

GRADUATE SCHOOL OF OCEANOGRAPHY

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A Compilation of Mortality and Longevity
Estimates for Fish, Mollusks, and Cetaceans,
with a Bibliography of Comparative
Life History Studies

by

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Summary

Various investigators have utilized compendia of life history parameters to derive equations for estimating crucial population parameters from parameters that are easy to measure or estimate. Available compendia of life history parameters, and the papers in which they are analysed, are reviewed in the first part of this report.

A compilation of mortality and longevity parameters of fish, mollusks and cetaceans is presented in the second part of this report. These data formed the basis of a paper, which derived a regression equation for predicting the mortality rate from the maximum age found in a stock.

Compendia of life history parameters have been used to study problems in physiology, evolution and ecology. Applied ecologists have used such compilations to develop equations for predicting crucial parameters from quantities that are easily measured or estimated. Most notably, Pauly (1979a) developed multiple regressions to predict the natural mortality rate of fish from growth parameters and mean water temperature. Ohsumi (1979) developed linear regressions to estimate natural mortality of cetaceans from maximum length or maximum age.

Undoubtedly, further advances in fisheries and wildlife management could be made if more compendia of life history parameters were produced and analysed. A list of data sources and of comparative life history studies is given in Table 1. This table is provided to suggest types of analyses which are possible and to suggest opportunities for further study.

The table does not represent an exhaustive search of the literature.

Recently Hoenig (in prep.) studied the relationship between maximum age in a sample and the total mortality rate for fish, cetaceans and mollusks. A plot of log (mortality) versus log (maximum age) showed a strongly

linear relationship in each case. The maximum age in a sample can be determined rather easily by aging just the largest few animals. Thus, the regression equation can provide a quick, robust method for estimating the mortality rate. The data used for these analyses are given in Tables 2 through 4. Names were updated according to Robins et al. (1980), Abbott (1974) and Leatherwood, Caldwell and Winn (1976). The breakdown by a taxonomic group is as follows:

<u>Group</u>	<u># Stocks</u>	<u>(# Species)</u>
Fish	82	51
Mollusks	26	11
Cetaceans	22	13
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All	130	75

Table 1. Comparative Life History Studies and Compendia of Life History

Parameters		
Reference	Taxonomic Group(s)	Parameters/analyses
Pauly, 1979a	fish	natural mortality vs. growth parameters and mean water temperature
Pauly, 1979b,1980	fish	growth, temperature, gill surface; use of auximetric grid to predict growth
Pauly, 1978	fish	growth parameters (1500 stocks in 500 species)
Nigrelli, 1959	fish	max. lifespan in aquaria
Carlander, 1950	fish	growth parameters
Beverton & Holt, 1959	fish	growth, natural mortality, max. age, max. size
McBride & Brown, 1980	fish	growth, mortality, max. age, age at maturity
Cushing, 1968	fish (several orders)	natural mortality vs. K (growth parameter)
Ursin, 1967	fish	natural mortality vs. asymptotic size
Taylor, 1958	cod	natural mortality vs. water temperature
Bagenal, 1973	fish	fecundity, stock, recruitment
Comfort, 1957	mollusk	duration of life
Zolotarev, 1980	mollusk	max. age, max. size
Antipova, 1978	mollusk	production and biomass
Taylor, 1959, 1960	2 mollusks	natural mortality and growth vary with water temperature
Sacher, 1959	mammals	potential longevity vs. brain and body weight
Sacher and Staffeldt, 1974	mammals	gestation time vs. brain weight
Spinage, 1972	ungulates (mammals)	survival curves

Table 1 (cont.)

Reference	Taxonomic Group(s)	Parameters/analyses
Ohsumi, 1966	cetaceans (mammals)	length at birth, length at maturity
Ohsumi, 1979	cetaceans (mammals)	natural mortality rate vs. max. age and max. length
Laws, 1956	cetaceans (mammals)	body length at physical maturity vs. length at sexual maturity
Bourliere, 1959	birds and mammals	survival curves
Blueweiss et al., 1978	virus to mammal	body weight vs: fecundity, litter weight, neonate weight, r_{max} , brood or gestation time, average and maximum lifespan, maturation time, defecation, neonate production

Table 2. Compilation of fish mortality and longevity estimates.

