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Compilation of Fish Stomachs Data from the Scotian Shelf and Bay of Fundy (1958-2002): CDEENA Diet Composition and Consumption Estimation Project

by

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Laurinolli, M.H., L.E. Harris, A. Bundy and L.P. Fanning. 2004. Compilation of Fish Stomachs Data from the Scotian Shelf and Bay of Fundy (1958-2002): CDEENA Diet Composition and Consumption Estimation Project, Can. Tech. Rep. Fish. Aquat. Sci. 2518: vi + 90 pp.

This project was undertaken as part of the Comparative Dynamics of Exploited Ecosystems in the Northwest Atlantic (CDEENA) study. Its aim was to compile all existing and new fish stomach contents data in the Maritimes Region and to concurrently use this data to analyse diet composition and estimate fish consumption. The database currently consists of data for over 100,000 stomachs from 1958-2002 for 51 fish species. Diet composition was determined from stomach contents at the time of sampling. Food consumption was estimated using a gastric evacuation model. The gastric evacuation model downscales the consumption of harder to digest foods such as crabs, shrimps and echinoderms since these would be present longer in the stomach. This report documents the organisational structure of the database and provides a summary of the diet data available. Examples of the estimation of food consumption and diet for cod, haddock, and pollock are included. The compilation of stomach contents data for the region will facilitate further analyses and ecosystem modelling."

RÉSUMÉ

Laurinolli, M.H., L.E. Harris, A. Bundy and L.P. Fanning. 2004. Compilation of Fish Stomachs Data from the Scotian Shelf and Bay of Fundy (1958-2002): CDEENA Diet Composition and Consumption Estimation Project, Can. Tech. Rep. Fish. Aquat. Sci. 2518: vi + 90 pp.

Le projet décrit ici a été entrepris dans le cadre de l'étude intitulée "Comparative Dynamics of Exploited Ecosystems in the Northwest Atlantic (CDEENA) ". Il a pour but de réunir toutes les données anciennes et nouvelles sur les contenus stomacaux des poissons de la Région des Maritimes et de les utiliser pour analyser la composition du régime alimentaire et estimer la consommation des poissons. L'information que contient actuellement la base de données porte sur plus de 100,000 contenus stomacaux échantillonnés de 1958 à 2002, qui provenaient de 51 espèces de poisson. La composition du régime alimentaire a été déterminée à partir des contenus stomacaux lors de l'échantillonnage. La consommation alimentaire a été quant à elle estimée d'après un modèle d'évacuation gastrique. Ce modèle minimise la consommation des aliments durs à digérer, comme les crabes, les crevettes et les échinodermes, ces aliments restant présents plus longtemps dans l'estomac. Le présent rapport documente la structure organisationnelle de la base de données et fournit un résumé des données sur l'alimentation qui sont disponibles. Il comporte des exemples d'estimation de la consommation et du régime alimentaires de la morue, de l'aiglefin et de la goberge. Le rassemblement des données sur les contenus stomacaux pour l'ensemble de la Région facilitera l'exécution d'analyses plus poussées et la modélisation de l'écosystème.

1 INTRODUCTION

A multi-year study entitled Comparative Dynamics of Exploited Ecosystems in the Northwest Atlantic (CDEENA) was undertaken by DFO to look at changes in the structure and function of ocean ecosystems over time and determine how these may have affected fish productivity. This project uses ecosystem-level models to investigate effects of environmental variation, predation, and fishing on changes in reproduction, mortality, growth and feeding. These changes in ecosystems can include changes in trophic structure which are reflected in changes in predator-prey interactions.

The ontogenetic, seasonal, annual, and geographic variation in predator-prey relationships are being investigated through the reconstruction of fish diet compositions and daily consumption for major predators based on stomach contents. The resulting information will provide basic biological information on the feeding habits of major predators found on the Scotian Shelf. This diet composition and consumption information will also be used as input to ecosystem models that describe temporal and spatial variation in energy fluxes through different ecosystems.

The reconstruction of fish diets is accomplished through the collection and analysis of stomach contents and the subsequent estimation of diet composition and daily consumption for the predators. At the beginning of this project, there were data from fewer than 1,800 fish stomachs from the eastern Scotian Shelf available. These stomachs were taken from cod, haddock, and white hake caught during research vessel and industry surveys. This project followed two parallel lines of investigation. First, an enhanced stomach collection program was put in place to acquire fish stomachs from both research and commercial activities and to process the resulting samples. The second approach was a concerted effort to locate any and all existing stomach sample data, reprocess it into standardised electronic formats and make them available in the same manner as the new data being collected concurrently.

Stomachs from only three species of predators have been collected on the eastern Scotian Shelf since 1996. In the summer of 1999, a three year enhanced fish diet sampling program began. This program targeted 32 species of common commercial and non-commercial fish of the Scotia-Fundy region. Samples were collected during research surveys (spring and summer groundfish, herring), industry surveys (4VsW sentinel, halibut), and commercial fishing (observer and Fishermen and Scientists Research Society (FSRS) sampling). The stomach collection was done in partnership with other researchers, members of industry, and the FSRS. All stomach contents were analysed by FSRS technicians. In addition, data from the Trawl Impact study (Kenchington *et al.* 2003) and from the commercial shark fishery (Joyce *et al.* 2002) were made available. The enhanced stomach collection program has amassed new diet data from over 20,000 stomachs.

During investigation of archival data, stomach content data were uncovered and restored from a variety of sources including: the pre-1970's fisheries surveys (1958-1969, Halliday and Koeller 1981); Fisheries Ecology Program surveys (1982-1983); a swordfish survey (1980); pollock surveys (1983-1988); juvenile haddock surveys (1989); a juvenile fish survey (1988); a silver hake survey (1981-1986, Waldron 1988); and groundfish surveys (1995-1996, Halliday and Koeller 1981). The format of this information ranged from hard copy to frozen fish collected for other research to preserved stomachs. These sources provided information from almost 84,000 fish.

The data collected came from many different sources and were in various formats. A stomach contents database was designed in Oracle to provide a single, secure location for the data. This database is linked to the original data tables, where possible, to make current set and fish detail sampling information available. This database provides a consistent format and increased accessibility to stomach data.

Finally, historical and current fish diet compositions and daily consumption estimates were reconstructed based on the stomach data. Diet composition was estimated from stomach contents at collection time. Because digestion rates are prey specific, gastric evacuation rates and models from the literature were used to estimate and adjust daily consumption based on these stomach contents. Diet composition was then re-calculated from these daily rations and compared to diet compositions in the stomachs without any correction for gastric evacuation differences.

2 METHODS

2.1 Data Sources

A summary list of all the data sources, including the codes used to identify the data in the stomach database and the years of coverage of the samples, used in this project is provided in Table 1. Table 1 is separated into the three types of stomach data sources to be described in this section of the report. The first data source includes stomachs collected during various sampling programs. The second data source contains stomach data obtained from previous diet research. The third data source includes other data available that have not yet been added to the stomach database. In the more detailed descriptions to follow, the current custodian refers to the holder of the data though most of these data (except where specified) are available through the stomach database in Oracle. Permission to use any data should be requested from the Marine Fish Division.

Table 1. Data sources and identification code (Database ID) used for the stomach contents database.

Data Source	Database ID	Years
Stomach Sample Sources:		
Enhanced Sampling Program:		
Groundfish Research Surveys	GS	1995 - Present
Herring Research (Pelagic) Surveys	PS	1999 - 2000
4VsW Sentinel Survey	SS, JSS	1996 - Present
Halibut Industry Surveys	HS	1999 - Present
Commercial Index	CI, CS	1997 - Present
Condition Factor	CF	1998 - Present
Other Sources:		
Browns Bank Survey	SP	2000
Juvenile Fish Survey	SP	1988
Trawl Impact Study	TIS	1997 - 1999
Diet Data Sources:		
Pre-1970's Surveys	P70	1958 - 1969
Fisheries Ecology Program	FEP	1982 - 1983
Pollock Surveys	POK	1983 - 1988
Other Data Available:		
Silver Hake Survey Data	SHS	1981 - 1986
Swordfish Data	SW	1980
Large Pelagics		2001
Commercial Shark Data		1999 - 2001
Recreational Shark Fishing		1999 - 2001
Juvenile Haddock Survey		1989
Dogfish Data		1985
Mackerel Diet Data		1970s
Dogfish Data – C. Semeniuk		1997 - 1998
Groundfish Port Sampling	GPS	2001
Commercial Fishing	CMF	2001
4Vn Sentinel Survey		1995 - 2001

2.2 Stomach Collection Protocol – Enhanced Sampling Program

Generally, a consistent protocol was followed during the enhanced stomach sampling program. The goal was to collect samples from a wide spectrum of species, with good predator size range (including juveniles) and geographic coverage. An example of the sampling request can be found in Appendix I. Fish were sampled on a length-stratified basis per set following the Scotia-Fundy groundfish surveys protocol. That is, for most species one fish per 1-cm length group was sampled. The flounders and plaice were sex and length stratified providing 2 samples per 1-cm group. When the selected fish were sampled, a visual estimate of stomach fullness was recorded. For the most part, only stomachs with contents were retained. The occurrence of empty, regurgitated, and everted stomachs was recorded. These stomachs were not replaced with full stomachs for the size class, thus not all sizes caught were represented by a collected stomach.

The stomachs were carefully excised by first cutting below the pyloric sphincter and then as high up the oesophagus as possible. The stomachs were then placed in brine in order to stop digestion and also to preserve the specimen. Large stomachs were split to allow the brine to enter. Stomachs were bagged and labelled individually. When a freezer was available, the samples were frozen at sea. Otherwise they were frozen as soon as they were brought back to the lab. There may have been some water loss to the contents due to the brine and/or the freezing, however no adjustments were made to the content weights to compensate.

2.3 Stomach Contents Analysis – Enhanced Sampling Program

All the stomachs collected during the enhanced stomach sampling program were analysed by FSRS technicians. After thawing, the stomachs and contents were drained on a fine mesh strainer. Prey items were sorted, identified, and measured. Prey length was always assumed to be for intact prey (*e.g.* fork length for fish, carapace width crabs). The Scotia-Fundy research species codes have been used since 2000 in order to maintain consistency and to reduce confusion caused by using common names. The data were recorded on the stomach analysis datasheet (Appendix II). These data were then entered into the stomach database edit tables through the Marine Fish Division Virtual Data Centre (VDC) website. Samples were assigned an individual identification number called sample index number. This is important for tracing data back to the original hard copy. It also provides a unique identifier for each sample and links the fish detail information with its stomach contents. A detailed account of the stomach content analysis protocol is in Appendix III.

The level to which prey were identified depended on the prey type. All fish as well as commercially important crustaceans and molluscs were identified to species, state of digestion permitting. Broader categories were used, such as class or even phylum, for prey that were less common or were more difficult to identify. There is a trade-off between the number of stomachs analysed and the taxonomic level of identification and an effort was made to process all the stomachs collected each year.

2.4 Stomach Collection and Analysis – Other Sources

The historical data and stomach samples provided by other researchers were collected under a variety of sampling regimes. In most cases, the details or protocols of collection and analysis are not available. The information that is currently known is described here.

The 1988 juvenile fish survey in the Scotian Shelf basins and on Georges Bank included stomach collection and preservation from adult fish for description of trophic interactions between scattering layers of zooplankton.

Stomachs were collected in 1997-1999 during a trawl impact study in the 4TVW Haddock Closed Area on Western Bank using an Engel 145 otter trawl. Two sampling protocols were followed. In the first, thirty stomachs were collected per species per trawl set on a length-stratified basis (N = 1432). Of these stomach samples analysed, 75% were analysed to a general level and the remaining 25% to the species level (MacIsaac pers. comm.). A second data set (N = 444), that was not length-stratified, consisted of seven samples per focussed species (cod, haddock, American plaice, yellowtail flounder, and winter flounder) per set for detailed stomach contents analyses to species, genus or family level (Kenchington *et al.* 2003). In both cases, food in the esophagus was pushed into the stomach and dissected stomachs were preserved in hypersaline solution and frozen. Empty, everted or ejected stomachs were recorded but not collected. These data may not be appropriate for modelling fish diet in the wild due to the design of the survey. The trawl repeatedly sampled the same area. With each pass, animals were crushed making them available to species that do not ordinarily feed on them. For example, the remnants of a large clam may have been found in the stomach of a haddock.

In the late 1950s to 1970, research surveys on basic biological information and fish distribution also included feeding studies. The stomach collection and contents analysis protocols are not known in detail, however samples were analysed at sea and recorded onto data sheets that were then key punched to fixed format 80 column cards and stored at the St. Andrews Biological Station.

Haddock stomachs were collected for feeding studies during 1982 and 1983 seasonal groundfish surveys as well as on dedicated 1983 Fisheries Ecology Program research surveys. These bottom-trawl surveys followed a depth-stratified random sampling design. Two to five fish were sampled per 2-cm length group. Empty or damaged stomachs were not collected however their numbers were recorded. In some cases, whole haddock were frozen.

During the 1983-1988 pollock distribution and abundance surveys stomachs were collected from a number of species but most were from pollock. The data were recorded at sea on data sheets. The details of the data vary, for some stomachs only the main prey item was listed and for others each prey item was weighed and counted. Some more collection and analysis details are provided in section 3.1.2.3 in the Results.

Silver hake stomachs collected by Waldron (1988) in the 1980s consisted of one fish per sex per 1-cm length class. Gut fullness was subjectively recorded, then stomachs were removed and injected with 10% buffered formalin. Wet stomachs were weighed and then contents were washed over a 10-μ sieve, sorted to the lowest possible taxa and weighed to the nearest centigram. The total number of specimens per taxonomic group was also recorded. Samples taken by observers aboard trawlers were quick-frozen as whole fish for 2 min at –20°C and then stored at –40°C in the lab for analysis within one month of capture. These samples augmented the formalin preserved samples where they were minimal. Contents descriptions were less detailed and items were sorted into 27 major taxa except whole fish prey were identified to species. The other prey groups were dried at 90°C for 24 h and weighed.

2.5 Stomach Database

The diet information used in this project came from a variety of sources and data formats. A stomach database was created in order to keep the data in a single, secure location. This also increased accessibility to other researchers.

The Oracle database has been separated into edit tables and production tables in the 'Groundfish' account. This allows for the editing of the data before they are added to the main data tables that are accessible to users. Error checks are performed on the edit tables before they are incorporated into the final production tables. The database contains three types of tables (Fig. 1): the first holds the set INFormation such as time and location (Fig. 2), the second holds the DETail information on each fish (Fig. 3), and the third holds the information on STOmach contents (Fig. 4). The edit tables found on Oracle are 'sdinf_edit', 'sddet_edit', and 'sdsto_edit'. The production tables are 'sdinf', 'sddet', and 'sdsto'. There is also a consolidated view (sdview1) that combines variables from all three tables to facilitate data extraction. A full description of the database and the data management protocols can be found at the Marine Fish Division website (http://marvdc.bio.dfo.ca/pls/vdc/mwmfdweb.splash).

The Oracle database also contains tables that describe the codes used in the above tables. Table 'sdsource' (Fig. 5) lists the codes used for each data source type and a description of the survey type. These data sources are the same as those stated in Table 1. The stomach fullness codes in table 'sddet' are described in 'sdfullness' (Fig. 6) and the digestion codes in table 'sdsto' are described in 'sddigest' (Fig. 7). The table 'sditem' contains the numeric codes and names of the prey items found in the stomachs (Fig. 8). The column 'tech' in 'sddet' has the code for the technician(s) who analysed each stomach and their corresponding names are listed in 'sdtech' (Fig. 9). Two other useful tables are 'sdpred' and 'sderrcd'. Table 'sdpred' lists the predator species codes and names from which stomachs have been collected. Table 'sderrcd' lists numeric codes and descriptions for the numbers in the 'status_flag' columns. These numbers are automatically entered into edit tables when an error in the database is encountered. This automatic error detection however may not detect all the problems. The edit tables should be examined further and all corrections made before promoting the data to the production tables.

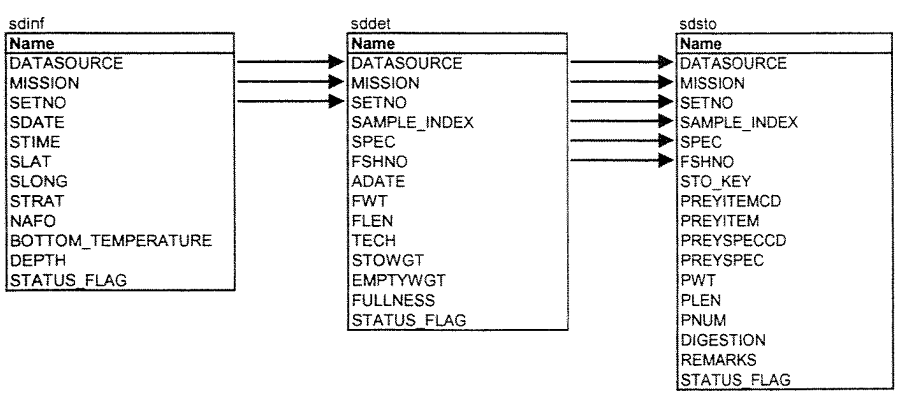


Figure 1. Entity relationship diagram for stomach database.

SDINF

Column	Type	Size	Description
DATASOURCE	VARCHAR2	3	Trip type code
MISSION	VARCHAR2	15	Trip Id
SETNO	NUMBER	3	Set Number
SDATE	DATE	7	Set date
STIME	NUMBER	4	Set time (24hr)
SLAT	NUMBER		Set latitude (DDMM.MM)
SLONG	NUMBER		Set longitude (DDMM.MM)
STRAT	VARCHAR2	3	Stratum
NAFO	VARCHAR2	10	NAFO division
BOTTOM_TEMPERATURE	NUMBER	5.2	Water temperature in degrees Celsius
DEPTH	NUMBER	4	bottom depth
STATUS_FLAG	NUMBER		row status

Figure 2. Oracle table 'sdinf' with the set information corresponding to the fish sampled.

SDDET

Column	Type	Size	Description
DATASOURCE	VARCHAR2	3	Trip type code
MISSION	VARCHAR2	15	Trip Id
SETNO	NUMBER	3	Set Number
SAMPLE_INDEX	NUMBER	6	Unique Stomach identifier
SPEC	NUMBER	4	Species research code
FSHNO	NUMBER	6	Individual fish number
ADATE	DATE	7	Stomach analysis date
FWT	NUMBER	6.1	Fish weight in grams
FLEN	NUMBER	4	Fish fork length in centimetres
TECH	VARCHAR2	10	Stomach analysis tech
STOWGT	NUMBER	5.1	Total stomach weight incl. contents in grams
EMPTYWGT	NUMBER	5.1	Empty stomach weight in grams
FULLNESS	NUMBER	1	Stomach fullness code
STATUS_FLAG	NUMBER		row status

Figure 3. Oracle table 'sddet' with detail information on the fish sampled.

SDSTO

Column	Type	Size	Description
DATASOURCE	VARCHAR2	3	Data Source
MISSION	VARCHAR2	15	Trip id
SETNO	NUMBER	3	Set Number
SAMPLE_INDEX	NUMBER	6	
SPEC	NUMBER	4	Predator fish species
FSHNO	NUMBER	6	Individual fish number
STO_KEY	ROWID	6	generated key to make each stomach item unique
PREYITEMCD	NUMBER	4	Prey item research code
PREYITEM	VARCHAR2	25	prey item
PREYSPECCD	NUMBER	4	Prey species research code
PREYSPEC	VARCHAR2	25	prey species
PWT	NUMBER	10.4	Prey weight in grams
PLEN	NUMBER	5.1	Prey length in centimetres
PNUM	NUMBER	6	number of prey
DIGESTION	VARCHAR2	1	digestion state code - use caution for FEP and P70
REMARKS	VARCHAR2	150	prey remarks
STATUS_FLAG	NUMBER		row status

Figure 4. Oracle table 'sdsto' with stomach contents information on the fish sampled.

SDSOURCE

DATASOURCE	DESCRIPTION
GPS	Groundfish Port Samples
CF	Condition Factor
CI	Commercial Index- observer coverage
CS	Commercial Index Sampling
FEP	Fisheries Ecology Program
GS	Groundfish Survey
HS	Halibut Survey-ISDB
JSS	Sentinel Survey-observer coverage
POK	Pollock Survey
PS	Herring Survey
SP	Special Sampling
SS	Sentinel Survey-ISDB
SW	Swordfish Survey
TIS	Trawl Impact Study
P70	Pre-1970s Surveys

Figure 5. Oracle table 'sdsource' with the data source codes and the survey type from which stomachs were collected.

SDFULLNESS

FULLNESS	DESCRIPTION
0	empty - no food contents
1	less than ¼ full
2	¼ to ½ full
3	½ to ¾ full
4	¾ full to full
5	everted
6	regurgitated

Figure 6. Oracle table 'sdfullness' with the codes for stomach fullness.

SDDIGEST

DIGESTION	DESCRIPTION
1	1-GOOD CONDITION
2	2-PARTLY DIGESTED
3	3-WELL DIGESTED
4	4-UNIDENTIFIABLE

Figure 7. Oracle table 'sddigest' with the codes for state of digestion for the prey times in the stomach.

SDITEM

Column	Type	Size	Description
PREYITEMCD	NUMBER	4	Food Item Code
PREYITEM	VARCHAR2	20	Food Item Group
PREYSPECIES	VARCHAR2	50	Food Item detail/species
PREYSPECCD	NUMBER	4	Food Item detail/species code

Figure 8. Oracle table 'sditem' with the list of prey species and their codes commonly found in stomachs.

SDTECH	
TECHCODE	DESCRIPTION
CM	C. MacDonald
CM/GC	C. MacDonald/G. Carmichael
GC	G. Carmichael
GC/CM	G. Carmichael/C. MacDonald
GC/SS	G. Carmichael/S. Scott
HC	H. Crowley
JG	J. Graves
JG/LM	J. Graves/L. MacPhee
JG/TW	J. Graves/T. Watson
JG/VB	J. Graves/V. Bushell
LM	L. MacPhee
LM/SG	L. MacPhee/S. Galluchon
SG	S. Galluchon
SG/LM	S. Galluchon/L. MacPhee
SS	S. Scott
SS/GC	S. Scott/G. Carmichael
SS/JG	S. Scott/J. Graves
SS/JG/TW	S. Scott/J. Graves/T. Watson
TW	T. Watson
TW/JG	T. Watson/J. Graves
VB	V. Bushell

Figure 9. Oracle table 'sdtech' with the codes for the stomach analysis technicians.

2.6 Consumption and Diet Estimation

Gastric evacuation calculations can be used to determine relative rates at which different prey species are evacuated from the stomach and thus estimate amount of food consumed. Gastric evacuation is defined as the expulsion of food broken down through a combination of muscular contractions of the stomach wall and enzymatic action from the stomach through the pyloric sphincter into the small intestine (Bromley 1994). The estimation of feeding using gastric evacuation studies is based on the input equals output rule. This rule assumes that, averaged over time, the amount of food leaving the stomach is equivalent to the amount of food consumed. The application of experimentally derived gastric evacuation rates to wild populations also assumes that food passes through experimental fish at the same rate as in the wild. Gastric evacuation models, in conjunction with stomach content data from fish in the wild, can be used to estimate total consumption and the proportion of the different prey items consumed by fish populations in order to quantify feeding interactions among species. For our analysis, gastric evacuation rates were taken from the literature to estimate consumption. Percent diet composition was estimated from stomach contents analysis.

The consumption model of dos Santos and Jobling (1995) based on experiments with cod was used to calculate consumption rates (per day) and then estimate diet composition. Although the parameters in their model were derived from experiments on cod, they were applied here to other species of fish as well. It is unlikely that all the species sampled had the same evacuation rate, however temperature and prey type seemed to be more important than predator species in determining rates. Jones (1974) found no significant differences in gastric evacuation rates of cod, haddock and pollock fed the same prey species. Durbin and Durbin (1980) found in their review of feeding experiments that temperature and prey type, not predator species, were the most important factors influencing gastric evacuation rates. Gastric evacuation rates for other species are available in the literature however the lack of standardisation in experimental design makes it impossible to compare among species, or even among studies for a single species. Most gastric evacuation models are based on single-meal experiments though a second meal can alter evacuation pattern of the first meal. Feeding methods can also have an effect on gastric evacuation. Some experiments starve fish beforehand and use different prey types (species) or preparations such as live, fresh, frozen, chopped, or in pellets. Fish have been fed to satiation, a set meal size, or force-fed (rarely). Water temperature, predator size and life stage can also have an effect.

The expected consumption of grams of species i per day (C_i) is given by dos Santos and Jobling (1995) as:

$$C_i = \frac{24 \ln 2\, e^{\gamma T} B^{\delta} S_i}{\alpha_i (\Sigma S_i)^{\beta}},$$

where T is water temperature, B is body size (in this case length), and S_i is the weight of species i in the stomach. The rate of gastric evacuation increases exponentially with temperature. The term $(\Sigma S_i)^{\beta}$ approximates the slowing of evacuation with increasing initial meal size. The constants β, γ, and δ were taken from dos Santos and Jobling (1995) as estimated through food consumption experiments using cod where $\beta = 0.48$, $\gamma = 0.13$, and $\delta = 0.46$. The term α_i is the prey-specific half-life (hours) for evacuation of each food type. The values used for this term were also taken from dos Santos and Jobling (1995) and extrapolated for other species not used in their model as described below.

The prey items were separated into the groups being used in CDEENA ecosystem modelling with Ecopath (Table 2). A list of all items found in the stomach database and the Ecopath group to which they were assigned can be found in the Oracle table groundfish.sd_ecopathcode. Consumption calculations were based on these groupings. Many of the prey found in the stomachs were not included in dos Santos and Jobling's experiment. These were assigned half-life parameters (α_i) according to their similarity in size and taxonomy to those present (Table 3).

Table 2. Prey item groupings for Ecopath ecosystem modelling.

ECOCODE	ECOGROUP	ECOCODE	ECOGROUP	ECOCODE	ECOGROUP
4	COD	17	MACKEREL	30	ECHINODERMS
5	J_COD	18	DEM_PISC	31	POLYCHAETES
6	SHAKE	19	LG_DEM	32	BIVALVES
7	J_SHAKE	20	SM_DEM	33	OBI
8	HADDOCK	21	CAPELIN	34	LG_ZOOPLANK
9	AM_PLAICE	22	SANDLANCE	35	SM_ZOOPLANK
10	HALIBUTS	23	TRANS_PEL	40	J_DEM_PISC
11	J_HALIBUTS	24	SM_PELAGIC	41	J_LG_DEM
12	FLOUNDERS	25	SM_MESOPEL	42	UNID_GADOIDS
13	SKATES	26	SQUID	100	UNID_INV
14	DOGFISH	27	LG_CRAB	200	UNID_FISH
15	REDFISH	28	SM_CRAB	300	UNID_FISH_INV
16	POLLOCK	29	SHRIMPS		

Table 3. Half-life parameters (α_i) as taken and extrapolated from dos Santos and Jobling (1995) and corresponding ecological groups of organisms used for Ecopath modelling and consumption calculations.

Prey[1]	**Ecological groups in data**	α_i
polychaetes	polychaetes, other benthic invertebrates	31
krill	lg. zooplankton, sm. zooplankton	46
polar cod	juvenile cod, juv. silver hake, juv. lg. demersals	60
long rough dab	plaice, flounders, halibuts, juv. halibuts, skates	64
capelin	capelin, sandlance, sm. mesopelagics	65
redfish	redfish	71
squid	squid, molluscs	87
haddock	cod, silver hake, haddock, dogfish, pollock, dem. piscivores, lg. demersals, sm. demersals, unidentified gadoids	90
herring	mackerel, sm. pelagics, transient pelagics	100
pandalus	shrimps, echinoderms	117
pandalus * 1.25	sm. crabs, lg. crabs	147
average of invertebrates[2]	unidentified invertebrates	70
average of fish[3]	unidentified fish	75
average of all[4]	unidentified fish and invertebrates	73

[1] Prey species examined in dos Santos and Jobling (1995).
[2] Half-life calculated as average of invertebrates listed above.
[3] Half-life calculated as average of fish listed above.
[4] Half-life calculated as average of all species listed above.

Some adjustments were made for weights of prey with large amounts of non-digestible inorganic material. For echinoderms, no empirical data were available to calculate the proportion of digestible and non-digestible materials. Species specific conversions were rejected because this would add a level of complexity that may not add any real information. The most common species in the diets were brittle stars which can be up to 90% exoskeleton (Mark Hansen 2001, pers. comm.). After discussion with CDEENA researchers in other areas, a conversion factor of 0.6 for echinoderm prey weights was agreed upon. Although this is lower than the estimated proportion of exoskeleton, other species are not adjusted to reflect their make up of organic versus inorganic matter.

