

COASTAL/ESTUARINE FISH HABITAT DESCRIPTION & ASSESSMENT MANUAL

PART I

SPECIES/HABITAT OUTLINES

Prepared for

Unsolicited Proposals Program Supply and Services Canada 12C1, Phase III 11 Laurier Street Hull, Québec K1A 0S5

Scientific Authority

Gordon Ennis Water Use Unit Fisheries and Oceans Canada 555 West Hastings Street Vancouver, B.C. V6B 5G3

Prepared by

Gary L. Williams G.L. Williams & Associates Ltd. 2300 King Albert Avenue Coquitlam, B.C. V3J 1Z8

September 1989

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PREFACE

In December 1987, G.L. Williams and Associates Ltd. was awarded a contract as a result of an unsolicited proposal to develop a marine foreshore on-site habitat description and assessment evaluation manual for the Department of Fisheries and Oceans (DFO). The unsolicited proposal was funded by the Unsolicited Proposals Program, Department of Supply and Services, Department of Fisheries and Oceans and Environment Canada, Parks. The overall objective of the work was to develop practical, consistent and ecologically based procedures to guide habitat biologists, fisheries officers and other field staff who routinely conduct habitat assessments and evaluations as part of the development project referral process. The work has resulted in four main components: species/habitat outlines for 49 species important to the commercial, sport and Native fisheries, habitat description procedures manual, habitat evaluation procedures manual, and a species/habitat references appendix.

To ensure that the work would be useful to field staff and be scientifically sound, a federal-provincial steering committee was formed to guide the work. The members of the Steering Committee are identified below.

Scientific Authority:

Gordon Ennis Habitat Management Division DFO

Steering Committee:

Dr. Colin Levings Coastal Habitat Ecology Fisheries Research Branch DFO

Denis Rowse/Tom Pendray North Coast Division DFO

John Mathers/Peter Delaney Habitat Management Division DFO

Dave McBurney Parks Environment Canada Kevin Conlin Fraser River, Northern B.C. Yukon Division DFO

Bruce Hillaby/Rob Russell South Coast Division DFO

Don Howes Recreational Fisheries Branch Ministry of Environment

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Earlier drafts of the species/habitat outlines were critically reviewed by research scientists and habitat biologists to improve the presentation and to ensure that the documentation was as accurate as possible. The author is very grateful to all those who reviewed the information and provided written comments, including Gordon Ennis, DFO; Colin Levings, West Vancouver Laboratory, DFO; Kevin Colin, DFO; L. Margolis, Terry Gjernes, Vivian Haist, Doug Hay, Sandy McFarlane, Laura Richards, Bruce Leaman, Rick Stanley, Mark Saunders, Al Tyler, Jeff Fargo, Neil Bourne, Glen Jamieson, Jim Boutillier, Pacific Biological Station, DFO; and Bruce Ward, Vic Swiatkiewicz, Pete Law, Maurice Lirette, B.C. Ministry of Environment. Thanks are also given to Bob Emmett, National Marine Fisheries Service, for providing reference lists for several species.

Most of the species illustrations included in this report were reproduced with the kind permission of the Department of Fisheries and Oceans or the Royal British Columbia Museum. The sources used have been cited below and credits given to both the author and illustrator. For species not covered in the reports cited below, original drawings were prepared by Sharon Galenzoski of XY3 Graphics. Credits for the illustrations include:

- Butler, T.H. 1980. Shrimps of the Pacific coast of Canada. Can. Bull. Fish. Aquat. Sci. 202: 280 p. [illustrated by A.A. Denbigh].
- Carl, G.C. 1963. Guide to marine life of British Columbia. B.C. Prov. Mus. Handb. 21: 135 p. [illustrated by F.L. Beebe]
- Hart, J.F.L. 1982. Crabs and their relatives of British Columbia. B.C. Prov. Mus. Handb. 40: 266 p. [illustrated by J.F.L. Hart].
- Hart, J.L. 1973. Pacific fishes of Canada. Bull. Fish. Res. Board Can. 180: 740 p. [illustrated by D.R. (Bon) Harriott].
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1.0 INTRODUCTION

In October 1986 the Department of Fisheries and Oceans (DFO) formally introduced its policy for the management of fish habitat. Although the policy outlines several policy objectives such as net gain and no net loss of fish habitat, the policy does not provide an implementation strategy or specific guidelines on how the policy will be carried out. This has resulted in each of the three regional divisions of DFO implementing their own approach to achieving policy objectives. In practice, there has been considerable variation in application of the policy, and there is a demonstrated need for a more standardized and consistent approach to habitat assessment for the Pacific coast.

In December 1987, G.L. Williams & Associates Ltd. was awarded a contract to carry out an unsolicited proposal to develop a coastal habitat description and assessment manual. Unique to this project was the preparation of succinct species/habitat outlines, from which specific procedures manuals could be developed. In a meeting in January 1988, the project Steering Committee identified over 50 potentially important species which could be covered. The species list was finalized after receiving input from DFO Coastal District offices and the 49 species are shown in Table 1. The species/habitat outlines were prepared following an intensive review of the literature and critical review by research scientists from the Pacific Biological Station and West Vancouver Laboratory, and from habitat biologists from DFO and the B.C. Ministry of Environment.

Table 1. Species list for species/habitat outlines.

	Cor	mmon Name	Scientific Name	
<u>—</u>	ANADROMO	OUS FISHES	<u> </u>	
		chinook salmon	Oncorhynchus tshawytscha	
	2	chum salmon	Ο μοτα	
	2.	coho salmon	O kisutch	
	5. 4	pink salmon	O gorbuscha	
		sockeve salmon	O. norka	
	5.	coastal cutthroat trout	O. clarki	
	0. 7	steelband trout	O. mukica	· .
	7.	Dolly Varden abor	O. Myriss Salvalinus malma	
	о. О	bolly valuen char	Acincus and transmost and	
	9. 10.	eulachon	Thaleichthys pacificus	
2	A A DINIT THE			
э.	MARINE FIS	Π <u>L</u> Ο		
	11.	Pacific herring	Clupea harenous pallasi	•
	12	surf smelt	Hypomesus pretiosus	
	13	lingcod	Ophiodon elongatus	
	13.	English sole	Pleuronectes vetulus	
	15	starry flounder	Platichthys stellatus	
	16	Pacific halibut	Hinnodossus stenolenis	
	17	hig skate	Raja hinoculata	
	18	copper rockfish	Sebastes caurinus	
	10.	vellowtail rockfish	S flavidus	
	20	velloweve rockfish	S. rubarrimus	
	20.	quillback rockfish	S. maliger	
7	MOLLUSCS			
	22.	butter clam	Saxidomus giganteus	
	23.	littleneck clam	Protothaca staminea	
	24.	Manila clam	Tapes philippinarum	
	25.	razor clam	Siliqua patula	
	26.	horse clam	Tresus capax	
	27.	horse (gaper) clam	T. nuttallii	
	28.	cockle	Clinocardium nuttallii	
	29.	geoduck	Panope abrupta	
	30.	soft-shell clam	Mva arenaria	
	- 57	Pacific oveter	Crassostraa aigas	

V-POOL

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Table 1. (continued).

Common Name

Scientific Name

C. MOLLUSCS (continued)

32. native oyster

- 33. pink scallop
- 34. spiny scallop

35. weathervane scallop

- 36. rock scallop
- 37. blue mussel
- 38. northern abalone
- 39. opal squid
- 40. giant Pacific octopus

D. ECHINODERMS

- 41. California sea cucumber
- 42. red sea urchin
- 43. green sea urchin

E. CRUSTACEANS

- 44. gooseneck barnacle
- 45. coonstripe shrimp
- 46. humpback shrimp
- 47. prawn
- 48. Dungeness crab
- 49. red rock crab

Ostrea lurida Chlamys rubida C. hastata Patinopecten caurinus Crassadoma gigantea Mytilus edulis Haliotis kamtschatkana Loligo opalescens Octopus dofleini

Parastichopus californicus Strongylocentrotus franciscanus S. droebachiensis

Pollicipes polymerus Pandalus danae P. hypsinotus P. platyceros Cancer magister C. productus

2.0 NOTES ON SPECIES/HABITAT OUTLINES

2.1 RATIONALE

The species/habitat outlines are intended to provide the scientific background for making ecologically sound habitat assessments specific to the British Columbia coast. One criticism of most habitat assessments or evaluations carried out as part of the standard development project review is that they tend to be only concerned with one species or group of organisms (e.g. Pacific salmon). This approach simplifies the logistical problems of conducting rapid assessments, but falls far short of generating an ecological evaluation from which habitat managers can make decisions about project approval, mitigation and compensation.

The species/habitat outlines provide succinct summaries of marine and estuarine nearshore habitat utilization and other pertinent information for 49 of the most economically and ecologically "important" organisms that support commercial, recreational and Native fisheries. They have been developed to provide field personnel with a species specific, ecological summary. Hopefully, they will impress upon users that coastal habitats support a diverse and dynamic flora and fauna, and that assessments must consider entire life cycles and include sufficient temporal and geographic boundaries. The outlines also provide a foundation for developing the habitat description and assessment procedures manuals.

2.2 SPECIES/HABITAT DOCUMENTATION

The species/habitat outlines consist of two main components: succinct text summarizing existing scientific information and figures showing habitat utilized and generalized life cycles. The format was developed to provide manual users with a short, easy-to-use guide to assist habitat assessment. Each species/habitat outline includes information on the following:

- taxonomy
- ecological data
- growth rate
- fishery
- references
- generalized life cycle, habitat utilization, and coastal distribution

The main categories are discussed below.

1. TAXONOMY

A basic taxonomic summary is provided to assist manual users determine to which group a particular organism belongs, since popularized Family names are often used in the literature to describe groups of animals. It also shows how the organisms are grouped according to similar characteristics, and will assist users to obtain more detailed information in text books or other more complete references.

2. ECOLOGICAL DATA

Although the primary focus of the manual is on habitat, it is important that an ecological approach be used in habitat assessments. To encourage use of a more ecological approach, notes are included on habitat and trophic interactions, including:

(a) Distribution

Many species have a wide distribution and are relatively abundant. Others may have a much more limited distribution either latitudinally or geographically, or according to exposure or other factor.

(b) Habitat

Information under this heading will probably be the most critical for habitat assessments. The habitat zone addressed in the manual is the coastal area between the riparian and 20 m subtidal depth. Habitat utilization was summarized according to the dominant stages of the life cycle. It attempts to stress the temporal nature of habitat utilization. For example, a continuum of habitats are used during the life of an organism and habitat assessments should try to determine how the development will affect the functional relationship between organism and habitat.

(c) Tidal elevation

Habitat utilization during much of a species life cycle is often largely confined to a restricted tidal zone. Therefore, it is important that habitat assessors be aware of specific usage. In other cases, habitat utilization varies with each stage in the life cycle.

(c) Food and predators

Primary food sources or prey are identified to try to show some of the ecological relationships for each of the 49 species.

3. GROWTH RATE

An indication of growth rate helps to provide some insight into habitat utilization. For example, slow growing organisms may reside in a particular habitat for extended periods of time, or the size of an animal may affect the amount of habitat required per individual, or size can be a useful characteristic for species identification.

4. FISHERY

Some species are more important economically and may require more restrictive habitat protection. Under this heading the size and/or value of the recent fishery may be provided, based on 1986 commercial catch statistics, or noted as being important. Quotas or fishing limits may also be useful information and was included where available.

5. REFERENCES

The most "useful" references were included to guide manual users to more complete scientific literature describing habitat utilization. More extensive references are provided in the Appendix report. As new data becomes available our understanding of habitat utilization will improve, and the existing references updated easily.

6. FIGURES

A three part figure was included for each species which shows (a) habitat utilization, (b) coastal distribution and (c) life cycle. Species illustrations are also included at the end of the report.

Part A – Habitat Utilization

Habitat utilization shows a cross-sectional view through typical habitat, from riparian to 20 m depth. It attempts to guide the manual user by indicating intertidal and subtidal utilization, dominant vegetation types, substrate, etc.

Part B – Coastal Distribution

Coastal distribution presents a hypothetical reach of inshore and open coast, along with the dominant habitat types. The area where one would expect to find the organism is shown by the shading, "expected presence". This figure will assist the manual user in considering the importance of habitats to specific organisms.

Part C – Life Cycle

Life cycle provides a simplified schematic identifying the main life stages. For some species the life cycle could be well represented by a figure, while others were more complicated and text seemed more appropriate. The aim of the life cycle figure was to provide the manual user with a more ecological impression of habitat utilization.

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3.0 SPECIES/HABITAT OUTLINES

CHINOOK SALMON, Oncorhynchus tshawytscha (Walbaum)

TAXONOMY

Phylum: Chordata Class: Osteichthyes Order: Salmoniformes Family: Salmonidae

ECOLOGICAL DATA

Distribution: spawn in medium to large streams and larger rivers; extensive feeding migration in Pacific Ocean.

Habitat: spawn in Jul-Nov in Fraser River, Aug-Sep in south, Oct on Vancouver Is. and in Sep in north; eggs laid in redds in gravel; fry emerge in Mar-May; three life history strategies exist: "immediate" fry migrate directly to estuary, "ocean-type" rear in freshwater for 60-120 days before migrating seaward as smolts, and "stream-type" fry rear in river for 1-2 yr and migrate seaward as smolts; fry (33-45 mm) utilize shallow, nearshore from May-Aug/Sep, e.g. tidal channels, tide flats and eelgrass beds; rear in deeper water as they grow until late summer; smolts (8-10 cm) migrate to estuary in Jul; rear in outer estuary or deeper nearshore water until fall; juveniles migrate to ocean and spend 2-4 yr feeding; some remain in inshore waters.

Tidal elevation: fry feed with tide cycle, at high tide line and in tidal channels at ebb tide; smolts and adults feed and migrate in deeper water.

Food: fry prey on insects, amphipods, decapod larvae and calanoid copepods; juveniles eat small fish (herring, sand lance, rockfish), crustaceans (amphipods, euphausiids, cladocerans); adults eat fish and euphausiids.

Predators: fishes, birds, marine mammals and bears.

GROWTH RATE

Largest of Pacific salmon; mature at 3-5 yr; maximum size 147 cm and 57 kg.

FISHERY

Support valuable commercial, sport and Native fisheries; 1986 commercial catch was 4420 t valued at almost \$19.7 million.

REFERENCES

Fraser, F.J., P.J. Starr, and A.Y Fedorenko. 1982. A review of the chinook and coho salmon of the Fraser River. Can. Tech. Rep. Fish. Aquat. Sci. 1126: 130 p.

Healey, 1980. Utilization of the Nanaimo River estuary by juvenile chinook salmon, *Oncorhynchus tshawytscha*. Fish. Bull. 77: 653-668.

Levings, C.D. 1982. Short term use of a low tide refuge in a sandflat by juvenile chinook, (*Oncorhynchus tshawytscha*), Fraser River estuary. Can. Tech. Rep. Fish. Aquat. Sci. 1111: 33 p.

Levings, C.D. McAllister, and B.D. Chang. 1986. Differential use of the Campbell River estuary, British Columbia, by wild and hatchery-reared juvenile chinook salmon (*Oncorhynchus tshawytscha*). Can. J. Fish. Aquat. Sci. 43: 1386-1397.

Levy, D.A., and T.G. Northcote. 1979. Juvenile salmon utilization of tidal channels in the Fraser River estuary, British Columbia. Univ. B.C. Westwater Res. Cen. Tech. Rep. 23: 70 p.

