Appendix G

Summary of Atlantic Tomcod Food Habits Study

APPENDIX G

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G.1 STUDY OBJECTIVE

The objective of the Atlantic tomcod food habits study was to examine the stomach contents of juvenile and adult Atlantic tomcod in order to detect differences in food habits throughout the Hudson River estuary and the possibility of cannibalism among Atlantic tomcod.

G.2 METHODS

A maximum of 100 juvenile and 25 adult Atlantic tomcod per river run were collected during the Fall Juvenile Survey. Up to 20 juvenile and 5 adult fish per river region (as defined below for the Atlantic tomcod food habits study) were preserved in 10 percent formalin and returned to the laboratory for analysis.

Atlantic Tomcod Food Habits River Regions

Region	River Miles	FJS Region Designations
21	0-23	BT, YK
22	24-38	TZ, CH
23	39-46	IP
24	47-76	WP, CW, PK
25	77-152	HP, KG, SG, CS, AL

In the laboratory, the entire stomach was removed from the fish and the contents carefully placed into a dissecting pan or petri dish. The contents were identified to family level for fish and to order for invertebrates, except for gammarid amphipods which were identified to family if possible. For each type of food item, a count and weight to the nearest hundredth gram were recorded on the laboratory data sheet. Other recorded information included sample number, region, and river run as well as fish length and life stage. Age, sex, and sexual condition were determined on Atlantic tomcod from river runs 9 through 11 only.

G.3 RESULTS

A total of 235 Atlantic tomcod stomachs, 227 juvenile fish and 8 adult fish, were analyzed in 2005 (Table G-1). Fish were captured from 11 of the 13 designated regions of the Hudson River estuary from July through November 2005, with 98 percent of the fish caught during the summer. Juvenile fish were collected mostly from the lower and middle estuary regions between Battery and Hyde Park whereas adult fish were mainly collected in the lower estuary regions. Of the Atlantic tomcod analyzed, 86 percent measured 90 mm or less and most of these were found in the lower and middle estuary (Table G-2). Fish larger than 90 mm were found mainly in the lower estuary.

The most abundant food item by weight found in juvenile Atlantic tomcod was sand shrimp (*Crangon*), comprising 44 percent of the total weight of all food items found in this age group (Table G-3). The other food items that made up 95 percent of the juvenile Atlantic tomcod diet were gammarid amphipods (*Gammarus*), mysids (*Neomysis*), and non-gammarid amphipods (*Amphipoda*). For adult Atlantic tomcod, *Crangon* was also the most abundant food item by weight, comprising 95 percent of the diet. The other food items that made up the adult Atlantic tomcod diet were *Neomysis* and unidentified invertebrate remains. No fish taxa were found in the stomachs of the analyzed Atlantic tomcod. A complete listing of all food items by month and region is presented in Table G-4.

Consumption of the major food items were compared by month (Figure G-1, top graph), by region (Figure G-1, bottom graph), and by length (Figure G-2). *Crangon* was the major food item in August and October, whereas *Gammerus* was consumed mainly in July and November. *Crangon* and *Neomysis* were the dominant food items in the lower estuary regions, but *Gammarus* dominated in regions from Indian Point to the north. The smallest Atlantic tomcod consumed more *Gammarus* than other food items, but as fish grew, *Crangon* became the dominant food item.

To ascertain whether fish size or location was more important in determining patterns in diet, a comparison of food items from the eight lower regions of the estuary investigated changes with region and length (Figure G-3). In the lower estuary (Battery and Yonkers regions), all sizes of fish consumed mainly *Crangon* and *Neomysis*. In the middle estuary (Indian Point and above), location may also determine food choice as evidenced by the consumption of mainly *Gammarus* and *Amphipoda* by all sizes of fish.

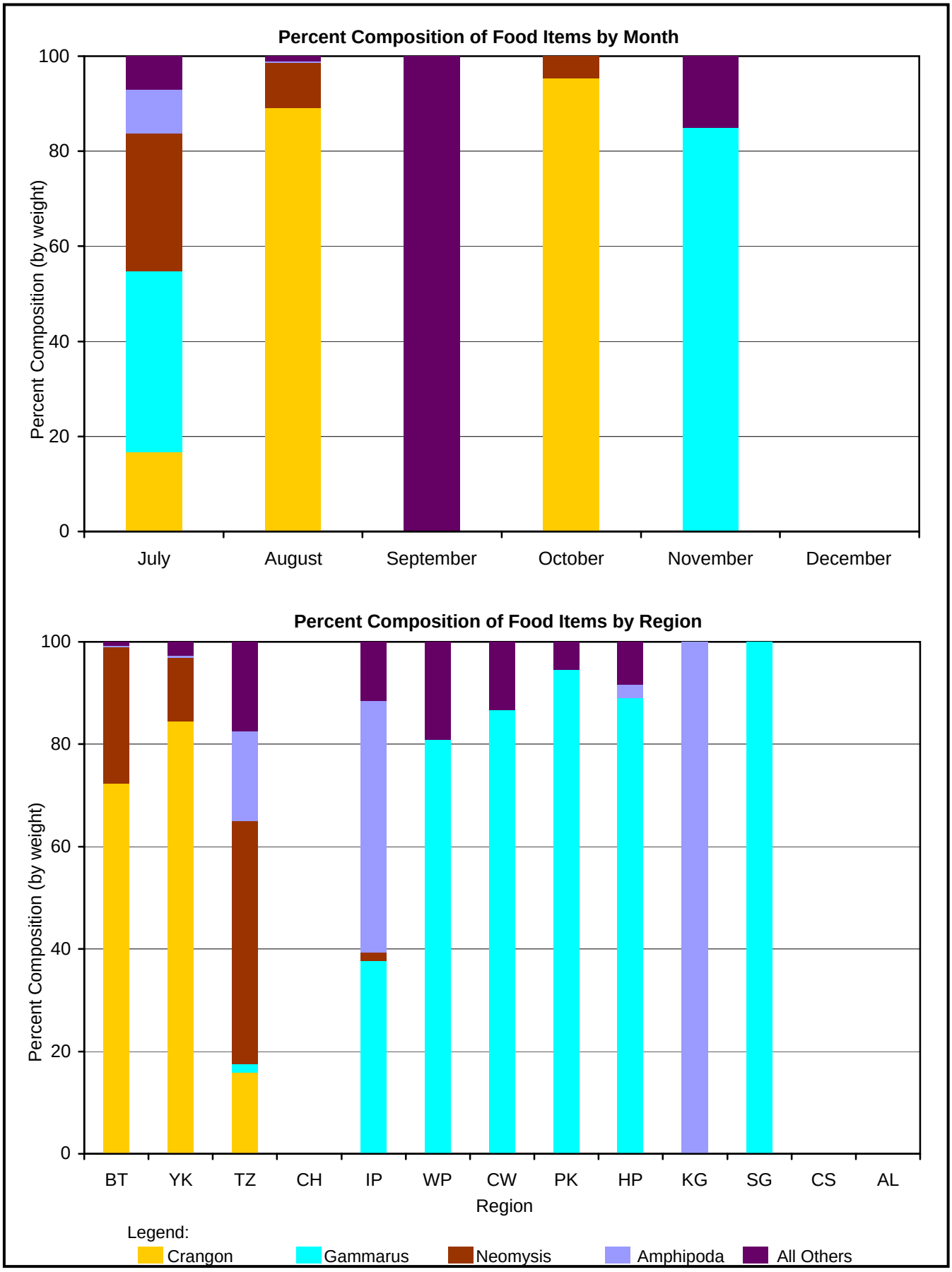

Figure G-1. Monthly and regional percent composition (by weight) of major food items from Atlantic tomcod food habit study, 2005.

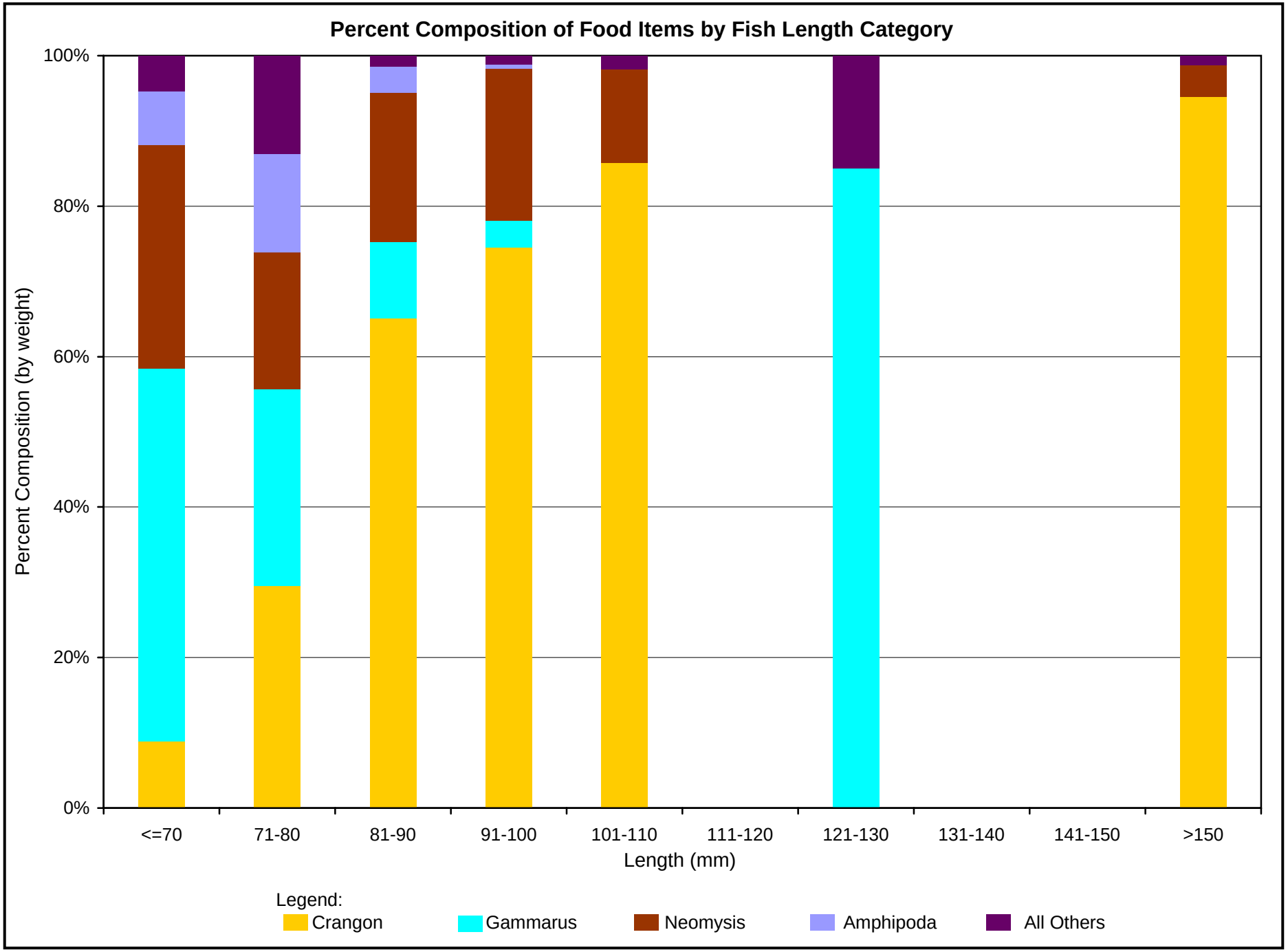

Figure G-2. Percent composition (by weight) of major food items by length category of Atlantic tomcod from food habit study, 2005.

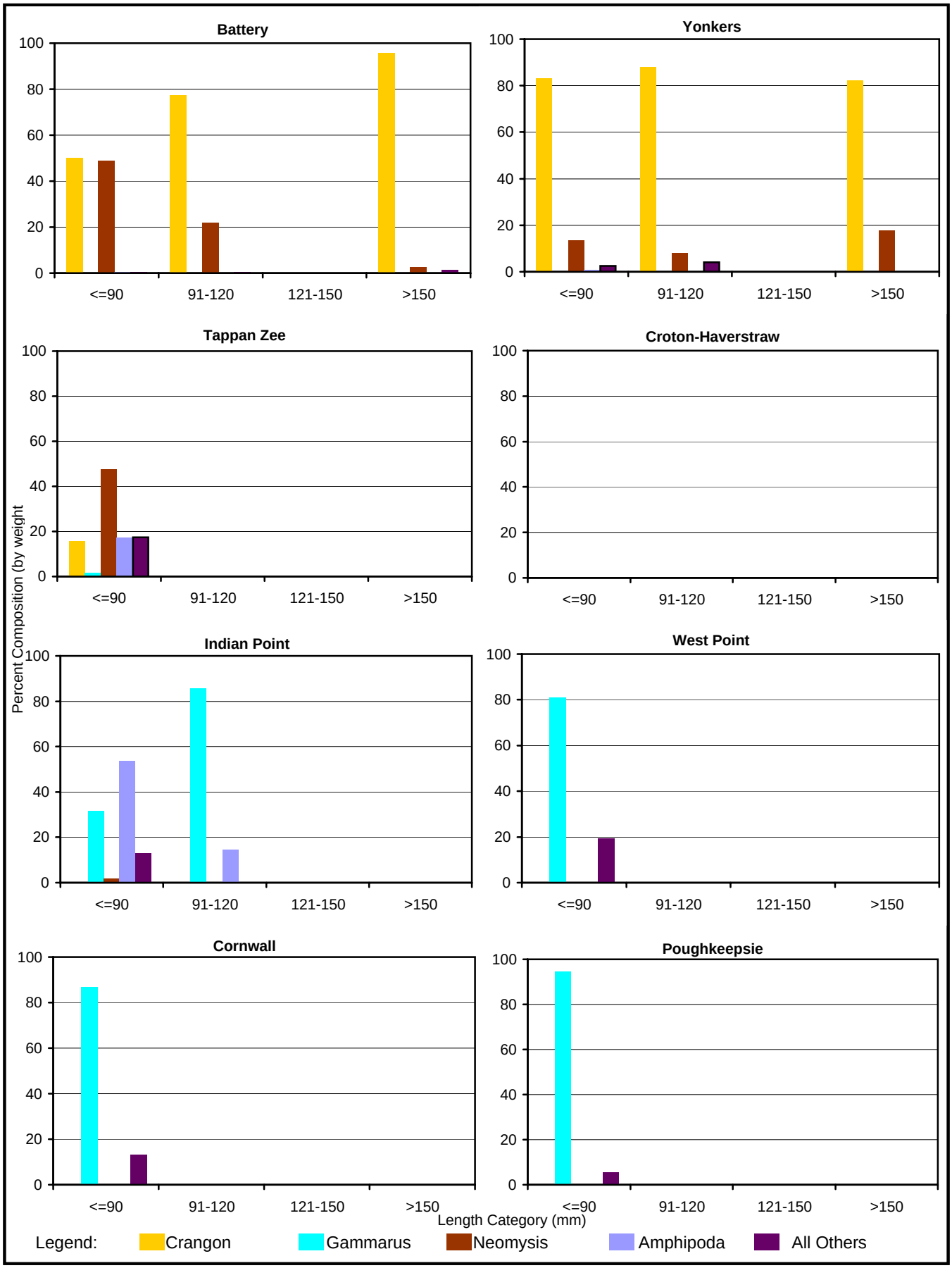

Figure G-3. Percent composition (by weight) of major food items by length category and region from Atlantic tomcod food habit study, 2005.

Table G-1 Number of Stomachs Analyzed for Atlantic Tomcod Food Habit Study, 2005

	July	August	September	October	November	December	Total
Juvenile							
Battery	30	22	--	2	--	--	54
Yonkers	10	13	1	--	--	--	24
Tappan Zee	22	--	--	--	--	--	22
Croton-Haverstraw	6	--	--	--	--	--	6
Indian Point	40	--	--	--	--	--	40
West Point	10	--	--	--	--	--	10
Cornwall	5	--	--	--	--	--	5
Poughkeepsie	25	--	--	--	--	--	25
Hyde Park	37	--	--	--	1	--	38
Kingston	1	--	--	--	--	--	1
Saugerties	2	--	--	--	--	--	2
Catskill	--	--	--	--	--	--	0
Albany	--	--	--	--	--	--	0
Total	188	35	1	2	1	0	227
Adult							
Battery	--	6	--	--	--	--	6
Yonkers	--	2	--	--	--	--	2
Tappan Zee	--	--	--	--	--	--	0
Croton-Haverstraw	--	--	--	--	--	--	0
Indian Point	--	--	--	--	--	--	0
West Point	--	--	--	--	--	--	0
Cornwall	--	--	--	--	--	--	0
Poughkeepsie	--	--	--	--	--	--	0
Hyde Park	--	--	--	--	--	--	0
Kingston	--	--	--	--	--	--	0
Saugerties	--	--	--	--	--	--	0
Catskill	--	--	--	--	--	--	0
Albany	--	--	--	--	--	--	0
Total	0	8	0	0	0	0	8
Total	188	43	1	2	1	0	235

-- = None collected.

Table G-2 Length Frequency Distribution of Atlantic Tomcod Analyzed for Food Habit Study, 2005

	Length Category (mm)									
	<=70	71-80	81-90	91-100	101-110	111-120	121-130	131-140	141-150	>150
Battery	17	8	12	12	5	--	--	--	--	6
Yonkers	7	4	9	3	1	--	--	--	--	2
Tappan Zee	11	9	2	--	--	--	--	--	--	--
Croton-Haverstraw	4	1	1	--	--	--	--	--	--	--
Indian Point	25	10	2	3	--	--	--	--	--	--
West Point	7	2	1	--	--	--	--	--	--	--
Cornwall	2	2	1	--	--	--	--	--	--	--
Poughkeepsie	21	4	--	--	--	--	--	--	--	--
Hyde Park	26	8	3	--	--	--	1	--	--	--
Kingston	--	--	1	--	--	--	--	--	--	--
Saugerties	2	--	--	--	--	--	--	--	--	--
Catskill	--	--	--	--	--	--	--	--	--	--
Albany	--	--	--	--	--	--	--	--	--	--
Total	122	48	32	18	6	0	1	0	0	8

-- = None collected.

Table G-3 Total Weight, Count, and Percent Composition of Food Items from Atlantic Tomcod Food Habit Study, 2005

Class	Order	Genus or Family	Species	Weight (g)[a]	Percent of Total Weight	Count	Percent of Total Count
Juvenile							
Malacostraca	Decapoda	Crangon		3.81	44.15	89	5.20
Malacostraca	Amphipoda	Gammarus		2.07	23.99	567	33.14
Malacostraca	Mysida	Neomysis		1.84	21.32	481	28.11
Malacostraca	Amphipoda			0.48	5.56	362	21.16
Invert remains				0.11	1.27	29	1.69
Malacostraca	Decapoda			0.10	1.16	13	0.76
Malacostraca	Cumacea			0.08	0.93	90	5.26
Plant remains				0.06	0.70	15	0.88
Insecta	Diptera	(Pupae)		0.02	0.23	3	0.18
Polychaeta				0.02	0.23	2	0.12
Inorganic mat.				0.02	0.23	3	0.18
Insecta	Odonata	(Juvenile)		0.01	0.12	1	0.06
Detritus				0.01	0.12	3	0.18
Empty stomach				< min.	0	5	0.29
Fish eggs				< min.	0	2	0.12
Pelecypoda				< min.	0	5	0.29
Gastropoda				< min.	0	1	0.06
Insecta	Diptera	Chironomidae	(Larvae)	< min.	0	13	0.76
Insecta	Trichoptera			< min.	0	1	0.06
Malacostraca	Isopoda	Chirodotea		< min.	0	1	0.06
Malacostraca	Isopoda	Edotea		< min.	0	1	0.06
Malacostraca	Isopoda	Cyathura		< min.	0	1	0.06
Malacostraca	Isopoda			< min.	0	4	0.23
Maxillipoda	Copepoda			< min.	0	14	0.82
Ostracoda				< min.	0	1	0.06
Branchiopoda	Diplostraca	Cladocera		< min.	0	3	0.18
Oligochaeta				< min.	0	1	0.06
Total				8.63	100	1711	100
Adult							
Malacostraca	Decapoda	Crangon		1.57	94.58	20	57.14
Malacostraca	Mysida	Neomysis		0.07	4.22	14	40.00
Invert remains				0.02	1.20	1	2.86
Total				1.66	100	35	100

[a] For some food items, weights were less than the minimum weight measurable by instrumentation and are represented here as "< min."

Table G-4 Summary of Food Items from Atlantic Tomcod Food Habit Study by Month and Region, 2005

