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Skimmer Trawl Fishery Catch Evaluations in Coastal Louisiana, 2004 and 2005

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ABSTRACT—Fishery observers collected data from 307 tows during 96 trips aboard skimmer trawl vessels in Louisiana's coastal waters from September 2004 through June 2005 to estimate catch rates of target and nontarget species, including sea turtles (Cheloniidae and Dermochelyidae), by area and season during commercial shrimping operations. About 16,965.7 kg of total catch were recorded during 517.0 hours of fishing operations. Based on weight extrapolations from species composition samples, penaeid shrimp (Penaeidae) dominated the catch at 66%, followed by finfish at 19%, nonpenaeid shrimp crustaceans at 7%, discarded penaeid shrimp at 6%, and debris at 3%. Noncrustacean invertebrates comprised less than 1%. Catch rates in kilograms per hour by category was 21.6 for penaeid shrimp, 6.2 for finfish, 2.2 for nonpenaeid crustaceans, 1.8 for discarded penaeid shrimp, and 0.9 for debris. White shrimp, Litopenaeus setiferus, *other penaeid shrimp, and Gulf menhaden,* Brevoortia patronus, *were the top three dominant species by weight. Seasonally, a higher catch rate was observed from May through August 2005 for penaeid shrimp as compared with the September through December 2004 period. Conversely, the September through December 2004 period experienced a higher catch rate for finfish than during May through August 2005. No sea turtle interactions were documented.*

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Introduction

The majority of penaeid shrimp (Penaeidae) harvested in the Gulf of Mexico and southeastern Atlantic are taken with bottom-otter trawls. Skimmer trawls (Fig. 1), an alternative method for shrimp capture, are paired-framed nets typically used in inshore waters. The gear can be passive, relying on tidal currents to move shrimp into the nets, or, more commonly, a vessel pushes the nets through the water column. Once the nets are lowered into the water, only the bags (cod ends) are picked up to remove the catch; the mouths of the skimmer trawls are continually fishing.

Skimmer trawls have been documented in Louisiana, North Carolina, and, more recently, in other coastal states in the Gulf of Mexico (Epperly et al., 2002). In 1992, the number of skimmer trawl licenses acquired in Louisiana was 1,836; by 2000, the number approximately doubled to 3,655 (Epperly et al., 2002). In North Carolina, skimmer trawls target white shrimp, *Litopenaeus setiferus*, in late summer through fall in Pamlico and Core Sounds. About 3,587 trips occurred in 2002 in North Carolina using skimmer trawl gear, with trips typically less than 24 h in length (Daniel[1]).

Hein and Meier (1995) reported on the history and use of skimmer trawls in coastal Louisiana. As reflected by increased license sales and based on dockside interviews, the advantages of skimmer trawls over the traditional otter trawl were presented. Increased efficiency relative to gear retrieval, better survivability and condition of both target and nontarget species, greater and more effective coverage of fishing areas, and improved safety were among the advantages given. Disadvantages included restricted fishing depth, greater care required to avoid obstructions at night, bottom damage resulting from improperly tuned gear, and vessel instability when underway.

Coale et al. (1994), using a skimmer trawl designed by a Louisiana commercial shrimp industry member, compared catch rates between skimmer and otter trawls in the inshore waters of North Carolina. They reported that the skimmer trawl caught less bycatch, had lower bycatch rates, and a lower fish-to-shrimp ratio ($\bar{x}$= 1.38) compared with the otter trawl during the peak white shrimp season. Moreover, white shrimp comprised 23.3% of the total weight in the skimmer trawl. In the otter trawl, white shrimp accounted for 5.1% of the total biomass. Conversely, brown shrimp, *Farfantepenaeus aztecus*, constituted 6.1% of the total catch in the skimmer trawl, compared with 16.8% of total biomass in the otter trawl. The authors also reported greater survivability of organisms captured in the skimmer trawl than those obtained in the otter trawl.