Family species	Z (yr ⁻¹)	T _{max} (yr)	Reference ^a
Lamnidae			
porbeagle (<u>Lamna nasus</u>)	.18	25	Aasen, 1963
Rajidae			
little skate (<u>Raja erinacea</u>)	.3	8	(1)
Acipenseridae			
lake sturgeon (<u>Acipenser fulvescens</u>)	.01	82	(2)
sturgeon (<u>Acipenser spp.</u>)	.03	30	(2)
Clupeidae			
Atlantic herring (<u>Clupea harengus harengus</u>)			
North Sea	.25	12	(2)
Norwegian Sea	.19	22	(2)
Norway	.78	10	(2)
Pacific herring (<u>Clupea harengus pallasii</u>)	.56	11	(2)
sprat (<u>Clupea sprattus</u>)	1.1	5.5	(2)
Pacific sardine (<u>Sardinops sagax</u>)	.15	13	(2)
Salmonidae			
lake whitefish (<u>Coregonus clupeaformis</u>)			
Canada-L. Nipigon	.17	24	(2)
Canada-Shakespeare Is.L.	.15	27	(2)
Canada-L. Opeongo	.4	12	(2)
dwarf form-L. Opeongo	1.3	5	(2)
cisco or lake herring (<u>Coregonus artedii</u>)			
Wisconsin-Trout Lake, male	1.1	6	(2)
Wisconsin-Trout Lake, female	1.1	11	(2)
Wisconsin-Muskellunge L., male	1.2	3	(2)
Wisconsin-Muskellunge L., female	1.2	4	(2)
Wisconsin-Silver L., male	1.1	6	(2)
Wisconsin-Silver L., female	.9	7	(2)
Wisconsin-Clear L., male	.4	9	(2)
Wisconsin-Clear L., female	.3	11	(2)
kiyi (<u>Coregonus kiyi</u>), male	.8	7	(2)
kiyi (<u>Coregonus kiyi</u>), female	.7	10	(2)
least cisco (<u>Coregonus sardinella</u>)	.6	11	(2)
Atlantic salmon (<u>Salmo salar</u>)	1.1	6	(2)
lake trout (<u>Salvelinus namaycush</u>)	.6	25	(2)
arctic char (<u>Salvelinus alpinus</u>)	.24	25	(2)
Osmeridae			
capelin (<u>Mallotus villosus</u>)	1.3	5	(2)
Esocidae			
northern pike (<u>Esox lucius</u>), male	.3181	15	Frost & Kipling, 1958
northern pike (<u>Esox lucius</u>), female	.3206	14	Frost & Kipling, 1958

Table 2. (cont.)

Family species	Z (yr ⁻¹)	T _{max} (yr)	Reference ^a
Ictaluridae			
channel catfish (<u>Ictalurus punctatus</u>)	.7	12	(2)
Cyprinidae			
minnow (<u>Phoxinus phoxinus</u>)	1.1	3	(2)
Gadidae			
poor cod (<u>Gadus minutus</u>)			
English channel, male	1.1	5	(2)
English channel, female	.9	5	(2)
Mediterranean	2.4	2	(2)
cod (<u>Gadus morhua</u>), North Sea	.2	12	(2)
cod (<u>Gadus morhua</u>), W.N. Atlantic	.2	22	(1)
haddock (<u>Melanogrammus aeglefinus</u>)			
North Sea	.3	10	(2)
W. North Atlantic	.2	18	(1)
hake (<u>Merluccius merluccius</u>), male	.6	10	(2)
hake (<u>Merluccius merluccius</u>), female	.5	10	(2)
pollock (<u>Pollachius virens</u>)	.2	23	(1)
pollock (<u>Pollachius virens</u>)	.15	10	(2)
red hake (<u>Urophycis chuss</u>)	.4	12	(1)
Poeciliidae			
top minnow (<u>Gambusia holbrookii</u>), male	1.5	1	(2)
top minnow (<u>Gambusia holbrookii</u>), female	.7	3	(2)
Atherinidae			
California grunion (<u>Leuresthes tenuis</u>)	1.2	3	(2)
Gasterosteidae			
threespine stickleback (<u>Gasterosteus aculeatus</u>)	.9	4	(2)
tenspined stickleback (<u>Pugitius pungitius</u>)	1.1	4	(2)
Syngnathidae			
seahorse (<u>Hippocampus erectus</u>)	2.5	1	(2)
Percidae			
Eurasian perch (<u>Perca fluviatilis</u>)	.29	17	(2)
Eurasian perch (<u>Perca fluviatilis</u>)	.16	23	(2)
sauger (<u>Stizostedion canadense</u>)	.44	13	(2)
Pomatomidae			
bluefish (<u>Pomatomus saltatrix</u>)	.2	14	(1)
Kyphosidae			
luderick (<u>Girella tricuspidata</u>)	.998	11	Pollock, 1981
Sciaenidae			
weakfish (<u>Cynoscion macdonaldi</u>)	.3	15	(2)

Table 2. (cont.)

Family species	Z (yr ⁻¹)	T _{max} (yr)	Reference ^a
Blenniidae			
blenny (<u>Blennius pholis</u>)	.9	6	(2)
Callionymidae			
dragonet (<u>Callionymus lyra</u>), male	.96	4	(2)
dragonet (<u>Callionymus lyra</u>), female	.86	6	(2)
Scombridae			
chub mackerel (<u>Rastrelliger neglectus</u>)	1.9	2	(2)
Pacific mackerel (<u>Scomber japonicus</u>)	.9	9	(2)
Atlantic mackerel (<u>Scomber scombrus</u>)	.225	19	(1)
yellowfin tuna (<u>Thunnus albacares</u>)	.8	5	(2)
Stromateidae			
butterfish (<u>Peprilus triacanthus</u>)	.8	6	(1)
Scorpaenidae			
redfish (<u>Sebastes marinus</u>)	.1	51	(1)
Cottidae			
bullhead (<u>Cottus gobio</u>)			
Windermere, male	1.1	4	(2)
Windermere, female	.9	6	(2)
R. Brathay, male	.9	4	(2)
R. Brathay, female	.8	6	(2)
Bothidae			
sand dab (<u>Citharichthys sordidus</u>), male	.7	7	(2)
sand dab (<u>Citharichthys sordidus</u>), female	.7	8	(2)
summer flounder (<u>Paralichthys dentatus</u>)	.2	20	(1)
Pleuronectidae			
witch (<u>Glyptocephalus cynoglossus</u>), male	.8844	10	Bowers, 1960
witch (<u>Glyptocephalus cynoglossus</u>), female	.7688	10	Bowers, 1960
butter sole (<u>Isopsetta isolepis</u>), male	1.40	10	(2)
yellowtail flounder (<u>Limanda ferruginea</u>)	.2	15	(1)
winter flounder (<u>Pseudopleuronectes americanus</u>)	.27	13	(1)
winter flounder (<u>Pseudopleuronectes americanus</u>)	.3	11	(2)
plaice (<u>Pleuronectes platessa</u>), male	.22	13	(2)
plaice (<u>Pleuronectes platessa</u>), female	.12	22	(2)
Soleidae			
sole (<u>Solea solea</u>)	.25	9	(2)

a) abbreviations: (1) = McBride and Brown, 1980; (2) = Beverton and Holt (1959)

Table 3. Compilation of mollusk mortality and longevity estimates.