Simenstad, C.A. 1983. The ecology of estuarine channels of the Pacific Northwest coast: a community profile. U.S. Fish Wildl. Serv. FWS/OBS-83/05: 81 p.



1-1

Generalized life cycle of the chinook salmon. Mature adults return to medium and larger streams to spawn. Spawn mainly from July to November in Fraser River, August to September in south coast, October on Vancouver Island and in September in north coast. Adults die soon after spawning. Eggs are laid in redds constructed in gravel reaches of river. Alevins remain in gravel until yolk sac is absorbed. Fry emerge from gravel from March to May. Fry follow one of three life history patterns: "immediate" fry migrate immediately to estuary or ocean, "ocean-type" fry rear for 60-120 days (i.e. 90 day fry) in freshwater before migrating seaward as smolts, and "stream-type" fry rear for 1-2 years in freshwater before migrating seaward as smolts the following spring. Fry rear in shallow water in estuaries, tideflats or eelgrass beds from April to August September. As they grow they move to more pelagic habitats. In fall they leave inshore and undergo 2-5 year ocean feeding migration. Some stocks remain inshore. Small numbers of males or "jacks" mature early and return to spawn at 2-3 years of age. Mature chinook return to natal stream and may hold off mouth for several days or weeks before migrating upstream to spawn. Maximum size is about 147 cm.

CHUM SALMON, Oncorhynchus keta (Walbaum)

TAXONOMY

Phylum: Chordata Class: Osteichthyes Order: Salmoniformes Family: Salmonidae

ECOLOGICAL DATA

Distribution: spawn in coastal streams and larger rivers (e.g. Fraser and Skeena); extensive feeding migration in Pacific Ocean.

Habitat: mature adults spawn from Sep-Jan in south and as early as Jul in north; eggs laid in gravel redds in lower reaches of streams, or up to 100 km from mouth in larger rivers; fry emerge from gravel in Apr and May and swim directly to estuary; form schools and disperse along shore rearing in shallow, nearshore nursery areas; utilize eelgrass beds, estuarine marshes and tidal channels; move to deeper water as they grow; late-Jun and early-Jul begin to migrate to ocean (80-100 mm); spend 2-3 summers in ocean; on return, may pause at mouth of spawning river for several days or weeks depending on river discharge before migrating upstream.

Tidal elevation: fry rear in shallow nursery areas; smolts and adults feed and migrate in deeper water.

Food: fry feed on harpacticoid copepods, decapod larvae, insects and amphipods in nursery areas; in outer estuary feed on cladocerans, decapod larvae, *Oikopleura* and gammarid amphipods; amphipods and euphausiids during ocean migration.

Predators: fishes, birds, marine mammals, and bears.

GROWTH RATE

Mature at 3-4 yr; fry, 36 mm in May leave for ocean at 12-25 cm in Sep; maximum size is 102 cm.

FISHERY

Support important commercial and Native fisheries; 1986 commercial catch was 24,922 t valued at \$37.6 million.

REFERENCES

Healey, M.C. 1979. Detritus and juvenile salmon production in the Nanaimo estuary: I. Production and feeding rates of juvenile chum salmon (*Oncorhynchus keta*). J. Fish. Res. Board Can. 36: 488-496.

Healey, M.C. 1980. The ecology of juvenile salmon in Georgia Strait, British Columbia., p. 203–229. *In* W.J. McNeil and D.C. Himsworth [ed.] Salmonid ecosystems of the North Pacific. Ore. State Univ. Press, Corvallis.

Healey, M.C. 1982. Juvenile Pacific salmon in estuaries: the life support system, p. 315-341. *In* V.S. Kennedy [ed.] Estuarine comparisons. Academic Press, N.Y.

Mason, J.C. 1974. Behavioural ecology of chum salmon fry (*Oncorhynchus keta*) in a small estuary. J. Fish. Res. Board Can. 31: 83–92.

Neave, F. 1966. Salmon of the north Pacific Ocean – Part III. A review of the life history of north Pacific salmon. 6. Chum salmon in British Columbia. Int. North Pac. Fish. Comm. Bull. 18: 81–85.



Generalized life cycle of the chum salmon. Mature chum salmon migrate to spawning streams from August to November. Spawn in gravel reaches of coastal streams, or as far as 100 km from the mouth in larger rivers, from September to January and as early as July in north. Adults die soon after spawning. Alevins remain in gravel after hatching until yolk has been absorbed. Fry emerge in April and May and migrate directly to estuary. Fry school prior to reaching salt water and rear in nursery areas along shoreline. Typically rear in eelgrass beds, tidal marsh channels and protected bays. As they grow they move to deeper water or outer estuary. During July and August move offshore to begin ocean feeding migration. Spend 2 years in ocean. Return to natal stream to spawn and may pause for several days or weeks at mouth, depending on discharge, prior to migrating upstream. Adults usually mature at 3–4 years and may reach 102 cm in length.

TAXONOMY

Phylum: Chordata Class: Osteichthyes Order: Salmoniformes Family: Salmonidae

ECOLOGICAL DATA

Distribution: One of the most widespread of Pacific salmon; spawn in smaller streams and rivers; extensive feeding migration in Pacific Ocean.

Habitat: adults migrate to streams from Jul to Nov; spawn from mid-Oct to mid-Dec, as late as Feb; eggs laid in gravel redds in streams; fry emerge in Apr and May; rear in freshwater for 1-2 yr and migrate as smolts to estuary in May and June, or fry may rear in estuary until late Sep-Nov; may rear in outer estuary from mid-May to June, occasionally to Sep; adults may make long ocean feeding migration, while resident or inshore migrants remain in Georgia Strait; some males or "jacks" return to freshwater after one summer in ocean; mature adults may hold in estuary for several days or weeks before migrating upstream to spawn.

Tidal elevation: fry may rear in estuary; smolts and adults feed and migrate in deeper water.

Food: fry prey on drift (e.g. Diptera and amphipods); smolts eat fish and decapod larvae, larval insects and crustaceans (e.g. gammarid amphipods); larger juveniles take herring and sand lance, euphausiids, amphipods and megalops larvae.

Predators: fishes, birds, marine mammals and bears.

GROWTH RATE

Mature at 3-4 yr, 1-2 yr in freshwater and 2 yr in ocean; may reach 98 cm.

FISHERY

Important sport fish; support commercial and Native fisheries; 1986 commercial catch was 11,666 t valued at \$39.3 million.

REFERENCES

Aro, K.V., and M.P. Shepard. 1967. Salmon of the north Pacific Ocean – Part IV. Spawning populations of north Pacific salmon. 5. Pacific salmon in Canada. Int. North Pac. Fish. Comm. Bull. 23: 225–327.

Fraser, F.J, P.J. Starr, and A.Y. Fedorenko. 1982. A review of the chinook and coho salmon of the Fraser River. Can. Tech. Rep. Fish. Aquat. Sci. 1126: 130 p.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Board Can. Bull. 180: 115-118.

Healey, M.C. 1980. The ecology of juvenile salmon in Georgia Strait, British Columbia., p. 203–229. *In* W.J. McNeil and D.C. Himsworth [ed.] Salmonid ecosystems of the North Pacific. Ore. State Univ. Press, Corvallis.

Healey, M.C. 1982. Juvenile Pacific salmon in estuaries: the life support system, p. 315-341. *In* V.S. Kennedy [ed.] Estuarine comparisons. Academic Press, N.Y.

Tschaplinski, P.J. 1987. The use of estuaries as rearing habitats by juvenile coho salmon, p. 123-142. *In* T.W. Chamberlain [ed.] Proc. Workshop: Applying 15 Years of Carnation Creek Results, Nanaimo, B.C.



Generalized life cycle of the coho salmon. Mature coho salmon migrate to spawning streams primarily from September to November (as early as July and late as December). Spawn in gravel reaches of small streams from Mid-October to Mid-December, and may extend into February. Adults die soon after spawning. Alevins remain in gravel after hatching until yolk sac has been absorbed. Fry emerge in April and May and rear in freshwater for one year or two years. In May and June, after spending 1-2 years in stream or off-channel habitat, smolts migrate to estuary. In smaller systems, fry may rear in estuary until late September or November and overwinter in nearshore areas. Generally smolts do not utilize inner estuaries for extended periods of time, but may rear in outer estuary until June or off tidal flats until fall. In late summer or fall most juveniles migrate to open ocean to feed. Ocean migration lasts about 18 months. Some coho reside solely inshore. Small percentage of males or "jacks" only spend one summer in ocean before returning to freshwater to spawn. Returning mature adults may hold off the mouths of spawning rivers for several days or weeks prior to migrating upstream to spawn. Adults may reach 98 cm.

PINK SALMON, Oncorhynchus gorbuscha (Walbaum)

TAXONOMY

Phylum: Chordata Class: Osteichthyes Order: Salmoniformes Family: Salmonidae

ECOLOGICAL DATA

Distribution: spawn in coastal streams and larger rivers; extensive feeding migration in Pacific Ocean.

Habitat: adults migrate up rivers to spawn in Sep and Oct; eggs laid in gravel redds and fry emerge from Mar to May and migrate directly to estuary; may remain in tidal channels of estuary for several days but school and rear in shallow (less than 1 m) nearshore water for 1–2 weeks (35–45 mm); rear in adjacent, deeper water as they grow; in July juveniles begin to migrate from inshore to ocean; make extensive ocean feeding migrations over 18 months; adults home to natal river to spawn at 2 yr, but may hold at mouth for several days or weeks before migrating upstream.

Tidal elevation: fry rear in shallow nearshore; larger juveniles and adults feed and migrate in deeper water.

Food: fry feed on epibenthos (i.e harpacticoid copepods) in shallow water; juveniles prey on zooplankton (copepods, barnacle larvae, euphausiid eggs and amphipods) and terrestrial insects; smolts and adults eat euphausiids, amphipods, copepods, squid and small fish (e.g. herring, eulachon).

Predators: fishes, birds, marine mammals and bears.

GROWTH RATE

Rapid; fry 35 mm in May grow to 100 mm Jul in Georgia Strait; reach sexual maturity at 2 yr.

FISHERY

Important commercial species; support Native and minor sport fisheries; 1986 commercial catch was 29,264 t valued at \$25.7 million.

REFERENCES

Godin, J.-G.J. 1981. Daily patterns of feeding behaviour, daily rations, and diets of juvenile pink salmon (*Oncorhynchus gorbuscha*) in two marine bays of British Columbia. Can. J. Fish. Aquat. Sci. 38: 10-15.

Healey, M.C. 1967. Orientation of pink salmon (*Oncorhynchus gorbuscha*) during early marine migration from Bella Coola River system. J. Fish. Res. Board Can. 24: 2321-2338.

Healey, M.C. 1980. The ecology of juvenile salmon in Georgia Strait, British Columbia., p. 203–229. In W.J. McNeil and D.C. Himsworth [ed.] Salmonid ecosystems of the North Pacific. Ore. State Univ. Press, Corvallis.

Manzer, J.I. 1956. Distribution and movement of young Pacific salmon during early ocean residence. Fish. Res. Board Can. Pac. Progr. Rep. 106: 24-28.

Neave, F. 1966. Salmon of the north Pacific Ocean – Part III. A review of the life history of north Pacific salmon. 5. Pink salmon in British Columbia. Int. North Pac. Fish. Comm. Bull. 18: 71–79.



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Generalized life cycle of the pink salmon. Mature pink salmon return to natal rivers to spawn in late summer. May hold off of mouth for several days or weeks before migrating upstream to spawn. Spawn in September or October in gravel reaches of rivers or streams. Adults die soon after spawning. Eggs hatch from late-December to late February and alevins remain in gravel until emergence from March to May. Fry migrate immediately downstream to estuary. Fry school once they reach estuary. Only remain in tidal channels several days, but rear in shallow (less than 1 m) nearshore water for 1-2 weeks. Move to deeper water as they grow. Leave inshore water in late summer and migrate to open ocean. Extensive feeding migration occurs in northeast Pacific over the next 18 months. Return as 2 year olds to spawn and die. The 2-year cycle is so invariable that adult runs in odd-calendar years are separate from even-year runs, and stocks are referred to as odd or even year. Adults may reach about 76 cm.

SOCKEYE SALMON, Oncorhynchus nerka (Walbaum)

TAXONOMY

Phylum: Chordata Class: Osteichthyes Order: Salmoniformes Family: Salmonidae

ECOLOGICAL DATA

Distribution: spawn in lake fed systems; extensive feeding migration in NE Pacific Ocean.

Habitat: mature adults enter natal river from Jun to Sep; spawn in Sep and Oct in gravel areas of lake tributaries, outlet, or spring-fed areas along shore; fry emerge in Apr and May and rear in lake for 1-2 yr; some stocks migrate as fry to rear in riverine or estuarine nursery areas; juveniles from lakes emigrate during Apr and May as smolts at 60-100 mm; May and Jun juveniles rear along Vancouver Is. and Gulf Is., and leave Georgia Strait by Jul; some fry rear in upper estuary over spring and summer until 60-70 mm, then enter Fraser plume in July and disperse from Strait by Sep-Oct; feed for 2-3 yr in ocean before returning to natal river/lake to spawn; may hold off mouth of river for up to several days or weeks before moving upstream to spawn.

Tidal elevation: some fry rear in shallow areas in estuaries; smolts and adults feed and migrate in deeper water.

Food: insects, copepods, euphausiids, fish larvae, amphipods, decapod larvae, and crustaceans, squid and small fishes offshore.

Predators: fishes, birds, marine mammals and bears.

GROWTH RATE

Fry grow from 35 mm on entrance to delta to 90–110 mm by Sep in Georgia Strait; reach sexual maturity at 4–5 yr and may live as long as 8 yr.

FISHERY

Most important species for commercial and Native fisheries; 1986 commercial catch was 29,811 t valued at \$143.3 million; also support sport fishery.

REFERENCES

Birtwell, I.K., M.D. Nassichuk, and H. Beune.
1987. Underyearling sockeye salmon (Oncorhynchus nerka) in the estuary of the Fraser River, p. 25-35. In H.D. Smith,
L. Margolis, and C.C. Wood. [ed.] Sockeye salmon (Oncorhynchus nerka) population biology and future management. Can. Spec. Publ. Fish.
Aquat. Sci. 96.

Foerster, R.E. 1968. The sockeye salmon, Oncorhynchus nerka. Fish. Res. Board Can. Bull. 162: 422 p.

Healey, M.C. 1980. The ecology of juvenile salmon in Georgia Strait, British Columbia, p. 203–229. *In* W.J. McNiel and D.C. Himsworth [ed.] Salmonid ecosystems of the North Pacific. Ore. State Univ. Press, Corvallis.

Healey, M.C. 1982. Juvenile Pacific salmon in estuaries: the life support system, p. 315-341. *In* V.S. Kennedy [ed.] Estuarine comparisons. Academic Press, N.Y.

Manzer, J.I. 1956. Distribution and movement of young Pacific salmon during early ocean residence. Fish. Res. Board Can. Pac. Progr. Rep. 106: 24-28.