The performance of the standard high-profile vs. low-profile skimmer trawls in North Carolina was examined by Hines et al. (1999). Catch rates for penaeid shrimp, including penaeid discards, were significantly lower in the low-profile net as opposed to the high-profile net. By species, brown shrimp catches were lower by 39.1%; no significant difference was detected between the two net designs for pink shrimp, *Farfantepenaeus duorarum*. The authors attributed this to low pink

[1]Daniel, L. 2004. North Carolina Division of Ma-rine Fisheries, Morehead City. Personal commun.

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shrimp abundance. No white shrimp were present during the study. Total finfish by weight was similar between the two net designs, with finfish comprising 67.5% in the low-profile net, and 62.0% in the high-profile net.

Rudershausen and Weeks (1999) discussed the advantages of skimmer trawls over conventional otter trawls used in North Carolina. These included reducing bycatch, minimizing disturbance to the benthic habitat, and increasing bycatch survivability. The authors compared steel and aluminum skimmer trawl frames to determine if fuel efficiency would increase with the lighter, yet more expensive, aluminum construction; there was no significant difference in fuel efficiency between materials.

Currently, there are no turtle excluder device (TED) or bycatch reduction device (BRD) requirements for skimmer trawls; however, limited tow-time restrictions apply due to the potential for sea turtle interactions. Tow times are established by individual states. Prior to this research effort, very limited historical and no known current data relative to catch composition, directed effort, or operational aspects for the Gulf of Mexico skimmer trawl fishery were available.

In September 2004, the NMFS Southeast Fisheries Science Center's Galveston Laboratory, in cooperation with the shrimp industry, initiated observer coverage of the skimmer trawl fishery operating in the U.S. Gulf of Mexico, exclusively within coastal waters of Louisiana. The primary objectives of this research were to estimate catch rates of target and nontarget species, including sea turtles, by area and season during commercial shrimping operations.

Methods

NMFS-approved observers were placed on cooperating skimmer trawl vessels targeting penaeid shrimp. Ninety-six skimmer trawl trips were observed from September 2004 through June 2005. A total of 307 tows during 114 sea days of observations (Fig. 2) were completed during the study period. No attempt was made to direct fishing location or to modify normal commer-

Figure 1.—A skimmer trawl vessel showing the paired-frame net design.

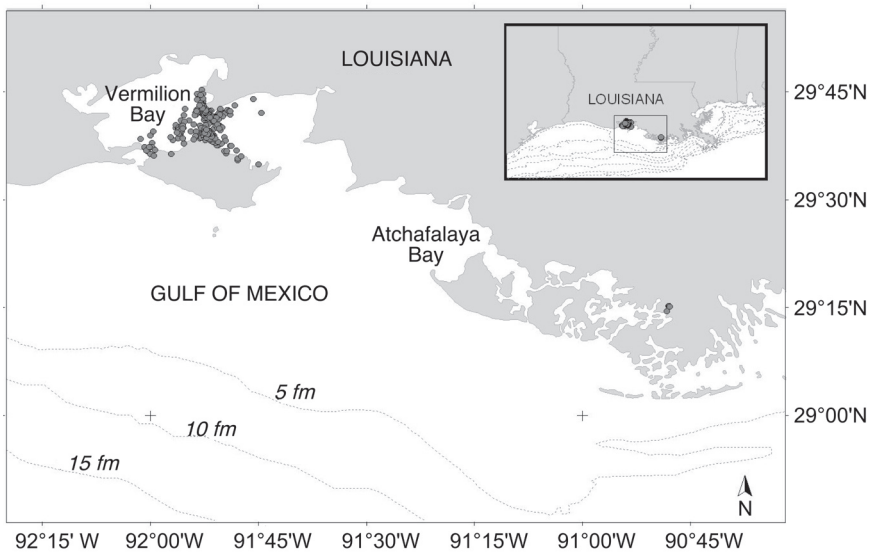

Figure 2.—Distribution of sampling effort (tows) aboard skimmer trawl vessels.

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cial operations. Effort allocation was based on vessel availability and current commercial effort trends by area and season.

