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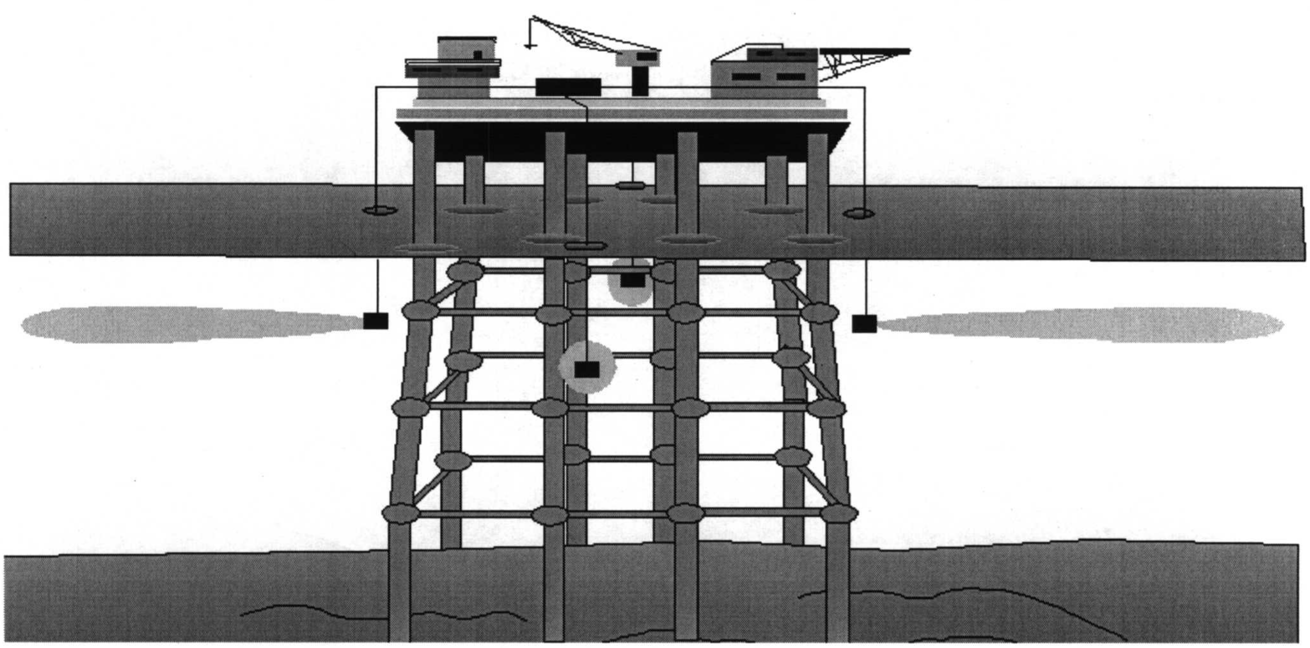
Coastal Marine Institute

Seasonal and Spatial Variation in the Biomass and Size Frequency Distribution of the Fish Associated with Oil and Gas Platforms in the Northern Gulf of Mexico



U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

Cooperative Agreement
Coastal Marine Institute
Louisiana State University

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EXECUTIVE SUMMARY

The largest artificial reef complex in the world, although unplanned, is composed of the 4,000 petroleum platforms scattered across the outer continental shelf (OCS) of the northern Gulf of Mexico (GOM). Scientists have hypothesized that artificial reefs and platforms improve and/or diversify habitat, increase resources, modify the assemblages of organisms in the region or concentrate existing resources. The placement of these defacto reefs has undoubtedly impacted the regional marine community although little information is available. Only recently have assessment methods been developed to test these and other hypotheses concerning artificial reefs.

Scientific investigations of fish assemblages at petroleum platforms did not start until the late 1970's. The consisted of visual surveys conducted by SCUBA divers, remotely operated underwater vehicles (ROV) and stationary cameras; the majority were short term, often only "snapshots" of the fishes at each site. The results of this early research provided insights into structure associated assemblages; abundance and species composition varied with platform, water depth and time of the year. However, results were difficult to compare due to problems with limited visibility, gear bias, diver avoidance and a lack of standardized survey methodology.

Earlier research demonstrated that towed hydroacoustics could be used to measure fish density near petroleum platforms off Cameroon. In response to the difficulty in assessing the fisheries resources associated with petroleum platforms and the bias's inherent with visual surveys. We used complimentary sampling methods of visual surveys and quantitative dual beam hydroacoustic surveys to document the assemblage of fishes associated with petroleum platforms in the northern Gulf of Mexico. With the sampling protocol established, the objectives of this research were to use dual beam hydroacoustics in conjunction with visual point count surveys to measure the density and size distribution of fishes associated with three petroleum platforms off the Louisiana coast. The goals of this research were to determine the effect of water depth on fish density, size distribution and species composition and ultimately to measure the fisheries value of platforms of different depths in the same geographical region.

The results of this project demonstrate the variability in abundance, size distribution and species composition of fishes associated with petroleum platforms. Similar results from earlier studies have been found with natural and artificial reefs. The variability in density and the size distribution of fishes at petroleum platforms in this project was linked to temporal, spatial and environmental variables.

At the shallowest site, South Timbalier 54 (ST54, water depth 22 m), the decline in fish density with distance from the platform was precipitous; after a distance of 18 m fish densities were similar to that of the open waters of the northern Gulf of Mexico. At the deeper sites a drop in fish density with distance from the site existed, although fish density was much higher to greater distances. At both Grand Isle 94 (GI94, water depth 60 m) and Green Canyon 18 (GC18, water depth 219 m) fish density approached that found in the open waters of the Gulf of Mexico after a distance of approximately 50 m. Despite some complications

hydroacoustics again illustrated its effectiveness in defining "area of influence" of the platform or the effective size of the artificial reef to the fish assemblage. As we defined it, the area of influence extended 10 m at GC18 and 18 m at GI94; fish densities within these distances were significantly higher than densities at greater distances and while this may result in conservative estimates of total abundance we feel it more accurately reflects the true abundance of fishes at the sites.

Six species made up over 90% of the fishes observed at each site on any survey and platform assemblages could be characterized as not specious and dominated by a few individual species. By site the dominant six species (highest to lowest abundance) were; GC18; creolefish, blue runner, Bermuda chub, almaco jack, amberjack, and barracuda; GI94; blue runner, horseeye jack, red snapper, mangrove snapper, gray triggerfish and barracuda; ST54; Atlantic spadefish, bluefish, blue runner, mangrove snapper, red snapper and sheepshead. While the species found at each site were somewhat unique and the dominant species at each site was different, a large amount of overlap of observed species existed between sites, especially adjacent sites. Seasonal migrations were common at each of the study sites. Since this research took place throughout the year we were able to document the seasonality alluded to by past research but not well documented. Common seasonal migrations observed in the winter were the appearance of significant numbers of Florida pompano and bluefish at ST54; and the appearance of blue runner and barracuda at GI94 and GC18. Summer seasonal observations included the appearance of tarpon and cobia at ST54, an increase in abundance of cobia, red snapper, greater amberjack and almaco jack at GI94, while no summer migrants were observed at GC18.

Comparison of results from this research with other petroleum platform studies from the northern Gulf of Mexico revealed similarities as well as significant differences in density and abundance. Comparison of acoustically derived estimates of density from our past research showed similar values with those from this project especially at ST54 and GI94. Mean densities from our earlier work at a site in 24 m of water were 0.244 (+/- 0.062, 95% confidence interval) fish$\cdot m^{-3}$, while mean densities found during this project were 0.333 (+/- 0.034) fish$\cdot m^{-3}$ at ST54, 0.496 (+/- 0.017) fish$\cdot m^{-3}$ at GI94 and 0.029 (+/- 0.003) fish$\cdot m^{-3}$ at GC18.

Total fish abundance estimates from the platforms in this project summer within the range of estimates of fishes at platforms from our earlier research in the Gulf of Mexico but are higher than those derived by visual only surveys. Our earlier research found an average of 12,473 (+/- 6,522, 95% confidence interval) fishes at a site in 24m of water, while during this project estimates of the total number of fish per site were 13,472 (+/- 1,346) at ST54, 28,952 (+/- 1,806) at GI94 and 13,856 (+/- 1,324) at GC18. One of the most interesting results of the project was the comparison of abundance between the sites. GC18 was 3 to 10 times larger than the others but the total abundance estimates were not significantly different than the smallest site (ST54), while the abundance estimates from GI94 were twice that of the other sites. The low abundances observed at GC18 are likely due to its location and water depth at the site. Fish abundance was essentially zero below 100 m and densities above 100 m were lower than those observed at the other sites. Because of the location of GC18 it is not influenced by the eutrophic waters on the continental shelf and the outflow from the Mississippi river, it most influenced by oligotrophic oceanic waters from the Caribbean. The combination of water depth and oligotrophic conditions likely reduced the abundance of fishes around GC18.

In response to the use of platforms by fishers in the region Louisiana and Texas both created artificial reef programs where the materials of choice are retired platform jackets. The standard deployment of these structures as reefs involves placing the jacket on its side, however, this minimizes vertical relief. If a platform such as GC18 was deployed in this manner it would extend approximately 80 m off the bottom. Based on our results at the site very few fishes would utilize the structure in this orientation and its value as an artificial reef would be questionable. This project is the first demonstrating the importance of vertical relief in maximizing the effectiveness of platforms as artificial reefs, especially with respect to deep water environments.

This research confirms the variability of fish assemblages associated with petroleum platforms and reinforces the need to sample on each side and throughout the water column to obtain an accurate estimate of fish abundance. The high abundance of fishes found at the sites demonstrates the importance of petroleum platforms to the marine environment of the northern GOM. Although some variance was observed, 10,000 to 30,000 fishes were found per site at any one time and since over 1,000 platforms are located in similar water depths it is clear that these structures impact the fisheries of the region.

This study continues to demonstrate the utility of merging hydroacoustics and visual survey techniques to study the assemblage of fishes associated with petroleum platforms. The combination of these techniques allows for the measurement of the area of influence of these defacto artificial reefs, as well as estimates of abundance, size distribution and species composition throughout the water column and over long time periods.

INTRODUCTION

The largest artificial reef complex in the world, although unplanned, is composed of 4,000 petroleum platforms scattered across the outer continental shelf (OCS) of the northern Gulf of Mexico (GOM). It is hypothesized that artificial reefs and platforms improve and/or diversify habitat, increase resources, modify the assemblages of organisms in the region or concentrate existing resources. The placement of these defacto reefs has undoubtedly impacted the regional marine community although little information is available. Only recently have assessment methods been developed to test these and other hypotheses concerning artificial reefs.

Since the first petroleum platform was placed off the Louisiana coast in 1948, they have been the preferred destination of commercial and recreational anglers. Past research has found that platforms were the destination of 70% of all recreational angling trips in the Exclusive Economic Zone (more than 4.8 km from shore) (Reggio 1987) and 37% of all saltwater recreational angling trips off the Louisiana coast (Witzig 1986). The catch at these structures was estimated to constitute 30% of the recreational fisheries catch for the region (Avanti Inc. 1991). Results from a logbook program documented that 48 species were commonly caught and that catch rates of the target species, spotted seatrout and red snapper, averaged over 2 fish/angler hour (Stanley and Wilson 1991). The high documented catch rates and popularity with user groups in the region make platforms an important component in the regions fisheries. Despite the number of sites, the time the structures have been present and their importance to the region's fisheries, little information exists on the assemblage of fishes associated with petroleum platforms.

Scientific investigations of fish assemblages at petroleum platforms did not start until the mid 1970's. They consisted of visual surveys conducted by SCUBA divers, remotely operated underwater vehicles (ROV) and stationary cameras; the majority of these projects were short term, often only "snapshots" of the fishes at each site (Shinn 1974, Sonnier et al. 1976; Gallaway et al. 1981; Continental Shelf Associates 1982; Gallaway and Lewbel 1982; Putt 1982). The results of this early research provided insights into structure associated assemblages including variations in abundance and species composition with platform, water depth and time of the year. However, results have been difficult to compare due to problems with limited visibility, gear bias, diver avoidance and a lack of standardized survey methodology. Although visual surveys are the method of choice to survey natural and artificial reefs (Bortone and Kimmel 1991), the presence of SCUBA divers can bias the density and possibly species composition of fishes at the site (Sale and Douglas 1981; Brock 1982; Bohnsack and Bannerot 1986; Stanley and Wilson 1995).

In response to the difficulty in assessing the fisheries resources associated with petroleum platforms and the bias's inherent with visual surveys, Gerlotto et al. (1989) demonstrated that towed hydroacoustics could be used to measure fish density near petroleum platforms off Cameroon. We later utilized complimentary sampling methods of visual surveys and quantitative dual beam hydroacoustic surveys to document the assemblage of fishes associated with petroleum platforms in the northern Gulf of Mexico (Wilson and Stanley 1991; Stanley and Wilson 1995, 1996, 1997).

Despite the range of methodologies, investigators found that fish abundance and species composition change dramatically with proximity to platform, location, and time of year (Sonnier et al. 1976; Continental Shelf Associates 1982; Gallaway and Lewbel 1982; Putt 1982; Stanley and Wilson 1996; 1997). Gerlotto et al. (1989) found that fish densities were 5 to 50 times higher immediately adjacent to a platform than 50 m away. Stanley and Wilson (1996, 1997) reported the near field area of influence of a platform on the continental shelf (water depth 25 m) to be 16 m away from the platform. Fish densities within 16 m of a platform were 3 to 25 times higher than at greater distances and densities observed at distances greater than 30 m were comparable to background levels of the open waters of the northern GOM. Long-term studies reported that fish populations at petroleum platforms were highly variable over time. Putt (1982) observed fluctuations of a factor of two from month to month in density. While Stanley and Wilson (1996, 1997) reported that monthly and seasonal abundances change by up to a factor of five.

Based on these previous research efforts, we know that significant numbers of fishes are found at these sites, although they do not exhibit a large species diversity and do not appear to have a high site fidelity. Since many of the common species at platforms are highly sought after by commercial and recreational users and there are a large number of platforms in the region, it is hypothesized that platforms they have considerable importance to regional fisheries. Despite this hypothesis of the importance of platforms on the regional fish assemblages, quantifiable censuses of fish assemblages were not possible until the combined use of dual beam hydroacoustics to enumerate the fishes at these sites and visual surveys with a remotely-operated underwater vehicle (ROV) to determine species composition were applied. While the results from previous research provided insights into the species composition and abundance at platforms the results are not comparable nor were they quantifiable. In order to measure the impact of the presence of platforms on the fisheries resources a standardized quantifiable methodology must be used.

The reuse of petroleum platform jackets is becoming a common phenomena as both Louisiana and Texas have established state artificial reef programs and have used approximately 100 retired structures to date. With the success of the artificial reef programs in the Gulf of Mexico, other countries are actively exploring the potential use of retired platforms as artificial reefs. Despite the popularity and enthusiasm for the use of these structures as artificial reefs a number of questions remain regarding the practical value of retaining petroleum platforms as artificial reefs. Questions include the affect of water depth, geographic location, seasonal migrations and hypoxia on the platform associated fish assemblages. These issues need to be addressed to determine the effectiveness of these structures as artificial reefs and their impact on the marine ecosystem in the region.

The specific objectives of this research were to:

1) Measure and compare the species composition, biomass and size frequency distribution of fish associated with three petroleum structures. It has been proposed that fish communities around oil and gas platforms vary with platform size and water depth. Therefore it may be inappropriate to extrapolate results from one depth to others. Despite the possibility of along-shelf differences, a comprehensive description of the platform associated fish communities at different depths will improve our understanding of these environments.

2) Determine the effect of temporal, physical and chemical variables on species composition, biomass and size distribution of fish associated with platforms. If reef fish are habitat limited then fish biomass should increase with platform size. In addition, if our results from WC352 hold true, biomass and size distribution should change over diel and seasonal periods.

3) Define the spatial near field influence of each platform on the abundance of fish. It is critical to have a measure of the near field of influence of a platform in order to accurately estimate the associated fish population. Estimates of platform specific fields of influence will allow us to covert measured densities into area estimates of fish densities.

4) Document the near field behavior patterns of fish around each platform. What behavioral patterns can be inferred by the diel and seasonal movements of fish around oil and gas platforms? Insight into this movement may help us better understand the influence that platforms have on fish communities and enable us to predict how future oil and gas activity will affect these populations.

METHODS

This research project was designed to effectively sample platforms in three water depths (shallow continental shelf, mid continental shelf, continental slope, Figure 1), across the Louisiana shelf during the four seasons (spring, summer, fall, and winter). Based on our previous research, a sampling regime of five days at each platform were required per site. Transport logistics limited us to a minimum of one week between sites, therefore the project was designed, and constrained to, twelve sampling events (four per site), during a project year.

Site Descriptions

Research trips were conducted quarterly (August 1994 to April 1997) to petroleum platforms Grand Isle 94 (GI94) (located at 28°31.33 N and 90°05.52 W, water depth 60 m, installed 1975, operated by Mobil USA Inc.) and Green Canyon 18 (GC18) (located 27°56.48' N and 91°02.28' W, water depth 219 m, installed in 1988, operated by Mobil USA Inc.) and quarterly (August 1995 and April 1997) to South Timbalier 54 G (ST54) (located 28°50.01'N and 90°22.40' W, water depth 22m, installed 1956, operated by Exxon USA Inc.). The platforms were selected to approximate a transect extending from Fourchon LA; ST54 was 24 km southwest from port; GI94 was 54 km south; GC18 was 179 km southwest (Figure 1). ST54 and GI94 were eight pile production platforms while GC18 was a large six pile production platform. Extraction and production of natural gas and crude oil occurred at each site and research activities were scheduled to minimize our impact on regular platform operations. Three research trips could not be completed during the project including spring 1995 trips to GI94 and GC18 due to lightening damage to the hydroacoustic equipment and the fall 1996 research trip to ST54 due to activities on the platform which Exxon USA Inc. deemed dangerous and denied access to the platform for research purposes over that period.

Three arrays of stationary dual beam hydroacoustic equipment developed through our past research were used to determine the density of fishes associated with the study sites (Wilson and Stanley 1991; Stanley and Wilson 1995, 1996, 1997,1998, in press). Arrays 1 and 2 (Figure 2) were designed to measure *in situ* target strength distribution and density of fishes immediately adjacent to each side of the platform. Array 1 consisted of four upward oriented transducers (120 kHz) suspended approximately 25 m below the surface (at ST 54 they were placed on the bottom), one on each side of the platform. The upward facing transducers provided acoustic coverage from the a depth of 10-15 m to the surface (Figure 2). Array 2 consisted of four downward oriented transducers (120 kHz) placed approximately 3 m below the surface, one on each side of the platform. The downward facing transducers provided acoustic coverage from a depth of 10 m to within 1 - 5 m of the substrate depending on the site. The use of four transducers (both upward and downward orientations) enables the calculation of density throughout the water column on all sides of the platform.

Array 3 was designed to estimate the near field density of fishes associated with the structure and consisted of four horizontally aligned dual beam transducers (120 kHz) deployed off each side of the platform at depth of 12 m (Figure 3). This arrangement enables relative fish density estimates to a distance of approximately 80 m from the platform and determination of the near field area of influence of each site.

Total fish abundance estimates at each site were calculated by determining the near-field area of influence of the platform, then multiplying mean density values for sample and platform side, in number of fish/m^3, by the volume of water on each side of the platform. Fish density in the center of the platform was calculated by averaging the density estimates of the four sides of the platform. Fish abundance in the center of the platform was calculated by multiplying the estimated fish density at the center by the volume of water in the center of the platform. After estimates of the number of fish were estimated on each side and center of the structure by strata these estimates were summed to calculate the total number of fishes at a site.

Horizontal and vertical acoustic sampling were conducted over three consecutive 24 hour intervals for each month's sampling trip; two hours of hydroacoustic data were collected encompassing four periods (dawn, noon, dusk and midnight) over each 24 hour interval. Hydroacoustic data were collected sequentially from each of the transducers in five minute intervals for each trip.

Acoustic data were collected using a Biosonics model ES2000 scientific echosounder/multiplexer-equalizer. The source levels ranged from 218.5 to 220.5 dB re μPa at 1 m depending on the transducer. The 20 log R system gains ranged from -156.4 to -146.8 dB re V μPa and the 40 log R system gains ranged from -168.9 to -165.8 dB re V μPa varying with transducer. Sampling rate ranged from 2 pings s^{-1} to 10 pings s^{-1} depending on array and sampling depth. Pulse width was 0.4 ms. Received signals were adjusted for spreading loss by applying a 40 log R time varied gain, digitized and recorded on digital audio tape (DAT). Reference voltages (approximately 5 V AC) were recorded on each DAT tape and used to calibrate the acoustic system prior to echo integration and target strength analyses. During data collection background noise levels were measured and did not exceed 40 mV. The voltage threshold used in later analyses was 100 mV corresponding to a minimum detectable target strength of -56 dB, or a fish of 2.5 cm total length according to Love (1971).

Digitized hydroacoustic data were processed by a Biosonics model 281 dual-beam processor. Target strengths and an average backscattering cross section (σ) for each depth strata were estimated using Biosonics TS software, and density estimates were calculated using Biosonics Crunch software with σ for each sample and depth strata. Fish densities were calculated for 5 to 20 m depth vertical intervals for Array 1 and 2 depending on site.

Visual point count surveys were performed on each sampling expedition on the downcurrent side of the platform using a Hydrobotics Orpheus, Benthos MiniRover, or Deep Ocean Engineering HD2 ROV. Visual surveys were performed on nektonic fishes freely swimming within the area of influence of the platform. Cryptic fishes were not included in the visual surveys since they could not be assessed in the acoustic surveys. Visual surveys done with ROV's were recorded on videocassette and the point counts performed later identifying individual fish to the lowest taxonomic level. Estimates of percent species composition for each strata corresponding to the acoustic strata were calculated from the visual point counts.

To estimate the number fishes by species at each site by depth strata the percent species composition data was applied to the quantitative acoustic estimates of total abundance and confidence intervals for each strata from every sampling trip.

Environmental data consisting of temperature (+/- 0.1 °C), salinity (+/- 0.1 ppt) and dissolved oxygen (+/- 0.5 ppm) were measured with a Seabird SBE 19 meter. Current speed (+/- 0.1 m/s) and direction (+/- 1 degree) were measured an Interocean S4 meter during each hydroacoustic data collection period through the entire water column at each site.

Data Analysis

Fish density data (number of fish·m^{-3}) from echo integration analysis contained a large number of zero values, similar to catch data from traditional fisheries sampling techniques (Pennington 1983; 1985; Shaw et al. 1985; Stanley and Wilson 1995; 1996; 1997). Therefore, hydroacoustic density data were transformed by log(density + 1) to approximate the normal distribution.

Two vectors describing current speed and direction to the east-west and north-south were calculated (Pond and Pickard 1982). Currents from the east and north were scaled to positive values; west and south currents were scaled to negative values. This scaling provided two vectors which represented current speed and direction in later analyses.

Randomized block ANOVA's (SAS Institute Incorporated 1986) were performed for each site with horizontal log(density + 1) of density data on distance from the platform, time of day (TOD), quarter, year and their interactions, blocking on side of the platform to examine differences due to these variables. Tukey's studentized range tests (Ott 1982) were used to compare the means of significant variables for horizontal analyses. Statistical tests were reported as significant at the alpha $\leq$ 0.01 level.

Separate randomized block ANOVA's using SAS (1986) GLM procedures were performed with vertical target strength data and log(density + 1) of vertical density data for each site on depth, time of day, quarter, year, temperature, dissolved oxygen level, east and north current vectors, squared east and squared north current vectors and their interactions, blocking on side of the platform to examine differences due to these variables. Tukey's studentized range tests (Ott 1982) were used to compare the means of significant variables for vertical and horizontal analyses. Tests were reported as significant at the alpha $\leq$ 0.01 level.

The total abundance estimates at the platform were calculated by determining the near-field area of influence of the platform, then multiplying mean density values (number of fish·m^{-3}) for each month and platform side by the volume of water on each side of the platform. Fish density in the center of the platform, not measured with acoustics due to interference by structural members, was assumed to be the average of the density estimates of the four sides of the platform. Fish abundance in the center of the platform was calculated by multiplying the estimated fish density of the center by the volume of water in the center of the platform.

RESULTS

South Timbalier 54

Vertical Density Distribution

Densities of fishes at the ST54 production platform (water depth 22 m) were highly variable over the study period ranging from 0 to over 5.2 fish/m^3. A RBD ANOVA with platform side as a block was used to examine differences in density due to year, season, time of day, current vectors, temperature, dissolved oxygen, depth and selected interactions. Density varied significantly with season, time of day, depth, platform side, east current vector, north squared current vector, salinity, dissolved oxygen and the time of day * depth interaction (Table 1).

Temporal differences in fish density were detected between season, time of day and the interaction of season*time of day (Table 1, Figure 4). Fish density was highest in 1995 and 1997 (although only one research trip occurred in 1997) indicating annual variation in the fish density at the site (Table 1). Seasonally, fish densities were significantly higher in the fall than all other seasons and lowest densities found in the spring and summer (Figure 5). No overall trend of fish densities with season and time of day could be detected over the entire study period but overall fish densities were significantly higher at midnight than all other times (Figure 6).

Spatially fish density varied with platform side, depth and the interactions of depth*time of day and depth*season. Significantly higher densities were found on the north side of the platform than all others (Figure 7). With respect to depth, densities were significantly higher in the upper 10 m of the water column than all other depth strata, although an increase in density from 20-22 m was observed when dissolved oxygen levels were greater than 3 ppm (Figure 8). While the interaction of depth*time of day was significant (Table 1) in the overall model, examination of fish density by depth with time of day did not reveal an overall trend with exception of higher fish densities in the upper 10 m regardless of time of day. The interaction of depth*season was also significant and examination of density values by depth for each season revealed significantly lower densities in the spring and summer from 20-22 m than in the fall and winter. This difference is likely due to the low oxygen conditions found near the bottom during these periods.

Environmental conditions also impacted density based on results from the RBD ANOVA (Table 1). Fish density was significantly affected by temperature, dissolved oxygen, east current vector and the north current vector squared (Table 1). Fish density decreased slightly with temperature although this is inconsistent with highest observed densities were from the fall and winter seasons when temperatures were lowest (Appendix 1) . A direct relationship between dissolved oxygen and density existed; highest densities were found at high levels of dissolved oxygen. During the summer 1996 sample a hypoxic event was noted and dissolved oxygen levels were < 1 ppm below 15 m. Along with these low dissolved oxygen levels, fish density was essentially zero from 15-22 m, but higher than average densities were detected from 0-10 m (Figure 9). The relationship between current speed and fish density, while significant (Table 1), was difficult to interpret. Fish density generally increased with increasing current speed although the maximum current speeds observed were 43 cm/s. Since the mean current speed was 11.3 cm/s, the majority of the speeds observed were likely not high enough to influence the behavior of the fishes as the mean size of the fishes was sufficient to negate the influence of low observed currents.

Horizontal Density Distribution

Horizontal density of fishes varied temporally and spatially at the platform. Spatially, horizontal fish density varied with side of the platform and distance from the platform (Table 2). Fish densities were significantly higher in the 2-10 and 10-18m strata than all others (Figure 10). At distances from 18-82 m fish densities were at only half of those nearer to the platform (Figure 10). Temporally, horizontal fish density varied significantly between years, seasons and time of day reinforcing the temporal variation observed with the vertically oriented transducer arrays (Table 2). Annual variation in horizontal density revealed highest horizontal density in 1995 and lowest in 1997, while seasonally highest densities were found in the fall with all other seasons not being significantly different (Table 2). Within a 24 hour period significantly higher densities were found at noon, while all other times were not significantly different (Table 2).

Horizontal fish densities were used to measure the near field area of influence of the platform. Based on the decrease in fish density with distance from the platform the near field area of influence was estimated at 18 m (Table 2, Figure 10). Beyond 18 m fish densities dropped off significantly and fish densities were not significantly different from 18 to 84 m (Figure 10).

Estimated Number of Fish and Species Composition

Examination of visual survey results revealed interesting and consistent trends in species composition with respect to depth, season and the dominance of a few species over the sample period (Table 3 a-g). A total of sixteen species were detected by the ROV during visual surveys but six species including Atlantic spadefish, bluefish, blue runner, mangrove snapper, red snapper and sheepshead consistently comprised over 95% of the fishes enumerated at the site (Table 3a-g). Less commonly observed species included seasonal migrants detected in warmer periods; barracuda, Bermuda chub, cobia and tarpon and species found during cooler water periods; Florida pompano and red drum (Table 3 a-f).

During all surveys planktivores were numerically dominant and the most common species observed were Atlantic spadefish and blue runners (Table 3a-f). These species typically constituted over 55% of the fishes surveyed (Table 3g) and either species was the most numerically dominant depending on season. Blue runners were generally more abundant in the warmer surveys with the exception of the summer of 1996 when they were absent from the survey (Table 3e, Figure 11). A possible cause for their absence was the presence of a hypoxic event when depressed dissolved oxygen conditions were found in the lower 12m of the water column (Appendix 1). During the hypoxic event there was a complete absence of fish below 15m. Dissolved oxygen levels from 15 - 22 m were less than 0.2 ppm while from 10 - 15 m dissolved oxygen levels were < 3 ppm; only a few red snapper were detected in this strata.

Depth also played an important role in the distribution of species at ST54 and consistent trends were observed with respect to the presence of species and depth (Table 3a-g). Examination of the depth distribution of the six most abundant species showed that Atlantic spadefish and bluefish were found in the upper water column, mangrove snapper and sheepshead were found throughout the water column but were most common at mid-depth, red snapper were most abundant in the lower 7 m of the water column and only blue runner were found evenly throughout the water column (Table 3g). Trends in depth distribution of the less common species show that barracuda, Florida pompano and red drum were most common near the bottom while cobia, gray triggerfish, jack crevelle, lookdown, and tarpon were observed throughout the water column (Table 3g).

Seasonal trends in species composition and depth distribution were also observed at ST54. During the winter sampling trips bluefish abundance was highest and they were found at mid-depth, blue runners were uncommon and although overall Atlantic spadefish abundance did not change they were found throughout the water column in contrast to their abundance near the surface during other sampling periods (Table 3a-f). During warmer sampling periods blue runner and mangrove snapper were more common and generally found in the upper water column (Table 3a-f).

Extrapolating the species composition estimates with the acoustic abundance data for each depth strata provided estimates of individual species abundance throughout the water column (Table 4, Figure 12). By species, Atlantic spadefish or blue runners were the most abundant fish at ST54 with the exception of the spring and summer 1996 samples when mangrove snapper abundance was slightly higher (Table 4a-f). Large fluctuations of 3-5 fold , by species was detected between samples (Table 4a-f, Figure 12). The species exhibiting the largest change over the sample period was mangrove snapper with abundances changing from an approximately 80 individuals in the summer of 1995 to approximately 4000 in the fall, then dropping to an estimated 90 fish in the Winter of 1996 and increasing to 2900 in the Spring of 1996 (Table 4a-d). Large fluctuations in abundance by species over time was observed and an example was the presence of over 2400 bluefish in the winter 1996 sample while at other times of the year this species was absent (Table 5a - f, Figure 12). With the exception of mangrove snapper the only recreationally and commercially important species that was abundant at ST54 were red snapper, other highly sought after species were generally rare (Table 4a-f).

The mean abundance, with 95% confidence intervals, of fishes at ST54 by sample was variable with a low of 7159 (+/- 993) fish at in the summer of 1995 and a high of 28553 (+/- 6141) fish in the fall of 1995 (Table 4a-f). Averaged over all the sample periods there were 13472 (+/- 1347) fish at the site (Table 4g). By depth 58% of the fishes were found in the upper 10 m of the water column with the lowest abundance of fish found adjacent to the substrate (Table 4g).

Grand Isle 94

Vertical Density Distribution

Densities of fishes at the GI94 production platform (60 m depth) were variable over the study period ranging from 0 to over 1.1 fish/m^3. A RBD ANOVA with platform side as a block was used to examine differences in density due to year, season, time of day, current vectors, temperature, dissolved oxygen, depth and selected interactions. Density varied significantly with year, season, time of day, depth, platform side, north current vector, east squared current vector, dissolved oxygen and temperature (Table 5).

Temporal differences in fish density were detected between year, season and time of day (Table 5). Fish density was significantly different between all years examined with significantly higher densities observed in 1997 than all other years, although only one research trip occurred in 1997 (Figure 4). The lowest annual densities were found in 1996 with 1994 and 1995 having significantly higher annual densities (Figure 4, Table 5). Seasonally, fish densities were significantly higher in the winter followed by fall then spring, and lowest in the summer (Figure 3, Table 5). Mean densities in the winter and fall were on average five to ten times higher than in the spring and summer (Figure 5). While fish densities varied with time of day and were significantly different (Table 5), the differences were much smaller than any other temporal variable examined (Figure 6). Highest densities were found at dawn and significantly lower densities were detected at dusk, otherwise densities were not significantly different (Figure 6).

Spatially, fish density varied with platform side and depth (Table 5). Significantly higher densities were found on the north and west side than on the others (Figure 7). Lowest densities were found on the east side of the platform (Table 5). Densities varied significantly with depth, with lowest densities were found from 5 - 20 m and highest near the surface and bottom (Figure 8). Significantly higher densities were found immediately above the bottom (water depth 50 - 55 m) than at all other depth strata (Figure 8). Other regions of high densities included 0 - 5 m and 40 - 60 m (Table 6, Figure 8).

Results from the RBD ANOVA of environmental variables showed significant impact on fish density due to temperature, dissolved oxygen, north current vector and the east current vector squared (Table 5). Fish density decreased slightly with temperature although this is in conflict to the highest observed overall densities which occurred in the fall and winter when temperatures are the lowest (Figure 5) and highest observed densities from 40 - 60 m where temperatures were generally lowest (Figure 8, Appendix 2). A positive relationship was detected between dissolved oxygen and density as density increased with increasing dissolved oxygen levels although hypoxic conditions were not observed at GI94. The lowest dissolved oxygen levels were found were 4.4 ppm (Appendix 2). This is the likely explanation for the positive relationship between dissolved oxygen and density since hypoxia was not an issue at GI94 (Appendix 2, Figure 8). The ANOVA results indicated a positive relationship between current speed and fish density (Table 5). While the relationship showed and an increase in density with decreasing current speed, less than 5% of the current observations exceeded 20 cm/s, with mean current speed of 10.0 cm/s and the maximum observed current speed was 39.6 cm/s (Appendix 2). Because of the low number of high current speed observations it is more plausible that the high densities observed at low current speeds were due to depth; the highest densities were found from 40 - 60 m where current speeds were typically the lowest (Figure 8, Appendix 2). Due to the relatively large size of the fishes observed at the site it is probable that the current speeds observed were not great enough to influence the behavior of the fishes.

Horizontal Density Distribution

Horizontal density of fishes varied temporally and spatially at the platform (Table 6). Spatially, horizontal fish density varied with side of the platform and distance from the platform while temporal variation was observed with year and season (Table 6). The interactions of time of day and distance from the platform, season and time of day and time of day and distance from the site were also significant (Table 6). The spatial relationship of horizontal density differing with side of the platform reinforced a similar relationship observed in the significant change in fish density between sides also observed in the vertical density distributions (Figures 8 and Table 6). With respect to side, the horizontal results were similar to the vertical density results. Highest densities were found on the north, west and south sides for both transducer arrays (Table 6, Figure 7).

The close association of fishes with platforms observed at shallower depths was not observed at GI94 (Figure 10). Relative fish density was significantly higher from 0 - 58 m away from the site than at all other distances examined (Figure 10). Lowest observed densities were at distances greater than 58 m from the site and beyond 58 m fish densities were similar to those acoustically measured in the open waters of the northen Gulf of Mexico (Figure 10).

Temporally, variation in relative density was found with year and season. Again, the temporal horizontal density results were similar to the vertical results with significantly higher densities were found in 1997 and 1995 as compared to 1994 and 1996 (Table 6, Figure 4). With respect to season highest densities were found in the winter and fall for densities measured with both horizontal and vertical transducer arrays (Table 6, Figure 6). The significant interaction terms of distance and season, time of day and distance and season and time of day emphasize the variability in the density of fishes associated with the site.

Horizontal fish densities were used to measure the near-field area of influence of the platform. The highest horizontal densities measurements were from 0-18 m, but these densities were not significantly higher than those from 18-58 m (Figure 10). Despite the measurement of high relative densities from 18 to 58 m at GI94, we estimated the near field area of influence at 18 m, while the relationship of fish density with distance from the site was difficult to resolve, we feel that a conservative area of influence of 18 m best reflects a true population size of the fishes at the site (Table 6, Figure 10). The increased water clarity and pelagic species composition at GI94 likely increased distance the fishes ranged from the site. However, based on the visual data from the ROV, 18 m best reflects the distance fishes typically ranged from the site based on the visual observations . Beyond 58 m the relative fish densities measured at GI94 decreased dramatically to levels found at other sites (Figure 10).

Estimated Number of Fish and Species Composition

Examination of visual survey results demonstrated interesting trends in species composition with respect to depth, season and the dominance of one species over the sample period (Table 7 a-k). A total of twenty-four species were detected by the ROV during visual surveys but one species, blue runner, comprised on average 87% of all observed fishes (Table 8k). By grouping blue runners with the next five most abundant species, horseeye jack, red snapper, mangrove snapper gray triggerfish and barracuda, over 95% of the fishes observed at the site were accounted for (Table 7a-k). Uncommon species at the platform included bigeye, black grouper, cobia, gag grouper, ocean triggerfish, rainbow runner, vermillion snapper and yellowfin grouper (Table 7a-k).

Seasonality in the abundance of fishes was detected at GI94 with cobia, red snapper, almaco jack and amberjack more common in the spring and summer than during cooler periods (Table 7a-j). During fall and winter we found an increase in the abundance of barracuda and blue runner (Table 7a-j). Blue runners exhibited the most dramatic seasonality. Few were found during summer samples when they constituted <30% of the fishes observed, however during fall, winter and spring samples blue runners were the dominant fish observed and composed 71 to 94% of the fishes found at the site (Table 7a-j). While most other species were found at a relatively narrow depth range, blue runners were found throughout the water column, although they were slightly more abundant near the surface (Table 7a-k). Fishes with higher abundance from mid depth to the bottom included greater amberjack, red snapper and scamp (Table 7a-k). Surface oriented species included bar jack, Bermuda chub and rainbow runner while species found throughout the water column included almaco jack, barracuda, gray triggerfish, horseeye jack, jack crevelle, and mangrove snapper (Table 7a-j).

Extrapolating the species composition estimates with the acoustic abundance data for each depth strata provided estimates of individual species abundance throughout the water column (Table 8a-k). The total number of fish at the GI94 ranged from a low of 2,380 (+/- 740, 95% confidence interval, Table 8g, Figure 12) during the Spring 1996 sample period to a high of 67,027 (+/- 4,696, Table 8j, Figure 12) during the Winter 1997 period with a mean of 28,952 (+/- 1,806) fishes averaged over all the sample periods. The seven most abundant species (highest to lowest) were blue runner, red snapper, horseeye jack, mangrove snapper, greater amberjack, barracuda and grey triggerfish (Table 8k). Blue runner dominated the number of fishes observed at the site with an average of 25,188 (+/- 1571, 95% confidence interval). Their abundance was highly variable with a low of 2,242 (+/- 698) observed in the Spring 1996 sample (Table 8g, Figure 11) to a high of 62,335 (+/-4,367) from the Winter 1997 sample (Table 8j, Figure 11). The estimated number of blue runner was also variable with a five to sixfold change in abundance was observed from the Fall of 1994 to Spring 1995 (Table 8b-d, Figure 11). Generally, their abundance would peak in fall or winter and then drop during other surveys (Figure 11).

The abundance of greater amberjack, horseeye jack, mangrove snapper, and red snapper was typically highest in fall and winter and lower during spring and summer samples (Figure 13), although the second highest number of red snapper observed over the study period was found during the summer 1994 research trip. Significant changes in the abundance of other individual species were also noted. Three to fivefold differences in estimated abundance between sample periods were common for greater amberjack, horseeye jack, mangrove snapper, and red snapper (Figure 13).

Green Canyon 18

Vertical Density Distribution

Densities of fishes at the GC18 production platform (water depth 219 m) were variable over the study period ranging from 0 to over 1.44 fish/m^3. A RBD ANOVA with platform side as a block was used to examine for differences in density due to year, season, time of day, current vectors, temperature, dissolved oxygen, depth and selected interactions. Density varied significantly with platform side, season, depth, north current vector squared and the interactions of time of day and depth and season and depth (Table 9).

The only significant temporal differences in fish density were detected with season and the interaction between depth and time of day (Table 9). Seasonally, fish densities were significantly higher in the winter and summer than the fall and spring (Figure 5, Table 9). Mean densities in the winter and summer were on average two to five times higher than in the spring and fall (Figure 5). Other differences observed in temporal variables examined (e.g., year and time of day) were not significant (Table 9, Figures 4 and 6).

Spatially, fish density varied with platform side and depth (Table 9). Significantly higher densities were found on the west side of the platform than at all others, and densities were not significantly different on the north and south sides (Figure 7). Densities on the east side were five to eight times lower than those on other sides of the platform (Table 9, Figure 7). The most dramatic results of the research project was the relationship between fish density and depth at GC18. A significant and spectacular drop in density with depth was observed at GC18 below 100 m (Table 9, Figure 14). Fish densities from 0 - 15 m were significantly higher than all other depth strata and were 4 to 68 times higher than all other depths (Figure 14). Densities from 15 to 95 m were not significantly different but were 3 to 12 times higher than depths from 115 to 210 m (Figure 14). From 115 to 210 m fish density was less than 0.002 fish/m^3, essentially zero, and lower than densities in the open waters of the Gulf of Mexico on the continental shelf (Figure 14).

Environmental conditions did little to impact fish density at GC18 based on results from the RBD ANOVA (Table 9). Fish density was significantly affected only by the north current vector squared, although temperature and dissolved oxygen were close to significant with a probability of a greater F of 0.0206 and 0.0283, respectively (Table 9). There was an inverse relationship between fish density and north vector squared as fish density decreased slightly as north vector squared increased. This decrease is likely due to observations from the summer 1995 sample when relatively high current speeds with a northerly component were found (Appendix 3). The close to significant relationship between density and temperature is likely correlated to the significant seasonal relationship documented earlier (Table 9, Figure 5) with highest densities found in the winter, although this relationship is confounded by the low densities at depths where temperatures were lowest (Figure 14, Appendix 3). The observation of declining density with low dissolved oxygen levels is probably due to the low fish densities observed below 95 m where dissolved oxygen levels were lowest (Table 9, Figure 14, Appendix 3). However, no hypoxic events where detected at GC18 (Appendix 3).

Horizontal Density Distribution

Horizontal density of fishes varied temporally and spatially at the platform (Table 10). Spatially, horizontal fish density varied with side of the platform and distance from the platform. Temporal variation was observed with season, time of day and the interactions of time of day and distance from the platform (Table 10).

The differences in fish density with side of the platform observed with the horizontally oriented transducers reinforces the observed variation in fish density with platform side from the vertically oriented arrays (Figure 7, Table 10). The close spatial association of fishes with platforms at sites on the continental shelf (e.g., ST54) was more evident at GC18 than GI94 (Figure 10). Fish density was significantly higher from 2-10 m away from the site than at all other distances examined (Figure 10). Densities from 10-42 m were not significantly different from each other and lowest observed densities were from 50 - 82 m from the site (Figure 10).

Temporally, the variation in horizontal fish density was found with respect to season is similar to the variation in fish density with season observed from the vertical density arrays (Table 9 and 10). Diel variation was observed in the horizontal density of fish with highest densities found at noon (Table 10). This was the only case during this research project where diel variation was observed, and because e it was not observed with the vertical transducer array it is presumably due to off site behavior of fishes in the upper water column since the maximum deployment depth of the horizontal transducers was 13 m and would not reflect behavior of fishes throughout the water column.

Horizontal densities were used to measure the near-field area of influence of the platform. Densities were significantly higher within 10 m of the site, and while densities from 10-42 m were high we feel that a conservative area of influence of 10 m best reflects a true population size of the fishes at the site (Table 10, Figure 10). Beyond 50 m the relative fish densities measured at GC18 decreased dramatically to levels found in the open shelf waters of the Gulf of Mexico (Figure 10).

Estimated Number of Fish and Species Composition

Examination of visual survey results revealed a fairly stable species assemblage at the site with interesting and consistent trends in species composition with respect to depth, season and the dominance of a few species over the sample period (Table 11 a-l). A total of eighteen species were detected by the ROV during visual surveys but six species including creolefish, blue runner, Bermuda chub, almaco jack, amberjack, and barracuda consistently comprised over 90% of the fishes enumerated at the site (Table 11 a-l). Other species observed included bar jack, black jack, blackfin tuna, grey triggerfish, horseeye jack, lesser amberjack, marbled grouper, ocean triggerfish, rainbow runner, scamp and yellowtail snapper. Due to their scarcity it is difficult to discern any seasonal patterns (Table 11 a-l).

Creolefish was the most common species enumerated at GC18 ranging from a maximum of 67% of the fishes detected in the summer of 1995 (Table 11e) to a minimum of 40% in the winter of 1995 (Table 11c) and on average they made up 50% of the fishes observed (Table 12l). With respect to depth, creolefish were concentrated in the mid to upper water column with approximately 90% of the individuals found above 60 m (Table 11 a-l). Seasonally, no consistent trends in creolefish abundance were found although their numbers tended to increase during fall and winter surveys (Table 11a-k). The next most common species detected was usually blue runner (Table 11d-k) making up an average of 20.5% of the fishes (Table 11l). However, during the fall 1994 sample blue runners were absent (Table 11b) and during the winter 1995 survey they made up less than 5% of the fishes observed (Table 11c). After creolefish and blue runner, no other species observed made up more than 10% of the fishes at GC18. The next most commonly observed species were Bermuda chub, almaco jack, greater amberjack and barracuda (Table 11) and while Bermuda chub typically were the third most abundant species observed there was a large amount of fluctuation in the fourth through sixth positions (Table 11a - j). Within these species it was difficult to discern any seasonal patterns with the exception of barracuda as their presence increased during cooler periods (Table 11a-j). With respect to depth barracuda and Bermuda chub were predominately found above 40 m (Table 11 a-j). Almaco jack were found from the surface to 160 m but approximately 90% of these fishes were found from 40 to 100 m (Table 11 a - j). Greater amberjack were almost exclusively found from 40 to 100 m with few observed outside of this depth range (Table 11a - j).

The ROV survey results below 100 m supported the acoustic findings with an almost a complete lack of fishes (a total of 38 fishes of 4 species) were observed in eleven surveys below 100 m (Table 11 a- l). Almaco jacks showed the widest depth range of any of the fishes observed at GC18 as they were common from the surface to mid depth and one of the few fishes found below 100 m (Table 11 a-l). Typically, most species exhibited a specific depth range and were less frequently found outside that range. Surface oriented species included bar jack, barracuda, Bermuda chub, blue runner and horseeye jack (Table 11a-k). Species common from 20 to 60 m included black jack, blackfin tuna, creolefish, grey triggerfish, rainbow runner and yellowtail snapper (Table 11a-k). Species commonly found from 60 to 100 m were almaco jack, greater amberjack and scamp, although as previously mentioned almaco jack had the widest depth range of any of the observed species (Table 11a-k).

Extrapolating the acoustic abundance data using the species composition estimates for each depth strata provided estimates of individual species abundance throughout the water column (Table 12 a-k). The total number of fish at the site ranged from a low of 8,321 (+/- 3,470, 95% CI, Table 12g) during the spring 1996 sample to a high of 21,767 (+/- 4,655,

Table 12k) during the winter 1997 sample. Averaged over all sample periods 13,855 (+/- 1,206) fishes were found at GC18 and the six most abundant species (highest to lowest) were creolefish, blue runner, Bermuda chub, almaco jack, greater amberjack and barracuda (Table 12k). Creolefish dominated the observed fishes at the site. An average of 4,924 (+/- 445) were estimated at GC18 over the study period which was twice as abundant as any other species on average (Table 12k, Figure 15). The next most abundant species was blue runner (Table 12 a-k, Figure 11). As with the other sites the abundance of blue runner was variable over the study period ranging from a high of 8,962 in the summer 1994 (Table 12a) to a low of 0 during the Fall 1994 survey (Table 12b). After the initial variability during the summer and fall 1994 surveys, blue runner abundance appeared to level off and the earlier heterogeneity decreased (Table 12a - j, Figure 11).

Examination of the abundance of other dominant species over the study period showed large changes in the abundance of amberjack, almaco jack and Bermuda chub between sample periods (Table 12 a-j, Figure 15). The only dominant species that did not undergo extreme changes in abundance over time was barracuda, however a twofold decrease in abundance was observed from spring 1996 to summer 1996 samples (Table 12 a-j, Figure 15). With respect to a seasonal pattern in abundance, highest numbers of amberjack and almaco jack were consistently found in the fall and winter surveys while Bermuda chub estimates were highest during spring and summer surveys (Table 12 a-j, Figure 15). Barracuda estimates, as pointed out earlier, were much more stable than the other dominant species but their abundance was typically higher in the cooler sampling periods (Table 12 a-j, Figure 15).

South Timbalier 54

Target Strength Distribution

The target strengths of the fishes at the ST54 production platform were variable over the study period and a RBD ANOVA with platform side as a block was used to test for differences in target strength due to year, season, time of day, current vectors, temperature, dissolved oxygen, depth and selected interactions. Target strength varied significantly with season, time of day, depth, platform side, temperature, east current vector, north current vector, north squared current vector, east squared current vector, and the interaction terms (Table 13).

Temporal differences in target strength were detected between season, time of day and the interaction of season and time of day (Table 13). Seasonally target strengths were significantly larger in summer, decreased in spring and winter and lowest in the fall (Table 14). Two groupings of target strength with time of day were found with largest target strengths in the dawn and noon samples and significantly smaller target strengths in dusk and midnight samples (Table 15). No overall trend of target strength with season and time of day could be detected over the entire study period.

Spatially, target strength varied with platform side, depth and the interactions of depth and time of day and depth and season. Target strengths were significantly different on all sides of the platform (Table 16). Significantly larger target strengths were found on the south side of the platform and smallest on the west (Table 16). With respect to depth, target strengths were larger near the surface and above the substrate than at mid depth and immediately adjacent to the bottom (Table 17). While the interactions of depth and time of day and season and depth were significant (Table 12), no consistent trends were observed in these interactions.

Environmental variables that significantly affected target strength included temperature, north, east current vector north squared and east squared current vectors (Table 13). The relationship between temperature and target strength showed a slight increase in target strengths as temperature increased. Target strength also increased with north and east current vector and north and east squared vectors suggesting that at high current speeds, larger fishes were more common.

Grand Isle 94

Target Strength Distribution

Target strengths of fishes at the GI94 production platform were variable over the study period and a RBD ANOVA with platform side as a block was used to examine differences in target strength due to year, season, time of day, current vectors, temperature, dissolved oxygen, depth and selected interactions. Target strength varied significantly with year, season, time of day, depth, platform side, north current vector, east squared current vector, north current vector squared, north*east interaction, dissolved oxygen, temperature, season*time of day, time of day*depth, and season*depth (Table 18).

Temporal differences in target strength were detected between year, season, time of day, the interactions of season*time of day, time of day*depth, and season*depth (Table 18). Target strength was significantly different between 3 of the 4 years examined with significantly larger target strengths found in 1995 than all other years (Table 19). Target strengths from 1994 and 1996 were not significantly different from one another and the smallest target strengths were found in 1997 (Table 19). Target strengths were also were significantly different with season (Table 21). Largest target strengths were found in the winter, followed by the spring and summer and smallest target strengths were found in fall (Table 20). While target strengths were significantly different with time of day, the contrasts were much smaller than any other temporal variable examined (Table 21). Largest target strengths were found at midnight and dusk; dusk and noon samples were not significantly different from each other and noon and dawn samples were not significantly different (Table 21).

Spatially, fish density varied with platform side and depth (Table 18). Target strength varied significantly on each side of the platform (Table 22). Largest target strengths were found on the south side, followed by the west and north with smallest target strengths on the east side (Table 22). Target strength varied significantly with depth and the largest target strengths were found from 40 to 60 m and from 0 to 5 m (Table 23). Intermediate target strengths were detected in the middle of the water column from 5 to 35 m, while smallest target strengths were found from 15 to 25 m (Table 23).

Environmental conditions also impacted target strengths based on results from the RBD ANOVA (Table 18). Target strengths were significantly affected by temperature, dissolved oxygen, north current vector, north squared and east squared current vector (Table 18). Target strengths decreased slightly with temperature indicating larger fishes were found during fall and winter. Increases in dissolved oxygen, slightly increased target strengths. Target strengths increased with the north current vector but decreased with north and east squared current vectors. These results show an increase in fish size with current speed, however at excessive current speeds (e.g., Appendix 2-25) when currents over 40 cm/s were common, it is likely that fish size increased along with density.

Green Canyon 18

Target Strength Distribution

Target strength of fishes at the GC18 production platform varied over the study period and a RBD ANOVA with platform side as a block was used to examine for differences in target strength due to year, season, time of day, current vectors, temperature, dissolved oxygen, depth and selected interactions. Target strength was significantly different with platform side, time of day, depth, north current vector, north current vector squared and the interaction of time of day and depth (Table 24).

Temporal differences in target strength at GC18 were found with time of day and the interaction of time of day and depth (Table 24). Largest target strengths occurred at dawn, target strengths at dusk and noon were not significantly different and smallest target strengths were found at midnight (Table 25). While the differences in target strengths were significant with respect to time of day the difference in dB was 1.5 dB or approximately 3.5 cm based on estimated fish lengths (Love 1971). With interaction of time of day and depth no consistent trends were found with the exception that the largest target strengths were found near the surface at all times.

Spatially, target strength varied with platform side and depth (Table 24). Significantly larger target strengths were found on the south side of the platform, with the west side second and the east and north sides smallest and not significantly different from each other (Table 26). The target strength differences between largest and smallest platform side at GC18 was the greatest observed at any of the sites and was 4 dB or approximately 12 cm based on estimated fish lengths (Love 1971). Target strengths were significantly different at all depths examined, and the largest target strengths were found near the surface (Table 27). No target strength data were found below 95 m, in agreement with the low or zero estimated densities from the same region.

Target strengths increased with the north current vector and north squared current vectors. These results show an increase in fish size with current speed, however at excessive current speeds however currents speeds rarely exceeded 40 cm/s and it is unlikely that currents of this scale would cause alter the size distribution of fishes.

DISCUSSION

This study again demonstrates the utility of merging hydroacoustics and visual survey techniques to study the fish assemblages at petroleum platforms. The combination of these techniques allows for the measurement of the area of influence of these defacto artificial reefs, estimates of abundance, size distribution and species composition throughout the water column and for extended time periods.

Our results demonstrate the variability in the abundance, size distribution and species composition of fishes associated with petroleum platforms. Our results were similar to earlier studies as variability in the abundance of fishes is typical at both natural and artificial reefs (Gallaway 1980, De Martini et al. 1989, Gallaway et al. 1981, Putt 1982, Sale 1984, Chang 1985, Shinn and Wicklund 1989, Bohnsak et al. 1991, Doherty 1991, Sale 1991, Bull and Kendall 1994, Stanley and Wilson 1996, 1997). The variability in density and the size distribution of fishes at petroleum platforms in this project was linked to temporal, spatial and environmental variables.

Spatial variability was consistently observed at all study sites. Fish density and size distribution of fishes varied significantly with depth, platform side and distance from the platform at ST54, GI94 and GC18. These results was similar to results from our past research (Stanley and Wilson 1995, 1996, 1997), findings by Morgan (1996), Gerlotto (1989) and Valdermarsen (1979). During mobile acoustic surveys of platforms sited as artificial reefs (Morgan 1996) and production platforms near Cameroon (Gerlotto et al. 1989) densities within 50 m of the sites were 3 to 10 times higher than nearby open water. The results of this study showed the highest densities of fishes were also observed within 50 m of all study sites, however differences in the rate of decline with distance were found between sites of different water depths. At the shallowest site, ST54, the decline in fish density with distance was precipitous; at distances greater than 18 m, fish densities were similar to that of the open waters of the northern Gulf of Mexico. Results from this study at ST54 are similar to those of our earlier work at a site of similar water depth but geographically separated by over 300 km (Stanley and Wilson 1995, 1996, 1997). At the deeper sites a drop in fish density with distance from the site existed, however fish density was higher to greater distances from the platform. A decline in fish density with distance did exist at both GI94 and GC18 as after a distance of approximately 50 m density approached those found in the open waters of the Gulf of Mexico.

The differences in the relationship of fish density with distance from site to site is likely due to the change in species composition and water clarity between shallow and deeper sites. At deepwater sites the water clarity was much greater thus allowing visually oriented species the capacity to range farther away from the site, while maintaining visual contact. Also, carangids were one of the dominant groups of fishes observed at the deeper sites and while these fishes associate with reefs they are pelagic animals and thus much more likely to range farther away from a site. Despite these complications, hydroacoustics again illustrated its effectiveness in defining "area of influence" of the platform defined as the effective size of the artificial reef to the fish assemblage. As we defined it, the area of influence extended 10 m at

GC18 and 18 m at GI94 and ST54 as fish densities within these distances were significantly higher than densities at greater distances. While these figures may lead to a conservative estimates of total abundance we feel it more accurately reflects the true abundance of fishes at the sites.

The spatial variation observed with target strength and platform side revealed that target strengths were greatest on the south side of each of the study sites otherwise no uniformity was detected with target strength and platform side. Largest target strengths on the south side was also consistent with our past research (Stanley and Wilson 1997), however we are at a loss to explain the rationale for larger fishes on one side of the platform. In an attempt to decipher the variation in fish density and target strength with platform side current speed and direction data were modeled with these variables. While significant relationships were detected between density, target strength and current vectors they did little to clarify the relationships. With respect to target strength there was a positive relationship at all sites with the north current vector. This suggests that as current speed from the north increased than target strength would increase. However, based on our findings of the south side of the platform having significantly larger targets one would expect a negative relationship between target strength and north current vectors, indicating larger targets were found with southerly oriented currents. A more likely explanation of the larger target strengths on the south side of the platform may be due to platform design and their influence on fish behavior. Since the most complex construction of structures is found at the north end, the well bay area, this may be a refuge for smaller fishes and explain the smaller target strengths found on these sides. Past research has demonstrated a relationship between hole size and/or reef complexity with fish size (Shulman 1984, Hixon and Beets 1989) and since the construction of platforms on the south end is open with little shelter, larger fishes appear to be more common.

The last spatial variable examined, and one of the primary questions to be addressed by the research, was the effect of depth on the density and size distribution of fishes. Similar results with respect to density and water depth were found for the two sites on the continental shelf, ST54 and GI94. Highest densities were found adjacent to the surface and the bottom. These results were similar to those of our earlier research (Stanley and Wilson 1995, 1996, 1997) and those of Chang (1985), Shinn and Wicklund (1989) and Rooker et al. (1997). The most dramatic result of the project was the change in density with depth at the site on the continental slope, GC18. A significant and striking decrease in fish density with depth was found, below 100 m where only very low fish densities fish were detected. Previous research supports these findings as species richness in the Pacific was negatively correlated with depth, especially in tropical latitudes (Stevens 1996) and bottom trawl data from the shelf break in the Gulf of Mexico (water depth > 110 m) documented the presence of 69 species however, low abundances were found and few reef dependent species were captured (Chittenden and Moore 1977). The concentration of fishes at GC18 near the surface is reflected in the fact that 88% of the fishes were found in the upper 60m ,of the water column. While near surface fish densities at GC18 were significantly higher than those below 60 m the near surface densities were only one half to two thirds of values found at sites on the continental shelf. The decrease is likely due to the location of GC18 and its distance from the highly productive waters of the Mississippi River. Both ST54 and GI94 are regularly influenced by the highly productive waters from the Mississippi River as reflected in the lower surface salinities observed at these sites. The high salinities observed at GC18 varied little from surface to the bottom, indicative of low productivity oceanic waters and the oligotrophic conditions appear to be reflected in lower fish densities even near the surface.

Water depth also influenced the size distribution of fishes represented by low mean target strengths at the shallowest site (ST54) and largest at the deepest site (GC18). Target strength also varied with depth at each site. Significantly larger target strengths were found near the surface and than generally decreased significantly with depth at each site. These results are different than our earlier research where target strength was shown not to be significantly different with depth (Stanley and Wilson 1996, 1997). The variation in size distribution with depth is likely due to the change in species composition with depth detected at each site.

The environmental variables examined measured influenced the density and target strength of fishes at the sites examined but not to the extent of the spatial and temporal factors. Environmental variables, including temperature, dissolved oxygen, current speed and direction, had their greatest impact on density and target strength at ST54 and least influence at GC18. The large impact at ST54 may be due to the large variation in environmental variables observed at the site. Temperatures varied by over 10 °C from summer to winter and while a positive relationship exited between temperature and density, the highest observed densities were found during cooler periods suggesting a bell shaped relationship where an optima is reached at a middle value with lower density values at the extremes. A similar relationship between temperature and density existed at GI94. Where a significant relationship existed between temperature and target strength (ST54 and GI94) divergent results were found. At ST54 a positive relationship existed between temperature and target strength. This relationship may be due to the presence of larger migratory species during the summer including cobia and tarpon. At GI94 a negative relationship existed between target strength and temperature and this is likely due to the large influx of blue runner, a small carangid, during winter.

Dissolved oxygen had a significant effect on density at ST54 and GI94 and target strength on GI94. Due to the location of ST54, it is typically impacted by the hypoxic events common during the warmer months off Louisiana coast (Rabalais et al. 1985). During sampling trips in early June and late July of 1996, hypoxia was found at ST54. During June 1996 dissolved oxygen levels were less than 1 ppm from 20 - 22 m and in July the hypoxic zone was substantially larger as dissolved oxygen levels were less than 0.5 ppm from 15 to 22 m. Not surprisingly fish densities were zero in these areas and an overall positive relationship existed between dissolved oxygen and density at ST54. This relationship was reinforced during the winter when high dissolved oxygen levels were present and densities were highest. An interesting observation during the hypoxic events at ST54 were the elevated fish densities found above the hypoxic layers. When overall fish abundance was compared between hypoxic and oxic summer sample periods, no significant difference in abundance was detected. This result suggests that a vertical compression of the fishes into the oxygenated water column occurred with little or no migration away from the site. Dissolved oxygen also significantly affected fish density and target strength at GI94. While hypoxia was not observed at GI94 a positive relationship was found between dissolved oxygen and density. This observation may be due to the highest densities observed in the winter when dissolved oxygen levels were highest.

The relationships between current speed and direction with density and target strength was not consistent and varied with site. At ST54, a positive correlation was found with current speed and density while at GI94 and GC18, negative relationships were observed. Past research has found that highest fish densities were up current of petroleum platforms (Continental Shelf Associates 1982, Putt 1982), while Chang (1985) and Lindquest and Pietrafesea (1989) observed that fishes oriented down current of artificial reefs. Our earlier research (Stanley and Wilson 1996, 1997) did not identify a consistent relationship of fishes orienting up or down current of a petroleum platform and it would appear that results from this project support the conclusion that no consistent relationship existed between fish orientation and platform side. Since median current speeds ranged from 8 to 19 cm/s at all the sites, than observed current speeds were not strong enough to influence the behavior of nektonic fishes with respect up or down current aggregations (Baxter 1969).

The temporal variation of density and target strength of fishes demonstrated the lack of consistent response to these variables. The longest temporal scale variable examined was between years and was only found to be significant at GI94 for both density and target strength. Highest densities were found in 1997 (although only one sampling trip occurred in 1997) and largest target strengths in 1995 at GI94. Seasonal differences in density and target strength were observed at all sites where highest fish densities were found during cooler periods, specifically fall and winter. This is similar to our earlier research (Stanley and Wilson 1996, 1997) but contrary to other research at platforms and artificial reefs in the northern Gulf of Mexico (Gallaway 1980, Lukens 1981, Gallaway and Lewbel 1982, Putt 1982). These differences as outlined in Stanley and Wilson (1997) are presumably due to the differing sampling techniques between our research and others. Prior to our use of hydroacoustics to assess abundance of fishes at petroleum platforms, only visual surveys were performed. While visual surveys are effective in high visibility conditions, they can be biased and underestimate abundance in low visibility conditions (Bohnsak and Bannerot 1986, Charbonnel et al. 1996). Since visibilities are generally poor during cooler periods in the northern Gulf of Mexico, it is probable that the earlier visual surveys underestimated the abundance of fishes and did not accurately reflect the total number of fishes at the sites.

The seasonal variation in target strengths observed at ST54 and GI94 were not consistent. Largest target strengths were found in the summer and smallest in the winter at ST54 while the reverse were detected at GI94. The results from ST54 were similar to those of our earlier research and was presumably due to the influx of large seasonal migrants such as cobia and tarpon in the summer. Unlike our earlier research (Stanley and Wilson 1996, 1997) variation due to time of day was observed at ST54 and GI94 in this study. At ST54 highest densities were found at midnight indicating some attraction to the site may have occurred due to the presence of high intensity artificial lights at the site. At GI94 highest densities were found at dawn and lowest at noon and dusk. It is difficult to explain our results with classic crepuscular activity of fishes observed at natural and artificial reefs with highest densities during the day and lowest a night. On natural and artificial reefs it is hypothesized that as light level decreases, the attraction to sites by fishes may decrease due to a loss of visual acuity, also off reef feeding at night is common by many fishes and this would cause a decrease in abundance of fishes at night (Munz and MacFarland 1973, Hobson 1974, McFarland et al, 1979, Heffman et al. 1982, Collins and Pettigrew 1988, Thorne et al. 1989). Target strengths were largest at ST54 during dawn and noon samples while at GI94 the target strengths were largest at midnight. The presence of high intensity artificial lights at these sites may influence the behavior of fishes at these sites and cause the changes from expected patterns common at natural and unlit artificial reefs.

Despite the range of depths of the sample sites, many species were common to all the sites. While approximately 20 species were observed at a site over the study period, 6 species made up over 90% of the fishes observed on any survey. The dominant six species by site (highest to lowest abundance) were; GC18 creolefish, blue runner, Bermuda chub, almaco jack, greater amberjack, and barracuda; GI94; blue runner, horseeye jack, red snapper, mangrove snapper, gray triggerfish and barracuda; ST54; Atlantic spadefish, bluefish, blue runner, mangrove snapper, red snapper and sheepshead. The species observed during this project agreed with the past research in the northern Gulf of Mexico (Sonnier et al. 1976; Gallaway 1980; Continental Shelf Associates 1982; Gallaway and Lewbel 1982; Putt 1982; Stanley and Wilson 1990, Rooker et al. 1997). Past research (Sonnier et al. 1976, Stanley and Wilson 1990, Rooker et al. 1997) noted that over 35 species were associated with platforms in the northern Gulf of Mexico, while we detected a total of 36 species over the three study sites. Despite the disparate methods and temporal differences there is general agreement in the species composition between this and past research indicating that platform assemblages are fairly predictable.

A unique observation from this study was the presence of yellowtail snapper at GC18. It is a common species on natural reefs in the Caribbean and southern Gulf of Mexico, but it is been rarely reported on natural reefs and platforms in the northern Gulf of Mexico (Darnell et al. 1983). During research trips in fall 94, winter 95 and spring 95, yellowtail snapper were relatively common at GC18 but were not observed on any subsequent surveys. This suggests these fishes either migrated away or experienced significant natural mortality and became extinct at the site and did not recolonize.

The species observed at ST54 were very similar to those found at platforms of similar depth by Putt (1982) and Stanley and Wilson (1996, 1997). An exception to this was the observation of tarpon at ST54, a species not previously reported during any visual observation research at platforms but are targeted by anglers and caught near petroleum platforms (Stanley and Wilson 1990, 1991).

Seasonal migrations were common at each of the study sites. Since this research took place throughout the year, we were able to document the seasonality alluded to by past research but not well documented (Sonnier et al. 1976, Putt 1982, Rooker et al. 1997). Common seasonal migrations observed in the winter included an increase in the abundance of Florida pompano and bluefish at ST54; blue runner and barracuda at GI94 and GC18.

Increased abundances during the summer season included the tarpon and cobia at ST54, cobia, red snapper, greater amberjack and almaco jack at GI94, while no summer migrants were observed at GC18.

Since only 6 species made up over 90% individuals each site on any survey, platform assemblages could be characterized as not specious but as dominated by a few species. While the species found at each site were somewhat unique and the dominant species at each site was different, overlap of observed species existed between sites, especially adjacent sites. Previous researchers have noted a zonation of the assemblage of fishes associated with platforms and have divided the shelf waters of the northern Gulf of Mexico into three zones, coastal (water depth < 27 m), offshore (water depth 27 to 64 m) and bluewater (water depth > 64 m) (Gallaway 1980, Gallaway et al. 1981, Gallaway and Lewbel 1982). While our results generally agree with the outlined zonation we feel that there is a large crossover between zones than previously described, especially seasonally. These conclusions were also echoed by Rooker et al. (1997), during a survey of the platform High Island A389. While Rooker et al. (1997) generally agreed with the zonation as defined by Gallaway (1980) there are significant differences and considerable overlap with shallower sites indicating it is problematic to define species composition only by depth. Comparison of our research with species composition from the High Island A389 site (water depth 125 m) surveyed by Rooker et al. (1997) found the overall species composition was most similar to GC18 (water depth 219 m) including the dominance of creolefish. Rooker et al. (1997) documented the presence of a large number of midwater carangids, but due to their study design and emphasis on cryptic reef fishes, they were not directly enumerated.

Based on our research and examination of the results from past platform studies, there generally is a keystone species that dominates the composition of fishes at a site, e.g., Atlantic spadefish at ST54, blue runner at GI4 and creolefish at GC18, but after the dominant species overlap of species existed between sites. Additionally, large fluctuations in abundance of species were common at all the sites over the study period. Due to the apparent migration of many of the fishes common at platforms in the northern Gulf of Mexico, and because of the range of depths and geographical location of these sites it is difficult to assign species to a certain zone. It may be more accurate to assign most species to a platform assemblage grouping with a secondary category on depth.

The trophic structure of the fishes at all three study sites was similar to results at natural reefs due to the dominance of planktivorous omnivores (Shaffer and Rosen 1961, Smith and Tyler 1972, Hobson 1974, 1992). However, while the trophic structure was similar between natural reefs and platforms the species composition of planktivores at natural reefs is different than those found at platforms. At natural reefs planktivorous Serranids, Chaetodontids, Pomacentrids, Holocentrids, Priacanthids and Balistids typically dominate the taxa (Randall 1967, Hobson 1974, 1991). While at platforms only a planktivorous serranid, creolefish, was found only at GC18. At the other sites planktivores dominate but the species were Atlantic spadefish at ST54, an Ephippid, and GI94 the dominant planktivore was blue runner, a Carangid. While the species composition at platforms in the northern Gulf of Mexico is generally different than from natural reefs, the trophic structure is similar as planktivores made 55 to 87% of the fishes observed at a site and this is similar to the results from natural reefs as planktivores can make up to 98% of the fishes found at natural reef (Hobson 1974, 1991, Sale et al. 1991). Another similarity between the trophic structure natural reefs and petroleum platforms is the relatively small proportion of piscivores. At natural reefs piscivores makeup 10 to 20% of the fishes at a site, this compares favorably with our results as piscivorous Serranids, Lutjanids and Carangids made up 10 to 24% of the fishes observed. At the trophic scale it would appear that the assemblage of fishes at petroleum platform function similarly to observations of the community of fishes at natural reefs with respect to the dominance of planktivores and the relative low numbers of piscivores.

Comparison of our results with other petroleum platform studies from the northern Gulf of Mexico revealed similarities and significant differences in density and abundance. Comparison of acoustically derived estimates of density from our past research showed similar density values with those from this project especially at ST54 and GI94. Mean densities from our earlier work (Stanley and Wilson 1995, 1996, 1997) at a site in 24 m of water were 0.244 (+/- 0.062, 95% confidence interval) fish·m^{-3}, while mean densities found during this project were 0.333 (+/- 0.034) fish·m^{-3} at ST54, 0.496 (+/- 0.017) fish·m^{-3} at GI94 and 0.029 (+/- 0.003) fish·m^{-3} at GC18. With the exception of GC 18, these values are consistent with those from Putt (1982) for a platform in 22 m of water off the Texas coast and an order of magnitude higher than the results of Continental Shelf Associates (1982) from four platforms surveyed in June 1980. Both Putt (1982) and Continental Shelf Associates (1982) used only visual surveys, Putt employed stationary cameras and Continental Shelf Associates used a ROV for visual surveys. While the densities from previous studies are comparable to those estimated from our earlier and current research using hydroacoustics; the visual techniques utilized are of limited value in low visibility by the authors' admission and their conclusions are limited to characterizations of fish populations under high visibility conditions. The densities found at platforms also are much higher than those from the open waters of the Gulf of Mexico. Morgan (1996) acoustically measured fish densities at artificial reefs in water depths from 20 to 35 m on the continental shelf off the Louisiana coast and found mean fish densities were approximately 0.01 fish·m^{-3}. Based on all the results to date it is apparent that large concentrations of fishes are found around these structures in the northern Gulf of Mexico but the debate continues as to the exact function of these structures on whether they increase productivity or attract existing organisms.

Total fish abundance estimates from the platforms in this project fall within the range of estimates at platforms from our earlier research in the Gulf of Mexico but are higher than those derived by visual only surveys. Stanley and Wilson (1995, 1996, 1997) calculated that there were on average a total of 12,473 (+/- 6,522, 95% confidence interval) fishes at a site in 24m of water, while during this project estimates of the total number of fish per site were 13,472 (+/- 1,346) at ST54, 28,952 (+/- 1,806) at GI94 and 13,856 (+/- 1,324) at GC18. Visual survey estimates were consistently lower than those derived using combined hydroacoustics and visual surveys. Putt (1982) estimated that a platform in 22 m of water had an average of 1,924 fish from July through September while single point count estimates by Continental Shelf Associates (1982) at four platforms off the Louisiana coast, found 283 to 3,955 fish associated with individual platforms, in water depths from 28 to 31 m. Rooker et al. (1997) performed visual surveys in the upper 24 m of a platform in 125 m of water and estimated 3,586 fishes were found at the site, however this included many cryptic and reef associated fishes that we did not include in our results nor did they include the large number of carangids and scombrids observed. The study by Rooker et al. (1997) would appear to be the best visual estimate of fishes directly associated with a platform as water clarity was not an issue and their methodology was more thorough and superior to earlier visual surveys. However, it is apparent that due to the open construction of platforms, that visual surveys alone underestimate or cannot assess the large number schooling species at these sites. Other differences may be due to the larger near-field area of influence measured in this study. Earlier researchers did not directly measure the near-field area of influence and assumed it to be 5 m (Continental Shelf Associates 1982, Putt 1982). The near-field area of influence measured at ST54 and GI94 was 18 m while at GC18 it was defined as 10 m. The relationship between density and distance was well defined statistically at ST54 and GI94. Densities within 18 m of the site were significantly higher than all other distances measured. At GC18 the relationship was not as well defined but based on acoustic derived density data and visual observations, the fishes remained close to the structure and 10 m was chosen as the near-field area of influence. Another possible explanation for the higher total fish abundance estimates from our research than those of Putt (1982) and Continental Shelf Associates (1982) may be size of the platform. Previous research (Rounsefell 1972, Ogawa et al 1973, Grove and Sonu 1983; Rountree 1989; Stanley and Wilson 1990) indicated that fish abundance increased with increasing artificial reef size and since ST54 and GI94 were larger than three of the four platforms compared in other studies this may explain some of the variation. Another likely explanation of the higher abundances detected during our research is the utilization of dual-beam hydroacoustics which did not influence fish behavior, was not limited by visibility and could determine the area of influence of the reef. The combination of these factors allows for more accurate assessments of the abundance of fishes at these sites.

One of the most interesting results of the project was the comparison of abundance between the sites. GC18 was 3 to 10 times larger than the others but the total abundance estimates were not significantly different than the smallest site (ST54), while the abundance estimates from GI94 was twice that of the other sites. Since structure size has been shown to affect fish density and the observation of higher density and abundance at the mid-size platform, it would appear that an optimal reef size may exist and this is consistent with results from our earlier research (Stanley and Wilson 1991). Previous studies have shown fish abundance is directly correlated with reef size to a maximum reef volume of 4,000 m^3 (Ogawa et al. 1973) or 25,000 - 50,000 ft^2 (Rounsefell 1972). While the platform with the highest abundance GI94, is larger than the optima from a reef volume perspective, due to the open construction of platforms, it is comparable to the optimal surface areas estimate from Rounsefell (1972). The low abundances observed at GC18 is likely due to its location and the water depth at the site. Since fish abundance was essentially zero below 100 m and densities above 100 m were lower than the other sites, these two factors combined to produce the low abundances observed at the site. Due to the location of GC18 it is not influenced by the eutrophic waters on the continental shelf and the outflow from the Mississippi river, it most influenced by oligotrophic oceanic waters from the Caribbean. The combination of water depth and oligotrophic conditions likely reduce the abundance of fishes at the GC18.

Conclusions

The 4,000 petroleum platforms in the northern Gulf of Mexico, provide an estimated 12.1 km^2 of additional hard substrate (Stanley and Wilson 1997) to a ecosystem that is dominated by a mud/sand substrate (Parker et al. 1983). The total area of the MMS No Activity Zones (this includes known natural reefs and hard bottom areas in the northern Gulf of Mexico) is 292.81 km^2 (Dr. Ann Bull, personal comm). The additional hard substrate provided by the petroleum platforms acting as defacto artificial reefs increases the amount of hard bottom habitat by 4.1% from Destin, Fl to Brownsville, TX. Off Louisiana the contribution is greater as the 3,600 platforms off the coast provide an estimated 10.9 km^2. The total area of the seventeen MMS No Activity Zones off the Louisiana coast is 104.5 km^2, based on these estimates platforms increase the hard bottom by 10.4%. The expansion of hard substrate habitat especially habitat in the upper water column has undoubtedly changed the dynamics of energy flow and influenced the utilization of marine resources but it has proved difficult to quantify the impact of these structures. Since 1990 over 90% of the commercial red snapper harvest has occurred off the Louisiana and Texas coasts (Schirriapa and Legault 1997) and while statistics do not exist on the percentage of red snapper caught at petroleum platforms, it is assumed to be a significant portion. Additional support of the importance of petroleum structures to fisheries was found in the highest published angler catch rates at petroleum platforms (Stanley and Wilson 1990). Fishes important to recreational and commercial fishes were common at the each of our study sites. At ST54 this included on average an estimated 1,000 red and 1,800 mangrove snapper as well as Florida pompano, cobia and gray triggerfish. Recreationally and commercially significant fishes common at GI94 included an estimated 870 red snapper, 290 greater amberjack, 290 gray triggerfish, 319 mangrove snapper and 144 scamp on average. While at GC18 commercially and recreational important carangids dominated, as an estimated 2,260 almaco jacks and 1,052 greater amberjack were found. Based on these results and the use of platforms by recreation and commercial groups it is obvious that these structures are an important component of the fisheries in the region.