Generalized life cycle of the sockeye salmon. Adult sockeye salmon enter mouths of natal rivers from June to September. Spawn during September or October in gravel redds located in lake tributaries, lake outlet or spring-fed areas along lake shore. Adults die soon after spawning. Eggs hatch in winter and spring and fry emerge from gravel in April and May after yolk sac is absorbed. Most juveniles rear in lake for 2-3 years and migrate to sea as smolts. In some stocks, fry migrate directly downstream and rear in river or upper estuary for up to 5 months. Yearlings may also rear in upper estuary for up to 6 weeks. Smolts may remain in estuarine waters for 2 weeks or more, but generally migrate quickly through shallow nearshore to deeper water. Usually spend 2-3 years feeding in the northeast Pacific Ocean before returning to spawn in natal tributary stream or lake. Maximum size is about 84 cm, and adults may live for up to 8 years. COASTAL CUTTHROAT TROUT, Oncorhynchus clarki (Richardson)

TAXONOMY

Phylum: Chordata Class: Osteichthyes Order: Salmoniformes Family: Salmonidae

ECOLOGICAL DATA

Distribution: spawn in small, low gradient streams or tributaries of larger drainages; common in shallow nearshore.

Habitat: enter natal streams to feed and spawn from Jul-Feb (Sep-Oct for larger rivers and Jan-Feb for small streams); spawn from Dec-May in gravel redds in streams; alevins (24 mm) emerge from gravel during Jun and Jul; juveniles rear in freshwater for 2-3 yr; at 10-25 cm smolts migrate during April and May to estuaries and marine water; reside close to shore, usually over cobble/sand beaches influenced by freshwater source (e.g. creek or stream); usually remain close to natal estuary (within 10 km), but may range up to 70 km; immatures and adults return to overwinter in freshwater streams in fall and return to estuarine areas in spring; adults hold in tidal pools as early as Jul in preparation for spawning migration as 4-5 yr olds.

Tidal elevation: juveniles and adults reside in shallow nearshore.

Food: feed on cobble/sand beaches with freshwater inflows; small fishes (stickleback, sand lance, herring), salmon eggs and fry, smelt, sculpins, shrimp, euphausiids.

Predators: harbour seals, mink, otters and birds.

GROWTH RATE

Reach 1.8 kg and about 50 cm; may live up to 10 yr.

FISHERY

Important sport fish; supports unique beach/estuary sport fishery.

REFERENCES

Armstrong, R.H. 1971. Age, food, and migration of sea-run cutthroat trout, *Salmo clarki*, at Eva, southeastern Alaska. Trans. Am. Fish. Soc. 100: 302-306.

Burns, T. 1980. Coastal cutthroat trout in British Columbia. B.C. Min. Environ. Fish Wildl. Branch, Victoria: 4 p.

Giger, R.D. 1972. Ecology and management of coastal cutthroat trout in Oregon. Ore. State Game. Comm., Fish. Res. Rep. 6: 61 p.

Guiguet, T. 1980. An annotated bibliography on the utilization of estuarine habitats by cutthroat and steelhead trout and Dolly Varden char. Hab. Protect. Sec. Fish. Wildl. Branch, Min. Environ.: 12 p.

Johnston, J.M. 1981. Life histories of anadromous cutthroat with emphasis on migratory behaviour, p. 123-127. In E.L. Brannon and E.O. Salo [ed.] Salmon and trout migratory behaviour symposium. Univ. Wash., Seattle.

Pauley, G.B., K. Oshima, K.L. Bowers, and G.L. Thomas. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest) – sea-run cutthroat trout. U.S. Fish Wildl. Serv. Biol Rep. 82(11.86). U.S. Army Corps of Engineers, TR EL-82-4: 21 p.



Generalized life cycle of the coastal cutthroat trout. Coastal cutthroat trout spawn from December to May. Early-entry spawning migrations in larger rivers begin in July, but are concentrated in September and October. Often fish hold in pools in lower reaches before migrating to spawning areas. Late entry runs occur in small streams during December and January, taking advantage of winter freshet. Eggs are laid in gravel redds in tributary streams. Alevins emerge from gravel in June and July and rear in freshwater for 2-3 years. Migrate as smolts to estuarine areas where they establish schools and move to nearshore marine water. Reside in salt water for 2-3 summers, usually over cobble/sand beaches influenced by a freshwater source (e.g. stream of creek). Overwinter in freshwater and migrate to marine water each spring. Cutthroat have a limited salt water range, usually remaining within 15 km of the natal estuary, and forage in shallow water close to shore. Maximum age is 10 years but normally live to 4-7 years and average about 45 cm.

STEELHEAD TROUT, Oncorhynchus mykiss (Richardson)

TAXONOMY

Phylum: Chordata Class: Osteichthyes Order: Salmoniformes Family: Salmonidae

ECOLOGICAL DATA

Distribution: spawn in larger streams and rivers; localized and extensive Pacific Ocean feeding migrations.

Habitat: adults spend several years in north Pacific Ocean feeding; spawning migrations upstream in rivers and larger streams to freshwater spawning areas occurs year round, but mostly as winter (Nov-May) or summer (May-Oct) runs; high degree of homing to natal river; juveniles rear in freshwater for 2-3 yr (range 1-5) before migrating to sea as smolts at 175 mm (range 130-250 mm) from Apr to Jun; remain in estuarine or nearshore for a period before moving offshore.

Tidal elevation: adults and smolts use tidal waters of estuaries and nearshore.

Food: adults prey on squid, euphausiids, amphipods and fishes; young eat insects, copepods, amphipods and other crustaceans and young fishes (e.g. sand lance, eulachon, herring).

Predators: fishes, birds and marine mammals.

GROWTH RATE

Rapid growth in ocean, e.g smolts (150-200 mm) were 480 mm after 1 yr ocean residence, 710 after 2 yr and 810 after 3 yr; maximum recorded size is 1140 cm and 19.5 kg.

FISHERY

A very popular sport fish in B.C.; commercial and Native fisheries; 1986 commercial catch was 158 t valued at \$0.3 million.

REFERENCES

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Board Can. Bull. 180: 128-131.

LeBrasseur, R.J. 1966. Stomach contents of salmon and steelhead trout in the northeastern Pacific Ocean. J. Fish. Res. Board Can. 23: 85-100.

Maher, F.P., and P.A. Larkin. 1955. Life history of the steelhead trout of the Chilliwack River, British Columbia. Trans. Am. Fish. Soc. 84: 27-38.

Manzer, J.I. 1968. Food of Pacific salmon and steelhead trout in the northeast Pacific Ocean. J. Fish. Res. Board Can. 25: 1085–1089.

Margolis, L. 1984. MS. Preliminary report on identification of continent of origin of ocean-caught steelhead trout, *Salmo gairdneri*, using naturally occurring parasite tags. Unpubl. Int. North Pac. Fish. Comm. Rep. 2822: 23 p.

Smith, S.B. 1960. A note on two stocks of steelhead trout (*Salmo gairdneri*) in Capilano River, British Columbia. J. Fish. Res. Board Can. 17: 739-742.

Ward, B.R., and P.A. Slaney. 1988. Life history and smolt-to-adult survival of Keogh River steelhead trout (*Salmo gairdneri*) and the relation to smolt size. Can. J. Fish. Aquat. Sci. 45: 1110-1122.

Withler, I.L. 1966. Variability in life history characteristics of steelhead trout (*Salmo gairdneri*) along the Pacific coast of North America. J. Fish. Res. Board Can. 23: 365–393.



Generalized life cycle of the steelhead trout. Mature adults enter rivers and larger streams year round, but generally concentrated as winter (November to May) and summer (May to October) runs. Steelhead may spawn more than once (3-40% of population). Eggs laid in gravel redds prepared by female in tributary stream or inlet/outlet of nursery lake from January to June. Eggs hatch in 4–7 weeks and fry emerge from gravel from mid–June to mid–August. Juveniles rear in freshwater for 2–4 years prior to migrating to sea as smolts from April to June. Only remain in estuary for a short period of time before moving offshore. Adults usually complete extensive feeding migrations in the Pacific Ocean before returning to spawn after 2–3 summers (range 1–4) in the ocean. Adults live to 6-8 years and may reach 1140 mm or 19 kg.

DOLLY VARDEN CHAR, Salvelinus malma (Walbaum)

TAXONOMY

Phylum: Chordata Class: Osteichthyes Order: Salmoniformes Family: Salmonidae

ECOLOGICAL DATA

Distribution: spawn in coastal drainages, but more abundant in northern areas.

Habitat: remain close to shore near river mouths; spawn in gravelly areas of freshwater streams and rivers during fall; migrate from nearshore from Jul to mid–Sep as spawners and immatures; overwinter in lakes and streams; outmigration of adults from mid–Mar to mid–May, and smolts during May to mid–Jun; feed in nearshore marine water and estuaries for 3–8 months.

Tidal elevation: smolts and adults feed and migrate in shallow nearshore and estuaries.

Food: smolts in shallow nearshore prey on crustaceans (e.g. amphipods, isopods and euphausiids) and small fish; subadults and adults, usually in outer estuary and deeper water feed primarily on fish (e.g. sand lance, capelin, herring, pink and chum fry), and some crustaceans.

Predators: fishes, such as salmon and cutthroat, birds and bears.

GROWTH RATE

Rapid growth in ocean, up to 45 mm for adults over 157 d and 74 mm for smolts over 107 d; maximum size is about 550 mm and 3 kg.

FISHERY

Sport (i.e fly and bait) fishery exists, including unique beach fisheries.

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Generalized life cycle of the Dolly Varden char. Dolly Varden char leave nearshore coastal feeding waters and migrate upstream to spawn from July to mid-September. Eggs are laid in a redd constructed by the female in gravel streambed. Adults may spawn one or more times. Eggs incubate in gravel and hatch in March or April. Alevins emerge from gravel after about 18 days, and juveniles rear in tributary streams for 2-3 years. Smolts outmigrate to marine feeding grounds during May to mid-June. Remain close to shore during marine feeding period, which lasts from 3-8 months. Char show complex migration patterns. Usually lakes are used to overwinter. Maximum size is about 550 mm and 3 kg.

WHITE STURGEON, Acipenser transmontanus (Richardson)

TAXONOMY

Phylum: Chordata Class: Osteichthyes Order: Acipenseriformes Family: Acipenseridae

ECOLOGICAL DATA

Distribution: sparse along inshore; appears to prefer lower reaches of large rivers, e.g. Fraser and Skeena.

Habitat: adults spawn in freshwater near rapids or below waterfalls during May and Jun; eggs adhere to bottom; juveniles may rear in sloughs in estuaries; appears to reside in turbid, current swept lower reaches of rivers or estuaries, e.g. mouth of Fraser Main Arm; feeding migration occurs in April in Fraser River, following the eulachon run; may be a migration downstream to brackish water in Jul and Aug.

Tidal elevation: utilize deeper sections of lower reaches of river, sloughs or estuaries.

Food: bottom feeder; young-of-the-year feed on chironomids (e.g. *Corophium*), oligochaetes, mysids and midge larvae and adults, molluscs and freshwater invertebrates; adults prey on fish (e.g. spawned-out eulachon, lamprey, sculpins, stickleback), chironomids and crayfish.

Predators: few due to bony plates; lamprey.

GROWIH RATE

Slow; 1 yr old 11–37 cm; 30 yr old male is 145 cm and female 183 cm; males sexually mature 11–22 yr and females at 11–34; maximum recorded size is 6.1 m and 816 kg; may live to be over 100 yr.

FISHERY

Small commercial and sport fisheries; 1986 commercial catch was 6 t valued at \$12,000.

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Generalized life cycle of the white sturgeon. Mature sturgeon spawn in swift flowing sections of the river, such as near rapids or below waterfalls, in May and June. Do not spawn every year, interval between spawning ranges from 4 to 11 years. Juveniles may rear in sloughs and estuaries. Sturgeon in the Fraser River appear to show migration patterns, ascending in April to feed on eulachon and descend in July and August to lower eaches of river. Generally prefer to inhabit turbid, current swept rivers or estuaries. Sturgeon may grow to 6.1 m and 816 kg, and may live as long as 100 years.

EULACHON, Thaleichthys pacificus (Richardson)

TAXONOMY

Phylum: Chordata Class: Osteichthyes Order: Salmoniformes Family: Osmeridae

ECOLOGICAL DATA

Distribution: common along B.C. coast; particularly abundant in spring in large rivers and larger streams.

Habitat: mature adults ascend larger rivers (e.g. Fraser and Nass) during mid-March to mid May to spawn; eggs are laid in coarse sand or gravel in freshwater; most adults die after spawning; eggs adhere to sand and hatch in 2-3 weeks; larvae (4-5 mm long) are carried by currents to sea; may rear in estuaries; widely dispersed by currents; juveniles use deeper water as they grow; juveniles and adults feed at moderate depths of inshore water.

Tidal elevation: adults use shallow water (i.e. less than 20 m) during spring spawning migration; larvae and juveniles may use shallow estuarine habitats for rearing.

Food: larvae and post-larvae eat phytoplankton, copepod eggs, copepods, mysids, barnacle larvae; juveniles prey on copepods; larger juveniles feed on euphausiids, copepods and other crustaceans.

Predators: important prey for white sturgeon, dogfish, salmon, Pacific halibut, Pacific cod, gulls and sea birds, marine mammals.

GROWTH RATE

Young-of-the-year range from 18-71 mm,

71-95 mm at 1 yr and 165 mm at 5 yr.; sexually mature at 2 yr (72-111 mm).

FISHERY

Small commercial and Native fisheries in Fraser River; 1986 commercial catch was 50 t valued at \$49,000; north coast closed for Native harvest.

REFERENCES

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Generalized life cycle of the eulachon. Mature eulachon ascend larger rivers in large numbers during April and May to spawn in freshwater. Most adults die after spawning. Eggs are laid over coarse sand or gravel and adhere to sand grains. In 2–3 weeks eggs hatch and 4–7 mm larvae are carried to rivers mouths by currents. Larvae dispersed by currents, and may rear in estuaries. Most of life is spent at moderate depths of inshore water. Most eulachon die in third year but some may live to 5 years and reach 230 mm.

PACIFIC HERRING, Clupea harengus pallasi (Valenciennes)

TAXONOMY

Phylum: Chordata Class: Osteichthyes Order: Clupeiformes Family: Clupeidae

ECOLOGICAL DATA

Distribution: B.C. coast is the center of abundance of Pacific herring for North America.

Habitat: mature adults leave offshore feeding grounds off mouth of Juan de Fuca Strait in south and in Hecate Strait in north, during Oct-Dec and migrate to inshore spawning areas; remain inshore in deep channels and bays near spawning areas to complete maturation; spawning peaks in Mar in south coast, late Mar to mid-Apr in north coast and Queen Charlotte Islands; very early and late spawners are resident inshore stocks; spawn on intertidal and subtidal vegetation, including filamentous and branching red algae, sea grasses, rockweed kelp, and other brown algae; eggs adhere to vegetation and fertilized externally; eggs hatch simultaneously in 10-21 days; 9 mm larvae live on yolk sac for about 6 d and then feed on plankton; currents tend to concentrate larvae in the surface layer near shore; juveniles undergo diel migrations, deep during day and shallow during darkness; during summer form large schools in protected waters of bays and inlets near spawning areas; in Sep gradually move seaward to feeding grounds, depth 150-200 m; immatures (2nd yr) tend to intermingle with juveniles and adults, depth of 100-150 m; adults in same offshore feeding grounds, depth 100-150 m; return to feed in Apr and May after spawning; some small resident populations remain inshore near spawning areas all year.

Tidal elevation: spawn from high tide to 20 m subtidal depth, and generally within a 150 m wide strip.

Food: larvae feed on invertebrate eggs,

copepods, diatoms; feed on larger zooplanton as they grow; adults eat larger forms of crustaceans and small fish; cease feeding during winter prior to spawning; adults also may filter feed when other food is unavailable.

