

A Review of Canadian Data Sources and Catch Records for Squid (spp.) in the Northeast Pacific Ocean

J. Wade, and J.M.R. Curtis

Fisheries and Oceans Canada
Science Branch, Pacific Region
Pacific Biological Station
Nanaimo, BC
V9T 6N7

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**A REVIEW OF CANADIAN DATA SOURCES AND CATCH RECORDS
FOR SQUID (spp.) IN THE NORTHEAST PACIFIC OCEAN**

By

J. Wade and J.M.R. Curtis

Fisheries and Oceans Canada
Science Branch, Pacific Region
Pacific Biological Station
3190 Hammond Bay Road
Nanaimo, BC
V9T 6N7

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ABSTRACT

Wade, J., and Curtis, J.M.R. 2015. A review of Canadian data sources and catch records for squid (spp.) in the Northeast Pacific Ocean. Can. Manuscr. Rep. Fish. Aquat. Sci. 3060: iv + 46 p.

Several species of squid are fished by multiple countries in the international waters of the North Pacific Ocean. These species are managed by the North Pacific Fisheries Commission (NPFC) according to the Convention on the Conservation and Management of High Seas Fisheries Resources of the North Pacific Ocean. In preparation for stock assessments led by the NPFC Scientific Working Group, Canada was asked to submit a time series of catch records for all squid species captured in the Northeast Pacific Ocean. This document serves as a summary of the types of data, including catch records, and information available on squid (spp.) within and adjacent to Canadian Pacific waters. As 17 squid species are reported from Canadian waters in the Northeast Pacific Ocean, we limited our review to those species for which the potential for commercial fisheries has been explored in British Columbia.

RÉSUMÉ

Wade, J., et Curtis, J.M.R. 2015. Examen des sources de données et des registres des pêches pour plusieurs espèces de calmars du Pacifique Nord-Est. Rapp. manus. can. sci. halieut. aquat. 3060: iv + 46 p.

Plusieurs espèces de calmars sont pêchées par de nombreux pays dans les eaux internationales de l'océan Pacifique Nord. Ces espèces sont gérées par Commission des pêches du Pacifique Nord (CPPN) conformément à la *Convention sur la conservation et la gestion des ressources halieutiques en haute mer du Pacifique Nord*. En vue des évaluations des stocks menées par le groupe de travail scientifique de la CPPN, on a demandé au Canada de soumettre une série chronologique des registres de pêches pour toutes les espèces de calmars capturées dans le Pacifique Nord-Est. Le présent document fait office de résumé des types de données, y compris les registres des pêches, et des renseignements disponibles sur les calmars (plusieurs espèces) dans les eaux canadiennes du Pacifique ou dans les zones adjacentes à celles-ci. Puisque 17 espèces de calmars sont répertoriées dans les eaux canadiennes du Pacifique Nord-Est, nous avons limité notre examen aux espèces pour lesquelles la possibilité de pêche commerciale a été étudiée en Colombie-Britannique.

INTRODUCTION

There are more than 17 species of squid found in the coastal waters of the North East Pacific Ocean (Macfarlane and Yamamoto, 1974). Jamieson and Francis (1986) identified four species with commercial potential, the opal squid (*Loligo opalescens*), red squid (*Berryteuthis magister*), nail squid (*Onychoteuthis borealijaponica*) and the neon flying squid (*Ommastrephes bartramii*). Gillespie (1997) identified four species of oceanic squid: neon flying squid, boreal clubhook squid (previously, nail squid), eight-armed squid (*Gonatopsis borealis*) and schoolmaster gonate squid (previously, red squid) for potential development in a jig fishery off British Columbia.

Several species of squid are fished by multiple countries in the international waters of the North Pacific Ocean. These species are managed by the North Pacific Fisheries Commission (NPFC) according to the Convention on the Conservation and Management of High Seas Fisheries Resources of the North Pacific Ocean. In preparation for stock assessments led by the NPFC Scientific Working Group, Canada was asked to submit a time series of catch records for all squid species captured in the Northeast Pacific Ocean.

Canada has participated in and conducted squid fisheries in the past and as a result there are considerable records of catch and by-catch both within and outside the 200 mile Fisheries Conservation Zone (FCZ). The governments of Canada, Japan and the United States participated in an observer program on board Japan's squid driftnet fleet from 1989 to 1991 (Waddell & McKinnell, 1994). Neon flying squid were the target species of this large scale driftnet fishery carried out by Japan, Korea and Taiwan up until 1992, when it was banned by the United Nations General Assembly (Gillespie, 1997). An experimental driftnet fishery (1979 to 1987) and a jig fishery (1979-1991) for neon flying squid took place within Canada's 200 mile Fisheries Conservation Zone (Campagna, 2000).

Canada's response to the North Pacific Fisheries Commission's request for squid data required a review of a broad range of disparate sources of information that are not readily available or summarized. The majority of the squid information is available only in government documents and unpublished databases. Summarized in this report are the types of data available from experimental and high seas fisheries, research surveys and anecdotal observations reported by regional experts. We limited our review to those species for which the potential for commercial fisheries has been explored in British Columbia.

BACKGROUND

Species

Four species of squid are or have been of commercial fishing interest in Canada: opal squid (*Loligo opalescens*), boreal clubhook squid (*Onychoteuthis borealijaponica*), neon flying squid (*Ommastrephes bartramii*), and the schoolmaster gonate squid (*Berryteuthis magister*).

In BC, opal squid are the most frequently seen species and rarely exceed 20 cm total length (Bernard, 1980). This species more than others tends to congregate at night in shallow waters which are well illuminated and can be found from the intertidal to 250m in depth. It is opal squid which is fished in both the Atlantic and Pacific coasts of the United States (Bernard, 1980).

Opal squid is also called market squid in California where there is a substantial, although erratic commercial fishery (S. McFarlane, Pers. Comm.). The major fishing areas off California for this species coincide with the spawning grounds off Monterey and along the Southern California Channel Islands (Bernard, 1980). Opal squid juveniles form an important element of the food web in coastal British Columbia, serving as food for many piscivorous fish species (Bernard, 1980). Adult opal squid feed on juvenile fish and small planktonic organisms during the daytime in 20 to 50 m of water (Bernard, 1980). In BC waters, two major spawning events occur, one in March in the Strait of Georgia and Queen Charlotte Strait and one in July off Victoria and the west coast of Vancouver Island (Bernard, 1980). Because of the unpredictability of spawning aggregations, opal squid were considered less suitable for commercial development in BC waters (Bernard, 1980).

The nail squid or boreal clubhook squid, as it is known today, may reach a total length of 45 cm (Bernard, 1980). It was called the nail squid because of its nail-like claws on the ends of its tentacles which are used in feeding. This species is found from as far south as California in the North Pacific to the Gulf of Alaska and west to the Okhotsk Sea and Sea of Japan (Bernard, 1980). Unlike the opal squid, this species is found primarily along the continental shelf in 500 to 1000 m water during the day and rises to the surface at night (Bernard, 1980). Extensive populations were reported present off La Perouse Bank and the northern tip of Vancouver Island (Bernard, 1980).