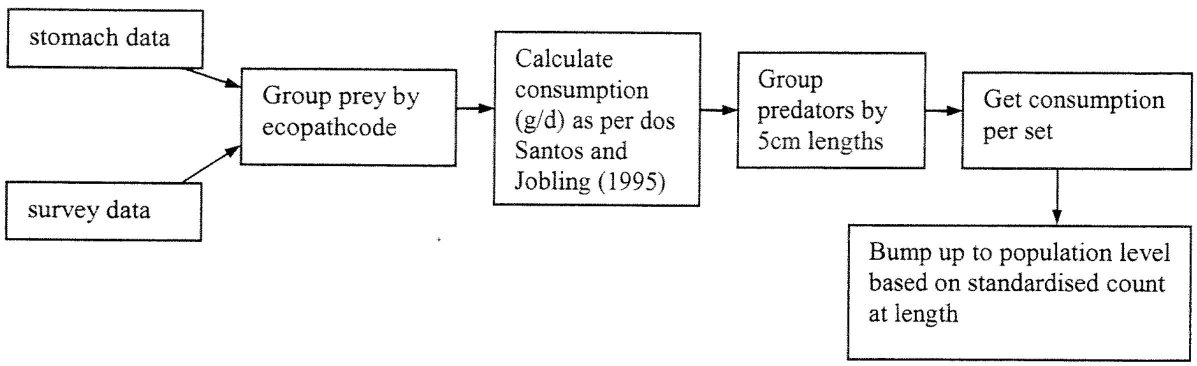
Molluscs also have a large amount of non-digestible material. Pieces of shells that were eroded or that had no flesh attached were classified as 'mollusc remains' as were opercula and squid beaks. These items can take many days to pass through the digestive system and would result in overrepresentation of molluscs in the diet. In order to calculate a conversion factor from total weight of bivalves to soft tissue weight, all bivalves caught during NED2001004 were collected, measured and weighed. The length, width, and height in centimetres and the whole weight, shell weight, and soft tissue weight in grams were recorded. A general conversion factor was then calculated based on all bivalves combined. Most of the bivalves caught were scallops since a bottom trawl was used (sea scallop n = 24, Iceland scallop n = 128, mussel n = 1, Iceland cockle n = 1, unidentified clam n = 1). A linear regression without the constant was used to calculate the conversion from total weight to soft tissue weight:

soft tissue weight = 0.421 * total weight (r^2 = 0.986).

Crabs were split into two groups based on the minimum size found in predator stomach contents: small crabs (less than 50 mm carapace width) and large crabs (greater than 50 mm carapace width). This is lower than the size split originally used for the Scotian Shelf (95 mm carapace width) which was based on recruitment to the fishery, size at maturity and ontogenetic changes in diet.

2.6.1 Consumption Calculations

The stomach data currently stored in Oracle was used in consumption and diet estimation. Preliminary analyses were restricted to groundfish survey data in the 4VsW and 4X NAFO divisions. Calculations were done in SQL*Plus (Structured Query Language Plus 8.0). A detailed description and flowchart of the SQL process used is given in Appendix IV. The scripts used in SQL are given in Appendix V. The general process is:



During groundfish survey stomach collection, empty stomachs were not collected in most cases. Some empty stomachs were collected and also some stomachs thought to have contents were then found to be empty during analysis. The same applies to stomachs designated as everted ('S5' or 's5' in GS database or with fullness = 5 in stomach database). For fish population consumption estimation, all empty and everted stomachs must be included to account for fish that were not feeding. Thus, empty and everted stomachs not included in the stomachs database had to be counted from the groundfish survey (GS) database, being careful not to duplicate counts from both databases.

The total numbers of fish surveyed were also calculated from the GS database. The data were first grouped into 5-cm length groups due to small sample sizes at 1-cm length classes. Standardised counts at 5-cm length groups were obtained from Oracle table NWAGS.gsd5lf_mv that is based on total counts of fish in the groundfish surveys. These numbers were used to bump up consumption estimates from the samples up to the population level.

The data were also separated by NAFO division and season (spring and summer). Consumption and diet composition was calculated for division 4VsW and calculations are in progress for 4X. The prey items in the stomachs were converted to estimates of prey amounts consumed per day per 5-cm length class by predator species based on dos Santos and Jobling (1995) as described earlier. The total population ration eaten per species per length class was calculated by summing across strata based on the number of net tows, the strata areas and tow area coverage. Average ration per fish was then estimated by the total ration divided by the total number of fish. Diet composition by percentage was then calculated from these results.

A final step in the process was to interpolate rations for length classes that were surveyed but for which no stomach analyses were performed. It was necessary to include all lengths existing in the population for the Ecopath ecosystem modelling that occurs subsequent to the work described here. This was done in Excel by averaging rations for lengths above and below the missing length class. Consumption calculations were also made with the 1999 and 2000 stomach data pooled together to reduce the numbers of missing length groups.

Diet composition was also calculated without using the dos Santos and Jobling (1995) gastric evacuation equation. The proportions of prey items in the stomachs were assumed to be the same as the proportions eaten by the fish and thus digestion of each item was assumed to be the same. Actual consumption could not be estimated since it was not known how long the food was there and what the rate of digestion was. These values were then compared to the diet compositions determined after using the gastric evacuation model.

3 RESULTS

3.1 Data Sources

Stomach data were obtained through various collection methods. For each data source type currently in the stomach database, stomach counts are given by species and NAFO division collected in. Where available, information is provided on: the original investigator of the research; who the data was obtained from; the current custodian of the data; the format of the data when it was received; the current format and location of the data; and citable references for methodology and data products.

Counts of all the stomach data available in the stomach database by species and era are given in Table 4. A total of 100,350 stomachs are included of which the majority are from cod and haddock, especially in the pre-1970's data set.

Table 4. Counts of stomach data available in the stomach database by species and era.

Species	Species code	1958-1969	1982-1988	1995-2000	Total
Alewife	62	277	3		280
American Plaice	40	5690	10	1988	7688
Argentine	160	1026	25	59	1110
Barndoor Skate	200	215			215
Black Dogfish	221	19			19
Capelin	64			214	214
Cod	10	21530	80	4741	26351
Eelpouts	642	35			35
Cusk	15	626	3	57	686
Fourbeard Rockling	114	10	3		13
Gray's Cutthroat Eel	602	11			11
Haddock	11	26450	4447	3861	34758
Halibut	30	526		252	778
Herring	60	562	1	409	972
Little Skate	203	28		8	36
Longfin Hake	112	152	4		156
Longhorn Sculpin	300	189		493	682
Lumpfish	501	22		5	27
Mackerel	70		5	388	393
Marlin-Spike Grenadier	410	74			74
Monkfish	400	262	16	117	395
Northern Sandlance	610		3	614	617
Ocean Pout	640			38	38
Pollock	16	2487	1203	502	4192
Red Hake	13	26	55	149	230
Redfish	23	771	12	689	1472
Sea Raven	320	51		87	138
Silver Hake	14	1179	132	1122	2433
Smooth Skate	202	95	1	129	225
Spiny Dogfish	220	147	323	380	850
Spotted Wolffish	51	23			23
Striped Atlantic Wolffish	50	76		220	296
Thorny Skate	201	999	2	637	1638
Turbot	31	4		502	506
Vahl's Eelpout	647			165	165
White Hake	12	1236	785	702	2723
Winter Flounder	43	244		428	672
Winter Skate	204	380		167	547
Witch Flounder	41	2721	7	1548	4276
Wolffish, unid.	59	220			220
Yellowtail Flounder	42	3195		951	4146
10 Other Species		31	6	13	50
Totals		71589	7126	21635	100350

3.1.1 Stomach Sample Sources

3.1.1.1 <u>Groundfish research surveys: GS (1995 - present)</u>

Original investigator: Marine Fish Division (MFD)
Received from: MFD
Current custodian: Alida Bundy (stomach data), Joe Hunt (survey data)
Received format: Oracle tables
Current status: Oracle tables (stomachs database, groundfish database - GS)
Reference(s): Halliday and Koeller (1981)

Stomachs were collected during the annual March 4VsW cod survey (Table 5) and the July groundfish research survey (Table 6). Standard depth-stratified random groundfish surveys began in 1969 to improve assessment accuracy for fisheries management purposes (Halliday and Koeller 1981). The sampling of 4VsW cod began in 1996 and the sampling program has now been expanded to include over 30 species from the Scotian Shelf and the Bay of Fundy. Fish stomachs were examined on a length-stratified basis during a stratified random bottom trawl survey. Stomach fullness was assessed visually and any stomachs found to contain food were preserved in brine and frozen at sea. In most cases, empty stomachs were not collected and these records are only in the groundfish database, not the stomach database. Mackerel and herring were collected and frozen whole for detailed sampling in labs at Maurice Lamontagne Institute and St. Andrews Biological Station respectively. Any stomachs with contents were then shipped back to the Bedford Institute of Oceanography (BIO) for analysis by FSRS technicians.

Table 5. Stomachs in the database collected during the spring groundfish research surveys.

	4VS	4W		5Z			
	2000	1999	2000	1996	1999	2000	Total
American Plaice	238		139				377
Argentine	1		4				5
Capelin	96		70				166
Cod	90		89				179
Cusk	1					1	2
Haddock	63		399				462
Halibut	5		14			3	22
Herring			5				5
Little Skate	3		3				6
Longhorn Sculpin	31		61	4			96
Lumpfish	5						5
Mackerel		48	172		97		317
Monkfish	8		9				17
Northern Sandlance	85		60				145
Ocean Pout			2				2
Pollock	7		23				30
Red Hake			7				7
Redfish	150		38				188
Sea Raven	5		3				8
Shorthorn Sculpin			2				2
Silver Hake	49		146			1	196
Smooth Skate	53		20				73
Spiny Dogfish	1		60				61
Striped Atlantic Wolffish	13		7				20
Thorny Skate	225		55				280
Turbot	98		10				108
Vahl's Eelpout	85		25				110
White Hake	116		23				139
Winter Flounder	1		2				3
Winter Skate	18		12				30
Witch Flounder	380		72				452
Yellowtail Flounder	39		122				161
Total	1866	48	1654	4	97	5	3674

Table 6. Stomachs in the database collected during the summer groundfish research surveys, not including uncollected empty stomachs.

	4VN				4VS				4VXWslope		4W					4X				Unknown				
	1996	1997	1999	2000	1996	1997	1999	2000	1999	2000	1995	1996	1997	1999	2000	1995	1996	1999	2000	1996	1997	1999	2000	Total
American Plaice			97	91			234	241	1	1				188	94			33	25					1005
Argentine							3	1	1					1	6			22	20					54
Black Belly Rosefish																		7						7
Capelin			8	10			16	10						3				1						48
Cod	119	27	86	76	40	36	60	53	1	1	20	106	44	166	165	6	283	150	188	28	70	1		1726
Cusk																		3	3					6
Haddock				12			51	27	1	2				379	605			385	288					1750
Halibut							6	5		2				3	3			7	11				1	38
Herring			32				14	1		1				83	10			104	7					252
Little Skate																		2						2
Longhorn Sculpin			2	1			20	29	2	1				95	62		10	38	39					299
Mackerel				1										6	4									11
Monkfish				2			6	2	2	1				18	19			16	23					89
Northern Sandlance							60	129	4					31	235									459
Ocean Pout			1				8							6	2			10	7					34
Pollock							6	1						52	63			101	78					301
Red Hake							9							37	17			42	10					115
Redfish			15	21			19	26	35	2				44	21			110	20					313
Sea Raven			1	2			8	3						12	17			13	14					70
Shorthorn Sculpin								1						2				1						4
Silver Hake							10	22						217	319			206	43				1	818
Smooth Skate			8	4			3	5						2	1			23	6					52
Spiny Dogfish							4	3						40	7			193	36					283
Striped Atlantic Wolffish			13	9			12	15						1	4			11	13					78
Thorny Skate			25	10			100	58	1	4				12	5			37	15				1	268
Turbot			14	10			66	58	29	8				25	52									262
Vahl's Eelpout			5	1			28	3						7	10									54
White Hake			27	21			26	56		2				63	76			76	60					407
Winter Flounder							3	1						22	58			20	40					144
Winter Skate				1			3							9				7	2					22
Witch Flounder			60	27			168	131	3	2				52	69			46	14					572
Yellowtail Flounder			2	3			100	119		1				195	225			19	40					704
Total	119	27	396	302	40	36	1043	1000	80	28	20	106	44	1771	2149	6	293	1683	1002	28	70	1	3	10247

3.1.1.2 Herring Research Surveys: PS (1999-present)

Original investigator: Mike Power – SABS
Received from: Mike Power
Current custodian: Alida Bundy (stomach, catch data), Mike Power (set, hydro data)
Received format: Oracle tables
Current status: Oracle tables (stomach database, pelagic survey database - PS), Excel (catch data)
Reference(s): Melvin, G. and M. Power. 1999. Herring Acoustic Survey Report: CGS Alfred Needler – N99-55, N99-60. Department of Fisheries and Oceans, Biological Sciences Branch, Maritimes Region, 6 pp.

This survey included sampling with ichthyoplankton gear, bottom trawl, and hydro-acoustic gear in October and November 1999 and 2000 to survey the distribution and abundance of herring on Georges Bank and the Scotian Shelf. Stomachs were collected in 4VsW and 5Z from the bottom trawl catches for a variety of species (Table 7). For species with 50 or fewer specimens caught in a set, the entire sample was examined, time permitting. When more than 50 specimens of a species were caught, 50 fish with a good range in size, including juveniles were selected. Stomach fullness was assessed visually and any stomachs found to contain food were preserved in brine and frozen at sea. Stomach contents were analysed by FSRS technicians.

Table 7. Stomachs in database collected during herring surveys.

	4VS	4W		5Z	
	2000	1999	2000	1999	Total
American Plaice		52	11	3	66
Cod		57	7	37	101
Haddock		102	97	37	236
Halibut			1	1	2
Herring		12	39	97	148
Longhorn Sculpin		21		52	73
Mackerel			1	55	56
Monkfish		1		3	4
Northern Sandlance			10		10
Ocean Pout			2		2
Pollock		1	65	5	71
Red Hake		4	3	16	23
Redfish		3	7	2	12
Sea Raven				8	8
Silver Hake	6	22	9	32	69
Smooth Skate		4			4
Spiny Dogfish		1			1
Striped Atlantic Wolffish		1			1
Thorny Skate		1			1
Turbot		4	22		26
Vahl's Eelpout		1			1
White Hake		26	1		27
Winter Flounder		9	2	3	14
Winter Skate		1		17	18
Witch Flounder		5			5
Yellowtail Flounder	5	22	3	26	56
Total	11	350	280	394	1035

3.1.1.3 4VsW Sentinel Surveys: SS, JSS (1996-present)

Original investigator: Paul Fanning and FSRS
Received from: FSRS
Current custodian: Alida Bundy
Received format: Oracle tables
Current status: Oracle tables (stomach database, industry survey database - ISDB)
Reference(s): none

Stomachs were collected in the fall from 1996 to the present during the annual 4VsW Sentinel Survey. This long-line survey includes inshore areas (strata 467, 468, 460) as well as the offshore areas covered by the annual groundfish surveys. The survey includes two parts: a stratified survey done by crewmembers (SS) and sometimes observers (JSS); and a commercial index portion where samples are collected by observers at sea (CI) or directly from fishermen on shore (CS). For the stratified survey, stomachs are examined during the routine detail sampling of selected species in the catch to visually determine stomach fullness. Any stomachs with contents are preserved in brine and returned to the FSRS for analysis. The numbers of stomachs examined by species are given in Table 8. The commercial index portion of the survey is described in subsection 3.1.1.5.

Table 8. Stomachs in database from the 1996-2000 stratified Sentinel Surveys (JSS, SS).

	4Vn	4Vs					4W					4X	Unknown				
	1997	1996	1997	1998	1999	2000	1996	1997	1998	1999	2000	1999	1996	1997	1998	1999	Total
American Plaice										1						6	7
Cod	4	86	33	5	22	10	295	151	162	268	260		2	1	37	23	1359
Cusk										1		6					7
Haddock		32	31	6	8		124	73	50	33	59			2	2	3	423
Halibut							1			3							4
Pollock							2		1	2	2						7
Red Hake										4							4
Thorny Skate																1	1
White Hake		2	12				5	5	5	28	18					2	77
Total	4	120	76	11	30	10	427	229	218	340	339	6	2	3	39	35	1889

3.1.1.4 Halibut Industry Survey: HS (1999-present)

Original investigator: Kees Zwanenburg
Received from: FSRS
Current custodian: Kees Zwanenburg
Received format: Oracle tables
Current status: Oracle tables (stomach database, ISDB)
Reference(s): Zwanenburg *et al.* (2003); Zwanenburg and Wilson (2000)

Halibut and a few other species were collected during the halibut industry survey (Table 9). The halibut survey takes place from May to July from the Grand Banks to southwest Nova Scotia. Stomachs were sampled on a length-stratified basis. Stomachs with contents were preserved in brine and returned to the lab. The contents were analysed by FSRS technicians.

Table 9. Stomachs in database from halibut industry surveys.

	3O		3P		4VS		4W		4X		Unknown	
	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000	2000	Total
American Plaice	1											1
Cod			1							3		4
Cusk							1					1
Halibut	2	9	10	2	47	35	28	6	12	18	17	180
White Hake					2	3		4				9
Total	3	9	11	2	49	38	29	10	12	21	17	195

3.1.1.5 Commercial Index: CI, CS (1997-present)

Original investigator: Paul Fanning and FSRS
Received from: FSRS
Current custodian: Carl MacDonald, FSRS
Received format: Oracle tables
Current status: Access database, Oracle tables (stomach database, ISDB)
Reference(s): none

Fish are collected by observers at sea (CI – Commercial Index observer coverage) and by shore-based collection from fishermen (CS – Commercial Index Sampling) from a number of species during the commercial index phase of the 4VsW sentinel survey (Table 10). The FSRS technicians process the stomach samples.

Table 10. Stomachs in database from the commercial index portion of the Sentinel Surveys.

	4Vn	4Vs		4W			4X	Unknown			
	1999	1997	1999	1997	1999	2000	1999	1998	1999	2000	Total
Cod	42	36	248	67	94	7	4		252	8	758
Cusk							13		5		18
Haddock		21		26			3	1	1		52
Pollock									5		5
Silver Hake									3		3
Spiny Dogfish			17		2				8		27
Thorny Skate					2				7		9
White Hake								2			2
Total	42	57	265	93	98	7	20	3	281	8	874

3.1.1.6 Condition Factor: CF (1998 - present)

Original investigator: Peter Hurley
Received from: FSRS
Current custodian: Peter Hurley
Received format: Oracle
Current status: Access database at FSRS, Oracle tables (stomach database)
Reference(s): none

Stomach samples are collected dockside by FSRS technicians from commercial fishing as part of a condition factor study (Table 11).

Table 11. Stomachs in the database from commercial fishing condition factor study.

	4Vn			4Vs		4VsW	4W			4X			5Z		Unknown		
	1998	1999	2000	1999	2000	1999	1998	1999	2000	1998	1999	2000	1999	2000	1999	2000	Total
American Plaice		214	126	1	30				25		20				42	71	529
Cod		47	38			23	7	51		8	185	77	35		6	3	480
Cusk								1			14	5	3				23
Haddock								12		6	336	92	30	4	19		499
Herring											4						4
Mackerel																4	4
Monkfish					1										6		7
Pollock						1		8			68		10				87
Redfish	7	54	52		10			1			6					46	176
Silver Hake															36		36
Spiny Dogfish											7	1					8
Striped Atlantic Wolffish			110													11	121
Thorny Skate		15		3	60												78
Turbot		38	30		38												106
White Hake					20	11		4			3				3		41
Winter Flounder				5							13	1			1		20
Winter Skate				28	69												97
Witch Flounder		304	155		57									3			519
Yellowtail Flounder					3								8	19			30
Total	7	672	511	37	288	35	7	77	25	14	656	176	86	26	113	135	2865

3.1.1.7 Browns Bank Survey: SP (2000)

Original investigator: Peter Hurley
Received from: Peter Hurley
Current custodian: Peter Hurley
Received format: Access database
Current status: Oracle tables (stomach database)
Reference(s): none available

Stomach samples were collected during a single set on Browns bank (4X) in February 2000 during the Georges Bank spring groundfish survey N965 (data designated as N965BB in stomach database) to collect haddock samples for Peter Hurley for maturity and condition analyses and cod for Don Clark. This data supplied 242 stomachs to the database of which 75 were from cod and 167 were from haddock.

3.1.1.8 Juvenile Fish Survey: SP (1988)

Original investigator: John Neilson
Received from: John Neilson
Current custodian: Paul Fanning
Received format: stomach samples
Current status: Oracle tables (stomach database)
Reference(s): Neilson, J. 1988. Cruise Report: Alfred Needler – N104. Department of Fisheries and Oceans, Marine Fish Division, Biological Sciences Branch, Science Sector, 4 pp.

Ten buckets of fish stomachs and whole fish preserved in formalin from cruise N104, 13-30 June 1988, were found in storage. These samples were taken primarily from Emerald and LaHave

Basins and from Georges Bank. The purpose of the cruise was to study the occurrence of juvenile fish in basins on the Scotian Shelf and to determine trophic interactions with high concentrations of zooplankton. It was also the first year of a midwater survey of abundance of age-0 gadids on Georges Bank. Most of the stomachs were from silver hake and spiny dogfish (Table 12). Other species included argentine, monkfish, witch flounder, cod, haddock, pollock, squid, hakes, and alewife.

Table 12. Stomachs in database from the 1988 Juvenile Fish Survey.

	4VSW	4X	5Z	Unknown	
Species	1988	1988	1988	1988	Total
Alewife			3		3
American Plaice	7	3			10
Argentine	14	11			25
Butterfish		1		1	2
Cod	8	13			21
Cusk	2	1			3
Fourbeard Rockling		1		2	3
Haddock	7	12		1	20
Herring		1			1
Longfin Hake	3	1			4
Mackerel	5				5
Monkfish	8	8			16
Northern Sandlance	3				3
Offshore Hake	2	1			3
Pollock	22	39		1	62
Red Hake	26	25	1	3	55
Redfish	3	5		1	9
Short-fin Squid		1			1
Silver Hake	76	36	18	2	132
Smooth Skate		1			1
Spiny Dogfish	53	48	47	2	150
Thorny Skate	1	1			2
White Hake	24	16		2	42
Witch Flounder	2	4		1	7
Total	266	229	69	16	580

3.1.1.9 Trawl Impact Study: TIS (1997-1999)

Original investigator: Ellen Kenchington
Received from: FSRS
Current custodian: Ellen Kenchington, Kevin MacIsaac
Received format: Oracle tables
Current status: some in Oracle tables (stomach database), some not yet available
Reference(s): Kenchington *et al.* (2003)

Stomachs were collected during this study of the effects of mobile fishing gear on demersal fish and benthic habitat (Kenchington *et al.* 2003). This bottom trawl survey was conducted within the 4TVW Haddock Closed Area on Western Bank. Only the stomachs collected in 1999 were analysed by the FSRS and so only these data are currently available in the database. These consist of 608 stomachs collected on cruise N99-013A. More data (another 1268 samples) are expected to become available from the Marine Environmental Sciences Division (MESD). Table 13 lists stomach numbers from 1998-1999 including those not yet entered into the stomach database. The amount of data collected in 1997 is unknown at this time. These data may not be appropriate for modelling fish diet in the wild due to the design of the survey. The trawl repeatedly samples the same area. With each pass, animals are crushed making them available to species that do not ordinarily feed on them. For example, the remnants of a large clam may be found in the stomach of a haddock.

Table 13. All stomachs collected during the trawl impact study 1998-1999.

	4W 1998	1999	Total
American Plaice	73	24	97
Cod	185	114	299
Haddock	235	328	563
Halibut		6	6
Longhorn Sculpin	3	35	38
Ocean Pout	14	2	16
Pollock		5	5
Redfish	2	2	4
Sea Raven		10	10
Striped Wolffish	2	2	4
Thorny Skate		1	1
Turbot		2	2
Winter Flounder	11	301	312
Winter Skate		2	2
Yellowtail	62	11	73
	587	845	1432

3.1.2 Diet Data Sources

3.1.2.1 <u>Pre-1970's Surveys: P70 (1958-1969)</u>

Original investigator: Marine Fish Division (MFD)
Received from: Kees Zwanenburg, Bob Branton
Current custodian: Kees Zwanenburg
Received format: Oracle tables created from original data sheets and key punched cards
Current status: Oracle tables (stomach database)
Reference(s): Halliday and Koeller (1981);

> Branton R., K. Zwanenburg and Joann Smith DDA Computer Consultants. 2000. Pre 70 groundfish research trawl data base "draft development plan". Department of Fisheries and Oceans, Virtual Data Centre.

The pre-1970s bottom-trawl surveys were exploratory in nature and their purpose was to increase basic biological knowledge on distribution and stock boundaries of exploited species (Halliday and Koeller 1981). The area surveyed was generally within 4TVWX, focussing on 4VW. From 1958 to the mid-1960s, seasonal surveys for the "Gulf Census" in the Gulf of St. Lawrence were used to determine recruitment and environmental effects on abundance, distribution and movements of cod and plaice. Survey coverage was extended from 1960-1964 into division 4V. On the Scotian Shelf, cruises initially focussed on haddock abundance and distribution from 1959-1966. Between 1966 and 1970, surveys explored underexploited species such as silver hake, sandlance and argentine. In the 1960s, research surveys also included studies of diurnal migration and behaviour, species associations, feeding, trawl engineering and hydro-acoustics. The stomach collection and contents analysis protocols are not known in detail, however samples were analysed at sea and recorded onto data sheets that were then key punched to fixed format 80 column cards and stored at the St. Andrews Biological Station (Branton *et al.* 2000). After 1970, seasonal standardised stratified random sampling on groundfish surveys began for more accurate assessments for fisheries management, however stomach sampling was ceased until 1995.

Stomachs were collected during 54 groundfish surveys between 1958 and 1969, with good seasonal coverage. The data cover 42 species of fish with cod and haddock being the most sampled (Table 14). Predator length, but not weight is available. Prey weight, but not length is available. The data do not appear well edited; there are predator species listed that do not normally occur in the region. These may be miscoded or possibly the codes have changed since this time period. Samples of 'Bonaparte' are likely miscoded since this species is very rare in the Northwest Atlantic. It is possible that these stomachs were from redfish (codes 20, 21, and 23) since the Bonaparte is code 22 and since redfish, a commonly caught species, was not otherwise present in the pre-1970's stomach data.

Table 14. Numbers of stomachs examined during the pre-1970's surveys. These include full and empty stomachs.

	4T	4VN	4VS	4W	4X	5YZ	Total
Alewife					277		277
American Plaice	56	675	1109	2456	1384	10	5690
Arctic Eelpout			8				8
Argentine			25	581	420		1026
Atlantic Spiny Lumpsucker				2	8		10
Barndoor Skate		2		98	115		215
Black Dogfish		19					19
Butterfish					2		2
Cod	2114	5303	2431	6647	4599	436	21530
Cusk	3			134	478	11	626
Eelpouts (NS)				18	17		35
Fourbeard Rockling					10		10
Gray's Cutthroat Eel					11		11
Haddock	149	445	1209	13552	9504	1591	26386
Halibut	20	11	12	345	134	4	526
Herring				2	560		562
Little Skate			2			26	28
Longfin Hake			6	58	88		152
Longhorn Sculpin			40	73	76		189
Lumpfish			11	5	6		22
Mailed Sculpin					1		1
Marlin-Spike Grenadier			11		63		74
Monkfish		3	10	151	98		262
Pollock	2	137	78	827	1244	199	2487
Rainbow Smelt					6		6
Red Hake				14	12		26
Redfish			45	209	517		771
Sea Raven		7	4	18	22		51
Silver Hake		2	1	748	428		1179
Smooth Skate		16	10	44	25		95
Spiny Dogfish		19		2	126		147
Spotted Wolffish				21	2		23
Striped Atlantic Wolffish		44	13	19			76
Thorny Skate	15	70	255	352	305	2	999
Turbot			2		2		4
White Hake	31	122	68	457	558		1236
Windowpane Flounder				2	2		4
Winter Flounder		2		39	196	7	244
Winter Skate			3	345	32		380
Witch Flounder	1	606	885	985	244		2721
Wolffish, unid.		29	4	15	166	6	220
Yellowtail Flounder		5	999	2131	18	42	3195
Total	2391	7517	7241	30350	21756	2334	71589

3.1.2.2 Fisheries Ecology Program: FEP (1982-1983)

Original investigator: Ken Waiwood, Robin Mahon
Received from: Mark Showell
Current custodian: Mark Showell
Received format: ASCII text file
Current status: Oracle tables (stomach database)
Reference(s): Mahon, R. and M. Buzeta 1983. Cruise Report: Lady Hammond – H088, H089. 1983. Department of Fisheries and Oceans, Atlantic Fisheries Service, Marine Fish Division, Fisheries Research Branch, Scotia-Fundy Region, 4 pp.