In recognition of the benefits of artificial reefs to marine fisheries in the northern Gulf of Mexico, Louisiana and Texas created artificial reef programs where retired petroleum platforms are the material of choice (Wilson et al. 1987, Stephan et al. 1990). The standard deployment of these structures as reefs involves placing the jacket on its side. However, this deployment minimizes vertical relief and if a platform such as GC18 was deployed in this manner it would extend approximately 80 m off the bottom. Based on our results a toppled deepwater artificial reef would be utilized by few fishes and a the structure sited in this manner would have limited value as an artificial reef. This project is the first demonstrating the importance of vertical relief in maximizing the effectiveness of platforms as artificial reefs especially with respect to deep water environments.

There are few assessments of the abundance of fishes at platforms in other areas of the world, despite the fact that over 2,500 of these structures are found outside of the Gulf of Mexico (Aabel et al. 1997). Estimates of fish abundance at structures in the North Sea based on experimental netting and visual surveys with ROV's have revealed high abundances of platform associated fishes (Valdermarsen 1979, AUMS 1987, ICIT 1991, Cripps and Aabel 1995, Cripps et al. 1995, Aabel et al. 1997). Mean density and abundance values were comparable to those from the northern Gulf of Mexico as 0.3 fish$\cdot$m^{-3} were detected by Cripps and Abel 1995 and total abundance estimates in the region range from 9,000 to 80,000 fishes varying with water depth, platform size and location (Valdermarsen 1979, AUMS 1987, ICIT 1991, Cripps and Aabel 1995, Cripps et al. 1995, Aabel et al. 1997). These results along with those from the Gulf of Mexico and the west coast of Africa (Gerlotto et al. 1989) clearly demonstrate that petroleum platforms are effective artificial reefs in a variety of climates and with various species assemblages.

This research confirms the variability of fish assemblages associated with petroleum platforms and reinforces the need to sample on each side and throughout the water column to obtain an accurate estimate of fish abundance. It also demonstrates the importance of petroleum platforms to the marine environment of the northern GOM due to the high abundance of fishes found at the sites. Although some variance was observed, 10,000 to 30,000 fishes were found at a site at any one time and since over 1,000 platforms are found in similar water depths it is clear that these structures impact the fisheries of the region.

This study continues to demonstrate the utility of merging hydroacoustics and visual survey techniques to study the assemblage of fishes associated with petroleum platforms. The combination of these techniques allows for the measurement of the area of influence of these defacto artificial reefs, estimates of abundance, size distribution and species composition throughout the water column and over long time periods.

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Table 1. RBD ANOVA (block on platform side) results of vertical log fish density (log (fish density/m^3) with platform side, year, season, time of day, depth, current vectors, temperature, salinity, dissolved oxygen and selected interactions at the ST54 petroleum platform.

Source	DF	SS	MS	F	Prob > F
Model	308	129.00907430	0.41886063	14.09	0.0001
Error	1596	47.44809218	0.02972938		
Corrected Total	1904	176.45716648			
	R-Square	**C.V.**	**Root MSE**		**LDENSITY Mean**
	0.731107	87.90991	0.1724221		0.1961350
Variables	**DF**	**Type III SS**	**Mean Square**	**F Value**	**Pr > F**
Side	3	14.78826719	4.92942240	165.81	0.0001
Year	1	0.01226440	0.01226440	0.41	0.5208
Season	3	2.36471052	0.78823684	26.51	0.0001
Diel	3	1.48166178	0.49388726	16.61	0.0001
Depth	4	1.64875440	0.41218860	13.86	0.0001
Temperature	1	0.50166204	0.50166204	16.87	0.0001
Dissolved oxygen	1	0.56616923	0.56616923	19.04	0.0001
Salinity	1	0.02415845	0.02415845	0.81	0.3675
North vector	1	0.17789554	0.17789554	5.98	0.0145
East vector	1	1.28431015	1.28431015	43.20	0.0001
North squared vector	1	0.19835984	0.19835984	6.67	0.0099
East squared vector	1	0.08600079	0.08600079	2.89	0.0892
North * East	1	0.00384716	0.00384716	0.13	0.7191
Season * Diel	9	3.89885440	0.43320604	14.57	0.0001
Diel * Depth	12	4.65341619	0.38778468	13.04	0.0001
Season * Depth	12	8.31623532	0.69301961	23.31	0.0001

Table 2. RBD ANOVA (block on platform side) results of horizontal log relative fish density (log (fish density/m ^{3}) with platform side, year, season, time of day, distance from the platform and selected interactions at the ST54 petroleum platform.

Source	DF	SS	MS	F	Prob > F
Model	591	67.26231465	0.11381102	32.41	0.0001
Error	4828	16.95542871	0.00351189		
Corrected Total	5419	84.21774337			
	R-Square	**C.V.**	**Root MSE**		**LDENSITY Mean**
	0.798672	104.4581	0.0592612		0.0567321
Variables	**DF**	**Type III SS**	**Mean Square**	**F Value**	**Pr > F**
Side	3	1.93480553	0.64493518	183.64	0.0001
Year	2	0.55152158	0.27576079	78.52	0.0001
Season	3	16.74014333	5.58004778	1588.90	0.0001
Diel	3	3.26312963	1.08770988	309.72	0.0001
Distance	3	2.04846570	0.22760730	64.81	0.0001
Season * Diel	9	7.20927947	0.80103105	228.09	0.0001
Diel * Distance	27	0.93008887	0.03444774	9.81	0.0001
Season * Distance	27	3.16415321	0.11719086	33.37	0.0001
Side * Season * Diel * Distance	508	34.03828042	0.06700449	19.08	0.0001

Table 3a. Number enumerated and percent species composition (in parentheses) by depth strata at South Timbalier 54 from July 30 - August 1, 1995 from visual point count surveys.

	Depth (m)					
Species	0 - 5	5- 10	10 - 15	15 - 20	20- 22	0 - 20
Atlantic Spadefish	178 (39.7)	198 (48.4)	246 (52.5)	120 (28.3)	75 (13.4)	817 (35.4)
Barracuda			2 (0.4)	1 (0.2)	1 (0.2)	4 (0.2)
Bermuda Chub						
Bluefish			3 (0.6)	1 (0.2)		4 (0.2)
Bluerunner	145 (32.4)	59 (14.4)	191 (40.7)	226 (53.3)	364 (65.0)	985 (42.6)
Cobia	1 (0.2)	1 (0.2)			1 (0.2)	3 (0.1)
Florida Pompano						
Gray Triggerfish				7 (1.7)	6 (1.1)	13 (0.6)
Jack Crevalle		4 (1.0)		1 (0.2)		5 (0.2)
Lookdown		10 (2.4)	8 (1.7)			18 (0.8)
Mangrove Snapper	2 (0.4)	3 (0.7)	8 (1.7)	3 (0.7)	10 (1.8)	26 (1.1)
Red Snapper				26 (6.1)	63 (11.3)	89 (3.9)
Red Drum						
Rockhind				2 (0.5)		2 (0.1)
Sheepshead	122 (27.2)	133 (32.5)	11 (2.3)	37 (8.7)	40 (7.1)	343 (14.8)
Tarpon		1 (0.2)				1 (0.0)

*Note: If cell is empty, no individuals were observed of that species for that depth interval.

Table 3b. Number enumerated and percent species composition (in parentheses) by depth strata at South Timbalier 54 from October 24 - 25, 1995 from visual point count surveys.

	Depth (m)					
Species	**0 - 5**	**5- 10**	**10 - 15**	**15 - 20**	**20- 22**	**0 - 22**
Atlantic Spadefish	232 (57.9)	244 (41.1)	122 (32.1)	38 (24.7)		636 (34.7)
Barracuda						
Bluefish						
Bluerunner	87 (21.7)	146 (24.6)	97 (25.5)	35 (22.7)		365 (19.9)
Cobia			3 (0.8)		2 (0.7)	5 (0.3)
Florida Pompano						
Gray Triggerfish		1 (0.2)			1 (0.3)	2 (0.1)
Jack Crevalle	1 (0.2)	4 (0.7)	1 (0.3)		2 (0.7)	8 (0.4)
Lookdown			8 (2.1)			8 (0.4)
Mangrove Snapper	16 (4.0)	114 (19.2)	101 (26.6)	19 (12.3)		250 (13.6)
Red Snapper		1 (0.2)	1 (0.3)	33 (21.4)	249 (81.9)	284 (15.5)
Red Drum					1 (0.3)	1 (0.1)
Rockhind				2 (1.3)		2 (0.1)
Sheepshead	65 (16.2)	84 (14.1)	47 (12.4)	26 (16.9)	49 (16.1)	271 (14.8)
Tarpon				1 (0.6)		1 (0.1)

Table 3c. Number enumerated and percent species composition (in parentheses) by depth strata at South Timbalier 54 from January 30 - February 1, 1996 from visual point count surveys.

	Depth (m)					
Species	**0 - 5**	**5- 10**	**10 - 15**	**15 - 20**	**20- 22**	**0 - 22**
Atlantic Spadefish	211 (84.7)	116 (35.6)	95 (43.0)	151 (36.5)	118 (31.0)	691 (43.4)
Barracuda						4 (0.0)
Bermuda Chub						1 (0.0)
Bluefish		57 (17.5)	28 (12.7)	125 (30.2)		210 (13.2)
Bluerunner	1 (0.4)	7 (2.1)	3 (1.4)	4 (1.0)	3 (0.8)	18 (1.1)
Cobia						14 (0.2)
Florida Pompano			14 (6.3)	10 (2.4)	1 (0.3)	25 (1.6)
Gray Triggerfish			1 (0.5)		1 (0.3)	2 (0.1)
Jack Crevalle		4 (1.2)	6 (2.7)	7 (1.7)	1 (0.3)	18 (1.1)
Lookdown					2 (0.5)	2 (0.1)
Mangrove Snapper	1 (0.4)	5 (1.5)	6 (2.7)	5 (1.2)	1 (0.3)	18 (1.1)
Red Snapper			28 (12.7)	66 (15.9)	139 (36.5)	233 (14.6)
Red Drum						
Rockhind						
Sheepshead	36 (14.5)	137 (42.0)	40 (18.1)	46 (11.1)	115 (30.2)	374 (23.5)
Tarpon						11 (0.1)

Table 3d. Number enumerated and percent species composition (in parentheses) by depth strata at South Timbalier 54 from June 6 - 7, 1996 from visual point count surveys.

	Depth (m)					
Species	**0 - 5**	**5- 10**	**10 - 15**	**15 - 20**	**20- 22**	**0 - 22**
Atlantic Spadefish	181 (55.0)	40 (14.3)	15 (6.9)	7 (13.0)		243 (27.6)
Barracuda						
Bermuda Chub						
Bluefish	3 (0.9)		2 (0.9)			5 (0.6)
Bluerunner	48 (14.6)	10 (3.6)				58 (6.6)
Cobia			1 (0.5)			1 (0.1)
Florida Pompano						
Gray Triggerfish		1 (0.4)	5 (2.3)	1 (1.9)		7 (0.8)
Jack Crevalle		3 (1.1)				3 (0.3)
Lookdown	16 (4.9)	20 (7.2)				36 (4.1)
Mangrove Snapper	67 (20.4)	172 (61.6)	101 (46.5)	11 (20.4)		351 (39.9)
Red Snapper		1 (0.4)	6 (2.8)	6 (11.1)		13 (1.5)
Red Drum						
Rockhind						
Sheepshead	14 (4.3)	32 (11.5)	87 (40.1)	29 (53.7)		162 (18.4)
Tarpon						

Table 3e. Number enumerated and percent species composition (in parentheses) by depth strata at South Timbalier 54 from July 17 - 18, 1996 from visual point count surveys.

	Depth (m)					
Species	**0 - 5**	**5- 10**	**10 - 15**	**15 - 20**	**20- 22**	**0 - 22**
Atlantic Spadefish	28 (48.3)	95 (18.6)				123 (21.5)
Barracuda						
Bermuda Chub		1 (0.2)				1 (0.2)
Bluefish						
Bluerunner						
Cobia		2 (0.4)				2 (0.3)
Florida Pompano						
Gray Triggerfish		2 (0.4)				2 (0.3)
Jack Crevalle						
Lookdown						
Mangrove Snapper	15 (25.9)	266 (52.1)				281 (49.1)
Red Snapper		15 (2.9)	3 (100.0)			18 (3.1)
Red Drum						
Rockhind						
Sheepshead	15 (25.9)	130 (25.4)				145 (25.3)
Tarpon						

Table 3f. Number enumerated and percent species composition (in parentheses) by depth strata at South Timbalier 54 from March 28 - 29, 1997 from visual point count surveys.

	Depth (m)					
Species	**0 - 5**	**5- 10**	**10 - 15**	**15 - 20**	**20- 22**	**0 - 22**
Atlantic Spadefish	198 (71.0)	177 (34.4)	126 (31.9)	20 (7.3)		521 (27.5)
Barracuda						
Bermuda Chub						
Bluefish						
Bluerunner	42 (15.1)	149 (29.0)	119 (30.1)	72 (26.3)	48 (11.0)	430 (22.7)
Cobia			2 (0.5)		1 (0.2)	3 (0.2)
Florida Pompano						
Gray Triggerfish						
Jack Crevalle	1 (0.4)	6 (1.2)	1 (0.3)	6 (2.2)	3 (0.7)	17 (0.9)
Lookdown			7 (1.8)			7 (0.4)
Mangrove Snapper	15 (5.4)	81 (15.8)	87 (22.0)	66 (24.1)	6 (1.4)	255 (13.4)
Red Snapper				52 (19.0)	287 (66.0)	339 (17.9)
Red Drum					7 (1.6)	7 (0.4)
Rockhind						
Sheepshead	23 (8.2)	96 (18.7)	41 (10.4)	37 (13.5)	62 (14.3)	259 (13.7)
Tarpon			2 (0.5)	6 (2.2)	1 (0.2)	9 (0.5)

Table 3g. Mean number enumerated and percent species composition (in parentheses) by depth strata at South Timbalier 54 for all research trips from July 1995 through March 1997 from visual point count surveys.

	Depth (m)					
Species	**0 - 5**	**5- 10**	**10 - 15**	**15 - 20**	**20- 22**	**0 - 22**
Atlantic Spadefish	1028 (58.3)	870 (33.2)	604 (36.2)	336 (25.8)	193 (11.6)	3031 (33.6)
Barracuda			2 (0.1)	1 (0.1)	1 (0.1)	4 (0.0)
Bermuda Chub		1 (0.0)				1 (0.0)
Bluefish	3 (0.2)	57 (2.2)	33 (2.0)	126 (9.7)		219 (2.4)
Bluerunner	323 (18.3)	371 (14.1)	410 (24.6)	337 (25.9)	415 (25.0)	1856 (20.6)
Cobia	1 (0.1)	3 (0.1)	6 (0.4)		4 (0.2)	14 (0.2)
Florida Pompano			14 (0.8)	10 (0.8)	1 (0.1)	25 (0.3)
Gray Triggerfish		4 (0.2)	6 (0.4)	8 (0.6)	7 (0.4)	25 (0.3)
Jack Crevalle	2 (0.1)	17 (0.6)	8 (0.5)	14 (1.1)	4 (0.2)	45 (0.5)
Lookdown	16 (0.9)	30 (1.1)	15 (0.9)		2 (0.1)	63 (0.7)
Mangrove Snapper	116 (6.6)	641 (24.4)	303 (18.2)	104 (8.0)	17 (1.0)	1181 (13.1)
Red Snapper		17 (0.6)	38 (2.3)	183 (14.0)	738 (44.5)	976 (10.8)
Red Drum					8 (0.5)	8 (0.1)
Rockhind				2 (0.2)		2 (0.0)
Sheepshead	275 (15.6)	612 (23.3)	226 (13.6)	175 (13.4)	266 (16.1)	1554 (17.2)
Tarpon		1 (0.0)	2 (0.1)	7 (0.5)	1 (0.1)	11 (0.1)

Table 4a. Estimated number of fish by species (with 95% confidence intervals) by depth strata at South Timbalier 54 from July 30 - August 1, 1995 from hydroacoustic and visual point count surveys.

	Depth (m)					
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 22**	**0 - 22**
Atlantic Spadefish	983.6 (66.4)	788.8 (71.2)	529.7 (103.4)	578.2 (136.2)		2880.3 (377.2)
Barracuda			4.0 (0.8)	4.2 (1.0)		8.2 (1.8)
Bermuda Chub						
Bluefish			6.1 (1.2)	4.1 (1.0)		10.2 (2.2)
Bluerunner	802.7 (54.2)	234.7 (21.2)	410.6 (80.1)	1088.9 (256.6)		2536.9 (412.1)
Cobia	5.0 (0.3)	3.3 (0.3)				8.3 (0.6)
Florida Pompano						
Gray Triggerfish				34.7 (8.2)		34.7 (8.2)
Jack Crevalle		16.3 (1.5)		4.1 (1.0)		20.4 (2.5)
Lookdown		39.1 (3.5)	17.2 (3.3)			56.3 (6.8)
Mangrove Snapper	9.9 (0.7)	11.4 (1.0)	17.2 (3.3)	14.3 (3.4)		52.8 (8.4)
Red Snapper				124.6 (29.4)		124.6 (29.4)
Red Drum						
Rockhind				10.2 (2.4)		10.2 (2.4)
Sheepshead	673.9 (45.5)	529.7 (47.8)	23.2 (4.5)	177.7 (41.9)		1404.5 (139.7)
Tarpon		3.3 (0.3)				3.0 (0.3)
TOTAL	2477.5 (167.3)	1629.8 (147.1)	1008.9 (196.9)	2043.0 (481.4)		7159.2 (992.7)

*Note: If cell is empty, no individuals were observed of that species for that depth interval.

Table 4b. Estimated number of fish by species (with 95% confidence intervals) by depth strata at South Timbalier 54 from October 24 - 25, 1995 from hydroacoustic and visual point count surveys.

	Depth (m)					
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 22**	**0 - 22**
Atlantic Spadefish	6882.3 (1384.1)	4325.4 (772.2)	1200.9 (316.4)	896.4 (138.9)		13305.0 (2611.6)
Barracuda						
Bermuda Chub						
Bluefish						
Bluerunner	2579.4 (518.7)	2589.0 (462.2)	954.0 (251.4)	823.8 (127.7)		6946.2 (1360.0)
Cobia			29.9 (7.9)		15.0 (2.3)	44.9 (10.2)
Florida Pompano						
Gray Triggerfish		21.0 (3.8)			6.4 (1.0)	27.4 (4.8)
Jack Crevalle	23.8 (4.8)	73.7 (13.2)	11.2 (3.0)		15.0 (2.3)	123.7 (23.3)
Lookdown			78.6 (20.7)			78.6 (20.7)
Mangrove Snapper	475.5 (95.6)	2020.6 (360.7)	995.1 (262.2)	446.4 (69.2)		3937.6 (787.7)
Red Snapper		21.0 (3.8)	11.2 (3.0)	776.6 (120.4)	1751.9 (265.0)	2560.7 (392.2)
Red Drum					6.4 (1.1)	6.4 (1.1)
Rockhind				47.2 (7.3)		47.2 (7.3)
Sheepshead	1925.6 (387.3)	1483.9 (264.9)	463.9 (122.2)	613.3 (95.1)	344.4 (52.1)	4831.1 (921.6)
Tarpon				21.8 (3.4)		21.8 (3.4)
TOTAL	11886.6 (2390.5)	10524.2 (1878.9)	374.1 (985.8)	3629.1 (562.5)	2139.1 (323.6)	28553.1 (6141.3)

Table 4c. Estimated number of fish by species (with 95% confidence intervals) by depth strata at South Timbalier 54 from January 30 - February 1, 1996 from hydroacoustic and visual point count surveys.

	Depth (m)					
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 22**	**0 - 22**
Atlantic Spadefish	1551.7 (149.2)	343.0 (39.4)	694.2 (75.7)	520.3 (73.1)	687.3 (279.9)	3796.5 (617.3)
Barracuda						
Bermuda Chub						
Bluefish		168.6 (19.4)	205.0 (22.4)	430.5 (60.5)		804.1 (102.3)
Bluerunner	7.3 (0.7)	20.2 (2.3)	22.6 (2.5)	14.3 (2.0)	17.7 (7.2)	82.1 (14.7)
Cobia						
Florida Pompano			101.7 (11.1)	34.2 (4.8)	6.7 (2.7)	142.6 (18.6)
Gray Triggerfish		8.1 (0.9)		6.7 (2.7)	8.1 (1.6)	22.9 (5.2)
Jack Crevalle			43.6 (4.8)	24.2 (3.4)	6.7 (2.7)	74.5 (10.9)
Lookdown					11.1 (4.5)	11.1 (4.5)
Mangrove Snapper	7.3 (0.7)	14.5 (1.7)	43.6 (4.8)	17.1 (2.4)	6.7 (2.7)	89.2 (12.3)
Red Snapper			205.0 (22.4)	226.7 (31.8)	809.2 (329.6)	1240.9 (383.8)
Red Drum						
Rockhind						
Sheepshead	265.6 (25.5)	404.7 (25.5)	292.2 (31.9)	158.2 (22.2)	669.5 (272.7)	1790.2 (377.5)
Tarpon						
TOTAL	1832.0 (176.1)	963.5 (110.8)	1614.5 (176.0)	1425.5 (200.3)	2217.0 (902.9)	8052.5 (1566.1)

Table 4d. Estimated number of fish by species (with 95% confidence intervals) by depth strata at South Timbalier 54 from June 6 - 7, 1996 from hydroacoustic and visual point count surveys.

	Depth (m)					
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 22**	**0 - 22**
Atlantic Spadefish	1388.8 (89.8)	231.7 (21.6)	69.7 (14.0)	273.2 (64.1)		1963.4 (189.5)
Barracuda						
Bermuda Chub						
Bluefish	22.7 (1.5)		9.1 (1.8)			31.8 (3.3)
Bluerunner	368.7 (23.9)	58.3 (5.4)				427.0 (29.3)
Cobia			5.1 (1.0)			5.1 (1.0)
Florida Pompano						
Gray Triggerfish		6.5 (0.6)	23.2 (4.7)	39.9 (9.4)		69.9 (14.7)
Jack Crevalle		17.8 (1.7)				17.8 (1.7)
Lookdown	123.7 (8.0)	116.6 (10.9)				240.3 (18.9)
Mangrove Snapper	515.1 (33.3)	998.0 (93.1)	469.8 (94.1)	428.7 (100.7)		2411.6 (321.2)
Red Snapper		6.5 (0.6)	28.3 (5.7)	233.3 (54.8)		268.1 (61.1)
Red Drum						
Rockhind						
Sheepshead	108.6 (7.0)	186.3 (17.4)	405.2 (81.2)	1128.5 (265.0)		1828.6 (370.6)
Tarpon						
TOTAL	2525.0 (163.4)	1620.1 (151.1)	1010.4 (202.4)	2101.4 (493.4)	12.5 (3.6)	7269.4 (1013.9)

Table 4e. Estimated number of fish by species (with 95% confidence intervals) by depth strata at South Timbalier 54 from July 17 - 18, 1996 from hydroacoustic and visual point count surveys.

	Depth (m)					
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 22**	**0 - 22**
Atlantic Spadefish	1138.7 (178.0)	837.8 (80.9)				1976.5 (258.9)
Barracuda						
Bermuda Chub	9.0 (0.9)					9.0 (0.9)
Bluefish						
Bluerunner						
Cobia	18.0 (1.7)					18.0 (1.7)
Florida Pompano						
Gray Triggerfish		18.0 (1.7)				18.0 (1.7)
Jack Crevalle						
Lookdown						
Mangrove Snapper	610.6 (95.4)	2346.8 (226.7)				2957.4 (322.1)
Red Snapper		130.6 (12.6)	1869.9 (216.1)			2000.5 (228.7)
Red Drum						
Rockhind						
Sheepshead	610.6 (95.4)	144.1 (110.5)				754.7 (205.9)
Tarpon						
TOTAL	2357.6 (368.5)	4504.5 (435.1)	1869.9 (216.1)	825.4 (293.9)	10.8 (2.9)	9568.2 (1316.5)

Table 4f. Estimated number of fish by species (with 95% confidence intervals) by depth strata at South Timbalier 54 from March 28 - 29, 1997 from hydroacoustic and visual point count surveys.

	Depth (m)					
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 22**	**0 - 22**
Atlantic Spadefish	3123.7 (599.5)	1921.7 (271.9)	681.5 (112.2)	1928.4 (221.8)	671.9 (114.7)	8327.2 (1320.1)
Barracuda						
Bermuda Chub						
Bluefish		944.7 (133.7)	201.3 (33.1)	1595.5 (216.1)		2741.5 (382.9)
Bluerunner	14.8 (2.8)	113.4 (16.0)	22.2 (3.7)	52.8 (7.2)	17.3 (3.0)	220.5 (32.7)
Cobia						18.0 (2.9)
Florida Pompano			99.8 (16.4)	126.8 (17.2)	6.5 (1.1)	233.1 (34.7)
Gray Triggerfish			7.9 (1.3)		6.5 (1.1)	14.4 (2.4)
Jack Crevalle		64.8 (9.2)	42.8 (7.0)	89.8 (12.2)	6.5 (1.1)	203.9 (29.5)
Lookdown					10.8 (1.9)	10.8 (1.9)
Mangrove Snapper	14.8 (2.8)	81.0 (11.5)	42.8 (7.0)	63.4 (8.6)	6.5 (1.1)	208.5 (31.0)
Red Snapper			201.3 (33.1)	840.0 (113.7)	791.1 (135.1)	1832.4 (281.9)
Red Drum						
Rockhind						
Sheepshead	534.8 (102.6)	2267.2 (320.8)	286.9 (47.2)	586.4 (79.4)	654.6 (111.7)	4329.9 (661.7)
Tarpon						24.5 (4.0)
TOTAL	3688.0 (707.8)	5398.0 (763.9)	1584.9 (261.0)	5283.2 (715.4)	2167.5 (370.0)	18121.6 (2818.1)

Table 4g. Mean estimated number of fish by species (with 95% confidence intervals) by depth strata at South Timbalier 54 from for all research trips from July 1995 through March 1997 from hydroacoustic and visual point count surveys.

	Depth (m)					
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 22**	**0 - 22**
Atlantic Spadefish	2230.8 (223.6)	1337.1 (114.0)	636.9 (63.0)	665.3 (54.3)	148.5 (27.3)	5018.6 (482.2)
Barracuda			1.8 (0.2)	2.6 (0.2)	1.3 (0.2)	5.7 (0.4)
Bermuda Chub		0.0 (0.0)				1.1 (0.1)
Bluefish	7.7 (0.8)	88.6 (7.6)	35.2 (3.5)	250.1 (20.4)		381. (32.3)
Bluerunner	700.2 (70.2)	567.8 (48.4)	432.8 (42.8)	667.9 (54.5)	320.0 (58.9)	2688.7 (274.8)
Cobia	3.8 (0.4)	4.0 (0.3)	7.0 (0.7)		2.6 (0.5)	17.4 (1.9)
Florida Pompano			14.1 (0.7)	20.6 (1.7)	1.3 (0.2)	36.0 (2.8)
Gray Triggerfish		8.1 (0.7)	7.0 (0.7)	15.5 (1.3)	5.1 (0.9)	35.7 (3.6)
Jack Crevalle	3.8 (0.4)	24.2 (2.1)	8.8 (0.9)	28.4 (2.3)	2.6 (0.5)	67.8 (6.2)
Lookdown	34.4 (3.5)	44.3 (3.8)	15.8 (1.6)		1.3 (0.2)	95.8 (9.1)
Mangrove Snapper	252.5 (25.3)	982.7 (83.0)	320.2 (31.7)	206.3 (16.8)	12.8 (2.4)	1774.5 (159.2)
Red Snapper		24.2 (2.1)	40.5 (4.0)	361.0 (29.5)	569.6 (104.9)	995.3 (140.5)
Red Drum					6.4 (1.2)	6.4 (1.2)
Rockhind				5.2 (0.4)		5.2 (0.4)
Sheepshead	596.9 (59.8)	938.4 (80.0)	239.3 (23.7)	345.5 (28.2)	206.1 (37.9)	2326.2 (229.6)
Tarpon		0.0 (0.0)	1.8 (0.2)	12.9 (1.1)	1.3 (0.2)	16.0 (1.5)
TOTAL	3826.4 (383.6)	4027.3 (343.4)	1759.5 (174.0)	2578.7 (210.4)	1280.0 (235.7)	13471.9 (1346.7)

Table 5. RBD ANOVA (block on platform side) results of vertical log fish density (log(number of fish/m^3) with platform side, year, season, time of day, depth, current vectors, temperature, salinity, dissolved oxygen and selected interactions at the GI94 petroleum platform.

Source	DF	SS	MS	F	Prob > F
Model	719	658.51165	0.91587	9.51	0.0001
Error	7210	694.42089	0.09631		
Corrected Total	7929	1352.93255			
	R-Square	**C.V.**	**Root MSE**		**LDENSITY Mean**
	0.486729	94.61222	0.3103		0.3280
Variables	**DF**	**Type III SS**	**Mean Square**	**F Value**	**Pr > F**
Side	3	34.43292	11.47764	119.17	0.0001
Year	3	1.11	0.37	12.17	0.0001
Season	3	88.32148	29.44049	305.67	0.0001
Diel	3	1.45685	0.48562	5.04	0.0017
Depth	11	20.22683	1.83880	19.09	0.0001
Temperature	1	3.53954	3.53954	36.75	0.0001
Dissolved oxygen	1	4.91742	4.91742	51.06	0.0001
Salinity	1	0.00003	0.00003	0.00	0.9849
North vector	1	1.32898	1.32898	13.80	0.0002
East vector	1	0.23100	0.23100	2.40	0.1215
North squared vector	1	0.42743	0.42743	4.44	0.0352
East squared vector	1	1.98548	1.98548	20.61	0.0001
North * East	1	0.10200	0.10200	1.06	0.3035
Diel * Depth	33	4.48975	0.13605	1.41	0.0590
Side * Season * Diel * Depth	658	226.51339	0.34425	3.57	0.0001

Table 6. RBD ANOVA (block on platform side) results of horizontal relative log fish density (log(number of fish/m^3) with platform side, year, season, time of day, distance from the platform and selected interactions at the GI94 petroleum platform.

Source	DF	SS	MS	F	Prob > F
Model	612	186.43939327	0.30463953	11.84	0.0001
Error	8327	214.25821327	0.02573054		
Corrected Total	8939	400.69760654			
	R-Square	**C.V.**	**Root MSE**		**LDENSITY Mean**
	0.465287	175.7350	0.1604074		0.0912780
Variables	**DF**	**Type III SS**	**Mean Square**	**F Value**	**Pr > F**
Side	3	13.25275329	4.41758443	171.69	0.0001
Year	3	17.72176044	5.90725348	229.58	0.0001
Season	3	17.15944638	5.71981546	222.30	0.0001
Diel	3	0.28291537	0.09430512	3.67	0.0118
Distance	9	6.20883438	0.68987049	26.81	0.0001
Season * Diel	9	3.42185811	0.38020646	14.78	0.0001
Diel * Depth	27	2.01761618	0.07472653	2.90	0.0001
Season * Depth	27	9.13703402	0.33840867	13.15	0.0001
Side * Season * Diel * Distance	528	84.63035253	0.16028476	6.23	0.0001

Table 7a. Number enumerated and percent species composition (in parentheses) by depth strata at Grand Isle 94 from August 9 - 10, 1994 from visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5- 10**	**10 - 15**	**15 - 20**	**20- 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Almaco Jack			1 (1.5)									1 (0.1)
Atlantic Spadefish												
Greater Amberjack					1 (1.0)		5 (6.8)	11 (13.3)	6 (7.7)	8 (13.1)	6 (24.0)	37 (4.3)
Bar Jack			6 (9.2)		1 (1.0)							7 (0.8)
Barracuda		2 (1.7)		1 (1.0)	1(1.0)	1 (3.3)						5 (0.6)
Bermuda Chub	16 (12.5)		8 (12.3)	1 (1.0)	8 (7.9)							33 (3.8)
Bigeye												
Black Grouper												
Bluerunner	112 (87.5)	119 (98.3)	40 (61.5)	64 (66.0)	43 (42.6)	9 (30.0)						387 (44.9)
Cobia			1 (1.5)									1 (0.1)
Coney Grouper												
Creolefish				1 (1.0)								1 (0.1)
Gag												

Table 7a (continued). Number enumerated and percent species composition (in parentheses) by depth strata at Grand Isle 94 from August 9 - 10, 1994 from visual point count surveys.

Depth (m)

Species	0 - 5	5- 10	10 - 15	15 - 20	20- 25	25 - 30	30 - 35	35 - 40	40 - 45	45 - 50	50 - 55	0 - 60
Gray Triggerfish			3 (4.6)	9 (9.3)	2 (2.0)	3 (10.0)	1 (1.4)	1 (1.2)				19 (2.2)
Horseye Jack				2 (2.1)								2 (0.2)
Jack Crevalle			3 (4.6)	11 (11.3)								14 (1.6)
Lookdown					35 (34.7)							35 (4.1)
Mangrove Snapper			3 (4.6)	8 (8.2)	10 (9.9)	6 (20.0)						27 (3.1)
Marbled Grouper												
Ocean Triggerfish												
Rainbow Runner												
Red Snapper						10 (33.3)	65 (89.0)	70 (84.3)	71 (91.0)	53 (86.9)	17 (68.0)	286 (33.2)
Scamp						1 (3.3)	2 (2.7)	1 (1.2)	1 (1.3)		2 (8.0)	7 (0.8)
Vermillion Snapper												
Yellowfin Grouper												

* note if cell empty then no individuals were of that species for that depth level

Table 7b. Number enumerated and percent species composition (in parentheses) by depth strata at Grand Isle 94 from November 8 - 9, 1994 from visual point count surveys.

Species	Depth (m) 0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	40 - 45	45 - 50	50 - 55	0 - 60
Almaco Jack	1 (1.6)											1 (0.2)
Atlantic Spadefish												
Greater Amberjack					4 (9.1)		7 (12.7)	8 (13.6)	10 (14.1)			29 (5.4)
Bar Jack	2 (3.2)						4 (7.3)					2 (0.4)
Barracuda	2 (3.2)	6 (7.8)	2 (3.2)	2 (3.2)	4 (9.1)	2 (4.5)	2 (3.6)	1 (1.7)				21 (3.9)
Bermuda Chub	43 (68.3)											43 (8.1)
Bigeye												
Black Grouper												
Bluerunner	14 (22.2)	68 (88.3)	34 (54.8)	31 (50.0)								147 (27.6)
Cobia												
Coney Grouper												
Creolefish			4 (6.5)	3 (4.8)		2 (4.5)						9 (1.7)
Gag												
Gray Triggerfish	1 (1.6)	1 (1.3)	2 (3.2)	2 (3.2)	3 (6.8)	18 (40.9)	9 (16.4)	12 (20.3)	16 (22.5)			64 (12.0)
Horseye Jack			20 (32.3)	17 (27.4)	3 (6.8)				8 (11.3)			48 (9.0)

Table 7b (continued). Number enumerated and percent species composition (in parentheses) by depth strata at Grand Isle 94 from November 8 - 9, 1994 from visual point count surveys.

	Depth (m)										
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Jack Crevalle				5 (8.1)	23 (52.3)	8 (18.2)		3 (5.1)				39 (7.3)
Lookdown												
Mangrove Snapper					6 (13.6)	12 (27.3)	4 (7.3)	2 (3.4)				24 (4.5)
Ocean Triggerfish												
Rainbow Runner												
Red Snapper							24 (43.6)	29 (49.2)	31 (43.7)			84 (15.8)
Scamp		2 (2.6)		2 (3.2)	1 (2.3)	2 (4.5)	5 (9.1)	4 (6.8)	6 (8.5)			22 (4.1)
Vermillion Snapper												
Yellowfin Grouper												

Table 7c. Number enumerated and percent species composition (in parentheses) by depth strata at Grand Isle 94 from January 31, 1995 from visual point count surveys.

Species	Depth (m) 0 - 5	5- 10	10 - 15	15 - 20	20- 25	25 - 30	30 - 35	35 - 40	40 - 45	45 - 50	50 - 55	0 - 60
Almaco Jack		3 (0.4)	1 (0.1)			2 (0.3)			2 (0.6)	2 (1.7)		8 (0.1)
Atlantic Spadefish									2 (0.6)			2 (0.0)
Greater Amberjack									2 (0.6)			4 (0.1)
Bar Jack				2 (0.2)			2 (0.5)					4 (0.1)
Barracuda						2 (0.3)	3 (0.7)	13 (3.5)	8 (2.3)	3 (2.6)		29 (0.4)
Bermuda Chub	2 (0.2)	3 (0.4)							1 (0.3)			6 (0.1)
Bigeye									1 (0.3)			1 (0.0)
Black Grouper									1 (0.3)			1 (0.0)
Bluerunner	927 (99.8)	744 (98.8)	1235 (99.8)	835 (99.6)	1074 (99.7)	603 (94.1)	389 (88.6)	315 (85.1)	198 (56.3)	50 (43.5)		6370 (94.3)
Cobia												
Coney Grouper												
Creolefish			1 (0.1)	1 (0.1)					1 (0.3)			3 (0.0)
Gag												
Gray Triggerfish		1 (0.1)	1 (0.1)		1 (0.1)	7 (1.1)	12 (2.7)	12 (3.2)	44 (12.5)	34 (29.6)		112 (1.7)

Table 7c (continued). Number enumerated and percent species composition (in parentheses) by depth strata at Grand Isle 94 from January 31, 1995 from visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5- 10**	**10 - 15**	**15 - 20**	**20- 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Horseye Jack												
Jack Crevalle												
Lookdown						23 (3.6)	28 (6.4)		6 (1.7)			57 (0.8)
Mangrove Snapper					2 (0.2)	3 (0.5)		12 (3.2)	13 (3.7)	3 (2.6)		33 (0.5)
Ocean Triggerfish												
Rainbow Runner		2 (0.3)										2 (0.0)
Red Snapper							1 (0.2)	7 (1.9)	49 (13.9)	15 (13.0)		72 (1.1)
Scamp						1 (0.2)	4 (0.9)	9 (2.4)	15 (4.3)	6 (5.2)		35 (0.5)
Vermillion Snapper								2 (0.5)	8 (2.3)	2 (1.7)		12 (0.2)
Yellowfin Grouper									1 (0.3)			1 (0.0)

Table 7d. Number enumerated and percent species composition (in parentheses) by depth strata at Grand Isle 94 from September 10 - 11, 1995 from visual point count surveys.

	Depth (m)										
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Almaco Jack		3 (2.8)	1 (1.1)							4 (9.3)		8 (1.4)
Atlantic Spadefish												
Greater Amberjack										4 (9.3)		4 (0.7)
Bar Jack				12 (10.7)								12 (2.1)
Barracuda		1 (0.9)		3 (2.7)	1 (0.8)	1 (1.5)						6 (1.1)
Bermuda Chub												
Bigeye												
Black Grouper												
Bluerunner		94 (87.9)	77 (88.5)	92 (82.1)	108 (81.8)	62 (95.4)				12 (27.9)		445 (79.5)
Cobia												
Coney Grouper												
Creolefish					12 (9.1)							12 (2.1)
Gag												
Gray Triggerfish	2 (100.0)	8 (7.5)	4 (4.6)	2 (1.8)	8 (6.1)		2 (28.6)	2 (100.0)	1 (100.0)	3 (7.0)	2 (100.0)	34 (6.1)
Horseye Jack		1 (0.9)										1 (0.2)

Table 7d (continued). Number enumerated and percent species composition (in parentheses) by depth strata at Grand Isle 94 from September 10 - 11, 1995 from visual point count surveys.

	Depth (m)										
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Jack Crevalle							5 (71.4)					5 (0.9)
Lookdown												
Mangrove Snapper			5 (5.7)	3 (2.7)								8 (1.4)
Ocean Triggerfish					3 (2.3)	2 (3.1)						5 (0.9)
Rainbow Runner												
Red Snapper										19 (44.2)		19 (3.4)
Scamp										1 (2.3)		1 (0.2)
Vermillion Snapper												
Yellowfin Grouper												

Table 7e. Number enumerated and percent species composition (in parentheses) by depth strata at Grand Isle 94 from November 14 - 15, 1995 from visual point count surveys.

Species	Depth (m) 0 - 5	5- 10	10 - 15	15 - 20	20- 25	25 - 30	30 - 35	35 - 40	40 - 45	45 - 50	50 - 55	0 - 60
Almaco Jack		2 (0.7)	1 (1.1)	2 (5.9)	1 (1.7)	2 (1.2)		2 (0.6)				10 (0.5)
Atlantic Spadefish												
Greater Amberjack								1 (0.3)	2 (0.6)	8 (4.0)	4 (7.1)	15 (0.8)
Bar Jack												
Barracuda	7 (5.1)	9 (3.1)	10 (10.5)	7 (20.6)	7 (12.1)	3 (1.8)	7 (2.2)	4 (1.2)	2 (0.6)	2 (1.0)		58 (2.9)
Bermuda Chub	19 (13.8)	5 (1.7)										24 (1.2)
Bigeye												
Black Grouper												
Bluerunner	104 (75.4)	222 (77.1)	45 (47.4)			99 (58.6)	242 (77.3)	295 (90.8)	264 (84.6)	123 (61.8)	16 (28.6)	1410 (71.0)
Cobia												
Coney Grouper												
Creolefish							2 (0.6)					2 (0.1)
Gag												
Gray Triggerfish		2 (0.7)				2 (1.2)	2 (0.6)	2 (0.6)		1 (0.5)		9 (0.5)

Table 7e (continued). Number enumerated and percent species composition (in parentheses) by depth strata at Grand Isle 94 from November 14 - 15, 1995 from visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5- 10**	**10 - 15**	**15 - 20**	**20- 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Horseye Jack	8 (5.8)	46 (16.0)	33 (34.7)	21 (61.8)	14 (24.1)	39 (23.1)	40 (12.8)	12 (3.7)	37 (11.9)	17 (8.5)		267 (13.4)
Jack Crevalle		1 (0.3)			5 (8.6)	5 (3.0)	3 (1.0)		1 (0.3)			15 (0.8)
Lookdown					22 (37.9)							22 (1.1)
Mangrove Snapper		1 (0.3)	5 (5.3)	4 (11.8)	9 (15.5)	16 (9.5)	13 (4.2)					48 (2.4)
Ocean Triggerfish												
Rainbow Runner			1 (1.1)									1 (0.1)
Red Snapper						2 (1.2)	4 (1.3)	6 (1.8)	4 (1.3)	44 (22.1)	34 (60.7)	94 (4.7)
Scamp						1 (0.6)		3 (0.9)	2 (0.6)	4 (2.0)	2 (3.6)	12 (0.6)
Vermillion Snapper												
Yellowfin Grouper												

Table 7f. Number enumerated and percent species composition (in parentheses) by depth strata at Grand Isle 94 from February 13 - 14, 1996 from visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5- 10**	**10 - 15**	**15 - 20**	**20- 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Almaco Jack	2 (0.9)	1 (0.5)					1 (0.5)				1 (0.4)	5 (0.2)
Atlantic Spadefish											11 (4.5)	11 (0.5)
Greater Amberjack							6 (2.8)	6 (3.0)	14 (5.1)	15 (5.4)	22 (8.9)	63 (3.0)
Bar Jack												
Barracuda			1 (2.2)	1 (0.9)	3 (1.6)	1 (0.6)	1 (0.5)	3 (1.5)	2 (0.7)			12 (0.6)
Bermuda Chub	5 (2.2)											5 (0.2)
Bigeye												
Black Grouper												
Bluerunner	220 (96.9)	183 (99.5)	34 (73.9)	99 (92.5)	170 (93.4)	153 (98.7)	194 (89.0)	152 (74.9)	252 (92.6)	249 (89.9)	93 (37.8)	1799 (85.0)
Cobia												
Coney Grouper												
Creolefish								1 (0.5)				1 (0.0)
Gag												
Grey Triggerfish			5 (10.9)	1 (0.9)		1 (0.6)		1 (0.5)	1 (0.4)			9 (0.4)

Table 7f (continued). Number enumerated and percent species composition (in parentheses) by depth strata at Grand Isle 94 from February 13 - 14, 1996 from visual point count surveys.

	Depth (m)										
Species	**0 - 5**	**5- 10**	**10 - 15**	**15 - 20**	**20- 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Horseye Jack			3 (6.5)	5 (4.7)	3 (1.6)		15 (6.9)	36 (17.7)				62 (2.9)
Jack Crevalle				1 (0.9)			1 (0.5)	2 (1.0)				4 (0.2)
Lookdown												
Mangrove Snapper					6 (3.3)							6 (0.3)
Ocean Triggerfish												
Rainbow Runner			3 (6.5)									3 (0.1)
Red Snapper										12 (4.3)	92 (37.4)	104 (4.9)
Scamp								2 (1.0)	3 (1.1)	1 (0.4)	27 (11.0)	33 (1.6)
Vermillion Snapper												
Yellowfin Grouper												

Table 7g. Number enumerated and percent species composition (in parentheses) by depth strata at Grand Isle 94 from April 23 - 24, 1996 from visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5- 10**	**10 - 15**	**15 - 20**	**20- 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Almaco Jack							1 (0.1)			2 (0.6)		3 (0.0)
Atlantic Spadefish		1 (0.2)									6 (5.8)	7 (0.1)
Greater Amberjack					1 (0 1)	7 (1.0)	11 (1.3)	4 (0.5)	11 (2.8)	11 (3.3)		45 (0.7)
Bar Jack												
Barracuda	3 (7.3)	4 (0.7)	6 (0.7)		1 (0.1)			1 (0.1)				15 (0.2)
Bermuda Chub	5 (12.2)	4 (0.7)										9 (0.1)
Bigeye												
Black Grouper												
Bluerunner	33 (80.5)	441 (78.6)	789 (98.3)	678 (98.3)	812 (94.3)	653 (92.5)	835 (97.3)	732 (98.7)	358 (92.7)	313 (94.0)	86 (83.5)	5730 (94.2)
Cobia					1 (0.1)			1 (0.1)				2 (0.0)
Coney Grouper												
Creolefish												
Gag												
Gray Triggerfish		4 (0.7)	1 (0.1)					1 (0.1)	2 (0.5)			8 (0.1)

Table 7g (continued). Number enumerated and percent species composition (in parentheses) by depth strata at Grand Isle 94 from April 23 - 24, 1996 from visual point count surveys.

	Depth (m)										
Species	**0 - 5**	**5- 10**	**10 - 15**	**15 - 20**	**20- 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Horseye Jack		100 (17.8)	4 (0.5)	12 (1.7)	44 (5.1)	18 (2.5)	2 (0.2)		7 (1.8)		1 (1.0)	188 (3.1)
Jack Crevalle		7 (1.2)	3 (0.4)		2 (0.2)	1 (0.1)						13 (0.2)
Lookdown						26 (3.7)						26 (0.4)
Mangrove Snapper							9 (1.0)	3 (0.4)				12 (0.2)
Ocean Triggerfish												
Rainbow Runner												
Red Snapper									7 (1.8)	6 (1.8)	8 (7.8)	21 (0.3)
Scamp						1 (0.1)			1 (0.3)	1 (0.3)	2 (1.9)	5 (0.1)
Vermillion Snapper												
Yellowfin Grouper												

Table 7h. Number enumerated and percent species composition (in parentheses) by depth strata at Grand Isle 94 from September 3-4, 1996 from visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Almaco Jack						6 (11.3)						6 (0.6)
Atlantic Spadefish												
Greater Amberjack						5 (9.4)	1 (5.6)					6 (0.6)
Bar Jack												
Barracuda	3 (1.0)	6 (2.7)	3 (3.6)	1 (0.5)		1 (1.9)						14 (1.5)
Bermuda Chub	14 (4.7)											14 (1.5)
Bigeye												
Black Grouper												
Bluerunner	278 (94.2)	143 (64.7)	50 (59.5)	134 (62.3)	35 (64.8)	36 (67.9)						676 (71.9)
Cobia			2 (2.4)									2 (0.2)
Coney Grouper												
Creolefish					2 (3.7)							2 (0.2)
Gag												
Gray Triggerfish				1 (0.5)			1 (5.6)					2 (0.2)

Table 7h (continued). Number enumerated and percent species composition (in parentheses) by depth strata at Grand Isle 94 from September 3-4, 1996 from visual point count surveys.

Species	Depth (m) 0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	40 - 45	45 - 50	50 - 55	0 - 60
Horseye Jack			24 (28.6)	45 (20.9)	5 (9.3)							74 (7.9)
Jack Crevalle		59 (26.7)	2 (2.4)	9 (4.2)	6 (11.1)	2 (3.8)						78 (8.3)
Lookdown				22 (10.2)								22 (2.3)
Mangrove Snapper		13 (5.9)	3 (3.6)	3 (1.4)	6 (11.1)	3 (5.7)	13 (72.2)					41 (4.4)
Ocean Triggerfish												
Rainbow Runner												
Red Snapper							2 (11.1)					2 (0.2)
Scamp							1 (5.6)					1 (0.1)
Vermillion Snapper												
Yellowfin Grouper												

Table 7i. Number enumerated and percent species composition (in parentheses) by depth strata at Grand Isle 94 from November 7 - 8, 1996 from visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Almaco	1 (2.6)											1 (0.2)
Atlantic Spadefish											4 (10.8)	4 (0.6)
Greater Amberjack									2 (16.7)	3 (18.8)	10 (27.0)	15 (2.4)
Bar Jack												
Barracuda	2 (5.3)	3 (1.5)	1 (1.7)	4 (4.9)	2 (4.5)	3 (3.8)	3 (10.7)	3 (9.7)	1 (8.3)	6 (37.5)	1 (2.7)	29 (4.6)
Bermuda Chub												
Bigeye												
Black Grouper												
Bluerunner	35 (92.1)	178 (86.8)	45 (76.3)	60 (74.1)	30 (68.2)	60 (76.9)	13 (46.4)	20 (64.5)	6 (50.0)		5 (13.5)	452 (71.9)
Cobia												
Coney Grouper												
Creolefish					1 (2.3)							1 (0.2)
Gag												
Gray Triggerfish					1 (2.3)	1 (1.3)	1 (3.6)	2 (6.5)		1 (6.3)		6 (1.0)
Horseye Jack		24 (11.7)	13 (22.0)	14 (17.3)	10 (22.7)	8 (10.3)	3 (10.7)		2 (16.7)	1 (6.3)		75 (11.9)

Table 7i (continued). Number enumerated and percent species composition (in parentheses) by depth strata at Grand Isle 94 from November 7 - 8, 1996 from visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Jack Crevalle				2 (2.5)		2 (2.6)	5 (17.9)	3 (9.7)	1 (8.3)	2 (12.5)	1 (2.7)	16 (2.5)
Lookdown												
Mangrove Snapper				1 (1.2)		4 (5.1)	3 (10.7)	3 (9.7)				11 (1.7)
Ocean Triggerfish												
Rainbow Runner												
Red Snapper										1 (6.3)	16 (43.2)	17 (2.7)
Scamp										2 (12.5)		2 (0.3)
Vermillion Snapper												
Yellowfin Grouper												

Table 7j. Number enumerated and percent species composition (in parentheses) by depth strata at Grand Isle 94 from March 9 - 10, 1997 from visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Almaco Jack	2 (0.6)									1 (0.1)	2 (0.5)	5 (0.1)
Atlantic Spadefish												
Greater Amberjack					1 (0.3)	1 (0.2)	1 (0.2)	1 (0.2)	8 (0.9)	9 (1.2)	15 (3.6)	36 (0.6)
Bar Jack												
Barracuda	6 (1.8)	11 (2.4)	7 (0.8)	6 (1.0)	8 (2.2)	14 (2.6)	5 (1.0)	2 (0.4)	5 (0.6)		1 (0.2)	65 (1.0)
Bermuda Chub	34 (10.2)	7 (1.5)										41 (0.7)
Bigeye												
Black Grouper												
Bluerunner	245 (73.4)	410 (88.0)	851 (97.8)	610 (97.9)	334 (90.0)	507 (94.8)	447 (91.8)	522 (98.3)	865 (96.6)	684 (92.8)	348 (84.1)	5823 (93.0)
Cobia												
Coney Grouper												
Creolefish				3 (0.5)			3 (0.6)					6 (0.1)
Gag					1 (0.3)		1 (0.2)				1 (0.2)	3 (0.0)
Gray Triggerfish						1 (0.2)	2 (0.4)	1 (0.2)	1 (0.1)			5 (0.1)

Table 7j (continued). Number enumerated and percent species composition (in parentheses) by depth strata at Grand Isle 94 from March 9 - 10, 1997 from visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Horseye Jack	45 (13.5)	34 (7.3)	5 (0.6)	2 (0.3)	3 (0.8)							89 (1.4)
Jack Crevalle	2 (0.6)	3 (0.6)	6 (0.7)									11 (0.2)
Lookdown												
Mangrove Snapper		1 (0.2)	1 (0.1)	2 (0.3)	24 (6.5)	10 (1.9)	26 (5.3)	5 (0.9)	12 (1.3)	1 (0.1)		82 (1.3)
Ocean Triggerfish												
Rainbow Runner												
Red Snapper						1 (0.2)	1 (0.2)		2 (0.2)	39 (5.3)	47 (11.4)	90 (1.4)
Scamp						1 (0.2)	1 (0.2)		2 (0.2)	3 (0.4)		7 (0.1)
Vermillion Snapper												
Yellowfin Grouper												

Table 7k. Number enumerated and percent species composition (in parentheses) by depth strata from all trips to Grand Isle 94 from August 1994 - March 1997 from visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Almaco Jack	5 (0.2)	9 (0.3)	4 (0.1)	2 (0.1)	1 (0.0)	10 (0.4)	2 (0.1)	2 (0.1)	2 (0.1)	7 (0.4)	3 (0.3)	47 (0.2)
Atlantic Spadefish		1 (0.0)							2 (0.1)		21 (2.4)	24 (0.1)
Greater Amberjack					7 (0.2)	13 (0.5)	31 (1.2)	31 (1.3)	55 (2.3)	60 (3.4)	57 (6.5)	254 (1.0)
Bar Jack	2 (0.1)		6 (0.2)	14 (0.5)	1 (0.0)		6 (0.2)					25 (0.1)
Barracuda	23 (1.0)	42 (1.4)	30 (0.9)	25 (0.9)	27 (0.9)	28 (1.1)	21 (0.8)	27 (1.2)	18 (0.8)	11 (0.6)	2 (0.2)	254 (1.0)
Bermuda Chub	138 (6.3)	19 (0.6)	8 (0.2)	1 (0.0)	8 (0.3)				1 (0.0)			175 (0.7)
Bigeye									1 (0.0)			1 (0.0)
Black Grouper									1 (0.0)			1 (0.0)
Bluerunner	1968 (89.7)	2602 (87.2)	3200 (93.9)	2603 (91.1)	2606 (89.3)	2182 (88.1)	2120 (84.9)	2036 (86.8)	1943 (81.7)	1431 (80.3)	548 (62.1)	23239 (87.0)
Cobia			3 (0.1)		1 (0.0)			1 (0.0)				5 (0.0)
Coney Grouper												
Creolefish			5 (0.1)	7 (0.2)	15 (0.5)	2 (0.1)	5 (0.2)	1 (0.0)	1 (0.0)			36 (0.1)
Gag					1 (0.0)		1 (0.0)				1 (0.1)	3 (0.0)
Gray Triggerfish	3 (0.1)	16 (0.5)	16 (0.5)	15 (0.5)	15 (0.5)	33 (1.3)	30 (1.2)	34 (1.4)	65 (2.7)	39 (2.2)	2 (0.2)	268 (1.0)

Table 7k (continued). Number enumerated and percent species composition (in parentheses) by depth strata from all trips to Grand Isle 94 from August 1994 - March 1997 from visual point count surveys.

	Depth (m)										
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Horseye Jack	53 (2.4)	205 (6.9)	102 (3.0)	118 (4.1)	82 (2.8)	65 (2.6)	60 (2.4)	48 (2.0)	54 (2.3)	18 (1.0)	1 (0.1)	806 (3.0)
Jack Crevalle	2 (0.1)	70 (2.3)	14 (0.4)	28 (1.0)	36 (1.2)	18 (0.7)	14 (0.6)	8 (0.3)	2 (0.1)	2 (0.1)	1 (0.1)	195 (0.7)
Lookdown				22 (0.8)	57 (2.0)	49 (2.0)	28 (1.1)		6 (0.3)			162 (0.6)
Mangrove Snapper		15 (0.5)	17 (0.5)	21 (0.7)	57 (2.0)	54 (2.2)	68 (2.7)	25 (1.1)	25 (1.1)	4 (0.2)		286 (1.1)
Ocean Triggerfish					3 (0.1)	2 (0.1)						5 (0.0)
Rainbow Runner		2 (0.1)	4 (0.1)									6 (0.0)
Red Snapper						13 (0.5)	97 (3.9)	112 (4.8)	164 (6.9)	189 (10.6)	214 (24.2)	789 (3.0)
Scamp		2 (0.1)		2 (0.1)	1 (0.0)	7 (0.3)	13 (0.5)	19 (0.8)	30 (1.3)	18 (1.0)	33 (3.7)	125 (0.5)
Vermillion Snapper								2 (0.1)	8 (0.3)	2 (0.1)		12 (0.0)
Yellowfin Grouper									1 (0.0)			1 (0.0)

Table 8a. Estimated number of fish by species (with 95% confidence intervals) by depth strata at Grand Isle 94 from August 9 - 10, 1994 from hydroacoustic and visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Almaco Jack			6.5 (1.2)									7.7 (1.6)
Atlantic Spadefish												
Greater Amberjack					3.0 (0.7)		29.2 (9.5)	53.9 (18.8)	24.8 (6.0)	688.9 (127.8)		331.7 (69.0)
Bar Jack			39.9 (7.4)		3.0 (0.7)							61.7 (12.8)
Barracuda		0.7 (0.2)		3.5 (0.7)	3.0 (0.7)	7.1 (1.7)						46.3 (9.6)
Bermuda Chub	6.1 (0.9)		53.3 (9.9)	3.5 (0.7)	23.4 (5.6)							293.1 (61.0)
Bigeye												
Black Grouper												
Bluerunner	42.8 (6.0)	41.3 (9.3)	266.7 (49.4)	232.7 (43.0)	126.2 (30.3)	64.6 (15.7)						3463.2 (720.4)
Cobia			6.5 (1.2)									7.7 (1.6)
Coney Grouper												
Creolefish				3.5 (0.7)								7.7 (1.6)
Gag												

Table 8a (continued). Estimated number of fish by species (with 95% confidence intervals) by depth strata at Grand Isle 94 from August 9 - 10, 1994 from hydroacoustic and visual point count surveys.

	Depth (m)										
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Gray Triggerfish			19.9 (3.7)	32.8 (6.1)	5.9 (1.4)	21.5 (5.2)	6.0 (2.0)	48.6 (1.7)				169.7 (35.3)
Horseye Jack				7.4 (1.4)								15.4 (3.2)
Jack Crevalle			19.9 (3.7)	39.8 (7.4)								123.4 (25.7)
Lookdown					82.8 (24.7)							316.2 (65.8)
Mangrove Snapper			19.9 (3.7)	28.9 (5.3)	29.3 (7.0)	43.0 (10.5)						239.1 (49.7)
Marbled Grouper												
Ocean Triggerfish												
Rainbow Runner												
Red Snapper						71.7 (17.4)	382.7 (124.9)	341.6 (118.9)	292.6 (71.2)	4569.7 (848.0)		2560.8 (532.7)
Scamp						7.1 (1.7)	11.6 (3.8)	4.9 (1.7)	4.2 (1.0)			61.7 (12.8)
Vermillion Snapper												
Yellowfin Grouper												
TOTAL	48.9 (6.8)	42.0 (9.5)	433.6 (80.4)	352.6 (65.1)	296.3 (71.1)	215.2 (52.3)	430.0 (140.3)	405.2 (141.1)	321.5 (78.2)	5258.6 (975.8)		7713.2 (160.4)

* note if cell empty then no individuals were of that species for that depth interval

Table 8b. Estimated number of fish by species (with 95% confidence intervals) by depth strata at Grand Isle 94 from November 8 - 9, 1994 from hydroacoustic and visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Almaco Jack	19.1 (2.6)											55.8 (7.9)
Atlantic Spadefish												
Greater Amberjack					75.8 (13.9)		294.2 (41.3)	478.1 (62.5)	733.1 (93.9)			1507.0 (214.6)
Bar Jack	38.3 (5.2)						169.1 (23.7)					111.6 (15.9)
Barracuda	38.3 (5.2)	32.1 (6.0)	2.5 (0.5)	19.0 (4.4)	75.8 (13.9)	56.7 (10.0)	83.4 (11.7)	59.8 (7.8)				1088.4 (155.0)
Bermuda Chub	816.5 (111.8)											2260.5 (322)
Bigeye												
Black Grouper												
Bluerunner	265.4 (36.3)	362.9 (68.3)	43.1 (8.4)	296.7 (68.1)								7702.6 (1097.0)
Cobia												
Coney Grouper												
Creolefish			5.1 (1.0)	28.5 (6.5)		56.7 (10.0)						474.4 (67.6)
Gag												
Gray Triggerfish	19.1 (2.6)	5.3 (1.0)	2.5 (0.5)	19.0 (4.4)	56.6 (10.4)	515.0 (90.8)	380.0 (53.3)	713.6 (93.3)	1169.9 (149.9)			3349.0 (477.0)

Table 8b (continued). Estimated number of fish by species (with 95% confidence intervals) by depth strata at Grand Isle 94 from November 8 - 9, 1994 from hydroacoustic and visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Horseye Jack			25.4 (5.0)	162.6 (37.3)	56.6 (10.4)				587.5 (75.3)			2511.7 (357.7)
Jack Crevalle				48.1 (11.0)	435.4 (80.0)	229.2 (40.4)		179.3 (23.4)				2037.3 (290.2)
Lookdown												
Mangrove Snapper					113.2 (20.8)	343.7 (60.6)	169.1 (23.7)	119.5 (15.6)				1255.9 (178.9)
Ocean Triggerfish												
Rainbow Runner												
Red Snapper							1010.0 (141.7)	1729.6 (226.2)	2272.2 (291.1)			4409.5 (628.0)
Scamp		10.7 (2.0)		19.0 (4.4)	19.1 (3.5)	56.7 (10.0)	2108.0 (29.6)	239.1 (31.3)	442.0 (56.6)			1144.2 (163.0)
Vermillion Snapper												
Yellowfin Grouper												
TOTAL	1195.5 (163.7)	411.0 (77.4)	78.7 (15.4)	593.3 (136.1)	832.5 (153.0)	1259.1 (222.1)	2316.6 (324.9)	3515.5 (459.8)	5199.5 (666.2)	2725.0 (344.2)	4865.9 (616.3)	27908.0 (3974.7)

Table 8c. Estimated number of fish by species (with 95% confidence intervals) by depth strata at Grand Isle 94 from January 31, 1995 from hydroacoustic and visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Almaco Jack		22.9 (2.2)	5.1 (0.5)			19.2 (1.6)			28.6 (3.1)	82.3 (6.0)		58.5 (5.2)
Atlantic Spadefish									28.6 (3.1)			0.0 (0.0)
Greater Amberjack									28.6 (3.1)			58.5 (5.2)
Bar Jack				10.6 (0.9)			27.8 (2.4)					58.5 (5.2)
Barracuda						19.2 (1.6)	39.0 (3.4)	172.8 (14.6)	109.5 (12.0)	125.9 (9.1)		234.0 (20.7)
Bermuda Chub	6.9 (0.7)	22.9 (2.2)							14.3 (1.6)			58.5 (5.2)
Bigeye									14.3 (1.6)			0.0 (0.0)
Black Grouper									14.3 (1.6)			0.0 (0.0)
Bluerunner	3420.8 (345.2)	5658.8 (551.7)	5109.0 (482.0)	5278.1 (453.5)	5833.4 (496.9)	6031.9 (498.1)	4931.3 (424.4)	4202.4 (355.5)	2681.5 (294.2)	2106.7 (152.3)		55161.5 (4879.3)
Cobia												
Coney Grouper												
Creolefish			5.1 (0.5)	5.3 (0.5)					14.3 (1.6)			0.0 (0.0)
Gag												
Gray Triggerfish		5.7 (0.6)	5.1 (0.5)		5.9 (0.5)	70.5 (5.8)	150.3 (12.9)	158.0 (13.4)	595.4 (65.3)	1433.6 (103.7)		994.4 (88.0)

Table 8c (continued). Estimated number of fish by species (with 95% confidence intervals) by depth strata at Grand Isle 94 from January 31, 1995 from hydroacoustic and visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Horseye Jack												
Jack Crevalle												
Lookdown						230.8 (19.1)	356.2 (30.7)		81 (8.9)			468.0 (41.4)
Mangrove Snapper					11.7 (1.0)	32.1 (2.6)		158.0 (13.4)	176.2 (19.3)	125.9 (9.1)		292.5 (25.9)
Ocean Triggerfish												
Rainbow Runner		17.2 (1.7)										0.0 (0.0)
Red Snapper							11.1 (1.0)	93.8 (7.9)	662.0 (72.9)	629.6 (45.5)		643.5 (56.9)
Scamp						12.8 (1.1)	50.1 (4.3)	118.5 (10.0)	204.8 (22.5)	251.8 (18.2)		292.5 (25.9)
Vermillion Snapper								24.7 (2.1)	109.5 (12.0)	82.3 (6.0)		117.0 (10.3)
Yellowfin Grouper									14.3 (1.6)			0.0 (0.0)
TOTAL	3427.7 (345.9)	5727.5 (558.4)	5119.2 (483.0)	5299.3 (455.3)	5851.0 (498.4)	6410.1 (529.3)	5565.8 (479.0)	4938.2 (417.7)	4762.9 (522.5)	4843.1 (350.2)	6551.1 (534.5)	58495.8 (5174.2)

Table 8d. Estimated number of fish by species (with 95% confidence intervals) by depth strata at Grand Isle 94 from September 10 - 11, 1995 from hydroacoustic and visual point count surveys.

	Depth (m)										
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Almaco Jack		25.1 (3.1)	1.5 (0.6)							153.1 (13.0)		119.0 (16.4)
Atlantic Spadefish												
Greater Amberjack										153.1 (13.0)		59.5 (8.2)
Bar Jack				24.6 (4.2)								178.5 (24.5)
Barracuda		8.1 (1.0)		6.2 (1.1)	2.7 (0.6)	5.6 (0.8)						93.5 (12.9)
Bermuda Chub												
Bigeye												
Black Grouper												
Bluerunner		788.5 (95.9)	120.8 (46.2)	188.8 (32.3)	279.6 (60.4)	356.9 (53.7)				459.3 (39.1)		6757.4 (929.1)
Cobia												
Coney Grouper												
Creolefish					31.1 (6.7)							178.5 (24.5)
Gag												
Gray Triggerfish	189.5 (20.3)	67.3 (8.2)	6.3 (2.4)	4.1 (0.7)	20.8 (4.5)		145.6 (20.1)	524.8 (72.9)	1002.8 (126.2)	115.2 (9.8)	1568.4 (244.0)	518.5 (71.3)

Table 8d. Estimated number of fish by species (with 95% confidence intervals) by depth strata at Grand Isle 94 from September 10 - 11, 1995 from hydroacoustic and visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Horseye Jack		8.1 (1.0)										17.0 (2.3)
Jack Crevalle							363.4 (50.2)					76.5 (10.5)
Lookdown												
Mangrove Snapper			7.8 (3.0)	6.2 (1.1)								119.0 (16.4)
Ocean Triggerfish					7.9 (1.7)	11.6 (1.7)						76.5 (10.5)
Rainbow Runner												
Red Snapper										727.7 (61.9)		289.0 (39.7)
Scamp										37.9 (3.2)		17.0 (2.3)
Vermillion Snapper												
Yellowfin Grouper												
TOTAL	189.5 (20.3)	897.0 (109.1)	136.5 (52.2)	230.0 (39.3)	341.8 (73.8)	374.1 (56.3)	509.0 (70.3)	524.8 (72.9)	1002.8 (126.2)	1646.4 (140.1)	1568.4 (244.0)	8499.9 (1168.7)

Table 8e. Estimated number of fish by species (with 95% confidence intervals) by depth strata at Grand Isle 94 from November 14 - 15, 1995 from hydroacoustic and visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Almaco Jack		19.9 (3.0)	16.5 (3.7)	97.3 (23.7)	31.2 (4.7)	51.4 (8.1)		29.8 (4.2)				219.8 (35.2)
Atlantic Spadefish												
Greater Amberjack								14.9 (2.1)	20.2 (2.9)	168.8 (23.4)	283.1 (56.3)	351.7 (56.4)
Bar Jack												
Barracuda	279.8 (37.3)	88.2 (13.4)	157.1 (35.1)	339.6 (82.9)	222.4 (33.5)	77.0 (12.2)	82.7 (12.7)	59.5 (8.5)	20.2 (2.9)	42.2 (5.8)		1274.9 (204.3)
Bermuda Chub	757.1 (101.0)	48.4 (7.4)										527.6 (84.5)
Bigeye												
Black Grouper												
Bluerunner	4136.4 (552.1)	2194.7 (333.7)	709.2 (158.3)			2507.6 (395.7)	2904.6 (447.9)	4503.9 (642.2)	2844.0 (413.1)	2608.3 (360.8)	1140.3 (226.7)	3121.3 (5001.5)
Cobia												
Coney Grouper												
Creolefish							22.5 (3.5)					44.0 (7.0)
Gag												
Gray Triggerfish		19.9 (3.0)				51.4 (8.1)	22.5 (3.5)	29.8 (4.2)		21.1 (2.9)		219.8 (35.2)

Table 8e (continued). Estimated number of fish by species (with 95% confidence intervals) by depth strata at Grand Isle 94 from November 14 - 15, 1995 from hydroacoustic and visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Horseye Jack	318.2 (42.5)	455.5 (69.2)	519.2 (115.9)	1018.9 (248.6)	442.9 (66.8)	988.5 (156.0)	481.0 (58.1)	183.5 (26.2)	400.0 (58.1)	358.8 (49.6)		5891.0 (943.9)
Jack Crevalle		8.5 (1.3)			158.1 (23.8)	128.4 (20.3)	37.6 (5.8)		10.1 (1.5)			351.7 (56.4)
Lookdown					696.5 (105.0)							483.6 (77.5)
Mangrove Snapper		8.5 (1.3)	79.3 (17.7)	194.5 (47.5)	284.9 (42.9)	406.5 (64.1)	157.8 (24.3)					1055.1 (169.1)
Ocean Triggerfish												
Rainbow Runner			16.5 (3.7)									44.0 (7.0)
Red Snapper						51.4 (8.1)	48.8 (7.5)	89.3 (12.7)	43.7 (6.3)	932.8 (129.0)	2420.2 (481.0)	2066.2 (331.1)
Scamp						25.7 (4.1)		44.6 (6.4)	20.2 (2.9)	84.4 (11.7)	143.5 (28.5)	263.8 (42.3)
Vermillion Snapper												
Yellowfin Grouper												
TOTAL	5485.9 (732.2)	2846.6 (432.8)	1496.3 (333.9)	1648.7 (402.3)	1837.8 (277.0)	4279.2 (675.2)	3757.6 (579.4)	4960.2 (707.3)	3361.7 (488.3)	4220.6 (583.8)	3987.1 (792.5)	43962.5 (7044.3)

Table 8f. Estimated number of fish by species (with 95% confidence intervals) by depth strata at Grand Isle 94 from February 13 - 14, 1996 from hydroacoustic and visual point count surveys.

