Sea Water Property (Profile) Data collected during:
NF-16-02 2016 Bluefin Tuna Ecology (BTE) and
NF-16-03 2016 Coral Reef Ecosystem Research (CRER) Research Cruises

This sea water property (profile) data submission comprises the final Conductivity, Temperature, Depth (CTD) dataset collected aboard the NOAA Ship *Nancy Foster* during two merged collaborative fisheries oceanography surveys (described in detail below) conducted from April 28, 2016 to June 25, 2016. The vessel's Sea-Bird Electronics (SBE) 911plus CTD system was operated at 119 discrete station locations along the survey track. At each location, the CTD package was lowered from the surface to a predetermined depth, sampling continuously. The CTD was configured with a pressure sensor, dual temperature, conductivity, and dissolved oxygen sensors, a chlorophyll *a* (chl_a) fluorometer, a colored dissolved organic matter (CDOM) fluorometer, and an altimeter. The sensor package was attached to a frame configured with a 24-bottle water sampler and 10-liter Niskin water sampling bottles.

The raw CTD data were post-processed to a final state using the SBE Data Processing Software package (Windows-based, publicly available at www.seabird.com). The specific subroutines applied to the data are outlined in the header of each ascii data file found in the dataset (.cnv files). The header of each file also includes the time and location of the cast. In addition to the ascii data in this data submission, .jpg plots of each CTD cast have also been included. These data were not calibrated to bottle samples and are considered final.

The measured and derived parameters in this dataset are:

Time of Cast (elapsed from start, s)
Pressure (Digiquartz, db)
Temperature (from primary sensor, ITS-90, deg C)
Temperature (from secondary sensor, ITS-90, deg C)
Conductivity (from primary sensor, S/m)
Conductivity (from secondary sensor, S/m)
Dissolved Oxygen Raw Voltage (from primary sensor, SBE 43, 0-5 VDC)
Dissolved Oxygen Raw Voltage (from secondary sensor, SBE 43, 0-5 VDC)
CDOM Relative Fluorescence (WET Labs CDOM Fluorometer, 0-5 VDC)
CHL_A Relative Fluorescence (WET Labs ECO-AFL Fluorometer, 0-5 VDC)
Altimeter (when in range, depth off the bottom, m)
Depth (in salt water, m)
Density (from primary sensors, sigma-theta, kg/m^3)
Density (from secondary sensors, sigma-theta, kg/m^3)
Potential Temperature (from primary sensors, ITS-90, deg C)
Potential Temperature (from secondary sensors, ITS-90, deg C)

Sound Velocity (from primary sensors, Chen-Millero, m/s)
Sound Velocity (from secondary sensors, Chen-Millero, m/s)
Dissolved Oxygen (from primary sensor, SBE 43, ml/l)
Dissolved Oxygen (from primary sensor, SBE 43, mg/l)
Dissolved Oxygen (from primary sensor, SBE 43, umol/l)
Dissolved Oxygen (from primary sensor, SBE 43, umol/kg)
Dissolved Oxygen (from secondary sensor, SBE 43, ml/l)
Dissolved Oxygen (from secondary sensor, SBE 43, mg/l)
Dissolved Oxygen (from secondary sensor, SBE 43, umol/l)
Dissolved Oxygen (from secondary sensor, SBE 43, umol/kg)
Salinity (from primary sensors, Practical, PSU)
Salinity (from secondary sensors, Practical, PSU)

The NOAA fleet cruise IDs for these two surveys are NF-16-02 and NF-16-03. However, the CTD were processed together and the cruise ID NF-16-02 refers to data from both cruises. A completed cruise track (with station locations) and project overviews are detailed below.