Waiwood, K. 1983. Cruise Report: Alfred Needler – N010. Department of Fisheries and Oceans, Atlantic Fisheries Service, Marine Fish Division, Fisheries Research Branch, Scotia-Fundy Region, 4 pp.

A total of 4,323 haddock stomachs were collected for feeding studies during 1982 and 1983 seasonal groundfish surveys as well as on dedicated 1983 Fisheries Ecology Program research surveys. The main purpose of the Fisheries Ecology Program (1983-1985) was to determine the distribution of adult and juvenile haddock in NAFO division 4X and the variance in fish density within and between established groundfish survey strata. In 1982, a total of 1,877 haddock stomachs were collected in 4X and 97 in 4W in all seasons during surveys HAM1982072 (16-24 Mar groundfish survey), HAM1982076 (10-26 May silver hake survey), HAM1982080 (9-19 Jul groundfish survey), and HAM1982085 (12-26 Oct groundfish survey). In 1983, a total of 2,446 haddock stomachs were collected in 4X in all seasons during surveys HAM1983088 (6-11 Jan FEP survey), HAM1983089 (12-18 Jan FEP survey), HAM1983095 (5-15 Apr groundfish survey), NED1983010 (25 May-4 Jun FEP survey), and NED1983015 (30 Aug-9 Sep FEP survey).

3.1.2.3 Pollock surveys: POK (1983-1988)

Original investigators: Jacquie McGlade, Diane Beanlands, Chris Annand
Received from: Diane Beanlands
Current custodian: Diane Beanlands
Received format: hard copy
Current status: Excel, Oracle tables (stomach database)
Reference(s): Annand, C. 1987. Cruise Report: Alfred Needler – N082. Department of Fisheries and Oceans, 13 pp.

McGlade, J. 1986. Cruise Report: Lady Hammond – H147. Department of Fisheries and Oceans, Atlantic Fisheries Service, Marine Fish Division, Fisheries Research Branch, Scotia-Fundy Region, 5 pp.

The purpose of these stratified random surveys was to determine the distribution and relative abundance of pollock and to investigate factors that influence these patterns. Stomachs were collected from a number of species but most were from pollock (Table 15). Data from the following pollock cruises were located:

No stomach data in:

P285: 3-7 Mar 1983. Emerald Bank and 4X; haddock stomachs were sampled but data were not located.

RE01: Inshore pollock survey. No stomach content data.

H065: 13-22 Oct 1981. Fall groundfish inventory. No stomach content data.

H068: 1-5 Dec 1981. No stomach content data.

H087: 15 Nov-10 Dec 1982. No stomach data.

H151: 3-9 Feb 1986. No stomach content data.

N052: 23-25 Sep 1985. Cruise aborted early due to mechanical problems. No stomach content data.

N062: May 1986. Lobster survey.

N130: Dogfish stomach content data.

Stomach data in:

H110: 28 Nov-8 Dec 1983. Up to 100 pollock stomachs per set were collected in 4VWX and 5Yd based on 3-cm length groups and placed in nylon stockings into buckets of 10% buffered formalin. Stomach contents descriptions for the 232 collected are not very detailed.

H129: 22 Nov-10 Dec 1984. Subsampled 50 pollock, 1 per 1-cm length group per set for a total of 187 samples. Stomachs were stored in nylon stockings in 10% formalin. Stomachs (743) were also collected from white hake for an ongoing feeding study for the Gulf Region. There may be some mix up in numbers with cruise H110. Data include fish number, content weight, stomach fullness, content id (count, length, and/or weight)

H147: 4-13 Dec 1985. Types and numbers of prey species were identified in pollock and dogfish stomachs (no weights). Some data on cod was also collected.

N082: 1-12 Jun 1987. No mention of stomach collection in cruise report. Only 8 empty stomachs in database.

N103: 30 May-10 June 1988. About 250 pollock stomach contents were examined at sea for gross analysis only.

Table 15. Stomachs collected during 1983-1988 Pollock surveys.

	4VS		4W				4X				5YZ			
	1984	1988	1983	1984	1985	1988	1983	1984	1985	1987	1983	1984	1985	Total
Cod													59	59
Haddock													7	7
White Hake	84			384				188				87		743
Pollock	6	206	100	82	232	46	34	43	52	8	98	56	178	1141
Redfish													3	3
Spiny Dogfish					60				15				98	173
Total	90	206	100	466	292	46	34	231	67	8	98	143	345	2126

3.1.3 Other Data Available

The following is a list of other data that have already been collected, some of which is available for editing and entry into stomach database and some of which is still in the hands of the custodians.

3.1.3.1 Groundfish Port Sampling: GPS (2001)

Original investigator: Peter Comeau
Received from: FSRS
Current custodian: Peter Comeau
Received format: Oracle
Current status: Oracle tables (stomach database edit mode)
Reference(s): none

About 600 cod and haddock stomachs were collected from commercial fish landings from the Scotian Shelf and Bay of Fundy during groundfish port sampling by request from the CDEENA project.

3.1.3.2 Commercial Fishing: CMF (2001)

Original investigator: MFD
Received from: Commercial fishery
Current custodian: MFD
Received format: Oracle
Current status: Oracle tables (stomach database edit mode), ISDB
Reference(s): none

Longhorn sculpin stomachs (175 samples) were collected from six commercial fishing trips by Lady Ella II and Vera & Sisters for bait in St. Mary's Bay in 2001 (trips: J01-0106C, J01-0106C, J01-0112B, J01-0115E, J01-0117E, J01-0123B).

3.1.3.3 Silver Hake Survey Data: SHS (1981-1986)

Original investigator: Don Waldron
Received from: Cynthia Bourbonnais
Current custodian: Wayne Stobo
Received format: ASCII files on Emerald
Current status: Excel, Oracle tables (stomach database edit mode)
Reference(s): Waldron, D. E. (1988)

West, J. 2001. Retrieval of 1981-1985 fish stomach content data. Unpublished report.

West, J. 2001. Restoration of archival fish diet data from 1981-1985. Unpublished report.

Silver hake and other groundfish stomachs were collected during research surveys and commercial fishing trips from 1981 to 1986 for a study of silver hake predation and impacts on gadids as wells as cannibalism. The data compiled for the stomach database consists of 4,559 stomachs of which

2,674 are from silver hake and 1,251 are from cod. The files have been archived on Emerald (accounts EMF0701, EMF0703, EMF0702) and processed into Excel format. These data required a fair amount of reworking to get them to the format of the database. The data set as received by the authors contained numerous duplicate entries with different fish identification formats. The data has been entered into the database edit tables, however many errors may still exist due to errors in the original data or misinterpretation of the original data format.

3.1.3.4 Swordfish Data: SW (1980)

Original investigator: Julie Porter
Received from: Julie Porter
Current custodian: John Neilson
Received format: Excel
Current status: Excel, ready for database
Reference(s): none

In 1980, 197 swordfish stomachs (with contents) were collected and analysed during industry longline surveys. The survey ran from August to September and sampled fish from Cape Hatteras, Georges Bank, the Scotian Shelf, and the Grand Banks. Bait was included in the stomach contents because it was not possible to distinguish it from other prey. The data have been keypunched from contract report #07SC.FP 706-1-C033 into an Excel spreadsheet. These are ready to be added to the stomach database.

3.1.3.5 Large Pelagics (2001)

Original investigator: steering committee for Central North Atlantic Bluefin Tuna Research
Current custodian: steering committee for Central North Atlantic Bluefin Tuna Research (DFO contact: John Neilson)
Current status: Access
Reference(s): none

Stomach samples were collected from swordfish and various tuna species during the 2001 Canadian North Atlantic Bluefin Tuna Survey in July. This survey extended from the Scotian Shelf to the mid-Atlantic ridge. These data are not currently available to DFO.

3.1.3.6 Christina Semeniuk's dogfish data (1997-1998)

Original investigator: Christina Semeniuk, Thomas Hurlbut
Current custodian: Christina Semeniuk
Current status: Excel, needs formatting for database
Reference(s): Semeniuk. C. and T. Hurlbut. 1998. Management and perceptions of spiny dogfish in Atlantic Canada. The IUCN/SSC Shark Specialist Group, Shark News 12: November 1998, http://www.flmnh.ufl.edu/fish/Organizations/SSG/sharknews/sn12/shark12news15.htm.

Spiny dogfish stomach data (313 samples) were collected in the Southern Gulf of St. Lawrence and on the Scotian Shelf in September 1997 and July and September 1998 on 4TVWX groundfish surveys for Christina Semeniuk's undergraduate thesis at Concordia University supervised by Dr. James Grant (Semeniuk and Hurlbut 1998). The study addresses the debate on predation impacts of dogfish on groundfish species.

3.1.3.7 Commercial Shark (1999-2001)

Original investigator: Steven Campana
Received from: Steven Campana
Current custodian: Steven Campana
Received format: Excel
Current status: Excel, needs formatting
Reference(s): Joyce *et al.* (2002)

Over 800 Porbeagle shark stomachs were collected and analysed during Canadian commercial longline fishing activities and a US National Marine Fisheries Service scientific survey from 1999 to 2001 (Joyce *et al.* 2002). The area sampled extends from the Grand Banks to the Gulf of St. Lawrence to the Gulf of Maine.

3.1.3.8 Recreational Shark Fishing (1999-2001)

Original investigator: Steven Campana, Meghan McCord
Current custodian: Steven Campana
Current status: unknown
Reference(s): McCord and Campana (In press)

During 1999-2001, 665 blue shark stomachs were examined in the Northwest Atlantic from recreational rod and reel fishing tournaments for a study on dietary differences based on sex, maturity and location (McCord and Campana, In press).

3.1.3.9 Juvenile Haddock Survey (1989)

Original investigator: Jeff McRuer
Current custodian: Ken Frank
Current status: Excel, not currently available to MFD
Reference(s): McRuer, J. 1989. Cruise Report: Alfred Needler – N121. Department of Fisheries and Oceans, Biological Sciences Branch, Science Sector, Marine Fish Division, Scotia-Fundy Region, 4 pp.

In May 1989, 300 juvenile haddock stomachs were collected from Southwest Nova during research survey N121. The purpose of this cruise was to assess the abundance of juvenile haddock in NAFO division 4X and to establish the most appropriate sampling time, technique and location for future surveys. A subsample of about 530 juvenile age-1+ haddock were retained in 4% buffered formalin and transferred to alcohol for gut analysis and otolith extraction. Another 400 samples of other species were retained, however it is not known whether stomachs were analysed.

3.1.3.10 Dogfish Data (1985)

Original investigator: C. Annand, R. Mahon
Current custodian: Tim Lambert
Current status: hard copy only
Reference(s): J.D. Neilson. 1985. Cruise Report: Alfred Needler – N047. DFO, Atlantic Fisheries Service, Marine Fish Division, Fisheries Research Branch, Scotia-Fundy Region, 4 pp.

R.I. Perry. 1985. Cruise Report: Lady Hammond – H138. DFO, Atlantic Fisheries Service, Marine Fish Division, Fisheries Research Branch, Scotia-Fundy Region, 4 pp.

S.J. Smith and P. Koeller. 1985. Cruise Report: alfred Needler – N048-49. DFO, Atlantic Fisheries Service, Marine Fish Division, Fisheries Research Branch, Scotia-Fundy Region, 4 pp.

Dogfish stomachs were collected during industry trips in the fall of 1985. In June and July 1985, 150 stomachs were collected during research surveys N047, N048, and H138. The stomach contents data are not very detailed.

3.1.3.11 Mackerel Diet Data (1962-1974, 1976)

An effort was made to recover the mackerel diet analysed in MacKay (1979) in which inshore commercial fishery and research cruise data from 1962-1974 were compiled from the Atlantic coast of Nova Scotia and the Gulf of St. Lawrence. Over 9,600 fish were measured but it is not clear if stomachs were collected from all of these. Kulka and Stobo (1981) examined 111 silver hake stomachs from the Scotian Shelf, Georges Bank, and Nantucket Shoals, 199 mackerel from the Scotian Shelf, and 42 mackerel from Cape Cod in 1976. However, neither data set could be located.

3.1.3.12 4Vn Sentinel Survey (1995-2001)

Original investigator: Tim Lambert
Current custodian: Mark Showell
Current status: Quattro Pro, ISDB
Reference(s): none

About 30,000 cod stomachs were collected and examined during the 4Vn sentinel surveys. These data are not very detailed and do not have weights for most of the prey items, thus they may not be useful for the stomach database.

3.1.3.13 Data Summary

An overall summary of data already in and for the stomach database is given in Table 16. Listings for which status is complete are already in the database. Data that are entered but still need some editing are in edit mode. Incomplete data need to be processed to conform to the format of the database and unavailable data have not been given to the custodians of the stomach database. Some of the samples have no location information available thus the area collected is unknown. The location of the actual data and the format saved in are given. The most common species collected in each survey or study are also listed.

Table 16. Summary of data already in or gathered for the stomach database. Some data are not yet available to the custodians of the stomach database. Stomachs in boldface with status complete are already in production mode within the database. Data in edit mode have been entered but need to be checked for errors. Incomplete data need processing. The most common species from which stomachs were taken are listed as common predator species.

Data source survey/study	ID	Stomachs	Years	Areas collected	Common predator species	Location *	Format	Status
Juvenile fish survey	SP	**580**	1988	4VsWX5Z, unknown	silver hake, spiny dogfish, 24 other species	SDB	Oracle	complete
Brown's Bank survey	SP	**242**	2000	4X	haddock, cod	SDB	Oracle	complete
4VsW sentinel survey	SS	**1874**	1996-2000	4VWX, unknown	mostly cod, haddock, 7 others	SDB, ISDB	Oracle	complete
- observer coverage	JSS	**15**	1998, 2000	4W	haddock, cod	SDB, ISDB	Oracle	complete
4VsW sentinel survey	SS,JSS	411	2001-2002		cod, 2 others	SDB, ISDB	Oracle	in edit mode
Commercial index - observers	CI	**168**	1997, 1999	4VsW	cod, haddock	SDB, ISDB	Oracle	complete
- commercial sampling	CS	**706**	1998-2000	4VWX, unknown	mostly cod, 7 others	SDB, ISDB	Oracle	complete
Commercial index - observers	CI	25	2000-2001		cod	SDB, ISDB	Oracle	in edit mode
- commercial sampling	CS	137	2001-2002		cod, 4 others	SDB, ISDB	Oracle	in edit mode
Condition factor	CF	**2865**	1998-2000	4VWX5Z, unknown	American plaice, cod, haddock, witch flounder, and 15 others	SDB, FSRS	Oracle, Access	complete
		296	2001-2002		haddock, 3 others	SDB, FSRS	Oracle, Access	in edit mode
Groundfish survey - summer and spring	GS	**13921**	1996-2000	4VWX5Z, unknown	plaice, cod, haddock, silver hake, witch & yellowtail flounder, 26 others	SDB, GSDB	Oracle	complete
		8874	2001-2002	4VWX5Z, unknown	cod, herring, sandlance, mackerel, capelin, silver hake, 31 others	SDB, GSDB	Oracle	in edit mode
Herring survey	PS	**1035**	1999-2000	4VsW5Z	cod, haddock, herring, 23 others	SDB, PSDB	Oracle, Excel	complete
Halibut industry survey	HS	**201**	1999-2000	3OP4VsW4X, unknown	halibut, 4 others	SDB, ISDB	Oracle	complete
		74	2001		halibut, 2 others	SDB, ISDB	Oracle	in edit mode
Trawl impact study	TIS	**608**	1999	4W, unknown	haddock, winter flounder, 5 others	SDB	Oracle	complete
		824	1998-1999		cod, haddock, plaice, yellowtail flounder, 11 others	MESD	Unknown	incomplete, unavailable
Pre-1970's survey	P70	**71589**	1958-1969	4TVWX5YZ	lots of cod & haddock; 40 others	SDB	Oracle	complete
Fisheries ecology program	FEP	**4420**	1982-1983	4WX	haddock	SDB	Oracle	complete
Pollock survey	POK	**2126**	1983-1987	4VsWX5YZ	pollock, white hake, 4 others	SDB	Oracle, Excel	complete
Silver hake data	SHS	4564	1981-1986	3LNOPn4RVWX5Z, unknown	silver hake, cod, 14 others	MFD	ASCII, Excel	ready for SDB
Swordfish data		197	1980	3LNO4VWX5Z	swordfish	SABS	Excel	ready for SDB
Large pelagics			2001	Scotian Shelf to mid-Atlantic ridge	swordfish, tuna	SABS	Access	incomplete, unavailable
Commercial shark		1022	1999-2001	Gulf of St. Lawrence to Gulf of Maine	porbeagle shark	MFD	SPSS	incomplete
Recreational shark fishing		665	1999-2001	Northwest Atlantic	blue shark	MFD		incomplete, unavailable
Juvenile haddock survey		300	1989	Southwest Nova	juvenile haddock	BIO	Excel	incomplete, unavailable
Dogfish data		150	1985		dogfish	MFD	hard copy	incomplete, unavailable
Mackerel data		9635? >352	1962-1974 1976	Gulf of St. Lawrence, Scotian Shelf, Georges Bank, Nantucket Shoals, Cape Cod	mackerel, silver hake			not located
Dogfish data - C. Semeniuk		313	1997-1998	Southern Gulf of St. Lawrence, Scotian Shelf	spiny dogfish	MFD	Excel	incomplete
Groundfish port sampling	GPS	602	2001	4VWX5YZ	cod, haddock	SDB	Oracle	in edit mode
Commercial fishing	CMF	185	2001		longhorn sculpin	SDB, ISDB	Oracle	in edit mode
4Vn sentinel survey		~30000	1995-2001	4Vn	cod	MFD	Quattro Pro	incomplete
Total stomachs		158976						

* SDB = stomach database; ISDB = industry survey database; GSDB = groundfish survey database; PSDB = pelagic survey database
FSRS = Fishermen and Scientists Research Society; MESD = DFO Marine Environmental Sciences Division; MFD = DFO Marine Fish Division;
SABS = St. Andrews Biological Station; BIO = Bedford Institute of Oceanography

3.2 Consumption and Diet Estimation

We present summary results on consumption and diet estimation for fish sampled during 4VsW groundfish summer (July) surveys. An example of the process used to determine population level average daily consumption was taken from cod sampled on mission NED2000966, set number 48 in the year 2000 winter survey. This example is taken from the winter survey because of its smaller sample size for cod. The sequence of SQL scripts as described in Appendix IV produces eleven intermediate tables to get to the final consumption results. This code could use some refinement to make it more concise and to remove extraneous steps or information.

The first table 'gssto_work' (Table 17) is compiled from all three stomach database tables and information such as location and date from the groundfish survey (GS) database. It contains all the necessary data for further calculations. The next step groups prey items (sums prey weights) by the ecopath model groupings (ecocodes, see Table 2) and produces the table 'gscross' with one row entry for each stomach collected (Table 18). Table 19, 'gsconsum_calc', has the fish length code added for the 5-cm length groups, ecocodes replaced by ecogroup names, and consumption (g/d) by each fish calculated using the dos Santos and Jobling (1995) model. The table 'gsconsumraw' (Table 20) then contains the average consumption, fish length, and fish weight of each predator species and 5-cm fish length group within a set for non-empty stomachs. 'Incl_empty_gsconsumraw' (Table 21) has these same values adjusted to include empty and everted stomachs some of which were collected and some were only recorded in the GS database. Contents for everted stomachs were averaged from contents of stomachs from the same species and fish length collected in the same NAFO division, season and year.

Table 17. Subsample of table 'gssto_work' of data taken from the stomach and groundfish survey databases that are required for consumption calculations. These data are only for cod sampled from set 48 of mission NED2000966.

MISSION	SETNO	STR	YEAR	SEAS	REGI	BOTTOM_TEMPERATURE	SPEC	FSHNO	FWT	FLEN	PREYSPEC	PREYSPECCD	PWT	PNUM	PLEN	ECOPRED	ECOPREY
NED2000966	48	404	2000	WINT	4VsW	6.33	10	155	1914	61	Herring	60	110.99	2	17.5	4	24
NED2000966	48	404	2000	WINT	4VsW	6.33	10	157	1980	59	Crab (Spider)	2519	9.15	1	2.4	4	28
NED2000966	48	404	2000	WINT	4VsW	6.33	10	157	1980	59	Isopod	2980	4.45	9	3	4	33
NED2000966	48	404	2000	WINT	4VsW	6.33	10	157	1980	59	Sea Anemone	8300	0.42	1	0.9	4	33
NED2000966	48	404	2000	WINT	4VsW	6.33	10	157	1980	59	Shrimp	2100	1.65	4	3.2	4	29
NED2000966	48	404	2000	WINT	4VsW	6.33	10	157	1980	59	rock	9200	1.03	1	1.2	4	0
NED2000966	48	404	2000	WINT	4VsW	6.33	10	157	1980	59	Sea Mouse	3200	4.73	1	4.5	4	31
NED2000966	48	404	2000	WINT	4VsW	6.33	10	160	1732	62	Fish Remains	1099	0.19	15	1	4	0
NED2000966	48	404	2000	WINT	4VsW	6.33	10	161	1356	54	Herring	60	33.5	1	19	4	24

Table 18. Table 'gscross' lists one stomach per row and has prey items summed by ecocode.

MISSION	SETNO	STR	REGI	YEAR	SEAS	TEMP	SPEC	ECOPRED	FSHNO	FLEN	FWT	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20
NED2000966	48	404	4VsW	2000	WINT	6.33	10	4	155	61	1914	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NED2000966	48	404	4VsW	2000	WINT	6.33	10	4	157	59	1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NED2000966	48	404	4VsW	2000	WINT	6.33	10	4	160	62	1732	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NED2000966	48	404	4VsW	2000	WINT	6.33	10	4	161	54	1356	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

P21	P22	P23	P24	P25	P26	P27	P28	P29	P30	P31	P32	P33	P34	P35	P40	P41	P42	P100	P200	P300	TOTAL	TOTAL_ID
0	0	0	110.99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	110.99	110.99
0	0	0	0	0	0	0	9.15	1.65	0	4.73	0	4.87	0	0	0	0	0	0	0	0	20.4	20.4
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	33.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33.5	33.5

Table 19. Table 'gsconsum_calc' contains consumption (g/d) values for each stomach and prey type as calculated using the dos Santos and Jobling (1995) model.

MISSION	SETNO	STR	REGI	YEAR	SEAS	TEMP	SPEC	FSHNO	FLEN	FLEN_CODE	FWT	COD	J_COD	SHAKE	J_SHAKE	HADDOCK	AM_PLAICE	HALIBUTS	J_HAL	FLNDRS	SKATES
NED2000966	48	404	4VsW	2000	WINT	6.33	10	155	61	63	1914	0	0	0	0	0	0	0	0	0	0
NED2000966	48	404	4VsW	2000	WINT	6.33	10	157	59	58	1980	0	0	0	0	0	0	0	0	0	0
NED2000966	48	404	4VsW	2000	WINT	6.33	10	160	62	63	1732	0	0	0	0	0	0	0	0	0	0
NED2000966	48	404	4VsW	2000	WINT	6.33	10	161	54	53	1356	0	0	0	0	0	0	0	0	0	0

DOGFISH	REDFISH	POLLOCK	MACK	DEM_PISC	LG_DEM	SM_DEM	CAPELIN	SLANCE	TRANS_PEL	SM_PEL	SM_MESO	SQUID	LG_CRAB	SM_CRAB
0	0	0	0	0	0	0	0	0	0	29.054738	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	3.6181856
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	14.734726	0	0	0	0

SHRIMP	ECHINO	POLY	BIVL	OBI	SM_ZOO	LG_ZOO	J_DEM_PISC	J_LG_DEM	UNID_GAD	UNID_INV	UNID_FISH	UNID_F_INV	ECOPRED	CONSUM
0	0	0	0	0	0	0	0	0	0	0	0	0	4	29.055
0.81975705	0	8.8692424	0	9.131757	0	0	0	0	0	0	0	0	4	22.439
0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
0	0	0	0	0	0	0	0	0	0	0	0	0	4	14.735

Table 20. Table 'gsconsumraw' of average consumption per 5-cm fish length group per set.

MISSION	YEAR	REGI	STR	SETNO	SEAS	SPEC	SAMPLE	FLEN_CODE	AVG_FLEN	AVG_FWT	AVGCOD	AVGJ_COD	AVGSHAKE	AVGJ_SHAKE	AVGHADDOCK	AVGAM_PLAICE
NED2000966	2000	4VsW	404	48	WINT	10	1	53	54	1356	0	0	0	0	0	0
NED2000966	2000	4VsW	404	48	WINT	10	1	58	59	1980	0	0	0	0	0	0
NED2000966	2000	4VsW	404	48	WINT	10	2	63	61.5	1823	0	0	0	0	0	0

AVGHALIBUTS	AVGJ_HAL	AVGFLNDRS	AVGSKATES	AVGDOGFISH	AVGREDFISH	AVGPOLLOCK	AVGMACK	AVGDEMPISC	AVGLG_DEM	AVGSM_DEM
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0

AVGCAPELIN	AVGSLANCE	AVGTRANS_PEL	AVGSM_PEL	AVGSM_MESO	AVGSQUID	AVGLG_CRAB	AVGSM_CRAB	AVGSHRIMP	AVGECHINO	AVGPOLY
0	0	0	14.734726	0	0	0	0	0	0	0
0	0	0	0	0	0	0	3.6181856	0.81975705	0	8.8692424
0	0	0	14.527369	0	0	0	0	0	0	0

AVGBIVL	AVGOBI	AVGSM_ZOO	AVGLG_ZOO	AVGJ_DEM_PISC	AVGJ_LG_DEM	AVGUNID_GAD	AVGUNID_INV	AVGUNID_FISH	AVGUNID_F_INV
0	0	0	0	0	0	0	0	0	0
0	9.131757	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

The average ration table 'avgr' (Table 22) is similar to 'incl_empty_gsconsumraw', however the columns of prey items have been converted back to rows. Zero values for prey types not eaten are included for calculations in later steps. The next step averages rations across sets resulting in average rations by series (season), year, and stratum. This table called 'avg_prey_ration' is not shown here since only a single set is being demonstrated. The standardised number of fish caught per 5-cm length class as determined by corrections for differences in area coverage of sets were obtained from oracle database NWAGS.gsd5lf_mv and arranged by series, year, and stratum in table 'avg_no_pred' (Table 23). This number of fish per length is used to calculate total rations per length class as shown in table 'tot_no_pred_rtn' for 53-cm cod from this set that is in stratum 404 (Table 24). The final consumption calculation is to determine the total ration for each NAFO division in table 'tot_unit_avgrtn' (Table 25). The ration for each stratum is calculated by multiplying the ration per net tow by the number of tows needed to cover the stratum (ration / no. tows * area / tow length * trawl width). These strata totals are summed for each NAFO area. This table also includes total standardised numbers of fish at length from 'totnopredatlgth' (Table 26) extrapolated for the NAFO area. The total number and total ration are then used to calculate an average ration. The final results table 'FINAL_avg_rtn' lists the average rations for prey types eaten and includes empty/everted stomachs as well as the number of stomachs collected and the total number of stomachs observed (from 'nopred_all', Table 27) by series, year, species and fish length group (Table 28).

Table 22. Table 'avgr' of the average rations per prey type for the 53-cm length group of cod in set 48 of mission NED2000966.

MISSION	SETNO	SPEC	FLEN_CODE	PREY	SAMPLE	AVGR
NED2000966	48	10	53	4	3	0
NED2000966	48	10	53	5	3	0
NED2000966	48	10	53	6	3	0
NED2000966	48	10	53	7	3	0
NED2000966	48	10	53	8	3	0
NED2000966	48	10	53	9	3	0
NED2000966	48	10	53	10	3	0
NED2000966	48	10	53	11	3	0
NED2000966	48	10	53	12	3	0
NED2000966	48	10	53	13	3	0
NED2000966	48	10	53	14	3	0
NED2000966	48	10	53	15	3	0
NED2000966	48	10	53	16	3	0
NED2000966	48	10	53	17	3	0
NED2000966	48	10	53	18	3	0
NED2000966	48	10	53	19	3	0
NED2000966	48	10	53	20	3	0
NED2000966	48	10	53	21	3	0
NED2000966	48	10	53	22	3	0
NED2000966	48	10	53	23	3	0
NED2000966	48	10	53	24	3	5.613229
NED2000966	48	10	53	25	3	0
NED2000966	48	10	53	26	3	0
NED2000966	48	10	53	27	3	0
NED2000966	48	10	53	28	3	0
NED2000966	48	10	53	29	3	0.518445
NED2000966	48	10	53	30	3	0
NED2000966	48	10	53	31	3	0
NED2000966	48	10	53	32	3	0
NED2000966	48	10	53	33	3	0.155375
NED2000966	48	10	53	34	3	0.446906
NED2000966	48	10	53	35	3	0
NED2000966	48	10	53	40	3	0
NED2000966	48	10	53	41	3	0.765978
NED2000966	48	10	53	42	3	0
NED2000966	48	10	53	100	3	0
NED2000966	48	10	53	200	3	0.042163
NED2000966	48	10	53	300	3	0

Table 23. Table 'avg_no_pred' with standardised count at length per 5-cm length class corrected for different tow lengths or gear.

