An Interdisciplinary Study of St. Georges Bay Fish Harvesters' Ecological Knowledge: White Hake (*Urophycis tenuis*) Predation on Juvenile American Lobster (*Homarus americanus*). Phase III

A Preliminary Report of Research Results

SRSF Research Report #6

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In Collaboration with

Fisheries and Oceans Canada, Oceans & Science Branch, Gulf Region

Gulf Nova Scotia Bonafide Fishermen's Association

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Summary of Findings[1]

White hake (*Urophycis tenuis*) is a demersal fish species that inhabits the nearshore waters of the Southern Gulf of St. Lawrence (sGSL). Recently, many St. Georges Bay fishermen have expressed concern that the white hake is a predator of juvenile American lobster (*Homarus americanus*). Standard research surveys do not support these concerns. Fishermen maintain, however, that the research surveys were conducted at inappropriate sampling times and locations to detect this predation. The present study is one component of a multiphase collaboration. It sampled demersal fishes in St. Georges Bay during a time of year and in locations selected by fishermen. These fishermen were identified by their peers as particularly knowledgeable about the local fishing grounds. Six zones covering water depths of 15-30 and 30-40 m were sampled with gillnets. A total of 1417 groundfish stomachs were collected, including 1316 of white hake. No American lobster were found in the stomachs of white hake. Herring and mackerel were the major prey items for all sampled groundfish. Only shorthorn sculpin was found to contain American lobster as a prey item, which suggests more work be done to assess the extent to which it interacts with American lobster.

[1] This study could not have been initiated, conducted and completed without the assistance of Dr. Anthony Davis (St. FXU), Dr. Mark Hanson (DFO Moncton), Dr. John Wagner (St. FXU), Dr. Michael Chadwick (DFO Moncton), and Ms. Kay Wallace (Gulf Nova Scotia Bonafide Fishermen's Association). We are especially grateful to Gulf Nova Scotia Bonafide Fishermen's Association Member Mr. John Andrew Boyd, for the use of his boat and assistance, and Mr. Greg MacPherson for his help in catching and sampling the fish. Thank you also to North Bay Fishermen's Co-op, Ceilidh Fishermen's Co-op, Dr. Edwin DeMont, Mr. Randy Lauff and the St.F.X. Biology Department for the use of their freezer.

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Introduction

White hake (*Urophycis tenuis*) is a bottom dwelling fish species that occurs as two distinct subpopulations in the southern Gulf of St. Lawrence (sGSL). One population lives in the deep, warm, waters of the Laurentian Channel while the second is confined to the coastal waters (i.e., <40 m deep) of the southern Gulf (Hurlbut & Clay 1998). In coastal waters, white hake appear to be a top predator, similar to Atlantic cod (*Gadus morhua*) in the midshore waters. Formerly widespread, today white hake is limited to the eastern end of the Northumberland Strait. The fishery is closed due to low numbers of this fish. The only known remaining spawning area is in St. Georges Bay (Poirier et al. 2000; Hurlbut & Poirier 2001). As with many of the marine fishes in Canada's Atlantic waters, the basic feeding information of white hake is all but lacking for the sGSL population(s) (reviewed by Hanson & Lanteigne 2000).

Recently, many St. Georges Bay fishermen have been concerned with groundfish predation, particularly that of white hake, on the juvenile American lobster (*Homarus americanus*). The concern is that as depleted groundfish populations recover from the effects of overfishing, they will consume an increasing number of juvenile American lobster and decrease the recruitment of juveniles into the harvestable size-classes. Consequently, the Department of Fisheries and Oceans (DFO) conducted seasonal surveys to assess these concerns (Hanson & Lanteigne 2000). The results of these studies did not support the concerns of St. Georges Bay fishermen who argued that these studies were conducted in the wrong places at inappropriate times of the year.

To address these concerns, a research collaboration was formed between Interdisciplinary Studies in Aquatic Resources (ISAR), Social Research for Sustainable Fisheries (SRSF) at St. Francis Xavier University, Fisheries and Oceans Canada and the Gulf Nova Scotia Bonafide Fishermen's Association (GNSBFA). Within this research collaboration, St. Georges Bay fish harvesters were interviewed within a systematic framework to determine the area and time of year in which the study of white hake predation on juvenile American lobsters should be conducted.

