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Nova Southeastern University
Halmos College of Natural Sciences
and Oceanography

Geographic and Depth Distributions of Decapod Shrimps (Caridea: Oplophoridae) from the northeastern Gulf of Mexico with notes on ontogeny and reproductive seasonality

By

Eric Anthony Burdett

Submitted to the Faculty of
Nova Southeastern University
Halmos College of Natural Sciences and Oceanography
in partial fulfillment of the requirements for
the degree of Masters of Science with a specialty in:

Marine Biology

Nova Southeastern University

April, 2016

Thesis of

Eric Anthony Burdett

Submitted in Partial Fulfillment of the Requirements for the Degree of

Masters of Science:

Marine Biology

Nova Southeastern University
Halmos College of Natural Sciences and Oceanography

April, 2016

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Charles Messing, Ph.D.

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ABSTRACT

Geographic and Depth Distributions of Decapod Shrimps (Caridea: Oplophoridae) from the northeastern Gulf of Mexico with notes on ontogeny and reproductive seasonality

This thesis presents the first description of the geographic and depth distributions of pelagic decapod shrimps in the area located around the Deepwater Horizon oil spill, based on the NOAA (National Oceanic and Atmospheric Administration) NRDA (National Resource Damage Assessment) trawl samples collected from April – June, 2011. This information is important in ecosystem models investigating trophic effects of the spill because pelagic decapod shrimp are consumed by a variety of organisms occupying higher trophic levels. One of the most abundant and diverse groups of decapods is the Family Oplophoridae. Their roles in pelagic food webs in the Gulf of Mexico (GOM) and other deep-sea ecosystems makes them ideal candidates for study; however, only a limited amount of research has been conducted on their distribution and reproductive biology. In the northeastern GOM, all previous studies have been conducted at Standard Station in the eastern Gulf (27°N, 86°W) (Hopkins and Lancraft, 1984; Hopkins *et al*., 1989; Hopkins and Gartner, 1992; Hopkins *et al*., 1994). The current study is unique because 1) it provides data from regions of the Gulf where oplophorids have never been studied, 2) allows for comparisons of distributions and abundances of oplophorid species in both the mesopelagic and bathypelagic zones by using a continuous data set, and 3) compares assemblages from two distinct bathymetric environments in the northeastern GOM: continental slope (200-1000 m bottom depth) and offshore (>1000 m). As the study site also encompasses the region most strongly impacted by the Deepwater Horizon oil spill, these data represent the first quantification of any component of the decapod crustacean assemblage in this location after the oil spill, and will be used for comparison with data obtained during future DEEPEND Consortium (Deep Pelagic Nekton Dynamics of the Gulf of Mexico) cruises to monitor changes, or lack thereof, in the assemblage after exposure to Deepwater Horizon oil and dispersants in the water column.

Keywords: Oplophoridae, Decapod Crustaceans, Deep Sea, Ontogenetic Patterns, Vertical Migration, Micronekton

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INTRODUCTION

The deep sea is the largest, yet least explored, environment in the world. The vast realm of the water column includes the epipelagic (0-200 m), mesopelagic (200-1000 m) bathypelagic (1000-4000 m), abyssopelagic (4000-6000 m), and hadopelagic (>6000 m) zones, and each has its own respective ecosystem and trophic structure. The Gulf of Mexico (GOM) is home to epipelagic, mesopelagic, and bathypelagic environments and has a high faunal diversity, including well over 100 species of decapod shrimp (Felder *et al*., 2009).

One of the most abundant and diverse groups of micronektonic decapod crustaceans is the Family Oplophoridae which consists of 10 genera and over 70 recognized species (Wong *et al*., 2015). The Family Oplophoridae is cosmopolitan, with species found in mesopelagic environments in every ocean; only a few benthic species are known (Fasham and Foxton, 1979; Kensley; 1981; Krygier and Pearcy, 1981; Chace, 1986; Wasmer, 1986; Iwasaki and Nemoto, 1987; Kensley *et al*., 1987; Krygier and Wassmer, 1988; Hendrickx and Estrada-Navarrete, 1989; Wasmer, 1993). Many of the pelagic species undergo diel vertical migrations (Foxton, 1972; Chace, 1986).

Pelagic decapod shrimp species have significant roles and contributions to the food webs and biomass of micronekton in all deep-sea communities (Pearcy and Forss, 1966; Hopkins *et al*., 1994). Micronekton is a collective term given to pelagic animals with body sizes ranging from 2-20 cm, and that have the ability to actively swim (Sutton, 2013). Oplophorids are primarily planktivores that feed on chaetognaths, juvenile fishes, and other smaller crustaceans in the water column (Foxton and Roe, 1974; Omori, 1974; Hopkins, 1982; Roe, 1984), while they in turn are preyed upon by cephalopods, cetaceans, and many species of pelagic and commercially important fishes (Borodulina, 1972; Hopkins *et al*., 1994).

Past studies on oplophorids in the northeastern GOM have been limited in location and depth. All previous studies have been conducted either solely in the bathypelagic zone (1000 to 4000 m depth) (Burghart *et al*., 2007) or in a combination of the epipelagic (0-200 m) and mesopelagic (200 m to 1000 m) zones (Hopkins *et al*., 1989; Hopkins *et al*., 1994). This study is unique because it 1) covers a much larger

geographic location in the northeastern GOM, and 2) it compares distributions and abundance of oplophorid species in the epipelagic, mesopelagic, and bathypelagic zones using one continuous data set.

In addition to the major depth zones, the deep sea along continental margins has its own distinct features. Boundary zones at the slope along continental margins are found in oceanic ecosystems worldwide; however, very few studies on faunal composition, species diversity, abundance, and biomass have been conducted. These studies vary on local scales and must be individually tailored based on the physical and geographical limitations of each location of interest. These communities offer unique opportunities to study interactions between the neritic and oceanic ecosystems. Micronektonic composition studies in boundary zones have focused on fish species with limited inclusion of cephalopods and crustaceans (Reid *et al*., 1991; Sutton, 2013; Feagans-Bartow and Sutton, 2014). A better understanding of oplophorid abundance and biomass patterns will contribute vital information needed to understand the community structure, trophic interactions, and relationships between these boundary ecosystems and adjacent oceanic systems.

The Deepwater Horizon oil rig exploded and sank on April 20, 2010. Over the next 87 days, 3.19 million barrels of oil spilled into the northeastern GOM until the well was finally capped on July 15, 2010, with the deepest hydrocarbon plume occurring at around 1100 m (Reddy *et al*., 2011; U.S. District Court, 2015). A spill of this magnitude has potentially significant effects on the deep-sea ecosystem. The data presented here, collected one year after the spill, represent the first quantification of oplophorids in this region. Without a pre-spill baseline, these data can serve as an "impacted" dataset against which to monitor recovery, or lack thereof, of the oplophorid assemblage after the Deepwater Horizon event to compare with data from future studies in the northeastern GOM.

MATERIALS AND METHODS

Sample collection and processing

Samples were collected from April 20 to June 29, 2011 on the M/V *Meg Skansi* using a 10-m^2 mouth area, six-net MOCNESS (Multiple Opening and Closing Net and Environmental Sensing System) (Wiebe *et al.*, 1976) with 3-mm mesh. Temperature and salinity data were collected at each station using a separate CTD cast, as the sensors on the MOCNESS were not calibrated for these measurements. The sampling protocol of the MOCNESS deployment was standardized by a series of alphanumeric depth zones down to 1500 m at most locations (Table 1). In addition to the oceanic depth zones, sampling depths were chosen based on the following additional rationales: net 5 fished a depth below where a subsurface hydrocarbon plume was detected during the initial spill, net 2 fished through this hydrocarbon plume (Reddy *et al*., 2011), net 3 fished where vertical migrating species are known to reside during the day, net 4 fished where vertical migrators are known to pass through during their diel vertical migrations, and net 5 fished the epipelagic zone where strong vertical migrators reside during the night. It is important to note that minor variations were made to this scheme at stations on or adjacent to the 1000-m isobaths (Table 1). The MOCNESS was deployed twice at each station: one day trawl and one night trawl.

Table 1. Depth codes used for *Meg Skansi* 7 data collection in the northeastern Gulf of Mexico

Depth Codes			
1	1500-1200 m	1a	1500-1000 m
2	1200-1000 m	1b	1300-1200 m
3	1000-600 m	3a	1000-0 m
4	600-200 m	3b	800-600 m
5	200-0 m	3c	900-800 m
		3d	1000-800 m
		4a	600-400 m
		4b	400-200 m
		4c	600-0 m
		5a	200-100 m

Sampling stations were selected based on a subset of the Southeast Area Monitoring and Assessment Program (SEAMAP) sampling grid (Eldridge, 1988), which was bound by the 1000-m isobath to the north and the 27°N latitudinal line to the south. Within this area, stations occurred along every whole- and half-degree latitude-longitude crossing. In order to determine if differences existed between oplophorid assemblages along the slope and offshore in the GOM, stations were labeled as either slope or offshore before analyses took place. Slope stations were those that were on or landward of the 1000-m isobath, whereas offshore stations were those on the open ocean side of the 1000-m isobath (Figure 1). Standard Station (27°N, 86°W), a site in the northeastern GOM at which oplophorids have been extensively researched, coincides with the SE-5 sampling station in the current study. The Deepwater Horizon site is also located on the slope (Figure 1)

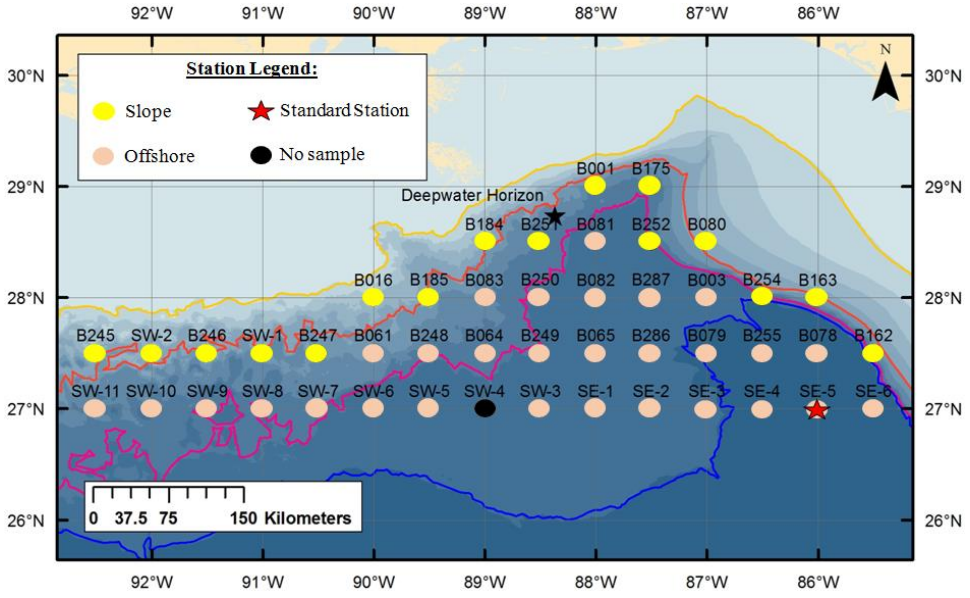

Figure 1. Map of 10 m^2 MOCNESS sampling stations during the Spring 2011 M/V *Meg Skansi* cruise with slope and offshore station distinctions. Standard Station is indicated with an orange star. The Deepwater Horizon oil rig is indicated by a black star.

The faunal composition and analyses presented here reflect the findings of the MS7 leg of a three-leg series. During the MS7 campaign, the MOCNESS system retrieved 516 trawl samples. The net 0 "oblique" samples and samples from which reliable flow data could not be calculated were omitted, leaving 340 discrete-depth

samples from 86 deployments at 45 stations for inclusion in quantitative analyses (Appendix I).

All samples collected during the MS7 survey were stored in a 10% formalin:seawater solution and archived at Alpha Analytical (Cambridge, MA), and then shipped to the Oceanic Ecology Lab at Nova Southeastern University for processing. Bulk samples were rough sorted into major taxonomic groups including crustaceans, fishes, cephalopods, and gelatinous zooplankton. Crustacean samples were then sent to the Deep Sea Biology lab at NSU, where they were identified to species level unless they were too damaged.

