**NASA DEVELOP National Program**

****NASA Goddard Space Flight Center

**Summer 2015**

**Short Title: Maryland Ecological Forecasting**

**Subtitle:** Utilizing NASA Earth Observations to Monitor and Strengthen the Survivorship of Maryland’s Sea Turtles

**VPS Title:** Troubles Among Turtles: Monitoring Maryland’s Sea Turtles Using EOS

**Project Team & Partners**

**Project Team:**

Christopher Long (Project Lead), [christopher.w.long@nasa.gov](mailto:christopher.w.long@nasa.gov)

Kiersten Newtoff

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**Advisors & Mentors:**

John Bolten (NASA GSFC)

**Partner Organizations**

Maryland Department of Natural Resources (MDDNR): Marine Mammal and Sea Turtle Stranding Program, End-User, POCs: Dr. Cindy Driscoll and Amanda Weschler

National Center for Atmospheric Research (NCAR), Collaborator, POC: Gary Strand

**Project Details**

**Applied Sciences National Applications Addressed:** Ecological Forecasting, Oceans

**Study Area:** Chesapeake Bay and Atlantic Coast of Maryland

**Study Period:** Sept 1991 - Present

**Earth Observations & Parameters**

Aqua, MODIS - Chlorophyll-a

Orbview-2, SeaWiFS - Chlorophyll-a

Terra, MODIS – Sea Surface Temperature

**Ancillary Datasets Utilized**

* MDDNR Marine Mammal and Sea Turtle Stranding Program - Sea Turtle Stranding and Mortality Data
* US Geological Survey - Airborne Coastal LiDAR
* AVHRR Pathfinder Ver 5.0 - Sea Surface Temperature
* WorldView 2 - Land cover

**Models Utilized**

* NCAR Community Climate System Model 3 (CCSM3)

**Software Utilized**

Microsoft Excel - Data organization, descriptive statistics

ArcGIS 10.3 - Raster and vector manipulation, habitat suitability analysis

Geospatial Modeling Environment – habitat suitability analysis

Python 2.7 – Various libraries such as arcpy, scipy, numpy, pandas, and seaborn were used for spatial and temporal data analysis, data conversion, data visualization, and data management.

**Project Overview**

**80-100 Word Objectives Overview**

Protecting Maryland’s endangered loggerhead turtle requires detailed knowledge on the factors contributing to their strandings and nesting. Some strandings are due to anthropogenic factors while the cause of other strandings remain unknown. We investigate sea surface temperature and algal bloom activity as measured by chlorophyll *a* to determine their relationship with strandings. Although nesting events are rare in Maryland, future climate change will push the nesting range of loggerheads northward. Using four IPCC scenarios, we identify when nesting will begin moving northward and identify ideal nesting locations along the Maryland coast.

**Abstract**

Maryland experiences dozens of sea turtle strandings every year on both the Atlantic and Chesapeake Bay coasts. The majority of these strandings are juvenile loggerhead sea turtles (*Caretta caretta*) that wash onshore during the late spring to early fall. Although some strandings are attributable to anthropogenic recreational activities, such as fishing and boating, most of the strandings lack a clear cause of death. Changes in sea surface temperature, algal bloom activity, and weather events can all affect the survivorship of sea turtles. Here, we analyzed correlations in loggerhead strandings with sea surface temperature and chlorophyll-*a* measured remotely by the Aqua Moderate Resolution Imaging Spectroradiometer (MODIS) sensor, the SeaWIFS instrument onboard OrbView-2, and the Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi National Polar-orbiting Partnership (NPP) satellite to understand the environmental variables affecting survivorship since 1991. The project also identified potential nesting site locations since this life cycle stage is the most sensitive. Nesting activity is limited in Maryland, but modeled climate change indicates warming along the Atlantic coastline – which will push the nesting range of loggerheads northward. Distance from human infrastructure, beach width, and beach slope were used to determine the greatest likelihood of future nesting under different climate and sea level rise scenarios using the Community Climate System Model. Findings will be used by the Maryland Department of Natural Resources to react faster and efficiently to future strandings and to conserve potential nesting site locations.

**Community Concerns**

* All species of sea turtles in U.S. waters are listed under the Endangered Species Act
* Over 500 turtle carcasses have been discovered or reported in Maryland’s waters or on its shores since 1991
* In addition to human interactions, environmental variables such as phytoplankton activity and sea/land temperatures may be contributing to these mortalities
* Changing climatic conditions will influence these variables, as well as many others significant to sea turtle ecology (including foraging, reproduction, and nesting), putting greater risk on these species in the future (Witt et al. 2010)

**Current Management Practices & Policies**

The Maryland Department of Natural Resources Marine Mammal and Sea Turtle Stranding Program currently uses public reporting and observations to respond to sea turtle strandings, nesting events, or sick/injured turtles needing rehabilitation. The DNR staff responds to reports as soon as possible, traveling to the location of the incident and carrying out the required protocols including field observations, sample/carcass collection or disposal, necropsies and sample analysis, and rehabilitation efforts if appropriate. The DNR staff may not be able to keep up with seasonal peaks of incidents or obtain fully detailed data due to logistical restrictions. The MD DNR does not currently use any spatial analysis in their preparation, response, or research of sea turtle strandings. For nesting, the MD DNR patrols the beaches weekly for evidence of sea turtle nesting and places barriers around nests to prevent predation and anthropogenic disturbance. Nesting events are rare so the land is not managed for this purpose (i.e. vehicles are allowed to drive on the beach). The Endangered Species Act of 1973 holds DNR staff to detailed and strict requirements for the research and management of sea turtle populations, and the Convention on the Conservation of Migratory Species of Wild Animals of 1979 provides a framework for US governmental bodies on the conservation of any endangered species that migrate across international boundaries.

**Decision Support Tools & Benefits**

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| **End-Product** | **Earth Observations Used** | **Benefit & Impact** |
| Loggerhead Stranding Risk Map | Aqua MODIS, Suomi NPP, AVHRR Pathfinder, OrbView-2, SeaWiFS | Current and forecasted condition risk maps can identify regions, seasons, and years with more strandings in order to send personnel to locations faster and hire more staff as needed. |
| Nest Suitability Map | WorldView-2 | To identify nesting site locations that loggerhead turtles will most likely use/areas of focus for future MD DNR conservation efforts |
| Future Nest Habitat Suitability Maps | WorldView-2 | Sea level and surface temperature will change as a result of climate change. Future nest suitability maps will identify the effect of sea level on the suitable nesting sites as well as areas of conservation concern |

**Reference**

Witt, M. J., Hawkes, L. A., Godfrey, M. H., Godley, B. J., & Broderick, A. C. 2010. Predicting the impacts of climate change on a globally distributed species: the case of the loggerhead turtle. *The Journal of Experimental Biology* *213*: 901-911.

**Project Imagery**

**Caption:** Utilizing historical sea turtle stranding density, chlorophyll-a concentration, and sea surface temperature to assess potential sea turtle mortality risk during peak stranding months in 2015. Image credit: Maryland Ecological Forecasting Team.

**Image:**

