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Diet of The Round Goby in the St. Clair River and Lake St. Clair, 1993

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Abstract.–The round goby *Neogobius melanostomus*, a species indigenous to the Black and Caspian Sea region of Europe, was first discovered in the St. Clair River in 1990. Since that time, they have expanded into Lake St. Clair and have also been collected from Lake Michigan and Lake Erie. Food habits of the round goby in the St. Clair River and Lake St. Clair have not been previously described. The stomach and intestine of round gobies obtained in 1993 from St. Clair River anglers (84 fish) and Lake St. Clair survey trawls (39 fish) were examined. Only one of the 123 fish examined was empty. The most common food item consumed for both locations was the non-indigenous zebra mussel *Dreissena polymorpha*. The only other important component of the diet for St. Clair River fish was caddisfly larvae. Zebra mussels were found in the diet of 96% of all St. Clair River round gobies; in contrast, the diet for Lake St. Clair round gobies consisted of amphipods, snails, ostracods, fingernail clams, caddisfly and chironomid larvae, in addition to zebra mussels. Although zebra mussels were found in 67% of all Lake St. Clair round gobies, the frequency of occurrence for several other food items, such as amphipods (63%), was relatively high. The study revealed little evidence of piscivory in round gobies from either area. Only one fish, a 28mm brook stickleback *Culaea inconstans* was found in the 123 round gobies examined.

Two species of gobies, the tubenose goby *Proterorhinus marmoratus* and round goby *Neogobious melanostomus*, were discovered in the St. Clair River in 1990. Jude et al. (1992) described the initial discovery of these two species and briefly discussed their possible effects on the native benthic fish community. Since 1990, round gobies have become a nuisance species for walleye *Stizostedion vitreum* anglers in the St. Clair River. Round gobies aggressively attack earthworms, the preferred bait for walleye in the St. Clair River. In fact, many long-time walleye fishermen believe the abundance of round gobies and their appetite for earthworms is impeding walleye fishing success in the river. Tubenose gobies have not been caught by anglers.

Observations by recreational divers in the St. Clair River also suggest that the abundance of round gobies has increased dramatically since 1990. These same anecdotal reports indicate that abundance of previously common species such as logperch *Percina caprodes* and sculpins *Cottus* spp. declined sharply during the same time period.

We enlisted the help of walleye anglers in collecting round gobies from the St. Clair River. We also incidentally caught round and tubenose gobies in trawls in Lake St. Clair, while collecting yellow perch *Perca flavescens* for a

separate research project. The objective of this study was to document the food habits of the round goby in the St. Clair River and Lake St. Clair during summer 1993.

Methods

Round gobies were collected from recreational anglers targeting walleye in the St. Clair River during July and August, 1993, near Marine City and Algonac, Michigan (Figure 1). All were taken using earthworms as bait. Most were placed on ice immediately upon capture and frozen whole within 6 h for later diet analysis.

Round gobies from Lake St. Clair were collected with a bottom trawl. Trawl collections were made in August, September, and October, 1993. The trawl used was a bottom trawl with a 10-m headrope and 9.5-mm stretched mesh (cod end), and was towed by the *R/V Channel Cat* at approximately 2.0 mile per hour. Round gobies were immediately placed on ice and frozen whole within 8 hours for later diet analysis.

Round gobies were thawed in the lab, and individual length, weight, and sex recorded. Scale samples were taken for age analysis. The anterior portion of the digestive tract was slightly enlarged, but a distinct stomach was not apparent. Therefore, the entire digestive tract was removed and all contents were placed in 70% ethyl alcohol. Food items were later identified to the lowest possible taxon. The diet was analyzed for "percentage composition by number" and "frequency of occurrence" as described by Windell and Bowen (1978). Percent composition by number is the percentage of the total number of food items examined accounted for by a selected taxa. Frequency of occurrence describes the percentage of fish with non-empty stomachs that contained at least one of a selected food item. Length of all intact zebra mussel shells were measured to the nearest millimeter for a subsample of 24 St. Clair River fish.

