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Bibliography on Daily Food Ration of Fishes

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BIBLIOGRAPHY ON
DAILY FOOD RATION OF FISHES

by

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ABSTRACT

Literature relating to the daily nutritional ration of fishes was compiled into a bibliography. A table summarizing the pertinent daily ration data for various fish is included in the report. The bibliography will help define missing data required to parameterize ecosystem models.

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INTRODUCTION

Several types of information are required in order to quantify trophic links in the marine environment. Of major interest is the fish food habits information obtained from fish stomach content analysis. This information shows where the trophic connections are between fish and their prey species and provides a relative measure of the strength of these links (i.e., the proportion of each prey in the food of the predator). In order to estimate the actual magnitude of biomass flow between trophic links we need, a measure of the actual amount of food consumed by a predator per unit time. This measure, usually expressed as daily ration, cannot be estimated solely from stomach content analysis.

Daily ration can be calculated in a variety of ways. Some scientists use a bioenergetics approach, basing the estimate of the amount of food a predator has consumed on the observed growth increment of the predator. Others have estimated daily ration using field data on stomach contents in conjunction with estimates of gastric evacuation rates. Many ingenious laboratory experiments have also been conducted to estimate various portions of the energy requirements of fishes.

The purpose here is to summarize, in the form of a bibliography, the literature on daily ration and related feeding aspects of fishes. For general reference purposes the results of some studies are arranged in tabular form grouped by fish predator species. This bibliography will serve as a base for identifying gaps in this type of information, and thus make research planning more effective.

Although the emphasis of this bibliography was intended to be North Pacific marine fish, due to sparsity of available references virtually all freshwater and marine fishes were eligible for inclusion. The species index to the references is arranged alphabetically by family, and within family, by scientific name of species.

Following the species index is a summary (Table 1) of some daily ration values for selected species. Numbers in parenthesis after references in the species index indicate the row in Table 1 where that information is located. The data in the table should be used for general information purposes only. Due to the variety of techniques, terminology, and energy units used in this type of research there is a great deal of room for misinterpretation in reporting other researcher's results. Therefore, the original reference should always be consulted for verification of a particular value.

Although we have attempted to gather every pertinent reference undoubtedly many were missed. We would appreciate hearing of any references not contained in the bibliography in order to keep the list up-to-date with current research.

ACKNOWLEDGMENTS

The authors wish to express their sincere appreciation to those who typed, edited, and printed this report. In particular, we are especially grateful to Marci Worlund, who showed tremendous skill and diligence in neatly arranging and typing the lengthy table. Finally, we want to thank Dr. Taivo Laevastu, who supported and prodded us through all the stases of this report, and kept us going long after our enthusiasm waned.

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 Milinski **1979**
 Paloheimo and Dickie 1966a,b
 Pennington **1981**
 Ware **1978**
 Winberg **1956**
 Windell 1978

ACIPENSERIDAE

Acipenser ruthenus
 Zakora **1978**

[140]

ALUTERIDAE

Stephanolepis cirrhifer
 Ishiwata **1969**

[42]

AMIIDAE

Amia calva
 Hersand Witt **1968**

[16]

ANGUILLIDAE

Anguilla sp.
 Tarr and Hill **1978**

[1]

Anguilla nebulosa
 Reddy et al. **1977**

[2]

BAGRIDAE

Mystus sp.
 Arunchalam and Reddy **1979**

[26]

BLENNIIDAE

Blennius pholis
 Grove and Crawford **1980**
 Vahl and Davenport **1979**

CARANGIDAE

Seriola quinqueradiata
 Hatanaka and Murakawa **1958**

[3]

Ishiwata **1969**

[47]

Trachurus japonicus
 Ishiwata **1979**

[77]

CENTRARCHIDAE

<u>Ambloplites rupestris</u>	
Keast and Welsh 1968	[8]
<u>Lepomis gibbosus</u>	
Keast and Welsh 1968	[109]
Seaburg and Moyle 1964	[108]
<u>Lepomis gulosus</u>	
Hunt 1960	[1 5 7]
<u>Lepomis macrochirus</u>	
Keast and Welsh 1968	[15]
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Seaburg and Moyle 1964	[12]
Windell 1978	[13]
<u>Micropterus dolomieu</u>	
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CICHLIDAE

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CLUPEIDAE

<u>Alosa aestivalis</u>	
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<u>Brevoortia tyrannus</u>	
Kjelson et al. 1975	[83]
Peters and Schaaf 1981	[82]
<u>Clupea harengus</u>	
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<u>Clupea harengus pallasii</u>	
Haegele and Outram 1978	[71]
<u>Dorosoma cepedianum</u>	
Pierce et al. 1981	[58]
<u>Sprattus fuegensis</u>	
Chekunova and Naumov 1977	[131]

COTTIDAE

Myoxocephalus scorpius
Bagge 1977

CYPRINIDAE

Abramis brama

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Zadorozhnaya 1977

Ctenopharyngodon idella

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Cyprinus carpio

Huisman 1976

Kevern 1966

Leuciscus cephalus

Backiel **1971**

Phoxinus phoxinus

Wootton et al. **1981**

Ptychocheilus oregonensis

Steigenberger and Larkin **1974**

Rutilus rutilus

Grigorash et al. **1972**

Ionova and Payusova **1977**

[18]

[17]