Species	Depth (m) 0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	40 - 45	45 - 50	50 - 55	0 - 60
Almaco Jack	12.0 (1.5)	4.7 (0.8)					12.5 (1.0)					43.4 (3.6)
Atlantic Spadefish												108.5 (8.9)
Greater Amberjack							69.9 (5.6)	93.9 (6.3)	180.4 (10.7)	134.2 (6.7)		651.0 (53.4)
Bar Jack												
Barracuda			11.8 (2.2)	5.0 (0.8)	14.2 (1.2)	8.1 (0.7)	12.5 (1.0)	47.0 (3.2)	24.8 (1.5)			130.2 (10.7)
Bermuda Chub	29.2 (3.7)											43.4 (3.6)
Bigeye												
Black Grouper												
Bluerunner	1287.9 (164.0)	938.1 (160.1)	395.7 (74.1)	511.6 (86.3)	831.4 (68.1)	1338.4 (115.6)	2221.7 (115.6)	2345.4 (157.5)	3276.2 (194.6)	2233.9 (111.1)		18446.2 (1512.8)
Cobia												
Coney Grouper												
Creolefish								15.7 (1.1)				0.0 (0.0)
Gag												
Gray Triggerfish			53.4 (10.9)	5.0 (0.8)		8.1 (0.7)		15.7 (1.1)	14.2 (0.8)			86.8 (7.1)

Table 8f (continued). Estimated number of fish by species (with 95% confidence intervals) by depth strata at Grand Isle 94 from February 13 - 14, 1996 from hydroacoustic and visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Horseye Jack			34.8 (6.5)	26.0 (4.4)	14.2 (1.2)		172.2 (13.9)	554.3 (37.2)				629.3 (51.6)
Jack Crevalle				5.0 (0.8)			12.5 (1.0)	31.3 (2.1)				43.4 (3.6)
Lookdown												
Mangrove Snapper					29.4 (2.4)							65.1 (5.3)
Ocean Triggerfish												
Rainbow Runner			34.8 (6.5)									21.7 (1.8)
Red Snapper										106.9 (5.3)		1063.4 (87.2)
Scamp								31.3 (2.1)	38.9 (2.3)	9.9 (0.5)		347.2 (28.5)
Vermillion Snapper												
Yellowfin Grouper												
TOTAL	1329.1 (169.2)	942.8 (160.9)	535.5 (100.3)	553.1 (93.3)	890.1 (72.9)	1356.0 (117.1)	2496.3 (201.2)	3131.4 (210.3)	3538.1 (210.1)	2484.9 (123.6)		21701.4 (1779.8)

Table 8g. Estimated number of fish by species (with 95% confidence intervals) by depth strata at Grand Isle 94 from April 23 - 24, 1996 from hydroacoustic and visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Almaco Jack							0.1 (0.0)			0.6 (0.1)		0.0 (0.0)
Atlantic Spadefish		0.2 (0.1)									10.5 (2.7)	2.38 (0.7)
Greater Amberjack					0.0 (0.0)	1.5 (0.5)	1.6 (0.3)	2.5 (0.5)	14.4 (5.1)	3.3 (0.5)		16.7 (5.2)
Bar Jack												
Barracuda	30.2 (21.2)	0.5 (0.2)	1.8 (0.8)		0.0 (0.0)			0.5 (0.1)				4.8 (1.5)
Bermuda Chub	50.5 (21.2)	0.5 (0.2)										2.4 (0.7)
Bigeye												
Black Grouper												
Bluerunner	333.4 (140.2)	59.4 (19.8)	248.7 (106.6)	40.0 (0.6)	34.3 (4.5)	136.4 (43.9)	116.5 (20.6)	491.5 (106.0)	476.4 (169.4)	94.2 (14.7)	151.0 (39.2)	2242.0 (697.6)
Cobia					0.0 (0.0)			0.0 (0.0)				0.0 (0.0)
Coney Grouper												
Creolefish												
Gag												
Gray Triggerfish		0.5 (0.2)	0.3 (0.1)					0.5 (1.1)	2.6 (0.9)			2.4 (0.7)

Table 8g (continued). Estimated number of fish by species (with 95% confidence intervals) by depth strata at Grand Isle 94 from April 23 - 24, 1996 from hydroacoustic and visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Horseye Jack		13.5 (4.5)	1.3 (0.5)	0.7 (0.1)	1.9 (0.2)	3.7 (1.2)	0.2 (0.0)		9.3 (3.3)		1.8 (0.5)	73.8 (23.0)
Jack Crevalle		0.9 (0.3)	1.0 (0.4)		0.1 (0.0)	0.1 (0.0)						4.8 (1.5)
Lookdown						5.5 (1.8)						9.5 (3.0)
Mangrove Snapper							1.2 (0.2)	2.0 (0.4)				4.8 (1.5)
Ocean Triggerfish												
Rainbow Runner												
Red Snapper									9.3 (3.3)	1.8 (0.3)	14.1 (3.7)	7.1 (2.2)
Scamp						0.1 (0.0)			1.5 (0.5)	0.3 (0.0)	3.4 (0.9)	2.4 (0.7)
Vermillion Snapper												
Yellowfin Grouper												
TOTAL	414.1 (174.1)	75.6 (25.2)	253.0 (108.4)	40.7 (6.7)	36.4 (4.8)	147.5 (47.5)	119.7 (21.2)	498.0 (107.4)	513.9 (182.7)	100.2 (15.6)	180.8 (46.9)	2380.0 (740.5)

Table 8h. Estimated number of fish by species (with 95% confidence intervals) by depth strata at Grand Isle 94 from September 3 - 4, 1996 from hydroacoustic and visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Almaco Jack						22.6 (8.0)						27.7 (8.3)
Atlantic Spadefish												
Greater Amberjack						18.8 (6.6)	5.6 (2.1)					27.7 (8.3)
Bar Jack												
Barracuda	173.6 (3.6)	12.5 (1.9)	14.4 (2.0)	1.3 (0.4)		3.8 (1.3)						69.4 (20.9)
Bermuda Chub	81.6 (17.1)											69.4 (20.9)
Bigeye												
Black Grouper												
Bluerunner	1635.6 (343.4)	299.4 (44.5)	237.5 (33.9)	163.9 (51.0)	97.3 (31.4)	135.7 (47.8)						3324.5 (999.5)
Cobia			9.6 (1.4)									9.2 (2.8)
Coney Grouper												
Creolefish					5.6 (1.8)							9.2 (2.8)
Gag												
Gray Triggerfish				1.3 (0.4)			5.6 (2.1)					9.2 (2.8)

Table 8h (continued). Estimated number of fish by species (with 95% confidence intervals) by depth strata at Grand Isle 94 from September 3 - 4, 1996 from hydroacoustic and visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Horseye Jack			114.1 (16.3)	55.0 (17.1)	14.0 (4.5)							365.3 (109.8)
Jack Crevalle		123.6 (18.4)	9.6 (1.4)	11.1 (3.4)	16.7 (5.4)	7.6 (2.7)						383.8 (115.4)
Lookdown				26.8 (8.4)								106.3 (32.0)
Mangrove Snapper		27.3 (4.1)	14.4 (2.0)	3.7 (1.1)	16.7 (5.4)	11.4 (4.0)	72.6 (26.6)					203.4 (61.2)
Ocean Triggerfish												
Rainbow Runner												
Red Snapper							11.2 (4.1)					9.2 (2.8)
Scamp							5.6 (2.1)					4.6 (1.4)
Vermillion Snapper												
Yellowfin Grouper												
TOTAL	1736.3 (364.5)	462.8 (68.8)	399.1 (56.9)	263.1 (81.9)	150.1 (48.5)	199.8 (70.4)	100.6 (36.9)	152.8 (76.4)	284.5 (161.8)	163.5 (75.8)	281.1 (123.0)	4623.8 (225.2)

Table 8i. Estimated number of fish by species (with 95% confidence intervals) by depth strata at Grand Isle 94 from November 7 - 8, 1996 from hydroacoustic and visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Almaco Jack	142.6 (19.0)											87.9 (14.1)
Atlantic Spadefish											430.6 (85.6)	263.8 (42.3)
Greater Amberjack									561.4 (81.5)	793.5 (109.8)	1076.5 (214.0)	1055.1 (169.1)
Bar Jack												
Barracuda	290.8 (38.8)	42.7 (6.5)	25.4 (5.7)	80.8 (19.7)	82.7 (12.5)	162.6 (25.7)	402.1 (62.0)	481.1 (68.6)	279.0 (40.5)	1582.7 (218.9)	107.7 (21.4)	2022.3 (324.0)
Bermuda Chub												
Bigeye												
Black Grouper												
Bluerunner	5052.5 (674.4)	2470.8 (375.7)	1141.7 (254.0)	1221.7 (188.9)	1253.4 (188.9)	3290.7 (519.2)	1743.5 (268.8)	3199.3 (456.2)	1680.9 (244.2)		538.3 (107.0)	31609.0 (5064.9)
Cobia												
Coney Grouper												
Creolefish					42.3 (6.4)							87.9 (14.1)
Gag												
Gray Triggerfish					42.3 (6.4)	55.6 (8.8)	135.3 (20.9)	322.4 (46.0)		265.9 (36.8)		439.6 (70.4)

Table 8i (continued). Estimated number of fish by species (with 95% confidence intervals) by depth strata at Grand Isle 94 from November 7 - 8, 1996 from hydroacoustic and visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Horseye Jack		333.1 (50.6)	329.2 (73.5)	285.2 (69.6)	417.2 (62.9)	440.8 (69.5)	402.1 (62.0)		561.4 (81.5)	265.9 (36.8)		5231.5 (838.3)
Jack Crevalle				41.2 (10.1)		111.3 (17.6)	672.6 (103.7)	481.1 (68.6)	279.0 (40.5)	527.6 (73.0)	107.7 (21.4)	1099.1 (176.1)
Lookdown												
Mangrove Snapper				19.8 (4.8)		218.2 (34.4)	402.1 (62.0)	481.1 (68.6)				747.4 (119.8)
Ocean Triggerfish												
Rainbow Runner												
Red Snapper										265.9 (36.8)	1722.4 (342.4)	1187.0 (190.2)
Scamp										527.6 (73.0)		131.9 (21.1)
Vermillion Snapper												
Yellowfin Grouper												
TOTAL	5485.9 (732.2)	2846.6 (432.8)	1496.3 (333.9)	1648.7 (402.3)	1837.8 (277.0)	4279.2 (675.2)	3757.6 (579.4)	4960.2 (707.3)	3361.7 (488.3)	4220.6 (583.8)	3987.1 (792.5)	43962.5 (7044.3)

Table 8j. Estimated number of fish by species (with 95% confidence intervals) by depth strata at Grand Isle 94 from March 9 - 10, 1997 from hydroacoustic and visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Almaco Jack	12.9 (1.0)									6.8 (0.5)	50.5 (2.7)	67.0 (4.7)
Atlantic Spadefish												
Greater Amberjack					18.3 (1.3)	2.9 (0.2)	2.9 (0.3)	4.6 (0.5)	37.2 (3.0)	81.1 (6.1)	368.7 (19.7)	402.2 (28.2)
Bar Jack												
Barracuda	38.6 (3.0)	55.1 (3.7)	55.7 (4.9)	14.7 (2.8)	134.1 (9.8)	37.5 (2.7)	14.6 (1.3)	9.2 (0.9)	24.8 (2.0)		20.2 (1.1)	670.2 (47.0)
Bermuda Chub	219.0 (16.9)	34.5 (2.3)										469.2 (32.9)
Bigeye												
Black Grouper												
Bluerunner	1575.8 (121.9)	2021.7 (136.2)	6813.5 (597.6)	1441.6 (223.2)	5487.8 (399.4)	1367.1 (99.7)	1336.0 (121.5)	2255.4 (222.8)	3990.4 (324.6)	6268.5 (469.9)	8495.4 (460.4)	62334.8 (4367.4)
Cobi												
Coney Grouper												
Creolefish				7.3 (1.1)			8.7 (0.8)					67.0 (4.7)
Gag					18.3 (1.3)		2.9 (2.6)				20.2 (1.1)	0.0 (0.0)
Gray Triggerfish						2.9 (0.2)	5.8 (0.5)	4.6 (0.5)	4.1 (0.3)			67.0 (4.7)

Table 8j (continued). Estimated number of fish by species (with 95% confidence intervals) by depth strata at Grand Isle 94 from March 9 - 10, 1997 from hydroacoustic and visual point count surveys.

Species	Depth (m) 0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	40 - 45	45 - 50	50 - 55	0 - 60
Horseye Jack	289.8 (22.4)	167.7 (11.3)	41.8 (3.7)	4.4 (0.7)	48.8 (3.6)							938.4 (65.7)
Jack Crevalle	12.9 (1.0)	13.8 (0.9)	48.8 (4.3)									134.1 (9.4)
Lookdown												
Mangrove Snapper		4.6 (0.3)	7.0 (0.6)	4.4 (0.7)	396.3 (28.8)	27.4 (2.0)	77.1 (7.0)	20.6 (2.0)	53.7 (4.4)	6.8 (0.5)		871.3 (61.0)
Ocean Triggerfish												
Rainbow Runner												
Red Snapper						2.9 (0.2)	2.9 (0.3)		8.3 (0.7)	358.0 (26.8)	1151.6 (62.4)	938.4 (65.7)
Scamp						2.9 (0.2)	2.9 (0.3)		8.3 (0.7)	13.5 (2.0)		67.0 (4.7)
Vermillion Snapper												
Yellowfin Grouper												
TOTAL	2146.9 (166.1)	2297.4 (154.8)	6966.8 (611.0)	1472.5 (228.0)	6097.6 (443.8)	1442.1 (105.2)	1455.3 (132.3)	2294.4 (226.7)	4130.9 (336.0)	6754.8 (506.4)	10101.6 (547.5)	67026.7 (4696.1)

Table 8k. Estimated number of fish by species (with 95% confidence intervals) by depth strata from all trips to Grand Isle 94 from August 1994 - March 1997 from hydroacoustic and visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Almaco Jack	5.7 (0.4)	4.1 (0.3)	1.4 (0.1)	1.3 (0.1)	0.0 (0.0)	8.0 (0.5)	2.3 (0.1)	2.8 (0.2)	3.3 (0.2)	13.1 (0.7)	11.9 (0.7)	57.9 (3.6)
Atlantic Spadefish	0.0 (0.0)								3.3 (0.2)		95.1 (5.5)	29.0 (1.8)
Greater Amberjack					2.8 (0.2)	10.0 (0.7)	27.3 (1.6)	37.0 (2.0)	76.5 (4.2)	111.2 (5.7)	257.4 (14.8)	289.5 (18.1)
Bar Jack	2.9 (0.2)		2.8 (0.2)	6.5 (0.5)	0.0 (0.0)		4.5 (0.3)					29.0 (1.8)
Barracuda	28.5 (1.8)	19.3 (1.4)	12.8 (1.0)	11.7 (0.9)	12.7 (0.9)	22.0 (1.5)	18.2 (1.0)	34.1 (1.9)	26.6 (1.4)	19.6 (1.0)	7.9 (0.5)	289.5 (18.1)
Bermuda Chub	179.6 (11.2)	8.3 (0.6)	2.8 (0.2)	0.0 (0.0)	4.2 (0.3)				0.0 (0.0)			202.7 (12.6)
Bigeye									0.0 (0.0)			0.0 (0.0)
Black Grouper									0.0 (0.0)			0.0 (0.0)
Bluerunner	2557.3 (159.0)	1201.4 (87.7)	1336.5 (105.2)	1183.4 (92.6)	1255.3 (92.9)	1760.8 (119.6)	1930.0 (111.4)	2468.8 (135.5)	2718.7 (148.0)	2625.6 (134.3)	24595.5 (141.6)	25188.4 (1571.2)
Cobia			1.4 (0.1)		0.0 (0.0)			0.0 (0.0)				0.0 (0.0)
Coney Grouper												
Creolefish			1.4 (0.1)	2.6 (0.2)	7.0 (0.5)	2.0 (0.1)	4.5 (0.3)	0.0 (0.0)	0.0 (0.0)			29.0 (1.8)
Gag					0.0 (0.0)		0.0 (0.0)				4.0 (0.2)	0.0 (0.0)

Table 8k (continued). Estimated number of fish by species (with 95% confidence intervals) by depth strata from all trips to Grand Isle 94 from August 1994 - March 1997 from hydroacoustic and visual point count surveys.

	Depth (m)											
Species	**0 - 5**	**5 - 10**	**10 - 15**	**15 - 20**	**20 - 25**	**25 - 30**	**30 - 35**	**35 - 40**	**40 - 45**	**45 - 50**	**50 - 55**	**0 - 60**
Gray Triggerfish	2.9 (0.2)	6.9 (0.5)	7.1 (0.6)	6.5 (0.5)	7.0 (0.5)	26.0 (1.8)	27.3 (1.6)	39.8 (2.2)	89.8 (4.9)	71.9 (3.7)	7.9 (0.5)	289.5 (18.1)
Horseye Jack	68.4 (4.3)	95.1 (6.9)	42.7 (3.4)	53.3 (4.2)	39.4 (2.9)	52.0 (3.5)	54.6 (3.1)	56.9 (3.1)	76.5 (4.2)	32.7 (1.7)	4.0 (0.2)	868.6 (54.2)
Jack Crevalle	2.9 (0.2)	31.7 (2.3)	5.7 (0.4)	13.0 (1.0)	16.9 (1.2)	14.0 (1.0)	13.6 (0.8)	85.3 (0.5)	3.3 (0.2)	3.3 (0.2)	4.0 (0.2)	202.7 (12.6)
Lookdown				10.4 (0.8)	28.1 (2.1)	40.0 (2.7)	25.0 (1.4)		10.0 (0.5)			173.7 (10.8)
Mangrove Snapper		6.9 (0.5)	7.1 (0.6)	9.1 (0.7)	28.1 (2.1)	44.0 (3.0)	61.4 (3.5)	31.3 (1.7)	36.6 (2.0)	6.5 (0.3)		318.5 (19.9)
Ocean Triggerfish					1.4 (0.1)	2.0 (0.1)						0.0 (0.0)
Rainbow Runner		1.4 (0.1)	1.4 (0.1)									0.0 (0.0)
Red Snapper						10.9 (0.7)	88.7 (5.1)	136.5 (7.5)	229.6 (12.5)	346.6 (17.7)	958.5 (55.2)	868.6 (54.2)
Scamp		1.4 (0.1)		1.3 (0.1)	0.0 (0.0)	6.0 (0.4)	11.4 (0.7)	22.8 (1.2)	43.3 (2.4)	32.7 (1.7)	146.5 (8.4)	144.8 (9.0)
Vermillion Snapper								2.8 (0.2)	10.0 (0.5)	3.3 (0.2)		0.0 (0.0)
Yellowfin Grouper									0.0 (0.0)			0.0 (0.0)
TOTAL	2850.9 (177.3)	1377.8 (100.6)	1423.3 (112.0)	1299.0 (101.7)	1405.7 (104.0)	1998.6 (135.8)	2273.3 (131.2)	2844.2 (156.1)	3327.7 (181.2)	3269.8 (167.3)	3960.6 (228.0)	28952.2 (1806.0)

Table 9. RBD ANOVA (block on platform side) results of vertical log fish density (log(number of fish/m ^{3}) with platform side, year, season, time of day, depth, current vectors, temperature, salinity, dissolved oxygen and selected interactions at the GC18 petroleum platform.

Source	DF	SS	MS	F	Prob > F
Model	90	2.0053289	0.0222814	20.93	0.0001
Error	5985	6.3729412	0.0010648		
Corrected Total	6075	8.3782700			
	R-Square	**C.V.**	**Root MSE**		**LDENSITY Mean**
	0.476178	252.0003	0.0284		0.0113
Variables	**DF**	**Type III SS**	**Mean Square**	**F Value**	**Pr > F**
Side	3	0.2220276	0.0740092	69.50	0.0001
Year	3	0.0115176	0.0382392	3.61	0.0128
Season	3	0.0352252	0.0117751	11.06	0.0001
Diel	3	0.0030421	0.0010140	1.25	0.2884
Depth	10	0.3454644	0.0354464	33.29	0.0001
Temperature	1	0.0051256	0.0051256	4.81	0.0283
Dissolved oxygen	1	0.0051131	0.0051131	5.37	0.0206
Salinity	1	0.0010461	0.0010461	0.98	0.3216
North vector	1	0.0011174	0.0011174	1.05	0.3057
East vector	1	0.0007499	0.0007499	0.07	0.4014
North squared vector	1	0.0079050	0.0079050	7.42	0.0065
East squared vector	1	0.0005933	0.0005933	0.56	0.4554
North * East	1	0.0035980	0.0035680	3.38	0.0661
Diel * Depth	30	0.1210778	0.0040359	3.79	0.0001
Season * Depth	30	0.3375548	0.0112518	10.57	0.0001

Table 10. RBD ANOVA (block on platform side) results of horizontal log relative fish density (log(number of fish/m^3) with platform side, year, season, time of day, distance from the platform and selected interactions at the GC18 petroleum platform.

Source	DF	SS	MS	F	Prob > F
Model	1159	84.788167	0.073156	5.68	0.0001
Error	4870	62.705195	0.012876		
Corrected Total	6029	147.493362			
	R-Square	**C.V.**	**Root MSE**		**LDENSITY Mean**
	0.574861	180.3045	0.1135		0.0629
Variables	**DF**	**Type III SS**	**Mean Square**	**F Value**	**Pr > F**
Side	3	21.033569	7.011190	544.52	0.0001
Year	3	0.080941	0.026980	2.10	0.0986
Season	3	3.245408	1.081803	84.02	0.0001
Diel	3	1.460569	0.486856	37.81	0.0001
Depth	9	0.166086	0.018454	1.43	0.1676
Diel * Depth	27	1.195570	0.044280	3.44	0.0001
Year * Season	1	0.35030	0.035030	2.72	0.0991
Side * Year * Season * Diel * Depth	1110	50.150390	0.045181	3.51	0.0001

Table 11a. Number enumerated and percent species composition (in parentheses) by depth strata at Green Canyon 18 from October 4 - 5, 1994 from visual point count surveys.

	Depth (m)									
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80- 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Almaco Jack	8 (3.2)	3 (1.9)	98 (28.3)	60 (33.7)	169 (18.1)					169 (18.1)
Greater Amberjack			34 (9.8)	37 (20.8)	71 (7.6)					71 (7.6)
Bar Jack		46 (28.4)	5 (1.4)		51 (5.5)					51 (5.5)
Barracuda	11 (4.4)	15 (9.3)	1 (0.3)		27 (2.9)					27 (2.9)
Bermuda Chub	37 (14.9)		1 (0.3)		38 (4.1)					38 (4.1)
Black Jack			1 (0.3)		1 (0.1)					1 (0.1)
Blackfin Tuna				80 (44.9)	80 (8.6)					80 (8.6)
Bluerunner	154 (61.8)				154 (16.5)					154 (16.5)
Creolefish	37 (14.9)	58 (35.8)	201 (58.1)		296 (31.7)					296 (31.7)
Gray Triggerfish	1 (0.4)	1 (0.6)	4 (1.2)	1 (0.6)	7 (0.7)					7 (0.7)
Horseye Jack	1 (0.4)	36 (22.2)			37 (4.0)					37 (4.0)
Lesser Amberjack										
Ocean Triggerfish										
Rainbow Runner		3 (1.9)			3 (0.3)					3 (0.3)
Scamp			1 (0.3)		1 (0.1)					1 (0.1)

*Note: If cell is empty, no individuals were observed of that species for that depth interval.

Table 11b. Number enumerated and percent species composition (in parentheses) by depth strata at Green Canyon 18 from November 30 - December 1, 1994 from visual point count surveys.

	Depth (m)									
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80 - 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Almaco Jack			10 (3.6)	9 (11.7)	1 (2.1)					20 (2.8)
Greater Amberjack			12 (4.3)	31 (40.3)	44 (93.6)					87 (12.2)
Bar Jack		4 (2.0)	30 (10.9)							34 (4.8)
Barracuda	6 (5.3)	6 (3.0)	2 (0.7)							14 (2.0)
Bermuda Chub	20 (17.7)									20 (2.8)
Black Jack		4 (2.0)	15 (5.4)							19 (2.7)
Blackfin Tuna										
Bluerunner										
Creolefish	79 (69.9)	159 (80.3)	187 (67.8)	29 (37.7)						454 (63.9)
Gray Triggerfish		2 (1.0)	10 (3.6)							12 (1.7)
Horseye Jack	4 (3.5)	19 (9.6)	10 (3.6)							33 (4.6)
Lesser Amberjack										
Rainbow Runner										
Scamp				8 (10.4)	2 (4.3)					10 (1.4)
Yellowtail Snapper	4 (3.5)	4 (2.0)								8 (1.1)

Table 11c. Number enumerated and percent species composition (in parentheses) by depth strata at Green Canyon 18 from January 20 - 21, 1995 from visual point count surveys.

	Depth (m)								
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80 - 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Almaco Jack	4 (0.8)		2 (1.1)	60 (35.5)	24 (14.2)					90 (5.7)
Greater Amberjack			1 (0.5)	37 (21.9)	79 (46.7)	1 (100.0)				118 (7.5)
Bar Jack	63 (12.8)	29 (5.3)		8 (4.7)						100 (6.4)
Barracuda	34 (6.9)	55 (10.1)	4 (2.1)	2 (1.2)	1 (0.6)					96 (6.1)
Bermuda Chub	137 (27.7)									137 (8.7)
Black Jack		5 (0.9)		2 (1.2)						7 (0.4)
Blackfin Tuna			31 (16.4)	12 (7.1)	37 (21.9)					80 (5.1)
Bluerunner		73 (13.4)								73 (4.7)
Creolefish	190 (38.5)	280 (51.4)	132 (69.8)	24 (14.2)						626 (39.9)
Gray Triggerfish			12 (6.3)	6 (3.6)						18 (1.1)
Horseye Jack	49 (9.9)	85 (15.6)								134 (8.6)
Lesser Amberjack										
Rainbow Runner	3 (0.6)									3 (0.2)
Scamp			7 (3.7)	18 (10.7)	28 (16.6)					53 (3.4)
Yellowtail Snapper	14 (2.8)	18 (3.3)								32 (2.0)

Table 11d. Number enumerated and percent species composition (in parentheses) by depth strata at Green Canyon 18 from May 11 - 12, 1995 from visual point count surveys.

	Depth (m)									
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80 - 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Almaco Jack		51 (11.7)	7 (4.1)	10 (17.9)						58 (8.1)
Greater Amberjack		11 (2.5)	7 (4.1)		5 (83.3)					33 (4.6)
Bar Jack		9 (2.1)								9 (1.3)
Barracuda	14 (31.8)	12 (2.8)								26 (3.6)
Bermuda Chub										
Black Jack		3 (0.7)								3 (0.4)
Blackfin Tuna			11 (6.4)							11 (1.5)
Bluerunner										
Creolefish	30 (68.2)	317 (72.7)	125 (72.7)	35 (62.5)						507 (71.0)
Gray Triggerfish		1 (0.2)	8 (4.7)							9 (1.3)
Horseye Jack		3 (0.7)	7 (4.1)	8 (14.3)						18 (2.5)
Lesser Amberjack										
Ocean Triggerfish			4 (2.3)							4 (0.6)
Scamp		1 (0.2)	3 (1.7)	3 (5.4)	1 (16.7)					8 (1.1)
Yellowtail Snapper		28 (6.4)								28 (3.9)

Table 11e. Number enumerated and percent species composition (in parentheses) by depth strata at Green Canyon 18 from July 11 - 12, 1995 from visual point count surveys.

	Depth (m)									
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80 - 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Almaco Jack				23 (24.0)	14 (70.0)					37 (3.8)
Bar Jack	3 (1.4)	6 (1.6)								9 (0.9)
Barracuda	6 (2.8)	4 (1.1)	2 (0.8)							12 (1.2)
Bermuda Chub	48 (22.5)									48 (4.9)
Black Jack		3 (0.8)								3 (0.3)
Blackfin Tuna										
Bluerunner	59 (27.7)	53 (13.9)	38 (14.3)							150 (15.4)
Creolefish	83 (39.0)	304 (80.0)	212 (79.7)	57 (59.4)						656 (67.3)
Gray Triggerfish			2 (0.8)	3 (3.1)						5 (0.5)
Greater Amberjack			4 (1.5)	11 (11.5)	4 (20.0)					19 (1.9)
Horseye Jack	14 (6.6)	6 (1.6)	8 (3.0)							28 (2.9)
Lesser Amberjack										
Ocean Triggerfish										
Rainbow Runner		4 (1.1)								4 (0.4)
Scamp				2 (2.1)	2 (10.0)					4 (0.4)

Table 11f. Number enumerated and percent species composition (in parentheses) by depth strata at Green Canyon 18 from December 1 - 2, 1995 from visual point count surveys.

	Depth (m)									
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80 - 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Almaco Jack			3 (0.9)	79 (23.2)	37 (72.5)	2 (100.0)	1 (100.0)	2 (100.0)		124 (5.0)
Bar Jack	25 (2.5)	19 (2.6)	4 (1.2)	2 (0.6)						50 (2.0)
Barracuda	24 (2.4)	29 (3.9)	5 (1.4)	2 (0.6)						60 (2.4)
Bermuda Chub	250 (24.9)									250 (10.1)
Black Jack		2 (0.3)	2 (0.6)	7 (2.1)						11 (0.4)
Blackfin Tuna										
Bluerunner	240 (23.9)	82 (11.2)	24 (6.9)	9 (2.6)						355 (14.3)
Creolefish	457 (45.5)	571 (77.7)	283 (81.8)	164 (48.1)						1475 (59.4)
Gray Triggerfish	4 (0.4)	7 (1.0)	3 (0.9)	22 (6.5)						36 (1.5)
Greater Amberjack		2 (0.3)	19 (5.5)	21 (6.2)	9 (17.6)					51 (2.1)
Horseye Jack		22 (3.0)		18 (5.3)						40 (1.6)
Lesser Amberjack				8 (2.3)						8 (0.3)
Ocean Triggerfish										
Rainbow Runner	4 (0.4)									4 (0.2)
Scamp		1 (0.1)	3 (0.9)	9 (2.6)	4 (7.8)					17 (0.7)

Table 11g. Number enumerated and percent species composition (in parentheses) by depth strata at Green Canyon 18 from March 4 - 5, 1995 from visual point count surveys.

	Depth (m)									
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80 - 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Almaco Jack				2 (2.6)	40 (59.7)	14 (82.4)				56 (3.5)
Bar Jack	22 (3.0)	3 (0.5)								25 (1.6)
Barracuda	38 (5.1)	7 (1.1)								45 (2.8)
Bermuda Chub	137 (18.5)	46 (7.5)								183 (11.4)
Black Jack										
Blackfin Tuna										
Bluerunner	291 (39.2)	63 (10.2)								354 (22.0)
Creolefish	225 (30.3)	445 (72.1)	85 (95.5)	72 (92.3)	13 (19.4)					840 (52.1)
Gray Triggerfish	5 (0.7)	4 (0.6)				1 (5.9)				10 (0.6)
Greater Amberjack		2 (0.3)	3 (3.4)	2 (2.6)	9 (13.4)	2 (11.8)				18 (1.1)
Horseye Jack	13 (1.8)	4 (0.6)								17 (1.1)
Lesser Amberjack										
Ocean Triggerfish	4 (0.5)									4 (0.2)
Rainbow Runner	7 (0.9)	43 (7.0)								50 (3.1)
Scamp			1 (1.1)	2 (2.6)	5 (7.5)					8 (0.5)

Table 11h. Number enumerated and percent species composition (in parentheses) by depth strata at Green Canyon 18 from April 9 -10, 1996 from visual point count surveys.

	Depth (m)									
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80 - 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Almaco Jack	1 (0.2)		49 (30.1)	35 (58.3)	5 (26.3)	1 (100.0)				91 (6.2)
Bar Jack	3 (0.5)									3 (0.2)
Barracuda	33 (5.3)	13 (2.1)	2 (1.2)							48 (3.3)
Bermuda Chub	74 (12.0)	8 (1.3)	6 (3.7)							88 (6.0)
Black Jack			3 (1.8)							3 (0.2)
Blackfin Tuna										
Bluerunner	251 (40.5)	235 (38.5)								486 (33.0)
Creolefish	220 (35.5)	309 (50.6)	89 (54.6)	15 (25.0)						633 (43.0)
Gray Triggerfish					1 (5.3)					1 (0.1)
Greater Amberjack			12 (7.4)	7 (11.7)	12 (63.2)					31 (2.1)
Horseye Jack	34 (5.5)	46 (7.5)								80 (5.4)
Lesser Amberjack										
Ocean Triggerfish										
Rainbow Runner	3 (0.5)									3 (0.2)
Scamp			2 (1.2)	3 (5.0)	1 (5.3)					6 (0.4)

Table 11i. Number enumerated and percent species composition (in parentheses) by depth strata at Green Canyon 18 from September 11 - 12, 1996 from visual point count surveys.

	Depth (m)									
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80 - 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Almaco Jack			24 (3.8)	42 (12.6)	2 (10.5)					68 (2.9)
Bar Jack	4 (0.6)		7 (1.1)							11 (0.5)
Barracuda	25 (4.0)	12 (1.6)	1 (0.2)							38 (1.6)
Bermuda Chub	75 (11.9)	26 (3.5)								101 (4.3)
Black Jack			6 (0.9)	2 (0.6)						8 (0.3)
Bluerunner	191 (30.4)	332 (45.2)	354 (55.8)							877 (37.3)
Creolefish	313 (49.8)	327 (44.6)	219 (34.5)	194 (58.1)						1053 (44.8)
Gray Triggerfish		1 (0.1)	3 (0.5)	10 (3.0)						14 (0.6)
Greater Amberjack			10 (1.6)	71 (21.3)	17 (89.5)					98 (4.2)
Horseye Jack	15 (2.4)	36 (4.9)	4 (0.6)							55 (2.3)
Lesser Amberjack										
Marbled Grouper				1 (0.3)						1 (0.0)
Ocean Triggerfish	1 (0.2)		2 (0.3)							3 (0.1)
Rainbow Runner	5 (0.8)									5 (0.2)
Scamp			4 (0.6)	13 (3.9)						17 (0.7)

Table 11j. Number enumerated and percent species composition (in parentheses) by depth strata at Green Canyon 18 from November 18 - 20, 1996 from visual point count surveys.

	Depth (m)									
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80 - 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Almaco Jack				26 (21.5)	2 (8.7)					28 (8.3)
Bar Jack				1 (0.8)						1 (0.3)
Barracuda	7 (5.3)	8 (21.6)	3 (13.0)	5 (4.1)						23 (6.8)
Bermuda Chub	25 (18.8)									25 (7.4)
Black Jack				6 (5.0)	2 (8.7)					8 (2.4)
Blackfin Tuna										
Bluerunner	57 (42.9)									57 (16.9)
Creolefish	39 (29.3)	26 (70.3)	19 (82.6)	60 (49.6)	9 (39.1)					153 (45.4)
Gray Triggerfish				1 (0.8)						1 (0.3)
Greater Amberjack				14 (11.6)	7 (30.4)					21 (6.2)
Horseye Jack	3 (2.3)	3 (8.1)	1 (4.3)							7 (2.1)
Lesser Amberjack										
Ocean Triggerfish										
Rainbow Runner	2 (1.5)									2 (0.6)
Scamp				8 (6.6)	2 (8.7)					10 (3.0)

Table 11k. Number enumerated and percent species composition (in parentheses) by depth strata at Green Canyon 18 from March 4 - 5, 1997 from visual point count surveys.

	Depth (m)									
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80 - 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Almaco Jack		2 (0.5)	2 (0.4)	80 (34.2)	14 (66.7)	4 (66.7)				102 (6.0)
Bar Jack	5 (0.9)									5 (0.3)
Barracuda	44 (7.9)	28 (6.4)	8 (1.8)	2 (0.9)						82 (4.8)
Bermuda Chub	61 (10.9)									61 (3.6)
Black Jack		5 (1.1)								5 (0.3)
Blackfin Tuna										
Bluerunner	164 (29.3)	74 (17.0)	264 (57.9)	28 (12.0)						530 (30.9)
Creolefish	214 (38.2)	296 (68.0)	174 (38.2)	79 (33.8)						763 (44.5)
Gray Triggerfish				9 (3.8)	2 (9.5)					11 (0.6)
Greater Amberjack		2 (0.5)	6 (1.3)	33 (14.1)	2 (9.5)	2 (33.3)				45 (2.6)
Horseye Jack	69 (12.3)	28 (6.4)								97 (5.7)
Lesser Amberjack										
Ocean Triggerfish										
Rainbow Runner	3 (0.5)									3 (0.2)
Scamp			2 (0.4)	3 (1.3)	3 (14.3)					8 (0.5)

Table 111. Number enumerated and percent species composition (in parentheses) by depth strata from all trips to Green Canyon 18 from August 1994 - March 1997 from visual point count surveys.

	Depth (m)									
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80 - 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Almaco Jack	13 (0.3)	56 (1.1)	195 (6.6)	416 (23.9)	139 (31.7)	21 (67.7)	1 (33.3)	2 (66.6)		843 (5.7)
Bar Jack	122 (2.6)	116 (2.4)	46 (1.6)	11 (0.6)						295 (2.0)
Barracuda	242 (5.1)	189 (3.9)	28 (0.9)	11 (0.6)	1 (0.2)					471 (3.2)
Bermuda Chub	864 (18.1)	80 (1.6)	7 (0.2)							951 (6.4)
Black Jack		14 (0.3)	27 (0.9)	15 (0.9)	2 (0.5)					58 (0.4)
Blackfin Tuna			42 (1.4)	92 (5.3)	37 (8.4)					171 (1.2)
Bluerunner	1407 (29.4)	912 (18.7)	680 (23.0)	37 (2.1)						3036 (20.5)
Creolefish	1887 (39.5)	3092 (63.3)	1726 (58.3)	729 (41.9)	22 (5.0)					7456 (50.2)
Gray Triggerfish	10 (0.2)	16 (0.3)	42 (1.4)	52 (3.0)	3 (0.7)	1 (3.4)				124 (0.8)
Greater Amberjack		17 (0.3)	108 (3.6)	274 (15.7)	188 (42.8)	5 (17.2)				592 (4.0)
Horseye Jack	202 (4.2)	288 (5.9)	30 (1.0)	26 (1.5)						546 (3.7)
Lesser Amberjack				8 (0.5)						8 (0.1)
Marbled Grouper				1 (0.1)						1 (0.0)
Ocean Triggerfish	5 (0.1)		6 (0.2)							11 (0.1)

Table 11 1 (continued). Number enumerated and percent species composition (in parentheses) by depth strata from all trips to Green Canyon 18 from August 1994 - March 1997 from visual point count surveys.

	Depth (m)									
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80 - 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Rainbow Runner	13 (0.3)	50 (1.0)								63 (0.4)
Scamp		2 (0.0)	23 (0.8)	67 (3.9)	46 (10.5)					138 (0.9)
Unidentified Grouper					1 (0.2)	2 (6.9)	1 (50.0)	1 (33.3)	1 (100.0)	6 (0.0)
Yellowtail Snapper	18 (0.4)	50 (1.0)								68 (0.5)

Table 12a. Estimated number of fish by species (with 95% confidence intervals) by depth strata at Green Canyon 18 from October 4 -5, 1994 from hydroacoustic and visual point count surveys.

	Depth (m)									
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80 - 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Almaco Jack	465.1 (44.4)	7.5 (5.2)	3.9 (1.8)							476.5 (51.4)
Bar Jack		111.7 (77.5)	0.2 (0.1)							111.9 (77.6)
Barracuda	639.5 (61.1)	36.6 (25.4)								676.1 (86.5)
Bermuda Chub	2165.5 (206.9)									2165.5 (206.9)
Black Jack										
Blackfin Tuna										
Bluerunner	8981.9 (858.0)									8981.9 (858)
Creolefish	2165.5 (206.9)	140.8 (97.7)	8.1 (3.8)							2314.4 (308.4)
Gray Triggerfish	58.1 (5.6)	2.4 (1.6)	0.2 (0.1)							60.7 (7.3)
Greater Amberjack			1.4 (0.6)							1.4 (.6)
Horseye Jack	58.1 (5.6)	87.3 (60.6)								145.4 (66.2)
Rainbow Runner		7.5 (5.2)								7.5 (5.2)
Scamp										
Yellowtail Snapper										
TOTAL										14941.3 (1668.1)

*Note: If cell is empty, no individuals were observed of that species for that depth interval.

Table 12b. Estimated number of fish by species (with 95% confidence intervals) by depth strata at Green Canyon 18 from November 30 - December 1, 1994 from hydroacoustic and visual point count surveys.

	Depth (m)									
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80 - 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Almaco Jack			74.3 (30.9)	118.3 (28.8)	8.4 (2.5)					506.0 (201)
Bar Jack		24.4 (13.4)	225.0 (93.4)							249.4 (106.8)
Barracuda	656.9 (138.0)	36.6 (20.0)	14.4 (60.0)							707.9 (218)
Bermuda Chub	2193.8 (460.8)									2193.8 (460.8)
Black Jack		24.4 (13.4)	111.4 (46.3)							135.8 (59.7)
Blackfin Tuna										
Bluerunner										
Creolefish	8663.7 (1819.8)	980.1 (536.3)	1399.3 (581.0)	381.2 (93.0)						11424.3 (3030.1)
Gray Triggerfish		12.2 (6.7)	74.3 (30.9)							86.5 (37.6)
Greater Amberjack			88.7 (36.9)	407.5 (99.3)	375.4 (112.2)					471.6 (248.4)
Horseye Jack	433.8 (91.1)	117.2 (64.1)	74.3 (30.9)							625.3 (186.1)
Rainbow Runner										
Scamp				105.2 (25.6)	17.2 (5.2)					122.4 (30.8)
Yellowtail Snapper	396.7 (91.1)	24.4 (13.4)								421.1 (104.5)
TOTAL										16944.1 (4683.8)

Table 12c. Estimated number of fish by species (with 95% confidence intervals) by depth strata at Green Canyon 18 from January 20 - 21, 1995 from hydroacoustic and visual point count surveys.

	Depth (m)									
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80 - 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Almaco Jack	39.6 (5.8)		21.5 (4.9)	872.9 (162.6)	135.7 (49.6)					1069.7 (222.9)
Bar Jack	617.0 (93.5)	76.6 (23.4)		115.6 (21.5)						809.2 (138.4)
Barracuda	332.6 (50.4)	146.0 (44.7)	41.1 (9.4)	29.5 (5.5)	5.7 (2.1)					554.9 (112.1)
Bermuda Chub	1335.3 (202.4)									1335.3(202.4)
Black Jack	13.0 (4.0)			29.5 (5.5)						42.5 (9.5)
Blackfin Tuna			321.2 (73.2)	174.6 (32.5)	209.3 (76.5)					705.1 (182.2)
Bluerunner		193.7 (59.3)								193.7 (59.3)
Creolefish	1856.0 (281.3)	143.0 (227.3)	1367.1 (311.7)	349.2 (65.0)						3715.3 (885.3)
Gray Triggerfish			123.4 (28.1)	88.5 (16.5)						211.9 (44.6)
Greater Amberjack			9.8 (2.2)	538.5 (100.3)	446.2 (163.2)	1348.0 (352.3)				2342.5 (618)
Horseye Jack	477.2 (72.3)	225.5 (67.0)								702.7 (139.3)
Rainbow Runner	28.9 (4.4)									28.9 (4.4)
Scamp			72.5 (16.5)	263.1 (49.0)	158.6 (58.0)					494.2 (123.5)
Yellowtail Snapper	135.0 (20.5)	47.7 (15.0)								182.7 (35.5)
TOTAL										12388.6 (2777.4)

Table 12d. Estimated number of fish by species (with 95% confidence intervals) by depth strata at Green Canyon 18 from July 11 - 12, 1995 from hydroacoustic and visual point count surveys.

	Depth (m)									
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80 - 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Almaco Jack				53.3 (23.8)	255.4 (202.3)					308.7 (226.1)
Bar Jack	161.7 (16.2)	14.9 (6.9)								176.6 (23.1)
Barracuda	323.3 (32.4)	10.2 (4.7)	0.8 (0.4)							334.3 (37.5)
Bermuda Chub	2598.0 (260.6)									2598 (260.6)
Black Jack		7.4 (3.4)								7.4 (3.4)
Blackfin Tuna										
Bluerunner	3198.4 (320.8)	129.4 (59.9)	15.1 (7.1)							3342.9 (387.8)
Creolefish	4503.2 (451.7)	744.9 (344.6)	84.4 (39.6)	132.0 (59.0)						5464.5 (894.9)
Gray Triggerfish			0.8 (0.4)	6.9 (3.1)						7.7 (3.5)
Greater Amberjack			1.6 (0.7)	25.6 (11.4)	73.0 (57.8)					100.2 (69.9)
Horseye Jack	762.1 (76.4)	14.9 (6.9)	3.2 (1.5)							780.2 (84.8)
Rainbow Runner		10.2 (4.7)								10.2 (4.7)
Scamp				4.7 (2.1)	36.5 (28.9)					41.2 (31)
Yellowtail Snapper										
TOTAL										13171.9 (2027.3)

Table 12e. Estimated number of fish by species (with 95% confidence intervals) by depth strata at Green Canyon 18 from December 1 - 2, 1995 from hydroacoustic and visual point count surveys.

	Depth (m)									
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80 - 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Almaco Jack			13.6 (4.1)	220.0 (32.9)	619.2 (280.1)	354.7 (75.9)	394.4 (112.7)	16.7 (5.2)		1618.6 (510.9)
Bar Jack	110.9 (17.3)	28.6 (10.0)	18.1 (5.5)	5.7 (0.9)						163.3 (33.7)
Barracuda	106.4 (16.6)	42.9 (15.0)	21.1 (6.4)	5.7 (0.9)						176.1 (38.9)
Bermuda Chub	1104.4 (172.6)									1104.4 (172.6)
Black Jack		3.3 (1.2)	9.0 (2.8)	19.9 (3.0)						32.2 (7)
Blackfin Tuna										
Bluerunner	1060.0 (165.6)	123.1 (43.1)	103.9 (31.8)	24.7 (3.7)						1311.7 (244.2)
Creolefish	2018.0 (315.3)	854.1 (299.1)	1231.8 (376.8)	456.0 (68.3)						4559.9 (1059.5)
Gray Triggerfish	17.7 (2.8)	11.0 (3.9)	13.6 (4.1)	61.6 (9.2)						103.9 (20)
Greater Amberjack		3.3 (1.2)	82.8 (25.3)	58.8 (8.8)	150.3 (68.0)					295.2 (103.3)
Horseye Jack		33.0 (11.6)		50.2 (7.5)						83.2 (19.1)
Lesser Amberjack				21.8 (3.3)						21.8 (3.3)
Rainbow Runner	17.7 (27.8)									17.7 (27.8)
Scamp		1.1 (0.4)	13.6 (4.1)	24.6 (3.7)	666.2 (30.1)					705.5 (38.3)
Yellowtail Snapper										
TOTAL										10193.5 (2278.6)

Table 12f. Estimated number of fish by species (with 95% confidence intervals) by depth strata at Green Canyon 18 from March 4 - 5, 1996 from hydroacoustic and visual point count surveys.

	Depth (m)									
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80 - 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Almaco Jack				88.7 (15.9)	949.7 (319.7)	1344.9 (355.4)				2383.3 (691)
Bar Jack	138.4 (22.7)	8.0 (2.6)								146.4 (25.3)
Barracuda	235.2 (38.7)	17.6 (5.6)								252.8 (44.3)
Bermuda Chub	835.5 (140.2)	119.7 (38.5)								955.2 (178.7)
Black Jack										
Blackfin Tuna										
Bluerunner	1808.5 (297.1)	162.8 (52.3)								1971.3 (349.4)
Creolefish	1397.9 (229.7)	1150.9 (369.7)	2027.1 (431.6)	3149.6 (118.9)	308.6 (103.9)					8034.1 (1253.8)
Gray Triggerfish	32.3 (5.3)	9.6 (3.1)				96.3 (25.4)				138.2 (33.8)
Greater Amberjack		4.8 (1.5)	72.2 (15.4)	88.7 (15.9)	213.2 (71.8)	192.6 (50.9)				571.5 (155.5)
Horseye Jack	83.0 (13.6)	9.6 (3.1)								92.6 (16.7)
Ocean Triggerfish	23.1 (3.8)									23.1 (3.8)
Rainbow Runner	41.5 (6.8)	111.7 (35.9)								153.2 (42.7)
Scamp			23.3 (5.0)	88.7 (15.9)	119.3 (40.2)					231.3 (61.1)
Unidentified Grouper							43.9 (10.0)			43.9 (10)
TOTAL										14996 (2866.1)

Table 12g. Estimated number of fish by species (with 95% confidence intervals) by depth strata at Green Canyon 18 from April 9 -10, 1996 from hydroacoustic and visual point count surveys.

	Depth (m)									
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80 - 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Almaco Jack	1.4 (0.4)		580.1 (215.1)	683.9 (234.4)	308.4 (172.1)	1339.5 (699.4)				2913.3 (1321.4)
Bar Jack	3.5 (1.0)									3.5 (1)
Barracuda	37.5 (10.6)	42.0 (16.8)	23.1 (8.6)							102.6 (36)
Bermuda Chub	85.0 (24.1)	26.0 (10.4)	71.3 (26.4)							182.3 (60.9)
Black Jack			34.7 (12.9)							34.7 (12.9)
Blackfin Tuna										
Bluerunner	286.9 (81.3)	769.7 (307.1)								1056.6 (388.4)
Creolefish	251.5 (71.3)	1011.6 (403.6)	1052.4 (390.2)	293.3 (100.5)						2608.8 (965.6)
Gray Triggerfish					62.1 (34.7)					62.1 (34.7)
Greater Amberjack			142.6 (52.9)	137.3 (47.0)	741.0 (413.6)					1020.9 (513.5)
Horseye Jack	39.0 (11.0)	149.9 (59.8)								188.9 (70.8)
Rainbow Runner	3.5 (1.0)									3.5 (1)
Scamp			23.1 (8.6)	58.7 (20.1)	62.1 (34.7)					143.9 (63.4)
Yellowtail Snapper										
TOTAL										8321.1 (3469.6)

Table 12h. Estimated number of fish by species (with 95% confidence intervals) by depth strata at Green Canyon 18 from September 11 - 12, 1996 from hydroacoustic and visual point count surveys.

	Depth (m)									
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80 - 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Almaco Jack			24.8 (7.5)	49.1 (15.3)	45.8 (35.4)					119.7 (58.2)
Bar Jack	52.8 (7.8)		7.2 (2.2)							60 (10)
Barracuda	351.7 (52.2)	44.3 (14.9)	1.3 (0.4)							397.3 (67.5)
Bermuda Chub	1046.4 (155.2)	97.0 (32.5)								1143.4 (187.7)
Black Jack			5.9 (1.8)	2.3 (0.7)						8.2 (2.5)
Bluerunner	2673.1 (396.6)	1252.3 (419.6)	363.6 (110.7)							4289 (926.9)
Creolefish	4379.0 (649.6)	1235.6 (414.0)	224.8 (68.4)	226.2 (70.4)						6065.6 (1202.4)
Gray Triggerfish		2.8 (0.9)	3.3 (1.0)	11.7 (3.6)						17.8 (5.5)
Greater Amberjack			10.4 (3.2)	82.9 (25.8)	390.0 (301.4)					483.3 (330.4)
Horseye Jack	211.0 (31.3)	135.8 (45.5)	3.9 (1.2)							350.7 (78)
Marbled Grouper				1.2 (0.4)						1.2 (.4)
Ocean Triggerfish	17.6 (2.6)		2.0 (0.6)							19.6 (3.2)
Rainbow Runner	70.3 (10.4)									70.3 (10.4)
Scamp			3.9 (1.2)	15.2 (4.7)						19.1 (5.9)
TOTAL										13045.2 (2889)

Table 12i. Estimated number of fish by species (with 95% confidence intervals) by depth strata at Green Canyon 18 from November 18 - 20, 1996 from hydroacoustic and visual point count surveys.

	Depth (m)									
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80 - 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Almaco Jack				201.3 (30.2)	74.3 (33.6)					275.6 (63.8)
Bar Jack				7.5 (1.1)						7.5 (1.1)
Barracuda	228.6 (37.3)	240.4 (83.1)	192.5 (59.9)	38.4 (5.8)						699.9 (186.1)
Bermuda Chub	811.0 (132.5)									811 (132.5)
Black Jack				46.8 (7.0)	74.3 (33.6)					121.1 (40.6)
Blackfin Tuna										
Bluerunner	1850.6 (302.3)									1850.6 (302.3)
Creolefish	1263.9 (206.5)	782.3 (270.6)	1223.1 (382.2)	464.4 (69.9)	333.9 (151.0)					4067.6 (1080.2)
Gray Triggerfish				7.5 (1.1)						7.5 (1.1)
Greater Amberjack				108.6 (16.3)	259.6 (117.4)					368.2 (133.7)
Horseye Jack	99.2 (16.2)	90.1 (31.2)	63.7 (19.8)							253 (67.2)
Rainbow Runner	64.7 (10.6)									64.7 (10.6)
Scamp				61.8 (9.3)	74.3 (33.6)					136.1 (42.9)
Unidentified Grouper					36.7 (16.6)					36.7 (16.6)
Yellowtail Snapper										
TOTAL										8699.5 (2078.7)

Table 12j. Estimated number of fish by species (with 95% confidence intervals) by depth strata at Green Canyon 18 from March 4 - 5, 1997 from hydroacoustic and visual point count surveys.

	Depth (m)									
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80 - 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Almaco Jack		11.7 (3.9)	8.3 (1.7)	1842.8 (309.4)	1573.9 (511.7)	2693.7 (597.7)				6130.4 (1424.4)
Bar Jack	47.5 (7.8)									47.5 (7.8)
Barracuda	416.6 (68.3)	149.8 (49.5)	37.5 (7.4)	48.5 (8.1)						652.4 (133.3)
Bermuda Chub	574.7 (94.2)									574.7 (94.2)
Black Jack		25.7 (8.5)								25.7 (8.5)
Blackfin Tuna										
Bluerunner	1544.9 (253.3)	397.8 (131.4)	1205.2 (239.5)	646.7 (108.6)						3794.6 (732.8)
Creolefish	2014.2 (330.2)	1591.2 (525.8)	795.2 (158.0)	1821.3 (305.8)						6221.9 (1319.8)
Gray Triggerfish				204.18 (34.4)	224.2 (72.9)					428.3 (107.3)
Greater Amberjack		11.7 (3.9)	27.1 (5.4)	759.8 (127.6)	224.2 (72.9)	1344.9 (298.4)				2367.7 (508.2)
Horseye Jack	648.6 (106.3)	149.8 (49.5)								798.4 (155.8)
Ocean Triggerfish										
Rainbow Runner	26.4 (4.3)									45.0 (9.7)
Scamp			8.3 (1.7)	70.0 (11.8)	337.4 (109.7)					26.4 (4.3)
Unidentified Grouper								4.4 (3.0)	649.7 (146.0)	654.1 (149)
TOTAL										21767.1 (4655.1)

Table 12k. Estimated number of fish by species (with 95% confidence intervals) by depth strata from all trips to Green Canyon 18 from August 1994 - March 1997 from hydroacoustic and visual point count surveys.

	Depth (m)									
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80 - 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Almaco Jack	18.7 (1.1)	17.0 (2.3)	88.4 (10.3)	421 (42.1)	326.6 (56.4)	1213.6 (148.2)	114.7 (17.2)	60.6 (37.5)		2260.6 (315.1)
Bar Jack	162.2 (9.1)	37.2 (5.1)	21.4 (2.5)	10.3 (1.1)						231.1 (17.8)
Barracuda	318.1 (17.9)	60.4 (8.2)	12.1 (1.4)	10.3 (1.1)	2.1 (0.4)					403.0 (29.0)
Bermuda Chub	1128.8 (63.4)	24.8 (3.4)	2.7 (0.3)							1156.3 (67.1)
Black Jack		4.6 (0.6)	12.1 (1.4)	15.5 (1.6)	5.2 (0.9)					37.4 (4.5)
Blackfin Tuna			18.8 (2.2)	91.0 (9.3)	86.6 (15.0)					196.4 (26.5)
Bluerunner	1833.6 (102.9)	289.6 (39.5)	308.2 (35.9)	36.1 (3.7)						2462.3 (182.0)
Creolefish	2463.4 (138.3)	908.4 (133.6)	781.2 (90.9)	719.7 (73.7)	51.5 (8.9)					4924.2 (445.4)
Gray Triggerfish	12.5 (0.7)	4.6 (0.6)	18.8 (2.2)	51.5 (5.3)	7.2 (1.2)	57.4 (7.0)				152 (17)
Greater Amberjack		4.6 (0.6)	48.2 (5.6)	269.7 (27.6)	441.0 (76.2)	288.6 (35.2)				1052.1 (145.2)
Horseye Jack	261.9 (14.7)	91.4 (12.4)	13.4 (1.6)	25.8 (2.6)						392.5 (31.3)
Lesser Amberjack				8.6 (0.9)						8.6 (.9)
Marbled Grouper				1.7 (0.2)						1.7 (.2)
Ocean Triggerfish	6.2 (0.4)		6 (0.3)							12.2 (.7)
Rainbow Runner	8.7 (1.1)	15.5 (0.2)								24.2 (1.3)
Scamp			10.7 (1.2)	67.0 (6.9)	108.2 (18.7)					185.9 (26.8)

Table 12k (continued). Estimated number of fish by species (with 95% confidence intervals) by depth strata from all trips to Green Canyon 18 from August 1994 - March 1997 from hydroacoustic and visual point count surveys.

	Depth (m)									
Species	**0 - 20**	**20 - 40**	**40 - 60**	**60 - 80**	**80 - 100**	**100 - 120**	**120 - 140**	**140 - 160**	**160 - 180**	**0 - 219**
Unidentified Grouper					6.2 (1.1)	29.5 (2.0)	29.3 (3.4)	6.6 (3.5)	6.7 (3.1)	78.3 (13.1)
Yellowtail Snapper	24.9 (1.4)	15.5 (0.2)								40.4 (1.6)
TOTAL										13855.5 (1324.1)

Table 13. RBD ANOVA (block on platform side) results of vertical target strength (dB) with platform side, year, season, time of day, depth, current vectors, temperature, salinity, dissolved oxygen and selected interactions at the ST54 petroleum platform.

Source	**DF**	**SS**	**MS**	**F**	**Prob > F**
Model	206	56386.345015	273.720121	34.40	0.0001
Error	1198	9532.903189	7.957348		
Corrected Total	1404	65919.248205			
	R-Square	**C.V.**	**Root MSE**		**MEANTS Mean**
	0.855385	-7.065331	2.8208772		-39.925621
Variables	**DF**	**Type III SS**	**Mean Square**	**F Value**	**Pr > F**
Side	3	6671.413209	2223.804403	279.47	0.0001
Year	1	40.001821	40.001821	5.03	0.0251
Season	2	603.144775	301.572388	37.90	0.0001
Diel	3	367.667924	122.555975	15.40	0.0001
Depth	4	2717.156715	679.289179	85.37	0.0001
Temperature	1	136.785653	136.785653	17.19	0.0001
Dissolved oxygen	1	14.260933	14.260933	1.79	0.1809
Salinity	1	26.135930	26.135930	3.28	0.0702
North vector	1	386.735952	386.735952	48.60	0.0001
East vector	1	70.694892	70.694892	8.88	0.0029
North squared vector	1	203.938224	203.938224	25.63	0.0001
East squared vector	1	352.882525	352.882525	44.35	0.0001
North * East	1	14.301287	14.301287	1.80	0.1803
Season * Diel	6	841.199710	140.199952	17.62	0.0001
Diel * Depth	12	1487.257674	123.938140	15.58	0.0001
Season * Depth	7	2822.349465	403.192781	50.67	0.0001

Table 14. Mean target strengths (dB), with Tukey's studentized means test results by season at South Timbalier 54.

Season	Mean Target Strength	Tukey's Means Test			
Summer	-36.9	A			
Spring	-39.5		B		
Winter	-44.8			C	
Fall	-46.4				D

Table 15. Mean target strengths (dB) with Tukey's studentized means test results by time of day at South Timbalier 54.

Time of Day	Mean Target Strength	Tukey's Means Test	
Dawn	-39.9	A	
Noon	-40.1	A	
Midnight	-42.1		B
Dusk	-42.2		B

Table 16. Mean target strengths (dB) with Tukey's studentized means test result by platform side at South Timbalier 54.

Platform Side	Mean Target Strength	Tukey's Means Test			
South	-38.5	A			
East	-40.9		B		
North	-41.6			C	
West	-43.2				D

Table 17. Mean target strength (dB) with Tukey's studentized means test by water depth (m) at South Timbalier 54.

Depth (m)	Mean Target Strength	Tukey's Means Test		
5-10	-39.7	A		
15-20	-39.8	A		
0-5	-40.2	A		
10-15	-42.3		B	
20-22	-46.2			C

Table 18. RBD ANOVA (block on platform side) results of vertical target strength (dB) with platform side, year, season, time of day, depth, current vectors, temperature, salinity, dissolved oxygen and selected interactions at the GI94 petroleum platform.

Source	DF	SS	MS	F	Prob > F
Model	670	156624.55	233.77	19.54	0.0001
Error	6954	83185.95	11.96		
Corrected Total	7624	239810.49			
	R-Square	**C.V.**	**Root MSE**		**MEANTS Mean**
	0.653118	-7.857822	3.4587		-37.015
Variables	**DF**	**Type III SS**	**Mean Square**	**F Value**	**Pr > F**
Side	3	7030.663	2343.554	195.91	0.0001
Year	3	15542.064	5180.688	433.08	0.0001
Season	3	24760.063	8253.354	689.95	0.0001
Diel	3	385.026	128.342	10.73	0.0001
Depth	11	5357.266	487.024	40.71	0.0001
Temperature	1	6116.911	6116.911	511.35	0.0001
Dissolved oxygen	1	2419.286	2419.286	202.24	0.0001
Salinity	1	49.542	49.542	4.14	0.0419
North vector	1	377.012	377.012	31.52	0.0001
East vector	1	7.174	7.174	0.60	0.4387
North squared vector	1	491.833	491.833	41.12	0.0001
East squared vector	1	959.615	959.615	80.22	0.0001
North * East	1	453.694	453.694	37.93	0.0001
Season * Diel	9	801.514	89.057	7.44	0.0001
Diel * Depth	33	2909.926	88.180	7.37	0.0001
Season * Depth	31	6949.762	224.186	18.74	0.0001

Table 19. Mean target strength (dB) with Tukey's studentized means test by year at Grand Isle 94.

Year	Mean Target Strength	Tukey's Means Test		
1995	-34.7	A		
1994	-36.4		B	
1996	-36.9		B	
1997	-39.4			C

Table 20. Mean target strength (dB) with Tukey's studentized means test by season at Grand Isle 94.

Season	Mean Target Strength	Tukey's Means Test			
Winter	-32.4	A			
Spring	-34.7		B		
Summer	-36.5			C	
Fall	-38.6				D

Table 21. Mean target strength (dB) with Tukey's studentized means test by time of day at Grand Isle 94.

Time of Day	Mean Target Strength	Tukey's Means Test
Midnight	-35.7	A
Dusk	-36.0	B
Noon	-36.1	B
Dawn	-36.3	B

Table 22. Mean target strength (dB) with Tukey's studentized means test by platform side at Grand Isle 94.

Platform Side	Mean Target Strength	Tukey's Means Test
South	-34.3	A
West	-35.3	B
North	-36.7	C
East	-37.6	D

Table 23. Mean target strength (dB) with Tukey's studentized means test by water depth (m) at Grand Isle 94.

Depth (m)	Mean Target Strength	Tukey's Means Test						
50-55	-34.1	A						
40-45	-34.6	A	B					
55-60	-34.9		B					
0-5	-35.0		B					
45-50	-35.2		B					
5-10	-35.3		B	C				
10-15	-36.0			C	D			
35-40	-36.3				D	E		
30-35	-36.9					E	F	
25-30	-37.2						F	
15-20	-38.0							G
20-25	-38.4							G

Table 24. RBD ANOVA (block on platform side) results of vertical target strength (dB) with platform side, year, season, time of day, depth, current vectors, temperature, salinity, dissolved oxygen and selected interactions at the GC18 petroleum platform.

Source	DF	SS	MS	F	Prob > F
Model	314	28349.978141	90.286555	12.56	0.0001
Error	3050	21933.357355	7.191265		
Corrected Total	3364	50283.335496			
	R-Square	**C.V.**	**Root MSE**		**MEANTS Mean**
	0.563805	-5.393938	2.6816534		-35.716060
Variables	**DF**	**Type III SS**	**Mean Square**	**F Value**	**Pr > F**
Side	3	7498.586156	2499.528719	347.58	0.0001
Year	3	13.604398	4.534799	0.63	0.5952
Season	3	46.340784	15.446928	2.15	0.0921
Diel	3	1059.419025	353.139675	49.11	0.0001
Depth	4	5300.963064	1325.240766	184.28	0.0001
Temperature	1	0.105401	0.105401	0.01	0.9036
Dissolved oxygen	1	0.000581	0.000581	0.00	0.9928
Salinity	1	0.464315	0.464315	0.06	0.7994
North vector	1	69.697543	69.697543	9.69	0.0019
East vector	1	14.455526	14.455526	2.01	0.1564
North squared vector	1	45.138318	45.138318	6.28	0.0123
East squared vector	1	0.069053	0.069053	0.01	0.9219
North * East	1	2.222840	2.222840	0.31	0.5783
Season * Diel	9	20.728956	2.303217	0.32	0.9687
Diel * Depth	12	531.820136	44.318345	6.16	0.0001
Season * Depth	12	92.638315	7.719860	1.07	0.3781

Table 25. Mean target strength (dB) with Tukey's studentized means test by time of day at Green Canyon 18.

Time of Day	Mean Target Strength	Tukey's Means Test
Dawn	-37.0	A
Dusk	-37.5	B
Noon	-37.8	B
Midnight	-38.5	C

Table 26. Mean target strength (dB) with Tukey's studentized means test by platform side at Green Canyon 18.

Platform Side	Mean Target Strength	Tukey's Means Test
South	-35.5	A
West	-37.2	B
East	-39.2	C
North	-39.4	C

Table 27. Mean target strength (dB) with Tukey's studentized means test by water depth (m) at Green Canyon 18.

Depth (m)	Mean Target Strength	Tukey's Means Test
0-15	-35.5	A
55-75	-37.0	B
15-35	-37.7	C
75-95	-38.3	D
35-55	-39.9	E

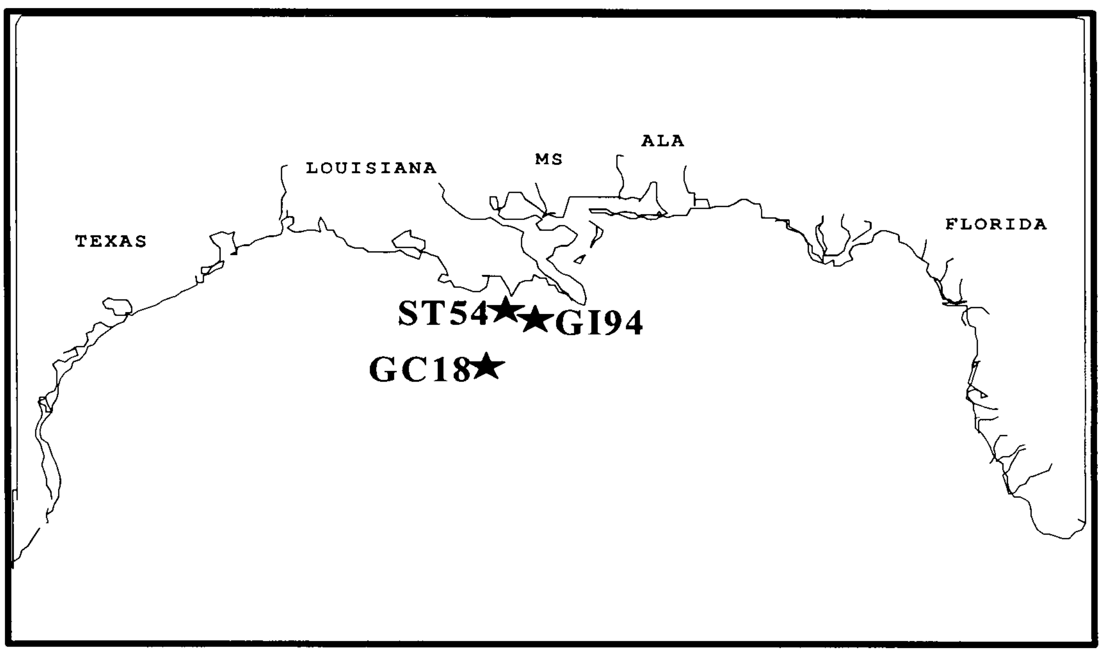


Figure 1. Position of the three study sites South Timbalier 54 (ST54), Grand Isle 94 (GI94) and Green Canyon 18 (GC18) off the Louisiana coast.

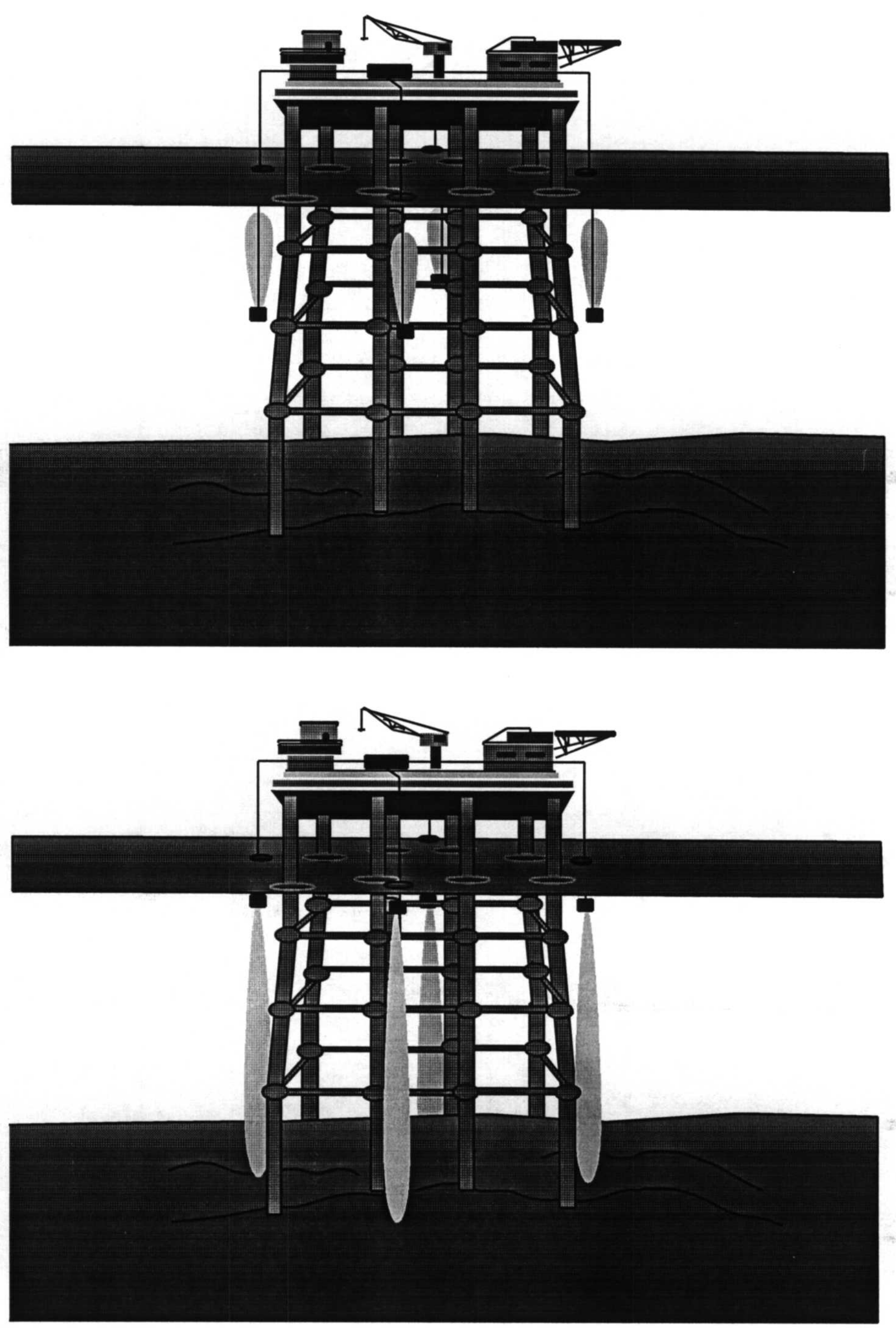


Figure 2. Schematic view of stationary hydroacoustic transducer deployment to measure *in situ* target strength and density of fishes throughout the water column on each side of the platform f the three study sites.

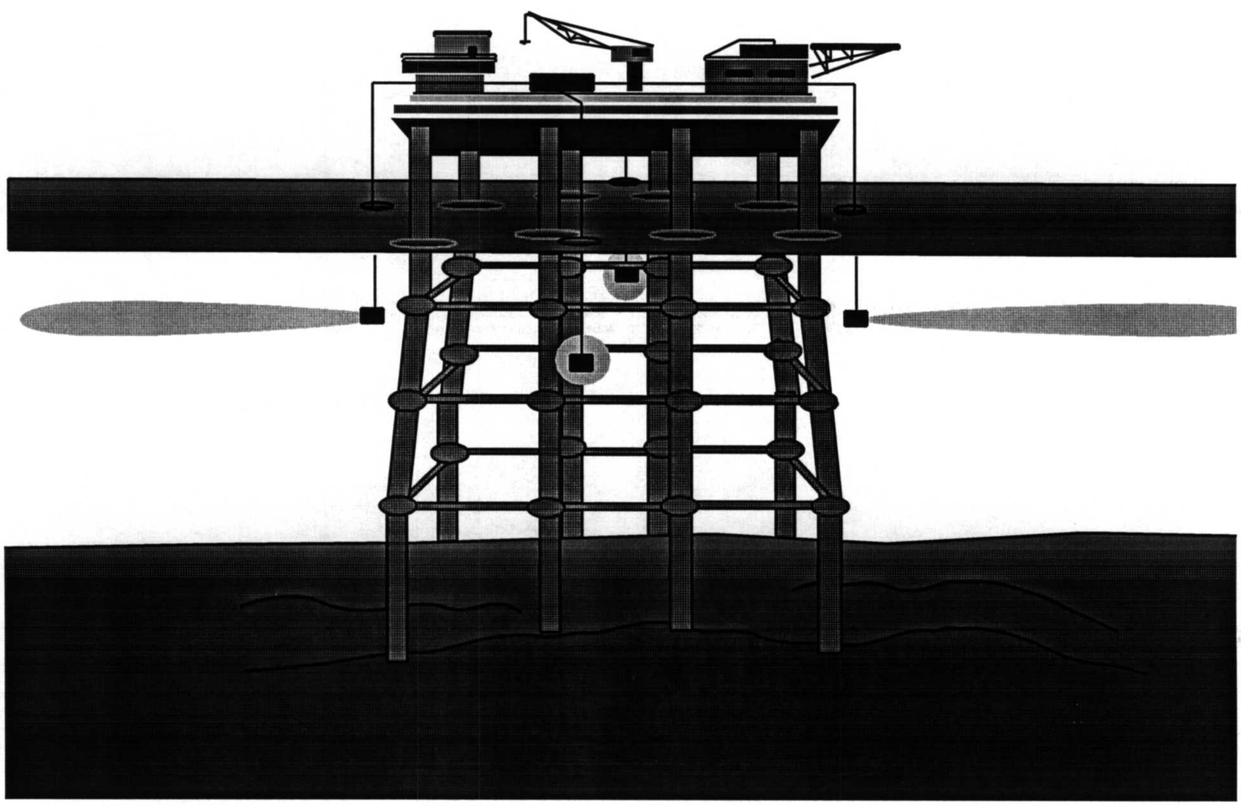


Figure 3. Schematic view of stationary hydroacoustic transducer deployment to measure horiz(relative density of fishes associated with petroleum platforms.

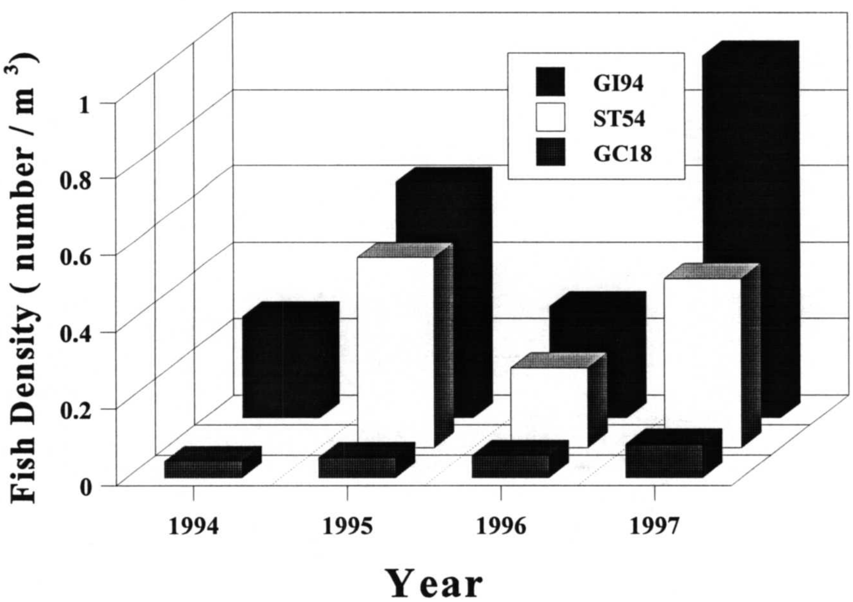


Figure 4. Mean fish density (number of fish/m^3) by year at Green Canyon 18 (GC18) and Grand Isle 94 (GI94) from July 1994 to March 1997 and South Timbalier (ST54) from August 1995 to February 1997.

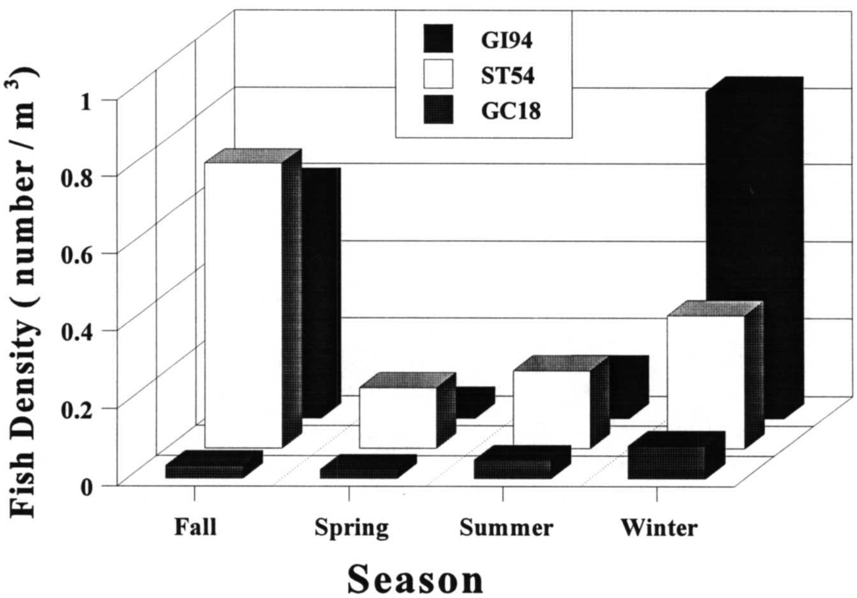


Figure 5. Mean fish density (number of fish / m^3) by season at Green Canyon 18 (GC18) and Grand Isle 94 (GI94) from July 1994 to March 1997 and South Timbalier 54 (ST54) from August 1995 to February 1997.

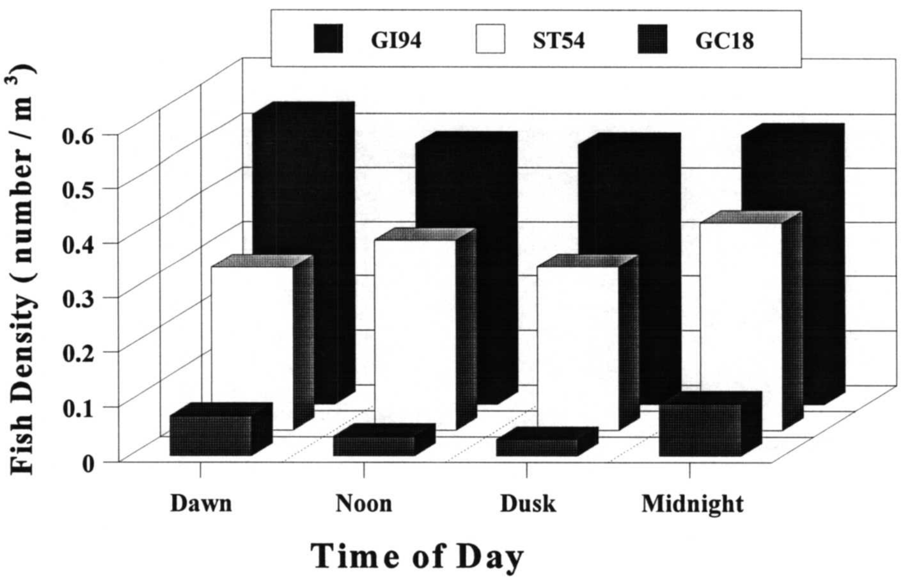


Figure 6. Mean fish density (number of fish / m ^{3}) by time of day from Green Canyon 18 (GC18) and Grand Isle 94 (GI94) from July 1994 to March 1997 and South Timbalier 54 (ST54) from August 1995 to February 1997.

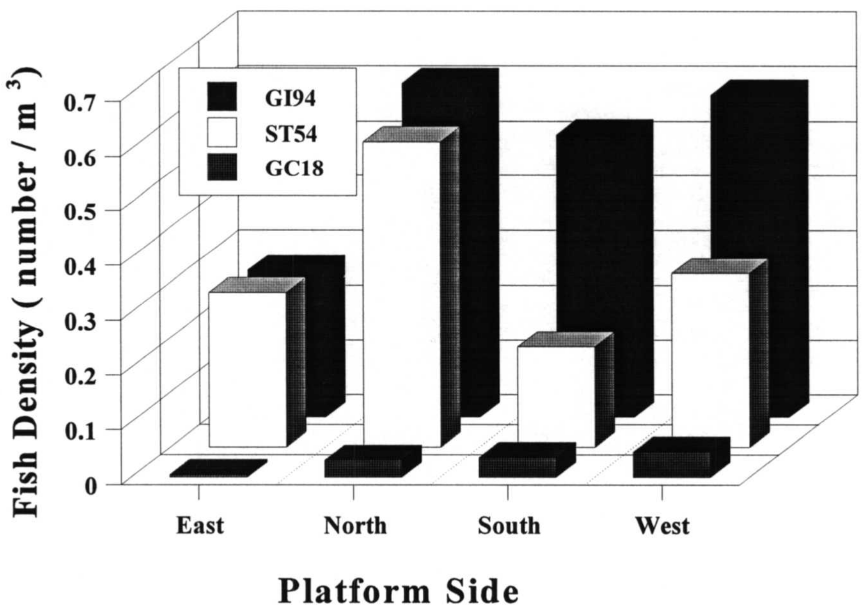


Figure 7. Mean fish density (number of fish / m^3) by platform side from Green Canyon 18 (GC18) and Grand Isle 94 (GI94) from July 1994 to March 1997 and South Timbalier 54 (ST54) from August 1995 to February 1997.