Specimens of Oplophoridae were identified using taxonomic keys and descriptions from Chace (1940), Crosnier and Forest (1973), Abele and Kim (1986), Holthuis (1993), and Felder *et al*. (2009). Chan *et al*.'s (2010) analysis of mitochondrial and rRNA genomes, suggested that Oplophoridae should be split into two separate families, with the genera *Janicella*, *Oplophorus*, and *Systellaspis* remaining in Oplophoridae, and the rest of the genera placed in a new family Acanthephyridae. However, recent evidence from Wong *et al*. (2015), based on a more comprehensive analysis of seven different genes from 30 oplophorid species, suggested that Oplophoridae should be treated as monophyletic as in the above-mentioned taxonomic keys. For this study, all genera are treated as oplophorids, consistent with the most up-to-date research and prior literature and taxonomic keys. After identification, carapace lengths of species used for ontogenetic analyses were measured (to the nearest millimeter) using digital calipers (CO030150 electronic digital caliper, Marathon Management). Wet weights were recorded to the nearest 0.01 g (P-114 balance, Denver Instruments) for each species in every sample. In addition to Oplophoridae, all families of micronektonic crustaceans were identified and weighed, allowing for an inter-familial comparison of biomass.

Abundance, Biomass, and Diversity Index Calculations

To compare assemblages of oplophorids found in slope stations with those found in offshore stations, raw counts were converted to standardized abundances (number of shrimp m^{-3}) by dividing raw counts by volume-filtered data from the MOCNESS.

Biomass totals for each species were calculated in the same manner, with preserved wet weights being standardized to grams of shrimp m^{-3} of water. Normality was tested for by using the Shapiro-Wilk test, and based on the non-normal distribution of data, Mann-Whitney *U* tests were applied to determine if slope and offshore assemblages differed significantly.

A scatterplot of the abundances of oplophorid species, with respect to slope and offshore locations, was generated to examine the monotonicity of the species assemblage in both locations. Monotonicity describes of the relationship of two variables as either positive (as the value of one variable increases, so does the other), negative (as the value of one variable increases, the other decreases), or non-monotonic (no relationship between the two variables). Oplophorid total abundance was also calculated for each station to determine how abundances varied from station to station with respect to slope and offshore locations. Intrastation variances were compared using a 1-way ANOVA test.

Species richness, diversity, and evenness measurements were calculated for slope and offshore oplophorid assemblages with respect to solar cycle and depth range. Species richness (*S*) is defined as the number of species in a given area. Species diversity was measured by using the Shannon Diversity index equation:

$$\mathbf{H' = -\Sigma p_i ln(p_i)}$$

where p_i represents the proportion of the population arising from the *i*th species. Evenness, or distribution of individuals among species in the assemblage, was calculated using the Pielou's Evenness Index:

$$\mathbf{J' = H'/H'_{max} = H'/logs}$$

where H'_{max} is the value when all species are equally abundant. Once indices were calculated, independent sample t-tests were then performed on Shannon Diversity Index values, as per Jayaraman (2000), with respect to solar cycle, depth range, and region.

Vertical Distribution

To determine the vertical distribution of each oplophorid species, raw counts were converted to standardized abundances. The abundance of any given species in a specific depth range was calculated as the total number collected divided by the total flow data for all samples in that range at that location. Day and night abundances were then converted

to percentages. This allowed calculation of the percent of the total day or night assemblage for a given species in each depth range. These percentages were used to construct double-sided histograms that illustrate the vertical distribution of each species. Species were then categorized based on the percentage of their assemblage that migrated. Species were considered to be strong vertical migrators if more than 50% of the assemblage migrated, weak migrators if 15-50% of the assemblage migrated, or non-migrators if < 15% of the assemblage migrated.

Gravid Female and Ontogenetic Data

Gravid females were noted and abundances for each species were calculated with respect to depth range and month of capture. The percent of the total catch for each species composed of gravid females was also calculated.

The five species with the highest abundance of gravid females were used for analysis of ontogenetic trends**.** The carapace length of the smallest gravid female was considered the minimum mature size; anything smaller was considered immature, per Hopkins *et al*. (1989). Abundances of mature and immature individuals were calculated for each species, as well as a ratio of mature to immature (M:I) individuals, with respect to depth range and time of day. Ratios were then compared among the depth ranges in which ≥ 90% of the individuals for a given species was found.

RESULTS

Hydrography

Sea surface temperatures ranged from as low as 24 ºC from stations sampled in May to slightly over 29 ºC at stations sampled in June. The thermocline ranged from 25 to 600 m across all stations. Temperatures at the deepest sampling depth (1500 m) at the offshore stations averaged 4.3 ± 0.02 ºC. Surface salinities remained fairly constant at 36.5 ± 0.4 psu in both offshore and slope stations through all three months. The halocline was typically located between 125 and 500 m, with minor variations from station to station. At the deepest sample depths, salinity averaged 34.9 ± 0.01 psu. Since the values and trends of temperature and salinity data did not vary within a given month of the

study, only representative T/S profiles for slope and offshore stations by month are presented in Figure 2, 3, and 4.

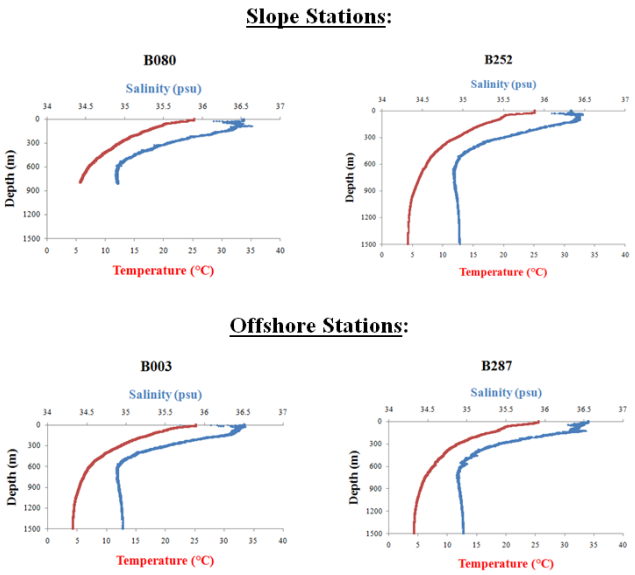

Figure 2. T/S profiles from MS7 *Meg Skansi* sample stations in April.

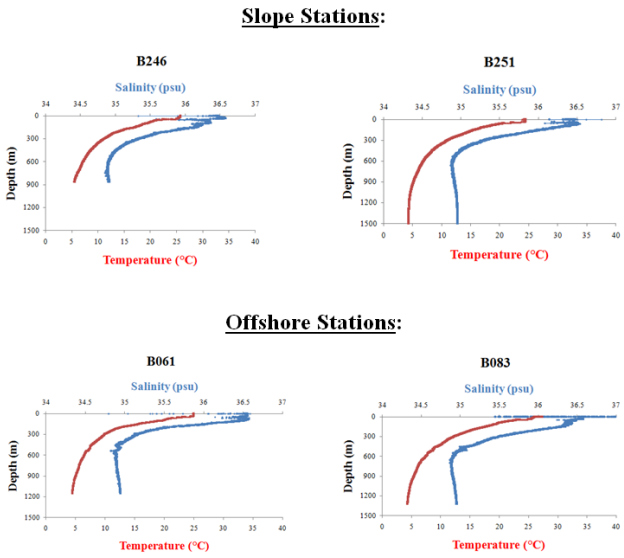

Figure 3. T/S profiles from MS7 *Meg Skansi* sample stations in May.

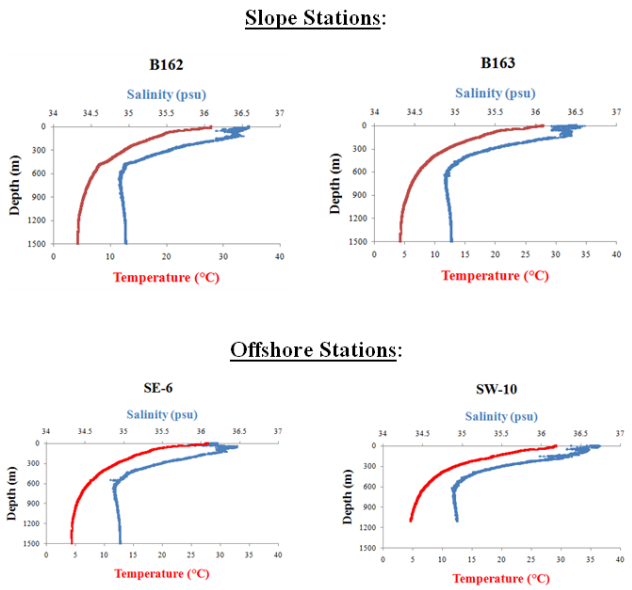

Figure 4. T/S profiles from MS7 *Meg Skansi* sample stations in June.

Oplophorid Abundance

A total of 5,089 specimens belonging to eight oplophorid genera were collected. Species were divided into four categories based on their percent contribution to the assemblage: 1) dominant species each contributed ≥ 10% (= ≥868 specimens) of total oplophorid abundance; 2) abundant species each contributed between 1-9% (=57-307); 3) uncommon species each contributed <1% but enough specimens (21-46) of each species were available to construct meaningful estimates of their vertical distributions; 4) rare species each accounted for <1%, the same percentage as the uncommon species, but for rare species, there were too few specimens available (≤17) to construct meaningful representations of vertical distributions. The three dominant species, *Acanthephyra purpurea*, *Acanthephyra stylorostratis*, and *Systellaspis debilis*, contributed ~62% of the total number of specimens collected (Figure 5).

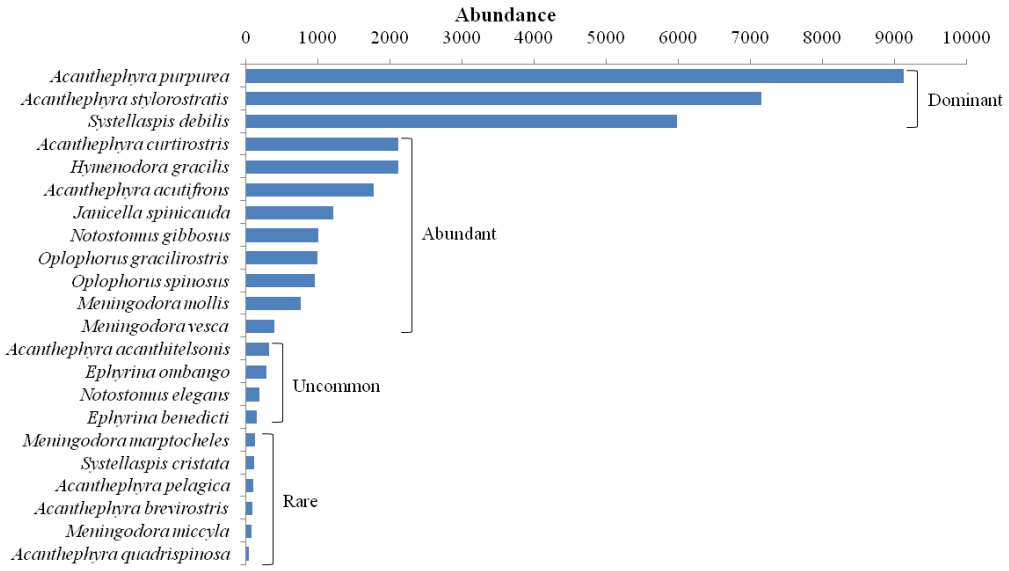

Figure 5. Total abundance (10^{-8} m^{-3}) of oplophorid species arranged from highest to lowest abundance.

Oplophorid Biomass

Family Oplophoridae contributed approximately 43% of the total decapod biomass and approximately 31% of the total crustacean biomass, which was more than any other family of micronektonic crustacean (Figure 6).