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ELEOTRIDAE

Philypnodon breviceps

Staples **1975**

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EMBIOTOCIDAE

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Hayase and Tanaka **1980**

Ditrema viridis

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Neoditrema ransonneti

Hayase and Tanaka **1980**

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ENGRAULIDAE

Engraulis encrasicolus

Mikhman and Tomanovich **1977**

Sirotenko and Danilevskiy 1977

Engraulis japonicus

Takahashi and Hatanaka **1960**

[5]

[6]

[4]

ESOCIDAE

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Diana **1979**

Johnson **1966**

Orlova and Popova **1975**

Esox masquinongy

Gammon **1963**

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Gadus morhua

Bagge 1977	
Braaten and Gokstad 1980	[30]
Cohen and Grosslein 1981	[36]
Daan 1973	[29]
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Cohen and Grosslein 1981	[66]
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Vinogradov 1977	[65]

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Francis 1982	[68]
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Wootton et al. 1981	

GEMPYLIDAE

Gempylus serpens

Lipskaya and Gorbunova 1980	[76]
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GOBIIDAE		
	<u>Pseudapocryptes dentatus</u>	
	Sarker et al. 1980	[59]
GONOSTOMATIDAE		
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	<u>Crenilabrus griseus</u>	
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	Stillwell 1981	[78]
	Stillwell and Kohler 1982	[79]
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	<u>Lepisosteus osseus</u>	
	Herting and Witt 1968	[57]
	<u>Lepisosteus platyrhincus</u>	
	Hunt 1960	[56]
LUTJANIDAE		
	<u>Lutjanus campechanus</u>	
	Wakeman et al. 1979	[110]
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MYCTOPHIDAE

Hygophum proximum

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Myctophum nitidulum

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NOTOTHENIIDAE

Dissostichus eleginoides

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OPLEGNATHIDAE

Oplegnathus fasciatus

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OSMERIDAE

Mallotus villosus

Vesin et al. 1981

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PERCICHTHYIDAE

Morone chrysops

Wissing 1974

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PERCIDAE

Perca flavescens

Keast and Welsh 1968

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Petromyzon marinus

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PLEURONECTIDAE

Hypsopsetta guttulata

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<u>Katsuwonus pelamis</u>	
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<u>Scomber japonicus</u>	
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Kjelson et al. 1975	[104]
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Jones and Geen 1977	[41]
STERNOPTYCHIDAE	
<u>Danaphos oculatus</u>	
Clarke 1978	[88]
TETRAODONTIDAE	
<u>Fugu vermicularis porphyreus</u>	
Ishiwata 1969	[107]

INVERTEBRATES

CEPHALOPODA

Illex illecebrosus

Hirtle et al. 1981

O'Dor et al. 1980

[134]

Vinogradov and Noskov 1975

[136]

Loligo opalescens

Hurley 1976

[135]

Loligo pealei

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[137]

CHAETOGNATHA

Sagitta sp.

Kuhlmann 1977

[27]

EUPHAUSIACEA

Euphausia pacifica

Lasker 1966

Table 1.--Summary of information from daily ration and conversion efficiency studies.

Predator name	Reference	Predator size range	Temperature range (°C)	Major food type used	Gastric evacuation model used	Daily ration (% BWD)	Percent conversion efficiency
1. African eel <u>Anguilla</u> sp.	Tarr and Hill 1978	102.0-688.7 mg	25	Powdered eel food	Linear	4.4	
2. African mottled eel <u>Anguilla nebulosa</u>	Reddy et al. 1977	278.3 + 14.3 mg	23	<u>Tubifex</u> sp. (Oligochaete worm)	Linear		$k_1 = 5.0$ + 2.0
3. Amberfish <u>Seriola quinqueradiata</u>	Hatanaka and Murakawa 1958	49.6-343 g	19.7-22.4 (21.2 ave)	Anchovies	Linear	15.1-4.6	29.1-12.9
		202.-704 g	11.6-18.6 (15.2 ave)			10.1-2.2	10.1-8.0
		42.8-146.8 g	19.7-22.8	Squid		17.3-9.5 (12.7 ave)	42.9-26.6 (34. ave)
4. Anchovy <u>Engraulis japonicus</u>	Takahashi and Hatanaka 1960	6.0-8.9 cm 1.7-7.3 g	13.6-20.0	<u>Euphausia</u> sp.	Linear	15.5-3.6	10.0-9.6
5. Azov anchovy <u>Engraulis encrasicolus maeoticus</u>	Mikhman and Tomanovich 1977	12.1-25.0 mm (larvae)	Summer	<u>Zooplankton</u>	Linear	3.4	
				<u>Zoobenthos</u>		9.3	
				<u>Phytoplankton</u>		3.0-1.4	
6. Black Sea Anchovy <u>Engraulis encrasicolus ponticus</u>	Sirotenko and Danilevsky, 1977	8.1-13.0 mm	15.4	Copepods, zooplankton, fish	Linear	15.9-10.5	
			25-29			22.4-19.8	

Table 1 .--Continued.

