An Annotated List of Tsimshian (Sm'algyax) Words Pertaining to the Marine Ecosystem

Stephen Watkinson
Fisheries Centre, UBC

Abstract

Recently there has been a trend to incorporate into science the traditional ecological knowledge (TEK) of First Nations in Canada. This in turn has created a need for cross validation between the two. Bridging the language barriers between scientists and First Nations will contribute toward this cross-validation. One initial step in this process is to catalogue and annotate the terms used by the local people to describe the flora and fauna of a given area. Such word lists can then give historical clues about species diversity and abundance. This contribution annotates a list of previously published Tsimshian words that are relevant to the marine ecosystem. The words are arranged into the following groups: fish, fish-related, marine plants, invertebrates, birds, mammals, and general fishing terms.

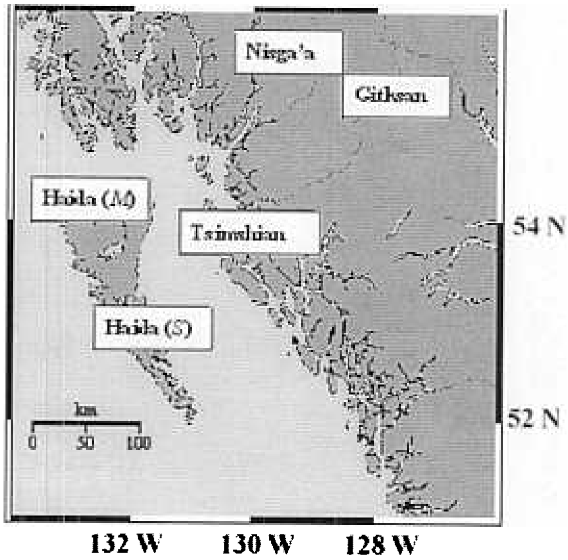

Figure 1. Map of the British Columbia coast showing the approximate location of the Tsimshian, Nisgz'a and Gitksan. The locations of Haida dialects are also shown ('*S*' = Skidegate, '*M*' =, see Jones, this volume).

Introduction

Scientists have a long history of ignoring the knowledge and observations of First Nations people. Though First Nations groups have occupied their territories for thousands of years, their observations of the land and/or ocean often have been dismissed as mere stories or myths. Recently, however, a trend to incorporate the traditional ecological knowledge (TEK) of First Nations people into the corpus of scientific knowledge has established itself.

Most notably, it has become obvious that TEK can be an invaluable source of information when trying to piece together historic trends of species abundance and distribution. The initial step to tap into this vast resource of knowledge is to catalogue and annotate the terms used by the local people to describe the flora and fauna of a given area (see e.g., Danko 1998, Jones, this vol., Preikshot and Leer 1998). Such a catalogue, when annotated with information pertaining to abundance, distribution, and behavior of organisms, can be a useful source of qualitative information to supplement scientific study.

Presently, scientific studies concern themselves mainly with well-documented quantitative facts and figures. In many cases, however, comparing recent trends with historical conditions requires that qualitative local knowledge is available. Archaeological evidence shows that the Tsimshian have occupied some coastal sites for over ten thousand years (Seguin1985). Consequently, much information has been passed on orally, not stored electronically or published. Thus, a lack of quantitative information should not be seen as a hindrance, but rather an opportunity to incorporate local TEK into science. Pauly *et al.* (1998) used this approach to model the Strait of Georgia as it might have been 100 and 500 years ago. This approach allowed for a more complete picture of the ecosystem, wherein its evolution was considered rather than just a snapshot in time.

TEK is also useful to track trends for single species. Historical inventories for local areas can be compiled in scientific databases such as Fishbase (Froese and Pauly 1998) so that trends in species distribution or diet may be seen. For instance, the Tsimshian people have one word, 'gaksaa', for both blue and hammerhead sharks (Dunn 1978). While blue sharks occur off the coast of British Columbia (Hart 1973), reports of hammerheads occurring in our waters could not be found in other sources. It is unlikely that the hammerhead could be confused with any other shark species due to its distinctively shaped head. If the possible occurrence of hammerheads in British Columbian waters is then reported in Fishbase, TEK is then transformed into a scientific format.

The Tsimshian language family encompasses four related groups: the Nisga'a, along the Nass River; the Gitksan, on the Upper Skeena; the Coast Tsimshian, along the lower Skeena and adjacent coast; and the Southern Tsimshian, on the coast and southern islands. Out of these four groups arose two languages, Nass-Gitksan and Coast Tsimshian (Haplin and Seguin 1990). This paper focuses only on the Coast Tsimshian language. The relative position of the territories of the Gitksan, Nisga'a, Tsimshian, and Haida (see Jones, this vol.) can be seen in Fig. 1.

The following list of Tsimshian words was adapted from Dunn (1978), who presented Tsimshian words in both Roman and phonetic characters. The latter are omitted here. The terms that were extracted were chosen based on their relevance to the marine ecosystem, and then grouped according to the following: fish names, fish terms, marine plants, invertebrates, birds, mammals, and general fishing terms. Whenever possible, each term is annotated. The reference number column refers to the word number in Dunn (1978).

The Dictionary

Fish names

TERM	TSIMSHIAN	REFERENCE
Black bass (Pacific sea bass) – B.C. fishers usually refer to the black rockfish (*Sebastes melanops*) when they use black bass.	Gakgak	293.1
Black cod - also known as sablefish (*Anoplopoma fimbria*)	Hadani	
Bullhead - cabezon, sculpin, sea raven, muddler (*Hemitripterus americanus, Myoxocephalus octodecemspinosus, Scorpaenichthys marmoratus*, and *Cottus bairdi*)	k'ayeet	
Chinook salmon - spring or king salmon (*Oncorhynchus tshawytscha*)	yee	
Chum salmon - dog salmon (*Oncorhynchus keta*)	Gayniis	
Old chum salmon (*Oncorhynchus keta*)	Ƚgum'yee	
Coho salmon - silver salmon (*Oncorhynchus kisutch*)	wüüx, waak,üük	2002; 2018; 2123
Coho salmon turned red (*Oncorhynchus kisutch*)	Ksihoon	965
Pink salmon - humpback salmon (*Oncorhynchus gorbuscha*)	sti'moon	1764
Pygmy salmon (*Oncorhynchus nerka*)	ts'üwaas	1980
Pygmy sockeye salmon (*Oncorhynchus nerka*)	ts'üwaasmmüsoo	1981
Sockeye salmon - red salmon (*Oncorhynchus nerka*)	Müsoo	1456
Sockeye - male in red phase (*Oncorhynchus nerka*)	Gyi'aȽ	582
Flounder - may refer to several members of the family Pleuronectidae	Daxs	203
Golden shiner minnow (*Notemigonus crysoleucas*)	t'axt'oosk	
Grey cod - probably referring to the Pacific cod (*Gadus macrocephalus*)	K'awts	
Hake (*Merluccius productus*)	Balaas	134
Ling cod (*Ophiodon elongatus*)	Wa'tuk	2071
Oolachan – candlefish (*Thaleichthys pacificus*)	Haalmmoot, haldm'oot, `wah	644; 707; 2045
Pacific halibut (*Hippoglossus stenolepsis*)	Txaw	1896
Pacific herring (*Clupea harengus pallasi*)	skah, tskah	1725; 1941

Rainbow trout/ Steelhead trout (*Oncorhynchus mykiss*)	meliit	
ratfish - angel fish, chimaera (*Hydrolagus colliei*)	Guumaa	502
Red snapper - red cod (*Sebastes ruberrimus*)	ts'mhon	
Shark - blue and hammerhead (*Prionace glauca* and *Sphyrna lewini*)	ksaa	
Skate, ray - could be the big skate (*Raja binoculata*) or the longnose skate (*R. rhina*)	gandah, k'andah	388; 878
Starry flounder (*Platichthys stellatus*)	kbidaxs, xbidaxs	900; 2136
Tommy cod (*Microgadus proximus*)	K'awts	
Wolf eel – Dunn (1978) notes "not *Anarchichas lupus* but a local common name for the eel". (*A. lupus* is the Atlantic wolf eel). Dunn *may* mean that the Sm'algyax word does *not* refer to the wolf eel, but to some other fish).	gyibawmts'm'aks	
Eel - it is unclear which species of eel this word refers to, but probably the Pacific wolf eel, *Anarrhichthys ocellatus.*	lo'k, lo'ox	184; 1192

Fish-related terms

Anal fin	geesk	461
Dorsal fin	nee'k	
Caudal fin	Na'tsiks	1517
Soft dorsal fin	Haas	
Pectoral fin	ts'muuhoon, waayt	1965; 2041
Ventral fin	waayt	2041
Dried fish	Gnsmhoon, luunüksmhoon	471
Dried fish belly	k'ak'wiikws	
Dried fish nose	gagok, nagaoxt	325, 1482
Half-dried salmon	Ksits'al	972
Female fish	Laanmhoon	1071
Fish- an old one	Dzalee	246
Fish brains	Gagox	325.2
Fish eggs	Laan	1070
Fish heart	Goopn	

Fish scales	Siksxa̲n	1669
Fish slime	YeŁ	2232
Fish sperm	loo	1185
herring eggs	Xs'waanx	2190
Male fish	Loomhoon	1188
Roe	laan	1070
Salmon for smoking	ts'aal	1900
Salmon - split open and dried	Dziga̲ws	257
Salmon stomach	k'wiinti	1013

Marine plants

Alaria algae (*Alaria* spp.)	Dayts	207
Dried sea weed	p'T'iŁosk	1598
Enteromorpha algae (*Enteromorpha* spp.)	Ła̲'a̲sk	1273
Fucus algae (*Fucus gardneri*)	p'aatsa̲h	1587
Gigartina algae (*Gigartina* spp.)	G̲a̲dza̲keew	316
Grinnella algae (*Grinnella* spp.)	Gyoos	637
Kelp- the kelp forests of the Pacific northwest are made up of giant kelp (*Macrocystis integrifolia*) and bull kelp (*Nereocystis luetkeana*)	mok̲	1436
Phosphorescent algae	adaaŁn̲, biwaatk	27; 161

Invertebrates

Abalone (*Haliotis kamtschatkana*)	Bilhaa	159
Barnacles - a species of either genus *Semibalanus* or *Balanus*	ts'maay	1948
Black katy chiton - sea prune, possibly referring to the black chiton (*Katharina tunicata*)	Yaanst	221
Butter clam (*Saxidomus gigantea*)	sam'k	1645
Clam - members of the class Bivalvia	ts'a'a	1898
Clam siphon	G̲a̲nts'iit	405
Crab - most likely referring to the Dungeness crab (*Cancer magister*), but may also include the red rock crab (*C. productus*)	G̲a̲lmoos	361

Crow chiton - hairy *Mopalia* (*Mopalia hindsii*)	Yensagawgaw	
Giant Pacific octopus (*Octopus dofleini*)	Xbihats'al	2137
Devil fish – local common name for octopus (*Octopus dofleini*)	Hats'al	777; 2137
Giant squid (*Dosidicus gigas*)	Xbihats'al	
Horse clam (*Tresus capax*)	Loon	189
Isopods - referring to order Isopoda (Crustacean) with approximately 10,000 species	sts'oolalop	767
Metridium anemone - member of the class Anthozoa	Masxayloop	
Mussel - most likely the blue mussel (*Mytilus edulis*)	Gyels	571
Oyster - Pacific oyster (*Crassostrea gigas*)	Hagwn	678
Sand dollar - sea urchin (*Strongylocentrotus droebachiensis*)	asuun	107
Scallop – could be the spiny scallop (*Chlamys hastata*), rock scallop (*Crassadoma gigantea*), pink scallop (*C. rubida*), or the weathervane scallop (*Patinopectea caurinus*)	k'aŁ'an, 'nŁgabuus	874; 1547
Sea anemone – members of the class *Anthozoa*	Daga'aw	186
Sea cucumber - members of the class Holothuroidea	Gyenti	
Sea urchin - describes three species – *Arbacia punctulata, Strongylocentrotus franciscanus,* and *Echinometra lucunter*	Dzügwiits	
Shipworm (*Bankia setacea*)	GyiwaŁgn	
Spider crab	k'almoosgmlaxsga'niis	873
Starfish - members of the class Asteroidea	Gamaats	370

Birds

Black duck - referring to either the white-winged scoter (*Melanitta fusca*) or the surf scoter (*M. perspicillata*)	Amgyiik	79
Bufflehead (*Bucephala albeola*)	Waal'k	
Common scoter - also known as black scoter (*Melanitta nigra*)	Ahoo	43
Coot - probably the American coot (*Fulica americana*)	Amgyiik	79