Results

Biological Data

A total of 84 round gobies were collected from walleye anglers fishing the St. Clair River. The fish ranged from 61 to 133 mm in total length, with an average length of 110 mm. Average weight for round gobies from St. Clair River was 24.3 g. Aging by scales was possible in 79 of the fish (Table 1). Ages ranged from 1 to 3 yr, with a mean age of 2. Males accounted for 74% of the sample.

Thirty-nine round gobies were collected by bottom trawl in Lake St. Clair. These fish ranged from 32 to 117 mm in total length, with an average length of 83 mm. Average weight for round gobies from Lake St. Clair was 10.8 g. Only 16 fish could be aged by scales (Table 1). Ages ranged from young of the year to 2 yr, with a mean age of 0.7 yr. Males made up 79% of the sample.

Diet Analysis

Percent Composition of Diet

Zebra mussels *Dreissena polymorpha* dominated the diet of fish from St. Clair River, accounting for 62% of the 1,409 food items examined (Table 1). Other numerically important components of the diet included caddisfly cases and larvae, as well as rocks. Zebra mussel byssal threads were attached to many of the rocks examined, suggesting that they were inadvertently consumed while foraging on zebra mussels. The largest number of zebra mussels found in a single fish was 25; the fish was 110 mm and 23.94 g. The mean number of zebra mussels per non-empty stomach was 11. No significant relationship was evident between round goby weight and the number of zebra mussels found in the gut (Figure 2). No fish were found in stomachs of round gobies from the St. Clair River.

Zebra mussels were also the most abundant component of the diet for round gobies from Lake St. Clair, accounting for 34% of the total of 370 food items examined (Table 2). Round

gobies from Lake St. Clair consumed a more varied diet, with amphipods, ostracods, snails, fingernail clams, caddisfly larvae, and chironomid larvae also numerically important in the diet. The highest number of zebra mussel shells found in a single fish was 16 (the fish was 101 mm and 15.22 g) with a mean number of 5 mussels per non-empty stomach. The relationship between number of zebra mussels in the gut and weight of round gobies (Figure 2) was significant ($F = 0.0001$, $R^2 = 0.32$) with smaller gobies containing fewer zebra mussels. One fish, a 28 mm brook stickleback *Culaea inconstans*, was found in a Lake St. Clair round goby (110 mm, 21.8 g).

Frequency of Occurrence

Zebra mussels were found in 96% of the non-empty St. Clair River round gobies examined (Table 1). Rocks were the next most frequently occurring item found. Other taxa identified in more than 20% of the non-empty stomachs included caddisfly larvae and cases, fingernail clams, and snails.

For Lake St. Clair, zebra mussels occurred in 68% of the non-empty stomachs examined (Table 2). Amphipods were nearly as frequent (63%). Other taxa occurring in more than 20% of the non-empty stomachs included fingernail clams, caddisfly larvae, snails, ostracods, chironomid larvae, and caddisfly cases.

Lengths of Zebra Mussels Consumed

A total of 139 whole zebra mussel shells were found in the stomach and intestines of a subsample of 24 round gobies from the St. Clair River. Shell lengths ranged from 3 to 12 mm, with a mean of 6.9 mm. Regression analysis indicated no significant relationship between goby total length and mean length of whole zebra mussel shells found in the digestive tract (Figure 3).

Discussion

Collections made for this study indicate that round gobies are well established in the St. Clair River, and are successfully colonizing Lake St. Clair. Fish of three age-groups were collected from both areas, with young of the year included in trawl catches from Lake St. Clair. If these fish are capable of colonizing Lake St. Clair, with its abundant populations of Great Lakes muskellunge *Esox masquinongy*, walleye, smallmouth bass *Micropterus dolomieu*, largemouth bass *Micropterus salmoides*, northern pike *Esox lucius*, rock bass *Ambloplites rupestris*, yellow perch, and channel catfish *Ictalurus punctatus*, I believe they will have no problem colonizing most inshore waters of the lower Great Lakes.

