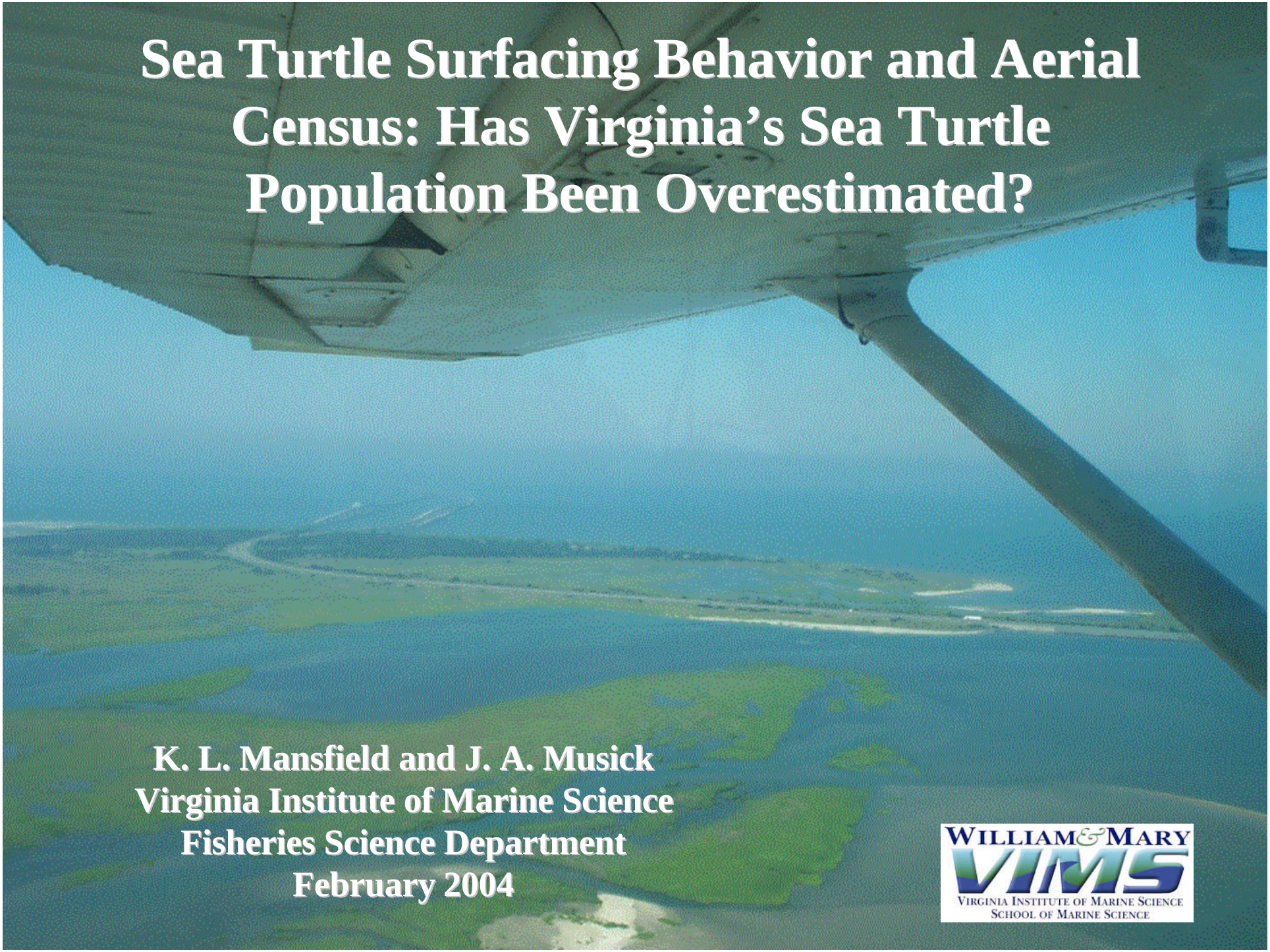
Sea Turtle Surfacing Behavior and Aerial Census: Has Virginia's Sea Turtle Population Been Overestimated?