Predators: gulls and diving ducks eat eggs; pilchards, ctenophores and jelly fish prey on larvae; gulls, diving ducks, fishes and marine mammals prey on adults, especially during spawning.

GROWTH RATE

Larvae are 9-25 mm; juveniles range from 25-100 mm at end of 1st year; sexually mature 3 yr, 180 mm; most adults 175-250 mm and 3-6 yr; maximum size age is 340 mm at 15 yr.

FISHERY

Valuable commercial fishery (2nd only to salmon), 16,341 t valued at \$40 million, and spawn on kelp of 150 t valued at \$6.4 million in 1986; native fishery and bait fishery for salmon sport fishing.

REFERENCES

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Generalized life cycle of the Pacific herring. Mature herring leave offshore feeding grounds, during October to December and migrate to inshore spawning areas. Maturation is completed inshore in deep channels and bays near spawning areas. Spawning peaks in March in south coast, late March to mid-April in north coast and in Queen Charlotte Islands. Spawn on intertidal and subtidal vegetation and eggs are fertilized externally. Adults return to offshore feeding grounds after spawning. Eggs hatch simultaneously in 10-21 days. Newly hatched larvae drift in plankton and live on yolk sac for about 6 days and then feed on plankton. At 25 mm (10 week post hatching) develop into juveniles over a 3 week period. Juveniles show diel migrations to feed and avoid predation. During summer juveniles form large schools in protected waters near spawning areas and in September gradually move to offshore feeding grounds, depth 150-200 m. Adults use same feeding grounds but are in shallower water 100-150 m, while immatures (2 years old) tend to occur in-between. Herring may live to over 15 years and reach a maximum length of 34 cm.
SURF SMELT, Hypomesus pretiosus pretiosus (Girard)

TAXONOMY

Phylum: Chordata Class: Osteichthyes Order: Salmoniformes Family: Osmeridae

ECOLOGICAL DATA

Distribution: widespread in nearshore, most abundant in Georgia Strait, Rivers and Smith Inlets, and in the Skeena estuary.

Habitat: adults utilize nearshore areas as well as open ocean; spawn on pea-sized gravel on protected beaches throughout the year but is most concentrated in summer or winter; often spawning habitat exists where freshwater seepage occurs at the foot of bluffs or where trees provide shade; eggs are adhesive and remain in gravel at depths of several cm for about 2 weeks for summer spawners or up to 3 months for winter spawners; planktonic larvae dispersed by currents; larvae and juveniles of some stocks rear in estuaries at least until 50-100 mm in length.

Tidal elevation: spawn over pea-sized gravel in the upper one half of the intertidal zone on protected beaches, and lower in the intertidal on exposed beaches with considerable wave action; spawning occurs in water depths of less than 0.5 m just before high tide and during high slack period.

Food: larvae feed on planktonic organisms; adults prey on crustaceans, (e.g. copepods, amphipods euphausids), combjellies and larval fishes.

Predators: gulls and birds eat eggs; staghorn sculpin, starry flounder, shiner perch and

chinook salmon prey on juveniles and adults.

GROWTH RATE

Sexually mature at 1 yr of age; 5 mm at emergence; may reach 210 mm at 5 yr but most individuals are under 3 yr and range from 120–180 mm.

FISHERY

Very small commercial fishery but intensive sport fishery; total 1986 smelt commercial catch was 1 t valued at \$3,000.

REFERENCES

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Penttila, D. 1978. Studies of the surf smelt (*Hypomesus pretiosus*) in Puget Sound. Wash. Dep. Fish. Tech. Rep. 42: 47 p.



Generalized life cycle of the surf smelt. Male and females spawn over pea-sized gravel (1-7 mm diameter) in shallow water (less than 0.5 m deep) usually at high tide. In protected areas, spawn in higher intertidal, while in areas with strong wave action the lower intertidal zone is used. Spawn throughout the year but mainly concentrated in summer-early fall or early winter (exact spawning times is specific to individual population). Eggs fall into and adhere to gravel where they incubate until emergence. Incubation period is 11-16 days for summer spawn and 27-56 days for winter spawn. Larvae emerge at 5 mm in length and feed on yolk sac for about one week, after which they feed on planktonic organisms. Juveniles reside in estuaries and nearshore waters for several months. Adults may reach 210 mm and live for 5 years, but most individuals range from 120-180 mm and are under 3 years of age.

LINGCOD, Ophiodon elongatus (Girard)

TAXONOMY

Phylum: Chordata Class: Osteichthyes Order: Scorpaeniformes Family: Hexagrammidae

ECOLOGICAL DATA:

Distribution: common in coastal waters.

Habitat: rocky areas or subtidal reefs, usually with strong currents; females congregate in deep waters late in year; males appear on shallow water, rocky bottom spawning grounds in Oct-Nov; females arrive in Jan; spawn in Jan and Feb; adhesive egg masses laid in rock crevice with strong current; males guard egg masses until hatching in late Mar; larvae dispersed by currents and remain in top 3 m for 2-3 months, feeding on plankton; larvae may form schools; move inshore, e.g. eelgrass and kelp beds, in late May and early Jun; mid to late Jun, at 70-80 mm begin demersal life; move to offshore reefs and rocky areas where they reside for several years before joining adult populations.

Tidal elevation: intertidal to subtidal depth exceeding 200 m.

Food: voracious piscivore; larvae feed on small copepods following absorbtion of yolk sac; prey on larger copepods, decapods, amphipods and euphausids as they grow; just prior to demersal life, begin to prey on juvenile herring and other small fish; prefers herring, sand lance, pollack cod and flounders.

Predators: greenling, sea perch, and sunflower star prey on eggs; adult lingcod and other fishes prey on young; sea lion on adults.

GROWTH RATE

Rapid growth; females sexually mature at 65-75 cm, 4-5 yr; males at 46-51 cm after 2 yr; maximum size for females is over 100 cm after 10-14 yr, males under 90 cm.

FISHERY

Important commercial fishery, 3,860 t valued at almost \$3.1 million in 1986; important sport fishery, bag limit of 3 (including greenling); taken by divers.

REFERENCES

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Generalized life cycle of the lingcod: Females congregate late in year in deep offshore waters prior to spawning. Males move into shallow water over rocky bottom spawning grounds in October and November followed by females in January. Spawn in January and February. Eggs are adhesive and laid in rock crevices with a strong current. Males guard large egg masses until eggs hatch in late March. Newly hatched larvae are 7 mm in length and spend 2–3 months drifting and feeding on plankton in upper 3 m. Form small, nearshore schools in early May. Late May and early June utilize inshore sites, often in eelgrass and kelp beds where zooplankton and small fish are plentiful. In late June, at 70–80 mm, juveniles begin feeding on juvenile herring and switch to demersal life style. Remain in large groups up to one year or until they reach 27 cm in length, then move to offshore reefs and rocky areas where they reside for several years before joining adult populations. Adult lingcod may live to be 17–20 years old, and reach maximum sizes of 152 cm for females and about 90 cm for males.

ENGLISH (LEMON) SOLE, Pleuronectes vetulus (Girard)

TAXONOMY

Phylum: Chordata Class: Osteichthyes Order: Pleuronectiformes Family: Pleuronectidae

ECOLOGICAL DATA

Distribution: range along entire coast but predominately in Hecate Strait.

Habitat: relatively deep water (60-100 m) over sand and silty substrates; spawn in Oct-Apr; buoyant eggs are pelagic until hatching in 6 d; larvae drift in plankton for 6-10 weeks, and are dispersed by currents; metamorphosis complete around 10 mm; adults migrate to and from spawning grounds.

Tidal elevation: adults found in intertidal to 600 m subtidal depth; commercial zone of abundance between 50-100 m; juveniles rear in shallow water (15-50 m).

Food: larvae feed on *Oikopleura*, tintinnids, invertebrate eggs and nauplii; adults eat clams, clam siphons, polychaete worms, small crabs and shrimp and brittle stars.

Predators: juveniles preyed upon by water birds; bottom fish.

GROWTH RATE

Fairly rapid, 10 cm by 1st Aug and 20 cm by 2nd yr; 50 % of females sexually mature at approx. 34 cm (4 yr); maximum age is 19 yr for females and 22 yr for males. Enter commercial fishery at 35 cm, 4 yr for females and 4-5 yr for males.

FISHERY

Major commercial species, accounted for approx. 16 % (430 t) of total sole landings in 1986; support bottom sport fishery.

REFERENCES

Bennett, D.M.A., and M.Stocker. 1980. Length and age composition of English sole (*Parophrys vetulus*) in commercial landings from north Heacte Strait, British Columbia, 1973–79. Can. Data Rep. Fish. Aquat. Sci. 190: 22 p.

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Generalized life cycle of the English sole. Spawn from October to April in deep water (over 200 m). Eggs are buoyant and remain pelagic until hatching in about 6 d. Larvae are approximately 2-3 mm and swim to the surface where they drift in plankton feeding on yolk sac for 6-10 days. Currents carry larvae into shallow water where metamorphosis occurs (completed by about 10 mm) and they take up a permanent benthic existence. Juveniles remain in sandy substrates in intertidal or shallow subtidal water for the summer and move to deeper water (over 18 m) in late fall. As the juveniles grow they move to progressively deeper water. Adults exhibit migrations to and from spawning grounds: shift to shallow feeding grounds in spring/summer and deeper water for spawning in winter. Maximum age and size is 19 years and 540 mm for females, and 22 years and 460 mm for males.

STARRY FLOUNDER, *Platichthys stellatus* (Pallas)

TAXONOMY

Phylum: Chordata Class: Osteichthyes Order: Pleuronectiformes Family: Pleuronectidae

ECOLOGICAL DATA

Distribution: common along B.C. coast, mainly shallow inshore; juveniles often found in estuaries and in lower reaches of rivers.

Habitat: shallow (less than 100 m) inshore water over sand and silt bottoms; juveniles rear in sandy areas and gently sloping tidal flats and often associated with eelgrass beds; may occur in lower freshwater reaches of larger rivers; spawn in Feb-Mar in depths less than 50 m; eggs float at surface; planktonic larvae are 2 mm at hatching and dispersed by currents; adults usually remain in one area and do not undergo extensive migrations.

Tidal elevation: intertidal to 250 m subtidal depth; adults usually in inshore water less than 100 m deep; juveniles occur intertidally in sandy areas and tidal flats, and in rivers.

Food: benthic carnivore; larvae feed on copepods and nauplii, barnacle larvae and cladocerans; adults prey on nemerteans and priapulids, polychaetes and clams.

Predators: water birds and bottom fish.

GROWTH RATE

Maximum size is 91 cm and 9.1 kg; males mature at 300 mm (2 yr), and females at 350 mm (3 yr).

FISHERY

Small component of commercial fishery; support small sport fishery.

REFERENCES

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Generalized life cycle of the starry flounder. Spawn in February to April in inshore water less than 50 m deep. Eggs are pelagic. Larvae measure 2 mm at hatching and are planktonic until metamorphosis occurs at about 6-8 mm and juveniles begin benthic existence. Juveniles rear in sandy substrates in intertidal areas and often are found in or adjacent to eelgrass beds. They are able to tolerate very low salinities and are frequently taken with beach seines in the lower reaches of large rivers. As they grow they presumably move to deeper more saline water. Adults do not appear to make extensive migrations. Generally adults are around 60 cm but make reach 90 cm.

PACIFIC HALIBUT, *Hippoglosus stenolepis* (Schmidt)

TAXONOMY

Phylum: Chordata Class: Osteichthyes Order: Pleuronectiformes Family: Pleuronectidae

ECOLOGICAL DATA

Distribution: shallow and deep water along B.C. coast; main concentrations off north coast.

Habitat: usually in deep water (40-200 m); spawn in Dec to Feb in water 275-412 mdeep; eggs are pelagic, occurring between 100 and 200 m; eggs and larvae pelagic for 4-5 months; larvae (8-15 mm long) mostly found 100-200 m, and rise in water column to 100 m after 3-5 months; eggs and larvae drift westward with current to Bearing Sea; and move eastward as juveniles (less than 7 yr); in May or June begin benthic existence at 2-3 cm; reside in shallow inshore for 1-3 yr, until 40-50 cm; immature halibut make restricted feeding migrations, but adults make extensive spawning migrations.

Tidal elevation; subtidal to 1100 m.

Food: benthic feeder; larvae prey on plankton; juveniles eat shrimp and fish (e.g.sand lance); adults take fish (e.g. herring, sand lance, cod, flatfish), crabs and octopus.

Predators: most predation occurs on larvae and juveniles, salmon and sablefish; sea lion, seals and killer whales may take adults.

GROWTH RATE

Largest flatfish; maximum recorded size, 267 cm and 225 kg; may live to over 40 yr; males sexually mature at 8 yr and females at 8-16 yr; at 5-7 yr enter commercial fishery.

FISHERY

Major commercial fishery, 4,231 t valued at \$18.9 million in 1986; Native fishery.

REFERENCES

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Generalized life cycle of the Pacific halibut. Spawn in deep water (275-412 m) from December to February. Eggs and larvae are pelagic for 4-5 months, ocurring between 40 and 935 m, but concentrated between 100 and 200 m. Newly hatched larvae generally occur below 425 m outside the edge of the continental shelf, are 8 to 15 mm long and feed from yolk sac until 18 mm. As they grow juveniles rise to shallower water and by 3-5 months occur at depths less than 100 m. Eggs and larvae drift westward with current into Bering Sea area, and then move eastward as juveniles (less than 7 years old). Juveniles take up benthic existence at 6-7 months. At 30 mm metamorphosis is complete and juveniles resemble adults. Females reach sexual maturity from 8-16 years of age and males at 8 years. Immature halibut make restricted feeding migrations. Adults make extensive migrations migrating from deep water to shallow banks and coastal waters in summer and return to deep water in winter to spawn. Adults may live to over 40 years and reach a maximum size of 267 cm and exceed 225 kg.

BIG SKATE, Raja binoculata (Girard)

TAXONOMY

Phylum: Chordata Class: Chondrichthyes Subclass: Elasmobranchii Order: Rajiformes Family: Rajidae

ECOLOGICAL DATA

Distribution: common along B.C. coast at moderate depths.

Habitat: inhabit sandy or muddy level bottoms, but may occur within a few metres of the surface; spawn in winter in deep water (about 70 m); eggs are fertilized internally and deposited on bottom in egg cases.

Tidal elevation: egg cases found around 70 m depths.

Food: clams, shrimp, marine worms and fishes.

Predators: fishes.

GROWTH RATE

Maximum recorded size is 2.4 m and 91 kg.

FISHERY

Incidentally taken in commercial fishery; pectoral fins or "wings" harvested; commercial fishery in Kelsey Bay., 1986 total skate commercial catch was 517 t valued at \$0.3 million.

REFERENCES

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Generalized life cycle of the big skate. Big skate are oviparous, with fertilization occurring internally and eggs deposited on bottom in egg cases. Young hatch and inhabit level, sandy or muddy bottoms. Generally found at moderate depths, but may occur a few metres from the surface. Adults reach 2.4 m and may weigh up to 91 kg.

COPPER ROCKFISH, Sebastes caurinus (Richardson)

TAXONOMY

Phylum: Chordata Class: Osteichthyes Order: Scorpaeniformes Family: Scorpaenidae

ECOLOGICAL DATA:

Distribution: common inshore along rocky shores and over shallow reefs throughout B.C. coast.

