U. S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southeast Fisheries Science Center
3209 Frederic St.
Pascagoula, MS 39567

Cruise Report

Date Submitted: 07/05/2012

Platform: NOAA Ship GORDON GUNTER

Cruise Number: GU-12-01 (66)

Project Title: SEAMAP Spring Ichthyoplankton

Cruise Dates: 03/28/2012 - 05/29/2012

Submitted by: Date: 07/05/2012
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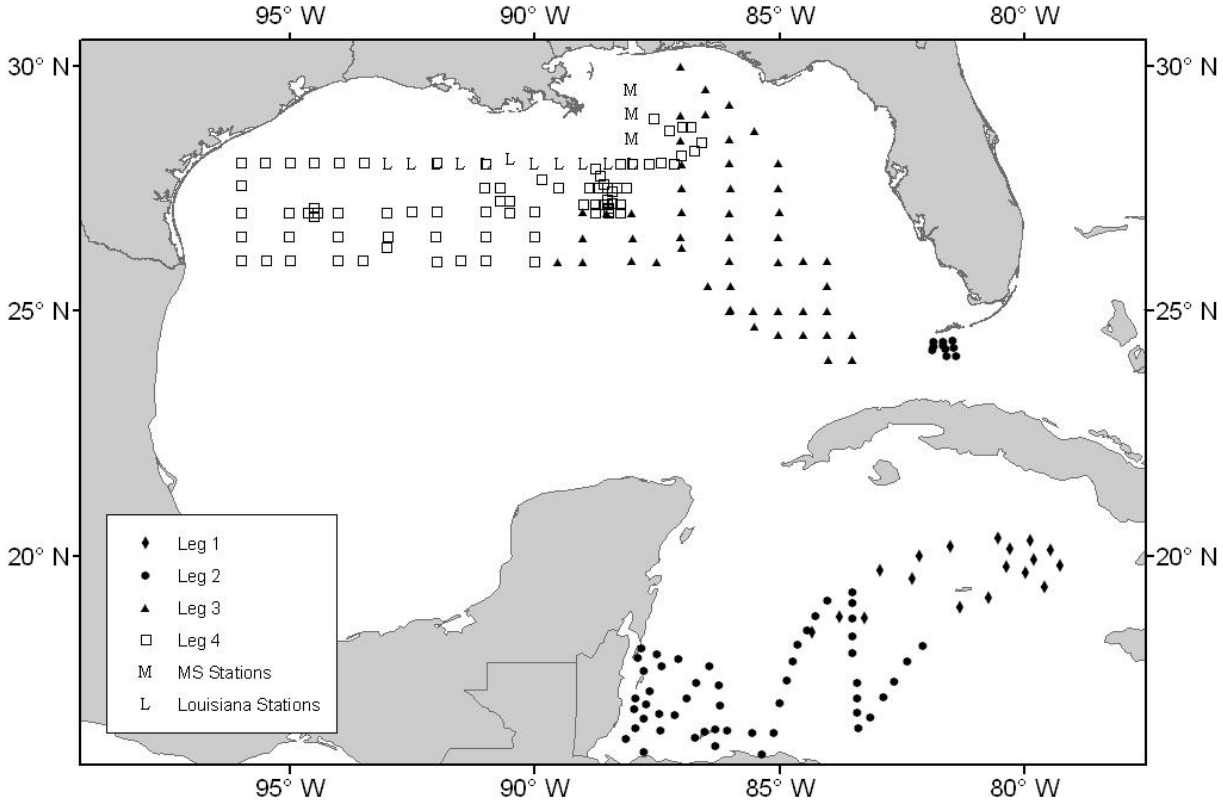
CRUISE RESULTS

Southeast Area Monitoring and Assessment Program
(SEAMAP) 2012 Spring Plankton Survey

NOAA Ship *Gordon Gunter* Cruise GU-12-01 (66)
March 28 - May 29, 2012



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INTRODUCTION

The National Oceanic and Atmospheric Administration (NOAA) Ship *Gordon Gunter* departed Pascagoula, MS on 28 March 2012 to initiate the Southeast Area Monitoring and Assessment Program (SEAMAP) Spring Ichthyoplankton Survey in the Gulf of Mexico. The SEAMAP Program is a cooperative State/Federal/University program designed to collect biological and environmental data from waters of the U.S. Gulf of Mexico. During the spring survey, plankton samples are collected from a systematic grid of stations to assess distribution, occurrence and abundance of the early life stages of a variety of species of fishes and invertebrates. This survey specifically targeted larval bluefin tuna (*Thunnus thynnus*). Directed sampling efforts to assess tuna spawning and larval habitat in the Caribbean Sea were the main focus of the first two legs of the cruise with the added component of a cooperative effort between the US and El Colegio de la Frontera Sur (ECOSUR), Mexico. Unfortunately, we were unable to obtain sampling permits for Mexico in time, so this year sampling in the Caribbean Sea was limited to waters off of the Cayman Islands, Honduras and Belize.

A total of 55 successful sea days was worked over four legs during the cruise: Leg 1, March 28 - April 7; Leg 2, April 10 - 25; Leg 3, April 29 – May 11 and Leg 4, May 15 - 29, 2012. The first leg of the survey was delayed in hopes that sampling permits for Mexican waters would come through; however, after 5 days we had no choice but to exclude Mexican waters from the sampling plan. During the 2nd leg, the clean power generator had to be shut down due to a bad bearing. All electronics in the dry lab had to be tied into the main power, which resulted in occasional losses of power during power spikes. Power was quickly restored after each outage and, with the exception of a few Continuous Underway Fish Egg Sampler (CUFES) and thermosalinograph (TSG) events, there was no data or mission time lost. The SBE 9plus Conductivity, Temperature, and Depth (CTD) froze up during one cast at station 052 (possibly the result of a power spike) and no cast data or water samples were collected. The generator was repaired while in port between Legs 3 and 4. During the 3rd leg the (TSG) timed out its connection repeatedly, resulting in the loss of some of the flow-through data. The SBE-19 SeaCat started to experience connection problems during the 4th leg of the survey and the issue was not able to be resolved while at sea, however, it did not greatly impact sampling and all objectives were still met. The Multiple Opening/Closing Net and Environmental Sensing System (MOCNESS) failed to trip any nets during a tow at station 022, which resulted in Net 0 being open for the entire tow. The Net 0 sample was kept, but the tow was not repeated and there were no further issues with the MOCNESS. Operations at station 083 (B008) during Leg 3 had to be stopped due to high winds and only “mini-bongo”, subsurface neuston, and bongo tows were completed. However, we were able to redo the station a few days later with improved weather. Three of the 97 targeted SEAMAP stations were completed by the University of Southern Mississippi (USM) and 11 SEAMAP stations were completed by the Louisiana Department of Wildlife and Fisheries.

OBJECTIVES

1. Assess the occurrence, abundance and geographical distribution of the early life stages of spring spawning fishes, especially bluefin tuna (*Thunnus thynnus*), from the continental shelf edge to deep Gulf waters using a bongo frame fitted with 0.335 mm nets and a neuston frame fitted with a 0.950 mm net at selected SEAMAP stations in support of annual stock assessments. An additional neuston frame fitted with a 0.505 mm net and a flowmeter was fished subsurface at all stations.

- **a.** Targeted sampling for bluefin tuna larvae in Caribbean waters was undertaken during the first two legs. Sampling sites were chosen based on satellite imagery of sea surface temperature and surface chlorophyll data. Stations were placed in a grid format near frontal zones and along cross-front transects to cover outside, on the edges and inside eddy features.
- **b.** Sampling for bluefin tuna larvae for inclusion in stock assessments was conducted at standard SEAMAP stations during Legs 3 and 4.

2. Describe the pelagic habitat of fish larvae through measurements of various physical and biological parameters.

- **a.** Record profiles through the water column of temperature, salinity, fluorescence, dissolved oxygen, and turbidity using a CTD.
- **b.** Measure chlorophyll *a* in replicate water samples taken at surface, mid or maximum chlorophyll layer and near bottom (to a maximum of 200 m) depths using bench top fluorometry.
- **c.** Detect and measure frontal features along the survey cruise track using data from the ship's thermosalinograph flow-through system (TSG) and the Acoustic Doppler Current Profiler (ADCP).
- **d.** Detect surface currents through deployment of surface drifters.
- **e.** Visually detect possible surface currents and frontal zones through recording of aggregated sargassum along the cruise track.

3. Map the distribution of fish eggs along the cruise track using a Continuous Underway Fish Egg Sampler (CUFES) that collects plankton samples in 30 min intervals.

4. Measure the vertical distribution of fish larvae by sampling at discrete depths in the water column at selected locations along the SEAMAP plankton survey grid using a 1 m Multiple Opening/Closing Net and Environmental Sensing System (MOCNESS) with a 0.505 mm nets.

5. Evaluate trophic pathways relative to the early life dynamics of Atlantic bluefin tuna larvae with the use of stable isotope analysis of samples collected using a 20 cm bongo (referred to as a "mini-bongo") fitted with one 0.055 mm and one 0.200 mm mesh net.

6. Collect detailed observations (i.e. identification, number, volume, bell diameter) of net caught jellyfish and ctenophores in the northern Gulf of Mexico.