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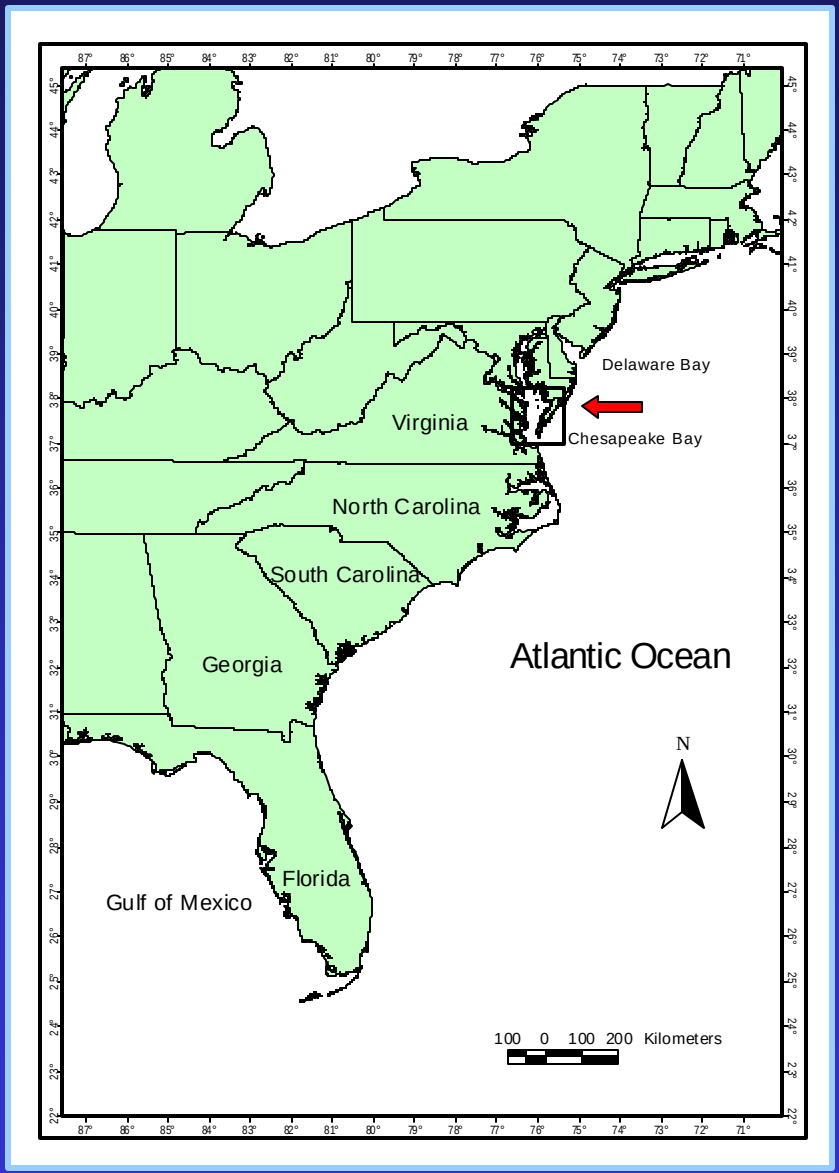
Virginia's Developmental Habitat:



- Chesapeake Bay: important juvenile sea turtle foraging habitat (~5% adults)
- Aerial Bay census from 1980's: 5,000 to 10,000 enter Bay waters each year
- Sea turtles are resident in Virginia spring through fall
- Turtles seasonally migrate into Bay waters when temperatures are 16°-18° C

(Musick and Limpus 1997; Lutcavage and Musick 1985)

Virginia's Sea Turtles:

Loggerhead sea turtles (*Caretta caretta)*

Kemp's ridley sea turtle (*Lepidochelys kempii)*

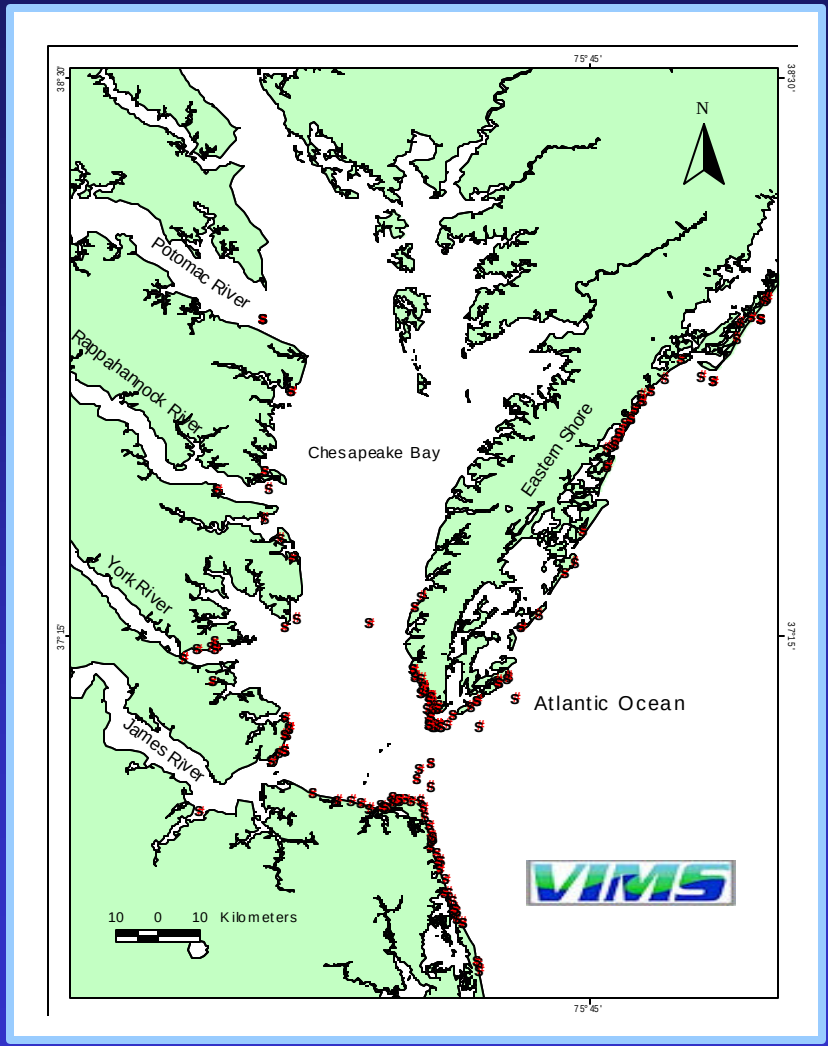
Leatherback sea turtle (*Dermochelys coriacea)*

