THE DISTRIBUTION AND ABUNDANCE OF BLUNTNOSE FLYINGFISH (*PROGNICHTHYS OCCIDENTALIS*) ACROSS THE GULF OF MEXICO

A Thesis

by

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ABSTRACT

Flyingfishes are an essential component of pelagic food webs, serving as both predator and prey. Many pelagic fishes (billfishes, dolphinfishes, and tunas) consume large quantities of flyingfish, and several studies have documented their importance as prey for apex predators residing in coastal and offshore environments. Six summer ichthyoplankton cruises were conducted from 2009 to 2011 to investigate ocean influences on the distribution and abundance of flyingfish larvae in the northern Gulf of Mexico (NGoM). Over the three-year sampling period, a total 9,533 bluntnose flyingfish (Prognichthys occidentalis) larvae were collected and this species alone accounted for 77% of the total flyingfish catch. The remainder of the flyingfish assemblage was comprised of 8 species from 4 different genera (*Cheilopogon*, *Hirundichthys*, *Exocoetus*, and *Parexocoetus*), but given the dominance of bluntnose flyingfish our assessment of distribution, abundance, and habitat associations focused on this species. Interannual variation was detected with densities of bluntnose flyingfish larvae higher in 2009 and 2010 (11.3 and 7.9 larvae 1000m^{-2}, respectively) than 2011 (1.9 larvae 1000m^{-2}). Bluntnose flyingfish larvae were present in each month and year sampled, and percent frequency of occurrence ranged from 40% in July 2011 to 100% in June 2010, suggesting that this species is a common and important component of the ichthyoplankton assemblage in this region. Generalized additive models were used to evaluate the effect of oceanographic conditions on the abundance of bluntnose flyingfish, and several environmental variables (sea surface height anomaly, distance to Loop Current, and salinity) were found to be influential in explaining patterns of abundance. Habitat suitability was linked to physicochemical properties of the seawater, and higher larval abundances were found at higher salinities and negative sea surface heights. In addition, a positive relationship with distance to the dominant mesoscale oceanographic feature in the NGoM (Loop Current) was detected, suggesting that the abundance of bluntnose flyingfish larvae increases away from this frontal feature. This study emphasizes the importance of NGoM as a spawning/nursery area of bluntnose flyingfish, and suggests that oceanographic conditions play an important role in determining their distribution and abundance in this region.

DEDICATION

To my parents, for instilling a passion for discovery, a love for nature, and their love and encouragement throughout my educational career.

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CHAPTER I

INTRODUCTION

Flyingfishes (family Exocoetidae) are epipelagic, subtropical to tropical species found worldwide. Eighty-one species of flyingfish exist throughout the oceans, and many countries in the Caribbean, South East Asia, and the South Pacific rely on these fishes as a source of food and income (Dalzell 1993; Huang and Ou 2012). In addition to their economic value, flyingfishes are an essential component of pelagic food webs, serving as both predator and prey. Many pelagic fishes (billfishes, dolphinfishes, and tunas) consume large quantities of flyingfish, and several studies have documented their importance as prey for apex predators residing in coastal and offshore environments (Oxenford and Hunte 1999; Rudershausen et al. 2010). Seabirds also target flyingfishes and/or their eggs, both being commonly consumed by several groups of tropical seabirds including petrels, frigate birds, and terns (Harrison 1983; Ballance et al. 1997). Apart from their functional role as prey, flyingfishes consume large quantities of zooplankton and ichthyoplankton, with the latter being numerically dominant in the diets of several species (Lewis et al. 1962; Van Noord et al. 2013). In response, predation by the flyingfish assemblage can influence the population dynamics of several marine invertebrates and vertebrates, and therefore play an important functional role in pelagic ecosystems.

Information on the spawning habitat and early life stages of flyingfish larvae are limited, especially in the Gulf of Mexico, despite being an important ecological link in the pelagic ocean between zooplankton and top predators (i.e. tunas, dolphinfishes, and billfishes). Therefore, establishing baseline data on the bluntnose flyingfish larvae can provide information on the pelagic predators that feed on them. Additionally, understanding the distribution and abundance of flyingfish larvae can provide critical information that can be used to better understand population trends of flyingfishes and environmental factors that affect recruitment and year class strength.

CHAPTER II

THE DISTRIBUTION AND ABUNDANCE OF BLUNTNOSE FLYINGFISH (*PROGNICHTHYS OCCIDENTALIS*) ACROSS THE GULF OF MEXICO

Introduction

Research on the ecology of flyingfishes in the Gulf of Mexico (GoM) is surprisingly limited, particularly studies investigating early life processes (Hunte et al. 1995). Early life studies on marine fishes, such as flyingfishes, provide fundamental information on their life history and population dynamics (Carassou et al. 2012). More specifically, spatial and temporal trends in the distribution and abundance of fish larvae can be used to characterize the timing and location of spawning as well as environmental conditions that favor early life survival (Rooker et al. 2012). An understanding of early life events can also help define processes that affect recruitment and year-class strength (Richardson et al. 2010; Carassou et al. 2012). Because early life survival is tied closely to primary productivity and environmental conditions, changes in larval fish abundance or distribution is useful for understanding the impacts of environmental perturbations, ranging from oil spills (e.g. Deepwater Horizon) to environmental shifts linked to climate change (Hernandez et al. 2010; Rooker et al. 2013). Therefore, establishing baseline data on the distribution and abundance of flyingfish larvae provides critical information that can be used to better understand population trends of flyingfishes and the pelagic predators that feed on them.

The Gulf of Mexico (GoM) is an ideal model system for evaluating early life ecology of flyingfishes because increased primary production associated with allochthonous nutrient inputs (i.e., Mississippi River) supports highly productive spawning and nursery areas for several pelagic fishes (Nurnberg et al. 2008; Rooker et al. 2013). In addition, the GoM is characterized by the presence of a dominant mesoscale oceanographic feature (Loop Current), and associated cyclonic and anti-cyclonic eddies (Nurnberg et al. 2008). Cyclonic eddies and areas of frontal convergence associated with the Loop Current represent zones of upwelling (Govoni et al. 2010), causing an increase in both primary and secondary production, and enhancing foraging opportunities for fish larvae (Ross et al. 2010). Previous studies have shown that several taxa of pelagic fishes spawn near convergence zones like fronts and eddies, suggesting that these features may represent important spawning or nursery areas for the larvae (Richardson et al. 2009). This combination of autochthonous and allochthonus drivers of production coupled with the unique oceanographic characteristics of the GoM make it an interesting location for investigating the early life ecology of flyingfish.

The goal of the present study is to characterize the spatial and temporal trends in the distribution and abundance of flyingfish larvae in the outer shelf and slope waters of the northern GoM (NGoM). Additionally, I examined the influence of oceanographic conditions on the distribution and abundance of the most common species, bluntnose flyingfish (Prognichthys occidentalis), using generalized additive models (GAMs). The working hypothesis is that the relative abundance of bluntnose flyingfish larvae will be higher in cyclonic eddies and frontal boundaries because these areas concentrate larvae and are assumed to be areas of increased primary and secondary production. The information gathered from this study will help assess the importance of this region as a spawning/nursery area for bluntnose flyingfish.

Methods

Sampling design

Six ichthyoplankton surveys were conducted in the outer shelf and slope waters of the NGoM during June and July from 2009 to 2011. The sampling region encompassed the area 26 to 28°N latitude and 86 to 93°W longitude (Figure 1). Flyingfish larvae were collected with paired 2-m by 1-m neuston nets with different mesh sizes, 500µm and 1200µm, during 2009 and 2010. In 2011, the sampling design was modified and only a single 1200µm mesh neuston net was used to collect the larvae. Nets were towed through the upper meter of the water column for 10 minutes at a speed of approximately 2.5 knots. Approximately 48 stations, spaced 8 nautical miles apart, were sampled during each survey allowing for a variety of oceanographic features to be sampled. A General Oceanics flowmeter (Model 2030R, Miami, FL) was placed in the center

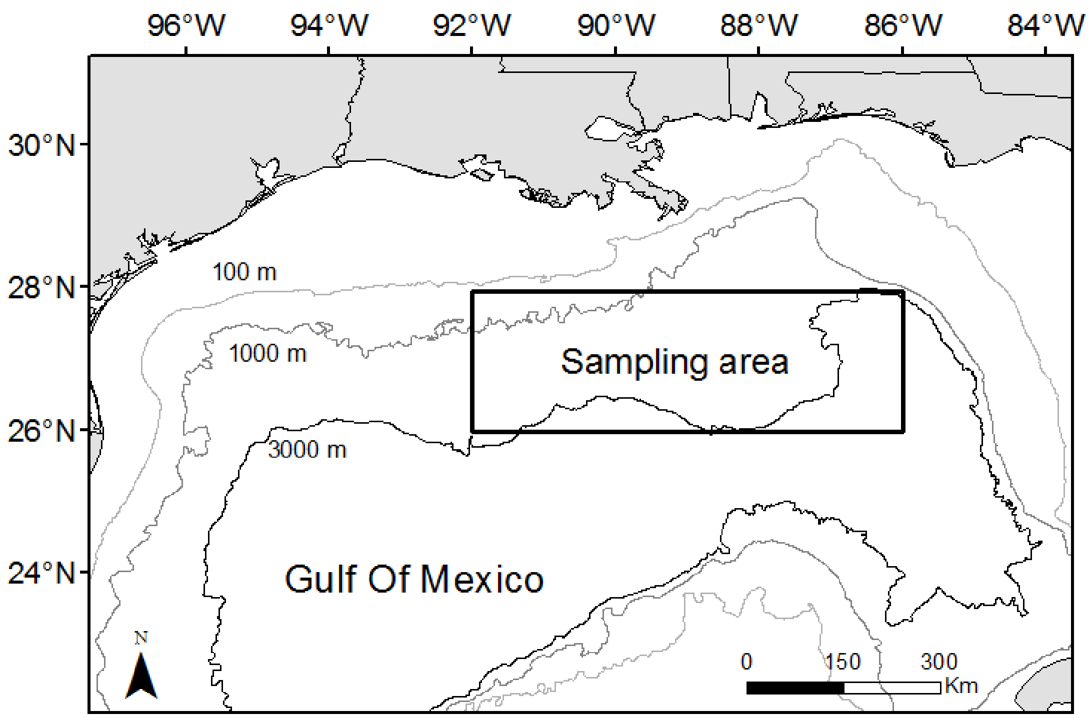

Figure 1: Ichthyoplankton sampling area (rectangle) in the outer shelf and slope waters of the northern Gulf of Mexico conducted during June and July of 2009- 2011.

of each neuston net to record the total surface area filtered during each tow. The total number of bluntnose flyingfish from both the 500µm and 1200µm nets was pooled and then divided by the combined surface area towed of both nets to determine density (larvae $1000m^{-2}$) of bluntnose flyingfish at each station sampled. Percent occurrence of bluntnose flyingfish was determined based on the number of stations where flyingfish were present divided by the total number of stations sampled during the survey. Geographic information system (GIS) was then used to visually display the density of bluntnose flyingfish (larvae $1000m^{-2}$) across the sampling area.

All ichthyoplankton and associated zooplankton collected were stored onboard in 70% ethanol, and then transferred to 100% ethanol after 48 hours. *Sargassum* biomass collected in the neuston nets at each station was also recorded. In the laboratory, all flyingfish larvae were sorted from other taxa and enumerated using a Leica MZ stereomicroscope and placed into individual vials with 70% ethanol before identified to species.

Due to similarity in larval characteristic, a genetic protocol using high-resolution melting analysis (HRMA), as outlined in Smith et al. (2009), was used to identify a subset of flyingfish (n=390) to species level before visually identifying the remaining larvae. DNA of larvae was isolated with a non-destructive sodium hydroxide DNA isolation method (Alvarado Bremer et al. 2014). The protocol was slightly modified with flyingfish larvae transferred to 600µl microfuge tubes containing 200µl of 70% ethanol and vortexed vigorously for 50 seconds. A 1µl aliquot was used as DNA in the HRMA reaction. The gene 16S-RNA targeted an asymmetric unlabeled probe high-resolution melting analysis (UP-HRMA) using the forward primer 16S-Exo-INT-F2 (5'-ATCTCCCCGTGCAGAAGCGG-3'), a diluted 1:10 reverse primer 16S-Exo-INT-R2 (5'-CGTGGTCGCCCCAACCGAAG-3'), and the unlabeled probe 16S-Exo-UPHRM-1R (5'-TAGGGCGATGTCCAATTGGCTTAGTTCCT/3Phos/-3'). The UP-HRMA amplifications were performed in 10µl reactions on the LightCycler 480 (Roche Diagnostics) containing 0.5µl of LCGreen® Plus (BiofireTechnologies), 5.0µl of EconotaqPlus (Lucigen), 0.5µl of each primer, 0.5µl of unlabeled probe, 2µl of ddH_2O, and 1µl of DNA template. Samples were denatured, annealed, and extended for 38 cycles at 94°C for 10s, 52°C for 30s, and 72°C for 10s respectively followed by 26 stepdown cycles where the annealing temperature was lowered to 44°C. High-resolution melting profiles of the unlabeled probes produced species-specific melting curves, which were compared to reference samples of known adult flyingfish collected in the Gulf of Mexico (Figure 2). Flyingfish larvae identified to the species level genetically with HRMA were then used in conjunction with larval descriptions provided by Fahay (1983) and Richards (2001) to visually identify bluntnose flyingfish larvae in the samples. A subsample of the visually identified bluntnose flyingfish larvae (n=161) were genetically identified using the above UP-HRMA technique to confirm visual identification.

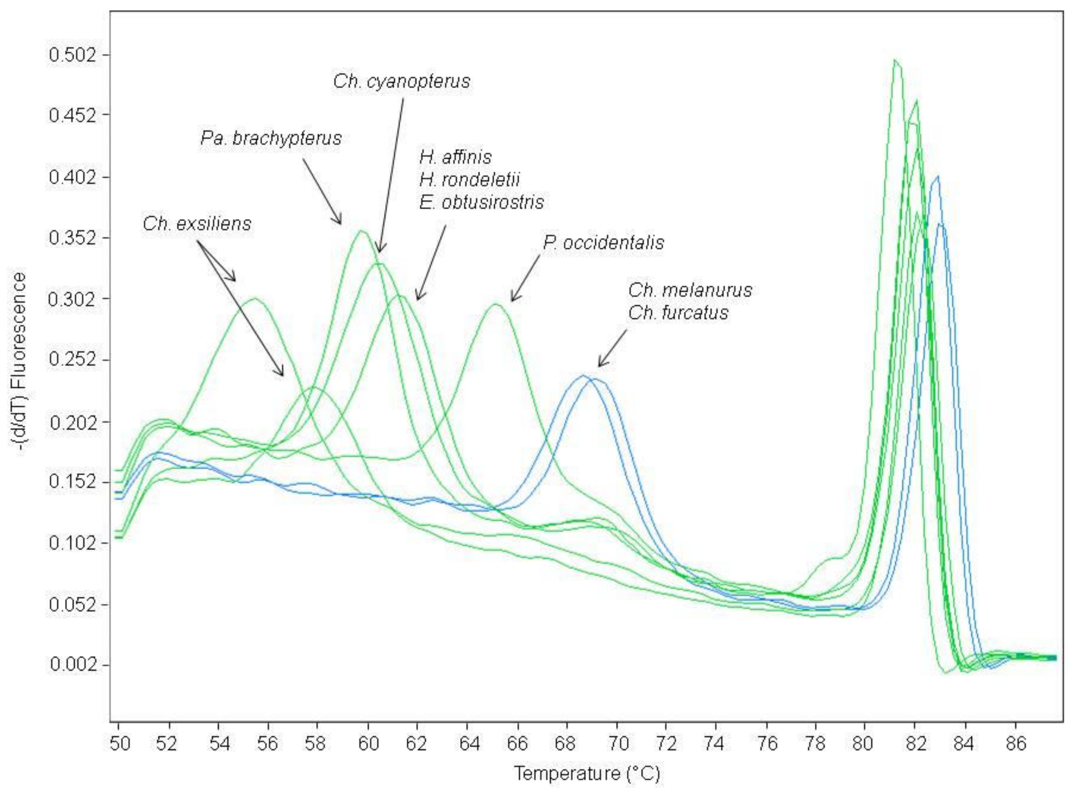

Figure 2: Species-specific melting profiles targeting the 16S-RNA region for flyingfish larvae based on UP-HRMA (unlabelled probe high resolution melting analysis) as a function of fluorescence over temperature (°C). Melting profiles for the nine species of flyingfish: *Cheilopogon exsiliens* (bandwing flyingfish), *Parexocoetus brachypterus* (sailfin flyingfish), *Ch.cyanopterus* (marginated flyingfish), *Hirundichthys affinis* (fourwing flyingfish), *H. rondeletii* (blackwing flyingfish), *Exocoetus obtusirostris* (oceanic two-winged flyingfish), *P. occidentalis* (bluntnose flyingfish), *Ch. furcatus* (spotfin flyingfish), and *Ch. melanurus* (Atlantic flyingfish) are presented.

At each station, temperature (°C), salinity (psu), and dissolved oxygen (mg/L) were measured using a Sonde 6920 Environmental Monitoring System (YSI Inc.). Other environmental parameters at each station were determined using remotely sensed data accessed through the marine geospatial ecology toolbox (version 0.8a44) in ArcGIS (version 10.0). Sea surface height anomaly (SSHA, cm) data was calculated weekly at a resolution of 1/3 degree using merged satellite altimetry measurements from Topex/Poseidon, Jason-1 and 2, Geosat Follow-On, ERS-1 and 2, and EnviSat (AVISO, http://www.aviso.oceanobs.com/duacs/). Distance to the Loop Current was estimated by measuring the linear distance from the edge of the feature, based on the 20cm SSHA contour, to each sampling station using the Spatial Analyst toolbox in ArcGIS. Sea surface chlorophyll concentration (mg m^{-3}) was obtained from Moderate Resolution Imaging Spectroradiometer (MODIS) sensor onboard the Aqua satellite over an 8-day period at 4km spatial resolution (Aqua, http://oceancolor.gsfc.nasa.gov). Water depth information for the GoM was accessed from NOAA National Geophysical Data Center using the GEODAS US Coastal Relief Model Grid with a grid cell size of 6 (http://www.ngdc.noaa.gov/mgg/gdas/gd_designagrid.html). To visually show the impact of certain variables on bluntnose flyingfish density, Ocean Data View (Schlitzer, 2013) was used to create density plots using the variables of temperature, salinity, sea surface height anomaly (SSHA), and distance to Loop Current (DisLC) as the independent variables and bluntnose flyingfish density across all three years as the response variable. These variables were selected because they were shown to be influential on bluntnose flyingfish density.