SERIES	YEAR	STR	SPEC	FLEN	STDCLEN
4VWCOD	2000	404	10	38	1.035503
4VWCOD	2000	404	10	48	3.1065089
4VWCOD	2000	404	10	53	4.1420118
4VWCOD	2000	404	10	58	3.1065089
4VWCOD	2000	404	10	63	5.1775148

Table 24. Table 'tot_no_pred_rtn' with total rations per length class for the standardised number of 53-cm cod in set 48 of mission NED2000966.

SERIES	YEAR	STR	SPEC	FLEN	PREY	NSETS	TOTNO	TOTR
4VWCOD	2000	404	10	53	4	1	4.1420118	0
4VWCOD	2000	404	10	53	5	1	4.1420118	0
4VWCOD	2000	404	10	53	6	1	4.1420118	0
4VWCOD	2000	404	10	53	7	1	4.1420118	0
4VWCOD	2000	404	10	53	8	1	4.1420118	0
4VWCOD	2000	404	10	53	9	1	4.1420118	0
4VWCOD	2000	404	10	53	10	1	4.1420118	0
4VWCOD	2000	404	10	53	11	1	4.1420118	0
4VWCOD	2000	404	10	53	12	1	4.1420118	0
4VWCOD	2000	404	10	53	13	1	4.1420118	0
4VWCOD	2000	404	10	53	14	1	4.1420118	0
4VWCOD	2000	404	10	53	15	1	4.1420118	0
4VWCOD	2000	404	10	53	16	1	4.1420118	0
4VWCOD	2000	404	10	53	17	1	4.1420118	0
4VWCOD	2000	404	10	53	18	1	4.1420118	0
4VWCOD	2000	404	10	53	19	1	4.1420118	0
4VWCOD	2000	404	10	53	20	1	4.1420118	0
4VWCOD	2000	404	10	53	21	1	4.1420118	0
4VWCOD	2000	404	10	53	22	1	4.1420118	0
4VWCOD	2000	404	10	53	23	1	4.1420118	0
4VWCOD	2000	404	10	53	24	1	4.1420118	23.250061
4VWCOD	2000	404	10	53	25	1	4.1420118	0
4VWCOD	2000	404	10	53	26	1	4.1420118	0
4VWCOD	2000	404	10	53	27	1	4.1420118	0
4VWCOD	2000	404	10	53	28	1	4.1420118	0
4VWCOD	2000	404	10	53	29	1	4.1420118	2.1474053
4VWCOD	2000	404	10	53	30	1	4.1420118	0
4VWCOD	2000	404	10	53	31	1	4.1420118	0
4VWCOD	2000	404	10	53	32	1	4.1420118	0
4VWCOD	2000	404	10	53	33	1	4.1420118	0.64356509
4VWCOD	2000	404	10	53	34	1	4.1420118	1.8510899
4VWCOD	2000	404	10	53	35	1	4.1420118	0
4VWCOD	2000	404	10	53	40	1	4.1420118	0
4VWCOD	2000	404	10	53	41	1	4.1420118	3.1726899
4VWCOD	2000	404	10	53	42	1	4.1420118	0
4VWCOD	2000	404	10	53	100	1	4.1420118	0
4VWCOD	2000	404	10	53	200	1	4.1420118	0.17463964
4VWCOD	2000	404	10	53	300	1	4.1420118	0

Table 25. Table 'tot_unit_avgrtn' of total rations per NAFO division based on area and tow coverage.

SERIES	YEAR	PRED	FLEN	PREY	NSETS	TOTNO	TOTR	AVGR
4VWCOD	2000	10	53	4	1	10530	0	0
4VWCOD	2000	10	53	5	1	10530	0	0
4VWCOD	2000	10	53	6	1	10530	0	0
4VWCOD	2000	10	53	7	1	10530	0	0
4VWCOD	2000	10	53	8	1	10530	0	0
4VWCOD	2000	10	53	9	1	10530	0	0
4VWCOD	2000	10	53	10	1	10530	0	0
4VWCOD	2000	10	53	11	1	10530	0	0
4VWCOD	2000	10	53	12	1	10530	0	0
4VWCOD	2000	10	53	13	1	10530	0	0
4VWCOD	2000	10	53	14	1	10530	0	0
4VWCOD	2000	10	53	15	1	10530	0	0
4VWCOD	2000	10	53	16	1	10530	0	0
4VWCOD	2000	10	53	17	1	10530	0	0
4VWCOD	2000	10	53	18	1	10530	0	0
4VWCOD	2000	10	53	19	1	10530	0	0
4VWCOD	2000	10	53	20	1	10530	0	0
4VWCOD	2000	10	53	21	1	10530	0	0
4VWCOD	2000	10	53	22	1	10530	0	0
4VWCOD	2000	10	53	23	1	10530	0	0
4VWCOD	2000	10	53	24	1	10530	59107	5.613
4VWCOD	2000	10	53	25	1	10530	0	0
4VWCOD	2000	10	53	26	1	10530	0	0
4VWCOD	2000	10	53	27	1	10530	0	0
4VWCOD	2000	10	53	28	1	10530	0	0
4VWCOD	2000	10	53	29	1	10530	5459	0.518
4VWCOD	2000	10	53	30	1	10530	0	0
4VWCOD	2000	10	53	31	1	10530	0	0
4VWCOD	2000	10	53	32	1	10530	0	0
4VWCOD	2000	10	53	33	1	10530	1636	0.155
4VWCOD	2000	10	53	34	1	10530	4706	0.447
4VWCOD	2000	10	53	35	1	10530	0	0
4VWCOD	2000	10	53	40	1	10530	0	0
4VWCOD	2000	10	53	41	1	10530	8066	0.766
4VWCOD	2000	10	53	42	1	10530	0	0
4VWCOD	2000	10	53	100	1	10530	0	0
4VWCOD	2000	10	53	200	1	10530	444	0.042
4VWCOD	2000	10	53	300	1	10530	0	0

Table 26. Table 'totnopredatlgth' of total standardised numbers of fish at length for the NAFO division.

SERIES	YEAR	PRED	FLEN	TOTNOFL	STDNSETS
4VWCOD	2000	10	38	2633	1
4VWCOD	2000	10	48	7898	1
4VWCOD	2000	10	53	10530	1
4VWCOD	2000	10	58	7898	1
4VWCOD	2000	10	63	13163	1

Table 27. Table 'nopred_all' of the total number of stomachs observed per fish length group.

SERIES	YEAR	SPEC	FLEN	STOMSTOT
4VWCOD	2000	10	38	1
4VWCOD	2000	10	48	2
4VWCOD	2000	10	53	3
4VWCOD	2000	10	58	1
4VWCOD	2000	10	63	3

Table 28. Table 'FINAL_avg_rtn' of final average rations for prey types eaten, including empty or everted stomachs. Column 'stomscolld' is the number of stomachs collected with contents and 'stomstot' is the total number of stomachs observed during the groundfish survey.

SERIES	YEAR	PRED	FLEN	PREY	NSETS	STOMSCOLLD	STOMSTOT	TOTR	TOTNOFL	AVGRNEW
4VWCOD	2000	10	38	0	1	0	1	0	2633	0
4VWCOD	2000	10	48	0	1	0	2	0	7898	0
4VWCOD	2000	10	53	24	1	1	3	59107	10530	5.6132004
4VWCOD	2000	10	53	29	1	1	3	5459	10530	0.51842355
4VWCOD	2000	10	53	33	1	1	3	1636	10530	0.15536562
4VWCOD	2000	10	53	34	1	1	3	4706	10530	0.44691358
4VWCOD	2000	10	53	41	1	1	3	8066	10530	0.7660019
4VWCOD	2000	10	53	200	1	1	3	444	10530	0.04216524
4VWCOD	2000	10	58	28	1	1	1	28575	7898	3.6180046
4VWCOD	2000	10	58	29	1	1	1	6474	7898	0.81970119
4VWCOD	2000	10	58	31	1	1	1	70045	7898	8.8687009
4VWCOD	2000	10	58	33	1	1	1	72118	7898	9.1311724
4VWCOD	2000	10	63	24	1	2	3	127478	13163	9.6845704

Table 29 shows average daily consumption (g/d) by fish for each fish length group and species surveyed for 1999 and 2000 pooled together. These values were calculated using the gastric evacuation model and include interpolated rations for fish lengths surveyed but not collected. Consumption generally increases with predator size. Monkfish, pollock and cod consume the most food in a day on average. Table 30 shows these results as annual (g/y) instead of daily consumption.

It is be expected that consumption would increase with size, however there are samples missing for some fish lengths in Tables 29 and 30. For example, cod of length 73 cm appear to be eating less than 68-cm cod and no value is available for 78-cm cod. Plots of consumption by individual fish (cod, haddock, and pollock) against body weight (Figure 10) show an increase in food intake with increasing fish size. The spread in the data at larger sizes shows the variation in consumption. This may be dependent on time of day and stomach fullness at collection.

The average daily consumption of each prey type by each predator species is shown in Table 31 and the same results are given as proportions of each prey type eaten in Table 32. These values were calculated with the gastric evacuation model, pooled across 1999-2000 and averaged across all fish lengths.

Diet estimation from actual stomach contents without the gastric evacuation model were compared to consumption proportions from the model for 1999 and 2000 separately and pooled together for cod (Table 33, Table 34), haddock (Table 35, Table 36) and pollock (Table 37, Table 38). The results are given by fish length and prey type. Cod diets appear to shift from predominantly shrimps and large zooplankton to sandlance with increasing cod size with or without the model.

The gastric evacuation model uses larger half-life parameters (see Table 3) for harder to digest prey items like small pelagics, shrimps and crabs and smaller half-lives for juvenile cod, juvenile silver hake, American plaice, polychaetes, other benthic invertebrates, and zooplankton. A larger half-life value accounts for slower digestion and thus the model suggests that these prey items were consumed less relative to the other items present in the stomach and vice versa for small half-life values. This is evident in the cod pie chart results pooled across 1999-2000 where for example the proportions of small pelagics and shrimps in the stomach contents are reduced with the consumption model and large zooplankton are increased (Figure 11).

Table 29. Average daily consumption (g/d) per fish by species and fish length pooled from 1999-2000 using the gastric evacuation model.

Fish Length	American plaice	Argentine	Capelin	Cod	Cusk	Haddock	Halibut	Little skate	Longhorn sculpin	Mackerel	Monkfish	Northern sandlance	Ocean pout	Pollock	Red hake	Redfish	Sea raven	Silver hake	Smooth skate	Spiny dogfish	Striped wolffish	Thorny skate	Turbot	Vahl's eelpout	White hake	Winter flounder	Winter skate	Witch flounder	Yellowtail flounder
3	0.05			0		0.10						0.12				0									0				0
8	0.05	0.08	0.03	0.15		0.07			0.05		0.16	0.11			0	0.16		0.17	0		0	0			0		0	0.02	0.03
13	0.14	0	0.11	0.37		0.18		0	0.74		4.89	0.12	0		0.005	0.67	0.31	0.69	0.74		0	0.89		0.05	0			0.21	0.24
18	0.32	0.15	0.27	0.71		1.00		0	0.71		0.31	0.17	0		0.80	1.26	4.09	1.41	1.07		0.14	2.08	1.05	0.10	1.30	1.71		0.39	0.61
23	0.58	0.75		1.73		0.97			1.05	1.12	1.62	0.21	0.06	1.50	2.03	1.32	2.44	1.84			0.49	2.94	1.66	0.41	2.65	1.41	1.44	0.72	0.79
28	0.93	0		2.38		2.23	4.07		1.73	1.12	2.34	0.20	0.46	3.37	1.39	1.38	2.53	2.62	1.40	0	0.97	3.46	1.84	0.40	2.22	0.50	1.44	0.86	1.27
33	0.87	1.42		3.54		3.32	2.04	0	2.10	0.42	6.23		0.87	3.98	0.86	1.49	7.27	3.95	1.01	1.12	0.68	1.46	3.19	0.13	3.20	0.44	1.45	1.24	1.51
38	0.98			5.30		4.53	0	0	5.44	1.83	6.23		0.71	3.89	3.32	3.60	2.34	10.87	0	1.35	1.09	1.23	2.45	0.66	6.61	0	0.77	2.13	1.70
43	1.15			5.81		5.90	6.55	0	13.80		16.44		2.11	4.92	0	5.49	3.81	8.84	1.27	4.36	2.49	0.95	4.29		9.12	0	1.71	3.38	0.55
48	0.89			8.11		8.89	0	0			0		0	9.27	0	5.49	11.52	0	3.26	2.05	4.96	1.25	3.36		15.49		4.91	3.07	
53	0			5.80		11.05	21.40	0			5.51		0.88	11.19			0		0.29	12.57	1.65	2.24	4.87		19.01		3.95	2.75	
58				11.57	0	10.28	0	0			4.21		0	18.18				0	1.78		0	2.67	4.40		28.30		0.15		
63				19.96	0	22.35	7.13				142.50		0	36.38						0	1.60	0.65	1.83		17.22		0		
68				17.96		6.80	7.13													0	10.05	0	0		0		0		
73				8.17			0													15.12		3.22	6.44		5.74		0		
78											0									7.10							0		
83				26.51			0													2.95							0		
88				44.84			0																				0		
93																					36.96				0		0		
103																						0							
123							0																						
Mean	0.54	0.40	0.14	9.58	0.00	5.55	3.72	0.00	3.20	1.12	14.65	0.15	0.46	10.30	0.93	2.09	3.81	3.04	1.08	4.24	4.36	1.54	2.95	0.29	6.93	0.68	0.99	1.48	0.75

Table 30. Average annual consumption (g/y) per fish by species and fish length pooled from 1999-2000 using the gastric evacuation model.

Fish Length	American plaice	Argentine	Capelin	Cod	Cusk	Haddock	Halibut	Little skate	Longhorn sculpin	Mackerel	Monkfish	Northern sandlance	Ocean pout	Pollock	Red hake	Redfish	Sea raven	Silver hake	Smooth skate	Spiny dogfish	Striped wolffish	Thorny skate	Turbot	Vahl's eelpout	White hake	Winter flounder	Winter skate	Witch flounder	Yellowtail flounder
3	19.2			0		35.2						42.2				0									0				0
8	19.2	27.8	10.2	54.2		26.3			16.6		56.9	39.0			0	58.5		61.3	0		0	0			0		0	8.9	12.2
13	50.4	0	41.7	135.5		66.5		0	271.7		1784.0	43.6	0		1.8	245.5	113.1	253.1	268.5		0	325.3		18.2	0			75.6	89.0
18	118.3	55.6	99.8	258.3		364.6		0	257.9		112.3	62.2	0		290.3	459.3	1494.1	514.6	392.1		51.3	760.9	384.4	36.6	473.5	625.3		143.2	224.4
23	212.4	274.3		630.3		353.4			384.2	409.6	591.4	75.8	21.1	548.3	742.2	483.1	892.1	669.8			178.2	1073.2	606.0	149.7	968.2	516.4	525.7	261.4	287.9
28	340.5	0		869.9		813.0	1486.3		630.3	409.6	855.5	74.0	169.1	1229.4	508.7	504.1	924.8	956.7	510.9	0	355.8	1263.9	671.6	146.7	809.7	183.4	525.7	313.1	464.3
33	318.7	518.9		1292.6		1210.5	743.1	0	767.3	152.8	2273.0		318.0	1453.5	313.5	542.4	2652.1	1441.3	370.1	408.1	249.6	534.0	1165.4	45.8	1168.6	159.6	528.0	450.9	552.3
38	357.4			1934.3		1653.0	0	0	1986.7	666.4	2274.5		257.7	1420.2	1211.3	1312.9	853.8	3966.5	0	491.5	399.1	449.8	892.5	242.6	2414.0	0	281.1	778.0	619.8
43	420.6			2120.2		2153.1	2390.6	0	5038.4		5999.6		768.8	1795.2	0	2002.3	1389.8	3226.1	464.7	1593.1	909.8	348.1	1566.9		3327.4	0	624.3	1233.0	201.8
48	324.7			2961.4		3243.6	0	0			0		0	3383.6	0	2002.3	4205.2	0	1190.3	749.8	1811.2	455.4	1226.6		5653.7		1790.4	1119.3	
53	0			2115.6		4032.7	7811.7	0			2010.9		321.2	4083.1			0		106.8	4587.4	602.0	818.0	1776.2		6936.9		1441.6	1005.6	
58				4224.1	0	3753.0	0	0			1536.0		0	6637.3				0	648.5		0	973.6	1605.3		10328.2		55.9		
63				7286.3	0	8158.4	2603.9				52013.9		0	13276.9						0	582.6	236.8	667.3		6283.6		0		
68				6554.5		2482.6	2603.9													0	3669.1	0	0		0		0		
73				2981.9			0													5519.6		1176.7	2351.5		2094.5		0		
78											0									2592.9							0		
83				9674.6			0													1075.4							0		
88				16367.3			0																				0		
93																					13491.8				0		0		
103																						0							
123							0																						
Mean	198.3	146.1	50.6	3497.7	0	2024.7	1356.9	0	1169.1	409.6	5346.8	56.1	168.7	3758.6	340.9	761.0	1391.7	1108.9	395.2	1547.1	1592.9	561.0	1076.1	106.6	2528.7	247.5	360.8	538.9	272.4

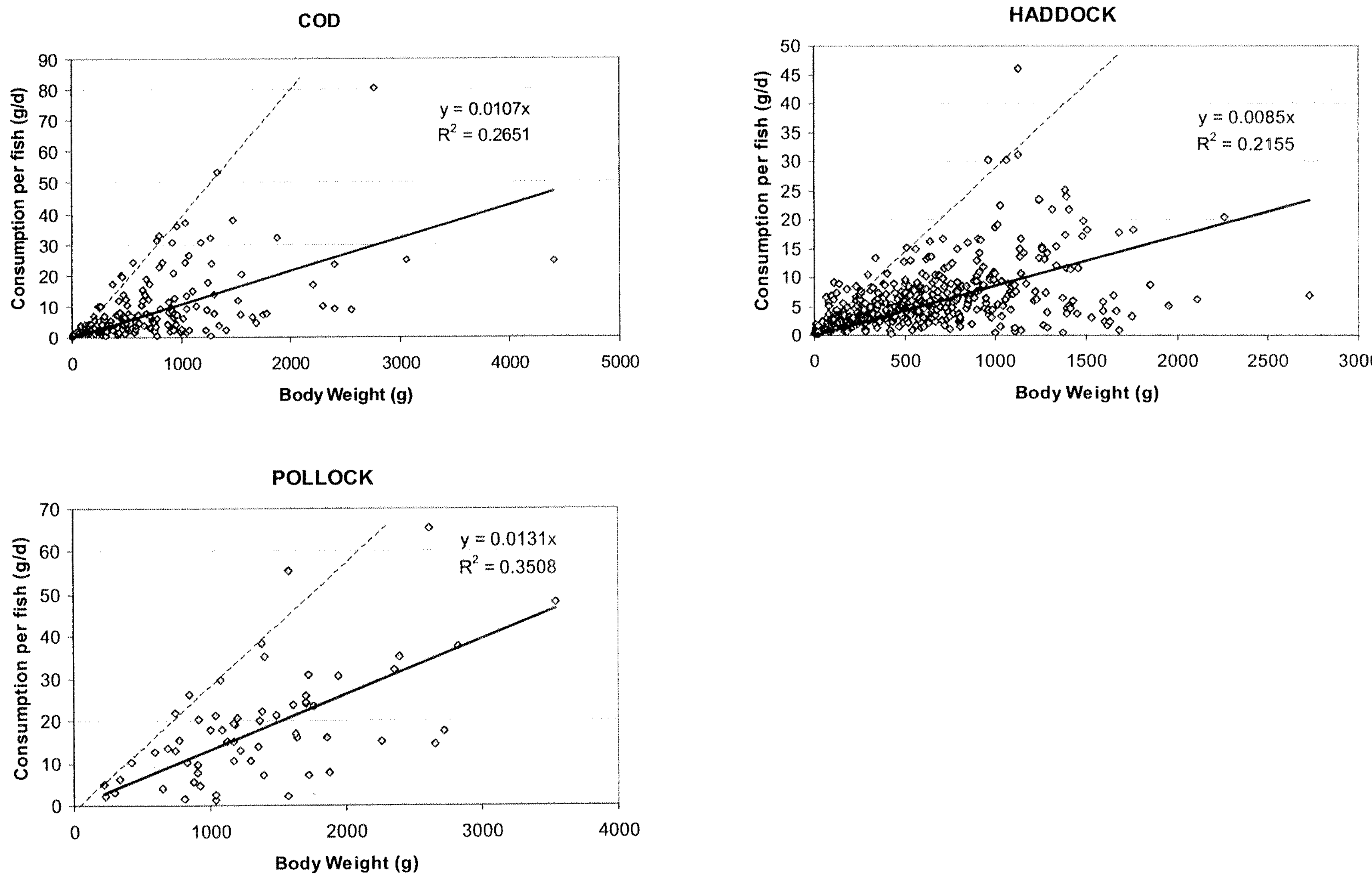


Figure 10. Daily consumption per fish plotted against body weight of cod, haddock, and pollock. The linear regression is shown as a solid line. The dashed line represents approximate maximum consumption by body weight.

Table 31. Average consumption (g/d) of each prey type eaten by each predator species. Values were taken from 1999-2000 pooled consumption results using the gastric evacuation model and were averaged across all fish lengths.

Prey \ Predator	American plaice	Argentine	Capelin	Cod	Haddock	Halibut	Longhorn sculpin	Mackerel	Monkfish	Northern sandlance	Ocean pout	Pollock	Red hake	Redfish	Sea raven	Silver hake	Smooth skate	Spiny dogfish	Striped wolffish	Thorny skate	Turbot	Vahl's eelpout	White hake	Winter flounder	Winter skate	Witch flounder	Yellowtail flounder
Juv. Cod				0.19			0.004		1.298			0.064	0.119			0.898				0.373			0.283				
Juv. Silver Hake				0.622	0.285		0.128		5.101			6.958			0.846	1.112		2.319			0.067		1.435				
Haddock				0.09	0.023				0.306			0.926			0.726	0.026							0.454				
Plaice	0.001			0.059									0.088		0.56			6.133									
Flounders	0.002			0.513	0.187		0.027		1.738			0.004			2.736						0.04		2.324				
Redfish	0.003			0.066	0.129		0.018		1.182	0.025		0.772	0.004	0.052			0.426	0.971		0.016			0.526	0.049		0.003	0.012
Pollock				0.371			0.014		0.037			0.062	0.009		0.348	0.303							0.011				
Lg. Demersals									142.5																		
Sm. Demersals	0.005			0.165	0.01				0.353				0.057	0.041	0.402	0.012	0.027			6E-04							0.003
Capelin				0.09												0.089	0.87			0.137							0.003
Sandlance	0.115	0.272		1.992	0.849		0.627		0.462		0.512	2.01	0.168	0.487	0.719	0.651	1.598	2.395		0.388	0.998		0.684		2.311		0.117
Sm. Pelagics	0.008			11.66			0.009		0.779			2.982			0.098	3.919		2.67			2.035		6.893				
Sm. Mesopelagics					0.021							0.14		1.958													
Squid	0.015			2.243	0.316	11.42	1.423		9.523			1.685		0.102	0.647	0.019		0.415					1.581				
Lg. Crabs				0.077	0.027		0.021												1.028				0.117				
Sm. Crabs	0.171			0.244	0.018		0.193					0.102	0.081		0.087	0.001	0.016		3.666	0.165	0.002	0.087	0.08	0.004		0.001	0.001
Shrimps	0.125	0.197	0.102	1.267	0.039	1.506	0.08	0.886	0.466	0.02	0.488	0.317	0.644	0.748	0.117	0.368	0.193	2.711	0.179	0.111	0.684	0.008	1.278	0.002	0.186	0.005	0.035
Echinoderms	0.032			0.008	0.435		4E-04			0.002	0.003								0.729	0.008	8E-04	0.142	4E-04			0.028	9E-04
Polychaetes	0.136		0.063	0.138	0.556		0.049				0.13	0.013	0.088				0.13		0.079	0.092	0.009	0.106	0.239	0.015	0.656	1.007	0.153
Bivalves	0.034			0.009	0.085		0.014				0.135								0.034	8E-04		0.021	5E-04	0.004		0.008	0.072
Other Benthic Inv.	0.03			0.121	2.15		0.222		0.017	1E-05		0.418	0.174			0.013	0.736	0.15	0.194	0.273			0.197	0.124		0.071	0.066
Lg. Zooplankton	0.088	0.041	0.046	0.474	0.89		1.707	0.451	1.514	0.065	0.059	1.675	0.175	0.306		1.203	0.522	0.028		0.659	0.198	0.017	0.325	0.108	0.067	0.068	0.229
Sm. Zooplankton				0.072										0.049													
Juv. Lg. Demersals	0.005			0.148	0.004		0.244		0.82						2.468						0.23		0.324				
Unid. Invert.	0.002			0.012	0.021		0.032			0.008		1.037	0.474	0.023		0.014	0.344	0.131	0.448	0.533	0.002	0.01	0.029	0.161	0.425	0.007	0.015
Unid. Fish	0.037			0.764	0.048	6.55	0.039	0.056	0.923		0.303	0.337	0.206	0.002	1.209	0.113	0.027	1.364		0.129	0.873		0.808			0.004	0.089
Unid Fish, Inv	0.094	0.375	0.019	0.462	1.45		0.238	0.103	1.189	0.101	0.429	1.483	0.143	0.164	0.203	0.232	0.607	1.975	3.408	0.552	0.358	0.131	0.327	0.778	0.785	0.712	0.345

Table 32. Proportion of each prey type eaten by each predator species. Values were taken from 1999-2000 pooled consumption results using the gastric evacuation model and were averaged across all fish lengths.