Habitat: rocky inshore reefs in shallow protected bays and inlets; adults tend to be solitary and demersal; mate in autumn and fertilization is internal; larvae (5-6 mm) are released in Mar and Apr, drift with currents; juveniles (2-5 cm) rear during summer and fall in small groups to large schools, often in eelgrass (*Zostera*) and kelp (*Agarum* and *Laminaria*); juveniles become more solitary and demersal with age.

Tidal elevation: generally found above 25 m depth inshore.

Food: juveniles eat polychaetes and gammarid amphipods; adults take fish (surfperch, herring, sand lance, anchovy, shiner seaperch) shrimp, euphausids, lingcod eggs, and crabs.

Predators: fishes, such as lingcod and larger rockfish.

GROWTH RATE

Slow; maximum recorded size is 57 cm.

FISHERY

Minor component of commercial fishery; 1986

total rockfish commercial catch was 18,781 t valued at \$11.8 million; combined sportfish limit for rockfish and sculpins is 8.

REFERENCES

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Generalized life cycle of the copper rockfish. Rockfish are ovoviviparous, meaning they bear live young. Mate in autumn but larvae are released in March or April in rocky or reef habitat in water depths of less than 20 m. Larvae are about 5 mm at birth and are carried inshore to protected bays where they rear during summer and fall. Typically they use beds of eelgrass (*Zostera marina*) or kelp (*Agarum* or *Laminaria*) for nursery areas. Young-of-the-year occur in groups or larger schools but adapt the adult solitary and demersal life style as they grow older. Adults tend to remain in localized areas and do not appear to undergo extensive migrations. Adults are slow growing and reach a maximum size of 57 cm.

YELLOWTAIL ROCKFISH, Sebastes flavidus (Ayres)

TAXONOMY

Phylum: Chordata Class: Osteichthyes Order: Scorpaeniformes Family: Scorpaenidae

ECOLOGICAL DATA:

Distribution: common in deeper inshore and offshore.

Habitat: adults occur along steeply sloping shores or above rocky reefs; much more pelagic than many rockfishes; mate in autumn; larvae released in deeper, offshore in March; juveniles (0-4 yr) common in shallow inshore; often occurs in relatively dense schools near bottom, but may range throughout water column.

Tidal elevation: occurs to 275 m; schools found from just beneath surface to 200 m.

Food: mainly sand lance and crab megalopae, but also mysids, amphipods, euphausiids, pteropods and juvenile fishes (e.g black cod and gadids).

Predators: fishes, such as lingcod and rockfishes.

GROWTH RATE

Slow; sexually mature at 41-45 cm or 11-15 yr; maximum size is 66 cm.

FISHERY

Important component of commercial fisheries along open south and central coast; 1986 total rockfish commercial catch was 18,781 t valued at \$11.8 million; sportfishing limit is 8.

REFERENCES

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Generalized life cycle of the yellowtail rockfish. Rockfish are ovoviviparous, meaning they bear live young. Mate in autumn but larvae are released in March in deeper, offshore waters. Larvae are about 5 mm at birth and are carried inshore to protected bays where they rear during summer and fall. Juveniles are abundant in shallow water, and often juveniles hide in rock crevices. Yellowtail are much more pelagic than the three other rockfishes covered and often occur in schools from just below the surface to depths of 200 m. Adults are slow growing and reach a maximum size of 61 cm. YELLOWEYE ROCKFISH, Sebastes ruberrimus (Cramer)

TAXONOMY

Phylum: Chordata Class: Osteichthyes Order: Scorpaeniformes Family: Scorpaenidae

ECOLOGICAL DATA:

Distribution: common in rocky areas and reefs both inshore and offshore.

Habitat: adults common around steep cliffs, rocky reefs, offshore pinnacles and boulder fields; mate in late fall or early winter; larvae released from May to Jul; juveniles often hide in rock crevices; adults are demersal and solitary; tend to remain localized and do not make extensive migrations.

Tidal elevations: range to 365 m; most common inshore at 40–70 m depth.

Food: fish (e.g. gadids, sand lance, herring, lump sucker and other rockfishes), rock crabs, shrimp and snails.

Predators: fishes such as lingcod and rockfishes.

GROWTH RATE

Slow; late maturing; females sexually mature 50-52 cm (15-20 y), and males 52-60 cm; maximum age is over 90 yr (91 cm).

FISHERY

Important component of commercial catch in north coast; 1986 total rockfish commercial catch was 18,781 t valued at \$11.8 million; sportfishing limit is 8.

REFERENCES

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Generalized life cycle of the yelloweye rockfish. Rockfish are ovoviviparous, meaning they bear live young. Mate in late fall or early winter but larvae are released between May and July. Juveniles often hide in rock crevices. Adults are solitary and demersal. They tend to remain in localized areas and do not appear to undergo extensive migrations. Adults are slow growing and maturing. Maximum size is 91 cm and they may live to over 90 years.

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QUILLBACK ROCKFISH, Sebastes maliger (Jordan and Gilbert)

TAXONOMY

Phylum: Chordata Class: Osteichthyes Order: Scorpaeniformes Family: Scorpaenidae

ECOLOGICAL DATA:

Distribution: common in shallow offshore, exposed bays and semi-protected waterways.

Habitat: adults usually inhabit rock pavement around boulder fields or unconsolidated coarse sediments that border rocky reefs, usually in deeper water than copper rockfish; mate from Oct to Jan but larvae released between Apr and May; juveniles rear in small groups in shallow nearshore during summer and fall; juveniles less than 15 cm may associate with cloud sponges on rocky reefs; adults are demersal and usually solitary; adults do not appear to make extensive migrations.

Tidal elevation: offshore to depths of 275 m; inshore tend to be above 40-50 m.

Food: juveniles (less than 12 cm) prey includes shrimp, crabs, calanoid copepods, euphausids, and gammarid amphipods; adults prey on shrimp, crabs, snails, amphipods and fish (e.g. herring and sand lance).

Predators: fish, e.g. lingcod and yelloweye rockfish.

GROWTH RATE

Slow; males sexually mature at 12 yr, approx. 31 cm, and females at 14 yr or 32 cm; maximum size is 61 cm and may live to over 32 years of age.

FISHERY

Important commercial species; 1986 total rockfish commercial catch was 18,781 t valued at \$11.8 million; sportfishing limit is 8.

REFERENCES

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Generalized life cycle of the quillback rockfish. Rockfish are ovoviviparous, meaning they bear live young. Mate from October to January but larvae are released between April and May in rocky or reef habitat in water depths of less than 40–50 m. Larvae are about 5 mm at birth and are carried inshore to protected bays where they rear during summer and fall. Typically they occur in boulder areas just above kelp (e.g. *Agarum* and *Laminaria*) beds, or may associate in colonies of cloud sponges. Young-of-the-year occur in small groups but adapt the adult solitary and demersal life style as they grow older. Adults tend to remain in localized areas and do not appear to undergo extensive migrations. Adults are slow growing and reach a maximum size of 61 cm.

BUTTER CLAM, Saxidomus giganteus (Deshayes)

TAXONOMY

Phylum: Mollusca Class: Bivalvia Order: Veneroida Family: Veneridae

ECOLOGICAL DATA

Distribution: common in protected beaches in bays and estuaries along B.C. coast.

Habitat: variety of substrates but typically occur in beaches of porous sand, broken shell, gravel and mud; may occur in association with littleneck clam; burrow to a maximum depth of 25 cm; planktonic larvae are dispersed by currents; adults remain in same burrow for life.

Tidal elevation: lower third of intertidal zone; may occur to 15 m subtidal depth.

Food: suspension feeder; mainly phytoplankton, but also zooplankton and detritus.

Predators: crabs and fishes prey on juveniles; moon snail, birds and sea stars prey on adults.

GROWTH RATE

Slow; sexually mature at 38 mm (about 3 yr.); legal size of 63 mm is reached in 5-6 yr in Strait of Georgia, 7-8 yr in Alert Bay and after 9 yr in north coast.

FISHERY

Commercial, Native and sport intertidal fisheries; formerly an important commercial species but at present accounts for less than 10% (159 t in 1986) of commercial intertidal clam harvest; sewage pollution and paralytic shellfish poisoning (PSP) have closed large areas of coast to harvesting.

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Fitch, J.E. 1953. Common marine bivalves of California. Calif. Dep. Fish Game Fish Bull. 90: 102 p.

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Quayle, D.B., and N. Bourne. 1972. The clam fisheries of British Columbia. Fish. Res. Board Can. Bull. 179: 70 p.



Generalized life cycle of the butter clam. Male and female clams spawn in May in the Strait of Georgia, later in north coast. Mass fertilization occurs in water column. Fertilized eggs develop into ciliated, motile larvae within 12 h of fertilization. Larval phase includes several stages (i.e. trochophore, veliger and umbone) and lasts for 3-4 weeks, during which time the larvae drift in the plankton and are dispersed by water currents. The larval phase ends when larvae settle from the plankton and attach themselves to gravel or broken shell by byssal threads, referred to as spatting. At approximately 5 mm the spat or juvenile clam creates a permanent burrow where it remains for life. Although butter clams may spawn every year, poor juvenile recruitment due to adverse environmental conditions, predation or competition can affect adult abundance. Adult clams may live to over 20 years and reach a maximum shell length of 130 mm. LITTLENECK CLAM, Protothaca staminea (Conrad)

TAXONOMY

Phylum: Mollusca Class: Bivalvia Order: Veneroida Family: Veneridae

ECOLOGICAL DATA

Distribution: common in protected beaches in bays and estuaries along B.C. coast, and near rocky outcrops on outer coast.

Habitat: firm, gravel beaches; often in association with butter clam; burrow to a maximum depth of 15 cm, but usually 3–8 cm below surface; planktonic larvae dispersed by currents; adults remain in same burrow for life.

Tidal elevation: slightly above mid-intertidal to subtidal; may occur to 12 m subtidal depth.

Food: suspension feeder; mainly phytoplankton, but also zooplankton and detritus.

Predators: crabs and fishes prey on juveniles; moon snail, birds, and sea stars prey on adults.

GROWTH RATE

Slow; sexually mature at 25 mm (about 2 yr.); legal size of 38 mm is reached in 3.5 yr in Strait of Georgia and 5–6 yr in north coast.

FISHERY

Commercial, Native and sport intertidal fisheries; accounts for about 10% (285 t in 1986) of commercial intertidal clam harvest; sewage and paralytic shellfish poisoning (PSP) have closed large areas of coast to harvesting.

REFERENCES

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Quayle, D.B., and N. Bourne. 1972. The clam fisheries of British Columbia. Fish. Res. Board Can. Bull. 179: 70 p.



Generalized life cycle of the littleneck clam. Male and female clams spawn from May to September in the Strait of Georgia, and begin later in north coast. Mass fertilization occurs in water column. Fertilized eggs develop into ciliated, motile larvae within 12 h of fertilization. Larval phase includes several stages (i.e. trochophore, veliger and umbone) and lasts for 3–4 weeks, during which time the larvae drift in the plankton and are dispersed by water currents. The larval phase ends when larvae settle from the plankton and attach themselves to gravel or broken shell by byssal threads, referred to as spatting. At approximately 5 mm the spat or juvenile clam creates a permanent burrow where it remains for life. Although littleneck clams may spawn every year, poor juvenile recruitment due to adverse environmental conditions, predation or competition can affect adult. abundance. Adult clams may live to 10 years and reach a maximum shell length of 75 mm.

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MANILA CLAM, Tapes philippinarum (Adams and Reeve)

TAXONOMY

Phylum: Mollusca Class: Bivalvia Order: Veneroida Family: Veneridae

ECOLOGICAL DATA

Distribution: exotic species; common in protected beaches in bays and estuaries in Georgia Strait and west coast of Vancouver Island; small isolated populations in Queen Charlotte Strait and around Bella Bella.

Habitat: sand-gravel beaches; burrow just below surface, to maximum depth of approximately 10 cm; planktonic larvae dispersed by currents; adults remain in same location for life.

Tidal elevation: from 1 m intertidal zone to well above mid-intertidal level; does not inhabit subtidal; limited spatial competition with native clams.

Food: suspension feeder; mainly phytoplankton, but also zooplankton and detritus.

Predators: mainly water birds due to higher intertidal colonization.

GROWTH RATE

Slow; sexually mature at 20 mm (about 2 yr.); legal size of 38 mm is reached in 3.5 yr in Strait of Georgia and 5-6 yr in north coast.

FISHERY

Commercial, Native and sport fisheries; accounts for more than 65% (1894 t in 1986) of commercial intertidal clam harvest; sewage and paralytic shellfish poisoning (PSP) have closed large areas of coast to harvesting.

REFERENCES

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Quayle, D.B., and N. Bourne. 1972. The clam fisheries of British Columbia. Fish. Res. Board Can. Bull. 179: 70 p.



Generalized life cycle of the Manila clam. Male and female clams spawn between mid-June and September in the Strait of Georgia, during August in central coast. Mass fertilization occurs in water column. Fertilized eggs develop into ciliated, motile larvae within 12 h of fertilization. Larval phase includes several stages (i.e. trochophore, veliger and umbone) and lasts for 3-4 weeks, during which time the larvae drift in the plankton and are dispersed by water currents. The larval phase ends when larvae settle from the plankton and attach themselves to gravel or broken shell by byssal threads, referred to as spatting. At approximately 5 mm the spat or juvenile clam creates a permanent burrow where it remains for life. Manila clams require surface water temperatures in excess of 14 degrees C to permit gametogenesis, spawning and larval development, so establishment is largely along south coast. Adult clams may live to 10 years and reach a maximum shell length of 75 mm.

RAZOR CLAM, Siliqua patula (Dixon)

TAXONOMY

Phylum: Mollusca . Class: Bivalvia Order: Veneroida Family: Cultellidae

ECOLOGICAL DATA

Distribution: occur only on surf-swept beaches in Long Beach region on the west coast of Vancouver Island and on beaches east of Masset on the northeast coast of Graham Island in the Queen Charlotte Islands.

Habitat: sandy, exposed beaches; usually burrows from just below surface to a depth of 25 cm; can burrow to depths greater than 60 cm in less than a minute; planktonic larvae dispersed by currents; do not form permanent burrows.

Tidal elevation: mid-tide level to 20 m subtidal depth.

Food: filter feeder; mainly planktonic diatoms, but also zooplankton and detritus.

Predators: gulls, ducks, crabs and fishes.

GROWTH RATE

Variable, fastest at lower beach levels; sexually mature after 1 yr in south and 3 yr in north; minimum legal size of 90 mm is reached in 1-2 yr at Long Beach and 3-4 yr on Queen Charlotte Islands; largest and oldest clams found in B.C. are from Queen Charlotte Islands.

FISHERY

Commercial, native and sport fisheries; accounts for less than 5% (142 t in 1986) of commercial intertidal clam harvest.

REFERENCES

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Ricketts, E.F., J. Calvin, and J.W. Hedgpeth. 1985. Between Pacific tides. 5th ed. Stanford Univ. Press, Stanford, Calif.: 256–257.



Generalized life cycle of the razor clam. Male and female clams spawn in late May and June at Long Beach and in July and early August in Queen Charlotte Islands. Mass fertilization occurs in water column. Fertilized eggs develop into ciliated, motile larvae within 12 h of fertilization. Larval phase includes several stages (i.e. trochophore, veliger and umbone) and lasts for about 3–4 weeks, during which time the larvae drift in the plankton and are dispersed by water currents. The larval phase ends when larvae settle from the plankton and attach themselves to sand or broken shell by byssal threads, referred to as spatting. At about 5 mm the spat or juvenile clam burrows into sand, but no permanent burrow can be constructed due to instability of sand. Recruitment of juvenile clams has occurred at low levels in Queen Charlotte beaches since 1971. Adult clams may live to over 10 years and reach a maximum shell length of 18 cm.