Phase 1 of this study sampled 1618 white hake and showed that white hake were not an important predator of American lobster during early autumn in waters 30 to 40 meters deep (Watts 2002). Indeed, the study found that white hake did not eat any American lobster, and that herring was the principal prey. Other important prey of white hake included mackerel, squid, flatfish, shrimp (*Pandalus montagui, Crangon septemspinosa*), rock crab, white hake, and Atlantic cod.

After further consultation, the second phase of this study was conducted at a different time of year and in different locations. Specifically, the fishermen concluded that American lobster would be a prominent prey of white hake collected in waters 15 to 30 meters deep during July and that large numbers of fish would be found in waters of this depth. Phase II of this study sampled 159 white hake indicating large numbers of white hake were not present in waters 15 to 30 meters in July. In addition, no American lobster were found in the white hake stomachs (Watts and MacPherson 2002). The most important prey of white hake was herring and mackerel. Other prey found included flatfish, shrimp (*Pandalus montagui, Crangon septemspinosa*), snakeblenny, unidentified fish remains, rock crab, 4 beard rockling, and sculpin.

Phase III of the study was conducted in September 2002 in the same water depths sampled during Phases I and II. Phase III used additional (smaller meshed) nets to sample for smaller fish so stomach diet data was obtained on a larger range of fish sizes. The purpose of Phase III was to sample all locations to make comparisons of diets between both water depths and time of year. Finally, Phase III also permitted comparisons of white hake diets between the two years of sampling.

Methods and Materials

Sample site selection

A number of St. Georges Bay fishermen were interviewed and asked where and when white hake should be sampled in order to examine white hake predation on juvenile American lobster. The fishermen interviewed had been identified by a stratified random sample of their peers as especially knowledgeable about the local fishing ground. Consequently, six sampling zones in St. Georges Bay, Nova Scotia were identified (Figure 1) as locations where large numbers of white hake would be found and where juvenile American lobster would most likely be preyed upon by these fish. Three of these zones (numbered 1, 2, 3 – Figure 1) were located in waters 30 to 40 meters deep, and three of these zones (numbered 4, 5, 6 – Figure 1) were located in waters 15 to 30 meters deep. Phase I of this study sampled white hake in zones 1, 2, and 3 during September 2001. Phase II sampled white hake in zones 4, 5, and 6 during July 2002. Phase III sampled white hake in all six zones during September 2002.

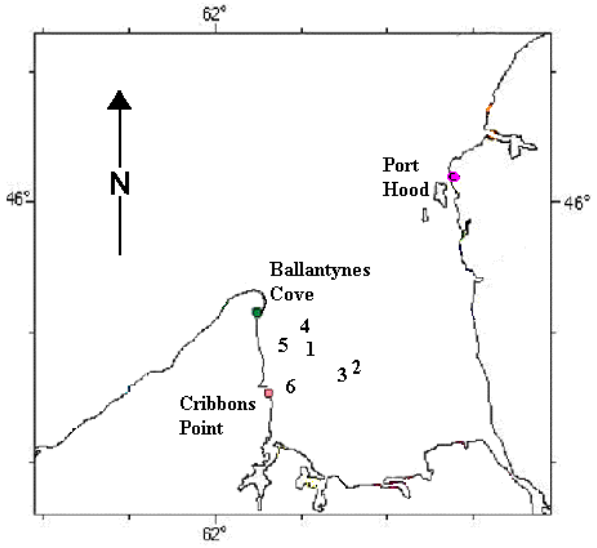

Figure 1. Map of St. Georges Bay, Nova Scotia. Figure shows the six zones where groundfish sampling occured in September 2002. (1= Zone 1, 2= Zone 2, 3= Zone 3, 4= Zone 4, 5= Zone 5, 6= Zone 6).

Sampling procedure

The fish were sampled by gillnets set and tended by members of the Gulf Nova Scotia Bonafide Fishermen's Association. Gillnets were used because most white hake caught in gillnets are dead when brought aboard the vessel. Live white hake (e.g., those caught on longline or with bottom trawl) are more apt to vomit when hauled to the surface.

Each of the six zones was sampled with 1 string of gillnets. Each string was composed of 5 panels, 100 fathoms in length. These strings had alternating net mesh sizes of 5 ½ and 6 inches. In addition, a panel with net mesh size 4 ½ inches was inserted in each string at random order to the 5 ½ and 6 inch mesh nets. The purpose of this procedure was to collect adult *and* juvenile fish, particularly white hake. This allowed us to test whether juvenile white hake were more likely than adult white hake to prey upon small American lobsters, as well as obtain stomach content data on a larger range of fish

sizes. In order to sample in all six zones systematically, one gillnet set was rotated through zones 4, 5, and 6, while the remaining two gillnet sets were rotated through zones 1, 2, and 3.The sampling period was September 3 to 11, 2002. Twenty-one gillnet sets were made, with each zone sampled at least twice (Table 1).