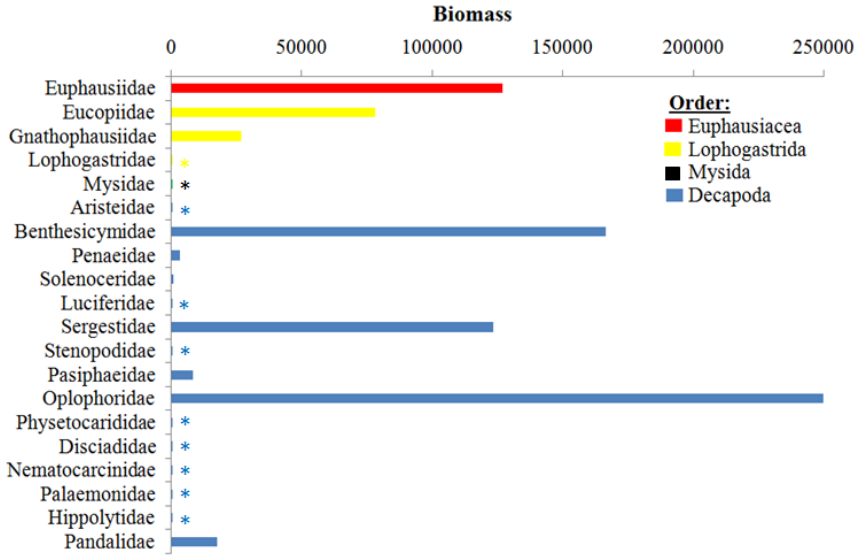

Figure 6. Biomass (10^{-9} g m^{-3}) of crustacean families by order.* indicates biomass values less than 5×10^{-7}.

Acanthephyra purpurea (18%), *Notostomus gibbosus* (18%), and *Systellaspis debilis* (16%) together accounted for ~52% of total oplophorid biomass (Figure 7).

Acanthephyra purpurea and *S. debilis* were also two of the three most abundant species. *Notostomus gibbosus* was considerably less abundant, but ranked among the top three in overall biomass due to the extremely large size of mature adults (up to 50 mm carapace lengths). *Acanthephyra acutifrons* (10%), *Acanthephyra stylorostratis* (9%), *Acanthephyra curtirostris* (7%), and *Oplophorus gracilirostris* (5%) collectively accounted for ~31% to the total oplophorid biomass. The remaining species accounted for less than 16% of the total, each individually contributing less than 3%.

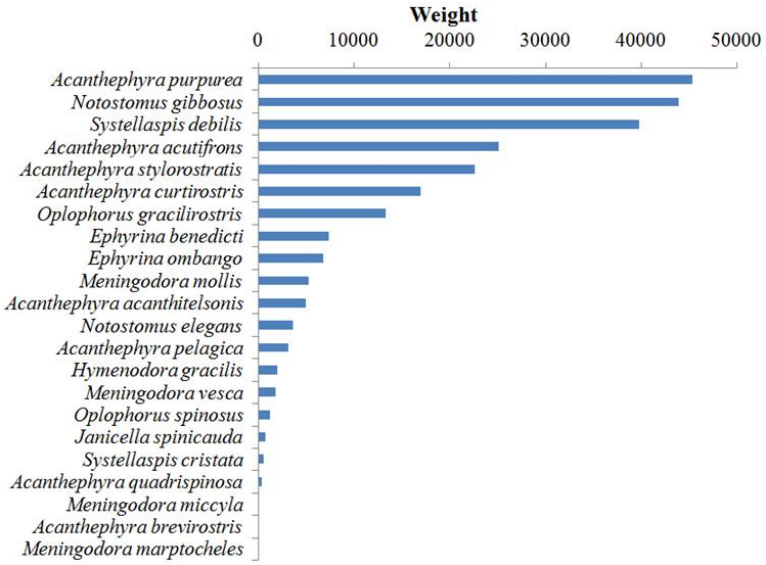

Figure 7. Total biomass (10^{-9} g m^{-3}) of oplophorid species arranged from highest to lowest values.

Slope vs. Offshore Assemblage Comparison

The pattern of species abundance was generally similar at slope and offshore stations (Figure 8), with *Acanthephyra purpurea*, *Systellaspis debilis*, and *Acanthephyra stylorostratis* the first-, second-, and third-most abundant species, respectively, in both sets of samples; however, all three were more abundant along the slope than offshore. Interestingly, the fourth- through sixth-most abundant species were more abundant offshore, whereas the eighth through tenth were more abundant at slope sites. By contrast, *Janicella spinicauda* was the seventh-most abundant species at offshore stations, but only one specimen was caught along the slope (Figure 8).

The assemblage of oplophorid species in both locations showed a positive monotonic relationship, indicating that the assemblages in both locations are similarly

structured with respect to individual species abundances (Figure 9). No significant differences were found between the total abundance of oplophorids collected at each station in slope (mean = 44×10^{-5} m^{-3}) versus offshore (mean = 34×10^{-5} m^{-3}) locations ($p > 0.5$) (Table 2.); however, intrastation variance was significantly higher ($p < 0.01$) within the slope stations (2.11×10^{-8} m^{-3}) than the offshore stations (1.27×10^{-8} m^{-3}).

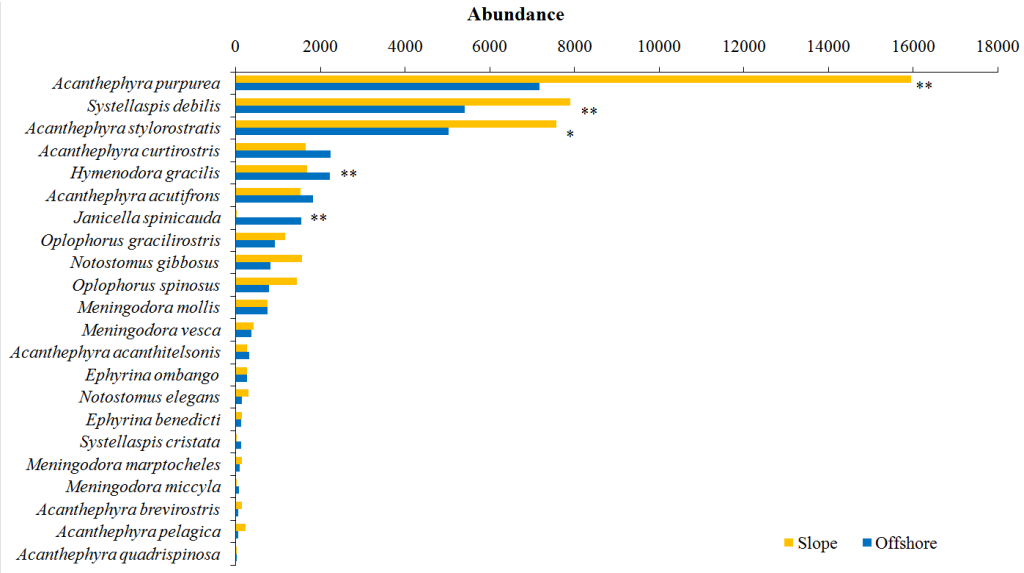

Figure 8. Abundance (10^{-7} m^{-3}) comparison of slope versus offshore oplophorids. Asterisks indicate species with significantly different abundances between the two locations. * indicates p values between 0.05-0.01. ** indicates p values less than 0.01.

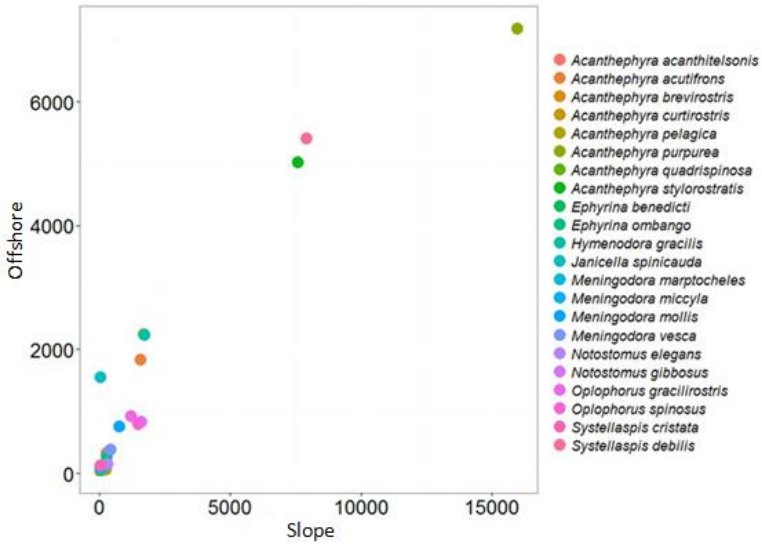

Figure 9. Positive monotonic relationship of oplophorid assemblages based on species abundance (10^{-7} m^{-3}) in offshore versus slope locations.

Table 2. Total abundance (10^{-5} m^{-3}) and variance of oplophorids by slope and offshore stations

Slope		Offshore	
Station	**Abundance**	**Station**	**Abundance**
B001	45	B003	21
B016	34	B061	52
B080	22	B064	45
B162	32	B065	27
B163	33	B078	37
B175	71	B079	40
B184	56	B081	34
B185	62	B082	53
B245	34	B083	47
B246	63	B248	43
B247	36	B249	38
B251	38	B250	39
B252	25	B255	42
B254	46	B286	44
SW-1	54	B287	29
SW-2	56	SE-1	26
		SE-2	11
		SE-3	22
		SE-4	22
		SE-5	26
		SE-6	25
		SW-3	31
		SW-5	58
		SW-6	26
		SW-7	39
		SW-8	28
		SW-9	27
		SW-10	20
		SW-11	37
Mean	44	Mean	34
Variance	2.11×10^{-8}	Variance	1.27×10^{-8}

Biomass trends reflected abundance trends, with biomass of the majority of observed oplophorid species higher at slope stations than at offshore stations (Figure 10). However, biomass did not closely reflect abundance trends for *Acanthephyra purpurea* and *Notostomus elegans*. Although *A. purpurea* was twice as abundant, its biomass was only ~50% greater in slope samples as in offshore samples, likely because offshore specimens had, on average, greater carapace lengths and, therefore, greater biomasses. Individuals of *N. elegans*, on the other hand, had greater average carapace lengths and biomass along the slope, resulting in a biomass that was five-fold greater in the slope samples, while abundance was only two-fold greater in slope versus offshore samples.

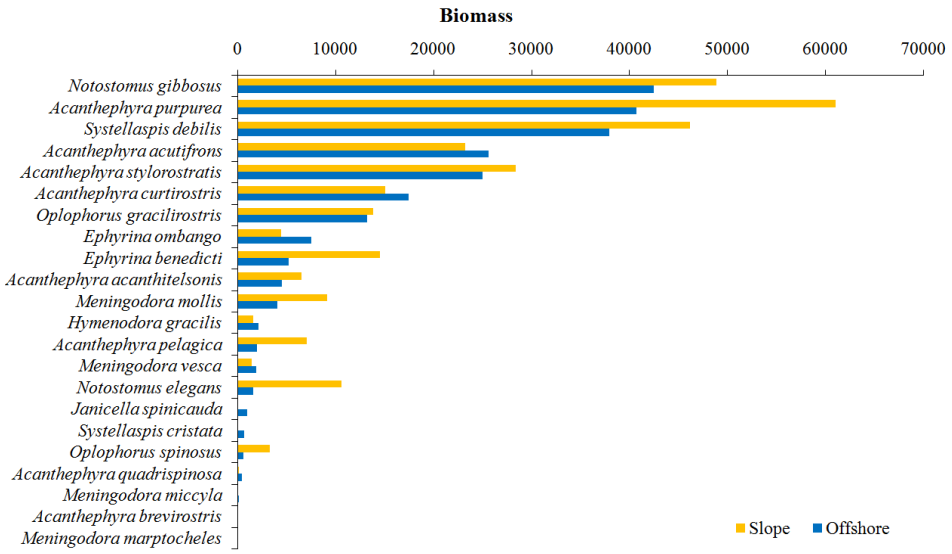

Figure 10. Biomass (10^{-9} g m^{-3}) comparison of slope versus offshore oplophorid species.

Notostomus gibbosus had the highest biomass in offshore samples and the second-highest in slope samples, whereas *Acanthephyra purpurea* had the highest biomass in slope samples and the second-highest biomass offshore. *Systellaspis debilis*, *Acanthephyra acutifrons*, and *Acanthephyra stylorostratis* accounted for the third-, fourth-, and fifth-highest biomass totals, respectively, in both locations. Although *A. acutifrons* had a higher biomass offshore, both *S. debilis* and *A. stylorostratis* had higher biomasses in slope samples. *Ephyrina ombango* and *Janicella spinicauda* were the only other species with substantially higher biomasses offshore than in slope samples.

Slope and offshore assemblages of oplophorids were compared using Shannon Diversity (*H'*) and Pielou's Evenness (*J'*) Indices with respect to depth range and solar cycle (Tables 3, 4). Because bottom depth differed from station to station, precluding bathypelagic trawls at many stations, only the epipelagic (0-200 m), upper mesopelagic (200-600 m), and lower mesopelagic (600-1000 m) zones were compared. Diversity increased with depth, during the day and at night, for both slope and offshore locations; however, no significant differences were found when comparing the diversity of oplophorid assemblages in both locations ($p > 0.5$ for all tests) (Tables 3, 4). Evenness of the oplophorid assemblage in both locations increased with depth during the day and night; however, as with H' values, no significant differences were seen among the slope and offshore locations ($p > 0.5$ for all tests) (Tables 3,4).

