FISHING FROM SPACE: FRYINGPANTOWER USES GIS TO PREDICT FISHING SPOTS

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ABSTRACT

The SST-Offshore.Com Network is a series of websites that provide offshore fishing information for recreational, charter and commercial fishermen along the East Coast and Gulf of Mexico. A key feature of this information is a product called Bluewater Supermap, a web-based map of the eastern seaboard of the United States and the Gulf of Mexico. Bluewater Supermap includes not only information of general interest to boaters such as weather forecasts and tide tables, but also certain conditions of the water itself including ocean current speed and heading, sea surface temperature, salinity, and plankton concentration. These factors are useful in predicting the probable locations of given species of fish. Bluewater Supermap utilizes over 40 hand-written programs, combining data from over a dozen government and private agencies, to present the state of the art in fish location prediction. The result is increased fishing yields per trip, which means greater profitability for commercial fishermen , greater customer satisfaction for charter captains and higher success rates for recreational fishermen. Included here is a description of the data offered by Bluewater Supermap, a description of the layers' applicability to locating fish, and a real-life exercise in using Bluewater Supermap to predict the location of desired species of fish.

Key words: ocean, fishing, modeling, temperature, plankton

INTRODUCTION

In 1990, FryingPanTower.Com was created to provide a web-based forum and web-based maps for discussion among fishermen on the east coast of the United States. In 2004 after seeing an exhibition of online mapping technology Captain Dave Tilley ventured into the online mapping world with a simple but effective online map called I-Map. I-Map combined bottom topography with satellite data to predict the concentrations of fish. In 2007, Captain Dave Tilley decided to put into practice (and onto the Internet) some relatively recent developments in the science of predicting where fish will collect. The result is Bluewater Supermap, a web-based map of over 40 datasets available for overlay ("layers") covering the entire eastern seaboard of the USA, from Maine to Texas.

The data provided by Bluewater Supermap allows for greater boating safety, by providing a single point of access for weather and ocean condition forecasts from various agencies, and greater fishing yields per trip, by providing information instrumental in predicting fish locations based on knowledge of the fishes' preferred water conditions.

BOATING SAFETY INFORMATION

Bluewater Supermap is an invaluable tool in boating safety and planning. It presents current weather information in the form of weather buoy data, weather warnings from the US National Weather Service (NWS), wind speed/direction maps, barometric pressure maps, and five different Doppler radar imagery overlays. Also offered are six separate weather forecasts from multiple agencies, tide tables, solunar tables, and SST-Offshore.Com's own offshore forecast systems: ReefCast, ReefCast With Extra Wave Data, and ReefCast Ensemble.

NWS Marine Forecasts, GFS and NAM Forecasts
NWS provides weather forecasts for over 400 coastal and offshore forecast zones along the east coast and the Gulf of Mexico. These forecasts are made available via Bluewater Supermap. The forecasts are updated hourly from the NWS.

NWS also makes available to the general public the output of the GFS forecasts and the ETA/NAM forecasts. These forecasts are made available through Bluewater Supermap in 3000 clickable stations located geographically thoughout the map. These weather prediction models are considered the most accurate in current use, and are the basis for most other weather predictions in the United States.

ReefCast

Bluewater Supermap includes the output from SST-Offshore's own offshore forecasting system. **[Figure 1]** ReefCast takes publicly avalible models to higher level through the inclusion of what we call "Local Knowledge". We combine different datasets and run them through our own process to output what is considered the very latest in the state of the art in offshore forecasting. ReefCast output is a 3 mile by 3 mile forecast of wind speed, wind direction, wave height, and wave period, predicting seven days into the future. ReefCast With Extra Wave Data is the same forecast except it is tracking multiple seas in both height and period, and ReefCast Ensemble is the overlay of the last 7 ReefCast model runs to show the stability of the forecast against past modelings. ReefCast as a whole has an accuracy rating of 93% at three days out, making it one of the premier forecasts in the offshore world.
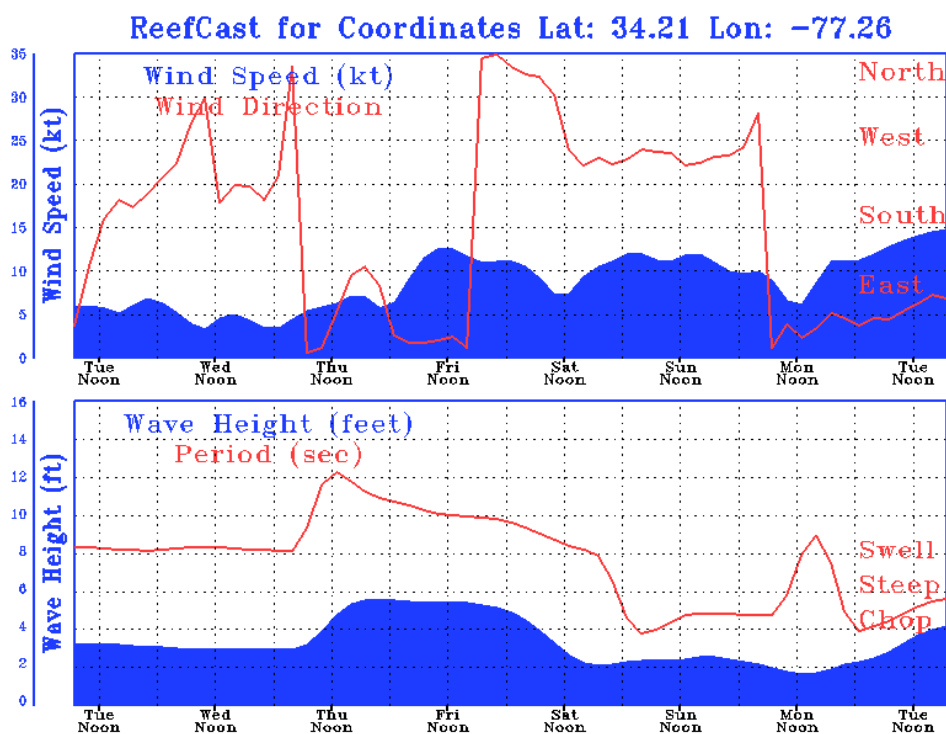