Green sea turtle (*Chelonia mydas)*

Hawksbill sea turtle (*Eretmochelys imbricata)*

Photos by K. Mansfield, E. Seney, and R. Boettcher

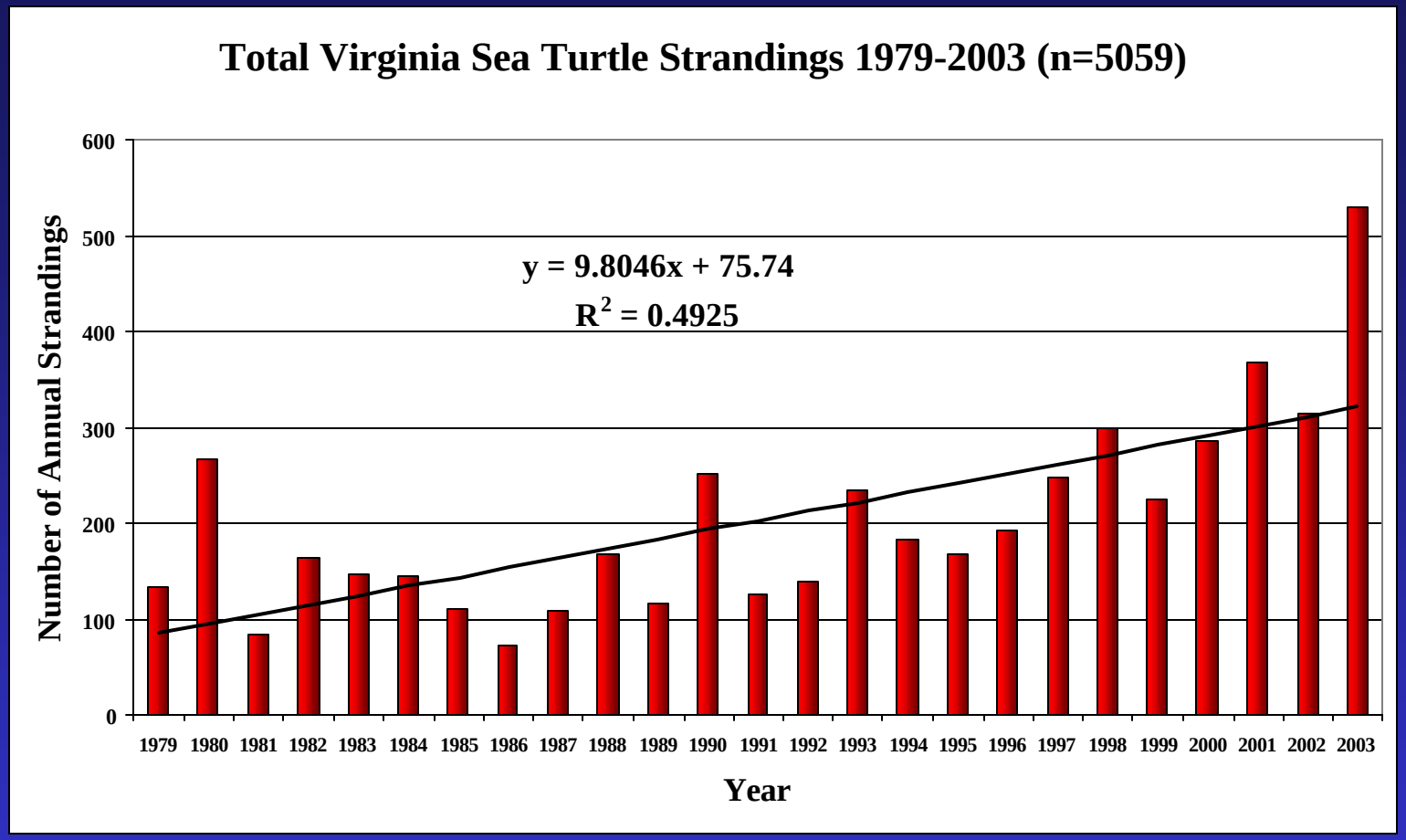
Springtime in Virginia (May-June):



Sea turtle stranding locations in Virginia, 2002

- 200 to 500 turtles strand in Virginia each year
- 50% to 60% of annual strandings occur in late May/early June
- Peak aerial densities are observed in spring
- Spring densities and strandings are highest in Bay mouth
- Spring water temperatures are vertically stratified (18°-20° C at surface; 10°-15° C on bottom)