Table 3. Average indices and equitability of nighttime slope and offshore assemblages of oplophorids. *S* = species richness, *N* = total number of shrimp 10^{-5} m^{-3} collected, *H′* = Shannon diversity index, *J′* = Pielou's evenness index.

	Depth Range (m)	***S***	***N***	***H′***	***J′***
Slope Assemblage	0-200	2.46	36.70	0.65	0.64
	200-600	3.33	62.90	0.81	0.66
	600-1000	5.27	42.20	1.23	0.80
Offshore Assemblage	0-200	2.87	37.40	0.71	0.70
	200-600	4.27	36.80	0.97	0.70
	600-1000	6.30	32.00	1.53	0.85

Table 4. Average indices and equitability of daytime slope and offshore assemblages of oplophorids. *S* = species richness, *N* = total number of shrimp 10^{-5} m^{-3} collected, *H′* = Shannon diversity index, *J′* = Pielou's evenness index.

	Depth Range (m)	***S***	***N***	***H′***	***J′***
Slope Assemblage	0-200	0.44	2.56	0.07	0.06
	200-600	2.12	17.8	0.51	0.38
	600-1000	5.77	113.50	1.20	0.71
Offshore Assemblage	0-200	0.47	2.20	0.09	0.10
	200-600	3.00	14.70	0.82	0.72
	600-1000	7.24	71.00	1.50	0.78

Vertical Distribution

Of the 22 species of oplophorids collected, eight were strong vertical migrators (SVM), seven were non-vertical migrators (NVM), and one was a weak vertical migrator (WVM). Figures 11, 12, and 13 illustrate the vertical distribution patterns of the three dominant species, nine abundant species, and four uncommon species, respectively. Four of the SVM species - *Janicella spinicauda*, *Oplophorus gracilirostris*, *O. spinosus*, and *Systellaspis debilis* - migrated into the epipelagic zone at night, whereas *Acanthephyra purpurea*, *Meningodora vesca*, and *Notostomus elegans* were limited to diel migrations within the mesopelagic zone. *Ephyrina benedicti* was the only SVM species found to migrate within the bathypelagic zone. The migration pattern of *A. acanthitelsonis*, the only WVM, was restricted to within the mesopelagic zone over a 24-hour period. Most NVM specimens were collected from the lower mesopelagic or bathypelagic zone, or overlapped both zones.

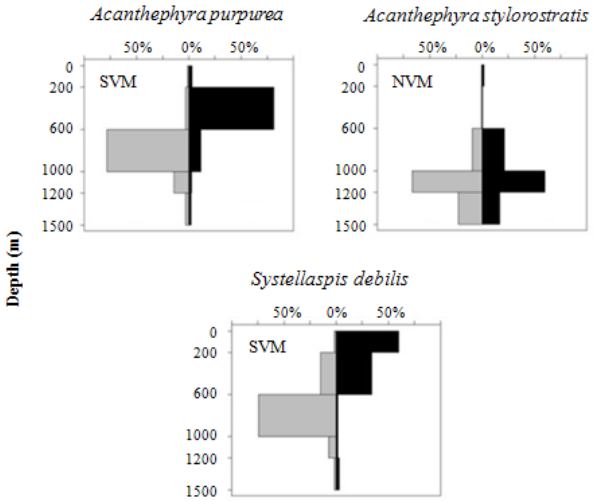

Figure 11. Vertical distribution patterns of dominant oplophorid species. SVM indicates a strong vertical migrator and NVM indicates a non-vertical migrator.

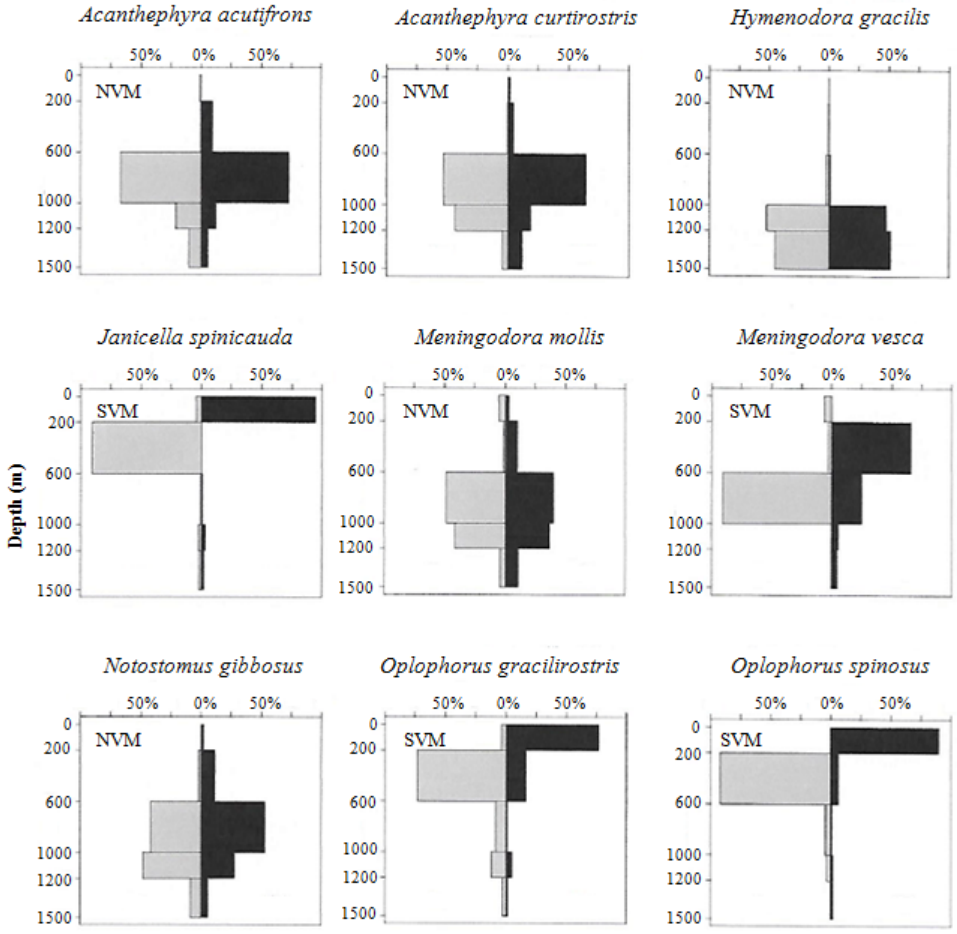

Figure 12. Vertical distribution patterns of abundant oplophorid species. SVM indicates a strong vertical migrator and NVM indicates a non-vertical migrator.

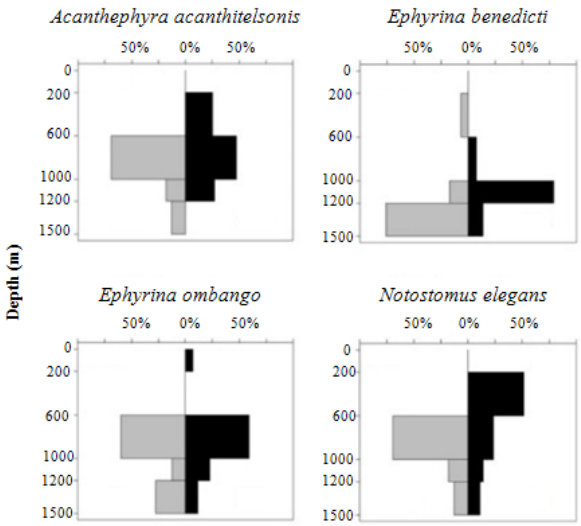

Figure 13. Vertical distribution patterns of uncommon oplophorid species. SVM indicates a strong vertical migrator, WVM indicates a weak vertical migrator, and NVM indicates a non-vertical migrator.

As stated above, too few individuals of the rare taxa were caught to draw any conclusions about their migratory behavior. Their abundance values corresponding depth ranges are shown in Table 5.

Table 5. Abundance and vertical distribution of rare species

Species	**Depth Range (m)**	**Abundance (10^{-7} m^{-3})**	
		Day	**Night**
Acanthephyra brevirostris	0-200	0	0
	200-600	0	0
	600-1000	27	23
	1000-1200	12	22
	1200-1500	0	0
Acanthephyra pelagica	0-200	0	0
	200-600	9	12
	600-1000	32	9
	1000-1200	25	0
	1200-1500	0	0
Acanthephyra quadrispinosa	0-200	0	0
	200-600	0	12
	600-1000	11	0
	1000-1200	0	0
	1200-1500	0	0
Meningodora marptocheles	0-200	0	0
	200-600	5	73
	600-1000	32	14
	1000-1200	0	0
	1200-1500	0	0

Meningodora miccyla	0-200	0	0
	200-600	5	8
	600-1000	0	28
	1000-1200	0	11
	1200-1500	0	0
Systellaspis cristata	0-200	0	0
	200-600	0	0
	600-1000	21	46
	1000-1200	25	0
	1200-1500	0	0

Gravid Female and Ontogenetic Data

At least one gravid female was noted in 13 of the 22 species of oplophorids in the study (Table 6). *Systellaspis debilis*, *Acanthephyra stylorostratis*, and *Acanthephyra purpurea* were the three species with the greatest numbers of gravid females. *Oplophorus gracilirostris* and *S. debilis* were the two species with the highest percentage of gravid females (16.8% and 15.6%, respectively).

Table 6. Abundances (10^{-7} m^{-3}) per depth range and percent of total assemblage composed of gravid females of each species

Species	**Abundance (10^{-7} m^{-3})**					**% of Total Assemblage**
	0-200 m	**200 - 600 m**	**600-1000 m**	**1000-1200 m**	**1200-1500 m**	
Acanthephyra acanthitelsonis	0	0	2	0	0	2.2
Acanthephyra acutifrons	0	0	0	6	0	0.4
Acanthephyra curtirostris	5	6	15	12	0	3.9
Acanthephyra purpurea	0	28	50	0	4	2.6
Acanthephyra stylorostratis	0	0	42	259	102	8.1
Ephyrina benedicti	0	0	0	0	4	4.8
Ephyrina ombango	0	0	7	0	0	7.5
Meningodora mollis	0	0	5	12	0	3.6
Meningodora vesca	0	2	7	6	0	8.8
Oplophorus gracilirostris	27	30	10	6	0	16.8
Oplophorus spinosus	5	0	0	0	0	0.7
Systellaspis cristata	0	0	2	0	0	6.2
Systellaspis debilis	128	99	151	18	4	15.6

Gravid female abundances were also examined with respect to sampling month (Table 7). The number of species with gravid females increased from April (n=6), to May (n=9), to June (n=11). However, three species, *A. purpurea*, *O. gracilirostris*, and *S. debilis*, which had gravid females in all three months, had substantially more in May than

in April or June. *Meningodora mollis* and *M. vesca*, on the other hand, had substantially more gravid females in April than May or June.

Table 7. Gravid female abundance (10^{-7} m^{-3}) by month for each species

Species	Abundance (10^{-7} m^{-3})		
	April	**May**	**June**
Acanthephyra acanthitelsonis	0	0	1
Acanthephyra acutifrons	0	3	0
Acanthephyra curtirostris	0	5	10
Acanthephyra purpurea	25	44	15
Acanthephyra stylorostratis	63	51	60
Ephyrina benedicti	0	0	1
Ephyrina ombango	0	3	2
Meningodora mollis	13	0	3
Meningodora vesca	25	3	2
Oplophorus gracilirostris	13	41	7
Oplophorus spinosus	0	3	0
Systellaspis cristata	0	0	1
Systellaspis debilis	63	189	57

For ontogenetic analyses, only the five species with the highest numbers of gravid females were used, with one exception (see below), as these included enough individuals to accurately separate immature (I) from mature shrimps (M). The carapace length of the smallest gravid female (Table 8) was used as the minimum length for sexually mature individuals of each species; smaller specimens were considered sexually immature per Hopkins *et al*., (1989). The one exception was *Notostomus gibbosus*, which included no gravid females; however, size classes of carapace lengths based on Hopkins *et al*. (1989) made analysis of ontogenetic trends possible (Table 8). Specimens with carapace lengths ≤ 20 mm were considered immature, whereas specimens with carapace lengths ≥ 35 mm were considered mature.