Cormorant - three species of cormorants are present in Hecate Strait: the double crested cormorant (*Phalacrocorax auritusi*), pelagic cormorant (*P. pelagicus*), and Brandt's cormorant (*P. penicillatus*)	hawts	
Duck	ann'aneex	92
Eagle - most likely the bald eagle (*Haliaeetus leucocephalus*)	Xsgyiik	
Goose - probably Canada goose (*Branta canadensis*)	ha'a, Ƚi'win	641; 1329
Harlequin duck (*Histrionicus histrionicus*)	K'agaa	861
Kingfisher - probably the Belted kingfisher (*Ceryle alcyon*)	ts'iyoolgy	1940
Mallard duck (*Anas platyrhynchos*)	na'na	1508
Sandhill crane (*Grus canadensis*)	<u>k</u>'<u>a</u>s<u>k</u>oos	886
Sandpiper - could be referring to any of the members of the genus *Calidris*	ts'iiȽ	
Sawbill duck - could refer to the Common merganser (*Mergus merganser*) or the red breasted merganser (*M. serrator*)	Ƚgümiik	1314
Sea gull - there are five species of gulls found in Hecate Strait: the mew gull (*Larus canus*), glaucus gull (*L. hyperboreus*), herring gull (*L. argentatus*), glaucus winged gull (*L. glaucescens*), and Thayer's gull (*L. thayeri*)	<u>Ga</u>goom	326
Sparrow - referring to members of the family Emberizidae	Güsgüüts	
Tree duck - golden eyed sea duck, viz. Common goldeneye (*Bucephala clangula*) and Barrows goldeneye (*B. islandica*)	ts'as	
Western black oyster catcher (*Haematopus bachmani*)	GyedmȽ	567
Wood duck - same as Tree duck	ts'as	1923
Wren - referring to members of the family Troglodytidae	güsgüüts, ts'<u>a</u>pts'ap, waaxs	500; 1922; 2040

<u>Mammals</u>

Blackfish - Killer whale (*Orcinus orca*)	`NaaxȽ	

Dolphin, porpoise – may refer to Pacific white sided dolphin (*Lagenorhynchus obliquidens*), Dall's porpoise (*Phocoenoides dalli*) or Harbour porpoise (*Phocoena phocoena*)	dziiw	
Grizzly bear (*Ursus arctos*)	Midiik	
Polar bear (*Ursus maritimus*)	Moksgm'ol	1439
River otter, Land otter (*Lutra canadensis*)	Watsa	
Sea otter (*Enhydra lutris*)	PȽoon	1603
Sea lion - probably referring to Steller sea lions (*Eumetopias jubatus*)	t'iibm	1845
Baby seal	k'a'ootk	880
Elephant seal (*Mirounga angustirostris*)	Badzit'ool	132
Fur seal (*Callorhinus ursinus*)	k'oon	938
Harbour seal (*Phoca vitulina*)	Uula	2003
Hooded seal (*Cystophora cristata*)	Badzit'ool	132
Snout of a bull hooded seal	t'ool	1872
Pregnant seal	WiniiȽk	
Seal fur	k'oon	938
Sea monster	hagwilo'ox, hala'lox	677; 704
Shore animal	Amgyeek	78
Walrus - may be referring to *Odobenus rosmarus*	t'iibm	1845
Whale	Ƚbuun	1295

General Fishing Terms

Catch fish, catch fish with a net	aadmhon, 'mak,	5; 1384
Catch salmon when they are red and in freshwater	xgüüs	2146
Coast Tsimshian language	sm'algyax	1727
Nass-Gitksan language	gaalmx, gyaanmx	284; 560
Cut salmon for smoking	ts'aal	1900
Fish-boiled whole	Tkadzemsk	1852
Fish basket	ts'ükts'alaa	1917
Fish trap	t'iin	1850
Fish trap-horseshoe rock trap	luulp	1253
Fish trap-weir trap	amsahoon, nisahoon	85; 1540

Fish weir	DzeeyeŁ, dziis	253; 261
Fisherman	aadit, huk'at	4; 816
Fishing ground (an owned place for fishing)	Nahoon	1489
Flood tide	Leeks'aaks	1135
High tide	ditxaks, wagagyik	220; 2043
Low tide	Wagagyik	2043
Zero-tide	Lugawsga'aaks	1203
Go ashore	DzagmdaawŁ	243
halibut boat	saxs uumtxaw	1653
halibut hook	nuu, t'a'awil, yügah	1568; 1822; 2240
Harpoon barb/point	naatsk	
Harpoon shaft	Sgank'yiin	1674
herring rake	K'yideh	1050
Hunt on the water	woo	2100
Ocean floor	s'yaan	1812
Offshore wind	Uksbaask	1989
Onshore wind	Dzogmbaask	269
Oolachan grease	Smk'awtsi	1738
Oolachan net	T'agaaŁ	1823
Open ocean	gyaaks	559
Oyster cutter	GyedmŁ	567
River	k'ala'aks	867
Nass river	Klusms	907
Head of a river	Magoon	1378
Salt water	moon	1445
Sand bar	Laxhuu	1110
Scoop net	bana	136
Sea shell	NŁts'iik	1549
Seine	ga'aat	
Seine boat	saxs labagayt se'kya	1652
Squall	gatgyetgabaask, sba'ala	422; 2132
Troll	magon, umhon	1377; 1998

Discussion

This list of Tsimshian terms is not exhaustive, at least in part due to the method in which the dictionary was constructed. As a linguist, Dunn may not have been able to gather words for species he was unfamiliar with. Thus, the list of Tsimshian terms contains relatively few words for some groups, such as marine invertebrates and plants. Furthermore, a few of the words are used to describe several species belonging to the same class or genera. For example, there is only one word to describe sea cucumbers despite the occurrence of 34 species in the waters from southern Alaska to southern British Columbia (Lambert 1997).

Variability in the use of common names may also have presented a problem for this list of Tsimshian words. Local populations tend to give local names to organisms (see also Jones, this vol.). For instance, the Tsimshian now describe the species *Oncorhynchus nerka* by a variety of English common names: sockeye salmon, red salmon, blueback salmon, and pygmy salmon. With so many common names occurring within a relatively small geographical area, it may have been confusing as to which species was actually being referred to. Lumping of different species into one common name also appears to have been a problem. Thus, Tsimshian uses the same word for squid and octopus, and for both sea lion and walrus. For all intents and purposes, these species may have been perceived as being the same in terms of function, i.e., it is the 'cephalopod' that is perceived. It is hard to believe that people who relied heavily on nature's resources would not be able to distinguish two different species.

What is not surprising about the list of words is the large number of species for which there are names. The early Coast Tsimshian people relied heavily on the sea for resources. The majority of species listed in the dictionary are those that were commonly caught for food and ceremonial purposes, or those that were economically exploited. Thus, it is not surprising that many words exist for activities and species belonging to the marine ecosystem. The natural cycle of species available for exploitation throughout the year dictated the timing of the activities for the people. Traditional foods such as fish, shellfish, herring, Oolachan, and seaweed that are harvested locally and consumed in the household still comprise the majority of the diet for the people (Inglis *et al.* 1990). Traditional harvesting sites are still being used to gather these marine and river resources.

The Tsimshian's close relationship with the land and sea is prevalent in our mythology where animals are able to transform themselves into human form and vice versa. From this belief came a deep respect for human interactions with animals. A reciprocal relationship, where other organisms are treated respectfully, developed so that both humans and animals can benefit. For instance, if the remains of animals were not treated properly, the human form of the animal, which has returned to its hidden village, will suffer (Miller and Eastman 1984). Similar rules for fish have also been described by Boas (1916) who states that the Tsimshian believed that it was necessary to drink water after eating fish so that the fish can be revived again and go home gladly. Men would also have to go through a ritual in which they purified themselves before going fishing or hunting. The ritual included fasting, bathing, drinking the juice of the root of the devil's club (*Oplopanax horridus*), and sexual continence. This purification was seen as necessary because an unclean person was thought to offend animals that would then refuse to allow themselves to be caught.

Tsimshian people have inhabited the northern coast of British Columbia for thousands of years. Therefore, the language contains words that describe all aspects of the local environment. The language is somewhat biased in the sense that the local abundance and diversity of organisms influenced the development of the language. This local bias is a benefit for scientists that wish to study historical ecosystems where published data may be non-existent. Bridging the language barrier between scientists and First Nations will lead to the cross-referencing of TEK and science.

Acknowledgements

I would like to thank Dr. Daniel Pauly, UBC Fisheries Centre, for encouraging me to explore my traditional language by compiling this list of words. This experience exposed me to a part of my culture that I have never explored. I would also like to thank Alasdair Beattie for his comments.

References

Boas, F. 1916. Tsimshian Mythology. *In*: W. LaBarre (ed). 1970. Landmarks in Anthropology: a series of reprints cultural anthropology. Johnson Reprint Corporation, 1037 pp.

Danko, J.P. 1998. Fish Related Terms From the Saanich Language. p. 29-33. *In:* D. Pauly, T. Pitcher and D. Preikshot (eds.) Back to the Future: Reconstructing the Strait of Georgia ecosystem. Fisheries Center Research Reports, Vol. 6(5).

Dunn, J.A. 1978. A Practical Dictionary of the Coast Tsimshian Language. National Museums of Canada, Ottawa. Canadian Ethnology Service Paper No. 42.

Froese, R. and D. Pauly (Editors). 1998. Fishbase 98: concepts, design and data sources. ICLARM, Manila, Philippines. 293 p.

Haplin, M.M. and M. Seguin 1990. Tsimshian Peoples: Southern Tsimshian, Coast Tsimshian, Nishga, and Gitksan.P.267-284. *In*: W. Suttles (ed.) Handbook of North American Indians Volume 7: Northwest Coast. Smithsonian Institution.

Hart, J.L. 1973. Pacific Fishes of Canada. Fish. Res. Board Can. Bull. 180. 740 p.

Inglis, G.B., D.R. Hudson, B.R. Rigsby and B. Rigsby, 1990. Tsimshian of British Columbia Since 1900. p. 285-293. *In* W. Suttles (ed.) Handbook of North American Indians Volume 7: Northwest Coast. Smithsonian Institution.

Lambert, P. 1997. Sea Cucumbers of British Columbia, Southeast Alaska and Puget Sound. Royal British Columbia Museum Handbook. UBC Press, Vancouver. 166 p.

Miller, J. and Eastman, C.M. (Editors). 1984. The Tsimshian and Their Neighbors of the North Pacific Coast. University of Washington Press, 343 p.

Pauly, D., T. Pitcher, and D. Preikshot (Editors). 1998. Back to the Future: Reconstructing the Strait of Georgia Ecosystem. Fisheries Center Research Reports, Vol. 6(5).

Preikshot, D., and J. Leer 1998. An Annotated List of Alutiiq Words Relevant to Modeling the Prince William Sound Ecosystem. p. 92-108. *In*: Okey, T.A., and D. Pauly (eds.). Trophic Mass-Balance Model of Alaska's Prince William Sound Ecosystem, for the Post-Spill Period 1994-1996. Fisheries Center Research Reports. 6(4).

Seguin, M. 1985. Interpretive Contexts for Traditional and Current Coast Tsimshian Feasts. National Museums of Canada. Canadian Ethnology Service Paper No. 98.

Haida Names and Utilization of Common Fish and Marine Mammals

R. Russ Jones
Haida Gwaii

Abstract

Names can be an important source of embedded cultural and biological information about species. This paper provides a list of Haida names and a brief summary of Haida knowledge about common fish and marine mammals from a variety of sources. The two main dialects of Haida from the Haida Gwaii region (British Columbia, Canada) are considered: the Skidegate dialect, and the Masset dialect. Where available, notes on the method of catch and preparation are included, as is the cultural significance of some species.

Introduction

The preparation of this paper was fraught with difficulties. Information on historical Haida resource use is scattered throughout the published and unpublished literature and is neither extensive nor complete. Despite this, some valuable accounts do exist. In particular, two researchers recorded information from Haida elders in the 1970s. These accounts are (1) unpublished work on the Skidegate Haida by David W. Ellis, who relied on Solomon Wilson as his primary source[1]; and (2) Margaret Blackman's (1979) work with several Massett elders including Florence Davidson, Percy Brown, William Russ Sr., Emma Matthews and Amanda Edgars.