Neon flying squid can reach total lengths of up to 1m and frequently reach mantle lengths of 50 cm (Bernard, 1980). This species aggregates in tropical and sub-tropical areas of the Pacific Ocean, then, migrates to cooler waters where breeding occurs. Neon flying squid are prey for marine mammals and large predatory fish such as tuna (Bernard, 1980). This species was the main target for the western Pacific Ocean gillnet fishery. It was also the target for the experimental fishery within Canadian waters from the late 1970s to early 1990s. When the moon is bright the species tends to migrate and feeds very little. Therefore, on dark nights jigging is most productive, but when the night is bright, gillnetting is more successful, this is opposite to opal squid fishing (Bernard, 1980).

Red squid, currently named schoolmaster gonate squid, can reach a total length of 45cm (Bernard, 1980). It is found from California to the Bering Sea and throughout the northwest Pacific (Bernard, 1980). Of all the species previously discussed, this species is believed to be more abundant in BC waters.

Fishing efforts

Table 1 summarizes the squid fishing activities Canada undertook from the 1970's to the 1990's in British Columbia. Some of these fisheries were termed "scientific", some "exploratory", and for others Canada just participated as observers.

Table 1: Summary of Pacific Canada fisheries activities for neon flying squid.

Year	Who	Where	Gear	Purpose	Species	Reference
1979	Japanese vessels with Canadian scientist aboard	Canadian waters	Gillnet and jig	Test fishing	Neon flying squid	Bernard (1980)
1980	Japanese vessels with Canadian scientist aboard	Canadian waters	Gillnet and jig	Test fishing	Neon flying squid	Bernard (1981)
1983	Japanese vessel with Canadian scientist aboard	Canadian waters (mostly within 200 miles)	Driftnet with some jigging	Test fishing, feasibility of a fishery	Neon flying squid	Robinson & Jamieson (1984); Sloan (1984)
1985	Japanese vessel	Both outside and inside FCZ	Driftnet	To show low bycatch of salmon and viable squid fishery	Neon flying squid	Jamieson & Heritage (1987)
1986	Japanese and Canadian vessels	Both outside and inside FCZ	Driftnet	To show low bycatch of salmon and viable squid fishery	Neon flying squid	Jamieson & Heritage (1987)
1987	Japanese and Canadian vessels	Outside FCZ	Driftnet and some jig	To show bycatch and viable squid fishery	Neon flying squid	Jamieson & Heritage (1988)
1988	Japanese high seas	NW & central Pacific Ocean	Driftnet	Japan observers	Squid & other	Waddell & McKinnell (1994)
1989 & 90				CDA/US/Japan observers		

1990 & 91	Japanese-Canadian vessels	Inside and outside FCZ	Jig (machine and hand)	Determine distribution and abundance; assess jig effectiveness; bycatch; introduce Japanese jigging equipment to Canadian fishers	Neon flying squid	Shaw & Smith (1995)
1996	Canadian	Within and adjacent to FCZ	Jig	Feasibility of automatic jig fishery (DFO, Prov. BC, Industry)	Neon flying squid	Gillespie & Shaw (1997)
1997	Canadian	Within and adjacent to FCZ	Jig	Feasibility of automatic jig fishery (DFO, Prov. BC, Industry)	Neon flying squid plus schoolmaster gonate, boread clubhook and boreopacific gonate	Campagna et al. (2000)
1998	Canadian	Within and adjacent to FCZ	Jig	Feasibility of automatic jig fishery (DFO, Prov. BC, Industry)	Neon flying squid plus schoolmaster gonate, boread clubhook and boreopacific gonate	Campagna et al. (2000)
1999-2002	Canadian	Within and adjacent to FCZ	Jig	Pilot fishery (continuation of 1996-98 fishery)	Neon flying squid plus schoolmaster gonate, boreal clubhook and boreopacific gonate	DFO (no date a)

Although efforts to develop a neon flying squid fishery were extensive, there was also an opal squid fishery open in the 1990's and early 2000's. Based on the fisheries management plans, opal squid was mainly taken by hook and line and side catcher or frame nets. Squid landed in BC were mainly used as bait for commercial crab, sablefish and halibut fisheries. There was interest in developing the opal squid fishery for food, but the large California squid fishery produces a low priced product which would make competition very difficult. Key information

from the fisheries management plans over this time period has been summarized together in an annotated bibliography included below (see DFO, various).

METHODS

Our review of the biological, fisheries and other data pertinent to squid included a comprehensive literature search, queries of survey and fisheries databases, and interviews with regional experts. Searches of reference to squid in government documents have been performed and summarized. Because different groups within DFO maintain their own databases and these databases are not integrated it was requested that these databases be searched by the data manager for reference to squid.

Literature search

Primary databases searched included: Academic Search Premier; American Fisheries Society journals; BioOne; JSTOR; NRC Research Press; Science Direct and SpringerLink. Search terms included: Squid; Opal squid; Neon flying squid; Squid AND Eastern AND Pacific; Squid fishery; Squid and British Columbia.

DFO library collections available online were searched, including: WAVES; Contractor Reports; Data Reports; Industry Reports; Manuscript Reports and; Technical Reports.

Reports searched included:

- Contractor reports (1-56)
- Data Reports
 - Fisheries and Marine Service Data Records (2-24)
 - Fisheries and Marine Service Data Reports (26-159)
 - Canadian Data Reports of Fisheries and Aquatic Sciences (161- 1238)
 - Canadian Data Reports of Hydrography and Ocean Sciences (1-190)
- Industry Reports
 - Project Reports/Canada. Dept. of Fisheries Industrial Development Service (1-26)
 - Project Report Series of the Industrial Development Branch (28-56)
 - Technical Report/Canada Fisheries and Marine Service Industrial Development Branch (58-86)
 - Technical Report Series of the Fishermen's Services Branch (89-91)
 - Fisheries and marine Service Industry Reports (93-110)
 - Canadian Industry Reports of Fisheries and Aquatic Sciences (111-286)
- Manuscript Reports-Fisheries
 - Manuscript Reports of the Biological Stations (1-623)
 - Manuscript Report Series (Oceanographic and Limnological) (56-145)
 - Manuscript Report Series (Biological) (636-886)
 - Manuscript Report Series (Fisheries Research Board of Canada) (907-1424)
 - Fisheries and Marine Service Manuscript Reports (1431-1542)
 - Canadian Manuscript Reports of Fisheries and Aquatic Sciences (1552-2995)
- Technical Reports-Fisheries
 - Technical Reports (Fisheries Research Board of Canada) (1-454)
 - Technical Reports (Canada Fisheries and Marine Service Research and Development Directorate) (463-714)

- Fisheries and Marine Service Technical Reports (717-922)
- Canadian Technical Reports of Fisheries and Aquatic Sciences (908-2993)
- Technical Reports- Hydrography and Ocean Sciences
 - Canadian Technical Reports of Hydrography and Ocean Sciences (2-274)

Search terms used in WAVES included: squid; neon flying squid; opal squid; market squid; stomachs AND groundfish; bird AND diet; mammals AND squid.

All DFO reports pertaining to anything marine on the west coast of Canada were searched for the term: squid. In addition, one word in each title was searched to ensure the search function was working. Because the webpage for the DFO reports is archived it is not up to date; it was last updated in 2012. WAVES should be up to date and can be used to identify DFO reports which have squid in the title or listed as a key word. However, if squid is merely mentioned as a component of a catch or stomach contents for example, it would not be identified in a keyword search. Although time consuming to open up each PDF of each type of DFO report, it does allow for the identification of obscure references to species. The documents which only mentioned squid as bait, for example in the sablefish fishery documents were excluded from the results.