Statistical analysis

Density of larval bluntnose flyingfish at each station was estimated using larvae collected in both nets during each cruise, except in 2011 when only a 1200µm mesh neuston net was used. Standardizing catch numbers to density would account for any variation in catch rates between the different mesh sizes. Variation in mean density of larval bluntnose flyingfish for each cruise was analyzed using a full factorial two-way analysis of variance (ANOVA) with month and year as the main factors. *Post-hoc* differences among means of the main effects were examined using a Tukey's Honestly Significant Difference test (Tukey HSD). Additionally, a non-parametric test, Kruskal-Wallis, was used when data violated assumptions of normality or homogeneity of variance. Because the Kruskal-Wallis test produced the same results as the ANOVA and parametric tests are more robust and have greater power than non-parametric tests (Sheskin 2003), only the ANOVA results are reported. All statistical analysis were run with SPSS Statistical software (version 16.0.1) with α=0.05.

The influence of biotic and abiotic environmental variables on bluntnose flyingfish density was analyzed using generalized additive models (GAMs) in R (version 3.0.0). GAMs, a non-parametric extension of the generalized linear models, allow for non-linear relationships between the response variable and many explanatory variables by fitting smoothing functions to the explanatory variables (Zuur 2009). This is an improvement over the generalized linear model because rarely does species abundance data and environmental data follow a linear trend (Maggini et al. 2006). For modeling purposes, density estimates were rounded to the nearest non-negative integer. The explanatory variables used in the GAM were month, year, sea surface temperature, sea surface height anomaly, distance to Loop Current, chlorophyll-*a* concentration, salinity, depth, and *Sargassum* weight. The general GAM model for the negative binomial distribution follows the equation:

$$E[y] = g^{-1}(\beta_0 + \sum_k S_k(x_{k)}))$$

Where $E[y]$ represents the predicted values for the response variable (density), g represents the link function, $\beta_0$denotes the intercept, *k* represents the number of explanatory variables used in the model, S_k is the smoothing function of each explanatory variable,x_k. Models were fit with cubic regression splines within the *mgcv* library using R 3.0 software (The R Foundation for Statistical Computing 2013). Cubic splines were limited to 3 degrees of freedom (df) to avoid creating unrealistic models (over fitting) with less predictive powers (Sandman et al. 2008). GAMs with lower and higher levels of smoothing complexity (df=2 and df=4) were also examined, but the smoothing value (df=3) was deemed more appropriate based on the total number of variables and model complexity (Guisan et al. 2002; Sandman et al. 2008). The best model was chosen based on minimizing the Akaike Information Criterion (AIC), which measures both model complexity and goodness of fit (Burnham and Anderson 2004).

Prior to running GAMs, multi-collinearity among explanatory variables was examined using the Spearman rank correlation coefficient (Spearman ρ) to remove highly correlated variables. If two variables had a Spearman ρ greater than 0.5, the variables were analyzed in separate models to determine the relative influence of each predictor. The predictor with the lower AIC remained in the initial model prior to the backwards stepwise selection process. After checking for mulit-collinearity using the Spearman ρ method, all remaining variables were further examined with the variance inflation factor (VIF) to check for multi-collinearity among the variables. A VIF over the threshold value (VIF>5) indicates that variables are correlated and should be removed (O'Brien 2007). A manual backwards stepwise selection process was used to remove the non-significant explanatory variables that influenced larval density. Backwards stepwise selection ended when all remaining variables were significant ($p<0.05$) or the AIC value started to increase when non-significant variables were removed, unless the increase was less than 1%. Percent deviance explained (DE) was calculated for each model to examine overall fit:

$$DE = ([\text{null deviance} - \text{residual deviance}]/\text{null deviance}) \times 100$$

Once the final model was selected, each variable was individually removed to examine the change in AIC and DE to assess the relative importance of each predictor variable to the response variable.

Prior to GAM development, initial Spearman ρ analysis indicated a significant correlation between two variables: salinity and chlorophyll-*a* concentration. The full model was run separately with salinity and chlorophyll-*a* concentration removed to determine which variable had a greater impact on the initial model. Because both variables are common oceanographic measurements and the variance inflation factor was less than five, salinity and chlorophyll-*a* concentration were kept in the initial model. The subsequent addition of distance to nearest eddy, distance to nearest temperature front, current velocity, latitude, longitude, and hours after sunrise resulted in an increase in the AIC value and were correlated with at least one of the initial parameters so these variables were kept out of the initial model.

Results

Over the three years sampled, a total of 12,390 flyingfish larvae were collected from 385 stations in the NGoM. Bluntnose flyingfish (*P. occidentalis*) was the most common species, accounting for 76.9% (n =9,533) of all flyingfish larvae collected (Table 1). The other species collected, *Cheilopogon cyanopterus* (marginated flyingfish), *Ch. exsiliens* (bandwing flyingfish), *Ch. furcatus* (spotfin flyingfish), *Ch. melanurus* (Atlantic flyingfish), *Hirundichthys* *affinis* (fourwing flyingfish), *H. rondeletii* (blackwing flyingfish), *Exocoetus obtusirostris* (oceanic two-wing flyingfish), and *Parexocoetus brachypterus* (sailfin flyingfish), accounted for 19.1% (n=2,370) of the total catch. The

Table 1: Catch statistics for bluntnose flyingfish collected during 2009-2011 in the northern Gulf of Mexico. Number of stations sampled during each cruise (n), total number of larvae collected (count), mean density (larvae 1000 m^{-2}), standard deviation (SD), and percent frequency of occurrence (% Freq) are given for bluntnose flyingfish (*P. occidentalis*).

Survey	**n**	**Count**	**Density (SD)**	**% Freq.**
June 3-9, 2009	92	4572	16.39 (24.33)	98.91
July 22-29, 2009	101	1693	6.30 (6.09)	95.05
June 15-18, 2010	48	1454	7.59 (6.94)	100.00
July 27-30, 2010	48	1533	8.20 (6.72)	100.00
June 14-18, 2011	48	229	3.20 (6.21)	77.08
July 17-20, 2011	48	52	0.62 (1.02)	39.58
	385	**9533**	**7.05**	**85.10**

remaining 4% (n=487) could not be visually identified because of damage. Mean density of bluntnose flyingfish ranged from 0.62 to 16.39 larvae 1000m^{-2}, with an average of 7.05 larvae 1000m^{-2} (Table 1). The highest density for bluntnose flyingfish at a single station occurred in June 2009 with a density of 198.02 larvae 1000m^{-2}. Frequency of occurrence was high for bluntnose flyingfish, with larvae collected in every month and year sampled. Percent frequency of occurrence for bluntnose flyingfish ranged from 39.6% in July 2011 to 100% in June and July 2010. In all years surveyed, except 2010, percent frequency of occurrence was higher in June than July.

Density of bluntnose flyingfish varied significantly among the three years surveyed (ANOVA, $F_{(2, 384)}$=16.966, p<0.001). Mean density of bluntnose flyingfish for years 2009 and 2010 (11.35 and 7.89 larvae 1000m^{-2}, respectively) was significantly higher than the mean density for 2011 (1.91 larvae 1000m^{-2}). Mean density also varied significantly between months sampled (ANOVA, $F_{(1, 384)}$=8.298, p<0.004), with densities in June (9.06 larvae 1000m^{-2}) greater than July (5.04 larvae 1000m^{-2}). A significant interaction was observed between month and year (ANOVA, $F_{(2, 384)}$=6.282, p<0.002). In all years except 2010, density of bluntnose flyingfish larvae was higher in June (Figure 3). Of all the surveys, June 2009 had the highest mean density (16.39 larvae 1000m^{-2}) and July 2011 had the lowest mean density (0.62 larvae 1000m^{-2}, respectively).

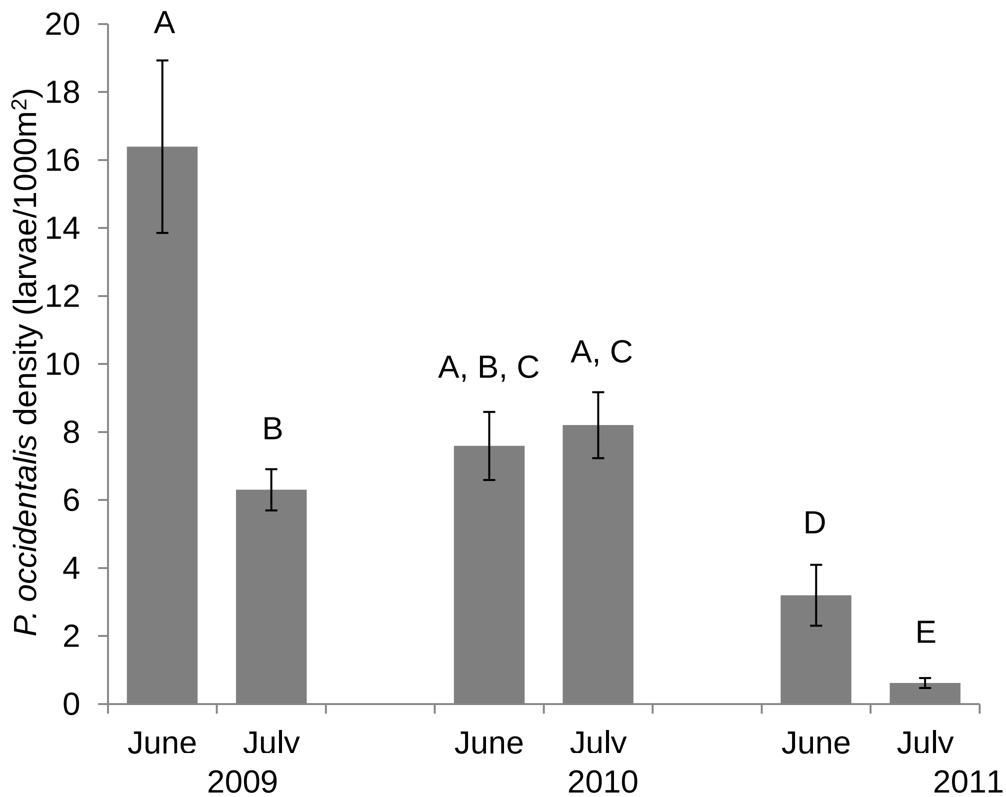

Figure 3: Mean density of bluntnose flyingfish (*P. occidentalis*) collected in June and July for each sampling year 2009-2011. Bars with different letters denote significant differences among months based on Tukey HSD post hoc groupings ($p<0.05$). Error bars represent one standard error of the mean.

Bluntnose flyingfish larvae were widespread and detected along much of the area sampled, but spatial differences in the distribution and abundance were detected among the six surveys (Figure 4). In 2009 and 2010, bluntnose flyingfish were present at nearly all stations surveyed (97% and 100% occurrence, respectively), but in 2011 the presence of bluntnose flyingfish decreased with larvae absent from more stations than the previous two years (58% occurrence).

The final GAM based on the density of bluntnose flyingfish included five oceanographic and temporal variables: month, year, sea surface height anomaly, distance to Loop Current, and salinity. The final model had an AIC of 2108 and percent deviance explained (DE) was 42.9% (Figure 5). Associated ΔAIC and ΔDE from the final model were used to further evaluate the relative influence of each parameter in explaining variation in the density of bluntnose flyingfish. The most influential parameter in the final model, based on ΔAIC, was sea surface height anomaly (37), followed by year (20), distance to Loop Current (14), and salinity (13). Similarly, ΔDE was highest for sea surface height anomaly (7.2%), followed by year (4.0%), and distance to Loop Current (2.9%), and salinity (2.7%) (Table 2). Removal of the remaining variable, month, from the final model resulted in changes in ΔAIC of less than 2 and ΔDE of less than 0.8%. Variables not retained in the final model were chlorophyll-*a* concentration, depth, sea surface temperature, and *Sargassum* biomass.

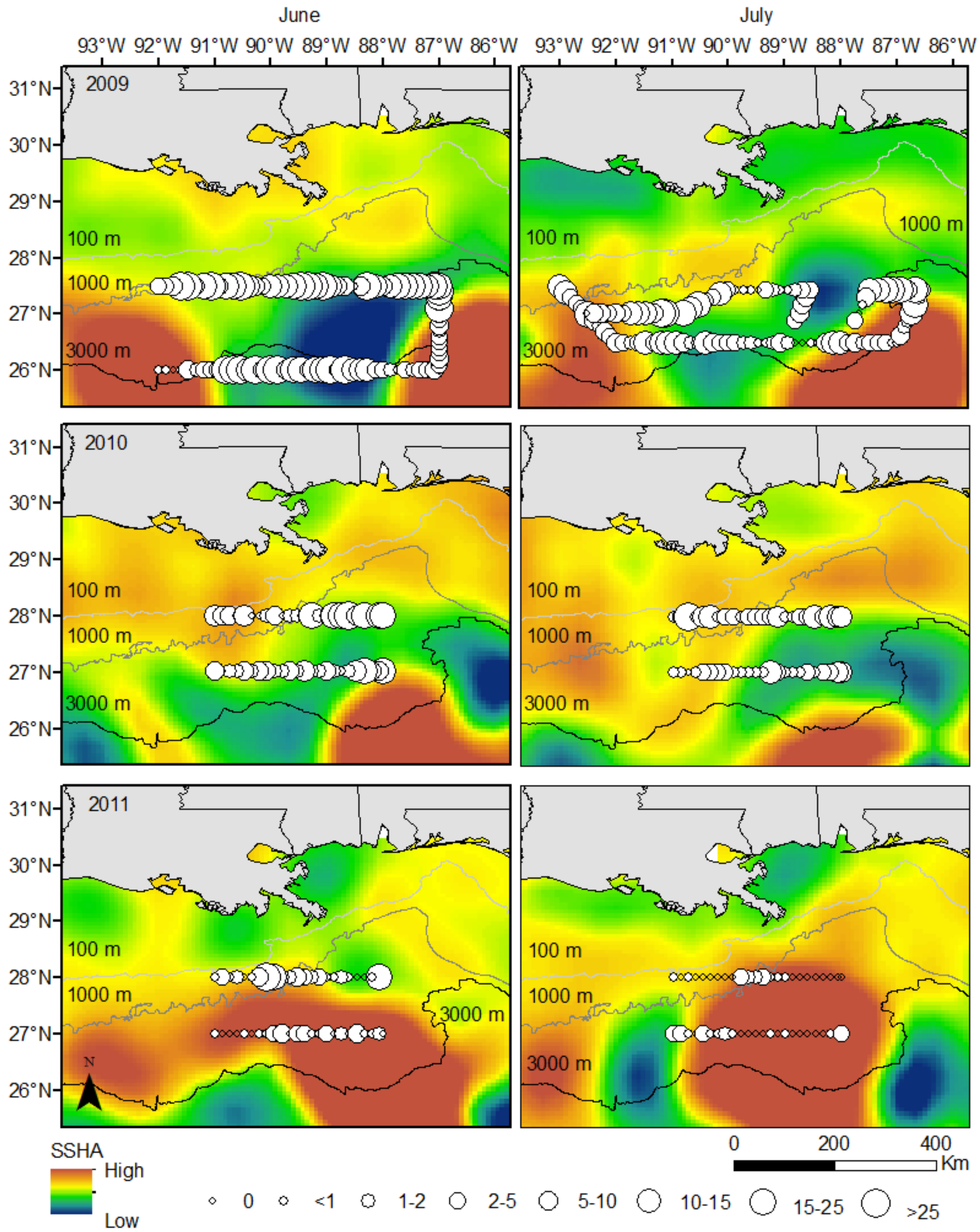

Figure 4: Spatial and temporal variability in the distributions of bluntnose flyingfish during summer ichthyoplankton cruises from 2009 (top), 2010 (middle), and 2011 (bottom) and June (left column) and July (right column). Sea surface height is denoted by color with red indicating areas of positive sea surface height and blue indicating areas of negative sea surface height. Density (larvae/1000m^2) at each sampling station is denoted by circle size.

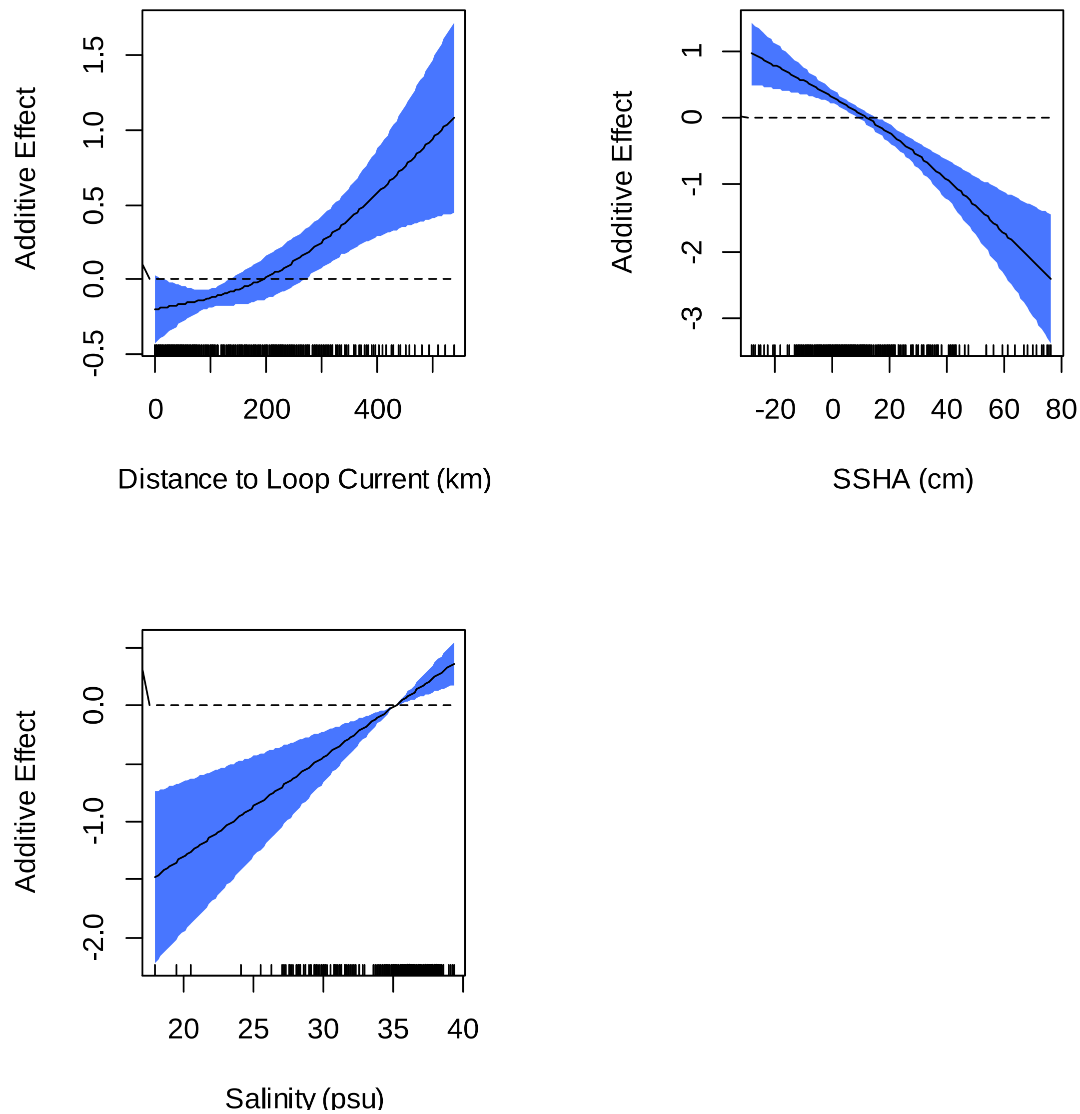

Figure 5: Response plots for oceanographic variable on the density of bluntnose flyingfish (*P. occidentalis*) from final generalized additive model (GAM). Plots include distance to Loop Current (km), sea surface height anomaly (SSHA, cm), and salinity (psu). Solid lines represent smoothed values and the shaded area represents 95% confidence intervals. Dashed line displayed at y=0 on each response plot.