Predator name	Reference	Predator size range	Temperature range (°C)	Major food type used	Gastric evacuation model used	Daily ration (% BWD)	Percent conversion efficiency
7. White bass <u>Morone chrysops</u>	Wissing 1974	4.4-7.7 cm	20-22	Daphnia, copepods, zooplankton	Linear	6.0	
8. Rock bass <u>Ambloplites rupestris</u>	Keast and Welsh 1968	100-170 mm 29-90 g	18-22	Isopods, amphipods, zygoptera nymphs, insects	Linear	4.0-2.0	
9. Largemouth bass <u>Micropterus salmoides</u>	Williams 1959	11.7-31.2 cm	70.3 F	Fish	Linear	4.7	
10. " "	Hunt 1960	19.0-22.5 cm 71-115 g	23-26	Fish	Linear	8.4-5.6	
11. Smallmouth bass <u>Micropterus dolomieu</u>	Hunt 1960	8.3-20.2 cm	23-26	Fish	Linear	4.6	
12. Bluegill <u>Lepomis macrochirus</u>	Seaburg and Moyle 1964	4.1-8.6 inches	64-74 F	Insects, fish	Linear	2.2-1.4	
13. " "	Windell 1978	6.2-223 g	5.7-26.8			14.3-0.5	
14. " "	Pierce and Wissing 1974	20.2-148.5 g	15-25	Insect nymphs	Winberg 1956	3.4-1.2 wet wt.	

Table 1 .--Continued.

Predator name	Reference	Predator size range	Temperature range (°C)	Major food type used	Gastric evacuation model used	Daily ration (% BWD)	Percent conversion efficiency
15. Bluegill <u>L. macrochirus</u>	Keast and Welsh 1968	20.2-148.5 g	15-25	Isopods, amphipods, zygoptera nymphs, insects	Linear	4.0-2.0	
16. Bowfin <u>Amia calva</u>	Herting and Witt 1968	11.5-16.1 cm 11-33 g	21.-26.2	Fish		6.5-4.9	
17. Bream <u>Abramis brama</u>	Zadorozhnaya 1977	805.7-978.4 g	9.7-17.0	Insects, insect larvae, plant detritus		6.4-0.7	
18. Bream <u>A. brama</u>	Nebol'sina 1968	299 g ave	18.4-19.2	Insects, detritus		2.3-1.1	
19. Bristle-mouths <u>Cyclothone</u> sp.	Gorelova and Tseytlin 1979	24-45 mm	6.5-9.0	Copepods		2.0-0.4	
20. Capelin <u>Mallotus villosus</u>	Vesin et al. 1981	75-195 mm Juveniles, adults	7-13	Zooplankton, copepods, euphausiids			5.0-2.5
21. Carp <u>Cyprinus carpio</u>	Huisman 1976	38.0-43.1 g	23	Commercial trout pellet		2.2	
22. Carp <u>Cyprinus carpio</u>	Kevern 1966	19.8-22.8 cm (yearlings)	12.5-20.0	Organic detritus, insect larvae		5.4 g (wet) 3.9 (mean BWT day)	12.5 (Gross) 3.2 (Net)

Table 1 .--Continued.

Predator name	Reference	Predator size range	Temperature range (°C)	Major food type used	Gastric evacuation model used	Daily ration (% BWD)	Percent conversion efficiency
23. Grass carp <u>Cteno-</u> <u>pharyngodon</u> <u>idella</u>	Kilambi and Robinson 1979	169-3954 g	12.8 18.3-29.4 29.4	Plant Material	Linear	5. 23.7 58.	
24. Catfish <u>Silurus</u> <u>glanis</u>	Backiel 1971	20-150 cm	1.6-20.0	Fish		3.0-0.9	
25. Channel catfish <u>Ictalurus</u> <u>punctatus</u>	Andrews and Stickney 1972	4.0 g (fingerlings)	18-22 26-34	Pellet diet	Linear	6-4 4-2	10.-2.4 2.4-1.4
26. Catfish <u>Mystus</u> sp.	Arunachalam and Reddy 1976	1.6-2.2 g	24	Worms	Linear	6.4	K1 15.1-3.1
27. Chaetog- naths	Kuhlman 1977	322-1,515 ^μ g 10-22 mm	15	Copepods fish larvae, fish eggs	Linear	4 (dry)	
28. Chub (fresh waters) <u>Leuciscus</u> <u>cephalus</u>	Backiel 1971	18-52 cm	1.6-20.0	Fish		2.6-1.5	
29. Atlantic cod <u>Gadus</u> <u>morhua</u>	Daan 1973	5-100 cm	(North Sea)	Fish, shrimp	Linear	5.3-0.5	

Table 1.--Continued.

Predator name	Reference	Predator size range	Temperature range (°C)	Major food type used	Gastric evacuation model used	Daily ration (% BWD)	Percent conversion efficiency
30. Atlantic cod <u>Gadus morhua</u>	Braaten and Gokstad 1980	23.4- 39.5 cm Adults	4-5	Fish	Linear	3.1-1.3 (1.9 ave)	
			6.2-6.5			3.1-1.9 (2.5 ave)	
31. " "	Tyler 1970	23-35 cm	2-10	Shrimp	Exponential	1.8-0.9	
			15-19			2.2-1.7	
32. " "	Jones 1978	18-94 cm	6 and 12		Exponential	2.8-1.1	
33. " "	Majkowski and Waiwood 1981	537-11,286 g	(Gulf of St. Lawrence)		Winberg	1.5-0.5	
34. " "	Kohler 1964	513-751 g	2.3-13.6	Fish	Linear	0.6-0.5	2.4-2.1:1
35. " "	Durbin et al. 1980	>30 cm	5.8-9.3	Fish	Exponential	1.9-1.1	
36. " "	Cohen and Grosslein 1981	Juveniles, adults	(Georges Bank)	Fish	Exponential	2.0-1.2	
37. " "	Grosslein, et al. 1980	Adults	(Georges Bank)	Fish, crustaceans		2.5-1.0	
38. " "	Edwards and Bowman 1979	Adults	(N.E. Atlantic)			2.5-1.0	

Table 1.--Continued.