Vessel length, hull construction material, gross tonnage, engine horsepower, and crew size information were obtained for each vessel. Characteristics related to net type and other associated gear were recorded at the start of each trip or when changes were made. Bottom time, vessel speed, and operational aspects relative to each net were documented for each tow.

Fishery-specific data were collected from one randomly selected net from each tow. Total catch and shrimp weights were recorded (i.e. not extrapolated and based on one net per tow). A subsample (about 20% of the total catch weight) was processed for species composition. Species weight and number were obtained from the subsample. A detailed description of the sampling procedures is contained in the NMFS Characterization of the U.S. Gulf of Mexico and Southeastern Atlantic Otter-trawl and Bottom Reef Fish Fisheries Observer Training Manual (NMFS[2]).

Species total weights and numbers were extrapolated from subsample weight to the total catch weight, and are also based on one net per tow. In the absence of a weight or number for a given species, the entire tow was set aside from the analysis.

Unique species, family, taxa, etc. (now referred to as species) were recorded. Species were placed into the following categories: penaeid shrimp, nonpenaeid shrimp crustaceans, fish, noncrustacean invertebrates, and debris (e.g. rocks, logs, trash). Debris counts, where present, were entered as a default of one and accounted for less than 1% based on one unit of debris for each tow.

Overall catch rates were presented for all years, areas, seasons, and depths. Catch rate estimates were also examined by year and season. Seasonal categories are as follows: January through April, May through August, and September through December.

Biological measurements were recorded in metric units. Vessel, gear, and depth measurements followed current standards for the fisheries (i.e. U.S. system equivalents) as related to relevant regulatory mandates.

For graphing purposes, percent values were rounded to the nearest whole number. The order of the categories presented in the graphs varied. Moreover, sample size used for extrapolation purposes varied by weight and number.

All data were entered into the southeast regional shrimp trawl bycatch database that has been developed since 1992 though a southeast regional program conducted by NMFS in cooperation with commercial fishing organizations and interests, state fishery management agencies, and universities. This database is housed and managed at the NMFS Southeast Fisheries Science Center's Galveston Laboratory where final data sets are archived. Summarized data (i.e. individual identifiers removed) are available for use by all interested stakeholders.

Results

Overview

Three observers collected data from 307 tows from ninety-six trips in coastal waters of Louisiana from September 2004 to June 2005. Based on these 307 tows (517.0 h), 16,965.7 kg of total catch were recorded based on one net from each tow. Retained shrimp species comprised 10,423.2 kg (heads-on), or 61.4% of the total weight. Catch-per-unit-of-effort (CPUE) for shrimp was 20.2 kg/h.

Three hundred and four tows contained species characterization data. Penaeid shrimp percent composition extrapolated from these subsamples was 66.1%. Extrapolated CPUE for shrimp based on subsamples was 21.6 kg/h.

A total of 63 unique species were collected. There were 56 species of fish and 4 species of penaeid shrimp. Crustaceans and invertebrates had one unique species each. Logs, rocks, etc. were placed in miscellaneous debris.

Vessels, Gear, and Tow Characteristics

Three unique vessels participated in the study. Overall vessel length ranged from 34 to 42 ft with 39.7 ft the average (± 4.0 s.d.). All vessels were of fiberglass construction and had ice storage capacity.

Based on a per tow basis, headrope length was 16.0 ft (± 0.0 s.d). Two nets were pushed on each tow. Nets were not equipped with TED's or BRD's. Towing speed ranged from 0.9 to 3.0 kn and averaged 1.8 kn (± 0.3 s.d.).

Tow depth averaged 1.3 fathoms (± 0.2 s.d) and ranged from 0.8 to 2.3 fathoms. Tow time ranged from 0.2 to 4.3 h, with an average tow time of 1.7 h (± 0.4 s.d). The majority of tows occurred between dawn and late afternoon; average trip length was 1 day.