Table 2: Environmental and temporal variables in the final bluntnose flyingfish (*P.* occidentalis) GAM with the relative influence of each final variable indicated by delta AIC (Akaike's Information Criterion) and delta DE (percent deviance explained). Variable codes: Distance to the Loop Current (DisLC) and sea surface height anomaly (SSHA)

Bluntnose flyingfish GAM	AIC= 2108.074	DE= 42.9%
Variable	**Delta AIC**	**Delta DE**
Month	2.101	0.8
Year	20.018	4.0
DisLC	14.019	2.9
SSHA	36.580	7.2
Salinity	12.586	2.7

Response plots from the final GAM showed a negative relationship with sea surface height anomaly and density of bluntnose flyingfish larvae with the highest densities found in waters with a negative sea surface height, correlating with cold-core eddies (Figures 5 and 6). Overall, densities were greater in areas with negative sea surface height anomalies (12.5 larvae $1000m^{-2}$) compared to areas with positive anomalies (6.2 larvae $1000m^{-2}$). Density of bluntnose flyingfish larvae was greater (18.4 larvae $1000m^{-2}$) in waters of higher salinities (>35 psu) than in lower salinity waters (8.1 larvae $1000m^{-2}$) (Figure 5). These higher salinity waters are typically associated with oceanic water masses over the continental shelf and slope. Although sea surface temperature was not a significant variable in the final GAM, the stations with the highest catches of flyingfish occurred in waters with lower temperature (Figure 6). Additionally, bluntnose flyingfish density and distance to Loop Current were positively related (Figures 5 and 6), and densities were higher at sites greater than 200 km from the Loop Current (12.3 larvae $1000m^{-2}$) relative to sites 0-200 km from this feature (5.7 larvae $1000m^{-2}$).

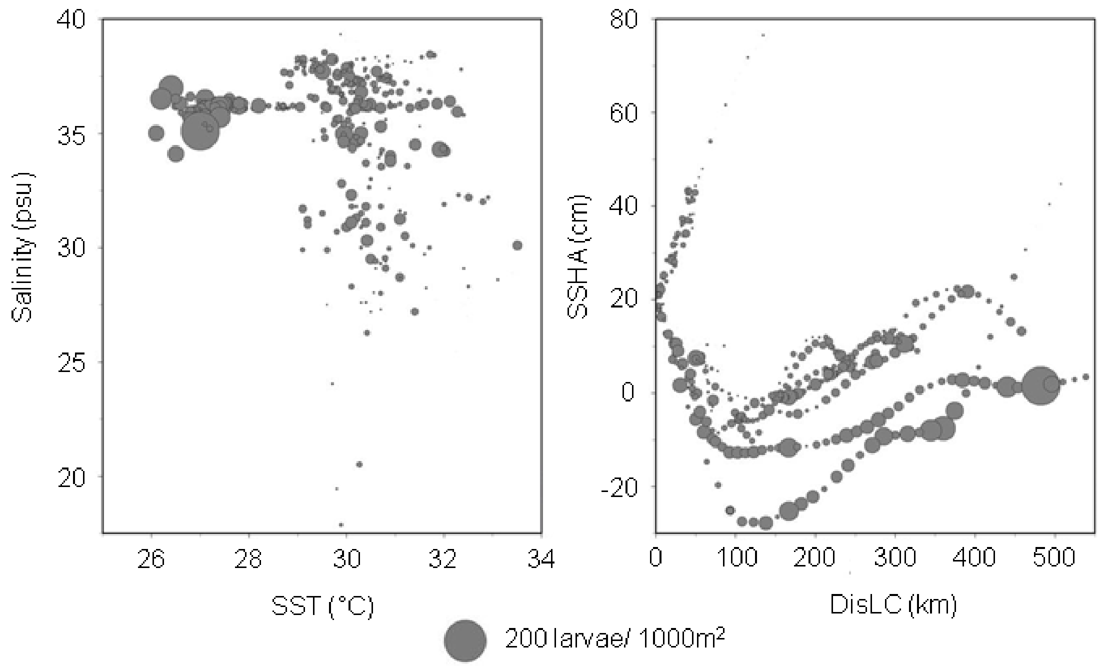

Figure 6: Influence of salinity, sea surface temperature, sea surface height anomaly, and distance to the Loop Current on bluntnose flyingfish density. A) Density (larvae/1000m^2) of bluntnose flyingfish at each station (n=385) plotted against salinity (psu) and sea surface temperature (SST °C) from all three years combined. B) Density (larvae/1000m^2) of bluntnose flyingfish at each station (n=385) plotted against sea surface height anomaly (SSHA, cm) and distance to the Loop Current (DisLC, km) from all three years combined.

Discussion

Flyingfish larvae were commonly collected in the ichthyoplankton surveys and observed densities were relatively high, suggesting that this group represents an important component of the larval fish assemblage in the NGoM. Although nine flyingfish species were collected in the survey area, bluntnose flyingfish dominated the overall catch, representing 77% of the total flyingfish collected. Densities of bluntnose flyingfish larvae were generally higher when compared to other larval pelagic fishes collected within the survey area (Rooker et al. 2012, 2013). Average densities of larval blue marlin (0.19 larvae $1000m^{-3}$), sailfish (0.55 larvae $1000m^{-3}$), and dolphinfish (0.72 larvae $1000m^{-3}$), in 2009 and 2010 were much lower than densities of bluntnose flyingfish (7.70 larvae $1000m^{-3}$) during the same two years whereas densities of blackfin tuna (11.89 larvae $1000m^{-3}$) were higher than bluntnose flyingfish (Rooker et al. 2013). Comparable assessments of flyingfish densities in the GoM and other regions are rare; nevertheless, a study by Hunte et al. (1995) within the eastern Caribbean examined density of larval flyingfishes and found a relative density of bluntnose flyingfish at 0.04 larvae $1000m^{-2}$, which is markedly lower than mean densities observed in my study (7.05 larvae $1000m^{-2}$).

Over the three-year sampling period, 85% of the neuston net tows captured bluntnose flyingfish, suggesting that the NGoM may represent an important spawning and nursery area for this species. Conversely, previous research in the Caribbean Sea during April and May showed that the tropical two-winged flyingfish (*Exocoetus volitans*) and sailfin flyingfish (*Parexocoetus brachypterus*) dominated the flyingfish assemblage (Hunte et al. 1995). Regional differences in the flyingfish assemblage between the Caribbean Sea and the NGoM were expected. In addition to geographic differences in species ranges (tropical vs. sub-tropical systems), variation may also be due in part to other spatial (e.g., shelf position) and temporal (e.g., sampling months) factors. In particular, both the timing of peak spawning and the location where adults spawn are species specific (Lewallen et al. 2011). Some species spawn in coastal waters (e.g., *Parexocoetus brachypterus*) while others spawn in oceanic waters (e.g., *Exocoetus volitans*), which are heavily impacted by currents and upwelling and will influence the distribution and availability of larvae (Hunte et al. 1995; Stevens et al. 2003). Moreover, some species spawn on substrate (*Hirundichthys affinis*), and therefore the availability of larvae from such species will be determined by the presence of flotsam and benthic substrate (Hunte et al. 1995).

High fluctuation in abundance is common for pelagic fishes within the GoM because larval survival is tightly coupled with oceanographic conditions and food availability (Cury and Roy, 1989; Fiksen et al., 2007). In my study, significant seasonal (monthly) differences occurred during the sampling period with density in June higher than July (exception 2010), indicating spawning times of bluntnose flyingfish in the NGoM correspond to spawning times of other flyingfishes in the eastern Caribbean Sea (Hunte et al. 1995) and western

Atlantic Ocean (Casazza et al. 2005). Although no spawning data on adult bluntnose flyingfish are available, results from this study suggest that in the NGoM this species spawns during the summer over a large region of the continental shelf and slope. The increase in larval abundance during the early sampling period (June) could be a result of greater food availability earlier in the summer. In the sampling corridor, primary productivity is impacted by both coastal (Mississippi River) and oceanic (upwelling) nutrient sources (Dorado et al. 2012). The continental shelf in the GoM receives considerable nutrient inputs from the Mississippi River that promotes primary productivity; therefore, changes in river discharge could impact food availability to fish larvae (Lehrter et al. 2009). During the three years sampled, freshwater inflow from the Mississippi River and Atchafalaya River to the NGoM was higher in June (35,633 m^3/s) than July (22,600 m^3/s) (Aulenbach et al. 2007) thus causing an influx of nutrients into the NGoM earlier in the summer, increasing primary and secondary productivity within the region (Biggs, 1992; Davis et al. 2002; Ross et al. 2010). Also within the NGoM, June typically has a higher abundance of phytoplankton biomass than July (Fennel et al. 2011); further suggesting that food availability is greater in June. Furthermore, *Trichodesmium*, an oceanic cyanobacterium, is an important primary producer and plays a critical role in fixing nitrogen that can then be incorporated into coastal and pelagic food web and increase secondary production in the NGoM (Dorado et al. 2012). Within the study region, *Trichodesmium* abundance was shown to be higher in June than July (Dorado et al. 2012), and therefore it appears that bluntnose flyingfish may match spawning times to peaks in phytoplankton abundance.

Inter-annual variability across the three years sampled was pronounced, with densities in 2011 markedly lower than the two previous years sampled. Temporal changes in abundance are common and have been linked to a variety of factors, including shifts in the spawning locations of adults, egg production and quality, or variability in early life survival, all of which are influenced by oceanographic conditions (Wright et al. 2009; Rooker et al. 2012). Yearly differences in the density of larvae could be attributed to shifts in oceanographic features or conditions, particularly the location of the Loop Current, which is known to affect the distribution and abundance of pelagic larvae in the NGoM (Lamkin 1997; Rooker et al. 2013). In 2011, the Loop Current penetrated farther north than the previous two years (Figure 4), potentially creating unfavorable spawning habitat for bluntnose flyingfish because of the warm, nutrient depleted waters associated with the Loop Current (Biggs 1992). The oligotrophic waters of the Loop Current are associated with lower primary and secondary production compared to areas of cyclonic circulation, possibly reducing foraging opportunities for larval flyingfish (Wormuth et al. 2002). In addition to the location of the Loop Current, the Mississippi River plume can also impact the distribution and abundance of fish larvae within the NGoM. The summer of 2011 was a major flooding event for the Mississippi River (Bianchi et al. 2012), and the NGoM saw a greater influx of freshwater to the region. This increase in freshwater to the sampling area would cause salinities to decrease and possibly reduce suitable habitat for bluntnose flyingfish larvae because bluntnose flyingfish occupy a more oceanic habitat. Additionally, the decline in 2011 could also be associated with anthropogenic factors such as the 2010 Deepwater Horizon oil spill. This event released 4.4×10^6 barrels of oil (Crone and Tolstoy 2010), and had the potential to impact both early life survival and the distribution of the spawning stock biomass of pelagic fishes in the NGoM (Rooker et al. 2013). Given their epipelagic nature and close association with surface waters it is possible that flyingfish were affected by the Deepwater Horizon oil spill, and observed declines in 2011 may be due in part to the effect of oil and dispersants on larvae mortality and development. However, more information on movement patterns of adults and spatiotemporal variability in spawning and early life survival is needed to fully evaluate the impact of this event on the early life ecology of bluntnose flyingfish.

High occurrence of larvae across the sampling corridor suggests that bluntnose flyingfish occupy a wide range of habitat types and oceanographic conditions, and therefore appears less sensitive to changes in oceanographic conditions than other pelagic fishes (i.e. billfishes) (Rooker et al. 2012). The capability of bluntnose flyingfish to reproduce and hatch in a wide range of oceanographic conditions could be a result of their life history strategy. The short life span of adults (maximum 2 years) and heavy predation by pelagic predators (Oxenford et al. 1994) could limit the time available for adults to seek ideal spawning habitat. Therefore, spawning may occur across multiple oceanographic features, implying that bluntnose flyingfish are adapted to a wider range of ecological conditions than other pelagic species (i.e. dolphinfishes and billfishes). Additionally, when compared to adult billfishes and tunas that travel long distances to spawn (Teo et al. 2007), adult flyingfish are more limited in their movement patterns (Oxenford 1994), and this reduced mobility of adult flyingfish could limit their ability to seek out favorable habitat for the larvae. The widespread distribution of bluntnose flyingfish and reduced sensitivity to environmental parameters likely explains the lower overall fit of the final GAM and reduced deviance explained when compared to the predictive capability of models using species that are less abundant and have more restricted distributions (Planque et al. 2007; Rooker et al. 2012).

Physicochemical processes of a nursery (e.g. salinity) have been shown to influence the distribution of larval fishes, and the interaction between a larva and its environment determines survival and ultimately recruitment success (Fogarty et al. 1991; Bruce et al. 2001). Temperature and salinity are known to impact larval distribution (Hernandez et al. 2010), and other studies on pelagic larvae (billfishes, tunas, and dolphinfishes) have shown that salinity and temperature are important factors in determining quality of early life habitat (Rooker et al. 2012 and 2013; Kitchens et al. in review). Within this study, the density of bluntnose flyingfish larvae increased at higher salinities; however, no temperature effect was observed. Near shore waters in the NGoM are impacted by freshwater input from the Mississippi River plume which can extend more than 100km offshore (Govoni et al. 1989) bringing lower salinity waters to the northern region of the sampling corridor. The abundance of bluntnose flyingfish larvae decreased in areas of low salinity, suggesting that waters near the Mississippi River plume provide unfavorable habitat for flyingfish larvae as the waters near the plume tend to have sharp changes in physicochemical properties (Govoni and Grimes 1992). In the NGoM, areas with higher salinities (> 35 psu) are typically found near the outer margin of continental shelf and beyond (i.e. slope waters), implying that bluntnose flyingfish larvae are associated with oceanic waters far removed from coastal processes such as freshwater inflow from the Mississippi River (Carassou et al. 2012).

Fish larvae spawned on the outer shelf and slope waters of the NGoM are heavily influenced by the Loop Current and associated eddies that impact the physical and chemical environments occupied by larvae (Lindo-Atichati et al. 2012). The final GAM indicated an increase in bluntnose flyingfish density in areas of negative sea surface height or areas associated with cyclonic features (i.e., cold-core eddies). Cyclonic circulation is typically associated with areas of upwelling which brings up cold, nutrient-rich waters from the depths to the surface (Ross et al. 2010). These areas of upwelling often enhance biological productivity (Bakun 2006; Govoni et al. 2010) and in turn increase foraging opportunities (Wormuth 2002; Bakun 2006). As a result, these areas may represent favorable environments for pelagic fishes during early life (Rooker et al. 2012). Although areas with negative sea surface height appear to represent suitable early life habitat for bluntnose flyingfish because of a potential increase in primary productivity, chlorophyll-*a* concentration (primary productivity) was not retained as a variable in the final GAM model. Grazing by zooplankton (secondary productivity) often leads to mismatches between chlorophyll-*a* and zooplankton biomass (Govoni et al. 2010), possibly explaining why chlorophyll-*a* concentration was not a significant factor in the final GAM for bluntnose flyingfish. Alternatively, densities of bluntnose flyingfish larvae may simply appear to be lower in anticyclonic and frontal regions because predation-induced mortality is higher in these features, where predators (i.e. juvenile tunas and dolphinfishes) are present in higher densities than cyclonic features (Lindo-Atichati et al. 2012).

My final model indicated that the abundance of bluntnose flyingfish larvae was greater in waters near or within cold-core eddies but lower in areas of convergence typically associated with high larval catches such as the western margin of the Loop Current. This finding differs from previous research on other taxa larvae that have emphasized the importance of temperature fronts and convergent zones as critical early life habitat of pelagic fishes (Lamkin 1997; Richardson 2009; Simms et al. 2010; Lindo-Atichati et al. 2012; Rooker et al., 2012). Previous work on other taxa of pelagic fishes (billfishes, dolphinfishes, tunas) have shown that densities of larvae increase with proximity to the Loop Current (Rooker et al. 2012, 2013), signifying that the location of the Loop

Current will influence their spatial distribution in the NGoM. Areas of convergence or fronts are typically characterized by sharp gradients in salinity, turbidity, and primary productivity (Lamkin 1997), which can accumulate both fish larvae and their prey (Govoni et al. 1989; Lamkin 1997). Here, I observed the opposite for bluntnose flyingfish with an increase in density of bluntnose flyingfish farther away from the Loop Current edge. This indicates that larval bluntnose flyingfish may preferentially spawn in the more stable, nutrient rich waters of cyclonic eddies that shed off the Loop Current rather than the mixed waters of the Loop Current edge. The hypothesis that bluntnose flyingfish abundance will be higher in cyclonic eddies cannot be rejected because greater densities of bluntnose flyingfish were found in areas of negative sea surface height. However, the hypothesis that bluntnose flyingfish abundance would be higher in areas closer to frontal boundaries can be rejected because as distance from the Loop Current boundary increased, densities of bluntnose flyingfish increased.

CHAPTER III

CONCLUSIONS

Previous studies on the early life ecology of flyingfishes have focused on populations in the Caribbean Sea, but comparable studies do not exist for species inhabiting other regions of the western Atlantic Ocean. This study represents the first attempt to characterize the distribution and abundance of larval bluntnose flyingfish, and identify critical spawning and nursery areas for this species within the NGoM. Cold-core eddies in the offshore region, away from the Loop Current were identified as critical spawning areas for bluntnose flyingfish larvae. The high abundance and broad distribution of this species highlights the importance of the NGoM as early life habitat, and suggests that flyingfish are an integral component of the pelagic ecosystem in this region.

Furthermore, understanding the early life behavior of flyingfish could provide insight into the predator-prey dynamics of the pelagic predators that prey upon flyingfish. Seabirds and pelagic fishes rely on flyingfishes as an important component of their diet and declines in abundance of flyingfishes could impact the growth rate, recruitment, and overall health of these top predators which, in turn, could impact associated fisheries. Understanding the recruitment success and critical spawning areas of flyingfish could help explain some of the yearly variability in the recruitment of billfishes and tunas.