Predator name	Reference	Predator size range	Temperature Range (°C)	Major food type used	Gastric evacuation model used	Daily ration (% BWD)	Percent conversion efficiency
40. Georgian cod <u>Notothenia rossi marmorata</u>	Tarverdiyeva 1972	49-86.5 cm (67.8 ave)	1.2-1.3	Ctenophora, crustaceans		13.9-4.9	
40. Black crappie <u>Pomoxis nigromaculatus</u>	Seaburg and Moyle 1964	5-15 inches	64-74 (F)	Fish, insects	Linear	2.1-0.6	
41. Dogfish <u>Squalus acanthias</u>	Jones and Green 1977	60-111 cm	10	Fish	Linear	1.3	
42. Filefish <u>Stephanolepis cirrhifer</u>	Ishiwata 1969	37.8 g (ave)	19.2 (ave)	Clams	Linear	(Fixed)	18.0 (gross)
43. Winter flounder <u>Pseudopleuronectes americanus</u>	Tyler and Dunn 1976	37-41 cm	7	Clams, beef liver	Exponential	2.0-1.0	17.0-1.0 K1
44. " "	Frame, 1973.	60.9-104.5 g	12-16	Clam siphons	Pandian 1970	2.5-1.9	19.0-13.9
		36.7-40.9 g	20.			2.4-0.6	

Table 1.--Continued.

Predator name	Reference	Predator size range	Temperature range (°C)	Major food type used	Gastric evacuation model used	Daily ration (% BWD)	Percent conversion efficiency
45. Yellowtail flounder <u>Limanda ferruginea</u>	Cohen and Grosslein 1981	Young of Year	(Georges Bank)	Fish	Exponential	6.2	
		Juveniles, adults				1.9-1.1	
46. " "	Grosslein et al. 1980.	Adults	(Georges Bank)	Fish, crustaceans		2.2-1.3	
47. Yellowtail flounder <u>Seriola quinqueradiata</u>	Ishiwata 1969	268 g (ave)	24.6	Fish	Linear	(fixed)	19.0
48. Plaice <u>Pleuronectes platessa</u>	Rafail 1968	15-211 g		Clams	Linear	9.0-0.0	
49. " "	Lockwood 1980	0-group	11.5-12.7 (summer)	Polychaetes, mysids	Linear	11-8	
			12.6-13.2 (winter)			3-1	
50. " "	Edwards et al. 1969	0-group	10-17	Oligochaetes	Linear		36.0
51. Atlantic dab <u>Limanda limanda</u>	Pandian 1970	1.1-121.5 g	13	Fish	Linear	6.7-0.6	
		2.7-274.1 g	3-8			2.1-0.0	
		6.2-160.7 g	13-18			6.9-1.2	
52. Plaice (Japanese) <u>Limanda yokohamae</u>	Hatanaka et al. 1956	51-269 g	8.4-19.0	Annelid worms	Linear	4.5-2.9	20.1-10.4
		117.5-216.0 g	13.1	Clams		5.9-1.8	22.6-4.3

Table 1.--Continued.

Predator name	Reference	Predator size range	Temperature range (°C)	Major food type used	Gastric evacuation model used	Daily ration (% BWD)	Percent conversion efficiency
53. Plaice (Japanese) <u>Kareius</u> <u>bicoloratus</u>	Hatanaka et al. 1956	86-302 g	8.2-18.7	Clams	Linear	6.4-1.2	21.9-7.5
		128.-210.5 g	16.7	Annelid worms		4.9-4.0	20.1-18.2
54. English sole <u>Parophrys</u> <u>vetulus</u>	Williams and Caldwell 1978	4-6 g 0-group	9.5-21	Commercial pellets		4-3	10.5-2
55. Diamond turbot <u>Hypsopsetta</u> <u>guttulata</u>	Lane et al. 1979	25-96 g	(Calif. coast)	Crustaceans, mollusks, fish	Exponential	3.8	9.6 (wet wt.)
56. Florida gar <u>Lepisosteus</u> <u>platy-</u> <u>rhincus</u>	Hunt 1960	27-32.5 cm 70-132 g	23-26	Fish	Linear	3.7-2.3	
57. Longnose gar <u>Lepisosteus</u> <u>osseus</u>	Herting and Witt 1968	Young of the year	26.4	Fish		6.7	
58. Gizzard shad <u>Dorosoma</u> <u>cepedianum</u>	Pierce et al. 1981	3-17 cm	(Ohio Lake)	Crustaceans, plankton, mollusks, detritus		61.5-3.1	

Table 1.--Continued.