Extrapolated Species Composition by Categories: Percent and CPUE

Based on weight extrapolations from species composition samples by category for both years, all areas, seasons, and depths (Fig. 3), penaeid shrimp dominated the catch at 66%, followed by fish species at 19%, nonpenaeid shrimp crustaceans at 7%, discarded penaeid shrimp at 6%, and debris at 3%.[3] Noncrustacean invertebrates comprised less than 1%. CPUE (kg/h) by category was 21.6 for penaeid shrimp, 6.2 for fish, 2.2 for crustaceans, 1.8 for discarded penaeid shrimp, and 0.9 for debris.

Extrapolated numbers from species composition samples by category for all years, areas, seasons, and depths are presented in Figure 4. Penaeid shrimp were dominant by number at 89%, followed by fish at 8%, discarded penaeid shrimp at 2%, and nonpenaeid shrimp crustaceans at 1%. As previously mentioned, tows where no counts were obtained (75) for a given species were set aside for the purpose of this analysis. CPUE estimates in numbers per hour for the category components were 6,498 for

[2]NMFS. 2002. Characterization of the U.S. Gulf of Mexico and southeastern Atlantic otter trawl and bottom reef fish fisheries. Observer Training Manual. NMFS Southeast Fisheries Science Center, Galveston Laboratory, Galveston, Tex.

[3]Percentages may not equal 100% due to rounding.

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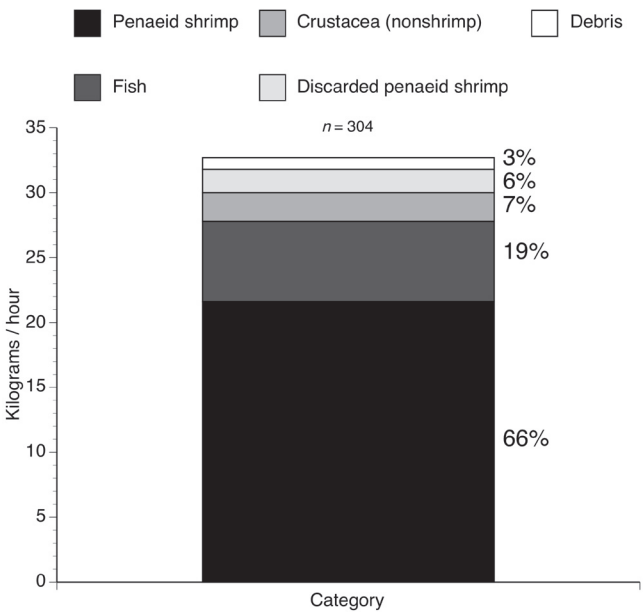

Figure 3.—CPUE and percent species composition by weight and category from skimmer trawl tows. Percentage does not equal 100% due to rounding.

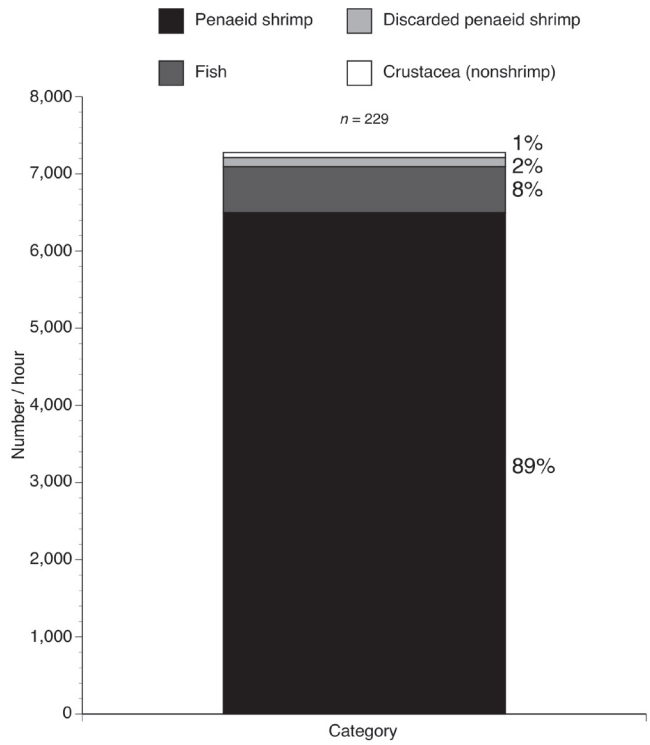

Figure 4.—Percent species composition by number and category from skimmer trawl tows.

penaeid shrimp, 595 for fish, 118 for discarded penaeid shrimp, and 66 for crustaceans.