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HORSE CLAM, Tresus capax (Gould)

TAXONOMY

Phylum: Mollusca Class: Bivalvia Order: Veneroida Family: Mactrinae

ECOLOGICAL DATA

Distribution: common in sheltered coastal areas.

Habitat: mud, gravel and shell beaches; common in eelgrass beds; associated with butter clams; burrows to 1 m; planktonic larvae dispersed by currents; adults remain in same burrow for life.

Tidal elevation: lower one third of intertidal zone to 20 m subtidal depth.

Food: suspension feeder; feeds on planktonic organisms and detritus.

Predators: birds, moon snail, sea stars, crabs, and fishes.

GROWTH RATE

Fairly rapid; sexually mature at 70 mm, after 3 yr in Strait of Georgia and 4 yr in Queen Charlotte Strait; reach 100 mm after 5 yr in Strait of Georgia and 6 yr in Queen Charlotte Strait; large adults (20 cm) can weigh up to 1.8 kg.

FISHERY

Small commercial, Native and sport fisheries; 1986 total horse clam commercial harvest was 96 t in 1986, valued at \$63,000; sewage pollution and paralytic shellfish poisoning (PSP) have closed some areas of coast to harvesting.

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Generalized life cycle of the horse clam. Male and female clams spawn in late February or early March in the Strait of Georgia, later in north coast. Mass fertilization occurs in water column. Fertilized eggs develop rapidly into ciliated, motile larvae. Larval phase includes several stages (i.e. trochophore, veliger and umbone), during which time the larvae drift in the plankton and are dispersed by water currents. The larval phase ends when larvae settle from the plankton and attach themselves to gravel or broken shell by byssal threads, referred to as spatting. The spat or juvenile clam creates a permanent burrow where it remains for life. Adult clams may live to 25 years and reach a maximum shell length of 20 cm.

HORSE (GAPER) CLAM, Tresus nuttallii (Conrad)

TAXONOMY

Phylum: Mollusca Class: Bivalvia Order: Veneroida Family: Mactrinae

ECOLOGICAL DATA

Distribution: occurs in sheltered coastal areas; less abundant in north than *T. capax*.

Habitat: sandy substrates; common in eelgrass beds; burrows to 1 m, but generally deeper than *T. capax*; planktonic larvae dispersed by currents; adults remain in same burrow for life.

Tidal elevation: lower one third of intertidal zone to 20 m subtidal depth.

Food: suspension feeder; feeds on planktonic organisms and detritus.

Predators: birds, moon snail, sea stars, crabs, and fishes.

GROWTH RATE

Fairly rapid; sexually mature at 60 mm, after 3 yr; reach 100 mm after 5 yr in Strait of Georgia and 6 yr in Queen Charlotte Strait; large adults (20 cm) can weigh up to 1.8 kg.

FISHERY

Small commercial, Native and sport fisheries; 1986 total horse clam commercial harvest was 96 t valued at \$63,00 in 1986; sewage pollution and paralytic shellfish poisoning (PSP) have closed some coastal areas to harvesting.

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Generalized life cycle of the horse clam. Male and female clams spawn in June and July in the Strait of Georgia, later in north coast. Mass fertilization occurs in water column. Fertilized eggs develop rapidly into ciliated, motile larvae. Larval phase includes several stages (i.e. trochophore, veliger and umbone), during which time the larvae drift in the plankton and are dispersed by water currents. The larval phase ends when larvae settle from the plankton and attach themselves to gravel or broken shell by byssal threads, referred to as spatting. The spat or juvenile clam creates a permanent burrow where it remains for life. Adult clams may live to 25 years and reach a maximum shell length of 20 cm.

COCKLE, Clinocardium nuttallii (Conrad)

TAXONOMY

Phylum: Mollusca Class: Bivalvia Order: Veneroida Family: Cardiidae

ECOLOGICAL DATA

Distribution: scattered on tide flats along coast, but not abundant in any one location.

Habitat: soft, sand-mud substrates of tide flats; abundant in eelgrass beds; associated with butter and littleneck clams; shallow burrow or may occur on surface; moves horizontally across beach, does not remain in same burrow;

Tidal elevation: high intertidal to 30 m subtidal depth; most common in intertidal or shallow subtidal.

Food: suspension feeder; phytoplankton and detritus.

Predators: sea stars, crabs, flatfish and birds; easy prey since they occur on surface of tide flats.

GROWTH RATE

Moderately rapid growth; 60 mm in 3 yr; sexually mature at 2 yr.

FISHERY

Incidental commercial catch but important in Native fishery; does not occur in large enough numbers to support commercial fishery; sewage pollution and paralytic shellfish poisoning (PSP) have closed large areas of coast to harvesting.

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Ricketts, E.F., J. Calvin, and J.W. Hedgpeth. 1985. Between Pacific tides. 5th ed. Stanford Univ. Press, Stanford, Calif.: 332–334.



Generalized life cycle of the cockle. Cockles are hermaphroditic. Spawning may extend over several months, but peak spawning occurs in May–September in south coast area. Mass fertilization occurs in water column. Fertilized eggs develop rapidly into ciliated, motile larvae. Larvae phase includes several stages (i.e. trochophore, veliger and umbone), during which time the larvae drift in the plankton and are dispersed by water currents. The larvae phase ends when larvae settle from the plankton and attach themselves to gravel or broken shell in sublittoral zone. Juvenile clam then burrows into substrate. As juvenile cockle grows it moves inshore and into intertidal. Adults usually live to a maximum age of 7 years and shell length may reach 12 cm.

GEODUCK CLAM, Panope abrupta (Conrad)

TAXONOMY

Phylum: Mollusca Class: Bivalvia Order: Veneroida Family: Hiatellidae

ECOLOGICAL DATA

Distribution: widespread, in sheltered to moderately exposed brackish or outer coastal areas.

Habitat: fine mud through sand to gravel; may be abundant in eelgrass; burrows up to 1 m; planktonic larvae dispersed by currents; adults create semi-permanent burrow.

Tidal elevation: subtidal, from 8 to 120 m depth; may occur in lower intertidal; occurs higher in intertidal in north coast; most common between 9–18 m subtidal.

Food: suspension feeder; mainly phytoplankton, but also zooplankton and detritus.

Predators: sea stars, crabs, fishes, and birds.

GROWTH RATE

Slow; sexually mature by 3 yr; reaches 16 cm in 10 yr, little change in length in remaining years; may weight up to 4.5 kg.

FISHERY

Largest clam in B.C., supports valuable subtidal commercial, Native and small intertidal sport fishery; in 1986 commercial harvest was over 5,000 t valued at \$4.3 million; sewage pollution and paralytic shellfish poisoning (PSP) have closed areas of the coast to harvesting.

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Ricketts, E.F., J. Calvin, and J.W. Hedgpeth. 1985. Between Pacific tides. 5th ed. Stanford Univ. Press, Stanford, Calif.: 325–328.



Generalized life cycle of the geoduck clam. Male and female clams spawn annually beginning in late April and peaking in late June. Mass fertilization occurs in water column. Fertilized eggs develop rapidly into ciliated, motile larvae. Larval phase includes several stages (i.e. trochophore, veliger and umboned), during which time the larvae drift in the plankton for 7 months and are dispersed by water currents. The larval phase ends when larvae settle, change form, and attach themselves to a suitable substrate by byssal threads. May spend several months settling different areas using byssal threads as a "parachute" for transport by currents. Upon final settling, juvenile geoduck creates permanent burrow where it usually remains for life. Adults may live to over 140 years and reach a maximum shell length of 23 cm.

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TAXONOMY

Phylum: Mollusca Class: Bivalvia Order: Myoida Family: Myidae

ECOLOGICAL DATA

Distribution: introduced from Atlantic around 1879; common along entire B.C. coast in protected estuaries and bays, often in brackish waters.

Habitat: soft muddy substrates in estuaries; common in eelgrass beds; survives in high organic-low oxygen conditions; poor digger, burrows to maximum of 20 cm; may occur with butter clams; planktonic larvae dispersed by currents; adults remain in same burrow for life.

Tidal elevation: upper tidal to mid-tide range; on Atlantic coast extends to 9 m subtidal depth.

Food: suspension feeder; mainly phytoplankton and detritus.

Predators: diving ducks, gulls, crows, cormorants, and fishes.

GROWTH RATE

Sexual maturity at 2-3 years (25 mm); grow to 7.5 cm in 3 yr; reach up to 10 cm in B.C.

FISHERY

Occasionally taken in commercial and sport fisheries; not abundant enough to support commercial fishery; sewage pollution and paralytic shellfish poisoning (PSP) have closed large areas of coast to harvesting.

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Kozloff, E.N. 1983. Seashore life of the northern Pacific coast. Douglas & McIntyre, Vancouver: 294–295.

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Generalized life cycle of the soft-shell clam. Male and female clams spawn in spring and summer. Mass fertilization occurs in water column. Fertilized eggs develop rapidly into ciliated, motile larvae. Larval phase includes several stages (i.e. trochophore, veliger and umbone), during which time larvae drift in the plankton for 2 weeks and are dispersed by water currents. The larval phase ends when the larvae settle from the plankton and attach themselves to gravel or broken shell by byssal threads, referred to as spatting. Juvenile clams may release byssal attachment and crawl about the bottom. At 6 mm they establish a permanent burrow and grow to full size.

PACIFIC OYSTER, Crassostrea gigas (Thunberg)

TAXONOMY

Phylum: Mollusca Class: Bivalvia Order: Ostreoida Family: Ostreidae

ECOLOGICAL DATA

Distribution: introduced from Japan in 1912; common in sheltered bays and estuaries along south coast.

Habitat: surface of gently sloping flats composed of firm mud, sand or gravel, also on rocks; restricted growth on muddy substrate; areas of clear, warm, sheltered waters such as Pendrell Sound, and to a lesser extent Hotham Sound and Pipestem Inlet are prime spawning areas; planktonic larvae are dispersed by currents; juveniles cement shell to hard clean surface and remain for life.

Tidal elevation: from 2-4 m intertidal zone.

Food: suspension feeder; mainly diatoms, detritus and zooplankton.

Predators: sea stars, oyster drills, ctenophores and crabs; mud and ghost shrimp can destroy oyster habitat.

GROWTH RATE

Temperature is critical to growth since it is at northern limit of range in B.C.; sexually mature in 2-3 yr.; commercial size, 100-127 mm, in 3 yr.

FISHERY

Important commercial, recreational and

Native fisheries in Georgia Strait; Baynes Sound supports 70% of B.C. culture; commercial harvest was 2,864 t valued at \$2.5 million in 1986; sewage pollution and paralytic shellfish poisoning (PSP) can impact fishery.

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Generalized life cycle of the Pacific oyster. Male and female oysters spawn in late July to early August. Spawning may not occur every year. Sex reversal may occur from year to year. Mass fertilization occurs in water column, within 15 hours of spawning. Fertilized eggs develop within 24 hours into ciliated, motile larvae. Larvae drift in plankton for 3-4 weeks, but retain position in the upper 4 m of water column. At 0.3 mm size larvae settle and attach the left valve to a solid, clean substrate using excreted cement, referred to as spatting. At approximately 25 mm the spat or juvenile oyster is referred to as "seed". Oysters remain fixed to substrate for life. Adults live to over 20 yr and reach a maximum shell length of over 30 cm.

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NATIVE OYSTER, Ostrea lurida (Carpenter)

TAXONOMY

Phylum: Mollusca Class: Bivalvia Order: Ostreoida Family: Ostreidae

ECOLOGICAL DATA

Distribution: scattered throughout B.C. coast.

Habitat: saltwater lagoons, gravel flats, on or under rocks in muddy substrate, rocky sites near estuaries or in tidal pools; planktonic larvae dispersed by currents; juveniles cemented to rock surface for life.

Tidal elevation: lower intertidal to 1-2 m subtidal depth; susceptible to temperature changes.

Food: suspension feeder; mainly diatoms, detritus and zooplankton.

Predators: oyster drill, sea stars, crabs and ctenophores.

GROWTH RATE

Slow; sexually mature by 2 yr; less than 60 mm maximum shell size.

FISHERY

Commercial fishery existed until 1936; recreational fishery.

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Generalized life cycle of the native oyster. Male and female oysters spawn in late May to September. Sex reversal may occur from year to year. Fertilization and initial stages of larvae development occur internally. Larvae are released to the plankton at a larger size than Pacific oysters and larvae remain in the upper 4 m of water column. At 0.3 mm size larvae settle and attach the left valve to a solid, clean substrate using excreted cement, referred to as spatting. At approximately 25 mm the spat or juvenile oyster is referred to as "seed". Oysters remain fixed to substrate for life. Adults live to 10 years and reach a maximum shell length of over 60 mm.

PINK SCALLOP, Chlamys rubida (Hinds)

TAXONOMY

Phylum: Mollusca Class: Bivalvia Order: Ostreoida Family: Pectinidae

ECOLOGICAL DATA

Distribution: discontinuous along coast; may exist in small, higher density beds.

Habitat: sand/mud bottom in areas with strong current; planktonic larvae dispersed by currents; adults attach to rock with byssus and may move by swimming to new location and re-attaching.

Tidal elevation: 5 to 200 m subtidal depth.

Food: suspension feeder; mainly phytoplankton, detritus and zooplankton.

Predators: sea stars, snails, fish and boring worms and sponges.

GROWTH RATE

Slow; maximum growth of 85 mm reached in 4-5 yr; sexually mature at 60 mm, 2-3 yr.

FISHERY

Sporatic dragging fishery in 10-40 m subtidal depth; 1986 total scallop commercial catch was 68 t valued at \$0.2 million.

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Mottet, M.G. 1979. A review of the fishery biology and culture of scallops. Wash. Dep. Fish. Tech. Rep. 39: 100 p.



Generalized life cycle of the pink scallop. Males and females probably spawn from January to March in Gulf Islands. Mass fertilization occurs in water column. Larvae drift as plankton for 3-4 weeks and are dipsersed by currents. Settle from plankton and attach to rock or shell by byssus. May break free several times and swim to new location by inhaling and expelling water in a series of jets. Adults reach 85 mm.

SPINY SCALLOP, Chlamys hastata (Sowerby)

TAXONOMY

Phylum: Mollusca Class: Bivalvia Order: Ostreoida Family: Pectinidae

ECOLOGICAL DATA

Distribution: discontinuous along coast; may exist in small, higher density beds.

Habitat: firm gravel or rock bottom in area with strong current; planktonic larvae dispersed by currents; adults attach to rock with byssus and may move by swimming to new location and re-attaching.

Tidal elevation: 5 to 150 m subtidal depth.

Food: suspension feeder; mainly phytoplankton, detritus and zooplankton.

Predators: sea stars, snails, fishes and boring worms and sponges.

GROWTH RATE

Slow; maximum growth of 85 mm reached in 4-5 yr; sexually mature at 60 mm, 2-3 yr.

FISHERY

Minor commercial and sport (diver) fisheries; proposed minimum size limit of 60 mm; 1986 total scallop commercial catch was 68 t valued at \$0.2 million.

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Generalized life cycle of the spiny scallop. Males and females probably spawn from mid-August to late October in Gulf Islands. Mass fertilization occurs in water column. Larvae drift as plankton for 3-4 weeks and are dispersed by currents. Settle from plankton and attach to rock or shell by byssus. May break free several times and swim to new location by inhaling and expelling water in a series of jets. Adults reach 85 mm.