Round gobies collected from the St. Clair River were larger and older than those collected from Lake St. Clair. It is probable that the difference in collection methods between the two areas is the main reason for these differences. Fishing with hook and line, the method of collection for the St. Clair River gobies, should select for larger individuals than trawling. Perhaps younger and smaller fish are actually more common in Lake St. Clair, since it was colonized more recently than the St. Clair River. However, this study does not provide the data needed to draw that conclusion.

It is clear that the round goby, an exotic fish species, forages heavily on another exotic species, the zebra mussel, in the St. Clair River and Lake St. Clair. As many as 25 zebra mussels, ranging in length from 3 to 12 mm, were found in a single round goby during this field study. In a laboratory study, Ghedotti et al. (1995) found round gobies consumed an average of 5.4 zebra mussels per hour, ranging in length from 4 to 13 mm. Few native fish species are expected to consume zebra mussels (French 1993). Thus, round gobies may have a competitive advantage over native species which may be competing with each other for shared food resources.

Although, direct competition for food resources between round gobies and native benthic fishes in the St. Clair River may not be intense, round gobies may still interact in other ways with those fish. Jude et al. (1992)

suggested that round gobies may influence darters *Etheostoma* spp., sculpins *Cottus cognatus*, and logperch *Percina caprodes* through predation on eggs, young and yearlings. I found little evidence of piscivory in round gobies collected from either the St. Clair River or Lake St. Clair in 1993. In fact, only 1 fish was found among the nearly 1800 food items in the 123 round gobies examined. However, soft tissued food items such as fish eggs or larvae, are infrequently encountered in diet studies due to their quick digestion time. As a result, predation by round gobies on fish eggs or young of the year may be underestimated by this study. Further, even low levels of piscivory by round gobies could be important at high population densities.

The St. Clair River has a higher taxonomic diversity of macrozoobenthos than Lake St. Clair (Edsall et al. 1988). Despite this, round gobies from Lake St. Clair consumed a more diverse diet than those collected from the St. Clair River. The reason for this is not clear. Perhaps areas in the St. Clair River where round gobies are routinely captured by anglers are characterized by benthic diversity much lower than the rest of the St. Clair River. Additionally, differences in the ages and sizes of gobies collected in the two areas may be involved. Finally, zebra mussel densities may be much higher at the collection sites in the St. Clair River than in Lake St. Clair, allowing the fish to forage more selectively.

Zebra mussels have been viewed as rechanneling energy flow from algae and zooplankton to the benthic macroinvertebrate community (Griffiths 1992). If round gobies are preyed upon by walleye or other game fish species, they offer a direct energy link from zebra mussels to piscivorous game fish. Unfortunately, there is little evidence from sport anglers to suggest that game fish species feed consistently on round gobies, and no concentrated survey effort targeting potential goby predators has been conducted.

This study was based on round gobies caught incidentally by survey bottom trawls in Lake St. Clair and sport anglers in the St. Clair River. While this small sample has provided a brief glimpse into the diet of the round goby in these waters, many unanswered questions surround the round goby and its effects on the fish community. As this species continues to expand its range and population densities across the Great Lakes, increased public awareness and concern over this newest of exotics is inevitable. A thorough, well-planned study to investigate the effects of both goby species on the Lake St. Clair and St. Clair River fish community would be a prudent effort.