Future considerations for managers and researchers interested in the fishery status of billfish and tuna could be to monitor multiple oceanographic features within the GoM, rather than focusing only on the Loop Current boundary. Previous studies (Lamkin 1997; Richardson 2009; Simms et al. 2010; Lindo-Atichati et al. 2012; Rooker et al., 2012) have emphasized the importance of the Loop Current and other frontal boundaries as larval fish habitat, but bluntnose flyingfish showed the opposite trend, with densities increasing away from the Loop Current. Fish species inhabit multiple oceanographic features so sampling designs need to be wide in scope to account for multiple habitat types to collect a representative sample of the ichthyoplankton assemblage within the GoM.

Given the growing interest in ecosystem-based management (EBM) of marine fisheries, there is a great need to better understand the population dynamics of ecologically important forage fishes at lower trophic levels in the pelagic ecosystem, such as flyingfishes. Understanding factors that influence the distribution, abundance, and population dynamics of lower trophic species such as bluntnose flyingfish is an important step in improving the knowledge base for EBM of pelagic ecosystems and may provide insight into the spatial distribution of other pelagic fishes that are both ecologically and economically important.

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APPENDIX A

Cruise	Station	Date	LAT	LON	Bluntnose flyingfish (500 mesh)	Bluntnose flyingfish (1200 mesh)	Pooled Bluntnose density (larvae/1000m^2)
10	1	6/3/2009	26.00	92 00	0	1	0.40
10	2	6/3/2009	26.00	91 52	1	0	0.43
10	3	6/3/2009	26.00	91 44	0	0	0.00
10	4	6/3/2009	26.00	91 36	1	1	0.78
10	5	6/3/2009	26.00	91 28	12	2	5.47
10	6	6/3/2009	26.00	91 20	4	0	1.55
10	7	6/3/2009	26.00	91 12	11	0	4.07
10	8	6/3/2009	26.00	91 04	5	1	2.42
10	9	6/3/2009	26.00	90 56	20	3	9.01
10	10	6/3/2009	26.00	90 48	80	33	42.56
10	11	6/4/2009	26.00	90 40	134	100	79.33
10	12	6/4/2009	26.00	90 32	160	36	61.26
10	13	6/4/2009	26.00	90 24	21	11	10.56
10	14	6/4/2009	26.00	90 16	64	40	33.73
10	15	6/4/2009	26.00	90 08	21	6	9.39
10	16	6/4/2009	26.00	90 00	92	38	43.36
10	17	6/4/2009	26.00	89 52	60	42	34.05
10	18	6/4/2009	26.00	89 44	12	11	7.52
10	19	6/4/2009	26.00	89 36	91	41	21.87
10	20	6/4/2009	26.00	89 28	39	21	18.69
10	21	6/4/2009	26.00	89 20	8	4	3.84
10	22	6/4/2009	26.00	89 12	45	23	21.35
10	23	6/4/2009	26.00	89 04	50	24	24.00
10	24	6/4/2009	26.00	88 56	91	58	49.72
10	25	6/4/2009	26.00	88 48	0	8	2.49
10	26	6/5/2009	26.00	88 40	56	27	25.73
10	27	6/5/2009	26.00	88 32	18	20	11.62
10	28	6/5/2009	26.00	88 24	24	17	12.86
10	29	6/5/2009	26.00	88 16	22	16	10.94
10	30	6/5/2009	26.00	88 08	9	6	4.85
10	31	6/5/2009	26.00	88 00	4	8	3.58
10	32	6/5/2009	26.00	87 52	1	3	1.28
10	33	6/5/2009	26.00	87 44	0	1	0.30
10	34	6/5/2009	26.00	87 36	4	5	2.87

Cruise	Station	Date	LAT	LON	Bluntnose flyingfish (500 mesh)	Bluntnose flyingfish (1200 mesh)	Pooled Bluntnose density (larvae/1000m^2)
10	35	6/5/2009	26.00	87 28	3	3	1.87
10	36	6/5/2009	26.00	87 20	9	4	4.26
10	37	6/5/2009	26.00	87 12	5	4	2.88
10	38	6/5/2009	26.00	87 04	21	7	9.37
10	39	6/5/2009	26.00	87 00	3	0	0.99
10	40	6/5/2009	27.00	87 00	5	5	4.03
10	41	6/6/2009	27.00	87 00	12	3	5.40
10	42	6/6/2009	27.00	87 00	5	5	3.23
10	43	6/6/2009	26.00	87 00	6	6	4.44
10	44	6/6/2009	27.00	87 00	6	7	4.78
10	45	6/6/2009	27.00	87 00	2	4	2.19
10	46	6/6/2009	27.00	87 00	2	1	1.17
10	47	6/6/2009	27.00	87 00	11	4	5.46
10	48	6/6/2009	27.00	87 00	5	5	3.75
10	49	6/6/2009	27.00	87 00	15	15	9.96
10	50	6/6/2009	27.00	87 00	44	38	29.39
10	51	6/6/2009	27.00	87 00	0	6	2.09
10	52	6/6/2009	27.00	87 00	48	13	21.96
10	53	6/6/2009	27.00	87 00	38	31	25.25
10	54	6/6/2009	28.00	87 00	27	15	16.33
10	55	6/6/2009	28.00	87 04	44	5	18.08
10	56	6/6/2009	28.00	87 12	10	21	11.52
10	57	6/6/2009	28.00	87 20	33	24	20.00
10	58	6/7/2009	28.00	87 28	40	21	20.10
10	59	6/7/2009	28.00	87 36	30	14	15.06
10	60	6/7/2009	28.00	87 44	38	25	19.56
10	61	6/7/2009	28.00	87 52	22	10	11.25
10	62	6/7/2009	28.00	88 00	5	12	5.49
10	63	6/7/2009	28.00	88 08	22	10	10.61
10	64	6/7/2009	28.00	88 16	77	70	49.18
10	65	6/7/2009	28.00	88 24	18	7	7.86
10	66	6/7/2009	28.00	88 32	1	1	0.72
10	67	6/7/2009	28.00	88 40	13	9	6.77
10	68	6/7/2009	28.00	88 48	14	6	6.58
10	69	6/7/2009	28.00	88 56	22	19	13.60
10	70	6/7/2009	28.00	89 04	36	49	27.45
10	71	6/7/2009	28.00	89 12	30	25	17.75

Cruise	Station	Date	LAT	LON	Bluntnose flyingfish (500 mesh)	Bluntnose flyingfish (1200 mesh)	Pooled Bluntnose density (larvae/1000m^2)
10	72	6/8/2009	28.00	89 20	44	35	25.65
10	73	6/8/2009	28.00	89 28	70	24	29.53
10	74	6/8/2009	28.00	89 36	37	12	16.96
10	75	6/8/2009	28.00	89 44	22	16	12.03
10	76	6/8/2009	28.00	89 52	22	13	11.69
10	77	6/8/2009	28.00	90 00	13	17	10.04
10	78	6/8/2009	28.00	90 08	9	3	3.88
10	79	6/8/2009	28.00	90 16	17	3	6.62
10	80	6/8/2009	28.00	90 24	28	21	14.86
10	81	6/8/2009	28.00	90 32	49	43	29.08
10	82	6/8/2009	28.00	90 40	23	24	15.18
10	83	6/8/2009	28.00	90 48	40	19	19.30
10	84	6/8/2009	28.00	90 56	0	18	6.03
10	85	6/8/2009	28.00	91 04	116	55	57.65
10	86	6/8/2009	28.00	91 12	24	27	17.76
10	87	6/9/2009	28.00	91 20	8	2	3.10
10	88	6/9/2009	28.00	91 28	398	165	198.02
10	89	6/9/2009	28.00	91 36	55	40	35.01
10	90	6/9/2009	28.00	91 44	9	6	5.34
10	91	6/9/2009	28.00	91 52	1	7	2.97
10	92	6/9/2009	28.00	92 00	10	4	4.81
11	1	7/22/2009	27.00	93 00	27	1	10.67
11	2	7/22/2009	27.00	92 54	29	1	10.89
11	3	7/22/2009	27.00	92 48	10	1	4.30
11	4	7/22/2009	27.00	92 42	7	1	3.06
11	5	7/22/2009	27.00	92 36	8	3	4.22
11	6	7/22/2009	27.00	92 30	54	14	24.62
11	7	7/22/2009	27.00	92 24	14	4	6.55
11	8	7/22/2009	27.00	92 18	3	0	1.09
11	9	7/22/2009	27.00	92 12	13	1	5.04
11	10	7/22/2009	27.00	92 06	7	0	2.43
11	11	7/22/2009	27.00	92 00	15	3	7.00
11	12	7/22/2009	27.00	91 52	4	3	2.54
11	13	7/22/2009	27.00	91 44	3	1	1.30
11	14	7/23/2009	27.00	91 36	10	2	4.15
11	15	7/23/2009	27.00	91 28	27	0	10.31

Cruise	Station	Date	LAT	LON	Bluntnose flyingfish (500 mesh)	Bluntnose flyingfish (1200 mesh)	Pooled Bluntnose density (larvae/1000m^2)
11	16	7/23/2009	27.00	91 20	3	3	2.03
11	17	7/23/2009	27.00	91 12	21	12	13.25
11	18	7/23/2009	27.00	91 04	29	0	11.05
11	19	7/23/2009	27.00	90 56	21	8	9.77
11	20	7/23/2009	27.00	90 48	20	3	8.92
11	21	7/23/2009	27.00	90 40	1	2	1.24
11	22	7/23/2009	27.00	90 32	4	1	1.98
11	23	7/23/2009	27.00	90 24	20	12	12.37
11	24	7/23/2009	27.00	90 16	10	3	5.20
11	25	7/23/2009	27.00	90 08	3	3	2.17
11	26	7/23/2009	27.00	90 00	5	1	2.59
11	27	7/23/2009	27.00	89 52	1	4	2.09
11	28	7/24/2009	27.00	89 44	3	1	1.60
11	29	7/24/2009	27.00	89 36	2	1	1.23
11	30	7/24/2009	27.00	89 28	1	0	0.41
11	31	7/24/2009	27.00	89 20	1	1	0.88
11	32	7/24/2009	27.00	89 12	1	2	1.33
11	33	7/24/2009	27.00	89 04	5	12	6.95
11	34	7/24/2009	27.00	88 56	3	0	1.31
11	35	7/24/2009	27.00	88 48	0	0	0.00
11	36	7/24/2009	27.00	88 40	0	0	0.00
11	37	7/24/2009	27.00	88 32	0	2	0.83
11	38	7/24/2009	27.00	88 24	1	1	0.84
11	39	7/24/2009	27.00	88 16	7	12	7.46
11	40	7/24/2009	27.00	88 08	22	10	12.39
11	41	7/24/2009	27.00	88 00	18	16	11.99
11	42	7/24/2009	27.00	87 52	6	1	2.61
11	43	7/25/2009	27.00	87 44	18	2	7.31
11	44	7/25/2009	27.00	87 36	5	1	1.98
11	45	7/25/2009	27.00	87 28	9	1	3.34
11	46	7/25/2009	27.00	87 20	4	11	4.89
11	47	7/25/2009	27.00	87 12	8	1	3.07
11	48	7/25/2009	27.00	87 04	1	1	0.68
11	49	7/25/2009	27.00	87 00	0	1	0.31
11	50	7/25/2009	27.00	86 56	15	1	5.73
11	51	7/25/2009	27.00	86 52	4	0	1.15
11	52	7/25/2009	27.00	86 48	2	1	1.11

Cruise	Station	Date	LAT	LON	Bluntnose flyingfish (500 mesh)	Bluntnose flyingfish (1200 mesh)	Pooled Bluntnose density (larvae/1000m^2)
11	53	7/25/2009	27.00	86 44	20	10	10.16
11	54	7/25/2009	27.00	86 40	31	15	15.92
11	55	7/25/2009	27.00	86 36	4	1	1.98
11	56	7/25/2009	27.00	86 32	5	5	4.07
11	57	7/26/2009	27.00	86 40	29	21	19.45
11	58	7/26/2009	27.00	86 48	18	1	7.33
11	59	7/26/2009	27.00	86 56	34	11	17.70
11	60	7/26/2009	27.00	87 04	44	4	19.24
11	61	7/26/2009	27.00	87 12	26	16	16.90
11	62	7/26/2009	27.00	87 20	16	8	10.04
11	63	7/26/2009	27.00	87 28	15	20	13.91
11	64	7/26/2009	27.00	87 32	10	6	6.59
11	65	7/26/2009	27.00	87 36	1	0	0.46
11	66	7/26/2009	27.00	87 40	0	0	0.00
11	67	7/26/2009	27.00	87 44	3	3	2.91
11	74	7/27/2009	27.00	88 48	5	4	3.02
11	75	7/27/2009	27.00	88 44	21	0	8.35
11	76	7/27/2009	27.00	88 40	7	13	7.78
11	77	7/27/2009	27.00	88 36	1	17	7.25
11	78	7/27/2009	27.00	88 32	13	0	4.79
11	79	7/27/2009	27.00	88 40	5	6	4.64
11	80	7/27/2009	27.00	88 48	4	0	1.60
11	81	7/27/2009	27.00	88 56	2	0	0.84
11	82	7/27/2009	27.00	89 04	1	1	0.83
11	83	7/27/2009	27.00	89 12	1	3	1.65
11	84	7/27/2009	27.00	89 20	10	1	4.45
11	85	7/27/2009	27.00	89 28	0	0	0.00
11	86	7/27/2009	27.00	89 36	0	1	0.44
11	87	7/27/2009	27.00	89 44	0	1	0.42
11	88	7/28/2009	27.00	89 52	0	2	0.86
11	89	7/28/2009	27.00	90 00	5	4	3.85
11	90	7/28/2009	27.00	90 08	20	4	9.85
11	91	7/28/2009	27.00	90 16	3	6	3.97
11	92	7/28/2009	27.00	90 24	4	7	4.72
11	93	7/28/2009	27.00	90 32	13	25	17.09
11	94	7/28/2009	27.00	90 40	15	9	10.07
11	95	7/28/2009	27.00	90 48	13	31	20.50

Cruise	Station	Date	LAT	LON	Bluntnose flyingfish (500 mesh)	Bluntnose flyingfish (1200 mesh)	Pooled Bluntnose density (larvae/1000m^2)
11	96	7/28/2009	27.00	91 08	49	19	26.46
11	97	7/28/2009	27.00	91 12	21	39	25.32
11	98	7/28/2009	27.00	91 20	7	5	5.18
11	99	7/28/2009	27.00	91 28	14	20	14.65
11	100	7/28/2009	27.00	91 36	7	21	11.80
11	101	7/29/2009	27.00	91 44	11	14	9.83
11	102	7/29/2009	27.00	91 52	8	4	4.99
11	103	7/29/2009	27.00	92 00	4	8	5.36
11	104	7/29/2009	27.00	92 08	6	6	4.88
11	105	7/29/2009	27.00	92 16	2	14	6.77
11	106	7/29/2009	27.00	92 24	16	2	7.07
11	107	7/29/2009	27.00	92 32	0	0	0.00
12	1	6/15/2010	28.00	91 00	20	37	12.53
12	2	6/15/2010	28.00	90 52	22	17	8.92
12	3	6/15/2010	28.00	90 44	13	7	5.68
12	4	6/15/2010	28.00	90 36	2	2	1.12
12	5	6/15/2010	28.00	90 28	41	0	10.85
12	6	6/15/2010	28.00	90 20	0	2	0.55
12	7	6/15/2010	28.00	90 12	3	1	0.94
12	8	6/15/2010	28.00	90 04	3	8	2.76
12	9	6/15/2010	28.00	89 56	10	16	7.09
12	10	6/15/2010	28.00	89 48	1	1	0.59
12	11	6/15/2010	28.00	89 40	16	5	2.85
12	12	6/16/2010	28.00	89 32	6	10	4.72
12	13	6/16/2010	28.00	89 24	9	1	2.65
12	14	6/16/2010	28.00	89 16	32	33	19.10
12	15	6/16/2010	28.00	89 08	2	5	2.08
12	16	6/16/2010	28.00	89 00	6	10	4.69
12	17	6/16/2010	28.00	88 52	25	45	18.65
12	18	6/16/2010	28.00	88 44	53	14	15.97
12	19	6/16/2010	28.00	88 36	72	32	33.95
12	20	6/16/2010	28.00	88 28	24	0	7.34
12	21	6/16/2010	28.00	88 20	0	57	18.15
12	22	6/16/2010	28.00	88 12	5	0	1.77
12	23	6/16/2010	28.00	88 04	35	21	17.21
12	24	6/16/2010	28.00	88 00	68	4	17.72

Cruise	Station	Date	LAT	LON	Bluntnose flyingfish (500 mesh)	Bluntnose flyingfish (1200 mesh)	Pooled Bluntnose density (larvae/1000m^2)
12	25	6/17/2010	27.00	88 00	28	38	15.73
12	26	6/17/2010	27.00	88 04	14	9	5.33
12	27	6/17/2010	27.00	88 12	18	9	6.63
12	28	6/17/2010	27.00	88 20	46	31	19.21
12	29	6/17/2010	27.00	88 28	41	23	14.14
12	30	6/17/2010	27.00	88 36	19	3	3.75
12	31	6/17/2010	27.00	88 44	0	4	1.11
12	32	6/17/2010	27.00	88 52	10	7	4.20
12	33	6/17/2010	27.00	89 00	31	4	8.44
12	34	6/17/2010	27.00	89 08	5	9	3.53
12	35	6/17/2010	27.00	89 16	6	9	3.73
12	36	6/17/2010	27.00	89 24	35	56	12.12
12	37	6/18/2010	27.00	89 32	7	4	2.30
12	38	6/18/2010	27.00	89 40	16	11	6.55
12	39	6/18/2010	27.00	89 48	13	3	3.27
12	40	6/18/2010	27.00	89 56	8	4	2.78
12	41	6/18/2010	27.00	90 04	15	7	5.72
12	42	6/18/2010	27.00	90 12	16	8	6.00
12	43	6/18/2010	27.00	90 20	12	3	4.18
12	44	6/18/2010	27.00	90 28	7	15	5.67
12	45	6/18/2010	27.00	90 36	6	6	3.01
12	46	6/18/2010	27.00	90 44	8	5	3.11
12	47	6/18/2010	27.00	90 52	2	0	0.51
12	48	6/18/2010	27.00	91 00	18	9	5.33
13	1	7/27/2010	28.00	91 00	8	9	4.01
13	2	7/27/2010	28.00	90 52	15	10	7.07
13	3	7/27/2010	28.00	90 44	57	89	41.72
13	4	7/27/2010	28.00	90 36	7	8	4.08
13	5	7/27/2010	28.00	90 28	18	20	10.87
13	6	7/27/2010	28.00	90 20	39	28	20.51
13	7	7/27/2010	28.00	90 12	4	10	3.94
13	8	7/27/2010	28.00	90 04	16	5	5.91
13	9	7/27/2010	28.00	89 56	13	14	7.98
13	10	7/27/2010	28.00	89 48	10	4	4.33
13	11	7/27/2010	28.00	89 40	9	16	6.26
13	12	7/27/2010	28.00	89 32	12	7	5.66