Unfortunately, early investigators did not focus on Haida usage of natural resources, although there are some notable exceptions. George M. Dawson provided some information on the more important food resources used by the Haida in the 1880s (Dawson 1880). John R. Swanton's ethnographic studies provided limited information on Haida resource use (Swanton 1905a), but the Haida oral history that he recorded provides insight into the traditional use of many species. Other potential sources of information from archives exist, such as C.F. Newcombe's field notes from the 1880s; however these have not yet been reviewed.

Another difficulty in preparing this paper was providing a consistent transcription of Haida words. Linguists have developed a variety of systems to write Haida (e.g., Enrico 1991). Haida has three main dialects – Skidegate, Masset and Alaska – in which words may be similar but differences are common (see Figure 1, in Watkinson, this vol., for approximate locations). A dictionary has been developed for Alaskan Haida (Swanton 1905a) and one is currently in development for Skidegate Haida (see footnote 2). The spelling of Skidegate words was provided by the Skidegate Haida Immersion School[2]. Some characteristics of the Skidegate writing system are:

Underlined characters (_) refer to a glotallized consonant;

A single quotation mark (') refers to an explosive sound;

The number **7** refers to a glottal stop.

A variety of sounds do not occur in English, including t', k', <u>k</u>, <u>g</u>, tl, tl', dl, x and <u>x</u>. The spelling of Masset Haida words is from Blackman (1979) which used a modified version of the international phonetic alphabet. She notes that she is not trained as a linguist, thus her rendition of Haida words may in some cases be phonetically incorrect. Unless otherwise noted, Skidegate terms were obtained from Ellis and Wilson (see footnote 1) and Masset words were obtained from Blackman (1979).

Some mention of the Haida system for control and management of resource harvesting areas is important. Rivers and

[1] Recording by Solomon Wilson and David W. Ellis, copies stored at the Canadian Museum of Civilization, Ottawa, and the Queen Charlotte Islands Museum, Skidegate. 30 minutes. October 21, 1974.

[2] Skidegate Haida Immersion School, School District #50, Queen Charlotte City, Haida Gwai. Spelling and translation of Skidegate words provided on January 8th, 1999.

streams were owned by Haida families (Blackman 1979, Dawson 1880, Swanton 1905a). Blackman (1979) recorded the ownership of streams by northern Haida lineages as recalled by Haida elders in the 1970s. Lineages also controlled other resource sites, such as berrypicking grounds and beaches for beachcombing whales. The author was told a story by Henry Geddes of Massett indicating lineage control of green sea urchin beds. Furthermore, at least some sites in the open ocean may have been lineage property, for example Swanton (1905a) remarked that "The halibut fishing grounds were all named and were owned by certain families". This account contrasts with Blackman (1979), who reported being told by Massett Haida that halibut fishing grounds were open to anyone with a boat and fishing line.

Description by Animal Group or Species

Descriptions are organized with the Haida name and dialect in the first column (Note that (S) = Skidegate dialect and (M) = Massett), followed by the meaning of the Haida word (if known), a description of the fishing technology and utilization of the species or group.

The dictionary

Fish

chiina (S) *chin (M)*	Solomon Wilson said *chiina* refers to fish from both fresh and saltwater that are found near the surface and are believed to "breathe air". Masset sources said *chin* was a general name for salmon (Blackman 1979).
sk'aagii (S) *sk'aga (M)*	Chum salmon (*Oncorhynchus keta*). Chum salmon were the most important salmon species to the early Haida because of their abundance, ready accessibility and preservative qualities (Jones and Lefaux-Valentine 1991; Blackman 1979). Chum, pink and coho were captured in the streams when they returned to spawn using traps made of boulders or saplings, nets, spears or gaffs (see footnote 1, Jones and Lefaux-Valentine 1991; Blackman 1979; Dawson 1880; Swanton 1905a; Acheson and Zacharius 1985; Stewart 1977; Langdon 1977). Food preparation was similar for most salmon species with the fillets, heads and roe generally being utilized (Jones and Lefaux-Valentine 1991). A single, wide fillet was usually prepared by splitting the fish along the backbone and leaving the belly intact. Thin slices were trimmed from the sides of the fillet that were dried separately and called *ts'ilgi (S)* or *tch'ilts (M)*. In the old days, fillets were preserved by a process of cold-smoking and drying in a smokehouse for approximately 10 days. Chum fillets were tied in bundles of 40 and could be kept in bent-wood cedar storage boxes for up to a year. The backbones were also smoke-dried. Heads were eaten fresh after boiling or aged in intertidal pits lined with seaweed and covered with rocks. Before eating, fillets could be rinsed in water and barbecued over an open fire or soaked in salt water and then boiled. Fresh eggs could be eaten raw or boiled with seaweed. Sometimes eggs were lightly smoked and roasted over a fire. 'Stink eggs' were prepared by placing the eggs in a bent-wood cedar box lined with skunk

cabbage leaves and covered with black mud and left until they became clear. Eggs could also be smoked, then pounded and stored in a container. Eggs were also fermented in a seal stomach that was hung in the house by the smoke hole until very dry. Glue could be made by chewing chum salmon skin and storing the liquid in a small container.

ts'iit'aan (*S*)

Pink salmon (*O. gorbuscha*). Pink salmon were not utilized as much as chum due to their earlier run timing, smaller size and a higher fat content that decreased shelf life (Jones and Lefaux-Valentine 1991). Fillets were often sun-dried because the runs returned in August when the weather was generally drier. Fillets were also half-smoked but would only keep only about four months. Fresh, bright pinks are still frequently used in *jum*, or fish stew. The small heads, tails and backbones were generally not utilized.

tyaayii (*S*)
t'aiya (*M*)

Coho salmon (*O. kisutch*). 'Jacks' or small precocious males that return to spawn were referred to as *ts'iidu* (*S*). The last run of coho in November was referred to as *Gaayda dahlgyang* which means 'needlefish in belly of coho' (see footnote 2). Coho returning in January or February were referred to as *ts'iing k'ii ga* which means 'sharp tooth' (see footnote 2). At Copper River, coho were taken using spears with a detachable barb that was attached by a line to the middle of the shaft (Jones and Lefaux-Valentine 1991). Coho were one of the most abundant salmon species at Cape Ball and were of special importance to the Haida of that area. Fresh coho were an esteemed food (Jones and Lefaux-Valentine 1991). Coho fillets and *ts'ilgi* would only keep about three months, because of the high fat content. Coho eggs were separated, soaked in freshwater until hard and white, and then pounded to a soft butter-like consistency. They were not considered suitable to make stink eggs. Milt from male coho were sometimes added to *jum* (fish stew).

taaxiid or *sgwaagaan* (*S*)
swagan (*M*)

Sockeye salmon (*O. nerka*). *Taxiid* referred to sockeye which return to local rivers, Copper River and Mathers Creek, in the spring (April to July). *Sgwaagaan* refers to common sockeye which are caught in the summer. *Taaxiid*, also known locally as 'blueback' were the first fresh salmon of the season and fishing rights in streams were carefully guarded. It was said that a trap owned by Chief Skidegate on the Copper River would catch one of the salmon species or steelhead all but ten days of the year (Jones and Lefaux-Valentine 1991). At one time gillnets made from fireweed fibre were used to catch sockeye on the Copper River (Jones and Lefaux-Valentine 1991). Sockeye were preserved and stored in boxes for the winter. Fresh sockeye heads, backbone and roe were commonly cooked by boiling. The roe was sometimes smoked. Sockeye *ts'ilgii* are a highly prized delicacy. Most Haida Gwaii sockeye streams are fished with gillnets and the Haida Fisheries Program develops annual management plans in consultation with Canada's Department of

Fisheries and Oceans (DFO), operates a counting fence and fish trap on the Copper River, samples smolts and participates in lake hydroacoustic assessments to assess fry numbers.

taagun (*S*)
t'aown (*M*)

Chinook salmon (*O. tsawytscha*). *Taagun gaaw gaada* (*S*) refers to 'white spring' and *taagun gaaw sg'iida* (*S*) refers to 'red spring'. The Haida utilized both migrating chinook found in tidal waters and a local stock on the Yakoun River. Haida use of chinook salmon prior to development of the commercial fishery at the turn of the century is not well documented. Trolling by other northern Indian groups, involved moving a baited hook of wood, bone and twine through the water so as to lure a salmon to strike. Ethnographic accounts of the gear and methods are available for the Tlingit (south-east Alaska) and the Nuu-chah-nulth (west coast of Vancouver Island). More recent accounts were provided for the Alaskan Haida (Langdon 1977, p. 186). Archaeological excavations at Kiusta in Haida Gwaii resulted in finds of bone barbs likely used for fish hooks and salmon vertebrae up to 18 mm in diameter, corresponding to chinook salmon between 30 and 40 pounds in midden deposits dated between 4,380 and 10,435 years of age (N. Gessler, Director of Kiusta excavations, pers. comm.). "Chinook salmon come and hit my heart", a Haida expression used when they are seen jumping, originates from the Haida creation stories where raven lures a chinook salmon into his canoe (see footnote 1, Jones and Lefaux-Valentine 1991, Enrico 1991). Another Haida story described a fisher who catches and sells a large quantity of chinook salmon for a feast (Swanton 1905b). Among the Tsimshian, and likely also the Haida, fresh chinook was considered 'rich food' which was essential for maintaining the dignity of the family by possession and distribution at potlatches (Boas 1916).

Chinook salmon were utilized fresh and half-smoked. The heads as well as the eggs were cooked by boiling. The fillets were either sun-dried or lightly smoked and had to be used soon afterwards because of the high fat content and limited shelf life. The Haida were one of the first to become involved in the commercial troll fishery for chinook salmon that began in the late 1800s (Forrester and Forrester 1975).

taatl'aad (*S*)
tatlat (*M*)

Trout (general). The Skidegate term included *t'ak'al* (rainbow and cutthroat trout) and *sidu* ("sea trout" found in saltwater), but not steelhead (Jones and Lefaux-Valentine 1991). Trout were caught in fish traps and were also fished with a noose (Enrico 1991, p.161). Dragonfly larvae or *sk'aadaasgwaal* were used as bait for catching trout and *maaluu* (see footnote 2).

maaluu (*S*)

This term refers to both freshwater salmon and trout fry (see footnote 1).

taayingaa (*S*)

Steelhead trout (*O. mykiss*). Steelhead were taken in fish traps,

taiyung (*M*)	and were frequently the only catch taken in the Copper River (Jones and Lefaux-Valentine 1991). Steelhead were considered closely related to red snapper because the bones of both fish were so tough (Jones and Lefaux-Valentine 1991, Blackman 1979).
sk'aahlaa (*S*)	This was the general name for bottomfish or those fish that "don't breathe air" (see footnote 1).
k'aaxada a7wga (*S*)	This was the general name for a large shark. The literal meaning is "dogfish mother". Stranded or moribund sharks were utilized for oil from their liver (Dawson 1880).
7uwii guuga (*S*)	Soupfin shark (*Galeorhinus zyopterus*). Soupfin shark were fished commercially for their liver and vitamin oils in the mid to late 1940s.
sliina nang gyuugings (*S*)	Sixgill shark (*Hexanchus griseus*). The literal meaning is "wearing gut ear rings."
k'aaxada (*S*) *q'ad* (*M*)	Spiny dogfish (*Squalus acanthias*). Utilized for oil from their livers which was sold to white traders (Dawson 1880). Also, the dogfish was the crest of the *Yaaku 7laanas* (Middle town people) and *Kyanuusilee* ([tom]cod people), two Haida Raven lineages (Swanton 1905a).
ts'iidga (*S*) *ch'iida* (*M*)	Skate (*Raja sp.*) Not eaten (Blackman 1979). A crest of the *Git7ins* of Tsiits, a Haida eagle lineage (Swanton 1905a).
k'aa 7un (*S*)	Ratfish (*Hydrolagus colliei*)
7iinang (*S*) *iinang* (*M*)	Herring (*Clupea harengus pallasi*). When used as an adjective, the Haida name means "plentiful". Also, it may be a compound word derived from *ii* (to have sexual intercourse) and *nang* (play). Traditionally it was caught using a herring rake, a light pole six to eight feet in length with sharpened nails driven through one end, and used for halibut bait. Nets were also used at one time (Gessler, N., Director of Kiusta excavations, pers. comm., also see Enrico 1991, p.173). Herring eggs or *k'aaw* were harvested on kelp and hemlock branches (Enrico 1991, p.84). It was sometimes picked from other substrate such as eelgrass and eaten on the spot. If weather permitted, *k'aaw* was sun-dried on a gravel beach. If dried indoors, drying was slower and the product was poorer quality. Dried fronds were tied into bundles of about ten and stored in bent-wood boxes. Dried *k'aaw* was susceptible to insect damage and turned brown and lost flavour. It was eaten dried or soaked in fresh water, then dipped in boiling water or fried. It is often eaten with eulachon oil or *hum* (*S*).
kiina (*S*) *qaian* (*M*	Surf smelt (*Hypomesus pretiosus pretiosus*, see footnote 1). Reported to be taken using a rake (Blackman 1979). The literal meeting in Skidegate Haida is "heavy" (Skidegate Haida Immersion School).