Predator name	Reference	Predator size range	Temperature range (°C)	Major food type used	Gastric evacuation model used	Daily ration (% BWD)	Percent conversion efficiency
59. Mudskipper (Gobioids) <u>Pseudapocryptes dentatus</u>	Sarker et al. 1980	43-205 mm (114 mm ave) 0.4-85.5 g 20.9 g ave)	Iraqi river estuary in November	Phytoplankton	Linear	10.5-1.3	
60. Haddock <u>Melanogrammus aeglefinus</u>	Jones 1978	18-45 cm	6		Exponential	2.8-1.1	
61. " "	Cohen and Grosslein 1981	Adults	(Georges Bank)	Fish	Exponential	2.9-1.5	
62. " "	Edwards and Bowman 1979	Adults	(NE Atlantic)			3.6-1.8	
63 " "	Hilsop et al. 1978	33.6-41.5 cm 375-730 g	9.1-12.5	Fish, squid	Linear	1.4-0.3	
64. Silver hake <u>Merluccius bilinearis</u>	Durbin et al. 1980	<20 cm ----- >20 cm	5.8-9.3	Fish	Exponential	4.-3.6 ----- 2.7-1.0	

Table 1.--Continued.

Predator name	Reference	Predator size range	Temperature range (°C)	Major food type used	Gastric evacuation model used	Daily ration (% BWD)	Percent conversion efficiency
65. " "	Vinogradov 1977	3-10 years old	6.7-12.4	Crustaceans, fish, squid		4.0-3.4	
66. " "	Cohen and Grosslein 1981	Adults	(Georges Bank)	Fish	Exponential	2.2-0.6	
67. Red hake <u>Urophycis chuss</u>	Vinogradov 1977	3-7 years old	6.7-12.4	Crustaceans, fish, squid		5.8-4.8	
68. Pacific whiting <u>Merluccius productus</u>	Francis 1982	336-880 g 2-8 years old		Fish, shrimp		1.1-0.7	
69. Atlantic herring <u>Clupea harengus</u>	De Silva and Balbontin 1974	0-group	6.2-6.5	Mussels, squid, mysids	Linear	8.8-5.4	
			14.5			12.9-4.5	
70. Blueback herring <u>Alosa aestivalis</u>	Burbridge 1974	4.8-6.9 cm	13.1-28.3	Copepods		29.3-5.4	29.1-2.9 (11.7 ave)
71. Pacific herring <u>Clupea harengus pallasi</u>	Haegele and Outram 1978	Larvae	9-11	Artemia, plankton	Linear		28.6-4.5

Table 1.--Continued.

Predator name	Reference	Predator size range	Temperature range (°C)	Major food type used	Gastric evacuation model used	Daily ration (% BWD)	Percent conversion efficiency
72. Lamprey <u>Petromyzon marinus</u>	Farmer 1980	16-155 g	10 + 1	Rainbow trout, lake trout	Linear	(dry) 8.3-6.3 15.1-10.2	39 (Gross)
73. Mackerel <u>Pneumatophorus japonicus</u>	Hatanaka and Takahashi 1956	45.3-58.2	16	Fish	Linear	11.3-10.0	39-25
		3.8-55.2	20.-24.5			24.3-3.7	
74. " "	Hatanaka and Takahashi 1960	229.5-438 g	21.5	Fish	Linear	6.8 ave	
75. " "	Hatanaka et al. 1957	31.5-95 g	20-22	Fish	Linear	18.5-10.1	19.9-15.4
		115.4-140 g	14.7-18.4			9.8-6.4	13.7-9.5
		93 g	18.7			15.9	20.5
		115 g	18.4			9.8	12.3
		95.1-97 g	21			23.3-14.8	20.6-16.6
76. Snake mackerel <u>Gempylus serpens</u>	Lipskaya and Gorbunova, 1980	8-14 mm	26-30	Copepods	Linear	50-40	
		15 150 mm		Fish larvae		35-30	
77. Jack mackerel <u>Trachurus japonicus</u>	Ishiwata 1979	0-year old 46-110 mm 2-22 g	22.2-23.8	Fish	Linear	6-3	

Table 1.--Continued.

Predator name	Reference	Predator size range	Temperature range (°C)	Major food type used	Gastric evacuation model used	Daily ration (% BWD)	Percent conversion efficiency
78. Shortfin Mako shark <u>Isurus oxyrinchus</u>	Stillwell 1981	Adult	(N.W. Atlantic)	Fish	Exponential	4.3-2.8	
79. " "	Stillwell and Kohler 1982	67-328 cm	(N.W. Atlantic)	Fish	Exponential	3.2	
80. Blue Marlin <u>Makaira nigricans</u>	Gorbunova and Lipskaya 1973	6-22 mm 9-130 g	tropical oceans	Fish	Linear	50-40	
81. Medusa fish <u>Icichthys lockingtoni</u>	Horn 1977	115 mm 30.6 g	8.8-22 (15 ave)	Shrimp		2.7-0.8 (wet)	46 (Gross)
82. Menhaden <u>Brevoortia tyrannus</u>	Peters and Schaaf 1981	1-30 g	Summer Coastal temp. N. Carolina	Phytoplankton, organic detritus		20-13	
83. " "	Kjelson et al. 1975	27-32 mm 43 mg	15-17	Copepods		4.9	
84. Mudskipper <u>Pseudopocryptes dentatus</u>	Sarker et al. 1980	43-205 mm (114. mm ave) 0.4-85.5 g (21 g ave)	(Iraq river estuary in Nov.)	Phytoplankton	Linear	10.5-1.3	

Table 1.--Continued.