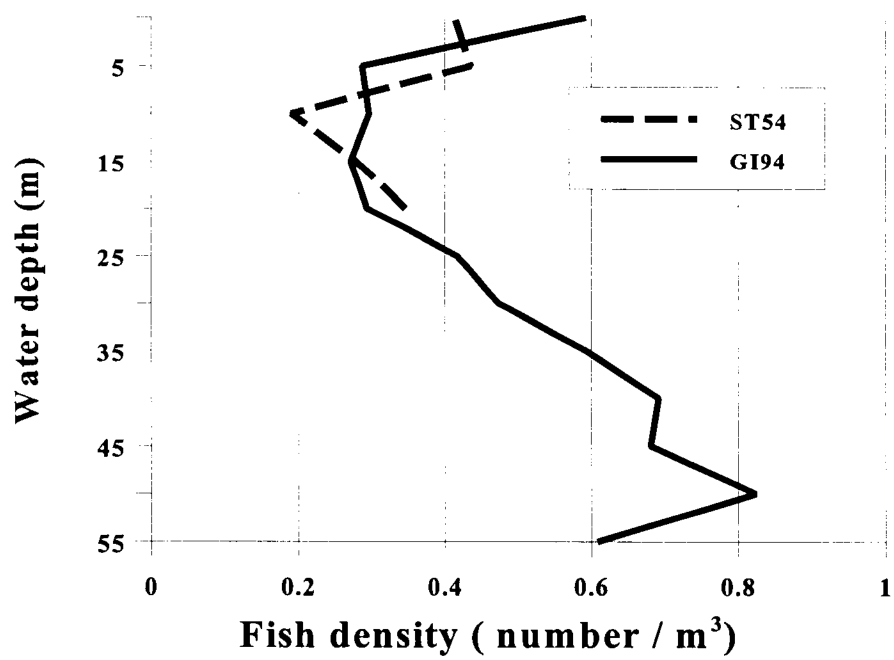


Figure 8. Mean fish density (number of fish / m^3) by depth at Grand Isle 94 (GI94) from July 1994 to March 1997 and South Timbalier 54 (ST54) from August 1995 to February 1997.

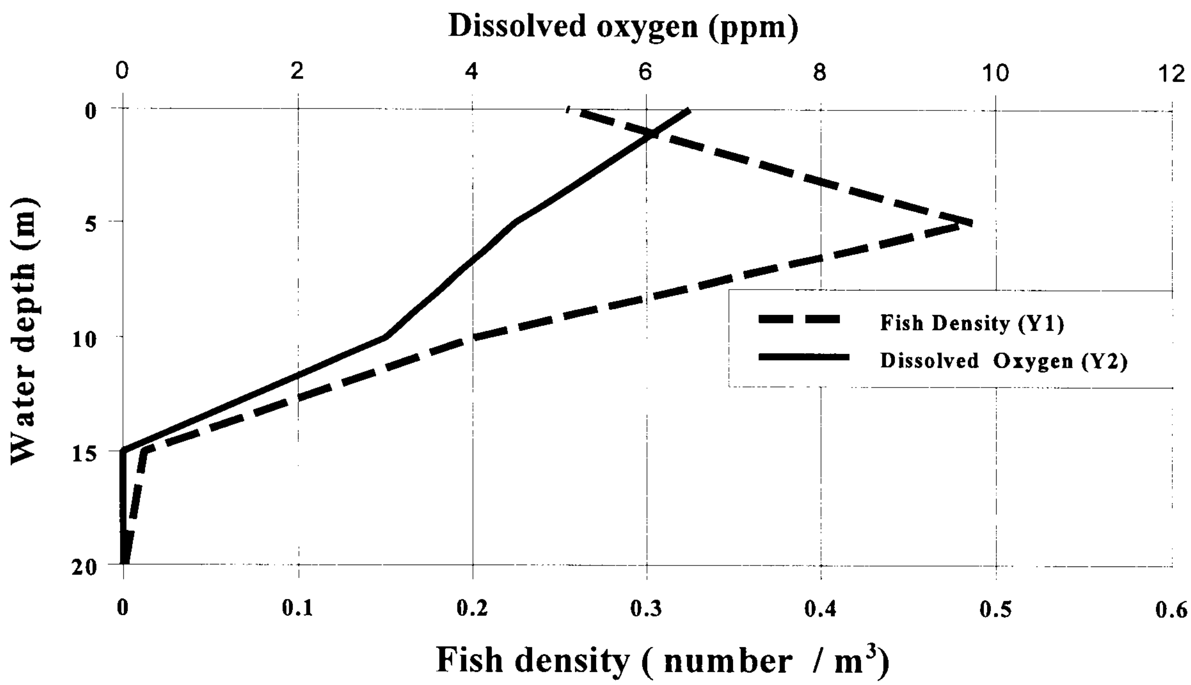


Figure 9. Mean fish density (number of fish / m^3) and dissolved oxygen (ppm) by depth at South Timabalier 54 from July 1996.

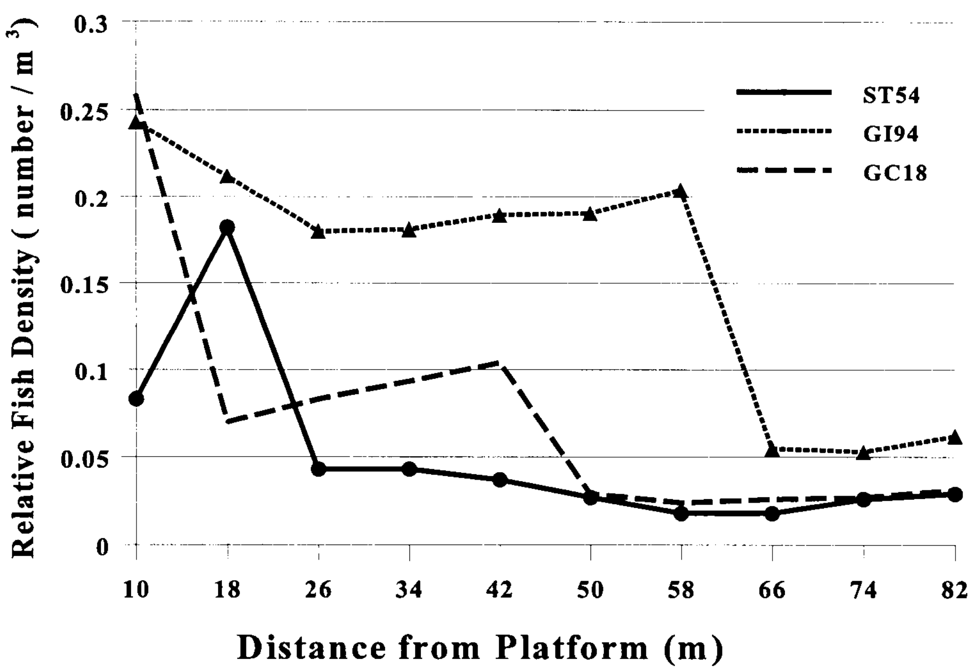


Figure 10. Mean relative fish density (number of fish / m^3) by distance from the platform at Green Canyon 18 (GC18) and Grand Isle 94 (GI94) from July 1994 to March 1997 and South Timbalier 54 (ST54) from August 1995 to February 1997.

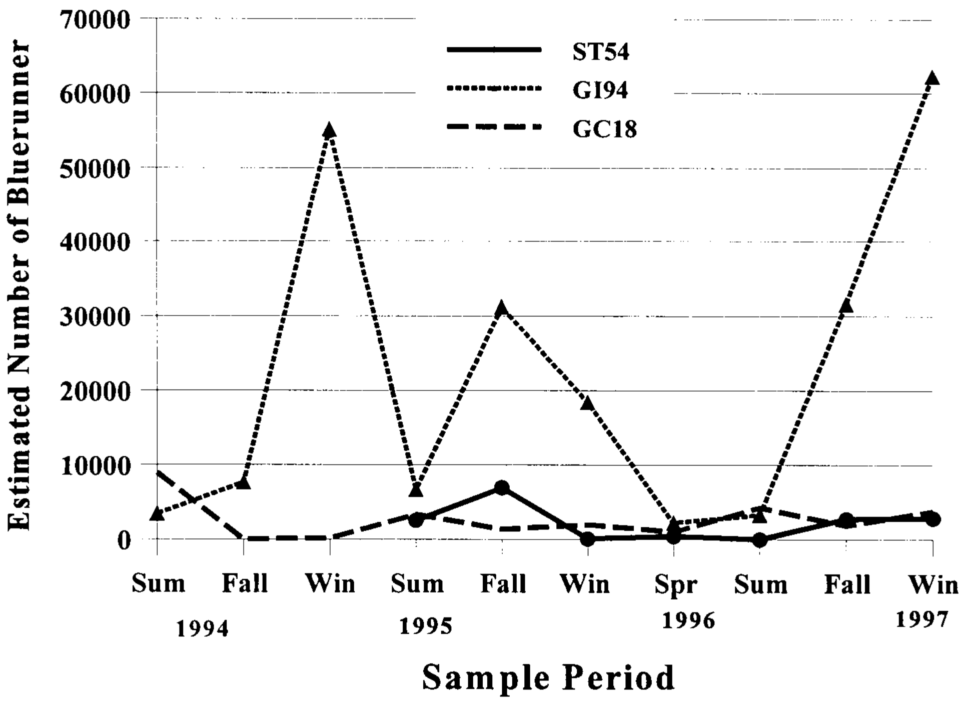


Figure 11. Estimated number of bluerunner for each quarterly sample period at Green Canyon 18 (GC18) and Grand Isle 94 (GI94) from July 1994 to March 1997 and South Timbalier (ST54) from August 1995 to February 1997.

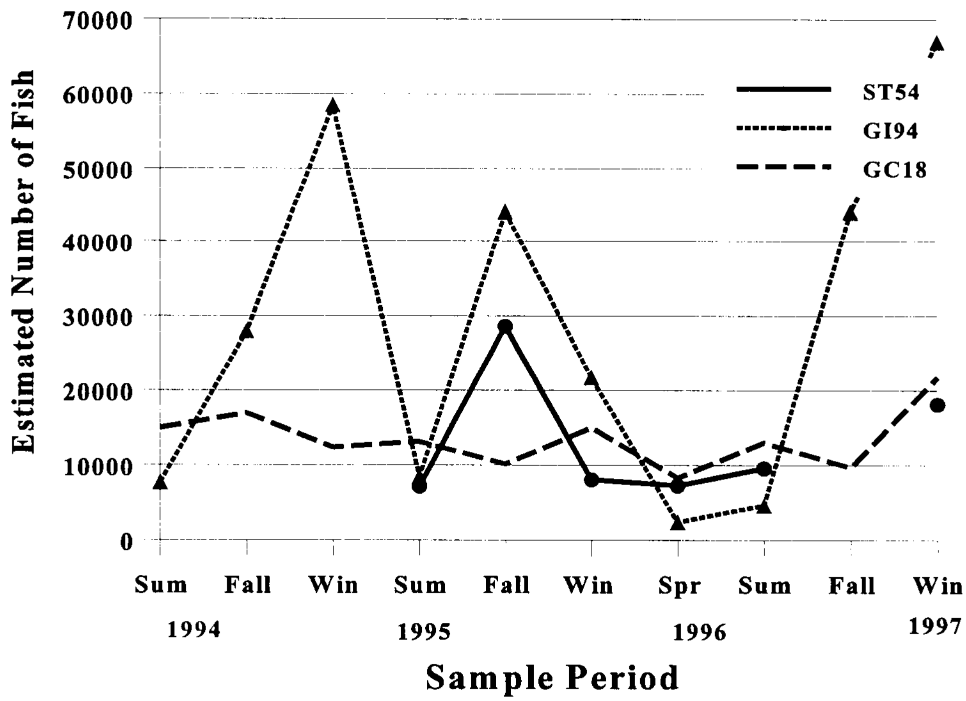


Figure 12. Estimated number of fishes for each quarterly sample period at Green Canyon 18 (GC18) and Grand Isle 94 (GI94) from July 1994 to March 1997 and South Timbalier (ST54) from August 1995 to February 1997.

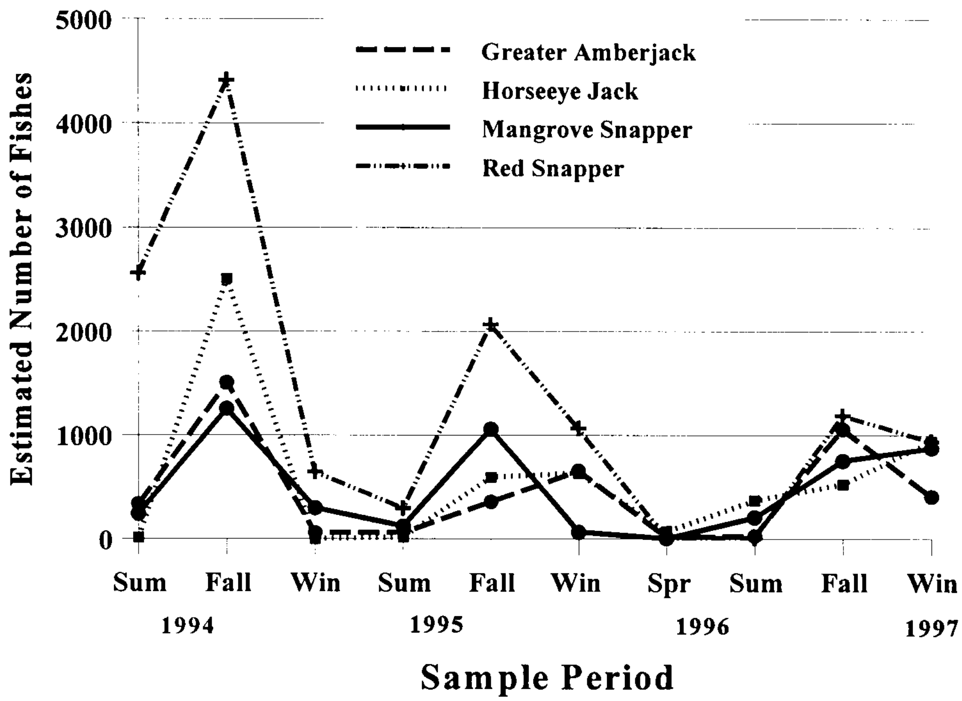


Figure 13. Estimated number of greater amberjack, horseeye jack, mangrove snapper and red snapper fishes for each quarterly sample period at Grand Isle 94 (GI94) from July 1994 to March 1997.

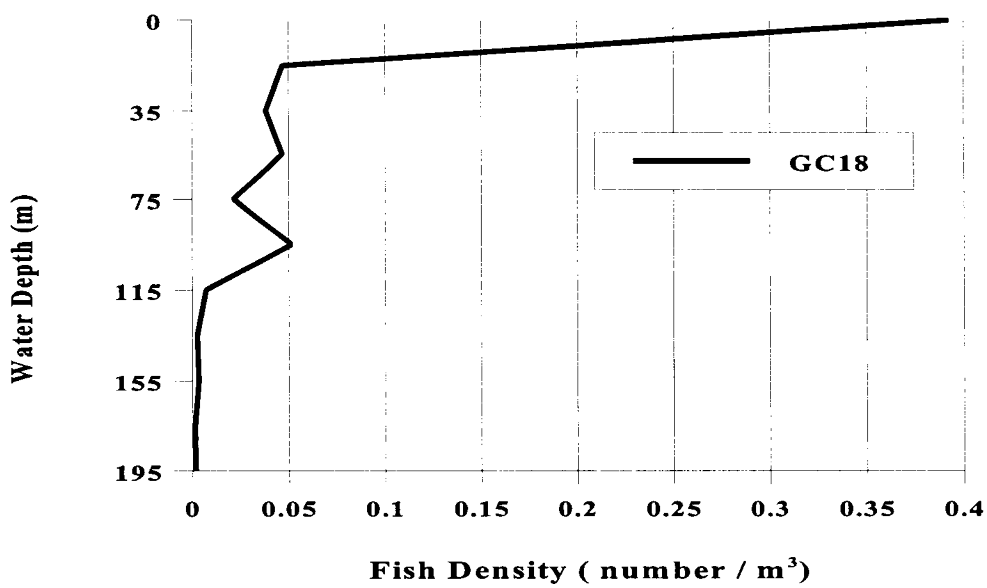


Figure 14. Mean fish density (number of fish / m^3) by depth at Green Canyon 18 from October 1994 to March 1997.

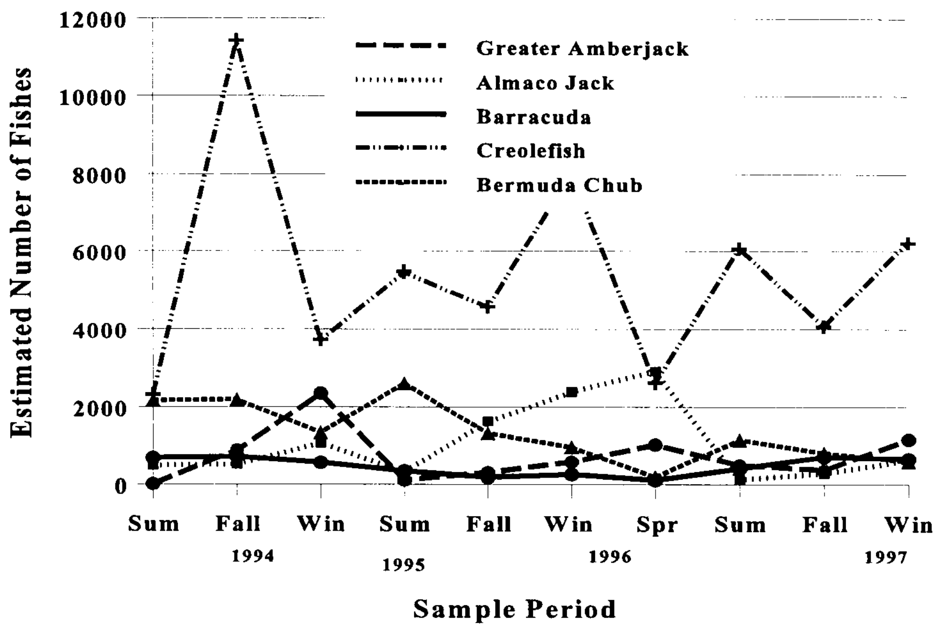
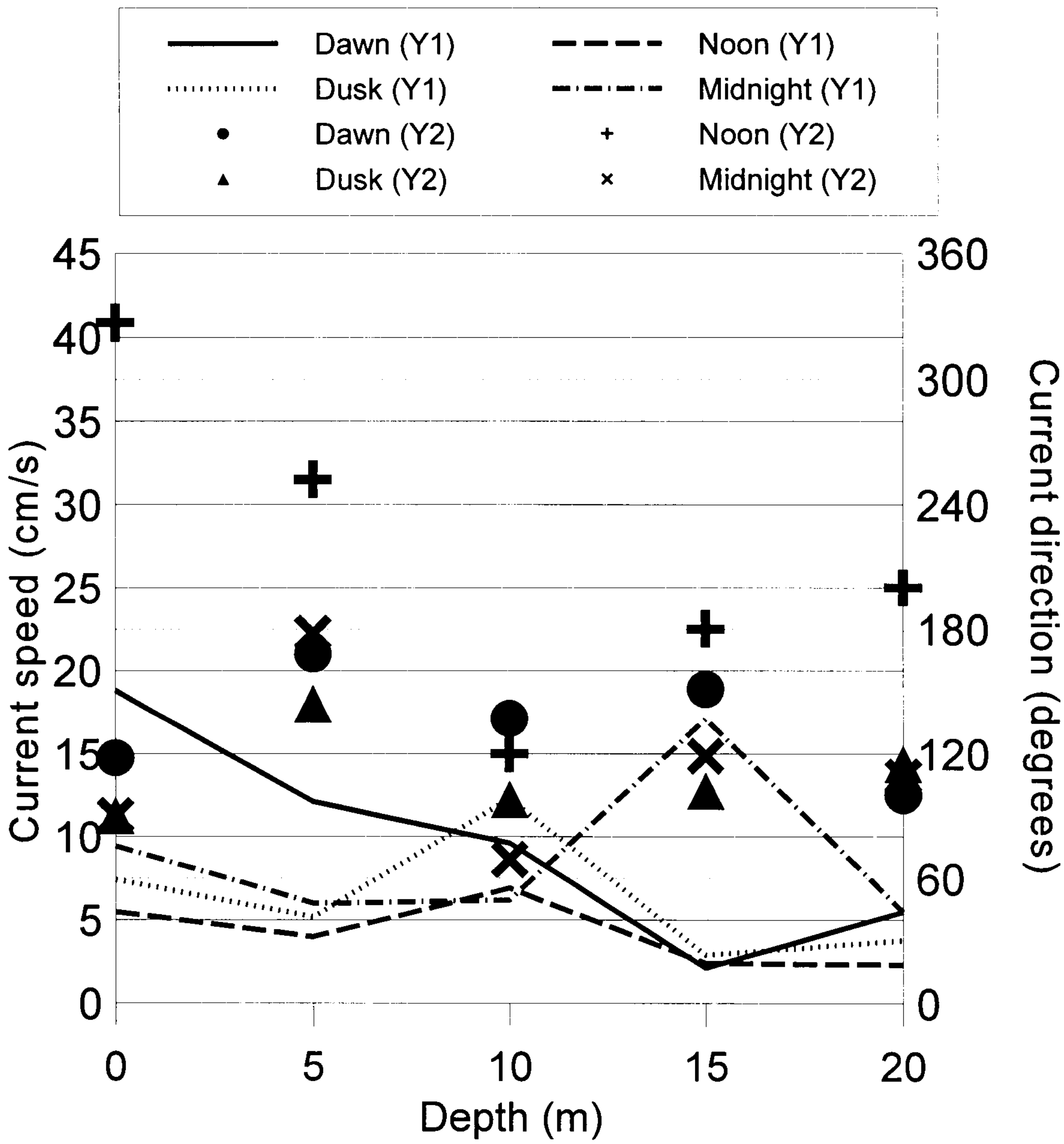


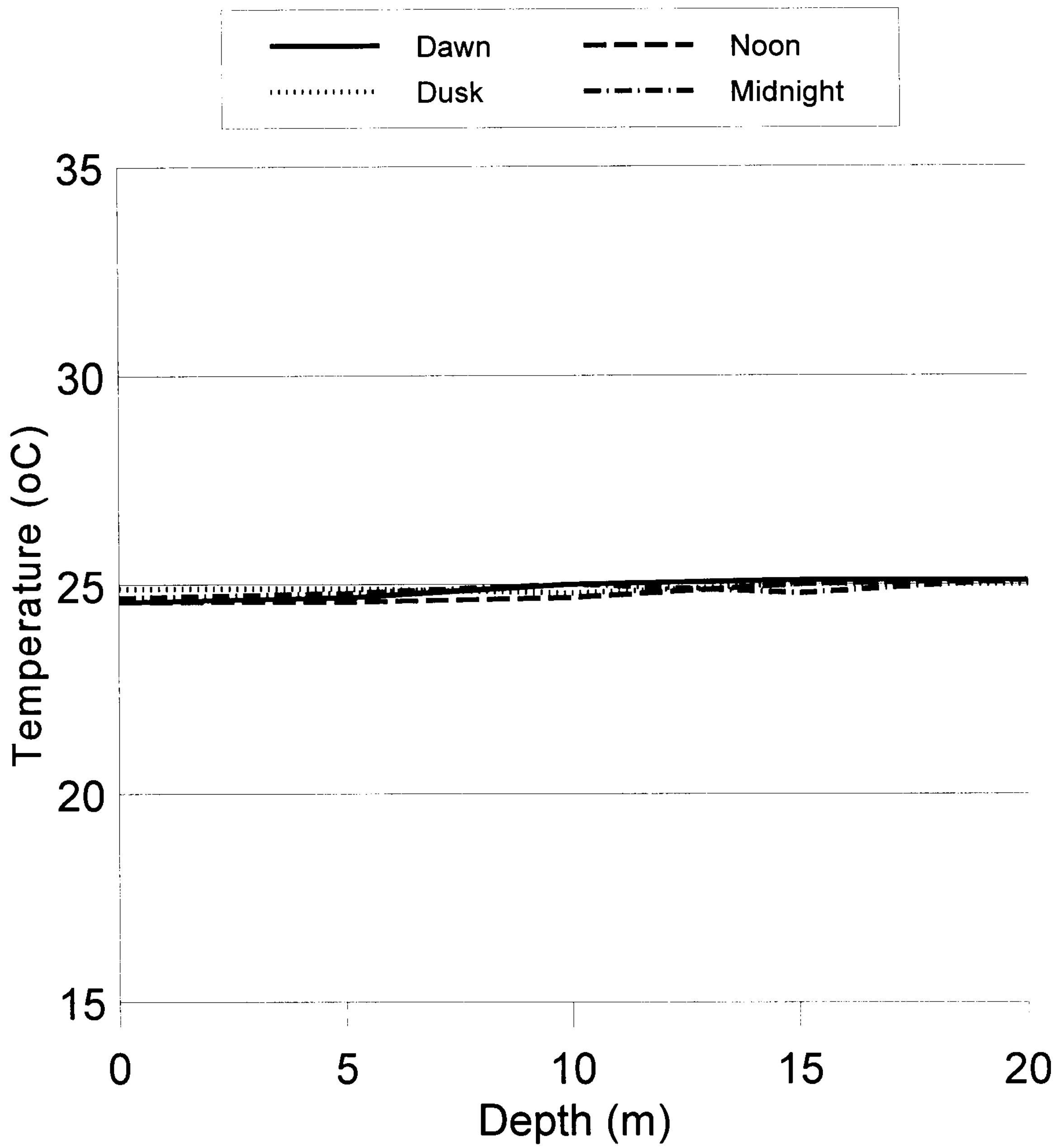
Figure 15. Estimated number of greater amberjack, almaco jack, barracuda, creolefish and Bermuda chub for each quarterly sample period at Green Canyon 18 from October 1994 to March 1997.

APPENDIX 1

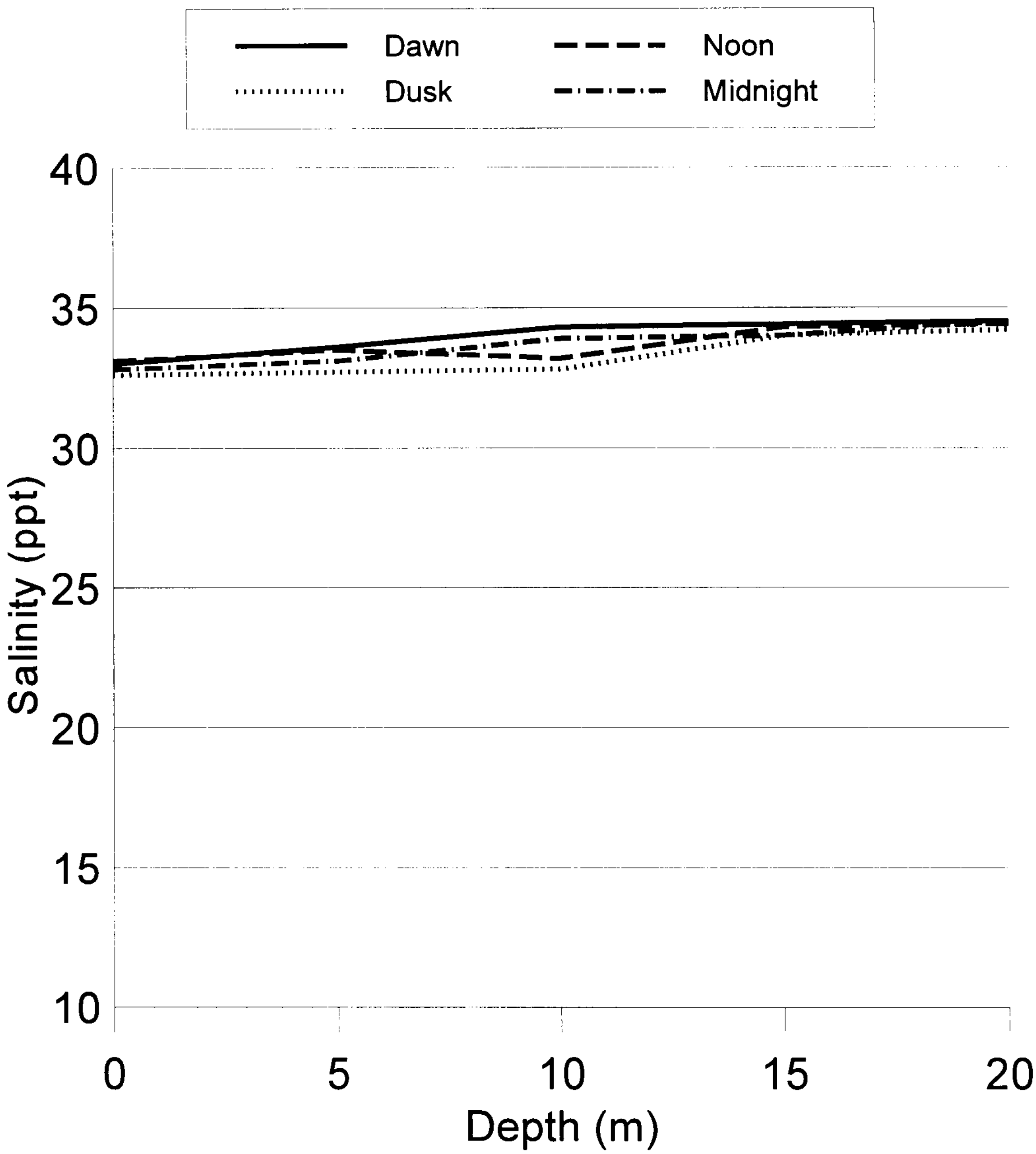
Current, Temperature, Salinity and Oxygen Data Coincident with Acoustic Data at South Timbalier 54



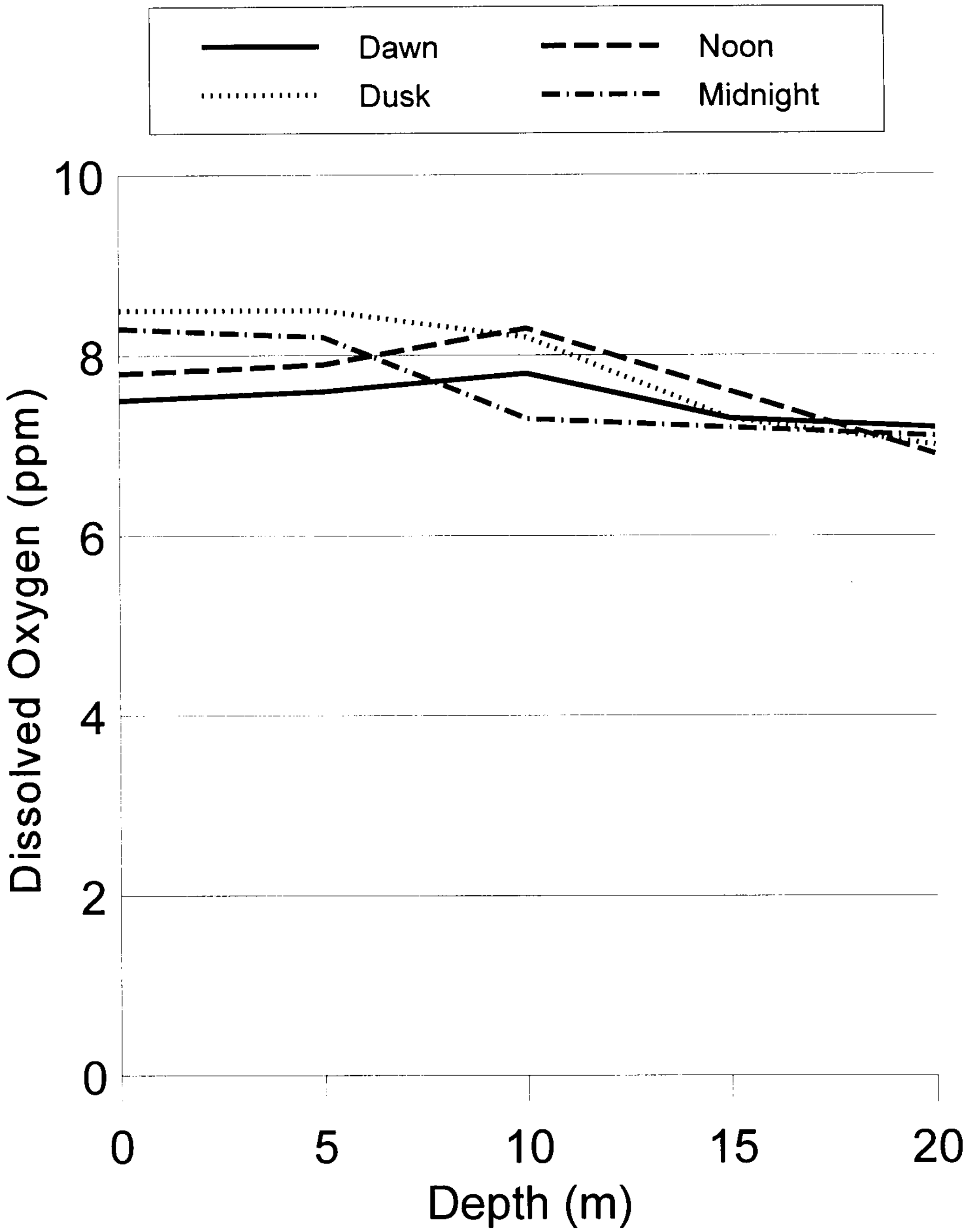
Appendix 1-1. Plot of current speed and direction with depth coincident with acoustic data at South Timbalier 54 from October 24-25, 1995.



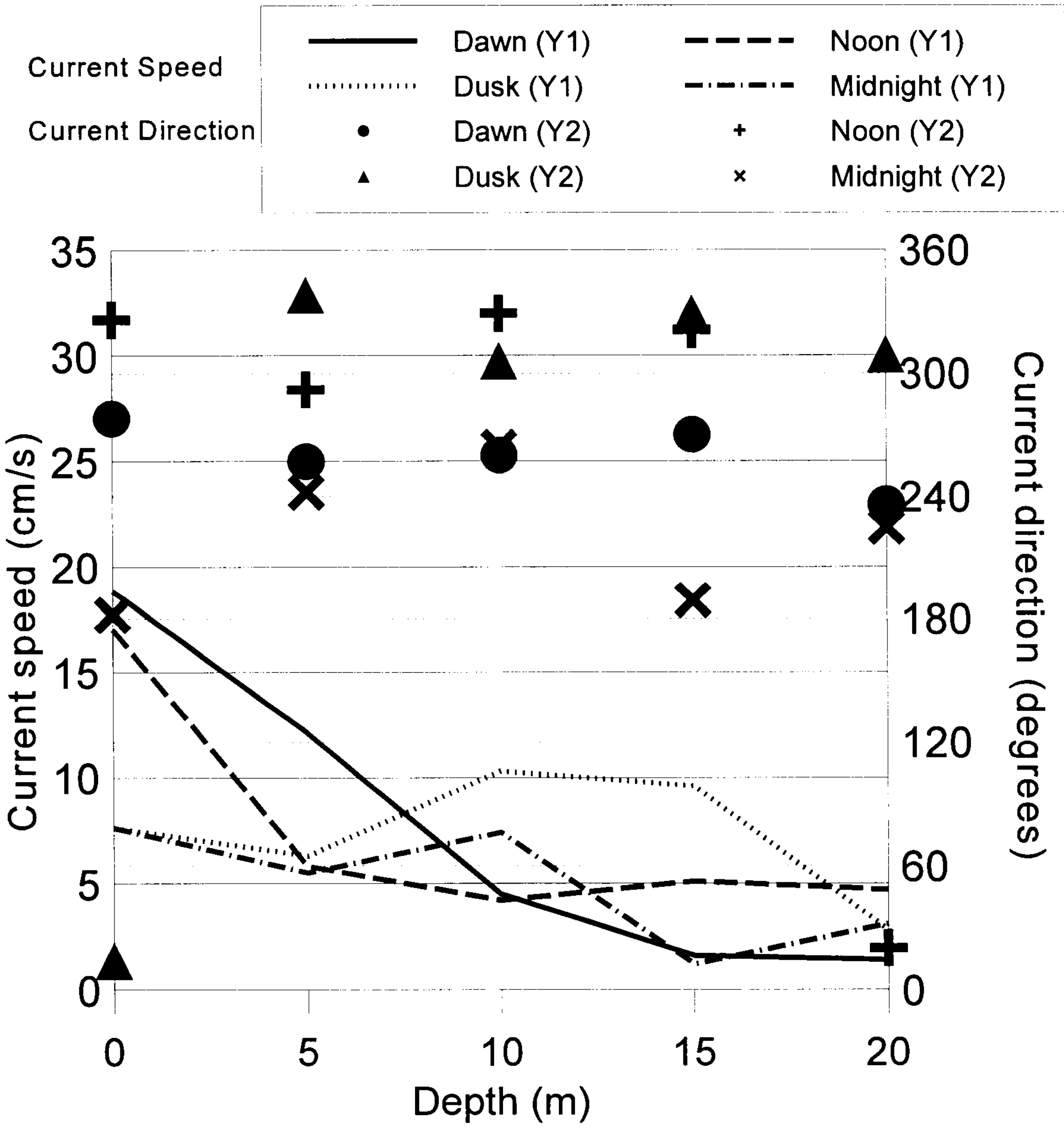
Appendix 1-2. Plot of temperature and water depth coincident with acoustic data at South Timbalier 54, October 24-25, 1995.



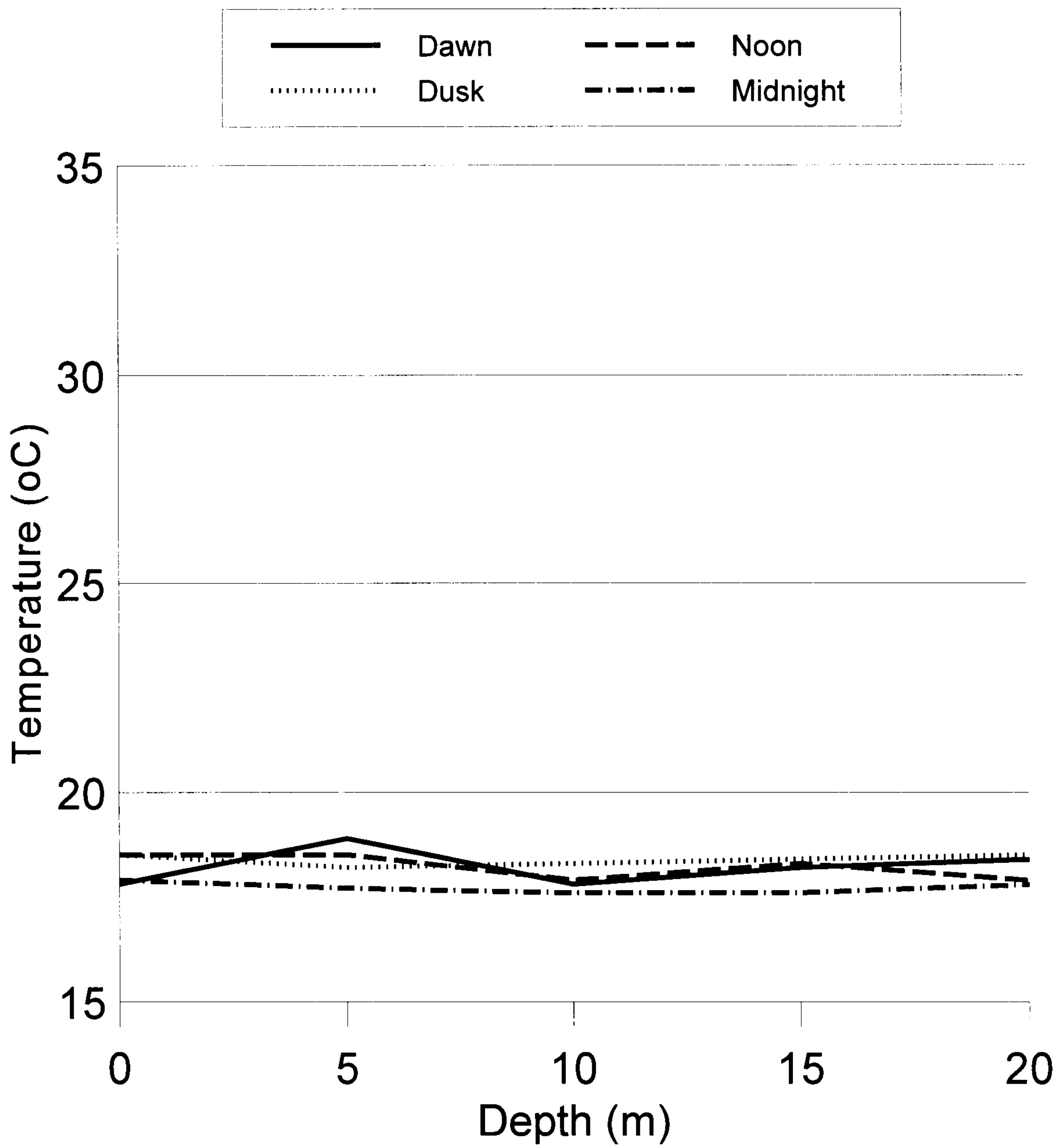
Appendix 1-3. Plot of salinity with depth coincident with the collection of acoustic data at South Timbalier 54 from October 24-25, 1995.



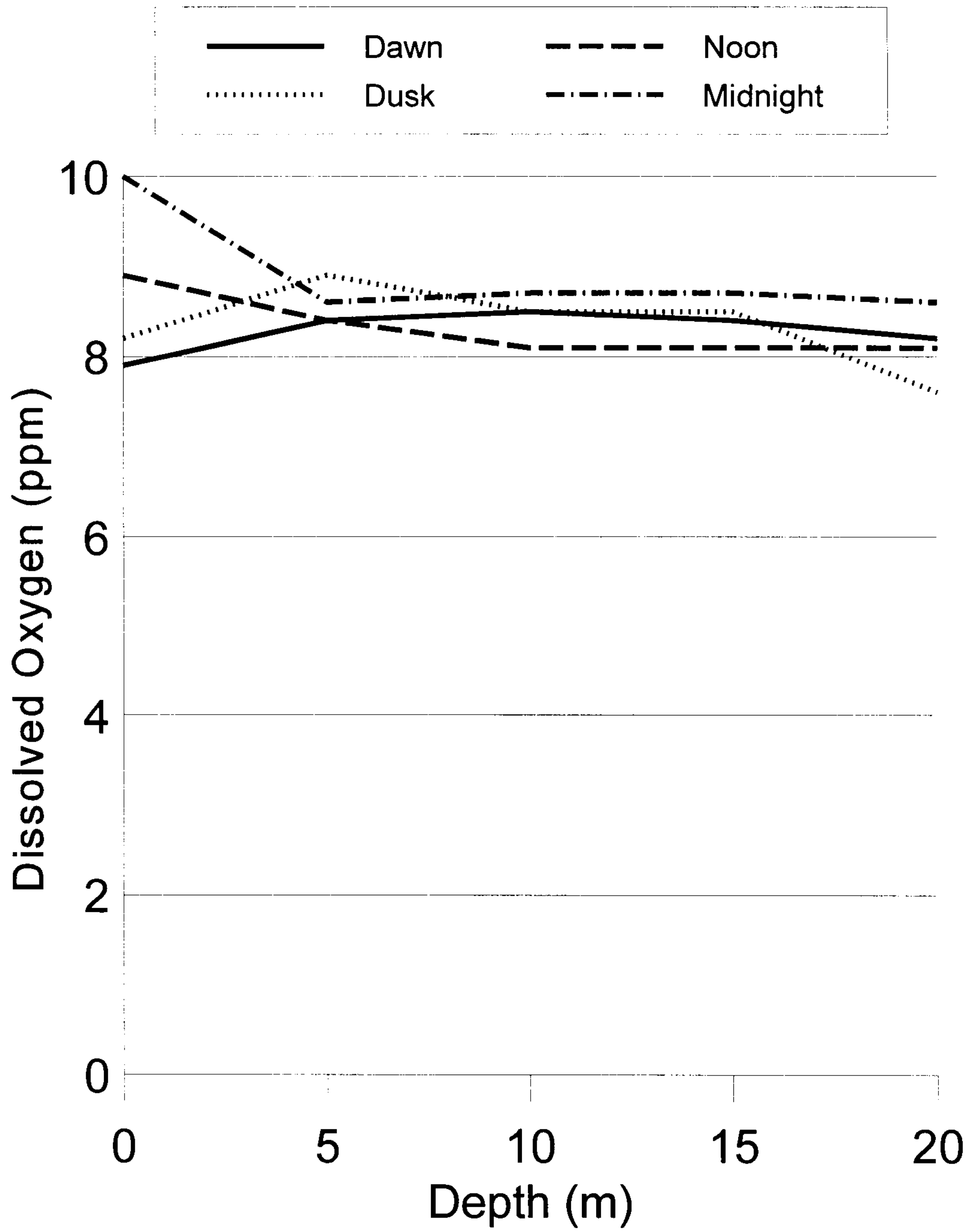
Appendix 1-4. Plot of depth with dissolved oxygen coincident with acoustic data at South Timbalier 54, October 24-25, 1995.



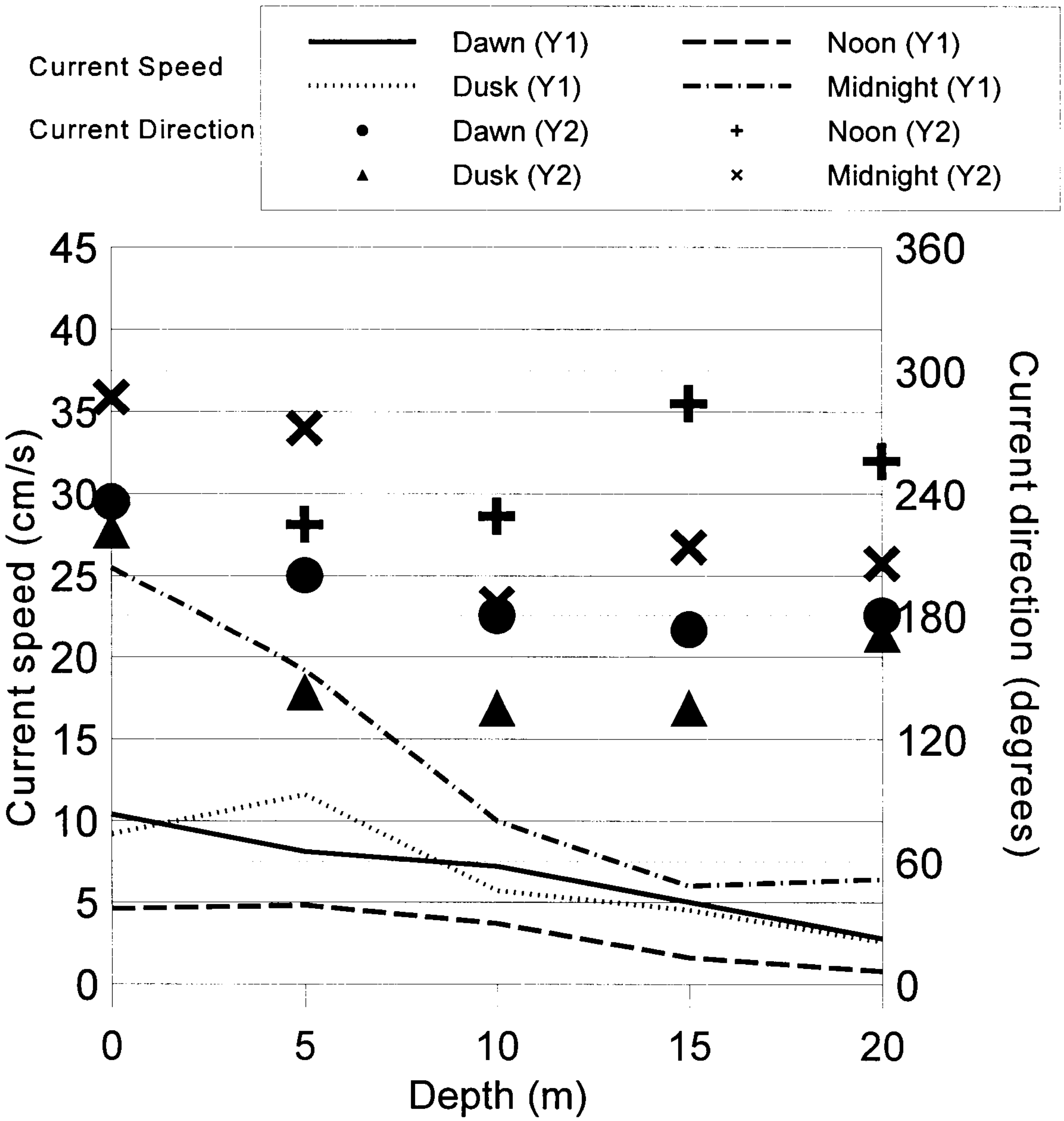
Appendix 1-5. Plot of current speed and direction with depth coincident with acoustic data at South Timbalier 54 from January 30 - February 1, 1996.



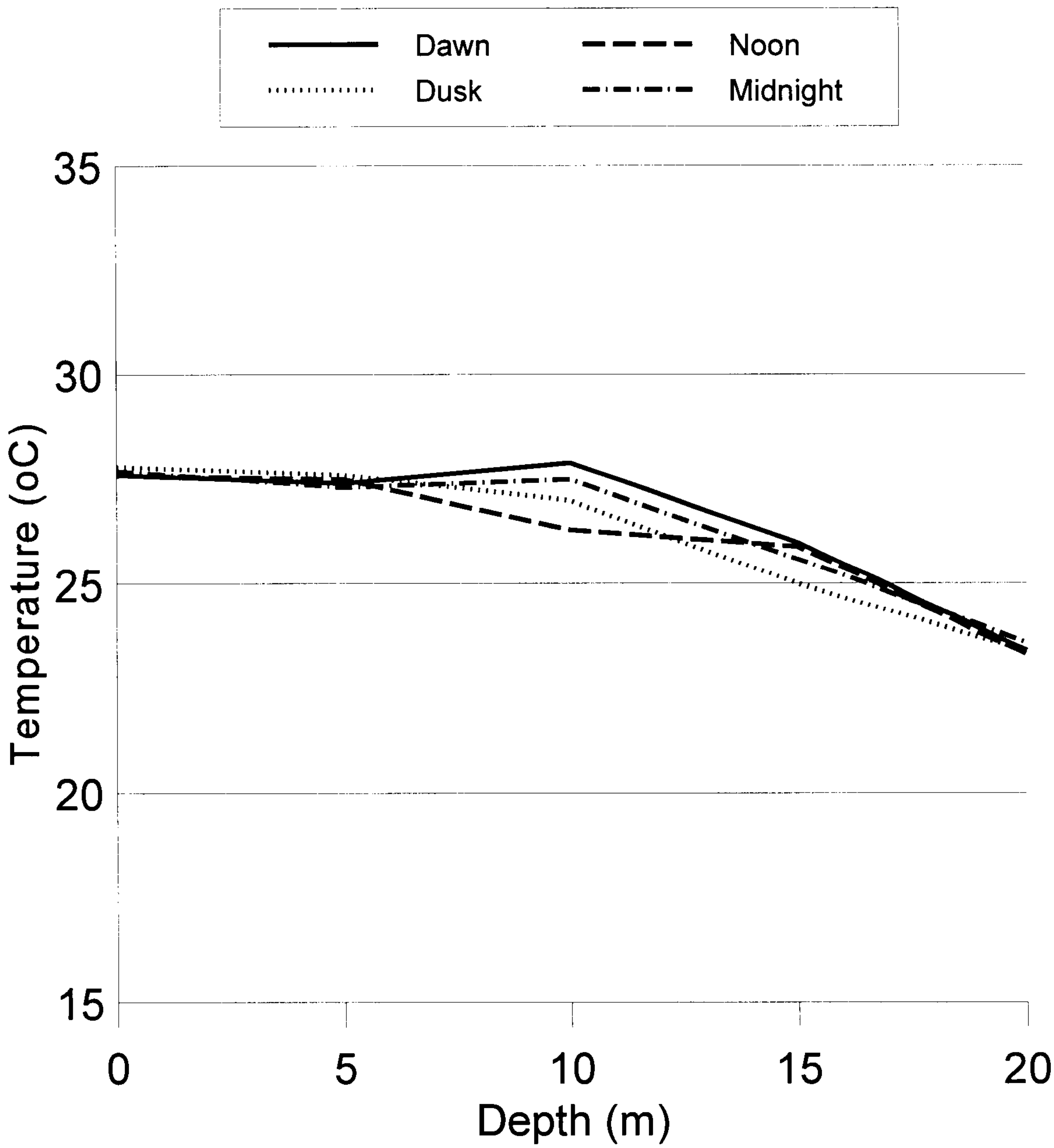
Appendix 1-6. Plot of temperature and water depth coincident with acoustic data at South Timbalier 54, January 30 - February 1, 1996.



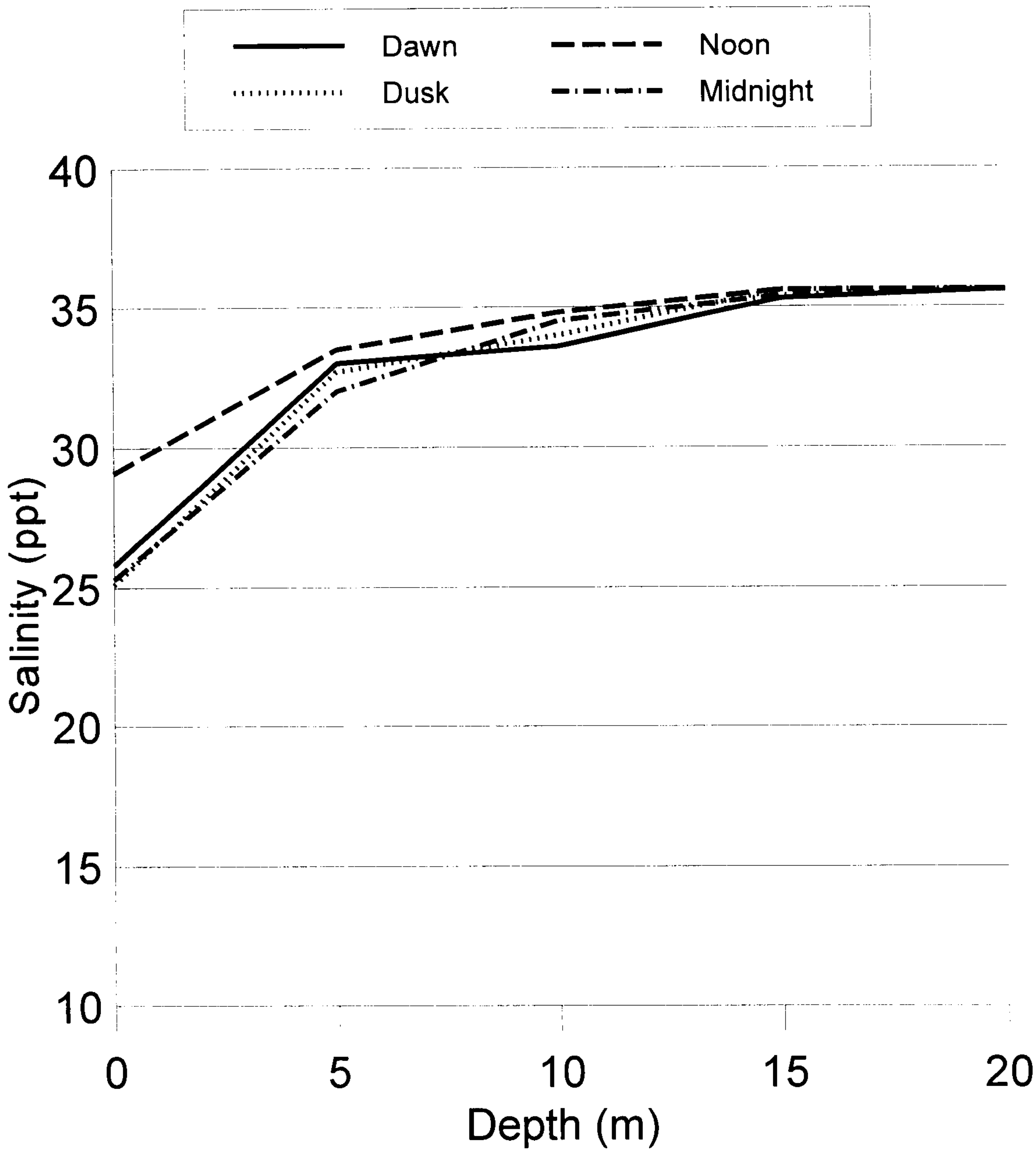
Appendix 1-8. Plot of depth with dissolved oxygen coincident with acoustic data at South Timbalier 54, January 30 - February 1, 1996.



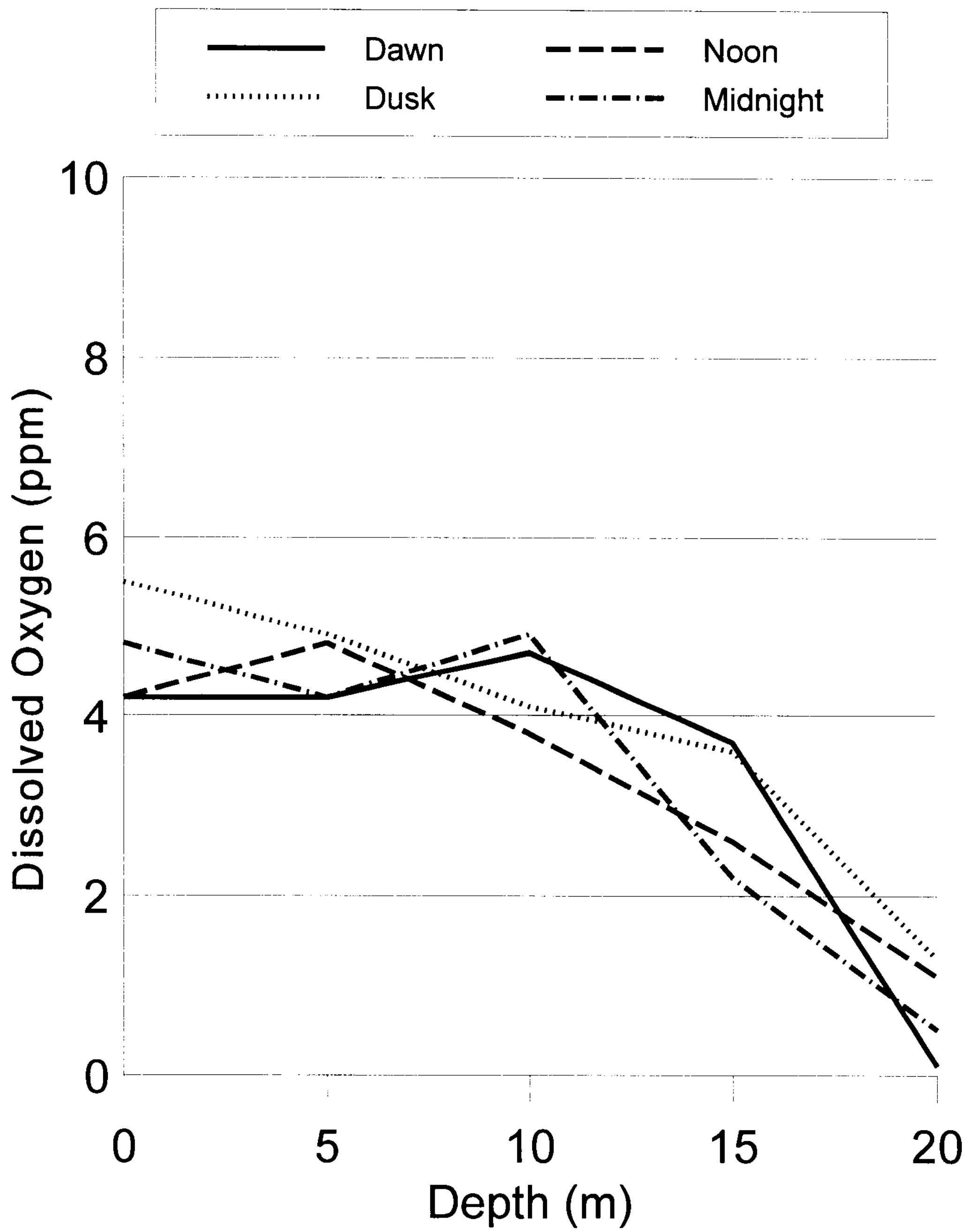
Appendix 1-9. Plot of current speed and direction with depth coincident with acoustic data at South Timbalier 54 from June 6-7, 1996.



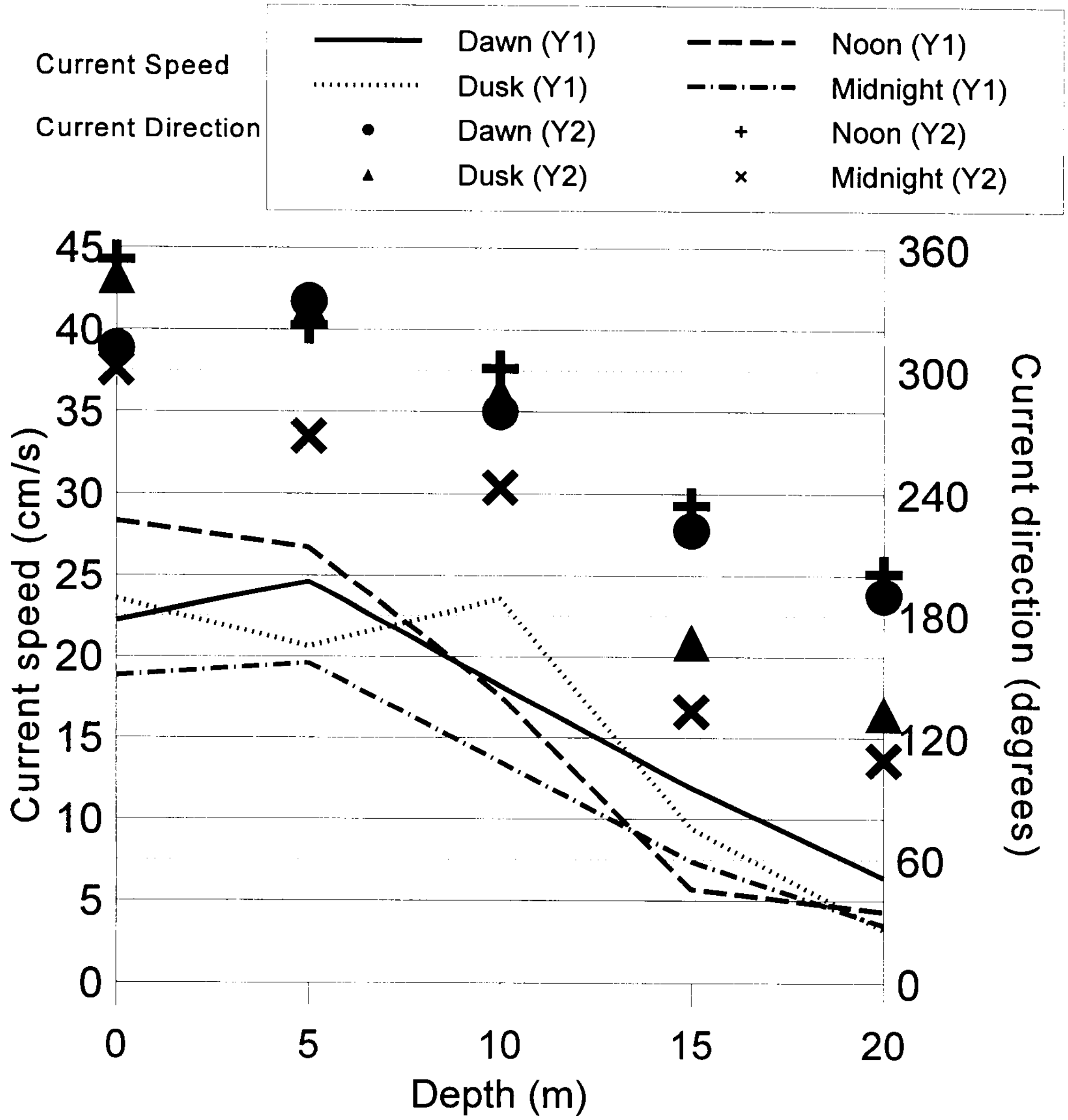
Appendix 1-10. Plot of temperature and water depth coincident with acoustic data at South Timbatlier 54, June 6-7, 1996.



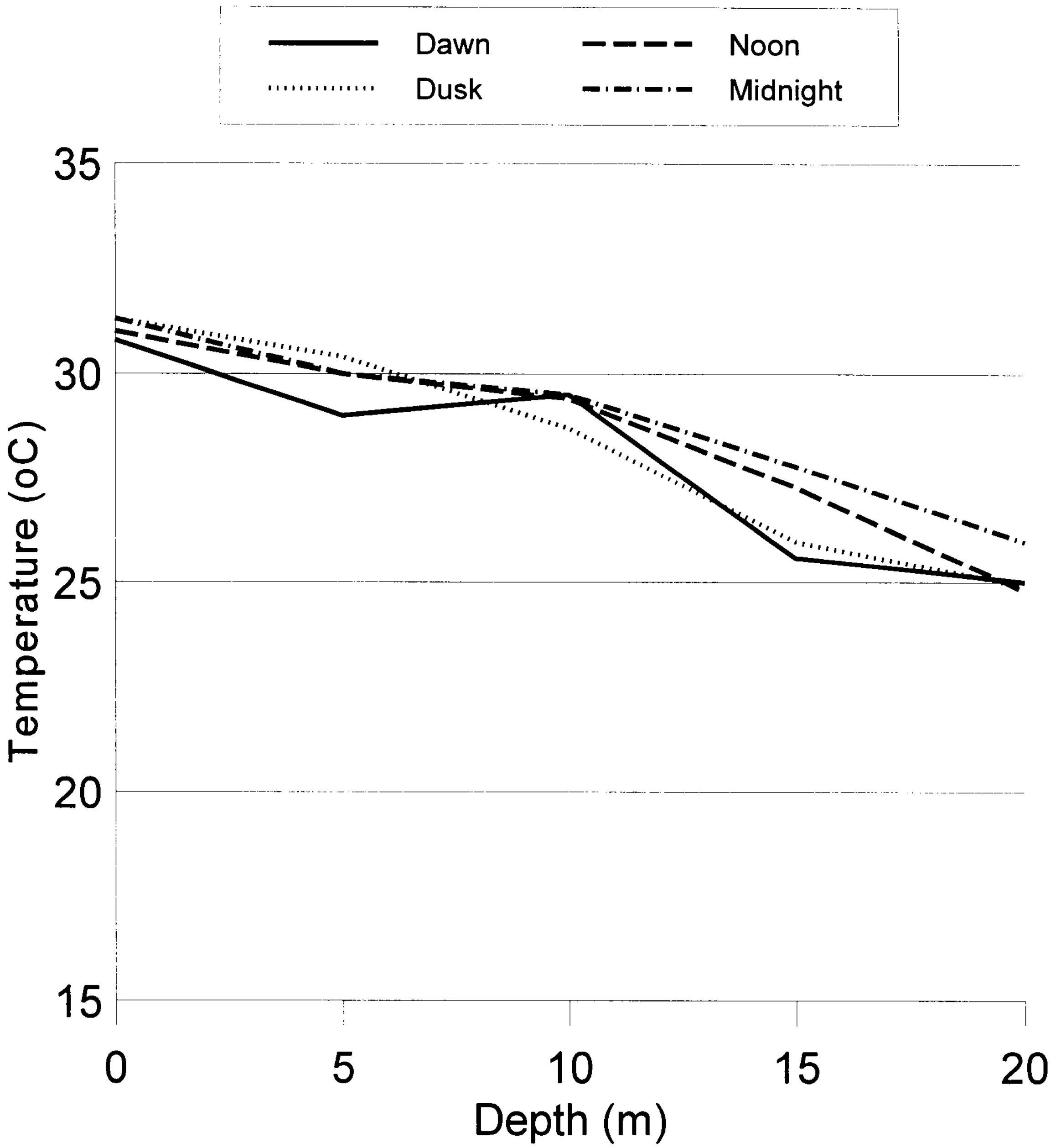
Appendix 1-11. Plot of salinity with depth coincident with the collection of acoustic data at South Timbalier 54 from June 6-7, 1996.



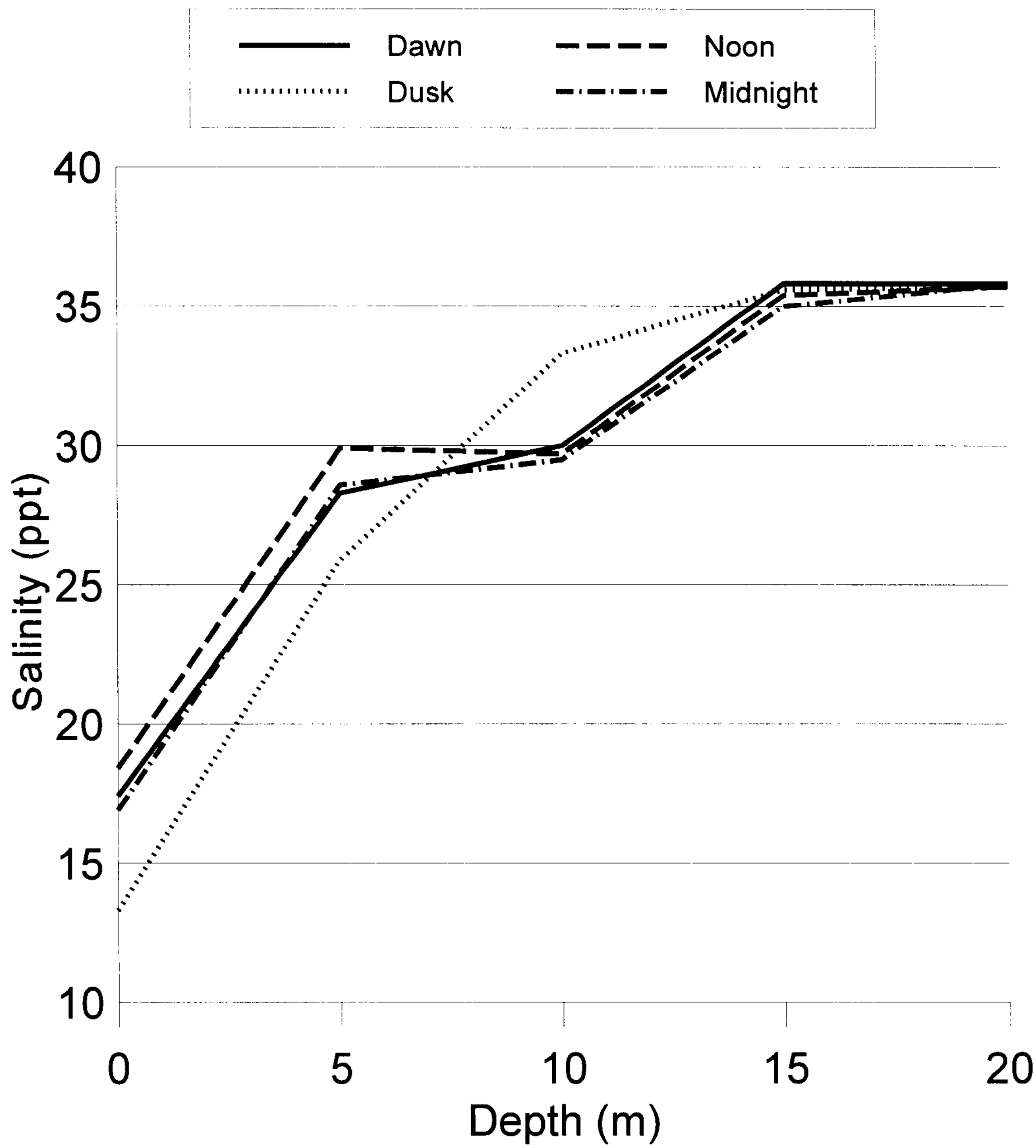
Appendix 1-12. Plot of depth with dissolved oxygen coincident with acoustic data at South Timbalier 54, June 6-7, 1996.



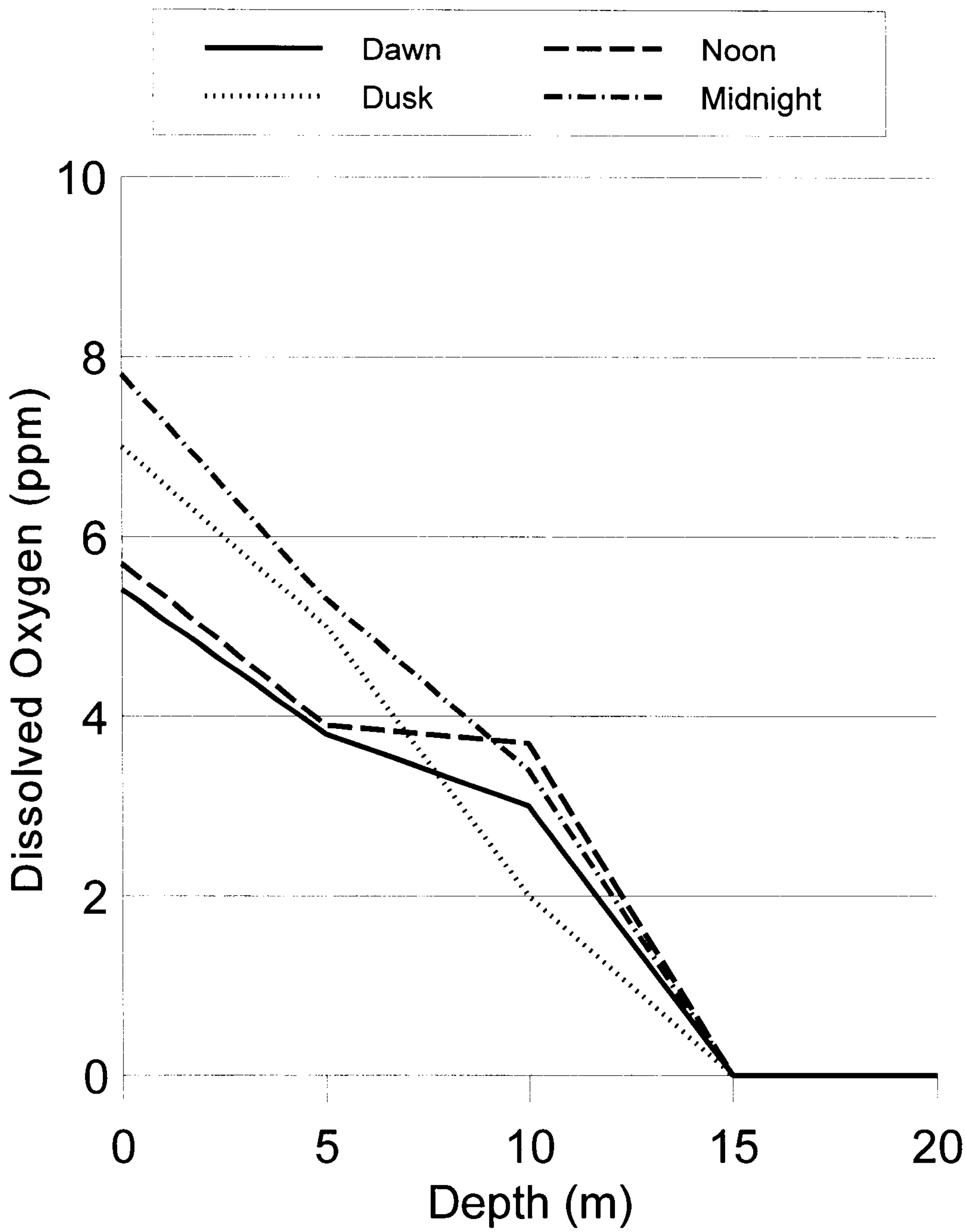
Appendix 1-13. Plot of current speed and direction with depth coincident with acoustic data at South Timbalier 54 from July 17-18, 1996.