Cruise	Station	Date	LAT	LON	Bluntnose flyingfish (500 mesh)	Bluntnose flyingfish (1200 mesh)	Pooled Bluntnose density (larvae/1000m^2)
13	13	7/28/2010	28.00	89 24	20	12	8.00
13	14	7/28/2010	28.00	89 16	24	12	9.03
13	15	7/28/2010	28.00	89 08	34	23	14.22
13	16	7/28/2010	28.00	89 00	8	7	3.81
13	17	7/28/2010	28.00	88 52	12	2	3.37
13	18	7/28/2010	28.00	88 44	13	9	5.77
13	19	7/28/2010	28.00	88 36	21	5	6.63
13	20	7/28/2010	28.00	88 28	46	25	19.99
13	21	7/28/2010	28.00	88 20	15	8	5.75
13	22	7/28/2010	28.00	88 12	47	17	15.82
13	23	7/28/2010	28.00	88 04	35	19	13.27
13	24	7/28/2010	28.00	88 00	42	18	14.75
13	25	7/29/2010	27.00	88 00	34	17	12.23
13	26	7/29/2010	27.00	88 04	37	14	11.49
13	27	7/29/2010	27.00	88 12	21	20	9.79
13	28	7/29/2010	27.00	88 20	21	20	9.06
13	29	7/29/2010	27.00	88 28	15	0	3.94
13	30	7/29/2010	27.00	88 36	15	7	5.78
13	31	7/29/2010	27.00	88 44	11	2	3.04
13	32	7/29/2010	27.00	88 52	7	6	3.31
13	33	7/29/2010	27.00	89 00	5	5	2.44
13	34	7/29/2010	27.00	89 08	11	15	8.62
13	35	7/29/2010	27.00	89 16	38	38	16.73
13	36	7/29/2010	27.00	89 24	13	7	4.40
13	37	7/29/2010	27.00	89 32	15	1	4.58
13	38	7/30/2010	27.00	89 40	9	5	4.07
13	39	7/30/2010	27.00	89 48	11	3	3.79
13	40	7/30/2010	27.00	89 56	12	5	4.80
13	41	7/30/2010	27.00	90 04	24	7	7.98
13	42	7/30/2010	27.00	90 12	22	8	7.65
13	43	7/30/2010	27.00	90 20	22	6	7.09
13	44	7/30/2010	27.00	90 28	16	10	7.41
13	45	7/30/2010	27.00	90 36	5	8	3.78
13	46	7/30/2010	27.00	90 44	2	4	1.75
13	47	7/30/2010	27.00	90 52	14	5	4.68
13	48	7/30/2010	27.00	91 00	4	6	2.45

Cruise	Station	Date	LAT	LON	Bluntnose flyingfish (500 mesh)	Bluntnose flyingfish (1200 mesh)	Pooled Bluntnose density (larvae/1000m^2)
14	1	6/14/2011	27.00	91 00	NA	1	0.96
14	2	6/14/2011	27.00	90 52	NA	0	0.00
14	3	6/14/2011	27.00	90 44	NA	0	0.00
14	4	6/14/2011	27.00	90 36	NA	0	0.00
14	5	6/14/2011	27.00	90 28	NA	1	0.49
14	6	6/14/2011	27.00	90 20	NA	0	0.00
14	7	6/14/2011	27.00	90 12	NA	1	0.56
14	8	6/15/2011	27.00	90 04	NA	1	0.68
14	9	6/15/2011	27.00	89 56	NA	6	3.87
14	10	6/15/2011	27.00	89 48	NA	11	7.68
14	11	6/15/2011	27.00	89 40	NA	0	0.00
14	12	6/15/2011	27.00	89 32	NA	5	2.82
14	13	6/15/2011	27.00	89 24	NA	6	3.70
14	14	6/15/2011	27.00	89 16	NA	1	0.69
14	15	6/15/2011	27.00	89 08	NA	1	0.69
14	16	6/15/2011	27.00	89 00	NA	10	3.83
14	17	6/15/2011	27.00	88 52	NA	0	0.00
14	18	6/15/2011	27.00	88 44	NA	2	1.49
14	19	6/15/2011	27.00	88 36	NA	0	0.00
14	20	6/15/2011	27.00	88 28	NA	11	7.49
14	21	6/15/2011	27.00	88 20	NA	1	0.75
14	22	6/16/2011	27.00	88 12	NA	2	0.96
14	23	6/16/2011	27.00	88 04	NA	2	1.18
14	24	6/16/2011	27.00	88 00	NA	0	0.00
14	25	6/16/2011	28.00	88 00	NA	3	1.80
14	26	6/16/2011	28.00	88 04	NA	18	17.44
14	27	6/16/2011	28.00	88 12	NA	1	0.56
14	28	6/16/2011	28.00	88 20	NA	0	0.00
14	29	6/16/2011	28.00	88 28	NA	0	0.00
14	30	6/16/2011	28.00	88 36	NA	1	0.55
14	31	6/17/2011	28.00	88 44	NA	4	1.84
14	32	6/17/2011	28.00	88 52	NA	2	0.92
14	33	6/17/2011	28.00	89 00	NA	1	0.45
14	34	6/17/2011	28.00	89 08	NA	8	4.26
14	35	6/17/2011	28.00	89 16	NA	4	1.87
14	36	6/17/2011	28.00	89 24	NA	7	3.84
14	37	6/17/2011	28.00	89 32	NA	18	9.03

Cruise	Station	Date	LAT	LON	Bluntnose flyingfish (500 mesh)	Bluntnose flyingfish (1200 mesh)	Pooled Bluntnose density (larvae/1000m^2)
14	38	6/17/2011	28.00	89 40	NA	4	2.00
14	39	6/17/2011	28.00	89 48	NA	3	1.83
14	40	6/17/2011	28.00	89 56	NA	24	19.60
14	41	6/17/2011	28.00	90 04	NA	46	34.68
14	42	6/17/2011	28.00	90 12	NA	14	9.75
14	43	6/18/2011	28.00	90 20	NA	1	0.54
14	44	6/18/2011	28.00	90 28	NA	0	0.00
14	45	6/18/2011	28.00	90 36	NA	2	1.05
14	46	6/18/2011	28.00	90 44	NA	1	0.89
14	47	6/18/2011	28.00	90 52	NA	3	2.03
14	48	6/18/2011	28.00	91 00	NA	1	0.65
15	1	7/17/2011	27.00	91 00	NA	4	2.74
15	2	7/17/2011	27.00	90 52	NA	4	2.51
15	3	7/17/2011	27.00	90 44	NA	1	0.43
15	4	7/17/2011	27.00	90 36	NA	0	0.00
15	5	7/17/2011	27.00	90 28	NA	4	2.36
15	6	7/17/2011	27.00	90 20	NA	2	0.86
15	7	7/17/2011	27.00	90 12	NA	1	0.39
15	8	7/17/2011	27.00	90 04	NA	3	1.29
15	9	7/17/2011	27.00	89 56	NA	1	0.39
15	10	7/17/2011	27.00	89 48	NA	0	0.00
15	11	7/17/2011	27.00	89 40	NA	0	0.00
15	12	7/17/2011	27.00	89 32	NA	0	0.00
15	13	7/18/2011	27.00	89 24	NA	0	0.00
15	14	7/18/2011	27.00	89 16	NA	1	0.52
15	15	7/18/2011	27.00	89 08	NA	0	0.00
15	16	7/18/2011	27.00	89 00	NA	1	0.53
15	17	7/18/2011	27.00	88 52	NA	0	0.00
15	18	7/18/2011	27.00	88 44	NA	0	0.00
15	19	7/18/2011	27.00	88 36	NA	0	0.00
15	20	7/18/2011	27.00	88 28	NA	0	0.00
15	21	7/18/2011	27.00	88 20	NA	0	0.00
15	22	7/18/2011	27.00	88 12	NA	1	0.71
15	23	7/18/2011	27.00	88 04	NA	0	0.00
15	24	7/18/2011	27.00	88 00	NA	3	2.13
15	25	7/19/2011	28.00	88 00	NA	0	0.00

Cruise	Station	Date	LAT	LON	Bluntnose flyingfish (500 mesh)	Bluntnose flyingfish (1200 mesh)	Pooled Bluntnose density (larvae/1000m^2)
15	26	7/19/2011	28.00	88 04	NA	0	0.00
15	27	7/19/2011	28.00	88 12	NA	0	0.00
15	28	7/19/2011	28.00	88 20	NA	0	0.00
15	29	7/19/2011	28.00	88 28	NA	0	0.00
15	30	7/19/2011	28.00	88 36	NA	0	0.00
15	31	7/19/2011	28.00	88 44	NA	0	0.00
15	32	7/19/2011	28.00	88 52	NA	0	0.00
15	33	7/19/2011	28.00	89 00	NA	2	0.85
15	34	7/19/2011	28.00	89 08	NA	1	0.35
15	35	7/19/2011	28.00	89 16	NA	2	0.97
15	36	7/20/2011	28.00	89 24	NA	8	4.67
15	37	7/20/2011	28.00	89 32	NA	3	1.89
15	38	7/20/2011	28.00	89 40	NA	3	1.62
15	39	7/20/2011	28.00	89 48	NA	5	2.81
15	40	7/20/2011	28.00	89 56	NA	0	0.00
15	41	7/20/2011	28.00	90 04	NA	0	0.00
15	42	7/20/2011	28.00	90 12	NA	0	0.00
15	43	7/20/2011	28.00	90 20	NA	0	0.00
15	44	7/20/2011	28.00	90 28	NA	0	0.00
15	45	7/20/2011	28.00	90 36	NA	0	0.00
15	46	7/20/2011	28.00	90 44	NA	1	0.72
15	47	7/20/2011	28.00	90 52	NA	0	0.00
15	48	7/20/2011	28.00	91 00	NA	1	0.76

APPENDIX B

Cruise	Station	Date	Time	SSHA (cm)	DisLC (km)	DisEddy (km)	SST front (km)	Current (m/s)
10	1	6/3/2009	10:05	44.72	507.51	32.48	297.20	0.47
10	2	6/3/2009	11:00	40.40	493.10	23.41	292.53	0.54
10	3	6/3/2009	11:58	35.74	477.57	16.47	288.06	0.62
10	4	6/3/2009	12:57	30.65	463.16	8.35	284.46	0.67
10	5	6/3/2009	13:58	24.84	448.75	4.58	281.40	0.70
10	6	6/3/2009	15:00	18.57	433.23	18.51	278.73	0.73
10	7	6/3/2009	16:01	12.05	418.82	26.32	276.86	0.66
10	8	6/3/2009	17:01	5.53	404.42	32.87	271.31	0.59
10	9	6/3/2009	18:01	-0.01	388.92	43.03	257.86	0.48
10	10	6/3/2009	19:01	-3.77	374.53	54.80	245.42	0.35
10	11	6/4/2009	6:15	-7.53	360.13	67.57	233.04	0.22
10	12	6/4/2009	7:17	-8.03	344.56	81.50	219.81	0.16
10	13	6/4/2009	8:18	-8.42	330.10	94.45	207.61	0.11
10	14	6/4/2009	9:21	-8.74	315.65	85.72	195.52	0.09
10	15	6/4/2009	10:24	-9.01	300.08	70.13	182.66	0.11
10	16	6/4/2009	11:26	-9.26	285.63	55.66	170.88	0.12
10	17	6/4/2009	12:26	-11.18	271.18	41.19	159.30	0.18
10	18	6/4/2009	13:26	-13.25	255.62	25.60	147.10	0.23
10	19	6/4/2009	14:22	-15.45	241.18	11.13	136.10	0.26
10	20	6/4/2009	15:18	-17.91	226.74	3.34	125.50	0.26
10	21	6/4/2009	16:15	-20.53	211.19	18.51	114.64	0.26
10	22	6/4/2009	17:12	-22.12	196.76	26.32	104.96	0.24
10	23	6/4/2009	18:08	-23.72	182.33	32.87	95.84	0.23
10	24	6/4/2009	19:05	-25.25	166.80	43.03	87.14	0.22
10	25	6/4/2009	19:58	-26.52	152.40	48.58	79.95	0.23
10	26	6/5/2009	6:22	-27.78	138.01	37.73	68.04	0.23
10	27	6/5/2009	7:25	-27.64	122.51	29.46	55.77	0.32
10	28	6/5/2009	8:28	-27.47	108.13	23.02	45.33	0.41
10	29	6/5/2009	9:31	-24.98	93.74	11.88	36.60	0.53
10	30	6/5/2009	10:31	-19.66	78.25	2.05	24.52	0.70
10	31	6/5/2009	11:28	-14.72	63.86	13.33	12.56	0.85
10	32	6/5/2009	12:33	-6.40	49.48	19.78	1.59	0.88

Cruise	Station	Date	Time	SSHA (cm)	DisLC (km)	DisEddy (km)	SST front (km)	Current (m/s)
10	33	6/5/2009	13:38	2.57	33.98	25.60	11.58	0.90
10	34	6/5/2009	14:34	10.22	19.65	11.13	17.38	0.86
10	35	6/5/2009	15:28	17.24	5.65	3.34	28.48	0.76
10	36	6/5/2009	16:23	24.74	9.34	18.51	41.72	0.65
10	37	6/5/2009	17:24	29.43	23.34	22.02	54.38	0.57
10	38	6/5/2009	18:18	34.12	37.60	22.02	67.20	0.49
10	39	6/5/2009	18:53	36.65	45.29	22.02	74.14	0.44
10	40	6/5/2009	19:48	36.80	43.25	34.34	73.20	0.49
10	41	6/6/2009	6:09	36.96	39.83	46.67	68.99	0.54
10	42	6/6/2009	7:03	36.37	33.73	51.70	61.47	0.60
10	43	6/6/2009	7:50	34.04	27.88	39.34	55.18	0.69
10	44	6/6/2009	8:36	31.71	21.67	26.98	47.79	0.78
10	45	6/6/2009	9:20	28.48	13.69	14.60	39.12	0.86
10	46	6/6/2009	10:04	23.26	5.27	2.21	30.16	0.91
10	47	6/6/2009	10:48	18.05	3.38	9.12	20.88	0.97
10	48	6/6/2009	11:33	12.72	12.35	18.44	10.79	0.97
10	49	6/6/2009	12:18	7.18	21.28	24.02	6.65	0.89
10	50	6/6/2009	13:07	1.63	30.80	29.84	4.66	0.81
10	51	6/6/2009	13:57	-2.89	40.33	38.22	15.44	0.69
10	52	6/6/2009	14:50	-5.63	50.33	48.39	26.50	0.52
10	53	6/6/2009	15:42	-8.36	60.51	59.42	37.60	0.35
10	54	6/6/2009	16:37	-9.81	70.85	70.59	47.82	0.23
10	55	6/6/2009	17:15	-10.42	75.20	74.06	49.50	0.21
10	56	6/6/2009	18:16	-11.56	83.55	68.98	53.38	0.16
10	57	6/6/2009	19:15	-12.70	92.59	61.77	59.86	0.11
10	58	6/7/2009	6:07	-12.75	102.62	50.46	68.39	0.17
10	59	6/7/2009	7:05	-12.77	112.42	37.65	74.78	0.22
10	60	6/7/2009	8:04	-12.59	122.51	26.39	73.62	0.27
10	61	6/7/2009	9:05	-12.18	133.41	18.47	71.81	0.31
10	62	6/7/2009	10:05	-11.80	144.02	13.43	72.02	0.34
10	63	6/7/2009	11:04	-11.73	154.64	18.47	71.97	0.34
10	64	6/7/2009	12:03	-11.66	166.47	24.51	72.20	0.35
10	65	6/7/2009	13:03	-11.52	177.63	24.62	74.74	0.34
10	66	6/7/2009	14:04	-11.32	188.88	30.77	79.30	0.31
10	67	6/7/2009	15:14	-11.09	201.42	38.84	86.10	0.28
10	68	6/7/2009	16:14	-10.46	213.43	49.44	92.14	0.27
10	69	6/7/2009	17:13	-9.84	225.72	61.64	98.90	0.25

Cruise	Station	Date	Time	SSHA (cm)	DisLC (km)	DisEddy (km)	SST front (km)	Current (m/s)
10	70	6/7/2009	18:18	-9.03	239.24	75.53	107.43	0.24
10	71	6/7/2009	19:16	-8.16	252.00	88.46	116.25	0.24
10	72	6/8/2009	6:07	-7.28	264.94	97.30	112.07	0.24
10	73	6/8/2009	7:03	-5.76	278.94	98.48	105.34	0.24
10	74	6/8/2009	8:02	-4.33	291.52	101.72	100.40	0.24
10	75	6/8/2009	9:08	-2.78	304.14	106.85	96.91	0.23
10	76	6/8/2009	10:08	-0.98	317.90	113.72	94.96	0.21
10	77	6/8/2009	11:07	0.70	330.82	120.52	94.74	0.19
10	78	6/8/2009	12:06	1.58	343.87	128.55	95.88	0.15
10	79	6/8/2009	13:04	2.52	358.04	138.37	98.95	0.10
10	80	6/8/2009	14:02	2.88	371.25	148.38	103.38	0.08
10	81	6/8/2009	15:03	2.74	384.50	159.07	108.66	0.06
10	82	6/8/2009	16:09	2.59	398.86	171.21	108.99	0.04
10	83	6/8/2009	17:08	2.12	412.26	182.95	108.53	0.04
10	84	6/8/2009	18:07	1.66	425.74	176.33	108.78	0.04
10	85	6/8/2009	19:06	1.35	440.32	164.78	110.58	0.04
10	86	6/8/2009	20:05	1.25	453.93	153.79	113.73	0.03
10	87	6/9/2009	6:03	1.14	467.58	143.41	118.18	0.03
10	88	6/9/2009	7:19	1.55	482.34	133.09	124.28	0.05
10	89	6/9/2009	8:39	1.94	496.09	124.50	130.55	0.08
10	90	6/9/2009	9:41	2.38	509.87	117.06	137.37	0.10
10	91	6/9/2009	10:44	2.92	524.77	110.08	145.62	0.13
10	92	6/9/2009	11:59	3.43	538.63	104.13	153.99	0.15
11	1	7/22/2009	6:30	13.24	458.02	516.75	108.10	0.21
11	2	7/22/2009	7:56	15.22	444.38	510.46	93.42	0.21
11	3	7/22/2009	9:03	17.35	430.81	501.61	78.81	0.21
11	4	7/22/2009	10:12	19.64	417.32	486.07	64.30	0.20
11	5	7/22/2009	11:19	20.99	403.90	470.54	49.99	0.17
11	6	7/22/2009	12:25	21.69	390.58	455.02	36.13	0.15
11	7	7/22/2009	13:30	22.32	377.36	439.59	23.54	0.15
11	8	7/22/2009	14:33	22.16	364.25	424.26	12.46	0.16
11	9	7/22/2009	15:33	21.10	351.26	409.03	3.22	0.19
11	10	7/22/2009	16:35	20.11	338.43	393.93	8.71	0.23
11	11	7/22/2009	17:37	19.29	325.74	378.96	3.10	0.28
11	12	7/22/2009	18:36	16.53	313.30	365.54	2.31	0.29
11	13	7/22/2009	19:37	13.56	299.94	351.18	4.68	0.30