Figure 1. ReefCast showing wind and wave information as a seven-day forecast.

NOAA Radar Images

A set of five NOAA Doppler radar composites are available: reflectivity composite, warnings, velocity, one-hour precipitation, and storm total precipitation. These image overlays are similar to those seen in television weather forecasts, blue and green clouds over the map indicating storm or precipitation conditions.

Tide Charts

Bluewater Supermap includes tidal predictions until 2037 for every Primary and Secondary tide station in the US. Tides are very important for the boating public and the tidal movement of water is considered a primary force in safety considerations. The tidal flow of water can cause large dangerous conditions in many parts of the US. An excellent example of this is Oregon Inlet along the North Carolina Outer Banks where a large amount of water flowing outward from the sound to the sea can cause inlet waves in excess of 20 feet even when the ocean waves are just a few feet.

USCG Offshore Navigation Charts

Bluewater Supermap includes a set of up to date USCG Navigation Charts **[Figure 2]** which have been georefenced, providing the mariner the ability to look at any of our 40 plus layers in relation to these well known charts.
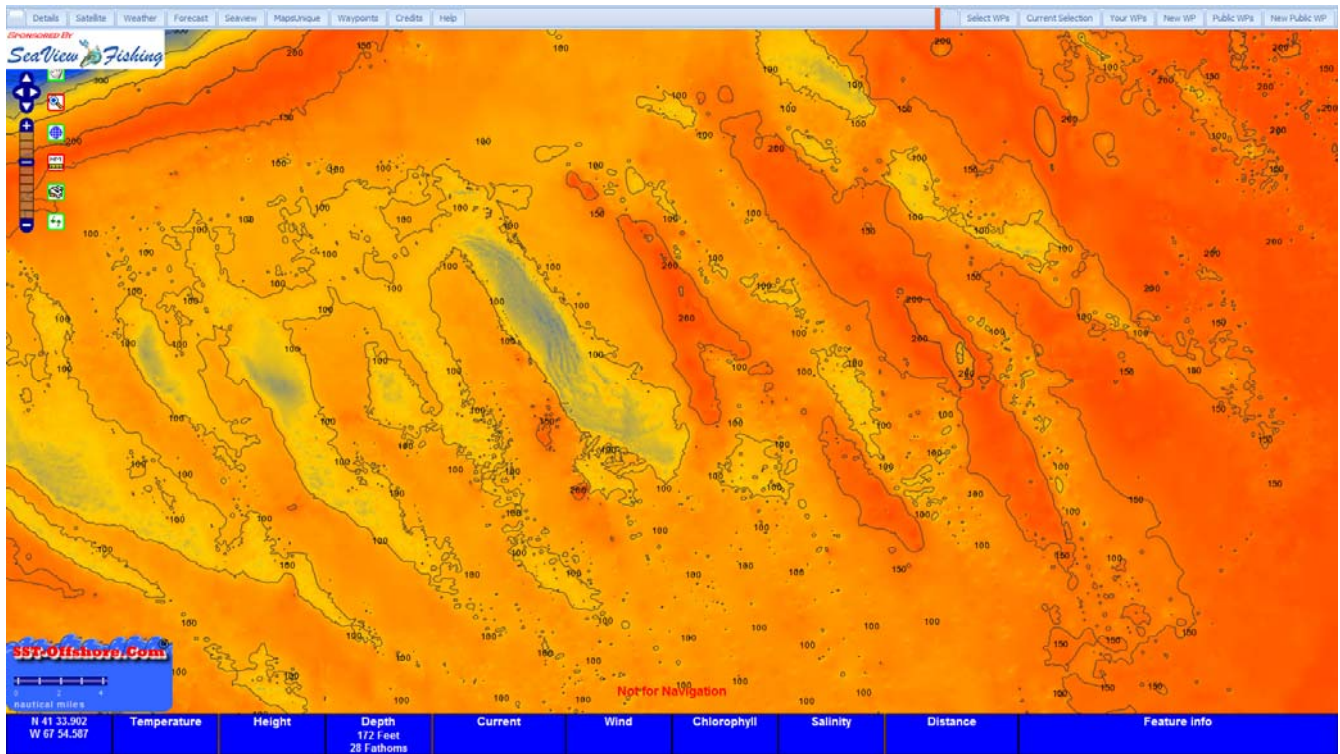

Figure 2. Bottom topography. Contour lines and shading give a sharp picture of the ocean floor, indicating canyons and mounts where fish collect. The lines and shading can be viewed separately.