All Canadian Science Advisory Secretariat publications were searched for the term “squid”.

Survey databases

DFO has a number of different survey databases most of which are not linked together; additionally, individual research groups may have their own databases which are not included in the survey databases. An email was sent to all Fisheries and Oceans Canada staff at the Pacific Biological Station (PBS) and South Coast Office asking them for their help in providing data on squid within the scope of their own work. All leads were followed up, resulting in further contact with individuals as well as other research teams. Contacts were asked to search for any records of *squid* in their respective databases. Data returned from queries of fishery databases were subject to the three party/vessel rule to abide by the Privacy Act.

Research groups/teams

There are several groups at DFO who conduct, or did conduct, scientific research without direct application to stock assessments. Specifically, Dr. Dick Beamish’s group including Dr. Ruston Sweeting and Ms. Chrys Neville and Ms. Lana Fitzpatrick and; Dr. Marc Trudel’s High Seas Salmon Research group were asked to check their databases for records of squid.

RESULTS

Literature search

A search of the primary literature resulted in a large number of papers on squid in non-Canadian or Atlantic Canadian waters. Because the goal of this review was to determine what information and data are available specific to Pacific Canada this literature was excluded.

For the most part, the results of the WAVES search were accounted for in the results of the search of the individual DFO reports. DFO data, technical and manuscript reports proved to be the greatest resources for squid information. Several thousand reports were first screened based

on location of study, then hundreds of those were searched for the key words. As there was both a high seas international drift fishery for squid as well as a scientific fishery for squid a few years later, there was considerable information pertaining to these fisheries in both the WAVES results as well as the DFO reports. The types of information or references to squid in the DFO reports have been summarized in Table 2.

Table 2: Summary of types of information available in DFO reports containing the term squid (G= in general, V=various sp., NF= Neon flying squid, H=Humboldt squid, B=Pacific bobtail squid, O=Opal squid, C=Boreal clubhook squid).

Author(s)	Year	Focus	Type of squid	Reference to squid		Notation	
				Stomach contents	Species	Data	Presence\ statement
Ashton et al.	1985	Mackerel diet	G	√			
Backe et al.	2011	Marine protected areas assessment	H				√
Barlow et al.	1994	Marine mammal mortality	NF		√		
Barner et al.	1979a	Bottom trawl tows	G			√	
Barner et al.	1979b	Bottom trawl tows	G			√	
Bernard	1980	Potential for commercial squid fishery BC	G		√		
Bernard	1981	Flying squid experimental fishery	NF		√	√	
Boutillier et al.	1998a	Shrimp survey	V		√	√	
Boutillier et al.	1998b	Shrimp survey	V		√	√	
Boutillier et al.	1998d	Shrimp survey	G		√		√
Boutillier et al.	1998c	Shrimp survey	V		√	√	
Bower et al.	1990	Flying squid parasites	NF		√	√	
Campagna et al.	2000	Flying squid pilot fishery	NF			√	
Canessa et al.	2003	Bowie Seamount	G		√		√
Chilton et al.	1974	Groundfish cruise data record	G			√	
Choromanski et al.	2002	Trawl survey data	V			√	
Choromanski et al.	2004	Trawl survey data	V			√	
Choromanski et al.	2005	Trawl survey data	V			√	
Clarke & Jamieson	2006	PNCIMA	G				√
Cooke & Groot	1990	Purse seine data	G			√	
Cooke et al.	1991	Surface trawl data	V			√	
DFO	1991	Description of drift net fishery	G			√	√

DFO	No date	Experimental squid fishery guidelines (2000-02)			√		
Farlinger & Bates	1985	Shellfish fishery review	G			√	
Farlinger et al.	1990	PSARC annual report	V		√	√	
Farlinger et al.	1991	PSARC annual report	V		√	√	
Flinn et al.	2002	Marine mammal diet	V			√	
Flostrand et al.	2011	Sardine forum	G		√		
Forrester	1969	Groundfish life history	G	√			
Gillespie	1997	Review of oceanic squids	V		√		
Gillespie & Shaw	1997	Review of pilot squid fishery 1996	NF		√	√	
Gillespie et al.	1993	Rockfish survey data	G			√	
Gregg	2004	Marine mammals	G			√	
Haegle et al.	2005	Herring survey data	G			√	
Haggarty et al.	2004	Lingcod survey data	B				√
Haggarty et al.	2005	Lingcod survey data	V				√
Haigh & Richards	1997	Rockfish logbook data	V				√
Hand et al.	1993	Pacific cod survey	G	√		√	
Harbo & Jamieson	1987	Invertebrate fishery status	V		√	√	
Harbo & Wylie	2006	Invertebrate fishery update	V		√	√	
Harling & Boutillier	1991	Shrimp survey data	G				√
Harling et al.	1970	Groundfish cruise data	G			√	
Harling et al.	1971	Groundfish cruise data	G				√
Harling et al.	1973	Groundfish cruise data	G				√
Henderson et al.	2004	Herring survey data	G			√	
Hillier et al.	2007	Gwaii Haanas conservation area	V				√
Holmberg	1967	Trawl fishery statistics	O			√	
Hrabok et al.	2007	Pacific sardine forum	V				√
Humphreys et al.	1994	PSARC annual report	G		√	√	
Irvine et al.	1992	PSARC annual report	V		√	√	
Irvine et al.	1993	PSARC annual report	V		√	√	
Jamieson & Francis	1986	Invertebrate fishery resources BC	V		√		
Jamieson & Heritage	1987	Experimental squid fishery	V		√	√	
Jamieson & Heritage	1988	Experimental squid fishery	V		√	√	
Ke et al.	1979	Squid processing	G		√		
Kennedy & Pletcher	1968	Sablefish study	G	√			√

Ketchen et al.	1983	Strait of Georgia fisheries	G				√
King et al.	2013	Groundfish survey data	V		√	√	
Krishka et al.	2005	Longspine trawl data	V		√	√	
Levings	1968	Groundfish cruise data	G		√	√	
Lucas et al.	2007	PNCIMA overview	G		√		
Macfarlane & Yamamoto	1974	Squid of BC	V		√	√	
McFarlane & MacDougall	2001	Pacific sardine cruise data	G			√	
Morris & Welch	1992	High seas salmon data	N			√	
Morris et al.	1992	USSR-CDA salmon data report	G	√		√	
Morris et al.	1993	High seas data	N, C		√	√	
Murray & Therriault	2010	Eulachon workshop	H		√		√
Nagtegaal & Farlinger	1980	Rockfish survey data	G		√		√
Nagtegaal & Farlinger	1980	Rockfish survey data	G		√		√
Nichol et al.	2002	Whaling database description	G	√			√
Olesiuk et al.	1990	Harbour seal feeding	G	√			√
Olsen et al.	2007	Groundfish survey data	V		√	√	
Olsen et al.	2007b	Groundfish survey data	V		√	√	
Olsen et al.	2007c	Groundfish survey data	V		√	√	
Olsen et al.	2007d	Groundfish survey data	V		√	√	
Olsen et al.	2008	Goundfish survey data	V		√	√	
Olsen et al.	2009	Goundfish survey data	V		√	√	
Olsen et al.	2009b	Goundfish survey data	V		√	√	
Olsen et al.	2009c	Goundfish survey data	V		√	√	
Olsen et al.	2009d	Goundfish survey data	V		√	√	
Ong et al.	2002	Shrimp bycatch data	V		√	√	
Pearsall & Fargo	2007	Groundfish diet study	V	√		√	
Prest	1968	Trawl survey data	O		√	√	
Prest	1969	Trawl survey data	O		√	√	
Ricker	1959	All Canadian fisheries	V		√		
Robinson & Jamieson	1984	Squid fishery BC	N		√	√	
Robinson et al.	1982	Dogfish diet study	G	√		√	
Rutherford	1999	Groundfish database	G				√
Rutherford	2001	Groundfish fishery catch	O		√	√	
Rutherford	2001b	Groundfish fishery catch	O		√	√	
Saunders et al.	1986	Groundfish survey data	V		√	√	
Scarsbrook et al.	1984	Hake and pollock survey	G		√	√	
Shaw & Smith	1995	Squid jig fishery	N		√	√	
Shaw et al.	1989	Survey data	G		√	√	

