitrogen in Carnivorous Cold stunned Turtle species	Empty stomachs due to starvation	Variety of foraging strategies, migration patterns and trophic positions

Future Research

- Integration of satellite tracking to model migratory patterns
- Increase ecological data collection on turtles prior to stranding
- Utilize technological advancements to gain better understanding of cold stunning in a variety of global regions

https://www.coastalstudiesinstitute.org/unc-csi-partners-release-satellite-tagged-sea-turtles-track-dispersal-habitat-use/

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- Friends
- Science Research Peers

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