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WEATHERVANE SCALLOP, Patinopecten caurinus (Gould)

TAXONOMY

Phylum: Mollusca Class: Bivalvia Order: Ostreoida Family: Pectinidae

ECOLOGICAL DATA

Distribution: scattered populations along coast; small concentrations in the Plumper Sound and Trincomali Channel area in Gulf Islands and in McIntyre Bay on the northeast coast of Queen Charlotte Islands;

Habitat: usually sand or mud bottom; planktonic larvae dispersed by currents; juveniles attach to rock or shell by byssus; may move to new location by swimming.

Tidal elevation: subtidal, 10 to 200 m depth.

Food: suspension feeder; mainly phytoplankton, detritus and zooplankton.

Predators: sea stars, boring sponges and polychaete worms, fishes and crabs.

GROWTH RATE

Fairly rapid growth in Strait of Georgia, individuals are 1.5 times as large as those of the same age from outer coast; 90 mm at 4 yr and 125 mm at 6 yr. sexually mature at 2 yr, 75 mm in north coast.

FISHERY

Populations too small to support a continuous fishery; proposed minimum shell height of 100 mm for harvesting; 1986 total scallop commercial harvest was 68 t valued at \$0.2 million.

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Generalized life cycle of the weathervane scallop. Males and females spawn from mid-April to mid-June in Gulf Islands and in June and July in north coast. Mass fertilization occurs in water column. Larvae drift as plankton for 3-4 weeks and are dispersed by currents. Settle from plankton and attach to rock or shell by byssus. May break free several times and swim to new location by inhaling and expelling water in a series of jets. Adults may live to over 25 years and reach 280 mm.

ROCK SCALLOP, Chlamys gigantea (Gray)

TAXONOMY

Phylum: Mollusca Class: Bivalvia Order: Ostreoida Family: Pectinidae

ECOLOGICAL DATA

Distribution: scattered along coast and occurs in low abundance.

Habitat: firmly attached to rocky shores; planktonic larvae dispersed by currents; juveniles attach to rock, usually in crevices and remain for life.

Tidal elevation: lowest intertidal to 80 m subtidal depth; rarely intertidal.

Food: suspension feeder; mainly phytoplankton, detritus and zooplankton.

Predators: sea stars and shell borers.

GROWTH RATE

Fairly rapid growth; maximum size is 250 mm.

FISHERY

No commercial fishery due to low abundance and difficulty in harvesting; sport fishery by divers; limit of 6 per person per day south of Cape Caution and 12 per person per day north of Cape Caution.

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Generalized life cycle of the rock scallop. Males and females spawn from June to September. Mass fertilization occurs in water column. Larvae drift as plankton for 3-4 weeks and are dispersed by currents. Settle from plankton and at about 25 mm shell height attach to rock or shell by cementing right valve to surface. Adults reach 250 m in shell height.

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BLUE MUSSEL, Mytilus edulis (Linne)

TAXONOMY

Phylum: Mollusca Class: Bivalvia Order: Mytiloida Family: Mytilidae

ECOLOGICAL DATA

Distribution: common and widely distributed along B.C. coast.

Habitat: rocky shorelines; attach to rocks, gravel, compact mud, man-made hard surfaces, and floating or suspended objects near the water surface; planktonic larvae dispersed by current; larvae first settle on filamentous algae or hydroids and then attach permanently to rock substrate.

Tidal elevation: intertidal to 45 m subtidal depth; dense colonization between 1.5 to 3.7 m tide levels.

Food: suspension feeder; small plankton, including phytoplankton, bacteria, zooplankton and detritus.

Predators: diving ducks, sea stars, crabs, snails, sea urchins.

GROWTH RATE

Lower intertidal individuals have more rapid growth than higher intertidal ones; sexually mature in 1 yr; reaches 50 mm in 2 yr intertidally, or 1 yr using raft culture; many seem to die after one spawning.

FISHERY.

Small culturing operations beginning in B.C.; small sport and Native harvest.

REFERENCES

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Generalized life cycle of the blue mussel. Sexes usually separate but some hermaphrodites may occur in population. Spawning occurs from March to October. Mass fertilization occurs in water column and larvae develop within several hours. Larvae remain planktonic for about 3–5 weeks and are dispersed by currents. At approximately 0.35 mm larvae settle from plankton. Primary settlement involves initial attachment to filamentous algae or hydroids. Secondary settlement occurs on adult clumps or on clear areas where firm attachment is made using byssus. Post–larval mussels use byssal threads as a "parachute" for transport by currents before attaching permanently to rocky or other hard surface. Adult mussels may grow to 80 mm, but in B.C. they seem relatively short lived and most appear to die after one spawning when they are typically 30–60 mm in length and 3–4 years old. NORTHERN ABALONE, Haliotis kamtschatkana (Jonas)

TAXONOMY

Phylum: Mollusca Class: Gastropoda Order: Archeogastropoda Family: Haliotidae

ECOLOGICAL DATA

Distribution: scattered, mostly found along outer coast.

Habitat: attach to firm (rocky) substrate in waters with high salinity and some wave or current action; planktonic larvae dispersed by currents; tend to settle in recently grazed areas, attracted by chemicals secreted by colonizing algae; adults often colonize kelp beds.

Tidal elevation: intertidal to over 100 m subtidal depth; optimum is subtidal, from 0 to 6 m depth.

Food: herbivore; very young feed on diatoms and attached microalgae; juveniles feed on attached algae, adults feed on kelp fragments.

Predators: octopus, sunflower star, wolf eel, and sea otter in subtidal; man, birds (oyster catcher), otter and mink in intertidal.

GROWTH RATE

More rapid growth and larger size in beds of bull kelp (*Nereocystis leutkeanana*) and giant kelp (*Macrocystis integrifolia*); legal size of 100 mm is reached in 6 to 10 yr; sexually mature at about 50 mm.

FISHERY

Only commercially exploited snail in B.C.;

Small commercial, native and sport fisheries; 1986 commercial catch was 52 t valued at \$0.7 million.

REFERENCES

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Generalized life cycle of the northern abalone. Male and female abalone spawn in April to August. Spawning may not occur every year. Mass fertilization occurs in the water column. Fertilized eggs hatch within one day into free-swimming larvae which remain in the plankton for 2–11 days before settling. Planktonic larvae are dispersed by current. Larval settlement may be triggered by chemical secreted by the encrusting red algae *Lithothamnion* and related genera, typically found in areas grazed by sea urchins or abalone. Following metamorphosis, juvenile abalone are light sensitive and seek habitats in cracks and underside of rocks. As the juveniles grow, they migrate up to preferred food source, often kelp. Abalone may live to 15 years and reach a maximum shell length of 150 mm.

OPAL SQUID, *Loligo opalescens* (Berry)

TAXONOMY

Phylum: Mollusca Class: Cephalopoda Order: Decapoda Family: Loliginidae

ECOLOGICAL DATA

Distribution: common in offshore coastal waters but moves inshore to spawn.

Habitat: spawn in sheltered locations over mud or sand bottom; egg cases deposited on mud or sand; juvenile squid feed in the upper 15 m and are dispersed by currents; juveniles move offshore as they grow.

Tidal elevation: intertidal to 250 m subtidal depth; spawns in water depths of 3 to 40 m.

Food: predatory carnivore; newly hatched larvae prey upon tiny crustaceans in the plankton; juveniles prey upon fish, crustaceans and smaller squid.

Predators: salmonids, flatfish, other fishes, sharks, marine mammals and sea birds.

GROWTH RATE

Sexually mature at 1 yr; maximum length is about 175 mm; adults weigh 14–70 g.

FISHERY

Small commercial fishery exists in B.C. (less than 70 t in 1984).

REFERENCES

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Generalized life cycle of the opal squid. Mature male and female squids move to shallow, sheltered waters to form pre-spawning aggregations. Mating occurs year round but major spawning period is between February and August. Female deposits eggs in egg cases on mud or sand bottoms of sheltered locations. After 3 months of egg development hatching occurs at night and larvae are about 5 mm total length. Juvenile squid feed on tiny crustaceans in the plankton and are dispersed by water currents. As they grow they move into deeper water. Feed on crustaceans, fish and smaller squid, and exhibit diel feeding movements. Squids have a maximum age of 2-3 years and die soon after spawning. Maximum adult size is 175 mm.

GIANT PACIFIC OCTOPUS, Octopus dofleini (Wulker)

TAXONOMY

Phylum: Mollusca Class: Cephalopoda Order: Octopoda Family: Octopodidae

ECOLOGICAL DATA

Distribution: in rocky areas throughout B.C. coast.

Habitat: establish dens in caves or rocky areas, or smaller individuals may dig dens in sand-shell substrates; inhabits deep water from February-April and August-October; females brood eggs on roof of dens; planktonic larvae until 50 mm length, then remain benthic.

Tidal elevation: subtidal, to a depth of over 100 m; inshore dens usually from 13-30 m.

Food: nocturnal predator; larvae feed on copepods and other zooplankton; juveniles and adults prey on crabs, cockle, littleneck clams, abalone, moon snails and small fish.

Predators: seals, sea lions, sea otters, dogfish, lingcod, flatfish and larger octopuses.

GROWTH RATE

Sexually mature at 2-3 yr, males after 12 kg and females after 20 kg; at 1 yr weighs 1 kg and 12 kg after 1.5 yr.

FISHERY

Small commercial fishery (53 t in 1986 valued at \$0.1 million.)

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Generalized life cycle of the giant Pacific octopus. Male and females mate throughout the year but most mating in British Columbia occurs in inshore waters during fall. About 2 months later, females lay eggs in clusters which adhere to the roof of the den. Female broods eggs for 5–6 months. Female dies after, or sometimes before, eggs hatch in spring. Newly hatched larvae are about 7 mm in length. Larvae swim upwards and remain in plankton for about 2 months. At approximately 50 mm they settle and follow a benthic existence. Migrations appear to occur between shallow inshore and deeper offshore waters. Octopuses are most common inshore from May to July and November to January, and offshore from February to March and August to October. Adults live to be 3 to 5 years old and males reach a maximum size of 25 kg.

SEA CUCUMBER, Parastichopus californicus (Stimpson)

TAXONOMY

Phylum: Echinodermata Class: Holothuroidea Order: Aspidochirota Family: Stichopodidae

ECOLOGICAL DATA

Distribution: common and widespread along B.C. coast.

Habitat: most common on bedrock substrate in areas with little or no current where detritus accumulates; also live on gravel, sand or mud, often in eelgrass beds; planktonic larvae dispersed by currents; settled larvae and juveniles hide in dense mats of filamentous red algae, algae holdfasts, under rocks or in rock crevices; spawning occurs in shallow water, less than 16 m depth.

Tidal elevation: from extreme low tide level in intertidal to 90 m subtidal depth.

Food: deposit feeder; lives on organic matter and associated microorganisms.

Predators: sea stars *Pycnopodia* and *Solaster* prey on adults; numerous predators on larvae.

GROWTH RATE

Slow; 5 to 20 mm at 1 yr; 5-6 yr to reach sexual maturity; maximum size is 500 mm and lives to over 8 yr.

FISHERY

Since 1980 a small diving fishery has existed; major fishery in Georgia Strait and minor one along west coast of Vancouver Island; 1986 commercial catch was 3786 t valued at over \$0.2 million; much of coast is under closure.

REFERENCES

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Sloan, N.A. 1986. Sea cucumber. Underwater World, Fish. Oceans Can., Ottawa: 4 p.



Generalized life cycle of the sea cucumber. Males and females spawn in shallow water (less than 16 m) during June to August, and assume a "cobra-like" posture while releasing gametes. Fertilization occurs in water column. Larvae drift as plankton for about 7-13 weeks, then settle and develop into juvenile sea cucumbers. Juveniles are secretive, usually hiding in macroalgae holdfasts, dense mats of filamentous red algae, under rocks or in rock crevices. Adults may reach 500 mm and may live to over 8 years.

RED SEA URCHIN, Strongylocentrotus franciscanus (Agassiz)

TAXONOMY

Phylum: Echinodermata Class: Echinoidea Order: Echinoida Family: Strongylocentrotidae

ECOLOGICAL DATA

Distribution: rocky areas throughout exposed and protected coastal waters.

Habitat: rocky substrates, especially ledges and crevices; locate near or in giant or bull kelp beds and other brown algae in areas of moderate to swift currents; larvae drift and feed in plankton; juveniles settle near kelp beds, often associate with aggregations of adults, remain under adult spines until they reach 40 mm.

Tidal elevation: extreme low tide to 100 m subtidal depth; most concentrated abundance just below the upper limit of range, usually 5-10 m subtidal.

Food: herbivore; grazes on attached marine plants and drifting kelp fragments; primary food is kelp and may limit kelp distribution.

Predators: sea stars, sea otter, octopus, crabs, wolf eels; numerous predators on larvae.

GROWTH RATE

Slow, very dependent on food (i.e. kelp) supply; sexually mature at 50 mm test diameter reached at 2 yr; reaches commercial size, 100 mm at 4-5 yr; may reach 190-200 mm test diameter.

FISHERY

Small commercial diving fishery; minimum size limit 100 mm; 1986 commercial catch was 2,067 t valued at \$1 million.

REFERENCES

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Sloan, N.A. 1986. Red sea urchin. Underwater World, Fish. Oceans Can., Ottawa: 4 p.



Generalized life cycle of the red sea urchin. Males and females generally spawn from June to September, peaking in July, but spawning periods vary from area to area. Mass fertilization occurs in water column. Fertilized eggs develop into free-swimming larvae or nauplii which drift and feed in plankton. After 6-8 weeks, larvae settle and develop into juvenile sea urchins. Often they seek aggregations of adults and remain under spines until they reach test diameter of 40 mm. Sea urchins are very vulnerable to predation between 50-80 mm. Sea urchins usually aggregate in areas where food is plentiful, with the preferred food, being giant or bull kelp. Adult urchins may reach 180 mm and live to be over 7-10 years old. GREEN SEA URCHIN, Strongylocentrotus droebachiensis (Muller)

TAXONOMY

Phylum: Echinoidermata Class: Echinoidea Order: Echinoida Family: Strongylocentrotidae

ECOLOGICAL DATA

Distribution: rocky areas throughout exposed and protected coastal waters.

Habitat: rocky substrates, especially ledges and crevices; locate near or in giant or bull kelp beds and other brown algae in areas of moderate to swift currents; larvae drift and feed in plankton; juveniles settle near kelp beds, often associate with aggregations of adults, remain under adult spines until mature.

Tidal elevation: extreme low tide to over 100 m subtidal depth; most concentrated abundance just below the upper limit of range.

Food: herbivore; grazes on attached marine plants and drifting kelp fragments; primary food is kelp and may limit kelp distribution;

Predators: sea stars, sea otter, octopus, crabs, wolf eels; numerous predators on larvae.

GROWTH RATE

Slow; average size is 50-60 mm, but may reach a maximum size of about 85 mm.

FISHERY

No commercial fishery exists at present due to small size though potential exists.

REFERENCES

Jamieson, G.S., and K. Francis. 1986. Sea urchins, pp. 8–12. *In.* G.S. Jamieson and K. Francis [ed.] Invertebrate and marine plant fishery resources of British Columbia. Can. Spec. Publ. Fish. Aquat. Sci. 91.

