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Food Habits of Winter Flounder in Woods Hole Harbor

by

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FOREWORD

This document stems from research conducted more than three decades ago. For reasons of workload and work priorities, the research results were not reported at that time. Through the gracious efforts of the senior author--who has long since retired from the federal government--the results of that research have now been analyzed and have been reported in this document.

The priority for research on winter flounder has changed since the beginning of the 1960s. The species is still highly prized by commercial and recreational fishermen in the Northeast, but it is one of several in the region which has endured more than a decade and a half of overfishing. Furthermore, because of the species' ubiquitous distribution throughout the region's marine and estuarine environments, combined with the occurrence of many, highly localized, coastal populations of the species, the winter flounder has become a "sentinel" species for monitoring and evaluating the effects of pollutants on living marine resources.

Because of the winter flounder's current dual status as an overfished and sentinel species, the basic biological information in this document is both useful and timely for the region's fishery researchers and managers.

Jon A. Gibson
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INTRODUCTION AND METHODS

Food habits of winter flounder (Pleuronectes americanus), a common coastal fish in New England and found from Georgia to Labrador, were examined through stomach analyses. The specimens were caught in Woods Hole Harbor in 1961 and 1962. This harbor is largely ice-free through the winter, and we therefore collected fish for study year-round to learn seasonal variations in diet. The fish were caught in a small otter trawl towed from an outboard-powered skiff and in water depths of about 1-5 m (Lux and Nichy 1971). Bottom sediments ranged from sand in shallower areas to mud in the deepest. Samples were obtained at approximately weekly intervals from September 1961 to December 1962, although few were caught in the winter months when fish were largely absent, and less sampling was done then. No winter flounder were caught in February sampling. There were 11 sampling dates in 1961 and 42 in 1962.

On each sampling date in 1961, the otter trawl tows were made between 1300 and 1430 hr; in 1962, they were made from about 0900 to 1030 hr. Usually, two or three tows were made on each sampling date. In October 1962, sampling was done every 4 hr around the clock for one 24-hr period to examine the diel pattern of feeding.

All winter flounder for stomach analyses were returned to the Woods Hole Laboratory of the Bureau of Commercial Fisheries (now the National Marine Fisheries Service) soon after being caught, and the stomach and intestine of each were excised and preserved in 4% formaldehyde for later examination, and accompanied by a label containing fish total length (mm), weight (g), sex, and state of gonad development.

For analysis, the contents of each stomach were placed in a small dish of water, and animals and plants were separated by major group and each identified to the lowest taxonomic group that could reasonably be assigned. The number of specimens for each taxon and the wet aggregate weight of each--briefly blotted on a paper towel to remove excess water--were recorded to the nearest 0.01 g for each fish. Notes on intestine contents also were made for many fish. Information from Miner (1950), Pratt (1935), and unpublished keys[1] assembled by various specialists for classroom use at the Marine Biological Laboratory in Woods Hole was used for identification of invertebrates in stomachs. Taylor (1957) was the principal source for identifying algae.

RESULTS AND DISCUSSION

The winter flounder collected for stomach analyses ranged in total length from 12 to 42 cm (Figure 1). In 1961-62, 1,163 stomachs from female and male fish were included in regular samples, and an additional 85 stomachs were obtained in the 1962 around-the-clock sampling. The female-to-male ratio was 1.65. Since the size distribution and sex ratio were similar in 1961 and 1962, the 2 yr of data were combined for the graphs of Figure 1.

We found no apparent difference between sexes in the quality or quantity of food ingested, and the two sexes were combined for the summary of stomach contents. The basic food contents data for 1961 and 1962 are presented in Tables 1 and 2, respectively. Unlike some fishes, such as the summer flounder (Parlichthys dentatus), winter flounder normally do not regurgitate stomach contents when caught. Therefore, it seems quite likely that stomachs found empty on examination were empty when the fish entered the net. The percentage of empty stomachs ranged from a high of about 45% in December and January to a low of about 7 or 8% in June, July, and October (Tables 1 and 2).

Material ingested consisted of invertebrates and algae. Non-food items such as sand or small stones which were found in a few stomachs were not included in stomach volumes. The invertebrate food (Tables 1 and 2) was almost entirely Annelida, Mollusca, and Crustacea. The only identified invertebrates not of these groups, and found occasionally, were pieces of nemerteans, Cerabratulus sp., and small whole sea anemones, class Anthozoa.

For Annelida, the great bulk consisted of polychaetes with the exception of the infrequent occurrence of worms of order Sipunclulida. Nereidae (Nereis sp.), Glyceridae (Glycera sp.), and Capitellidae (Capitella sp.) were the main polychaetes eaten, but as the data of Tables 1 and 2 indicate, individuals of many families, of both free-swimming and sedentary forms, were eaten. Many of the polychaetes recovered from stomachs were only part of the animal, such as parapodia, which we did not attempt to assign to families.

Among the pelecypods eaten (Tables 1 and 2), Macoma sp., Solemya velum, and Mya arenaria were the principal forms ingested, Macoma making up the greatest volume of all foods. The Mya arenaria in stomachs consisted entirely of siphon tips which flounder remove from the clams despite their lack of the kind of teeth that could bite them off. Some stomachs contained 30 or 40 siphon tips, and these tips regularly constituted an important portion of stomach contents. Canadian studies in New Brunswick waters (Medcof and MacPhail 1952) found that winter flounder ate entire Mya seed clams as well as siphons alone. We found no entire Mya in Woods Hole specimens.