Cruise	Station	Date	Time	SSHA (cm)	DisLC (km)	DisEddy (km)	SST front (km)	Current (m/s)
11	14	7/23/2009	6:25	10.97	287.59	337.94	11.13	0.30
11	15	7/23/2009	7:27	8.53	275.30	324.80	12.60	0.28
11	16	7/23/2009	8:33	5.92	262.14	310.79	6.33	0.26
11	17	7/23/2009	9:32	3.96	250.01	297.86	2.62	0.24
11	18	7/23/2009	10:29	2.00	237.96	284.93	2.30	0.23
11	19	7/23/2009	11:26	0.12	225.11	271.07	5.42	0.21
11	20	7/23/2009	12:23	-1.43	213.30	258.37	6.91	0.20
11	21	7/23/2009	13:22	-2.98	201.64	245.86	6.92	0.19
11	22	7/23/2009	14:29	-3.74	189.28	232.65	7.65	0.18
11	23	7/23/2009	15:27	-4.43	178.03	220.65	8.30	0.17
11	24	7/23/2009	16:26	-4.54	167.02	208.98	2.31	0.17
11	25	7/23/2009	17:29	-3.99	155.27	196.82	2.31	0.18
11	26	7/23/2009	18:28	-3.48	144.37	185.98	3.11	0.18
11	27	7/23/2009	19:26	-2.61	133.69	175.67	9.89	0.17
11	28	7/24/2009	6:20	-1.66	122.69	165.27	4.07	0.15
11	29	7/24/2009	7:24	-1.02	112.80	156.38	17.05	0.14
11	30	7/24/2009	8:28	-0.59	102.92	145.31	16.20	0.13
11	31	7/24/2009	9:34	-0.13	92.24	133.41	18.33	0.12
11	32	7/24/2009	10:36	0.61	82.97	123.10	11.62	0.12
11	33	7/24/2009	11:34	1.36	74.61	113.71	6.93	0.12
11	34	7/24/2009	12:30	2.12	66.07	104.89	2.43	0.16
11	35	7/24/2009	13:24	2.79	58.16	98.11	6.94	0.24
11	36	7/24/2009	14:18	3.45	51.30	91.75	12.23	0.31
11	37	7/24/2009	15:12	4.82	42.94	86.56	21.07	0.40
11	38	7/24/2009	16:04	6.11	34.13	84.07	26.39	0.49
11	39	7/24/2009	16:57	8.59	24.89	83.74	26.75	0.58
11	40	7/24/2009	17:50	12.59	15.82	83.74	25.46	0.66
11	41	7/24/2009	18:42	16.31	7.20	83.74	27.50	0.74
11	42	7/24/2009	19:33	20.62	1.30	78.29	32.00	0.76
11	43	7/25/2009	7:42	25.26	9.91	62.71	38.47	0.79
11	44	7/25/2009	8:27	29.34	17.61	48.24	44.71	0.78
11	45	7/25/2009	9:19	33.21	25.07	33.77	51.04	0.74
11	46	7/25/2009	10:07	37.36	33.44	18.18	59.37	0.69
11	47	7/25/2009	10:55	40.84	41.67	3.71	66.83	0.61
11	48	7/25/2009	11:43	44.31	49.94	10.76	71.42	0.53
11	49	7/25/2009	12:11	46.18	54.42	18.55	74.08	0.48
11	50	7/25/2009	13:13	42.90	49.37	26.35	65.09	0.54

Cruise	Station	Date	Time	SSHA (cm)	DisLC (km)	DisEddy (km)	SST front (km)	Current (m/s)
11	51	7/25/2009	14:22	38.16	42.84	30.44	57.69	0.58
11	52	7/25/2009	15:25	33.64	34.01	14.31	53.20	0.61
11	53	7/25/2009	16:26	28.33	20.50	1.84	50.64	0.60
11	54	7/25/2009	17:30	22.15	5.31	19.25	51.90	0.61
11	55	7/25/2009	18:36	15.62	10.55	35.44	55.66	0.54
11	56	7/25/2009	19:44	9.08	26.43	51.65	39.69	0.45
11	57	7/26/2009	7:03	10.65	23.50	51.65	48.40	0.46
11	58	7/26/2009	8:19	10.63	24.53	51.65	42.37	0.45
11	59	7/26/2009	9:35	10.60	26.10	51.65	31.11	0.43
11	60	7/26/2009	10:46	9.06	27.85	52.24	21.20	0.42
11	61	7/26/2009	11:55	6.20	33.50	56.25	17.75	0.42
11	62	7/26/2009	13:03	3.35	42.06	62.61	22.66	0.42
11	63	7/26/2009	14:06	0.00	51.57	70.27	33.17	0.38
11	64	7/26/2009	15:23	1.03	45.30	62.49	25.53	0.46
11	65	7/26/2009	16:35	1.15	40.42	60.04	21.22	0.55
11	66	7/26/2009	17:48	3.51	33.63	59.59	6.14	0.61
11	67	7/26/2009	19:12	6.50	26.08	62.85	0.46	0.67
11	74	7/27/2009	6:20	-1.26	93.71	143.08	26.11	0.22
11	75	7/27/2009	7:27	-4.14	99.25	155.85	38.25	0.28
11	76	7/27/2009	8:37	-7.57	107.14	171.04	49.99	0.31
11	77	7/27/2009	9:46	-8.92	113.48	168.42	60.93	0.28
11	78	7/27/2009	10:57	-10.21	120.52	167.18	73.77	0.23
11	79	7/27/2009	12:03	-8.39	129.10	181.44	76.75	0.31
11	80	7/27/2009	13:03	-4.89	137.18	194.87	81.56	0.34
11	81	7/27/2009	14:03	-1.39	145.83	208.44	85.87	0.37
11	82	7/27/2009	15:02	2.16	154.95	215.49	90.75	0.36
11	83	7/27/2009	16:00	5.26	163.42	221.41	96.87	0.32
11	84	7/27/2009	16:59	8.36	172.44	227.84	103.38	0.28
11	85	7/27/2009	17:58	9.89	180.90	235.02	97.71	0.22
11	86	7/27/2009	18:56	11.26	188.44	242.38	93.99	0.17
11	87	7/27/2009	19:50	11.96	196.34	250.36	91.95	0.14
11	88	7/28/2009	6:12	11.95	204.86	259.59	88.64	0.14
11	89	7/28/2009	7:09	11.94	213.01	268.68	81.05	0.13
11	90	7/28/2009	8:14	10.98	216.59	272.75	67.15	0.15
11	91	7/28/2009	9:18	9.84	221.06	277.67	52.09	0.18
11	92	7/28/2009	10:26	8.80	225.80	282.62	38.23	0.20
11	93	7/28/2009	11:32	8.03	231.40	286.57	26.80	0.22

Cruise	Station	Date	Time	SSHA (cm)	DisLC (km)	DisEddy (km)	SST front (km)	Current (m/s)
11	94	7/28/2009	12:39	6.77	237.27	291.31	19.16	0.22
11	95	7/28/2009	13:47	5.73	243.19	296.21	21.98	0.20
11	96	7/28/2009	16:05	6.64	270.74	325.01	26.61	0.14
11	97	7/28/2009	16:36	6.87	276.61	331.32	22.46	0.13
11	98	7/28/2009	17:49	7.28	287.57	343.20	19.56	0.11
11	99	7/28/2009	18:51	8.66	299.56	356.21	24.98	0.15
11	100	7/28/2009	19:55	9.96	310.84	368.47	34.56	0.19
11	101	7/29/2009	6:17	11.74	322.24	380.88	45.80	0.22
11	102	7/29/2009	7:20	14.21	334.66	394.41	52.08	0.23
11	103	7/29/2009	8:23	16.50	346.29	407.10	44.25	0.25
11	104	7/29/2009	9:25	18.26	358.01	419.90	39.20	0.22
11	105	7/29/2009	10:28	20.16	370.72	433.80	37.93	0.18
11	106	7/29/2009	11:32	21.18	382.61	446.73	37.94	0.17
11	107	7/29/2009	12:36	21.49	394.56	459.67	40.21	0.16
12	1	6/15/2010	9:30	11.16	316.84	244.31	66.28	0.11
12	2	6/15/2010	10:31	12.13	306.69	236.56	63.10	0.09
12	3	6/15/2010	11:19	13.17	295.91	228.94	62.35	0.06
12	4	6/15/2010	12:13	13.21	285.98	222.45	63.63	0.07
12	5	6/15/2010	13:16	12.37	276.28	216.13	66.98	0.12
12	6	6/15/2010	14:22	11.43	266.15	210.17	67.81	0.18
12	7	6/15/2010	15:25	9.47	257.03	205.53	70.93	0.18
12	8	6/15/2010	16:25	7.51	248.00	201.82	76.08	0.19
12	9	6/15/2010	17:23	5.86	238.57	198.94	83.48	0.17
12	10	6/15/2010	18:20	4.74	230.22	197.33	80.76	0.15
12	11	6/15/2010	19:20	3.63	222.31	196.77	70.93	0.12
12	12	6/16/2010	6:50	3.04	214.32	197.35	61.59	0.11
12	13	6/16/2010	7:40	2.50	207.45	198.99	54.17	0.10
12	14	6/16/2010	8:45	1.88	199.92	201.66	45.58	0.10
12	15	6/16/2010	9:45	1.10	191.79	99.60	32.03	0.11
12	16	6/16/2010	10:45	0.38	184.58	91.33	19.73	0.12
12	17	6/16/2010	11:38	-0.11	177.99	84.06	8.96	0.13
12	18	6/16/2010	12:35	-0.63	171.70	77.81	8.11	0.14
12	19	6/16/2010	13:30	-0.87	166.68	73.52	8.28	0.14
12	20	6/16/2010	14:30	-0.89	162.54	71.93	14.73	0.14
12	21	6/16/2010	15:25	-0.91	159.02	73.44	24.83	0.13
12	22	6/16/2010	16:18	-0.85	156.15	77.67	35.55	0.11

Cruise	Station	Date	Time	SSHA (cm)	DisLC (km)	DisEddy (km)	SST front (km)	Current (m/s)
12	23	6/16/2010	17:14	-0.78	153.11	84.40	47.33	0.10
12	24	6/16/2010	18:14	-0.74	151.46	91.13	53.71	0.09
12	25	6/17/2010	6:50	4.10	43.44	99.37	72.34	0.46
12	26	6/17/2010	7:23	2.38	45.01	109.70	68.39	0.46
12	27	6/17/2010	8:25	-0.81	48.89	120.31	62.46	0.44
12	28	6/17/2010	9:30	-4.01	55.43	131.65	58.00	0.43
12	29	6/17/2010	10:45	-6.09	63.61	144.50	53.99	0.33
12	30	6/17/2010	11:53	-7.99	71.33	156.87	53.20	0.23
12	31	6/17/2010	13:00	-8.50	78.18	201.06	48.52	0.17
12	32	6/17/2010	14:15	-7.46	86.10	193.26	44.44	0.16
12	33	6/17/2010	15:30	-6.49	94.69	186.27	43.93	0.15
12	34	6/17/2010	16:25	-4.93	103.75	179.32	45.24	0.17
12	35	6/17/2010	17:25	-3.26	113.95	173.25	50.40	0.18
12	36	6/17/2010	18:29	-2.11	123.94	168.20	57.83	0.18
12	37	6/18/2010	6:25	-1.33	134.06	164.03	66.94	0.17
12	38	6/18/2010	7:25	-0.50	145.42	161.40	77.71	0.15
12	39	6/18/2010	8:23	0.28	156.25	160.05	86.85	0.16
12	40	6/18/2010	9:23	1.05	167.10	159.86	96.85	0.16
12	41	6/18/2010	10:14	2.09	178.84	35.02	108.30	0.17
12	42	6/18/2010	11:10	3.24	189.81	35.88	119.39	0.18
12	43	6/18/2010	12:03	4.39	200.79	41.27	130.81	0.19
12	44	6/18/2010	13:27	5.06	212.62	47.84	143.38	0.21
12	45	6/18/2010	13:45	5.68	223.69	57.37	155.26	0.23
12	46	6/18/2010	14:39	5.70	234.96	68.24	167.28	0.25
12	47	6/18/2010	15:30	5.07	247.27	80.26	173.45	0.27
12	48	6/18/2010	16:20	4.48	258.84	91.33	174.64	0.30
13	1	7/27/2010	9:20	9.05	327.29	344.54	33.97	0.10
13	2	7/27/2010	10:19	9.74	319.52	334.31	43.54	0.09
13	3	7/27/2010	11:22	10.49	311.54	323.64	55.33	0.09
13	4	7/27/2010	12:23	11.01	304.51	314.11	66.96	0.08
13	5	7/27/2010	13:27	11.35	297.88	304.96	78.96	0.06
13	6	7/27/2010	14:29	11.69	291.21	295.59	92.13	0.04
13	7	7/27/2010	15:27	11.62	285.13	287.37	104.50	0.05
13	8	7/27/2010	16:29	11.53	278.09	279.66	116.96	0.05
13	9	7/27/2010	17:29	11.14	270.17	271.97	130.46	0.06
13	10	7/27/2010	18:36	10.52	263.26	265.41	135.93	0.08

Cruise	Station	Date	Time	SSHA (cm)	DisLC (km)	DisEddy (km)	SST front (km)	Current (m/s)
13	11	7/27/2010	19:43	9.88	256.81	258.99	123.28	0.11
13	12	7/27/2010	19:06	8.74	250.13	252.66	109.71	0.14
13	13	7/28/2010	8:08	7.64	244.33	247.52	97.16	0.16
13	14	7/28/2010	9:06	6.60	239.02	243.13	84.69	0.19
13	15	7/28/2010	10:03	5.54	233.96	239.30	71.39	0.21
13	16	7/28/2010	11:06	4.65	229.93	236.60	59.25	0.24
13	17	7/28/2010	12:00	4.24	226.55	234.77	47.47	0.25
13	18	7/28/2010	12:58	3.89	223.70	233.78	34.92	0.26
13	19	7/28/2010	13:58	3.84	221.80	233.67	23.22	0.26
13	20	7/28/2010	15:05	4.04	219.77	232.83	13.69	0.26
13	21	7/28/2010	16:05	4.22	217.83	225.59	2.89	0.25
13	22	7/28/2010	17:07	4.22	216.44	219.15	5.82	0.25
13	23	7/28/2010	18:06	4.19	215.66	213.17	4.09	0.25
13	24	7/28/2010	18:48	4.12	215.55	210.30	10.53	0.25
13	25	7/29/2010	6:53	-5.64	104.45	99.60	85.87	0.12
13	26	7/29/2010	7:34	-5.40	104.68	104.62	82.92	0.12
13	27	7/29/2010	8:30	-5.10	106.02	108.83	78.79	0.12
13	28	7/29/2010	9:31	-4.90	107.93	108.83	76.63	0.12
13	29	7/29/2010	10:29	-5.28	110.03	108.83	76.70	0.11
13	30	7/29/2010	11:19	-5.75	112.37	108.83	78.98	0.10
13	31	7/29/2010	12:12	-5.96	116.13	109.06	83.21	0.09
13	32	7/29/2010	13:05	-5.90	121.60	111.16	89.64	0.09
13	33	7/29/2010	13:59	-5.69	127.61	114.99	97.02	0.08
13	34	7/29/2010	14:56	-4.76	134.05	120.44	105.45	0.12
13	35	7/29/2010	15:53	-3.59	141.85	127.35	115.46	0.17
13	36	7/29/2010	16:49	-2.16	149.23	134.24	125.41	0.20
13	37	7/29/2010	17:43	-0.39	156.03	142.24	135.85	0.23
13	38	7/30/2010	7:50	1.54	162.72	151.94	147.53	0.27
13	39	7/30/2010	8:55	3.69	168.74	161.77	140.22	0.25
13	40	7/30/2010	10:32	5.85	175.42	172.26	131.13	0.24
13	41	7/30/2010	13:15	7.80	183.37	184.16	119.36	0.19
13	42	7/30/2010	14:10	9.25	191.38	194.33	108.88	0.13
13	43	7/30/2010	15:08	10.62	199.90	203.67	97.55	0.06
13	44	7/30/2010	16:07	10.31	209.60	214.37	83.66	0.08
13	45	7/30/2010	17:11	9.90	219.01	224.81	70.76	0.10
13	46	7/30/2010	18:14	9.01	228.78	235.69	57.86	0.12
13	47	7/30/2010	19:23	7.51	239.53	247.81	43.98	0.12

Cruise	Station	Date	Time	SSHA (cm)	DisLC (km)	DisEddy (km)	SST front (km)	Current (m/s)
13	48	7/30/2010	20:31	6.25	249.79	259.39	31.10	0.13
14	1	6/14/2011	-	18.97	9.03	151.70	159.53	0.18
14	2	6/14/2011	13:36	20.06	1.25	239.89	163.25	0.19
14	3	6/14/2011	14:43	21.16	12.44	161.26	167.92	0.20
14	4	6/14/2011	15:51	21.29	10.23	147.34	173.47	0.23
14	5	6/14/2011	17:28	20.48	1.26	133.62	179.81	0.28
14	6	6/14/2011	18:28	19.66	1.29	120.16	186.87	0.33
14	7	6/14/2011	20:20	18.89	4.06	106.90	194.55	0.34
14	8	6/15/2011	6:30	18.12	6.02	93.64	202.81	0.35
14	9	6/15/2011	7:38	18.80	3.66	80.58	211.56	0.36
14	10	6/15/2011	8:45	20.95	3.80	68.24	220.75	0.37
14	11	6/15/2011	9:28	23.09	13.98	57.11	230.33	0.39
14	12	6/15/2011	10:37	27.39	24.04	48.03	240.25	0.44
14	13	6/15/2011	11:41	31.68	34.45	41.27	250.46	0.49
14	14	6/15/2011	12:35	35.32	45.99	30.65	260.95	0.53
14	15	6/15/2011	13:31	38.30	46.93	17.39	271.67	0.55
14	16	6/15/2011	14:21	41.28	45.96	4.93	282.59	0.57
14	17	6/15/2011	15:50	41.98	43.43	1.69	293.71	0.61
14	18	6/15/2011	16:41	42.68	41.76	1.89	304.99	0.64
14	19	6/15/2011	17:35	43.11	41.12	1.89	316.41	0.67
14	20	6/15/2011	18:25	43.26	40.59	5.00	327.97	0.69
14	21	6/15/2011	19:10	43.42	40.13	12.75	339.65	0.72
14	22	6/16/2011	7:32	42.51	39.53	25.71	351.44	0.73
14	23	6/16/2011	8:21	41.59	39.09	12.75	363.32	0.74
14	24	6/16/2011	8:50	41.14	37.36	5.00	369.30	0.75
14	25	6/16/2011	15:29	-0.86	72.20	1.89	336.61	0.17
14	26	6/16/2011	15:55	-1.54	71.78	93.70	330.11	0.17
14	27	6/16/2011	16:52	-2.91	71.51	91.02	317.11	0.15
14	28	6/16/2011	17:44	-4.27	70.83	87.31	304.12	0.14
14	29	6/16/2011	18:45	-4.01	70.35	86.04	291.14	0.17
14	30	6/16/2011	19:38	-3.76	69.85	87.31	278.18	0.20
14	31	6/17/2011	6:25	-2.35	68.04	91.02	265.24	0.23
14	32	6/17/2011	7:25	0.21	65.68	96.87	252.32	0.26
14	33	6/17/2011	8:30	2.77	64.62	103.48	239.42	0.30
14	34	6/17/2011	9:30	4.71	62.29	111.01	226.55	0.27
14	35	6/17/2011	10:36	6.65	59.97	119.92	213.70	0.24