WATER CONDITION LAYERS

The prediction of fish location is based on many conditions. Bottom structure, sea surface temperature, sub-surface temperatures, plankton concentrations, salinity concentrations, and currents play a large part in predicting where fish will concentrate. Different species of fish prefer different temperatures and salinity ranges. Plankton is a food source and fish are attracted to it, whether those fish eat the plankton directly or eat the fish which eat plankton. Bottom topography and structure (trenches, reefs, shipwrecks, rocks) tend to attract and hold fish. The speed and direction of ocean currents predict the movement of the temperature, salinity, and plankton "clouds" over time. Bluewater Supermap combines all of these element into a single user interface and the end user can then use to predict the location of targeted species of fish.

Bottom Topography

Bluewater Supermap includes science-grade bottom topography. Color coded and georeferenced, this bottom topography creates an easy to use visual representation of the sea floor that makes finding and following bottom features much easier. The ocean overall is a vast desert with pockets of life, and this life follows a food chain that starts with small organisms attached to exposed rocks or ledges on the seafloor. If you can find those exposed rocks, you will generally find the small organisms which are the food source for larger fish and in turn the predator fish which we mostly target.

Waypoints

The ocean floor is littered with rocks, ledges, coral heads, live bottom, and other natural structures. Man has added

to that shipwrecks, oil rigs, artificial reefs, and various other debris. We display the GPS locations of these points of interest in Bluewater Supermap as both "Public Waypoints" and "Private Waypoints" which can be displayed on top of other data layers **[Figure 3]** and downloaded in GPX format to be uploaded to GPS units.

Public Waypoints are added and edited by the administrator through a user interface and those waypoints are available to all users of the Bluewater Supermap. Private Waypoints are added by individual users either by clicking the map or by uploading GPX files from their GPS. Private Waypoints are only available to the user who uploaded them.
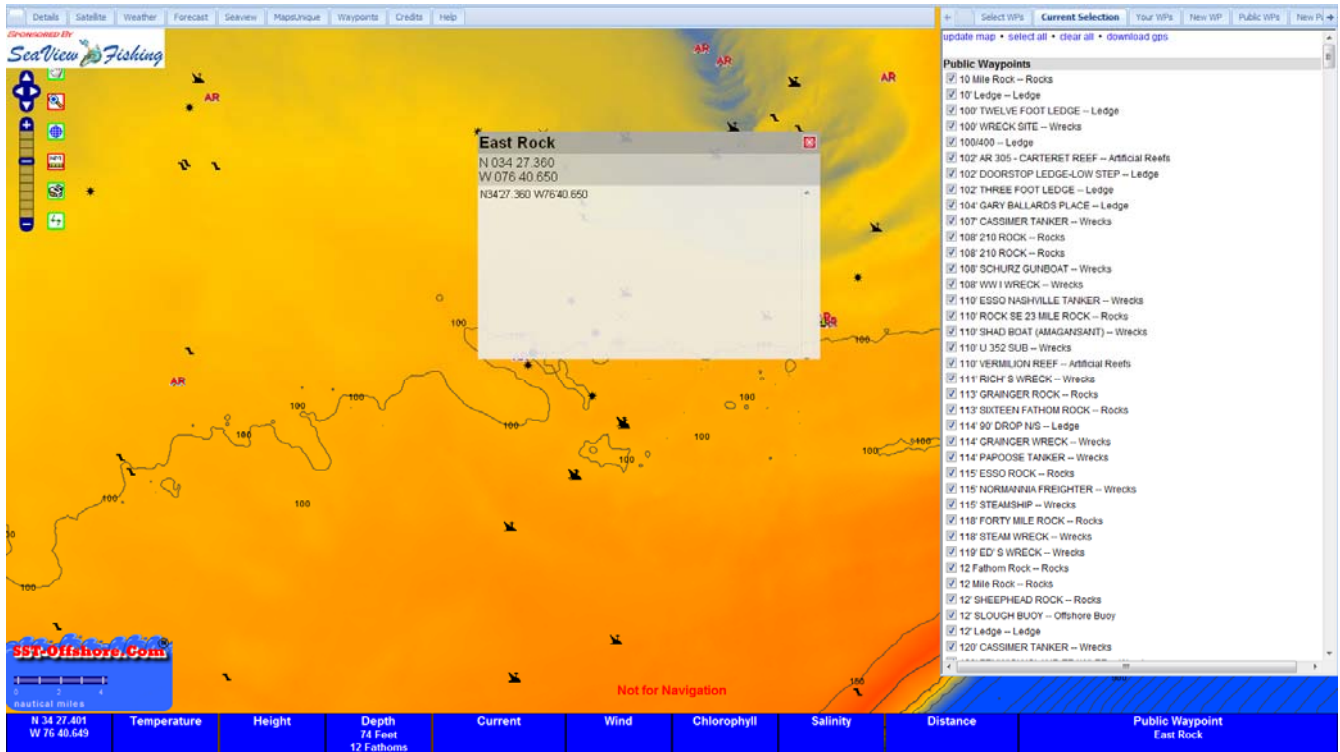

Figure 3. An example of the waypoints available in the map.
Waypoints can represent safety concerns such as obstructions, or recreational opportunities such as diving attractions.