The Gastropda were not a very important food item (Tables 1 and 2). Except for Haminoea solitaria and Crepidula sp., none stood out as being eaten regularly in any quantity, and some of the smaller species, too small to have significant food value, may have been ingested incidentally. The rather tiny Mitrella sp. and Bittium sp., for examples, occurred almost entirely in stomachs that contained benthic macroalgae, and numbers present were roughly proportional to the amount of algae eaten (Tables 1 and 2). Miner (1950) indicated that these forms often crawl on algae, something we also found from macroalgae in our trawl hauls. We suspect, therefore, that those forms in stomachs were not selected, but were taken with the algae or other foods.

A number of the stomachs and intestines, mostly in October and November, contained one or more young Polinices duplicatus about 4-10 mm shell height. It is a matter of some curiosity that the P. duplicatus in samples we examined in late 1962 apparently passed unharmed through the entire digestive tract, for some that had extruded from the anal opening of freshly caught fish began crawling about when placed in a seawater aquarium. One intestine contained 13 live P. duplicatus. The tough and tightly fitting operculum of these gastropods may have been the key in protecting them from the flounder digestive juices. We do not know if any of those eaten were digested.

The large amount of stomach contents listed under other Gastropoda in April 1962 (Table 2) consisted mostly of a single shell-less form which occurred in considerable amounts in 10 stomachs. We determined these to be sea slugs, order Nudibranchia, although digestion precluded identification to a lower taxon. This was the only time we found them in stomachs.

The Crustacea in stomachs (Tables 1 and 2) were, in volume and weight, almost entirely Decapoda and Amphipoda. Hermit crabs (Pagurus spp.) and the sevenspine bay shrimp (Crangon septemspinosa) made up much of the usual decapod portion. A few mud crabs, family Xanthidae, and some unidentified crab larvae also were found in stomachs.

In late October 1962, large quantities of softshelled spider crabs (Libinia sp.) were eaten. These were found in only one stomach in October 1961. Many of these crabs were molting in late October and softshelled spider crabs, therefore, became an available food. While both L. dubia and L. emarginata occurred in trawl catches, the former was the most abundant and probably was the principal species eaten. The stomach of one 390-mm winter flounder contained a softshelled spider crab of 39 g in weight and which had a greater volume than we previously had thought a flounder of this size could ingest. This stomach held the greatest volume of contents of any in the study. No hardshelled spider crabs were found in stomachs.

Amphipoda in stomachs were mostly Ampelisca sp. Some Erichthonius sp., Leptocheirus pinguis, Microdeutopis sp., Phoxocephalus sp., and Caprella sp. also were ingested. Caprella, a "skeletal form" of little substance, we feel was eaten incidentally along with macroalgae which was found in all stomachs containing them. Isopods and cumaceans rarely occurred in stomachs (Tables 1 and 2). The tiny copepods, found in many of the stomachs that contained algae, contributed no significant volume of food, and it appears likely that they also were taken in with the algae. Both Caprella sp. and copepods were abundant in the algae picked up by the otter trawl.

Benthic macroalgae in stomachs, eaten mostly from late May to October (Tables 1 and 2), consisted chiefly of Champia parvula and Lomentaria baileyana, both red algae, and Enteromorpha sp., a green. These three forms, taken in small pieces a few centimeters in length, clearly were ingested by intent, at least from summer to fall. In stomachs from those seasons, it frequently was the only food item present. In most stomachs containing these algae, only a single kind occurred, as though fish were specifically grazing on it. Individual stomachs commonly held 4-5 g of them; the most recorded, in September, was 10 g of Champia. The two red algae are small, finely divided plants that grow in tufts 3-7 cm high, and they are of a crisp-gelatinous texture. The Enteromorpha sp. specimens found in stomachs, perhaps more than one species but largely E. intestinalis, were small filamentous branches.

For these algae, there appeared to be some seasonality with respect to the kind eaten. Champia sp. was eaten in large quantities from late June to late October, Lomentaria sp. was eaten mainly in July and August, and Enteromorpha sp. from August to mid-October (Tables 1 and 2).

Four other red algae also were found in stomachs during the late-spring-to-fall period in smaller quantities of about 0.50 g or, usually, less: Grinnellia sp., Agardhiella sp., Ceramium sp., and Polysiphonia sp. Since in many cases these were the only food present, we suspect that at least some also were eaten purposely.

All of the algae discussed here are common New England forms, flourishing in the warmer months (Taylor 1957; Sears and Wilce 1975). The value of algae as flounder food is discussed later in this report.

Small fragments of eelgrass, Zostera marina, a non-algal seaweed, not infrequently were found in stomachs in trace amounts (<0.01 g). These always occurred with invertebrate food, and we conclude that they were ingested incidentally along with that food.

Other studies of winter flounder food habits indicate that the fish's diet, while varying widely with habitat, was in many ways similar to that we found at Woods Hole: Linton (1922); Bigelow and Schroeder (1953); Pearcy (1962); Kennedy and Steele (1971); Wells et al. (1973); Frame (1974); Mauer and Bowman (1975); and Hacunda (1981). Some of these authors, however, found little algae in stomachs. Howell et al. (1992) provide a summary of the various reports on the diet of this species.

Stomach Contents by Fish Size Group

We divided the winter founder from regular weekly sampling into three length groups to examine possible variations in diet with size: 115-214 mm, 215-314 mm, and 315 mm and greater. The largest fish in samples was 424 mm. Food composition by major food groups (Figure 2) indicated that the percentage of algae ingested increased with fish size, but that there was little difference in the general kinds of invertebrates eaten for these fish sizes. Smaller fish, as one might expect, ate smaller individuals of a given food type. That smaller fish ate a greater proportion of annelids than did larger fish may have been because smaller fish are generally found in shallower water where available foods may have differed somewhat.