Prey \ Predator	American plaice	Argentine	Capelin	Cod	Haddock	Halibut	Longhorn sculpin	Mackerel	Monkfish	Northern sandlance	Ocean pout	Pollock	Red hake	Redfish	Sea raven	Silver hake	Smooth skate	Spiny dogfish	Striped wolffish	Thorny skate	Turbot	Vahl's eelpout	White hake	Winter flounder	Winter skate	Witch flounder	Yellowtail flounder
Juv. Cod	0	0	0	0.009	0	0	0.001	0	0.008	0	0	0.003	0.049	0	0	0.100	0	0	0	0.109	0	0	0.016	0	0	0	0
Juv. Silver Hake	0	0	0	0.028	0.038	0	0.025	0	0.030	0	0	0.332	0	0	0.076	0.124	0	0.109	0	0	0.012	0	0.080	0	0	0	0
Haddock	0	0	0	0.004	0.003	0	0	0	0.002	0	0	0.044	0	0	0.065	0.003	0	0	0	0	0	0	0.025	0	0	0	0
Plaice	0.002	0	0	0.003	0	0	0	0	0	0	0	0	0.036	0	0.050	0	0	0.288	0	0	0	0	0	0	0	0	0
Flounders	0.002	0	0	0.023	0.025	0	0.005	0	0.010	0	0	0.000	0	0	0.245	0	0	0	0	0	0.007	0	0.130	0	0	0	0
Redfish	0.004	0	0	0.003	0.017	0	0.004	0	0.007	0.113	0	0.037	0.002	0.013	0	0	0.077	0.046	0	0.005	0	0	0.029	0.039	0	0.001	0.011
Pollock	0	0	0	0.017	0	0	0.003	0	0.000	0	0	0.003	0.004	0	0.031	0.034	0	0	0	0	0	0	0.001	0	0	0	0
Lg. Demersals	0	0	0	0	0	0	0	0	0.847	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sm. Demersals	0.006	0	0	0.008	0.001	0	0	0	0.002	0	0	0	0.023	0.011	0.036	0.001	0.005	0	0	0.000	0	0	0	0	0	0	0.002
Capelin	0	0	0	0.004	0	0	0	0	0	0	0	0	0	0	0	0.010	0.158	0	0	0.040	0	0	0	0	0	0	0.003
Sandlance	0.127	0.307	0	0.091	0.113	0	0.123	0	0.003	0	0.249	0.096	0.069	0.124	0.064	0.073	0.291	0.113	0	0.113	0.182	0	0.038	0	0.522	0	0.103
Sm. Pelagics	0.009	0	0	0.534	0	0	0.002	0	0.005	0	0	0.142	0	0	0.009	0.437	0	0.126	0	0	0.370	0	0.385	0	0	0	0
Sm. Mesopelagics	0	0	0	0	0.003	0	0	0	0	0	0	0.007	0	0.498	0	0	0	0	0	0	0	0	0	0	0	0	0
Squid	0.017	0	0	0.103	0.042	0.586	0.280	0	0.057	0	0	0.080	0	0.026	0.058	0.002	0	0.020	0	0	0	0	0.088	0	0	0	0
Lg. Crabs	0	0	0	0.004	0.004	0	0.004	0	0	0	0	0	0	0	0	0	0	0	0.105	0	0	0	0.007	0	0	0	0
Sm. Crabs	0.190	0	0	0.011	0.002	0	0.038	0	0	0	0	0.005	0.033	0	0.008	0.000	0.003	0	0.375	0.048	0.000	0.167	0.004	0.003	0	0.001	0.001
Shrimps	0.138	0.222	0.442	0.058	0.005	0.077	0.016	0.592	0.003	0.088	0.237	0.015	0.265	0.190	0.010	0.041	0.035	0.128	0.018	0.032	0.124	0.015	0.071	0.002	0.042	0.003	0.031
Echinoderms	0.035	0	0	0.000	0.058	0	0.000	0	0	0.011	0.002	0	0	0	0	0	0	0	0.075	0.002	0.000	0.272	0.000	0	0	0.015	0.001
Polychaetes	0.150	0	0.273	0.006	0.074	0	0.010	0	0	0	0.063	0.001	0.036	0	0	0	0.024	0	0.008	0.027	0.002	0.203	0.013	0.012	0.148	0.526	0.134
Bivalves	0.037	0	0	0.000	0.011	0	0.003	0	0	0	0.065	0	0	0	0	0	0	0	0.003	0.000	0	0.040	0.000	0.003	0	0.004	0.063
Other Benthic Inv.	0.033	0	0	0.006	0.285	0	0.044	0	0.000	0.000	0	0.020	0.072	0	0	0.001	0.134	0.007	0.020	0.079	0	0	0.011	0.099	0	0.037	0.058
Lg. Zooplankton	0.098	0.047	0.201	0.022	0.118	0	0.336	0.301	0.009	0.295	0.029	0.080	0.072	0.078	0	0.134	0.095	0.001	0	0.192	0.036	0.033	0.018	0.087	0.015	0.035	0.201
Sm. Zooplankton	0	0	0	0.003	0	0	0	0	0	0	0	0	0	0.012	0	0	0	0	0	0	0	0	0	0	0	0	0
Juv. Lg. Demersals	0.005	0	0	0.007	0.000	0	0.048	0	0.005	0	0	0	0	0	0.221	0	0	0	0	0	0.042	0	0.018	0	0	0	0
Unid. Invert.	0.002	0	0	0.001	0.003	0	0.006	0	0	0.034	0	0.049	0.195	0.006	0	0.002	0.063	0.006	0.046	0.155	0.000	0.020	0.002	0.130	0.096	0.004	0.013
Unid. Fish	0.041	0	0	0.035	0.006	0.336	0.008	0.037	0.005	0	0.147	0.016	0.085	0.001	0.108	0.013	0.005	0.064	0	0.038	0.159	0	0.045	0	0	0.002	0.078
Unid Fish, Inv	0.104	0.424	0.084	0.021	0.192	0	0.047	0.069	0.007	0.458	0.208	0.071	0.059	0.042	0.018	0.026	0.110	0.093	0.349	0.161	0.065	0.251	0.018	0.625	0.177	0.372	0.302

Table 33. Cod diet composition estimation from stomach contents (without gastric evacuation model) and consumption estimation from the gastric evacuation model for years 1999 and 2000. All values are average proportions of each prey type for each fish length listed across the top.

YEAR 1999 DIET COMPOSITION - COD

Fish Length	3	8	13	18	23	28	33	38	43	48	53	58	63	68	73
Total Sample Size	1	25	12	4	24	39	55	54	55	40	22	7	6	5	1
None	0														
Juv. Cod								0.003							
Juv. Silver Hake											0.11		0.03	0.06	
Plaice										0.01					
Redfish					0.001			0.001		0.01	0.01				
Pollock							0.15		0.04	0.22					
Sm. Demersals														0.02	
Capelin									0.03						
Sandlance		0.17	0.10			0.05	0.61	0.25	0.57	0.36	0.48		0.36	0.02	0.63
Sm. Pelagics									0.04	0.04					
Squid											0.08			0.19	
Lg. Crabs								0.18			0.001				
Sm. Crabs					0.02	0.06	0.01	0.11	0.04	0.04	0.04	0.16		0.09	
Shrimps		0.25	0.65	0.89	0.86	0.57	0.19	0.13	0.09	0.12	0.23	0.40	0.52	0.46	0.18
Echinoderms								0.001	0.0003		0.0001	0.01			
Polychaetes						0.005	0.004	0.002	0.001		0.03				
Bivalves								0.001	0.01	0.00002	0.002				
Other Benthic Inv.					0.0002	0.001		0.0001	0.003				0.01		
Lg. Zooplankton		0.12	0.04	0.05	0.05	0.06	0.02	0.18	0.01		0.0002				
Juv. Lg. Demersals							0.01								
Unid. Invert				0.04	0.001	0.002	0.0003	0.001		0.001					
Unid. Fish				0.01	0.02	0.15	0.001	0.04	0.13	0.17		0.30	0.05	0.16	
Unid Fish, Inv		0.46	0.21	0.01	0.05	0.11	0.004	0.09	0.03	0.02	0.02	0.14	0.04		0.19

YEAR 2000 DIET COMPOSITION - COD

Fish Length	3	8	13	18	23	28	33	38	43	48	53	58	63	68	73
Total Sample Size	1	5	1	13	30	29	48	61	37	34	21	10	2	2	2
None	0		0												0
Juv. Cod											0.07				
Juv. Silver Hake										0.01		0.002			
Haddock									0.04						
Flounders										0.07					
Redfish							0.01			0.02					
Sm. Demersals					0.04			0.01	0.01			0.01			
Sandlance					0.16	0.05	0.26	0.19	0.25	0.22	0.30	0.61			
Sm. Pelagics								0.22	0.11	0.29		0.30	1		
Sm. Crabs						0.02	0.00	0.05	0.05	0.03	0.08	0.01			
Shrimps				0.24	0.46	0.60	0.42	0.24	0.39	0.10	0.41	0.05		1	
Echinoderms								0.0002			0.0002				
Polychaetes						0.06		0.01							
Bivalves						0.004						0.0004			
Other Benthic Inv.				0.16	0.06		0.002		0.0002						
Lg. Zooplankton				0.30	0.14	0.23	0.20	0.20	0.03	0.09	0.06				
Sm. Zooplankton				0.15											
Juv. Lg. Demersals											0.02	0.01			
Unid. Fish						0.01	0.06	0.02	0.07			0.01			
Unid Fish, Inv		1		0.15	0.13	0.03	0.04	0.05	0.05	0.17	0.06				

YEAR 1999 CONSUMPTION PROPORTIONS - COD

Fish Length	3	8	13	18	23	28	33	38	43	48	53	58	63	68	73
Total Sample Size	1	25	12	4	24	39	55	54	55	40	22	7	6	5	1
None	0														
Juv. Cod								0.003							
Juv. Silver Hake											0.15		0.03	0.15	
Plaice										0.01					
Redfish					0.005			0.002		0.03	0.02				
Pollock							0.20		0.05	0.19					
Sm. Demersals														0.03	
Capelin									0.03						
Sandlance		0.06	0.05			0.04	0.57	0.25	0.60	0.42	0.41		0.31	0.06	0.70
Sm. Pelagics									0.02	0.03					
Squid											0.07			0.27	
Lg. Crabs								0.09			0.0005				
Sm. Crabs					0.02	0.03	0.02	0.08	0.02	0.05	0.03	0.11		0.05	
Shrimps		0.08	0.35	0.65	0.63	0.45	0.14	0.10	0.07	0.10	0.19	0.27	0.43	0.22	0.11
Echinoderms								0.001	0.0003		0.0001	0.01			
Polychaetes						0.01	0.01	0.004	0.005		0.11				
Bivalves								0.0003	0.01	0.0001	0.002				
Other Benthic Inv.					0.002	0.004		0.0003	0.01				0.06		
Lg. Zooplankton		0.32	0.28	0.21	0.17	0.10	0.03	0.32	0.02		0.001				
Juv. Lg. Demersals							0.01								
Unid. Invert				0.07	0.01	0.002	0.001	0.001		0.01					
Unid. Fish				0.03	0.05	0.20	0.001	0.05	0.14	0.15		0.47	0.11	0.22	
Unid. Fish, Inv.		0.54	0.31	0.04	0.10	0.17	0.01	0.10	0.03	0.02	0.01	0.14	0.06		0.19

YEAR 2000 CONSUMPTION PROPORTIONS - COD

Fish Length	3	8	13	18	23	28	33	38	43	48	53	58	63	68	73
Total Sample Size	1	5	1	13	30	29	48	61	37	34	21	10	2	2	2
None	0		0												0
Juv. Cod											0.11				
Juv. Silver Hake										0.02		0.01			
Haddock									0.03						
Flounders										0.13					
Redfish							0.03			0.02					
Sm. Demersals					0.02			0.003	0.02			0.02			
Sandlance					0.16	0.11	0.27	0.28	0.36	0.29	0.28	0.49			
Sm. Pelagics								0.03	0.04	0.15		0.37	1		
Sm. Crabs						0.03	0.001	0.03	0.03	0.02	0.05	0.02			
Shrimps				0.09	0.36	0.33	0.29	0.15	0.25	0.07	0.36	0.04		1	
Echinoderms								0.0004			0.0001				
Polychaetes						0.13		0.05							
Bivalves						0.01						0.001			
Other Benthic Inv.				0.30	0.13		0.01		0.001						
Lg. Zooplankton				0.25	0.21	0.31	0.29	0.32	0.06	0.10	0.12				
Sm. Zooplankton				0.22											
Juv. Lg. Demersals											0.03	0.04			
Unid. Fish						0.02	0.05	0.03	0.08			0.01			
Unid. Fish, Inv.		1		0.14	0.13	0.06	0.07	0.09	0.13	0.20	0.06				

Table 34. Cod diet composition estimation from stomach contents and consumption estimation from the gastric evacuation model for data pooled across 1999-2000. All values are average proportions of each prey type for each fish length.

DIET COMPOSITION

Fish Length	3	8	13	18	23	28	33	38	43	48	53	58	63	68	73	83	88
None	0																
Juv. Cod								0.001			0.04						
Juv. Silver Hake										0.01	0.04	0.002	0.01	0.05			
Haddock									0.02								
Plaice										0.004							
Flounders										0.03							
Redfish					0.001		0.01	0.0003		0.01	0.002						
Pollock							0.03		0.02	0.13							
Sm. Demersals					0.02			0.004	0.01			0.01		0.02			
Capelin									0.01								
Sandlance		0.17	0.10		0.07	0.05	0.33	0.21	0.40	0.30	0.36	0.51	0.09	0.01	0.63	0.07	
Sm. Pelagics								0.16	0.08	0.15		0.25	0.74			0.89	1
Squid											0.03			0.17			
Lg. Crabs								0.05			0.0003						
Sm. Crabs					0.01	0.03	0.004	0.07	0.05	0.04	0.06	0.03		0.07			
Shrimps		0.25	0.65	0.76	0.70	0.59	0.38	0.21	0.25	0.11	0.35	0.10	0.13	0.53	0.18	0.02	
Echinoderms								0.001	0.0002		0.0002	0.001					
Polychaetes						0.05	0.001	0.01	0.0004		0.01						
Bivalves						0.003		0.0001	0.01	0.00001	0.001	0.0004					
Other Benthic Inv.				0.03	0.02	0.0003	0.002	0.00003	0.002				0.003				
Lg. Zooplankton		0.12	0.04	0.10	0.09	0.19	0.17	0.20	0.02	0.04	0.04						
Sm. Zooplankton				0.03													
Juv. Lg. Demersals							0.002				0.02	0.01					
Unid. Invert.				0.03	0.001	0.0004	0.0001	0.0002		0.001							
Unid. Fish				0.01	0.01	0.04	0.05	0.03	0.10	0.09		0.05	0.01	0.14			
Unid Fish, Inv		0.47	0.21	0.04	0.08	0.05	0.03	0.06	0.04	0.09	0.05	0.02	0.01		0.19	0.02	

CONSUMPTION PROPORTIONS

Fish Length	3	8	13	18	23	28	33	38	43	48	53	58	63	68	73	83	88
None	0																
Juv. Cod								0.001			0.06						
Juv. Silver Hake										0.01	0.06	0.01	0.01	0.13			
Haddock									0.02								
Plaice										0.01							
Flounders										0.06							
Redfish					0.002		0.02	0.001		0.02	0.01						
Pollock							0.05		0.02	0.10							
Sm. Demersals					0.01			0.002	0.01			0.02		0.03			
Capelin									0.02								
Sandlance		0.06	0.05		0.11	0.09	0.35	0.27	0.48	0.36	0.33	0.37	0.14	0.05	0.70	0.14	
Sm. Pelagics								0.02	0.03	0.09		0.28	0.57			0.80	1
Squid											0.03			0.24			
Lg. Crabs								0.03			0.0002						
Sm. Crabs					0.01	0.03	0.005	0.05	0.03	0.03	0.04	0.04		0.04			
Shrimps		0.08	0.35	0.39	0.45	0.37	0.25	0.14	0.16	0.08	0.29	0.10	0.19	0.32	0.11	0.02	
Echinoderms								0.001	0.0002		0.0001	0.002					
Polychaetes						0.09	0.002	0.04	0.003		0.04						
Bivalves						0.003		0.0001	0.01	0.00003	0.001	0.0005					
Other Benthic Inv.				0.14	0.09	0.001	0.004	0.0001	0.004				0.03				
Lg. Zooplankton		0.31	0.28	0.23	0.20	0.24	0.22	0.32	0.04	0.05	0.07						
Sm. Zooplankton				0.10													
Juv. Lg. Demersals							0.004				0.02	0.03					
Unid. Invert.				0.04	0.003	0.001	0.0002	0.0003		0.004							
Unid. Fish				0.01	0.02	0.08	0.03	0.04	0.11	0.08		0.13	0.05	0.19			
Unid Fish, Inv		0.55	0.31	0.09	0.12	0.10	0.05	0.09	0.08	0.11	0.04	0.04	0.03		0.19	0.04	

Table 35. Haddock diet composition estimation from stomach contents (without gastric evacuation model) and consumption estimation from the gastric evacuation model for years 1999 and 2000. All values are average proportions of each prey type for each fish length listed across the top.

YEAR 1999 DIET COMPOSITION - HADDOCK

Fish Length	3	8	13	18	23	28	33	38	43	48	53	58	68
Total Sample Size	2	101	72	16	51	54	61	86	96	64	26	10	1
Juv. Silver Hake											0.03		
Flounders											0.001	0.11	
Redfish					0.04	0.21	0.13	0.06	0.08	0.07	0.01		
Sandlance						0.00		0.28	0.06	0.09	0.04	0.12	
Sm. Mesopelagics										0.01			
Squid									0.05	0.02	0.56		
Lg. Crabs									0.03		0.02		
Sm. Crabs						0.003	0.01	0.003	0.002	0.02	0.001		
Shrimps		0.42	0.22	0.34	0.03	0.03	0.01	0.05	0.02	0.01	0.02	0.02	
Echinoderms			0.00		0.01	0.02	0.01	0.01	0.04	0.05	0.04	0.02	0.67
Polychaetes		0.01	0.001	0.24	0.003	0.002	0.05	0.05	0.05	0.15	0.16	0.003	
Bivalves			0.03	0.04	0.005	0.003	0.005	0.002	0.004	0.002	0.002	0.19	
Other Benthic Inv.					0.01	0.00	0.02	0.00	0.02	0.03	0.03	0.01	
Lg. Zooplankton		0.11	0.65	0.004	0.04	0.02	0.04	0.00	0.05	0.12	0.01	0.01	
Unid. Invert.		0.03	0.02	0.06	0.002	0.001	0.004	0.02	0.02		0.01		
Unid. Fish			0.01					0.000	0.03	0.001	0.02		
Unid Fish, Inv	1	0.43	0.07	0.31	0.87	0.71	0.72	0.53	0.55	0.45	0.05	0.52	0.33

YEAR 2000 DIET COMPOSITION - HADDOCK

Fish Length	3	8	13	18	23	28	33	38	43	48	53	58	63
Total Sample Size	1	63	38	86	141	118	158	141	118	69	18	5	3
None	0												
Haddock									0.01	0.01			
Redfish							0.00		0.01				
Sm. Demersals				0.08						0.0001			
Sandlance						0.12	0.04	0.13	0.10	0.06	0.17	0.63	
Squid								0.01					
Sm. Crabs							0.02	0.001	0.03	0.003	0.0001		
Shrimps		0.04	0.001		0.004	0.03	0.01	0.03	0.03	0.03	0.01		
Echinoderms				0.004	0.02	0.04	0.06	0.03	0.09	0.11	0.05	0.002	
Polychaetes		0.34		0.27	0.06	0.05	0.02	0.03	0.02	0.02	0.00		
Bivalves			0.05		0.001	0.01	0.004	0.002	0.01	0.004	0.01		0.02
Other Benthic Inv.		0.16	0.95	0.09	0.07	0.05	0.02	0.05	0.03	0.04	0.01	0.35	0.94
Lg. Zooplankton		0.01	0.002	0.08	0.01	0.51	0.57	0.46	0.41	0.47	0.66		
Juv. Lg. Demersals									0.0003				
Unid. Fish						0.03		0.00	0.02	0.01			
Unid Fish, Inv		0.44	0.002	0.48	0.83	0.16	0.26	0.25	0.25	0.25	0.09	0.01	0.04

YEAR 1999 CONSUMPTION PROPORTIONS - HADDOCK

Fish Length	3	8	13	18	23	28	33	38	43	48	53	58	68
Total Sample Size	2	101	72	16	51	54	61	86	96	64	26	10	1
Juv. Silver Hake											0.05		
Flounders											0.01	0.09	
Redfish					0.04	0.18	0.12	0.07	0.09	0.05	0.01		
Sandlance						0.001		0.11	0.03	0.05	0.05	0.04	
Sm. Mesopelagics										0.004			
Squid									0.01	0.01	0.20		
Lg. Crabs									0.01		0.01		
Sm. Crabs						0.001	0.002	0.002	0.001	0.01	0.0004		
Shrimps		0.33	0.06	0.07	0.03	0.02	0.01	0.03	0.01	0.01	0.01	0.005	
Echinoderms			0.001		0.005	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.56
Polychaetes		0.03	0.002	0.60	0.01	0.01	0.10	0.12	0.10	0.21	0.46	0.003	
Bivalves			0.07	0.03	0.01	0.002	0.004	0.003	0.004	0.002	0.002	0.05	
Other Benthic Inv.					0.02	0.001	0.03	0.001	0.05	0.07	0.04	0.01	
Lg. Zooplankton		0.23	0.76	0.004	0.07	0.03	0.06	0.02	0.07	0.14	0.03	0.005	
Unid. Invert.		0.05	0.02	0.04	0.003	0.002	0.01	0.04	0.02		0.01		
Unid. Fish			0.003					0.0003	0.02	0.001	0.01		
Unid. Fish, Inv.	1	0.36	0.08	0.26	0.81	0.75	0.66	0.60	0.57	0.43	0.10	0.78	0.44

YEAR 2000 CONSUMPTION PROPORTIONS - HADDOCK

Fish Length	3	8	13	18	23	28	33	38	43	48	53	58	63
Total Sample Size	1	63	38	86	141	118	158	141	118	69	18	5	3
None	0												
Haddock									0.01	0.01			
Redfish							0.001		0.004				
Sm. Demersals				0.03						0.00003			
Sandlance						0.11	0.04	0.13	0.11	0.11	0.05	0.49	
Squid								0.01					
Sm. Crabs							0.01	0.001	0.01	0.002	0.0001		
Shrimps		0.02	0.001		0.003	0.01	0.005	0.01	0.01	0.01	0.01		
Echinoderms				0.001	0.01	0.02	0.03	0.02	0.04	0.05	0.03	0.001	
Polychaetes		0.66		0.46	0.15	0.18	0.11	0.07	0.07	0.06	0.003		
Bivalves			0.02		0.002	0.02	0.01	0.002	0.004	0.01	0.004		0.03
Other Benthic Inv.		0.13	0.97	0.06	0.11	0.12	0.05	0.08	0.09	0.09	0.02	0.49	0.90
Lg. Zooplankton		0.01	0.01	0.06	0.004	0.33	0.46	0.40	0.32	0.32	0.66		
Juv. Lg. Demersals									0.001				
Unid. Fish						0.02		0.0002	0.02	0.01			
Unid. Fish, Inv.		0.17	0.01	0.39	0.72	0.19	0.29	0.27	0.31	0.32	0.22	0.01	0.07

Table 36. Haddock diet composition estimation from stomach contents and consumption estimation from the gastric evacuation model for data pooled across 1999-2000. All values are average proportions of each prey type for each fish length.

DIET COMPOSITION - HADDOCK

Fish Length	3	8	13	18	23	28	33	38	43	48	53	58	63	68
Juv. Silver Hake											0.015			
Haddock									0.01	0.004				
Flounders											0.0004	0.01		
Redfish					0.01	0.05	0.04	0.02	0.04	0.03	0.003			
Sm. Demersals				0.07						4.E-05				
Sandlance						0.09	0.03	0.19	0.09	0.07	0.11	0.57		
Sm. Mesopelagics										0.003				
Squid								0.01	0.02	0.01	0.25			
Lg. Crabs									0.01		0.01			
Sm. Crabs						0.001	0.01	0.002	0.02	0.01	0.001			
Shrimps		0.35	0.04	0.05	0.01	0.03	0.01	0.04	0.02	0.02	0.01	0.002		
Echinoderms			0.0004	0.003	0.02	0.03	0.04	0.02	0.07	0.08	0.05	0.004		0.67
Polychaetes		0.07	0.0001	0.27	0.04	0.04	0.03	0.04	0.03	0.08	0.07	0.0003		
Bivalves			0.05	0.01	0.002	0.01	0.004	0.002	0.01	0.003	0.01	0.02	0.02	
Other Benthic Inv.		0.03	0.79	0.07	0.05	0.04	0.02	0.03	0.03	0.03	0.02	0.31	0.94	
Lg. Zooplankton		0.10	0.11	0.07	0.02	0.39	0.44	0.27	0.26	0.31	0.37	0.001		
Juv. Lg. Demersals									0.0002					
Unid. Invert.		0.02	0.003	0.01	0.001	0.0002	0.001	0.01	0.01		0.004			
Unid. Fish			0.001			0.03		0.0002	0.02	0.01	0.01			
Unid Fish, Inv	1	0.43	0.01	0.46	0.85	0.29	0.38	0.37	0.37	0.34	0.07	0.07	0.04	0.33

CONSUMPTION PROPORTIONS - HADDOCK

Fish Length	3	8	13	18	23	28	33	38	43	48	53	58	63	68
Juv. Silver Hake											0.03			
Haddock									0.004	0.003				
Flounders											0.003	0.03		
Redfish					0.02	0.05	0.04	0.03	0.04	0.03	0.003			
Sm. Demersals				0.02						1.E-05				
Sandlance						0.08	0.03	0.12	0.07	0.08	0.05	0.33		
Sm. Mesopelagics										0.002				
Squid								0.003	0.005	0.004	0.11			
Lg. Crabs									0.004		0.003			
Sm. Crabs						0.0003	0.01	0.001	0.01	0.005	0.0002			
Shrimps		0.25	0.03	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.002		
Echinoderms			0.001	0.001	0.01	0.02	0.02	0.01	0.03	0.03	0.03	0.003		0.56
Polychaetes		0.19	0.00	0.50	0.10	0.14	0.10	0.09	0.09	0.14	0.24	0.001		
Bivalves			0.04	0.01	0.003	0.01	0.005	0.003	0.004	0.004	0.003	0.02	0.03	
Other Benthic Inv.		0.03	0.56	0.05	0.08	0.09	0.05	0.05	0.07	0.08	0.03	0.33	0.90	
Lg. Zooplankton		0.18	0.33	0.05	0.03	0.25	0.33	0.25	0.20	0.23	0.33	0.002		
Juv. Lg. Demersals									0.001					
Unid. Invert.		0.03	0.01	0.01	0.001	0.0004	0.002	0.02	0.01		0.003			
Unid. Fish			0.001			0.02		0.0002	0.02	0.01	0.005			
Unid Fish, Inv	1	0.31	0.03	0.36	0.76	0.33	0.41	0.40	0.43	0.38	0.16	0.28	0.07	0.44

Table 37. Pollock diet composition estimation from stomach contents (without gastric evacuation model) and consumption estimation from the gastric evacuation model for years 1999 and 2000. All values are average proportions of each prey type for each fish length listed across the top.

YEAR 1999 DIET COMPOSITION - POLLOCK

Fish Length	28	33	38	43	48	53	58	63
Total Sample Size	4	6	6	13	20	15	9	2
Juv. Silver Hake	0.84						0.09	0.50
Redfish				0.08	0.25	0.08	0.03	
Pollock		0.08						
Flounders						0.0003		
Sandlance			0.68		0.15			0.50
Sm. Pelagics						0.18	0.64	
Sm. Mesopelagics				0.01	0.01			
Squid						0.13	0.16	
Sm. Crabs			0.04					
Shrimps	0.10	0.91	0.19	0.37	0.004	0.04		
Polychaetes				0.0001			4.E-05	
Other Benthic Inv.			0.002					
Lg. Zooplankton	0.06	0.01	0.08	0.37	0.18	0.36	0.001	
Unid. Invert.					0.21	0.09	0.02	
Unid. Fish				0.16	0.04	0.02	0.0001	
Unid Fish, Inv				0.01	0.15	0.11	0.05	

YEAR 2000 DIET COMPOSITION - POLLOCK

Fish Length	23	28	33	38	43	48	53	58	63
Total Sample Size	2	13	27	9	8	10	13	8	4
Juv. Cod						0.01			
Juv. Silver Hake							0.31		0.45
Haddock			0.05			0.82	0.56	0.04	
Redfish			0.03						0.03
Sandlance		0.26	0.29	0.13	0.13	0.06		0.26	
Sm. Mesopelagics									0.22
Shrimps			0.11		0.86	0.11	0.01	0.003	0.03
Other Benthic Inv.		0.17							
Lg. Zooplankton		0.13	0.30	0.42					
Unid. Fish		0.06	0.10				0.04	0.04	0.27
Unid Fish, Inv	1	0.38	0.11	0.45	0.02		0.08	0.66	

YEAR 1999 CONSUMPTION PROPORTIONS - POLLOCK

Fish Length	28	33	38	43	48	53	58	63
Total Sample Size	4	6	6	13	20	15	9	2
Juv. Silver Hake	0.75						0.17	0.70
Redfish				0.11	0.28	0.10	0.09	
Pollock		0.28						
Flounders						0.0004		
Sandlance			0.48		0.05			0.30
Sm. Pelagics						0.08	0.38	
Sm. Mesopelagics				0.003	0.01			
Squid						0.08	0.19	
Sm. Crabs			0.05					
Shrimps	0.09	0.68	0.11	0.15	0.002	0.03		
Polychaetes				0.0002			0.002	
Other Benthic Inv.			0.01					
Lg. Zooplankton	0.16	0.04	0.36	0.61	0.23	0.43	0.01	
Unid. Invert.					0.21	0.11	0.05	
Unid. Fish				0.09	0.03	0.02	0.0002	
Unid. Fish, Inv.				0.04	0.19	0.15	0.12	

YEAR 2000 CONSUMPTION PROPORTIONS - POLLOCK

Fish Length	23	28	33	38	43	48	53	58	63
Total Sample Size	2	13	27	9	8	10	13	8	4
Juv. Cod						0.03			
Juv. Silver Hake							0.15		0.43
Haddock			0.03			0.85	0.58	0.11	
Redfish			0.04						0.02
Sandlance		0.11	0.23	0.06	0.09	0.08		0.18	
Sm. Mesopelagics									0.20
Shrimps			0.13		0.79	0.05	0.002	0.004	0.02
Other Benthic Inv.		0.25							
Lg. Zooplankton		0.18	0.31	0.54					
Unid. Fish		0.10	0.08				0.02	0.08	0.33
Unid. Fish, Inv.	1	0.36	0.18	0.41	0.11		0.25	0.63	

Table 38. Pollock diet composition estimation from stomach contents and consumption estimation from the gastric evacuation model for data pooled across 1999-2000. All values are average proportions of each prey type for each fish length.