g̱aaydaa (S)	Capelin (*Mallotus villosus*) or sand lance (*Ammodytes hexapterus*)
saaw (S)	Eulachon (*Thaleichthys pacificus*) or Pacific sardine (*Sardinops sagax*). Dried and smoked eulachon and eulachon grease or *hum* (*S*) were obtained in trade with the Coast Tsimshian.
st'aaydaay (S)	Pacific cod (*Gadus macrocephalus*). The literal meaning was "chin whiskers" (see footnote 2).
g̱aadaa (S)	Shiner perch (*Cymatogaster aggregata*). The literal meaning is "white" (see footnote 2).
7uusduu (S) *ḵ'aay ḵuul kyaadsiid (S)*	Striped perch (*Embiotoca lateralis*). Pile perch (*Rhacochilus vacca*). The Haida name means "searchers of the bottom of the kelp" (see footnote 1).
st'aax̱aam (S)	Wolf eel (*Anarrhichthys ocellatus*). Also refers generally to any blenny (see footnote 1)
sg̱an (S) *s'aan (M)*	Yelloweye rockfish (*Sebastes ruberrimus*). Haida usage of rockfish was considerable, particularly of yelloweye rockfish (Jones and Lefaux-Valentine 1991). Rrockfish were caught using light kelp lines or spears. Rockfish were allowed to age for several days before they were scaled, cut into chunks and boiled. rockfish were eaten fresh and not usually preserved (see footnote 1). However, lingcod have been said to be dried and traded with halibut to Mainland First Nations. The head was also cooked by boiling and eaten. *Sg̱an Gwaii* (*S*) (or Anthony Island), which means Yelloweye Island, is well known for the abundance of this rockfish. It was said that yelloweye could be taken by the people of Skedans in the lee of Skedans Islands in any time of weather. They were also fished outside the sealion rocks at North Island and in Masset Inlet. The eggs were boiled and had a similar consistency to porridge.
ḵ'itsg̱alang or x'asaa (S) *qaja (M)*	Black rockfish (*Sebastes melanops*). The name means "hard" and it is considered a really proud fish because it will not take just any kind of bait. They were caught on hooks similar to halibut hooks, but smaller. Found in kelp beds. Eaten fresh, not preserved. (Jones and Lefaux-Valentine 1991)
sḵun g̱'wiidsxuldan (S)	Quillback rockfish (*Sebastes maliger*).
xaadxadaay or taayii (S) *hat' (M)*	Copper rockfish (*Sebastes caurinus*). The name means "white" in Masset dialect (Blackman 1979)
k'aa (S)	Canary rockfish (*Sebastes pinniger*).
ḵ'aalts'iida (S)	An unidentified rockfish. The literal meaning is "crow" (see footnote 2).
st'iiydiiy (S)	An unidentified rockfish (see footnote 1).
sḵil (S) *sqEl (M)*	Sablefish or black cod (*Anoplopoma fibria*). Immature sablefish are referred to as *sqiitl'aaga* (*S*). Haida use and fishing methods were recounted by Solomon Wilson and recorded by David W. Ellis (see footnote 1). Since sablefish live at great depth, their

capture by the early Haida required a great deal of technological skill as well as physical effort. Fishing was done in winter using 150 to 200 fathom kelp lines (see the halibut section for care and handling of lines). Special hooks were constructed from a spruce tree knot. A rock anchor was used. As fish were hooked, they knocked out the sticks holding the bait that could be counted on the surface. The lines broke easily if chafed on the gunwale of the canoe. Lines and hooks were individually owned and the crew shared the catch accordingly. The fish were gutted and the head and backbone removed. The stomach and gills were often saved and boiled with seaweed. After soaking overnight, the fish were boiled in bent-wood cedar box with hot rocks and the oil skimmed off. Oil was also extracted by wrapping the boiled meat in spruce root sacks and squeezing them between two boards. The boiled meat was also consumed. In the Englefield Bay area, blackcod were taken mainly for their oil, which was a valuable trade item not only with the mainland Indian tribes but also with Haida from other areas of Haida Gwaii who did not have access to sablefish. The eggs were also eaten and could be preserved by drying. In northern Haida Gwaii, sablefish were a preferred food that was sometimes caught and was sliced and smoked for winter use and highly valued for its oil (see footnote 1). Swan obtained samples of sablefish at Skidegate Village (Swan 1885). A saltery for sablefish was established in Englefield Bay for a short time about 1890.

kiijii (S)

Greenling (Hexagrammidae).

kits (M)

Probably whitespotted greenling. Fished off Tow Hill and *kits chai (M)*, the spawn, is found on seaweed in August. Neither the fish nor its spawn were preserved but were eaten fresh. (Blackman 1979).

skaynung (S)
sqoiinan (M)

lingcod (*Opiodon elongatus*) (see footnote 1, Jones and Lefaux-Valentine 1991; Blackman 1979). The nickname, *sgaagaay (S)*, means 'shaman dance' and refers to the way a shaman shakes his head when dancing (Skidegate Haida Immersion School). lingcod and inshore rockfish were taken with special spears and lines. People at Tanu village often speared lingcod and rockfish close to the local kelpbeds. lingcod eggs were reported eaten in Skidegate but not in Massett (see footnote 1; Jones and Lefaux-Valentine 1991).

hl'aama (S)

Bullhead or sculpin (Fam. Cottidae) Referred to by Ellis as bullhead (see footnote 1). It is a crest for several Haida eagle lineages (Swanton 1905a).

k'aal (S)
q'al (M)

Identified by Solomon Wilson as Buffalo sculpin (*Enophrys bison*) or Brown Irish Lord (*Hemilepidotus spinosus*) and described to David Ellis as "bullhead without horns" (see footnote 1). In Masset the term was described to Blackman as the name for several species of sculpin. Florence Davidson stated that they were not eaten, though Percy Brown noted that the

	giant sculpins were taken with *hlskujiit* (*M*), a two or three pronged rake or fork. (Blackman 1979).
7wagwahlagaay	An unindentified sculpin. The literal meaning is "bullhead with horns" (see footnote 2).
k̲'aayaay (*S*)	An unidentified sculpin. The literal meaning is "old".
galdaa (*S*)	A large unidentified sculpin that Solomon Wilson described to David Ellis as "good to eat". (see footnote 1).
t'aal (*S*)	Small flounder.
t'al khlugwung (*M*)	Flounder; literally translated the name means "Stay around bottom by big, wide kelp". Taken with *hlkujida,* a long two or three timed fork. Also taken with small hooks. Not preserved, eaten fresh (Blackman 1979)
sg̲an t'aal (*S*)	Lemon sole (*Parophyrys vetulus*). Found in commercial abundance in Skidegate Inlet.
x̲aadlin (*S*)	Starry flounder (*Platichthys stellatus*).
x̲agu (*S and M*)	Pacific halibut (*Hippoglossus stenolepsis*). Information on halibut utilization and fishing technology are from Ellis (Jones and Lefaux-Valentine 1991) unless otherwise noted. halibut were an important staple food and trade item for the Haida, due to its' year-round availability, large size and good preservative qualities. halibut was also an important feast and potlatch food. Many Haida villages were located at exposed, seaward locations which gave ready access to halibut fishing grounds even during the winter. An old Haida saying "When the salmonberries are ripe, the halibut are in the kelp" reflects that halibut are more plentiful in shallow waters during the spring and summer months. halibut were caught using a special wooden halibut hook. The shape of the hook is remarkably similar to 'circle' hooks that were adopted by the commercial longline fishery in the early 1980s as more efficient than the J-shaped hook. In shallow water, fishing lines were made of cedar bark and spruce root while in deep water kelp was used. Kelp lines would last for many years but had to be properly cared for because they easily broke if they rubbed against the edge of a canoe. They had to be properly cured, coiled and stored and were soaked in seawater prior to use. Two hooks were often suspended from the same float, which would stand up when a fish was caught to alert the fishers. In Skidegate, halibut could be fished from the shore and one individual would attach the fishing line to a pole stuck in the ground with a rattle on top that would signal when a fish was caught[3]. An inflated seal stomach was often attached to the line in case a large fish was hooked. Locations where halibut could be caught were called *gyu* (both *S* and *M*) or halibut houses. Swanton indicated that "the halibut bands were all named and owned by certain families" (Swanton 1905a). halibut are large

James Young, Skidegate. Interview with Russ Jones, August 1998 fish, sometimes often exceeding 50 kgs. Blackman noted that one or two men would generally go out in a medium-sized canoe to take halibut (Blackman 1979). Halibut were bled by cutting and breaking the vertebrae at the tail. Almost every part of the fish was utilized. The head was boiled fresh in *jum* (fish stew). The fish was filleted and fillets were sliced into thin strips that were sun-dried as *ts'ilgi* or sometimes partly smoked. Dried halibut was stored in bent-wood cedar boxes. Dried halibut was eaten after dipping in eulachon or sea mammal oil. The backbone was boiled fresh or preserved by sun-drying or smoking. The skin was usually lightly smoked and dried and eaten after being blistered over the fire. The cheeks, called *xang*, were often smoked and said to be a special food of chiefs. halibut eggs were added to *jum* or barbecued over a fire. Glue would be prepared by chewing the skin around the tail and storing the liquid in a container.

Marine mammals

k'aay (*S*) *q'ai* (*M*)	Northern Sea lion. Taken at North Island on sea lion rocks known as *q'ai q'adle* ('sea lion island'), and also on the west coast outside the Haida village of Tian. (Blackman 1979). A crest of several Haida raven lineages.
kuu (*S*) *qo* (*M*)	Sea Otter. Hunted from small canoes or *qothlu* meaning 'sea otter canoe'. Furs were made into capes and worn by high ranking Haida. Sea otter were hunted intensively and depleted in the early 1800s (Blackman 1979)
k'uuwan (*S*) *k'waan* (*M*)	Northern Fur Seal. Hunted from early spring through summer when these seals migrated northward, passing through Haida Gwaii waters. Hunters "had to go way out to get it". Taken for its fur and for the meat which was brined and smoked dry (Blackman 1979). Fur seal were hunted during their migration and were depleted by about 1900 (Forrester and Forrester 1975).
xuud (*S*) *x'ot* (*M*)	Harbour seal. Can be taken all year round, but were mainly hunted in wintertime. Seal meat was preserved by smoking and drying. *Xot t'o,* the seal oil, was eaten but not at feasts or potlatches (Blackman 1979).
skul (*S*) *sqwhul* (*M*)	'Sea porpoise', probably the Dall's Porpoise (Blackman 1979). Percy Brown thought they were hunted with a bow and arrow. One Skidegate story tells about catching porpoise while fishing herring with nets (Enrico 1991, p. 173). The meat was boiled and eaten fresh. *Au sqwhul* (*M*), described as an 'Inlet porpoise' (probably the Harbour Porpoise), was not hunted.
sgaana (*M*) *sqan* (*M*)	Killer whale. Percy Brown identified a second type of *hotgal* (*M*) Killer whale, which goes up on the beach to die. It was not hunted or economically important. A crest of all the Haida raven lineages (Swanton 1905a).

kun (*S,M*) Humpback whale. The literature records that the Haida utilized whales found on the beach but did not actively hunt them. However, Percy Brown indicated that humpback whale were taken from *klu inuwe* (a relatively small canoe also used for halibut fishing). The harpooner used a toggle-headed harpoon, *kittu,* made of hemlock. Acheson recorded a high proportion of whale bones at some village sites at the south end of Haida Gwaii that indicated active whaling (Acheson and Wigen 1996).

Acknowledgements

The assistance of the Skidegate Haida Immersion School and the instructor, Diane Brown, in reviewing the spelling of words in the Skidegate dialect was much appreciated. Her work greatly enhanced the usefulness of this paper for Skidegate Haida speakers. David W. Ellis's summary of Haida fish use from his unpublished field notes and his tape recording of fish names with Solomon Wilson were invaluable references. Thanks also to Daniel Pauly of the Fisheries Centre, UBC for his encouragement in completing this work.

References

Acheson, S. and R.J. Wigen. 1996. Evidence for a prehistoric whaling tradition among the Haida. Circum-Pacific Prehistory Conference, Seattle. August 1989.