Seasonal Variations in Food Intake

For a comparison of the food intake by season, we adjusted weights of food per stomach to a fish body weight of 360 g, the approximate mean weight of all fish sampled. Grams of total contents per stomach by month, along with surface temperature (Figure 3), show the marked seasonal variation in total amounts eaten. Contents per stomach dropped in late fall 1961 as the water cooled, increased to a peak of over 4 g in April 1962 after spawning was completed, dropped slightly in mid-summer at peak water temperatures, rose somewhat in early fall, and again fell in late fall 1962 as water temperature again dropped. Since few winter flounder were caught in winter, little can be said about food intake then except that it appeared to be low. Based on the winter samples we obtained, the proportion of empty stomachs was much higher than in other seasons (Tables 1 and 2).

Winter to early spring is the spawning season for Southern New England winter flounder, and Bigelow and Schroeder (1953) stated that studies at Woods Hole in 1921 indicated that this species ceases feeding when about to spawn. While the gonads of some of our late fall specimens were beginning to mature, we encountered no ripe fish, and so obtained no information on food intake of spawners which apparently moved elsewhere to spawn. In Passamaquoddy Bay, where temperatures are lower than at Woods Hole, McLeese and Moon (1989) found this flounder to fast through the entire winter, losing considerable weight and suffering a reduced condition factor at that time.

Grams of food per stomach per 360-g fish by major taxa by month (Figure 4) show the seasonal trends in the kinds of food selected. Annelids, as noted mostly polychaetes, were the principal invertebrates in spring stomachs. Later in the season, the heavy growth of benthic algae, as reflected by large amounts in the trawl in each tow, may have reduced the availability of annelids. Mollusks, too, were generally most common in stomachs in spring. Crustaceans exhibited no seasonal trend in levels consumed, except for the October 1962 peak in the graph when the softshelled spider crabs were ingested. For algae, the largest amounts occurred in stomachs from mid-summer to early fall. Overall, the diet composition in fall 1961 was similar to that of 1962.

Diurnal Cycle of Food Intake

It is common knowledge that many fishes follow a daily cycle in feeding. As Pearcy (1962) and Olla et al. (1969) reported, winter flounder feed in daylight hours, visually orienting on prey. To learn something of the diurnal feeding cycle of winter flounder at Woods Hole, we collected fish every 4 hr over a single 24-hr period in 1962. Collections were begun at 1200 hr on October 22, and ended at 0800 hr on October 23. The 85 fish caught, 18-38 cm in length, were similar in size to the regular October samples.

Stomach contents, by major food types, of these fish--sizes and sexes combined (Table 3, Figure 5)--indicated that at Woods Hole, too, the food apparently was ingested in the daylight hours, with stomach contents being greatest at 0800 hr (1.97 g/stomach) and 1600 hr (2.42 g/stomach). Of the 40 daylight samples, only two stomachs (collected at 1200 hr) were empty.

At night, the mean stomach contents varied from 0.50 g/stomach at 2000 hr to 0.04 g/stomach at 0400 hr. Olla et al. (1969) estimated that it took about 7-11 hr for stomach evacuation in this species at September water temperatures off New York. In view of this, it seems likely that food in our night-caught samples was eaten in daylight. The proportion of empty stomachs was far greater at night, and increased as the night progressed: at 2000 hr, 4 out of 15 were empty; at 2400 hr, 10 of 16 were empty; and at 0400 hr, 11 of 14 were empty.

Role of Algae as Flounder Food

Invertebrate foods of the kinds eaten by the winter flounder of this study are well-known foods of fishes and are readily utilized by them. With respect to the algae ingested, the matter is not as clear, since, so far as is known, this species possesses neither the enzymes nor the gut microflora needed to digest cellulose. Visual inspection also indicated that the algae in our specimens passed through the digestive tract without being greatly broken down. However, given the large quantities consumed and the related feeding behavior described earlier, we believe it likely that some unknown amount of nutritive substance was extracted. There are, of course, many wholly herbivorous fishes that thrive on plant material. Montgomery and Gerking (1980), for example, found in two species of herbivorous subtropical reef damselfishes which graze extensively on red and green benthic macroalgae that the fish drew organic nutrients from the algae without fully digesting it. While they calculated total algal assimilation efficiencies of 20-24% in those fish, any algal assimilation that might take place in winter flounder, only occasional herbivores, quite possibly is lower.

Reports we obtained from Massachusetts commercial fishermen of a strong iodine odor in winter flounder on some shoal-water grounds in summer also support our view that these fish extract material from macroalgae eaten, considering that the latter generally are high in iodine content. Some fishermen call the odor a "carbolic" smell, and refer to one fishing area in Nantucket Sound as the Carbolic Ground. We, ourselves, found the flesh of the Woods Hole flounder in our study to have an iodine odor and taste in the period when algae were consumed, providing further evidence of some algal assimilation.

As one further effort to assess the possible value of algae as flounder food in our study, we computed the condition factor, by month, for winter flounder from April to November 1962 to examine possible changes in fish condition as the season progressed (Figure 6). (There were not enough fish in the other months for reliably estimating condition factor.) To overcome possible differences with fish size, we divided the fish into two length groups: 21-30 cm and 31-40 cm. The data show that the condition factor was lowest in April at about 1.20 for the smaller fish (i.e., left bar in Figure 6), about half of which gonad inspection showed had recently spawned, and about 1.10 for larger fish, all of which had recently spawned. It rose to a peak of about 1.40 for both size groups in June and July, and then dropped slightly in late summer and fall to about 1.30. These data show that the fish were maintaining themselves well in the period when algae were consumed in large amounts.

Other investigators also have found algae in winter flounder stomachs, e.g., Linton (1922), Kennedy and Steele (1971), Wells et al. (1973), and Hacunda (1981). Of these, Wells et al. specified the kinds of algae eaten, finding them to be about 40% of winter flounder stomach contents in the Bay of Fundy, and identifying *Arctosiphonia arcta*, *Enteromorpha intestinalis*, *Cladophora sericea*, and *Pilayella littoralis* as being important. They stated that, "The quantities of filamentous algae in stomachs suggest that winter flounder can utilize this plant material."