DIET COMPOSITION - POLLOCK

Fish Length	23	28	33	38	43	48	53	58	63
Juv. Cod						0.01			
Juv. Silver Hake		0.02					0.06	0.08	0.50
Haddock			0.04			0.33	0.11	0.01	
Flounders							0.0002		
Redfish			0.03		0.06	0.15	0.06	0.03	0.0004
Pollock			0.01						
Sandlance		0.25	0.27	0.54	0.03	0.11		0.04	0.49
Sm. Pelagics							0.14	0.54	
Sm. Mesopelagics					0.01	0.004			0.003
Squid							0.10	0.13	
Sm. Crabs				0.03					
Shrimps		0.003	0.18	0.15	0.49	0.05	0.03	0.001	0.001
Polychaetes					0.0001			3.E-05	
Other Benthic Inv.		0.16		0.001					
Lg. Zooplankton		0.13	0.27	0.17	0.28	0.11	0.29	0.001	
Unid. Invert.						0.12	0.07	0.02	
Unid. Fish		0.06	0.10		0.12	0.03	0.02	0.01	0.004
Unid Fish, Inv	1	0.37	0.10	0.11	0.01	0.09	0.11	0.15	

CONSUMPTION PROPORTIONS - POLLOCK

Fish Length	23	28	33	38	43	48	53	58	63
Juv. Cod						0.01			
Juv. Silver Hake		0.03					0.02	0.13	0.69
Haddock			0.03			0.23	0.08	0.03	
Flounders							0.0003		
Redfish			0.04		0.10	0.20	0.08	0.06	0.001
Pollock			0.02						
Sandlance		0.11	0.22	0.30	0.01	0.06		0.04	0.28
Sm. Pelagics							0.07	0.28	
Sm. Mesopelagics					0.002	0.01			0.01
Squid							0.07	0.14	
Sm. Crabs				0.03					
Shrimps		0.004	0.16	0.07	0.24	0.01	0.03	0.001	0.001
Polychaetes					0.0002			0.001	
Other Benthic Inv.		0.24		0.01					
Lg. Zooplankton		0.18	0.30	0.43	0.53	0.17	0.36	0.005	
Unid. Invert.						0.15	0.09	0.04	
Unid. Fish		0.10	0.08		0.08	0.02	0.02	0.02	0.01
Unid Fish, Inv	1	0.35	0.17	0.17	0.05	0.14	0.16	0.25	

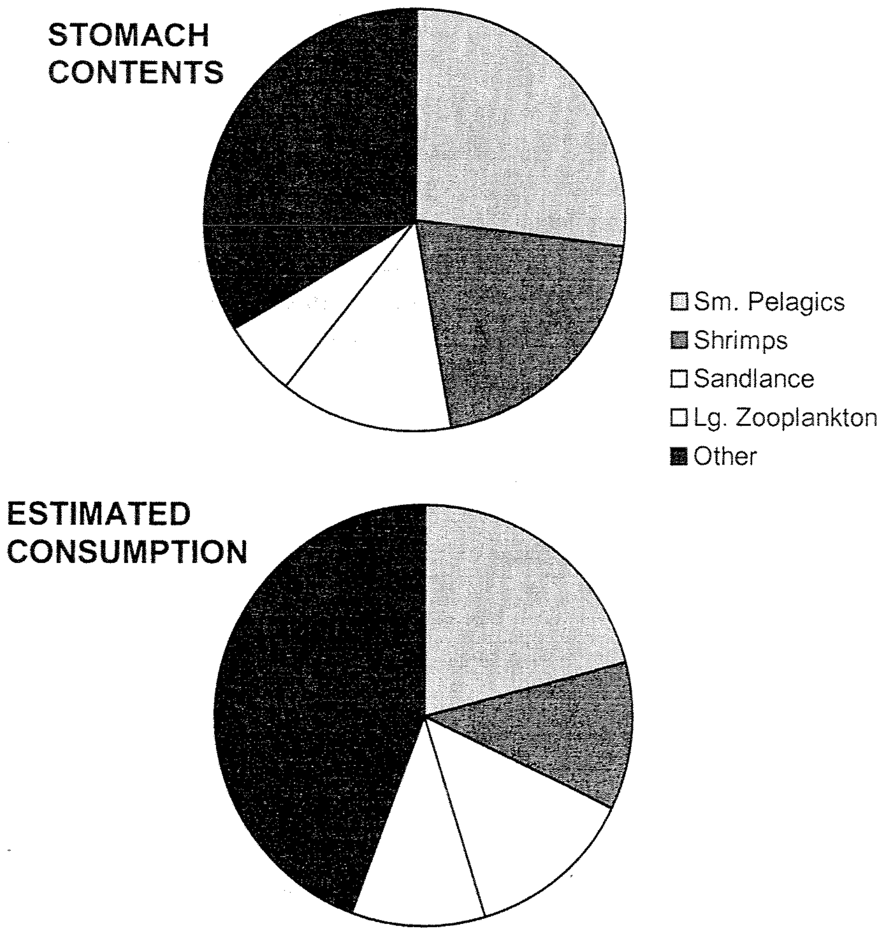


Figure 11. Proportions of each prey type found in cod stomachs and proportions consumed estimated with the gastric evacuation model from 1999-2000 pooled results.

CONCLUSION

The compilation of data from various stomach collection programs resulted in creating a sizeable source for present and future research. Although data is lacking from the 1980s, hopefully new data will be added to facilitate study of longer time series' of data. The reformatting of various types of data is a time consuming process and unfortunately some information was lost or missing along the way. Requests should be made to stomach data collectors to gather all the useful information even if it is not required for the collector's own research. Care should also be taken in the data collection and logging process to reduce errors as much as possible. The data in this database should not be assumed to be fully accurate. The data has been checked for errors, but some problems may have been missed. This document should provide enough information for future managers and users of the stomach database.

4 ACKNOWLEDGEMENTS

The authors wish to acknowledge the financial support of the Comparative Dynamics of Exploited Ecosystems in the Northwest Atlantic (CDEENA) project the BIO Data Rescue "Hudson Fund". In addition, the support and assistance provided by the many data custodians named in this document and other DFO staff was invaluable in bringing together the abundance of stomach data and information that already existed. In particular, we would like to thank Pierre Brien and Bob Branton for setting up the database and Virtual Data Centre applications. Recovery of pre-1970's data was accomplished with the assistance of Kees Zwanenburg, Carl MacDonald, and Shelley Bond.

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APPENDIX I: STOMACH SAMPLING REQUEST

Stomach Sampling Request for the July Groundfish Survey, July 2000

As part of the focus on ecosystem models this year we are requesting that stomach samples be collected on a length-stratified basis for the following list of species. If sampling cannot be completed on every station due to time constraints it is desired that samples include a good geographic coverage and good predator size coverage, including juveniles, if caught.

Top Priority		Less Priority	
species code	common name	species code	common name
10	Cod (Atlantic)	13	Red Hake
11	Haddock	14	Silver Hake
12	White Hake	15	Cusk
16	Pollock	30	Halibut (Atlantic)
23	Redfish	31	Greenland Halibut
40	American Plaice	41	Witch Flounder
60	Herring (Atlantic)	42	Yellowtail Flounder
201	Thorny Skate	43	Winter Flounder
204	Winter Skate	50	Striped Atlantic Wolffish
220	Spiny Dogfish	51	Spotted wolffish
300	Longhorn Sculpin	52	Northern wolffish
320	Sea Raven	64	Capelin
610	Sandlance	70	Mackerel (Atlantic)
647	Vahls Eelpout	160	Argentine
		202	Smooth skate
		400	Monkfish
		501	Lumpfish
		640	Ocean pout

Individual Fish Data: Prior to the stomach's removal from the fish, the bag label should be completed including:

Cruise number
Set number
MFD research code (e.g. '10' for cod)
Fish number

Information should be clearly written in permanent ink on the bag or in pencil on a piece of waterproof paper placed in the bag.

Stomach Fullness Index: As part of the detailed sampling requirements for the selected species, a stomach sample will be required as follows:

For each required sample, determine the stomach fullness index using the following scale. It is realised that there is a degree of judgement required to assessing the fullness.

0 - empty - no food contents
1 – less than ¼ full
2 – ¼ to ½ full } based on visual assessment of contents
3 – ½ to ¾ full } with respect to estimated capacity

4 – ¾ full to full }
5 – everted - stomach displaced into oesophagus and/or mouth
6 – regurgitated - stomach flabby and thin, may have food remains in mouth

Stomach excision: For stomachs with contents, index 1-4, push any contents from the oesophagus back into the stomach. Then make a cut at the posterior end of the stomach at the pyloric caeca. Cut the oesophagus as far forward as possible. Place the stomach and contents in a pre-labelled Whirl-Pak bag or 8-lb poly bag. Carefully slit the stomach wall once the stomach has been placed in the bag. This will allow the brine into the stomach stopping digestion. Add brine* to the bag to cover the contents and seal it. Place bags in totes in the freezer.

Data recording: To generate a fish number for species where no otolith is taken, the code '2' will be entered into the age material field. When otoliths and the stomach are both taken the code '1', which is usually used in the age material field, will be used. The stomach fullness code will be entered in the Remarks field, preceded by an 'S' for stomach (e.g. a full stomach would have 'S4' as a remark).

* Concentrated brine is made by adding 2 double handfuls of salt to a 10-litre bucket of seawater. After stirring well, there should still be some salt on the bottom. Concentrated brine should not freeze solid. When in doubt, add more salt.

APPENDIX II: DATA SHEET

STOMACH ANALYSIS DATA SHEET

Trip: ____________ Set #: ____________ Species: ____________

Date Caught: ____________ Date Analyzed: ____________ Fullness: 0 1 2 3 4 5 6

Fish #: ____________ Analyzed By: ____________ Fish Length : ____________

Stomach Total Wt.: ____________ Empty Stomach Wt: ____________ Fish weight (g): ____________

Technician: ____________ Vessel name: ____________

Item	Species	Length	Weight	Number	Item condition	Remarks

Fullness codes: 0=empty, 1=25%, 2=50%, 3=75%, 4=100%, 5=everted, 6=regurgitated
Item condition: 1=great condition, 2= good condition, 3= very digested, 4=unidentifiable

APPENDIX III: SAMPLE PROCESSING PROTOCOLS

Stomach Analysis

Working in pairs makes the analysis of the stomach contents more organised and can facilitate species identification.

Technician1:

- the label data from the bag containing the thawed predator stomach and contents is recorded on the data sheet
- the stomach contents are removed by emptying the bag onto a fine mesh strainer and the bag is gently rinsed to ensure no loss of contents
- the contents are emptied onto a small plastic tray along with the empty stomach
- the contents and emptied stomach are weighed and the weight recorded on the data sheet (to 0.01g.)
- the empty stomach is weighed separately and the weight recorded on the data sheet. The empty stomach is then placed back into its bag and set aside
- the tray and the stomach contents are passed onto the second technician

Technician 2:

- each item on the tray is identified, if possible, and the weight and length of the item are recorded on the data sheet, as well as the quantity of the item
- otoliths are used as further identification of fish species when the scales, skin and flesh is too digested for a positive ID
- keys are used for consultation as well as the help of the other technician

If there is uncertainty about the species or items are too digested, a detailed description of what is seen should be recorded in the 'Remarks' section of the data sheet. Species codes should be used when listing species in the general and detailed category for easier accessibility in the database.

N.B.: appropriate safety procedures must be strictly followed for samples preserved in formaldehyde.
Technicians must wear gloves and goggles at all times. To process the sample, it is first removed from the formaldehyde and rinsed for several minutes over a screen. The waste formaldehyde is collected and stored in a container for later disposal. The sorting, as outlined above, is then performed under a fume hood. After processing is complete, the stomach and its contents are stored for proper disposal.

Identification level

The following is a list of common prey 'items' found in fish stomachs form the Scotia-Fundy region and the taxonomic level to which they are normally classified.

PREYITEM
Anthozoa - class
Cnidaria - class
Crustacean - species for commercially important or abundant specimens, order otherwise
Crustacean Eggs - order
Ctenophore - phylum
Decapoda larvae - order
Echinoderm - class
Fish - species
Fish eggs - species
Invertebrate eggs - phylum
Mollusc - species for the commercially important or abundant species, class otherwise
Mollusc Eggs - class
Nematode - class
Polychaete larvae - class
Protochordata sp - class
Platyhelminthes - phylum
Polychaete- family
Porifera - phylum
Pycnogonida - class
Seaweed - phylum
Urochordata - class

Identification Keys

The keys commonly used by the FSRS technicians in identifying prey items include:

- Keys to Marine Invertebrates of the Woods Hole Region
- Keys to the Fauna and Flora of the Minas Basin
- Peterson's Field Guide
- Scott and Scott

Special Cases

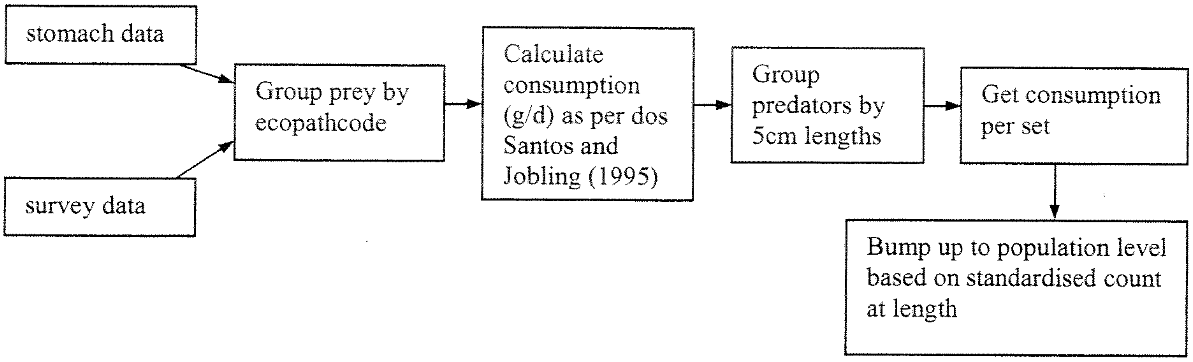
The following prey items are exceptions to the naming practices outlined above:

- *Indigestible remains*: Remains (*e.g.* mollusc remains or fish remains) is used as the species name for indigestible parts such as shells, squid beaks, otoliths, and other hard materials.
- *Eggs and larvae*: Eggs and larvae should be identified as such in the item and species fields rather than simply identifying them by species, *e.g.* Fish eggs, Skate Purse instead of Fish, Skate.
- *Bait*: Bait should be identified as bait in the item field and type of bait in the species field, *e.g.* Bait, Bait Mackerel.
- *Garbage*: Anthropogenic garbage should be identified simply as inorganic debris. Any details can be added in the remarks column.

- *Unidentified materials*: Terms such as unidentified or organic debris should be avoided. Rather, be specific such as unidentified fish or unidentified invertebrates. Details should be added to the remarks column whenever possible.
- *Shrimp like*: This term is confusing and should be avoided. Enter as shrimp or krill if not easily recognisable as Pandalus sp.
- *Shrimp*: Often used when the item is very digested and is identifiable only as a shrimp species, which could include pandalids.

APPENDIX IV: CONSUMPTION SQL PROCEDURE

The individual stomach data were used to calculate population level consumption estimates using various SQL scripts. The general process is:



The following text describes and details the SQL code and Oracle table creation process that culminates with a final table of consumption results (average population level rations per length class) called 'FINAL_avgrtn'. The steps are numerous and fairly complex. The subsequent flowcharts connect the codes, tables and datasets to assist in visualization of the process.

A) empty_stoms.sql and s5_stoms.sql – to pull out empty and everted (S5) stomachs from both GS and SD databases since most of these were not actually collected (*NB*: some empties were collected). Also, empties must be included in consumption calculations.

B) consumption gs ML.sql – to get consumption at set level using gastric evacuation model

Creates tables:

1. gssto_work
2. gscross
3. gsconsum_calc
4. gsconsumraw

5. non5fsh_gsconsum
6. allfsh_gsconsum
7. incl_empty_gsconsumraw

1. GSSTO_WORK with mission, setno, strat, year, seas, region, bottom_temperature, spec, fshno, fwt, flen, preyspec, preyspeccd, pwt, pnum, plen from groundfish.sdview1 and groundfish.gsinf where fullness is 1,2,3 or 4, datasource is GS, fish length is not null and stratum not 494 or 495 (upper Bay of Fundy). Add columns ecopred, ecoprey from the ecopathcode table. Also add temperature from gstemperature which was created from groundfish.gshyd.

2. GSCROSS with mission, setno, strat, region, year, seas, bottom_temperature, spec, ecopred, fshno, flen, fwt and p4, p5 etc. This has one row entry for each stomach collected. Each p4, p5 etc. column has the sum of the species prey weights that correspond to each of these ecopathcode prey categories. Add column "total" for weight of material in stomach and "total_id" for material of only identified origin (not p100, p200, p300).

3. GSCONSUM_CALC with mission, setno, strat, region, year, seas, temp, spec, ecopred, fshno, flen, flen_code (5*ceil(flen/5)-2, 5cm length groups), fwt, cod, j_cod etc. The columns cod, j_cod etc. have consumption (g/day) calculated with equation from dos Santos and Jobling (1995). Get a row entry for each stomach. Only calculated when bottom temperature is not null. (Lei Harris had calculated only where not all stomach contents are unidentified, but this has been changed).
4. GSCONSUMRAW with mission, year, region, strat, setno, seas, spec, sample, flen_code, avg_flen, avgcod, avgj_cod, etc. This averages consumption for each predator species and fish length within a set –calculate consumption on a set by set basis regardless of how many fish sampled, thus each set waited equally. Only for NON-EMPTY stomachs.
5. NON5FSH_GSCONSUM. Adds empty stomachs from table empty_stoms (created in code empty_stoms.sql from GS and stomach databases) to gsconsum_calc.
6. ALLFSH_GSCONSUM. Adds everted (S5) stomachs from table s5_stoms (created in code s5_stoms.sql from GS and stomach databases) to gsconsum_calc. Contents for everted stomachs were averaged from contents of stomachs from the same species and fish length collected in the same NAFO division, season and year.
7. INCL_EMPTY_GSCONSUMRAW. Same as gsconsumraw but with empty and everted stomachs included.

Now use code avgr0_ML.sql and incl_empty_gsconsumraw to create table AVGR0 that has the columns of prey consumption expanded into rows. Include all zeros to properly calculate average consumption.

The AVGR0 table is used in weighted by number*.sql to calculate population level consumption.

C) weighted by number seqtl_0_ML.sql – to get population level rations

Creates views or tables:

1. avg_prey_ration – The average prey rations for each predator species length class by series, year and stratum. First create avg_prey_ration0 with all zero values included from the AVGR0 table. Average ration for each prey type is calculated based on a single average ration value (in the AVGR0 table) calculated for each set. Therefore not a weighted average based on how many fish caught per set.
2. avg_no_pred – The average number of predator species at length (standardised count at 5 cm length classes from NWAGS.gsd5lf_mv) by series, year and stratum for a selected area or unit and year range.
3. tot_no_pred_rtn – The total number of predators at length and the total ration of prey by series, year and stratum. The standardised count at length is summed across sets for each prey type. This only gives the total number of fish eating that prey type.
4. tot_unit_avgrtn – The total rations for the area or unit. Stratum totals are calculated by multiplying the total ration per net tow with the number of tows needed to cover the stratum

(ration / no. tows * area / tow length * trawl width). Strata totals are summed to cover the whole area or unit. [Note: tow length=1.75nm, trawl width=41ft, 1nm=6080.2ft]

D) consump count at length.sql – To get total standardised population count at length.

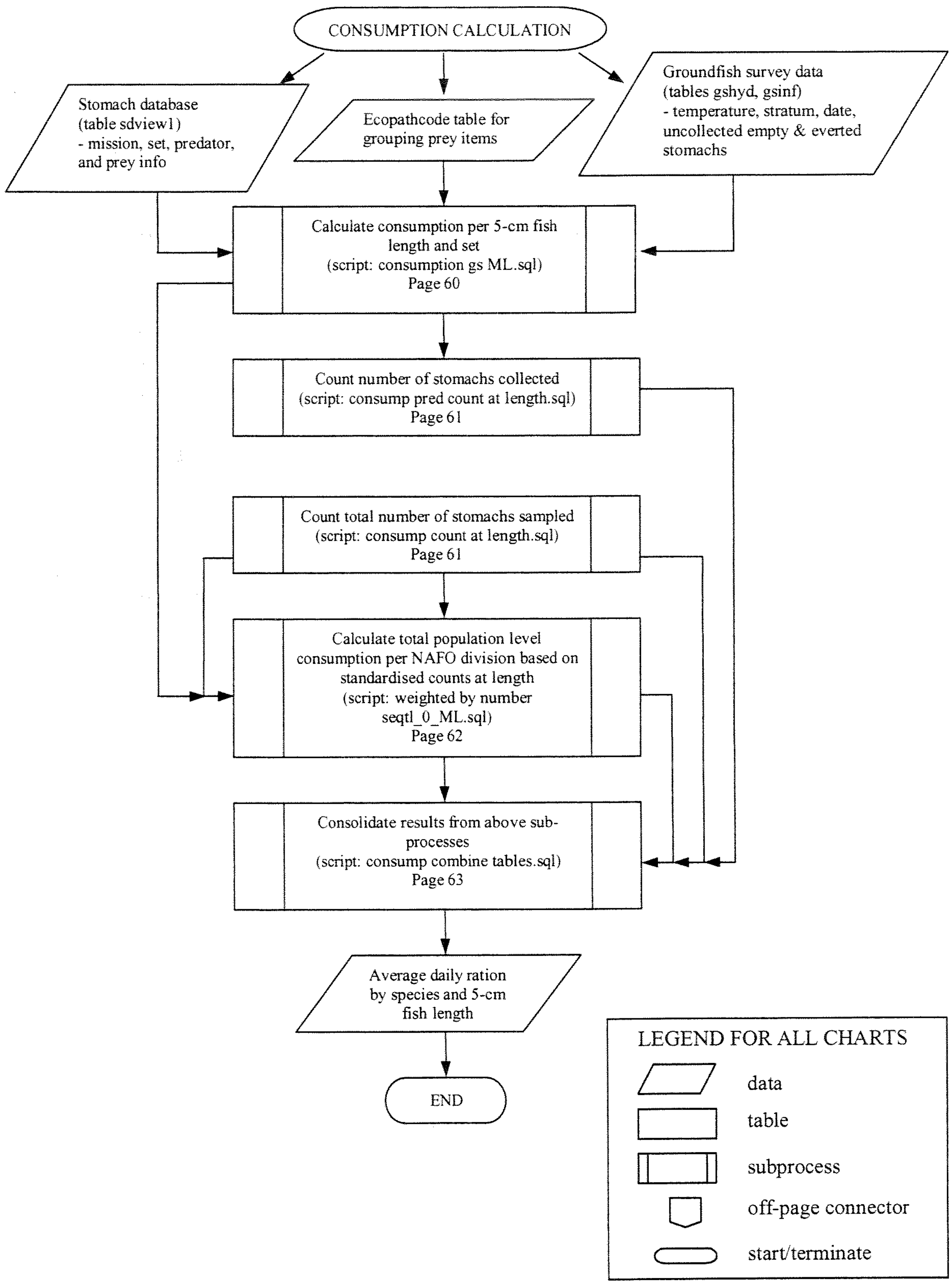
1. totnopredatlgth – Calculate standardised total number of fish at length (totnofl) within each stratum and then sum these up to cover the whole area or unit. These numbers are used to calculate average ration per fish using the total rations in table tot_unit_avgrtn above.

E) consump pred count at length.sql – To determine the actual number of stomachs collected per set as table nopred.

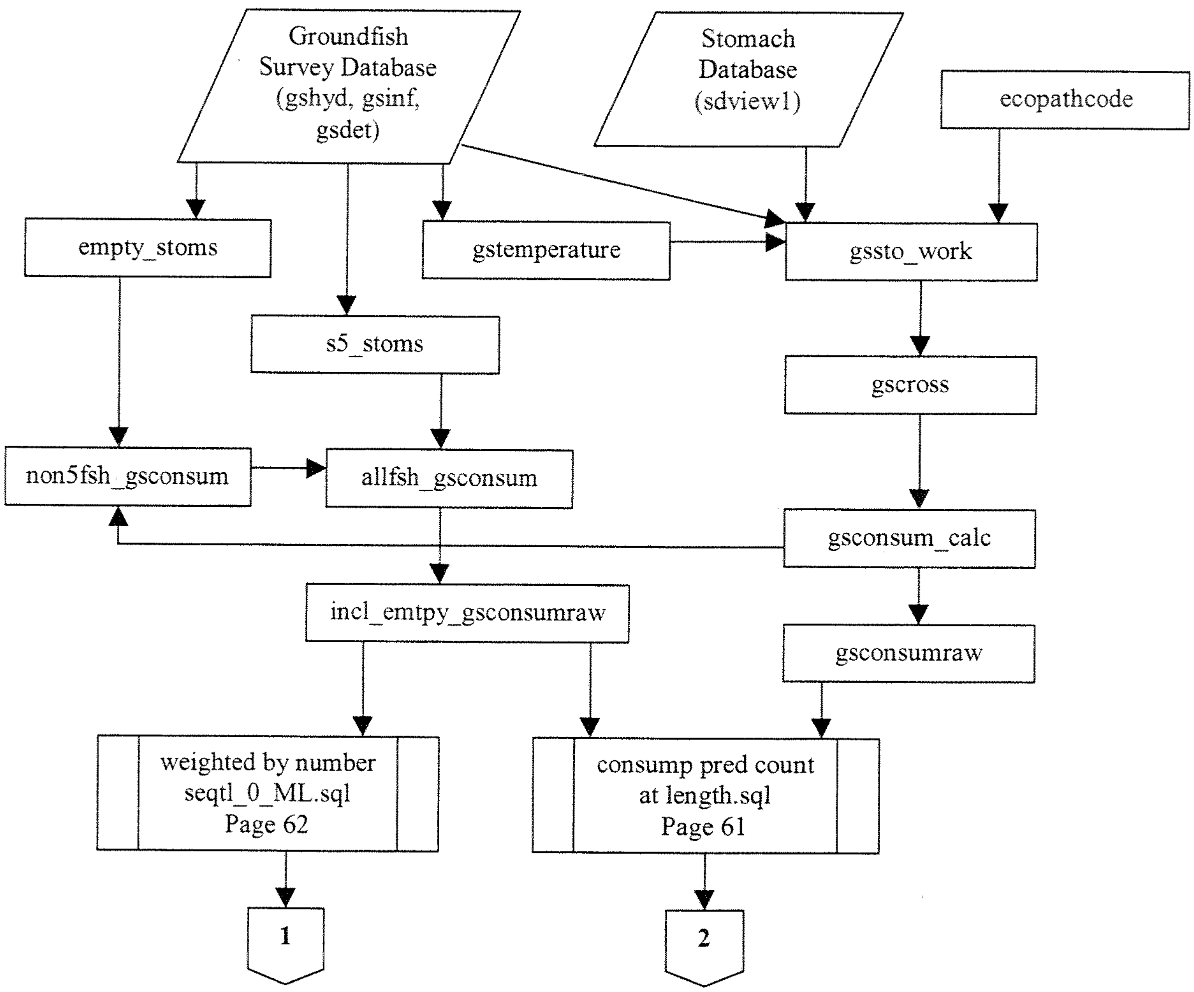
F) Consump combine tables.sql – Takes series, year, predator, fish length, prey, total ration from table tot_unit_avgrtn, number of stomachs sampled per fish length (obs) from table nopred, and total number of fish in population per fish length (totnofl) from table totnopredatlgth and combines them into a single table called gsconsfinal. Zeros are added for fish lengths for which only empty stomachs were examined from table gsconszeros to produce a final table called FINAL_avgrtn. Another table must be produced from using totnopredatlgth to fill in rations for fish lengths sampled in the groundfish survey that had no stomachs collected.

The last step is to import the results into Excel and incorporate the missing fish lengths. Then calculate rations for the missing fish lengths based on rations for fish lengths above and below the blank ones.