7. Collect and freeze sargassum samples, as well as associated fish and invertebrates, caught in neuston tows for Dauphin Island Sea Lab (DISL).

SURVEY RESULTS
Ichthyoplankton Data

Survey Design

As part of a NASA funded grant, directed sampling efforts targeting bluefin tuna larvae occurred during all legs (Figures 1 - 4). These non-standard stations were chosen to cross frontal features of the Loop Current and associated cyclonic and anticyclonic eddies. These mesoscale oceanographic features were located based on satellite imagery of sea surface temperature and surface chlorophyll. Daily updates of Moderate Resolution Imaging Spectroradiometer (MODIS) based imagery products were examined by Roffer's Ocean Fishing Forecasting Service, Inc. (ROFFS) to track movements of these features and to position the ship. Shipboard CTD profiles were sent daily to the Miami laboratory from the beginning of the cruise until the end of the cruise to assist in the determination of sampling locations. Stations were placed in a grid format near frontal zones and along cross-front transects to cover outside, on the edges and inside eddy features. Gear used at these stations consisted of a subsurface neuston tow, a surface neuston tow, a CTD, and occasionally a subsurface 20 cm bongo tow.

A predefined cruise track of 97 standard Spring SEAMAP stations, approximately 30 NM apart in a systematic grid, were targeted for Legs 3 and 4 (Figures 1 and 4). Standard SEAMAP plankton gear used at each station consisted of a bongo net, a neuston net, and a CTD. At the standard SEAMAP stations, the subsurface neuston tow was examined for bluefin tuna larvae. If larvae were detected, extra sampling was done at that station consisting of an extra subsurface neuston tow or a MOCNESS tow at the original station position and/or subsurface neuston tows located 5 NM from the original station position in the cardinal directions.

Sampling Methodology

Samples and data collection were implemented in accordance with procedures outlined in the SEAMAP data collections manual. SEAMAP plankton samples were

taken with the standard SEAMAP 61 cm bongo frame outfitted with two 0.335 mm mesh nets and towed in an oblique path from near bottom or 200 m maximum depth to the surface. An SBE19 Seacat Profiler was attached on the towing wire above the frame to provide real time depth readings along with temperature and salinity. A flowmeter mounted inside each side of the bongo frame measured the volume filtered during the tow. SEAMAP plankton samples were also taken using a 0.950 mm mesh neuston net attached to a 1 x 2 m metal frame that was towed for 10 min at a vessel speed (~ 2 kn) sufficient to keep the net opening half submerged in the water maintaining a sampling depth of 0.5 m. Preservation protocol called for the left bongo samples to be preserved in 10% formalin and then transferred to fresh 95% ETOH after 36 h. The original standard SEAMAP method of initial preservation in 10% formalin for 48 h was changed to 36 h in order to improve long term storage for genetic analysis. The right bongo and both types of neuston samples were initially preserved in 95% ETOH and then transferred to fresh 95% ETOH after 24 h. Subsurface samples were taken with a 0.505 mm mesh neuston net attached to a 1 x 2 m metal frame that was towed for 10 min at the same vessel speed (~ 1.5-2 kn) as the regular neuston. The neuston frame was submerged to a depth of 10 m, returned to the surface, submerged again, and bounced throughout the 10 min tow period. In high density areas, the total tow time was reduced to 5 min. A flowmeter was mounted inside the neuston frame to measure the water volume filtered during the tow. Subsurface samples were partially sorted for bluefin tuna larvae upon completion of each tow. If several larvae were found, additional sampling (i.e. MOCNESS or more subsurface tows) would occur.

The MOCNESS carried five 0.505 mm nets to collect samples at discrete depths. One net was used in an oblique tow (Net 0) from the surface to a maximum depth of 50 m. Nets 1-5 sampled 10 m depth bins. Winch and ship speeds were maintained at rates that would result in filtered water volumes of 250 - 350 m^3 per depth bin. In order to ensure enough volume was filtered for each depth bin, a 'bounce' method was used during the retrieval. The MOCNESS was brought up to the top of the depth bin, lowered back down to the bottom of the bin, and then brought back up to the top. This method allowed for consistency in sampling each of the depth bins during the tow. All MOCNESS samples were initially preserved in 95% ETOH and transferred to fresh 95% ETOH after 24 h.

Stable isotope samples were collected with a 20 cm bongo frame (referred to as a "mini-bongo") outfitted with a 0.200 mm mesh on the right bongo and a 0.055 mm mesh on the left bongo. The 20 cm bongo was then towed in the same manner as the subsurface neuston tows. Half of the 0.200 mm sample was preserved in 95% ETOH, while the other half was frozen. The 0.055 mm sample was separated into organisms that were greater than 0.200 mm and those that were less than 0.200 mm but greater than 0.055mm. The size fractionated samples were then frozen and saved for genetic analysis.

Any sargassum caught in the net during a neuston tow was saved and frozen as part of a graduate student project at DISL aimed at examining the trophic dynamic of sargassum communities. Whenever sargassum was saved, extra water was collected at the surface and was filtered and frozen for stable isotope analysis. If time permitted, additional sargassum was collected on station in an effort to collect any fish and invertebrates associated with the sargassum.

Collection Summary

Ichthyoplankton samples were collected at 208 stations (Figures 1-3). A total of 18 stations were sampled during Leg 1 resulting in 18 neuston, 18 subsurface neuston, 24 MOCNESS (four tows) and 18 "mini-bongo" samples (Table 1). A total of 61 stations were sampled on Leg 2 resulting in 48 neuston, 61 subsurface neuston, 91 MOCNESS (15 tows), and 41 "mini-bongo" samples (Table 1). A total of 50 stations were sampled on Leg 3 resulting in 26 right bongo, 26 left bongo, 49 neuston, 50 subsurface neuston, 42 MOCNESS (seven tows), and 27 "mini-bongo" samples (Table 1). A total of 79 stations were sampled on Leg 4 resulting in 17 right bongo, 17 left bongo, 34 neuston, 79 subsurface neuston, 96 MOCNESS (16 tows), and 26 "mini-bongo" samples (Table 1).

A total of 805 near-surface zooplankton and fish egg samples (Table 1, Figure 4) were collected between stations using the CUFES. Sample water for the CUFES was taken from the sea chest with an intake approximately 3 m from the surface of the water. The seawater was then filtered through a 0.505 mm sieve within the CUFES. Collections were taken at 30 min intervals between stations and preserved in 95% ETOH.

Jellyfish and ctenophores collected in bongo, neuston, subsurface neuston, and MOCNESS nets were thoroughly rinsed, removed from the plankton samples, and noted in the database. Ten drifters were deployed in the Caribbean Sea and the northern GOM over the course of the cruise to map surface currents (Figure 5).

Archival Storage

Plankton samples were assigned SEAMAP numbers at sea (Table 2). Right bongo, neuston, subsurface neuston, and some MOCNESS samples will be shipped to the Sea Fisheries Institute, Plankton Sorting and Identification Center, Gdynia, Poland for sorting. The left bongos will be deposited in the SEAMAP Invertebrate Archive at GCRL, USM, Ocean Springs, MS. The remainder of MOCNESS samples not being shipped to Poland will be deposited at the NMFS lab in Miami, FL. All samples from Legs 1 and 2 were deposited at El Colegio de la Frontera Sur (ECOSUR), except for 10 subsurface neuston samples that were sent to the NMFS lab in Miami, FL. Stable isotope samples were not assigned SEAMAP numbers since they were not chemically preserved. All stable isotope samples were sent to the NMFS lab in Miami, FL for genetic analysis.

All CUFES samples will be held at the NMFS lab in Pascagoula, MS until they are ready for sorting, identification and some fish egg genetic analyses. Data on gelatinous organisms and sargassum collected during the cruise will be archived at Mississippi Laboratories for future analysis.

Environmental Data

Environmental data were collected with a Seabird SBE 9/11 Plus CTD at a total of 207 stations (Figures 7 - 10) during the survey. The SBE 9/11 plus CTD profiles were processed at sea by the Field Party Chief using Seabird's SEASAVE processing software. Information from shipboard sensors was accessed via the Scientific Computer System (SCS), which continuously displayed and recorded the ship's position, heading, speed, wind direction, wind speed, barometric pressure, sea surface temperature, air temperature and water depth. All environmental data and data from the ship's SCS were returned to the NMFS Pascagoula Laboratory for editing, analysis and archival storage. The ThermoScientific Orion 3-star portable dissolved oxygen meter was used every few days to measure to the DO of the deepest water sample.

CTD profiles were taken to a maximum of 500 m except for two deep casts of 1500 m (transmissometer removed) at directed satellite sampling stations (Legs 1 and 2) while CTD profiles at standard SEAMAP stations were taken to a maximum of 200 m or to near-bottom (Legs 3 and 4).

Water samples were taken at 191 stations where the Seabird SBE 9/11 Plus CTD was deployed, using Niskin bottles attached to a SBE Carousel sampler. Standard SEAMAP target sampling depths were: surface, chlorophyll maximum, and near-bottom (up to 200 m maximum), however, during Legs 1 and 2 water was collected at 50m instead of near-bottom. Samples were analyzed for chlorophyll *a* concentrations (μg/L) at sea using a Turner Designs 10-AU-005 benchtop fluorometer with a 10-040R optical kit and the modified Welshmeyer method. Standard protocol for SEAMAP stations calls for analysis of three replicate water samples from each of the three target depths. However, at shallower stations where the water column was well mixed and no chlorophyll maximum was present, only surface and bottom samples were taken. Samples from six stations were compromised and not included in the plots or tables. All replicates at each sample depth were averaged and entered into the Microsoft Access database.