SUMMARY AND CONCLUSIONS

Stomach contents were examined for 1,248 Woods Hole area winter flounder, 12-42 cm in total length, which were collected throughout 1961-62. Food consisted of invertebrates and algae. Most of the invertebrates, eaten throughout the year, were Annelida (largely Polychaeta), Mollusca (largely Pelecypoda), and Crustacea (largely Decapoda). Benthic macroalgae, the only food in many stomachs, were ingested, clearly by intent, in large amounts in summer and early fall, and consisted principally of *Champia* sp., *Lomentaria* sp., and *Enteromorpha* sp.

Stomachs of winter flounder collected around the clock were fullest during daylight hours and mostly empty at night, indicating that the fish fed largely, or entirely, during the day.

There was little difference in the kinds of food eaten with fish length, for sizes included here. However, the proportion of algae ingested was greater in larger fish.

Quantity and quality of selected food varied seasonally, with annelids being the principal diet item in spring, and algae being important in summer. The fish ate little during winter months; however, few winter samples were obtained for analysis as winter flounder vacated the sampled area.

While the role of algae in the diet of winter flounder is not wholly clear, we believe the evidence indicates that nutritive value was derived from it. The condition factor varied little through the seasons, suggesting that the fish subsisted well during the period when large amounts of algae were eaten.

ENDNOTE

1. These keys later were published by Smith (1964).

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Table 1. Stomach contents of weekly samples of Woods Hole winter flounder in 1961, in numbers and weights (g) of food items

	September		October		November		December	
Food Item	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
ANNELIDA								
Nereidae	10	4.10	44	3.36	45	36.95	85	11.77
Nephtyidae	3	0.13	5	0.90	10	1.38	–	–
Glyceridae	27	5.82	47	27.78	56	27.75	–	–
Maldanidae	17	2.03	18	1.28	16	4.68	–	–
Arabellidae	15	0.13	30	2.87	119	2.77	3	0.02
Polynoidae	–	–	2	0.18	2	0.14	–	–
Others[1]	47	11.28	65	10.35	42	10.63	7	2.98
PELECYPODA								
Macoma sp.	215	3.53	1,085	17.82	2,534	55.13	35	1.32
Mya arenaria	68	2.40	660	27.03	465	20.36	3	0.12
Solemya velum	16	4.05	24	4.88	72	12.11	–	–
Yoldia sp.	3	0.27	6	0.63	11	2.01	–	–
Laevicardium sp.	–	–	7	0.83	26	4.49	–	–
Ensis directus	–	–	3	0.18	–	–	–	–
Nucula sp.	2	0.01	1	0.01	5	–	–	–
Mercenaria mercenaria	–	–	1	0.02	–	–	–	–
Others[2]	6	0.61	9	0.35	7	1.04	–	–
GASTROPODA								
Crepidula sp.	2	0.05	14	1.37	25	1.98	–	–
Polinices duplicatus	4	0.04	29	2.34	10	1.66	–	–
Haminoea solitaria	1	–	21	0.02	102	0.47	2	0.01
Bittium alternatum	167	0.30	107	0.44	1	0.01	–	–
Mitrella lunata	88	0.26	37	0.12	3	0.02	1	–
Others[3]	9	1.09	3	0.03	4	0.74	–	–
CRUSTACEA								
Decapoda	9	0.25	20	28.94	7	2.22	65	4.11
Amphipoda	373	1.93	212	1.69	265	1.10	13	0.08
Isopoda	3	–	6	–	–	–	–	–
Copepoda	129	0.11	–	–	–	–	–	–
OTHER NON-ALGAE[4]	–	9.40	–	7.25	–	7.64	–	–
ALGAE (mixed)[5]	–	204.97	–	86.31	–	1.00	–	–
TOTAL CONTENTS	1,214	252.76	2,456	226.98	3,827	196.28	214	20.41
MEAN CONTENTS	11.13	2.32	20.30	1.88	29.67	1.52	7.92	0.76
TOTAL STOMACHS	109		121		129		27	
EMPTY STOMACHS	17		5		19		11	

[1] Includes Ampharetidae, Arenicolidae, Flabelligeridae, Lumbrineridae, Onuphidae, Pectinariidae, Phyllodocidae, Spionidae and unidentified parts.
[2] Includes *Lysonia* sp., *Mulinea lateralis*, *Petricola* sp., and *Tagelus divisus*.
[3] Includes *Anachis* sp., *Buccinum* sp., *Eupleura* sp., *Lacuna* sp., and *Urosalpinx cinerea*
[4] Includes *Cerabratulus* sp., unidentified invertebrate remains, *Zostera marina* fragments, and mucus.
[5] Mostly *Champia* sp. and *Enteromorpha* sp.