Cruise	Station	Date	Time	SSHA (cm)	DisLC (km)	DisEddy (km)	SST front (km)	Current (m/s)
14	36	6/17/2011	11:40	7.70	58.64	126.48	200.89	0.23
14	37	6/17/2011	12:46	7.87	57.33	130.77	188.12	0.23
14	38	6/17/2011	13:58	8.05	55.14	136.53	175.41	0.24
14	39	6/17/2011	15:13	7.84	52.49	143.14	162.76	0.26
14	40	6/17/2011	16:45	7.64	50.43	150.16	150.18	0.28
14	41	6/17/2011	18:03	7.46	50.17	158.26	137.71	0.30
14	42	6/17/2011	19:30	7.32	50.58	167.28	125.36	0.31
14	43	6/18/2011	5:59	7.18	50.99	177.09	113.18	0.32
14	44	6/18/2011	7:00	6.75	52.68	187.56	101.24	0.30
14	45	6/18/2011	7:58	6.31	57.24	198.59	89.62	0.28
14	46	6/18/2011	9:07	5.81	63.11	210.02	78.46	0.26
14	47	6/18/2011	10:05	5.25	69.96	219.42	68.00	0.23
14	48	6/18/2011	11:15	4.69	77.57	229.40	58.61	0.19
15	1	7/17/2011	6:31	-0.19	45.01	48.03	111.14	0.44
15	2	7/17/2011	7:41	5.38	32.07	57.11	102.53	0.53
15	3	7/17/2011	8:46	10.96	19.14	63.08	94.99	0.63
15	4	7/17/2011	9:55	16.91	6.23	48.24	85.00	0.69
15	5	7/17/2011	11:05	23.23	6.61	33.40	72.22	0.70
15	6	7/17/2011	12:16	29.55	19.46	18.55	59.65	0.72
15	7	7/17/2011	13:36	35.75	32.43	3.71	47.46	0.72
15	8	7/17/2011	14:55	41.96	45.40	11.13	36.02	0.71
15	9	7/17/2011	16:02	47.97	58.37	25.97	26.33	0.70
15	10	7/17/2011	17:07	53.79	71.34	38.80	20.99	0.68
15	11	7/17/2011	18:11	59.61	84.24	38.80	15.51	0.65
15	12	7/17/2011	19:13	64.02	95.98	41.54	11.91	0.57
15	13	7/18/2011	6:36	68.42	106.59	47.96	8.29	0.49
15	14	7/18/2011	7:37	71.81	115.24	55.27	2.35	0.40
15	15	7/18/2011	8:38	74.17	124.68	65.04	13.86	0.28
15	16	7/18/2011	9:42	76.53	134.76	76.45	19.22	0.17
15	17	7/18/2011	10:46	76.01	140.08	88.89	16.44	0.20
15	18	7/18/2011	11:48	75.50	138.29	80.58	22.88	0.23
15	19	7/18/2011	13:05	73.57	125.56	68.24	28.50	0.30
15	20	7/18/2011	14:19	70.23	112.83	57.11	21.98	0.40
15	21	7/18/2011	15:24	66.90	100.10	48.03	20.82	0.50
15	22	7/18/2011	16:25	61.67	87.37	41.27	23.65	0.56
15	23	7/18/2011	17:22	56.45	74.65	35.80	32.14	0.63

15	24	7/18/2011	18:04	53.84	68.28	35.02	37.45	0.67
15	25	7/19/2011	6:44	23.58	11.53	49.13	135.50	0.48
15	26	7/19/2011	8:37	24.95	17.10	49.13	134.13	0.52
15	27	7/19/2011	9:55	27.69	24.66	43.61	132.36	0.60
15	28	7/19/2011	11:18	30.43	27.38	30.81	131.88	0.68
15	29	7/19/2011	12:35	32.26	29.62	20.87	128.58	0.73
15	30	7/19/2011	13:51	34.10	29.46	14.25	118.74	0.77
15	31	7/19/2011	15:12	34.72	29.95	12.22	109.46	0.79
15	32	7/19/2011	16:26	34.12	29.33	12.22	101.05	0.77
15	33	7/19/2011	17:35	33.53	28.31	12.22	93.74	0.76
15	34	7/19/2011	18:49	31.80	27.05	17.55	87.42	0.71
15	35	7/19/2011	20:12	30.07	25.71	25.25	74.29	0.65
15	36	7/20/2011	6:31	28.15	23.36	37.04	61.17	0.58
15	37	7/20/2011	7:58	26.02	20.08	50.25	48.05	0.52
15	38	7/20/2011	9:22	23.90	13.25	60.51	34.94	0.45
15	39	7/20/2011	11:02	21.10	3.59	67.99	21.86	0.41
15	40	7/20/2011	12:19	18.30	5.27	77.58	8.92	0.36
15	41	7/20/2011	13:36	15.87	15.93	86.36	2.35	0.31
15	42	7/20/2011	14:43	13.81	26.87	88.88	13.73	0.25
15	43	7/20/2011	15:42	11.75	37.04	93.70	26.76	0.19
15	44	7/20/2011	16:39	11.20	45.91	100.17	38.07	0.14
15	45	7/20/2011	17:33	10.66	54.41	107.06	47.29	0.08
15	46	7/20/2011	18:25	10.33	64.29	115.31	58.04	0.06
15	47	7/20/2011	19:19	10.23	74.87	124.79	45.33	0.06
15	48	7/20/2011	20:13	10.12	85.47	135.24	32.82	0.07

Cruise	Station	Date	SST (°C)	Salinity (psu)	Depth (m)	Sargassum (kg)	Chl a (mg^{-3})
10	1	6/3/2009			2401.20	0.0	0.03
10	2	6/3/2009			2359.20	0.0	0.02
10	3	6/3/2009			2269.80	0.0	0.02
10	4	6/3/2009	25.70		2304.10	0.0	0.03
10	5	6/3/2009	26.00		2478.20	0.9	0.08
10	6	6/3/2009	26.20		3114.90	0.0	0.12
10	7	6/3/2009	26.40		3388.10	0.0	0.12
10	8	6/3/2009	26.50		3371.10	0.0	0.12
10	9	6/3/2009	26.50		3381.90	0.0	0.12
10	10	6/3/2009	26.40		3380.60	0.9	0.13
10	11	6/4/2009	26.40	37.00	3365.20	0.9	0.13
10	12	6/4/2009	26.20	36.50	3345.20	0.0	0.12

Cruise	Station	Date	SST (°C)	Salinity (psu)	Depth (m)	Sargassum (kg)	Chl a (mg^{-3})
10	13	6/4/2009	26.10	35.00	3336.30	0.0	0.12
10	14	6/4/2009	26.10	35.00	3314.70	0.5	0.13
10	15	6/4/2009	26.50	36.20	3233.60	0.0	0.09
10	16	6/4/2009	27.00	35.80	3206.40	0.5	0.09
10	17	6/4/2009	27.30	35.60	3200.20	1.2	0.07
10	18	6/4/2009	27.30	35.50	3185.10	0.0	0.05
10	19	6/4/2009	27.50	36.00	3167.00	0.0	0.06
10	20	6/4/2009	27.60	36.50	3153.90	1.1	0.07
10	21	6/4/2009	27.60	36.30	3138.80	0.0	0.07
10	22	6/4/2009	27.60	36.30	3119.70	0.0	0.06
10	23	6/4/2009	27.30	36.30	3094.80	0.9	0.06
10	24	6/4/2009	27.10	36.50	3050.80	0.0	0.07
10	25	6/4/2009	27.00	36.40	3010.00	0.0	0.06
10	26	6/5/2009	26.60	36.30	3000.50	0.0	0.09
10	27	6/5/2009	26.80	36.60	3005.30	0.7	0.09
10	28	6/5/2009	26.50	36.50	3027.10	0.5	0.11
10	29	6/5/2009	27.60	36.30	3005.00	0.0	0.14
10	30	6/5/2009	27.60	36.30	3004.20	0.0	0.14
10	31	6/5/2009	27.90	36.40	3016.90	2.4	0.05
10	32	6/5/2009	28.60	36.30	3037.80	0.1	0.05
10	33	6/5/2009	28.90	36.20	3090.70	0.0	0.04
10	34	6/5/2009	28.90	36.20	3120.50	0.0	0.05
10	35	6/5/2009	29.00	36.10	3145.30	0.0	0.04
10	36	6/5/2009	28.90	36.20	3165.40	0.0	0.04
10	37	6/5/2009	28.30	36.20	3185.40	0.0	0.04
10	38	6/5/2009	27.90	36.10	3189.40	0.0	0.04
10	39	6/5/2009	27.70	36.10	3205.50	0.0	0.04
10	40	6/5/2009	27.90	36.10	3157.00	0.0	0.04
10	41	6/6/2009	28.10	36.10	3109.30	0.6	0.04
10	42	6/6/2009	28.40	36.20	3084.30	0.0	0.05
10	43	6/6/2009	28.60	36.10	3049.20	0.0	0.05
10	44	6/6/2009	28.70	36.10	2985.20	0.0	0.06
10	45	6/6/2009	28.80	36.10	2967.50	0.0	0.05
10	46	6/6/2009	28.80	36.10	2936.60	0.1	0.05
10	47	6/6/2009	28.70	36.20	2915.50	0.0	0.08
10	48	6/6/2009	28.70	36.20	2957.10	0.0	0.09
10	49	6/6/2009	27.90	36.30	2959.80	0.0	0.11

Cruise	Station	Date	SST (°C)	Salinity (psu)	Depth (m)	Sargassum (kg)	Chl a (mg^{-3})
10	50	6/6/2009	28.20	36.20	2969.80	0.0	0.12
10	51	6/6/2009	27.50	36.20	3001.50	0.0	0.12
10	52	6/6/2009	27.80	36.10	3007.20	0.3	0.12
10	53	6/6/2009	27.50	36.30	3013.60	0.6	0.10
10	54	6/6/2009	27.30	36.30	3054.50	0.0	0.10
10	55	6/6/2009	27.30	36.30	3037.80	0.0	0.11
10	56	6/6/2009	27.80	36.40	3012.90	2.8	0.11
10	57	6/6/2009	27.80	36.30	2979.30	0.0	0.11
10	58	6/7/2009	27.10	36.20	2911.50	0.0	0.11
10	59	6/7/2009	27.10	36.20	2897.80	0.2	0.12
10	60	6/7/2009	27.20	36.20	2801.60	0.5	0.12
10	61	6/7/2009	27.30	36.20	2660.90	0.5	0.11
10	62	6/7/2009	27.30	36.20	2537.80	0.5	0.09
10	63	6/7/2009	27.30	36.20	2433.60	0.2	0.09
10	64	6/7/2009	27.40	36.20	2246.20	0.0	0.10
10	65	6/7/2009	27.00	35.70	2082.00	0.0	0.10
10	66	6/7/2009	27.00	35.00	2054.30	0.0	0.12
10	67	6/7/2009	27.20	34.60	1928.20	1.2	0.12
10	68	6/7/2009	27.20	35.90	1906.80	0.0	0.12
10	69	6/7/2009	27.00	35.90	1872.00	0.0	0.11
10	70	6/7/2009	27.40	36.10	1681.40	0.6	0.10
10	71	6/7/2009	27.30	36.10	1771.10	0.5	0.07
10	72	6/8/2009	27.00	36.00	1758.10	0.5	0.07
10	73	6/8/2009	26.90	35.90	1840.10	0.3	0.07
10	74	6/8/2009	26.90	35.90	1763.90	0.3	0.07
10	75	6/8/2009	26.70	35.80	1355.00	0.5	0.06
10	76	6/8/2009	26.80	36.00	1293.40	0.0	0.06
10	77	6/8/2009	26.80	36.00	1190.70	0.2	0.07
10	78	6/8/2009	26.60	35.90	1124.50	0.0	0.07
10	79	6/8/2009	26.80	35.70	1190.30	0.2	0.07
10	80	6/8/2009	27.00	35.80	1146.30	0.0	0.08
10	81	6/8/2009	26.80	35.60	1034.10	0.0	0.08
10	82	6/8/2009	27.00	35.70	1301.80	0.2	0.08
10	83	6/8/2009	27.10	35.80	1012.10	0.2	0.08
10	84	6/8/2009	27.30	35.60	1128.10	0.0	0.09
10	85	6/8/2009	27.40	35.70	1317.80	0.0	0.10
10	86	6/8/2009	27.20	35.30	1136.00	6.7	0.11

Cruise	Station	Date	SST (°C)	Salinity (psu)	Depth (m)	Sargassum (kg)	Chl a (mg^{-3})
10	87	6/9/2009	26.90	35.20	927.10	2.5	0.13
10	88	6/9/2009	27.00	35.10	949.40	0.7	0.14
10	89	6/9/2009	26.50	34.10	1131.10	0.3	0.15
10	90	6/9/2009	27.20	35.20	919.50	0.8	0.11
10	91	6/9/2009	27.10	35.40	826.50	4.5	0.16
10	92	6/9/2009	27.70	36.00	772.30	3.2	0.15
11	1	7/22/2009	29.70	36.90	835.40	0.0	0.09
11	2	7/22/2009	29.80	36.90	739.30	0.0	0.08
11	3	7/22/2009	29.90	36.70	1088.90	0.0	0.08
11	4	7/22/2009	29.90	36.70	1057.60	0.0	0.07
11	5	7/22/2009	30.10	36.80	1309.60	0.0	0.07
11	6	7/22/2009	30.30	36.80	1376.70	0.0	0.07
11	7	7/22/2009	30.60	36.90	1498.20	0.1	0.07
11	8	7/22/2009	30.90	36.80	1869.70	0.2	0.07
11	9	7/22/2009	30.80	36.70	1938.30	0.2	0.07
11	10	7/22/2009	31.50	36.90	1801.10	0.1	0.07
11	11	7/22/2009	31.10	36.80	1826.60	0.0	0.07
11	12	7/22/2009	31.70	36.80	1876.60	0.8	0.09
11	13	7/22/2009	31.10	31.60	2362.80	0.0	0.32
11	14	7/23/2009	29.80	30.70	2138.10	0.0	0.33
11	15	7/23/2009	29.90	32.80	2472.00	9.5	0.34
11	16	7/23/2009	30.30	30.90	2293.80	0.3	0.45
11	17	7/23/2009	30.00	30.90	2165.10	0.0	0.42
11	18	7/23/2009	30.40	31.10	2036.50	1.5	0.43
11	19	7/23/2009	30.70	30.90	2131.30	0.2	0.46
11	20	7/23/2009	31.20	30.50	2200.90	0.5	0.45
11	21	7/23/2009	31.20	31.50	2766.70	0.0	0.44
11	22	7/23/2009	31.70	30.00	2731.20	0.0	0.50
11	23	7/23/2009	33.50	30.10	2881.30	0.0	0.49
11	24	7/23/2009	32.80	32.00	2946.10	0.0	0.50
11	25	7/23/2009	32.90	32.20	2957.30	0.5	0.41
11	26	7/23/2009	32.00	31.90	2923.80	0.2	0.40
11	27	7/23/2009	32.30	32.30	2954.20	0.0	0.36
11	28	7/24/2009	30.50	33.00	2916.20	0.1	0.37
11	29	7/24/2009	30.20	31.80	2930.60	0.0	0.58
11	30	7/24/2009	29.60	27.50	2914.70	0.0	0.81

Cruise	Station	Date	SST (°C)	Salinity (psu)	Depth (m)	Sargassum (kg)	Chl a (mg^{-3})
11	31	7/24/2009	30.40	27.60	2866.50	0.0	0.92
11	32	7/24/2009	30.70	29.30	2817.80	2.9	0.88
11	33	7/24/2009	31.40	27.20	2800.70	0.0	0.78
11	34	7/24/2009	32.50	28.30	2731.00	0.0	0.66
11	35	7/24/2009	32.50	27.80	2618.00	0.0	0.36
11	36	7/24/2009	33.40	28.90	2563.30	0.0	0.27
11	37	7/24/2009	33.10	28.60	2561.30	0.0	0.13
11	38	7/24/2009	32.40	29.10	2589.30	0.0	0.12
11	39	7/24/2009	32.50	32.20	2630.90	0.0	0.09
11	40	7/24/2009	31.50	36.20	2691.80	4.8	0.09
11	41	7/24/2009	31.60	36.30	2724.50	0.0	0.06
11	42	7/24/2009	31.10	36.30	2771.30	0.0	0.06
11	43	7/25/2009	30.40	36.10	2817.30	0.0	0.06
11	44	7/25/2009	30.50	36.20	2879.10	0.0	0.07
11	45	7/25/2009	30.50	36.20	2917.30	0.0	0.06
11	46	7/25/2009	30.60	36.10	2924.80	0.0	0.06
11	47	7/25/2009	31.00	36.20	2968.90	0.0	0.06
11	48	7/25/2009	31.50	35.30	2989.50	0.9	0.06
11	49	7/25/2009	31.50	36.20	2985.20	0.0	0.06
11	50	7/25/2009	30.90	36.20	2994.60	0.0	0.06
11	51	7/25/2009	30.90	36.20	3048.10	0.0	0.05
11	52	7/25/2009	30.80	35.60	3048.80	0.0	0.06
11	53	7/25/2009	31.30	36.10	3051.70	0.2	0.06
11	54	7/25/2009	30.70	36.10	3067.70	1.5	0.08
11	55	7/25/2009	30.70	34.10	3084.80	0.0	0.39
11	56	7/25/2009	30.70	31.80	3141.80	0.0	0.47
11	57	7/26/2009	30.70	35.30	3088.30	0.5	0.39
11	58	7/26/2009	30.40	33.70	3054.10	0.0	0.45
11	59	7/26/2009	30.90	34.00	3034.30	0.0	0.63
11	60	7/26/2009	30.90	33.80	3018.60	0.0	0.49
11	61	7/26/2009	31.10	31.25	3009.30	0.0	0.33
11	62	7/26/2009	31.10	28.70	2977.10	0.0	0.41
11	63	7/26/2009	30.50	29.50	2892.40	0.0	0.44
11	64	7/26/2009	30.80	29.10	2818.90	0.0	0.48
11	65	7/26/2009	31.10	28.70	2842.80	0.0	0.62
11	66	7/26/2009	30.90	30.70	2830.70	0.0	0.61
11	67	7/26/2009	30.70	28.00	2816.80	0.0	0.09