Sea Surface Temperature (SST)

Sea surface temperature (SST) data are made available as an overlay, coloring the water to indicate the temperature **[Figure 4]**. SST data are taken from several different agencies and sensors including MODIS, GOES, and AVHRR.

The number of flyby images ("shots") available varies depending on the satellite: AVHRR averages 10-15 shots per day, MODIS averages 5-10, and GOES is a one-per-day composite of the best information available from all previous shots. The SST data is updated hourly, collecting the most recent data available.

SST data are retained and available for viewing for seven days. In order to aid in trend visualization ("Which direction is the warmer water moving?") all shots are also composited into an animated loop.

Chlorophyll (Plankton) Concentration

In addition to temperature, the MODIS AQUA satellite also measures chlorophyll concentrations in the water. In the water, chlorophyll correlates presumptively with plankton and algae, a food source and attraction to fish.

On average, 15-20 flyby shots are collected per day. These shots are collected hourly and are stored for seven days, and an animated loop is available to make movement and trends visually intuitive.

Salinity

The salinity layer shows a color-coding of the concentration of salt in the water. There is one overlay per day available for display on the map, and it is a composite of the best information from all shots available for that day. Since new shots and data corrections come in throughout the day, the composite is updated hourly to constantly present the best available data. Like most other layers, salinity data are archived for seven days and are also made into loops.
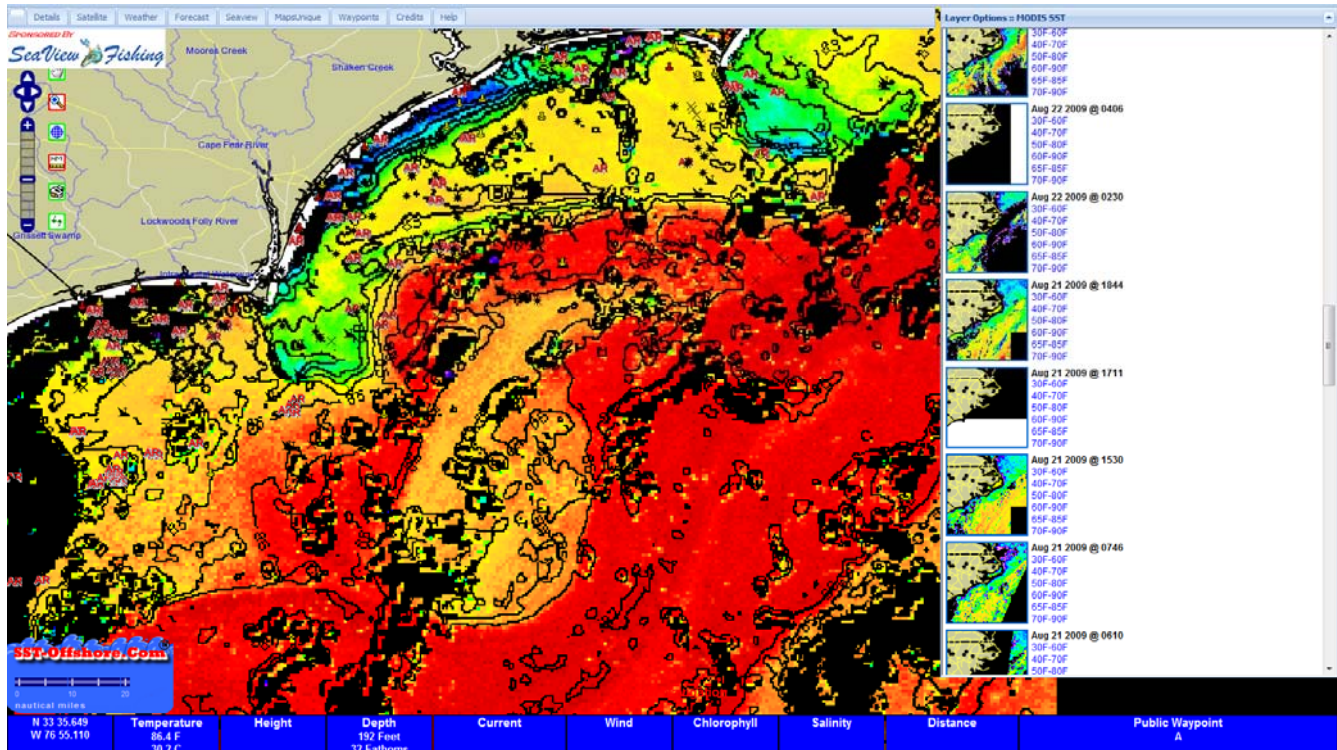
Figure 4. Sea surface temperature (SST) as detected by the MODIS AQUA satellite. A number of shots are visible going back seven days, with color enhancement adjustable to fit a variety of temperature ranges.

Ocean Currents

The speed and direction of the ocean current is made available via the Bluewater Supermap as well. When ocean current is displayed as a set of wind barbs overlaid onto the water, the result is visually intuitive as to the speed and direction of water at both large and small scales.