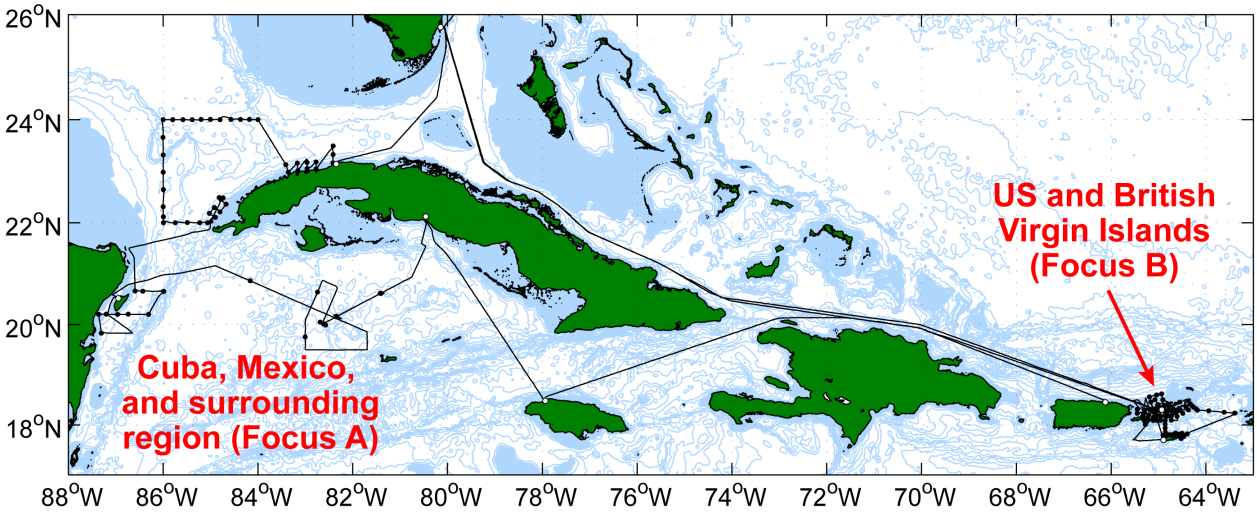

Figure 1. Completed survey track and focus areas. Black dots along the trackline indicate discrete station locations.

FOCUS A. Bluefin Tuna Ecology (BTE)

Atlantic bluefin tuna (ABT) is the highest-valued Atlantic tuna species on the market today. The species is an important export for American fishermen, with the majority of the product going to Japanese markets. The United States also imports ABT for consumption from a number of nations. Management of the ABT fishery in the Atlantic Ocean, Gulf of Mexico, and the Caribbean Sea is carried out in accordance with agreements by the International Commission for the Conservation of Atlantic Tunas (ICCAT) and the National Marine Fisheries Service (NMFS). In U.S. waters, ABT are subject to two regulations: the Magnuson-Stevens Fishery Conservation and Management Act and the Atlantic Tunas Convention Act. Given the highly migratory behavior of this species, its management is a complex, international concern. ABT are overfished

throughout their range in the Atlantic Ocean, and current population levels are at a historic low. Plankton surveys targeting larval ABT have been completed by NMFS annually in the northern Gulf of Mexico since 1977 using a fixed-grid of stations. However, this current ichthyoplankton sampling strategy is limited to the U.S. Exclusive Economic Zone (EEZ). Previous sampling expeditions have found small numbers of ABT larvae along the Yucatan shelf, in the Loop Current just north of the Yucatan Channel, and in the Straits of Florida. To gain a better understanding of the importance of alternative spawning sites and to improve management of the western Atlantic stock, we sampled areas adjacent to confirmed spawning grounds and assessed their potential contribution to the overall spawning activity.

NOAA and ICCAT scientists traditionally use the larval abundance data collected from surveys in the northern Gulf of Mexico to calculate a larval index of spawning stock biomass. Variability in the current larval index is high: up to 100% of the mean and larger. It is likely that physical oceanographic factors contribute to this variance, but relationships between the distribution of ABT larvae and environmental conditions are not well known. Additionally, little is known about ABT spawning outside the U.S. EEZ. Initial analyses of larval ABT abundances from 1977 to the present indicate that while larvae are found across the Gulf of Mexico between late April and early June, it is not clear what effect, if any, mesoscale features have on these observed larval distributions. This uncertainty is partially an artifact of the design of the fixed-grid surveys, as the distance between sampled stations is large enough to preclude reliable correlations between ABT larvae and environmental gradients. Also, the current index does not take into account multiple sources of larvae and the possibility of extended regional spawning.

ABT are known to spawn in areas outside the Gulf of Mexico, but the numbers of spawning individuals and the geographic extent of spawning are unknown. As these areas have not been included in the standard larval surveys, it is critical to define possible alternative spawning sites. Previous results suggest ABT spawning north of the Bahamas and north of Cozumel, Mexico. Additionally, preliminary results from collections taken in 2015 south of Cuba suggest there may be limited ABT spawning in this region as well. Results from the 2015 survey have provided evidence that larval transport via the Yucatan current, and persistent eddy translation south of Cuba may be important mechanisms for maintaining regional population connectivity. Our 2016 survey extended the larval survey into the relatively unexplored regions of the western Caribbean to determine the extent of ABT spawning and use adaptive sampling methods to further develop a larval habitat model for this species. Additionally, results should increase our understanding of larval transport, the role of eddies in larval retention, trophic ecology, and other mechanisms by which larvae are either exported or retained.

During FOCUS A of our 2016 research survey aboard NF, we continued our study of the distribution and abundance of ABT and other tuna larvae in the Gulf of Mexico and western Caribbean Sea. The 2016 survey builds upon the data collected from our 2015 expedition to Cuba and Mexico by applying adaptive sampling methods in both predicted larval ABT and other tuna habitats, as well as in areas that are key to understanding larval transport and retention across the region. The collected data will help to further develop a larval habitat model for ABT, reduce the variance in the calculation of the ABT larval index (which will improve regional stock assessments), and increase our knowledge of the role that ocean circulation features play in maintaining regional ABT stocks and the associated trophic ecology.