Predator name	Reference	Predator size range	Temperature range (°C)	Major food type used	Gastric evacuation model used	Daily ration (% BWD)	Percent conversion efficiency
85. <u>Gray mullet</u> <u>Mugil cephalus</u>	DeSilva and Perera 1976	Juveniles	25 ± 1.6	Rice bran, fish meal	Linear	8-5	6-3
86. <u>Muskellunge</u> <u>Esox masquinongy</u>	Gammon 1963	172.5-222.5 mm 15.9-31.4 g	17-22 (19.5 ave)	Fish	Linear	7.3-3.4 (5.0 ave)	2.7:1 (ratio)
87. <u>Lanternfish</u> <u>Hygophum proximum</u>	Clark 1978	Juveniles, adults	15-19	Copepods, crustaceans	Exponential	5.7	
88. <u>Danaphos oculatus</u>	" "	" "	0	Copepods	" "	1.9	
89. <u>Valenciennulus tripunctulatus</u>	" "	" "	5-6	Copepods	" "	7.3 4.3	
90. <u>Vinciguerrina nimbaria</u>	" "	" "	13-17	Copepods, ostracods, Euphausiids	" "	18.1	
91. <u>Parrot fish</u> <u>Oplegnathus fasciatus</u>	Fukusho 1977	19.3-22.8 cm Juveniles	(Japan)	Copepods		15.8	

Table 1.--Continued.

Predator name	Reference	Predator size range	Temperature range (°C)	Major food type used	Gastric evacuation model used	Daily ration (% BWD)	Percent conversion efficiency
92. Eurasian perch <u>Perca fluviatilis</u>	Thorpe 1977	18-22 cm (Adults)	15-17	Fish		6.5-3.2	
93. " "	Popova and Sytina 1977	Adults	8-10	Fish		4.0-0.5	
94. " "	Spanovskaya and Grygorash 1977	0-age (larvae) Fingerlings	5-10	Cladocerans, copepods		16-12 28-5	
95. Yellow perch <u>Perca flavescens</u>	Nakashima and Leggett 1980	54-150 mm	17	Oregon moist pellets	Linear	2.4-0.4	
96. " "	Mills and Forney 1981	15-34 mm (0-age)	18-22	Daphnia		23	
97. " "	Noble 1972	Fingerlings	21-22	Zooplankton		31-23	
98. " "	Keast and Welsh 1968	90-130 mm 7.8-26.5 g	18-22	Isopods, amphipods, zygoptera nymphs, insects	Linear	4-2	

Table 1.--Continued.

Predator name	Reference	Predator size range	Temperature range (°C)	Major food type used	Gastric evacuation model used	Daily ration (% BWD)	Percent conversion efficiency
99. " "	Nakashima and Leggett 1978	83-310 mm	(Vermont, Quebec lake in summer)	Insects, cladocera, decapods		6.7-2.2	
100. Pike <u>Esox lucius</u>	Orlova and Popova 1975	40-60 cm	8-15	Fish	Linear	2.1-0.2	
101. " "	Johnson 1966	21.3-107 g	18-19	Fish		2.0-1.0	
102. " "	Diana 1979	Juveniles, Adults	2 (winter) 16. (summer)	Fish		0.8-0.4 16.3-10.7	
103. Pike perch <u>Stizostedion luciooperca</u>	Popova and Sytina 1977	Adults	80-10	Fish		5.5-0.5	
104. Pinfish <u>Lagodon rhomboides</u>	Kjelson et al. 1975	16-20 mm (32 mg ave)	15-17	Copepods		3.5	
105. " "	Kjelson and Johnson 1976	15-19 mm (larvae)	12	Copepods		9.0 (wet)	
106. Pollock <u>Pollachius virens</u>	Cohen and Grosslein 1981	Adults	(Georges bank)	Fish	Exponential	5.5-2.2	

Table 1.--Continued.

Predator name	Reference	Predator size range	Temperature range (°C)	Major food type used	Gastric evacuation model used	Daily ration (% BWD)	Percent conversion efficiency
107. Pufferfish <u>Fugu vermicularis porphyreus</u>	Ishiwata 1969	14.1 g ave	24.5 ave	Fish	Linear	(Fixed)	33.0
108. Pumpkin-seed fish <u>Lepomis gibbosus</u>	Seaburg and Moyle 1964	4.1-7.3 inches	64-74° F	Insects, fish	Linear	1.4-0.6	
109. " "	Keast and Welsh 1968	100-140 mm 18-62 g	18-22	Isopods, amphipods, zygoptera nymphs, insects	Linear	4.0-2.0	
110. Red snapper <u>Lutjanus campechanus</u>	Wakeman et al. 1979	23.2-74.5 cm 235-7,005 g	20	Fish, shrimp		1.5	30
111. Caspian roach <u>Rutilus rutilus caspicus</u>	Ionova and Payusova 1977	2.7-3.9 cm 315-1,032 mg	(Summer, Volga river)	Insect larvae		8.1-5.0	
112. Roach <u>Rutilus rutilus</u>	Grigorash et al. 1972	7.7-66.8 mm 2.7-5,477 mg	14.6-20.2	Copepods, crustaceans		26.4-21.7 (larvae) 15.0 Juveniles	

Table 1.--Continued.