Table 1. Number of sets made at each of the six sampling zones. Zones were identified by St. Georges Bay fishermen as locations where white hake predate on juvenile American lobster. Zones were sampled in September 2002.

Zone No.	Number of Sets
1	5
2	5
3	4
4	3
5	2
6	2

Stomach sampling

All fish were taken out of the nets on board the vessel and their stomachs were removed and placed in individual plastic bags. Individual stomachs were labelled with location, date, species, length of fish, and sex of fish. The plastic bags were immediately placed on ice and stored in insulated boxes. Upon return to the wharf, the stomachs were placed in a freezer until analysis could be conducted.

Stomach analysis

Two research assistants were trained in stomach contents description and analysis in the Moncton, N.B., Fisheries and Oceans science laboratory by Dr. Mark Hanson.

Stomachs were thawed in cold water in the laboratory. Each stomach was cut open and prey were identified to species level (if possible), blotted wet weight recorded, and (when possible) length was measured.

Results and Discussion

White Hake Size Distribution

A total of 1316 white hake were collected. The number of white hake sampled in each zone ranged between 111-300 fish (Table 2). An ANOVA performed on white hake lengths in all six zones indicated significant differences in white hake lengths among zones ($P<0.05$).

Table 2. Number and average lengths of white hake sampled in September 2002 in St. Georges Bay, Nova Scotia.

Zone No.	White Hake No.	Mean White Hake Per Set	Mean Length (cm)
1	236	47.2	60.3
2	253	50.6	58.5
3	291	72.75	60.7
4	300	100	57.7
5	125	62.5	57.8
6	111	55.5	59.1

The overall mean number of white hake per set for the 30-40m depth was 55.7 compared to 76.6 for water 15-30m in depth. A t-test indicated no significant difference between the number of white hake caught per set in each zone ($P>0.05$). It was anticipated that white hake would occur more commonly in waters 30 - 40m in depth

since they would have finished spawning in the shallower waters by this time, and be returning to deeper water to resume feeding.

Stomach analysis

Herring (range 69.4- 82.2% of prey biomass per zone) and mackerel (9.8- 22.2% of prey biomass per zone) were the dominant prey of white hake in both water depths (Figure 3). White hake, flatfish, and various miscellaneous roundfish were the other fish prey eaten by white hake. The most commonly identified fish prey (first five prey listed in Table 3) also contributed to the highest percentage of prey biomass (Figure 3).

Other prey found included snake blenny, shrimp (*Pandalus montagui, Crangon septemspinosa, Argis* spp.), rock crab, *Axius serratus*, cunner, ocean pout, mussels, sea stars, and sea cucumbers. No American lobsters were found in the stomachs of white hake. These results are consistent with previous studies that show white hake rarely prey on American lobster (Hanson and Lanteigne 2000, Garrison and Link 2000), as well as with the results from Phase I and II of this study.

Table 3. Occurrence of prey in the diet of St. Georges Bay white hake sampled in September 2002 in St. Georges Bay, Nova Scotia. White hake that vomited were not included in the analysis.

Prey	*Zone No*						% Occurrence
	1	*2*	*3*	*4*	*5*	*6*	
Herring	101	109	150	148	58	46	**50.0**
Mackerel	19	19	32	13	22	13	**9.6**
Roundfish	6	9	14	26	8	9	**5.8**
Flatfish	14	5	8	12	3	7	**4.0**
White hake	5	3	4	1	2	2	**1.4**
Snake blenny	0	4	1	5	2	3	**1.2**
Various shrimp	0	1	5	4	1	0	**0.9**
Rock crab	0	1	4	2	0	1	**0.6**
Argis spp.	0	0	5	1	0	0	**0.4**
Pandalus spp.	3	1	0	1	0	1	**0.4**
Oceanpout	1	0	3	2	0	0	**0.4**
Crangon spp.	0	2	3	0	0	0	**0.4**
Axius spp.	0	2	1	1	0	0	**0.3**
Cunner	1	0	0	1	0	0	**0.1**
Mussel	0	0	1	0	0	0	**0.1**
Sea star	0	0	1	0	0	0	**0.1**
Sea cucumber	0	0	0	0	1	0	**0.1**
Totals	**150**	**156**	**232**	**217**	**97**	**82**	**100.0**

Of the 1316 white hake examined, 27.4% had empty stomachs, and 6.4% of the fish had vomited. Slightly fewer fish (2.7%) vomited in water 15-30m deep than in water 30-40m deep (3.7%). The shallower water creates less of a pressure gradient when the fish were hauled from the bottom, likely resulting in fewer fish vomiting.