Table 2. Stomach contents of weekly samples of Woods Hole winter flounder in 1962, in numbers and weights (g) of food items

	January		March		April		May		June		July		August		September		October		November	
Food Item	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
ANNELIDA																				
Nereidae	3	0.50	25	9.67	43	23.52	58	9.84	58	7.19	22	15.34	17	8.38	6	29.17	10	15.67	2	0.27
Nephtyidae	-	-	-	-	42	3.98	10	1.42	2	0.03	3	0.53	10	2.52	4	0.43	10	1.89	2	0.16
Slyceridae	-	-	-	-	15	9.62	13	10.35	30	16.82	44	26.93	42	17.27	26	12.33	57	23.68	10	4.84
Maldanidae	-	-	10	1.11	54	6.89	12	1.77	6	0.40	10	0.68	2	0.29	3	0.11	22	3.20	5	1.19
Arabellidae	-	-	4	0.02	16	3.02	27	2.55	7	0.10	1	0.01	20	0.29	31	0.28	24	2.82	9	0.15
Polynoidae	-	-	11	2.75	14	3.53	6	0.28	9	0.28	3	0.71	-	-	-	-	1	0.47	1	1.35
Capitellidae	-	-	1	1.23	35	51.25	43	72.49	20	19.18	-	-	-	-	1	0.79	236	4.57	-	-
Others[1]	-	-	15	7.02	42	25.42	29	6.08	29	14.29	38	18.27	19	6.52	20	4.55	53	11.58	16	2.99
PELECYPODA																				
Macoma sp.	-	-	-	-	322	16.93	510	27.41	844	59.25	520	36.31	427	22.88	154	6.22	369	12.74	133	5.67
Mya arenaria	-	-	2	0.01	118	9.29	30	1.39	37	1.64	36	1.24	27	0.52	96	4.33	309	13.95	156	7.20
Solemya velum	-	-	1	-	9	1.94	6	0.20	8	0.90	16	1.73	15	2.84	17	2.75	23	4.68	2	0.28
Yoldia sp.	-	-	-	-	1	0.20	6	0.60	67	2.72	54	1.71	17	0.79	1	0.04	2	0.13	2	0.56
Laevicardium sp.	-	-	1	0.15	2	0.12	2	0.01	1	0.07	-	-	-	-	-	-	5	1.34	2	0.29
Ensis directus	-	-	-	-	-	-	-	-	5	0.20	2	0.20	1	0.22	1	0.17	-	-	-	-
Nucula sp.	-	-	-	-	-	-	-	-	1	-	4	-	4	-	-	-	4	-	1	-
Mercenaria mercenaria	-	-	-	-	-	-	-	-	-	-	4	1.17	1	0.17	1	0.35	2	0.26	-	-
Others[2]	-	-	7	1.61	5	0.53	5	0.25	7	0.76	5	0.34	4	1.63	1	1.60	11	0.92	-	0.07
GASTROPODA																				
Crepidula sp.	-	-	4	0.17	6	0.32	1	0.28	6	0.54	3	0.30	2	0.02	-	-	6	0.24	-	-
Polinices duplicatus	-	-	-	-	-	-	-	-	4	0.39	-	-	-	-	3	0.37	15	1.44	1	0.01
Haminoea solitaria	-	-	-	-	4	-	393	7.13	63	2.01	21	0.46	11	0.18	-	-	4	-	-	-
Bittium alternatum	-	-	-	-	-	-	-	-	-	-	1	-	2	0.01	49	0.14	35	0.12	-	-
Mitrella lunata	-	-	-	-	6	0.02	4	0.02	14	0.08	16	0.21	20	0.06	41	0.13	28	0.14	1	0.01
Others[3]	-	-	7	1.64	20	31.25	9	0.14	12	0.03	1	0.03	1	0.07	1	0.23	6	0.93	-	-
CRUSTACEA																				
Decapoda	1	0.10	9	0.58	20	1.31	6	0.82	10	2.04	6	1.69	1	0.01	10	3.29	18	93.13	5	0.25
Amphipoda	-	-	114	0.83	865	6.28	138	1.17	205	1.98	56	1.01	10	0.07	-	-	21	0.25	14	0.17
Isopoda	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-
Cumacea	-	-	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OTHER NON-ALGAE[4]	-	-	-	6.53	-	53.52	-	31.77	-	26.79	-	20.16	-	5.03	-	3.75	-	15.58	-	1.67
ALGAE																				
Champia sp.	-	-	-	-	-	-	-	-	-	6.5	-	37.4	-	17.8	-	54.4	-	31.5	-	-
Lomentaria sp.	-	-	-	-	-	-	-	-	-	1.4	-	52.7	-	26.3	-	1.3	-	-	-	-
Grinnellia sp.	-	-	-	-	-	-	-	-	-	-	-	4.1	-	0.2	-	2.4	-	-	-	-
Enteromorpha sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	11.5	-	13.6	-	2.3	-	-
Others[5]	-	-	-	0.2	-	0.2	-	5.7	-	0.3	-	0.1	-	-	-	-	-	-	-	-
TOTAL CONTENTS	4	0.60	214	33.52	1,642	249.14	1,308	181.67	1,446	165.89	866	223.33	653	125.57	466	142.73	1,271	243.53	363	27.13
MEAN CONTENTS	2.0	0.30	14.26	2.23	20.78	3.15	19.82	2.75	17.42	2.00	8.49	2.19	4.27	0.82	5.29	1.62	9.07	1.74	7.41	0.55
TOTAL STOMACHS	2		15		79		66		83		102		153		88		140		49	
EMPTY STOMACHS	1		2		7		8		7		7		31		14		13		15	

1 Includes Arenicolidae, Cirratulidae, Flabelligeridae, Lumbrineridae, Onuphidae, Orbiniidae, Pectinariidae, Phyllodocidae, Terebellidae, Sipunculida, and unidentified Annelida.