Predator name	Reference	Predator size range	Temperature range (°C)	Major food type used	Gastric evacuation model used	Daily ration (% BWD)	% conversion efficiency
113. Sailfish <u>Istio-</u> <u>phorus</u> <u>platy-</u> <u>pterus</u>	Lipskaya and Gorbunova 1977	10-130 mg (larvae)	22-24	Zooplankton, fish		45-30 50-40	$K_2=0.4$
114. Sockeye salmon <u>Oncorhyn-</u> <u>chus</u> <u>nerka</u>	Brett and Shelbourn 1975	1.3 g ave (fry)	15	Commercial trout pellets	Exponential	13.1-1.1	25-+2.5
115. " "	Doble and Eggert 1978	6.4-9.5 cm 8.4-12.5 cm	8.5-10.0 (summer) 5.5-6.0 (winter)	Cladocerans, copepods, insect larvae		4.4-1.3 1.5-0.3	
116. " "	Jobling 1981a	Juveniles	5-10 15-23			6.7-5.5 7.5-5.9	
117. " "	Brett and Higgs 1970	15.0-17.5 cm 30-40 g	15-17	Commercial salmon pellets		2.8	
118. " "	Biette and Green 1980	199-966 mg (Under yearling)	6.2-15.9	Lake zooplankton	Linear	7.8-6.2	20 at 15.9° C

Table 1.--Continued.

Predator name	Reference	Predator size range	Temperature range (°C)	Major food type used	Gastric evacuation model used	Daily ration (% BWD)	Percent conversion efficiency
119. Pink salmon <u>Oncorhynchus gorbuscha</u>	Godin 1981	0.2-4.4 cm (Juveniles)	10	Copepods, barnacle larvae		13.1-6.6	
120. Chum salmon <u>Oncorhynchus keta</u>	Healy 1979	4.2 cm ave 0.5-1.3 g	10-15	Copepods		18.0-4.4 (15.0 ave)	
121. " "	Le Brasseur 1969	3.7-4.4 cm	14-16	Crustaceans, euphausiids, copepods	Linear	5.4	
122. Atlantic salmon <u>Salmo salar</u>	Farmer et al. 1979	8.5+3.0 g	10.+1.0	Commercial pellets	Linear	6.0-5.0	
123. Sauger <u>Stizostedion canadense</u>	Swenson and Smith 1976	Young of the year up to 225 g	14.5-20.0	Fish	Linear	3.5-0.5	
124. " "	Swenson 1977		15-20	Fish		2.3-0.6	
125. Sea chub <u>Ditrema viridis</u>	Hayase and Tanaka 1980	0+ and 1+ age groups	(Summer Odawa bay, Japan)	Amphipods, copepods, cyclopoids, bivalves	Linear	3.0-2.0	

Table 1.--Continued.

Predator name	Reference	Predator size range	Temperature range (°C)	Major food type used	Gastric evacuation model used	Daily ration (% BWD)	Percent conversion efficiency
126. Sea chub <u>Ditrema temmincki</u>	Hayase and Tanaka 1980	0+ and 1+ age groups	(Summer Odaway bay, Japan)	Amphipods, copepods, cyclopoids, bivalves	Linear	5.0-2.0	
127. Sea chub <u>Neoditrema ransonneti</u>	" "	" "	" "	" "	" "	4.0-1.0	
128. Sheatfish <u>Silurus glanis</u>	Orlova and Popova 1975	50-70 cm	8-15	Fish, cyprinids	Linear	4.1-0.4	
129. Snakehead <u>Ophiocephalus striatus</u>	Pandian 1967	1.9-123.8 g	28±1.5	Prawns, fish	Linear	7.2-1.8	36.1-14.0
130. Snakehead <u>Ophiocephalus punctatus</u>	Gerald 1973	6.2 g	28	Fish	Linear	6.3	
		16.1 g				5.6	
131. Falkland sprat <u>Sprattus fuegensis</u>	Chekunova and Naumov 1977	14-69.7 (1-5 years old)	10	Euphausiids, copepods		8-6	
132. Spot fish <u>Leiostomus xanthurus</u>	Kjelson et al. 1975	17-23 mm 33 mg	15-17	Copepods		9.0-4.3	

Table 1 .--Continued.

Predator name	Reference	Predator size range	Temperature range (°C)	Major food type used	Gastric evacuation model used	Daily ration (% BWD)	Percent conversion efficiency
133. " "	Kjelson and Johnson 1976	16-22 mm larvae	17	" "		9.0 (wet)	
134. Squid <u>Illex illecebrosus</u>	O'Dor et al. 1980.	19.3+1.6 cm mantle length 142 + 43 g	7-17	Fish		6.7-3.6	51-35
135. Squid <u>Loligo opalescens</u>	Hurley 1976	2.7-13.0 mm (8.0 mm ave), mantle length; newly hatched to 85 days old	15-17	Artemia, fish larvae		80-35 (50 ave)	
136. Short-finned squid <u>Illex illecebrosus</u>	Vinogradov and Noskov 1975	19-25 cm	N.W. Atlantic	Fish, squid		5.8	
137. Longfinned squid <u>Loligo peali</u>	" "	8-15 cm	" "	" "		3.8 (est.)	
		16-30 cm				3.2 (est.)	
138. Threespine stickleback <u>Gasterosteus aculeatus</u>	Manzer 1976	14-86 mm (45 mm ave) 24.7 mg ave	4-24 (Feb to July)	Cladocerans, copepods, insects		July 6.5 Oct. 7.8	

Table 1 .--Continued.