Extrapolated Species Composition by Species: Percent and CPUE

Weight extrapolations from the species composition samples for both years, all areas, seasons, and depths (Fig. 5) indicate that white shrimp comprised 49% of the total catch; followed by penaeid shrimp at 17%; Gulf menhaden, *Brevoortia patronus*, at 8%; blue crab, *Callinectes sapidus*, at 7%; discarded penaeid shrimp at 6%; debris at 3%; Atlantic croaker, *Micropogonias undulatus*, and threadfin shad, *Dorosoma petenense*, each at 2%; and blue catfish, *Ictalurus furcatus*, at 1%. All other species (54) comprised 5% of the total weight. Corresponding CPUE (kg/h) were 16.1 for white shrimp, 5.4 for penaeid shrimp, 2.7 for Gulf menhaden, 2.2 for blue crab, 1.8 for discarded penaeid shrimp, 0.9 for debris, 0.7 for Atlantic croaker, 0.6 for threadfin shad, and 0.4 for blue catfish.

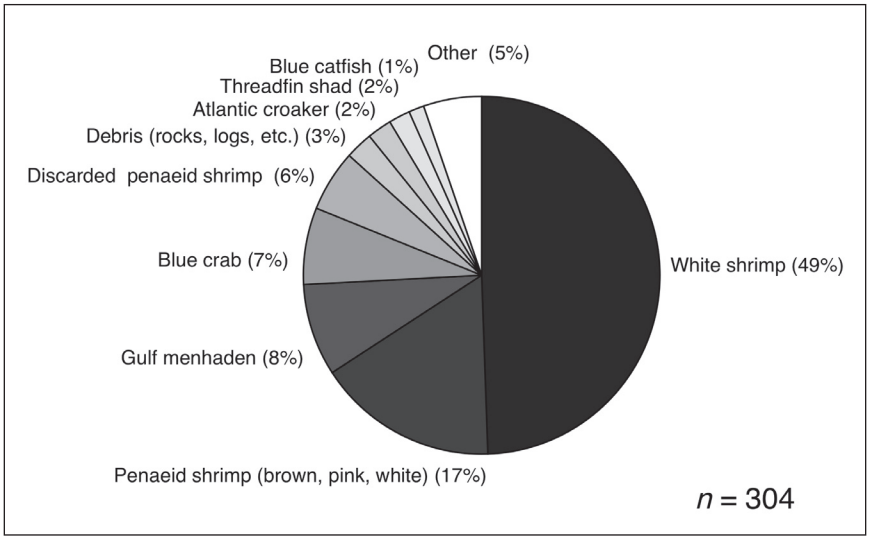

Figure 5.—Percent species composition by weight from skimmer trawl tows.

From number extrapolations, species composition samples for both years, all areas, seasons, and depths (Fig. 6) denote that white shrimp comprised 61% of the total catch, followed by penaeid shrimp at 28%, Gulf menhaden at 4%, and discarded penaeid shrimp and Atlantic croaker each at 2%. Debris counts accounted for less than 1% based on one unit of debris for each tow. All other species (57) comprised 4% of the total number. CPUE in number per hour

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were 4,475 for white shrimp, 2,016 for penaeid shrimp, 291 for Gulf menhaden, 118 for discarded penaeid shrimp, and 112 for Atlantic croaker.