White Hake Sexual Characteristics

When identifying sex, similar numbers of both male and female white hake were sampled. Males accounted for 53.7% and females made up 46.3% of all white hake sampled. Hurlbut and Clay (1998) also found slightly more males than females when they sampled white hake.

Other sampled fish

A total of 101 "other" groundfish were collected, including: Atlantic cod (*Gadus morhua*), spiny dogfish (*Squalus acanthias)* and shorthorn sculpin (*Myoxocephalus scorpius*) (Table 2, Figures 4 – 6).

Table 4. Other groundfish species sampled during September 2002 in St. Georges Bay, Nova Scotia.

Species	Number Sampled
Atlantic cod	66
Spiny dogfish	21
Shorthorn sculpin	14

No American lobster was found in the stomachs of Atlantic cod or spiny dogfish, a result consistent with earlier findings (Hanson and Lanteigne 2000, Watts and MacPherson 2002).

One examined shorthorn sculpin consumed an American lobster (carapace length=40mm). While the sample size was quite low, the occurrence of American lobster as prey for shorthorn sculpin is consistent with previous studies (Hanson and Lanteigne 2000, Watts 2002, Watts and MacPherson 2002). Future work on the prey consumption of this species is needed in order to assess whether they represent an important source of natural mortality for American lobster.

In summary, the third phase supported the expectation that large numbers of white hake would be captured in waters 15 to 40 meters deep in St. Georges Bay during September. The expectation that substantial numbers of American lobster would be eaten by white hake is not supported by the results of this study.