Table 8. Carapace lengths (mm) of smallest gravid female used for ontogenetic analysis

Species	Carapace length (mm)
Acanthephyra curtirostris	13.62
Acanthephyra purpurea	10.85
Acanthephyra stylorostratis	10.43
Notostomus gibbosus	20.00
Oplophorus gracilirostris	14.28
Systellaspis debilis	10.54

More immature specimens of all six species were collected at shallower depths (Table 9). At night, M:I ratios had greater variation between depth ranges than during the day, likely due to the increased abundance of mature individuals of each species. Of the three species of vertical migrators, *Oplophorus gracilirostris* showed the greatest change in assemblage structure between depth zones at night, whereas *Notostomus gibbosus* exhibited the most prominent change of the three non-migrating species.

Table 9**.** Abundances (10^{-7} m^{-3}) and ratios of mature to immature individuals (M:I) for each species with respect to depth range and time of day

Species	Depth Range (m)	Day			Night		
		Mature Abundance (10^{-7} m^{-3})	**Immature Abundance (10^{-7} m^{-3})**	**M:I Ratio**	**Mature Abundance (10^{-7} m^{-3})**	**Immature Abundance (10^{-7} m^{-3})**	**M:I Ratio**
Acanthephyra curtirostris	0-200	0	0	-	10	0	+
	200-600	0	5	-	24	16	1.5
	600-1000	75	434	0.2	65	498	0.1
	1000-1200	75	323	0.2	56	101	0.6
	1200-1500	36	9	4.0	78	26	3.0
Acanthephyra purpurea	0-200	22	22	1.0	0	83	-
	200-600	5	97	0.1	582	1866	0.3
	600-1000	842	1812	0.5	51	295	0.2
	1000-1200	224	273	0.8	11	67	0.2
	1200-1500	54	54	1.0	9	52	0.2
Acanthephyra stylorostratis	0-200	0	11	-	10	62	0.2
	200-600	0	19	-	4	16	0.2
	600-1000	54	311	0.2	143	706	0.2
	1000-1200	534	1924	0.3	437	2096	0.2
	1200-1500	288	405	0.7	356	347	1.0
Notostomus gibbosus	0-200	0	0	-	0	10	-
	200-600	0	9	-	0	53	-
	600-1000	43	161	0.3	83	152	0.5
	1000-1200	137	112	1.2	101	22	4.5
	1200-1500	36	9	4.0	17	0	+
Oplophorus gracilirostris	0-200	0	11	-	145	373	0.4
	200-600	32	194	0.2	97	16	6.0
	600-1000	27	0	-	0	5	-

	1000-1200	12	25	0.5	11	22	0.5
	1200-1500	0	9	-	9	0	+
Systellaspis debilis	0-200	11	33	0.3	612	1141	0.5
	200-600	88	263	0.3	460	533	0.9
	600-1000	852	836	1.0	14	32	0.4
	1000-1200	62	112	0.6	0	45	-
	1200-1500	9	36	0.3	26	61	0.4

- indicates depth ranges with insufficient mature abundances to calculate ratio
+ indicates depth ranges with insufficient immature abundances to calculate ratio

DISCUSSION

Hydrography

Over 280 trillion gallons of freshwater flow into the GOM annually from over twenty major river systems, with over half of this influx coming from the Mississippi River alone (Moody, 1967). Jochens and DiMarco (2008) noted lower salinity concentrations in surface waters at stations sampled southeast and southwest of the Mississippi River Delta than in stations sampled further offshore. April and May are almost always the times of maximum discharge, whereas the least drainage tends to occur in September and October (Kourafalou and Androulidakis, 2013). Temperature and salinity data collected during this study, however, showed little variation between slope and offshore stations, suggesting that these parameters cannot explain differences in oplophorid distribution patterns between the slope and offshore locations.

Oplophorid Abundance

The dominant species of oplophorids found in this study (*Acanthephyra purpurea*, *Acanthephyra stylorostratis*, and *Systellaspis debilis*) accounted for approximately 62% of the total oplophorid catch. Hopkins *et al*. (1989) also found that *A. purpurea* and *S. debilis* were among the dominant species of oplophorids present at Standard Station in the northeastern GOM. They found *A. stylorostratis* to be relatively rare, but this was because they only sampled at depths above 1000 m. At the same location, Burghart *et al*. (2007) recorded *A. stylorostratis* as the second-most abundant oplophorid at depths between 1000 and 3000 m in the bathypelagic zone. In the current study, *Hymenodora*

gracilis was abundant in numbers but had a relatively low contribution to the total biomass due to smaller carapace sizes, backing up the previous findings by Burghart *et al*. (2007).

Since the current study only sampled the top 1500 m of the water column, several deeper bathypelagic oplophorid species, such as *Hymenodora glacialis* and *Acanthephyra gracilipes* were not collected. Burghart *et al*. (2007) recorded these two as the first- and fifth-most abundant oplophorids, respectively, caught in the bathypelagic zone. Burghart *et al*. (2007) also collected two rare species of bathypelagic oplophorids not seen in the current study: *Systellaspis braueri* and *Systellaspis pellucida*.

Oplophorid Biomass

Understanding the contributions of individual families is important, because pelagic decapod shrimp species play significant roles in pelagic food webs and make significant contributions to the total biomass in all deep-sea pelagic communities yet studied (Pearcy and Forss, 1966; Hopkins *et al*., 1994). In this study, Oplophoridae contributed the most of any family to overall micronektonic crustacean biomass, highlighting its importance in the deep-sea ecosystem of the GOM. Oplophoridae accounted for approximately 31% of total crustacean biomass; Benthesicymidae accounted for ~21%, the next highest total.

Acanthephyra purpurea, *Notostomus gibbosus*, *Systellaspis debilis*, *Acanthephyra acutifrons*, and *Acanthephyra stylorostratis* recorded the five highest biomass totals, in descending order. Hopkins *et al*. (1994) also found *S. debilis*, *A. purpurea*, and *A. stylorostratis* among their five highest biomass totals, but *A. curtirostris* and *A. acanthitelsonis* completed their top five list. *Acanthephyra curtirostris* was fourth in abundance in the current study, but its smaller size accounted for its lower total biomass.

As in the current study, Burghart *et al*. (2007) found *Acanthephyra acutifrons*, *Notostomus gibbosus*, and *Acanthephyra stylorostratis* to have three of the five highest biomass totals. However, as with Hopkins *et al*. (1994), they included *A. curtirostris* rather than *A. acutifrons* (in the current study) in the top five in terms of biomass.

Slope vs. Offshore Assemblage Comparison

Five species of oplophorids showed significant differences in assemblage abundance between slope and offshore locations. Of these, *Acanthephyra stylorostratis*, *A. purpurea*, and *Systellaspis debilis* were significantly more abundant at slope stations, with *A. purpurea* more than twice as abundant in slope stations as in offshore stations. *Hymenodora gracilis* was significantly more abundant offshore, and *Janicella spinicauda* was completely absent from slope samples except for one specimen collected from the lower mesopelagic zone during the day. Since *J. spinicauda* was collected from 11 offshore stations, these results appear to be real and not simply the result of more offshore sampling. Significantly higher variance in oplophorid abundance among slope stations relative to offshore was probably due to substantially fewer slope stations coupled with higher abundances in the former area (Table 2). Significantly higher slope variance is also a possible explanation for the observed differences of individual species abundances with respect to both locations.

Studies on relationships between slope and offshore fauna are relatively uncommon; however, Reid *et al.* (1991) discussed differences in the distributions of micronektonic crustacean assemblages along the Hawaiian Islands. *Oplophorus gracilirostris* showed a clearly distinct mesopelagic-boundary distribution, with few specimens in offshore tows. *Janicella spinicauda* was common in both inshore and offshore trawls and was thus considered a facultative member of the boundary community. Although Reid *et al*. (1991) collected only two oplophorid species, they identified 23 micronektonic species with distinct boundary zone assemblages. Differences in the spatial abundance of *J. spinicauda* between the current study and Reid *et al*. (1991) support the hypothesis that slope communities are unique to their respective local region, and as such, more studies need to be completed to understand their interactions with offshore ecosystems.

No significant differences were seen for diversity (*H'*) and evenness (*J'*) comparisons of slope assemblages versus offshore oplophorid assemblages. Species richness was greater in both the epipelagic and lower mesopelagic zones in the offshore regions during the day. Hopkins *et al*. (1994) noted that the eastern GOM is an oligotrophic environment, which facilitates more competition among micronektonic

species for food and resources than in more productive areas. However, thirteen more trawls were conducted in offshore stations than in slope stations, so that more rare species were collected offshore. Both of these factors likely contribute to the higher species richness values offshore.

The scatterplot of oplophorid abundances indicates a positive monotonic relationship between offshore and slope assemblages, meaning that the hierarchy of species found in both locations are similar. This relationship, along with species diversity, and evenness data suggest that these two assemblages are structured similarly, even though differences in abundances exist between the two areas for five oplophorid species.

Vertical Distribution

All oplophorid species were more abundant at night than during the day. Visual avoidance of collection gear by micronektonic organisms has been reported (Itaya *et al*., 2007) and offers a possible explanation for the difference in catch rates in the current study.

The vertical distribution data found for many of the species of oplophorids in this study support the results of Hopkins *et al*. (1989) and Hopkins *et al*. (1994), so this discussion will emphasize new data for the GOM, highlighting differences between this location and others studied.

Meningodora vesca and *Oplophorus spinosus* were both strong vertical migrators, a pattern that has not been reported before for these species in the GOM, but has been reported for the north Atlantic (Foxton, 1970; Fasham and Foxton, 1979). *Meningodora vesca* migrated from the lower mesopelagic zone to the upper mesopelagic zone in the current study. Foxton (1970), working in the Canary Islands, collected only six specimens of *M. vesca*, but based on the collection depth of specimens, speculated that this species migrated within the mesopelagic zone during a 24-hour cycle. *Oplophorus spinosus* underwent diel migrations from the upper mesopelagic zone to the epipelagic zone, similar to what Fasham and Foxton (1979) found for this species in the eastern North Atlantic.

The vertical distributions of the non-vertically migrating species found in this study also back up the findings of previous mesopelagic and bathypelagic studies in the northeastern GOM (Hopkins *et al*., 1989; Hopkins *et al*., 1994; Burghart *et al*., 2007).

Slight differences in vertical distribution descriptions of oplophorid species between the current and previous studies can be attributed to differences in sampling protocol. Hopkins *et al*. (1994) took samples every 50 m from the surface to 1000 m depth, giving more detailed information on the depth distributions of each species. Burghart et al. (2007) measured the bathypelagic zone from 1000-3000 by sampling in 500-m increments. This is a similar protocol to the current study, which, however, only sampled the upper 500 m of the bathypelagic zone. More discrete-depth sampling of the bathypelagic zone in the GOM is needed to get accurate depth of maximum occurrences for each bathypelagic oplophorid.

Table 10 provides the depth ranges of all oplophorid species found in the GOM, summarized from all previous studies conducted through the GOM together with data provided by the current study.