Species	Z (yr ⁻¹)	T _{max} (yr)	Reference
Cardiidae			
Nuttall's cockle (<u>Clinocardium nuttallii</u>)			Weymouth & Thompson, 1931
Tillamook	.525	7	
Copalis	.594	7	
Cordova	.286	17	
Constantine	.384	13	
Kukak Bay	.258	16	
Port Moller	.225	16	
Solenidae			
Pacific razor clam (<u>Siliqua patula</u>)			Weymouth & McMillin, 1931
Pismo, CA	1.01	5	
Crescent City, OR	.668	9	
Channel, WA	.768	8	
Sink, WA	.728	8	
Copalis, WA	.342	9	
Masset, BC	.405	10	
Controller Bay, WA	.507	13	
Karl Bar, AK	.391	17	
Swickshack, AK	.356	15	
Hallo Bay, AK	.331	19	
Mactridae			
Alaska surf clam (<u>Spisula polynyma</u>)	.19	25	Hughes & Bourne, 1981
horse clam (<u>Tresus capax</u>)			Bourne & Smith, 1972
1949 sample	.456	16	
1971 sample	.385	16	
Pectinidae			
scallop (<u>Chlamys tehuelcha</u>)	.703	7-8	Olivier & Capitoli, 1980
black scallop (<u>Chlamys varia</u>)	.518	6	Conan & Shafee, 1978
Veneridae			
amethyst gem clam (<u>Gemma gemma</u>)	1.1	2.5	Thompson, 1982
southern quahog (<u>Mercenaria campechiensis</u>)	.277	22	Saloman & Taylor, 1969
Ostreidae			
American oyster (<u>Crassostrea virginica</u>)	1.3	4-5	Mackin, 1959
Trochidae			
trochid (<u>Monodonta lineata</u>)	.74	15	Williamson & Kendall, 1981
Potamididae			
horn shell (<u>Cerithidea decollata</u>)	.478	9	Cockcroft & Forbes, 1980

Table 4. Compilation of cetacea mortality and longevity estimates.

Species ^a	Z (yr ⁻¹)	T _{max} (yr)	Reference
Balaenopteridae			
fin whale, NA (<u>Balaenoptera physalus</u>)	.06177	45	Lockyer & Brown, 1979
fin whale, NA (<u>Balaenoptera physalus</u>)	.06387	45	Lockyer & Brown, 1979
fin whale, NP (<u>Balaenoptera physalus</u>)	.046	101	Ohsumi, 1979
fin whale, NA (<u>Balaenoptera physalus</u>)	.04	80	Ohsumi, 1979
fin whale, SH (<u>Balaenoptera physalus</u>)	.04	114	Ohsumi, 1979
minke whale, SH (<u>Balaenoptera acutorostrata</u>)	.115	47	Ohsumi, 1979
humpback whale, NP (<u>Megaptera novaeangliae</u>)	.065	77	Ohsumi, 1979
humpback whale, SH (<u>Megaptera novaeangliae</u>)	.07	74	Ohsumi, 1979
blue whale, NP (<u>Balaenoptera musculus</u>)	.04	91	Ohsumi, 1979
blue whale, SH (<u>Balaenoptera musculus</u>)	.05	110	Ohsumi, 1979
pygmy blue whale, SH (<u>Balaenoptera musculus</u>)	.05	84	Ohsumi, 1979
sei whale, NP (<u>Balaenoptera borealis</u>)	.057	64	Ohsumi, 1979
sei whale, NWA (<u>Balaenoptera borealis</u>)	.07	71	Ohsumi, 1979
sei whale, SH (<u>Balaenoptera borealis</u>)	.065	74	Ohsumi, 1979
Bryde's whale, NP (<u>Balaenoptera edeni</u>)	.085	55	Ohsumi, 1979
Physetridae			
sperm whale, SH (<u>Physeter catodon</u>)	.06	62	Ohsumi, 1979
sperm whale, NP (<u>Physeter catodon</u>)	.065	77	Ohsumi, 1979
Ziphiidae			
bottlenose whale, NA (<u>Hyperoodon ampulatus</u>)	.085	>37	Ohsumi, 1979
Delphinidae			
pilot whale, NA (<u>Globicephala melaena</u>)	.115	45	Ohsumi, 1979
striped dolphin, NP (<u>Stenella coeruleoalba</u>)	.137	34	Ohsumi, 1979
spotted dolphin, NP (<u>Stenella plagiodon</u>)	.161	31	Ohsumi, 1979
Monodontidae			
white whale ^b , AR (<u>Delphinapterus leucus</u>)	.06	23	Ohsumi, 1979
Eschrichtidae			
gray whale, CA (<u>Eschrichtius robustus</u>)	.08	73	Ohsumi, 1979

a) abbreviations: NA = North Atlantic, NP = North Pacific, SH = southern hemisphere, CA = California, NWA = Northwest Atlantic, AR = Arctic Sea

b) Ohsumi (1979) considered these data unreliable and excluded them from his analysis. Hoenig (in prep) also excluded these data.

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