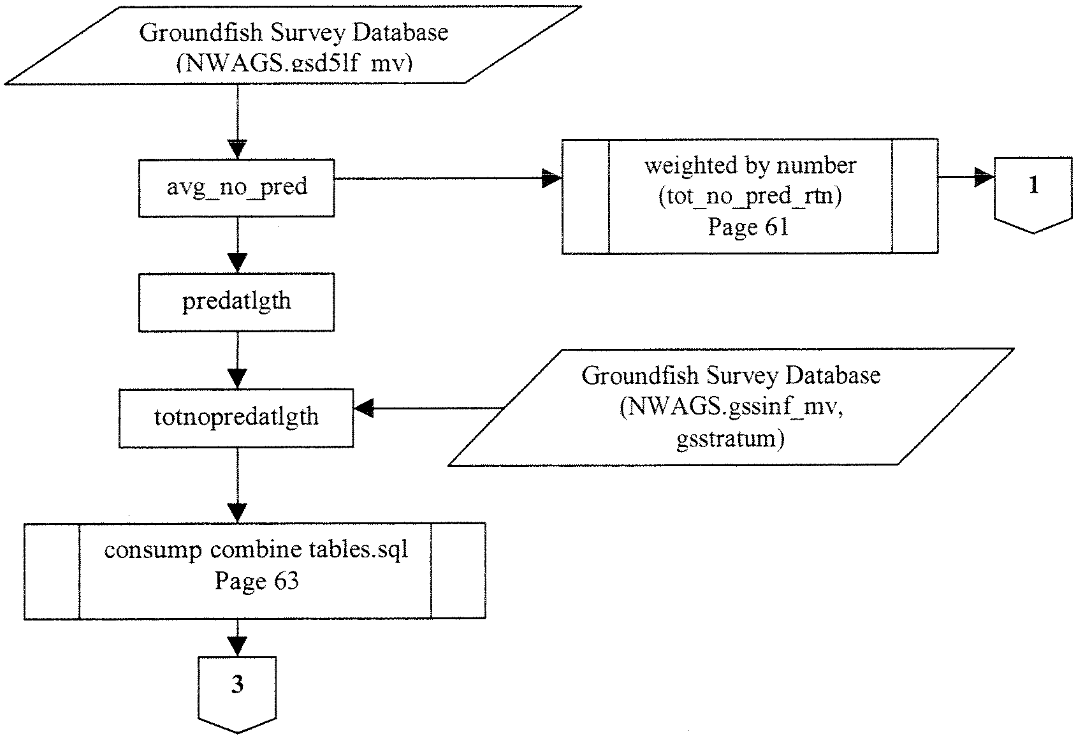
Consumption Calculation Overview



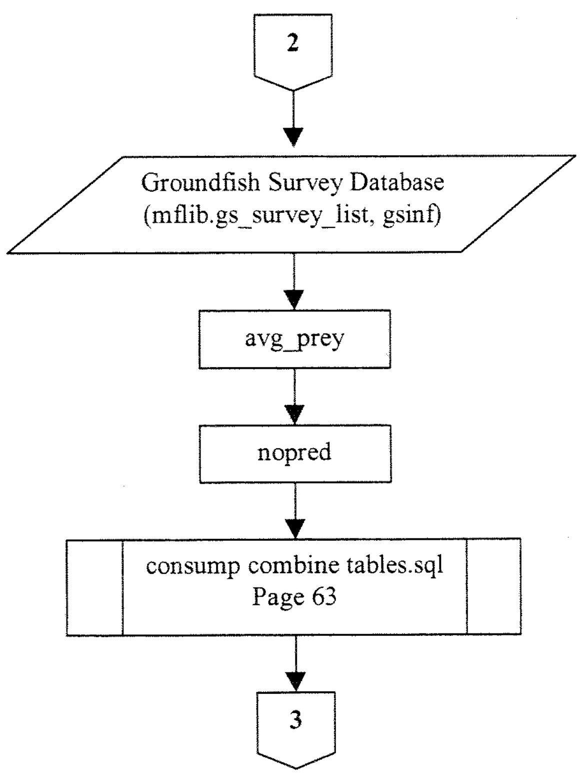
Calculate consumption per fish length and set
(script: consumption gs ML.sql)



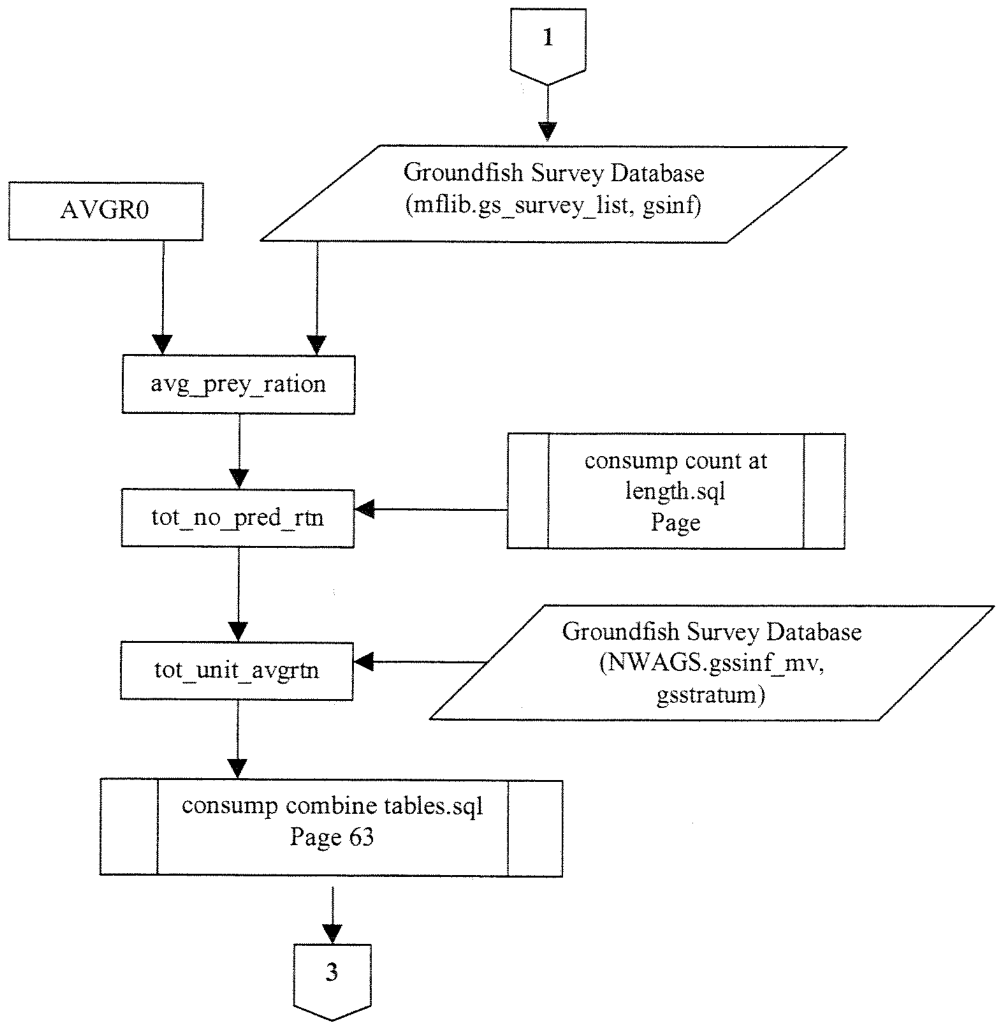
Count total number of stomachs sampled
(script: consump count at length.sql)



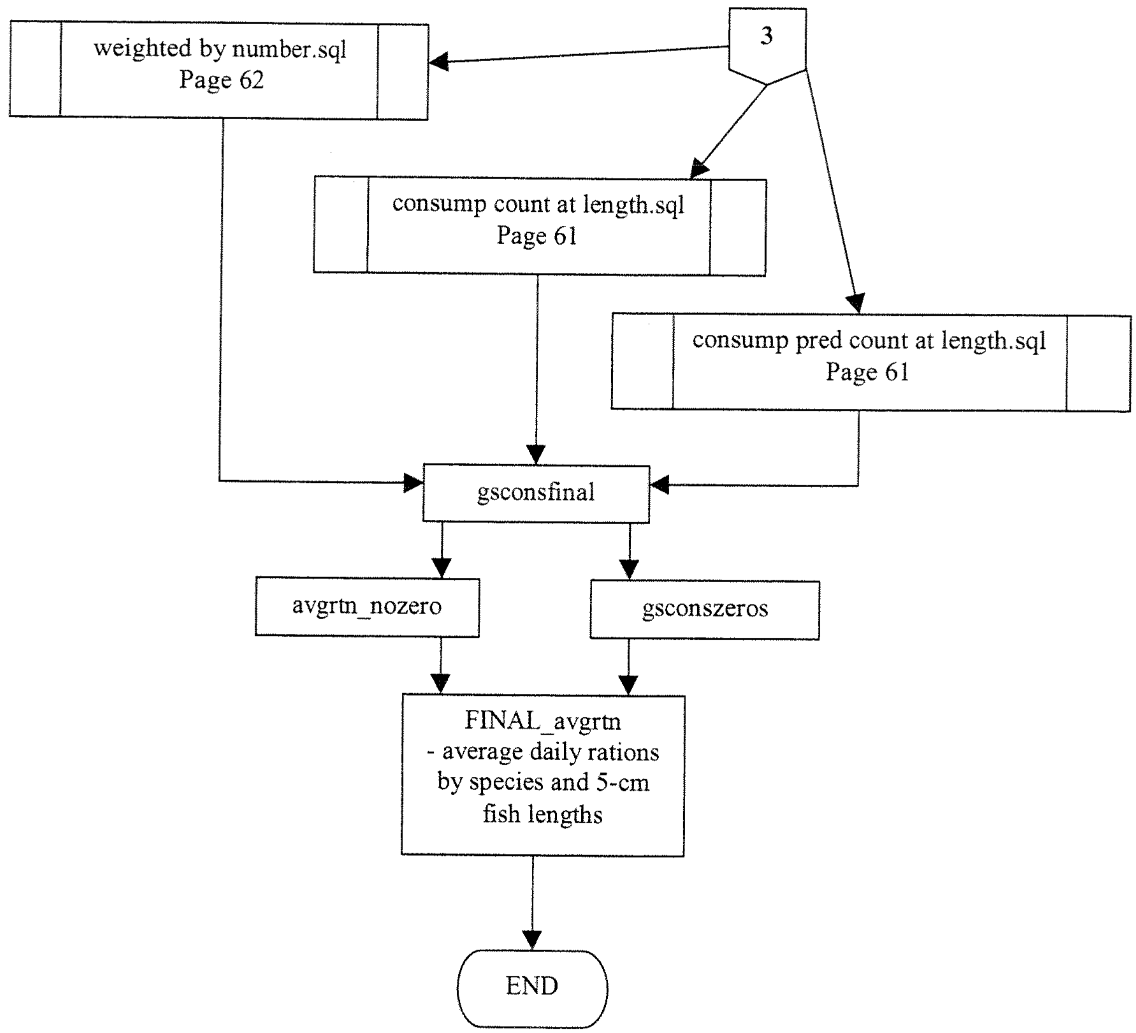
Count number of stomachs collected
(script: consump pred count at length.sql)



Calculate total population level consumption per NAFO division
(script: weighted by number seqtl_0_ML.sql)



Consolidate results from sub-processes
(script: consump combine tables.sql)



APPENDIX V: CONSUMPTION SQL SCRIPT

SQL script for consumption calculation for groundfish survey stomach data

Consumption calculation

```
REM "consumption gs ML.sql"
REM original created by Lei Harris June 28th 2001, edited Dec 20th 2001
REM calculate diet species by species rather than by ecopath code
REM excluded upper bay of fundy - not in strat 494,495

REM changes made Aug-Sep 2002 by Marjo Laurinolli
REM consumption calculations for GS surveys only
REM no calculation of consumption if no bottom_temperature
REM include empty stomachs in the calculations
REM empty and s5 (everted) stomachs incorporated from GS and SD tables with union command - checked
for duplicates
REM see empty_stoms.sql land s5_stoms.sql for empty and s5 tables
REM 16 entries missing that had duplicate mission,setno,spec,fshno (blank),flen,fwt in empties-
minus command removed them
REM compare to non-gastric evacuation results by using code "preywts without ge.sql"
REM season and year info incorporated here is not used in later steps, taken from
mflib.gs_survey_list instead
REM nafo also taken later from mflib.gsmgt

-- get bottom temperatures
drop table gstemperature;
create table gstemperature as
select mission,setno,sdepth,temp as bottom_temperature from gshyd a
where (mission like 'NED199%' or mission like 'NED20%')
and sdepth = (select max(sdepth) from gshyd b where (mission like 'NED199%' or mission like
'NED20%')
and a.mission=b.mission and a.setno=b.setno group by mission, setno);

column year format a4;

-- get distinct records from GS with non-empty stomachs
-- add ecopath codes for prey items
drop table gssto_work;
create table gssto_work as
    select distinct d.mission, d.setno, i.strat, to_char (i.sdate, 'yyyy') as year,
        decode((to_char (i.sdate, 'Q')), 1, 'WINT', 2, 'SPRI', 3, 'SUMM', 4, 'FALL', 999) as seas,
        decode(area, '440','4Vn','441', '4Vn','442','4Vn','452','4VsW','453','4VsW','460',
        '4VsW','461','4VsW','462','4VsW',
        '463','4VsW','464','4VsW','465','4VsW','466','4VsW','467','4VsW',
        '468','4VsW','469','4VsW','471','4X','472','4X','473','4X','474','4X','475','4X',
        '476','4X','477','4X', '511','5YZ','515','5YZ','521','5YZ','522','5YZ','523', '5YZ',
        '524','5YZ','525','5YZ','526','5YZ','999') region, i.bottom_temperature,
        spec, fshno, fwt, flen, preyspec, preyspeccd, pwt, pnum, plen
    from sdview1 d, gsinf i
where d.mission=i.mission and d.setno=i.setno
and fullness in (1,2,3,4) and datasource='GS' and flen is not null
and i.strat not in ('494','495');

REM  SQL> select count (*) from gssto_work;
REM    18482

alter TABLE gssto_work add (
 ECOPRED number(3),
 ECOPREY number(3));

update gssto_work set ECOPREY=
       (select ECOCODE
       FROM harrisle.ECOPATHCODE
       where spec=gssto_work.preyspeccd and (gssto_work.plen >= MINLEN AND gssto_work.plen
<MAXLEN));
REM  18482 rows updated.
```

```
update gssto_work set ECOPREY=
        (select max(ECOCODE)
        FROM harrisle.ECOPATHCODE
        where spec=gssto_work.preyspeccd and (plen is NULL))
 where  ecoprey is null;
REM  5170  rows updated.

update gssto_work set ECOPRED=
        (select ECOCODE
        FROM harrisle.ECOPATHCODE
        where spec=gssto_work.spec and (gssto_work.flen >= MINLEN AND gssto_work.flen <MAXLEN));
REM  18482 rows updated.

update gssto_work set bottom_temperature=
    (select bottom_temperature
    from gstemperature
    where  gssto_work.mission=gstemperature.mission and gssto_work.setno=gstemperature.setno);

-- sum prey wts within each ecopath prey code p4,p5 etc.
-- for echinoderms (p30) use pwt*0.6 due to large amount of inorganic exoskeleton
-- for crabs separate into small (p28) and large (p27)
-- for bivalves (p32) use pwt*0.421 to get viscera weight without shell
drop table gscross;
create table gscross as
select distinct mission, setno, strat, region, year, seas, bottom_temperature,
spec, ecopred, fshno, flen, fwt,
        sum(decode (ecoprey, 4, pwt, 0)) p4,
        sum(decode (ecoprey, 5, pwt, 0)) p5,
        sum(decode (ecoprey, 6, pwt, 0)) p6,
        sum(decode (ecoprey, 7, pwt, 0)) p7,
        sum(decode (ecoprey, 8, pwt, 0)) p8,
        sum(decode (ecoprey, 9, pwt, 0)) p9,
        sum(decode (ecoprey, 10, pwt, 0)) p10,
        sum(decode (ecoprey, 11, pwt, 0)) p11,
        sum(decode (ecoprey, 12, pwt, 0)) p12,
        sum(decode (ecoprey, 13, pwt, 0)) p13,
        sum(decode (ecoprey, 14, pwt, 0)) p14,
        sum(decode (ecoprey, 15, pwt, 0)) p15,
        sum(decode (ecoprey, 16, pwt, 0)) p16,
        sum(decode (ecoprey, 17, pwt, 0)) p17,
        sum(decode (ecoprey, 18, pwt, 0)) p18,
        sum(decode (ecoprey, 19, pwt, 0)) p19,
        sum(decode (ecoprey, 20, pwt, 0)) p20,
        sum(decode (ecoprey, 21, pwt, 0)) p21,
        sum(decode (ecoprey, 22, pwt, 0)) p22,
        sum(decode (ecoprey, 23, pwt, 0)) p23,
        sum(decode (ecoprey, 24, pwt, 0)) p24,
        sum(decode (ecoprey, 25, pwt, 0)) p25,
        sum(decode (ecoprey, 26, pwt, 0)) p26,
        sum(decode (ecoprey, 27, pwt, 0)) p27,
        sum(decode (ecoprey, 28, pwt, 0)) p28,
        sum(decode (ecoprey, 29, pwt, 0)) p29,
        sum(decode (ecoprey, 30, (pwt*0.60), 0)) p30,
        sum(decode (ecoprey, 31, pwt, 0)) p31,
        sum(decode (ecoprey, 32, (pwt*0.421), 0)) p32,
        sum(decode (ecoprey, 33, pwt, 0)) p33,
        sum(decode (ecoprey, 34, pwt, 0)) p34,
        sum(decode (ecoprey, 35, pwt, 0)) p35,
        sum(decode (ecoprey, 40, pwt, 0)) p40,
        sum(decode (ecoprey, 41, pwt, 0)) p41,
        sum(decode (ecoprey, 42, pwt, 0)) p42,
        sum(decode (ecoprey, 100, pwt, 0)) p100,
        sum(decode (ecoprey, 200, pwt, 0)) p200,
        sum(decode (ecoprey, 300, pwt, 0)) p300
        from gssto_work
group by mission, setno, strat, region, year, seas, bottom_temperature,spec, ecopred, fshno, flen,
fwt;
REM 10307

alter table gscross add(
TOTAL           number(10,4),
```

```
TOTAL_ID        number(10,4));

-- only identifiable prey items
update gscross set total_id
=p4+p5+p6+p7+p8+p9+p10+p11+p12+p13+p14+p15+p16+p17+p18+p19+p20+p21+p22+p23+p24+p25+p26+p27+p28+p29+
p30+p31+p32+p33+p34+p35+p40+p41+p42;

-- all prey items
update gscross set
total=(p4+p5+p6+p7+p8+p9+p10+p11+p12+p13+p14+p15+p16+p17+p18+p19+p20+p21+p22+p23+p24+p25+p26+p27+p2
8+p29+p30+p31+p32+p33+p34+p35+p40+p41+p42+p100+p200+p300);

-- estimate amount consumed from gastric evacuation equation
-- one entry per stomach collected
-- include all zeros for empty stomachs (removed where total>0 and total_id>0 from Lei's code)
-- half-life parametres for 100=avg inverts half-life, 200=avg fish, 300=avg all.
drop table gsconsum_calc;
create table gsconsum_calc as
select mission, setno, strat, region, year, seas, bottom_temperature, spec, fshno,
flen, (5*ceil(flen/5)-2) flen_code, fwt,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p4))/(90*(power(total,0.48)))) as cod,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p5))/(60*(power(total,0.48)))) as
j_cod,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p6))/(90*(power(total,0.48)))) as
shake,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p7))/(60*(power(total,0.48)))) as
j_shake,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p8))/(90*(power(total,0.48)))) as
haddock,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p9))/(64*(power(total,0.48)))) as
am_plaice,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p10))/(64*(power(total,0.48)))) as
halibuts,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p11))/(64*(power(total,0.48)))) as
j_hal,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p12))/(64*(power(total,0.48)))) as
flndrs,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p13))/(64*(power(total,0.48)))) as
skates,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p14))/(90*(power(total,0.48)))) as
dogfish,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p15))/(71*(power(total,0.48)))) as
redfish,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p16))/(90*(power(total,0.48)))) as
pollock,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p17))/(100*(power(total,0.48)))) as
mack,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p18))/(90*(power(total,0.48)))) as
dem_pisc,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p19))/(90*(power(total,0.48)))) as
lg_dem,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p20))/(90*(power(total,0.48)))) as
sm_dem,
decode(total,0,0,
```

```
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p21))/(65*(power(total,0.48)))) as
capelin,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p22))/(65*(power(total,0.48)))) as
slance,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p23))/(100*(power(total,0.48)))) as
trans_pel,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p24))/(100*(power(total,0.48)))) as
sm_pel,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p25))/(65*(power(total,0.48)))) as
sm_meso,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p26))/(87*(power(total,0.48)))) as
squid,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p27))/(147*(power(total,0.48)))) as
lg_crab,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p28))/(147*(power(total,0.48)))) as
sm_crab,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p29))/(117*(power(total,0.48)))) as
shrimp,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p30))/(117*(power(total,0.48)))) as
echino,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p31))/(31*(power(total,0.48)))) as
poly,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p32))/(87*(power(total,0.48)))) as
bivl,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p33))/(31*(power(total,0.48)))) as obi,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p34))/(46*(power(total,0.48)))) as
sm_zoo,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p35))/(46*(power(total,0.48)))) as
lg_zoo,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p40))/(60*(power(total,0.48)))) as
j_dem_pisc,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p41))/(60*(power(total,0.48)))) as
j_lg_dem,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p42))/(90*(power(total,0.48)))) as
unid_gad,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p100))/(70*(power(total,0.48)))) as
unid_inv,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p200))/(75*(power(total,0.48)))) as
unid_fish,
decode(total,0,0,
((24*ln(2)*exp(0.13*bottom_temperature)*(power(flen, 0.46))*p300))/(73*(power(total,0.48)))) as
unid_f_inv,
ecopred
from gscross
where bottom_temperature is not null;
REM 10060 (247 with null temperature removed)

REM ********************************************************

alter table gsconsum_calc add(
consum         number(7,3));
```

```
update gsconsum_calc set
consum= (cod+j_cod+shake+j_shake+haddock+ am_plaice+ halibuts+ j_hal+ flndrs+ skates+
dogfish+ redfish+pollock+mack+ dem_pisc+lg_dem+sm_dem+ capelin+slance+trans_pel+
sm_pel+ sm_meso+ squid+ lg_crab+ sm_crab+shrimp+ echino+poly+bivl+obi+ sm_zoo+
lg_zoo+ j_dem_pisc+ j_lg_dem+ unid_gad+unid_inv+unid_fish+unid_f_inv);

/* drop table gsconsumraw;
create table gsconsumraw as
select mission, year, region, strat, setno, seas, spec, count (*) as sample, flen_code, avg(flen)
as avg_flen, avg (fwt) as avg_fwt,
avg(cod) avgcod, avg(j_cod) avgj_cod, avg(shake) avgshake, avg(j_shake) avgj_shake, avg(haddock)
avghaddock,
avg(am_plaice) avgam_plaice, avg(halibuts) avghalibuts, avg(j_hal) avgj_hal, avg(flndrs) avgflndrs,
avg(skates) avgskates, avg(dogfish) avgdogfish, avg(redfish) avgredfish, avg(pollock) avgpollock,
avg(mack) avgmack, avg(dem_pisc) avgdempisc, avg(lg_dem) avglg_dem, avg(sm_dem) avgsm_dem,
avg(capelin) avgcapelin,
avg(slance) avgslance, avg(trans_pel) avgtrans_pel, avg(sm_pel) avgsm_pel, avg(sm_meso) avgsm_meso,
avg(squid) avgsquid, avg(lg_crab) avglg_crab, avg(sm_crab) avgsm_crab, avg(shrimp) avgshrimp,
avg(echino) avgechino,
avg(poly) avgpoly, avg(bivl) avgbivl, avg(obi) avgobi, avg(sm_zoo) avgsm_zoo, avg(lg_zoo)
avglg_zoo,
avg(j_dem_pisc) avgj_dem_pisc, avg(j_lg_dem) avgj_lg_dem, avg(unid_gad) avgunid_gad,
avg(unid_inv) avgunid_inv, avg(unid_fish) avgunid_fish,  avg(unid_f_inv) avgunid_f_inv
from gsconsum_calc
group by mission, year, region, strat, setno, seas, spec, flen_code; */
REM 5552

REM**************************************************

-- add data for s0 empty stomachs, see code below
drop table non5fsh_gsconsum;
create table non5fsh_gsconsum as
select * from gsconsum_calc union all select * from empty_stoms;
REM 23420 rows, gscons with 10060, empty with 13360 (total 23420); only 23412 distinct
REM 8 entries in both tables, but with different sample_index,adate so OK

-- add data for s5 everted stomachs, see code below
drop table allfsh_gsconsum;
create table allfsh_gsconsum as
select * from non5fsh_gsconsum union all (select * from s5_stoms where consum is not null);
REM 24998 rows, (23420+1718-140nulls) only 24989 distinct mission,setno,spec,fshno,flen,fwt
REM have 8 doubles with same m,s,s,f,f,f however different adate,sample_index thus KEEP
REM also one double without fshno where one is s0, the other is s5 OK
REM DOES NOT include 16 from empty_stoms that have same mission,setno,spec,blank fshno,flen,fwt

-- use "avgr0_ML.sql" to convert columns in this table to rows for use in
-- "weighted by number seqtl_0_ML.sql" to produce population level consumption
-- gives average consumption per set (doesn't matter how many fish sampled)
drop table incl_empty_gsconsumraw;
create table incl_empty_gsconsumraw as
select mission, year, region, strat, setno, seas, spec, count (*) as sample, flen_code, avg(flen)
as avg_flen, avg (fwt) as avg_fwt,
avg(cod) avgcod, avg(j_cod) avgj_cod, avg(shake) avgshake, avg(j_shake) avgj_shake, avg(haddock)
avghaddock,
avg(am_plaice) avgam_plaice, avg(halibuts) avghalibuts, avg(j_hal) avgj_hal, avg(flndrs) avgflndrs,
avg(skates) avgskates, avg(dogfish) avgdogfish, avg(redfish) avgredfish, avg(pollock) avgpollock,
avg(mack) avgmack, avg(dem_pisc) avgdempisc, avg(lg_dem) avglg_dem, avg(sm_dem) avgsm_dem,
avg(capelin) avgcapelin,
avg(slance) avgslance, avg(trans_pel) avgtrans_pel, avg(sm_pel) avgsm_pel, avg(sm_meso) avgsm_meso,
avg(squid) avgsquid, avg(lg_crab) avglg_crab, avg(sm_crab) avgsm_crab, avg(shrimp) avgshrimp,
avg(echino) avgechino,
avg(poly) avgpoly, avg(bivl) avgbivl, avg(obi) avgobi, avg(sm_zoo) avgsm_zoo, avg(lg_zoo)
avglg_zoo,
avg(j_dem_pisc) avgj_dem_pisc, avg(j_lg_dem) avgj_lg_dem, avg(unid_gad) avgunid_gad,
avg(unid_inv) avgunid_inv, avg(unid_fish) avgunid_fish,  avg(unid_f_inv) avgunid_f_inv
from allfsh_gsconsum
group by mission, year, region, strat, setno, seas, spec, flen_code;
REM count(*) 10115 rows

REM ****************************************
```