Table 10**.** Depth distributions of oplophorid species found in the Gulf of Mexico

Species	**Depth Range (m)**	**Sources**
*Acanthephyra acanthitelsonis**	200-4000	Burghart *et al*. (2007), Chace *et al*. (1956), Crosnier and Forest (1973), Hopkins *et al*. (1994), Pequegnat and Wicksten (2006)
*Acanthephyra acutifrons**	0-4200	Burghart *et al*. (2007), Chace (1940), Chace (1986), Hopkins *et al*. (1994), Pequegnat and Wicksten (2006)
Acanthephyra armata	365-2880	Chace (1986), Pequegnat and Wicksten (2006)
*Acanthephyra brevirostris**	600-5300	Chace (1940), Chace (1986), Chace *et al*. (1956), Pequegnat and Wicksten (2006)
*Acanthephyra curtirostris**	0-5900	Burghart *et al*. (2007), Chace (1940), Chace *et al*. (1956), Hopkins *et al*. (1994), Hopkins *et al*. (1989), Pequegnat and Wicksten (2006)
Acanthephyra eximia	200-4700	Burghart *et al*. (2007), Bullis and Thompson (1965), Chace (1986), Crosnier and Forest (1973), Pequegnat and Wicksten (2006)

Acanthephyra gracilipes	1000-3000	Burghart *et al*. (2007)
*Acanthephyra pelagic**	183-2500	Burghart *et al*. (2007), Chace (1940), Chace (1986), Crosnier and Forest (1973), Pequegnat and Wicksten (2006), Williams and Wigley (1977)
*Acanthephyra purpurea**	0-3292	Burghart *et al*. (2007), Chace (1986), Hopkins *et al*. (1994), Hopkins *et al*. (1989), Pequegnat and Wicksten (2006)
*Acanthephyra quadrispinosa**	200-3000	Burghart *et al*. (2007)
*Acanthephyra stylorostratis**	0-3548	Burghart *et al*. (2007), Chace (1986), Hopkins *et al*. (1994), Hopkins *et al*. (1989), Pequegnat and Wicksten (2006)
*Ephyrina benedicti**	200-5000	Burghart *et al*. (2007), Chace (1986), Hopkins *et al*. (1989), Pequegnat and Wicksten (2006)
*Ephyrina ombango**	0-2500	Burghart *et al*. (2007), Chace (1986), Crosnier and Forest (1973), Pequegnat and Wicksten (2006)
Heterogenys microphthalma	2000-4792	Chace (1986), Chace *et al*. (1956), Crosnier and Forest (1973), Pequegnat and Wicksten (2006)
Hymenodora glacialis	1000-3000	Burghart *et al*. (2007)
*Hymenodora gracilis**	600-5400	Burghart *et al*. (2007), Chace (1986), Chace *et al*. (1956), Crosnier and Forest (1973), Pequegnat and Wicksten (2006)
*Janicella spinicauda**	0-1500	Burghart *et al*. (2007), Chace (1986), Chace *et al*. (1956), Crosnier and Forest (1973), Hopkins *et al*. (1989), Pequegnat and Wicksten (2006)
*Meningodora marptocheles**	200-3477	Burghart *et al*. (2007), Chace (1940), Chace (1986), Pequegnat and Wicksten (2006)
*Meningodora miccyla**	200-3000	Burghart *et al*. (2007)
*Meningodora mollis**	0-5000	Burghart *et al*. (2007), Chace (1940), Chace (1986), Chace *et al*. (1956), Crosnier and Forest (1973), Hopkins *et al*. (1989), Pequegnat and Wicksten (2006)
*Meningodora vesca**	0-5393	Burghart *et al*. (2007), Chace (1940), Chace (1986), Crosnier and Forest (1973), Hopkins *et al*. (1989)

*Notostomus elegans**	200-5380	Chace (1986), Crosnier and Forest (1973), Hopkins *et al*. (1989), Pequegnat and Wicksten (2006)
*Notostomus gibbosus**	0-4000	Burghart *et al*. (2007), Chace (1940), Chace (1947), Chace (1986), Crosnier and Forest (1973), Hopkins *et al*. (1994), Pequegnat and Wicksten (2006)
*Oplophorus gracilirostris**	0-2400	Bullis and Thompson (1965), Chace (1947), Chace (1986), Pequegnat and Wicksten (2006)
*Oplophorus spinosus**	0-2000	Abele and Kim, 1986; Chace, 1947; Chace, 1986; Crosnier and Forest, 1973; Pequegnat and Wicksten, 2006
Systellaspis braueri	1000-3000	Burghart *et al*., 2007
*Systellaspis cristata**	200-3241	Burghart *et al*., 2007; Chace, 1986; Chace *et al*., 1956; Crosnier and Forest, 1973; Hopkins *et al*., 1989; Pequegnat and Wicksten, 2006
*Systellaspis debilis**	0-4594	Burghart *et al*., 2007; Chace, 1986; Crosnier and Forest, 1973; Hopkins *et al*., 1989; Pequegnat and Wicksten, 2006; Pohle, 1990
Systellaspis pellucida	274-3292	Burghart *et al*., 2007; Chace, 1947; Chace, 1986; Chace *et al*., 1956; Crosnier and Forest, 1973; Pequegnat and Wicksten, 2006

*indicates species caught in current study

Gravid Female and Ontogenetic Data

The carapace lengths of gravid females used to indicate the minimum size of mature individuals in this study are similar to those found by Hopkins *et al*. (1989) with *Acanthephyra purpurea* the sole exception. The smallest berried female of *A. purpurea* measured in the current study had a carapace length of 10.85 mm, considerably smaller than the smallest (16 mm) measured by Hopkins *et al.* (1989), and is the smallest gravid female of this species on record. As in the current study, Hopkins *et al*. (1989) found no berried females of *Notostomus gibbosus*; however, they did note that mature specimens ranged from 35-45 mm in carapace length and immature specimens ranged from 8-24 mm. The current study used similar size classes; although several immature specimens had carapace lengths < 5 mm, and the largest mature carapace length recorded was 53.19 mm. However, the true size at sexual maturity cannot be determined until berried females have been examined.

Ontogenetic depth patterns were observed in *Acanthephyra curtirostris*, *Acanthephyra purpurea*, *Acanthephyra stylorostratis*, *Notostomus gibbosus*, *Oplophorus gracilirostris*, and *Systellaspis debilis*. More immature, smaller individuals of all six species were found at shallower depths than mature, larger specimens, supporting the hypothesis that smaller animals of pelagic species are found in shallower waters due to a decrease in size-dependent visual predation risk (De Robertis *et al*., 2000). Hopkins *et al*. (1989) noted a similar ontogenetic pattern for *S. debilis* at night, but did not describe ontogeny for any other oplophorid species.

The gravid female and ontogenetic trends presented in this study will be especially beneficial when compared to data from future studies of oplophorids in providing a better understanding of whether seasonality in reproduction exists. In addition, comparisons of abundances of gravid females or juveniles with data from future studies are important to monitor ecosystem recovery.

CONCLUSIONS

The results of this study indicate that there are no distinct differences between slope and offshore assemblages of oplophorids in the northeastern GOM, as indicated by the positive monotonic relationship of the two assemblages, as well as the results of diversity and evenness indices. However, three species of oplophorids had significantly higher abundances along the slope and two species had significantly higher abundances offshore. Based on the current study and previous studies in other locations, boundary communities and offshore communities, such as those in slope regions, are unique and should be treated on a local scale rather than a global one. The data presented here indicate that several species of oplophorids exhibit ontogenetic patterns in their vertical distributions, and provide a starting point for future studies on reproductive seasonality. Data such as these are critical for modeling potential impacts of anthropogenic perturbations, as well as recovery timelines.

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APPENDICES

Appendix I. Sample collection data from the *Meg Skansi* 7 cruise in the northern Gulf of Mexico

Sample	Date	Latitude (°N)	Longitude (°W)	Min. trawl depth (m)	Max. trawl depth (m)	Vol. filtered (m^3)	Solar cycle	Depth zone
B001N_01	20-Apr	28.97	87.97	1000	1182	N/A	N	2
B001N_02	20-Apr	28.96	87.96	600	1000	N/A	N	3
B001N_03	20-Apr	28.95	87.95	201	600	N/A	N	4
B001D_03	21-Apr	28.91	87.90	200	602	42989.7	D	4
B001D_04	21-Apr	28.89	87.86	0	200	23466.5	D	5
B175N_01	21-Apr	28.99	87.50	1201	1502	28885	N	1
B001N_04	21-Apr	28.91	87.93	6	201	N/A	N	5
B175D_01	22-Apr	28.95	87.52	1200	1500	33817.9	D	1
B175D_02	22-Apr	28.92	87.53	1002	1200	19875.2	D	2
B175N_02	22-Apr	28.96	87.50	1002	1201	20866.2	N	2
B175N_03	22-Apr	28.94	87.51	596	1002	54620.7	N	3
B252N_01	22-Apr	28.49	87.51	999	1503	N/A	N	1a
B252N_02	23-Apr	28.44	87.50	601	999	N/A	N	3
B252N_03	23-Apr	28.41	87.48	202	601	N/A	N	4
B252N_04	23-Apr	28.38	87.46	0	202	N/A	N	5
B252D_02	23-Apr	28.46	87.44	600	996	32233.4	D	3
B252D_03	23-Apr	28.44	87.42	200	600	33241.9	D	4
B252D_04	23-Apr	28.41	87.41	0	200	24764.3	D	5
B252D_01	23-Apr	28.50	87.47	996	1501	N/A	D	1a
B003N_01	24-Apr	28.01	87.03	1001	1499	N/A	N	1a
B080D_04	24-Apr	28.45	86.96	0	200	20225.1	D	5
B080N_04	24-Apr	28.41	86.97	0	199	20225.1	N	5
B003D_01	25-Apr	27.99	86.98	1001	1500	N/A	D	1a
B003D_02	25-Apr	27.96	86.93	601	1001	45253.5	D	3
B003D_03	25-Apr	27.93	86.88	200	601	35926.4	D	4
B003D_04	25-Apr	27.89	86.83	0	200	21156.9	D	5
B003N_02	25-Apr	27.97	86.98	598	1001	46389.9	N	3
B003N_03	25-Apr	27.93	86.94	200	598	48124.2	N	4
B003N_04	25-Apr	27.90	86.92	10	200	26634.1	N	5
B287N_01	25-Apr	27.95	87.51	1000	1499	N/A	N	1a
B287D_02	26-Apr	27.91	87.44	601	998	41895.2	D	3
B287D_03	26-Apr	27.87	87.43	200	601	43186.1	D	4
B287D_04	26-Apr	27.82	87.43	0	200	24060.5	D	5
B287N_02	26-Apr	27.91	87.51	600	1000	41703.2	N	3

B287N_03	26-Apr	27.87	87.48	201	600	45792	N	4
B287N_04	26-Apr	27.83	87.46	0	201	18473.6	N	5
B287D_01	26-Apr	27.97	87.48	998	1501	N/A	D	1a
B251N_01	4-May	28.46	88.54	1202	1400	N/A	N	1
B081N_01	5-May	28.50	87.99	1201	1501	28806	N	1
B081N_02	5-May	28.50	87.96	999	1201	15255.1	N	2
B251D_01	5-May	28.48	88.54	1203	1403	24534	D	1
B251D_02	5-May	28.50	88.52	1001	1203	25034.8	D	2
B251D_03	5-May	28.51	88.49	600	1001	48694.3	D	3
B251D_04	5-May	28.54	88.43	200	600	46895.6	D	4
B251D_05	5-May	28.55	88.39	0	200	25633.8	D	5
B251N_02	5-May	28.48	88.53	1001	1202	25219.9	N	2
B251N_03	5-May	28.50	88.51	599	1001	66539.5	N	3
B251N_04	5-May	28.55	88.47	199	599	38870.4	N	4
B251N_05	5-May	28.58	88.46	0	199	17178.1	N	5
B081D_01	6-May	28.51	88.02	1200	1501	27647.1	D	1
B081D_02	6-May	28.54	88.01	1000	1200	13997	D	2
B081D_03	6-May	28.55	88.00	601	1000	35786.2	D	3
B081D_04	6-May	28.58	87.99	200	601	41671	D	4
B081D_05	6-May	28.62	87.97	0	200	25131.1	D	5
B081N_03	6-May	28.50	87.94	600	999	48838.2	N	3
B081N_04	6-May	28.49	87.88	199	600	48185.5	N	4
B081N_05	6-May	28.48	87.83	0	199	27840.5	N	5
B082N_01	6-May	27.99	88.03	1200	1501	35902.1	N	1
B082D_02	7-May	28.01	87.98	1000	1200	23006	D	2
B082D_03	7-May	28.01	88.01	600	1000	53615.9	D	3
B082D_04	7-May	28.02	88.07	197	600	51963.5	D	4
B082D_05	7-May	28.02	88.12	0	197	42205.7	D	5
B082N_02	7-May	27.97	88.07	1000	1200	19337.9	N	2
B082N_03	7-May	27.96	88.09	600	1000	35250.1	N	3
B082N_04	7-May	27.95	88.11	201	600	44365.8	N	4
B082N_05	7-May	27.93	88.14	0	201	27647.4	N	5
B250D_01	8-May	27.99	88.51	1200	1500	28991.9	D	1
B250D_02	8-May	27.98	88.54	994	1200	22920.3	D	2
B250D_03	8-May	27.97	88.56	601	994	44005.6	D	3
B250D_04	8-May	27.96	88.62	365	601	N/A	D	4a
B250N_01	8-May	27.93	88.61	1201	1501	N/A	N	1
B250N_02	9-May	27.90	88.65	1001	1201	39369	N	2
B250N_03	9-May	27.88	88.67	600	1001	24823.6	N	3
B250N_04	9-May	27.85	88.71	164	600	46545.1	N	4
B250N_05	9-May	27.82	88.75	0	164	134.2	N	5
B249D_01	9-May	27.69	88.58	1197	1501	30530.5	D	1
B249D_02	9-May	27.64	88.58	1000	1197	19192.5	D	2