Salinity (PSU), sea temperature (º C), and dissolved oxygen (mg/L) were recorded from the sensors on the CTD for the same depths as water samples for the chlorophyll *a* measurements. Near surface (≤ 6 m depth) comparisons of sea temperature (º C), salinity (PSU), dissolved oxygen (mg/L), and chlorophyll *a* concentrations (μg/L) for stations are presented in Figures 6 - 10.

Throughout the cruise, an SBE21 TSG equipped with a Turner Designs 10-AU fluorometer continuously measured surface salinity, temperature, and fluorescence. A dedicated computer recorded all the information and was backed up daily to the ship's server. This complete dataset was copied off the ship's server and returned to the NMFS Pascagoula Laboratory for analysis and archiving. These data and the ADCP data were also returned to the NMFS Pascagoula Laboratory for editing, analysis and archival storage.

Preliminary Results

Though the subsurface tows were only partially sorted at sea, some preliminary analysis of the data has illustrated a correlation between the occurrence of bluefin tuna larvae and chlorophyll *a* concentrations in the northern GOM (Figures 11 – 13).

Table 1. Summary of valid ichthyoplankton collections taken during Spring Plankton Survey, 28 March - 29 May 2012.

Leg	CTD Casts	Right Bongo (samples)	Left Bongo (samples)	Neuston (samples)	Subsurface Neuston (samples)	MOCNESS (tows/samples)	CUFES (samples)	20 cm Bongo "mini-bongo" (samples)
		(0.335 mm)	(0.335 mm)	(0.950 mm)	(0.505 mm)	(0.505 mm)		(0.200 / 0.055 mm)
I	18	0	0	18	18	4 / 24	89	18
II	60	0	0	48	61	16 / 91	152	41
III	49	26	26	49	50	7 / 42	281	27
IV	79	17	17	34	79	16 / 96	283	26
Total	**206**	**43**	**43**	**149**	**208**	**43 / 253**	**805**	**112**

Figure 1. Plankton stations completed during the SEAMAP Spring Plankton Survey aboard the NOAA Ship *Gordon Gunter*, cruise GU-12-01 (66) 28 March - 29 May 2012.

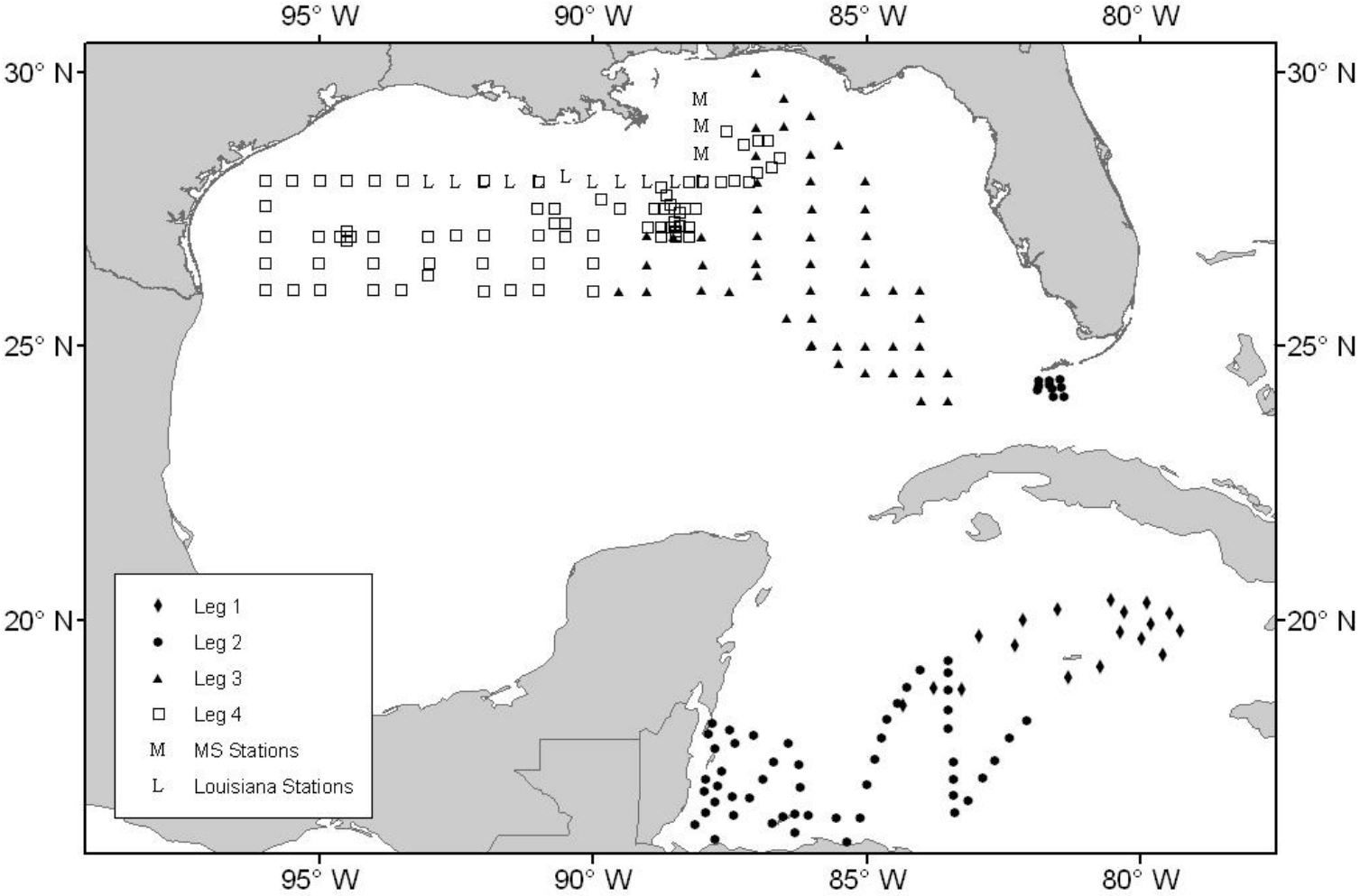

Figure 2. Locations of stations where MOCNESS tows were completed during the SEAMAP Spring Plankton Survey aboard the NOAA Ship *Gordon Gunter*, cruise GU-12-01 (66) 28 March - 29 May 2012.

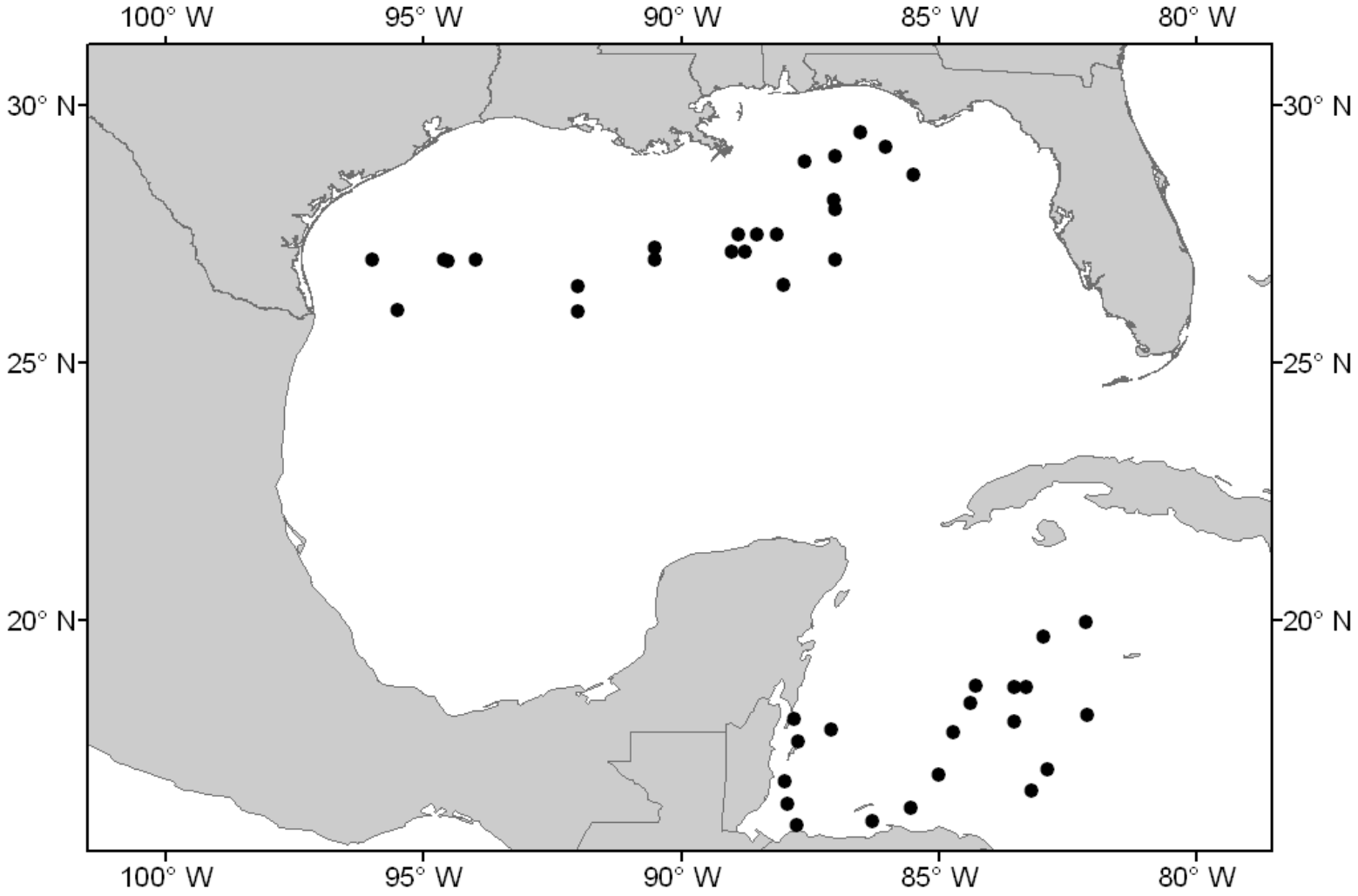

Figure 3. Locations of stable isotope ("mini-bongo") samples taken during the SEAMAP Spring Plankton Survey aboard the NOAA Ship *Gordon Gunter*, cruise GU-12-01 (66) 28 March - 29 May 2012.