In addition to pelagic tuna larvae, the 2016 survey also targeted other ecologically and commercially important larval species found near regional coastal reefs. These species included larval snapper, grouper, parrotfish, lionfish, and spiny lobster, and were sampled concurrently during the search for ABT larvae. Understanding population connectivity across this portion of the Intra-Americas Sea (IAS) and the role that the major current systems play in the dispersal/retention of these species is critical for developing adaptive management strategies

for regional Marine Protected Areas (MPA). Our collection strategy serves to help identify possible spawning locations, examine growth and survival of larvae, and increase our understanding of species recruitment to benthic habitats. In this light, additional information should also be gained from a high-resolution multi-beam bathymetric survey of Cuba's Banco de San Antonio conducted during the research cruise.

FOCUS B. Coral Reef Ecosystem Research (CRER)

The United States Virgin Islands' (USVI) Grammanik Bank, located to the south of St. Thomas, is the site of a multi-species spawning aggregation for economically important fish including yellowfin grouper, Nassau grouper, tiger grouper, and dog snapper. Fishing pressure at this suspected source of larval recruits prompted the U.S. Caribbean Fishery Management Council (CFMC) in 2005 to close the bank yearly from February to April. A series of banks south of St. Thomas and St. John, around St. Croix, and south of the British Virgin Islands (BVI) provides similar habitats and spawning aggregation sites. Prior to the inception of this study, the biological and physical processes which drive production on these banks, and the circulation connecting these areas, had not been quantified. As the 2005 management decisions were made in the absence of these data, regional MPA designations and temporary closures are presently based on professional judgment rather than quantifiable, defensible scientific information. In addition, meeting new annual catch limit (ACL) requirements of the Magnuson-Stevens reauthorization has become a priority of the CFMC. However, data limitations preclude comprehensive stock assessments for most fisheries in the region.

To address these data gaps, NOAA scientists from SEFSC and AOML in Miami, Florida, working with scientists from the University of the Virgin Islands (UVI) and Department of Planning and Natural Resources (DPNR) in St. Thomas, are presently conducting a multi-year, interdisciplinary research project utilizing the NF to conduct biological and physical oceanographic surveys of the Virgin Islands (VI) bank ecosystems and surrounding regional waters. The long-term sustainability of fisheries in the VI and surrounding regions will depend on a comprehensive understanding of regional spawning aggregations, larval transport, and overall larval recruitment in the study area.

Data collected from this program will not only provide information on a data-poor region, but have the potential to address two additional specific needs. First, should economically important species of grouper, snapper, and parrotfish be delineated from individual island groups (e.g. Puerto Rico, St. Thomas/St. John, and St. Croix), from the U.S. Caribbean, or from the broader Caribbean region? This interdisciplinary effort will provide information on the interconnectivity of fish populations and assist in this stock delineation. Secondly, indices of abundance have been identified as a critical component of the length-based assessment methods currently employed in the Caribbean. However, regional indices are lacking, or in some cases nonexistent. This research will serve to improve existing and generate new indices of abundance for the study area, including not only U.S. waters, but also the surrounding regions.

During FOCUS B of our 2016 research project aboard NF, we measured/sampled water properties, currents, and dispersal and transport of fish larvae in the VI and neighboring regions. This year a special emphasis was placed on the search for larval parrotfish (an economically important species for the region). Additional genetics and isotope sampling from collected larvae and zooplankton aim to provide definitive biological linkages and trophic structure comparisons between populations of larval parrotfish found near St. Croix, St. Thomas, St. John, and the British Virgin Islands. These data will be used to examine patterns in selective mortality (in terms of growth and genetic selection) for parrotfishes. In general, results from the survey should enhance our understanding of regional spatial variation in the supply of fish larvae

between managed and non-managed areas, as well as offer insights into the relative importance of Grammanik Bank as a source of juvenile fishes recruiting to the waters of the VI.

METHODOLOGY (FOCUS A AND B)

The shipboard survey work associated with the two project components (focus areas A and B) outlined above included plankton tows using a Neuston net (towed at various depths: standard, s10, s20, and s25), a 60cm-bongo net, a mini-bongo net, and a Multiple Opening and Closing Net Environmental Sensing System (MOCNESS). Conductivity-Temperature-Depth (CTD) casts measuring temperature, salinity, dissolved oxygen, chlorophyll, colored dissolved organic matter (CDOM), and water velocity were also performed. Continuous surface measurements of temperature, salinity, chlorophyll, CDOM, and water velocity were collected via the ship's flow-through system and hull-mounted/shipboard acoustic Doppler current profiler (SADCP). 100 eXpendable Bathy Thermograph (XBT) probes and 13 satellite-tracked, Lagrangian surface drifters were also deployed.