B249D_03	9-May	27.62	88.58	601	1000	51064.3	D	3
B249D_04	9-May	27.58	88.59	200	601	48855.6	D	4
B249D_05	9-May	27.54	88.60	0	200	25731.7	D	5
B249N_01	9-May	27.50	88.49	1200	1500	61864.6	N	1
B064D_01	10-May	27.49	88.98	1200	1500	28628.3	D	1
B064D_02	10-May	27.46	88.98	1000	1200	24418.5	D	2
B064N_01	10-May	27.50	88.99	1201	1501	45796.3	N	1
B249N_02	10-May	27.44	88.51	1001	1200	28706.7	N	2
B249N_03	10-May	27.41	88.52	601	1001	49009	N	3
B249N_04	10-May	27.37	88.54	200	601	40857.6	N	4
B249N_05	10-May	27.33	88.55	0	200	28558.9	N	5
B083D_04	11-May	27.90	88.89	0	199	N/A	D	5
B064N_02	11-May	27.47	88.96	998	1201	24242.8	N	2
B064N_03	11-May	27.45	88.94	576	998	50321.5	N	3
B064N_04	11-May	27.42	88.90	201	576	38843.4	N	4
B064N_05	11-May	27.39	88.88	0	201	26178	N	5
B083D_01	11-May	27.99	88.98	1000	1200	17855.1	D	2
B083D_02	11-May	27.98	88.96	601	1000	47858.9	D	3
B083D_03	11-May	27.94	88.93	199	601	63254.2	D	4
B083N_01	11-May	28.05	88.98	1000	1202	28183.6	N	2
B083N_02	11-May	28.02	88.98	601	1000	46424.9	N	3
B083N_04	12-May	27.93	88.93	0	194	N/A	N	5
B083N_03	12-May	27.98	88.95	194	601	60248	N	4
B184N_01	14-May	28.47	88.79	601	1005	64562	N	3
B184D_01	15-May	28.43	88.70	999	1201	22321.3	D	2
B184D_02	15-May	28.46	88.71	601	999	48536.7	D	3
B184D_03	15-May	28.50	88.73	201	601	46947.2	D	4
B184D_04	15-May	28.54	88.76	9	201	26528.1	D	5
B184N_02	15-May	28.51	88.83	200	601	67442.2	N	4
B184N_03	15-May	28.56	88.89	5	200	23462	N	5
B016D_01	16-May	27.99	90.01	200	440	30381.4	D	4
B016D_02	16-May	28.02	90.00	10	200	21696.4	D	5
B016N_02	16-May	28.05	89.84	201	595	55882.5	N	4
B016N_03	16-May	28.10	89.88	0	201	30102.8	N	5
B185N_02	16-May	27.94	89.53	400	600	28187	N	4
B185N_01	16-May	27.91	89.49	600	857	N/A	N	3b
B185D_03	17-May	27.99	89.51	0	601	N/A	D	4c
B185D_01	17-May	27.95	89.51	800	900	14086.9	D	3
B185D_02	17-May	27.97	89.51	601	800	19269.4	D	3
B248N_01	17-May	27.53	89.46	1201	1301	16607.7	N	1
B248N_02	17-May	27.55	89.45	1001	1201	34556.9	N	2
B061N_01	18-May	27.49	89.96	1000	1175	25877.1	N	2
B248D_01	18-May	27.48	89.49	1200	1302	10757.8	D	1

B248N_03	18-May	27.60	89.45	601	1001	46050.6	N	3
B248N_04	18-May	27.64	89.46	200	601	46045.3	N	4
B248N_05	18-May	27.69	89.46	5	200	24455.8	N	5
B061D_01	19-May	27.48	89.94	999	1099	N/A	D	2
B061D_02	19-May	27.47	89.92	798	999	22992.1	D	3
B061D_03	19-May	27.45	89.90	601	798	19227.8	D	3
B061D_04	19-May	27.44	89.88	195	601	41216.4	D	4
B061D_05	19-May	27.42	89.84	8.4	195	6478.5	D	5
B061N_02	19-May	27.48	89.93	800	1000	26231.9	N	3
B061N_03	19-May	27.46	89.90	601	800	30199.9	N	3
B061N_04	19-May	27.45	89.86	200	601	64228.7	N	4
B061N_05	19-May	27.41	89.80	5	200	30541.5	N	5
B247N_01	19-May	27.52	90.52	800	957	12732.3	N	3
B247N_02	19-May	27.51	90.51	601	800	32576.4	N	3
B247D_01	20-May	27.47	90.47	1002	1198	29781.7	D	2
B247D_02	20-May	27.45	90.45	800	1002	21460.3	D	3
B247D_03	20-May	27.43	90.43	600	800	22189.7	D	3
B247D_04	20-May	27.41	90.42	201	600	38788.4	D	4
B247D_05	20-May	27.37	90.39	8	201	27717.9	D	5
B247N_03	20-May	27.49	90.48	400	601	19583.5	N	4
B247N_04	20-May	27.48	90.46	200	400	28482.7	N	4
B247N_05	20-May	27.47	90.43	5	200	22803.2	N	5
B245N_01	21-May	27.44	92.46	700	850	N/A	N	3b
B245N_02	21-May	27.42	92.44	599	700	N/A	N	3b
B245D_02	21-May	27.47	92.54	401	600	18081.7	D	4
B245D_03	21-May	27.46	92.53	200	401	20770.5	D	4
B245D_04	21-May	27.44	92.53	100	200	13137.5	D	5
B245D_05	21-May	27.42	92.52	10	100	8176.3	D	5
B245N_03	21-May	27.41	92.44	400	599	21344.6	N	4
SW-2N_01	22-May	27.53	92.02	600	700	N/A	N	3b
B245N_04	22-May	27.39	92.43	201	400	22934.7	N	4
B245N_05	22-May	27.37	92.42	5	201	29858	N	5
SW-2D_01	22-May	27.56	92.02	402	599	27334	D	4
SW-2D_02	22-May	27.54	92.01	201	402	23641.3	D	4
SW-2D_03	22-May	27.52	91.99	100	201	12549	D	5
SW-2D_04	22-May	27.51	91.99	8	100	11928.1	D	5
B246N_01	23-May	27.49	91.47	800	850	N/A	N	3c
B246D_01	23-May	27.54	91.52	800	875	8869.8	D	3
B246D_02	23-May	27.53	91.51	601	800	20929.4	D	3
B246D_03	23-May	27.51	91.50	398	601	18140.8	D	4
B246D_04	23-May	27.49	91.49	200	398	20440.2	D	4
B246D_05	23-May	27.47	91.49	0	200	19828.9	D	5
B246N_02	23-May	27.49	91.46	600	800	30431	N	3

SW-2N_02	23-May	27.51	92.01	400	600	26557	N	4
SW-2N_03	23-May	27.49	92.01	201	400	28307.3	N	4
SW-2N_04	23-May	27.46	92.00	100	201	14296.8	N	5
SW-2N_05	23-May	27.44	92.00	5	100	13819.9	N	5
SW-1D_01	24-May	27.52	91.03	801	850	N/A	D	3c
SW-1N_01	24-May	27.48	90.98	801	1001	N/A	N	3d
B246N_03	24-May	27.50	91.43	400	600	26285.2	N	4
B246N_04	24-May	27.50	91.40	200	400	31777.9	N	4
B246N_05	24-May	27.50	91.36	6	200	27674	N	5
SW-1D_02	24-May	27.52	91.02	601	801	18392.1	D	3
SW-1D_03	24-May	27.50	91.01	399	601	21510.4	D	4
SW-1D_04	24-May	27.48	91.00	201	399	23461.6	D	4
SW-1D_05	24-May	27.46	90.98	9	201	27547.2	D	5
SW-1N_02	25-May	27.51	91.00	600	801	18975.4	N	3
SW-1N_03	25-May	27.53	91.02	400	600	20043.5	N	4
SW-1N_04	25-May	27.55	91.04	200	400	20998.4	N	4
SW-1N_05	25-May	27.58	91.06	6	200	25503.2	N	5
B065D_02	3-Jun	27.48	88.01	1000	1200	16967.7	D	2
B065D_03	3-Jun	27.47	88.02	600	1000	41756.5	D	3
B065D_05	3-Jun	27.44	88.07	5	200	26488.7	D	5
B065N_03	3-Jun	27.53	87.95	600	1000	43911	N	3
B065N_05	3-Jun	27.49	88.01	5	200	26142.6	N	5
B286N_01	3-Jun	27.50	87.46	1200	1502	34571.2	N	1
B079N_01	4-Jun	27.50	87.01	1200	1502	29231.6	N	1
B286D_01	4-Jun	27.52	87.52	1199	1506	32426	D	1
B286D_02	4-Jun	27.55	87.54	1000	1199	19595.1	D	2
B286D_03	4-Jun	27.56	87.56	600	1000	48892.4	D	3
B286D_04	4-Jun	27.57	87.62	200	600	50987.4	D	4
B286N_02	4-Jun	27.51	87.50	1000	1200	17552.3	N	2
B286N_03	4-Jun	27.52	87.51	597	1000	44804.2	N	3
B286N_04	4-Jun	27.54	87.55	200	597	46437.9	N	4
B286N_05	4-Jun	27.56	87.59	5	200	21731.5	N	5
B079D_01	5-Jun	27.48	86.98	1200	1500	35537	D	1
B079D_02	5-Jun	27.51	87.00	1000	1200	25411.8	D	2
B079D_03	5-Jun	27.54	87.02	600	1000	49808.9	D	3
B079D_04	5-Jun	27.58	87.06	200	600	54322.5	D	4
B079D_05	5-Jun	27.63	87.09	5	200	28154.6	D	5
B079N_02	5-Jun	27.52	87.04	1001	1200	16309.3	N	2
B079N_03	5-Jun	27.53	87.06	600	1001	52105.1	N	3
B079N_04	5-Jun	27.56	87.10	200	600	66156.6	N	4
B079N_05	5-Jun	27.60	87.15	5	200	26403.1	N	5
B255N_01	5-Jun	27.52	86.52	1200	1501	34702.8	N	1
B255D_05	6-Jun	27.62	86.50	5	201	N/A	D	5

B254N_01	6-Jun	27.91	86.52	1200	1500	31804.4	N	1
B255D_01	6-Jun	27.48	86.49	1201	1499	18461.2	D	1
B255D_02	6-Jun	27.50	86.49	1001	1201	23481.6	D	2
B255D_03	6-Jun	27.53	86.49	600	1001	37726.9	D	3
B255D_04	6-Jun	27.57	86.49	201	600	52107.1	D	4
B255N_02	6-Jun	27.54	86.55	1000	1200	22512	N	2
B255N_03	6-Jun	27.56	86.58	599	1000	44632.7	N	3
B255N_04	6-Jun	27.59	86.62	201	599	58603	N	4
B255N_05	6-Jun	27.63	86.66	5	201	22906.1	N	5
B163N_01	7-Jun	28.01	86.08	800	1002	20280.3	N	3
B163N_02	7-Jun	27.99	86.06	600	800	17576.8	N	3
B254D_01	7-Jun	27.88	86.46	1199	1500	30629.4	D	1
B254D_02	7-Jun	27.91	86.48	1000	1199	19845	D	2
B254D_03	7-Jun	27.94	86.48	600	1000	46240.3	D	3
B254D_04	7-Jun	27.96	86.43	200	600	50179	D	4
B254D_05	7-Jun	27.97	86.37	5	200	24208.5	D	5
B254N_02	7-Jun	27.92	86.55	1000	1200	17732.5	N	2
B254N_03	7-Jun	27.92	86.57	600	1000	42204.4	N	3
B254N_04	7-Jun	27.93	86.62	200	600	45810.4	N	4
B254N_05	7-Jun	27.93	86.67	5	200	20775.1	N	5
B078N_01	8-Jun	27.52	86.04	1200	1501	40052	N	1
B163D_01	8-Jun	27.84	86.12	1201	1503	32845.3	D	1
B163D_02	8-Jun	27.85	86.08	1000	1201	17794.7	D	2
B163D_03	8-Jun	27.85	86.05	599	1000	41389.8	D	3
B163D_04	8-Jun	27.85	86.00	201	599	35389.7	D	4
B163D_05	8-Jun	27.85	85.96	3	201	24293.3	D	5
B163N_03	8-Jun	27.98	86.05	401	600	27295.3	N	4
B163N_04	8-Jun	27.96	86.02	200	401	34127.3	N	4
B163N_05	8-Jun	27.93	86.00	5	200	45826.7	N	5
B078N_02	9-Jun	27.49	86.00	1000	1200	27045.5	N	2
B078N_03	9-Jun	27.47	85.97	599	1000	57867.4	N	3
B078N_04	9-Jun	27.43	85.92	200	599	49834.4	N	4
B078N_05	9-Jun	27.40	85.88	5	200	21919.7	N	5
B162N_01	9-Jun	27.53	85.65	1200	1500	59904.3	N	1
B162D_01	10-Jun	27.48	85.63	1202	1500	58567.1	D	1
B162D_02	10-Jun	27.49	85.60	1001	1202	36684.3	D	2
B162D_03	10-Jun	27.50	85.58	601	1001	70440.8	D	3
B162D_04	10-Jun	27.51	85.54	201	601	80224	D	4
B162D_05	10-Jun	27.53	85.51	13	201	23883.1	D	5
B162N_02	10-Jun	27.49	85.63	1000	1200	46654.1	N	2
B162N_03	10-Jun	27.47	85.61	592	1000	87540.2	N	3
B162N_04	10-Jun	27.43	85.59	201	592	67976.9	N	4
B162N_05	10-Jun	27.39	85.58	6	201	35307.9	N	5