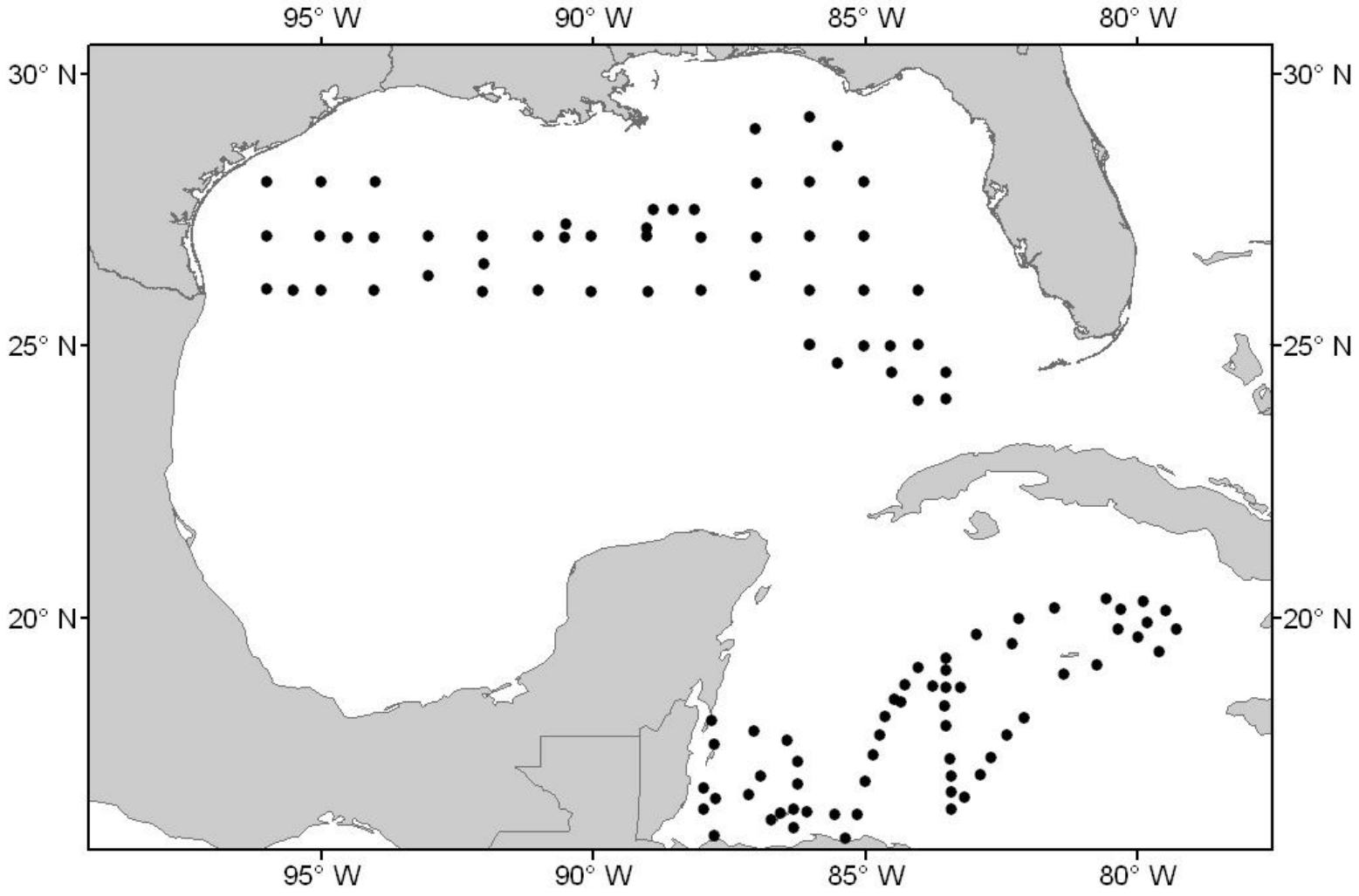

Figure 4. Locations of CUFES samples taken during the SEAMAP Spring Plankton Survey aboard the NOAA Ship *Gordon Gunter*, cruise GU-12-01 (66) 28 March - 29 May 2012.

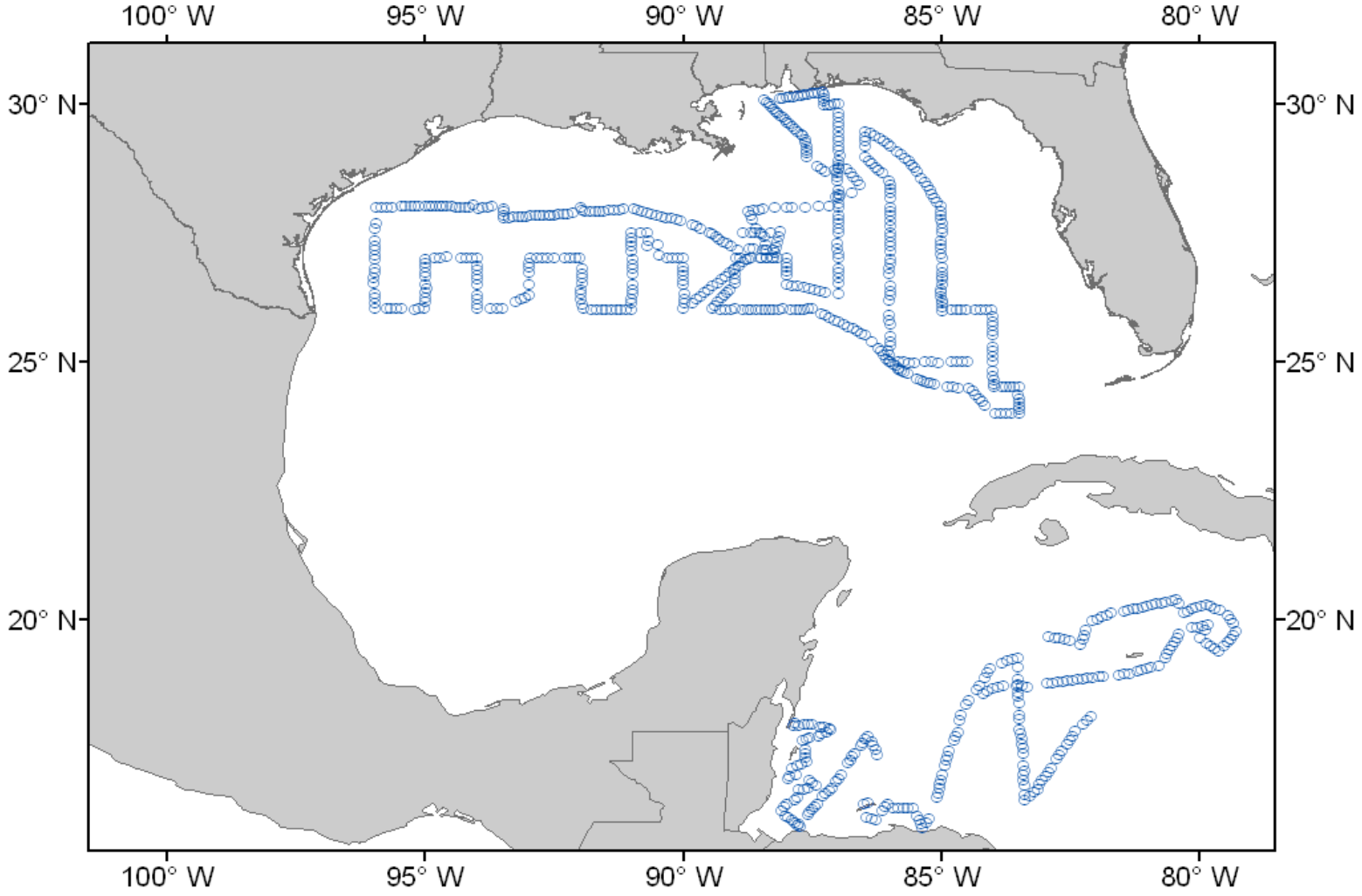

Figure 5. Deployment locations drifters deployed during the SEAMAP Spring Plankton Survey aboard the NOAA Ship *Gordon Gunter*, cruise GU-12-01 (66) 28 March - 29 May 2012.