Sub Surface Temperatures

Sub Surface Temperatures show a color coding of the temperature ranges at 50m, 100m and 300m. Fish will tend to accumulate at or near a temperature range of their liking, and these layers are very useful in finding Swordfish, Yellowfin Tuna, and other predatory fish that live at depth. These layers are composited and updated daily.

Mixed Layer Depth

Mixed layer depth (MLD) shows the depth of the thermocline (a rapid temperature change). This layer is a very good indicator of upwellings and areas of drastic change have been known to hold predatory fish. It is near these areas of thermocline that we find the convergence zone. It is this convergence zone that holds the fish.

AN EXERCISE IN FINDING FISH

Not all fish enjoy the same water conditions. In the wild, Wahoo prefer water temperatures of 70° F to 86° F and these temperatures are often associated with higher catch rates. Their sensitivity to cooler temperatures also limits vertical movements to the relatively thin layer between the thermocline and surface. This information can be used to selectively fish for Wahoo and other predatory fish.

Sea Surface Temperature

We start with an MODIS sea surface temperature (SST) shot from Bluewater Supermap **[Figure 5]**. You can see where the hot water is pushing over the what we call The Break, where the depth of the water drops off drastically at the edge of the continental shelf. The area in the middle, inshore from The Break, is of the appropriate temperature for Wahoo.
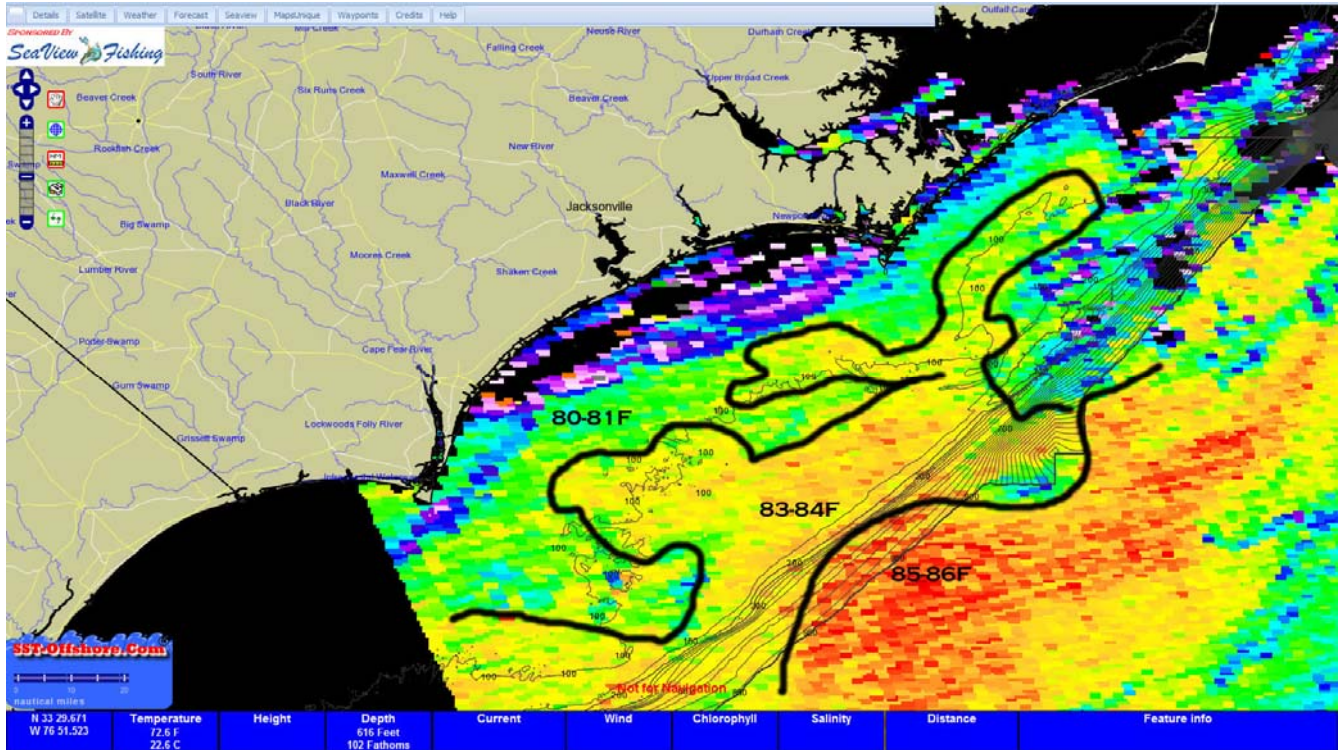

Figure 5. Sea surface temperature from SeaView, with color enhancement in the 80F – 95F range.

SeaView Plankton

Next, a view of the ocean's favorite food: plankton. **[Figure 6]** Green represents higher concentrations of chlorophyll, while blue represents much lower levels. Note how the chlorophyll (and thus plankton) concentration mirrors the temperature, with highest concentrations found in moderate-temperature waters. Convergence zones between high levels of chlorophyll and low levels of chlorophyll, represent optimal areas of temperature and food.