Empty (S0) stomachs

```
REM "empty_stoms.sql"
-- get empty stomachs from GS database
drop table gsempty_test;
create table gsempty_test as
select d.mission,d.setno,i.strat,
decode(area, '440','4Vn','441', '4Vn','442','4Vn','452','4VsW','453','4VsW','460',
        '4VsW','461','4VsW','462','4VsW',
        '463','4VsW','464','4VsW','465','4VsW','466','4VsW','467','4VsW',
        '468','4VsW','469','4VsW','471','4X','472','4X','473','4X','474','4X','475','4X',
        '476','4X','477','4X', '511','5YZ','515','5YZ','521','5YZ','522','5YZ','523', '5YZ',
        '524','5YZ','525','5YZ','526','5YZ','999') as region,
        to_char (i.sdate, 'yyyy') as year,
        decode((to_char (i.sdate, 'Q')), 1, 'WINT', 2, 'SPRI', 3, 'SUMM', 4, 'FALL', 999) as seas,
        i.bottom_temperature,
       d.spec,d.fshno,d.flen,(5*ceil(d.flen/5)-2) flen_code,d.fwt,
       0 as cod,0 as j_cod,0 as shake,0 as j_shake,0 as haddock,0 as am_plaice,
       0 as halibuts,0 as j_hal,0 as flndrs,0 as skates,0 as dogfish,0 as redfish,
       0 as pollock,0 as mack,0 as dem_pisc,0 as lg_dem,0 as sm_dem,
       0 as capelin,0 as slance,0 as trans_pel,0 as sm_pel,0 as sm_meso,
       0 as squid,0 as lg_crab,0 as sm_crab,0 as shrimp,0 as echino,
       0 as poly,0 as bivl,0 as obi,0 as sm_zoo,0 as lg_zoo,0 as j_dem_pisc,
       0 as j_lg_dem,0 as unid_gad,0 as unid_inv,0 as unid_fish,0 as unid_f_inv
from gsinf i,gsdet d
where d.mission=i.mission and d.setno=i.setno
and (d.remarks like 's0%' or d.remarks like 'S0%')
and (d.mission like 'NED199%' or d.mission like 'NED2000%')
and d.flen is not null
and i.strat not in ('494','495');
REM 11769 rows selected (NB: 1488 without fshno and 16 of these with same flen,fwt etc. as another)

drop table gsnotempty;
create table gsnotempty as
select  a.mission,a.setno,a.strat,a.region,a.year,a.seas,a.bottom_temperature,
a.spec,a.fshno,a.flen,a.flen_code,a.fwt,cod,j_cod,shake,j_shake,haddock,am_plaice,
halibuts,j_hal,flndrs,skates,dogfish,redfish,pollock,mack,dem_pisc,lg_dem,sm_dem,
capelin,slance,trans_pel,sm_pel,sm_meso,squid,lg_crab,sm_crab,shrimp,echino,poly,
bivl,obi,sm_zoo,lg_zoo,j_dem_pisc,j_lg_dem,unid_gad,unid_inv,unid_fish,unid_f_inv
from gsempty_test a, sddet b
where fullness in (1,2,3,4,5)
and a.mission=b.mission and a.setno=b.setno and a.spec=b.spec and a.fshno=b.fshno
and a.flen=b.flen and a.fwt=b.fwt;
REM 38 entries as before

drop table gsempty_stoms_test;
create table gsempty_stoms_test as
(select * from gsempty_test)
minus (select * from gsnotempty);
REM 11715 - subtracts doubles too!

update gsempty_stoms_test set bottom_temperature=
    (select bottom_temperature
    from gstemperature
    where  gsempty_stoms_test.mission=gstemperature.mission and
gsempty_stoms_test.setno=gstemperature.setno);

-- get empties from stomachs database
drop table sdempty_test;
create table sdempty_test as
select d.mission,d.setno,i.strat,
decode(nafo,'440','4Vn','441', '4Vn','442','4Vn','452','4VsW','453','4VsW','460',
        '4VsW','461','4VsW','462','4VsW',
        '463','4VsW','464','4VsW','465','4VsW','466','4VsW','467','4VsW',
        '468','4VsW','469','4VsW','471','4X','472','4X','473','4X','474','4X','475','4X',
        '476','4X','477','4X', '511','5YZ','515','5YZ','521','5YZ','522','5YZ','523', '5YZ',
        '524','5YZ','525','5YZ','526','5YZ','999') as region,
        to_char (i.sdate, 'yyyy') as year,
```

```
        decode((to_char (i.sdate, 'Q')), 1, 'WINT', 2, 'SPRI', 3, 'SUMM', 4, 'FALL', 999) as seas,
        i.bottom_temperature,
        d.spec,d.fshno,d.flen,(5*ceil(d.flen/5)-2) flen_code,d.fwt,
        0 as cod,0 as j_cod,0 as shake,0 as j_shake,0 as haddock,0 as am_plaice,
        0 as halibuts,0 as j_hal,0 as flndrs,0 as skates,0 as dogfish,0 as redfish,
        0 as pollock,0 as mack,0 as dem_pisc,0 as lg_dem,0 as sm_dem,
        0 as capelin,0 as slance,0 as trans_pel,0 as sm_pel,0 as sm_meso,
        0 as squid,0 as lg_crab,0 as sm_crab,0 as shrimp,0 as echino,
        0 as poly,0 as bivl,0 as obi,0 as sm_zoo,0 as lg_zoo,0 as j_dem_pisc,
        0 as j_lg_dem,0 as unid_gad,0 as unid_inv,0 as unid_fish,0 as unid_f_inv
from sdinf i,sddet d
where d.mission=i.mission and d.setno=i.setno
and d.datasource='GS'
and fullness=0
and (d.mission like 'NED199%' or d.mission like 'NED2000%')
and d.flen is not null
and i.strat not in ('494','495');
REM 1659 entries

update sdempty_test set bottom_temperature=
    (select bottom_temperature
    from gstemperature
    where  sdempty_test.mission=gstemperature.mission and sdempty_test.setno=gstemperature.setno);

-- union GS and SD empties
drop table empty_stoms_test;
create table empty_stoms_test as
select * from gsempty_stoms_test union
select * from sdempty_test;
REM 13360, doubles missing (11715+16+1659-14=13376)

alter table empty_stoms_test add
(ECOPRED number(3));

update empty_stoms_test set ECOPRED=
(select ECOCODE from harrisle.ecopathcode
where spec=empty_stoms_test.spec and (empty_stoms_test.flen >= minlen and
empty_stoms_test.flen < maxlen));

alter table empty_stoms_test add(
consum         number(7,3));

update empty_stoms_test set
consum= (cod+j_cod+shake+j_shake+haddock+ am_plaice+ halibuts+ j_hal+ flndrs+ skates+
dogfish+ redfish+pollock+mack+ dem_pisc+lg_dem+sm_dem+ capelin+slance+trans_pel+
sm_pel+ sm_meso+ squid+ lg_crab+ sm_crab+shrimp+ echino+poly+bivl+obi+ sm_zoo+
lg_zoo+ j_dem_pisc+ j_lg_dem+ unid_gad+unid_inv+unid_fish+unid_f_inv);

REM****************************
```

Everted (S5) stomachs

```
REM "s5_stoms.sql"
drop table gss5_test;
create table gss5_test as
select d.mission,d.setno,strat,
decode(area, '440','4Vn','441', '4Vn','442','4Vn','452','4VsW','453','4VsW','460',
        '4VsW','461','4VsW','462','4VsW',
        '463','4VsW','464','4VsW','465','4VsW','466','4VsW','467','4VsW',
        '468','4VsW','469','4VsW','471','4X','472','4X','473','4X','474','4X','475','4X',
        '476','4X','477','4X', '511','5YZ','515','5YZ','521','5YZ','522','5YZ','523', '5YZ',
        '524','5YZ','525','5YZ','526','5YZ','999') region,
        to_char (i.sdate, 'yyyy') as year,
        decode((to_char (i.sdate, 'Q')), 1, 'WINT', 2, 'SPRI', 3, 'SUMM', 4, 'FALL', 999) as seas,
        i.bottom_temperature,
       spec,fshno,flen,(5*ceil(flen/5)-2) flen_code,fwt,
       0 as cod,0 as j_cod,0 as shake,0 as j_shake,0 as haddock,0 as am_plaice,
       0 as halibuts,0 as j_hal,0 as flndrs,0 as skates,0 as dogfish,0 as redfish,
       0 as pollock,0 as mack,0 as dem_pisc,0 as lg_dem,0 as sm_dem,
       0 as capelin,0 as slance,0 as trans_pel,0 as sm_pel,0 as sm_meso,
       0 as squid,0 as lg_crab,0 as sm_crab,0 as shrimp,0 as echino,
       0 as poly,0 as bivl,0 as obi,0 as sm_zoo,0 as lg_zoo,0 as j_dem_pisc,
       0 as j_lg_dem,0 as unid_gad,0 as unid_inv,0 as unid_fish,0 as unid_f_inv
from gsinf i,gsdet d
where d.mission=i.mission and d.setno=i.setno
and (d.remarks like 's5%' or d.remarks like 'S5%')
and (d.mission like 'NED199%' or d.mission like 'NED2000%')
and flen is not null
and i.strat not in ('494','495');
REM 1724 rows selected

drop table gs_nots5_test;
create table gs_nots5_test as
select distinct a.mission,a.setno,a.strat,a.region,a.year,a.seas,a.bottom_temperature,
a.spec,a.fshno,a.flen,a.flen_code,a.fwt,cod,j_cod,shake,j_shake,haddock,am_plaice,
halibuts,j_hal,flndrs,skates,dogfish,redfish,pollock,mack,dem_pisc,lg_dem,sm_dem,
capelin,slance,trans_pel,sm_pel,sm_meso,squid,lg_crab,sm_crab,shrimp,echino,poly,
bivl,obi,sm_zoo,lg_zoo,j_dem_pisc,j_lg_dem,unid_gad,unid_inv,unid_fish,unid_f_inv
from gss5_test a,sddet b
where fullness in (0,1,2,3,4)
and a.mission=b.mission and a.setno=b.setno and a.spec=b.spec and a.fshno=b.fshno
and a.flen=b.flen and a.fwt=b.fwt;
REM 8 entries

drop table GSS5_STOMS_TEST;
create table gss5_stoms_test as
select * from gss5_test minus select * from gs_nots5_test;
REM 1716 entries - OK

update gss5_stoms_test set bottom_temperature=
    (select bottom_temperature
    from gstemperature
    where  gss5_stoms_test.mission=gstemperature.mission and
gss5_stoms_test.setno=gstemperature.setno);

drop table sds5_stoms_test;
create table sds5_stoms_test as
select d.mission,d.setno,strat,
decode(nafo, '440','4Vn','441', '4Vn','442','4Vn','452','4VsW','453','4VsW','460',
        '4VsW','461','4VsW','462','4VsW',
        '463','4VsW','464','4VsW','465','4VsW','466','4VsW','467','4VsW',
        '468','4VsW','469','4VsW','471','4X','472','4X','473','4X','474','4X','475','4X',
        '476','4X','477','4X', '511','5YZ','515','5YZ','521','5YZ','522','5YZ','523', '5YZ',
        '524','5YZ','525','5YZ','526','5YZ','999') region,
        to_char (i.sdate, 'yyyy') as year,
        decode((to_char (i.sdate, 'Q')), 1, 'WINT', 2, 'SPRI', 3, 'SUMM', 4, 'FALL', 999) as seas,
        i.bottom_temperature,
       spec,fshno,flen,(5*ceil(flen/5)-2) flen_code,fwt,
       0 as cod,0 as j_cod,0 as shake,0 as j_shake,0 as haddock,0 as am_plaice,
       0 as halibuts,0 as j_hal,0 as flndrs,0 as skates,0 as dogfish,0 as redfish,
```

```
        0 as pollock,0 as mack,0 as dem_pisc,0 as lg_dem,0 as sm_dem,
        0 as capelin,0 as slance,0 as trans_pel,0 as sm_pel,0 as sm_meso,
        0 as squid,0 as lg_crab,0 as sm_crab,0 as shrimp,0 as echino,
        0 as poly,0 as bivl,0 as obi,0 as sm_zoo,0 as lg_zoo,0 as j_dem_pisc,
        0 as j_lg_dem,0 as unid_gad,0 as unid_inv,0 as unid_fish,0 as unid_f_inv
from sdinf i,sddet d
where d.mission=i.mission and d.setno=i.setno
and d.datasource='GS'
and fullness=5
and (d.mission like 'NED199%' or d.mission like 'NED2000%')
and flen is not null
and i.strat not in ('494','495');
REM 2 entries

update sds5_stoms_test set bottom_temperature=
    (select bottom_temperature
    from gstemperature
    where  sds5_stoms_test.mission=gstemperature.mission and
sds5_stoms_test.setno=gstemperature.setno);

drop table s5_stoms_test;
create table s5_stoms_test as
select * from gss5_stoms_test union
select * from sds5_stoms_test;
REM 1718 entries OK as of 17 Sep 02

update s5_stoms_test set cod=
(select avg(cod) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);
REM remove ' and s5_stoms_test.year=year' if want to average over all years

update s5_stoms_test set j_cod=
(select avg(j_cod) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set shake=
(select avg(shake) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set j_shake=
(select avg(j_shake) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set haddock=
(select avg(haddock) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set am_plaice=
(select avg(am_plaice) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set halibuts=
(select avg(halibuts) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set j_hal=
(select avg(j_hal) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set flndrs=
(select avg(flndrs) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);
```

```
update s5_stoms_test set skates=
(select avg(skates) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set dogfish=
(select avg(dogfish) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set redfish=
(select avg(redfish) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set pollock=
(select avg(pollock) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set mack=
(select avg(mack) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set dem_pisc=
(select avg(dem_pisc) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set lg_dem=
(select avg(lg_dem) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set sm_dem=
(select avg(sm_dem) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set capelin=
(select avg(capelin) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set slance=
(select avg(slance) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set trans_pel=
(select avg(trans_pel) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set sm_pel=
(select avg(sm_pel) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set sm_meso=
(select avg(sm_meso) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set squid=
(select avg(squid) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);
```

```
update s5_stoms_test set lg_crab=
(select avg(lg_crab) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set sm_crab=
(select avg(sm_crab) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set shrimp=
(select avg(shrimp) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set echino=
(select avg(echino) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set poly=
(select avg(poly) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set bivl=
(select avg(bivl) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set obi=
(select avg(obi) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set sm_zoo=
(select avg(sm_zoo) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set lg_zoo=
(select avg(lg_zoo) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set j_dem_pisc=
(select avg(j_dem_pisc) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set j_lg_dem=
(select avg(j_lg_dem) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set unid_gad=
(select avg(unid_gad) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set unid_inv=
(select avg(unid_inv) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set unid_fish=
(select avg(unid_fish) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

update s5_stoms_test set unid_f_inv=
```

```
(select avg(unid_f_inv) from gsconsum_calc_test
where s5_stoms_test.flen_code=flen_code and s5_stoms_test.spec=spec
and s5_stoms_test.region=region and s5_stoms_test.seas=seas and s5_stoms_test.year=year);

alter table s5_stoms_test add
(ECOPRED number(3));

update s5_stoms_test set ecopred=
(select ecocode from harrisle.ecopathcode
where spec=s5_stoms_test.spec and (s5_stoms_test.flen >= minlen and
s5_stoms_test.flen < maxlen));

alter table s5_stoms_test add(
consum          number(7,3));

update s5_stoms_test set
consum= (cod+j_cod+shake+j_shake+haddock+ am_plaice+ halibuts+ j_hal+ flndrs+ skates+
dogfish+ redfish+pollock+mack+ dem_pisc+lg_dem+sm_dem+ capelin+slance+trans_pel+
sm_pel+ sm_meso+ squid+ lg_crab+ sm_crab+shrimp+ echino+poly+bivl+obi+ sm_zoo+
lg_zoo+ j_dem_pisc+ j_lg_dem+ unid_gad+unid_inv+unid_fish+unid_f_inv);
REM note: have 140 entries with null values for consumption
```

Convert columns to rows

```
REM "avgr0_ML.sql"
REM this table was created August 10 2001 by Lei Harris
REM in order to rationalise the table gsconsumraw_test. (ie. turn columns of prey into rows -ML)
REm It is to be used when extrapolating average consumption by spec, flen_code, setno to get total
consumption.
REM used by M Laurinolli 30 Sep 2002 (changed gsconsumraw_test to incl_empty_gsconsumraw_test)
REM revised 01 Nov 2002 to include zeros and include number of samples
REM average consumption per set

drop table avgr0;
create table AVGR0 (
mission         varchar (15),
setno           number(3),
spec               number(4),
flen_code       number(3),
prey          number(3),
sample          number(3),
avgr       number(12,6));


REM When include flens surveyed from gs, cons calculated from other flens for
REM those flens without prey items.
insert into avgr0 select mission, setno, spec, flen_code, 4, sample, avgcod         from
incl_empty_gsconsumraw_test ;
insert into avgr0 select mission, setno, spec, flen_code, 5, sample, avgj_cod       from
incl_empty_gsconsumraw_test  ;
insert into avgr0 select mission, setno, spec, flen_code, 6, sample, avgshake       from
incl_empty_gsconsumraw_test ;
insert into avgr0 select mission, setno, spec, flen_code, 7, sample, avgj_shake     from
incl_empty_gsconsumraw_test  ;
insert into avgr0 select mission, setno, spec, flen_code, 8, sample, avghaddock     from
incl_empty_gsconsumraw_test  ;
insert into avgr0 select mission, setno, spec, flen_code, 9, sample, avgam_plaice   from
incl_empty_gsconsumraw_test  ;
insert into avgr0 select mission, setno, spec, flen_code, 10,  sample, avghalibuts   from
incl_empty_gsconsumraw_test    ;
insert into avgr0 select mission, setno, spec, flen_code, 11,  sample, avgj_hal      from
incl_empty_gsconsumraw_test      ;
insert into avgr0 select mission, setno, spec, flen_code, 12,  sample, avgflndrs     from
incl_empty_gsconsumraw_test     ;
insert into avgr0 select mission, setno, spec, flen_code, 13,  sample, avgskates     from
incl_empty_gsconsumraw_test      ;
insert into avgr0 select mission, setno, spec, flen_code, 14,  sample, avgdogfish    from
incl_empty_gsconsumraw_test    ;
```

```
insert into avgr0 select mission, setno, spec, flen_code, 15,  sample, avgredfish    from
incl_empty_gsconsumraw_test        ;
insert into avgr0 select mission, setno, spec, flen_code, 16,  sample, avgpollock    from
incl_empty_gsconsumraw_test        ;
insert into avgr0 select mission, setno, spec, flen_code, 17, sample,  avgmack       from
incl_empty_gsconsumraw_test           ;
insert into avgr0 select mission, setno, spec, flen_code, 18, sample,  avgdempisc   from
incl_empty_gsconsumraw_test       ;
insert into avgr0 select mission, setno, spec, flen_code, 19, sample,  avglg_dem     from
incl_empty_gsconsumraw_test         ;
insert into avgr0 select mission, setno, spec, flen_code, 20, sample,  avgsm_dem     from
incl_empty_gsconsumraw_test         ;
insert into avgr0 select mission, setno, spec, flen_code, 21, sample,  avgcapelin    from
incl_empty_gsconsumraw_test        ;
insert into avgr0 select mission, setno, spec, flen_code, 22, sample,  avgslance     from
incl_empty_gsconsumraw_test         ;
insert into avgr0 select mission, setno, spec, flen_code, 23, sample,  avgtrans_pel  from
incl_empty_gsconsumraw_test       ;
insert into avgr0 select mission, setno, spec, flen_code, 24, sample,  avgsm_pel     from
incl_empty_gsconsumraw_test         ;
insert into avgr0 select mission, setno, spec, flen_code, 25, sample,  avgsm_meso    from
incl_empty_gsconsumraw_test        ;
insert into avgr0 select mission, setno, spec, flen_code, 26, sample,  avgsquid      from
incl_empty_gsconsumraw_test          ;
insert into avgr0 select mission, setno, spec, flen_code, 27, sample,  avglg_crab    from
incl_empty_gsconsumraw_test        ;
insert into avgr0 select mission, setno, spec, flen_code, 28, sample,  avgsm_crab    from
incl_empty_gsconsumraw_test        ;
insert into avgr0 select mission, setno, spec, flen_code, 29, sample,  avgshrimp     from
incl_empty_gsconsumraw_test         ;
insert into avgr0 select mission, setno, spec, flen_code, 30, sample,  avgechino     from
incl_empty_gsconsumraw_test        ;
insert into avgr0 select mission, setno, spec, flen_code, 31, sample,  avgpoly       from
incl_empty_gsconsumraw_test           ;
insert into avgr0 select mission, setno, spec, flen_code, 32, sample,  avgbivl       from
incl_empty_gsconsumraw_test           ;
insert into avgr0 select mission, setno, spec, flen_code, 33, sample,  avgobi        from
incl_empty_gsconsumraw_test            ;
insert into avgr0 select mission, setno, spec, flen_code, 34, sample,  avgsm_zoo     from
incl_empty_gsconsumraw_test         ;
insert into avgr0 select mission, setno, spec, flen_code, 35, sample,  avglg_zoo     from
incl_empty_gsconsumraw_test         ;
insert into avgr0 select mission, setno, spec, flen_code, 40, sample,  avgj_dem_pisc from
incl_empty_gsconsumraw_test     ;
insert into avgr0 select mission, setno, spec, flen_code, 41, sample,  avgj_lg_dem   from
incl_empty_gsconsumraw_test       ;
insert into avgr0 select mission, setno, spec, flen_code, 42, sample,  avgunid_gad   from
incl_empty_gsconsumraw_test       ;
insert into avgr0 select mission, setno, spec, flen_code, 100,sample,  avgunid_inv   from
incl_empty_gsconsumraw_test      ;
insert into avgr0 select mission, setno, spec, flen_code, 200,sample, avgunid_fish  from
incl_empty_gsconsumraw_test     ;
insert into avgr0 select mission, setno, spec, flen_code, 300, sample, avgunid_f_inv from
incl_empty_gsconsumraw_test    ;

REM 384370 rows (10115*38)
```

Expand to population level consumption

```
REM "weighted by number_seqtl_0_ml.sql"
REM 08 Nov 2002 Final code for pop consumption calculation
REM M. Laurinolli: extended code into sequential views for clarity 2 Oct 2002
REM added r.flen to final view
REM all zeros included for empties

REM This is Bob Branton's script from January 16th 2002.  The numbers at length were checked
REM  against the VDC output and they coincided. This script is to obtain consumptions.  flen and
species
REM must be specified to get split ecopath group estimates. Use this to get consumption for Alida.
```

```
--
--    average prey ration for each predator species length class by series, year and strat(b)
--
drop table avg_prey_ration;
create table avg_prey_ration as
SELECT l.series, l.year, i.strat, a.spec,
               a.flen_code flen, a.prey, count(*) nsets, AVG(a.avgr) avgr
        FROM laurinollim.avgr0 a,
             groundfish.gsinf i,
             mflib.gs_survey_list l
               WHERE l.mission=i.mission
                       AND a.mission=i.mission
                       AND a.setno=i.setno
                       and l.year>1994 and l.year<2001
                           GROUP BY l.series, l.year, i.strat, a.spec, a.flen_code, a.prey;
REM count 215840 with zeros
REM count 10572
-- create or replace view avg_prey_ration as
-- select * from avg_prey_ration0;
-- select series,year,strat,spec,flen,prey,obs,avgr from avg_prey_ration0
-- where avgr>0;
REM 10572

--
--    average number of predator species at length by series, year and strat (d)
--      select unit, here ESS - change to 4VSW; also do 4X separately
--
drop table avg_no_pred;
create table avg_no_pred as
SELECT series, year, strat, spec, flen, stdclen
        FROM NWAGS.gsd5lf_mv
        WHERE strat IN (SELECT DISTINCT strat FROM mflib.gsmgt WHERE unit='4VSW')
--       and spec in (14,13,50,51,59,112,301,410,501,640,641,642,647)
--       and flen >30
--      above for split ecopathcodes
        and year>1994 and year<2001
        AND spec IN (SELECT DISTINCT spec FROM laurinollim.avgr0);
REM 26296 rows for 4VSW; 24 null flens??
REM 14599 for 4X
REM stdclen for each setno and mission

--
--     total number of predators at length and total ration of prey by series, year, strat (r)
-- ML: want to include flen from avg_no_pred where no ration available in avg_prey_ration (leave as
null)-don't know how
--
drop table tot_no_pred_rtn;
create  table tot_no_pred_rtn as
SELECT d.series,d.year, d.strat, d.spec, d.flen, b.prey, sum(b.nsets) nsets,
                         SUM(d.stdclen) totno, SUM(b.avgr*d.stdclen) totr
        FROM avg_prey_ration b, avg_no_pred d
        WHERE b.series=d.series
                AND b.year=d.year
                AND b.strat=d.strat
                AND b.spec=d.spec
          AND b.flen=d.flen
          and d.year>1994 and d.year<2001
        GROUP BY d.series, d.year, d.strat, d.spec, d.flen, b.prey;
REM 6425 rows for 4VSW
REM 2874 for 4X

REM 06 Nov 02 conversion factor (nm to ft) changed
drop table tot_unit_avgrtn;
create table tot_unit_avgrtn as
SELECT  r.series,t.year,r.spec pred, r.flen, r.prey, sum(nsets) nsets,
          ROUND(SUM((r.totno / t.ntows) * (s.area/(1.75*41/6080.2)))) totno,
          ROUND(SUM((r.totr / t.ntows) * (s.area/(1.75*41/6080.2)))) totr,
          ROUND(SUM((r.totr / t.ntows) * (s.area/(1.75*41/6080.2)))/
                SUM((r.totno / t.ntows) * (s.area/(1.75*41/6080.2))),3) avgr
  FROM
```

```
 tot_no_pred_rtn r,
       NWAGS.gssinf_mv t,
       groundfish.gsstratum s
 WHERE r.series=t.series
   AND r.year=t.year
   AND r.strat=t.strat
   AND t.strat=s.strat
 GROUP BY r.series, t.year,  r.spec, r.flen, r.prey
ORDER BY r.series,  t.year, r.spec, r.flen, r.prey;

REM 2529 rows 4VSW; 27930 with all zeros
REM 1323 for 4X
```

Total standardised number of fish at length in population

```
REM "consump count at length.sql"
REM gives pop. standardised count at length (totnofl) for all lengths in gs
REM how can use this to fill in blanks in sd? Used in long-hand way in Excel

-- sum across sets within a strat
create or replace view predatlgth as
select series,year,strat,spec,flen,count(*) stdnsets, sum(stdclen) totnofl
from avg_no_pred
group by series,year,strat,spec,flen;

drop table totnopredatlgth;
create table totnopredatlgth as
SELECT  r.series,t.year,r.spec pred, r.flen,
           ROUND(SUM((r.totnofl / t.ntows) * (s.area/(1.75*41/6080.2)))) totnofl,
           sum(stdnsets) stdnsets
  FROM predatlgth r,
       NWAGS.gssinf_mv t,
       groundfish.gsstratum s
 WHERE r.series=t.series
   AND r.year=t.year
   AND r.strat=t.strat
   AND t.strat=s.strat
 GROUP BY r.series, t.year,  r.spec, r.flen
ORDER BY r.series,  t.year, r.spec, r.flen;

REM count(*) is 2953 for 4VSW Nov 2002
```

Number of stomachs used for calculations

```
REM gives number of fish stomachs sampled per fish length
-- only want to count stomachs collected, not all empties so use gsconsumraw instead of incl_empty
--
create or replace view avg_prey as
SELECT l.series, l.year, i.strat, a.spec,
                            a.flen_code flen, sum(sample) obs
--      FROM incl_empty_gsconsumraw_test a,
        FROM gsconsumraw_test a,
        groundfish.gsinf i,
             mflib.gs_survey_list l
                WHERE l.mission=i.mission
                        AND a.mission=i.mission
                        AND a.setno=i.setno
                        and l.year>1994 and l.year<2001
                        and i.strat IN (SELECT DISTINCT strat FROM mflib.gsmgt WHERE unit='4VSW')
                        AND a.spec IN (SELECT DISTINCT spec FROM laurinollim.avgr)
                            GROUP BY l.series, l.year, i.strat, a.spec, a.flen_code;

REM count 3222 4VSW; 2108 without empties

-- sum across strat
drop table nopred;
create table nopred as
select series,year,spec,flen,sum(obs) obs
```

```
from avg_prey
group by series,year,spec,flen;

REM count 576 4VsW
```

Combine tables into final result

```
REM "consump combine tables.sql"
REM table totnopredatlgth has totnofl - the total number of fish at each length at pop level
REM table tot_no_pred has obs - total sample size of fish stomachs analysed
REM view tot_unit_avgrtn has totr - total pop ration per flen, prey type

-- avgr and sample_index NOT correct population average ration; only fish eating that prey
drop table gsconsfinal;
create table gsconsfinal as
select a.series, a.year, a.pred, a.flen, a.prey, a.nsets,c.stdnsets, a.totno,a.avgr,
a.totr, c.totnofl,
b.obs nstoms,
(a.totr/c.totnofl) avgrnew
from tot_unit_avgrtn a,
nopred b,
totnopredatlgth c
where a.series=c.series
and a.series=b.series
and a.year=c.year
and b.year=a.year
and a.pred=c.pred
and b.spec=a.pred
and a.flen=c.flen
and b.flen=a.flen
order by a.series,a.year,a.pred,a.flen,a.prey;

REM count 2529 for 4VSW; 2519 without empties
REM 27930 with all zeros

drop table gsconszeros;
create table gsconszeros as
select series,year,pred,flen,totnofl,sum(totr) totr,nsets,stdnsets from gsconsfinal
group by series,year,pred,flen,totnofl,nsets,stdnsets;
alter table temp add(
prey    number,
avgrnew         number);
update temp set prey=0;
update temp set avgrnew=0;

drop table avgrtn_nozero;
create table avgrtn_nozero as
select series,year,pred,flen,totnofl,totr,nsets,stdnsets,prey,avgrnew from gsconsfinal
where totr>0;

drop table FINAL_avgrtn;
create table FINAL_avgrtn as
(select series,year,pred,flen,prey,nsets,stdnsets,totr,totnofl,avgrnew from avgrtn_nozero)
union all (select series,year,pred,flen,prey,nsets,stdnsets,totr,totnofl,avgrnew
from gsconszeros where totr=0)
order by series,year,pred,flen,prey;
-- NOTE: totnofl not quite correct where totr=0?
-- NSETS,STDNSETS ALL WRONG!
REM 2696 with zeros
```