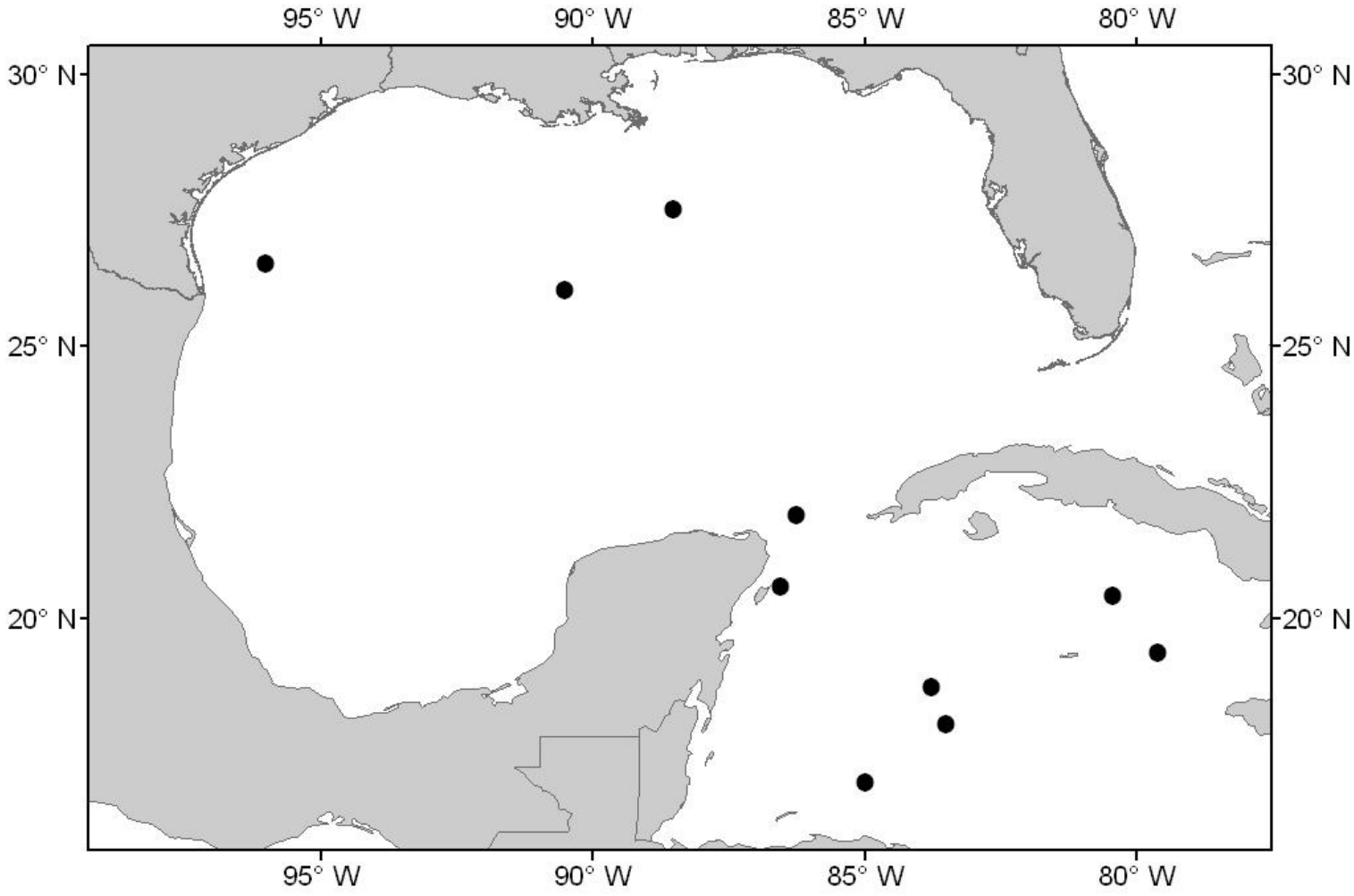

Figure 6. Sea temperature (º C) near the surface (≤ 6 m depth) at plankton stations during the SEAMAP Spring Plankton Survey aboard the NOAA Ship *Gordon Gunter* cruise GU-12-01 (66), 28 March - 29 May 2012.

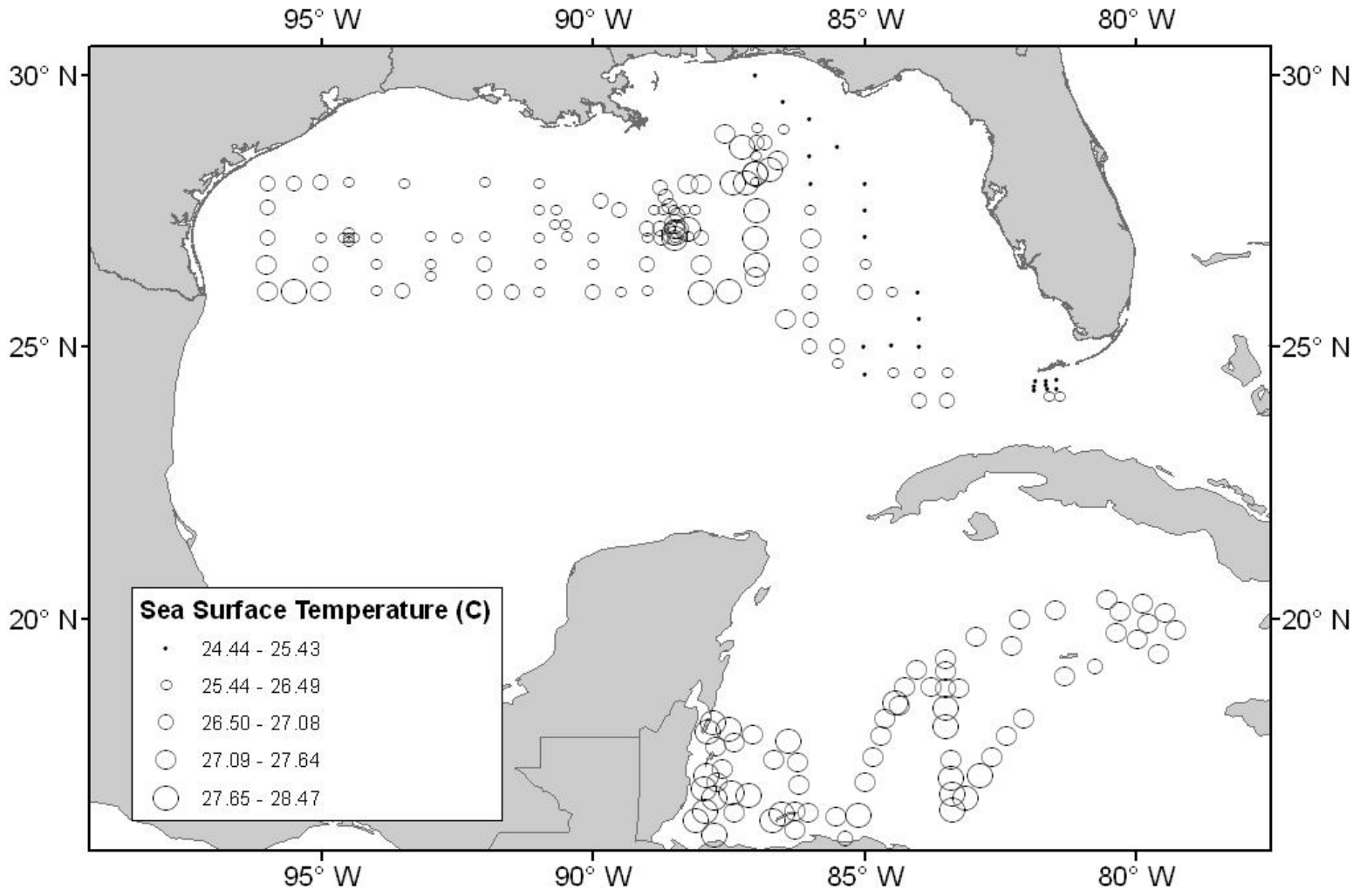

Figure 7. Salinity (PSU) near the surface (≤ 6 m depth) at plankton stations during the SEAMAP Spring Plankton Survey aboard the NOAA Ship *Gordon Gunter* cruise GU-12-01 (66), 28 March - 29 May 2012.