SeaView Salinity

Salinity shows the amount of salt suspended in the water. **[Figure 7]** This can be used to show currents and water movement. Notice how the salinity gradient is following The Break. Our target area would have a moderate salinity, not too light yellow and not too dark orange. The borthwest border of the "salinity cloud" looks about right.

SeaView Mixed Layer Depth

The mixed layer depth (MLD) thermocline helps indicate the depth at which fish are likely to collect. **[Figure 8]** Convergence zones where the MLD changes sharply indicate upwellings which bring fish to the surface following their preferred temperature, as well as stir up plankton and other edible ocean debris.

Narrowing it Down

The area south of the center of the map, has optimal conditions for finding Wahoo, Mahi, and King Mac. It has a temperature around 84F, a moderate salinity, a plankton convergence zone, and a mixture of thermocline depths. If we zoom in to the area of interest **[Figure 9]**, we can quickly identify MLD convergence zones in closer detail. We have now indicated several prime spots where fishing will be very good.
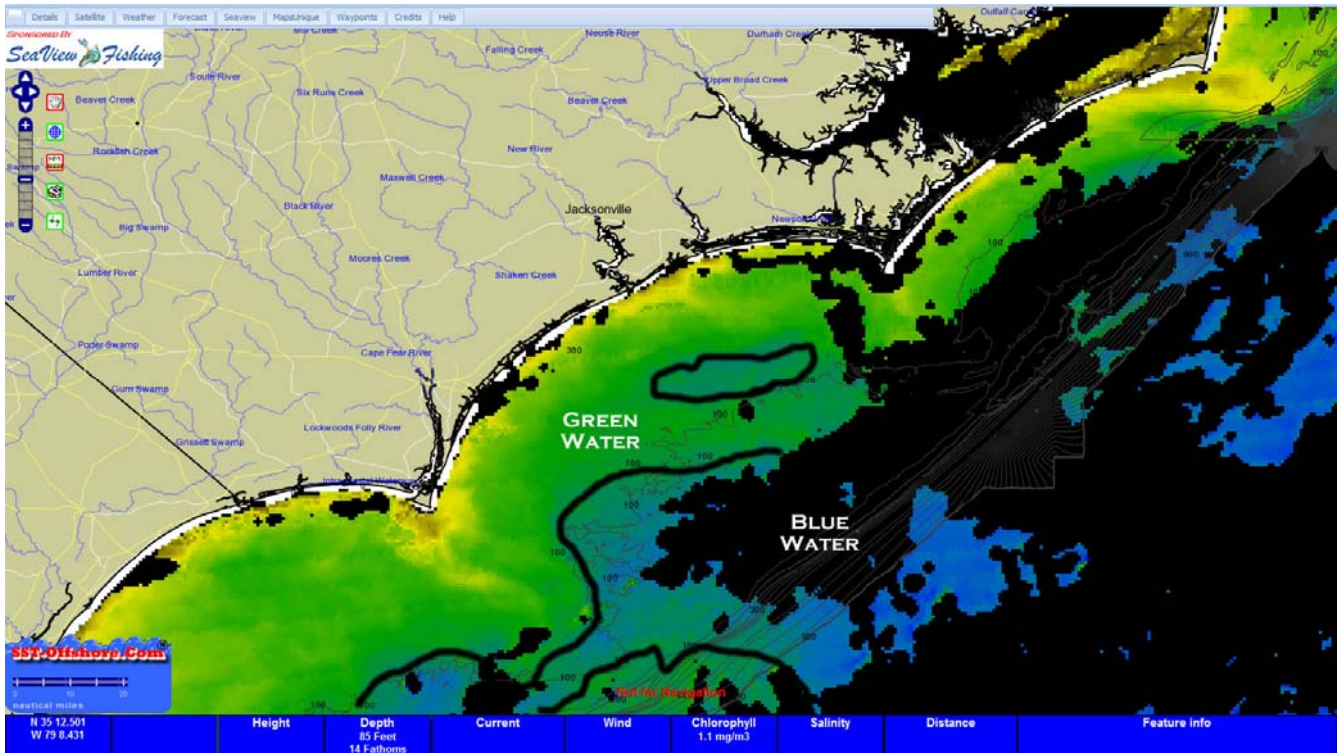
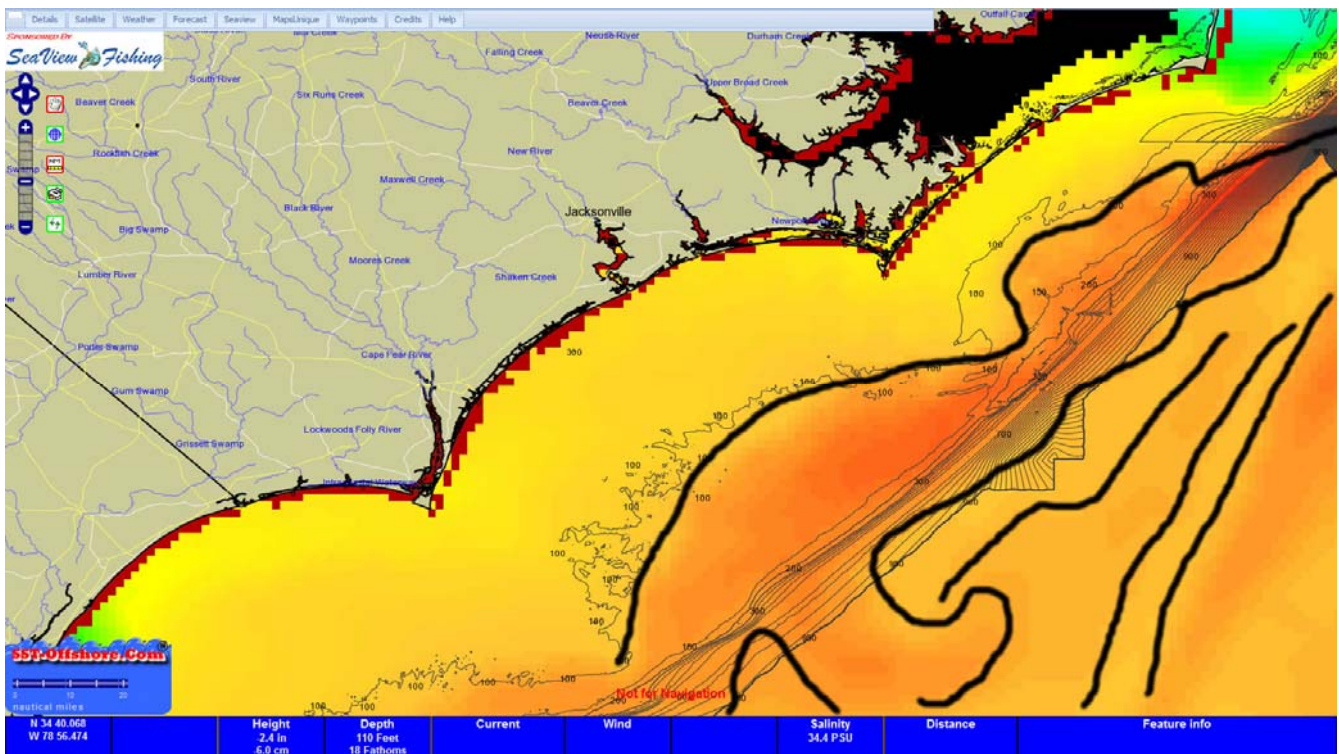**Figure 6.** A photo of plankton concentration from MODIS AQUA.