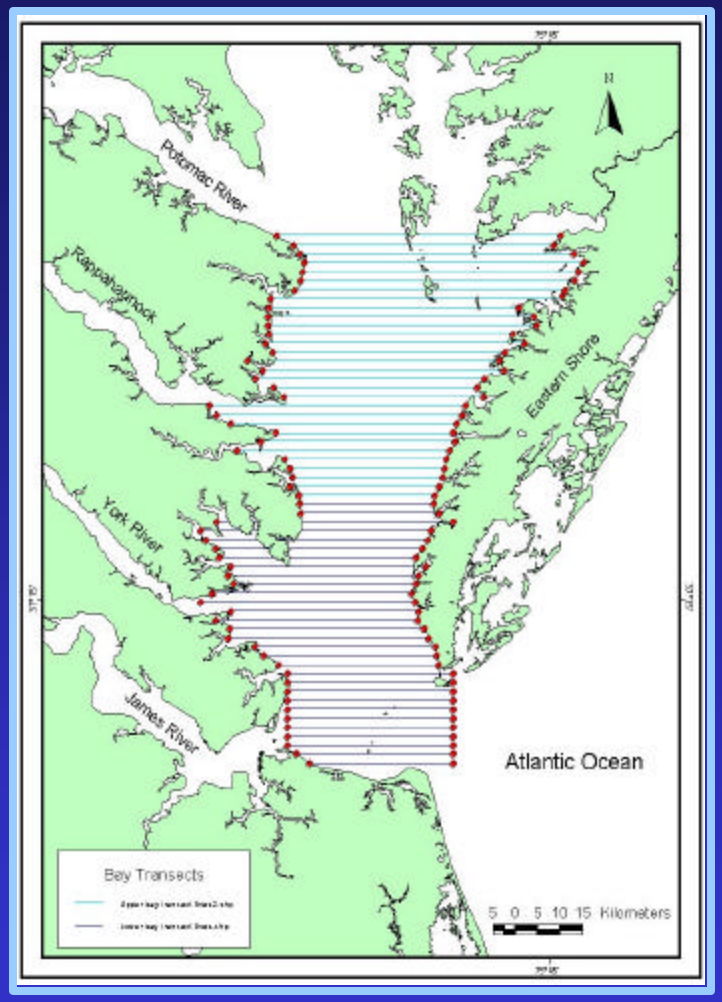
(Byles 1988; Keinath 1993; Mansfield et al. 2002a, 2002b)



- **State strandings are increasing over time due in part to:**
  - **increasing turtle population?**
  - **new sources of mortality (increasing fishing effort)?**

(Data courtesy of the Virginia Sea Turtle Stranding Network)

Virginia's Sub-Population Estimates:



Aerial transect locations in the Chesapeake Bay

- **Aerial surveys were reinstated in 2001, replicating Byles (1988) methods**
- **Densities peak in spring when turtles are first observed in state waters**
- **Aerial census models rely heavily on visual observations of turtles when at the surface of water**
- **Byles (1988) estimates included corrections for summer surfacing behavior of upper Bay foragers, extrapolating density data based on turtle "sightability"**
- **Surfacing data from arriving migrants in spring, or lower Bay foragers were not collected**

Research Question:

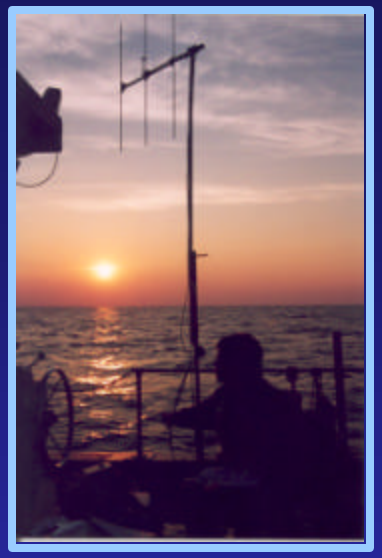
- **Are there seasonal differences in sea turtle diving behavior?**
  - Are Virginia's sea turtles more likely to be at the surface in the spring (migration behavior, temperature preferences)?

Previous Research (juvenile loggerheads):

- Musick et al. (1987) tracked a loggerhead off North Carolina that spent **16.6%** of its time at surface during the spring migration
- Byles' (1988) tracked summer/fall loggerhead foragers in Virginia that spent a mean time of **5.3 - 7.3%** at surface (1:18)
- Keinath (1993) tracked a loggerhead in vertically stratified offshore waters near the continental shelf—the turtle spent **24%** of its time at the surface, never diving deeper than 10 m

Methods:

- Juvenile loggerheads (n=7) and Kemp's ridleys (n=2) were tracked in the spring-summer 2002 and 2003
- All turtles were released in the Chesapeake Bay entrance
- Turtles tracked eight to 24+ hour post-release using a 40' tracking vessel with inboard engine
- Lotek VHF radio/sonic tags were attached with marine epoxy/fiberglass resin (Vemco V16TP-5H sonic tags were used in 2003 for temp/depth observations)
- Surfacing and dive behaviors were recorded with Lotek SRX 400 receiver, 3-element Yagi antenna; Vemco VH65 hydrophone and VR60 receiver)
- Locations calculated using GPS, hand-held compass and power bearings from tags
- Vertical temperature profiles taken ~each hour (YSI CTD)