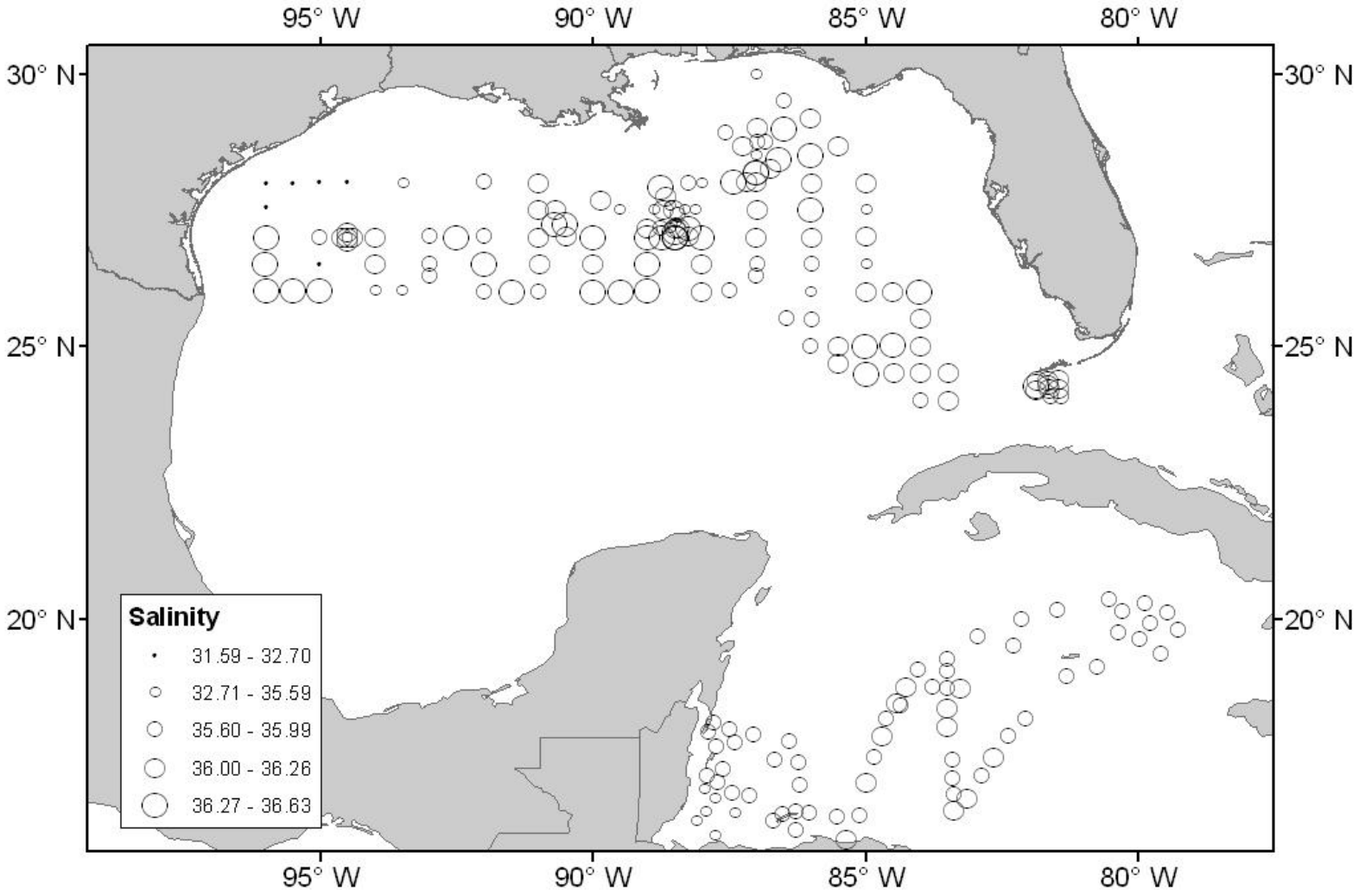

Figure 8. Dissolved oxygen (mg/L) near the surface (≤ 6 m depth) at plankton stations during the SEAMAP Spring Plankton Survey aboard the NOAA Ship *Gordon Gunter* cruise GU-12-01 (66), 28 March - 29 May 2012.

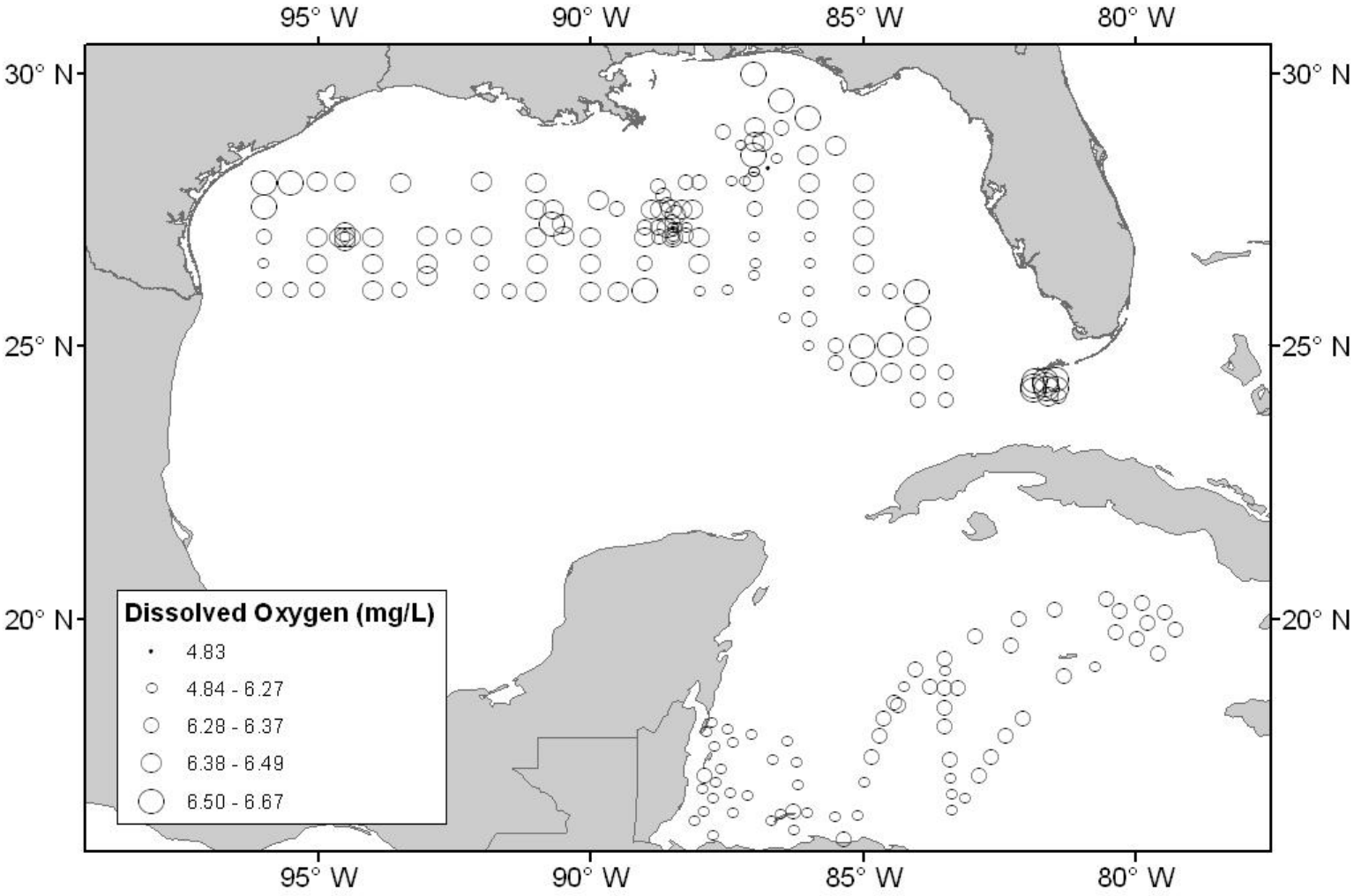

Figure 9. Chlorophyll *a* concentrations (µg/L) near the surface (≤ 6 m depth) at plankton stations in the Caribbean Sea during the SEAMAP Spring Plankton Survey aboard the NOAA Ship *Gordon Gunter* cruise GU-12-01 (66), 28 March - 29 May 2012.