	Battery		Yonkers		Tappan Zee		Croton Haverstraw		Indian Point		West Point		Cornwall		Poughkeepsie		Hyde Park		Kingston		Saugerties		Catskill		Albany	
	Ct.	Wt.	Ct.	Wt.	Ct.	Wt.	Ct.	Wt.	Ct.	Wt.	Ct.	Wt.	Ct.	Wt.	Ct.	Wt.	Ct.	Wt.	Ct.	Wt.	Ct.	Wt.	Ct.	Wt.	Ct.	Wt.
July																										
Empty stomach	-	-	-	-	1	< min.	2	< min.	-	-	-	-	-	-	-	-	1	< min.	-	-	-	-	-	-	-	-
Fish eggs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	< min.	-	-	-	-	-	-	-	-
Pelecypoda	1	< min.	-	-	-	-	-	-	-	-	-	-	1	< min.	-	-	3	< min.	-	-	-	-	-	-	-	-
Gastropoda	-	-	-	-	-	-	-	-	1	< min.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chironomidae (Larvae)	-	-	-	-	1	< min.	-	-	1	< min.	1	< min.	4	< min.	1	< min.	5	< min.	-	-	-	-	-	-	-	-
Odonata (Juvenile)	-	-	-	-	-	-	-	-	1	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trichoptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	< min.	-	-	-	-	-	-	-	-	-	-
Diptera (Pupae)	-	-	-	-	-	-	-	-	1	0.01	-	-	1	0.01	1	< min.	-	-	-	-	-	-	-	-	-	-
Crangon	14	0.45	11	0.28	3	0.1	-	-	1	< min.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Decapoda	5	0.01	-	-	2	0.03	-	-	1	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gammarus	-	-	-	-	4	0.01	1	< min.	53	0.23	47	0.17	30	0.13	162	0.52	214	0.8	-	-	16	0.04	-	-	-	-
Chirodotea	-	-	-	-	-	-	-	-	-	-	1	< min.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Edotea	1	< min.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyathura	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	< min.	-	-	-	-	-	-	-	-	-	-
Cumacea	13	< min.	-	-	51	0.06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Neomysis	268	1.01	34	0.12	58	0.3	-	-	13	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isopoda	1	< min.	-	-	-	-	-	-	-	-	1	< min.	1	< min.	1	< min.	-	-	-	-	-	-	-	-	-	-
Amphipoda	3	< min.	2	< min.	116	0.11	-	-	168	0.3	28	< min.	8	< min.	-	-	14	0.03	6	0.02	-	-	-	-	-	-
Copepoda	3	< min.	2	< min.	-	-	-	-	-	-	9	< min.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ostracoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	< min.	-	-	-	-	-	-	-	-
Cladocera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	< min.	-	-	-	-	-	-	-	-	-	-
Oligochaeta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	< min.	-	-	-	-	-	-	-	-
Polychaeta	-	-	-	-	1	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plant remains	-	-	-	-	-	-	-	-	2	< min.	1	0.01	1	< min.	5	0.01	5	0.01	-	-	-	-	-	-	-	-
Detritus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	0.01	-	-	-	-	-	-	-	-
Invert remains	-	-	1	0.01	4	0.01	3	< min.	7	0.01	3	0.03	2	0.01	1	0.01	6	0.03	-	-	1	< min.	-	-	-	-
Inorganic mat.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.01	1	0.01	-	-	-	-	-	-	-	-
August																										
Empty stomach	1	< min.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Crangon	49	3.06	27	1.29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Decapoda	2	0.01	3	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cumacea	3	< min.	5	< min.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Neomysis	87	0.35	34	0.11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Amphipoda	2	0.01	11	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polychaeta	-	-	1	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Invert remains	1	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(Continued)

NOTE: All weights are in grams. For some food items, weights were less than the minimum weight measurable by instrumentation and are represented here as "< min."

Table G-4 (Continued)

	Battery		Yonkers		Tappan Zee		Croton Haverstraw		Indian Point		West Point		Cornwall		Poughkeepsie		Hyde Park		Kingston		Saugerties		Catskill		Albany	
	Ct.	Wt.	Ct.	Wt.	Ct.	Wt.	Ct.	Wt.	Ct.	Wt.	Ct.	Wt.	Ct.	Wt.	Ct.	Wt.	Ct.	Wt.	Ct.	Wt.	Ct.	Wt.	Ct.	Wt.	Ct.	Wt.
September																										
Cumacea	-	-	18	0.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Amphipoda	-	-	1	< min.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
October																										
Crangon	4	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Neomysis	1	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Amphipoda	3	< min.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
November																										
Gammarus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40	0.17	-	-	-	-	-	-	-	-
Plant remains	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.03	-	-	-	-	-	-	-	-
Invert remains	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	< min.	-	-	-	-	-	-	-	-

NOTE: All weights are in grams. For some food items, weights were less than the minimum weight measurable by instrumentation and are represented here as “< min.”