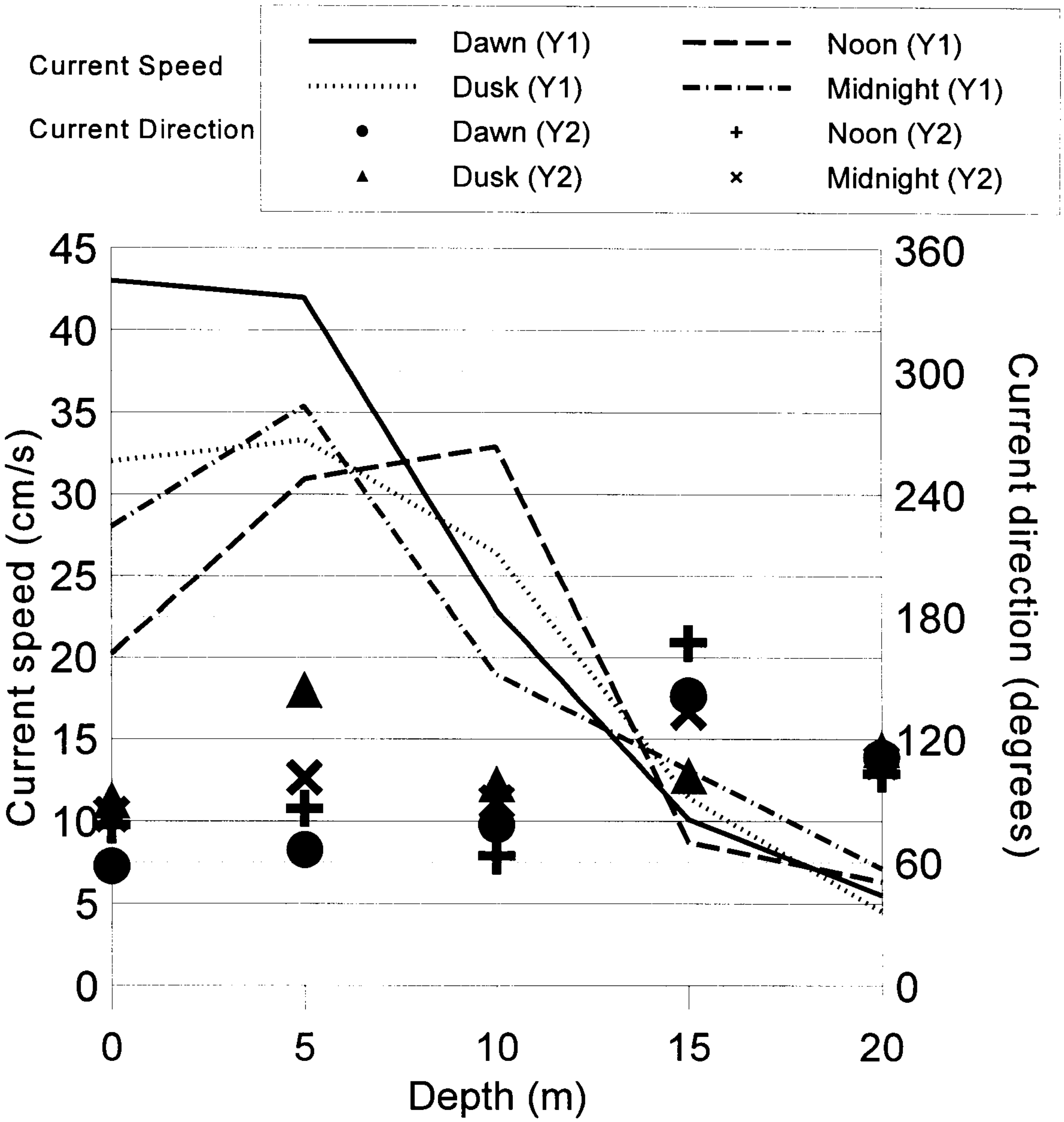
Appendix 1-14. Plot of temperature and water depth coincident with acoustic data at South Timbalier 54, July 17-18, 1996.



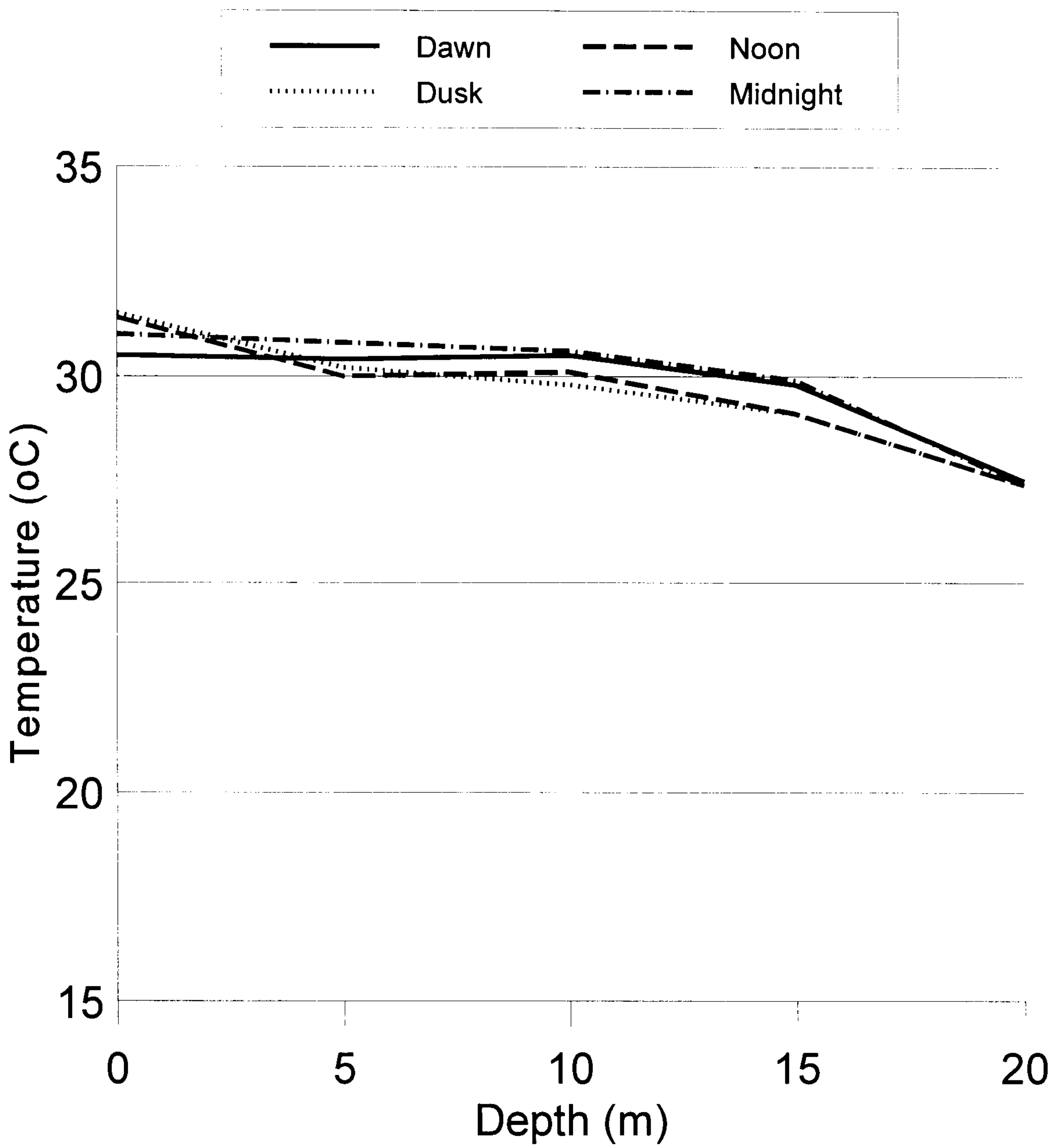
Appendix 1-15. Plot of salinity with depth coincident with the collection of acoustic data at South Timbalier 54 from July 17-18, 1996.



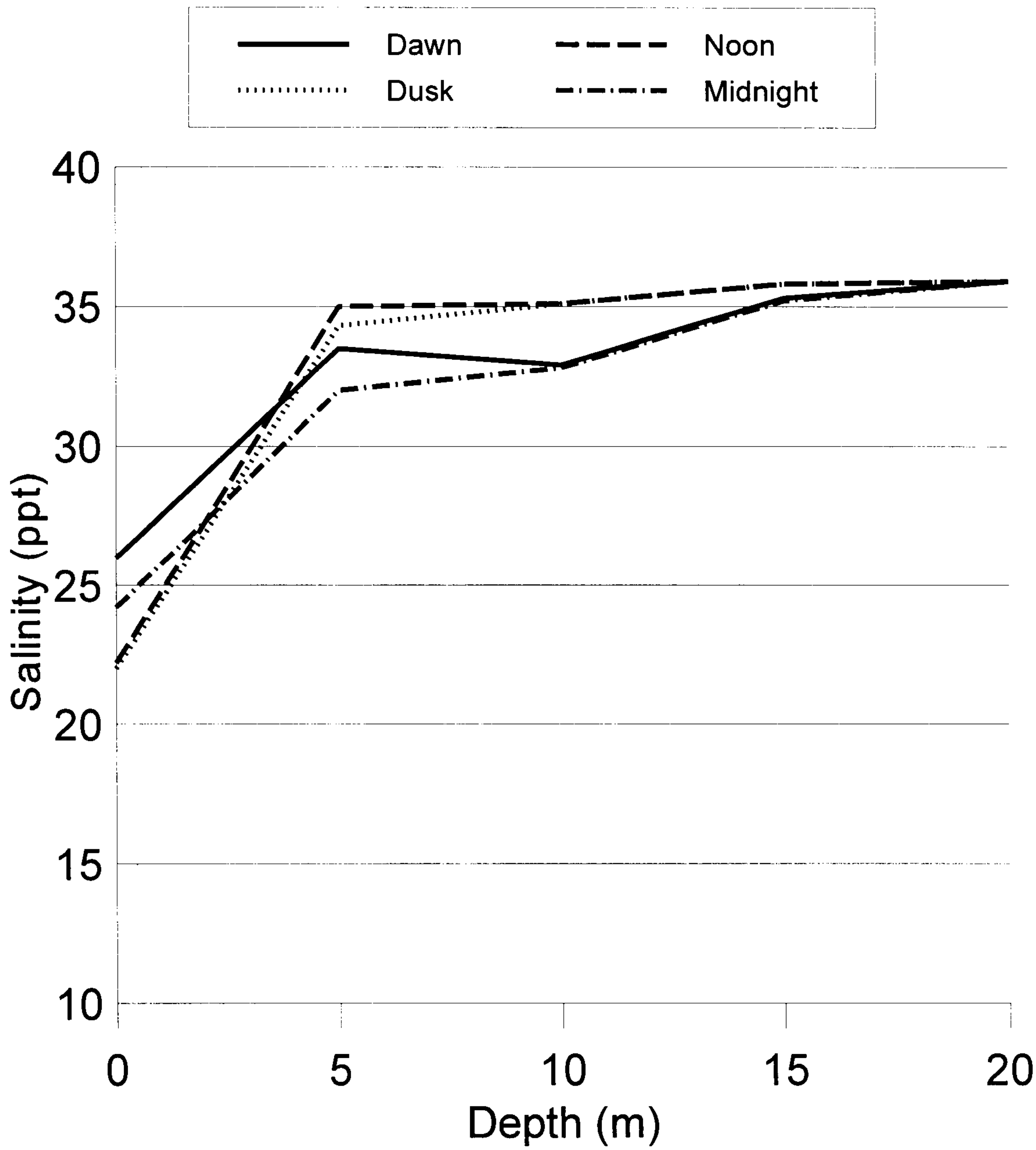
Appendix 1-16. Plot of depth with dissolved oxygen coincident with acoustic data at South Timbalier 54, July 17-18, 1996.



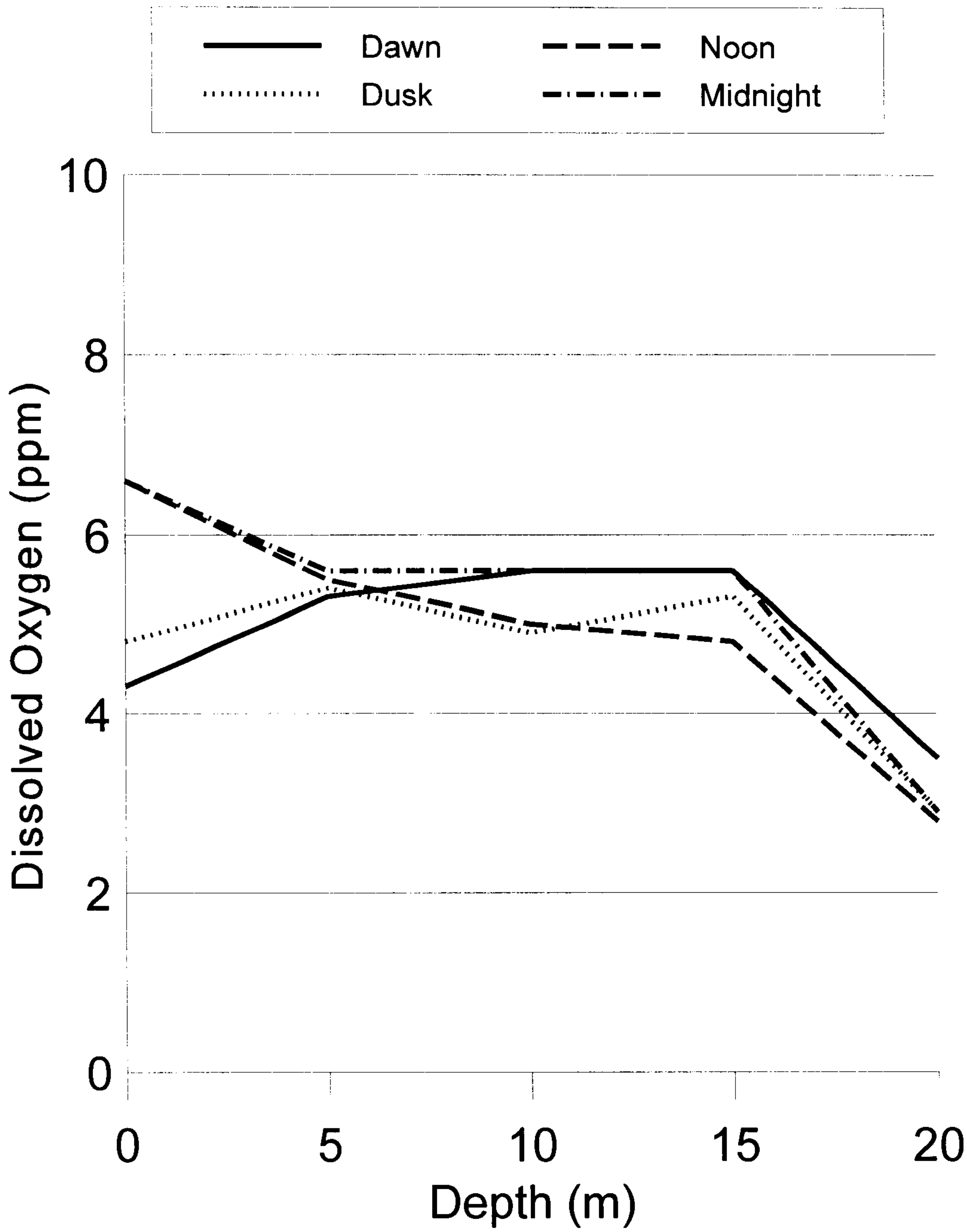
Appendix 1-17. Plot of current speed and direction with depth coincident with acoustic data at South Timbalier 54 from August 30-31, 1996.



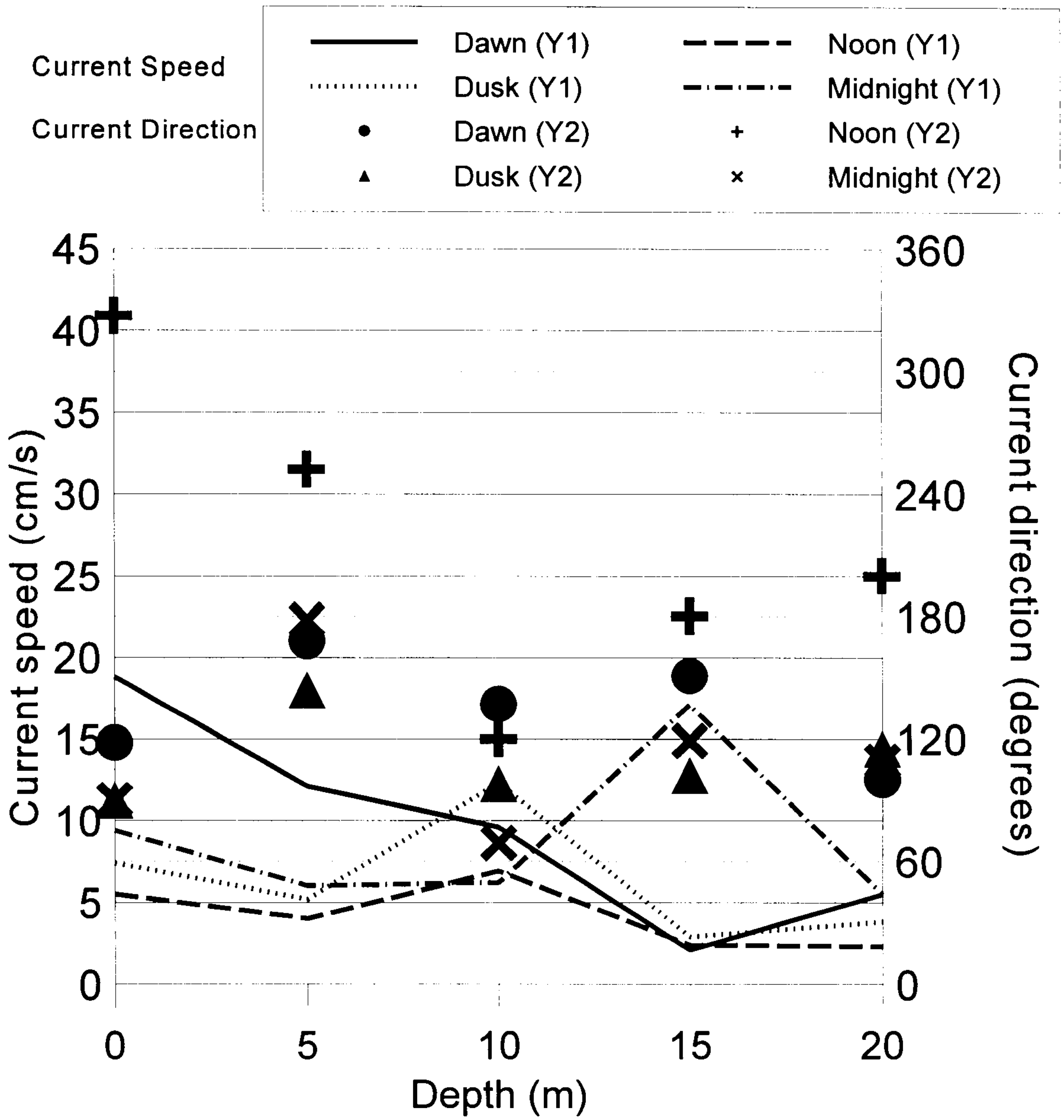
Appendix 1-18. Plot of temperature and water depth coincident with acoustic data at South Timbalier 54, August 30-31, 1996.



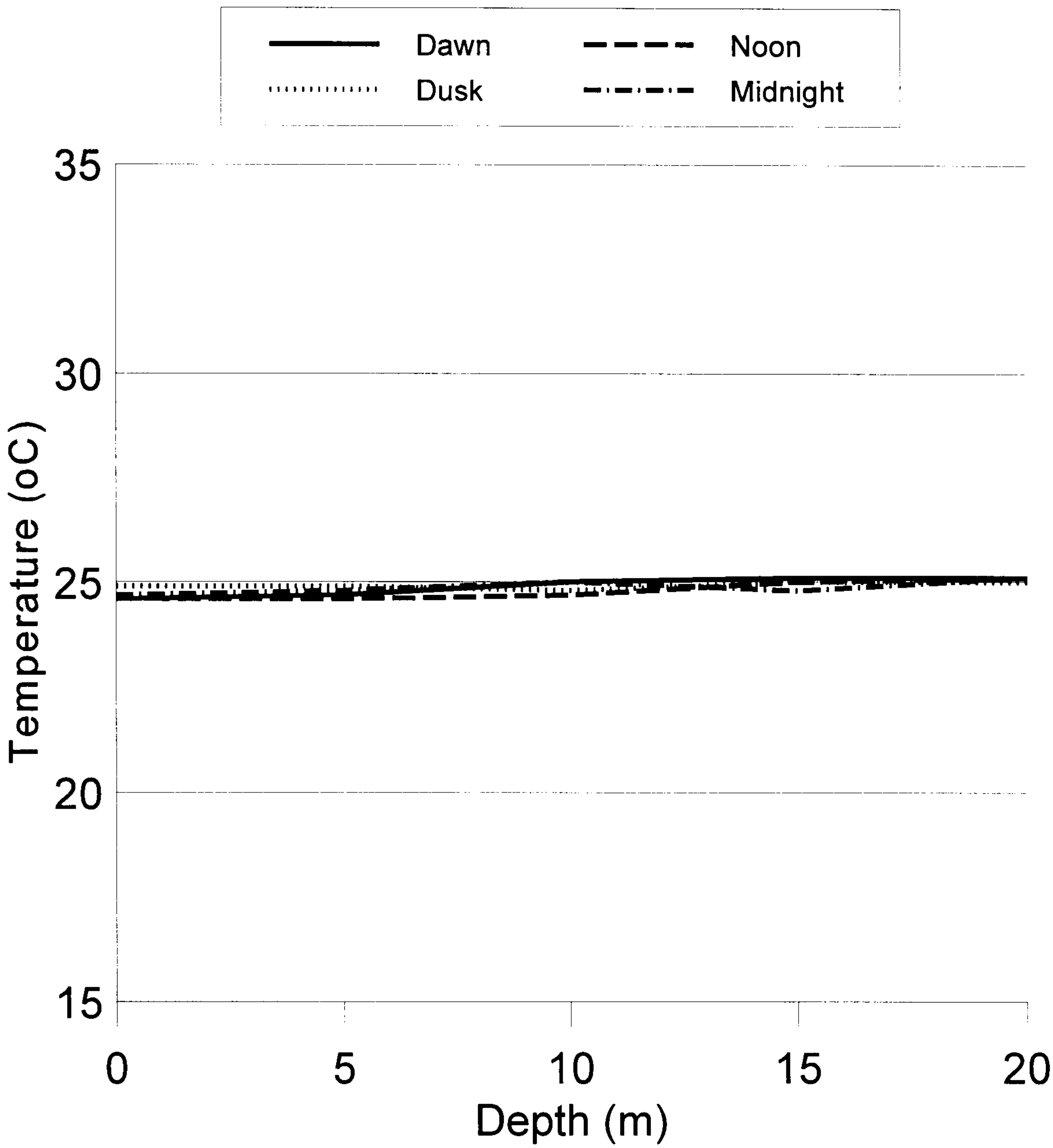
Appendix 1-19. Plot of salinity with depth coincident with the collection of acoustic data at South Timbalier 54 from August 30-31, 1996.



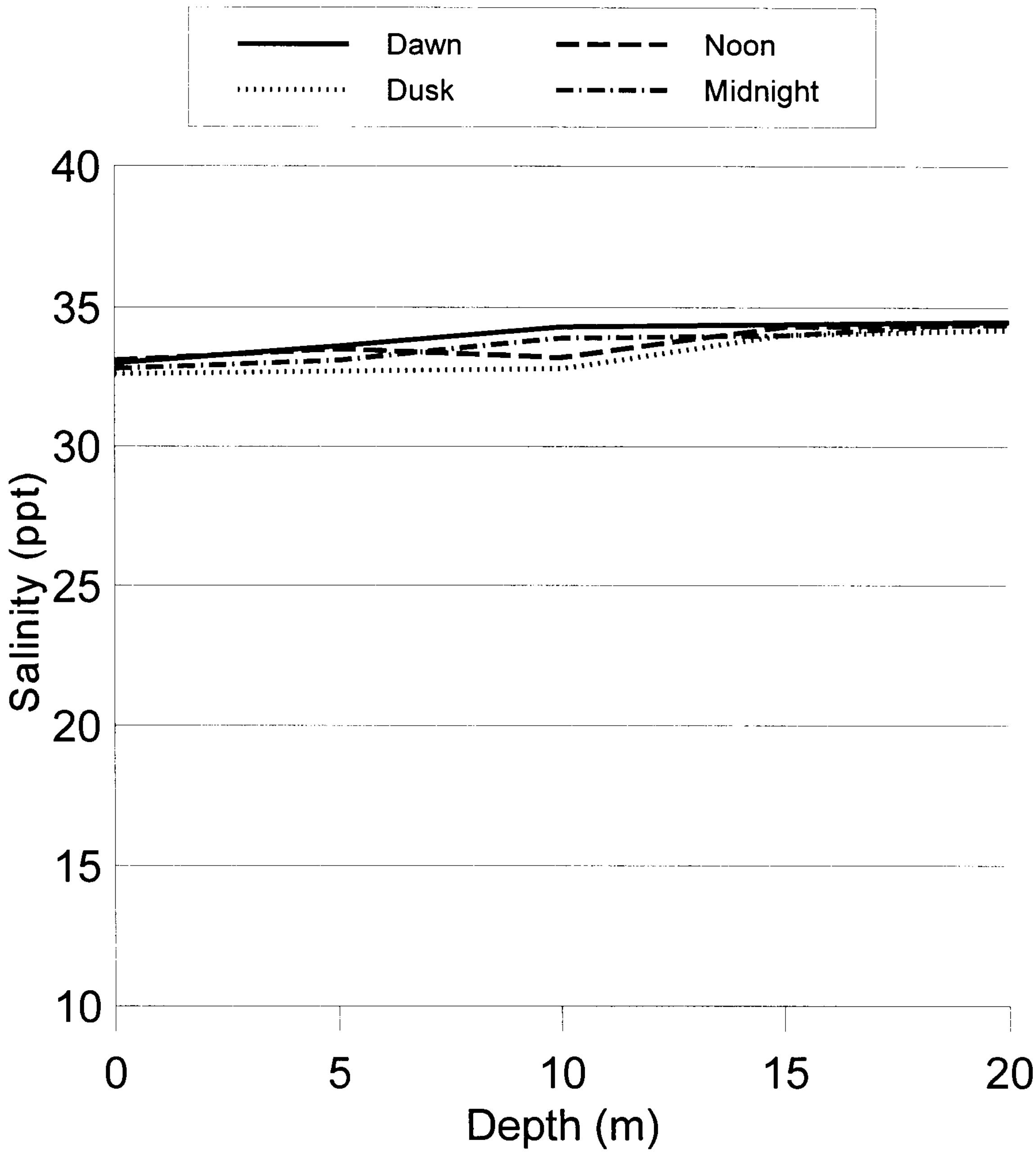
Appendix 1-20. Plot of depth with dissolved oxygen coincident with acoustic data at South Timbalier 54, August 30-31, 1996.



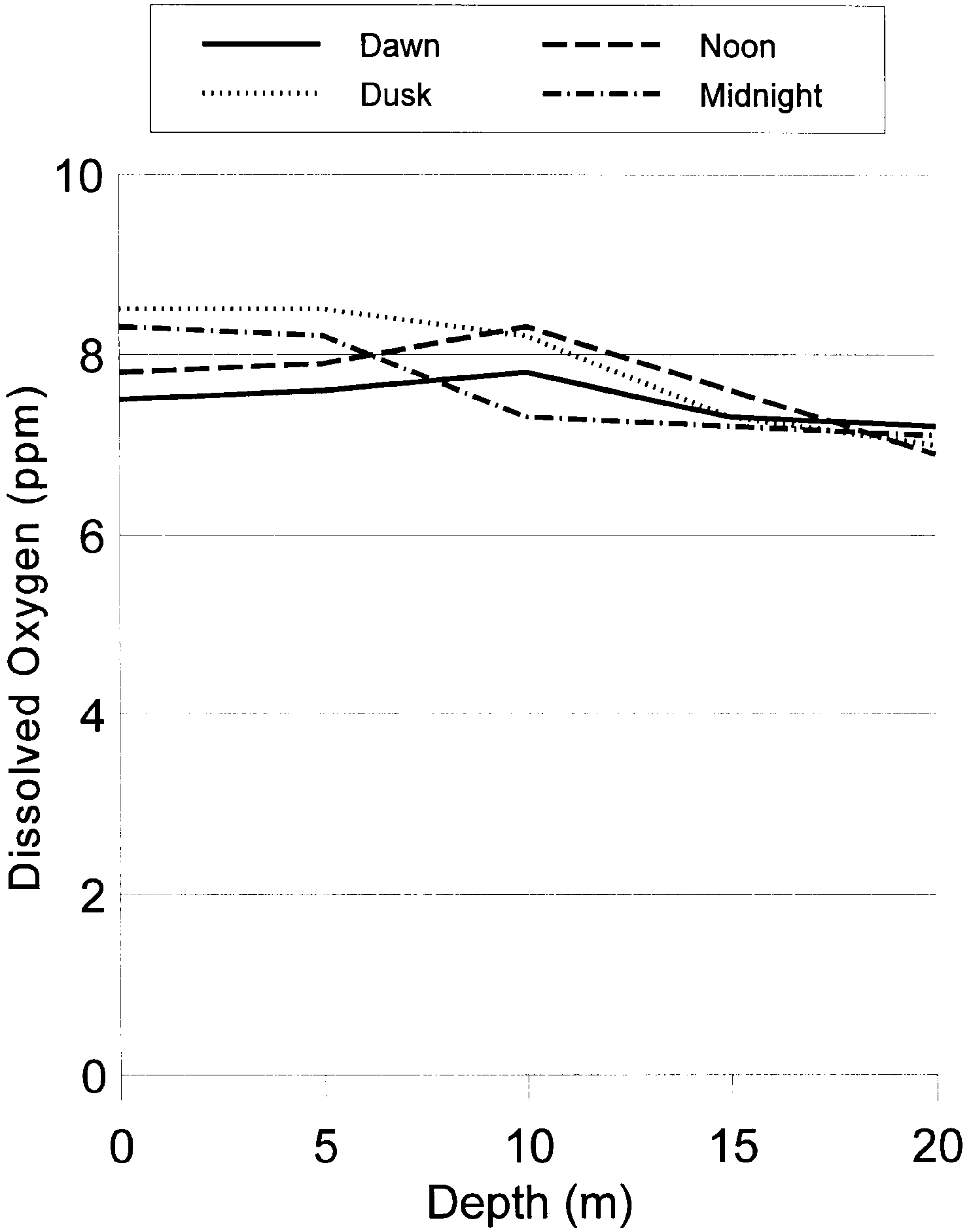
Appendix 1-21. Plot of current speed and direction with depth coincident with acoustic data at South Timbalier 54 from October 24-25, 1996.



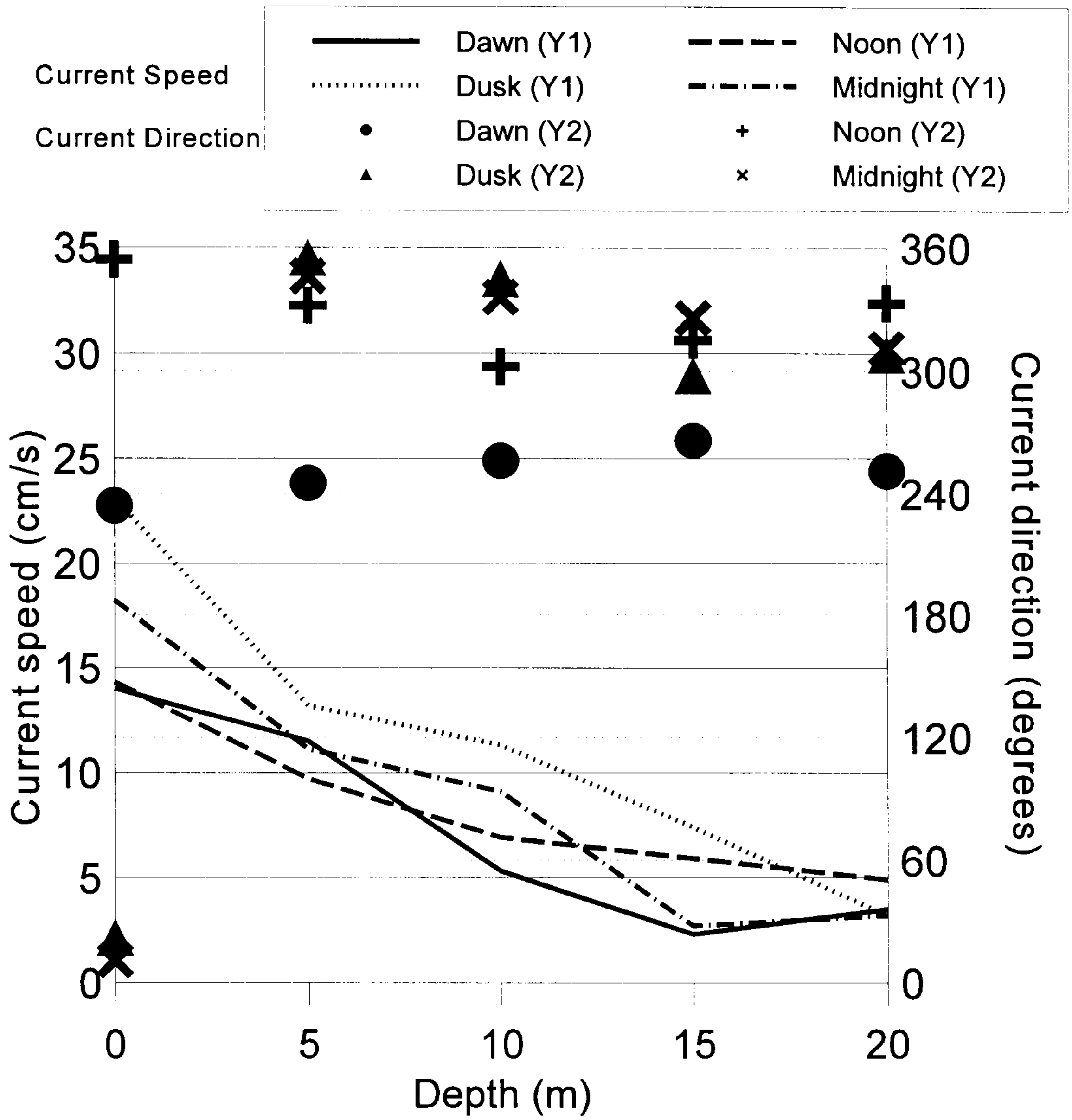
Appendix 1-22. Plot of temperature and water depth coincident with acoustic data at South Timbatlier 54, October 24-25 1996.



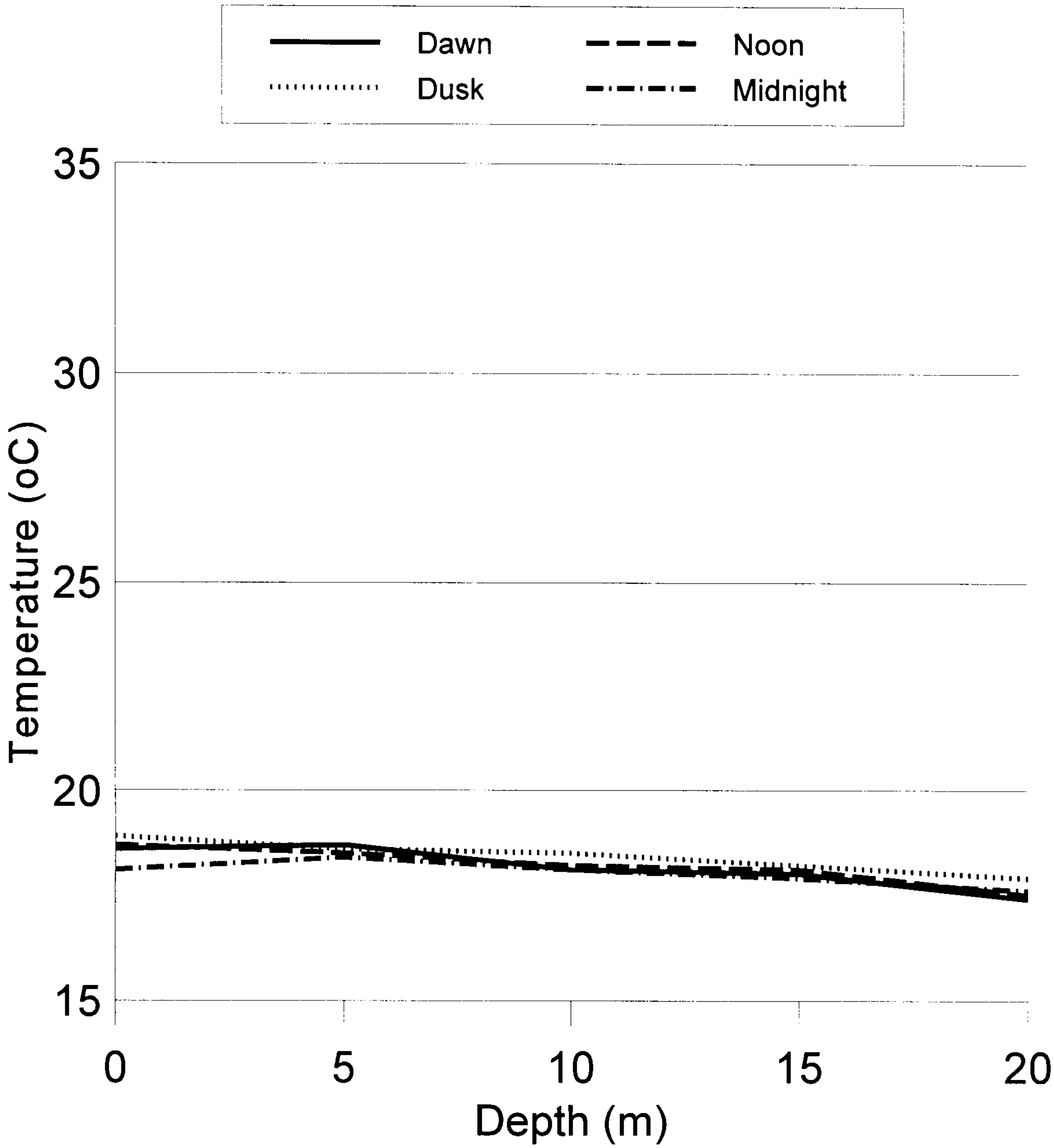
Appendix 1-23. Plot of salinity with depth coincident with the collection of acoustic data at South Timbalier 54 from October 24-25, 1996.



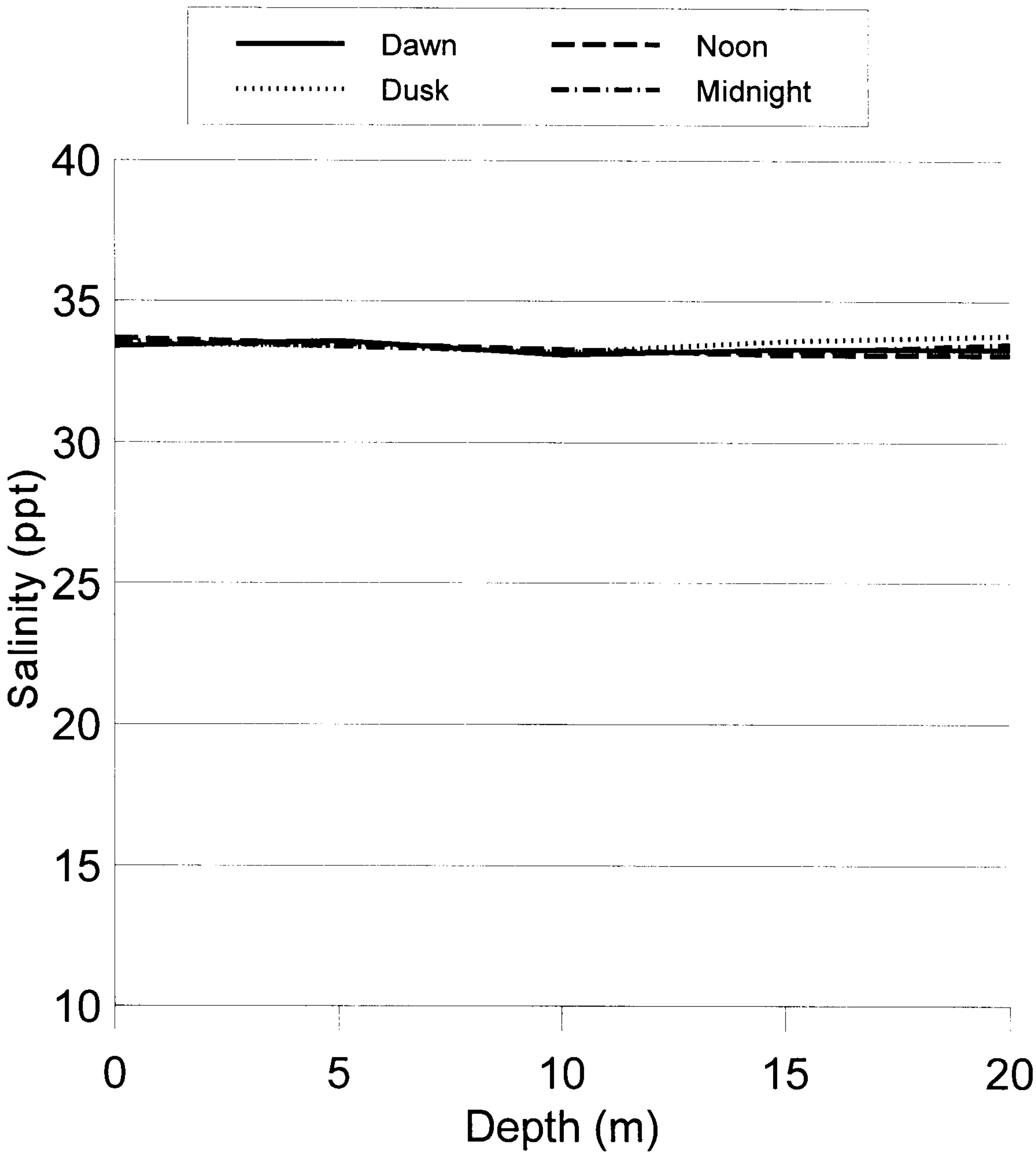
Appendix 1-24. Plot of depth with dissolved oxygen coincident with acoustic data at South Timbalier 54, October 24-25, 1996.



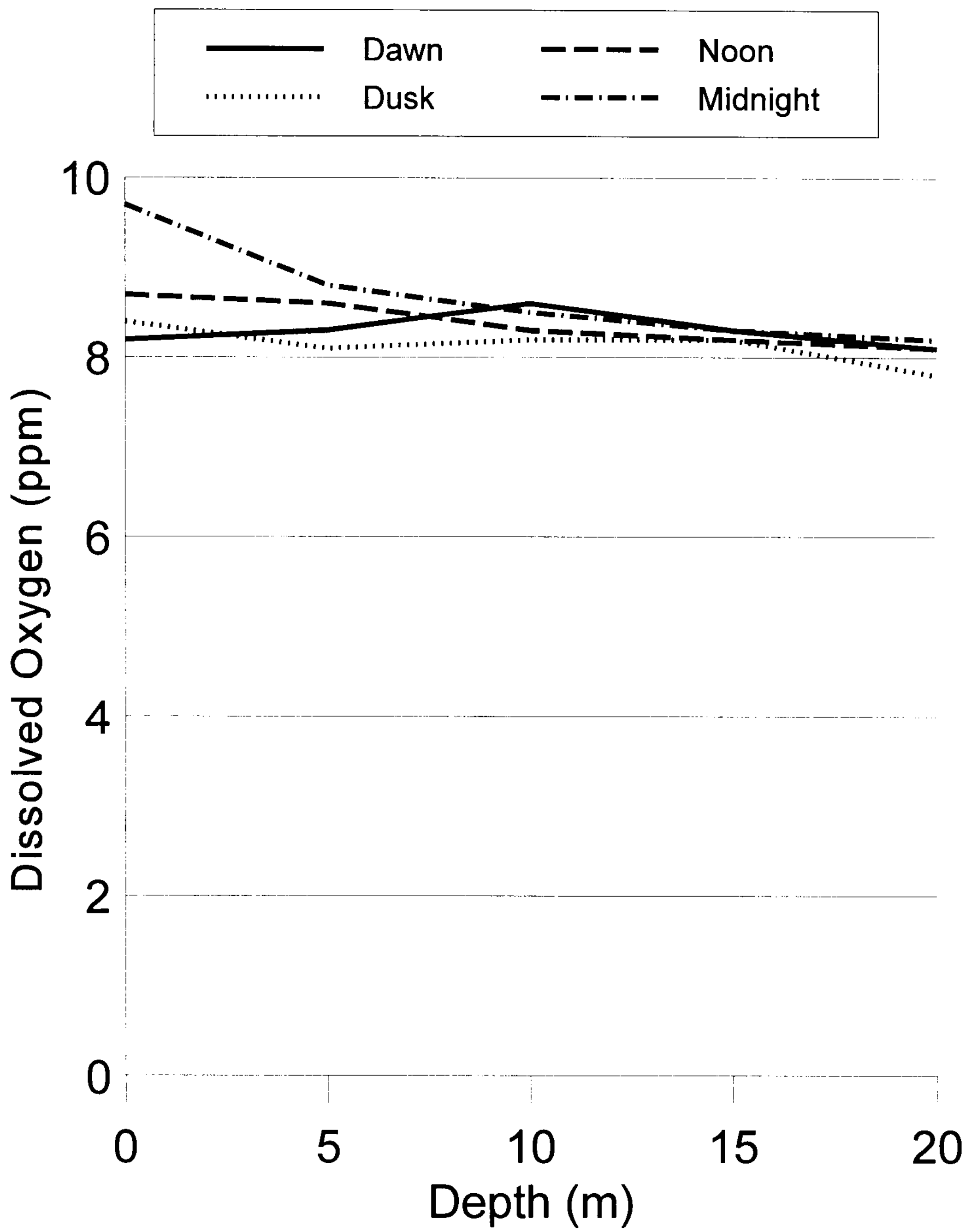
Appendix 1-25. Plot of current speed and direction with depth coincident with acoustic data at South Timbalier 54 from January 30 - February 1, 1997.



Appendix 1-26. Plot of temperature and water depth coincident with acoustic data at South Timbatlier 54, January 30 -February 1, 1997.



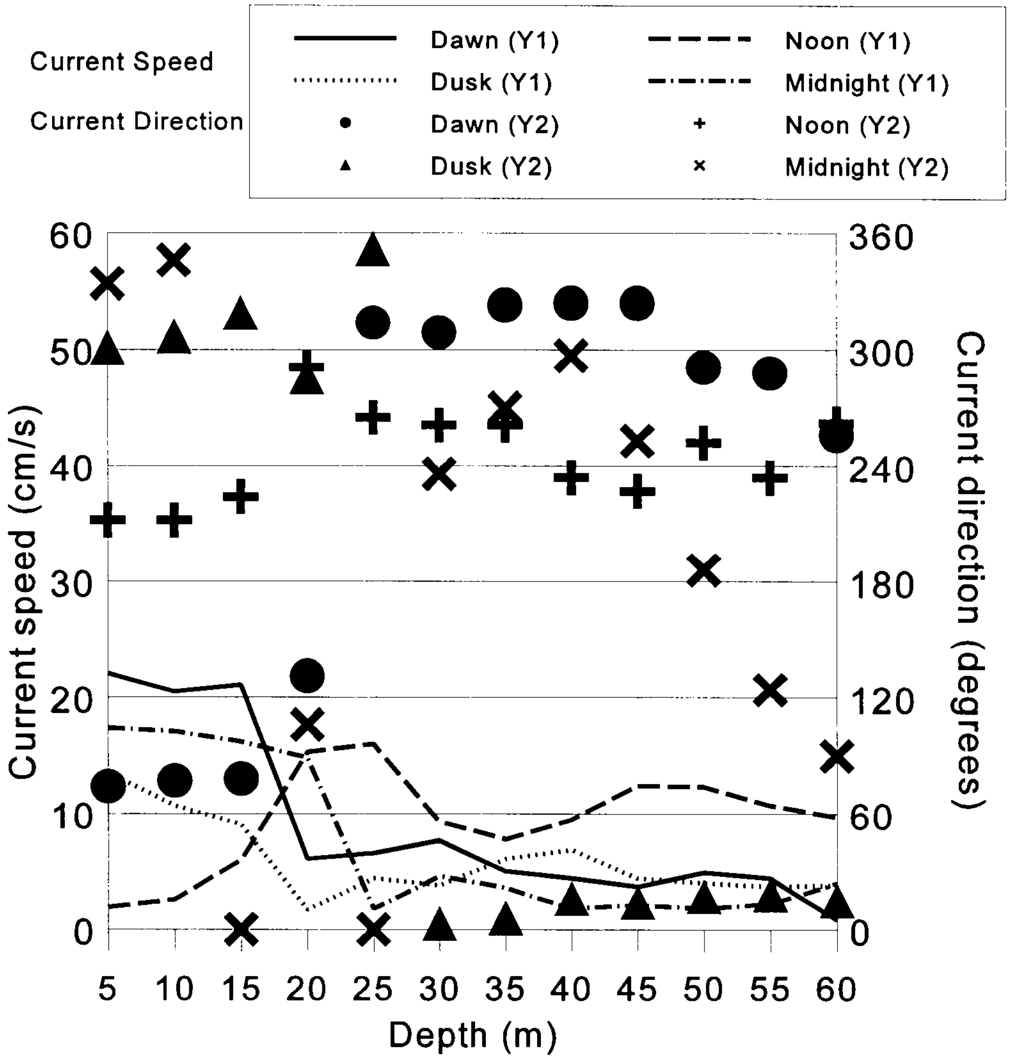
Appendix 1-27. Plot of salinity with depth coincident with the collection of acoustic data at South Timbalier 54 from January 30 - February 1, 1997.



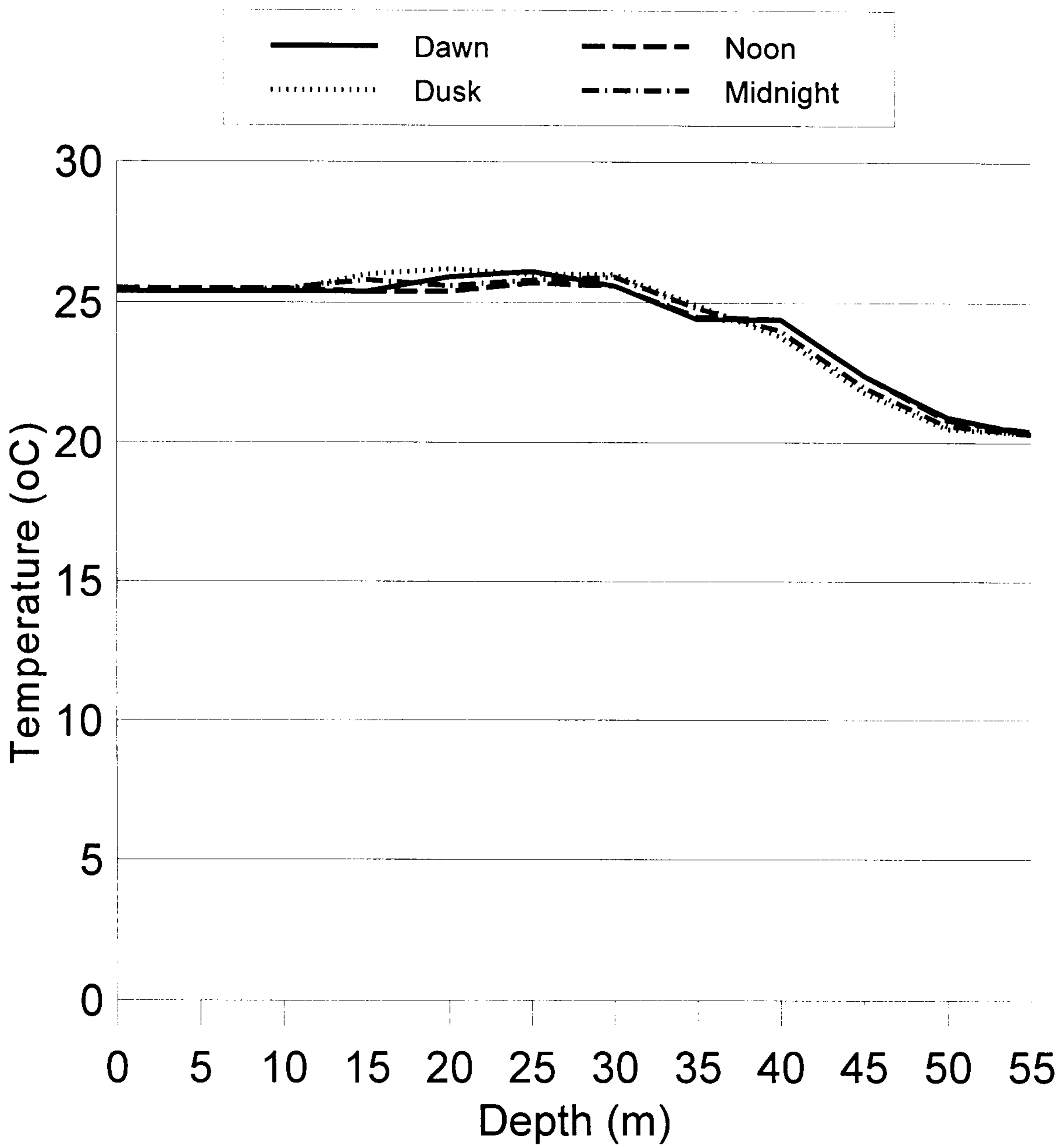
Appendix 1-28. Plot of depth with dissolved oxygen coincident with acoustic data at South Timbalier 54, January 30 -February 1, 1997.

APPENDIX 2

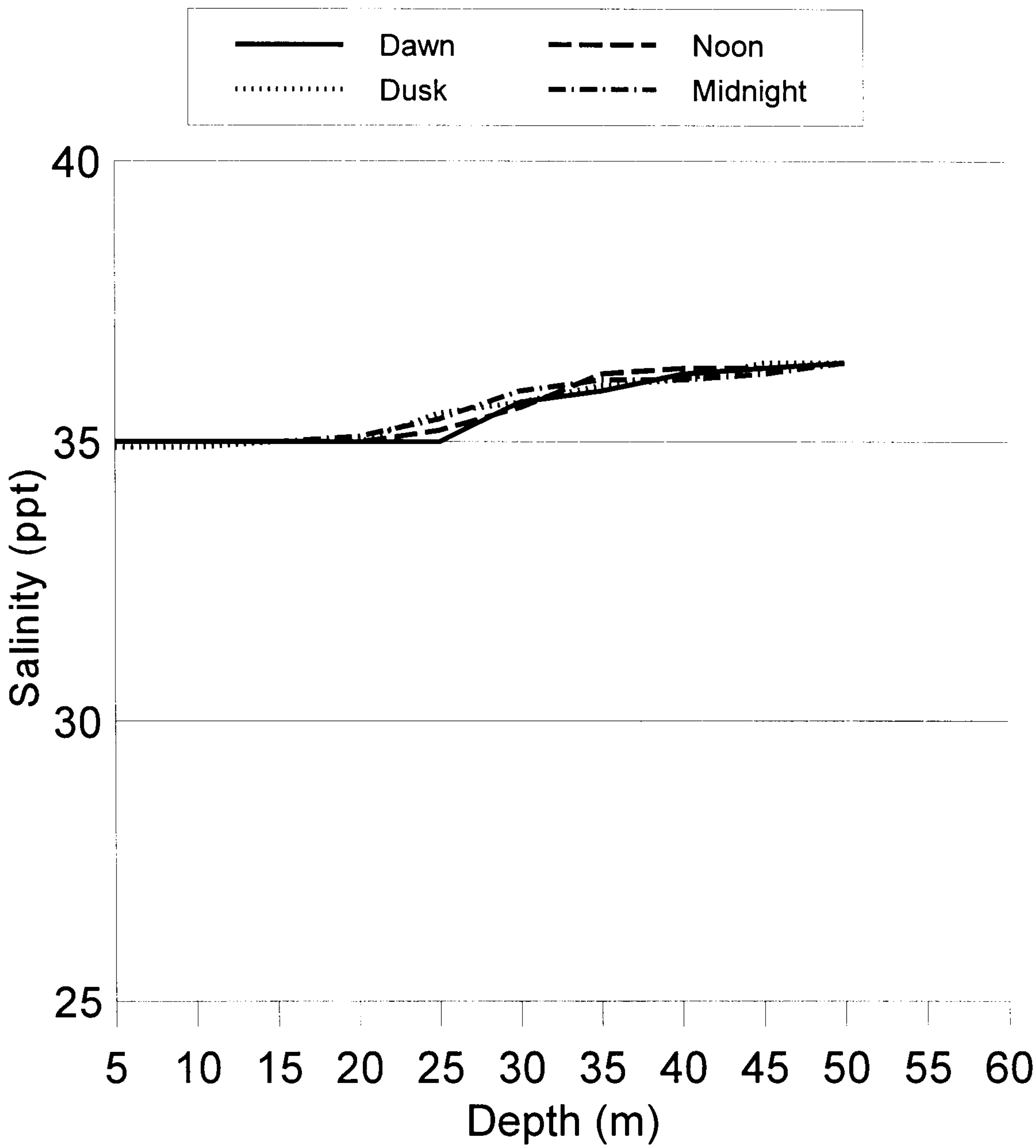
Current, Temperature, Salinity and Oxygen Data Coincident with Acoustic Data at Grand Isle 94



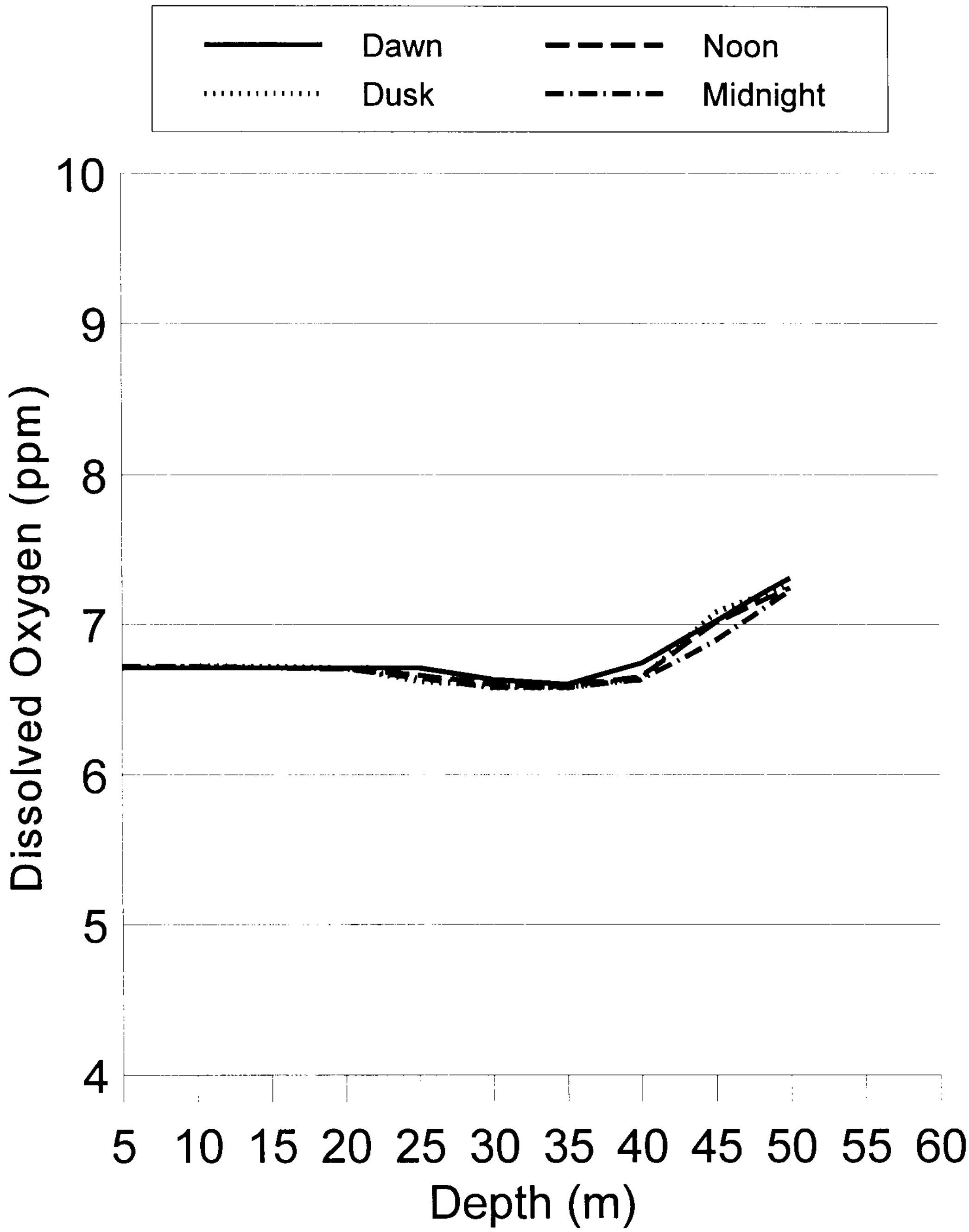
Appendix 2-1. Plot of current speed and direction with depth coincident with acoustic data at Grand Isle 94, October 12-13, 1994.



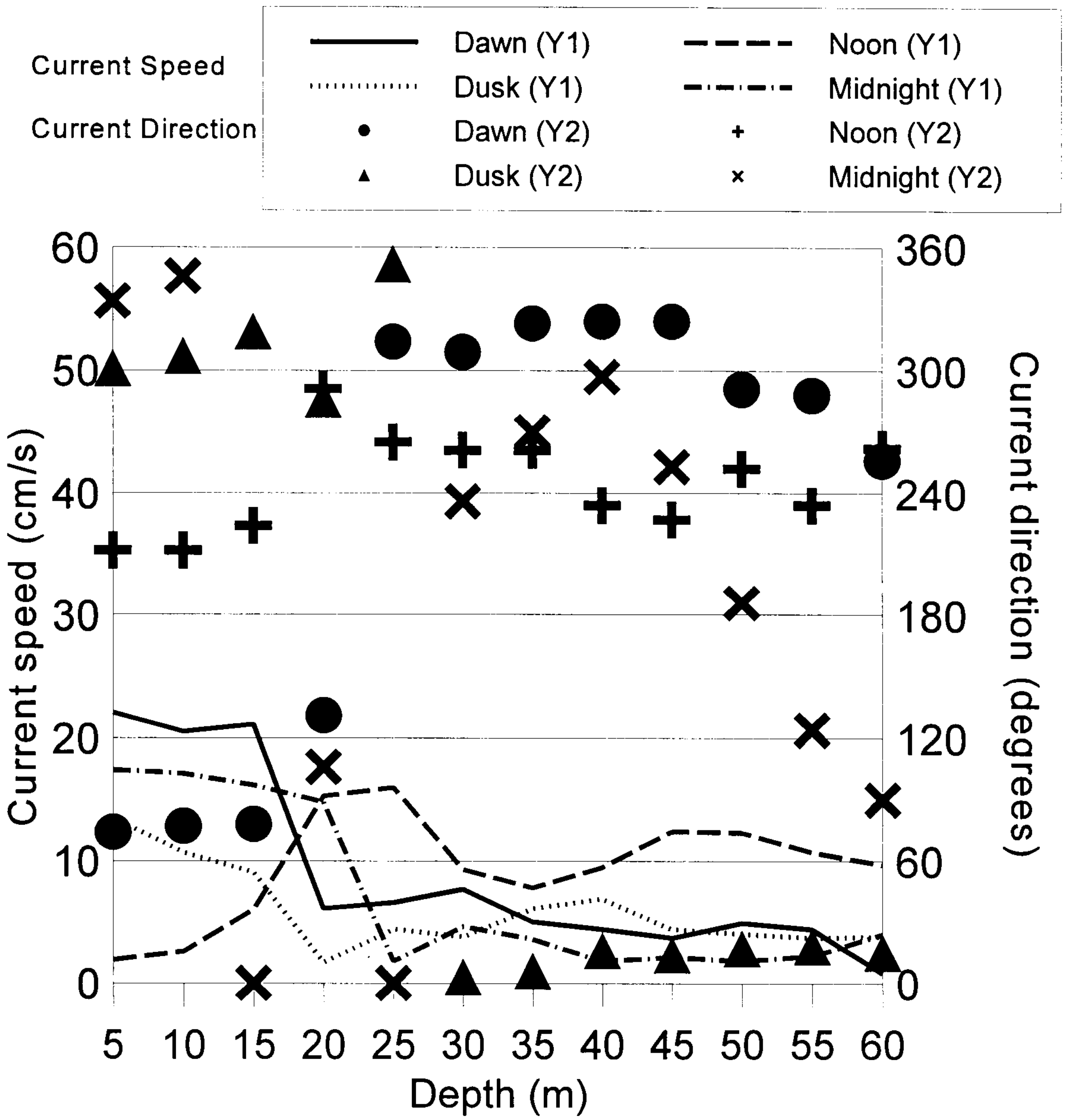
Appendix 2-2. Plot of temperature and water depth coincident with acoustic data at Grand Isle 94, October 12, 1994.



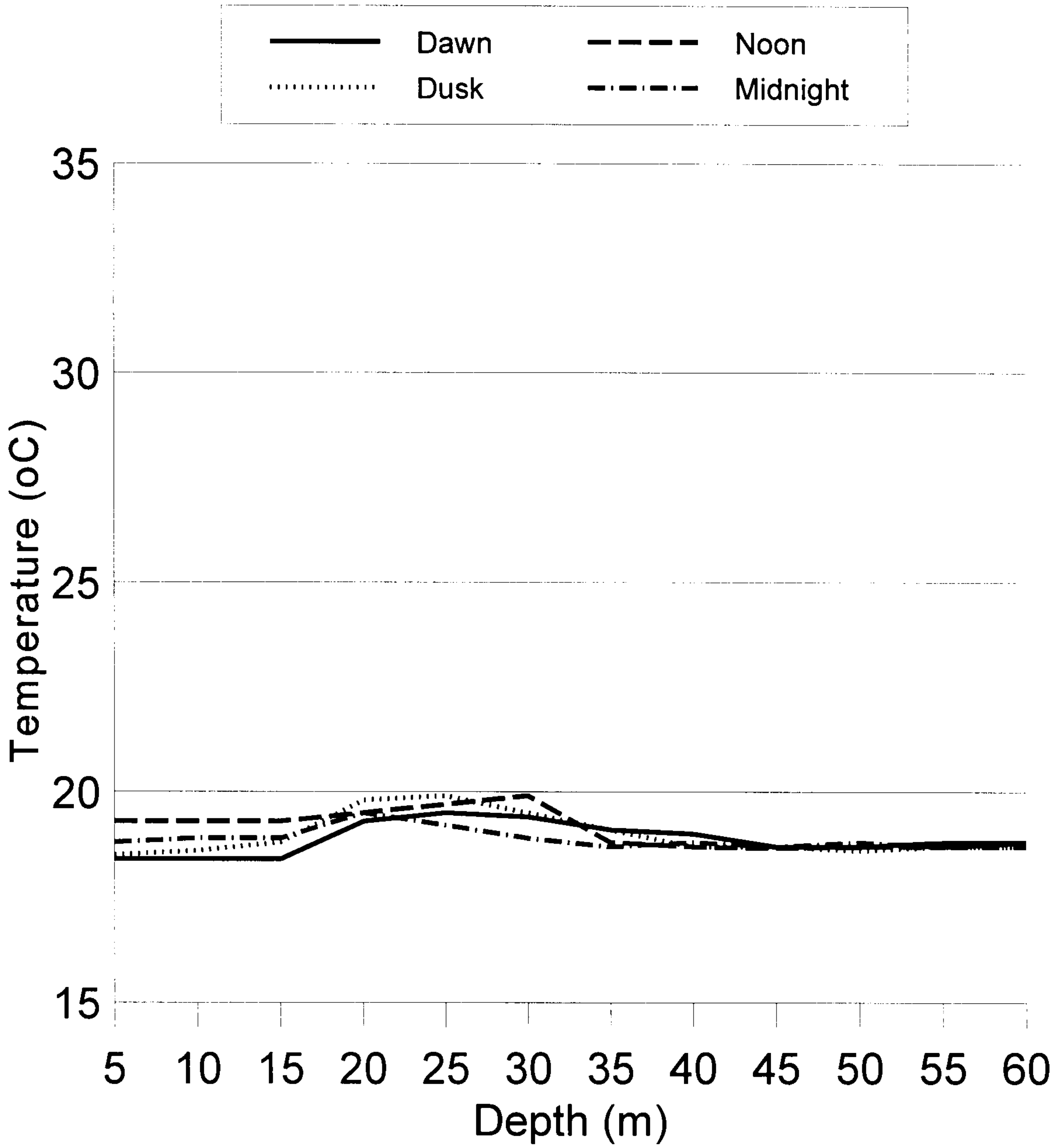
Appendix 2-3. Plot of salinity with depth coincident with the collection of acoustic data at Grand Isle 94, October 12, 1994



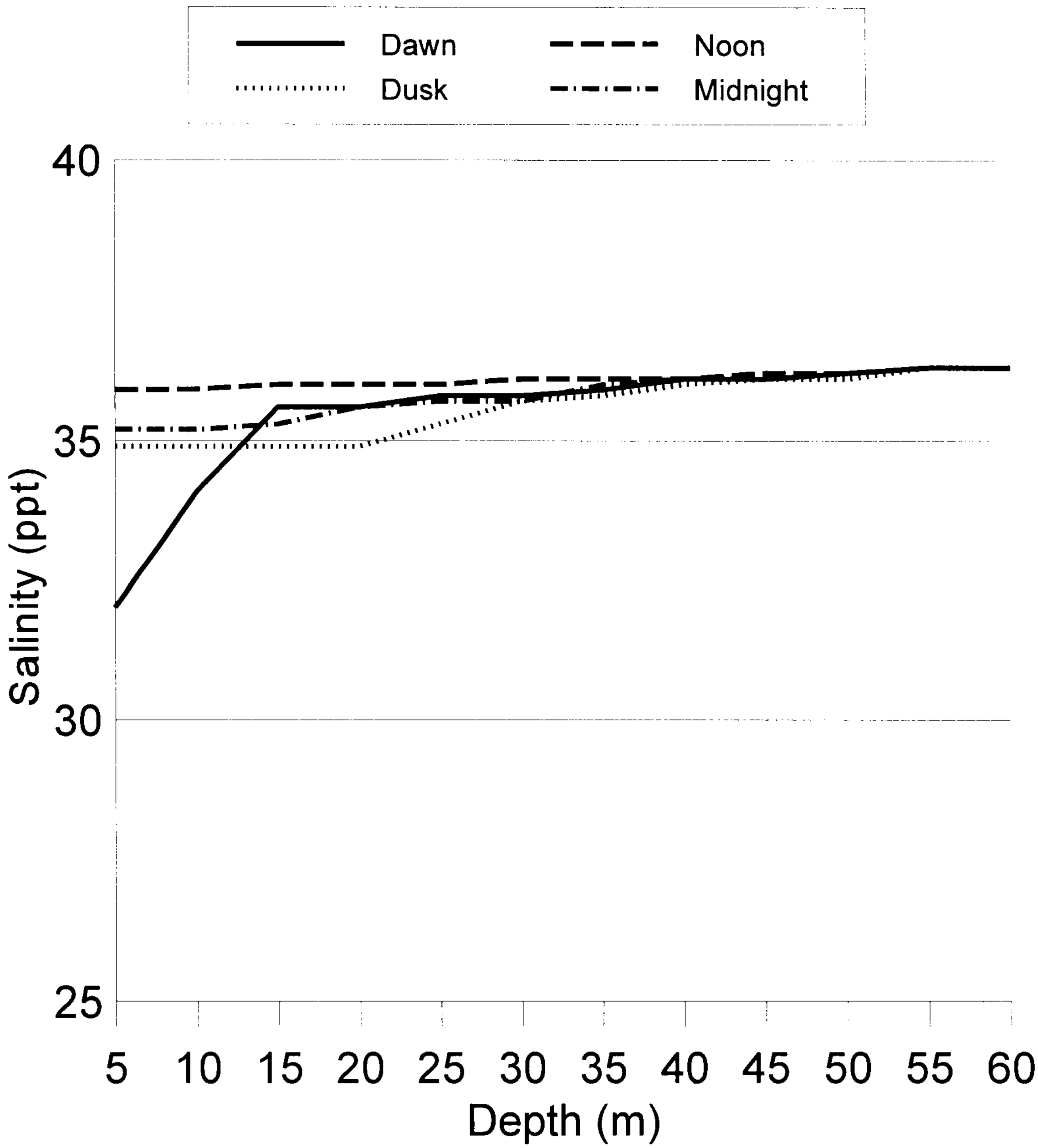
Appendix2-4. Plot of temperature and dissolved oxygen coincident with acoustic data at Grand Isle 94, October 12, 1994.



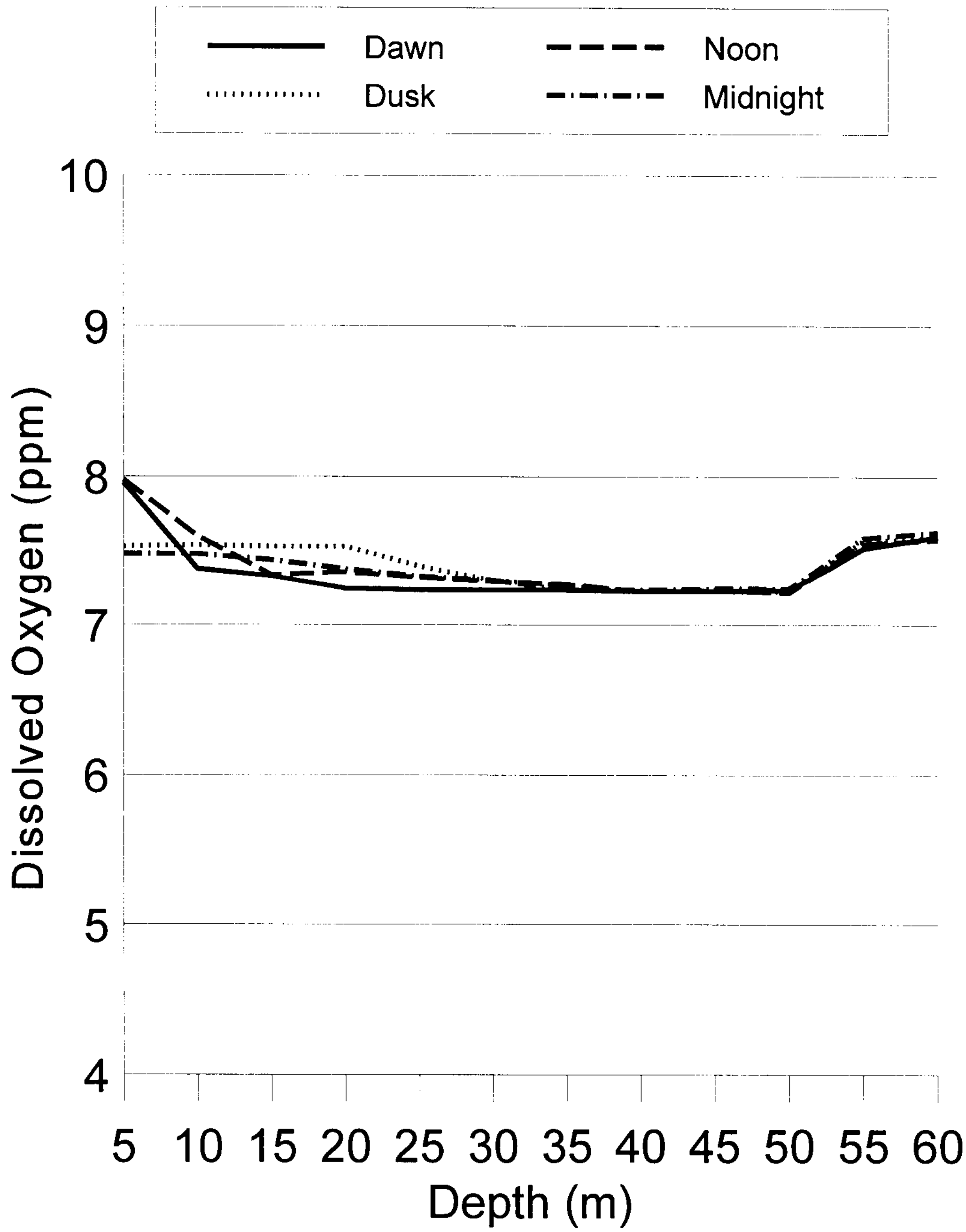
Appendix 2-5. Plot of current speed and direction with depth coincident with acoustic data at Grand Isle 94, January 30-31, 1995.



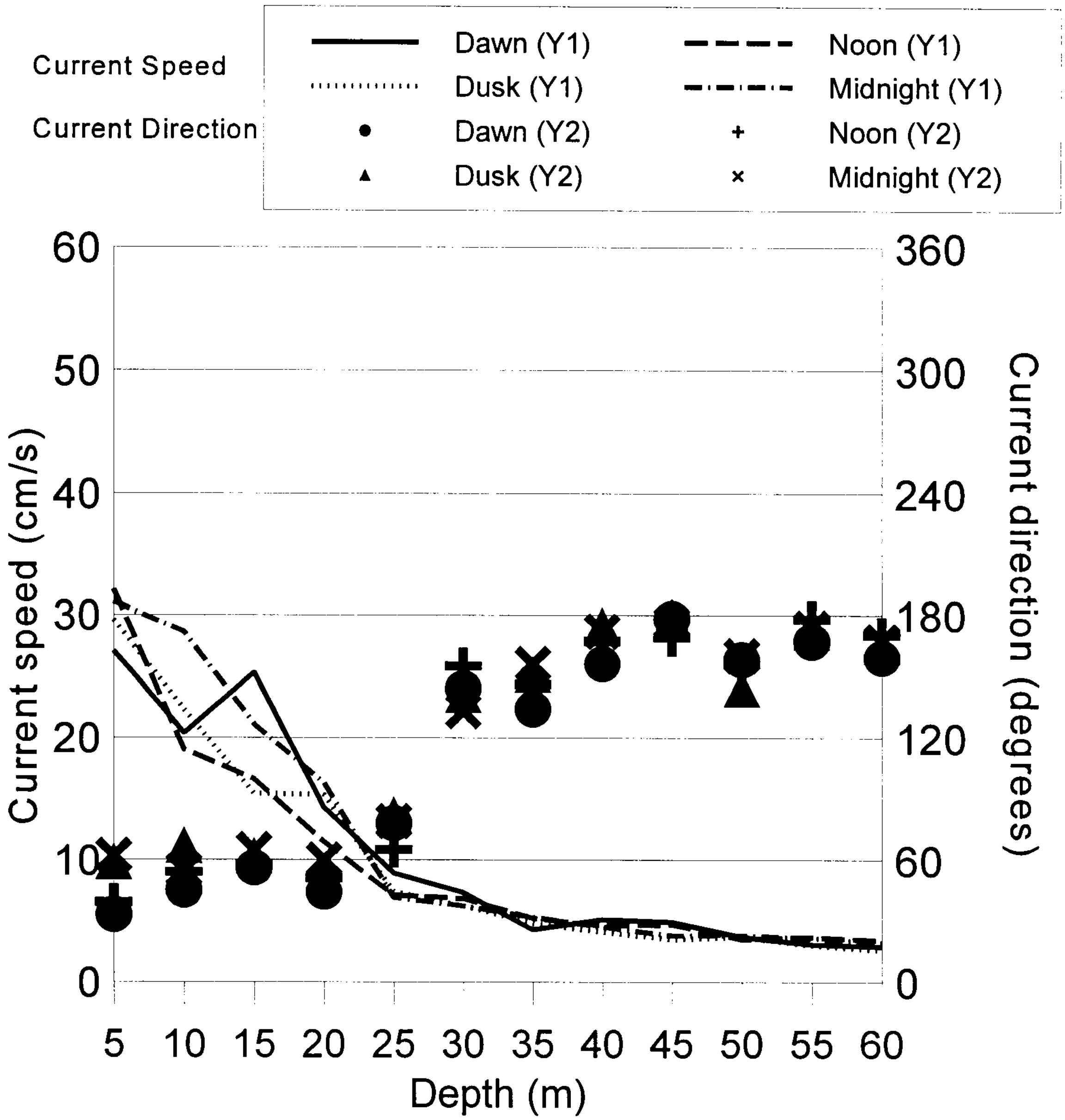
Appendix 2-6. Plot of temperature and water depth coincident with acoustic data at Grand Isle 94, January 30-31, 1995.