Sloan	1983	Salmon bycatch during squid fishery	N		√	√	
Sloan	1984	Experimental squid fishery	N		√	√	
Smith	1970	Trawl fishery data	O		√	√	
Smith	1971	Trawl fishery data	O		√	√	
Smith	1972	Trawl fishery data	O		√	√	
Smith	1973	Trawl fishery data	O		√	√	
Smith & Kristiansen	1970	Groundfish survey	G	√		√	
Smith et al.	1996	Sablefish surveys	G				√
Starr et al.	2002	Thornyhead survey	V		√	√	
Starr et al.	2004	Thornyhead survey	V		√	√	
Stocker	1987	PSARC annual report	V		√	√	
Stocker et al.	1988	PSARC annual report	V		√	√	
Stocker et al.	1989	PSARC annual report	V		√	√	
Surry et al.	2005	Lingcod survey	V	√		√	
Surry et al.	2007	Lingcod survey	V		√	√	
Taylor	1967	Trawl catch data	G		√		√
Taylor	1970	Herring survey	G		√		√
Taylor et al.	1970	Herring survey	G		√		√
Taylor et al.	1970b	Herring survey	G		√		√
Taylor et al.	1970c	Herring survey	G		√		√
Thomas & Farlinger	1992	Shellfish fishery review	G		√	√	
Thompson & Beamish	1979	Pollock	G	√	√	√	
Thompson & Hrabok	2007	Herring survey	G		√	√	
Thompson & Schweigert	2007	Herring survey	G		√	√	
Thompson & Schweigert	2009	Herring survey	G		√		√
Thompson & Therriault	2007	Herring survey	O		√	√	
Thompson & Therriault	2009	Herring survey	G		√	√	
Thompson et al.	2003	Herring database	V		√		√
Thompson et al.	2005	Herring survey	G		√	√	
Thompson & Therriault	2006	Herring survey	O		√	√	
Thompson et al.	2009	Herring survey	G		√		√
Thompson et al.	2010	Herring survey	G		√	√	
Thompson et al.	2010b	Herring survey	G		√	√	

Thompson et al.	2010c	Herring survey	G		√	√	
Thompson et al.	2011	Herring survey	G		√	√	
Thompson et al.	2011b	Herring survey	G		√		√
Vermeer	1985	Auklet diet	G	√			√
Vermeer et al.	1987	Seabird populations	G	√			√
Waddell & McKinnell	1994	Squid driftnet fishery	N		√	√	
Walthers & Gillespie	2002	Squid review	V		√	√	
Weir et al.	1978	Bottom trawl survey	G		√	√	
Welch et al.	2002	Salmon survey	G	√			√
Welch et al.	2002b	Salmon survey	G	√			√
Welch et al.	2002c	Salmon survey	G		√	√	
Welch et al.	2002d	Salmon survey	G	√		√	
Westrheim et al.	1969	Groundfish survey	G		√		√
Westrheim et al.	1972	Groundfish survey	G		√		√
Westrheim et al.	1972b	Groundfish survey	G		√		√
Westrheim et al.	1973	Groundfish survey	G		√		√
Westrheim et al.	1989	Stomach contents	G	√		√	
Westrheim	1967	Groundfish survey	G		√	√	
Westrheim et al.	1980	Groundfish survey	G		√	√	
Westrheim et al.	1984	Groundfish survey	G		√	√	
Wilson et al.	1994	Biota review	G		√	√	
Workman et al.	1997	Trawl survey	G		√	√	
Workman et al.	1998	Rockfish survey	G		√	√	
Workman et al.	2001	Tanner crab trawl survey	V		√	√	
Workman et al.	2007	Groundfish survey	V		√	√	
Workman et al.	2008a	Groundfish survey	V		√	√	
Workman et al.	2008b	Groundfish survey	V		√	√	
Workman et al.	2008c	Groundfish survey	V		√	√	
Workman et al.	2008d	Groundfish survey	V		√	√	
Yamanaka et al.	2008	IPCC catch	G		√	√	

Survey databases

Database extractions were made from the groundfish, night pelagics (formerly small pelagics) and shellfish databases and are available upon request to the authors.

Groundfish database

The request for catch records of squid from groundfish research and commercial trips is broken down into five databases. Each of these will be described separately.

Research and charters

Data categorized under research and charters include extractions from the Groundfish Biological database “GFBio”. These data do not include information from seamounts. The results of the squid query are from 1966 to 2014. There were 2390 returns for squid over that time period. Location, depth, gear type and set number are provided for each entry. Bottom trawl, midwater trawl, shrimp trawl and some trap gear were used to fish. Either catch weight or count is provided for squid, in many instances neither is recorded. Because it is not standardized it would be inaccurate to calculate total weight or count. There are two different species categories which may be used, “Species_Science” and/or “Species_Description”; the frequency of both are provided in Table 3.

Table 3: Number of entries for squid by name or species according to the heading "Species_Science" and "Species_Description" from the GFBio database.

Species_Science	# Entries	Species_Description	# Entries
<i>Abraliopsis felis</i>	26	<i>Abraliopsis felis</i>	26
<i>Architeuthis martensi</i>	8	<i>Belonella borealis</i>	6
<i>Belonella borealis</i>	6	Berry armhook squid	2
<i>Berryteuthis magister</i>	823	Boreal clubhook squid	14
<i>Chiroteuthidae</i>	1	Boreopacific gonate squid	40
<i>Chiroteuthis calyx</i>	31	<i>Chiroteuthidae</i>	1
<i>Cranchiidae</i>	8	<i>Chiroteuthis calyx</i>	31
<i>Dosidicus gigas</i>	81	Clawed armhook squid	28
<i>Galiteuthis phyllura</i>	1	Clubhook squids	2
<i>Gonatidae</i>	5	<i>Cranchiidae</i>	8
<i>Gonatopsis borealis</i>	40	<i>Galiteuthis phyllura</i>	1
<i>Gonatus</i>	34	Giant squid	8
<i>Gonatus berryi</i>	2	Gonate squids	5
<i>Gonatus onyx</i>	28	<i>Gonatus</i>	34
<i>Histioteuthidae</i>	37	<i>Histioteuthidae</i>	37
<i>Histioteuthis heteropsis</i>	5	<i>Histioteuthis heteropsis</i>	5
<i>Histioteuthis hoylei</i>	3	Humboldt squid	81
<i>Loliginidae</i>	10	Jewel squid	3
<i>Loligo</i>	2	<i>Loliginidae</i>	10
<i>Loligo opalescens</i>	452	<i>Loligo</i>	2
<i>Moroteuthis robusta</i>	74	Neon flying squid	35
<i>Octopoteuthis deletron</i>	22	<i>Octopoteuthis deletron</i>	22
<i>Ommastrephes bartramii</i>	35	<i>Ommastrephidae</i>	1
<i>Ommastrephidae</i>	3	Opalescent inshore squid	452
<i>Onychoteuthis borealijaponicus</i>	14	Robust clubhook squid	74
<i>Taonius pavo</i>	16	Schoolmaster gonate squid	823