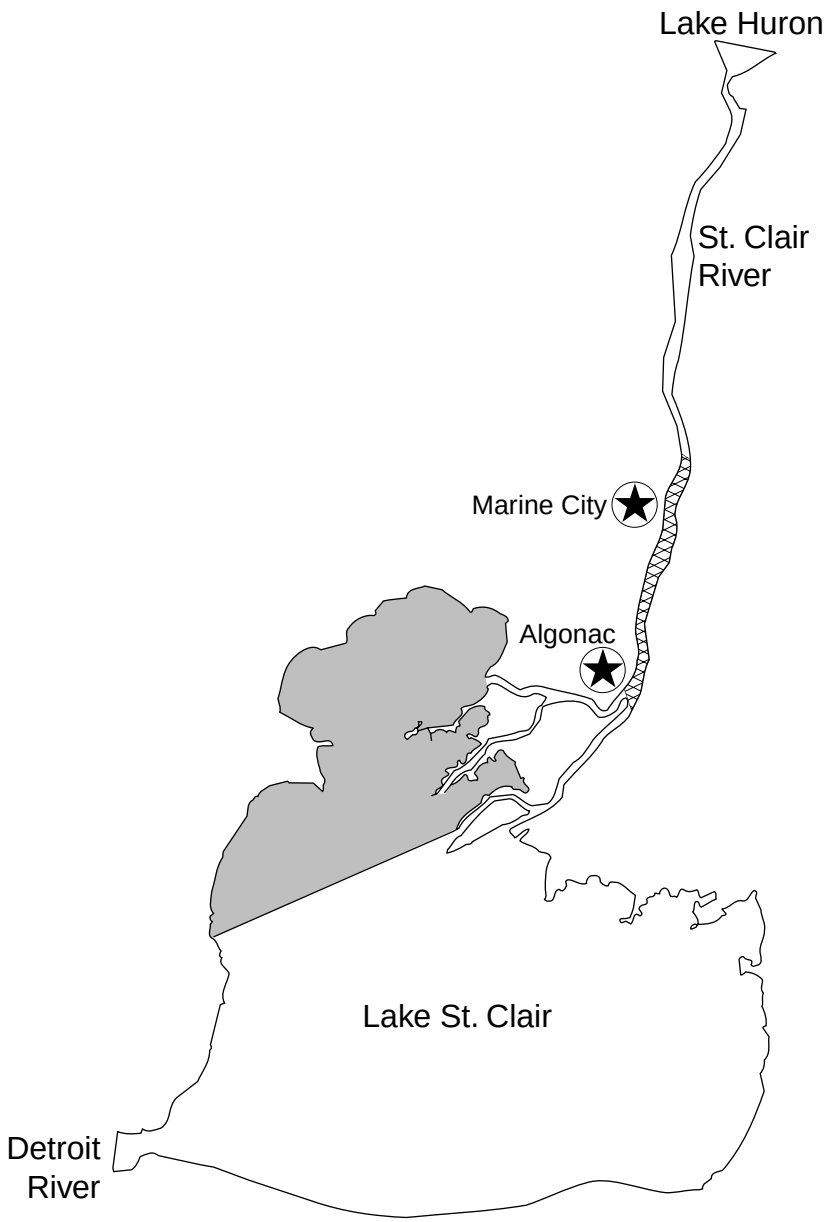

Figure 1.—Map of St. Clair River and Lake St. Clair showing areas of round goby collections by angling (cross hatched) and trawling (gray stippled).