Cruise	Station	Date	SST (°C)	Salinity (psu)	Depth (m)	Sargassum (kg)	Chl a (mg^{-3})
11	74	7/27/2009	29.10	29.90	2279.40	0.0	1.15
11	75	7/27/2009	29.10	31.70	2230.80	0.0	3.25
11	76	7/27/2009	29.20	31.20	2306.40	0.0	0.68
11	77	7/27/2009	29.20	31.00	2395.20	0.0	0.18
11	78	7/27/2009	29.50	31.50	2161.90	0.0	0.15
11	79	7/27/2009	29.60	29.90	2169.60	0.0	0.17
11	80	7/27/2009	30.30	30.00	1992.60	0.0	0.24
11	81	7/27/2009	30.60	29.10	1922.00	0.0	0.51
11	82	7/27/2009	30.80	29.40	1803.10	0.0	0.92
11	83	7/27/2009	30.80	29.50	1889.70	0.0	1.24
11	84	7/27/2009	30.60	29.40	1917.60	0.0	1.35
11	85	7/27/2009	30.50	27.60	1994.30	0.0	1.21
11	86	7/27/2009	30.70	27.30	1917.70	0.0	1.12
11	87	7/27/2009	30.50	27.20	1498.10	0.0	1.14
11	88	7/28/2009	30.30	27.60	1398.10	0.0	1.05
11	89	7/28/2009	30.10	28.30	1220.20	0.0	1.06
11	90	7/28/2009	30.40	31.80	1325.80	0.0	0.93
11	91	7/28/2009	30.10	31.80	1288.10	2.5	0.64
11	92	7/28/2009	30.30	31.50	1390.20	0.1	0.55
11	93	7/28/2009	30.10	32.30	1304.10	0.0	0.56
11	94	7/28/2009	30.20	31.30	1464.40	0.0	0.64
11	95	7/28/2009	30.10	31.10	1622.10	0.0	0.63
11	96	7/28/2009	30.20	34.70	1876.60	0.0	0.28
11	97	7/28/2009	30.30	35.00	1745.80	0.0	0.33
11	98	7/28/2009	30.20	36.20	2205.30	0.0	0.45
11	99	7/28/2009	30.20	37.30	1736.60	0.0	0.14
11	100	7/28/2009	30.10	37.20	1692.70	0.0	0.06
11	101	7/29/2009	30.10	37.30	1571.80	0.0	0.18
11	102	7/29/2009	30.10	37.30	1521.30	0.0	0.17
11	103	7/29/2009	30.20	37.30	1460.10	0.1	0.14
11	104	7/29/2009	30.30	37.30	1913.30	0.1	0.11
11	105	7/29/2009	30.30	37.30	1525.50	0.0	0.11
11	106	7/29/2009	30.30	37.30	1562.50	0.5	0.09
11	107	7/29/2009	30.30	37.30	1365.40	1.2	0.07
12	1	6/15/2010	29.05	36.15	162.00	0.9	0.13
12	2	6/15/2010	29.35	36.53	289.50	0.1	0.12

Cruise	Station	Date	SST (°C)	Salinity (psu)	Depth (m)	Sargassum (kg)	Chl a (mg^{-3})
12	3	6/15/2010	29.26	36.60	230.00	0.0	0.14
12	4	6/15/2010	29.32	34.68	256.90	0.0	0.22
12	5	6/15/2010	29.80	35.59	345.60	0.1	0.22
12	6	6/15/2010	29.50	35.90	451.30	0.0	0.22
12	7	6/15/2010	30.36	35.43	509.70	0.0	0.23
12	8	6/15/2010	30.28	34.54	587.70	0.0	0.33
12	9	6/15/2010	30.71	33.54	600.60	0.0	0.54
12	10	6/15/2010	30.88	32.59	783.40	0.0	1.39
12	11	6/15/2010	31.36	30.09	748.70	0.0	2.51
12	12	6/16/2010	30.79	29.54	950.00	0.0	3.43
12	13	6/16/2010	30.87	29.96	1232.00	0.0	3.72
12	14	6/16/2010	30.42	30.31	1333.50	0.0	3.85
12	15	6/16/2010	30.46	32.63	1254.80	0.0	1.53
12	16	6/16/2010	31.25	33.57	1305.00	0.0	2.47
12	17	6/16/2010	31.41	34.50	1570.70	0.0	0.75
12	18	6/16/2010	32.02	34.22	1897.60	0.0	0.15
12	19	6/16/2010	31.91	34.29	1896.00	0.1	0.15
12	20	6/16/2010	31.98	34.34	2163.60	0.1	0.20
12	21	6/16/2010	32.27	35.95	2150.70	0.0	0.13
12	22	6/16/2010	32.40	35.80	2304.90	0.7	0.11
12	23	6/16/2010	31.86	36.29	2427.10	0.0	0.10
12	24	6/16/2010	32.12	36.40	2417.70	1.7	0.09
12	25	6/17/2010	29.82	37.55	2749.20	0.3	0.09
12	26	6/17/2010	29.67	37.20	2725.00	0.6	0.08
12	27	6/17/2010	29.81	37.67	2675.20	0.7	0.10
12	28	6/17/2010	30.01	37.86	2634.90	0.2	0.08
12	29	6/17/2010	30.25	36.42	2517.00	0.3	0.07
12	30	6/17/2010	30.73	34.27	2357.20	1.6	0.07
12	31	6/17/2010	30.66	33.94	2246.60	0.0	0.08
12	32	6/17/2010	30.92	36.80	2183.20	0.0	0.08
12	33	6/17/2010	30.85	37.33	2371.80	0.0	0.08
12	34	6/17/2010	30.67	37.36	2433.10	0.1	0.10
12	35	6/17/2010	30.43	37.46	2499.30	0.1	0.09
12	36	6/17/2010	30.79	37.40	2548.90	0.0	0.08
12	37	6/18/2010	29.93	37.11	2477.40	1.4	0.07
12	38	6/18/2010	29.71	36.96	2372.30	0.2	0.07
12	39	6/18/2010	29.65	37.28	2413.10	0.3	0.08

Cruise	Station	Date	SST (°C)	Salinity (psu)	Depth (m)	Sargassum (kg)	Chl a (mg^{-3})
12	40	6/18/2010	30.31	37.31	2362.10	0.9	0.08
12	41	6/18/2010	30.34	37.18	2425.70	0.2	0.09
12	42	6/18/2010	30.56	37.16	2353.80	0.0	0.08
12	43	6/18/2010	31.23	37.22	2015.80	0.0	0.08
12	44	6/18/2010	30.96	37.19	1867.80	0.3	0.08
12	45	6/18/2010	30.89	37.49	1557.70	0.0	0.09
12	46	6/18/2010	30.78	37.46	1624.60	0.2	0.06
12	47	6/18/2010	30.70	37.47	1706.30	0.2	0.06
12	48	6/18/2010	30.82	37.55	1692.40	0.2	0.07
13	1	7/27/2010	29.53	35.12	162.00	0.0	0.18
13	2	7/27/2010	29.56	34.80	289.50	0.0	0.14
13	3	7/27/2010	29.95	34.98	230.00	0.0	0.17
13	4	7/27/2010	29.94	34.95	256.90	1.0	0.19
13	5	7/27/2010	30.12	34.35	345.60	0.0	0.20
13	6	7/27/2010	29.94	34.62	451.30	0.0	0.22
13	7	7/27/2010	30.20	34.84	509.70	0.0	0.22
13	8	7/27/2010	30.03	35.56	587.70	0.0	0.16
13	9	7/27/2010	30.30	34.67	600.60	0.0	0.14
13	10	7/27/2010	30.11	35.31	783.40	0.0	0.13
13	11	7/27/2010	29.95	35.40	748.70	0.0	0.14
13	12	7/27/2010	29.74	35.40	950.00	0.0	0.16
13	13	7/28/2010	29.85	35.65	1232.00	0.0	0.14
13	14	7/28/2010	30.08	35.93	1333.50	0.0	0.14
13	15	7/28/2010	30.16	36.12	1254.80	0.0	0.11
13	16	7/28/2010	30.09	36.21	1305.00	1.4	0.10
13	17	7/28/2010	30.17	35.97	1570.70	0.0	0.09
13	18	7/28/2010	30.33	36.09	1897.60	0.0	0.09
13	19	7/28/2010	30.38	36.18	1896.00	0.0	0.10
13	20	7/28/2010	30.49	36.27	2163.60	0.0	0.10
13	21	7/28/2010	30.45	36.07	2150.70	0.0	0.09
13	22	7/28/2010	30.41	36.24	2304.90	0.0	0.09
13	23	7/28/2010	30.23	36.28	2427.10	0.0	0.08
13	24	7/28/2010	30.18	36.07	2417.70	0.0	0.09
13	25	7/29/2010	29.56	36.19	2749.20	1.1	0.06
13	26	7/29/2010	29.60	36.12	2725.00	0.0	0.03
13	27	7/29/2010	29.93	36.41	2675.20	2.0	0.03

Cruise	Station	Date	SST (°C)	Salinity (psu)	Depth (m)	Sargassum (kg)	Chl a (mg^{-3})
13	28	7/29/2010	29.91		2634.90	1.9	0.04
13	29	7/29/2010	29.80		2517.00	1.5	0.08
13	30	7/29/2010	29.83		2357.20	0.7	0.08
13	31	7/29/2010	30.03		2246.60	0.0	0.07
13	32	7/29/2010	30.09	38.06	2183.20	0.0	0.08
13	33	7/29/2010	30.12	37.99	2371.80	0.0	0.09
13	34	7/29/2010	30.06	37.19	2433.10	1.1	0.10
13	35	7/29/2010	30.06	37.52	2499.30	3.3	0.10
13	36	7/29/2010	30.07	37.77	2548.90	0.8	0.11
13	37	7/29/2010	30.00	37.25	2477.40	0.3	0.11
13	38	7/30/2010	29.45	37.56	2372.30	0.3	0.10
13	39	7/30/2010	29.55	38.08	2413.10	0.0	0.08
13	40	7/30/2010	29.30	37.87	2362.10	2.8	0.09
13	41	7/30/2010	28.83	37.10	2425.70	4.4	0.07
13	42	7/30/2010	29.11	38.15	2353.80	0.0	0.05
13	43	7/30/2010	28.85	37.61	2015.80	0.7	0.06
13	44	7/30/2010	28.72	37.67	1867.80	0.0	0.06
13	45	7/30/2010	28.98	37.86	1557.70	0.0	0.06
13	46	7/30/2010	29.13	37.92	1624.60	0.0	0.06
13	47	7/30/2010	29.29	37.75	1706.30	0.0	0.06
13	48	7/30/2010	29.15	37.59	1692.40	0.0	0.06
14	1	6/14/2011	29.64		1692.40	5.4	0.05
14	2	6/14/2011	30.53	38.11	1701.10	0.0	0.05
14	3	6/14/2011	31.22	38.05	1628.00	0.0	0.05
14	4	6/14/2011	31.71	38.27	1557.70	5.0	0.05
14	5	6/14/2011	30.59	38.33	1958.80	13.6	0.05
14	6	6/14/2011	31.92	38.60	2016.90	2.5	0.06
14	7	6/14/2011	30.67	38.16	2353.80	2.5	0.06
14	8	6/15/2011	29.09	38.23	2423.40	0.0	0.05
14	9	6/15/2011	29	38.28	2360.90	0.5	0.05
14	10	6/15/2011	29.11	38.26	2413.10	9.1	0.05
14	11	6/15/2011	28.92	38.29	2366.10	0.0	0.05
14	12	6/15/2011	29.12	38.00	2476.00	0.0	0.05
14	13	6/15/2011	29.35	38.22	2548.90	0.0	0.05
14	14	6/15/2011	29.79	38.30	2501.10	0.0	0.05
14	15	6/15/2011	30.21	38.24	2433.90	0.0	0.05

Cruise	Station	Date	SST (°C)	Salinity (psu)	Depth (m)	Sargassum (kg)	Chl a (mg^{-3})
14	16	6/15/2011	31.79	38.42	2371.80	0.0	0.05
14	17	6/15/2011	31.63	38.45	2183.40	0.0	0.05
14	18	6/15/2011	32.35	37.80	2244.30	0.0	0.05
14	19	6/15/2011	31.48	38.33	2357.20	0.0	0.05
14	20	6/15/2011	31.71	38.45	2520.90	0.9	0.05
14	21	6/15/2011	31.32	38.10	2633.50	0.0	0.08
14	22	6/16/2011	29.27	38.21	2675.20	2.4	0.09
14	23	6/16/2011	28.97	38.12	2726.80	0.0	0.09
14	24	6/16/2011	29.09	38.33	2749.20	3.6	0.08
14	25	6/16/2011	30.39	37.84	2417.70	0.5	0.16
14	26	6/16/2011	30.62	37.70	2426.40	1.8	0.17
14	27	6/16/2011	30.89	36.39	2304.90	0.0	0.20
14	28	6/16/2011	30.68	36.38	2149.00	1.4	0.24
14	29	6/16/2011	30.25	36.16	2169.90	0.9	0.23
14	30	6/16/2011	30.56	28.03	1896.00	0.0	0.23
14	31	6/17/2011	29.89	17.87	1893.40	0.0	0.22
14	32	6/17/2011	29.71	24.04	1565.30	0.0	0.17
14	33	6/17/2011	29.80	19.45	1305.00	0.0	0.15
14	34	6/17/2011	30.27	20.51	1259.20	0.0	0.14
14	35	6/17/2011	30.47	34.50	1337.50	2.5	0.23
14	36	6/17/2011	30.42	26.28	1232.00	0.0	2.03
14	37	6/17/2011	30.36	36.30	957.00	0.9	3.77
14	38	6/17/2011	30.29	36.40	746.50	0.0	2.72
14	39	6/17/2011	29.88	37.52	783.40	3.4	1.03
14	40	6/17/2011	29.70	38.24	594.00	1.6	0.23
14	41	6/17/2011	29.51	37.70	590.60	0.0	0.16
14	42	6/17/2011	29.46	37.80	509.70	0.0	0.19
14	43	6/18/2011	29.04	38.00	445.00	0.0	0.13
14	44	6/18/2011	28.80	38.03	346.20	0.5	0.13
14	45	6/18/2011	29.02	38.15	256.90	0.0	0.11
14	46	6/18/2011	29.09	38.15	229.00	5.4	0.11
14	47	6/18/2011	29.12	37.74	296.50	3.2	0.12
14	48	6/18/2011	29.14	37.89	162.00	0.0	0.12
15	1	7/17/2011	29.4	38.05	1692.40	0.0	0.09
15	2	7/17/2011	29.33	38.07	1701.10	0.0	0.10
15	3	7/17/2011	29.45	38.12	1628.00	0.7	0.09

Cruise	Station	Date	SST (°C)	Salinity (psu)	Depth (m)	Sargassum (kg)	Chl a (mg^{-3})
15	4	7/17/2011	30.26	38.63	1557.70	2.0	0.08
15	5	7/17/2011	29.95	37.72	1958.80	0.0	0.09
15	6	7/17/2011	30.38	37.73	2016.90	0.0	0.08
15	7	7/17/2011	30.95	38.04	2353.80	0.7	0.09
15	8	7/17/2011	30.85	38.36	2423.40	0.0	0.10
15	9	7/17/2011	30.69	37	2360.90	0.0	0.08
15	10	7/17/2011	30.45	30.8	2413.10	0.0	0.08
15	11	7/17/2011	30.52	37	2366.10	0.9	0.07
15	12	7/17/2011	30.27	36.09	2476.00	1.6	0.04
15	13	7/18/2011	29.79	37.38	2548.90	0.0	0.03
15	14	7/18/2011	29.78	37	2501.10	0.0	0.03
15	15	7/18/2011	29.91	37.66	2433.90	0.7	0.03
15	16	7/18/2011	29.88	39.34	2371.80	0.0	0.03
15	17	7/18/2011	29.97	39.3	2183.40	0.0	0.02
15	18	7/18/2011	29.99	39.12	2244.30	0.0	0.02
15	19	7/18/2011	30.22	39	2357.20	0.0	0.03
15	20	7/18/2011	30.24	28.22	2520.90	0.0	0.06
15	21	7/18/2011	30.41	38	2633.50	0.0	0.07
15	22	7/18/2011	31.2	38.16	2675.20	0.0	0.06
15	23	7/18/2011	31.03	38.16	2726.80	0.7	0.07
15	24	7/18/2011	31.54	38.34	2749.20	0.0	0.07
15	25	7/19/2011	29.2	37.87	2417.70	0.0	0.11
15	26	7/19/2011	29.55	37.76	2426.40	0.0	0.09
15	27	7/19/2011	30.3	37.56	2304.90	0.0	0.06
15	28	7/19/2011	30.79	37.89	2149.00	0.0	0.07
15	29	7/19/2011	30.08	37.9	2169.90	0.0	0.08
15	30	7/19/2011	30.8	37.42	1896.00	2.5	0.06
15	31	7/19/2011	29.31	37.29	1893.40	0.0	0.04
15	32	7/19/2011	29.66	37.86	1565.30	1.1	0.05
15	33	7/19/2011	30.1	37.92	1305.00	0.0	0.06
15	34	7/19/2011	30.09	38	1259.20	0.0	0.06
15	35	7/19/2011	30.01	37.78	1337.50	0.0	0.07
15	36	7/20/2011	29.55	38.54	1232.00	0.0	0.08
15	37	7/20/2011	30.35	38.25	957.00	0.0	0.08
15	38	7/20/2011	29.78	38.19	746.50	0.0	0.08
15	39	7/20/2011	30.84	37.94	783.40	0.0	0.09
15	40	7/20/2011	31.67	37.78	594.00	0.0	0.12

Cruise	Station	Date	SST (°C)	Salinity (psu)	Depth (m)	Sargassum (kg)	Chl a (mg^{-3})
15	41	7/20/2011	30.49	37.79	590.60	0.0	0.30
15	42	7/20/2011	32.23	25.46	509.70	0.0	0.65
15	43	7/20/2011	32.47	26.98	445.00	0.0	0.61
15	44	7/20/2011	32.42	27.53	346.20	0.0	0.48
15	45	7/20/2011	31.83	27.71	256.90	0.0	0.52
15	46	7/20/2011	31.63	28.23	229.00	0.0	1.17
15	47	7/20/2011	31.62	28.32	296.50	0.0	1.19
15	48	7/20/2011	31.6	29.71	162.00	0.0	1.21