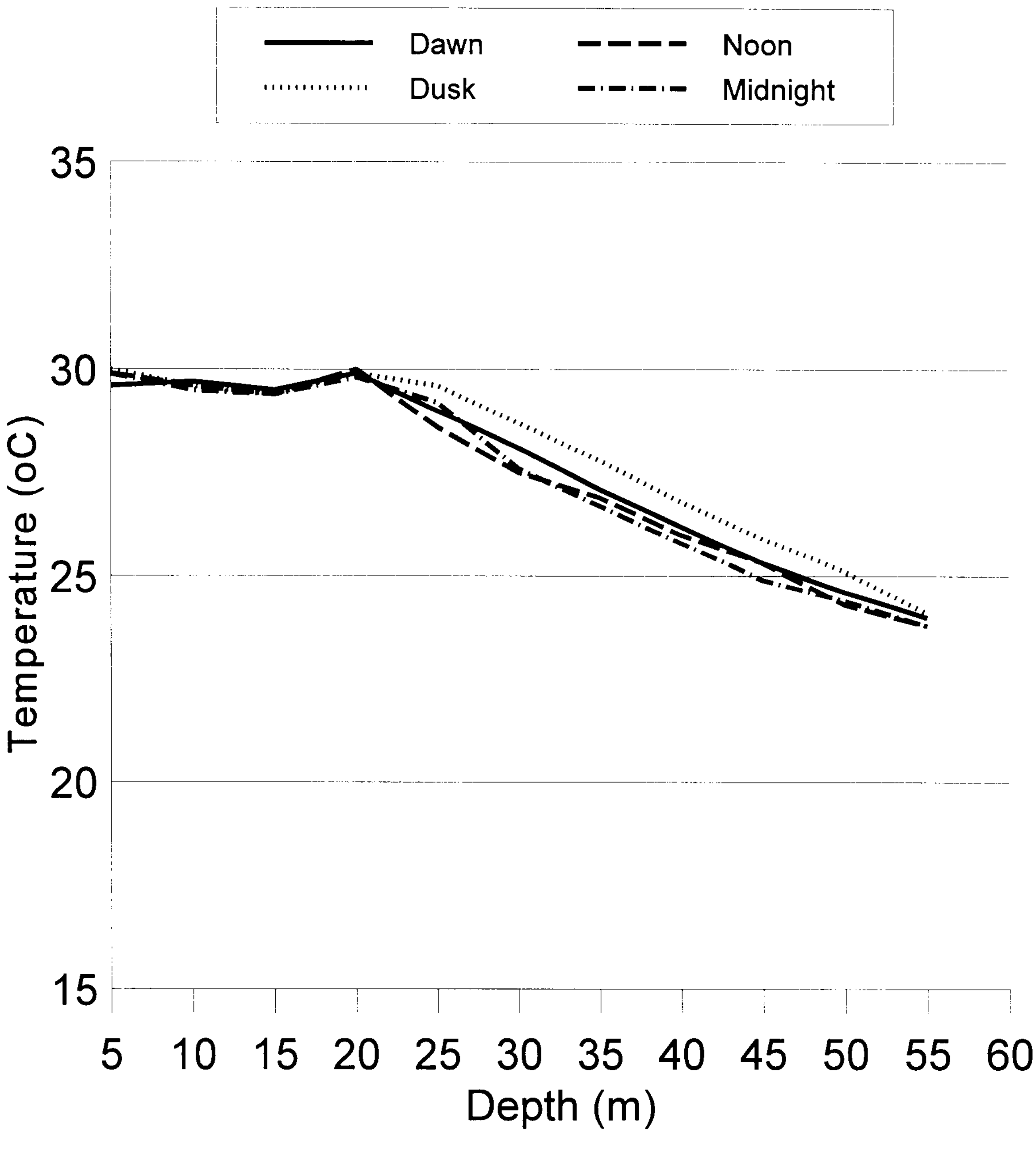
Appendix 2-7. Plot of salinity with depth coincident with the collection of acoustic data at Grand Isle 94, January 30-31, 1995.



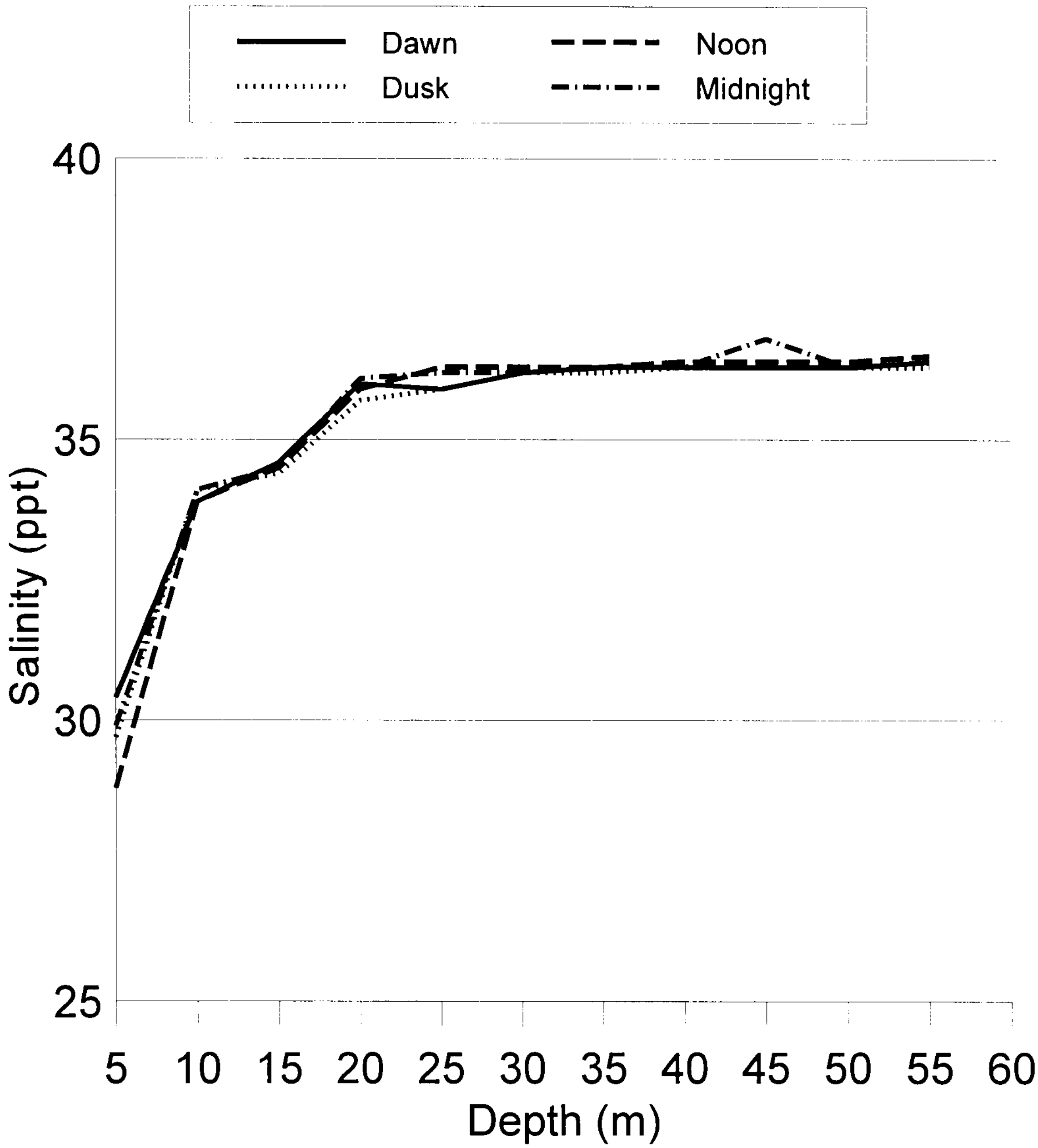
Appendix 2-8. Plot of temperature and dissolved oxygen coincident with acoustic data at Grand Isle 94, January 30-31, 1995.



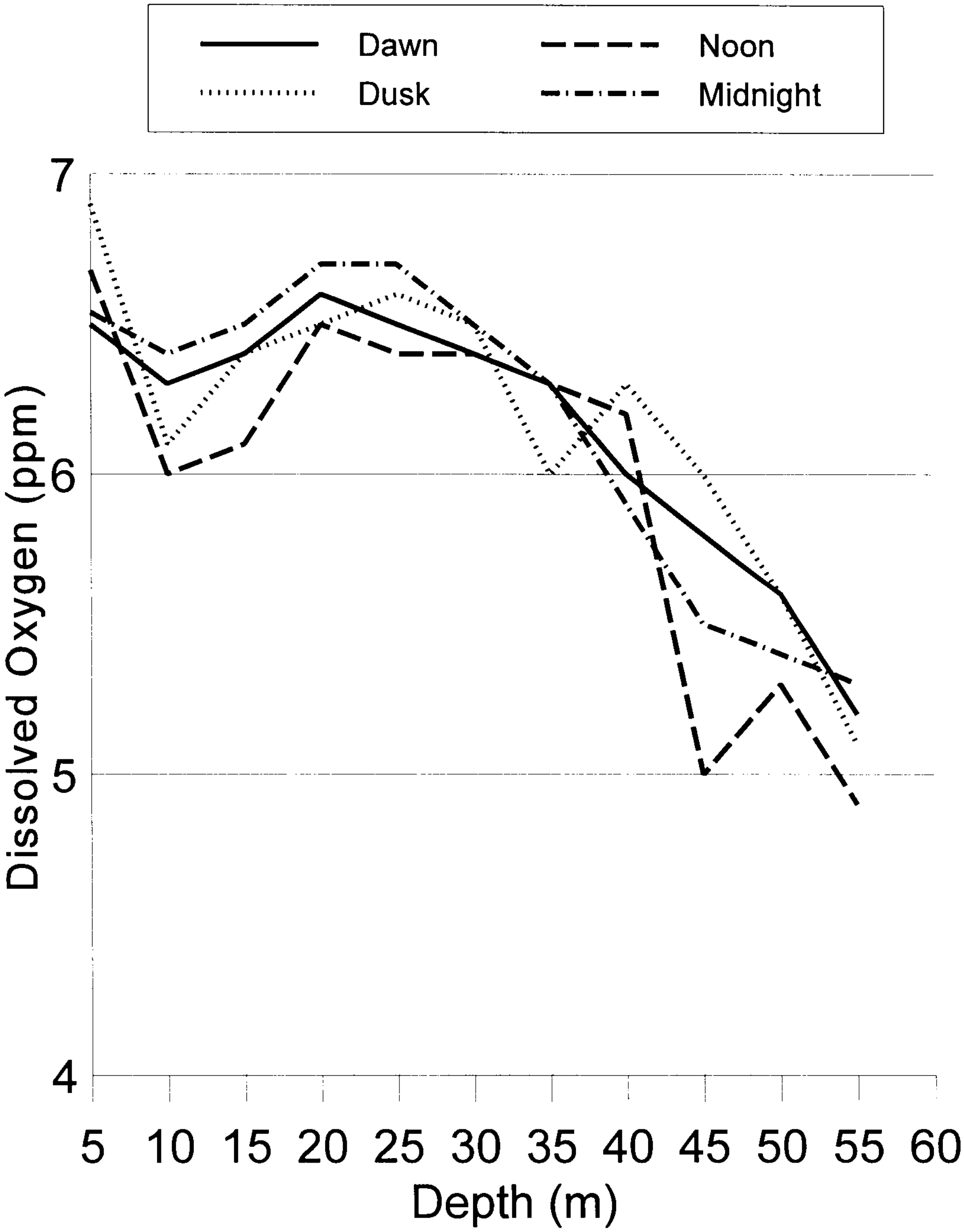
Appendix 2-9. Plot of current speed and direction with depth coincident with acoustic data at Grand Isle 94, September 11-13, 1995.



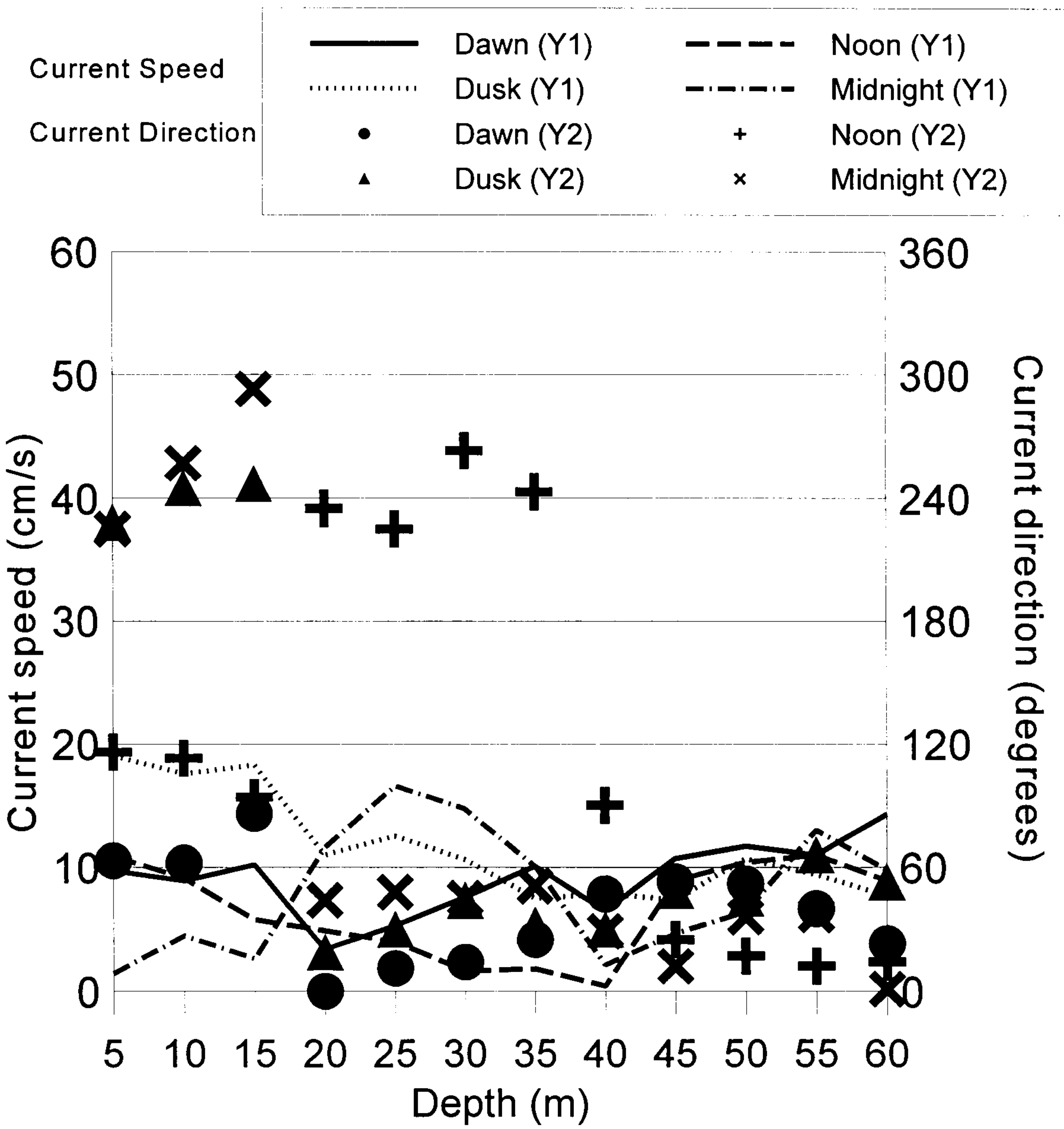
Appendix 2-10. Plot of temperature and water depth coincident with acoustic data at Grand Isle 94, September 11-13, 1995.



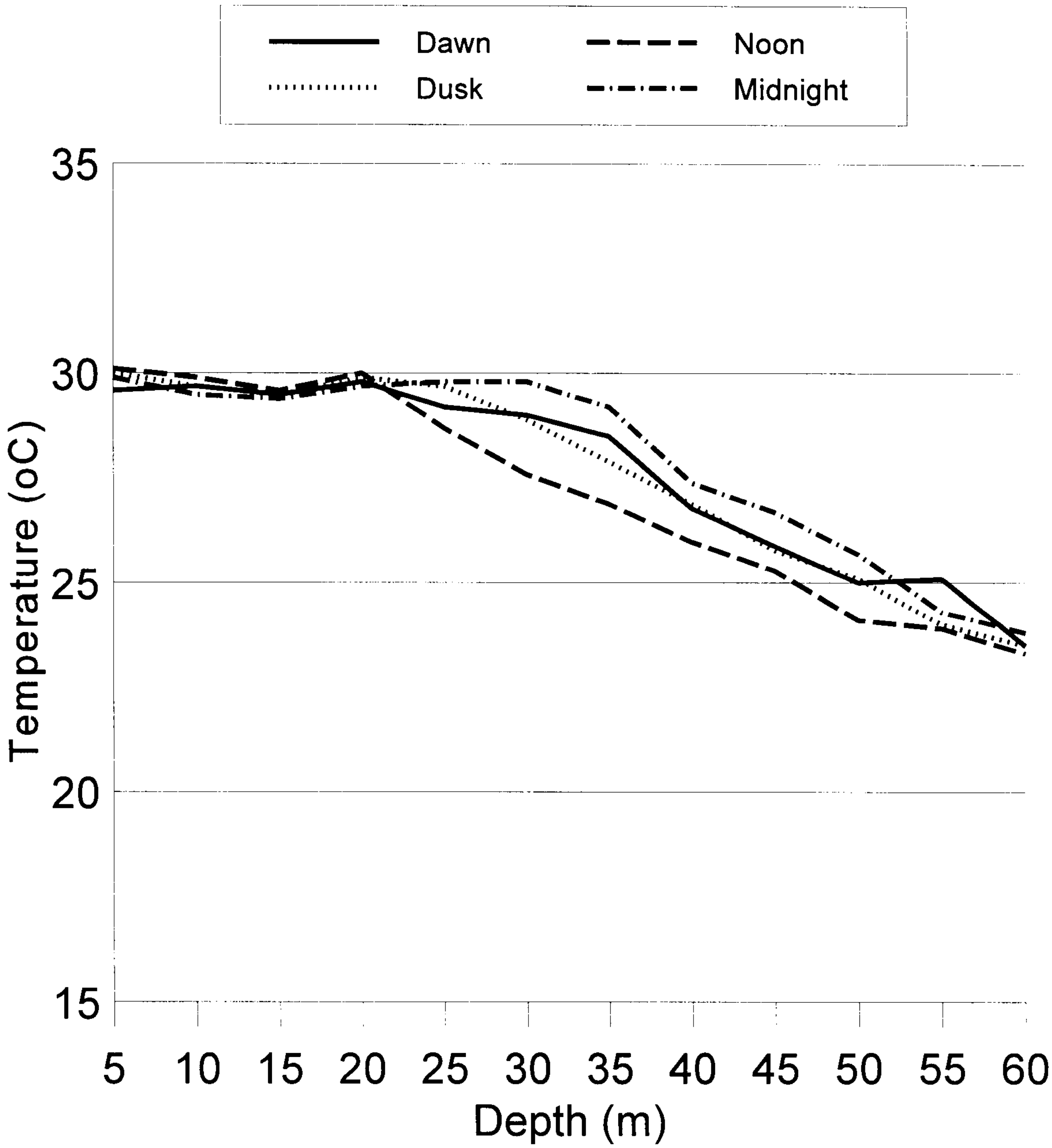
Appendix 2-11. Plot of salinity with depth coincident with the collection of acoustic data at Grand Isle 94, September 11-13, 1995.



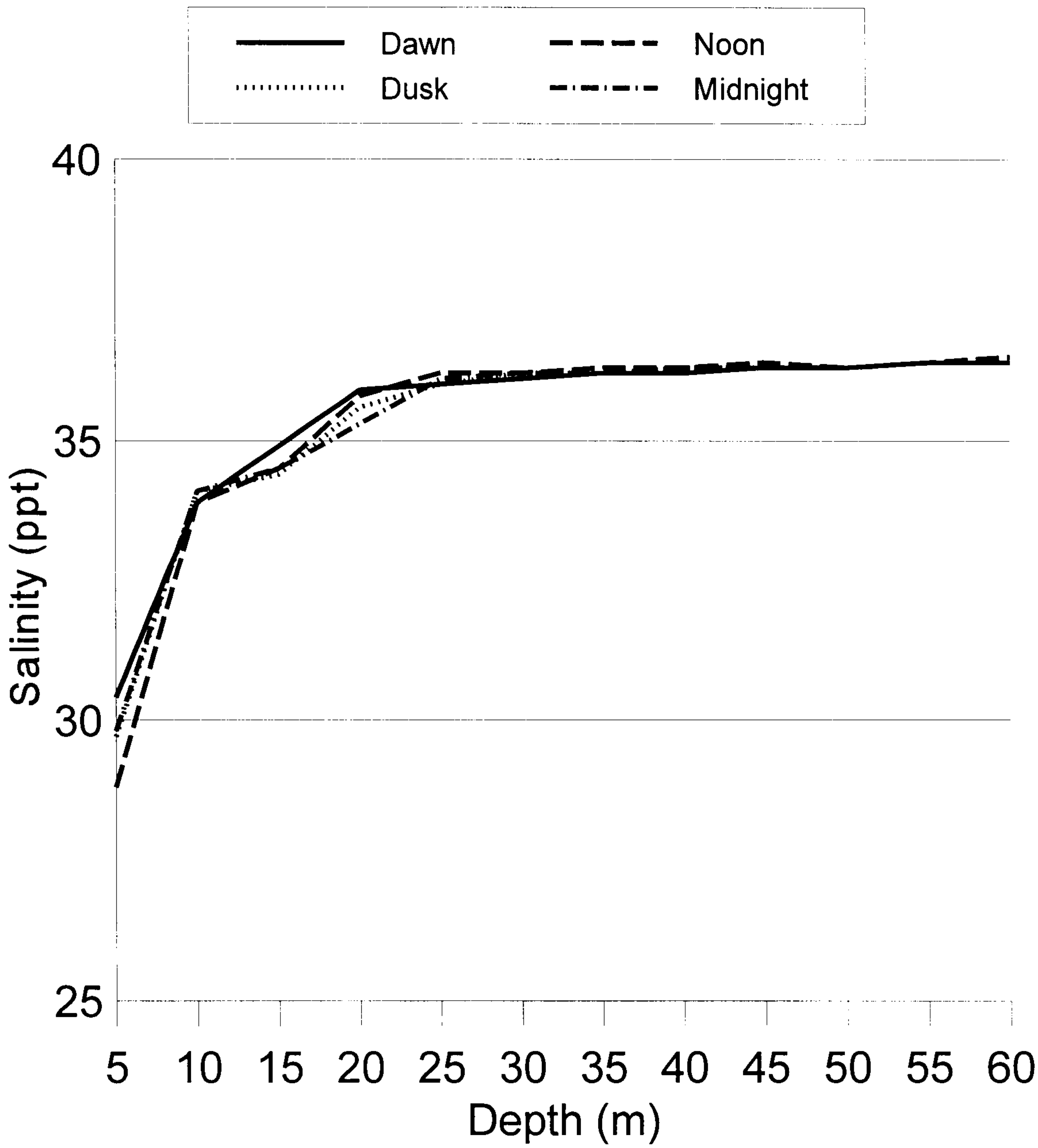
Appendix 2-12. Plot of temperature and dissolved oxygen coincident with acoustic data at Grand Isle 94, September 11-13, 1995.



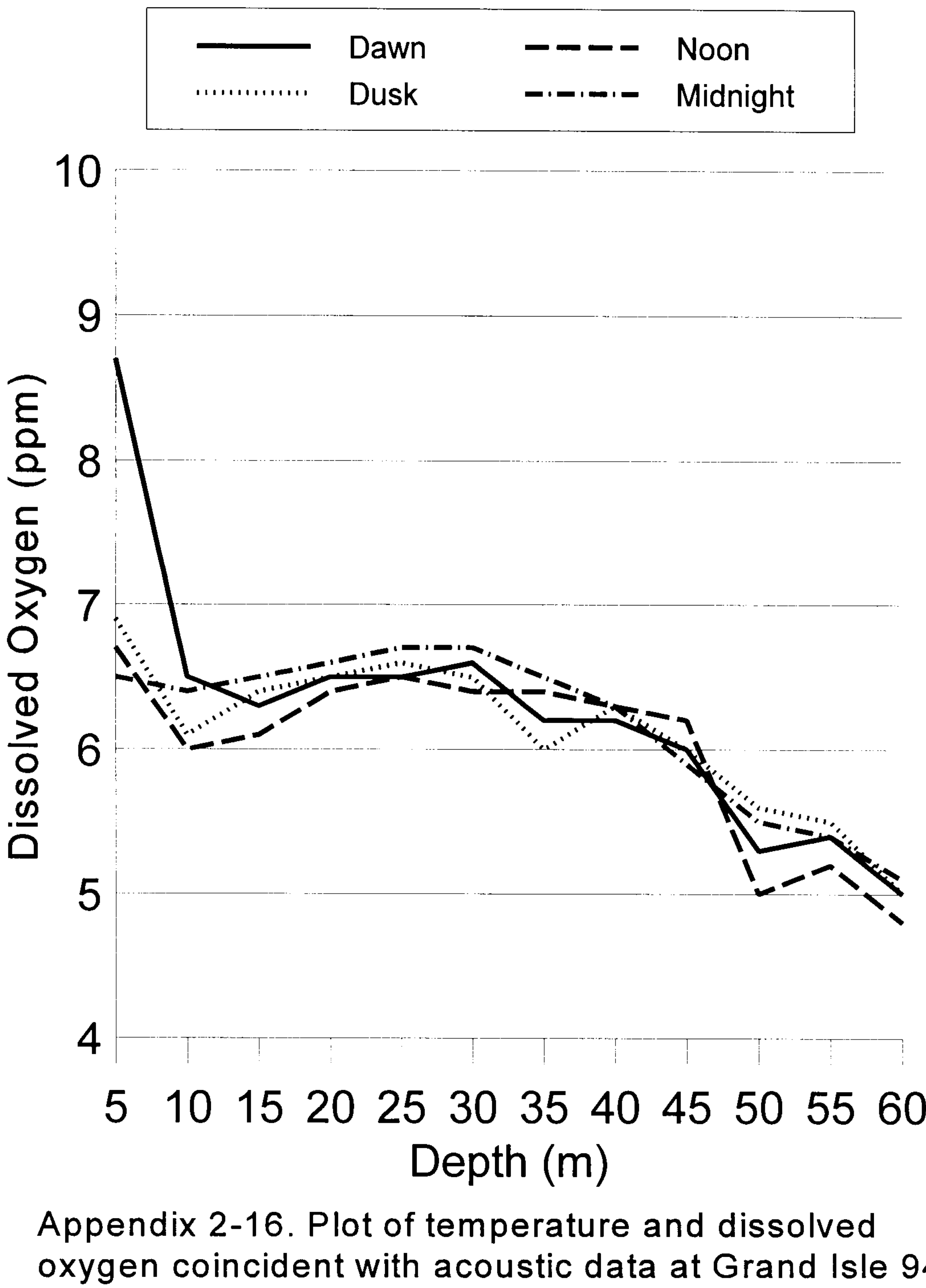
Appendix 2-13. Plot of current speed and direction with depth coincident with acoustic data at Grand Isle 94, November 14-16, 1995.



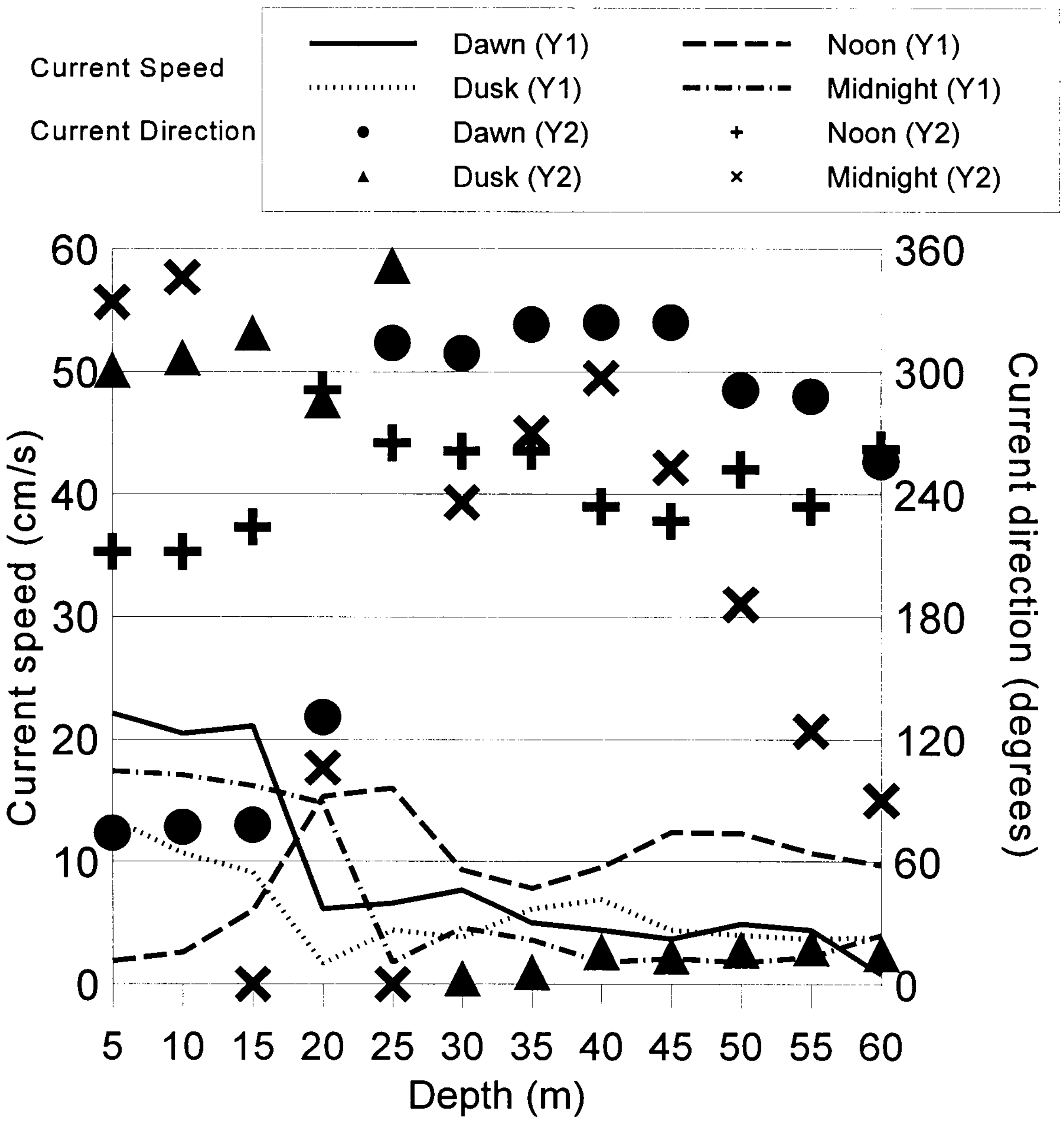
Appendix 2-14. Plot of temperature and water depth coincident with acoustic data at Grand Isle 94, November 14-16, 1995.



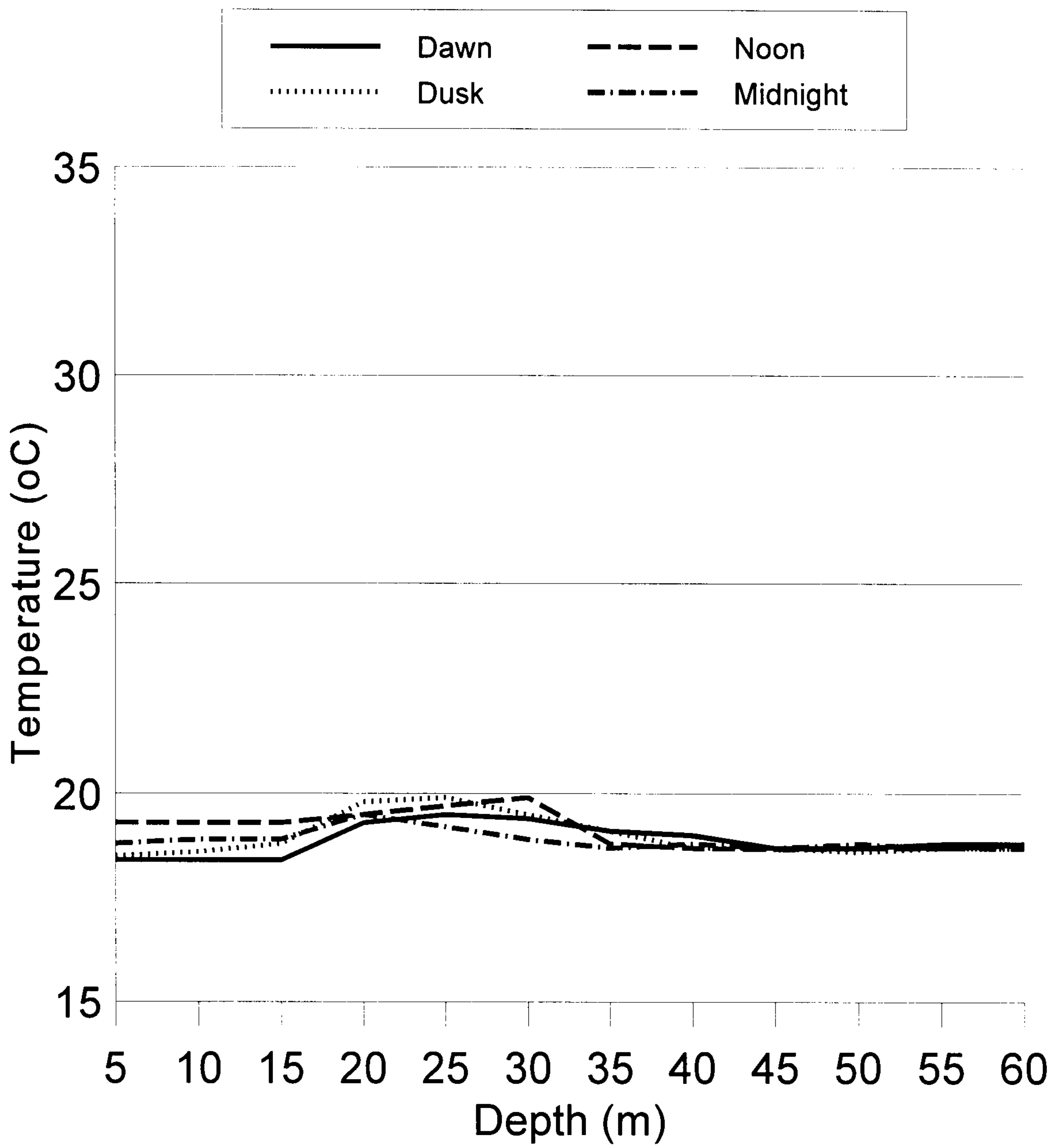
Appendix 2-15. Plot of salinity with depth coincident with the collection of acoustic data at Grand Isle 94, November 14-16, 1995.



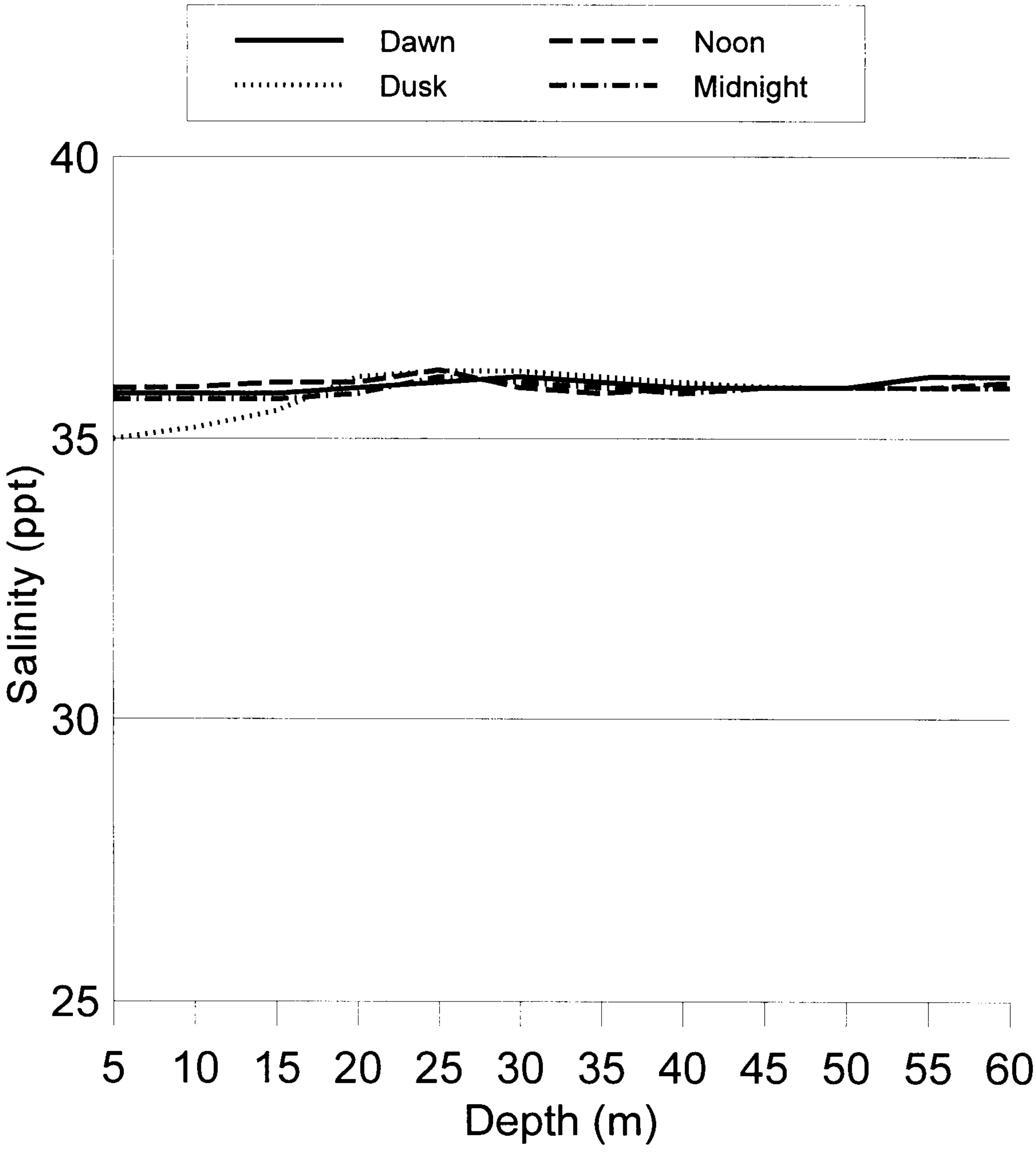
Appendix 2-16. Plot of temperature and dissolved oxygen coincident with acoustic data at Grand Isle 94, November 14-16, 1995.



Appendix 2-17. Plot of current speed and direction with depth coincident with acoustic data at Grand Isle 94, January 30-31,1996.

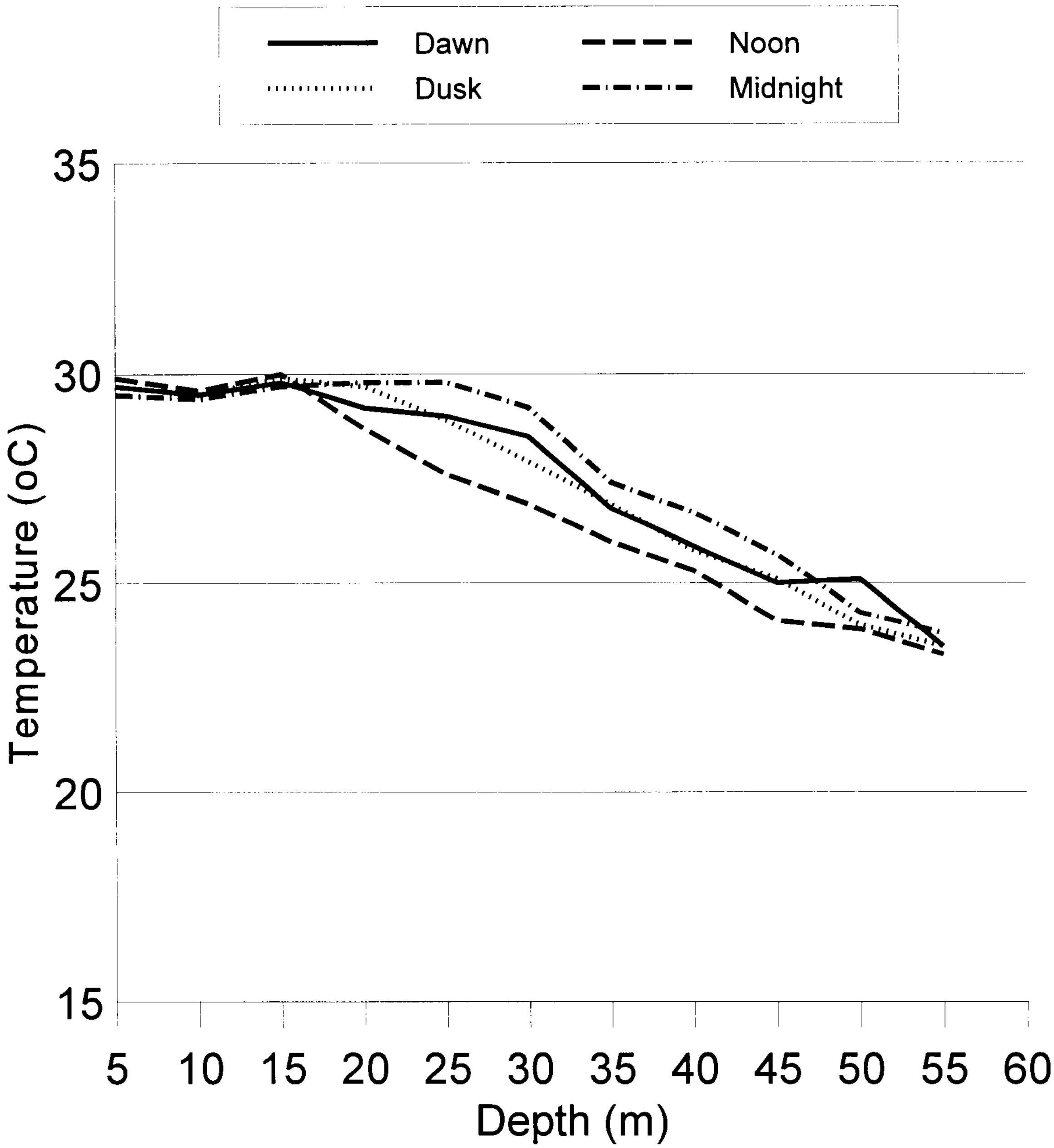


Appendix 2-18. Plot of temperature and water depth coincident with acoustic data at Grand Isle 94, February 13-14, 1996.

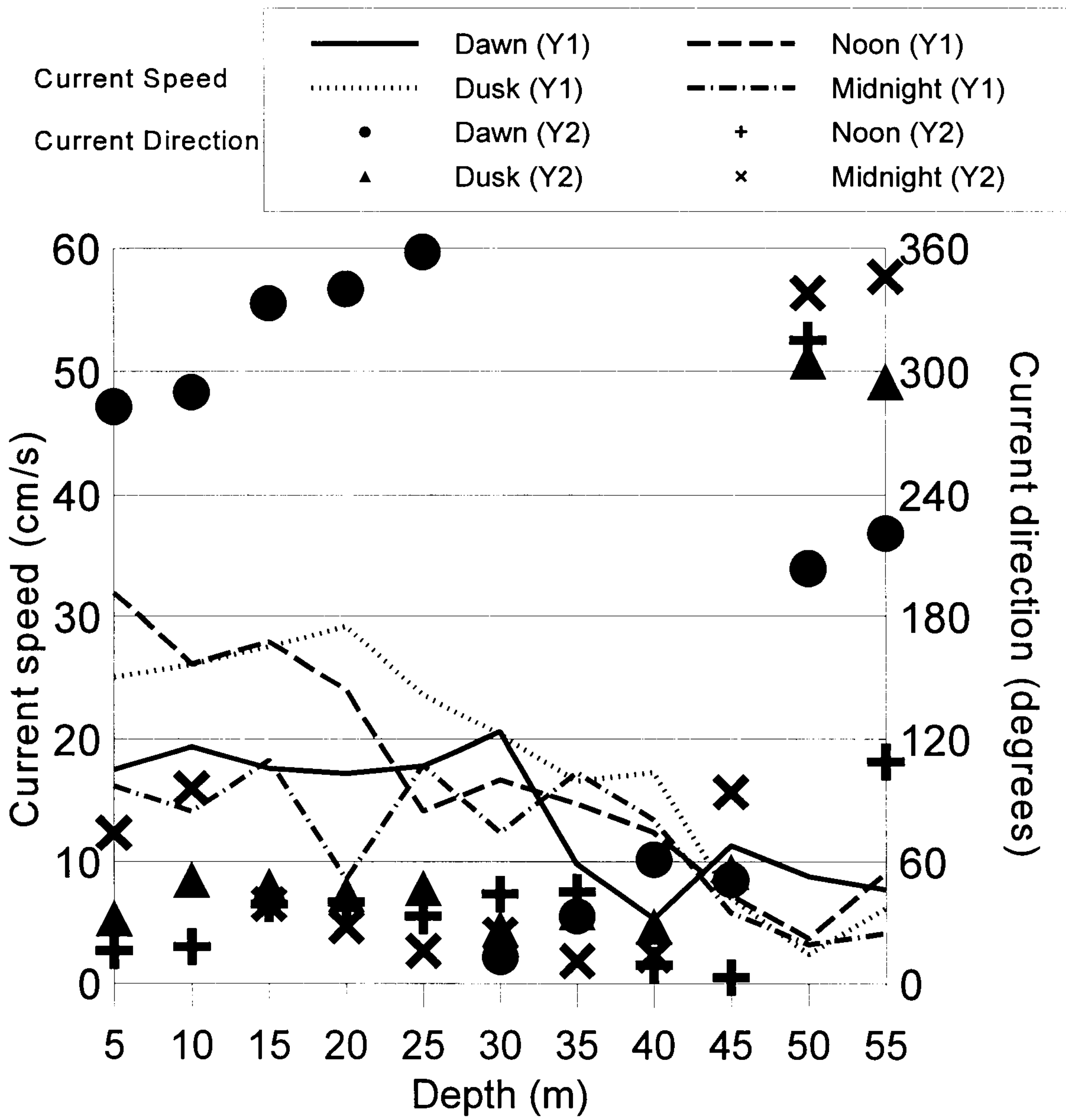


Appendix 2-19. Plot of salinity with depth coincident with the collection of acoustic data at Grand Isle 94, February 13-14, 1996.

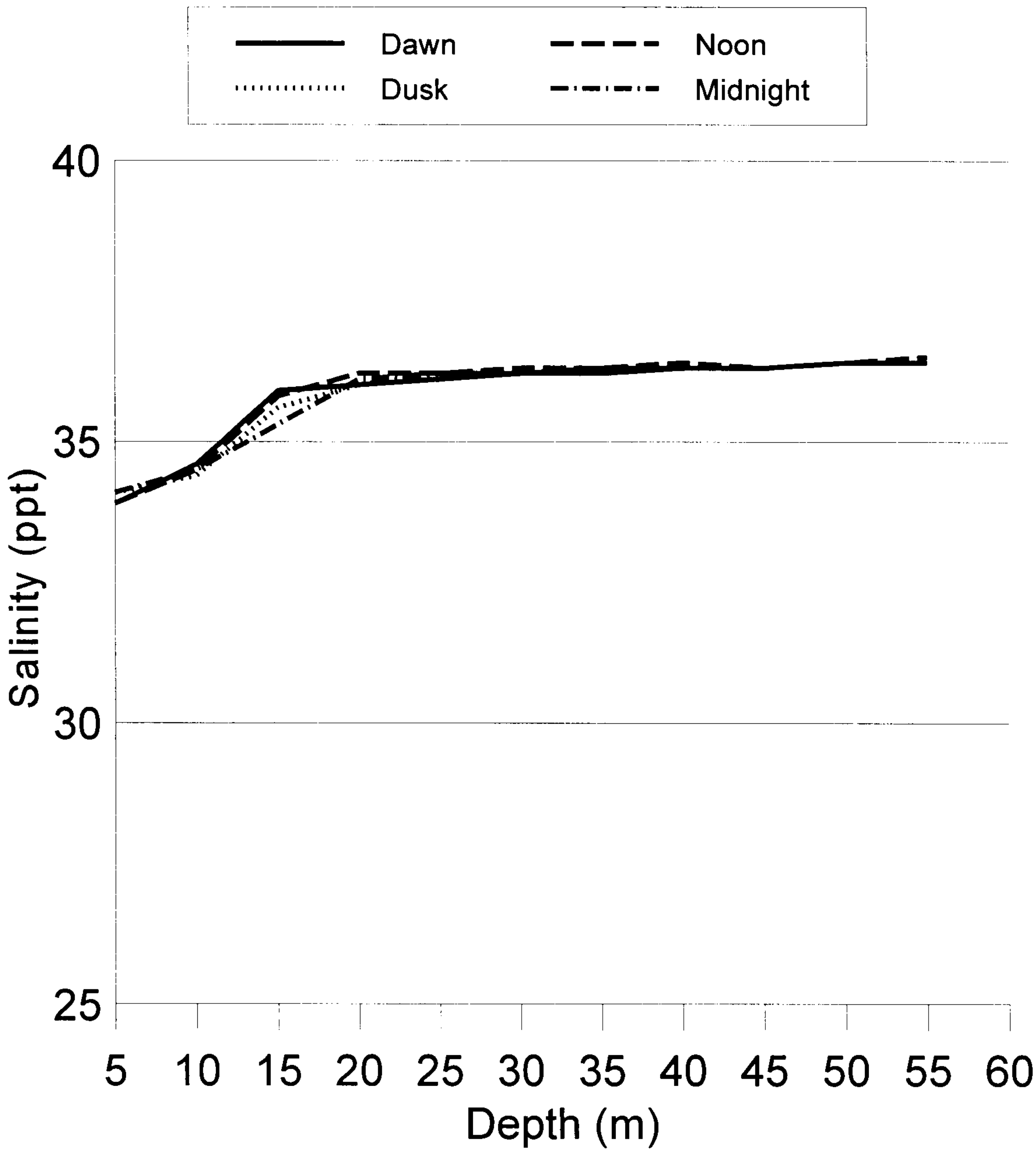
Appendix 2-24. Plot of temperature and dissolved oxygen coincident with acoustic data at Grand Isle 94, April 23-25, 1996.



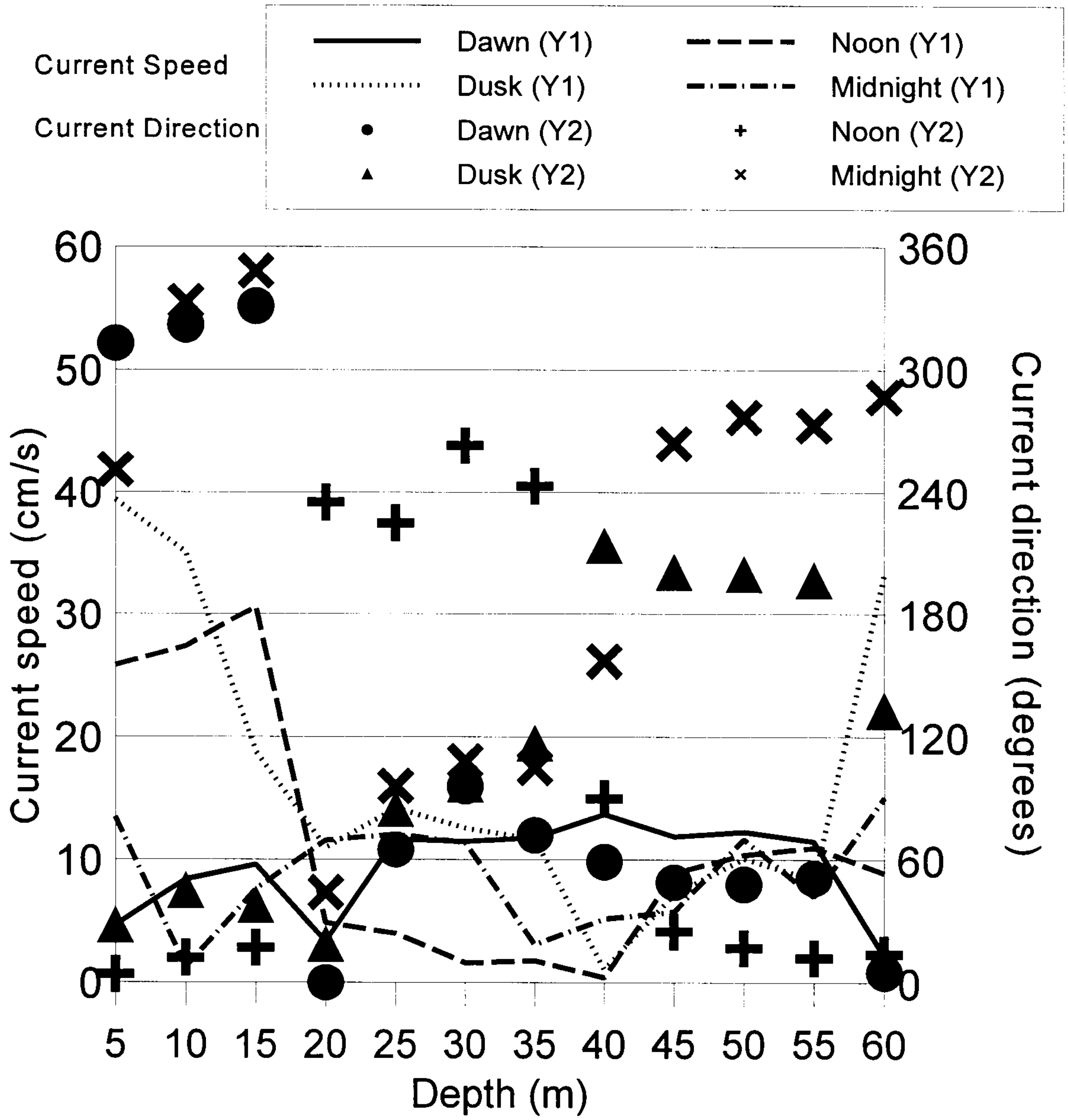
Appendix 2-22. Plot of temperature and water depth coincident with acoustic data at Grand Isle 94, April 23-25,1996.



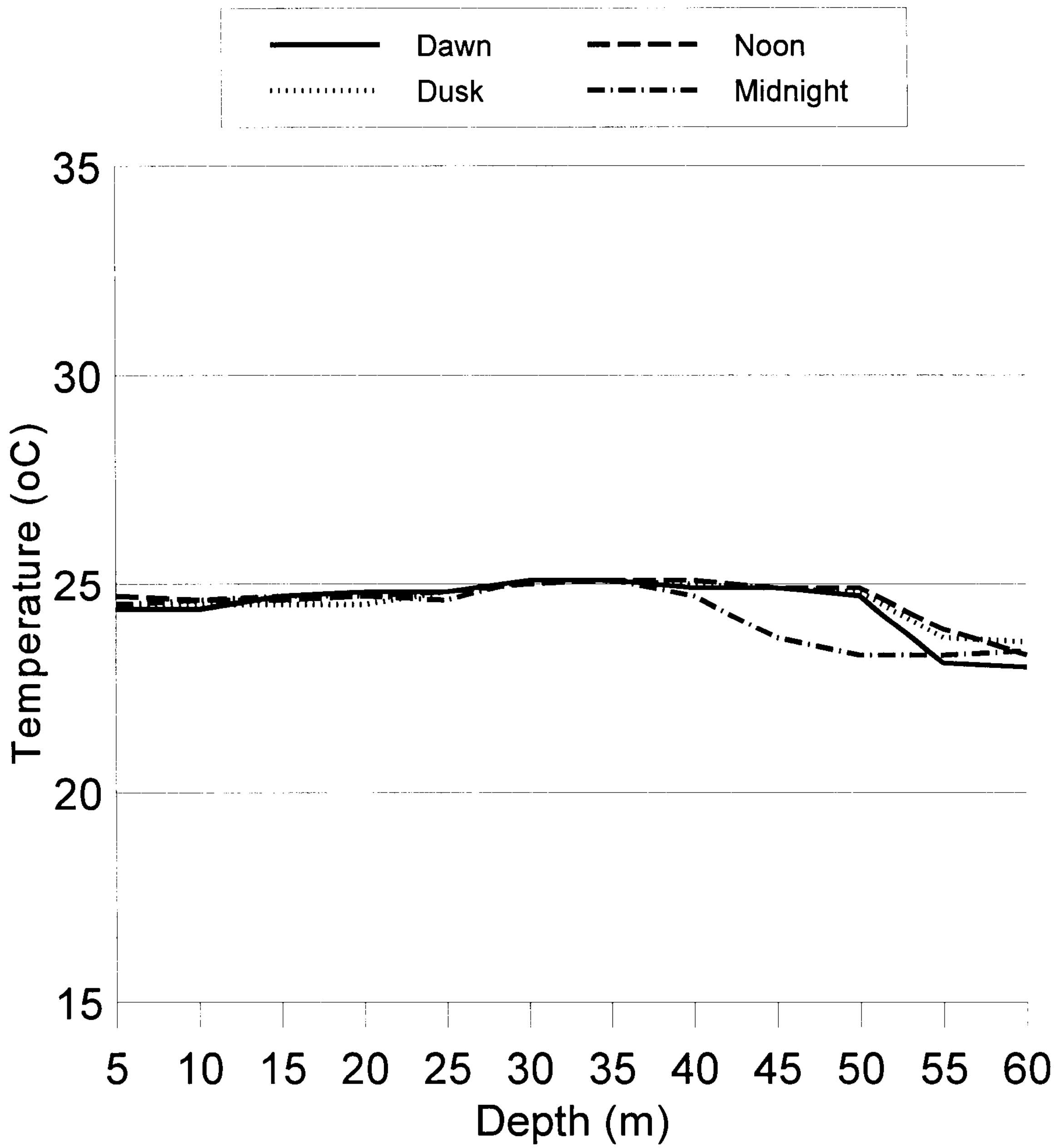
Appendix 2-21. Plot of current speed and direction with depth coincident with acoustic data at Grand Isle 94, April 23-25, 1996.



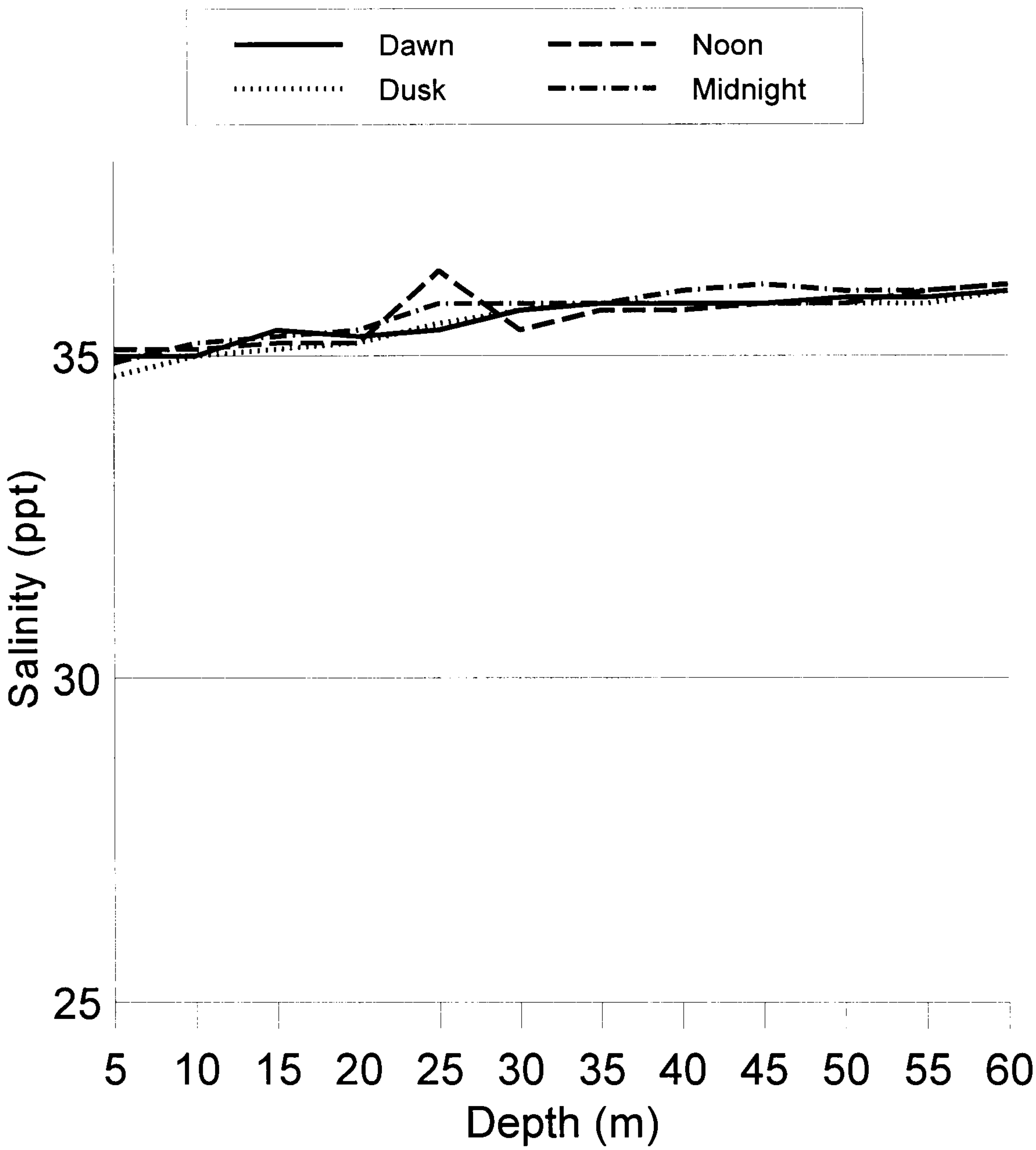
Appendix 2-23. Plot of salinity with depth coincident with the collection of acoustic data at Grand Isle 94, April 23-25, 1996.



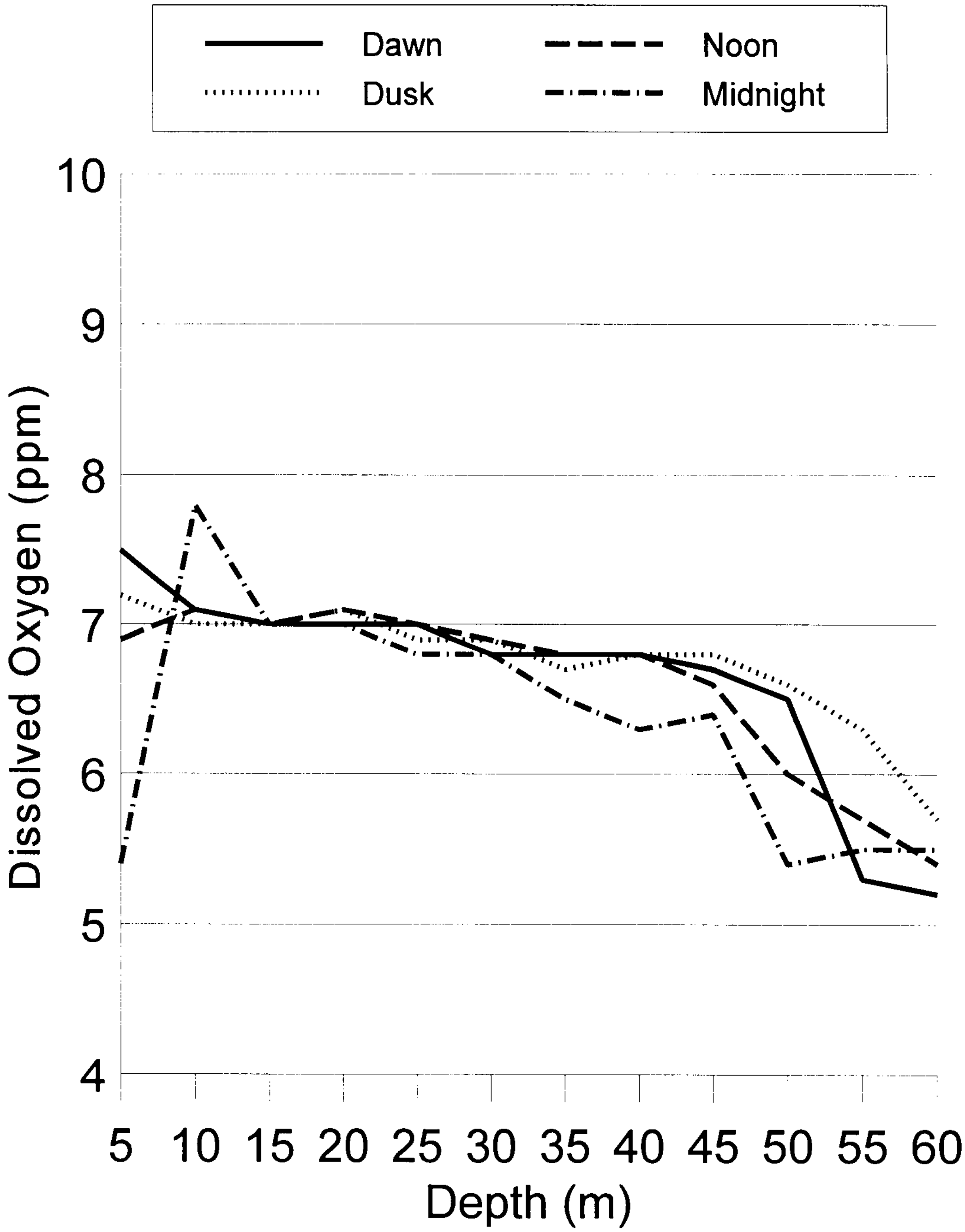
Appendix 2-25. Plot of current speed and direction with depth coincident with acoustic data at Grand Isle 94, November 5-6, 1996.



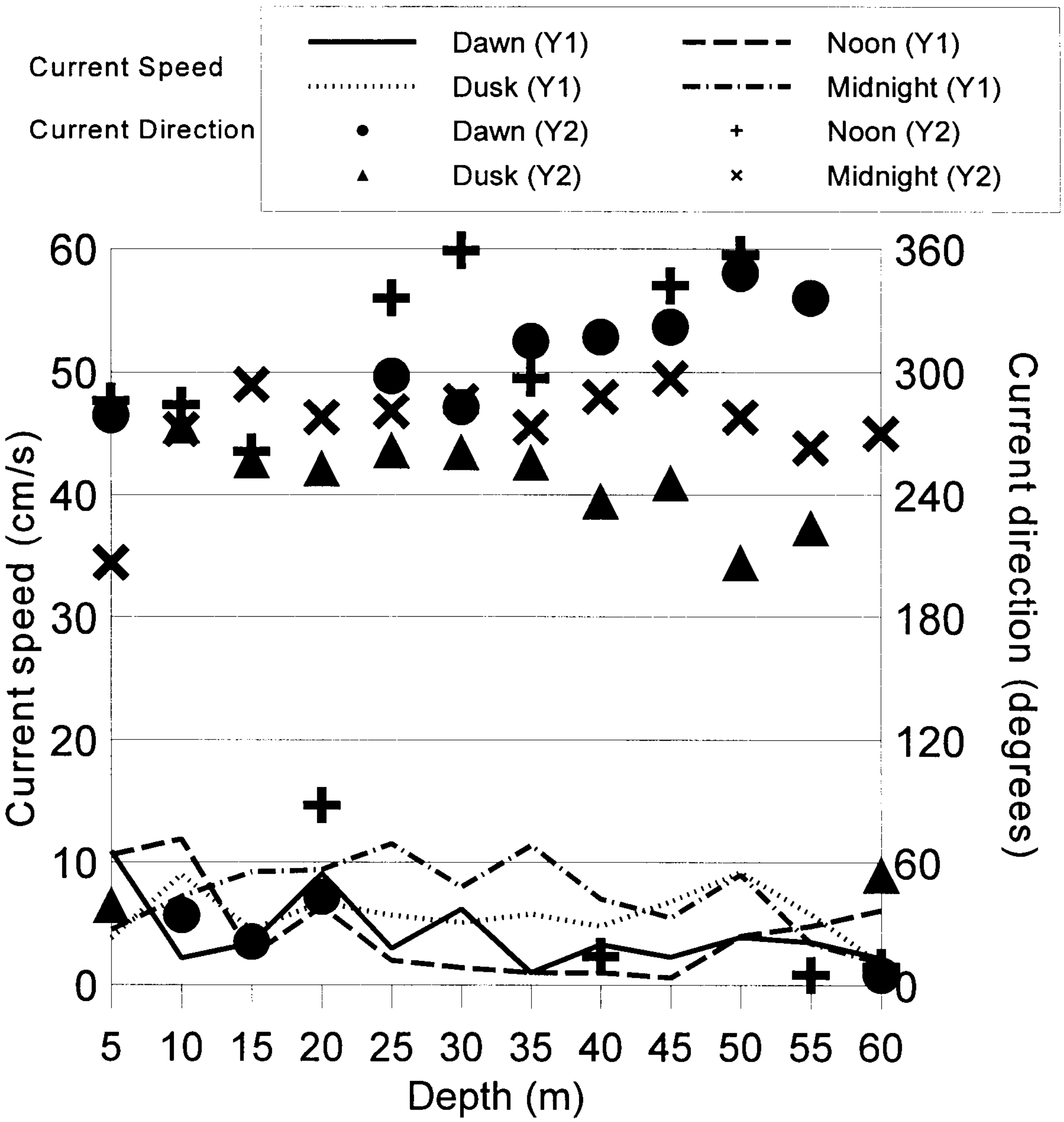
Appendix 2-26. Plot of temperature and water depth coincident with acoustic data at Grand Isle 94, November 5-6, 1996.



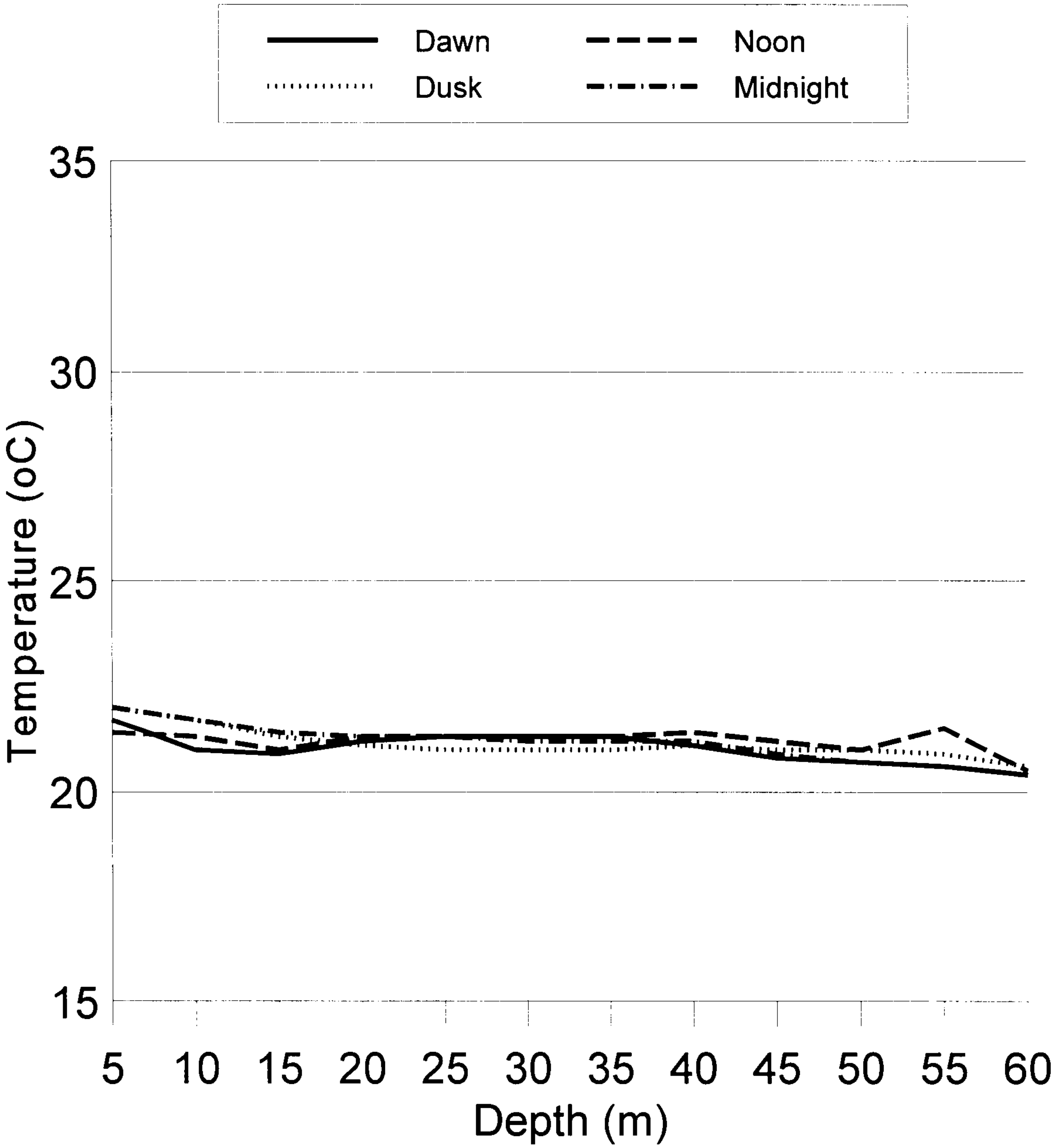
Appendix 2-27. Plot of salinity with depth coincident with the collection of acoustic data at Grand Isle 94, November 5-6, 1996.



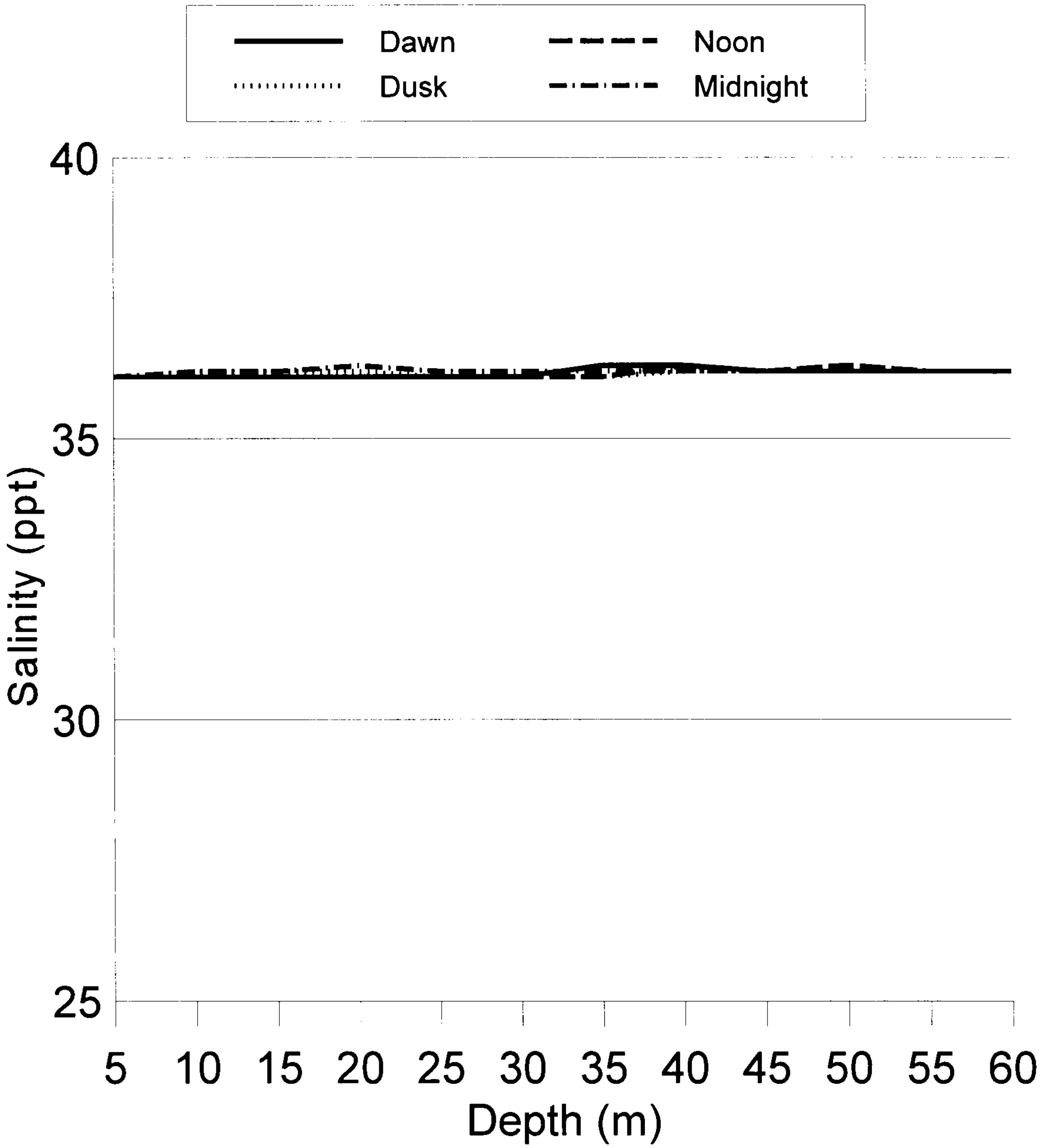
Appendix 2-28. Plot of temperature and dissolved oxygen coincident with acoustic data at Grand Isle 94, November 5-6, 1996.