2 Includes *Lyonsia* sp., *Mulinia lateralis*, *Petricola pholadiformis*, *Tagelus divisus*, and *Tellina* sp.

3 Includes *Anachis* sp., *Nassarius* sp., *Natica* sp., and *Retusa* sp.

4 Includes *Cerabratulus* sp., unidentified invertebrate remains, *Zostera marina* fragments, and mucus.

5 Includes *Ceramium* sp., *Agardhiella* sp., *Polysiphonia* sp., and *Grinnellia* sp.

Table 3. **Stomach contents, by major food groups, of Woods Hole winter flounder collected through a 24-hr period during October 22-23, 1962**

Item	Hour of Collection					
	1200	1600	2000	2400	0400	0800
Number of fish	12	13	15	16	14	15
Empty stomachs	2	0	4	10	11	0
Mean length (mm)	283	307	296	285	291	311
Mean weight (g)	308	355	341	298	318	400
Mean food/stomach (g)						
Crustacea	0.11	<0.01	0.09	---	---	<0.01
Mollusca	0.39	1.23	0.15	0.07	0.01	0.54
Annelida	0.47	0.62	0.13	0.44	---	0.91
Other invertebrates*	0.20	0.30	0.07	0.02	0.03	0.19
Total invertebrates	1.17	2.16	0.44	0.53	0.04	1.65
Algae	0.03	0.26	0.06	0.08	---	0.33
Total contents	1.20	2.42	0.50	0.61	0.04	1.98

*Includes small amounts of unidentified invertebrates and inverebrate parts.

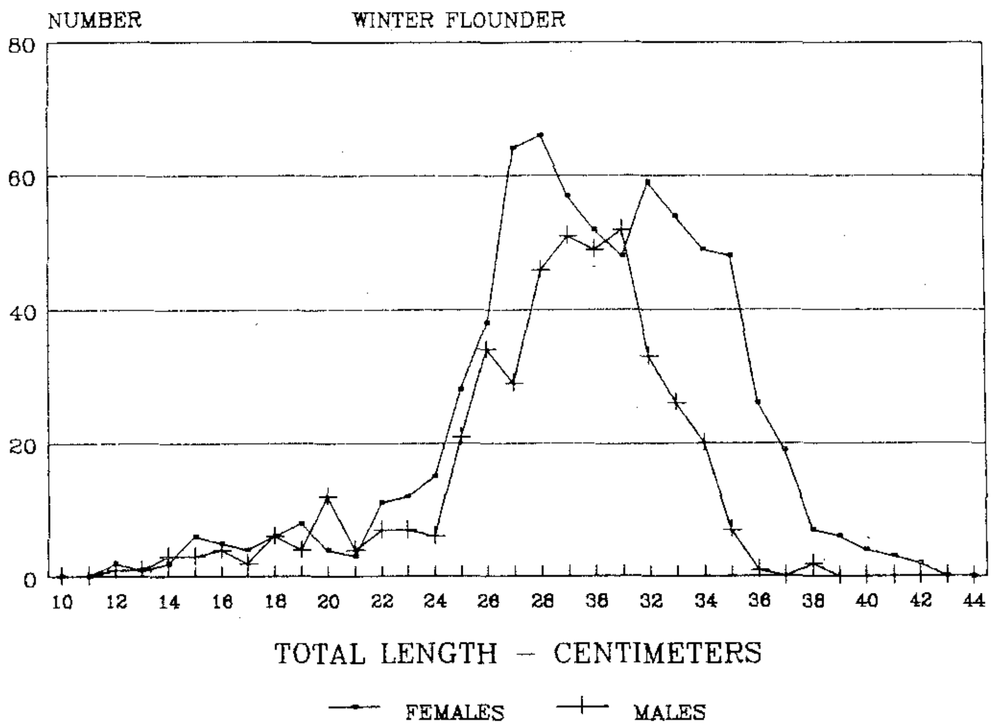

Figure 1. Length frequency of male and female winter flounder collected for stomach analyses in Woods Hole Harbor in 1961-62.

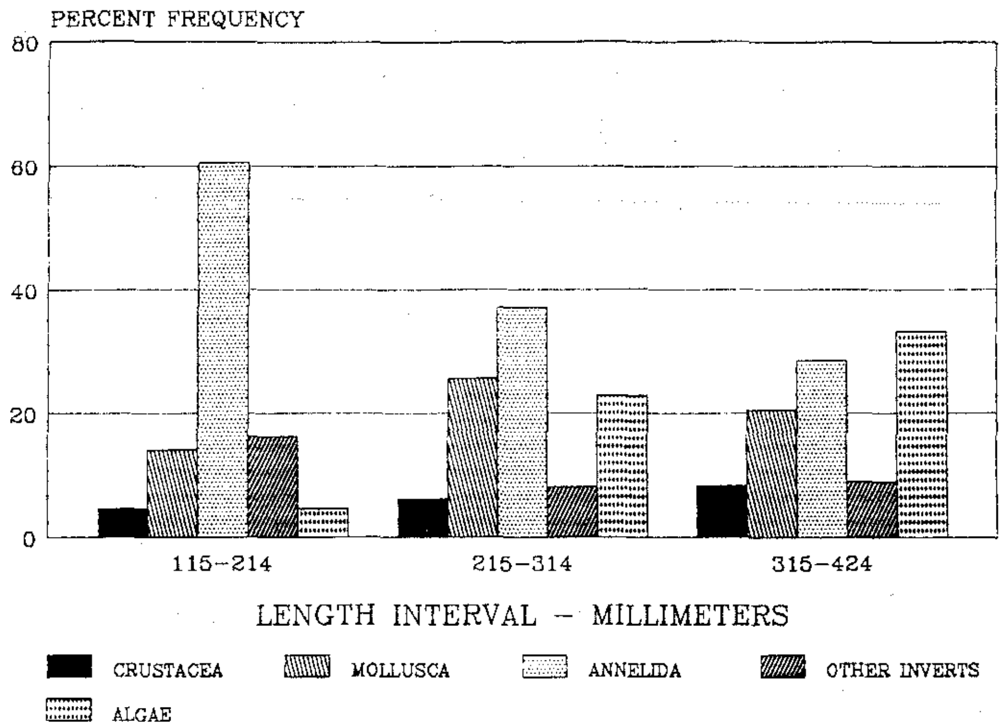

Figure 2. Percent frequency by fish length groups of major food types in Woods Hole winter flounder stomachs in 1961-62 (numbers of fish in parentheses).