Acheson, S.R. and S. Zacharias. 1985. Kunghit Haida Culture History Project: Results of Phase 1: 1984 Archaeological Site Inventory Permit No. 1984-32.

Blackman, M. 1979. Northern Haida land and resource utilization. P. 43-55. In "Tales of the Queen Charlotte Islands"' Regional Council of Senior Citizens of the Queen Charlotte Islands.

Boas, F. 1916. Tsimshian Mythology. *In:* 31st Annual Report of the Bureau of American Ethnology for the Years 1909-1910. Washington: Government Printing Office

Dawson, G.M. 1880. Report on the Queen Charlotte Islands, 1978. Geological Survey of Canada Report of Progress for 1878-79, Vol. 4. Reprinted by UBC Press, 1993.

Enrico, J. 1991. Skidegate Haida Myths and Histories. Collected by J.R. Swanton. Edited and translated by J. Enrico. 212 p.

Forrester, J.E. and A.D. Forrester. 1975. Fishing: British Columbia's Commercial Fishing History. Hancock House. Saanichton, BC. 224 p.

Jones, R.R. and W. Lefeaux-Valentine. 1991. Gwaii Haanas – South Moresby National Park Reserve, Review of Vertebrate Fishery Resources. Prepared for Canadian Parks Service. August 1991. 234 p.

Langdon, S. 1977. Technology, Ecology, and Economy: Fishing Systems in Southeast Alaska. Ph.D. Dissertation, Stanford University.

Stewart, H. 1977. Indian Fishing. J.J. Douglas, North Vancouver, BC. 181 p.

Swan, J. 1885. Report on blackcod of the North Pacific Ocean. Bull. U.S. Fish Comm. (15):225-234.

Swanton, J.R. 1905a. Haida texts and myths: Skidegate dialect. Bureau of American Ethnology Bulletin. Bulletin No. 54

Swanton, J.R. 1905b. Contributions to the Ethnology of the Haida. Publications of the Jesup North Pacific Expedition 5; Memoirs of the American Museum of Natural History, New York 8(1):1-300.

Estimating lingcod Biomass in Hecate Strait Using Stock Reduction Analysis

Steve Martell
Fisheries Centre, UBC

Abstract

In this paper an age-structured model and historical catches from the commercial Hecate Strait lingcod fishery are used to reconstruct the present population size. A minimum of 7260 tonnes of lingcod must have been present in 1955 in order to sustain the observed catches between 1956 and 1995. The maximum likelihood estimate for the initial slope of the stock-recruitment curve is 2.3 times greater than the slope through the equilibrium recruitment point. The present lingcod stock in Hecate Strait is approximately 2990 t, or 41 % of the biomass present in 1955. There is no persistent contrast in the catch per unit effort (CPUE) time series, an indication that the fisheries catch statistics do not reflect changes in stock size. It was not possible to estimate an upper bound for the 1955 biomass because the relative abundance time series does not reflect any change in the stock size. Additional fishery-independent data are required to estimate past recruitment anomalies, and to avoid assuming proportionality between CPUE and stock size.

Introduction

Stock Reduction Analysis (SRA) is a method that uses a time series of historical catches to estimate the past stock size required to sustain the observed catches. The important population parameters of interest are the unfished biomass and the initial slope of the stock recruitment curve. Coupled with a time series of relative abundance data (such as CPUE data or survey data), SRA is a useful method for estimating the present day stock size (Kimura and Tagart 1982).

The process of reconstructing the lingcod stock in Hecate Strait is outlined in Fig. 1. The stock parameters contain information pertaining to the biology of lingcod, the size of the stock prior to the fishery, and the productivity of the stock (recruitment parameters). The historical removals are used to drive the dynamic annual changes in the age-structured model. The age-structured model incorporates all of the biology, reproduction, and annual harvest to predict a dynamic set of state variables (e.g., the number of fish in a given year). Using the dynamic state variables predicted by the age-structured model, the observation model generates a set of predicted observations.

A Bayesian approach as used to estimate two important population parameters, the unfished biomass and the initial slope of the stock-recruitment curve after the method

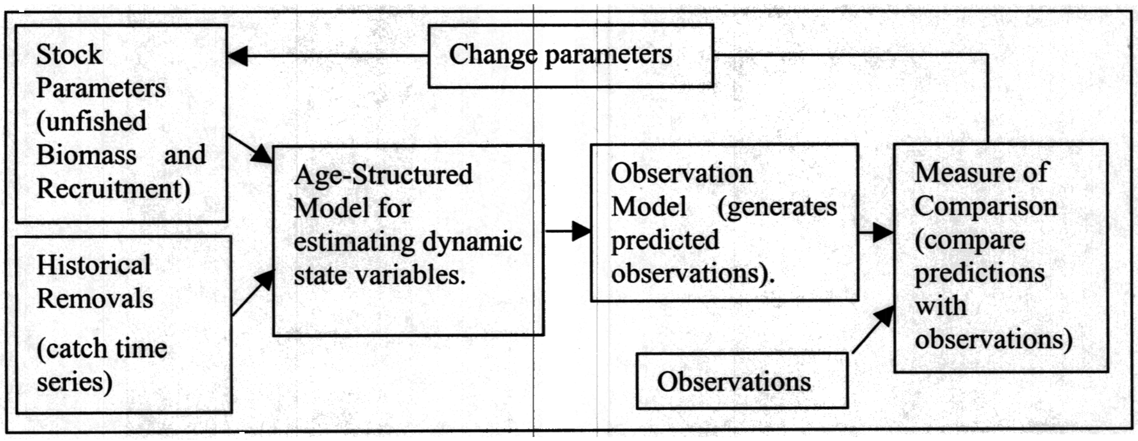

Figure1. A diagrammatic interpretation of SRA methods used to reconstruct the Hecate Strait lingcod biomass.

described by Walters and Ludwig (1994). In this context, Bayes' theorem is used to assign a probability distribution to a range of hypotheses about the size of the unfished biomass and the initial slope of the stock-recruitment curve. For each hypothesized parameter value the model generates a measure of credibility. The next step is to change the parameter values and generate a second measure of credibility, and the process is repeated until all possible parameter combinations are explored. Finally, all possible parameter values are compared in the form of a posterior distribution. The mean of the posterior distribution is the best estimate of the parameter value in question and the peak of the posterior distribution is the maximum likelihood estimate.

In this paper, the catch and catch per unit of effort data for the commercial lingcod fishery in Hecate Strait are used to estimate the biomass in 1956 before the start of the fishing season. In addition, estimates of the initial slope of the stock recruitment curve (a measure of the stock productivity) are provided, based on these data. Using the most likely estimates of the initial biomass and the slope of the stock recruitment curve, the observed catch time series can then be used to estimate the size of the present day stock.

The data

The catch time series in Fig. 2 shows the total landings from the commercial lingcod fishery in Hecate Strait (McFarlane and Leaman 1996). These are combined catch from the trawl fishery and a directed line fishery. CPUE is expressed in kilograms of lingcod caught per hour of fishing. The CPUE index is collected from interviews with commercial fishers. The number of interviews per year ranges from 1 to 69. In years with a high number of interviews, there is a better chance of capturing the true CPUE than in years with only one interview. Therefore, CPUE data were only used in years when there were more than five interviews. As a result of omitting a portion of the data set, the 40-year time series is reduced to 30 years of information about relative abundance (CPUE). An important point to keep in mind is that the relative abundance data are not independent of the fishery. Also, the only relative abundance data available from the literature, on this particular stock, are the commercial fishery CPUE data. Additional age structured data or fishery independent surveys for this stock could not be found.

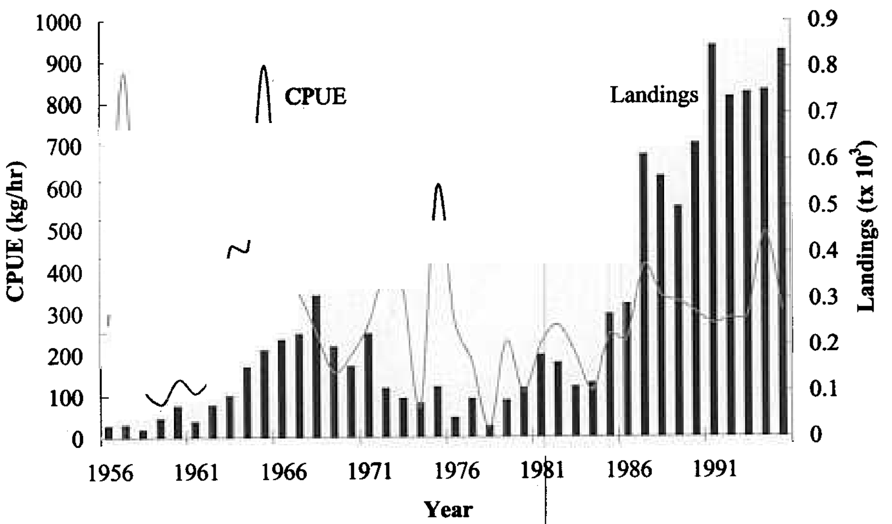

Figure 2. The historical landings and catch per unit of effort (CPUE) for the commercial lingcod fishery in the Hecate Strait from 1956 to 1995 (source: McFarlane and Leaman 1996). These data are used to estimate the historical biomass and the intial slope of the stock recruitment curve.

Stock parameters and the age structured model

The age-structured model uses the weight-at-age, vulnerability-at-age, and a constant survival rate to propagate biomass over time. The weight at age was estimated from a tagging study carried out on the West Coast of Vancouver Island (Smith and McFarlane 1990). Female lingcod are larger and grow faster than male lingcod (Cass *et al.* 1990). In this model, a 50:50 sex ratio is assumed, and the average weights at age for the two sexes are used. This implies that the sex ratio in the catch is also 50:50. The minimum legal size for lingcod is 65 cm, and prior to 1987 the minimum legal size was 58 cm. Therefore, the vulnerability at age changes during this 1956 to 1995 time series. According to the length-at-age estimates from Cass *et al.* (1990), the 50% age of recruitment to the fishery prior to 1987 is 4 years old, and 5 years old after 1987 (Figure 3). The natural survival rate was estimated from a tagging study in the Strait of Georgia. Smith and McFarlane (1990) estimated that the instantaneous natural mortality falls between 0.24 – 0.64, or 20% to 48% per year. To avoid over-estimating the population size, the most optimistic survival rate (80% per year) was used. This may seem counter-intuitive, but by over-estimating the natural survival rate, the model is less likely to over-estimate the relationship between the spawning stock size and the number of recruits produced. In other words, a long-lived population (low natural mortality rate) has a lower reproductive rate.

Two important elements in the age-structured model are the unfished biomass and the initial slope of the stock recruitment curve. When these two parameters are changed, the observation model generates a set of predicted observations and the predicted observations are compared to the real observation data (CPUE). There is no single correct solution to this simple system of non-linear equations. Either the unfished stock is very large and less productive, or the stock is small and very productive. Calculating the stock-recruitment curve parameters assumes that the stock was in a steady state before the fishery. Therefore, a stock with a high mortality rate must also have a high natural rate of recruitment in order to sustain a steady state. The form of the stock-recruitment relationship assumed was a Beverton-Holt type.

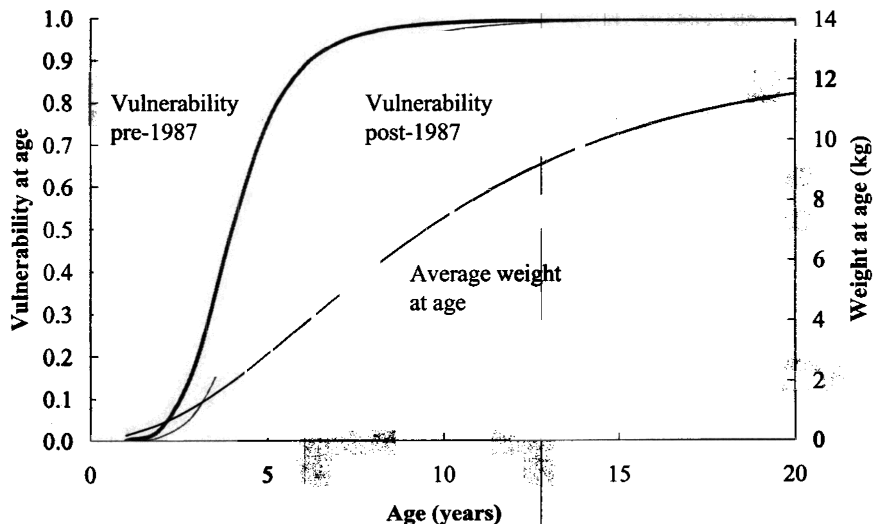

Figure 3. The average weight-at-age for male and female lingcod, estimated from West Coast Vancouver Island lingcod (Smith and McFarlane, 1990). Also, the graph illustrates the vulnerability-at-age schedule used in the stock reconstruction model.