Kramer, D.E., and D.M.A. Nordin. 1978. Physical data from a study of size, weight and gonad quality for the green sea urchin (*Strongylocentrotus droebachiensis*) over a one-year period. Fish. Mar. Serv. MS Rep. 1476: 68 p.

Mottet, M.G. 1976. The fishery biology of sea urchins in the Family Strongylocentrotidae. Wash. Dep. Fish. Tech. Rep. 20: 66 p.



Generalized life cycle of the green sea urchin. In the B.C. south coast spawning seems to occur from September to January. Mass fertilization occurs in water column. Fertilized eggs develop into free-swimming larvae or nauplii which drift and feed in plankton. After 6-8 weeks, larvae settle and change form into juvenile sea urchins. Often they seek aggregations of adults and remain under spines until mature. Sea urchins usually aggregate in areas where food is plentiful, with the preferred food being giant or bull kelp. Adult urchins may reach 851 mm and live to about 4 years old.

GOOSENECK BARNACLE, Pollicipes polymerus (Sowerby)

TAXONOMY

Phylum: Arthropoda Class: Crustacea Order: Thoracica Family: Scalpellidae

ECOLOGICAL DATA

Distribution: common on rocky, exposed coastal areas with strong wave action.

Habitat: form tight clumps on exposed rocky shorelines with strong wave action; occur in rocky gullies in more sheltered locations; associated with California mussel (*Mytilus californianus*) and sea star *Pisaster ochraceus*; planktonic larvae dispersed by currents; larvae often settle on stalks of adults.

Tidal elevation: mid-intertidal zone, extending higher in gullies where wave action is concentrated.

Food: filter feeder; feeds on copepods, algae and detritus, and larger invertebrates such as amphipods; obtains food from wave-wash running off of rocks.

Predators: sea stars and crabs.

GROWTH RATE

Slow; sexual maturity reached after 5 y (approx. 12 mm capitulum height); may live to 20 yr.

FISHERY

Small fishery exists; stalk or peduncle is used for food.

REFERENCES

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Kozloff, E. N. 1983. Seashore life of the northern Pacific coast. Douglas & McIntyre, Vancouver: 135–136.

Lewis, C.A. 1975. Development of the gooseneck barnacle *Pollicipes polymerus* (Cirripedia: Lepadomorpha): fertilization through settlement. Mar. Biol. 32: 141–153.



Generalized life cycle of the goose barnacle. Goose barnacles are hermaphrodites and brood fertilized eggs internally for 20-31 days prior to hatching in summer. Free-swimming larvae or nauplii drift as plankton for about 42 days. During their planktonic life, larvae molt several times and develop into cypris larvae. The larvae usually settle near or on the stalk or peduncle of adults and develop into juvenile goose barnacles. Growth is slow, with adults reaching a maximum size of about 150 mm in about 20 years.

COONSTRIPE SHRIMP, Pandalus danae (Stimpson)

TAXONOMY

Phylum: Arthropoda Class: Crustacea Order: Decapoda Family: Pandalidae

ECOLOGICAL DATA

Distribution: throughout coastal waters, but main fisheries are along south coast.

Habitat: sandy, gravel and rocky bottoms in areas with rapid tidal current flows; planktonic larvae utilize 18–54 m depths but prefer bottom layer as they develop; remain in shallow water bays and inlets during first year due to abundant food supply; may be common around docks.

Tidal elevation: intertidal to 185 m subtidal depth.

Food: carnivore; mysids, amphipods and polychaete worms.

Predators: ling cod.

GROWTH RATE

Shrimp are potandrous hermaphrodites: spend the early part of their lives as males and the remainder as females; following 5 larval stages, metamorphosis is complete by June and males are 60–70 mm by October; reach 85 mm by second autumn; most become females in the spring of the 2nd yr, and reach 100 mm in fall; life span is about 3 yr and maximum size is 123 mm for males and 140 mm for females.

FISHERY

Commercial and sport fisheries; commercial fishery in Burrard Inlet until 1960; winter trap fishery in Sooke Harbour yields 5-50 t per season; sport fishery off docks, e.g. near Sidney; 1986 total shrimp commercial catch was 768 t valued at \$1.2 million.

REFERENCES

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Generalized life cycle for the coonstripe shrimp. Coonstripe shrimp are potandrous hermaphrodites, spending the early part of life cycle as males and the later part as females. Some individuals develop directly into females. Breeding occurs in the fall (November). Females lay eggs which remain attached to abdominal appendages until hatching in March and April, usually between 18-54 m water depth. Nauplii or free-swimming larvae spend 2-3 months in plankton but utilize progressively deeper depths as they develop. They settle to bottom and by late June metamorphosis is complete. By October, as males, they are 60-70 mm in length. Remain in shallow water bays and inlets during first year because detritus from summer plankton and larger algae production supports amphipods and mysids which are preyed upon by young shrimp. By the following autumn males reach 85 mm. Most adults become females in the spring of their second year, and grow to 100 mm by October. Maximum life span is 3 years and maximum size for males is 123 mm and 140 mm for females.

HUMPBACK SHRIMP, Pandalus hypsinotus (Brandt)

TAXONOMY

Phylum: Arthropoda Class: Crustacea Order: Decapoda Family: Pandalidae

ECOLOGICAL DATA

Distribution: throughout coastal waters, tends to be more common along north coast.

Habitat: muddy bottoms; planktonic larvae but prefers bottom layer as they develop; remain in shallow bays and inlets during first year due to abundant food supply.

Tidal elevation: 5 to 406 m subtidal depth.

Food: carnivore; mysids, other crustaceans and polychaete worms.

Predators: sand sole.

GROWTH RATE

Shrimp are potandrous hermaphrodites: spend the early part of their lives as males and the remainder as females; as sexually mature males reach 90 mm in March-May and 110 mm in fall of second year; change to females at 2-2.5 yr and measure 90-135 mm; life span is about 3 yr but may live until 4 yr; maximum size is 151 mm for males and 192 mm for females.

FISHERY

Commercial fishery in Masset Inlet, but taken in shrimp fisheries along coast; 1986 total shrimp commercial catch was 768 t valued at \$1.2 million.

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Generalized life cycle for the humpback shrimp. Humpback shrimp are potandrous hermaphrodites, spending the early part of life cycle as males and the later part as females. Some individuals develop directly into females. Breeding occurs in the fall. Females lay eggs which remain attached to abdominal appendages until hatching in March and April. Nauplii or free-swimming larvae spend 2-3 months in plankton but utilize progressively deeper depths as they develop. They settle to bottom and by late June metamorphosis is complete, usually in water depths of 65-82 m (adult habitat) or in shallower water (37-55 m). Remain in shallow bays and inlets during first year because detritus from summer plankton and larger algae production supports amphipods and mysids which are preyed upon by young shrimp. Matures as a male at 1.5 yr and measures 110 mm by fall. At 2-2.5 years changes to female and measures 90-135 mm. Males may grow to 151 mm and females 192 mm. Life span is usually 3 years, but some females may live to 4 years.

TAXONOMY

Phylum: Arthropoda Class: Crustacea Order: Decapoda Family: Pandalidae

ECOLOGICAL DATA

Distribution: in rocky areas along B.C. coast.

Habitat: rocky substrate, crevices in rock faces or in lairs under boulders; adults remain deep by day (over 50 m) and move up to 18 m at night; planktonic larvae utilize 70-90 m depths but prefer bottom layer as they develop; late larvae and post-larvae may utilize 12-18 m water depths; remain in shallow water (54 m or less) in bays and inlets during first year due to abundant food supply; juveniles may occur on muddy bottoms.

Tidal elevation: intertidal to 487 m subtidal depth.

Focd: carnivore; mysids, amphipods and polychaete worms.

Predators: octopus and yelloweye rockfish.

GROWTH RATE

Prawn are potandrous hermaphrodites: spend the early part of their lives as males and the remainder as females; 100 mm after 1 yr, and 150 mm by second autumn; in spring of 4th yr change to females at 200 mm; 85 mm by second autumn; maximum size is 230 mm for males and 250 mm for females.

FISHERY

Valuable commercial and sport fisheries; 1986 commercial catch was 550 t valued at \$3.7 million.

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Generalized life cycle for the prawn. Prawn are potandrous hermaphrodites, spending the early part of life cycle as males and the later part as females. Breeding occurs in the fall and is usually complete by the end of October. Females lay eggs which remain attached to abdominal appendages until hatching in March and April, usually between 70–90 m water depth. Free-swimming larvae or nauplii spend 2–3 months in plankton. Late and post-larvae remain in shallow water (less than 54 m) until winter months. Prawn reside in shallow water bays and inlets during first year because detritus from summer plankton and larger algae production supports amphipods and mysids which are preyed upon by young prawns. One year after hatching, at about 100 mm, prawns move to deeper (over 100 m) and by autumn males reach 150 mm. In fourth spring, at 200 mm, they change to females. Maximum life span is 5 years, but most live 4 years, and maximum length for males is 230 mm and 253 mm for females.
DUNGENESS CRAB, Cancer magister (Dana)

TAXONOMY

Phylum: Arthropoda Class: Crustacea Order: Decapoda Family: Cancridae

ECOLOGICAL DATA

Distribution: common and widespread in sandy areas along B.C. coast.

Habitat: sandy substrate; may occur on mud and gravel; often buried just below surface of sand or in vegetation; planktonic larvae dispersed by currents; juveniles remain in intertidal and shallow subtidal hiding beneath or among plants, rocks and shell debris until 2nd summer; breeding occurs in inshore waters and females may move to deeper water to hatch eggs.

Tidal elevation: intertidal to over 180 m subtidal depth.

Food: bivalves, crustaceans, marine worms and fish.

Predators: octopus, halibut, dogfish, sculpins, rockfish, birds, and larger crabs.

GROWTH RATE

Must molt to grow; females and males sexually mature at 100 and 150 mm, respectively (2-3 yr); males reach legal size (165 mm) at 3-4 yr; females seldom reach legal size.

FISHERY

Supports valuable commercial, Native and sport crab fisheries; minimum legal size is

165 mm carapace width; 1986 total crab commercial catch was 1,321 t valued at \$5.7 million.

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Generalized life cycle of the Dungeness crab. Mature female crabs generally molt between May-August, and mating occurs immediately after the female has molted and before the new exoskeleton hardens. In October or November, eggs are fully developed and the eggs are extruded and fertilized. Eggs remain attached to the female's abdomen until hatching in late winter. Females are often buried in sand as the eggs develop. The larval phase, lasting about 4 months, consists of five zoeal and one megalopa stages. From May to September, megalopae settle and metamorphise into the first post-larval instar. Juvenile crabs remain in lower intertidal or shallow subtidal waters and overwinter as less than 70 mm crabs, sometimes in shallow water. As one year olds, they may grow to about 120 mm. As they grow, they tend to move into progressively deeper water. Adult crabs may live to over 10 years and reach a maximum carapace width of 230 cm and maximum weight of 2 kg.

RED ROCK CRAB, Cancer productus (Randall)

TAXONOMY

Phylum: Arthropoda Class: Crustacea Order: Decapoda Family: Cancridae

ECOLOGICAL DATA

Distribution: widespread and common in semi-protected bays and estuaries along B.C. coast; also in protected rocky areas associated with rocky headlands and outcrops.

Habitat: rock, gravel or kelp beds in bays or estuaries, or rocky areas where rocky headlands or outcrops provide some wave protection; lack gill straining apparatus required for living in muddy/sandy habitat; planktonic larvae dispersed by currents; juveniles remain in intertidal and shallow subtidal associated with macroalgae until 2nd summer; breeding occurs in inshore waters.

Tidal elevation: intertidal to 79 m subtidal depth.

Food: carnivore; barnacles, bivalves, smaller living crabs and dead fishes.

Predators: rockfish and other large fishes, octopus and marine mammals.

GROWTH RATE

Must molt to grow; maximum width is 158 mm.

FISHERY

Too small for commercial harvest, but is taken in sport fishery.

REFERENCES

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Generalized life cycle of the red rock crab. The reproductive cycle appears to be similar to *C. magister*. Mating occurs in May to August immediately after the female has molted and before the new exoskeleton hardens. Eggs extruded from October to early June but mostly in December and January. Hatching occurs in late March or early April. Larval phase consists of five zoeal stages and one megalopa stage and lasts for about 3–4 months. Juveniles presumably utilize shallow waters, hiding in eelgrass and macroalgae, and move into deeper water as they grow. Adults may grow to a maximum size of 158 mm carapace width.

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SPECIES ILLUSTRATIONS

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CHINOOK SALMON, Oncorhynchus tshawytscha (Walbaum)

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CHUM SALMON, Oncorhynchus keta (Walbaum)



COHO SALMON, Oncorhynchus kisutch (Walbaum)



PINK SALMON, Oncorhynchus gorbuscha (Walbaum)



SOCKEYE SALMON, Oncorhynchus nerka (Walbaum)



COASTAL CUTTHROAT TROUT, Oncorhynchus clarki (Richardson)

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STEELHEAD TROUT, Oncorhynchus mykiss (Richardson)



DOLLY VARDEN CHAR, Salvelinus malma (Walbaum)



WHITE STURGEON, Acipenser transmontanus (Richardson)



EULACHON, Thaleichthys pacificus (Richardson)



PACIFIC HERRING, Clupea harengus pallasi (Valenciennes)



SURF SMELT, Hypomesus pretiosus pretiosus (Girard)





STARRY FLOUNDER, Platichthys stellatus (Pallas)



PACIFIC HALIBUT, Hippoglosus stenolepis (Schmidt)

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COPPER ROCKFISH, Sebastes caurinus (Richardson)



YELLOWEYE ROCKFISH, Sebastes ruberrimus (Cramer))



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QUILLBACK ROCKFISH, Sebastes maliger (Jordan and Gilbert)



LITTLENECK CLAM, Protothaca staminea (Conrad)

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MANILA CLAM, Tapes philippinarum (Adams and Reeve)



RAZOR CLAM, Siliqua patula (Dixon)



HORSE CLAM, Tresus capax (Gould)



HORSE (GAPER) CLAM, Tresus nuttallii (Conrad)

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GEODUCK CLAM, Panope abrupta (Conrad)



SOFT-SHELL CLAM, Mya arenaria (Linne)



PACIFIC OYSTER, Crassostrea gigas (Thunberg)

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NATIVE OYSTER, Ostrea lurida (Carpenter)



PINK SCALLOP, Chlamys rubida (Hinds)



SPINY SCALLOP, Chlamys hastata (Sowerby)

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WEATHERVANE SCALLOP, Patinopecten caurinus (Gould)



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ROCK SCALLOP, Chlamys gigantea (Gray)



BLUE MUSSEL, Mytilus edulis (Linne)



NORTHERN ABALONE, Haliotis kamtschatkana (Jonas)



OPAL SQUID, Loligo opalescens (Berry)



GIANT PACIFIC OCTOPUS, Octopus dofleini (Wulker)



SEA CUCUMBER, Parastichopus californicus (Stimpson)



RED SEA URCHIN, Strongylocentrotus franciscanus (Agassiz), left, and GREEN SEA URCHIN, Strongylocentrotus droebachiensis (Muller), right



GOOSENECK BARNACLE, Pollicipes polymerus (Sowerby)



COONSTRIPE SHRIMP, Pandalus danae (Stimpson)

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HUMPBACK SHRIMP, Pandalus hypsinotus (Brandt)



PRAWN, Pandalus platyceros (Brandt)



DUNGENESS CRAB, Cancer magister (Dana)



RED ROCK CRAB, Cancer productus (Randall)

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