Figure 7. Salinity data from SeaView. Darker color indicates higher salt density.
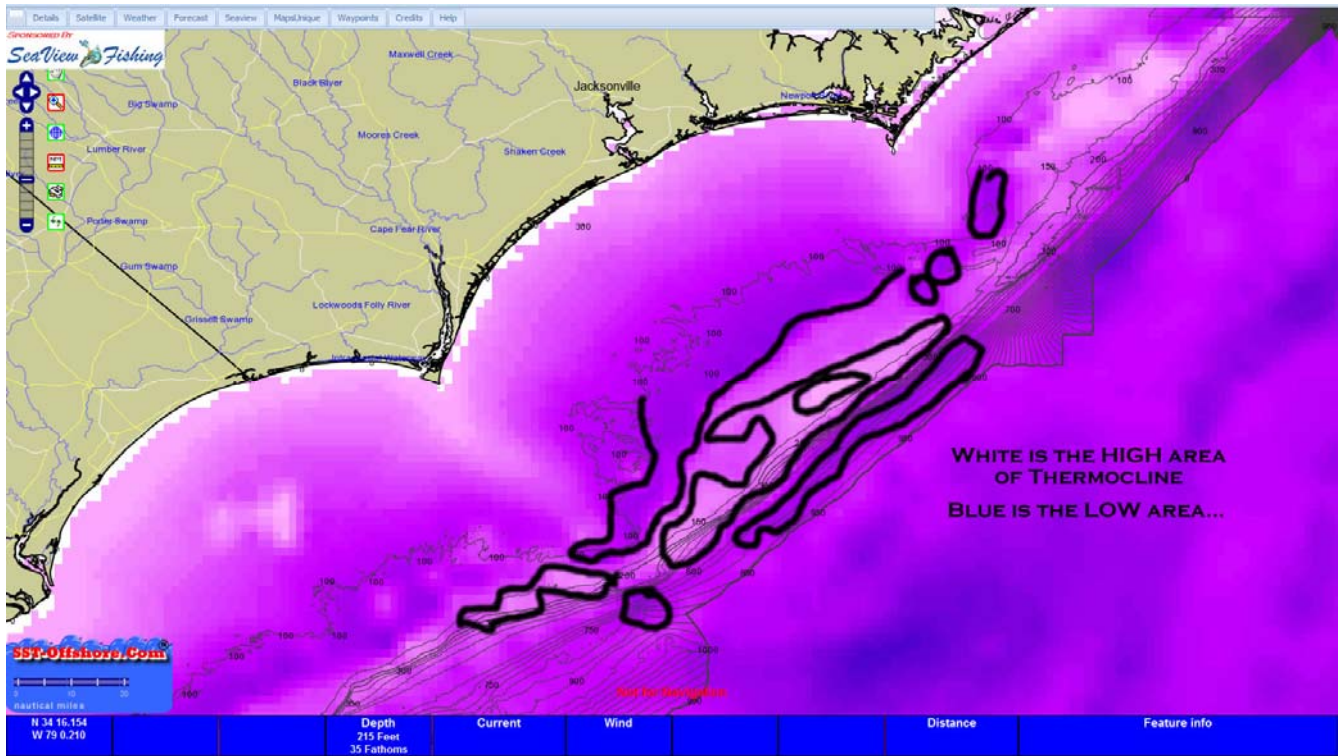
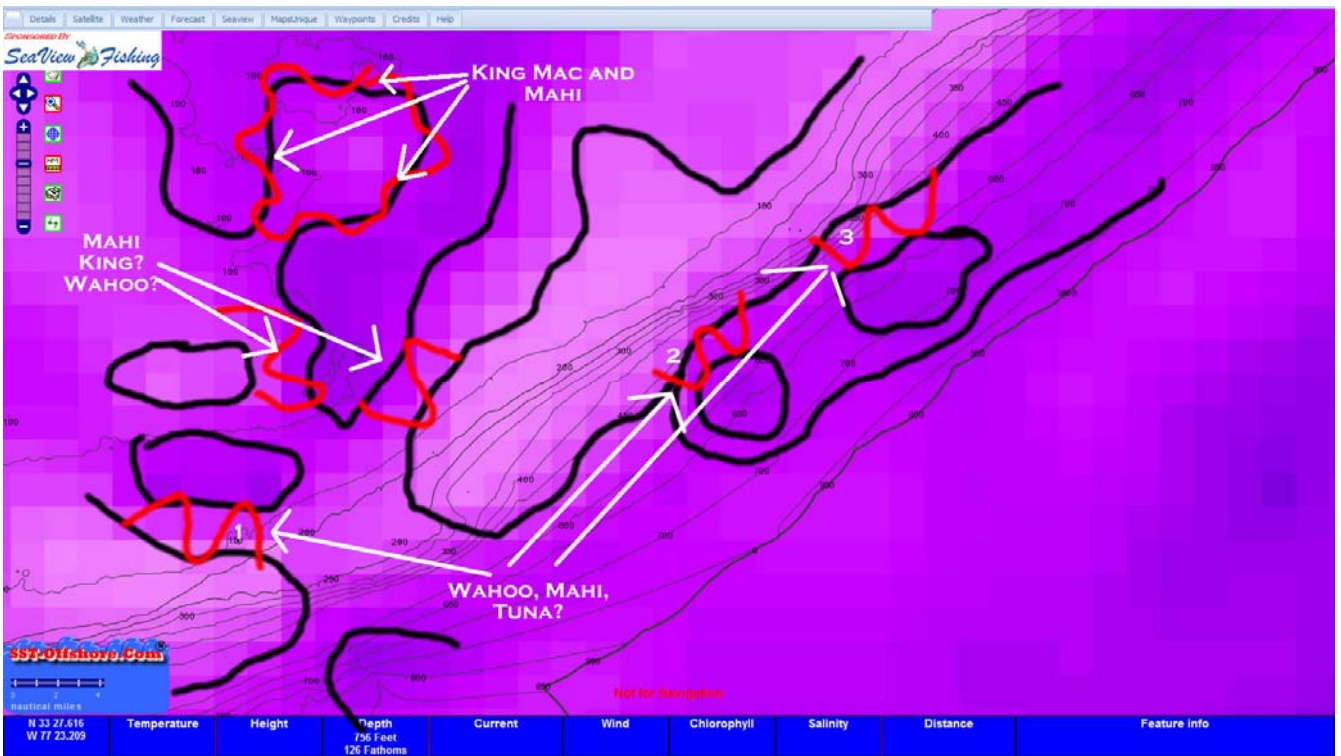**Figure 8.** The mixed layer depth (MLD) thermocline.