Estimated CPUE by Year and Season

Figure 7 depicts CPUE estimates (kg/h) by season and year. Catch rates of penaeid shrimp were higher compared with other species categories for both years and seasons. The highest estimated catch rate of penaeid shrimp was observed from May through August 2005 (23.6 kg/h); CPUE was lower in September through December 2004 (21.0 kg/h). Fish CPUE was higher in September through December 2004 (6.5 kg/h) as compared with May through August 2005 (5.1 kg/h). Nonpenaeid shrimp crustacean catch rate was highest from May through August 2005 (3.3 kg/h), followed by September through December 2004 (1.9 kg/h). Debris estimated CPUE was similar between years and seasons with the highest catch rate from May through August 2005 (1.0 kg/h) followed by September through December 2004 (0.8 kg/h). CPUE of discarded penaeid shrimp was highest from September through December 2004 (2.1 kg/h) as compared with May through August 2005 (0.8 kg/h). Noncrustacean invertebrate CPUE was less than 1.0 kg/h for both seasons.

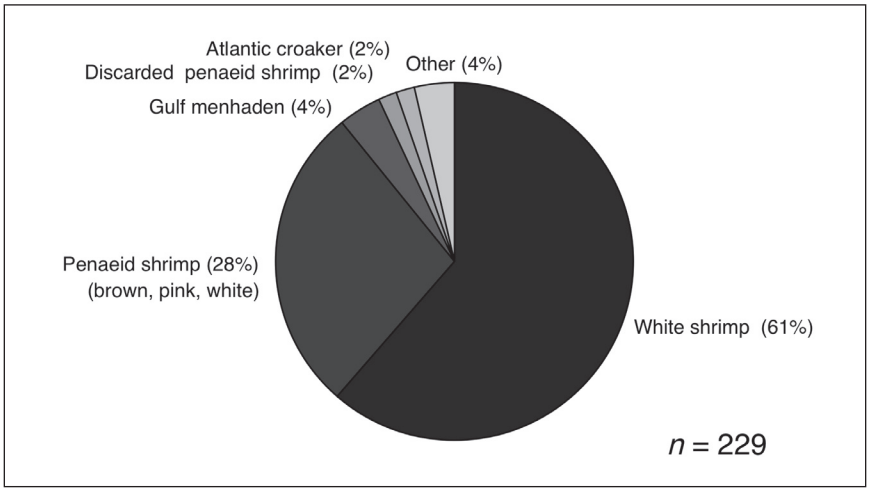

Figure 6.—Percent species composition by number from skimmer trawl tows. Percentage does not equal 100% due to rounding.

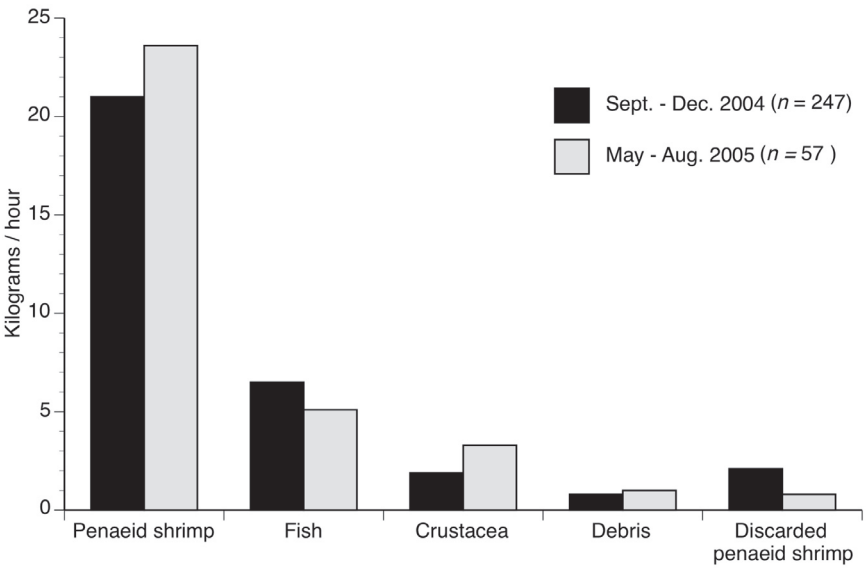

Figure 7.—CPUE (kg/h) by year, season, weight, and category from skimmer trawl tows.