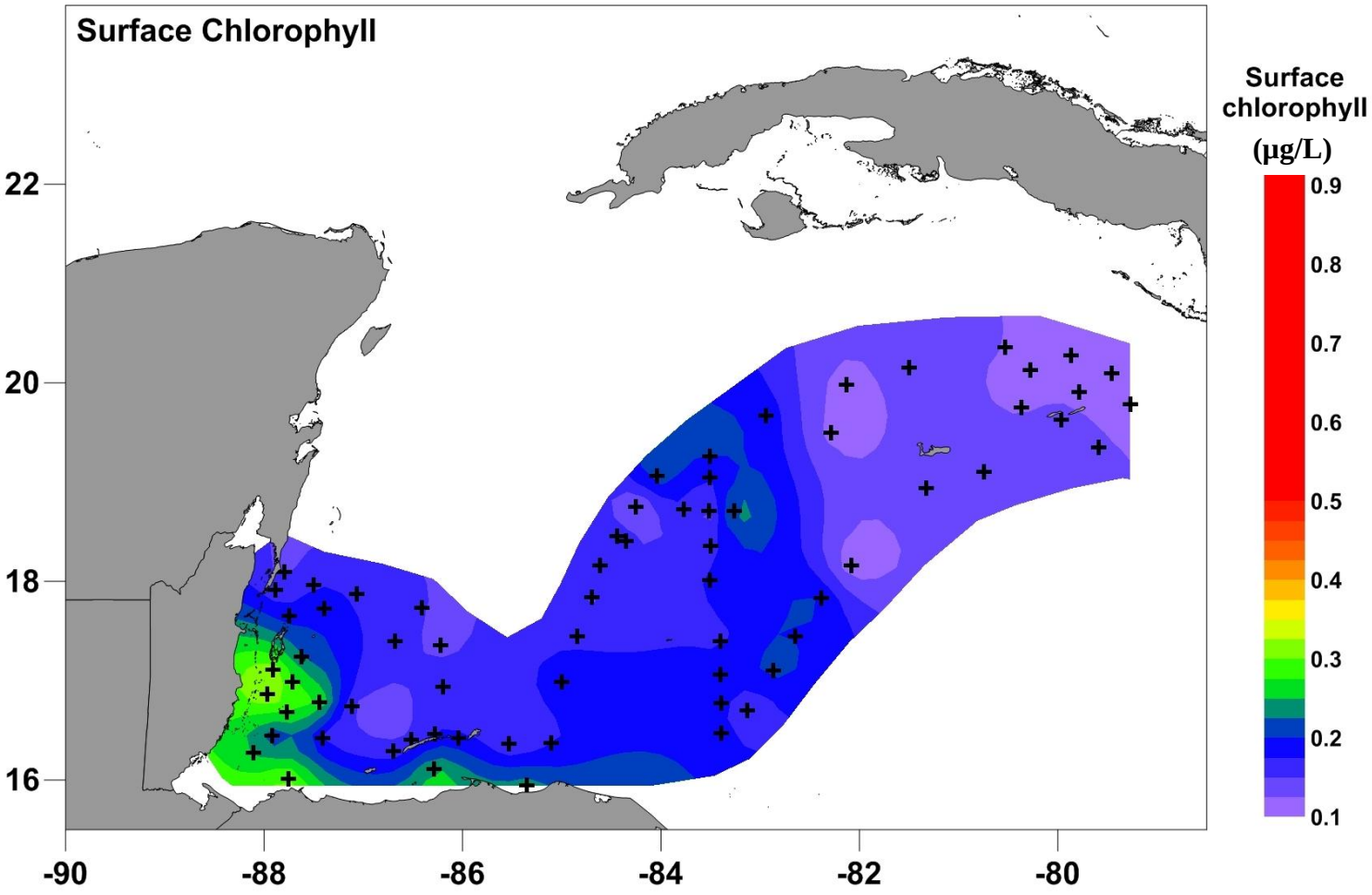

Figure 10. Chlorophyll *a* concentrations (µg/L) near the surface (≤ 6 m depth) at plankton stations in the northern Gulf of Mexico during the SEAMAP Spring Plankton Survey aboard the NOAA Ship *Gordon Gunter* cruise GU-12-01 (66), 28 March - 29 May 2012.

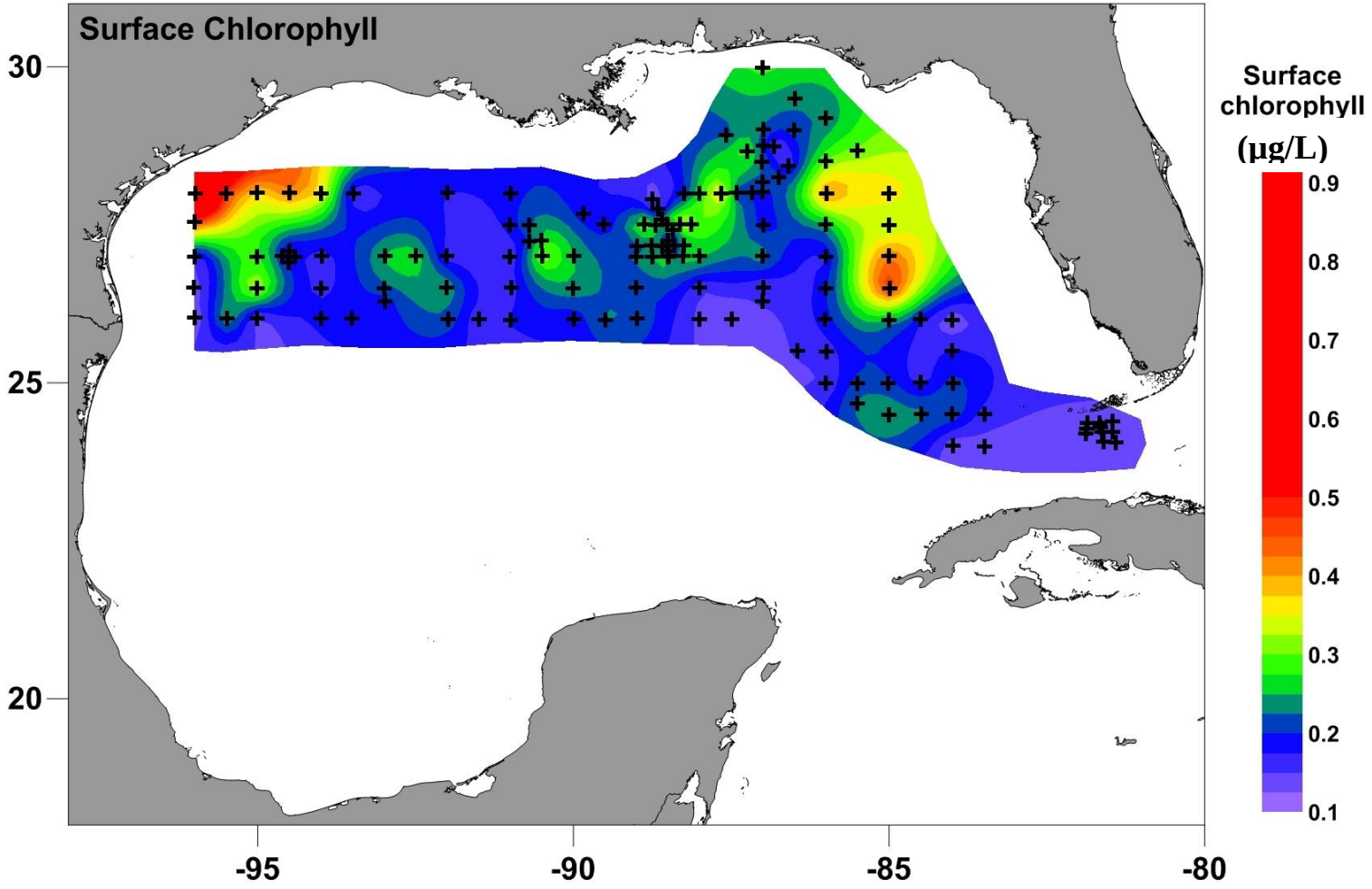

Figure 11. Number of bluefin tuna larvae removed from partially sorted subsurface tows overlaid on surface chlorophyll *a* concentrations (µg/L).

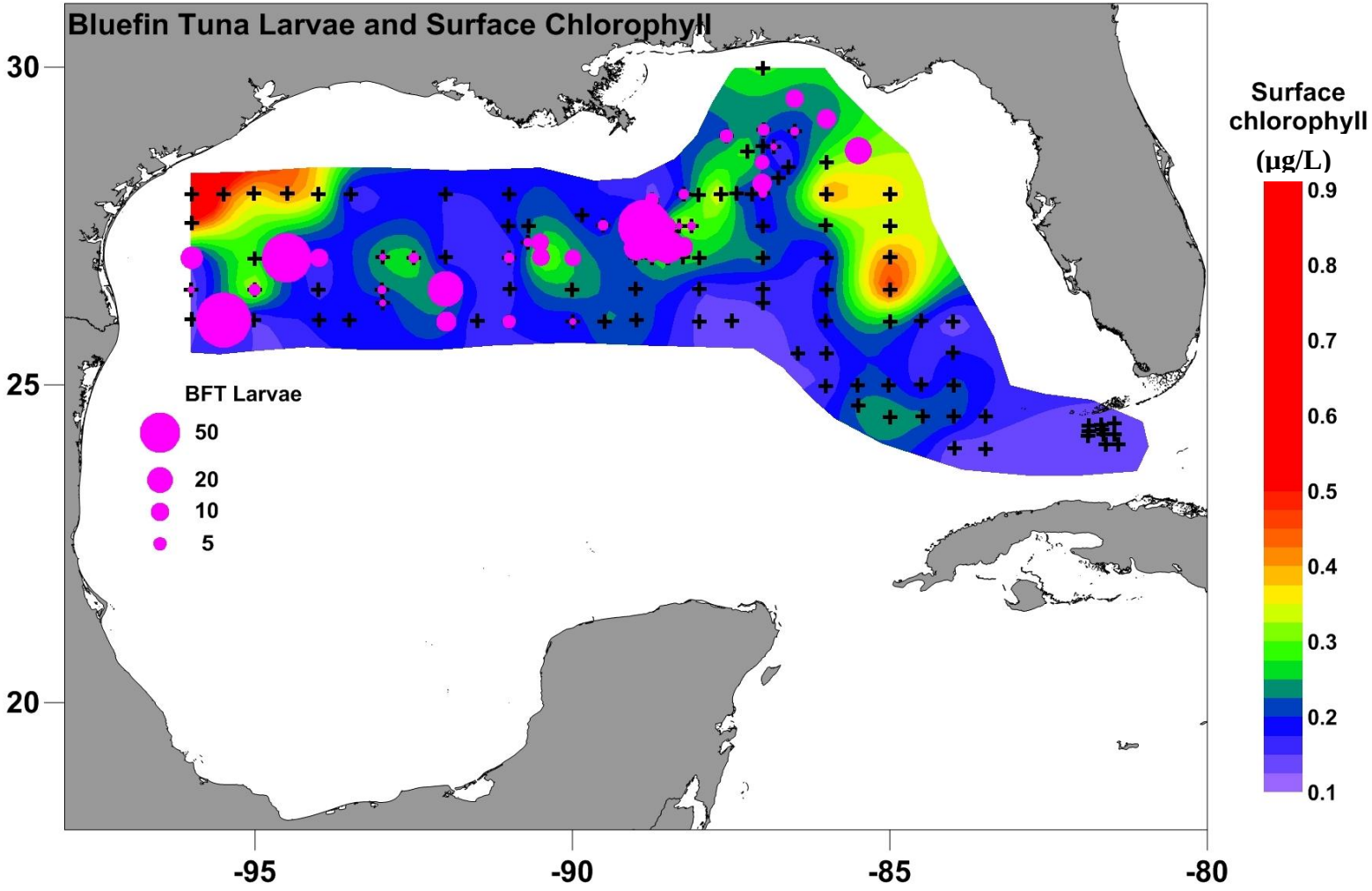

Figure 12. Number of bluefin tuna larvae removed from partially sorted subsurface tows overlaid on maximum chlorophyll *a* concentrations (µg/L).