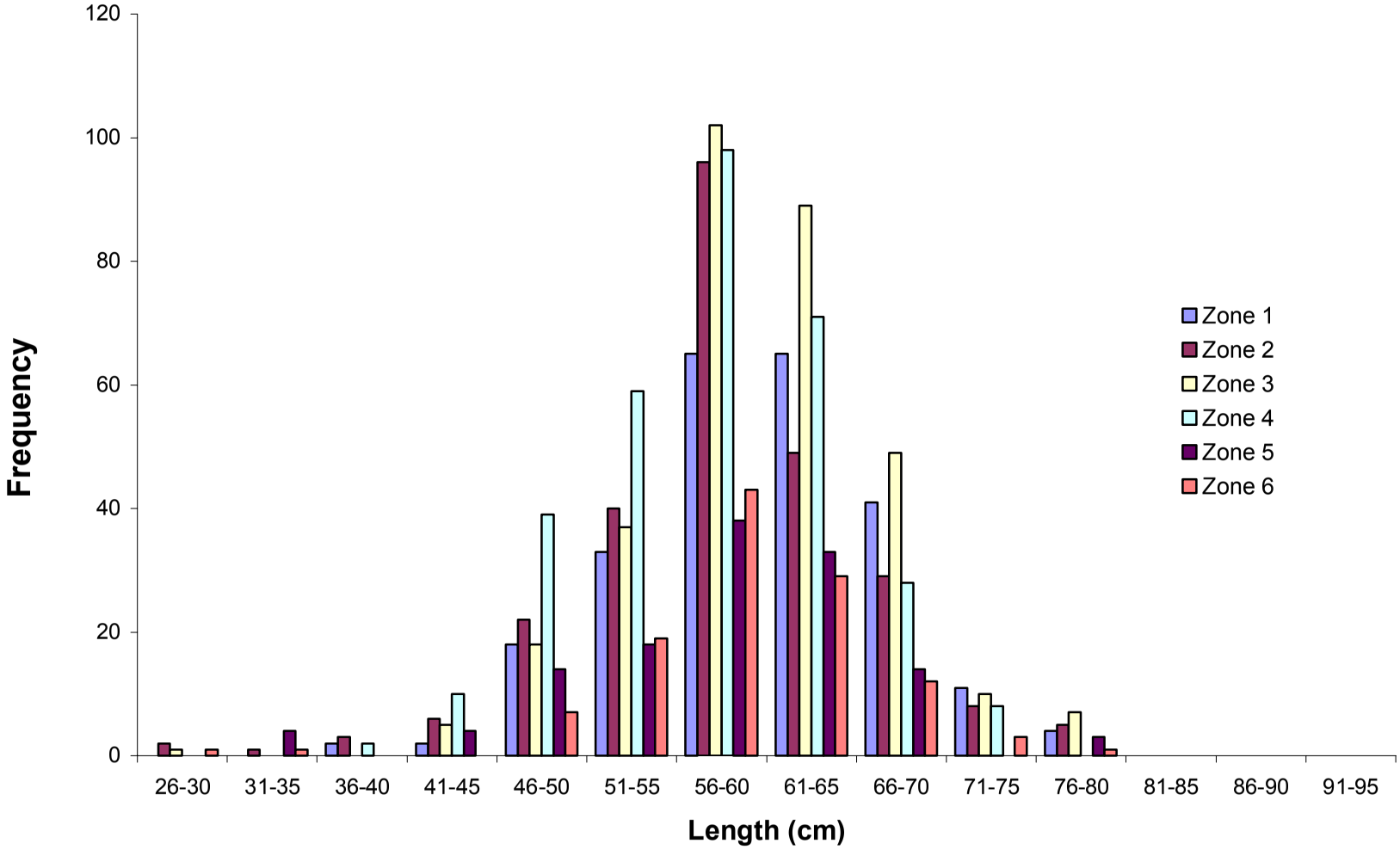

Figure 2. White Hake (*Urophycis tenius*) Distribution. Hake were caught in September 2002 in St. Georges Bay, Nova Scotia.

