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 Kiersten Newtoff Erica Scaduto

Advisors & Mentors:

John Bolten (NASA GSFC)

Partner Organizations

Maryland Department of Natural Resources (MDDNR): Marine Mammal and Sea Turtle Stranding Program, End User/Partner, POC: Amanda Johnson, Program Coordinator; Dr. Cindy Driscoll, Director of the Fish & Wildlife Health Program

Project Details

Applied Sciences National Applications Addressed:

Ecological Forecasting, Oceans

Study Area: Chesapeake Bay and Atlantic Coast of Maryland

Study Period: September 1991 - Present

Earth Observations & Parameters

Aqua, MODIS - Chlorophyll-a, Sea Surface Temperature Orbview-2, SeaWiFS - Chlorophyll-a Suomi-NPP, VIIRS Level-3 SMI - Chlorophyll-a AVHRR Pathfinder Ver 5.0 - Sea Surface Temperature Landsat 8, OLI - Land cover WorldView 2 - Land cover

Ancillary Datasets Utilized

- MDDNR Marine Mammal and Sea Turtle Stranding Program Sea Turtle Stranding and Mortality Data
- US Geological Survey Airborne Coastal LiDAR

Models Utilized

- NCAR CCSM3 IPCC Climate Change Commitment Scenario Ensembles
- NOAA Coastal Relief Model, 3 arc second, Vol. 1 (Atlantic Northeast)



Software Utilized

Microsoft Excel - data organization, descriptive statistics

ArcGIS - raster and vector manipulation, habitat suitability analysis

- Python ArcPy site package used for geographic data analysis, data conversion, and data management. Urllib module used to extract datasets from ERDDAP data server.
- Pandas software library for Python used for data manipulation, and analysis; particularly utilizing the time-series-functionality.

Project Overview

80-100 Word Objectives Overview

Protecting Maryland's endangered loggerhead turtle requires detailed knowledge on the factors contributing to their strandings. Past, current, and future sea surface temperature and algal bloom activity provide critical data in understanding these unexplained deaths. Likewise, future climate change will push the nesting range of loggerheads northward, requiring the protection of ideal habitats along the Maryland coast.

Abstract

Maryland's coast 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 on the shore during the late spring to early fall. Although some strandings are easily 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 trends in loggerhead strandings using many satellites measuring sea surface temperature and chlorophyll a to understand the environmental variables affecting their survivorship since 1991. We also examined nesting site locations since this life cycle stage is the most sensitive. Nesting activity is limited in Maryland but climate change will warm the coastline and push the nesting range of loggerheads northward. Climate change will also affect algal bloom activity and sea surface temperatures and impact sea turtle strandings. We forecasted future climate scenarios using the Community Climate System Model to provide information on trends for future nesting and strandings in this region. Our findings will be used by the Maryland Department of Natural Resources to predict future stranding locations for quicker recovery, removal, and analysis of this Endangered Species.

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

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 and nesting. 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.

End-Product	Earth Observations Used	Benefit & Impact
Loggerhead Stranding	Aqua MODIS, Suomi NPP,	Current and forecasted condition
Risk Map	AVHRR Pathfinder,	risk maps can identify
	Orbview-2, SeaWiFS	regions/seasons/years with more
		strandings in order to send
		personnel to locations faster and
		hire more staff as needed
Future Nest Habitat	Landsat 8, Worldview 2	Nesting sites are rare in Maryland,
Suitability maps		but with climate change increasing
		temperatures on the coastline,
		loggerhead turtles will be moving
		northward. MD DNR can use these
		maps to begin acquiring land and
		notifying key personnel on the tracts
		of land that need to be preserved.

Decision Support Tools & Benefits

Project Imagery

Caption: Image:

