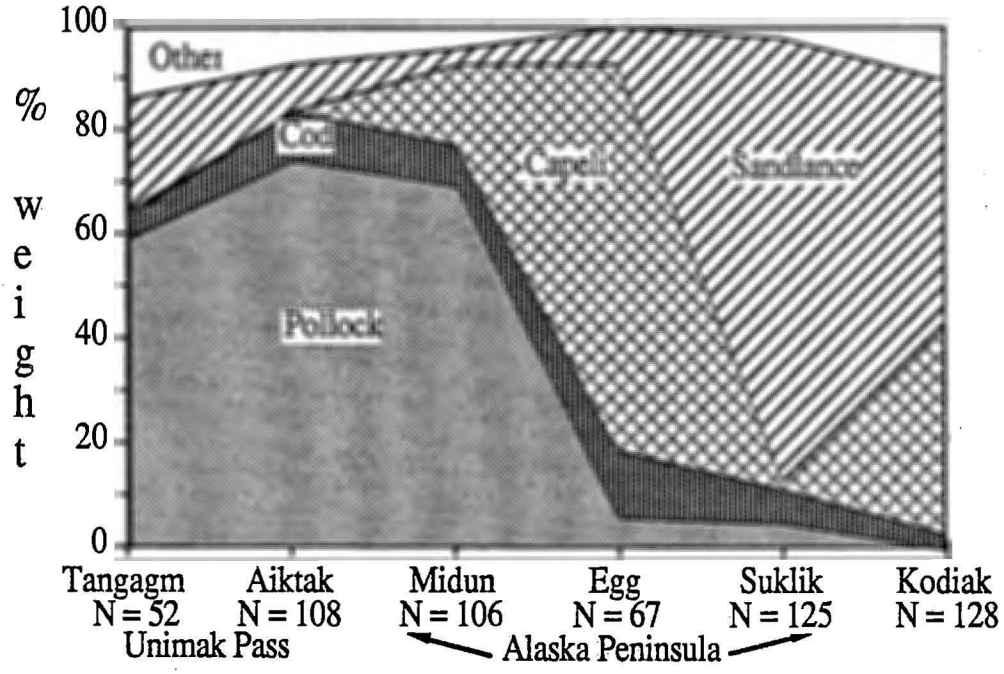
Alaska Fish and Wildlife Research Center
Seabird Research Team Field Report

DIETS OF NESTLING TUFTED PUFFINS (*Fratercula cirrhata*) IN THE GULF OF ALASKA AND EASTERN ALEUTIAN ISLANDS IN 1986, WITH SPECIAL REFERENCE TO "FORAGE FISH"



by

Gerald A. Sanger and Scott A. Hatch

Migratory Bird Section
Alaska Fish and Wildlife Research Center
U. S. Fish and Wildlife Service
1011 East Tudor Road
Anchorage, Alaska 99503
(907) 786-3512

April 1987

Seabird Research Team Field Report

DIETS OF NESTLING TUFTED PUFFINS (*Fratercula cirrhata*) IN THE GULF OF ALASKA AND EASTERN ALEUTIAN ISLANDS IN 1986, WITH SPECIAL REFERENCE TO "FORAGE FISH"

by

Gerald A. Sanger
Seabird-Fisheries Interactions Project Leader

and

Scott A. Hatch
Seabird Research Team Leader

Migratory Bird Section
Alaska Fish and Wildlife Research Center
U. S. Fish and Wildlife Service
1011 East Tudor Road
Anchorage, Alaska 99503
(907) 786-3512

April 1987

DIETS OF NESTLING TUFTED PUFFINS (*Fratercula cirrhata*) IN THE GULF OF ALASKA AND EASTERN ALEUTIAN ISLANDS IN 1986, WITH SPECIAL REFERENCE TO "FORAGE FISH"

by Gerald A. Sanger and Scott A. Hatch
U. S. Fish and Wildlife Service
Alaska Fish and Wildlife Research Center
Anchorage, Alaska 99503

ABSTRACT

In late summer 1986, diets of nestling tufted puffins were studied at 18 breeding colonies between Prince William Sound and Unimak Pass as part of a continuing investigation into the commercial fish food dependencies of puffins in the northern Gulf of Alaska and eastern Aleutian Islands. Juvenile walleye pollock (*Theragra chalcogramma*) were found to be the main prey from the Sandman Reefs to Unimak Pass, but the species was a minor dietary component or absent from the diet east of there, where capelin and Pacific sand lance were the main prey. Two consecutive years (1985 and 1986) of data from the Semidi Islands show that pollock utilization dropped from 20% to 5% by weight, while that of sand lance increased from 50% to 80%, thus underscoring the importance of continuing studies to learn annual variations in the diet.

A study of puffin diets in the manner used here, i.e., at several geographic locations within a narrow time window, provides a synoptic view of fish distribution, and appears to have excellent potential for augmenting data gatheredby traditional juvenile fish surveys. Coordination between such surveys and puffin diet studies in the future may benefit both disciplines by providing information to ornithologists about the availability of prey in waters near nesting colonies, while providing fisheries biologists with additional data on fish distribution.

Field studies in 1987 will focus on nesting colonies with large puffin populations, and sampling in the eastern part of our study region (i.e., Kodiak Island and eastward) will thus be greatly reduced or eliminated. Studies will include sampling every few days throughout the nestling stage at Suklik Island in the Semidi Islands (essentially mid-July to the first week in September), similar sampling late in the nestling stage at Unimak Pass. Food collections at Kodiak will be limited to Cathedral Island, and perhaps one other location. We will continue to share our data with the National Marine Fisheries Service (NMFS), Northwest and Alaska Fisheries Center (NWAFC), and to work toward closer cooperation between our respective studies.

INTRODUCTION

This report describes field work and preliminary results of a study of the diets of nestling tufted puffins (*Fratercula cirrhata*) at several breeding colonies in the northern and western Gulf of Alaska between Prince William Sound and Unimak Pass during late summer 1986. The overall objectives of the study are to learn the degree of geographic and annual variation in the puffins' diet, and to relate these findings to fisheries trends, particularly to the rapidly-changing fishery for walleye pollock (*Theragra chalcogramma)* in the Gulf of Alaska. Besides learning about puffin diets, objectives of the 1986 field studies were to determine which colonies were best suited for future work, and to improve field techniques used in 1985 at the Semidi Islands (Hatch and Sanger 1985).

BACKGROUND

This is a continuing project that is part of a broader program of investigations on seabirds conducted by the U. S. Fish and Wildlife Service (FWS), Alaska Fish and Wildlife Research Center (AFWRC). The present study was begun in light of adverse impacts to seabird populations from overfishing that have been demonstrated elsewhere in the world (Sanger in prep.), and because of a scarcity of data on how seabird populations and fish stocks interact in the Gulf of Alaska and eastern Aleutian Islands.

Under Section 303.1.B of the Alaska National Interest Lands Act (ANILCA), the FWS is responsible for conserving adequate food supplies for seabirds breeding on the myriad islands that comprise the Alaska Maritime National Wildlife Refuge (AMNWR), where 70% of all Alaskan seabirds breed. In a similar vein, a stated management objective of the North Pacific Fisheries Management Council (NPFMC) is for fisheries management ". . . to be consistent with resource stewardship responsibilities for the continuing welfare of living marine resources . . ." (NPFMC 1986). The results of the present and similar studies will help wildlife and fisheries management agencies to address their management objectives with a stronger base of biological information.

Although the kinds of prey that seabirds eat in the Gulf of Alaska are generally known, very little is known about geographic, seasonal, and annual changes in the utilization of commercial fish prey by seabirds. Such information is basic to understanding interactions between fish stocks and seabird populations. At present, the FWS is unable to make informed recommendations to resource managers to assure conservation of adequate amounts of forage fish to maintain the continuing welfare of seabirds. If this situation were to continue, a "worst case scenario" could conceivably leave the FWS and the fisheries management agencies open to litigation from

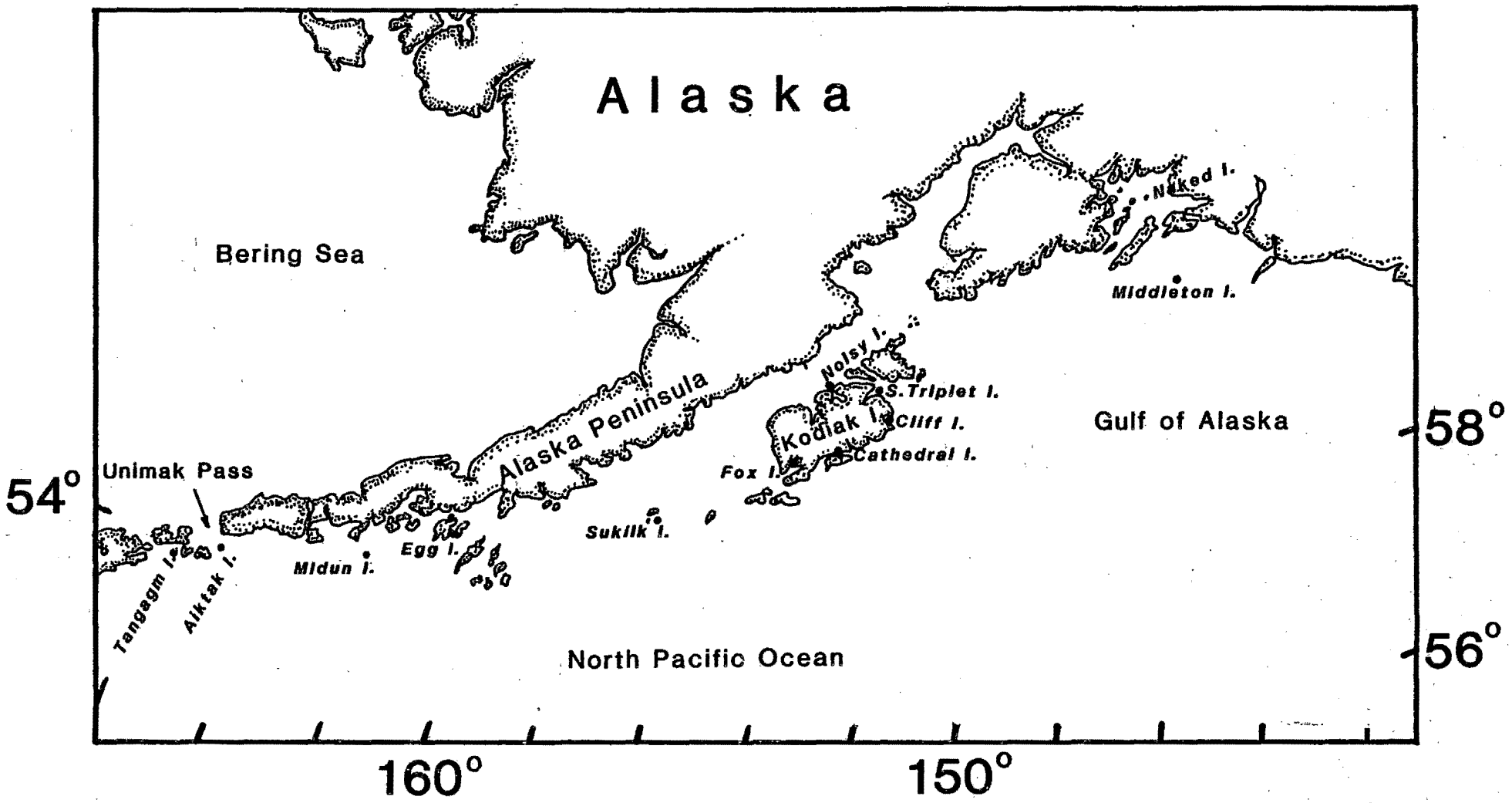


Figure 1. Western Gulf of Alaska and eastern Aleutian Islands, indicating islands where diets of nestling tufted puffins were studied, late summer 1986.

environmental protectionists for not taking measures to conserve stocks of forage fish. The present study is especially timely because the fishery for walleye pollock in the Gulf of Alaska has been growing rapidly since its inception in 1980, and stocks have been depleted for the past two years (Sanger in prep.), and the effect on the Gulf of Alaska ecosystem remains essentially unknown.

The present study of puffin diets represents a modest, but time- and cost-effective step at learning more about commercial fish food dependencies of seabirds in the Gulf of Alaska and eastern Aleutian Islands. Tufted puffins are particularly well suited as "sampling devices" for juvenile walleye pollock, Pacific cod (*Gadus pacificus*) and other forage fish because these seabirds readily dive to at least 60 m, and their feeding and nesting behavior readily lend themselves to efficiently collecting food samples; see below.

METHODS

LOGISTICS PLAN

The general plan for collecting puffin food samples was to visit as many colonies in the western Gulf of Alaska and the Unimak Pass area as practicable, and within as narrow a time frame as possible (Figure 1). We used three general criteria to select colonies to sample from among the scores of potential sites: 1. Population size; 2. Workability and logistical considerations; and, 3. Proximity to known nursery ares for juvenile pollock, as determined from surveys of the National Marine Fisheries Service (NMFS) (A. Kendall & H. Shippen, NMFS, pers. comm.).

FIELD METHODS

Sampling was accomplished between late July and early September by two mobile teams of two people each (Table 1). One team (Sanger and an assistant) worked colonies in the Kodiak Island area and Prince William Sound, and the other (Hatch and an assistant) covered colonies south of the Alaska Peninsula and westward to Unimak Pass. Depending on the situation, transportation was by commercial and charter aircraft and by Zodiak inflatable skiff powered with a 25 hp outboard motor; field crews camped on each island during the work there. Samples were also collected at two additional islands by other FWS personnel (A. L. Sowls and J. W. Nelson) who were engaged in other projects.

Tufted puffins lay a single egg in burrows about 0.5-1.5 m in length that they dig into seaward-facing, vegetated slopes of relatively small islands. Eggs hatch about mid-July, when both parents begin catching prey for their chick. Prey items are held crosswise in their bill as the parents return to the colony to feed their chick in the burrow. Most feeding takes place in the early morning hours, although some occurs throughout the day.

We collected food samples with minimal disturbance to parents or chicks by placing screens of 1/2" hardware cloth in burrow entrances, and returning at one-to two-hour intervals to collect food samples. Any prey found on or near a screen was considered to be one sample, but it was impossible to tell if samples with more than one prey item constituted more than one bill load (i.e., food deliveries from both parents). Most sampling effort occured immediately after daybreak, but collections were also made in the late afternoon or evening on some islands. We marked screened burrows with surveyor's tape tied to adjacent vegetation, and removed both the screen and tape from any burrows with food samples. We removed all remaining screens and tape after each day's sampling effort.

Sampling continued on each island until either 30 or more samples were obtained or until it was determined that it was not possible to do so without endangering the successful completion of the remaining sampling schedule before the chicks fledged. In practice, this translated to stays on any given island of less than 24 hr, to as long as three days (Table 1).

Prey in samples from Kodiak Island colonies were measured in the field to the nearest mm with a ruler and weighed individually to the nearest 0.1 g with a small spring (Pesola®) scale. Selected lots of Pacific sand lance (*Ammodytes hexapterus*), and capelin (*Mallotus villosus*), all gadids, and voucher specimens of other species, were preserved in 10% formalin buffered with seawater, and transferred to 50% isopropanol a few days later for subsequent verification of identification by taxonomic specialists. Samples from all other islands were preserved as above for subsequent processing in the laboratory.

LABORATORY AND DATA ANALYSES

Samples were identified to the lowest possible taxon, and individual prey were weighed to the nearest 0.1 g on a Mettler® H80 electronic balance. Total lengths were measured to the nearest mm. Total sample weights were determined by summing the individual weights of all prey in the sample. All unidentified fish, and voucher specimens of species we tentatively identified, were sent to taxonomic specialists at the National Marine Fisheries Service (NMFS), Northwest and Alaska Fisheries Center (NWAFC), Seattle, for identification. Specimens of capelin and Pacific sand lance that had been weighed in the field were re-weighed to determine the amount of weight change with preservation.

A Microsoft Excel® program was used with an Apple MacIntosh® 512E microcomputer for data entry, verification, and analyses utilizing the program's database, spreadsheet analysis and graphing capabilities. Fish length-frequency histograms (see below) were prepared with a Cricketgraph® program on the Macintosh.

RESULTS

Sixteen islands (Figure 1) were visited a total of 18 times (repeat visits at two colonies) by four project biologists, plus five temporary cooperators from other FWS projects. However, there was wide variation in the workability and sampling success among the islands. Colonies with the largest numbers of birds provided the greatest sampling success (samples found per number of screens set), and low populations or poor workability precluded five or six colonies from future sampling. See Table 1 for details.

PUFFIN DIETS

Unimak Pass Area

Tangagm Island. Tangagm Island is located in Akutan Pass, approximately 20 km east of Dutch Harbor (Figure 1). Between 30 August and 3 September, 52 samples were collected that included a total of 249 prey items. Juvenile walleye pollock was by far the most important prey, and comprised 59% of the diet by weight. Pollock were followed in importancce by Pacific sand lance (*Ammodytes hexapterus*) at 22% of the diet, 8% Atka mackerel (*Pleurogrammus monopterigius*), 6% Pacific cod (*Gadus pacificus*), and traces of capelin and other species (Figure 2).

Aiktak Island. Farther east at Aiktak Island, located in the Krenitzen Islands of Unimak Pass (Figure 1), juvenile pollock accounted for 76% of the diet in 108 samples that included 720 items(Figure 2). Cod accounted for another 10%, sand lance 9%, and greenlings (hexagrammidae), 5%.

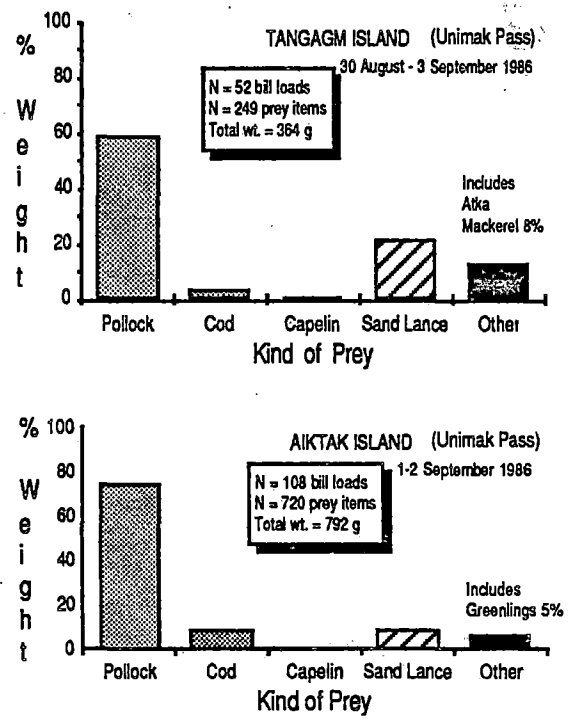


Figure 2. Diets of nestling tufted puffins at colonies in the Unimak Pass area in 1986.

Alaska Peninsula Area

Midun Island . Juvenile pollock were the main prey at Midun Island, located in the Sandman Reefs area (Figure 1), where the species accounted for 75% of the diet in 106 samples that included 841 prey items (Figure 3). Capelin assumed greater importance to the puffins here, forming 16% of the diet, followed by juvenile cod at 8%, smaller amounts of sand lance and other species.

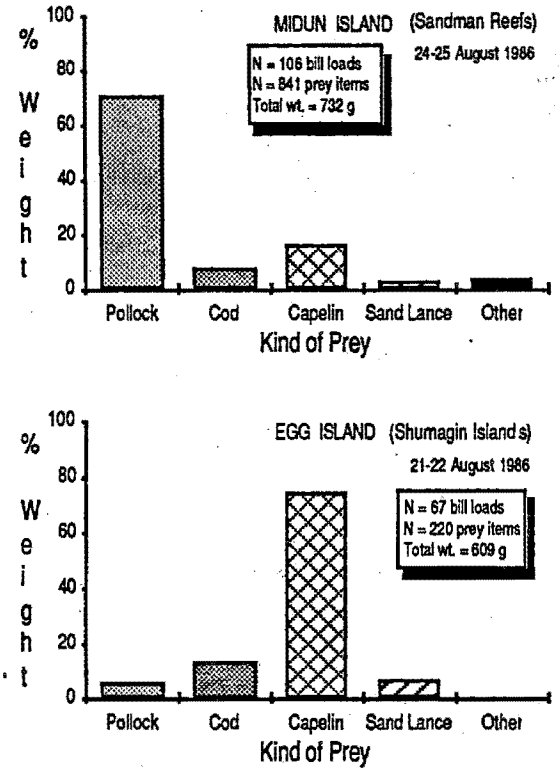


Figure 3. Diets of nestling tufted puffins at colonies in the Alaska Peninsula area in 1986.

Egg Island. There was a dramatic difference in puffin diets between Midun Island and Egg Island, the latter located near the villiage of Sand Point in the Shumagin Islands (Figure 1). At Egg Island, among 220 prey items in 67 samples, juvenile pollock dropped to only 7% of the diet, while capelin jumped to 73% (Figure 3). Cod rose to 13% of the diet and sand lance made up the remaining 7%.

Suklik Island. Data from Suklik Island in the Semidi Islands (Figure 1) provide our only information from the study thus far on annual changes in the puffins' diet, but they illustrate that the diet composition can change substrantially from year to year. The diet was less varied in 1986

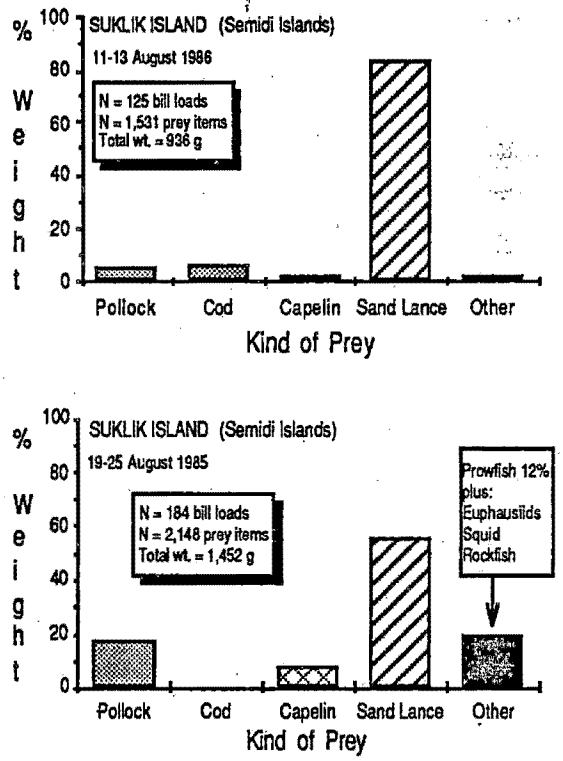


Figure 4. Comparison of diets of nestling tufted puffins at Suklik Island in 1985 and 1986.

than in 1985, when 2,148 prey items found in 184 samples fell out at 21% juvenile pollock, no cod, 50% sand lance, 9% capelin, 12% prowfish (*Zaprora silenius*), and the remaining 9% a variety of squid, octopi, euphausiids, osmerids, rockfish and juvenile flatfish (pleuronectidae)(Figure 4). In contrast, the 1986 samples comprised1,531 prey items in 125 samples, that included only 5% juvenile pollock, but 6% juvenile cod, 2% capelin, and 85% sand lance.

Kodiak Island Area

Fox Island. Fox Island is located in Alitak Bay at the southern end of Kodiak Island (Figure 1), and, although the puffin colony there numbers only 1,000 or so birds, it was chosen to sample because of important juvenile pollock

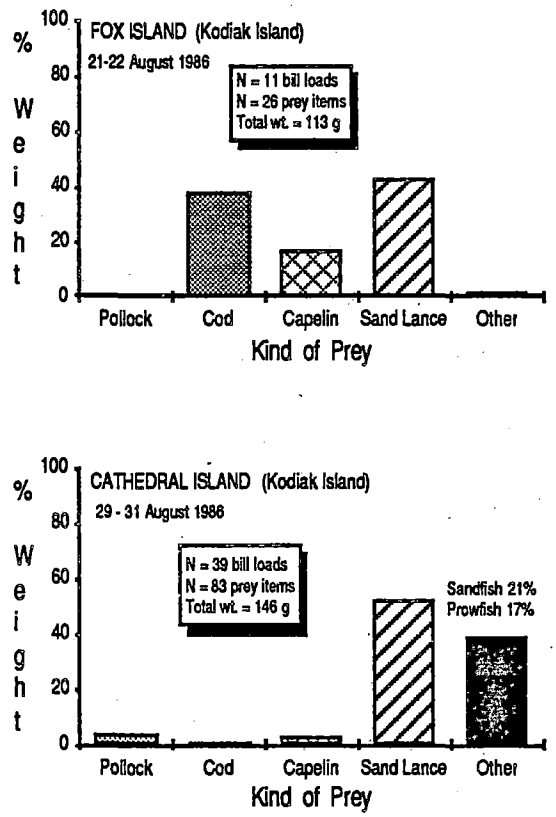


Figure 5. Diets of nestling tufted puffins at colonies in southern Kodiak Island in 1986.

nursury areas off southern Kodiak Island. Sampling resulted in only 11 samples, containing but 26 prey items (Figure 5). Of these, 43% by weight were sand lance, followed by cod (38%), capelin (17%), and 2% "other." Due to poor sampling success and difficult logistics required to reach the island, we do not plan on sampling Fox Island in the future.

Cathedral Island. Cathedral Island is located in the Sitkalidak Straits area of Kodiak Island (Figure 1), and with an estimated 12,000 breeding tufted puffins, the colony is one of the largest in the Kodiak Archepelago. The island was one of several sites in the Gulf of Alaska where breeding biology and nestling diets of several species of seabirds, including tufted puffins, were studied in 1977 and 1978 as part of the Alaska Outer Continental Shelf Environmental Assessment Program (OCSEAP) (Baird and Gould 1986).

Thirty-nine samples collected during the present study produced 83 prey items, and a fairly wide variety of prey (Figure 5). Pacific sand lance was by far the most important prey, forming 52% of the diet, followed by Pacific sandfish (*Trichodon trichodon*) at 21%, and prowfish (*Zaprora silenius*) (17%). Small amounts of pollock, cod and capelin rounded out the diet.

Noisy Island. Noisy Island is located on the northeast corner of Kodiak Island, on Shelikof Strait (Figure 1). A one-day sampling effort produced 32 prey items in 12 samples, wherein capelin (35%) and sand lance (32%) were the main foods (Figure 6). Pacific sandfish (24%) and squid (6%) rounded out the diet.

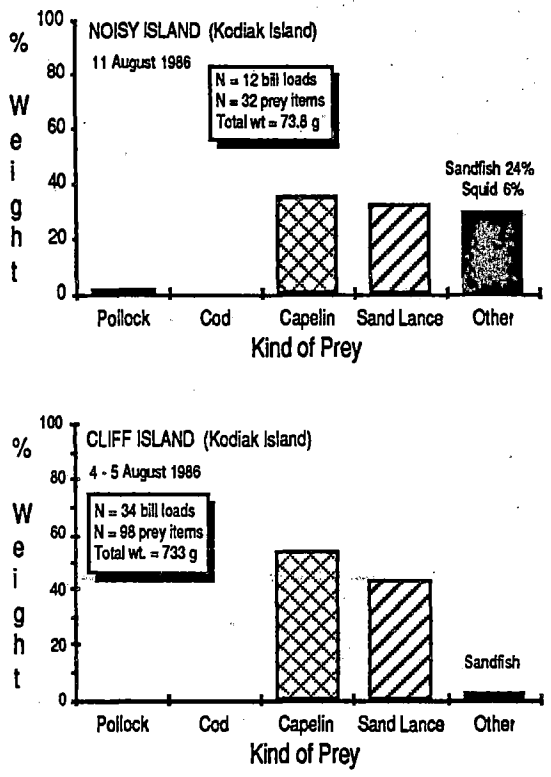


Figure 6. Diets of nestling tufted puffins at colonies in the northern Kodiak area in 1986.

Cliff Island. Cliff Island is located in Chiniak Bay, near the town of Kodiak (Figure 1). We visited this colony in early August, and again in early September. Capelin dominated the early August diet, and formed 54% by weight of 98 prey items in 34 samples (Figure 6). The rest of the diet was comprised of sand lance (43%) and sandfish (3%). The September visit to the colony produced only two samples for 220 screens set over a two-day period, and it appeared that the parent puffins had already left the chicks to fledge. Several chicks that were removed from their burrows for size measurement indicated that they were very near fledging.

South Triplet Island. South Triplet Island, located in The Triplets group in Marmot Bay just north of Kodiak Island (Figure 1), was sampled in early August and again a month later. Six samples collected in August, and 26 more collected in September contained a total of 14 and 93 prey items, respectively. Capelin and sand lance together dominated the diet, and there were trace amounts of sandfish and squid (Figure 7).

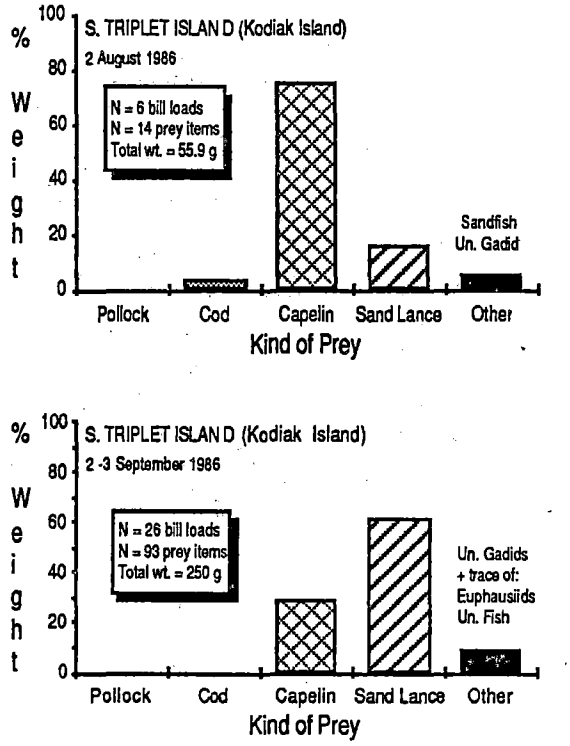


Figure 7. Diets of nestling tufted puffins at colonies in Marmot Bay, Kodiak area, in 1986.

Middleton Island and Prince William Sound

Five of six prey items in five samples at Middleton Island were sand lance and the other was a pollock. Two samples from Naked Island in Prince William Sound

consisted of one pollock and one juvenile chum salmon (*Onchorhynchus keta*) (Figure 8). Due to the poor sampling success at these locations we do not plan to sample them in the future.

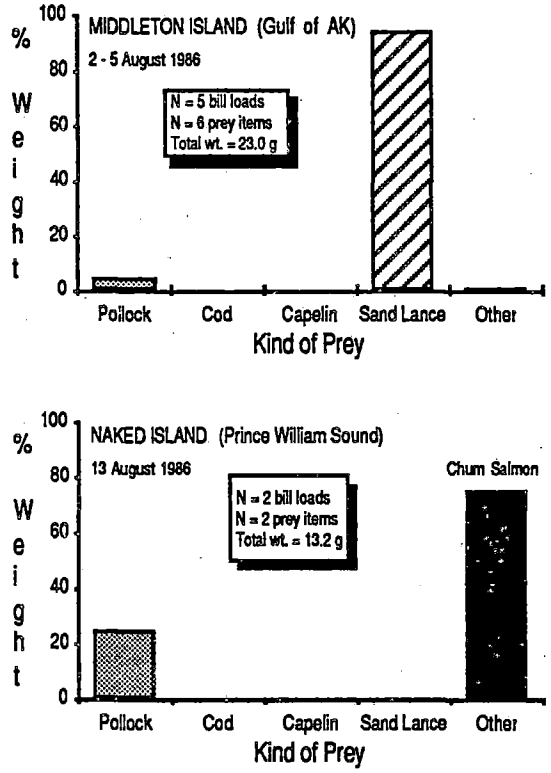


Figure 8. Diets of nestling tufted puffins at Middleton and Naked Islands in 1986.

FISH LENGTHS

Walleye Pollock

A total of 808 whole pollock occured in samples from the five islands studied between the Semidi Islands and Unimak Pass (Table 2). Overall, their total lengths ranged from about 30 to 90 mm, although the vast majority ranged from about 45 to 70 mm in length (Figure 9). This would seem to indicate that they were all age-0 fish. Length data were not compared statistically,

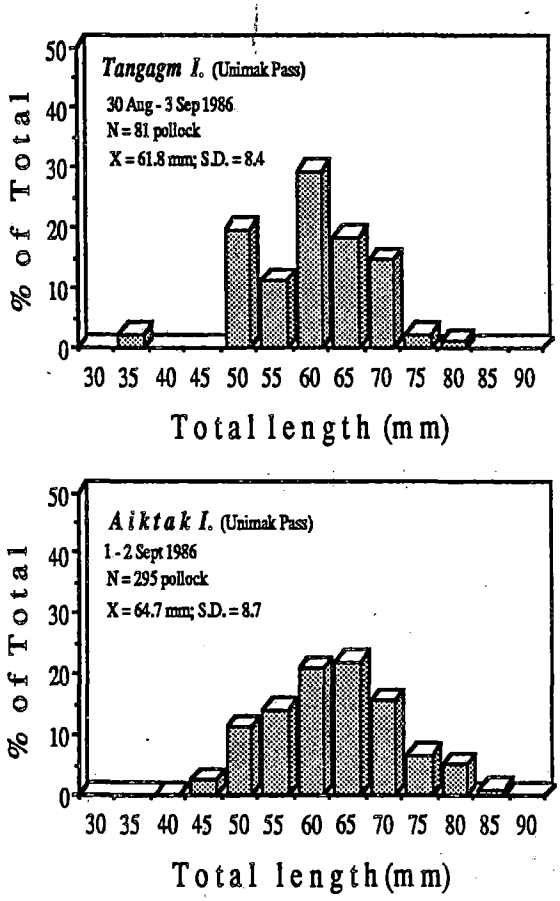


Figure 9a. Length frequencies of pollock in the diets of nestling tufted puffins in the Unimak Pass area in 1986.

but it appears from these data that fish from Tangagm Island and Aiktak Islands in the Unimak Pass area averaged in the 60-65 mm range, while those from Midun, Egg and Suklik Islands farther east averaged smaller by 10 mm or more less (Figure 9). This apparant difference could have resulted at least in part from time differences in the sampling. Suklik Island was sampled on 11-13 August, Egg and Midun Islands were sampled between 21 and 25 August, and the colonies in the Unimak Pass area, Tangagm

and Aikta, were not sampled until August 30 to September 3.

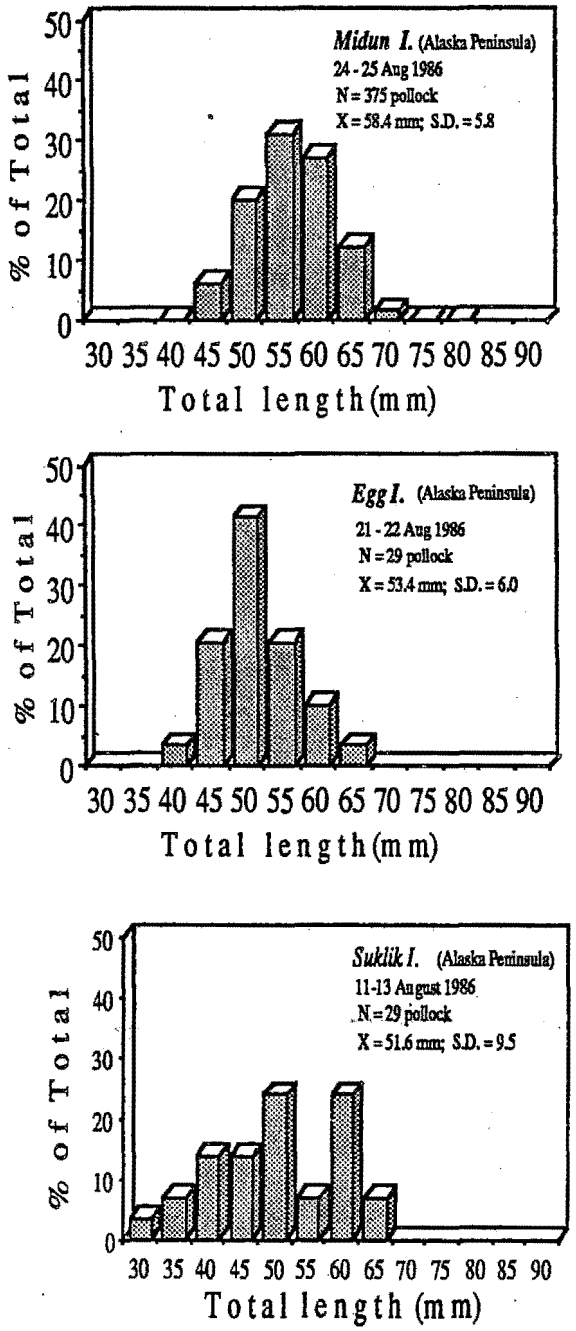
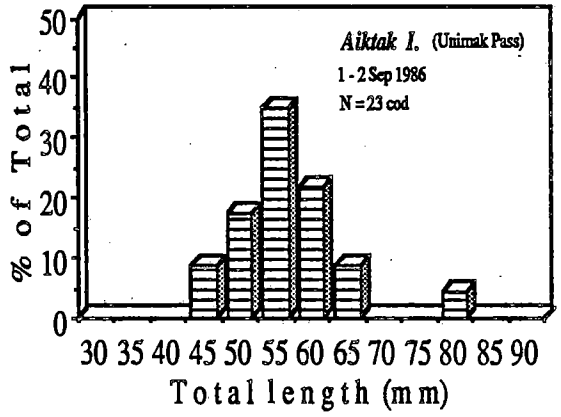
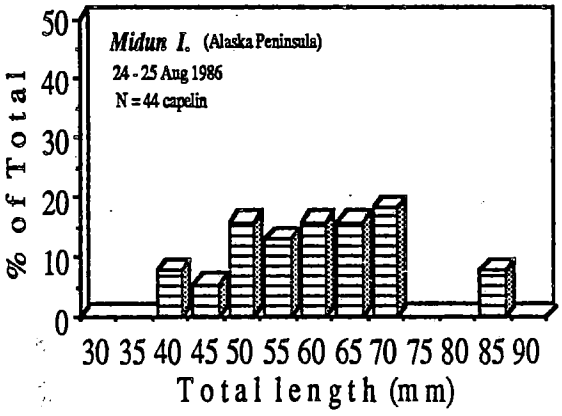


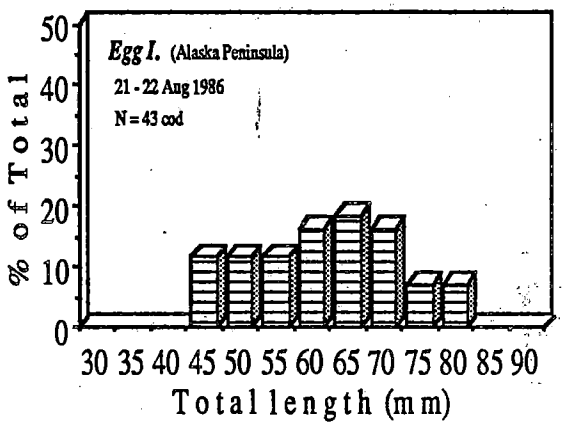
Figure 9b. Length frequencies of pollock in the diets of nestling tufted puffins in the Alaska Peninsula area in 1986.

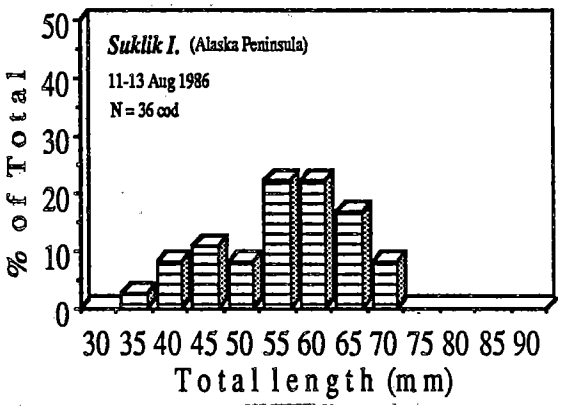
Pacific Cod

Juvenile cod occured in the samples essentially from Fox Island in southern Kodiakand westward, plus only one or two from two colonies farther east on Kodiak (Table 3). In total, 164 whole cod occured in the samples. Overall, total lengths ranged from about 35 to 90 mm, and most were in the 50-70 mm range (Figure 10).









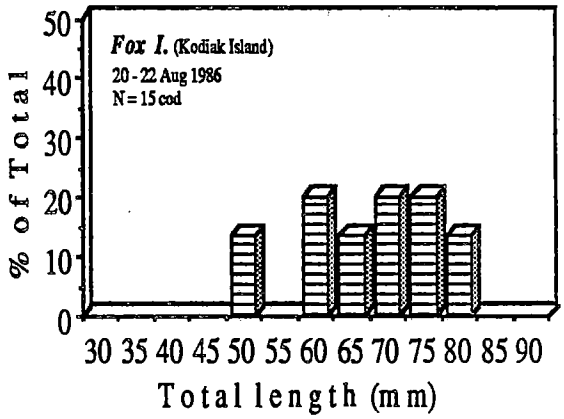
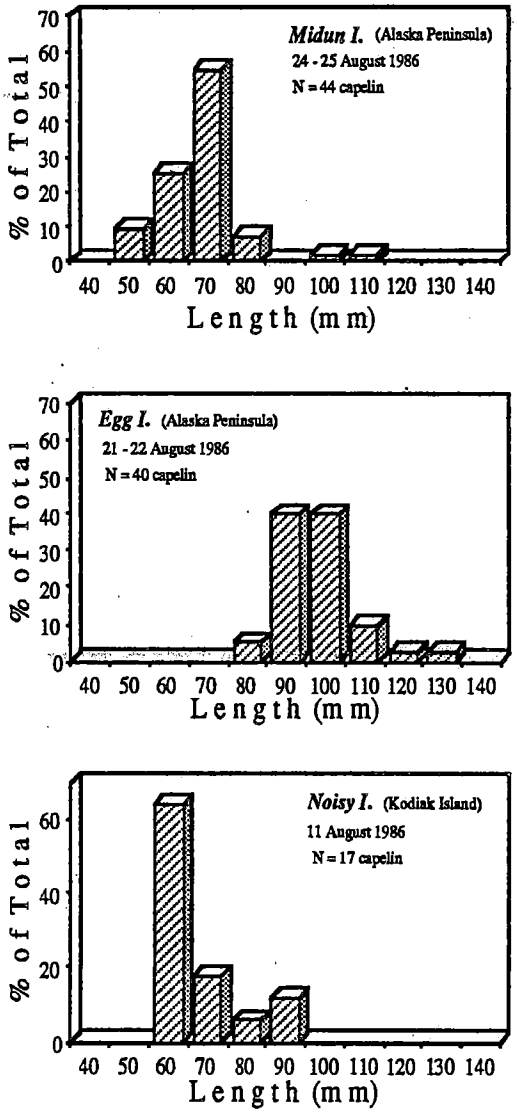


Figure 10. Length frequencies of Pacific cod in the diets of nestling tufted puffins in the western Gulf of Alaska in 1986.

Capelin

A total of 164 whole capelin occured in the samples (Table 4). Overall total lengths ranged from 50 mm at Midun Island to 150 mm at Cliff Island; sample sizes at any one island were small (maximum of 44 at Midun Island), but it appears that at least two age classes were present at each island (Figure 11).



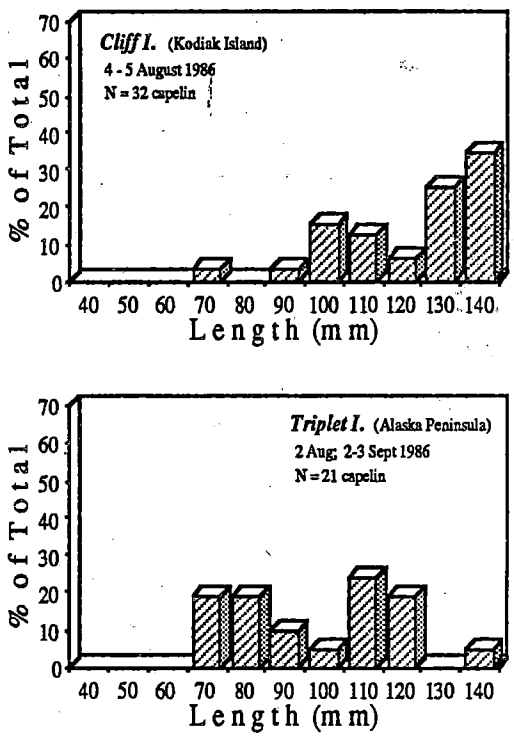
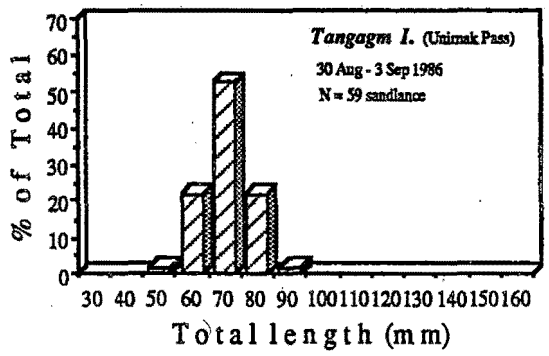
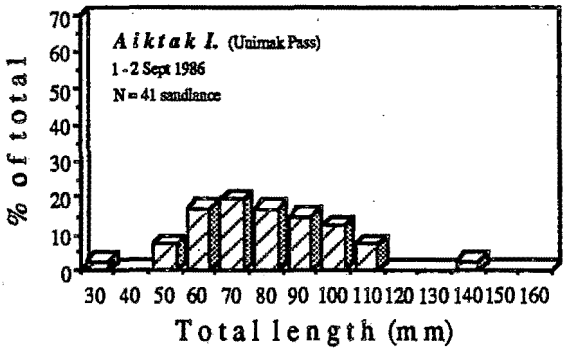


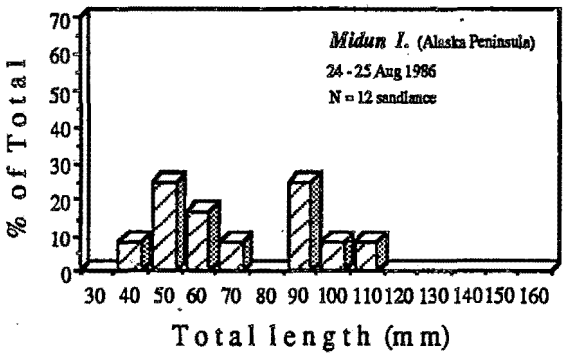
Figure 11. Length frequencies of capelin in the diets of nestling tufted puffins in the Alaska Peninsula and Kodiak areas in 1986.

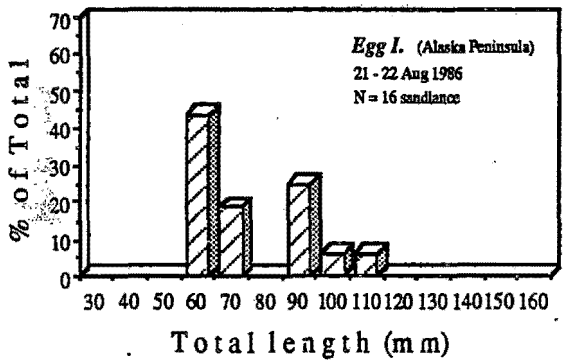
Pacific Sand Lance

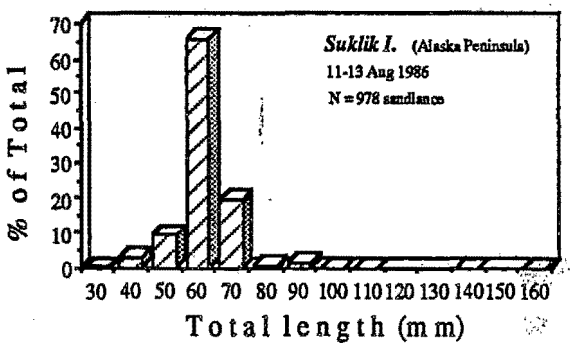
Data on sand lance lengths (Table 5, Figure 12) show that overall lengths for all samples ranged from about 30 to 155 mm in total length, and there were likely at least two year classes present. At Suklik Island, however, where 978 sand lance occured in the 125 samples collected, the large majority of fish were in the 60-65 mm length increment, suggesting that one year class dominated.

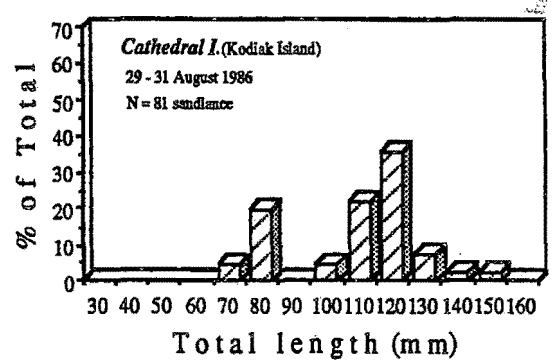


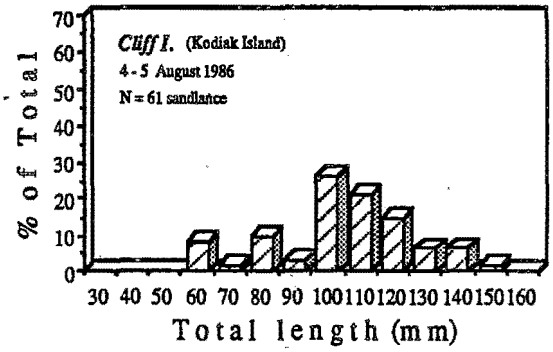












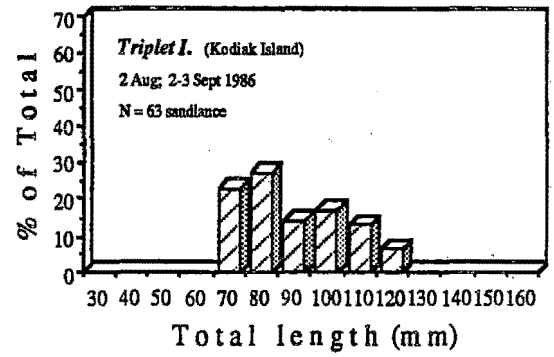


Figure 12. Length frequencies of Pacific sandlance in the diets of nestling tufted puffins in the Gulf of Alaska and eastern Aleutian Islands, late summer 1986.

SUMMARY

MAIN CONCLUSIONS

In late summer 1986, diets of nestling tufted puffins were studied at 18 breeding colonies between Prince William Sound and Unimak Pass as part of a continuing investigation into the commercial fish food dependencies of puffins in the northern Gulf of Alaska and eastern Aleutian Islands. Juvenile walleye pollock (*Theragra chalcogramma*) were found to be the main prey from the Sandman Reefs to Unimak Pass, but the species was a minor dietary component or absent from the diet east of there, where capelin and Pacific sand lance were the main prey (Figure 13). Two consecutive years (1985 and 1986) of data from the Semidi Islands show that pollock utilization dropped from 20% to 5% by weight, while that of sand lance increased from 50% to 80% (Figure 4), thus underscoring the importance of continuing studies to learn annual variations in the diet.

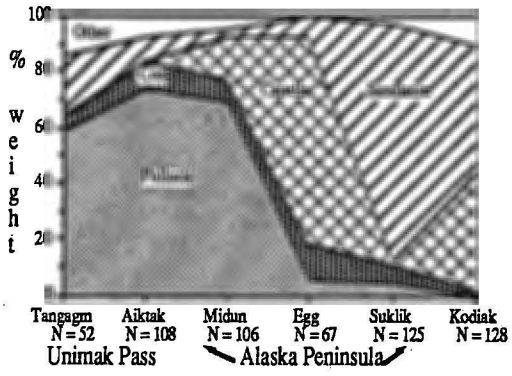


Figure 13. Summary of nestling tufted puffin diets, late summer 1986

TUFTED PUFFINS AS JUVENILE FISH SAMPLERS

A study of puffin diets in the manner used here, i.e., at several geographic locations within a narrow time window, provides a synoptic view of fish distribution, and appears to have excellent potential for augmenting data gathered by traditional juvenile fish surveys. Coordination between such surveys and puffin diet studies in the future may benefit both disciplines by providing information to ornithologists about the availability of prey in waters near nesting colonies, while providing fisheries biologists with additional data on fish distribution.

1987 AND BEYOND

Field studies in 1987 will focus on nesting colonies with large puffin populations, and sampling in the eastern part of our study region (i.e., Kodiak Island and eastward) will thus be greatly reduced or eliminated. Studies will include sampling every few days throughout the nestling stage at Suklik Island in the Semidi Islands (essentially mid-July to the first week in September) and similar sampling late in the nestling stage at Unimak Pass. Food collections at Kodiak will be limited to Cathedral Island, and perhaps one other location. We will continue to share our data with the National Marine Fisheries Service (NMFS), Northwest and Alaska Fisheries Center (NWAFC), and to work toward closer cooperation between our respective studies.

ACKNOWLEDGEMENTS

The success of this project benefitted from the help of several people. We wish particularly to acknowledge Lori Terwilliger and Michael North for assistance in the field and laboratory, and North for preliminary data analysis. Other field assistance was rendered by FWS personnel David Irons, Jay Nelson, Sylvia Lane, Art Sowls, and Una Swain. We are grateful to the staffs of the Kodiak National Wildlife Refuge and the Izembek National Wildlife Refuge for hospitality and assistance.

Special thanks are due the officials and people of the Natives of Akhiok-Kaguyak, Inc., the Old Harbor Tribal Council, the Ouzinkie Native Corporation, and the Unga Corporation for their hospitality and for allowing us to work on their land. Special thanks also go to Art Kendall and Herb Shippen, Northwest and Alaska Fisheries Center, for their encouragement and interest in the project, and to Beverly Vinter for taxonomic assistance with the fish.

REFERENCES

Baird, P. A. and P. J. Gould, eds.

1986. The breeding biology and feeding ecology of marine birds in the Gulf of Alaska. U. S. Dep.Commer., NOAA OCSEAP Final Rept. 45:121-504.

Hatch, S. A. and G. A. Sanger

1986. Seabird studies on the Semidi Islands, Alaska, 13-27 August 1985.USFWS, Alaska Fish & Wildl. Res. Ctr. Unpubl. field rept. 15 pp.

North Pacific Fisheries Management Council

1986. Gulf of Alaska groundfish management plan. NPFMC, Anchorage, AK

Sanger, G. A.

In preparation. Trophic interactions between commercial fisheries and seabirds in Alaskan waters.USFWS, Alaska Fish & Wildl. Res. Ctr., Anchorage, AK. MS in prep.

Table 1. Field itinerary for nestling tufted puffin diet study.

Date	Area	Island Name	Number of: Screens deployed	Number of: Samples found	Personnel (1)	Notes
25 - 27 July	Prince William Sound	Long	0	0	GS, DI	Reconaissance visit; small population &/or difficult access precluded sampling.
29 - 30 July	Kodiak - Ugak Bay	Long	0	0	GS, LT	Very small TUPU population & heavy River Otter predation precluded sampling.
31 July - 2 Aug	Kodiak - Marmot Bay	S Triplett	194	6	GS, LT	Highly variable burrow densities; best areas not found until following visit.
3 - 5 August	Kodiak - Chiniak Bay	Cliff	ca. 220	34	GS, LT	Medium burrow densities on readily accessible but island very small.
2 - 5 August	Gulf of Alaska	Middleton	?	5	AS	Small TUPU population & confusion with Rhinoceros Auklet burrows limited sampling success.
10 - 11 August	Kodiak - Uganik Bay	Noisy	ca. 100	12	JN	Good burrow densities, but JN's main project precluded more sampling.
10 - 11 August	Semidi Islands	Suklik	ca. 400	125	SH, MN	Remote, & logistics sometimes difficult, but otherwise an outstanding island to work.
11 - 12 August	Prince William Sound	Porpoise Rocks	0	0	GS, LT, US	Very small population, difficult access, & heavy seas precluded sampling.
12 - 13 August	Prince William Sound	S Naked	31	2	GS, LT, US	Perhaps 200 birds on entire island, with a concentration of ca. 50 at wester n end.
19 - 20 August	Kodiak - Alitak Bay	Sundstrom	0	0	GS, LT	Maximum of ≤30 TUPU on entire island; no sampling.

(Continued)

Table 1. Field itinerary (continued).

Date	Area	Island Name	Number of: Screens deployed	Number of: Samples found	Personnel (1)	Notes
20 - 22 August	Kodiak - Alitak Bay	Fox	ca. 200	11	GS, LT	Difficult to work on small-medium population; burrow densities low except for S end.
20 - 22 August	Shumagin Islands	Egg	ca. 490	67	SH, MN	Very close to Sand Pt; good, workable island.
23 - 25 August	Sandman Reefs	Midun	ca. 395	106	SH, MN	Large population; island fairly accessible, easily worked.
28 -31 August	Kodiak - Sitkalidak Str.	Cathedral	ca. 230	39	GS, LT	Large population; island fairly accessible, easily worked.
29 Aug - 3 Sept	Unimak - Akutan Pass	Tangagm	ca. 200	52	SH, MN	Poor nesting success caused difficulties; large pop., but many burrow entrances; inconveniently large.
1 - 2 September	Unimak Pass - Baby Isl.	Aiktak	ca. 300	108	SH, MN	Remote island with large population; easily worked.
1 - 3 September	Kodiak - Marmot Bay	S Triplett	ca. 210	26	GS, LT	Concentrated sampling in high burrow densities.
4 - 6 September	Kodiak - Chiniak Bay	Cliff	215	2	GS, SL	Very few adult birds seen.

(1) GS = G. Sanger; SH = S. Hatch; LT = Lori Terwilliger; AS = Art Sowls; JN = Jay Nelson; MN = Mike North; US = Una Swain; SL = Sylvia Long; David Irons

Table 2. Length frequencies (%) of walleye pollock in the diet of nestling tufted puffins, late summer 1986.

Length	Tangagm I.		Aiktak I.		Midun I.		Egg I.		Suklik I.		Fox I.		Cathedral I.		Cliff I.		Noisy I.		Triplet I.	
(mm)	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
30-34	0		0		0		0		1	3.4	0		0		0		0		0	
35-39	2	2.5	0		0		0		2	6.9	0		0		0		0		0	
40-44	0		1	0.3	1	0.3	1	3.4	4	13.8	0		0		0		0		0	
45-49	0		8	2.7	24	6.4	6	20.7	4	13.8	0		0		0		0		0	
50-54	16	19.8	33	11.2	76	20.3	12	41.4	7	24.1	0		0		0		0		0	
55-59	9	11.1	42	14.2	117	31.2	6	20.7	2	6.9	0		0		0		0		0	
60-64	24	29.6	62	21.0	102	27.2	3	10.3	7	24.1	0		0		0		1	100	0	
65-69	15	18.5	65	22.0	47	12.5	1	3.4	2	6.9	0		0		0		0		0	
70-74	12	14.8	46	15.6	6	1.6	0		0		0		0		0		0		0	
75-79	2	2.5	20	6.8	1	0.3	0		0		0		0		0		0		0	
80-84	1	1.2	15	5.1	1	0.3	0		0		0		0		0		0		0	
85-89	0		3	1.0	0		0		0		0		1	100	0		0		0	
Total	81	100	295	100	375	100	29	100	29	100	0		1	100	0		1	100	0	

Table 3. Length frequencies (%) of Pacific cod in the diet of nestling tufted puffins, late summer 1986.

Length (mm)	Tangagm I. N	%	Aiktak I. N	%	Midun I. N	%	Egg I. N	%	Suklik I. N	%	Fox I. N	%	Cathedral I. N	%	Cliff I. N	%	Noisy I. N	%	Triplet I. N	%
30-34	0		0		0		0		0		0		0		0		0		0	
35-39	0		0		0		0		1	2.8	0		0		0		0		0	
40-44	0		0		3	7.9	0		3	8.3	0		0		0		0		0	
45-49	0		2	8.7	2	5.3	5	11.6	4	11.1	0		0		0		0		0	
50-54	1	33.3	4	17.4	6	15.8	5	11.6	3	8.3	2	13.3	0		0		0		1	50.0
55-59	1	33.3	8	34.8	5	13.2	5	11.6	8	22.2	0		1	100	0		0		0	
60-64	1	33.3	5	21.7	6	15.8	7	16.3	8	22.2	3	20.0	0		0		0		1	50.0
65-69	0		2	8.7	6	15.8	8	18.6	6	16.7	2	13.3	0		0		0		0	
70-74	0		1	4.3	7	18.4	7	16.3	3	8.3	3	20.0	0		0		0		0	
75-79	0		0		0		3	7.0	0		3	20.0	0		0		0		0	
80-84	0		1	4.3	0		3	7.0	0		2	13.3	0		0		0		0	
85-89	0		0		3	7.9	0		0		0		0		0		0		0	
Total	3	100	23	100	38	100	43	100	36	100	15	100	1	100	0		0		2	100

Table 4. Length frequencies (%) of capelin in the diet of nestling tufted puffins, late summer 1986.

Length	Tangagm I.		Aiktak I.		Midun I.		Egg I.		Suklik I.		Fox I.		Cathedral I.		Cliff I.		Noisy I.		Triplet I.	
(mm)	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
40-49	0		0		0		0		0		0		0		0		0		0	
50-59	0		0		4	9.1	0		0		0		0		0		0		0	
60-69	0		0		11	25.0	0		1	20.0	0		0		0		11	64.7	0	
70-79	0		0		24	54.5	0		2	40.0	0		1	50.0	1	3.1	3	17.6	4	19.0
80-89	1	100	0		3	6.8	2	5.0	1	20.0	0		1	50.0	0		1	5.9	4	19.0
90-99	0		0		0		16	40.0	0		0		0		1	3.1	2	11.8	2	9.5
100-109	0		0		1	2.3	16	40.0	1	20.0	0		0		5	15.6	0		1	4.8
110-119	0		0		1	2.3	4	10.0	0		1	50.0	0		4	12.5	0		5	23.8
120-129	0		0		0		1	2.5	0		0		0		2	6.3	0		4	19.0
130-139	0		0		0		1	2.5	0		1	50.0	0		8	25.1	0		0	
140-149	0		0		0		0		0		0		0		11	34.4	0		1	4.8
Total	1	100	0		44	100	40	100	5	100	2	100	2	100	32	100	17	100	21	100

Table 5. Length frequencies (%) of Pacific sand Lance in the diet of nestling tufted puffins, late summer 1986.

Length (mm)	Tangagm I. N	%	Aiktak I. N	%	Midun I. N	%	Egg I. N	%	Suklik I. N	%	Fox I. N	%	Cathedral I. N	%	Cliff I. N	%	Noisy I. N	%	Triplet I. N	%
30-39	0		1	2.4	0		0		2	0.2	0		0		0		0		0	
40-49	0		0		1	8.3	0		29	3	0		0		0		0		0	
50-59	1	1.7	3	7.3	3	25	0		93	9.5	0		0		0		0		0	
60-69	13	22.1	7	17.1	2	16.7	7	43.8	637	65.3	0		0		5	8.2	0		1	
70-79	31	52.5	8	19.5	1	8.3	3	18.8	191	19.6	0		4	4.9	1	1.6	0		14	22.5
80-89	13	22	7	17.1	0		0		8	0.8	0		16	19.7	6	9.9	0		17	27
90-99	1	1.7	6	14.6	3	25	4	25	14	1.4	2	28.6	0		2	3.3	0		9	14.3
100-109	0		5	12.2	1	8.3	1	6.3	1	0.1	0		4	4.9	16	26.2	0		10	16.7
110-119	0		3	7.3	1	8.3	1	6.3	1	0.1	0		18	22.3	13	21.4	0		8	13.1
120-129	0		0		0		0		0		0		29	35.9	9	14.8	4	100	4	6.4
130-139	0		0		0		0		0		5	71.5	6	7.4	4	6.5	0		0	
140-149	0		1	2.4	0		0		1	0.1	0		2	2.4	4	6.6	0		0	
150-159	0		0		0		0		0		0		2	2.5	1	1.6	0		0	
160-169	0		0		0		0		1	0.1	0		0		0		0		0	
Total	59	100	41	99.9	12	99.9	16	100	978	100	7	100	81	100	61	100	4	100	63	100