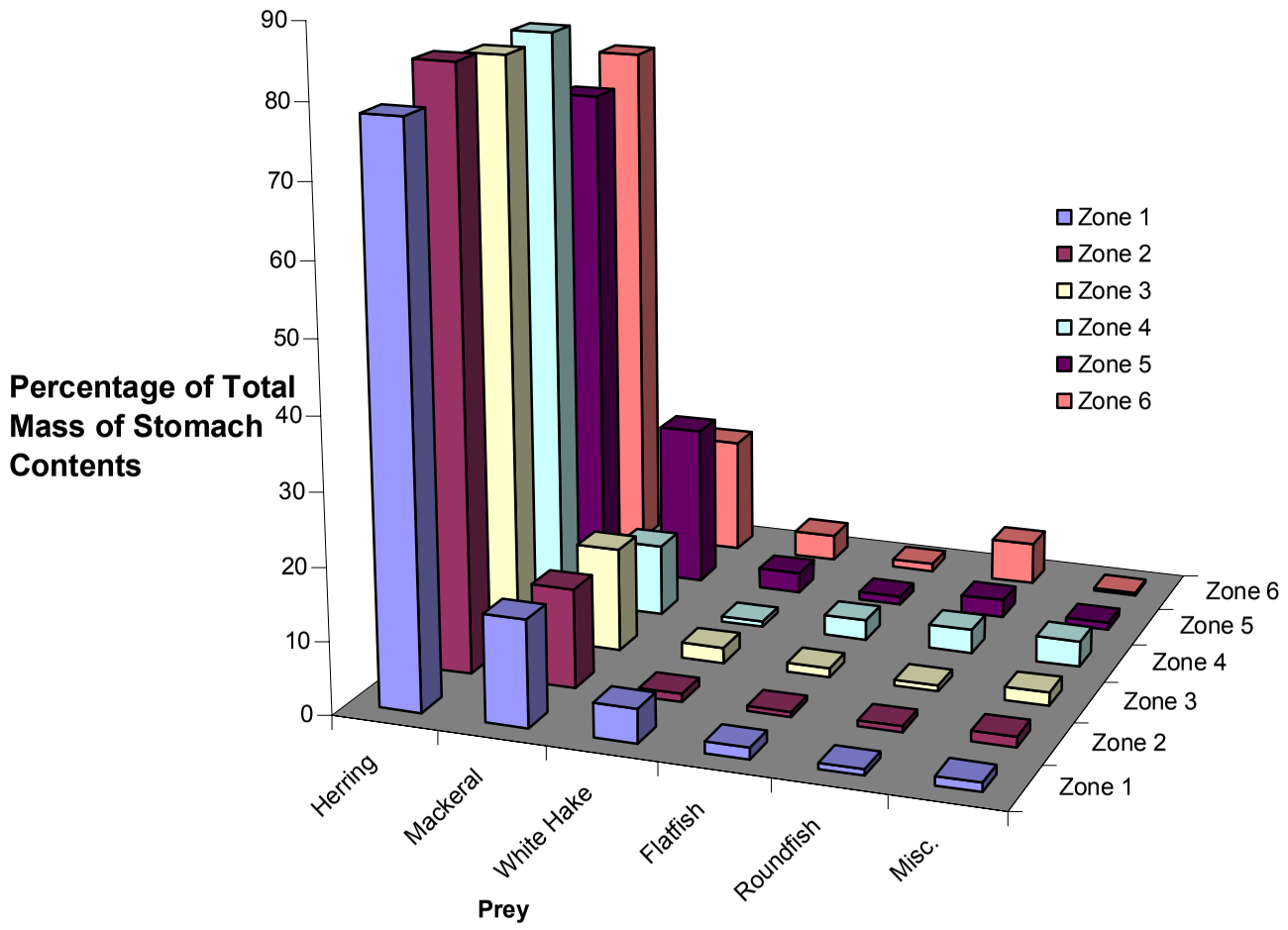

Figure 3. Percentage of Prey Consumed by White Hake during September 2002 in St. Georges Bay, Nova Scotia. Miscellaneous includes shrimp, cunner, oceanpout, mussels, sea cucumbers, sea stars, snakeblenny, and rock crab.