Photos by K. Mansfield

Telemetry Analyses:

Respiration Analyses

- **Daytime surface ratios (total surfacing time/total track time)**
- **ANOVA—Difference between individuals; individual turtle tracks treated as independent samples (Byles 1988; Pemberton 2000); significance based on $p<0.05$.**

Circular Statistics (ArcView 3.2, Animal Movement 2.5):

- **Circular Point Statistics (Hooge 1988)—used to determine travel direction and significance of travel direction**

2002 Results (May through June):

- Sample: Five juvenile loggerheads
- Temperature profiles: 22°/25° (surface) to 18°/24° (bottom)
- Mean daytime surfacing time: 00:00:23 (+/- 00:00:09 SD)
- Mean daytime dive duration: 00:05:01 (+/- 00:02:10 SD)

- Significant differences among individual surfacing times and frequencies: ANOVA; $p<0.05$

- Surface to submergence time: 9.9% (+/- 2.9% SD) or ~1:10

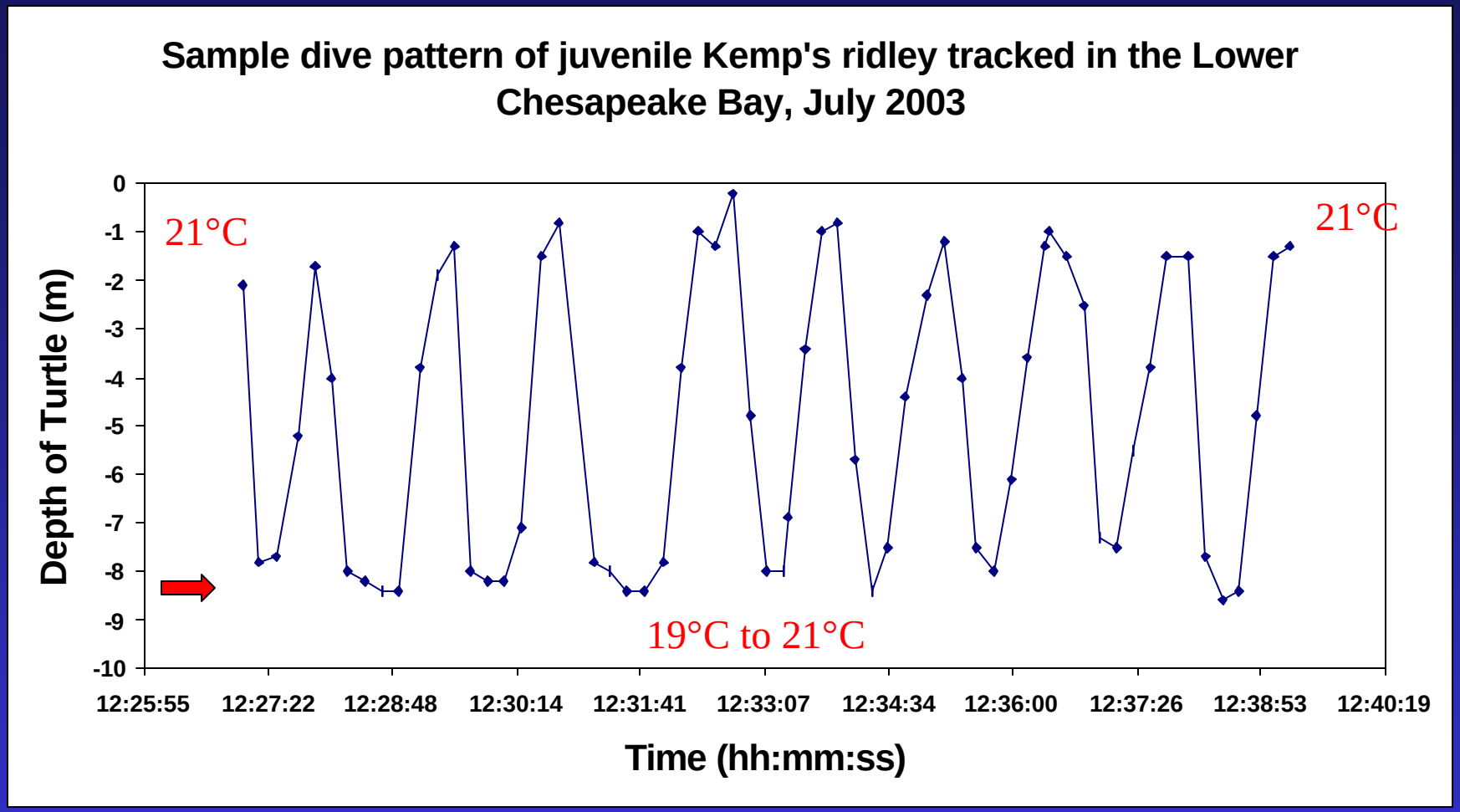
  range = 7.1% to 12.7%

- Observed directed movement ($p<0.05$) in all but one turtle, however direction of movement differed among individuals; one traveled out of Bay

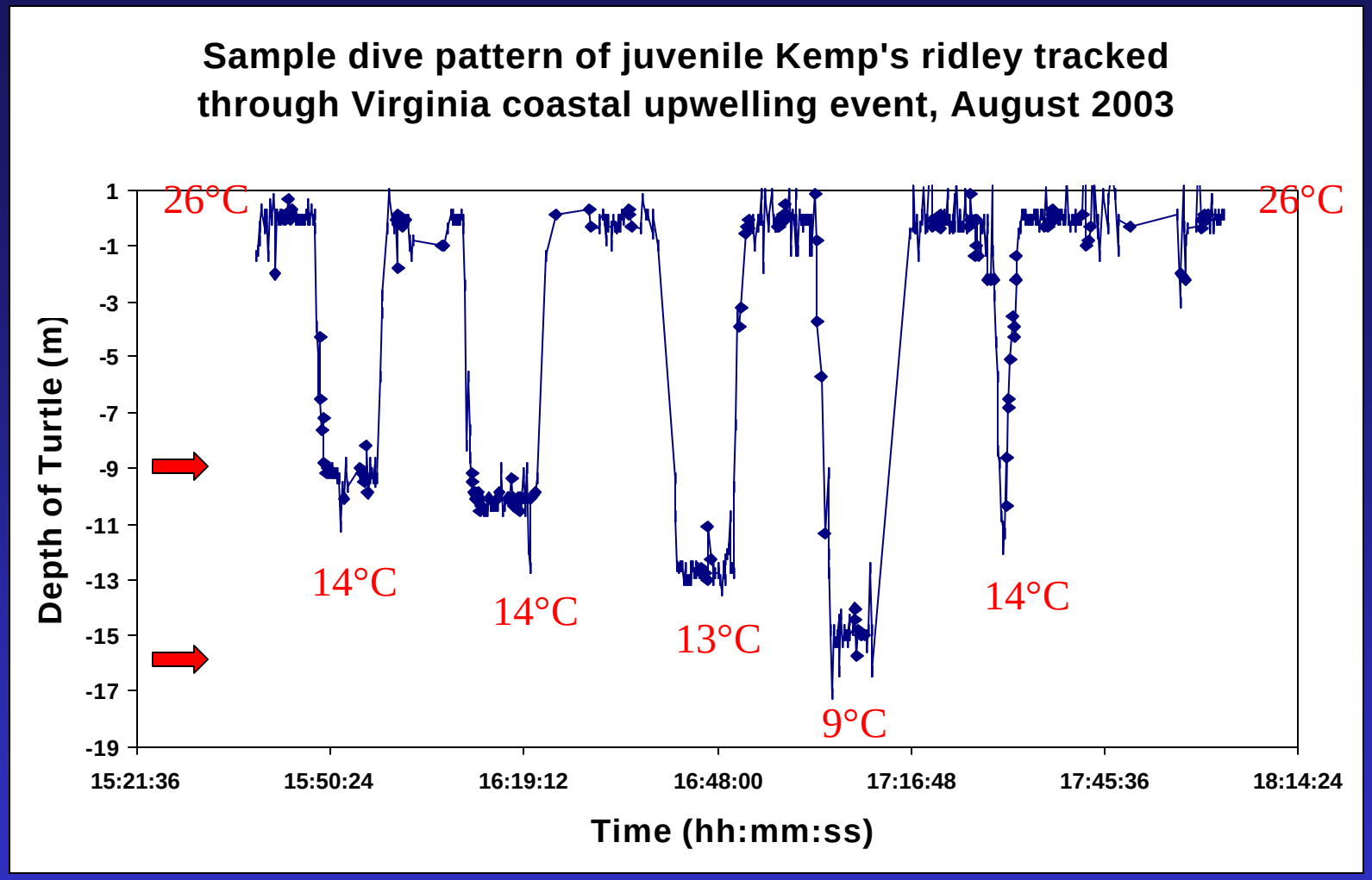
2003 Results (June through August):