Results and discussion

The relative abundance data (CPUE from the fishery, Figure 2) show no clear indication of the stock size changing over time. In this analysis, I assume that the catch rate (CPUE) is directly proportional to the stock size. In general, this is a very dangerous assumption to make and should be avoided if at all possible (Walters and Ludwig 1994; Hilborn and Walters 1992); however, the intent of this analysis is to provide a minimum estimate of the current lingcod biomass present in Hecate Strait. These results are not intended for assisting fisheries managers with policy decisions.

The marginal posterior distribution for the unfished biomass is shown in Fig. 4. Each point along the line in Fig. 4 can be interpreted as a measure of credibility or 'believability' about the estimated size of the unfished biomass in 1955. The minimum biomass estimate for 1955 that is required to sustain the observed catches (shown in Fig. 2) is 7260 t. Initial population sizes below this level result in extirpation before 1995, and we know from the observed catches that lingcod have not been extirpated from Hecate Strait. The posterior distribution does not have an upper bound (it is a so-called 'non-integrable' posterior). This, however, does not mean there is no upper limit to the population. The problem here is the lack of contrast in the relative abundance data and/or a violation in assuming proportionality between stock size and CPUE.

Recall that the stock-recruitment relationship is calculated under the assumption of a steady state population prior to the start of the fishery. If this assumption is correct, then the equilibrium recruitment must be equal to the total number of animals dying in a given year. The initial slope of the stock-recruitment curve defines how resilient the population is to exploitation. For example, a stock with a steep initial slope is more resilient to exploitation then a stock with a shallow initial slope. In other words, a steep slope implies that the same number of offspring will be produced at lower stock sizes.

The maximum likelihood estimate of the initial slope is 2.326, which corresponds to the peak of the posterior distribution shown in Fig. 5. The initial slope of the stock-recruitment curve is roughly 2.3 times greater than the slope of a strait line running through the origin and a point corresponding to the equilibrium recruitment and the unfished biomass. The initial slope of the recruitment curve and the unfished biomass are calculated simultaneously. Therefore, the recruitment slope is also estimated from the CPUE data in Fig. 2. Consequently, the slope of the recruitment curve is also calculated under the assumption of proportionality between CPUE and stock size.

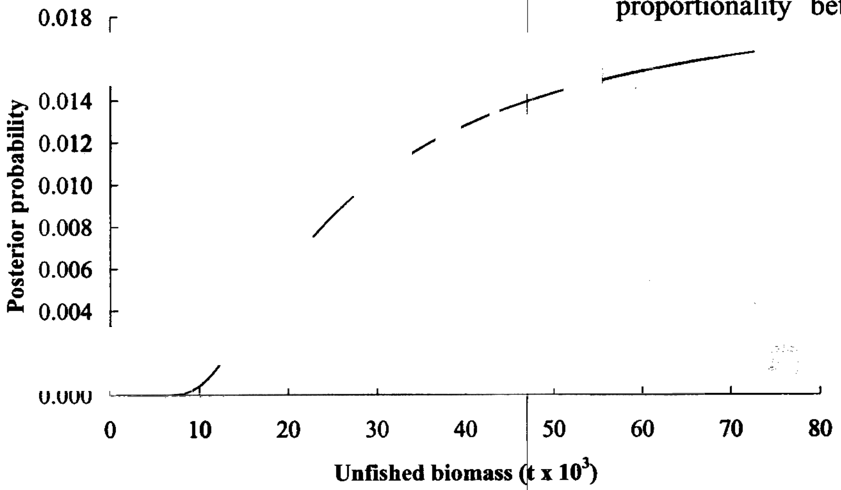

Figure 4. The marginal posterior probability distribution for the unfished lingcod biomass in Hecate Strait. The minimum biomass required to sustain the observed catches is 7260 tons (corresponding to the x-intercept).

Using the minimum estimate of the unfished biomass (7260 t) and a slope of 2.36 to initialize the model, the model we can then be run with the observed catches from 1956 to 1995. The result is a historical reconstruction of the stock, as shown in Fig. 6. The annual exploitation rate is equal to the observed catch in year *t* divided by the estimated biomass in year *t*. The

Figure 5. The marginal posterior probability distribution for the initial slope of the recruitment curve.

difference between the vulnerable biomass and the total biomass is a property of the fishing gear and the age of recruitment to the fishery (*i.e.* minimum size limits). In Fig. 6, prior to 1987 the vulnerable biomass consists of 4+ year old fish, and after 1987 the vulnerable biomass consists of 5+ year old fish. Note too, however, that the minimum size limit in the commercial fishery increased from 58 cm to 65 cm in 1988.

Over the time series shown in Fig. 6, the annual exploitation rate ranges from <0.01 to 0.45. During the late 1960s and early 1970s, there was an increase in the annual catches followed by a decrease (Fig. 2). As shown in Fig. 6, the lingcod population actually increased during the period of small catches in the 1970s. Using this deterministic approach, the estimate of total biomass in Hecate Strait is approximately 2990 t (41.2% of the unfished biomass). The estimated vulnerable biomass (the biomass available to harvest) is 1548 t, or 25.8% of the vulnerable biomass available in 1955. Note that this does not preclude the biomass in the early 1900s from being even higher, see below and the estimates provided by workshop participants (Beattie *et al.* this

The results shown in Fig. 6 do not actually reflect well the true population biomass in Hecate Strait. This analysis is supposed to be a worst case scenario (i.e., a minimum estimate of the 1955 biomass required to support the observed catches). Data on annual catches and catch rates are only available back to 1956. In reality, this fishery started before 1955, and the stock

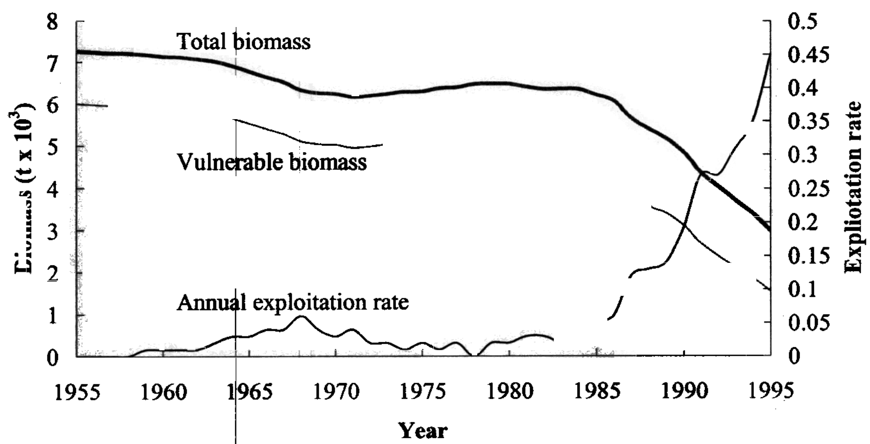

Figure 6. The reconstructed lingcod biomass in Hecate Strait. This stock was reconstructed using the observed catches (Figure 2) and an estimate of the pre-1956 biomass (7260 t) and a recruitment curve slope of 2.326.

had already been eroded from its unfished state. Therefore, calculating the stock recruitment relationship using a stock that is below its carrying capacity will result in under-estimating the initial slope of the stock recruitment curve. In other lingcod stocks, however, highly variable recruitment has been observed (McFarlane and Leaman 1996, Cass *et al.* 1990), so it is still possible that this approach is over-estimating the average annual recruitment.

A note on some problems, and their remedies

A major problem with this analysis is the use of CPUE data collected from the fishery. In most fisheries, CPUE data gathered from fisheries are biased (Hilborn and Walters 1992). Thus, the relationship between CPUE and stock size is not directly proportional, and may even be of an inverse nature, at least until very small stock sizes occur. Imagine how this lingcod fishery works: lingcod aggregate in small areas, fishers remove an aggregation; then they search for a new aggregation. As long as fishers remain fishing on aggregations, the catch rates will remain constant or even increase, until the last aggregation is removed. A simple remedy for this problem is the use of a fishery-independent sampling program. The focus of the sampling program would be to maximize the information about the stock, not maximize the catch.

The second major problem with this assessment is assuming a deterministic stock-recruitment relationship. In the absence of any age-structured data, however, there is no justification to assume anything but a deterministic relationship. As an alternative to collecting age-structured data, random recruitment anomalies could be incorporated into the analysis and Monte-Carlo simulations (i.e., run the model 10,000 times) could be used to calculate the posterior distributions for each parameter. The problem with this method, however, is the proportionality assumption between CPUE and stock size is still required. Random samples of the catch and aging of fin rays is a practicable solution for gathering age-structured information about the stock. In fact, this method is already in use for the Strait of Georgia and West Coast of Vancouver Island lingcod stocks (McFarlane and Leaman 1996). A simpler method, one that could be carried out by the users of the resource, is to gather length frequency data on the fish. Catch-at-length data can be transformed to catch-at-age data quite readily using simple computer programs.

Finally, a minor problem in dealing with stock reduction analysis is examining the trade-off between stock size and productivity. As mentioned previously, there is no single solution for the simple system of non-linear equations (Kimura and Tagart 1982, Kimura *et al.* 1984). In general, the observed data can be explained equally well by a small, highly productive stock, or a large, unproductive, stock. lingcod are not generally thought of as being highly productive. lingcod fisheries are typically supported for many years by a single, strong year-class (McFarlane and Leaman 1996, Cass *et al.* 1990). Again, catch-at-age data (or an equivalent) can be used to resolve the uncertainties about the productivity of the stock.

Acknowledgements

I would like to thank Dr. Daniel Pauly for his encouragement towards completing this paper, Scott Wallace and Alasdair Beattie for supplying the historical data, and of course, Dr. Carl Walters for the ongoing whippings.

References

Cass, A.J., R.J. Beamish, and G.A. McFarlane. 1990. lingcod (*Ophiodon elongatus*). Can. Spec. Publ. Fish. Aquat. Sci. 109, 40 p.

Hilborn, R., and C.J. Walters. 1992. Quantitative Fisheries Stock Assessment: choice, dynamics & uncertainty. Chapman & Hall. New York. 570 p.

Kimura, D. K., and J. V. Tagart, 1982. Stock reduction analysis, another solution to the catch equations. Can. J. Fish. Aquat. Sci 39: 1467-1472.

Kimura, D. K., J. W. I. Balsiger, and D. H. Ito, 1984. Generalized stock reduction analysis. Can. J. Fish. Aquat. Sci. Vol. 41: 1325-1333.

McFarlane, G.A., and B. L. Leaman. 1996. Offshore lingcod stock assessment and recommended yield options for 1997. Pacific Stock Assessment Review Committee. Department of Fisheries and Oceans.

Smith, B. D., G. A. McFarlane. 1990. Movements and mortality of tagged male and female lingcod in the Strait of Georgia, British Columbia. Trans. Amer. Fish. Soc. 119:813-824.