<i>Teuthida</i>	623	Squids	623
		<i>Taonius pavo</i>	16

Commercial fishery data-Fishery Operations System

Commercial fishery data records from the Fishery Operations System (FOS) from two different fisheries and time periods were returned; from the trawl fishery from April 1, 2007 to present and line gear fishery from April 1, 2006 to present. Trawl data are a merge of at-sea observer logbooks which provide set-by-set enumeration of location details, the amounts of each species caught and dockside monitoring program data including actual weight of species landed. The amounts from the dockside monitoring program are prorated to fishing sets based on proportions recorded at sea. The line gear data are a merge of fisher logbook data and dockside monitoring program data. Amounts of each species caught are a mix of pieces and weight depending on the species caught.

There were 8296 returns for squid in the Fishery Operations System. Year, fishery sector, location, depth, gear type and set number are provided for each entry. As in the research and charter database, there are two different species categories which may be used, "Species_Science" and/or "Species_Description". This database also provides categories for amount released and landed by both count and weight. There are very few incidences where these data are not provided. The total released (round) in this database is 295,941.16 kg, there was only one case in which count was recorded (total count=1) (Table 4).

Table 4: Number of entries and total weight (kg) of squid released according to the heading "Species_Description" from the Fishery Operation System database.

Species_Description	Total released (kg)	# Entries
<i>Berryteuthis magister</i>	99,440.16	7,378
<i>Dosidicus gigas</i>	177,942.81	109
<i>Gonatidae</i>	3.63	3
<i>Loligo opalescens</i>	299.14	100
<i>Moroteuthis robusta</i>	18,252.24	702
<i>Onychoteuthis borealijaponicus</i>	3.18	4
Total	295,941.16	8,296

Commercial fishery data-PacharvTrawl database

Commercial fishery data records from DFO's Groundfish Section PacharvTrawl database were searched for squid. These include data from 1996 to 2007 from observer logs for the groundfish trawl fishery. Data categories include: year, location, depth, amount landed (kg) and released (kg). The query returned 21,119 entries pertaining to squid (Table 5). Two different species categories which are used, "Species_Science" and "Species_Name".

Table 5: Number of entries, total landed (kg) and total released (kg) of squid according to the heading “Species_Name” in the PacharvTrawl groundfish database.

Species_Name	Total landed (kg)	Total released (kg)	# Entries
Boreal clubhook squid	0	43.1	23
Gonatus	0	1,757.07	169
Neon flying squid	0	510.28	95
Opalescent inshore squid	0	1,925.44	598
Robust clubhook squid	13.15	25,197.48	706
Schoolmaster gonate squid	0	65,332.11	5,595
Squids	17,513.3	155,122.87	13,933
Total	17,526.45	249,888.35	21,119

Commercial fishery data-PacharvHL database

Commercial fishery data records from DFO’s Groundfish Section PacharvHL database were searched for squid. These include data from 1996 to 2006. During this time period not all fishery sectors were required to complete logbooks therefore data coverage is incomplete. Data categories include: year, location, depth, landed/retained (kg) and discarded (kg). Two different species categories are used, “Species_Science” and “Species_Name”.

The query returned 7 entries pertaining to squid, one in each of 1997 and 1998, two in 1999 and three in 2000. Two entries were listed as “squids” with a total 4073.3 kg landed/retained. The remaining five entries were for schoolmaster gonate squid with a total landed/retained weight of 18.98 kg.

Commercial fishery data- PacharvSable database

Commercial fishery data records from DFO’s Groundfish Section PacharvSable database were searched for squid. These include data from 1996 to 2007 for the sablefish fishery. Data categories include: year, location, fishery type, depth, gear type, catch weight (kg). Two different species categories which are used, “Species_Science” and “Species_Name”.

The query returned 1 entry pertaining to squid. This entry was for 5 Kg of schoolmaster gonate squid from the sablefish fishery in 2004.

Night pelagic trawl ecosystem survey database

Previously termed the Small Pelagics Database, the Night Pelagic Trawl Ecosystem Survey Database contains data from 2002 to present. From 2002 to 2004 surveys were conducted during the day, in 2005 half the surveys were during the day, half at night. From 2006 onward, all surveys were conducted at night. These surveys are for small pelagics such as sardine and Pacific herring (depending on the year) off the west coast of Vancouver Island.

Ms. Linnea Flostrand has checked the database reports of squid. Data fields include: date, vessel, location, tow information (duration, depth, tow speed etc.), species catch code (squid or Humboldt squid), catch weight and count. There were 102 incidences of squid or Humboldt squid (*Dosidicus gigas*) in the database over the time period 2002 to 2014. Other than Humboldt squid there are three other catch codes relating to squid, neon flying squid (code 94H),

opalescent inshore squid (code 92D) and loligo (code 92E). It is believed that the latter two are the same animal. Squid count was not always reported therefore it is not possible to determine the total number captured over this time period.

Shellfish databases

Ms. Katie Gale queried three shellfish databases for squid. The first database was the commercial squid logbook database which has records from 1982 to 2005. There were 1548 records returned all of which were for opal squid. Data fields include: year, day/month/hour, statistical area and sub area, depth, tow timing, weight landed and weight code. The location (latitude and longitude) are not included. A total of 1,193,370 kg of opal squid were captured in commercial fisheries during that time period.

The second database queried was the shrimp research database. This database contains records from biological trawl surveys from 1953 to 2014 (Tables 6 and 7). These surveys took place off the west coast of Vancouver Island north along the coast to the fjords of Alaska. Squid, if mentioned, would be bycatch. There were 7755 records returned specific to cephalopods. Species may be identified or they may be recorded as “squids”. An example of some of the data fields includes: species identifiers, catch weight, catch number, catch number/ kg, vessel and set information, time and location/position.

Table 6: Catch of squid by species in the shrimp research database.

Identification	Weight (kg)
Squids	690.368
Boreoatlantic armhook squid	0.001
Clawed armhook squid	0.090
Pacific bobtail squid	1007.468
Robust clubhook squid	0.100
Gonate squids	0.110
Boreal clubhook squid	0.200
Opalescent inshore squid	86.213
Schoolmaster gonate squid	158.338
Total weight	1942.888

Table 7: Catch of octopus by species in the shrimp research database.