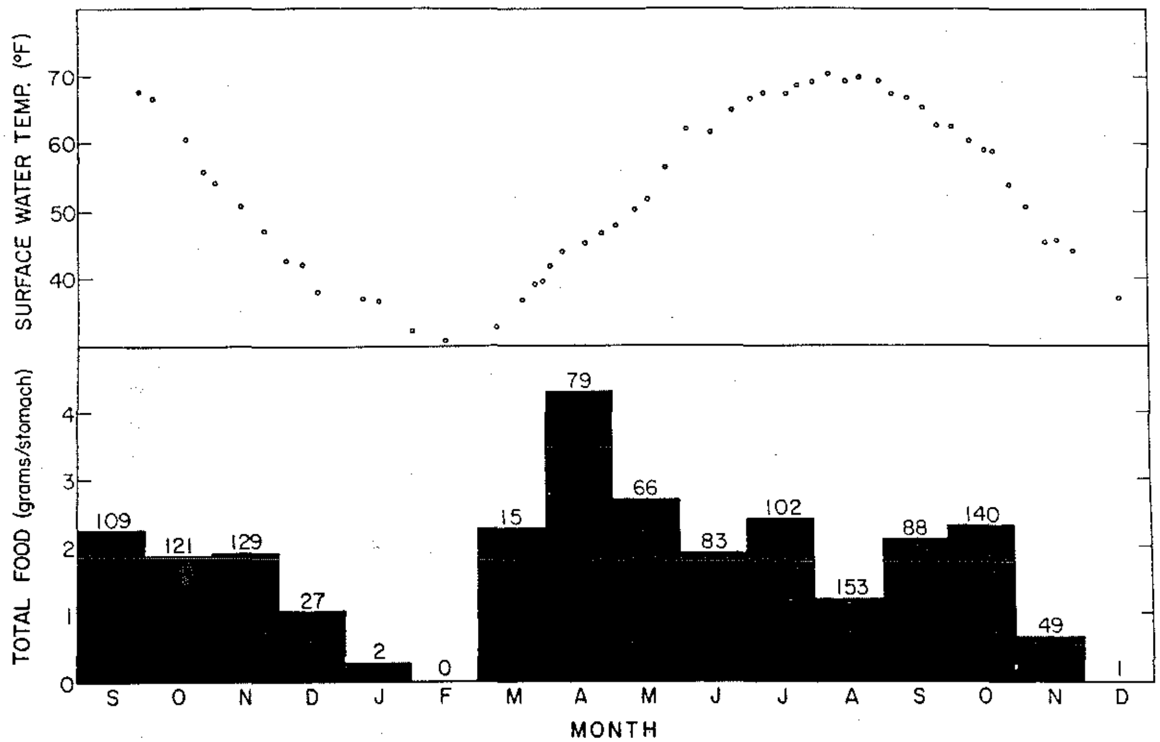

Figure 3. Total stomach contents by month, September 1961 - December 1962, of Woods Hole winter flounder, in terms of grams per stomach per 360-g fish, and surface water temperature (°F) at the sampling location.

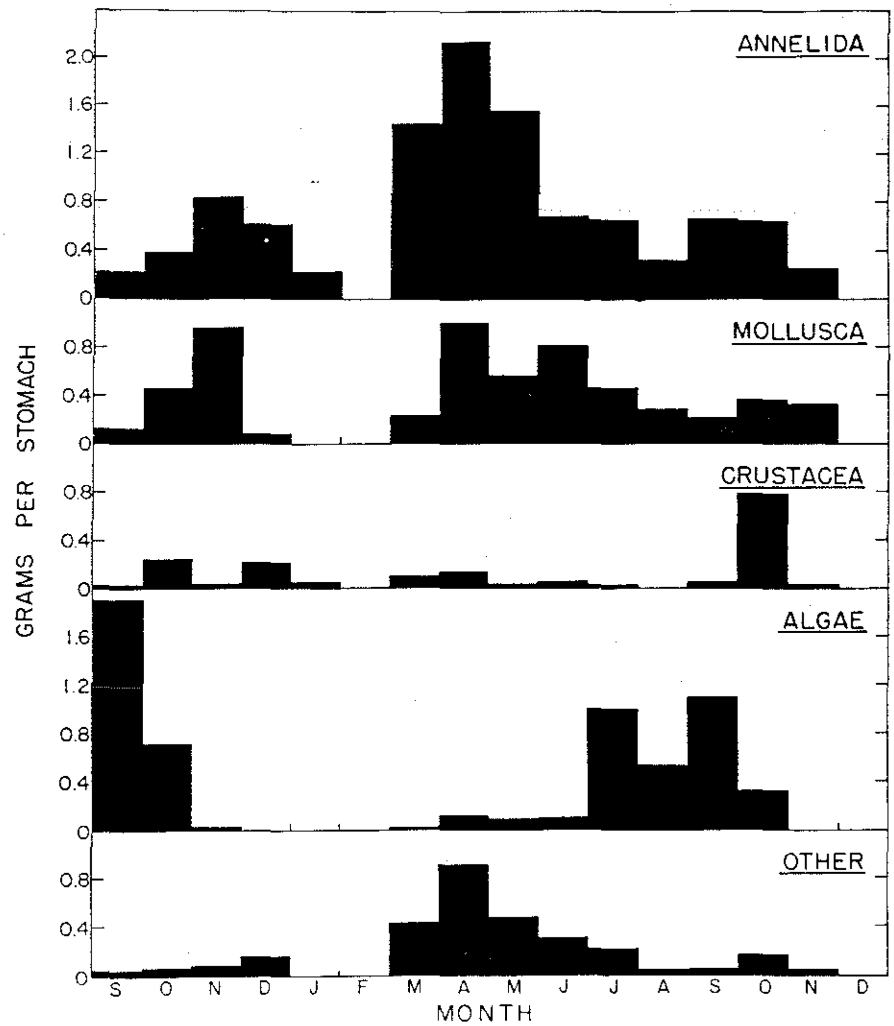

Figure 4. Stomach contents by month by major food groups of Woods Hole winter flounder, September 1961 - December 1962, in terms of grams per stomach per 360-g fish ("Other" category at bottom of figure includes other invertebrates, unidentified invertebrates, *Zostera marina* fragments, and mucus).