Predator name	Reference	Predator size range	Temperature range (°C)	Major food type used	Gastric evacuation model used	Daily ration (% BWD)	Percent conversion efficiency
139. Threespine stickle-back <u>Gasterosteus aculeatus</u>	Rajasilta 1980	40.7-51.7 mm	10-18	Fish	Linear	16.9-2.4	
		39.4-55.1 mm		Daphnia		19.4-4.4	
		42.4-43.1 mm		Plankton		2.8-1.7	
140. Sterlet <u>Acipenser ruthenus</u>	Zakora 1978	28.6-43.5 cm	3.2-13.6	Fish, crustaceans		6.1-0.2	
		121.3-518.3 g	16.6-21.7			5.5-2.1	
141. Pacific tarpon (ox-eye) <u>Megalops cyprinoides</u>	Pandian 1967	1.3-149.6 g	2.8+1.5	Prawns, fish	Linear	9.2-1.8	34.2-19.5
142. Tilapia <u>Tilapia mossambica</u>	Mironova 1974	3.1-14.7 g 2-6 months	25	Vegetation		6.9-3.1	
		0.1-26.1 g 0-6 months		Algae		33.7-1.8	
		0.2-27.6 g 0-6 months		Algae, animal food		23.8-1.7	

Table 1.--Continued.

Predator name	Reference	Predator size range	Temperature range (°C)	Major food type used	Gastric evacuation model used	Daily ration (% BWD)	Percent conversion efficiency
143. <u>Tilapia</u> <u>Tilapia</u> <u>mossambica</u>	Mironova 1974	0.2-76.4 g 0-12 months age	25	Animal food		18.9-0.6	
144. Patagonian toothfish <u>Dissosti-</u> <u>chus</u> <u>eleginoides</u>	Tarverdiyeva 1972	45-96 cm	1.2-1.3	Ctenophora, euphausiids		5.1	
145. Rainbow trout <u>Salmo</u> <u>gairdneri</u>	Grove et al. 1978	10-35 cm 10-500 g	5	Commercial trout pellets	Linear	6.9-0.1	
146. " "	Huisman 1976	38.6-43.1 g	23	Commercial trout pellets		2.2	
		65.5-70.0 g	15			1.3	
147. " "	Grayton and Beamish 1977	14.1-16.3 g (wet)	10	Commercial trout pellets	Linear	4.2-2.8	
148. " "	Wurtsbaugh and Davis 1977a	0.9-2.4 g	6.9	Commercial trout pellets		2.2	
			22.5			7.5	
149. " "	Wurtsbaugh and Davis 1977b	0.6-5.3 g	12	Commercial trout pellets	Linear	11.6-4.1	

Table 1.--Continued.

Predator name	Reference	Predator size range	Temperature range (°C)	Major food type used	Gastric evacuation model used	Daily ration (% BWD)	Percent conversion efficiency
150. Rainbow Trout <u>Salmo gairdneri</u>	MacLeod 1978	14 cm ave. 34 g ave. 0+ year group	4.2-9.9	Commercial trout pellets	Rectilinear	(Fixed)	0.0-19.0
151. " "	Bromley and Smart 1981	72 g ave.	9	Commercial trout pellets	Linear	2.8-0.8 (2.3 ave)	2.9-1.0 (1.5 ave)
152. " "	Ishiwata 1969	5.8 g ave.	11.8 ave.	Mysids, fish, barley bran	Linear	(Fixed)	42.0
153. Upland bully <u>Philypnodon breviceps</u>	Staples 1975	1+, 2+, 3+ years age	14.4 - 17.5	Fish, Insects		5.1-1.5 (3.2 ave)	16.0 (Gross)
154. Lake Walleye <u>Stizostedion vitreum vitreum</u>	Swenson and Smith 1973	179-422 g	14.5-20.0	Fish	Linear	3.1-1.4	22.3 ave
155. " "	Kelso 1972	137-205 g	16	Fish, crayfish	Linear	8.5-2.5	14.2-10.6 (Gross) 14.9-10.9 (net)
156. " "	Swenson and Smith 1976	Young of the year up to 388 g	14.5-20.0	Fish	Linear	4.1-0.5	

Table 1.--Continued.

Predator name	Reference	Predator size range	Temperature range (°C)	Major food type used	Gastric evacuation model used	Daily ration (% BWD)	Percent conversion efficiency
157. " "	Swenson 1977	98-280 g	15-20	Fish		4.0-3.0	22-17
158. Warmouth <u>Chaenobryttus gulosus</u>	Hunt 1960	15.3-17.9 cm 72-113 g	8.7-20.4	Fish	Linear	5.3-3.5	
159. Whiting <u>Merlangius merlangus</u>	Flintegaard 1981	10-43 cm	6, 12	Fish	Linear	2.1-0.9	
160. Blue whiting <u>Micromesistius poutassou</u>	Timokhina 1974	26-32 cm (13.5 g ave.)	(June, Norwegian Sea)	Euphausiids, copepods, amphipods, chaetognaths		3.0-1.6	
161. Eye-spot wrasse <u>Crenilabrus ocellatus</u>	Duka 1973	126-1,748 mg 25-56 mm (fingerlings)	16.8±0.2	Polychaetes, zooplankton		(wet) 8.3-0.5 (2.6±0.6 ave) (dry) 7.4-0.2 (2.6±0.7 ave)	
162. Grey wrasse <u>Crenilabrus griseus</u>	Duka 1973	367-11,175 mg 30-51 mm (fingerlings)	" "	" "	" "	(wet) 22.6-0.2 (4.1±1.5 ave) (dry) 13.2-0.6 (3.5±1.2 ave)	

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