Identification	Weight (kg)
Octopus	713.292
North Pacific bigeye octopus	0.080
Sepiolea and cuttlefish	0.110
Cephalopods	5.825
East Pacific red octopus	43.504
Smoothskin octopus	46.523
Giant Pacific octopus	305.698
Total weight	1115.032

The tanner crab research database was also queried for instances of squid. As with the shrimp database, any mention of squid would be as bycatch. This database contains records from the tanner crab research surveys off the west coast of Vancouver Island and the west coast of Haida Gwaii between 1999 and 2006 (Table 8). 953 cephalopod records were returned. Almost all of the same data fields are available for this database as are available for the shrimp database.

Table 8: Catch of squid by species in the tanner crab research database.

Identification	Weight (kg)
Boreopacific gonate squid	0.160
Cockatoo squid	5.490
Cranchiidae (Family)	0.550
Enope squid	0.120
Fiery armhook squid	0.050
Flapjack devilfish	367.700
Gonate squids	0.080
Gonatus spp	10.710
<i>Graneledone boreopacifica</i>	89.110
Humboldt squid	13.180
<i>Japattella diaphana</i>	3.120
Jewel squid	1.290
Opalescent inshore squid	1.830
Robust clubhook squid	0.200
Schoolmaster gonate squid	337.396
Smallfin gonate squid	0.220
Squids	3.286
Swordtail squid	5.620
Vampire squid	3.760
Vampyroteuthidae (Family)	1.210
Total weight	845.082

Table 9: Catch of octopus by species in the shrimp research database.

Identification	Weight (kg)
Benthoctopus Sp A	2.750
Benthoctopus Sp B	42.310
Benthoctopus Sp C	5.290
Benthoctopus Spp	16.705
Cephalopods	6.502
East Pacific red octopus	1.490
Giant Pacific octopus	1.800
Octopoteuthidae (Family)	0.300
Octopus	3.668
Octopus spp	9.390
Octopus squid	42.690
Smoothskin octopus	1.670
Total weight	134.565

Research groups/teams

High seas salmon research group

The high seas salmon database contains information from salmon research cruises off the Pacific coast of Canada. The database contains biological data from mid-water trawls conducted between the fall of 2004 and summer of 2014. Ms. Mary Thiess searched the database for reference to squid; the species of squid is not normally identified. Data fields include: cruise number, vessel, location, tow information, number of squid (general), and number of Humboldt squid. Mantle length (mm) has also been provided for those which were measured.

There were 165 incidences of squid in the database query between 2004 and present. A total of 34,077 squid were recorded over this time period, only 10 Humboldt squid were recorded, all from one tow in 2004. It was noted in the query results that catches greater than 50 in any one tow should be considered an estimate only. These numbers are estimated by expanding an average weight based on a measured subsample.

Dr. Beamish's group

From 1992 to the time of his retirement, Dr. Dick Beamish and his research team conducted trawl and purse seine surveys in the Strait of Georgia including mainland inlets, Juan de Fuca Strait, Puget Sound and the west coast of Vancouver Island. After his retirement, these surveys continued with Dr. Ruston Sweeting and Ms. Chrys Neville as chief scientists. Currently it is not possible to search all these years of data in a straightforward manner. Efforts are being made to migrate the data into a database which can be searched. This work should be completed by early 2015.

For the most part, surveys took place twice a year, at the end of June, early July and again in September. These dates could vary however from mid-June to late July and then early September to late October. Extra surveys were often conducted in November and February.

Generally speaking from 1992 to 1997 fishing efforts were primarily focused on purse seine surveys and from 1998 to present were trawl surveys. However, there was a mix of purse seine and trawl surveys conducted throughout this time period depending on the research focus. Trawl surveys were conducted along standardized tracklines to determine juvenile salmon distribution and abundance. Depths for the majority of the sets ranged from 0-60 m but there were also sets beyond 60 m and down to 400 m to look for salmon and other species.

Over the years the types of data collected have expanded. It is important to note that although juvenile salmon were a focus, other species captured were recorded. Some non-salmonids were weighed and measured for length, others were counted by piece, and others still were just noted on data sheets. For squid, the data range from a notation of presence, to volume, to count. Rarely were the squid identified to species. Lately, mantle length has been measured, either all individuals captured or a random sample of 30 individuals.

Marine mammals research group

The Department's marine mammals research group provided three peer reviewed papers and one conference abstract that they recommended regarding marine mammal diets in the North East Pacific Ocean. The first paper is a diet analysis of northern fur seals (*Callorhinus ursinus*) off western North America (Perez & Bigg, 1986). The second paper (Flinn et al., 2002) is an analysis of diets of fin, sei and sperm whales from commercial whaling records. The third paper is a harbour and Dall's porpoise diet analysis (Nichol et al., 2012). These papers are summarized in the annotated bibliography.

In December 2012, the 20th Biennial Conference on the Biology of Marine Mammals was held in New Zealand. Dr. John Ford of the Pacific Biological Station presented on the expanding view of killer whale dietary specializations in the North Pacific Ocean. He describes the three ecotypes present in and around British Columbia, the resident which feeds on salmon and occasionally squid, the Bigg's (transient) which feeds on marine mammals and an offshore ecotype which is believed to specialize in elasmobranchs. New data which was presented showed that Bigg's killer whales were, at times, feeding on substantial quantities of squid as well as mammals. Five different squid species were identified. The offshore whales did prey upon elasmobranchs as previously thought but also consumed Chinook salmon, the prey of resident killer whales. The findings support the existence of ecological specialization but also that the diets may not be as narrow as previously thought.

Dr. Andrew Trite's marine mammal research group at the University of British Columbia has an extensive database on marine mammals in this region, including diet information. Further enquiries regarding squid as a component of marine mammal diet can be made to this research group.

Annotated bibliography of selected documents

Because such a large number of documents referencing squid were found during the literature search, it was necessary to prioritize those to be included in the annotated bibliography based on the desired outcome of this review. Therefore, documents which were only available in hard copy have been included in the annotated bibliography. In addition, documents which had a significant amount of catch data were also included. Because of the many years of exploratory

and scientific fishery data available for squid, there is considerable repetition of data from early studies to late, consequently, these data are only presented once in this document.

Anonymous. 1986. Survey of demersal fish resources and flying squid fishing grounds in the North Pacific. Technical Report of Fisheries Research & Development Agency, Pusan, Republic of Korea 65: 213p.

This document was only available in hard copy and was requested from the library located at DFO's Institute for Ocean Sciences (IOS) in Sidney, BC. The text is in Korean but the data tables and graphs have English translations. Specific to squid: catch, location and mantle length are recorded. Squid tagging data are also provided, however because the text is in Korean, it is not possible to determine what the experiment was based on this document. Maps are provided in order to determine the sampling locations. Other catch data are recorded, for example, CPUE for Pacific cod, sablefish, rockfishes, soles, salmon and skates.

Anonymous. 1990. Catch data of flying squid. Republic of Korea. 40p.

This document was only available in hard copy and was requested from the library located at IOS in Sidney, BC. There is no text at all, just the year and date at the top of each page and tables of data by statistical area indicating: number of gillnets; number of vessels; number of days; squid (kg). The title at the top of each page states "Catch of squid for the Korean flying squid gillnet fishery in the North Pacific Ocean".