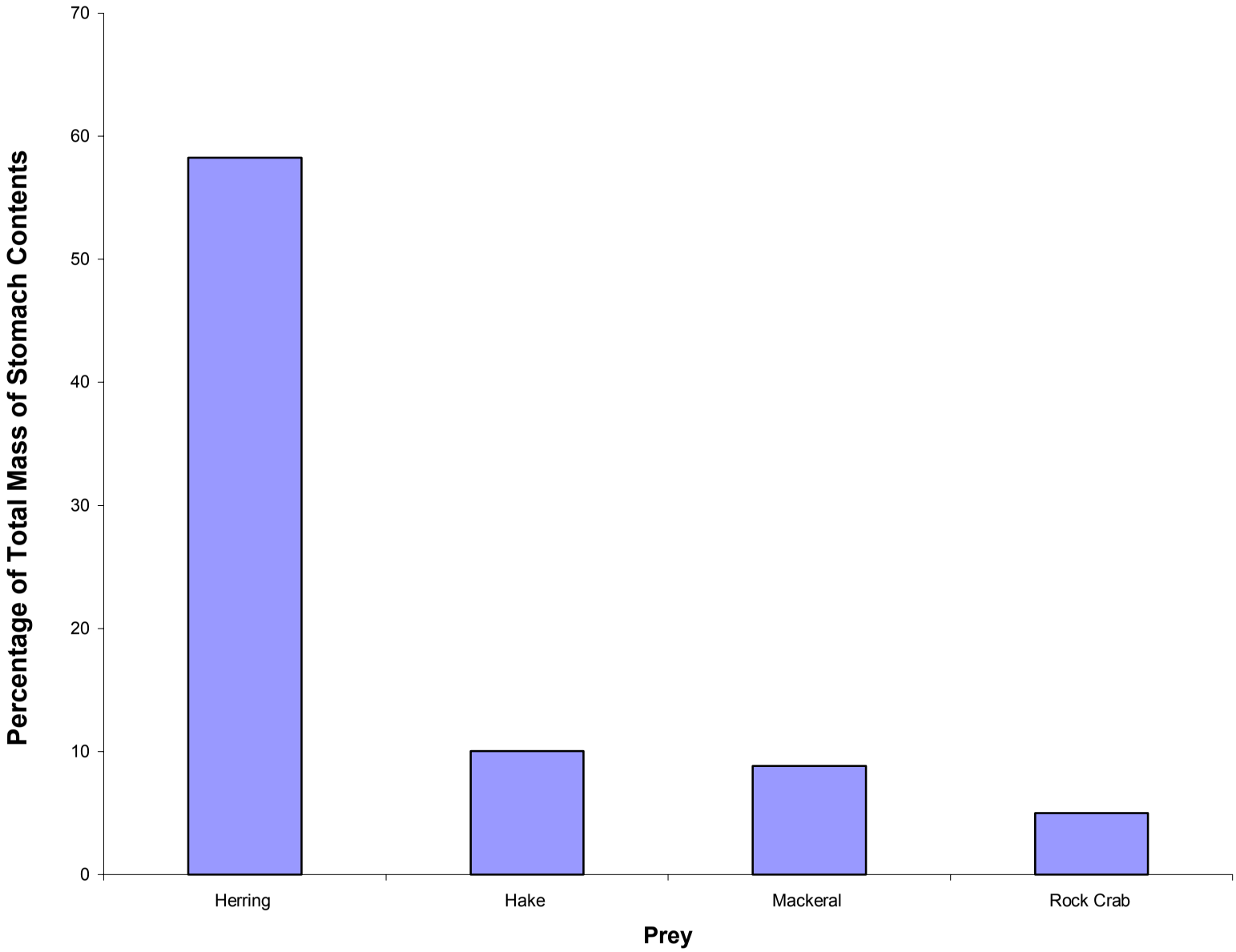

Figure 4. Percentage of Prey Consumed by Atlantic Cod during September 2002 in St. Georges Bay, Nova Scotia.

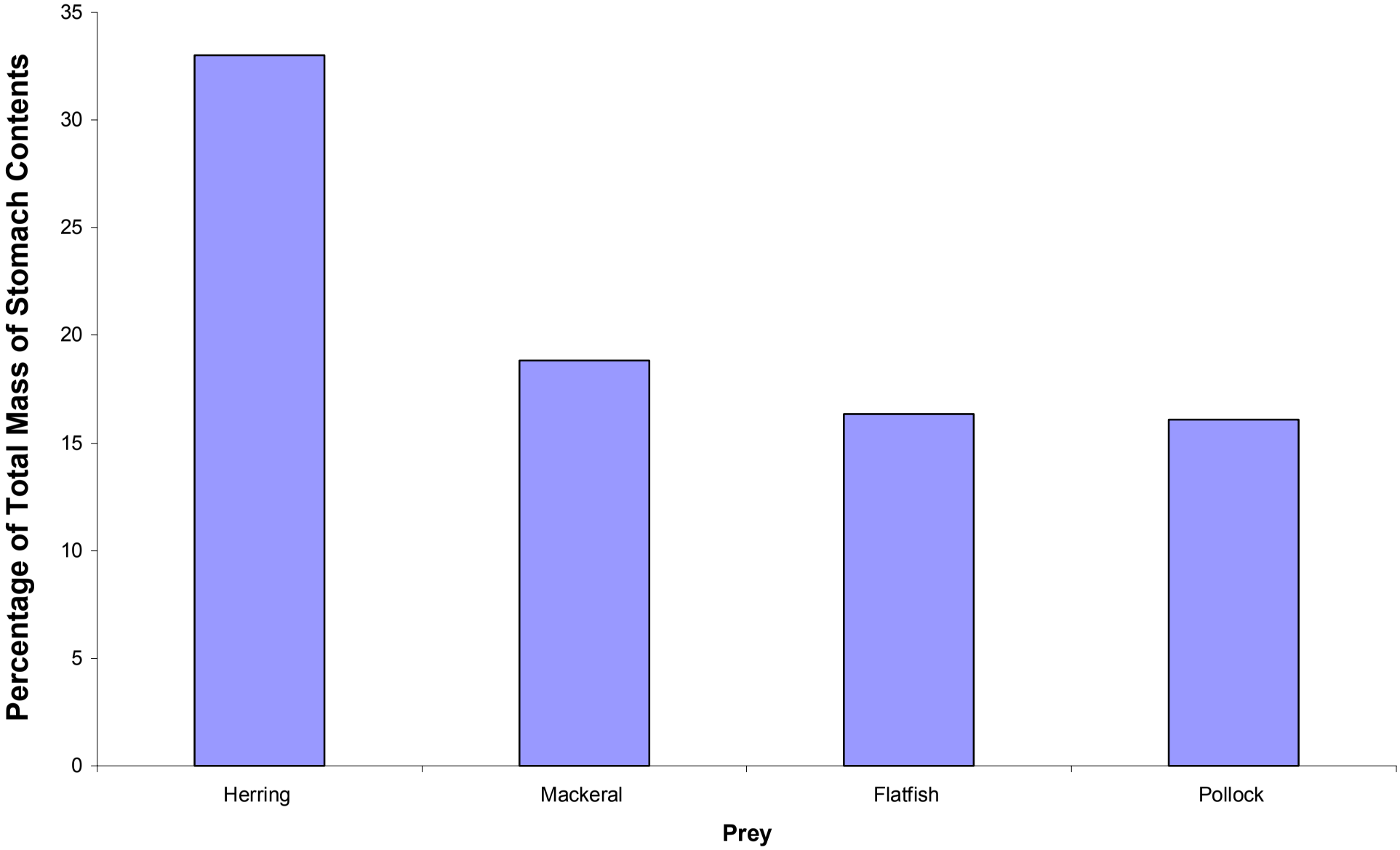

Figure 5. Percentage of Prey Consumed by Spiny Dogfish during September 2002 in St. Georges Bay, Nova Scotia.