Figure 9. Having identified a region of optimal temperature, salinity, and plankton, we zoom in for more detail on MLD convergence zones. We have now identified several areas of only a few square miles apiece.

CONCLUSION

The combination of sea surface temperature, chlorophyll, thermocline, and bottom topography with GPS waypoints of known structure is a deadly combination for finding fish. The ability to "know before you go" saves the end user time, fuel, and money and increases the catch rate. With the price of marine fuels topping $3.00 per gallon and most boats getting gallons per mile vs miles per gallon, SST-Offshore.Com's Bluewater Supermap makes every mile count.

ABOUT THE AUTHORS

Captain Dave Tilley

Captain Dave is a USCG 100 ton Master with over 20 years of Offshore Fishing experience, and he currently operates the 100+ foot Head Boat Continental Shelf based in Morehead City, NC. The unusual combination of Captain and Computer Geek lead Captain Dave to create the SST-Offshore.Com network and Bluewater Supermap. This would not have been possible without HostGIS and lead programmer Greg Allensworth.

Greg Allenworth

Greg has been tinkering on Unix systems since 1992, before the invention of the World Wide Web. After college in 1996, he became a system administrator and dabbled in programming. He is system administrator for HostGIS, which also means programming for customers when time permits, and he has a wall covered in certifications.

FURTHER READING / BIBLIOGRAPHY

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http://map.fishthecarolinacoast.com/ads/Why%20is%20Bluewater%20Supermap%20Different.pdf
A non-technical document describing how Bluewater Supermap helps improve catch. The target audience is non-technical fishermen.