- Sample: Two juvenile loggerheads, two juvenile Kemp's ridleys
- Temperature profiles: 19°/26° (surface) to 9°/19° (bottom)
- Mean daytime surfacing time (Cc): 00:00:37 (+/- 00:00:13 SD)
  (Lk): 00:04:13 (+/- 00:04:41 SD)
- Mean daytime dive duration (Cc): 00:04:50 (+/- 00:01:14 SD)
  (Lk): 00:04:27 (+/- 00:01:01 SD)
- Significant differences among individual surfacing times and frequencies (Cc & Lk): ANOVA; $p<0.05$
- Surface to submergence time (Cc): 25.0% (+/- 16.3% SD) or ~1:4
  range = 13.5 % to 36.5%

  (Lk): 32.9% (+/- 23.1% SD) or ~1:3
  range = 16.5 % to 49.2%
- Observed directed movement ($p<0.05$) for all turtles, however direction of movement differed among individuals (two into, two out of Bay)



- **Kemp's ridley tracked into lower Chesapeake Bay (July 31, 2003)**
  - **Turtle spent 16.5% of time at surface**
  - **Vertical temperature profiles well mixed**



- **Kemp's ridley tracked in deeper coastal waters off Virginia Beach (August 15, 2003) through coastal upwelling event:**
  - **Turtle spent 49.2% of time at surface**
  - **Vertical temperature profiles very stratified, colder on bottom**

Discussion:

- Mean loggerhead surfacing behaviors in spring (9.9% and 25.0%) were higher than Byles (1988) observations (5.3% to 7.3%)
- Byles (1988) data were from tracks in the middle of the Bay, mid-summer when vertical temperatures are well mixed
- 2002 springtime loggerhead ranges are tight (7.1% to 12.7%), unlike 2003 (13.5% to 49.2%)
- Turtles with highest 2002-2003 surfacing times (both species) were tracked in deeper, cooler waters of Bay mouth and/or Atlantic coastline
- Most turtles exhibited directed movement post-release with and against tides, versus Byles (1988) observations of Bay foragers (turtles moved with tides)

Conclusions:

- Variations in surfacing behavior between seasons may be due to environmental factors (T) and/or metabolic requirements of different behaviors (foraging vs. migratory/directed movement)
- Large differences (1:18 vs. 1:10 or 1:4) in seasonal sea turtle 'sightability' may bias historic extrapolated abundance estimates
- Higher spring densities observed by offshore/lower Bay aerial surveys in Virginia, may be due to warmer surface temperatures over steep thermoclines influencing sea turtle "sightability"
- Geographic peaks or seasonal variation in density observations may be a reflection of temperature or movement driven surfacing behavior

Future Work:

- Tracking will continue in 2004 to increase springtime sample size
- Dive profile analyses will be conducted to examine any correlations between vertical sea temperatures and behavior
- Historic and recent Virginia density estimates from the lower Bay will be recalculated to account for seasonal differences in turtle surfacing behavior
- This will most likely result in lower annual population estimates for Virginia's juvenile sea turtles than previously reported during historic spring peaks
- Byles (1988) summer/fall estimates would not be affected

Acknowledgements:

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