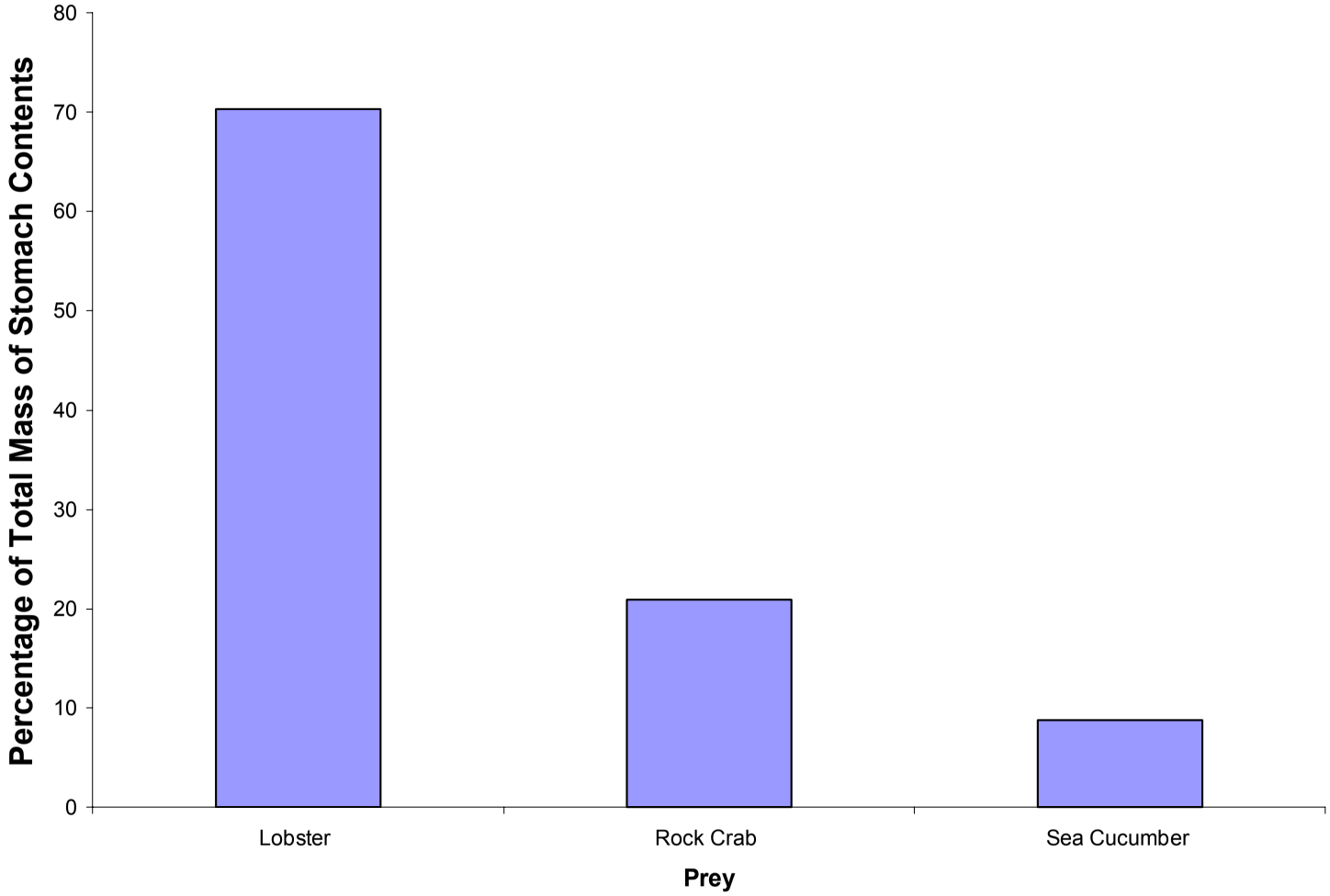

Figure 6. Percentage of Prey Consumed by Shorthorn Sculpin during September 2002 in St. Georges Bay, Nova Scotia.

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