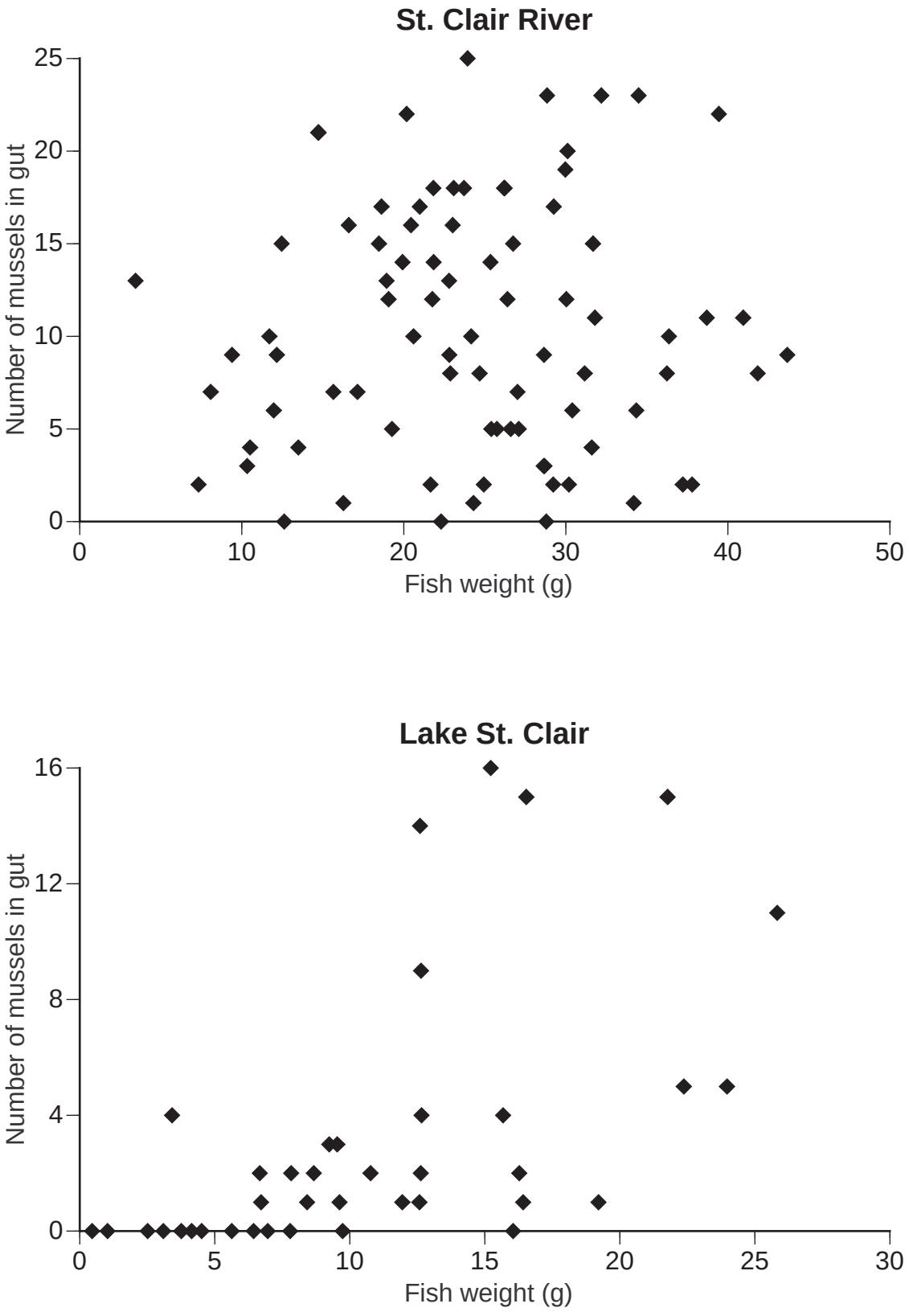

Figure 2.—Relationship between the number of zebra mussels found in the digestive tract and the weight of round gobies from the St. Clair River (above) and Lake St. Clair (below).