SE-6N_01	10-Jun	27.00	85.49	1200	1501	82923.6	N	1
SE-5N_01	11-Jun	26.99	86.01	1200	1502	62709.7	N	1
SE-6D_01	11-Jun	26.99	85.51	1200	1500	64868.9	D	1
SE-6D_02	11-Jun	27.01	85.48	1000	1200	40996.1	D	2
SE-6D_03	11-Jun	27.02	85.46	600	1000	98830.7	D	3
SE-6D_04	11-Jun	27.06	85.42	200	600	96157.5	D	4
SE-6D_05	11-Jun	27.07	85.37	0	200	36674.9	D	5
SE-6N_02	11-Jun	27.01	85.44	1000	1200	42390.6	N	2
SE-6N_03	11-Jun	27.01	85.42	600	1000	82616	N	3
SE-6N_04	11-Jun	27.02	85.37	200	600	90914.8	N	4
SE-6N_05	11-Jun	27.03	85.32	5	200	31349.3	N	5
SE-5D_01	12-Jun	26.95	85.97	1175	1501	N/A	D	1
SE-5D_02	12-Jun	26.98	85.96	1001	1175	35197.1	D	2
SE-5D_03	12-Jun	27.00	85.96	600	1001	100841.2	D	3
SE-5D_04	12-Jun	27.04	85.94	200	600	89737.9	D	4
SE-5D_05	12-Jun	27.07	85.91	5	200	26897.9	D	5
SE-5N_02	12-Jun	27.01	85.99	1000	1200	35397.2	N	2
SE-5N_03	12-Jun	27.03	85.98	600	1000	106644.6	N	3
SE-5N_04	12-Jun	27.07	85.94	201	600	103579.2	N	4
SE-5N_05	12-Jun	27.12	85.90	5	201	26416.4	N	5
SW-11N_01	17-Jun	27.00	92.52	1200	1253	7564	N	1
SW-11N_02	17-Jun	27.00	92.52	1000	1200	37208.8	N	2
SW-11N_03	17-Jun	26.98	92.54	600	1000	90838.5	N	3
SW-10N_01	18-Jun	26.94	91.95	1200	1350	34420.9	N	1
SW-10N_02	18-Jun	26.92	91.95	996	1200	46752.9	N	2
SW-11D_01	18-Jun	27.00	92.49	1200	1257	24839.9	D	1
SW-11D_02	18-Jun	26.99	92.48	990	1200	44991.2	D	2
SW-11N_04	18-Jun	26.97	92.57	199	600	100670.5	N	4
SW-11N_05	18-Jun	26.94	92.60	5	199	31465.7	N	5
SW-10D_01	19-Jun	27.00	92.00	1200	1353	59174.7	D	1
SW-10D_02	19-Jun	26.97	91.99	1000	1200	54916	D	2
SW-10D_03	19-Jun	26.94	91.98	599	1000	119286	D	3
SW-10D_04	19-Jun	26.89	91.96	200	599	77020.8	D	4
SW-10D_05	19-Jun	26.84	91.96	5	200	25026.5	D	5
SW-10N_03	19-Jun	26.90	91.94	600	996	95489.9	N	3
SW-10N_04	19-Jun	26.85	91.92	200	600	111912.5	N	4
SW-10N_05	19-Jun	26.80	91.89	5	200	30596.7	N	5
SW-9N_01	19-Jun	27.02	91.50	1200	1501	57830.1	N	1
SW-9D_05	20-Jun	26.99	91.44	0	202	N/A	D	5
SW-9N_05	20-Jun	26.91	91.44	0	199	N/A	N	5
SW-8N_01	20-Jun	27.01	91.02	1200	1500	69260.4	N	1
SW-9D_01	20-Jun	27.09	91.51	1198	1502	80898.5	D	1
SW-9D_02	20-Jun	27.06	91.48	999	1198	30620.6	D	2

SW-9D_03	20-Jun	27.05	91.48	600	999	74551.8	D	3
SW-9D_04	20-Jun	27.02	91.46	202	600	69085.7	D	4
SW-9N_02	20-Jun	26.99	91.49	1000	1200	30651.9	N	2
SW-9N_03	20-Jun	26.98	91.48	583	1000	89728.6	N	3
SW-9N_04	20-Jun	26.94	91.46	199	583	97929.6	N	4
SW-7N_01	21-Jun	27.00	90.50	1200	1400	32097.2	N	1
SW-8D_01	21-Jun	27.06	91.00	1200	1502	72483.9	D	1
SW-8D_02	21-Jun	27.03	90.97	999	1200	31236.5	D	2
SW-8D_03	21-Jun	27.02	90.97	598	999	71305.3	D	3
SW-8D_04	21-Jun	26.99	90.95	200	598	85798.4	D	4
SW-8D_05	21-Jun	26.96	90.93	5	200	52050.1	D	5
SW-8N_02	21-Jun	26.98	91.01	1002	1200	48324.4	N	2
SW-8N_03	21-Jun	26.96	90.99	602	1002	85098	N	3
SW-8N_04	21-Jun	26.94	90.96	199	602	106202.5	N	4
SW-6N_01	22-Jun	27.04	90.03	1200	1500	53230.4	N	1
SW-6N_02	22-Jun	27.01	90.04	1000	1200	32108.5	N	2
SW-7D_01	22-Jun	26.98	90.52	1199	1401	36927.4	D	1
SW-7D_02	22-Jun	26.96	90.51	999	1199	30858.5	D	2
SW-7D_03	22-Jun	26.95	90.50	600	999	78984.2	D	3
SW-7D_04	22-Jun	26.91	90.49	199	600	94372.6	D	4
SW-7D_05	22-Jun	26.88	90.48	0	199	37690.8	D	5
SW-5N_01	23-Jun	27.00	89.51	1200	1500	62907.7	N	1
SW-5N_02	23-Jun	26.97	89.51	1001	1200	43827.1	N	2
SW-6D_01	23-Jun	27.01	90.12	1200	1501	66811.7	D	1
SW-6D_02	23-Jun	26.97	90.12	999	1200	28320.6	D	2
SW-6D_03	23-Jun	26.96	90.12	600	999	67635.7	D	3
SW-6D_04	23-Jun	26.93	90.10	201	600	105046.3	D	4
SW-6D_05	23-Jun	26.89	90.08	0	201	35114.8	D	5
SW-6N_03	23-Jun	26.99	90.04	600	1000	84620.9	N	3
SW-6N_04	23-Jun	26.96	90.03	201	600	81385.6	N	4
SW-6N_05	23-Jun	26.93	90.01	5	201	32524.5	N	5
SW-3N_01	24-Jun	26.99	88.49	1200	1505	57554.9	N	1
SW-3N_02	24-Jun	27.00	88.53	1001	1200	36117.1	N	2
SW-5D_01	24-Jun	26.98	89.51	1199	1501	46940.1	D	1
SW-5D_02	24-Jun	26.96	89.52	998	1199	25052.5	D	2
SW-5D_03	24-Jun	26.95	89.52	600	998	74199.4	D	3
SW-5D_04	24-Jun	26.92	89.51	199	600	124325.7	D	4
SW-5D_05	24-Jun	26.87	89.47	0	199	28550.6	D	5
SW-5N_03	24-Jun	26.95	89.52	601	1001	71838.4	N	3
SW-5N_04	24-Jun	26.92	89.53	200	601	104815.4	N	4
SW-5N_05	24-Jun	26.87	89.54	1	200	33192.6	N	5
SW-3D_01	25-Jun	26.99	88.46	1199	1502	37416.1	D	1
SW-3D_02	25-Jun	27.00	88.48	1000	1199	30065	D	2

SW-3D_03	25-Jun	27.00	88.50	600	1000	65990.5	D	3
SW-3D_04	25-Jun	27.02	88.53	200	600	90142.6	D	4
SW-3D_05	25-Jun	27.03	88.57	5	200	29494.9	D	5
SW-3N_03	25-Jun	27.01	88.56	600	1001	87963.4	N	3
SW-3N_04	25-Jun	27.02	88.61	200	600	87043	N	4
SW-3N_05	25-Jun	27.01	88.65	5	200	29179.4	N	5
SE-2D_01	26-Jun	26.97	87.51	1198	1500	71453.4	D	1
SE-2D_02	26-Jun	26.93	87.51	998	1198	15204.7	D	2
SE-2D_03	26-Jun	26.93	87.51	600	998	32512.7	D	3
SE-2D_04	26-Jun	26.92	87.53	200	600	106667.6	D	4
SE-2D_05	26-Jun	26.93	87.57	2	200	17193.2	D	5
SE-4N_01	26-Jun	26.99	86.52	1194	1501	59446.2	N	1
SE-3N_01	27-Jun	27.03	87.01	1200	1499	64228.4	N	1
SE-3N_02	27-Jun	26.99	86.99	1000	1200	42990.1	N	2
SE-4D_01	27-Jun	27.01	86.46	1200	1505	44726.2	D	1
SE-4D_02	27-Jun	26.99	86.47	1000	1200	33396.5	D	2
SE-4D_03	27-Jun	26.97	86.49	600	1000	56451.7	D	3
SE-4D_04	27-Jun	26.95	86.51	201	600	90639.2	D	4
SE-4D_05	27-Jun	26.92	86.54	6	201	37257.3	D	5
SE-4N_02	27-Jun	26.97	86.55	1000	1194	40022.3	N	2
SE-4N_03	27-Jun	26.95	86.57	599	1000	74550.2	N	3
SE-4N_04	27-Jun	26.92	86.60	200	599	98490.9	N	4
SE-4N_05	27-Jun	26.92	86.64	7	200	35915.8	N	5
SE-1N_01	28-Jun	26.99	88.00	1200	1500	59626.5	N	1
SE-1N_02	28-Jun	27.01	88.03	1000	1200	47095.8	N	2
SE-3D_01	28-Jun	27.01	87.00	1200	1500	41336.6	D	1
SE-3D_02	28-Jun	26.99	87.02	1000	1200	26480.1	D	2
SE-3D_03	28-Jun	26.98	87.03	600	1000	72300.6	D	3
SE-3D_04	28-Jun	26.95	87.07	200	600	74990.2	D	4
SE-3D_05	28-Jun	26.93	87.10	6	200	28230.2	D	5
SE-3N_03	28-Jun	26.97	86.99	592	1000	81489.2	N	3
SE-3N_04	28-Jun	26.94	86.97	201	592	77120.3	N	4
SE-3N_05	28-Jun	26.91	86.96	5	201	34525.7	N	5
SE-1D_01	29-Jun	26.95	88.00	1201	1500	69695.2	D	1
SE-1D_05	29-Jun	27.03	88.15	5	199	17150.5	D	5
SE-1N_03	29-Jun	27.02	88.05	601	1000	104143.9	N	3
SE-1N_04	29-Jun	27.05	88.10	200	601	100204.1	N	4
SE-1N_05	29-Jun	27.07	88.14	0	200	23064.8	N	5

N/A indicates samples where flow data could not be calculated