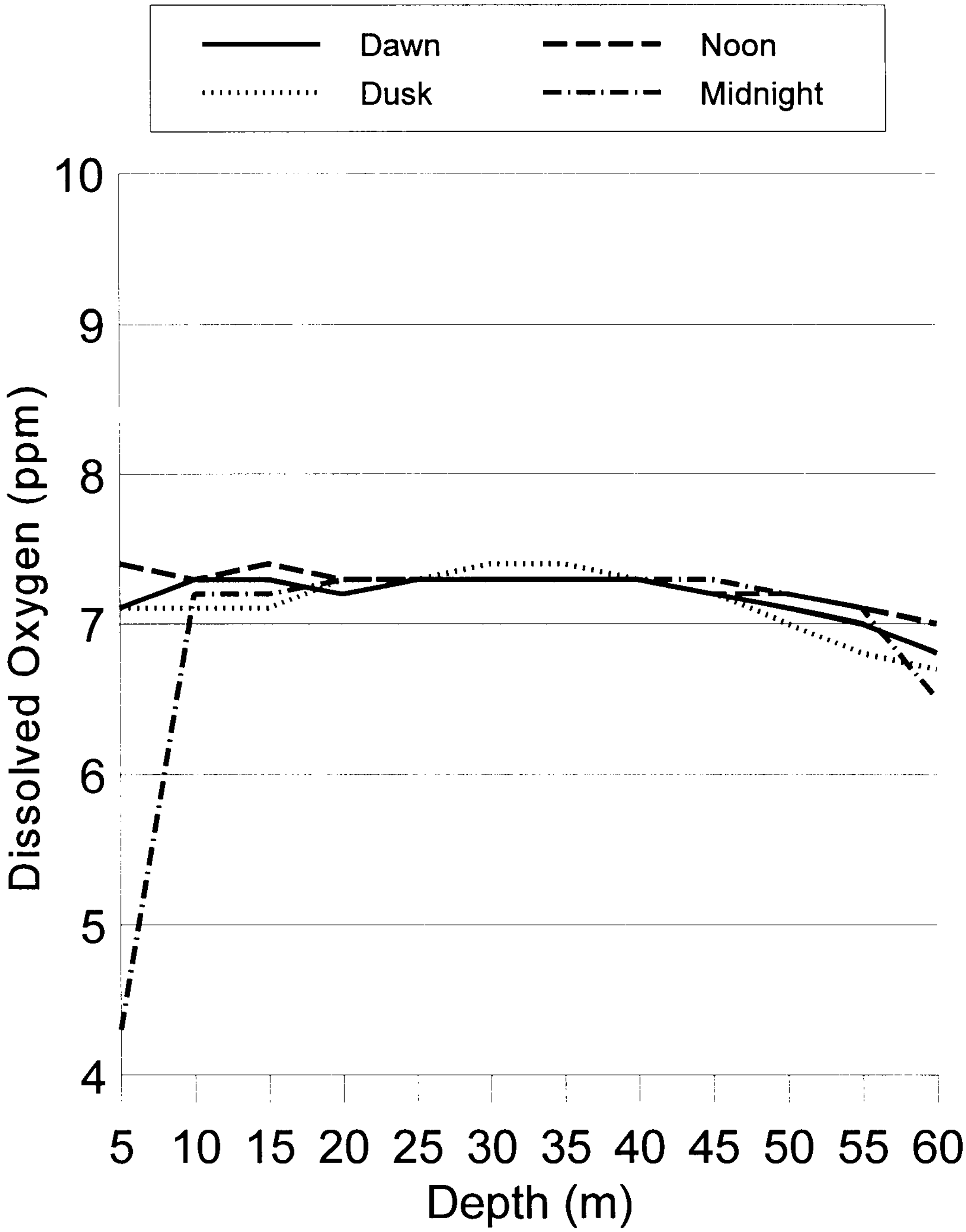
Appendix 2-29. Plot of current speed and direction with depth coincident with acoustic data at Grand Isle 94, March 3-4, 1997.



Appendix 2-30. Plot of temperature and water depth coincident with acoustic data at Grand Isle 94, March 3-4, 1997.



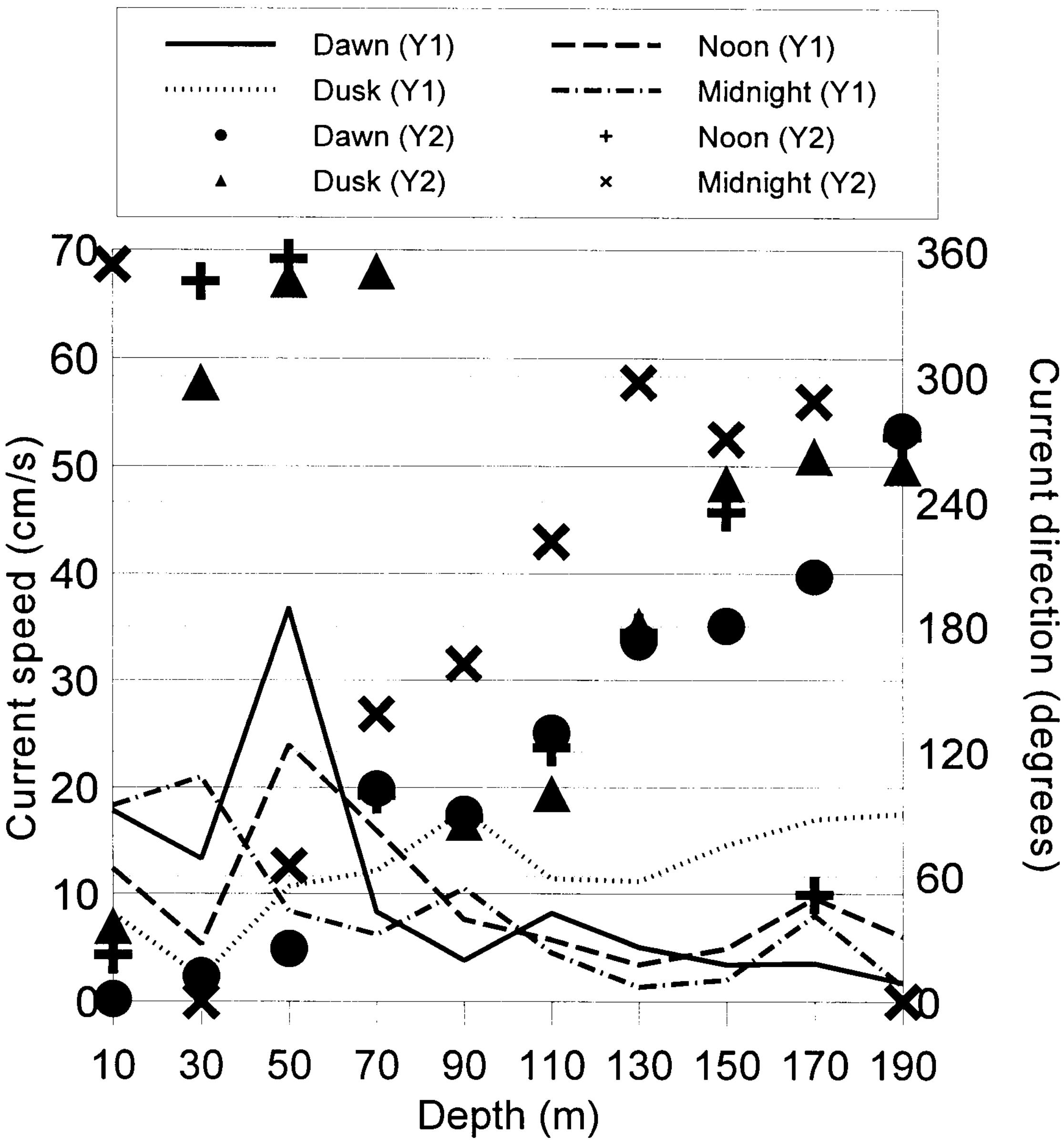
Appendix 2-31. Plot of salinity with depth coincident with the collection of acoustic data at Grand Isle 94, March 3-4, 1997.



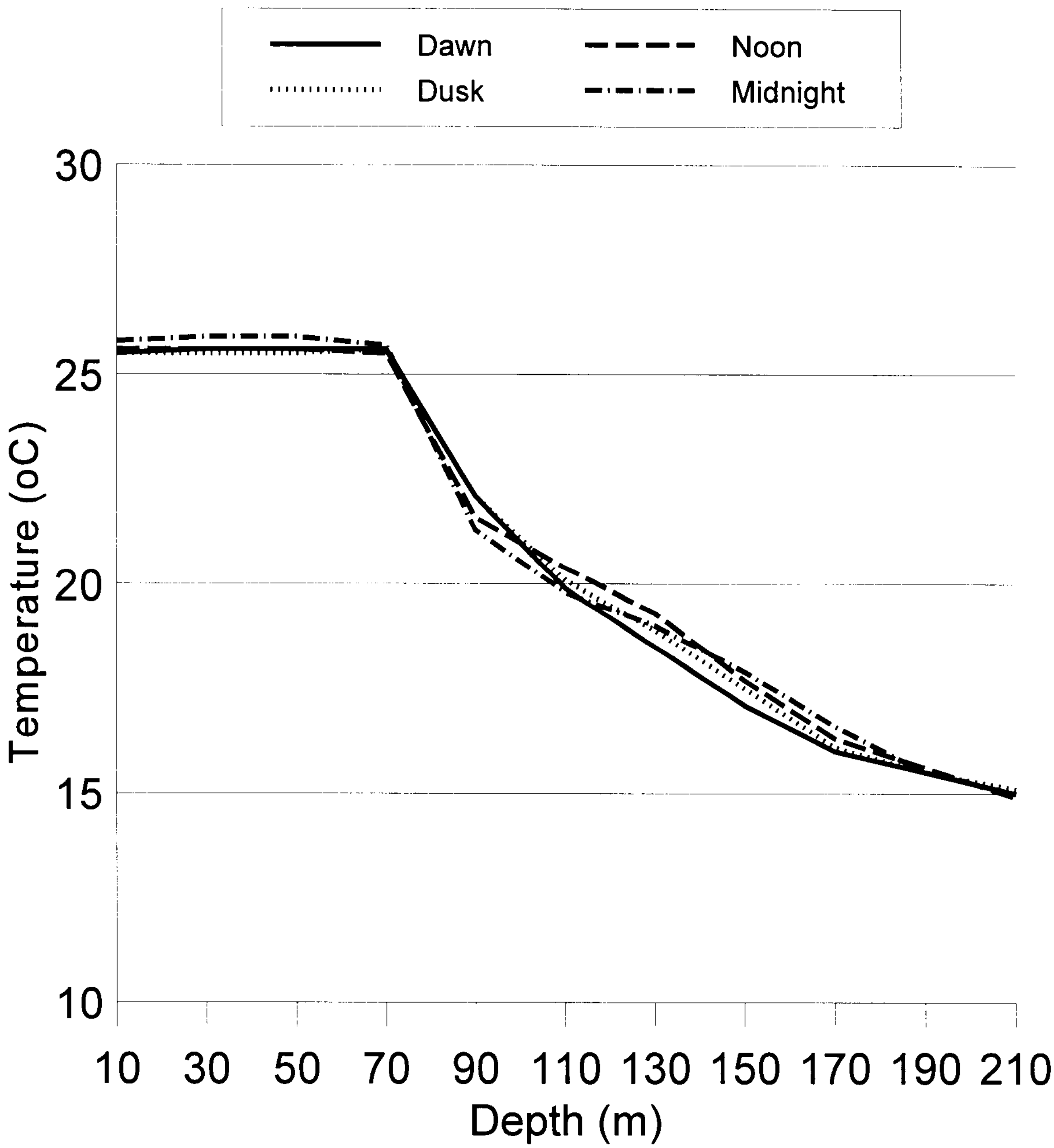
Appendix 2-32. Plot of temperature and dissolved oxygen coincident with acoustic data at Grand Isle 94, March 3-4, 1997.

APPENDIX 3

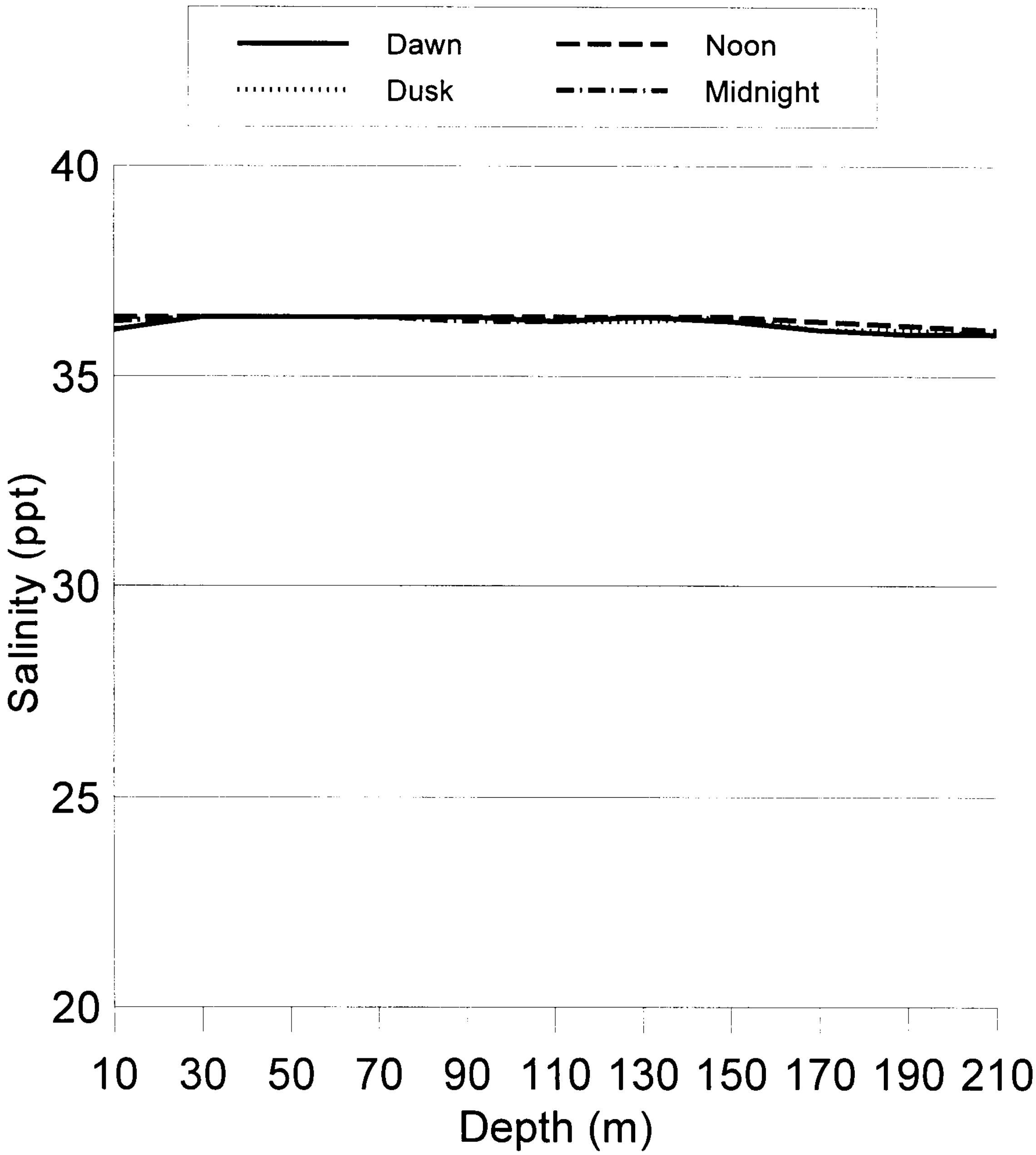
Current, Temperature, Salinity and Oxygen Data Coincident with Acoustic Data at Green Canyon 18



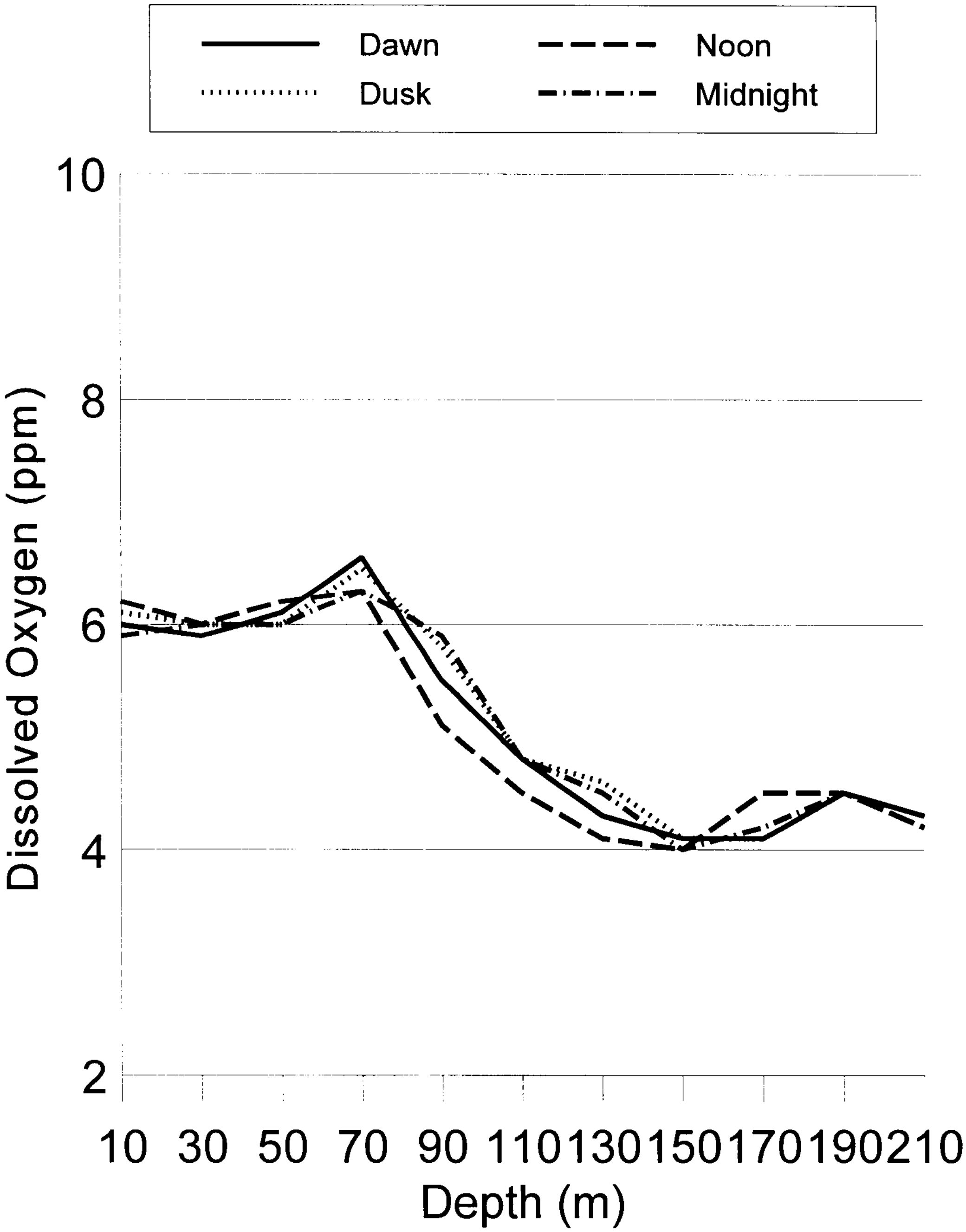
Appendix 3-1. Plot of current speed and direction with depth coincident with acoustic data at Green Canyon 18, November, 29, 1994.



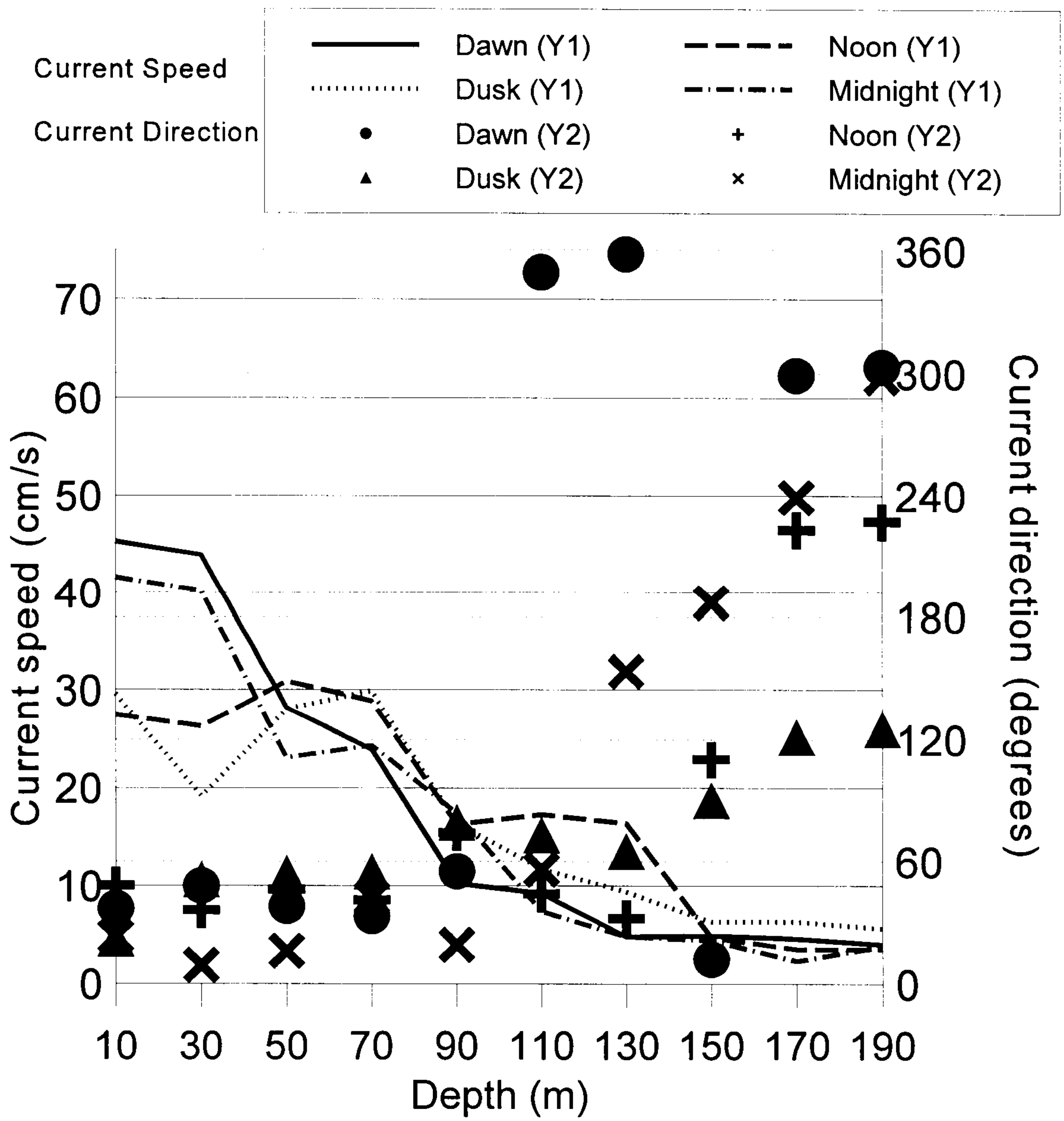
Appendix 3-2. Plot of temperature and water depth coincident with acoustic data at Green Canyon 18, November 29, 1994.



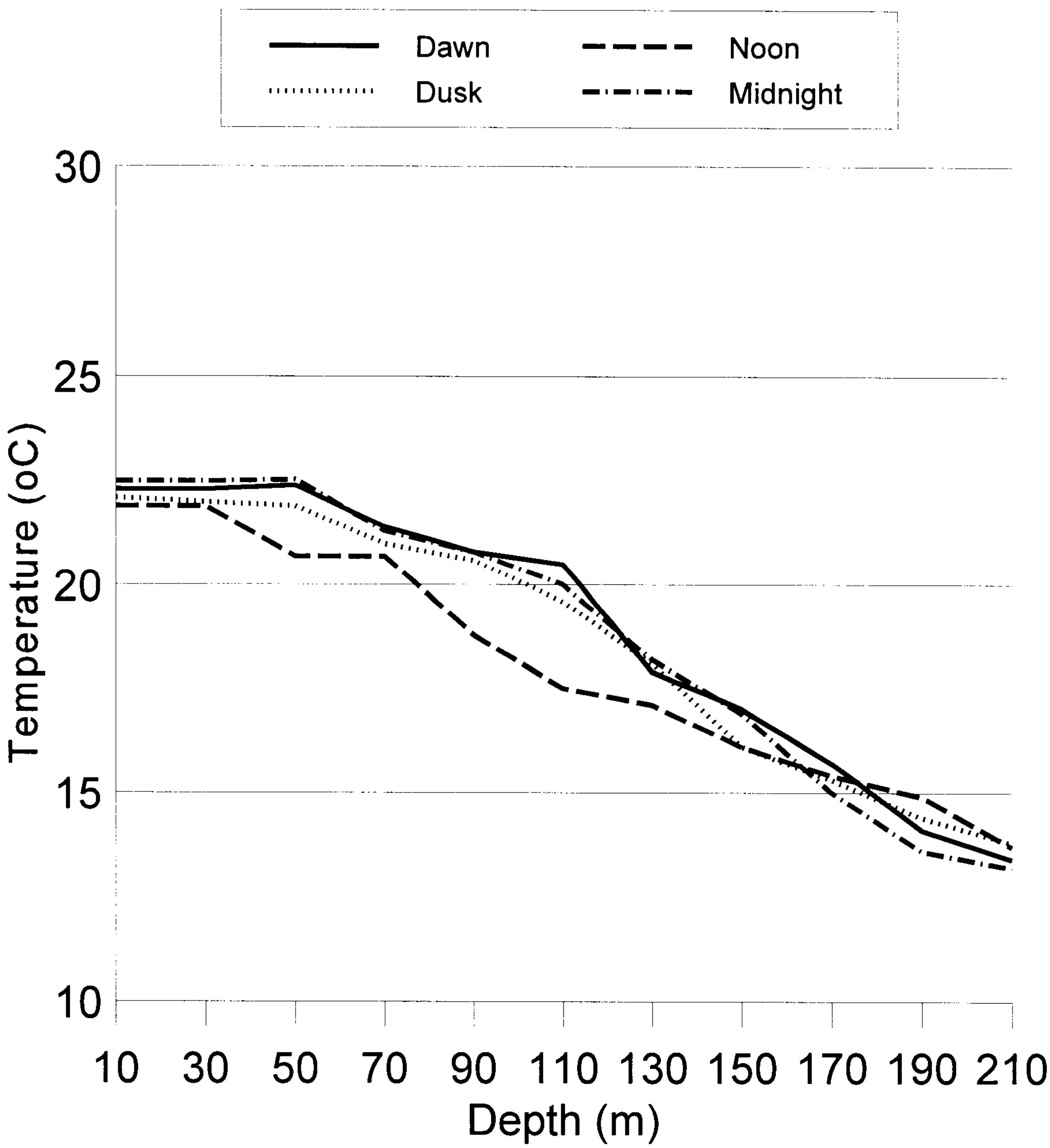
Appendix 3-3. Plot of depth with salinity coincident with acoustic data at Green Canyon 18, November 29, 1994.



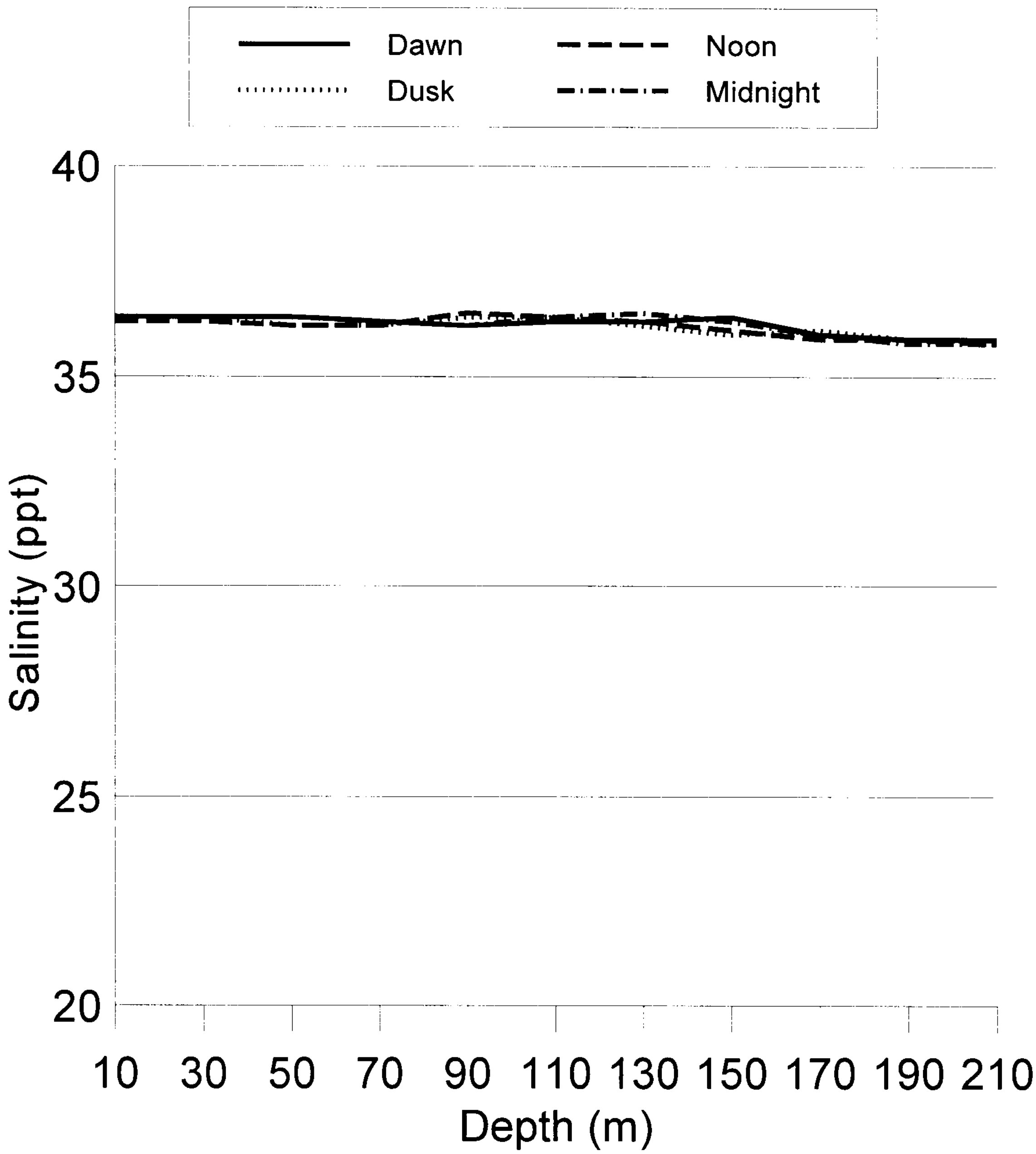
Appendix 3-4. Plot of depth with dissolved oxygen coincident with acoustic data at Green Canyon 18, November 29, 1994.



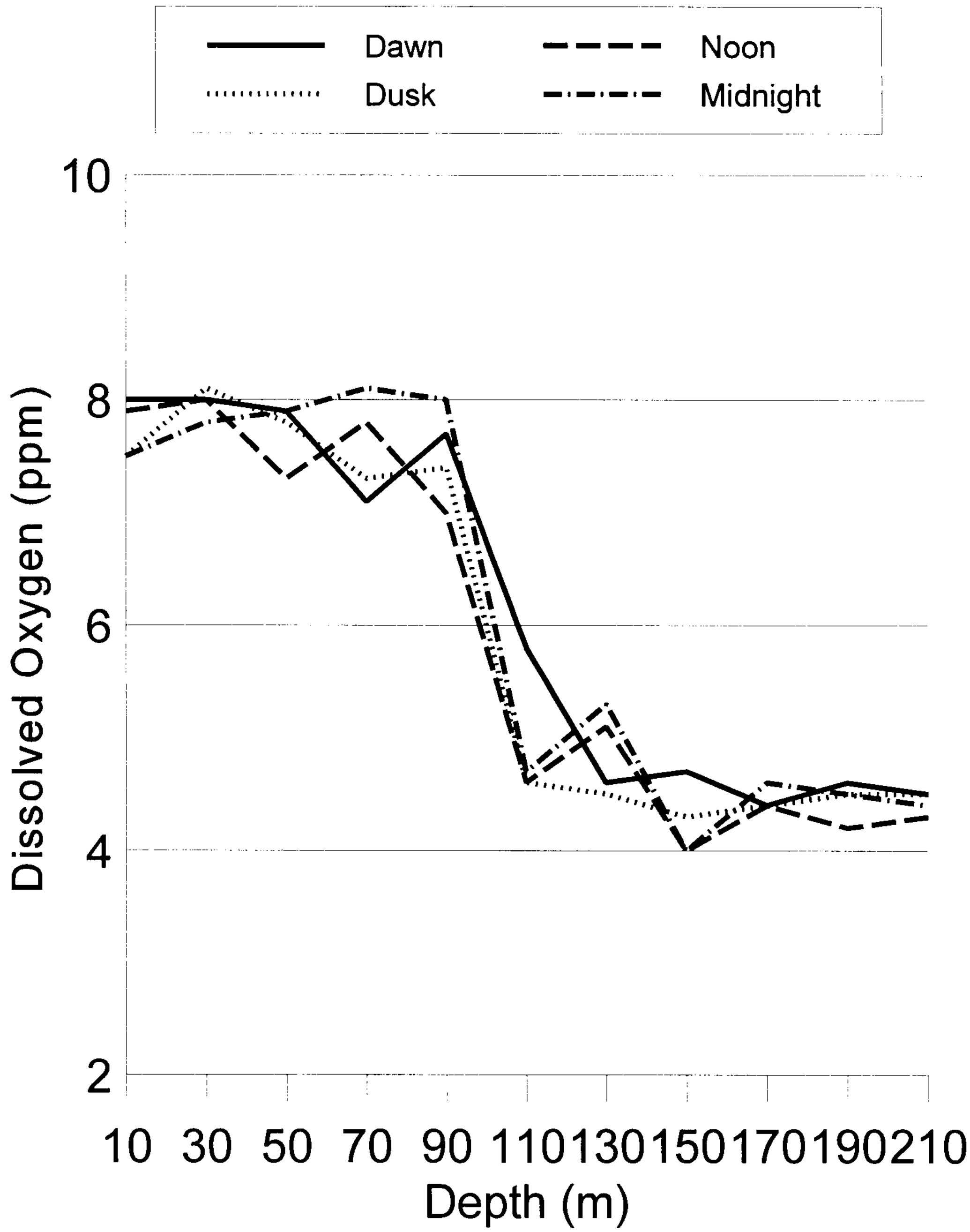
Appendix 3-5. Plot of current speed and direction with depth coincident with acoustic data at Green Canyon 18, February. 22-23, 1995.



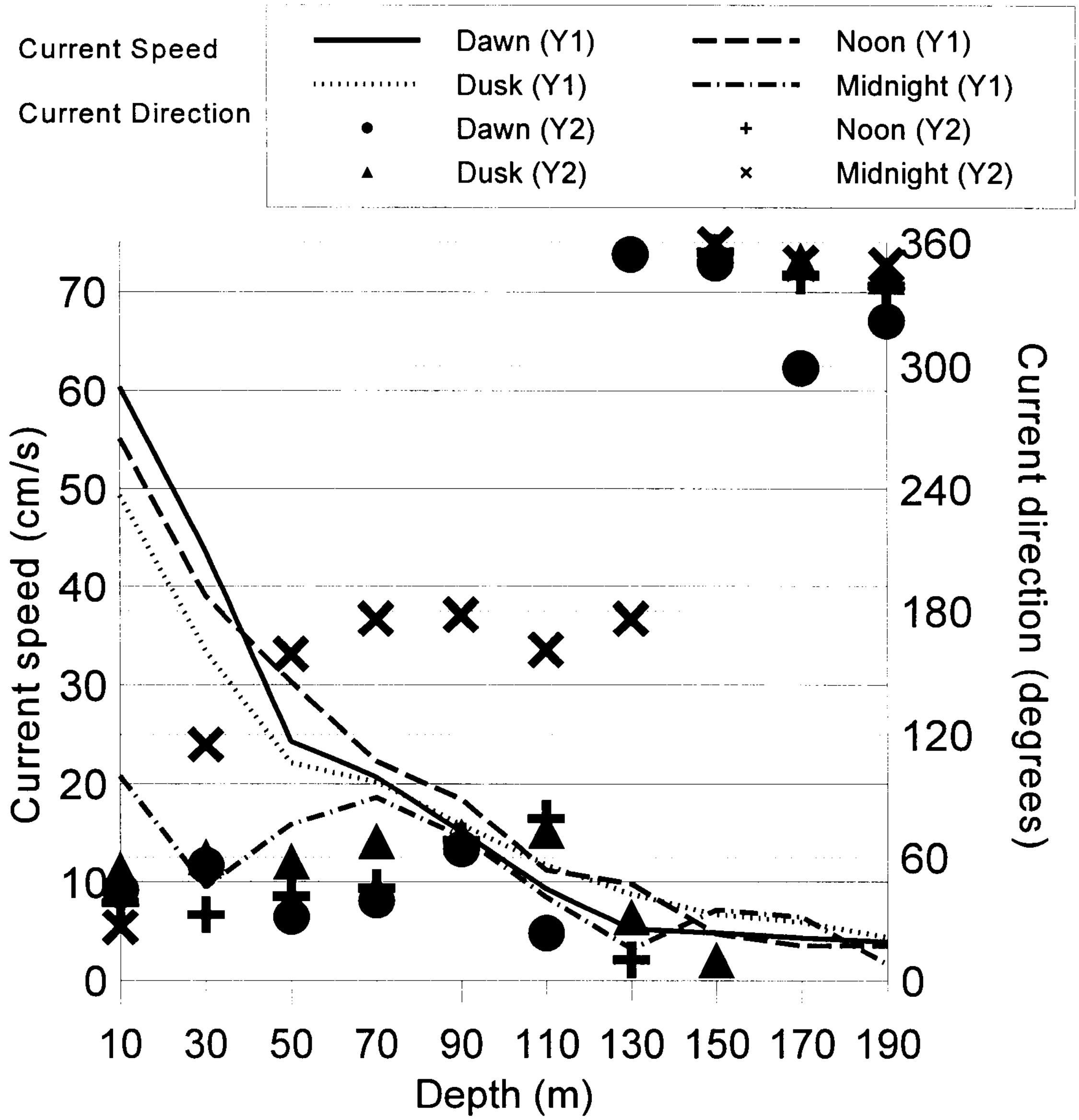
Appendix 3-6. Plot of temperature and water depth coincident with acoustic data at Green Canyon 18, February 22-23, 1995.



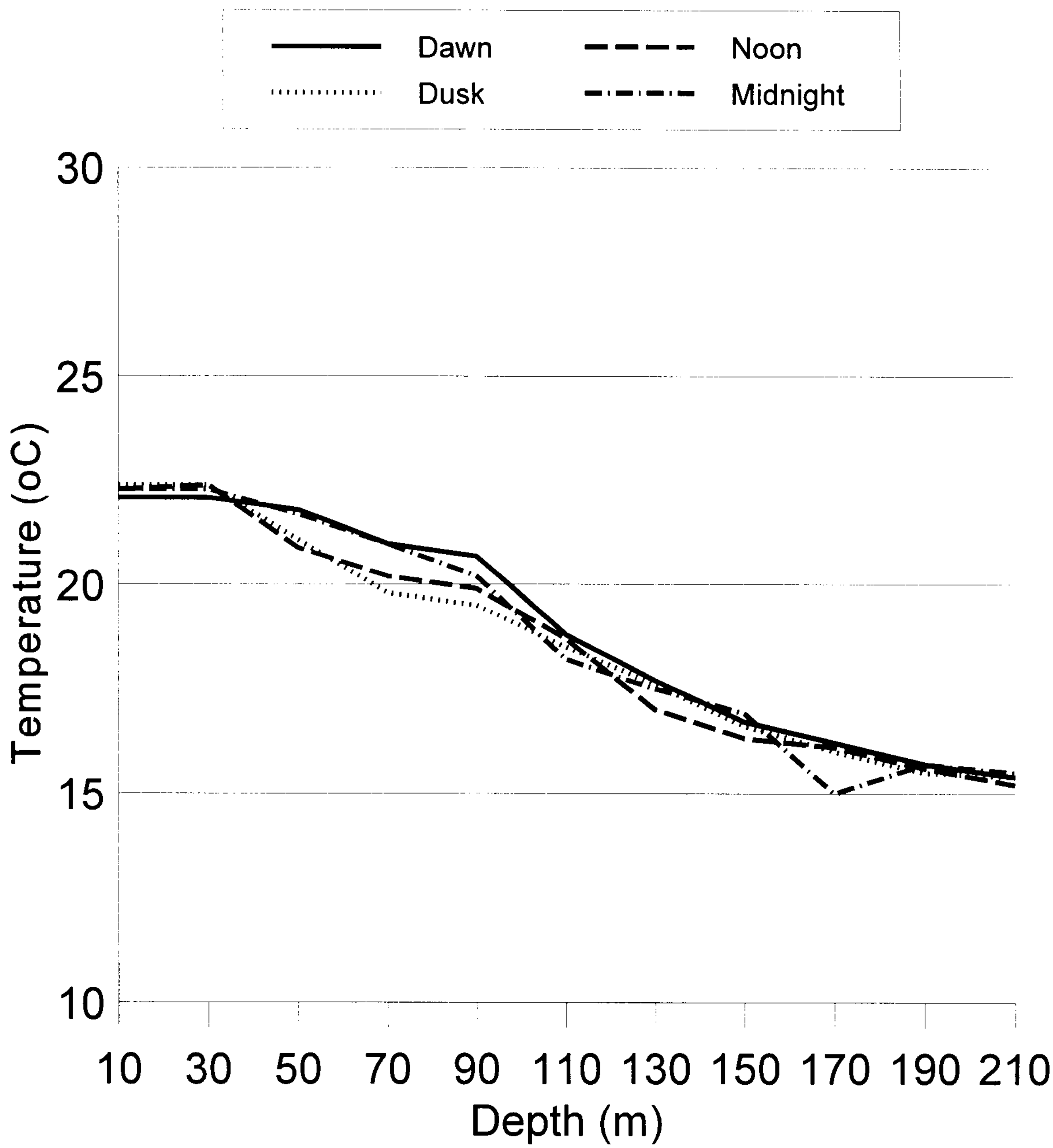
Appendix 3-7. Plot of salinity with depth coincident with the collection of acoustic data at Green Canyon 18, February 22-23, 1995.



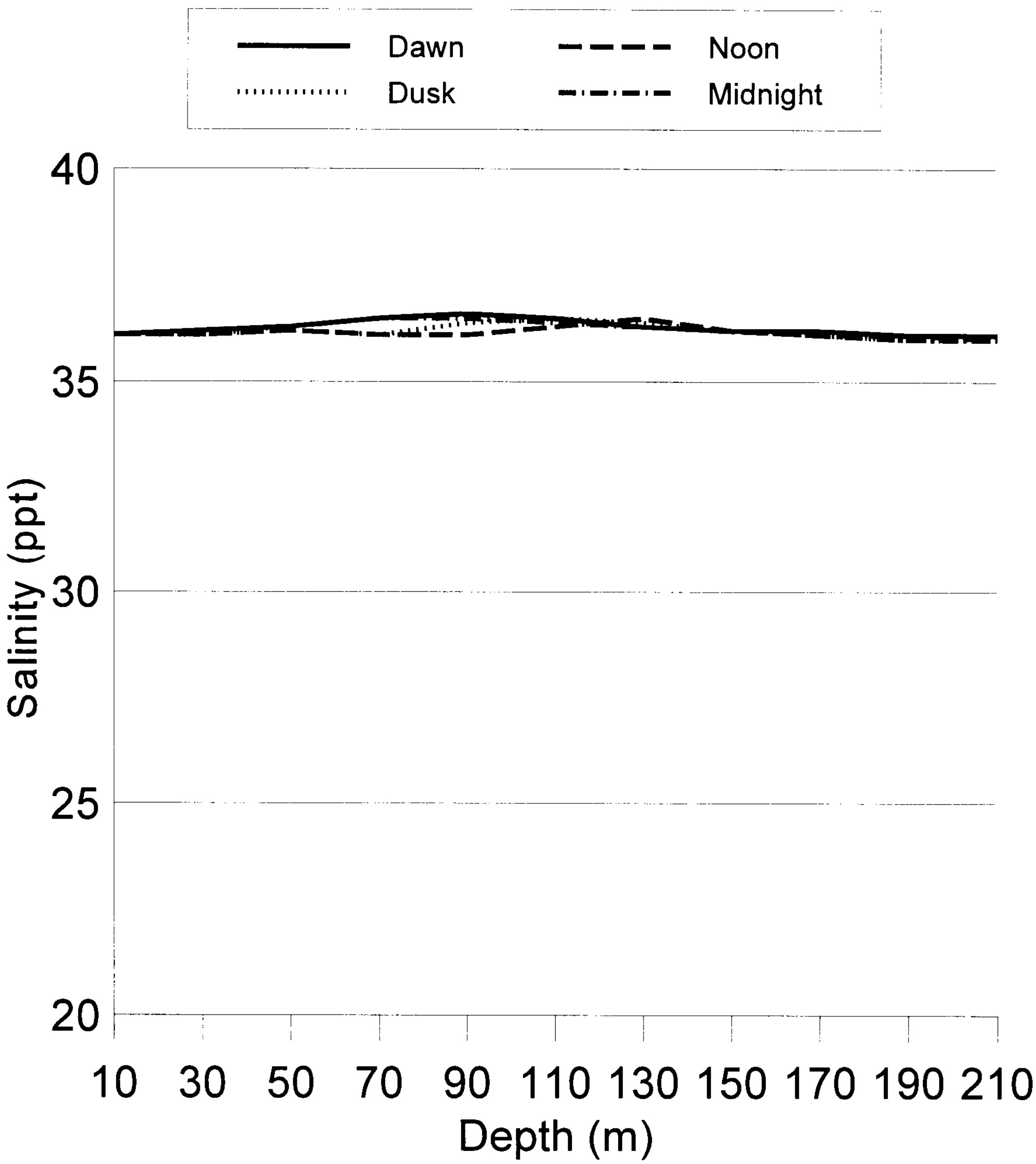
Appendix 3-8. Plot of depth with dissolved oxygen coincident with acoustic data at Green Canyon 18, February 22-23, 1995.



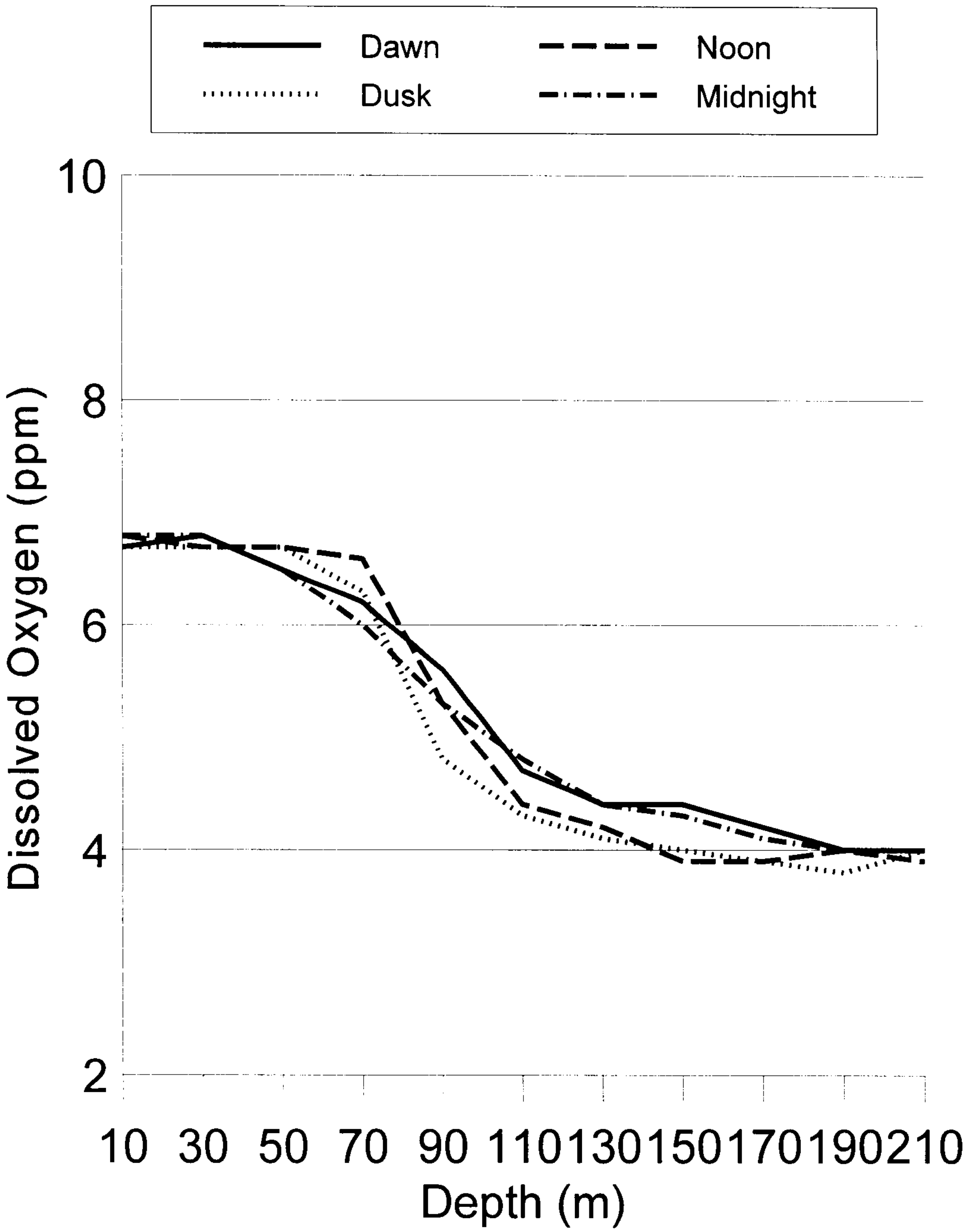
Appendix 3-9. Plot of current speed and direction with depth coincident with acoustic data at Green Canyon 18, April 3-4, 1995.



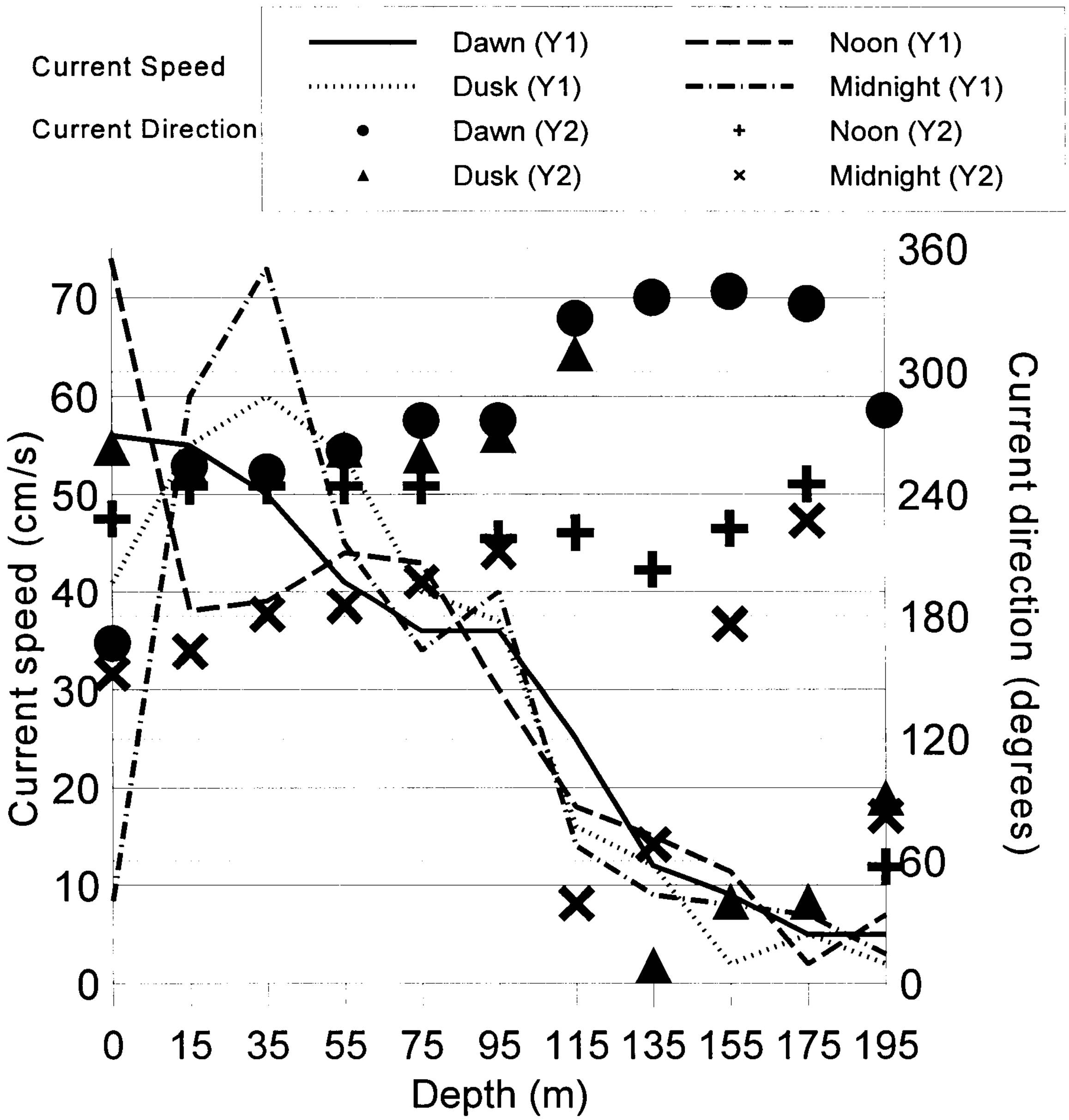
Appendix 3-10. Plot of temperature and water depth coincident with acoustic data at Green Canyon 18, April 3-4, 1995.



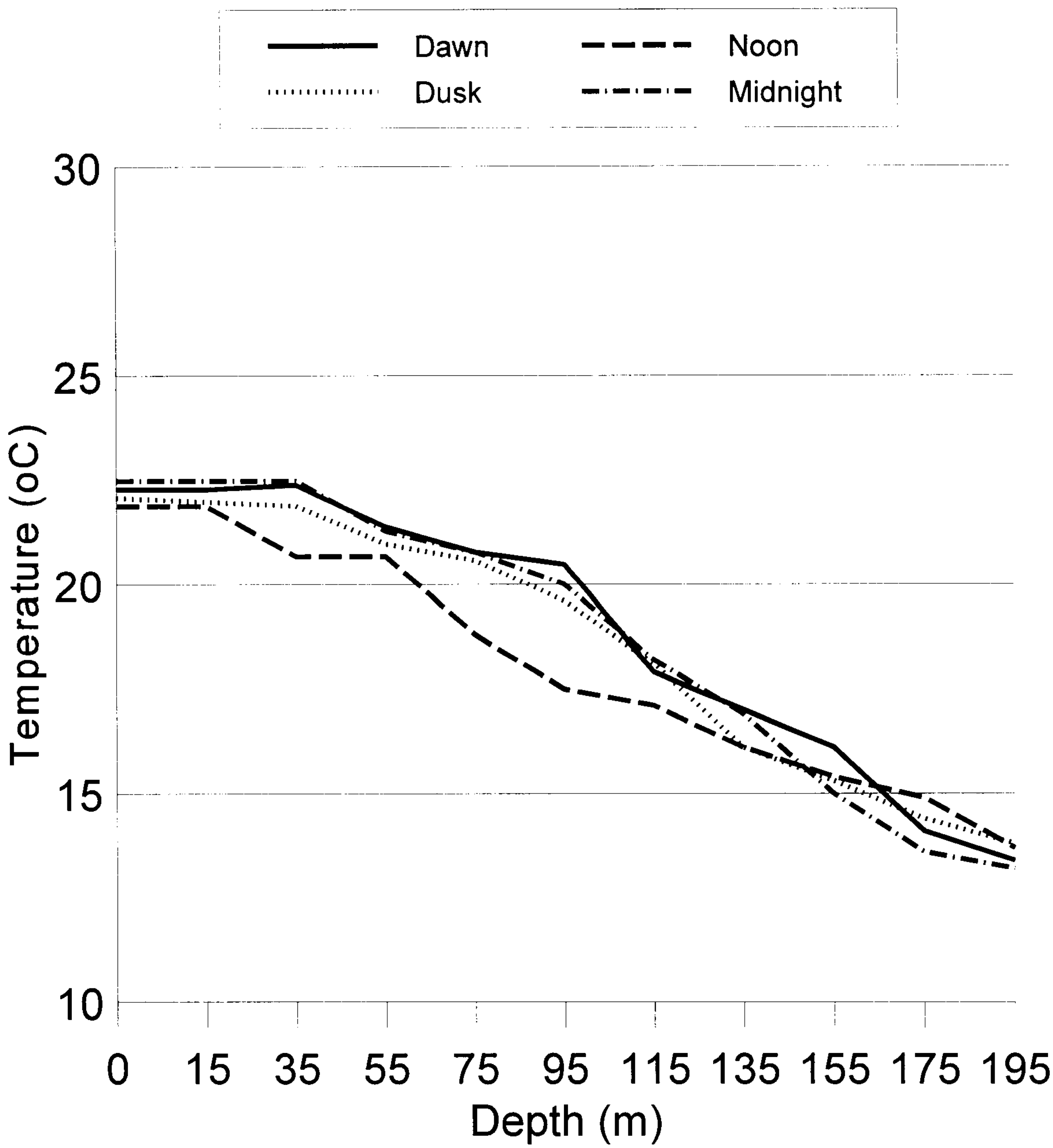
Appendix 3-11. Plot of salinity with depth coincident with the collecttion of acoustic data at Green Canyon, 19, April 3-4, 1995.



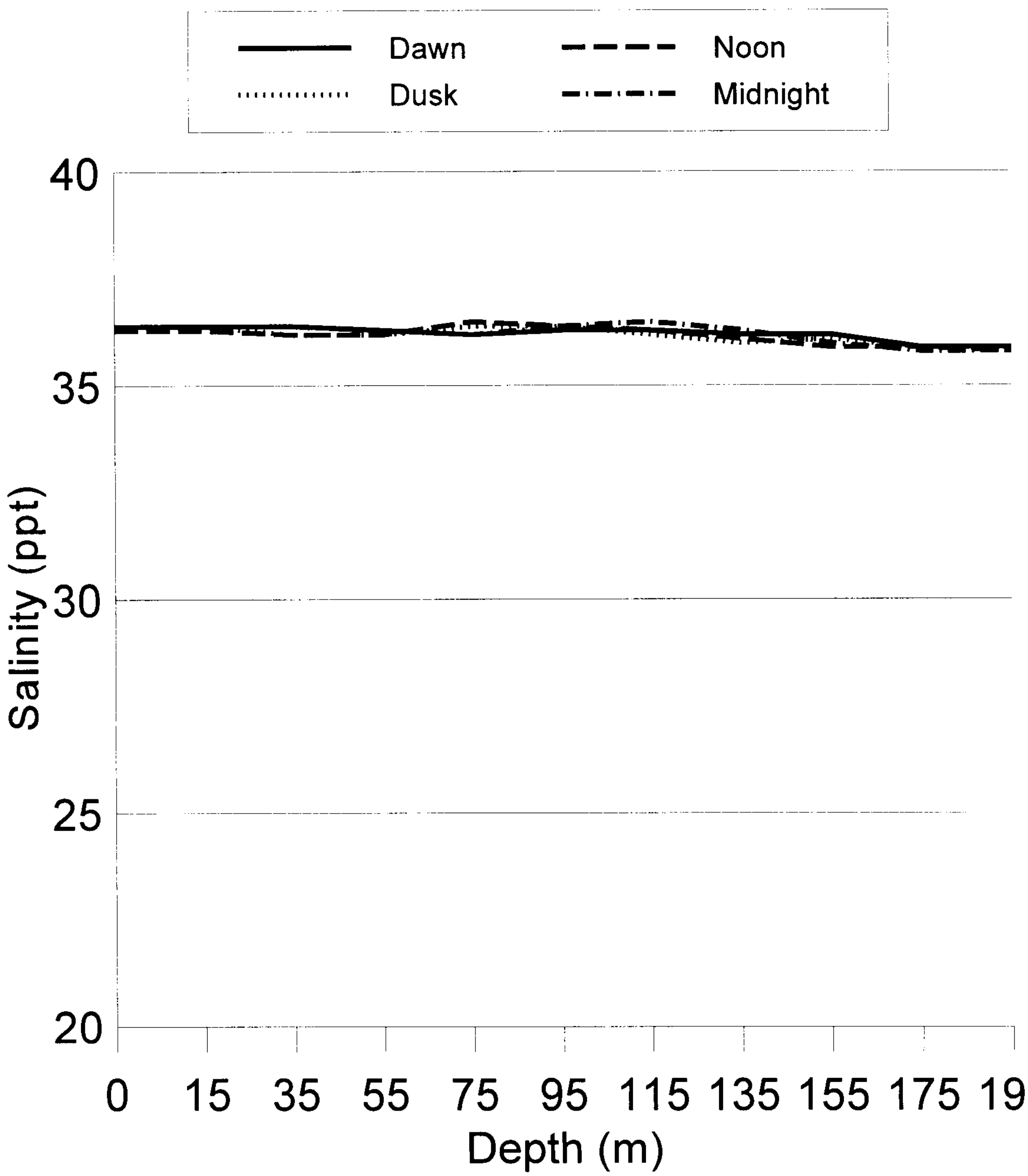
Appendix 3-12. Plot of depth with dissolved oxygen coincident with acoustic data at Green Canyon 18, April 3-4, 1995



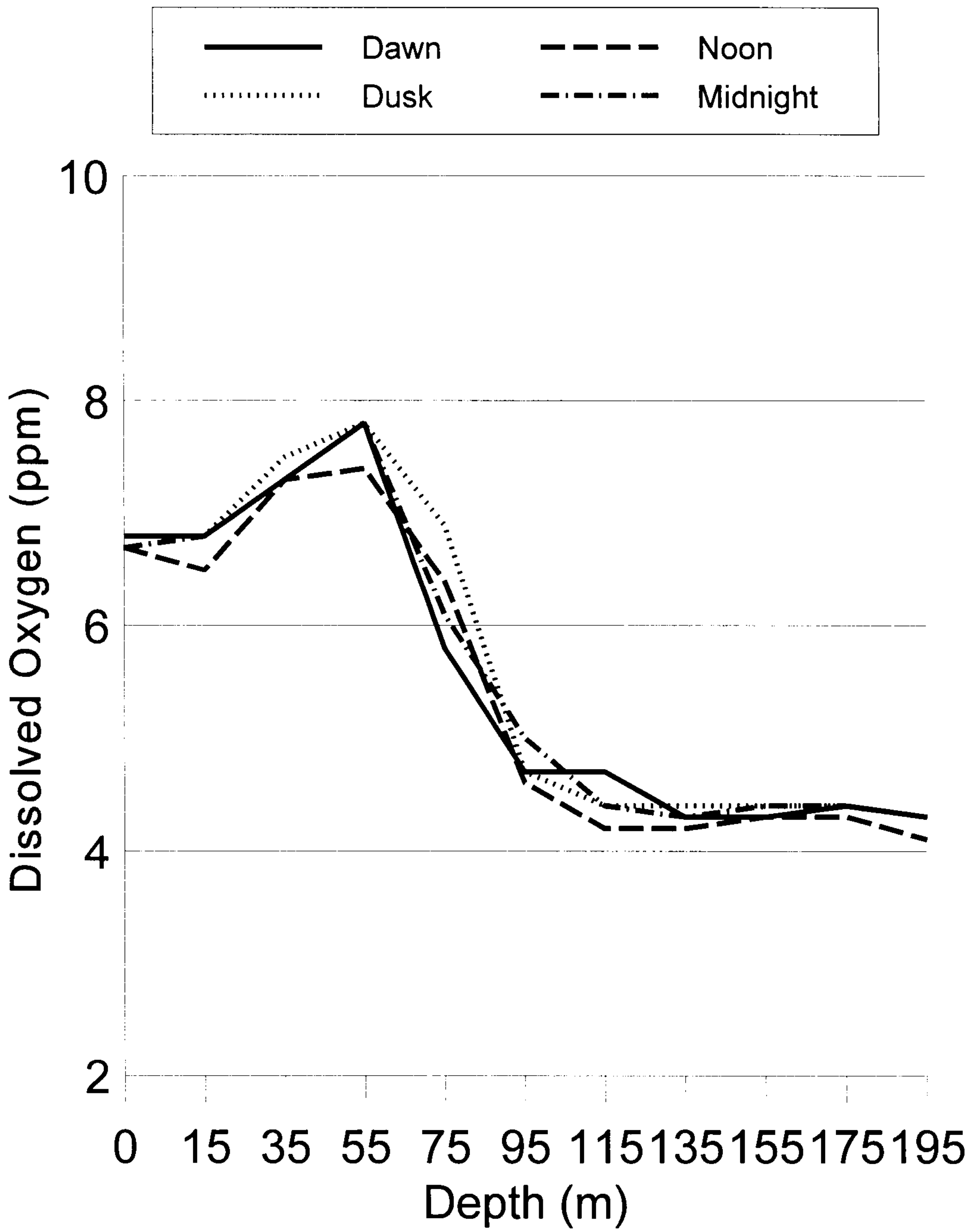
Appendix 3-13. Plot of current speed and direction with depth coincident with acoustic data at Green Canyon 18, July 11-12, 1995.



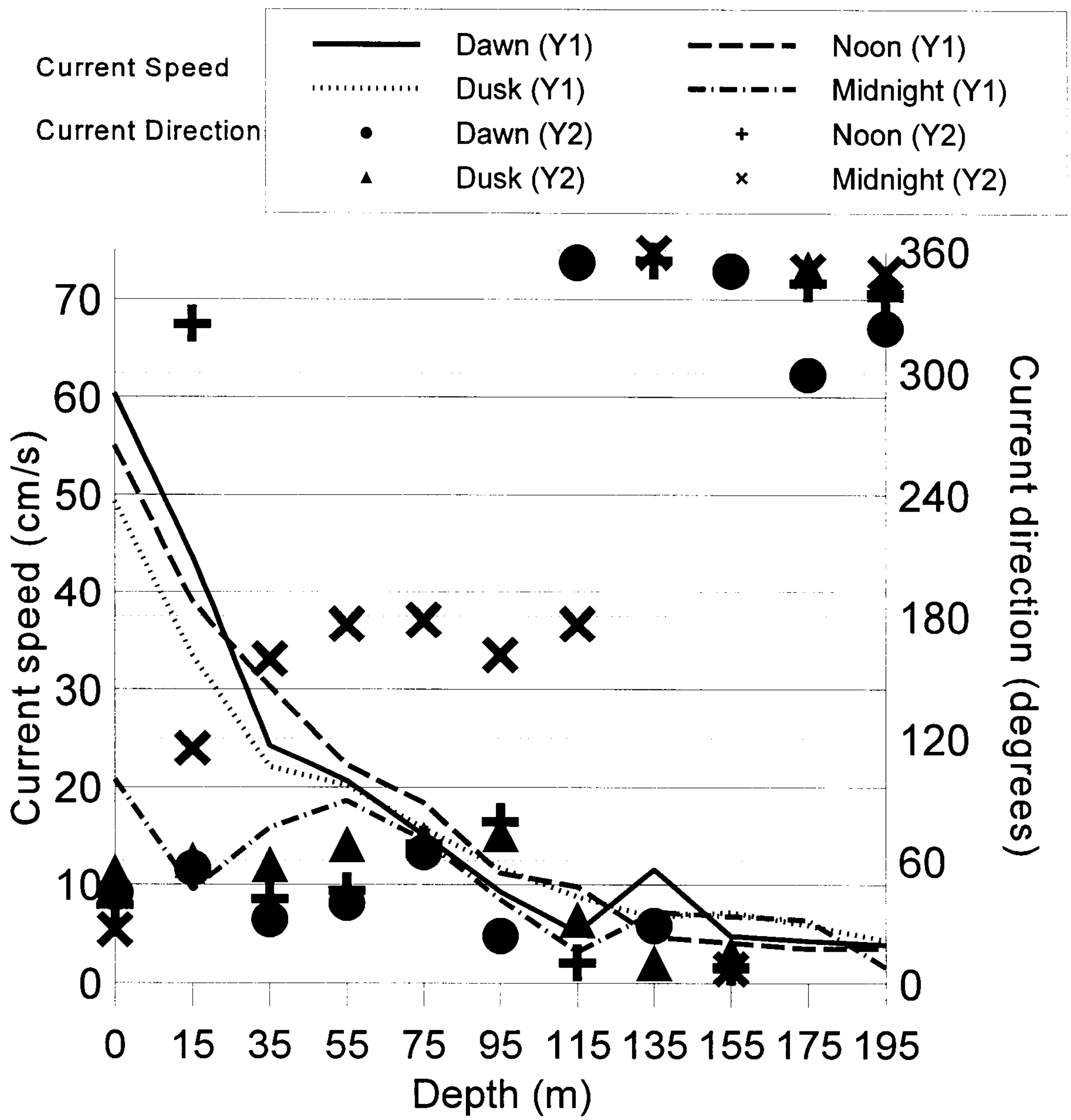
Appendix 3-14. Plot of temperature and water depth coincident with acoustic data at Green Canyon 18, July 11-12, 1995.



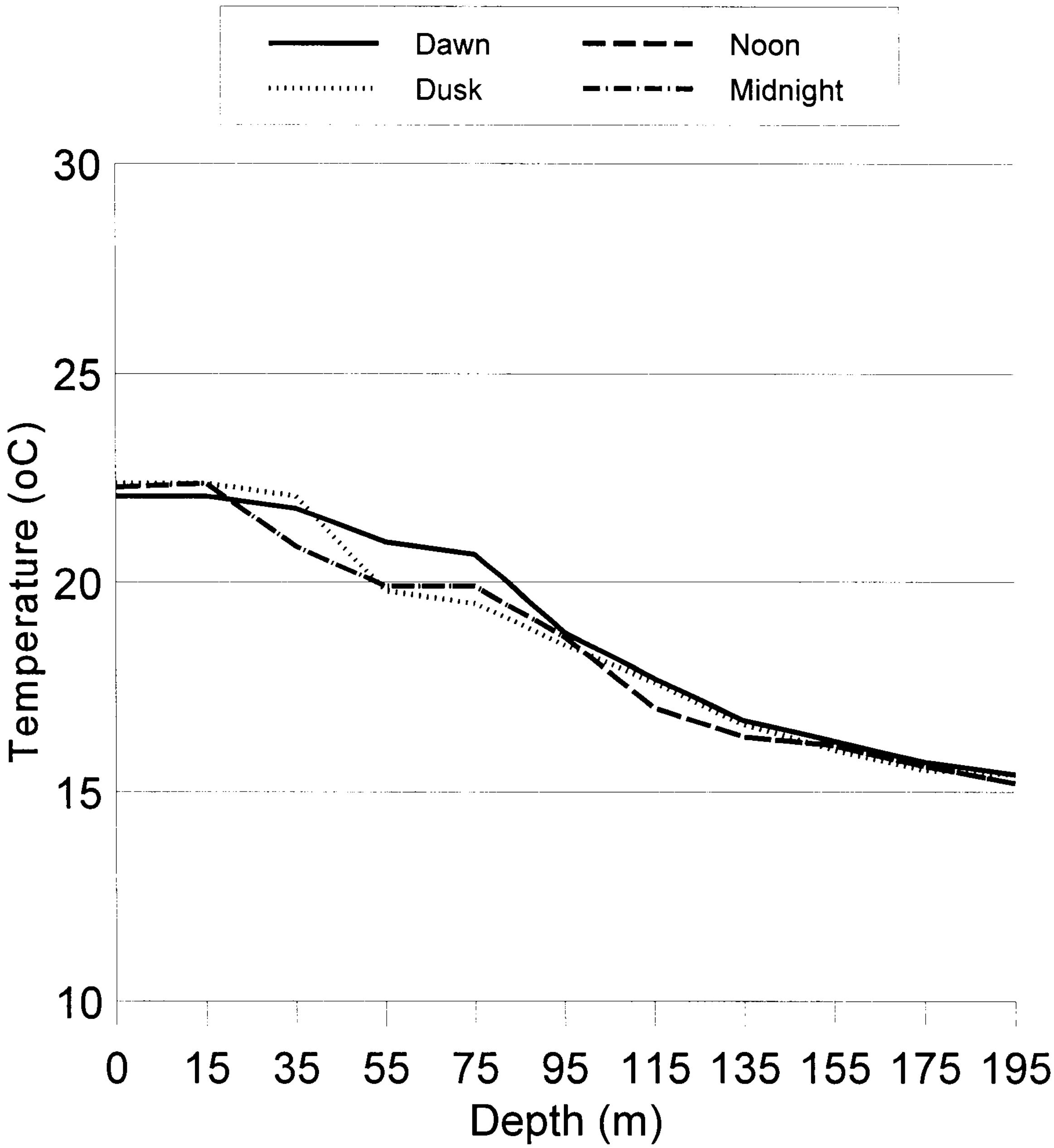
Appendix 3-15. Plot of salinity with depth coincident with the collection of acoustic data at Green Canyon 18, July 11-12, 1995.



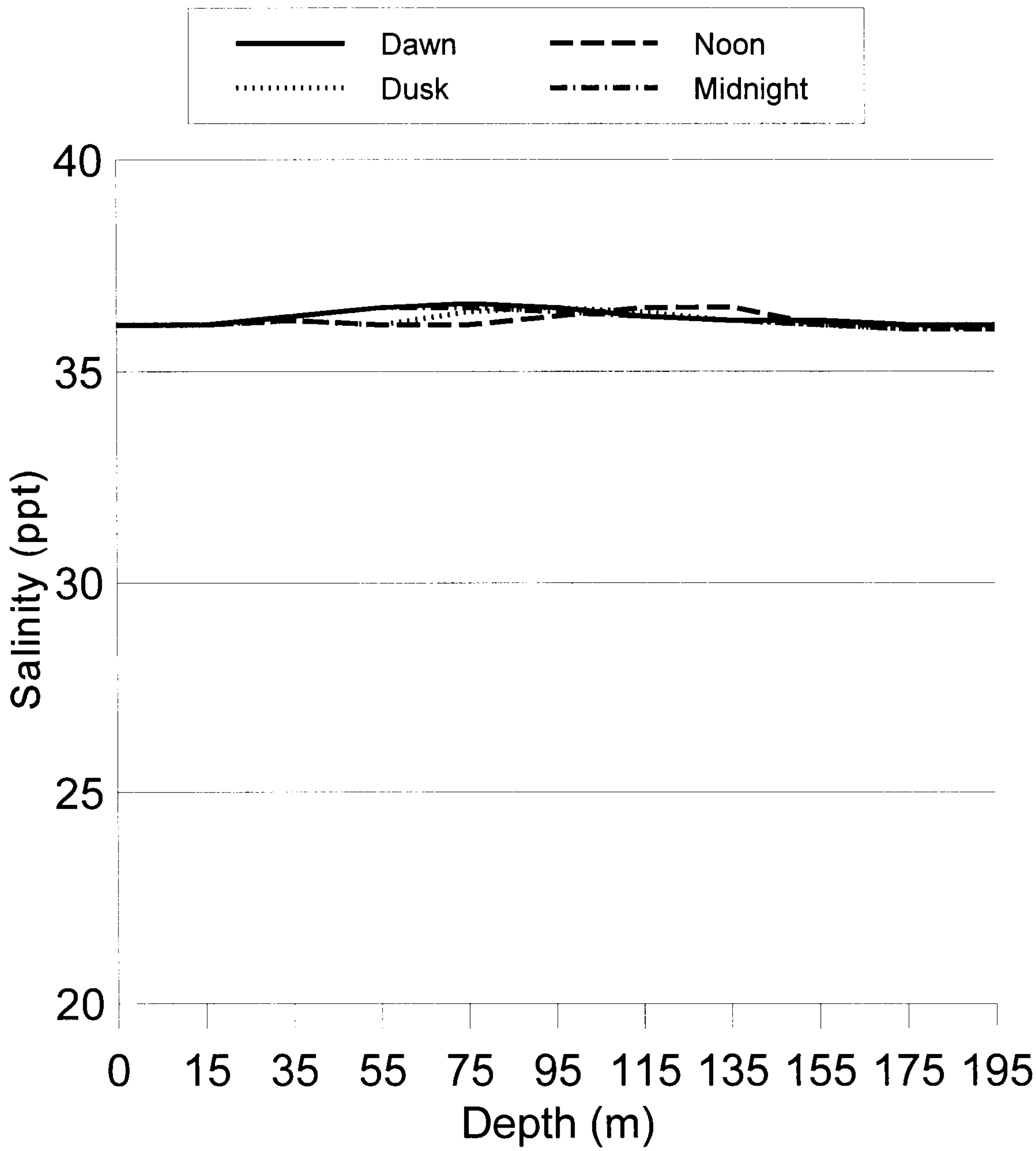
Appendix 3-16. Plot of depth with dissolved oxygen coincident with acoustic data at Green Canyon 18, July 11-12, 1995.