Sea Turtle Interactions

Restricted tow times are established by individual states based on the potential for sea turtle interactions. During the study period, no sea turtles were captured.

Discussion

From September 2004 through June 2005, data from about 307 tows were collected during 96 trips (114 sea days) aboard three skimmer-trawl vessels in coastal Louisiana. Vessel and fishing characteristics were documented. Overall vessel length averaged 39.7 ft. All vessels were of fiberglass construction and had ice hold capacity. Two nets were pushed on each vessel, each with a headrope length of 16 ft. Tow time averaged 1.7 h. The average fishing depth was 1.3 fathoms, with a mean towing speed of 1.8 kn.

Vessel selection was opportunistic, and may not be representative of the entire fleet. Moreover, as reported by Hein and Meier (1995), the use of skimmer trawls is prevalent throughout coastal Louisiana. Our study was restricted to two generalized areas in Louisiana.

From nonextrapolated data, penaeid shrimp (heads-on) constituted 61% of the total weight; corresponding CPUE (kg/h) was 20.2. Extrapolated data from species composition samples yielded slightly higher estimates. Penaeid shrimp accounted for 66% of the total catch; CPUE (kg/h) was 21.6.

Similarly, based on extrapolated data, finfish accounted for 19% of the total weight, followed by crustaceans at 7%, discarded penaeid shrimp at 6%, and

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debris at 3%. Corresponding CPUE (kg/h) was 6.2 for finfish, 2.2 for crustaceans, 1.8 for discarded penaeid shrimp, and 0.9 for debris.

Compared with previous studies conducted in North Carolina (Coale et al. 1994; Hines et al. 1999), our study yields substantially higher penaeid shrimp and lower finfish CPUE. This may be attributed to higher shrimp production in Louisiana than in North Carolina, alternate gear designs, variable fishing practices, or a combination of all these factors.

The discards to landings ratio was 0.63 for the skimmer trawl fishery in our study. This was notably less than the ratio of 4.56 reported by Harrington et al. (2005) for the Gulf of Mexico otter-trawl fishery.

In our study, the dominant species by weight were white shrimp, followed by other penaeid shrimp species, Gulf menhaden, blue crab, discarded penaeid shrimp, debris, Atlantic croaker, threadfin shad, and blue catfish. By number, the dominant species were white shrimp, followed by other penaeid shrimp species, Gulf menhaden, discarded penaeid shrimp, and Atlantic croaker.

Seasonally, higher penaeid shrimp CPUE occurred from May through August 2005 compared with September through December 2004. This pattern was also observed for nonpenaeid shrimp crustacean and debris. For finfish and discarded penaeid shrimp, CPUE was higher from September through December 2004 compared with May through August 2005. In conclusion, bycatch rates in this study were substantially lower in skimmer trawls compared with historical and current estimates of bycatch associated with capture from otter trawls. Based on these findings and previous studies (Coale et al., 1994; Hines et al., 1999), skimmer trawls provide an alternative to conventional otter trawls for harvesting penaeid shrimp. The tangible benefits include, but are not limited to, reducing finfish bycatch, lessening bottom habitat disruption, and decreasing fuel consumption. Subsequent shrimp yield based on size (i.e. growth overfishing), potential sea turtle interactions, and other abiotic and biotic interactions warrant further investigation, and should be considered when assessing the optimal approach to resource management.

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We first commend the outstanding efforts given by the fishery observers involved in this research effort and the commercial fishing industry members who seek to make a difference in the management of the resource by allowing observers onboard. Linda Guidry was an invaluable asset in locating participants and for logistical support. We sincerely thank Dennis Koi for all his help with the data entry system and summarization of data files. Estella Garcia has devoted many long hours of outstanding work in data entry.

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