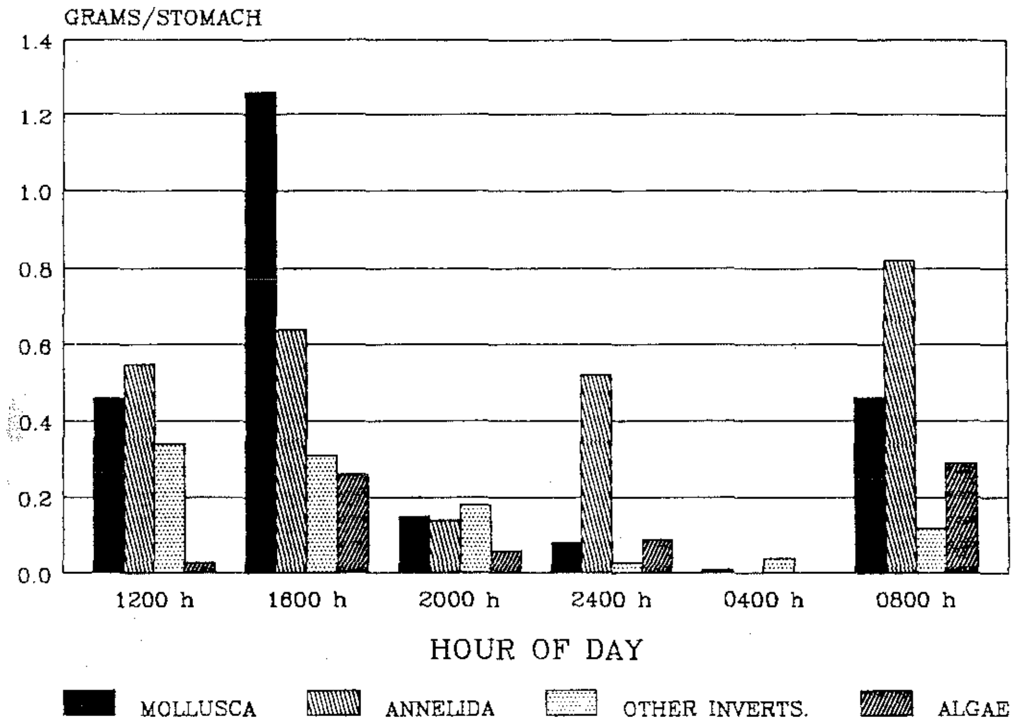

Figure 5. Stomach contents, by major food groups, of Woods Hole winter flounder collected through a 24-hr period during October 22-23, 1962.

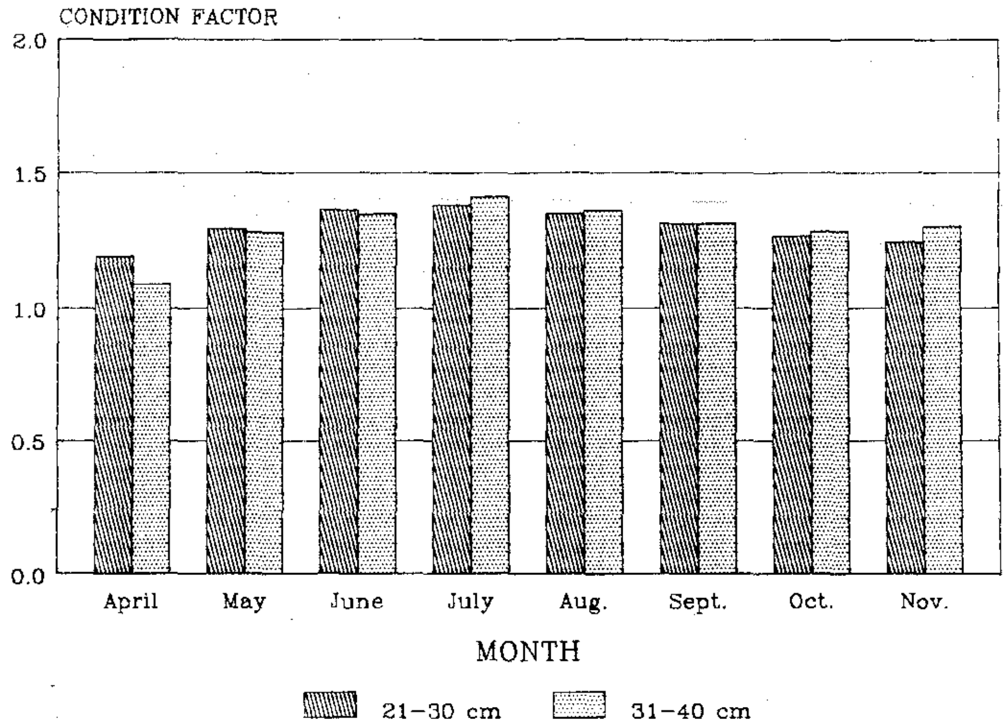

Figure 6. Condition factor (K) for Woods Hole winter flounder of two size groups, April-November 1962 ($K=10^5W/L^3$; W is weight in grams, L is length in millimeters).