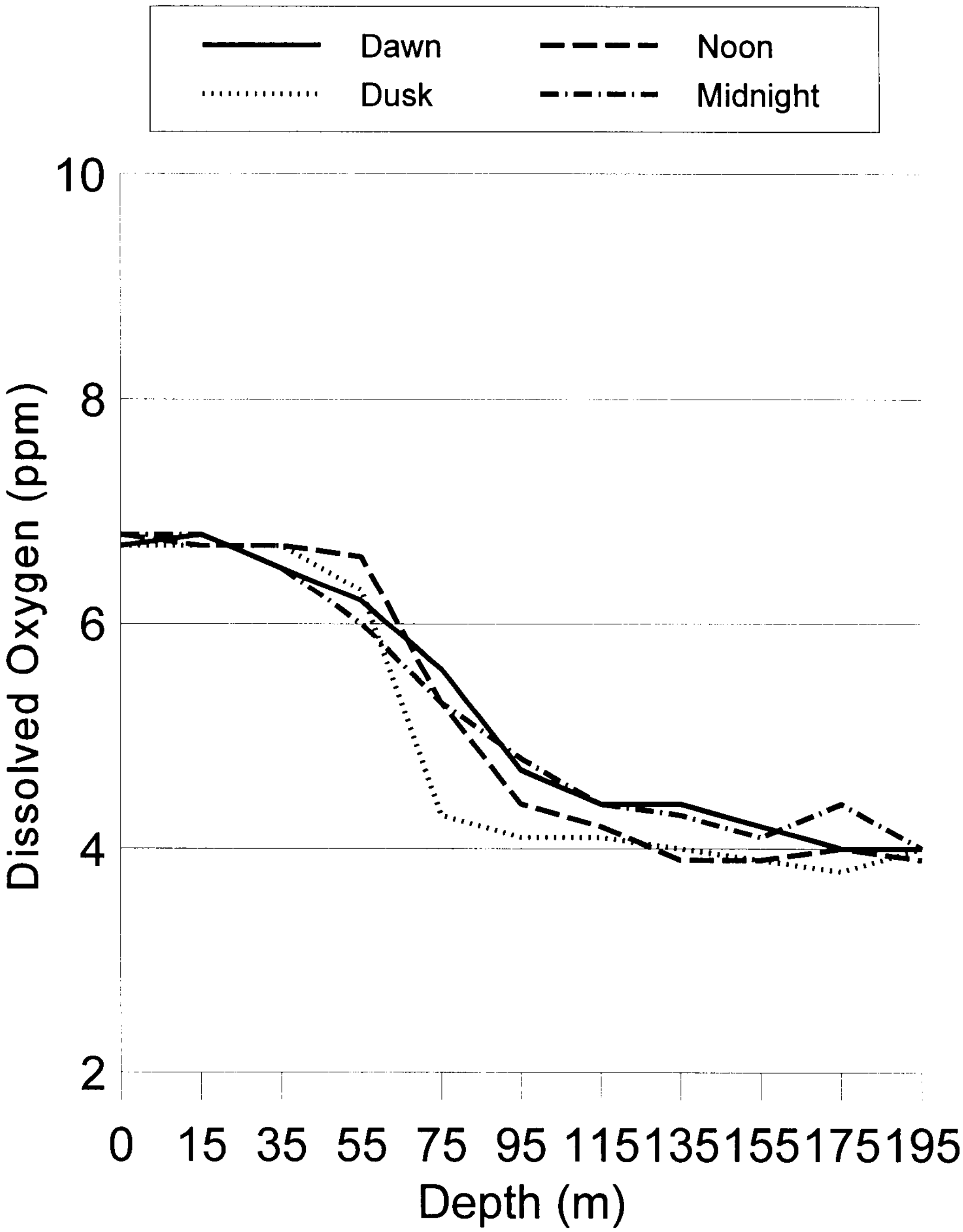
Appendix 3-17. Plot of current speed and direction with depth coincident with acoustic data at Green Canyon 18, November 20, 1995.



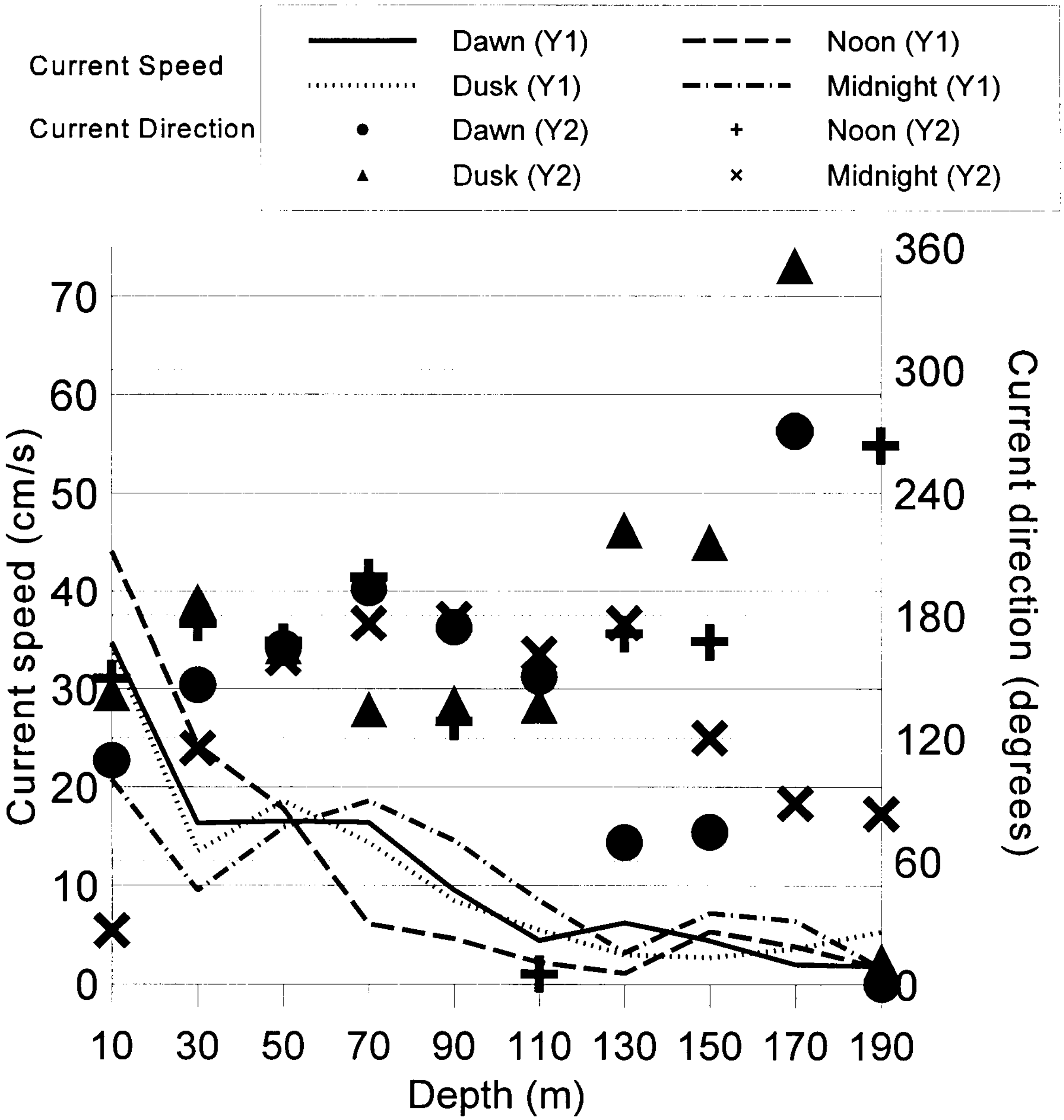
Appendix 3-18. Plot of temperature and water depth coincident with acoustic data at Green Canyon 18, November 18-20, 1995.



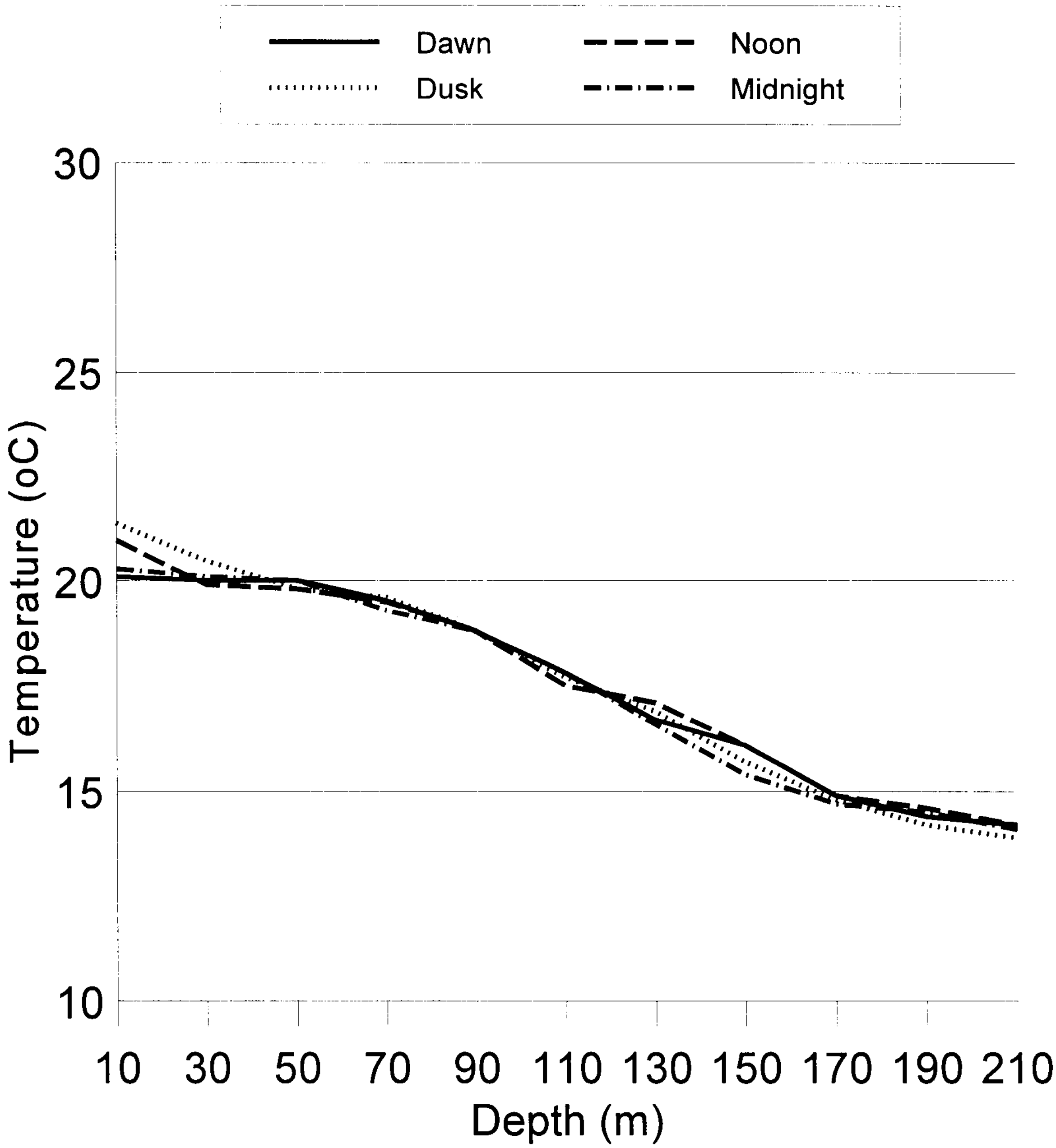
Appendix 3-19. Plot of salinity with depth coincident with the collection of acoustic data at Green Canyon 18, November 18-20, 1995.



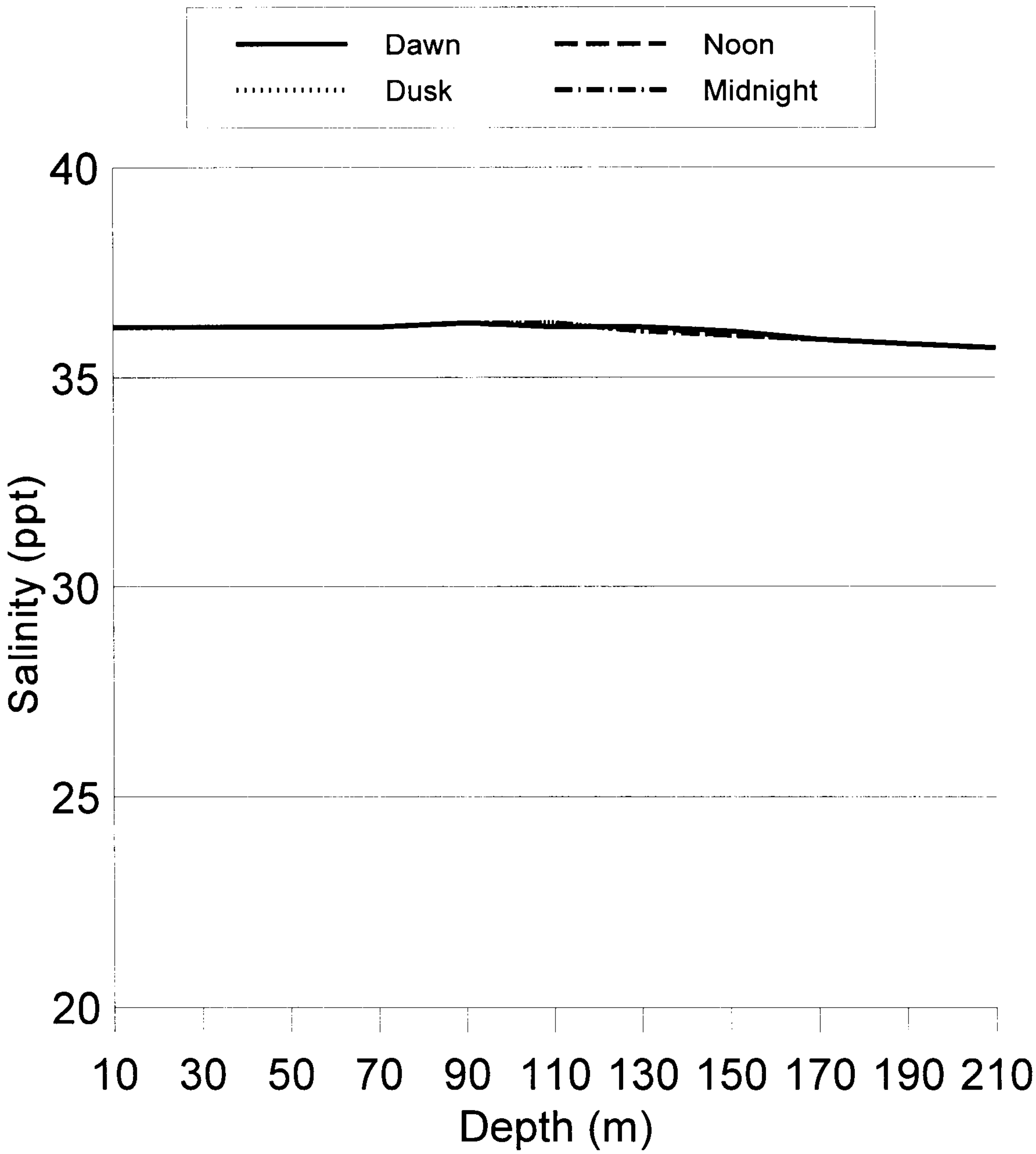
Appendix 3-20. Plot of depth with dissolved oxygen coincident with acoustic data at Green Canyon 18, November 18-20, 1995.



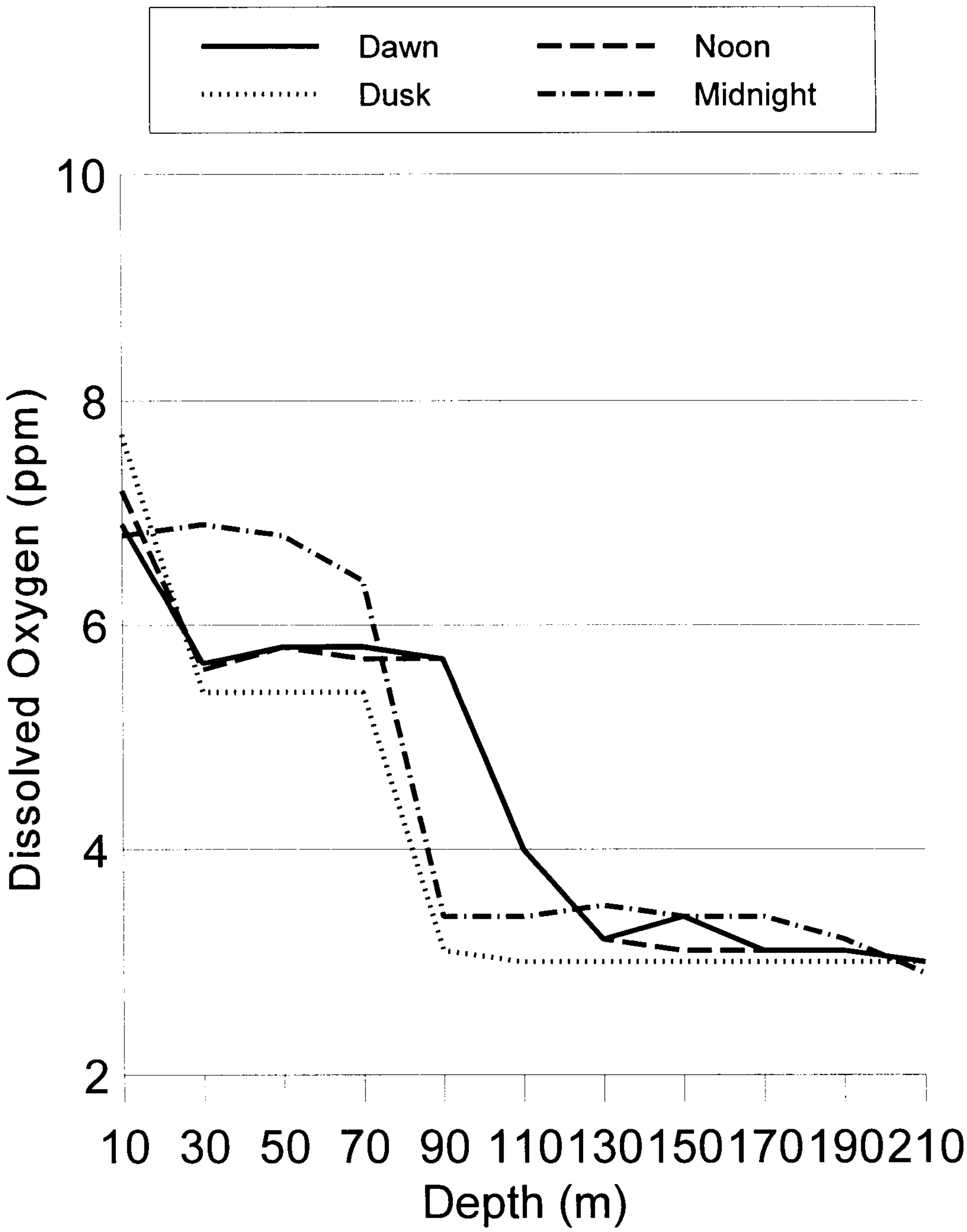
Appendix 3-21. Plot of current speed and direction with depth coincident with acoustic data at Green Canyon 18, March 4-5, 1996.



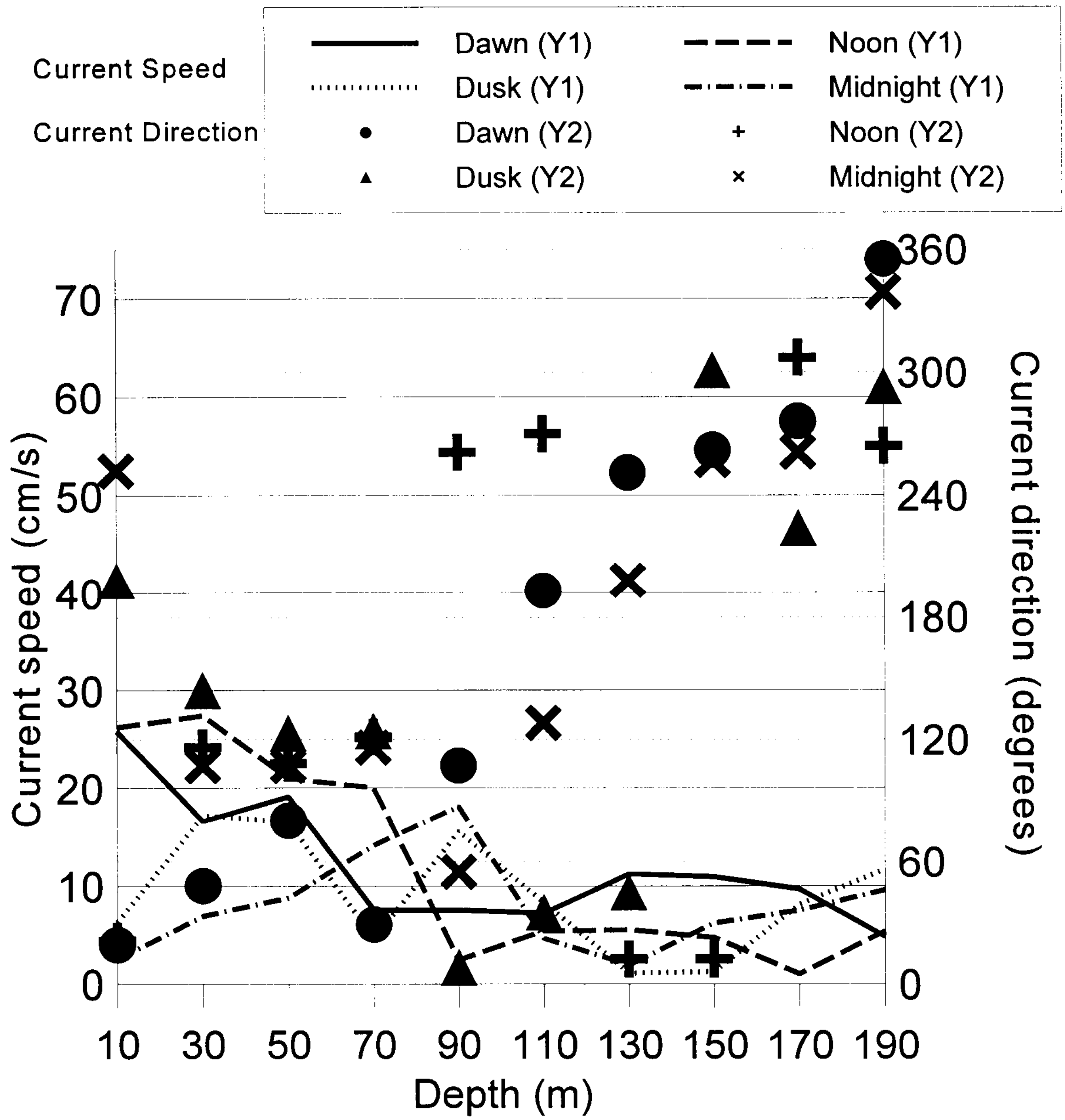
Appendix 3-22. Plot of temperature and water depth coincident with acoustic data at Green Canyon 18, March 4-5, 1996.



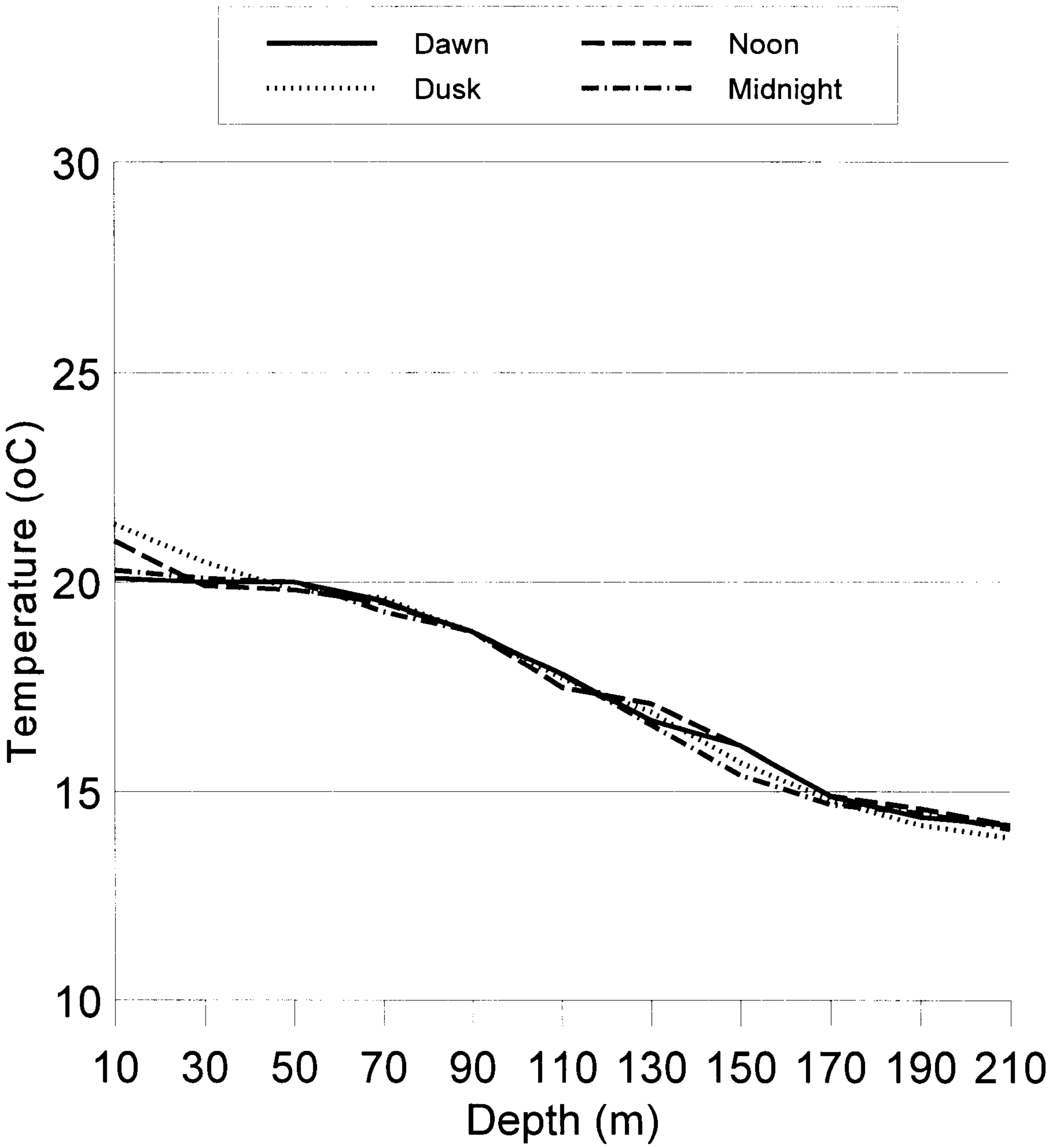
Appendix 3-23. Plot of salinity with depth coincident with the collection of acoustic data at Green Canyon 18, March 4-5, 1996.



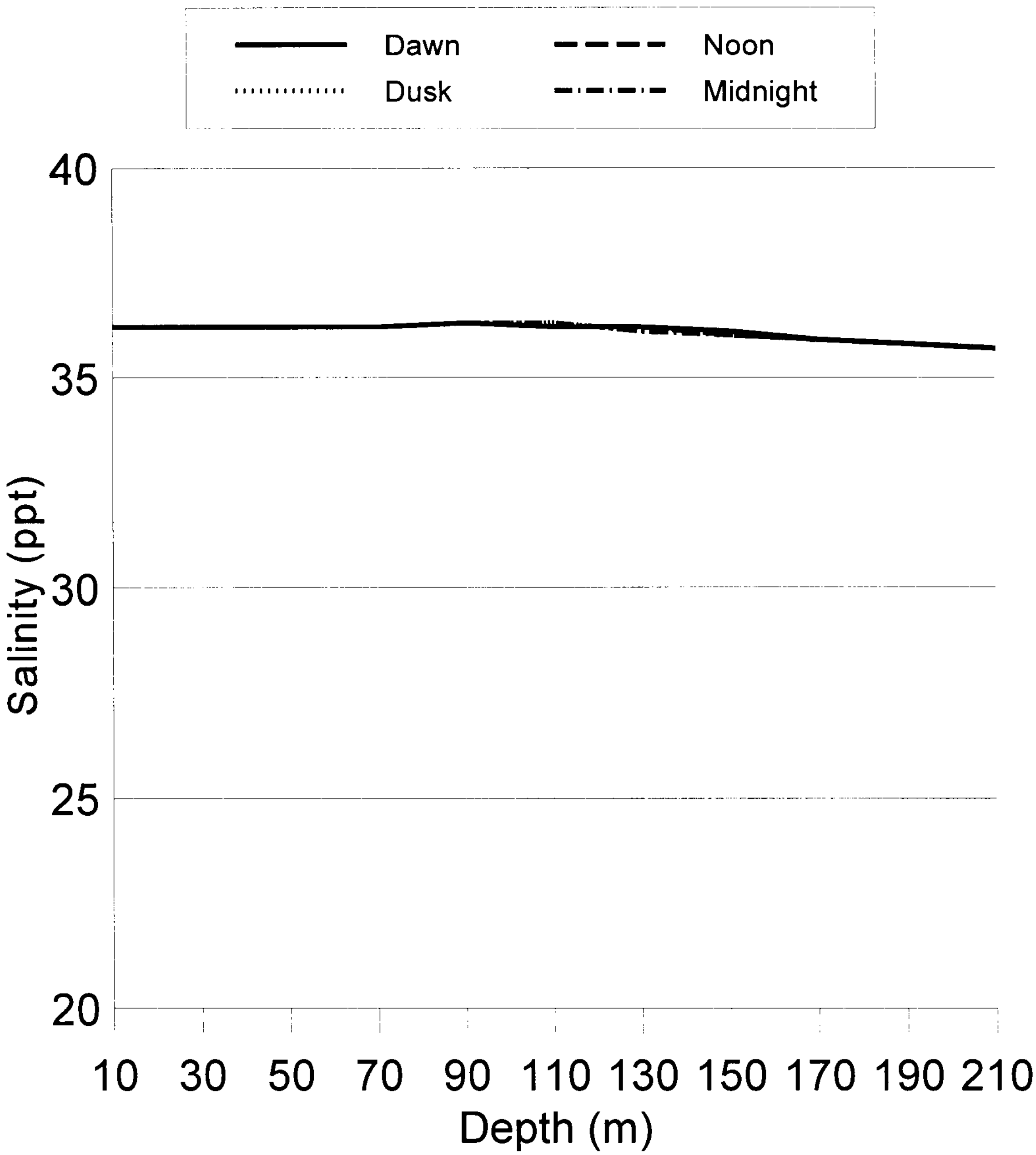
Appendix 3-24. Plot of depth with dissolved oxygen coincident with acoustic data at Green Canyon 18, March 4-5, 1996.



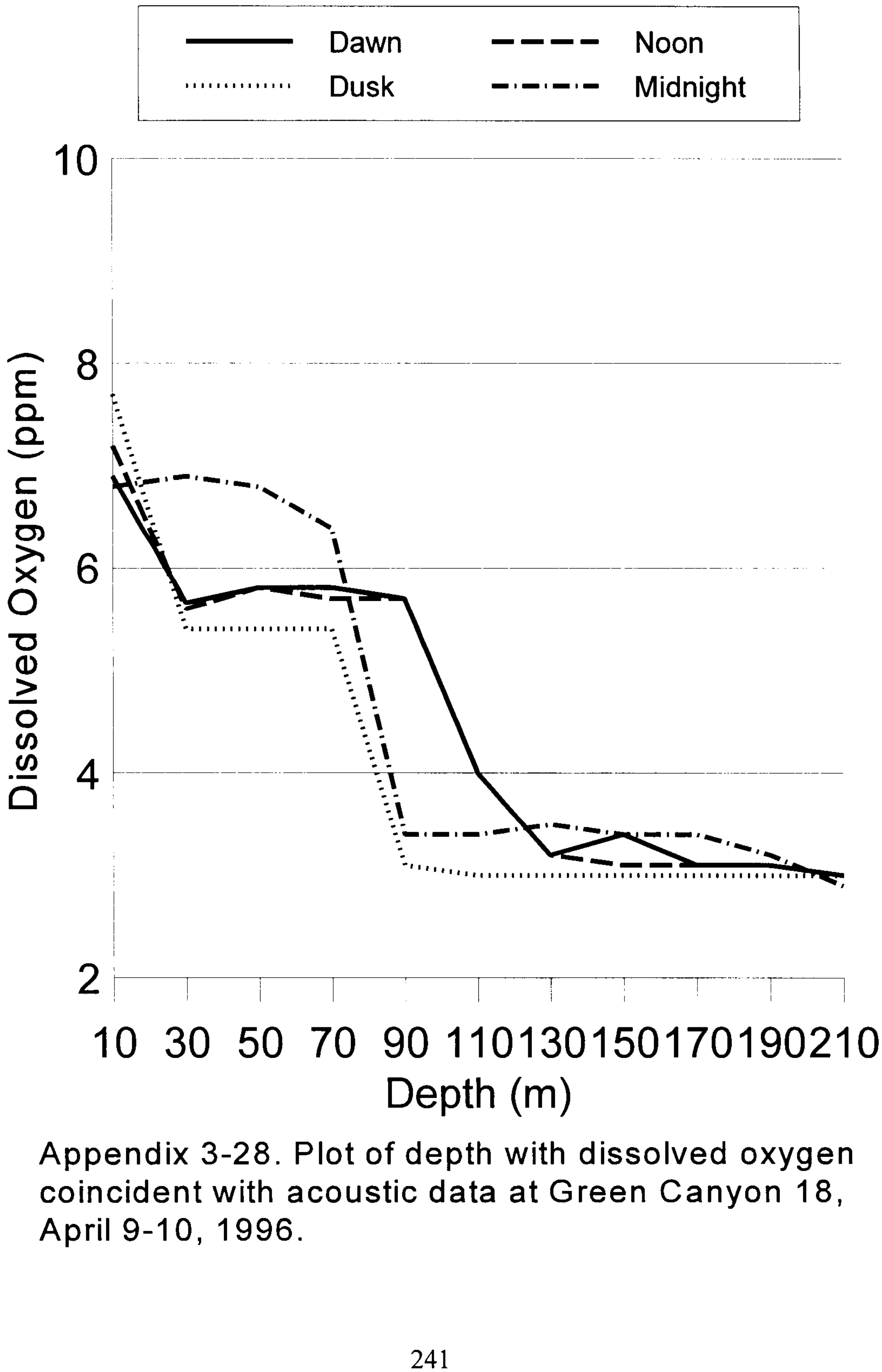
Appendix 3-25. Plot of current speed and direction with depth coincident with acoustic data at Green Canyon 18, April 9-10, 1996.



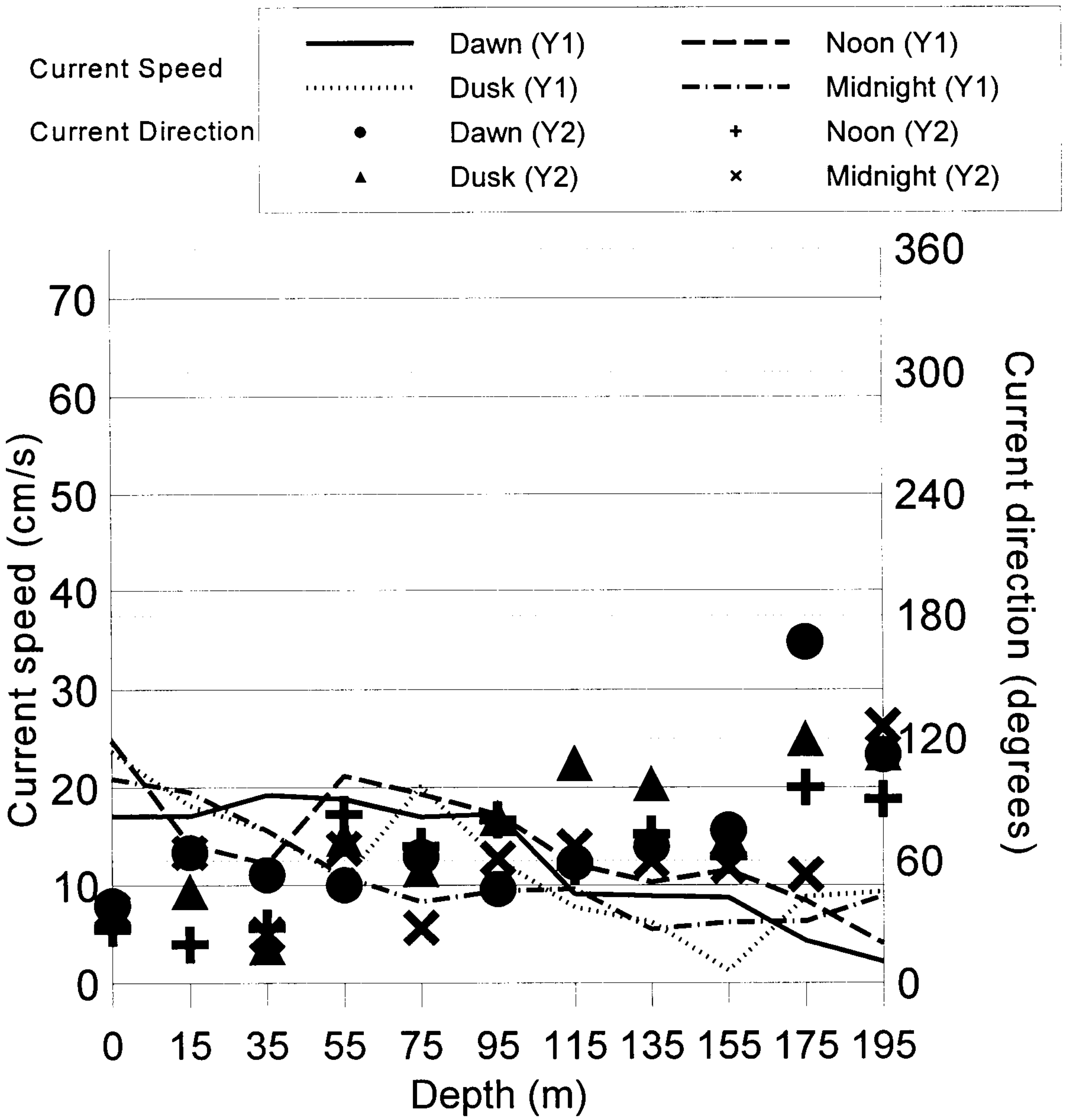
Appendix 3-26. Plot of temperature and water depth coincident with acoustic data at Green Canyon 18, April 9-10, 1996.



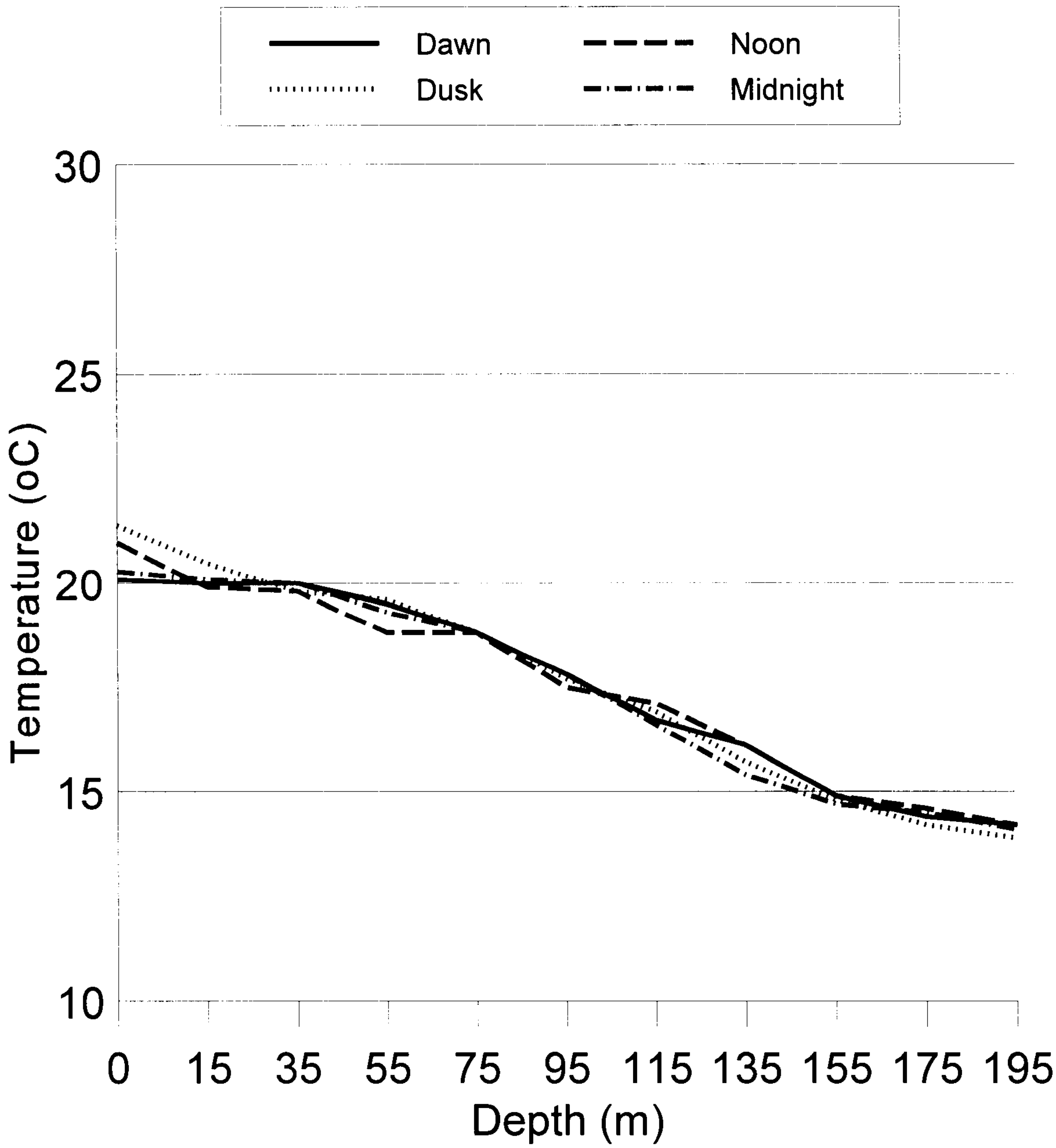
Appendix 3-27. Plot of salinity with depth coincident with the collection of acoustic data at Green Canyon 18, April 9-10, 1996.



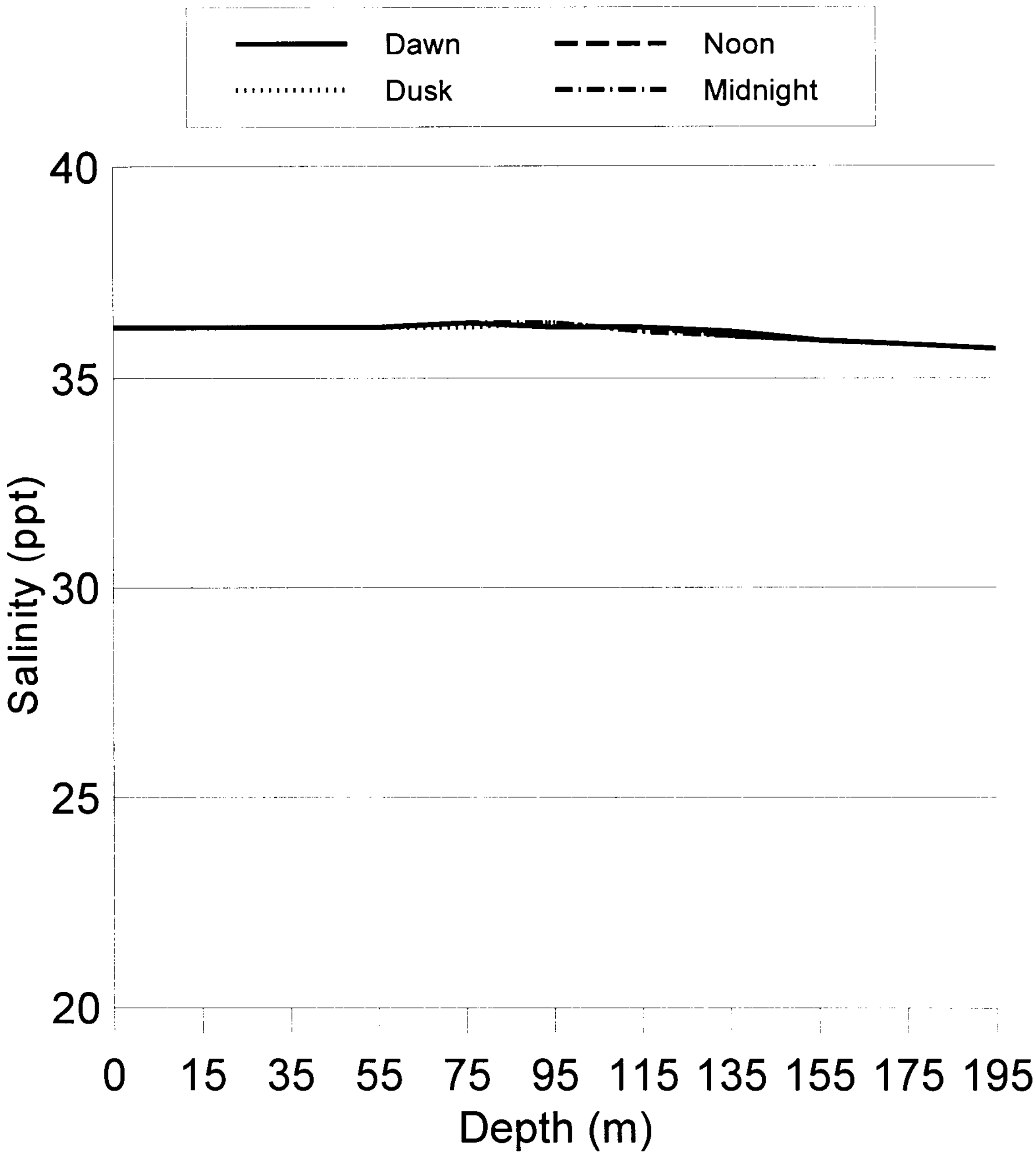
Appendix 3-28. Plot of depth with dissolved oxygen coincident with acoustic data at Green Canyon 18, April 9-10, 1996.



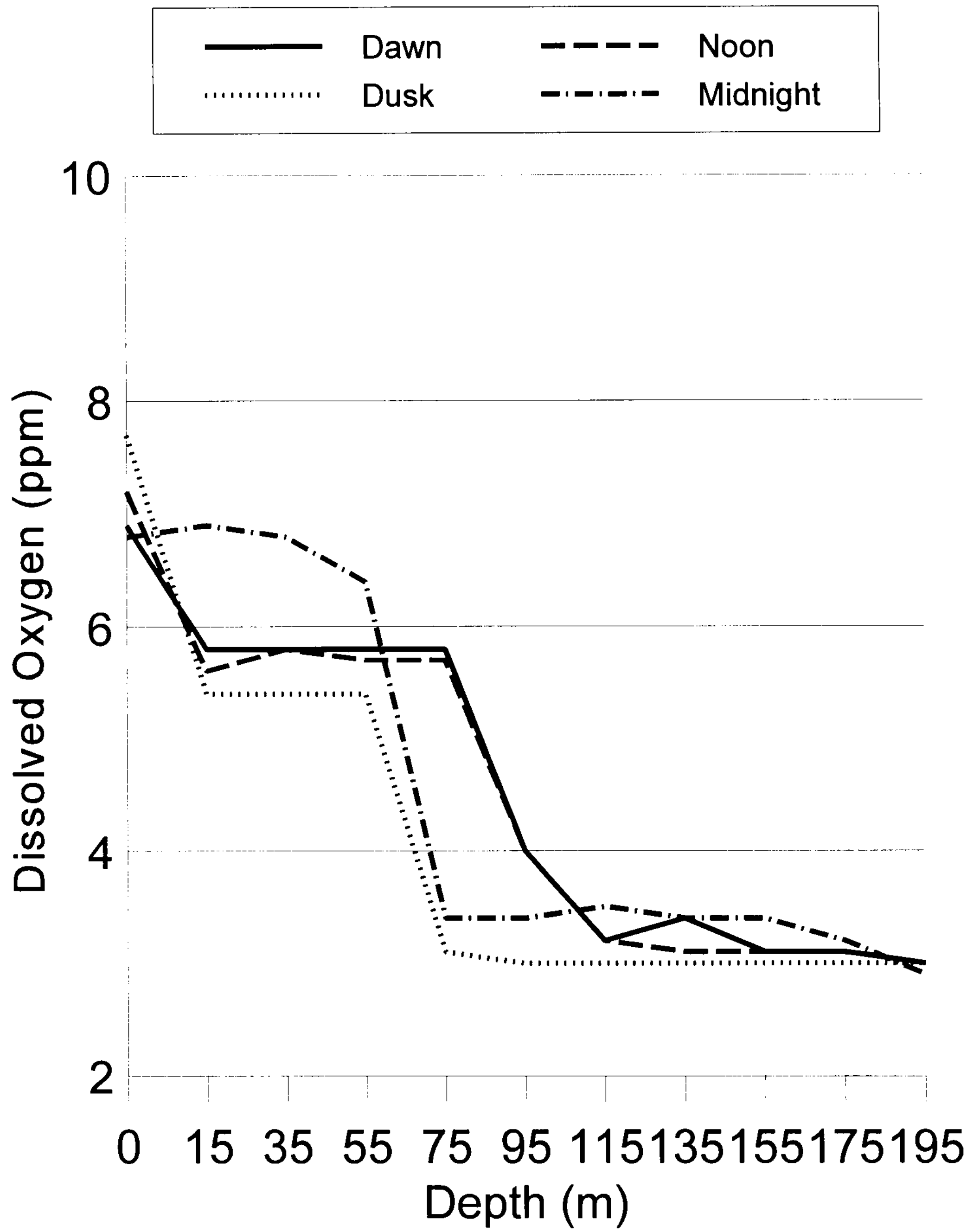
Appendix 3-29. Plot of current speed and direction with depth coincident with acoustic data at Green Canyon 18, Auguust 13, 1996.



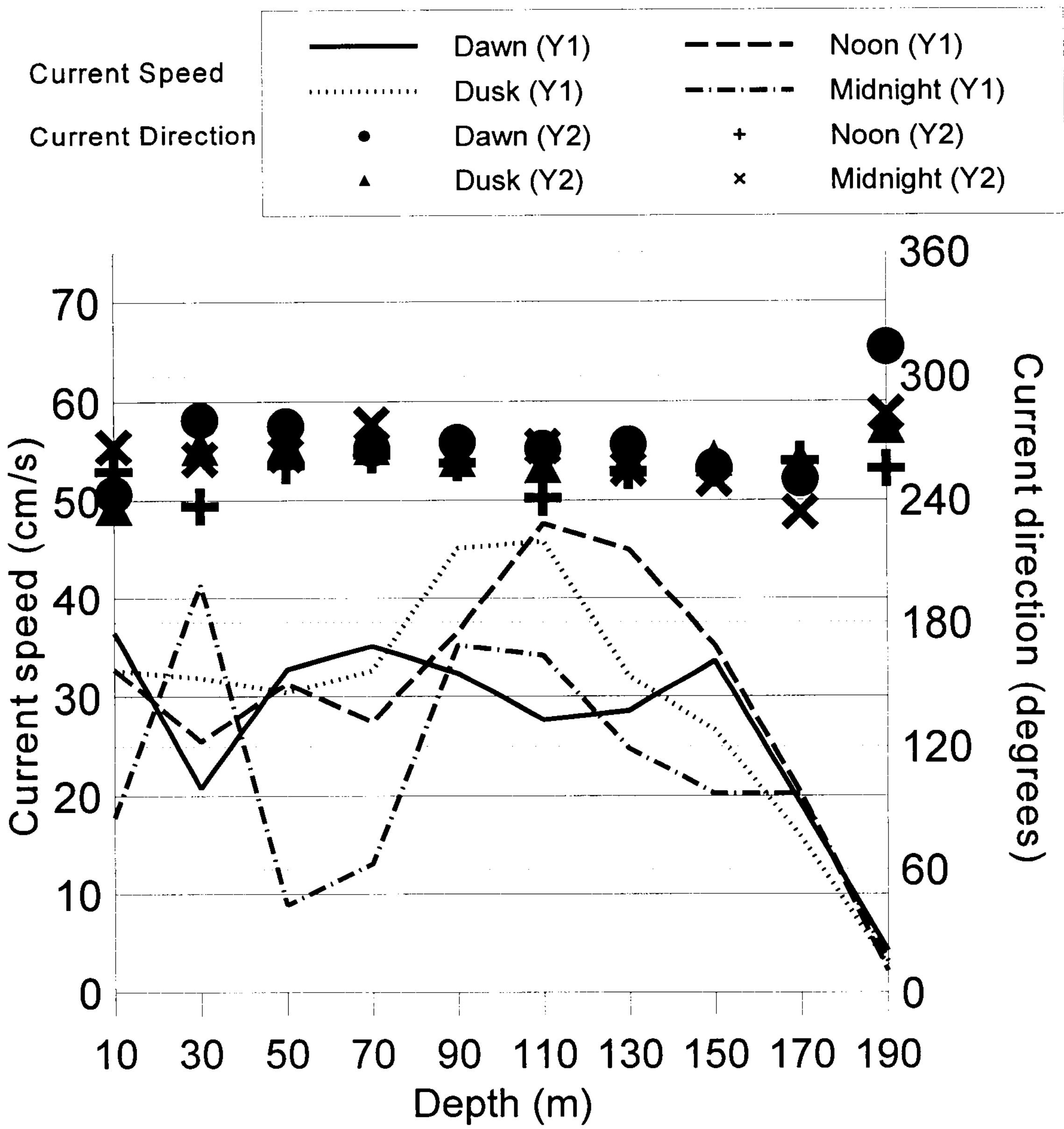
Appendix 3-30. Plot of temperature and water depth coincident with acoustic data at Green Canyon 18, August 13, 1996.



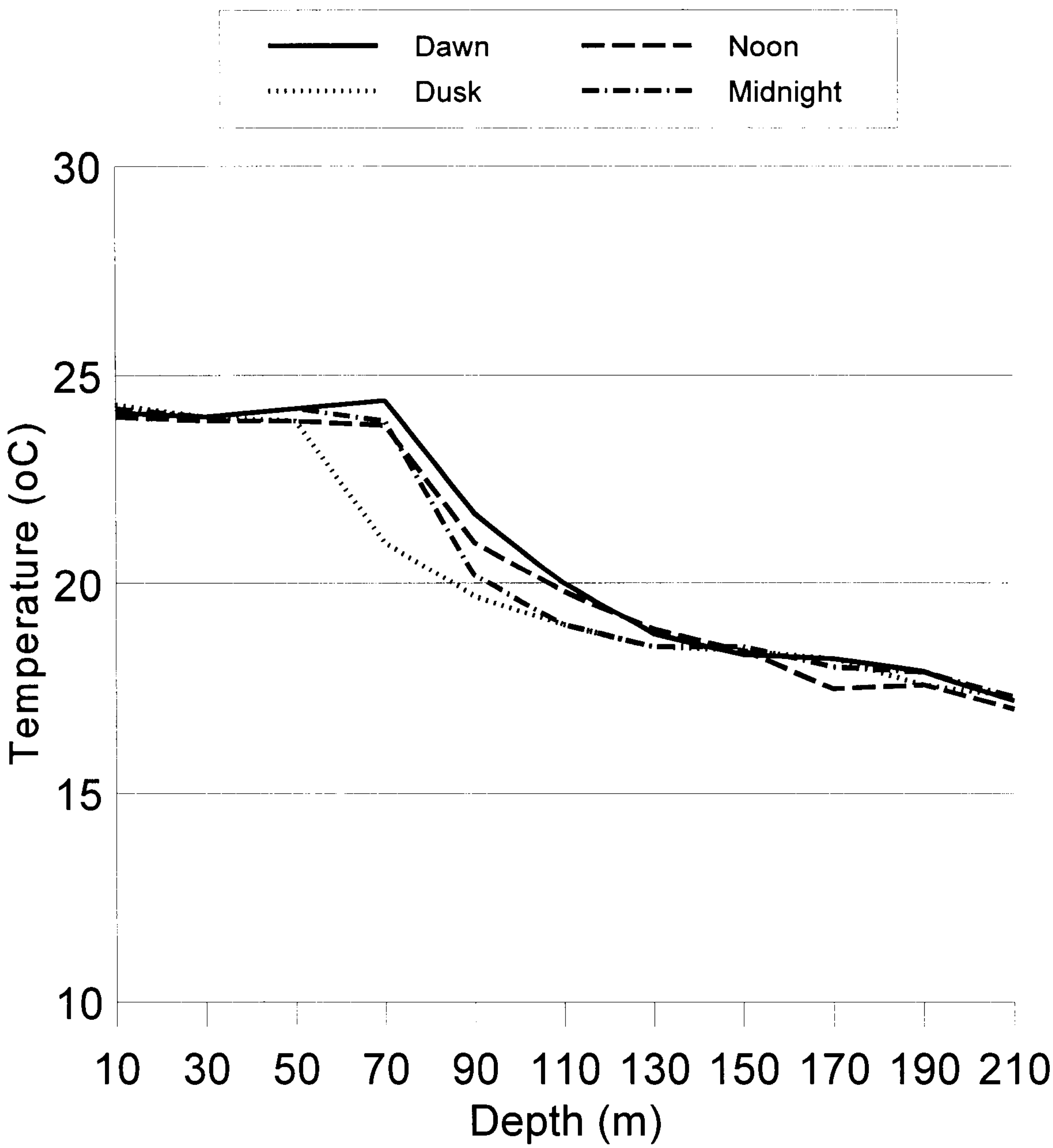
Appendix 3-31. Plot of salinity with depth coincident with the collection of acoustic data at Green Canyon 18, Auugust 13, 1996.



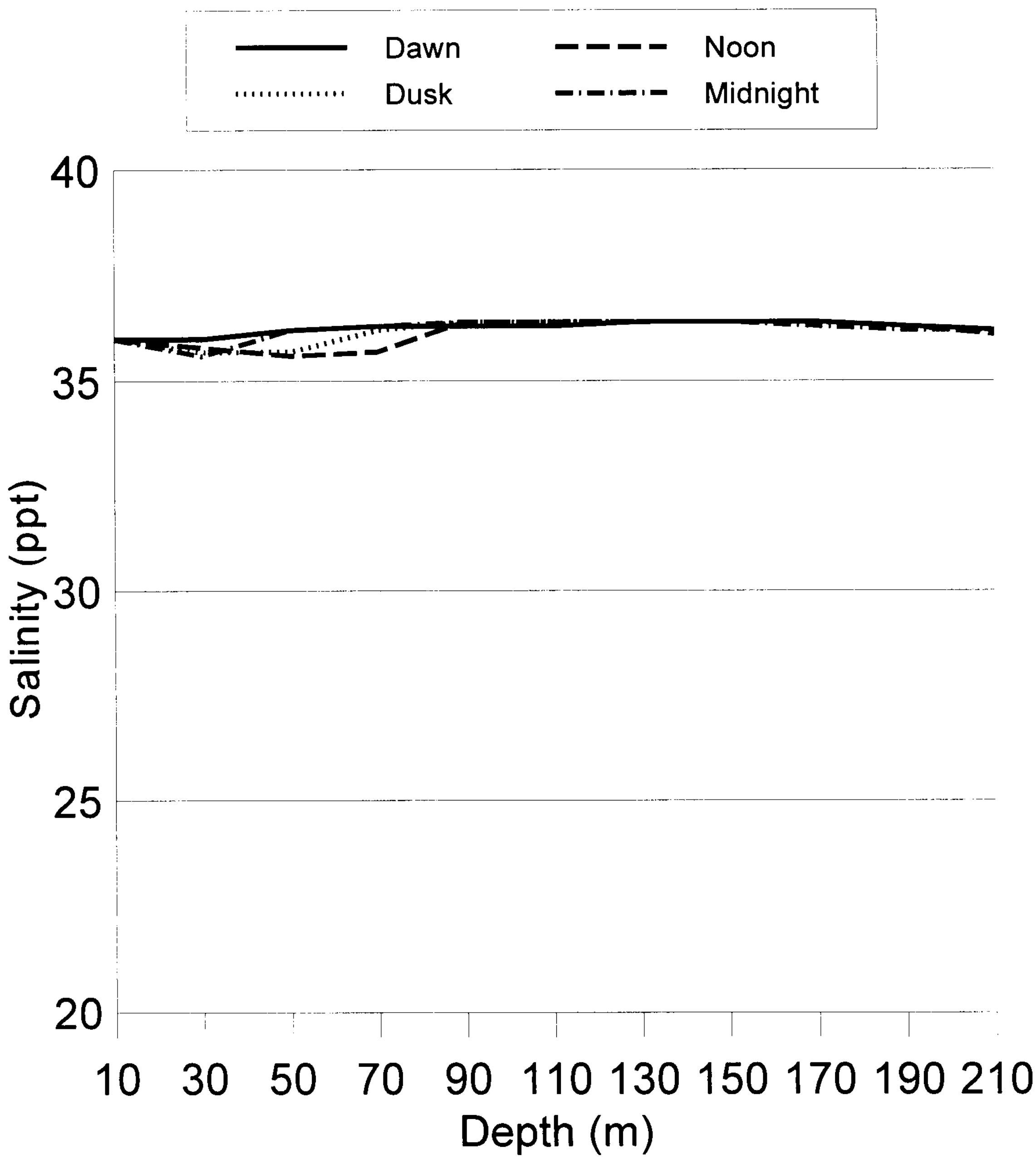
Appendix 3-32. Plot of depth with dissolved oxygen coincident with acoustic data at Green Canyon 18, August 13, 1996.



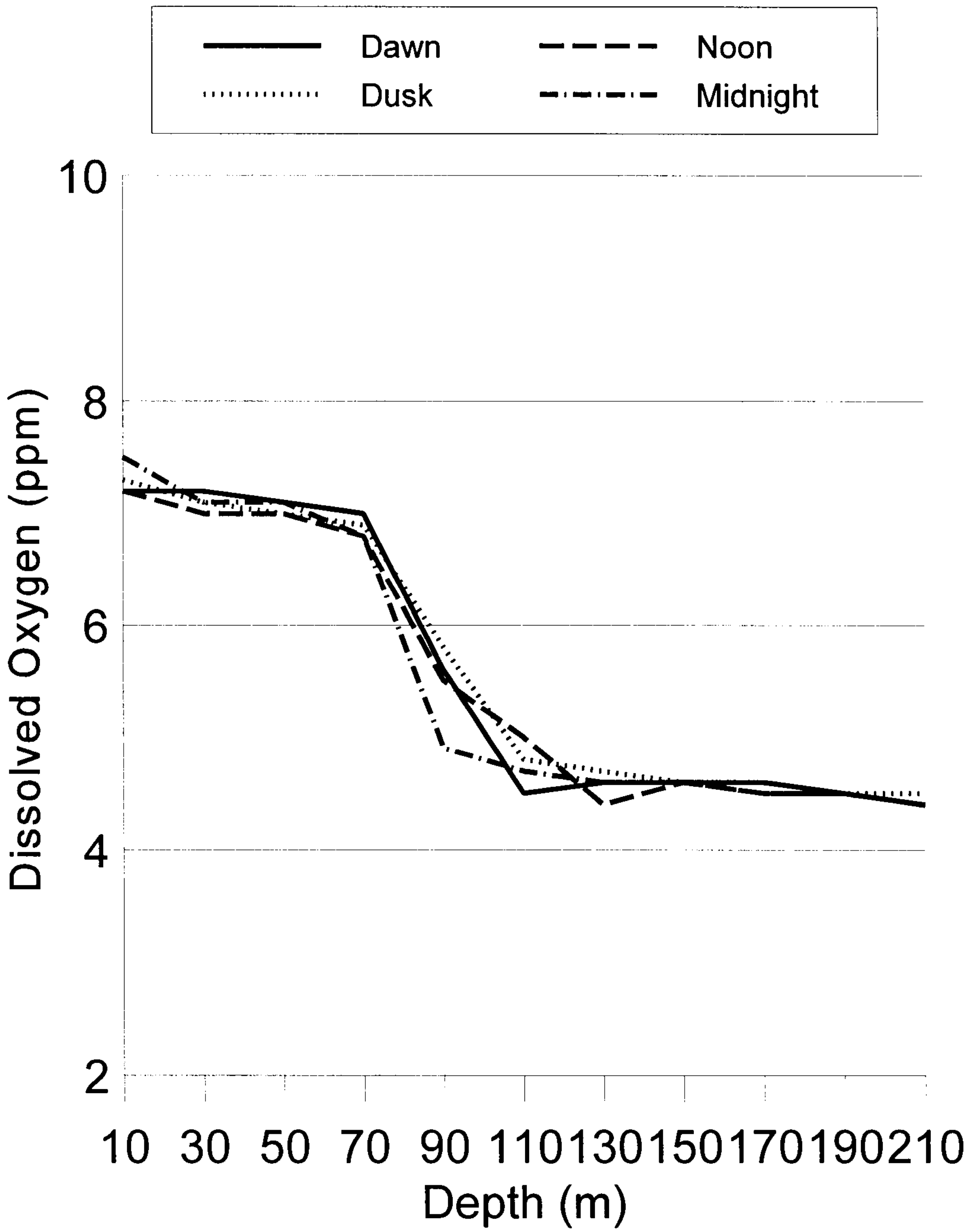
Appendix 3-33. Plot of current speed and direction with depth coincident with acoustic data at Green Canyon 18, November 20, 1996.



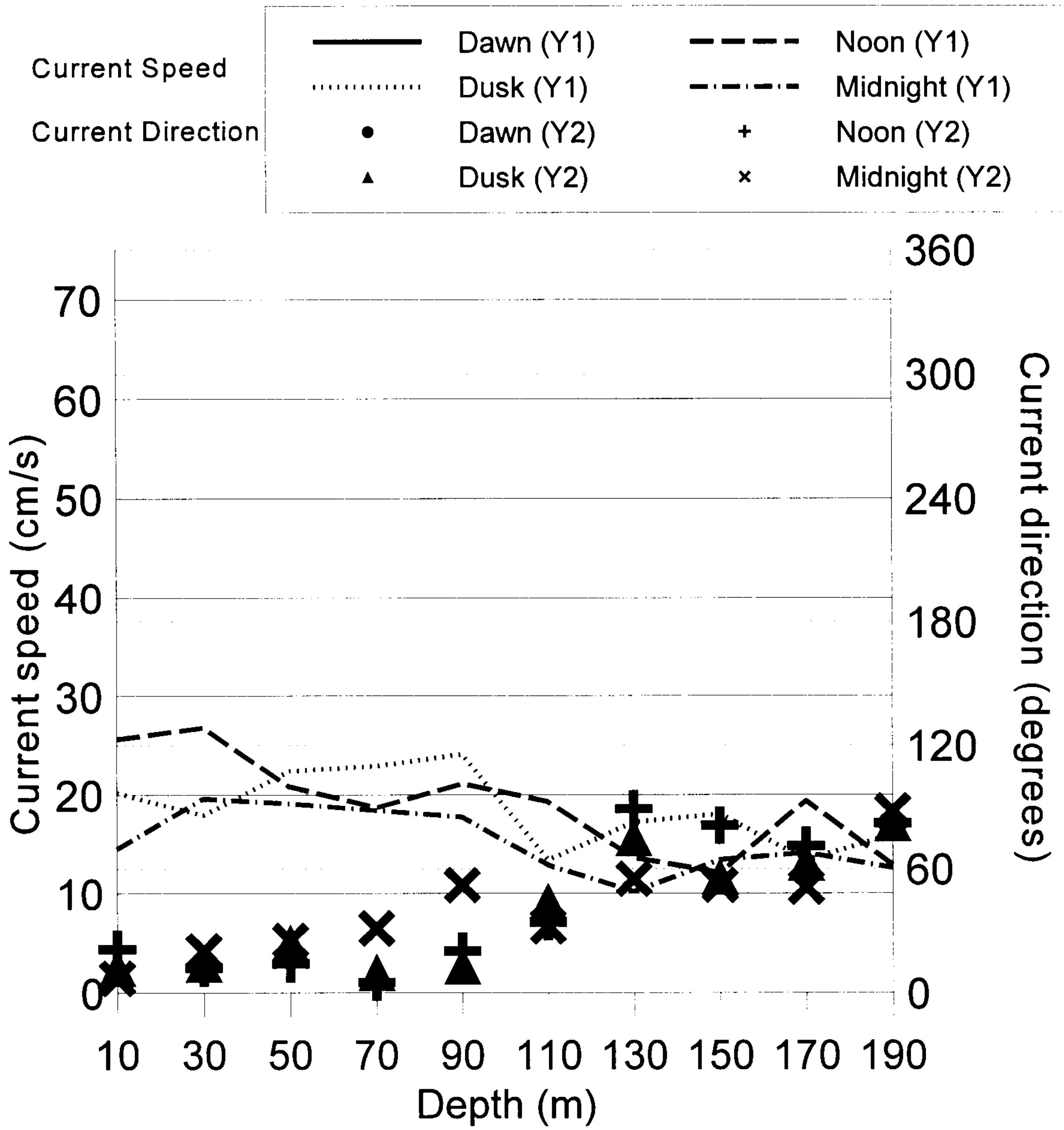
Appendix 3-34. Plot of temperature and water depth coincident with acoustic data at Green Canyon 18, November 18-20, 1996.



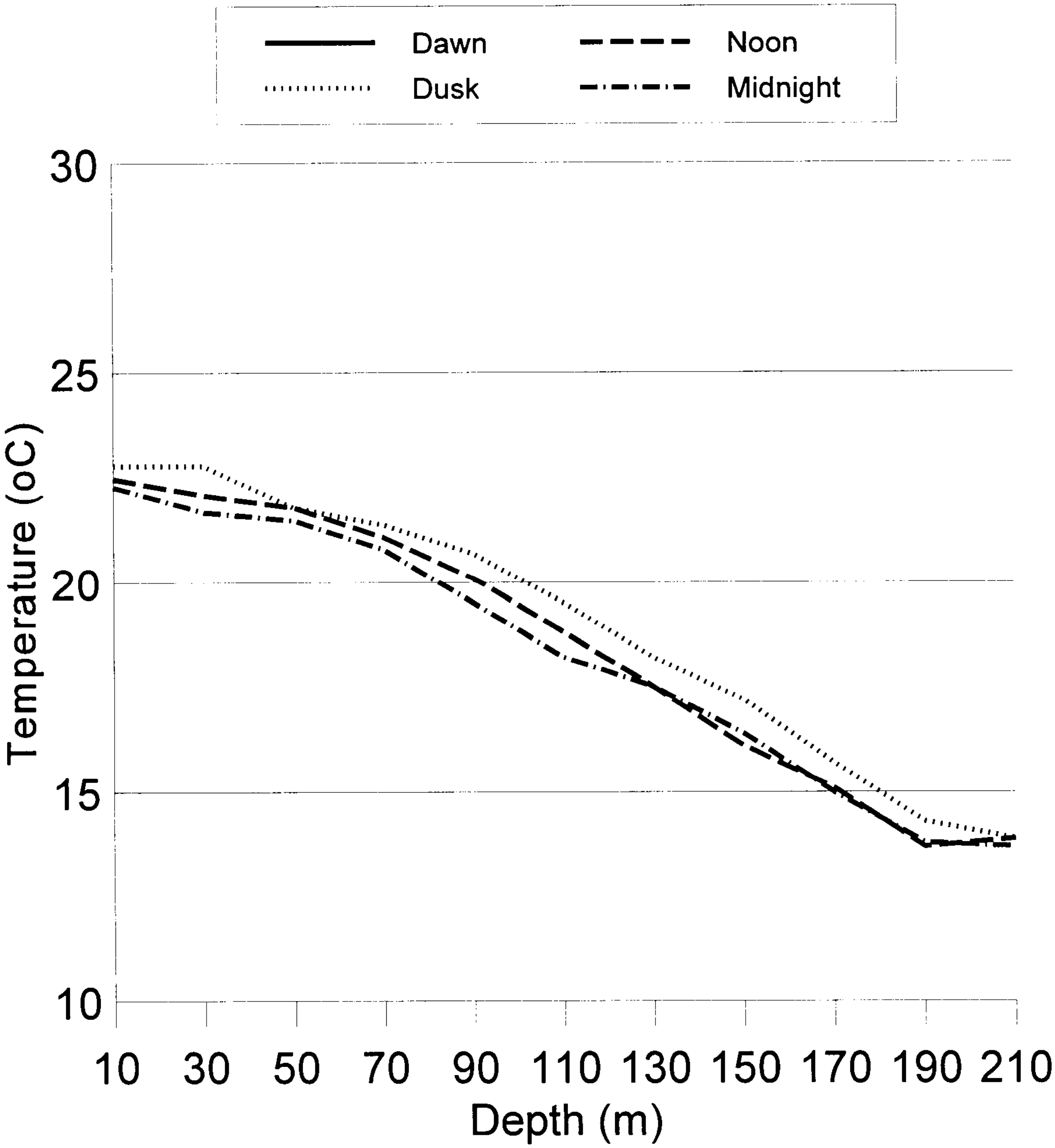
Appendix 3-35. Plot of salinity with depth coincident with the collection of acoustic data at Green Canyon 18, November 18-20, 1996.



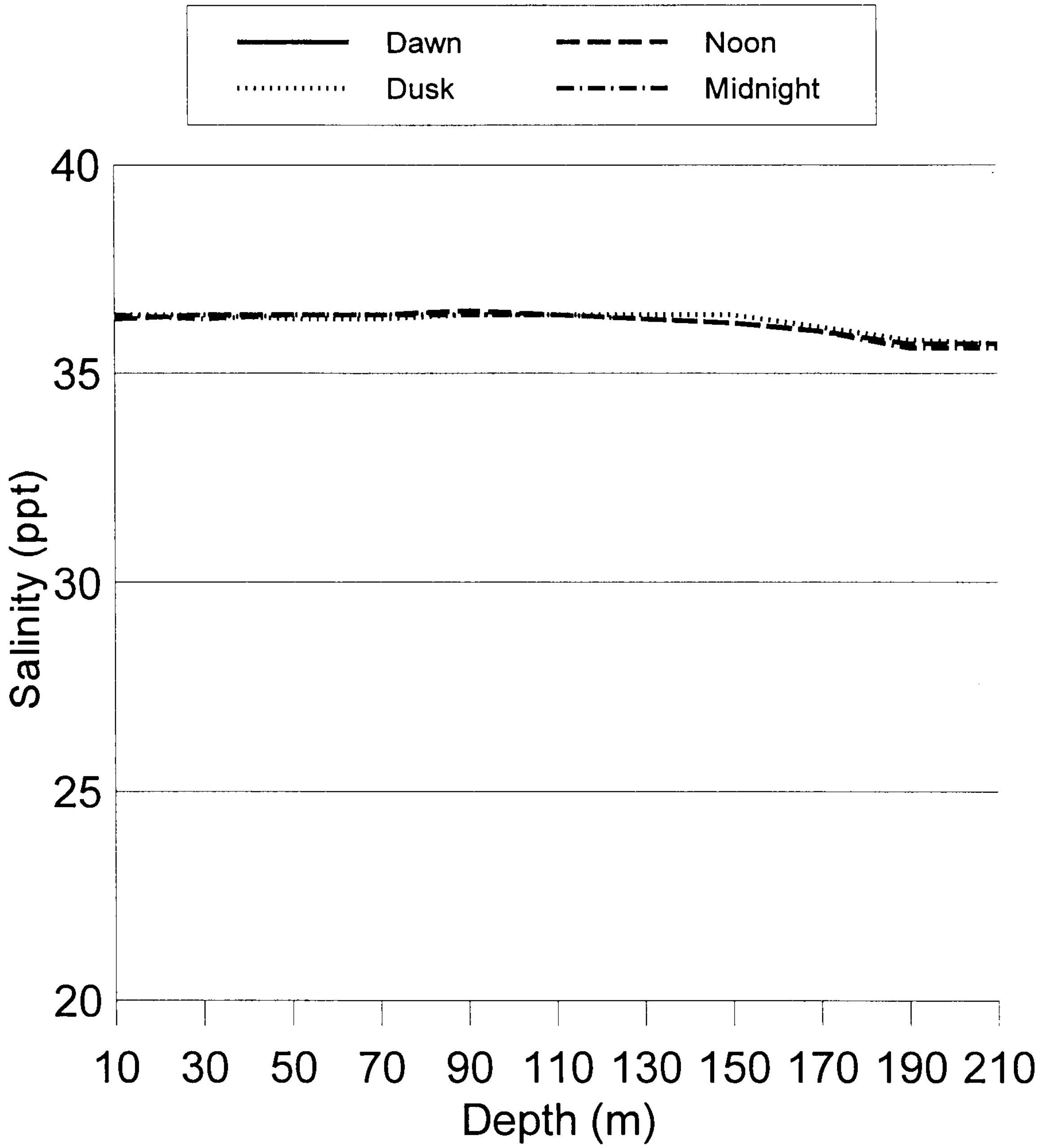
Appendix 3-36. Plot of depth with dissolved oxygen coincident with acoustic data at Green Canyon 18, November 18-20, 1996.



Appendix 3-37. Plot of current speed and direction with depth coincident with acoustic data at Green Canyon 18, March 4-5, 1997 (note Dawn data not available due to winch failure).



Appendix 3-38. Plot of temperature and water depth coincident with acoustic data at Green Canyon 18, March 6-7, 1997



Appendix 3-39. Plot of salinity with depth coincident with the collection of acoustic data at Green Canyon 18, March 6-7, 1997.

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Royalty Management Program** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.