Anonymous. 1991. Statistics of Taiwanese gillnetter in North Pacific in season 1990 (include squid gillnetter and large-meshed gillnetter). The Institute of Fishery Biology of Ministry of Economic Affairs and National Taiwan University. 102p.

This document was only available in hard copy and was requested from the library located at IOS in Sidney, BC. There is very little text, the title provides a description of the entire document. It is a detailed report of tables of catch data for the squid fishery by location. There are also bycatch tables broken down by general groupings of: seal, mammal, dolphin, tuna for example.

Anonymous. 1991. Final report 1990 observations of the Taiwanese high seas driftnet fisheries in the North Pacific Ocean. Joint report of: Republic of China Council of Agriculture, United States National Marine Fisheries Service, United States Fish and Wildlife Service. 83p.

This document was only available in hard copy and was requested from the library located at IOS in Sidney, BC. A complete description of the methodologies for the squid fishery and monitoring thereof is provided. Observed catch and CPUE are provided by location and date for both squid and pomfret. Bycatch data are also provided for birds, mammals, turtles and fish. All information is for the 1990 fishing year only.

Anonymous. 1991. Squid driftnet observer manual. 66p + appendices

This document was only available in hard copy and was requested from the library located at IOS in Sidney, BC. The majority of the document describes the observer program for the high seas driftnet fishery. Included are many appended reference materials for the identification of

birds, fish, mammals etc. which may be captured as bycatch. A short description at the beginning of the document outlines where and when fishing activities take place. Included are maps. No data are reported.

Bernard, F.R. 1980. Preliminary report on the potential commercial squid of British Columbia. Canadian Technical Report of Fisheries and Aquatic Sciences 942: 51p.

This report describes the fishing methods used in squid harvesting, processing and the biology of the four potential target species, opal squid, nail squid, neon flying squid and red squid. The introduction provides good background as to why a fishery may be possible in BC waters as well as the need for further information such as population abundance, recruitment and age at maturity. This report provides excellent resources for background information about squid fisheries in the North Pacific Ocean. A figure of landings of opal squid off California (1916-1979) is reproduced. Data are provided for the 1979 exploratory squid fishery for September/October. It was mentioned that this timing was a bit late in the season and catches earlier in the year would be anticipated to be higher. Five jig “stations” and twelve net stations were fished in September, 1979 from the Tenyu Maru. Sixteen jig stations and three net stations were fished in September/October 1979 from the Kohoku Maru 18. All stations were identified by latitude and longitude as well as on maps. Squid species and catch are provided for stations as well as duration of fishing activity, depth and water temperature. From these exploratory fishing activities a potential distribution map was created based on the four species captured.

Bernard, F.R. 1981. Canadian west coast flying squid experimental fishery. Canadian Industry Report of Fisheries and Aquatic Sciences 122: 23p.

This report describes the experimental fishery for neon flying squid in 1980. It is a follow up report to Bernard (1980) which described the 1979 experimental squid fishery. In 1980, the same two vessels were used (Tenyo Maru 37 and Tomi Maru 88 of the Japanese Longliners Association) under agreement between the governments of Japan and Canada to undertake further exploratory fishing off the west coast of Vancouver Island in July and August. The squid were captured using monofilament drift nets. This report concluded that although there appeared to be considerable neon flying squid to support a fishery, the development of the fishery was “not imminent” due to lack of suitable vessels (minimum 50m length) and shore-based processing facilities as well as volatile prices for squid. The report provides a detailed description of the gill netting process. In July-August 1980, 16 stations were fished with the Tenyu Maru, in August the Tomi Maru 88 fished 12 stations. For each station data include: location, set duration, net length and catch of squid and bycatch (Kg).

Broadley, T.A. 1994. Technical and economical development plan for the commercialization of a directed squid jigging fishery in British Columbia. Prepared for: North Pacific Offshore Fisheries Cooperative Association (NPOFCA). 40p.

This document was only available in hard copy, and it was requested from the library located at IOS in Sidney, BC. No squid data are included in this document. There are very detailed descriptions of squid jigging gear and methods, including diagrams. A 5 year action plan is included for the successful commercial development of the fishery.

Campagna, S., Gillespie, G.E., and Shaw, W. 2000. Review of the 1997 and 1998 pilot commercial fisheries for neon flying squid (*Ommastrephes bartrami*) off the west coast of Canada. Canadian Industry Report of Fisheries and Aquatic Sciences 256: 72p.

In 1996, 1997 and 1998 a commercial jig fishery for neon flying squid was initiated off the west coast of Canada. This report details the catch, effort, CPUE, location and oceanographic data collected in 1997 and 1998. The purpose of the exploratory fishery (1996-1998) was to determine the feasibility of an automatic jig technology for harvesting large squid. A total allowable catch (TAC) for neon flying squid was set at 1,500 t, in 1997 and 1998 a TAC of 75t was set for each of boreal clubhook squid, gonate squid and schoolmaster gonate squid. This report provides a detailed description of squid jigging methods as well as a description of the reporting requirements, participants and partnerships between DFO and the BC Ministry of Agriculture, Fisheries and Food. Total number and weight are provided for both 1997 and 1998 for squid broken down by species as well as mackerel, Pacific pomfret and blue shark. CPUE of neon flying squid is provided for 1990, 1991, 1996, 1997, and 1998 broken down by inside or outside the Canadian Fishery Conservation Zone as well as day or night catches. One table provides a breakdown of all catches of neon flying squid from various sources from the Canadian experimental driftnet and jig fisheries from 1979 to 1998, CPUE is not calculated (reproduced below Table 10).

Table 10: Summary of driftnet and jig catches from 1979 to 1998.

Year	Jig catch (kg)	Driftnet catch (kg)	Reference
Sept. 1979	414	10,599	Bernard (1980)
July-Aug. 1980	-	130,045	Bernard (1981)
July-Aug 1983	64	32,986	Robinson & Jamieson (1984)
July-Aug 1983	1,475	329,561	Sloan (1984)
July-Sep. 1985	-	771,130	Jamieson & Heritage (1987)
June-Sep. 1986	-	1,111,527	Jamieson & Heritage (1988)
June-Aug. 1987	71	1,527,476	Jamieson & Heritage (1988)
June-Sep. 1990	320,274	-	Shaw & Smith (1995)
July-Aug. 1991	3,820	-	Shaw & Smith (1995)
Aug. 1996	7,434	-	Gillespie & Shaw (1997)
May-Oct. 1997	1,258	-	Campagna et al. (2000)
July-Sep. 1998	63,032	-	Campagna et al. (2000)

DFO. 1991. Scientific review of North Pacific high seas driftnet fisheries, Sidney B.C., June 11-14, 1991. Report for presentation to the United Nations pursuant to Resolutions 44/225 and 45/197. 86p.

This document is a report of the outcome of a meeting with the goal of providing a forum for review of the best available scientific data on the impact of large scale pelagic driftnet fishing in the North Pacific. The meeting was held in response to the United Nations resolutions 44/225 and 45/197 regarding pelagic driftnet fishing. Present at the meeting were scientists, delegates and observers from Japan, the Republic of Korea, the United States, Taiwan, Canada, Australia, the United Nations and the International North Pacific Fisheries Commission. The document

provides a description of the driftnet fisheries in the North Pacific Ocean as well as summaries from break out groups. Breakout group summaries are provided for marine mammals, salmon and squid, non-salmonid fishes and turtles, marine birds. For each of these summaries, different types of data are provided and may include: catch rates, mortality estimates and abundance estimates for Japan, Korea and Taiwan.