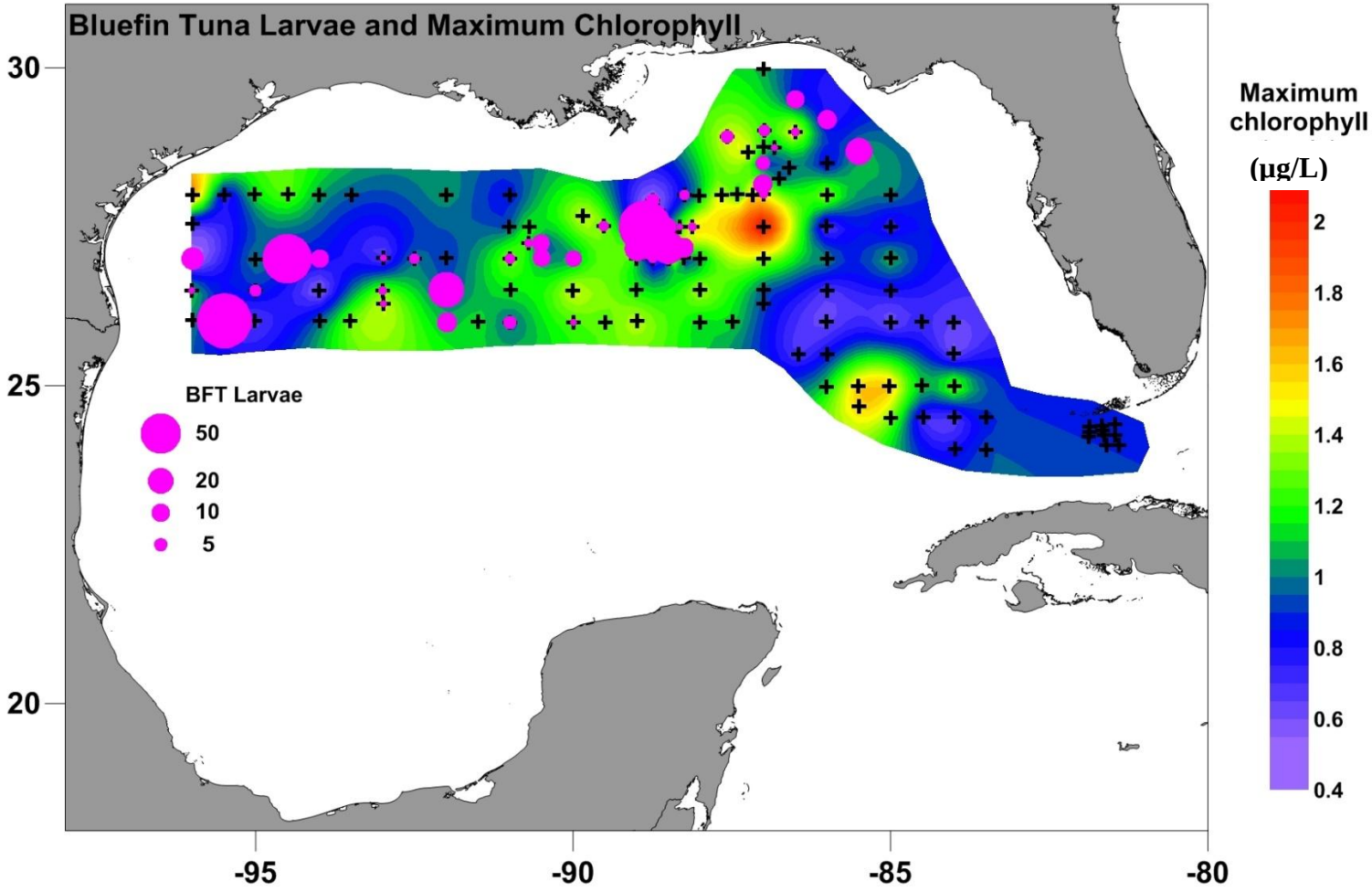
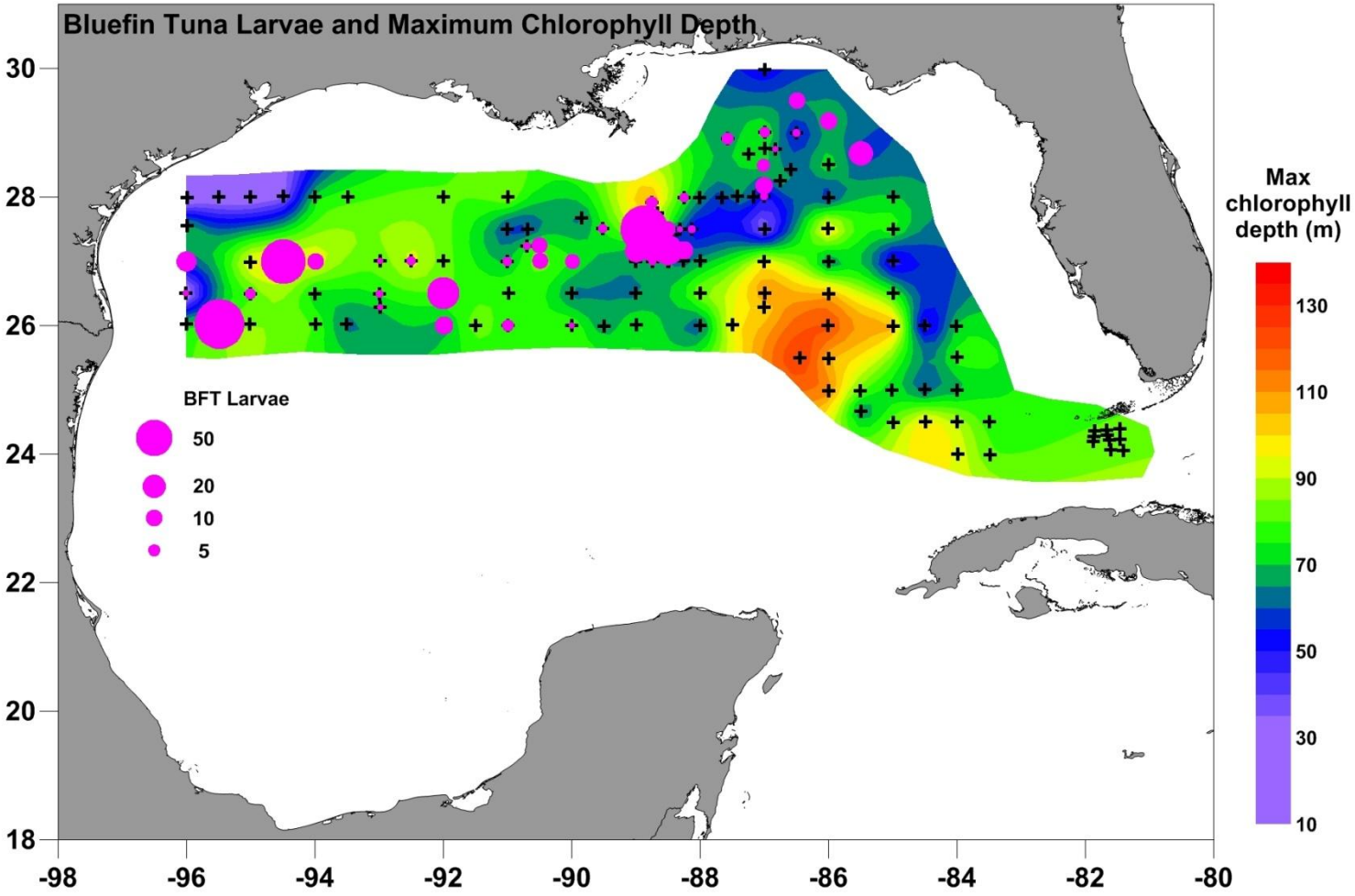
Figure 13. Number of bluefin tuna larvae removed from partially sorted subsurface tows overlaid on depth of maximum chlorophyll *a* concentrations.