Walters, C. J. and D. Ludwig, 1994. Calculation of Bayes' Posterior Probability Distributions for key population parameters. Can. J. Fish. Aquat. Sci. 51: 713-722

Appendix I. List of Participants

David Archer
Northwest Maritime Institute
737 2nd Ave. West
Prince Rupert, BC,
V8J 1A6
Tel: (250) 627-5216

Jo-ann Archibald
First Nations House of Learning
The Longhouse, UBC
1985 West Mall
Vancouver, BC, V6T 1Z2
Email: jarchi@unixg.ubc.ca

Alasdair Beattie
UBC Fisheries Centre
2204 Main Mall
Vancouver, BC, V6T 1Z4
Email: beattie@fisheries.com

Charlie Bellis
Council of the Haida Nation
Massett, Haida Gwaii,
V0T 1M0

Gladys Blyth
c/o Ann Blyth
418 Sherbrooke
Prince Rupert, BC,
V8J 2V9
Tel: (250) 624-6782

Dempsey Collinson
(Chief Skidegate)
Skidegate
Haida Gwaii, V0T 1S0

Ray Gardiner
1451 Plaza Pl.
Prince Rupert, BC,
V8J 3A9
Tel: (250) 624-4821

Nigel Haggan
UBC Fisheries Centre
2204 Main Mall
Vancouver, BC, V6T 1Z4
Tel (604) 822-6939
Fax: (604) 822-8934
Email: nhaggan@fisheries.com

Ken Harris
1655 Herman Place
Prince Rupert, BC,
V8J 2E9
Tel: (250) 624-5247

George Hayes
Director, Northwest Maritime Institute
737 2nd Ave. West
Prince Rupert, BC,
V8J 1A6
Tel: (250) 627-5216

Bob Hill, President
Tsimshian Tribal Council
138 1st Ave W.
Prince Rupert, BC,
V8J 1A8
Tel: (250) 627-8782
Fax: (250) 627-1938

Foster Husoy
548 Cassiar
Prince Rupert, BC,
V8J 3Z5
Tel: (250) 624-5364

Glen S. Jamieson
Coastal and Marine Habitat Science Section
Marine Environment and Habitat Science Division
Pacific Biological Station
Nanaimo, BC, V9R 5K6
Tel: (250) 756-7223

Ivar Johansen
2059 Graham
Prince Rupert, B.C
V8J 1C8
Tel: (250) 624-2962

Russ Jones
Haida Fisheries Program
Skidegate
Haida Gwaii, VOT 1SO
Tel: (250) 559-8945
Fax: (250) 559-8951
Email: rjones@ptialaska.net

Nancy Oliver
(Coordinator)
PO Box 41
Port Edward, BC,
V0V 1G0
Tel: (250) 628-3298
Fax: (250) 628-3309

Charlie Parkin
508-4th Ave. East
Prince Rupert, BC,
V8J 1N9

Paul Pearson
Skidegate Band Council
Skidegate
Haida Gwaii,
V0T 1S0

Alf Ritchie
146 - 7th Ave. East
Prince Rupert, BC,
V8J-2H4
R. L. (Bob) Warren
2121 Graham
Prince Rupert, BC,
V8J 1C9
Tel: (250) 624-5564

Appendix II. ECOPATH Outputs.

Table A. Basic estimates as supplied by the ECOPATH software for the present day model of the Hecate Strait. Values in bold characters were calculated by the software.

Group name	Trophic level	Biomass (Wet weight, (t km⁻²))	Production/ Biomass ($year^{-1}$)	Consumption/ Biomass ($year^{-1}$)	Prod.uction / Consumption	Ecotrophic efficiency	Omnivory index
Transient orcas	**5.0**	0.002	0.200	12.130	**0.016**	-	**0.045**
Odontocetae	**4.1**	0.020	0.400	15.590	**0.026**	**0.607**	**0.059**
Pinnipeds	**4.1**	0.052	0.400	15.330	**0.026**	**0.875**	**0.155**
Lingcod	**4.0**	0.065	0.580	3.300	**0.176**	**0.508**	**0.281**
Pacific halibut	**3.9**	0.305	0.440	1.730	**0.254**	**0.201**	**0.181**
Sablefish, juvenile	**3.8**	1.500	0.600	6.600	**0.091**	**0.852**	**0.267**
Turbot	**3.7**	1.130	0.775	3.210	**0.241**	**0.969**	**0.533**
Sablefish, adult	**3.6**	0.200	0.080	3.730	**0.021**	**0.813**	**0.315**
Seabirds	**3.6**	0.016	0.100	112.000	**0.001**	-	**0.241**
Ratfish, skates	**3.4**	1.240	0.310	**1.240**	0.250	**0.996**	**0.215**
Pacific cod	**3.4**	**0.059**	1.200	4.000	**0.950**	0.950	**0.325**
Walleye pollock	**3.3**	0.357	0.800	4.760	**0.513**	**0.513**	**0.128**
Spiny dogfish	**3.2**	1.250	0.750	5.000	**0.813**	**0.813**	**0.119**
Rockfish, small benthic fish	**3.2**	**41.347**	0.170	3.440	**0.980**	0.980	**0.036**
Flatfish	**3.1**	2.831	0.775	3.210	**0.451**	**0.451**	**0.346**
Mysticetae	**3.1**	0.310	0.020	13.370	**0.196**	**0.196**	**0.012**
P. O. Perch	**3.1**	0.841	0.100	3.440	**0.950**	0.950	-
Salmon, juvenile	**3.1**	4.430	0.980	7.115	**0.116**	**0.116**	-
Herring, small pelagic fish	**3.1**	**2.959**	2.200	11.000	**0.980**	0.980	-
Carnivorous jellies	**3.0**	6.190	7.000	**23.333**	0.187	**0.187**	**0.163**
Crustaceans	**2.2**	15.000	1.600	**6.400**	0.757	0.757	**0.171**
Macrobenthos	**2.1**	40.000	1.913	**21.256**	0.564	0.564	**0.111**
Zooplankton	**2.1**	40.000	59.591	**297.955**	0.665	**0.665**	**0.111**
Phytoplankton	**1.0**	257.500	135.000	-	**0.323**	**0.323**	-
Detritus	**1.0**	7.000	-	-	**0.013**	**0.013**	**0.153**

Table B. Basic estimates as supplied by the ECOPATH software for the 100-year model of the Hecate Strait. Values in bold characters were calculated by the software.

Group name	Trophic level	Biomass (Wet weight, (t·km⁻²))	Production/ biomass (year⁻¹)	Consumption/ biomass (year⁻¹)	Production/ consumption	Ecotrophic efficiency	Omnivory index
Transient orcas	**5.1**	**0.002**	0.200	12.130	0.0160	**0.000**	**0.046**
Odontocetae	**4.1**	**0.024**	0.400	15.590	0.0260	**0.505**	**0.059**
Pinnipeds	**4.1**	**0.052**	0.400	15.330	0.0260	**0.875**	**0.119**
Lingcod	**4.0**	**0.127**	0.580	3.300	0.1760	**0.216**	**0.312**
Pacific halibut	**3.9**	**0.305**	0.440	1.730	0.2540	**0.000**	**0.192**
Sablefish, juvenile	**3.7**	**1.950**	0.600	6.600	0.0910	**0.650**	**0.263**
Sablefish, adult	**3.7**	**0.130**	0.080	3.730	0.0210	**0.000**	**0.258**
Turbot	**3.7**	**1.130**	0.775	3.210	0.2410	**0.315**	**0.516**
Seabirds	**3.6**	**0.032**	0.100	112.000	0.0010	**0.000**	**0.241**
Flatfish	**3.5**	**3.680**	0.775	3.210	0.2410	**0.968**	**0.301**
Ratfish, skates	**3.5**	**1.240**	0.310	1.240	0.2500	**0.944**	**0.306**
Pacific cod	**3.4**	**0.051**	1.200	4.000	0.3000	**0.548**	**0.331**
Walleye pollock	**3.3**	**0.357**	0.800	4.760	0.1680	**0.475**	**0.128**
Spiny dogfish	**3.2**	**1.250**	0.750	5.000	0.1500	**0.888**	**0.123**
Rockfish, small benthic fish	**3.2**	50.050	0.170	3.440	0.0490	0.980	**0.036**
Mysticetae	**3.1**	**0.310**	0.020	13.370	0.0010	**0.196**	**0.012**
P.O. Perch	**3.1**	0.478	0.100	3.440	0.0290	0.500	-
Herring, small pelagic fish	**3.1**	**4.925**	2.200	11.000	0.2000	**0.756**	-
Salmon, juvenile	**3.1**	**4.430**	0.980	7.115	0.1380	**0.152**	-
Carnivorous jellies	**3.1**	**6.190**	7.000	23.333	0.3000	**0.193**	**0.163**
Crustaceans	**2.2**	**15.000**	1.600	6.400	0.2500	**0.874**	**0.171**
Macrobenthos	**2.1**	**40.000**	1.913	21.256	0.0900	**0.576**	**0.111**
Zooplankton	**2.1**	**40.000**	59.591	297.955	0.2000	**0.686**	**0.111**
Phytoplankton	**1.0**	**257.500**	135.000	-	-	**0.323**	-
Detritus	**1.0**	**7.000**	-	-	-	**0.013**	**0.154**

Table C. Diet composition for all groups used in the present day model. Values are identical for the 100-year model, except as noted in the text (see Beattie *et al.* this volume).

Prey / Predator	Transient Orcas	Odontocetae	Pinnipeds	Mysticetae	Seabirds	Spiny dogfish	Ratfish, skates	Pacific Halibut	Pacific Cod	Walleye Pollock	Sablefish, juvenile	Sablefish, adult	Herring, small pelagics	Carnivorous jellies	Crustaceans	Macrobenthos	Zooplankton	Salmon, juvenile	P.O.Perch	Flatfish	Rockfish, small benthics	Turbot	Lingcod
Transient Orcas	-	-	-		-		-	-	-		-	-	-		-	-	-	-	-	-	-	-	
Odontocetae	0.200	-	-		-		-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	
Pinnipeds	0.750	-	-		-		-	-	-		-	-		-	-	-	-	-	-	-	-	-	
Mysticetae	0.050	-	-		-		-	-	-		-	-		-	-	-	-	-	-	-	-	-	
Seabirds	-	-	-		-		-	-	-		-	-		-	-	-	-	-	-	-	-	-	
Spiny dogfish	-	0.602	0.278		0.016	0.050	-	-	-		-	-		-	-	-	-	-	-	-	-	-	0.038
Ratfish, skates	-	-	-		-	-	-	-	-		-	-		-	-	-	-	-	-	-	-	0.100	-
Pacific Halibut	-	-	-		-	-	-	-	-		-	-		-	-	-	-	-	-	-	-	-	-
Pacific Cod	-	0.023	0.013		-	-	-	-	-	-	-	0.030		-	-	-	-	-	-	-	-	-	-
Walleye Pollock	-	-	0.170		-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	
Sablefish, juvenile	-	-	0.027		-	-	-	-	0.020	-	-	0.020		-	-	-	-	-	-	-	-	0.200	-
Sablefish, adult	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Herring, small pelagics	-	[illegible]	0.	0.012		-	-	0.	0.250	0.150	0.410	0.400	-	-	-	-	-	-	-	-	-	-	0.289
Carnivorous jellies	-	-	-	-	0.005	0.050	-	-	-	-	0.040	0.030	-	0.051	-	-	-	-	-	-	-	-	-
Crustaceans	-	0.055	0.116	-	0.142	0.130		0.120	0.125	-	0.	0.410	-	-	0.040	-	-	-	0.081	0.390	0.048	0.200	0.151
Macrobenthos	-	-	-	0.092	0.001	0.050	0.400	0.100	0.149	0.600	-	-	-	050	0.120	-	-	0.526	0.025	0.310	0.007	0.400	-
Zooplankton	-	-	-	0.896	0.412	0.700	-	-	0.380	0.250	0.300	0.060	.000	[illegible]	-	0.100	0.100	0.474	0.894	-	0.910	0.050	0.115
Salmon, juvenile	-	-	-	-	-	-	-	-	-		0.050	-	-	-	-	-	-	-	-	-	-	-	0.038
Phytoplankton	-	-	-	-	-	-	-	-	-		-	-		-	-	0.600	0.900	-	-	-	-	-	-
P.O. Perch	-	-	0.030	-	-	-	-	-	-		-	-		-	-	-	-	-	-	-	-	-	-
Flatfish	-	-	-	-	-	0.005	0.150	0.040	0.014		0.050	0.025		-	-	-	-	-	-	0.150	-	-	0.116
Rockfish, small benthics	-	-	0.070	-	-	0.010	0.150	-	0.012		0.010	0.025		-	-	-	-	-	-	0.150	0.035	-	0.115
Turbot	-	-	-	-	-	0.005	-	0.040	-		0.050	-		-	-	-	-	-	-	-	-	0.050	0.100
Lingcod	-	-	-	-	-	-	-	-	-		-	-		-	-	-	-	-	-	-	-	-	0.038
Detritus	-	-	-	-	-	-	-	-	0.050	-	-	-	-	0.099	0.840	0.300	-	-	-	-	-	-	-