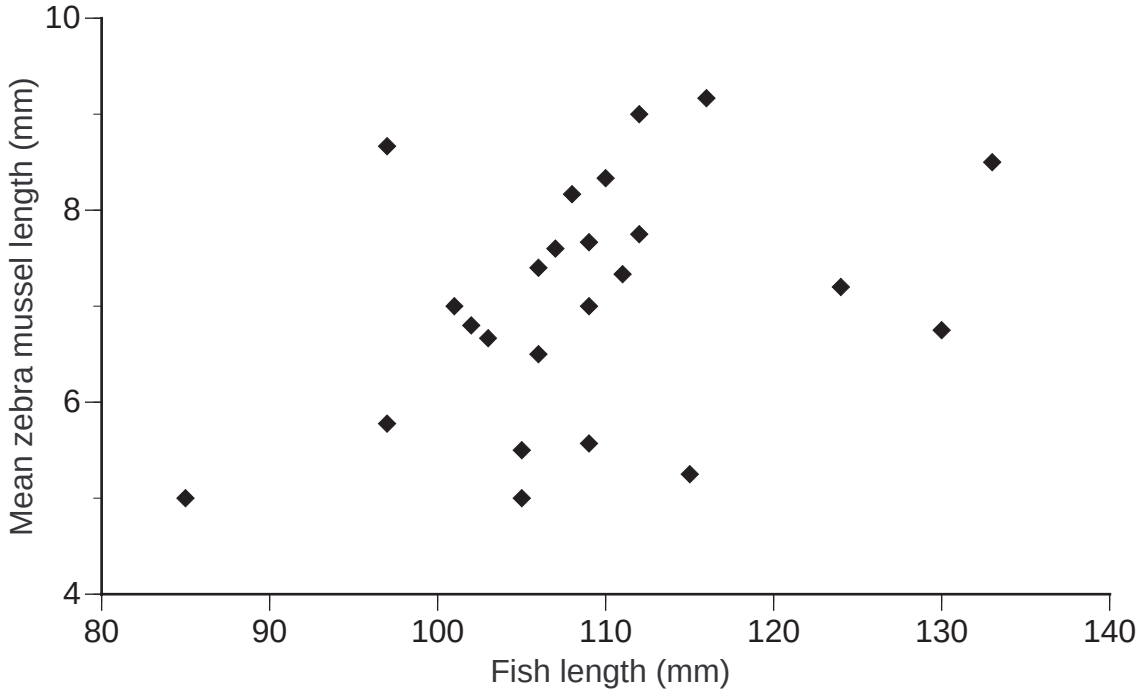

Figure 3.—Mean length of zebra mussels consumed by 24 round gobies in the St. Clair River.

Table 1.–Mean length and weight at age for round gobies *Neogobius melanostomus* collected in 1993. One SE is given in parentheses.

	Age			
	0	I	II	III
		St. Clair River		
Mean length (mm)	–	90 (17)	113 (10)	118 (10)
Mean weight (g)	–	11.9 (6.1)	25.4 (7.9)	28.6 (7.9)
Percent males	–	60	79	69
Number	0	10	56	13
		Lake St. Clair		
Mean length (mm)	53 (12)	97 (12)	110	–
Mean weight (g)	2.6 (1.4)	14.6 (4.6)	21.8	–
Percent males	43	78	0	0
Number	7	9	1	0

Table 2.–Taxa accounting for >5% by number of total stomach contents of round gobies collected in 1993 from the St. Clair River. n = 84.

	Zebra mussel	Rocks	Caddisfly cases	Caddisfly larvae
	Percent composition of diet:			
Total	874	104	192	113
Mean	11	2	6	3
Range	1-25	1-13	1-11	1-44
% of diet	62.0	7.4	13.6	8.0
	Frequency of occurrence:			
Stomachs containing at least 1	81	44	34	34
% of non-empty stomachs	96.4	52.4	40.5	40.5

Table 3.–Taxa accounting for >5% by number of total stomach contents of round gobies collected in 1993 from Lake St. Clair. n = 39.

	Zebra mussel	Fingernail clam	Caddisfly larvae	Snail	Scuds	Chironomid larvae	Seed shrimp
			Percent composition of diet				
Total	127	29	22	42	58	20	36
Mean	5	2	2	3	2	2	3
Range	1-16	1-4	1-5	1-7	1-9	1-7	1-7
% of diet	34.3	7.8	5.9	11.4	15.7	5.4	9.7
			Frequency of occurrence:				
Stomachs containing at least 1	26	14	13	13	24	10	12
% of non-empty stomachs	68.4	36.8	34.2	34.2	63.2	26.3	31.6

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