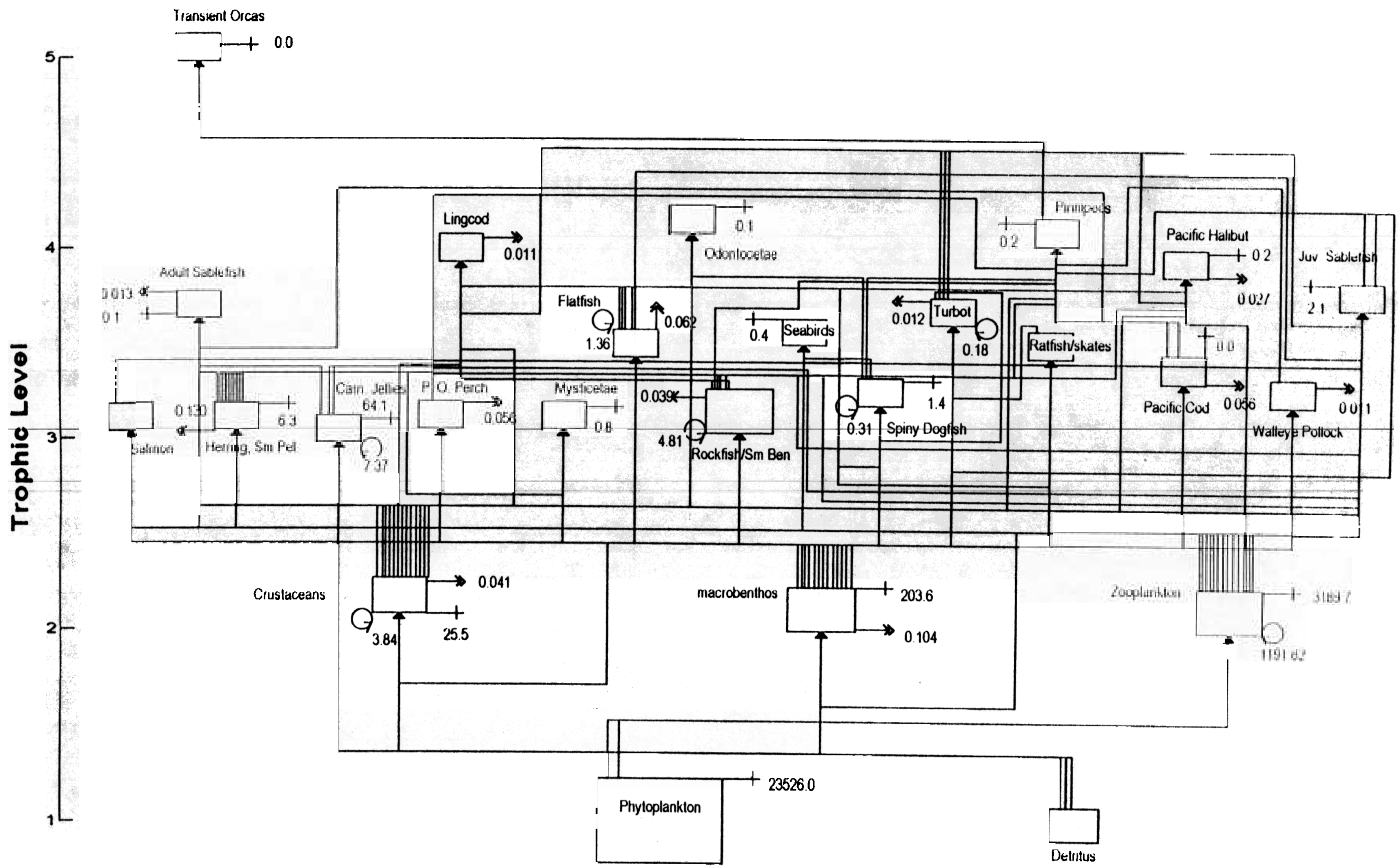

Figure A. A flow diagram of the present Hecate Strait Ecosystem as presented at the workshop held in Prince Rupert. Box size is proportional to the biomass of the functiuonal group, and boxes are centered at the trophic level calculated by the software. All production exits from the top of the box; consumption enters in the bottom of the box; minor flows between boxes not shown for simplicity. Double arrows indicate harvest, circles indicate cannabalism, and crosses indicate flows to detritus.

Appendix III. General Index

FISHERIES CENTRE RESEARCH REPORTS ISSN 11989-6727

1993 Volume 1(1) – 1999 Volume 7(4)

Pitcher, T. and Chuenpagdee, R. (eds) (1993) Commercial Whaling - The Issues Reconsidered. Fisheries Centre Research Reports 1(1): 36 pp. $20

Pitcher, T. and Chuenpagdee, R. (eds) (1993) Decision Making by Commercial Fisherman. Fisheries Centre Research Reports 1(2): 75 pp. $20

Pitcher, T. and Chuenpagdee, R. (eds) (1994) Bycatch in Fisheries and their Impact on the Ecosystem. Fisheries Centre Research Reports 2(1): 86 pp. $20

Bundy, A. and Babcock, E. (eds) (1995) Graduate Student Symposium on Fish Population Dynamics and Management. Fisheries Centre Research Reports 3(2): 33 pp. $20

Pitcher, T. and Chuenpagdee, R. (eds) (1995) Harvesting Krill: Ecological Impact, Assessment, Products and Markets. Fisheries Centre Research Reports 3(3): 82 pp. $20

Pauly, D., Christensen, V. and Haggan, N. (eds) (1996) Mass-Balance Models of North-eastern Pacific Ecosystems. Fisheries Centre Research Reports 4(1): 131pp. $20

Pitcher, T. (ed) (1996) Reinventing Fisheries Management. Fisheries Centre Research Reports 4(2): 84pp. $20

Pitcher, T. (ed) (1997) The Design & Monitoring of Marine Reserves. Fisheries Centre Research Reports 5(1), 47pp. $20

Dalsgaard, J. and Pauly, D. (1997) Preliminary Mass-Balance Models of North-eastern Pacific Ecosystems. Fisheries Centre Research Reports 5(2), 33 pp. $20

Pitcher, T., Watson, R., Courtney, A. and Pauly, D. (1998) Assessment of Hong Kong's Inshore Fishery Resources. Fisheries Centre Research Reports 6(1):148 pp. $40

Pauly, D. and Weingartner, G. (eds) (1998) Use of Ecopath with Ecosim to Evaluate Strategies for Sustainable Exploitation of Multi-Species Resources. Fisheries Centre Research Reports 6(2): 49 pp. $20

Vasconcellos, M. and Preikshot, D. (eds) (1998) Graduate Student Symposium on Fish Population Dynamics and Management. Fisheries Centre Research Reports 6(3): 40 pp. $20

Okey, T. and Pauly, D. (eds) (1998) Trophic Mass-Balance Model of Alaska's Prince William Sound Ecosystem for the Post-Spill Period 1994-(1996) Fisheries Centre Research Reports 6(4): 143 pp. $40

Pauly, D., Pitcher, T., Preikshot, D. and Hearne, J. (eds) (1998) Back to the Future: Reconstructing the Strait of Georgia Ecosystem. Fisheries Centre Research Reports 6(5): 99 pp. $40

Bonfil, R., Munro, G., Sumaila, U., Valtysson, H., Wright, M., Pitcher, T., Preikshot, D., Haggan, N. and Pauly, D. (eds) (1998) Distant Water Fleets: An Ecological, Economic and Social Assessment. Fisheries Centre Research Reports 6(6): 111 pp. $40

Trites, A., Livingston, P., Mackinson, S., Vasconcellos, M., Springer, A. and Pauly, D. (1999) Ecosystem Change and the Decline of Marine Mammals in the Eastern Bering Sea. Fisheries Centre Research Reports 7(1): 106 pp. $40

Pitcher, T. (ed.) (1999) Evaluating the Benefits of Recreational Fisheries. Fisheries Centre Research Reports 7(2): 169 pp. $40

Haggan, N., Beattie, A. and Pauly, D. (eds) (1999) Back to the Future: Reconstructing the Hecate Strait Ecosystem. Fisheries Centre Research Reports 7(3): 65 pp. $20

Okey, T. and Pauly, D. (eds) (1999) A Trophic Mass-Balance Model of Alaska's Prince William Sound Ecosystem for the Post-Spill Period 1994-1996, 2nd Edition. Fisheries Centre Research Reports 7(4): 137 pp. $40

Fisheries Centre Research Reports publish results of research work carried out, or workshops held, at the UBC Fisheries Centre. The series focuses on multidisciplinary problems in fisheries management and aims to provide a synoptic overview of the foundations, themes and prospects of current research. *Fisheries Centre Research Reports* are distributed to appropriate workshop participants or project partners and are recorded in *Aquatic Sciences and Fisheries Abstracts*. Copies of some of these research reports may be obtained at a cost from $20.00 to $40.00, which includes surface mail. Payment may be made by Visa or MasterCard, cheque or money order. Some reports are available at no charge, and in the near future it is expected that all reports will be available for free downloading from the Fisheries Centre website. Please contact:

Events Officer, **Fisheries Centre,** University of British Columbia
2204 Main Mall, Vancouver, BC V6T 1Z4 Canada

Phone: 604 822-0618
Fax: 604 822-8934

E-mail: events@fisheries.ubc.ca

Website: http://fisheries.ubc.ca

FISHERIES CENTRE RESEARCH REPORTS

ISSN 11989-6727

2000 Volume 8(1) 2002 Volume 10(3)

Guénette, S., Chuenpagdee, R. and Jones, R. (2000) Marine Protected Areas with an Emphasis on Local Communities and Indigenous Peoples: A Review. Fisheries Centre Research Reports 8(1): 56 pp. $20

Pauly, D. and Pitcher, T. (eds) (2000) Methods for Evaluating the Impacts of Fisheries on North Atlantic Ecosystems. Fisheries Centre Research Reports 8(2): 195 pp. n/c

Hunter, A. and Trites, A. (2001) An Annotated Bibliography of Scientific Literature (1751-2000) Pertaining to Steller Sea Lions (*Eumetopias jubatus*) in Alaska. Fisheries Centre Research Reports 9(1): 45 pp. $20

Watson, R., Pang, L and Pauly, D. (2001) The Marine Fisheries of China: Development and Reported Catches. Fisheries Centre Research Reports 9(2): 50 pp., n/c.

Zeller, D., Watson, R. and Pauly, D. (eds) (2001) Fisheries Impacts on North Atlantic Ecosystems: Catch, Effort and National/Regional Data Sets Fisheries Centre Research Reports 9(3): xxx pp, n/c.

Guénette, S., Christensen, V. and Pauly, D. (eds) (2001) Fisheries Impacts on North Atlantic Ecosystems: Models and Analyses. Fisheries Centre Research Reports 9(4): xxx pp., n/c

Pitcher, T., Sumaila, R. and Pauly, D. (eds) (2001) Fisheries Impacts on North Atlantic Ecosystems: Evaluations and Policy Exploration. (2001) Fisheries Centre Research Reports 9(5): 94 pp. n/c

Preikshot, D. and Beattie, A. (eds) (2001) Fishing for Answers: analysis of ecosystem dynamics, tropic shifts and salmonid population changes in Puget Sound, 1970-1999. Fisheries Centre Research Reports 9(6): 35 pp. $20

Tyedmers, P. and Ward, B. (2001) A Review of the Impacts of Climate Change on BC's Freshwater Fish Resources and Possible Management Responses. Fisheries Centre Research Reports 9(7): 12 pp. $20

Sumalia, U. and Alder, J. (eds) (2001) Economics of Marine Protected Areas. Fisheries Centre Research Reports 9(8): 250 pp. $40

Pitcher, T., Vasconcellos, M., Heymans, S., Brignall, C. and Haggan, N. (eds) (2002) Information Supporting Past and Present Ecosystem Models of Northern British Columbia and the Newfoundland Shelf. Fisheries Centre Research Reports 10(1): 116 pp. $40

Pitcher, T. and Cochrane, K. (2002) The Use of Ecosystem Models to Investigate Multispecies Management Strategies for Capture Fisheries. Fisheries Centre Research Reports 10(2): 156 pp. $40

Pitcher, T., Buchary, E. and Trujillo, P. (eds) (2002) Spatial Simulations of Hong Kong's Marine Ecosystem: Ecological and Economic Forecasting of Marine Protected Areas With Human-Made Reefs. Fisheries Centre Research Reports 10(3): 169 pp. $40

Fisheries Centre Research Reports publish results of research work carried out, or workshops held, at the UBC Fisheries Centre. The series focuses on multidisciplinary problems in fisheries management and aims to provide a synoptic overview of the foundations, themes and prospects of current research. *Fisheries Centre Research Reports* are distributed to appropriate workshop participants or project partners and are recorded in *Aquatic Sciences and Fisheries Abstracts*. Copies of some of these research reports may be obtained at a cost from $20.00 to $40.00, which includes surface mail. Payment may be made by Visa or MasterCard, cheque or money order. Some reports are available at no charge, and in the near future it is expected that all reports will be available for free downloading from the Fisheries Centre website. Please contact:

Events Officer, **Fisheries Centre,** University of British Columbia
2204 Main Mall, Vancouver, BC V6T 1Z4 Canada

Phone: 604 822-0618
Fax: 604 822-8934

E-mail: events@fisheries.ubc.ca

Website: http://fisheries.ubc.ca