DFO. No date. Pacific region 2000/2002 multi-year experimental guideline neon flying squid. 18p.

No catch data were presented in this document, however, it does provide important information on the total allowable catch (TAC) of the fishery as well as the guidelines for fishing. For each of 2000-2002, a TAC was set for 1,500 metric tonnes round weight for neon flying squid, 75 mt for each of schoolmaster gonate, boreal clubhook squid and boreopacific gonate squid. Annual bycatch allowance of 20 percent of the total catch weight of neon flying squid per vessel in each of the two fishing time periods (March 1 2000 to March 31 2001 and April 1 2001 to March 31 2002) was permitted for other squid species, pomfret and blue shark in aggregate.

DFO. Various. Fisheries management plans for opal squid (2000-2007).

The summary created here is a synthesis of the fisheries management plans for opal squid for the years 2000 to 2007 inclusive. There are other fisheries management plans for the species before 2000 but they have not been included as the information presented is highly consistent from year to year. The opal squid fishery was a seine net, ring net and hook and line fishery operating under a Z-E licence. Automatic jiggers were allowed. Because a fisheries management plan was drafted for each year and they are highly repetitive they will be discussed here as a group.

The fisheries management plan for 2000 stated that the 10 year annual average landing for opal squid was 57 tonnes (1989 to 1998). Specifically, landings were 116 tonnes (1994), 5.9 (1997) and 23 (1998). Landings for other years were not provided.

The management plan for opal squid in 2002 (DFO, no date d) stated that the fishery was the “last unlimited entry invertebrate fishery in the Pacific region.” There were no restrictions on numbers of licences issued and no harvest limits. Importantly, there were five main issues with the fishery 1) unlimited entry; 2) insufficient biological information; 3) unsatisfactory reporting; 4) bycatch and; 5) lack of Departmental resources.

The 2003 fisheries management plan outlined shortfalls in the 2002 season (DFO, no date c). Chiefly, 10 licences were issued, 2 were fished. Only one biological sample was sent to the stock assessment group. Logbook entries were considered good as there was only one fisher. The requirement for reporting of “nil” fishing activity was not performed. Discussions with fishers began in 2003 regarding potential changes to the fishery.

The 2004 fisheries management plan (DFO, no date d) states under domestic considerations that “no exploratory or experimental activities are underway or contemplated at this time. The Department has no resources available to accommodate such investigations.” Participation in the fishery in 2003 was reviewed and was as equally unsuccessful as was described for 2002 above. Nine licences were issued, one reported landings. No biological samples were submitted. A provisional Total Allowable Catch was implemented and limited to a maximum 116,364 kg. This

TAC was based on the maximum total landings reported on record for all fishers for any year in the past 10 years.

The lack of biological information remained a concern for the 2005 management plan (DFO, no date e). Twelve opal squid licences were issued for 2004, one reported landings. The same issues with biological samples were identified as were identified in the 2003 and 2004 plans. The TAC for 2005 was the same for 2004.

The integrated fisheries management plan for 2006 (DFO, no date f) mentioned that there were significant numbers of larger Humboldt squid present in BC waters in 2005. Eight licences were issued in 2005, no landings were reported. The document further discusses the consultations with fishers regarding the lack of biological samples being submitted as well as results of the consultations.

No new information is presented in the 2007 fisheries management plan for opal squid (DFO, no date g).

Fishery Agency of Japan. 1991. Catch and effort statistics for the Japanese squid driftnet fishery in 1990. Fisheries Agency of Japan. 45p.

This document was only available in hard copy, and it was requested from the library located at IOS in Sidney, BC. This document was submitted by the Fisheries Agency of Japan to the International North Pacific Fisheries Commission (INPFC) outlining catch and effort statistics for 1990 squid fishing. Data provided include: date, area, catch (squid, albacore, pomfret, shark, skipjack, yellow tail, billfish). Charts have also been created to show where catches occurred.

Fishery Agency of Japan. 1992. Catch and effort statistics for the Japanese squid driftnet fishery in 1991. Fisheries Agency of Japan. 37p.

This document was only available in hard copy, and it was requested from the library located at IOS in Sidney, BC. This document was submitted by the Fisheries Agency of Japan to the International North Pacific Fisheries Commission (INPFC) outlining catch and effort statistics for 1991 squid fishing. Data provided include: date, area, catch (squid, albacore, pomfret, shark, skipjack, yellow tail, billfish). Charts have also been created to show where catches occurred.

Flinn, R.D., Trites, A.W., Gregr, E.J., and Perry, R.I. 2002. Diets of fin, sei, and sperm whales in British Columbia: An analysis of commercial whaling records, 1963-1967. Marine Mammal Science 18:663-679.

This paper was provided by the Marine Mammals Research Group at PBS as a good reference as to the importance of squid in diets of these species. This paper was written as it was believed that it was unlikely that large-scale diet studies using stomach contents would be conducted on fin, sei or sperm whales ever again. This paper referenced data from 1936, 1937, 1948 and 1949 which found that baleen whales fed primarily on euphausiids, sperm whales fed on two species of squid (*Gonatus fabricii* and *Moroteuthis robusta*). The stomach contents of 2,728 fin, sei and sperm whales killed by the Coal Harbour whaling station in BC from 1963 to 1967 were examined. These years were chosen due to high quality and quantity of data. It was found that most fin whale and sei whale stomachs were empty with some trace amounts of food, usually euphausiids. The number of sperm whales with full, trace and empty stomachs differed between

the sexes. North Pacific giant squid were the dominant prey for both sexes but the fish species varied between males and females. Small squid were present in low frequencies in a few years. Seasonal changes in diet between and within the sexes were observed.

Gillespie, G.E. 1997. Review of biology, fisheries and assessment of oceanic squids, particularly *Ommastrephes bartrami*, *Onychoteuthis borealijaponica*, *Gonatopsis borealis* and *Berryteuthis magister*. Canadian Stock Assessment Secretariat Research Document 97/143. 45p

This document reviews the available literature on the biology, fisheries, assessment and management of neon flying squid, boreal clubhook squid, eight-armed squid and schoolmaster gonate squid. Relevant tables have been reproduced below (Tables 11, 12 and 13). Note, some US data from Oregon and Washington states are included.

Table 11: Exploratory fishing catches of oceanic squid species off the west coast of North America (NFS=neon flying squid; BCS=boreal clubhook squid; EAS=Eight-armed squid; SGS=Schoolmaster gonate squid; OS=opalescent squid; RCS=Robust clubhook squid; PFS=purpleback flying squid; *=catches estimated; **=catches incomplete; ***= US data).

Year	Gear	Species	Catch		Source
			Numbers	Weight (kg)	
Sep. 1979	Net	NFS	-	10,599	Bernard (1980)
		BCS	-	9	
	Jig	NFS	-	414	
		BCS	-	111	
		OS	-	1	
July-Aug. 1980	Net	NFS	-	130,045	Bernard (1981)
May-Sep. 1971	Jig	NFS	2	-	Mercer & Bucy (1983)***
		BCS	1,259	-	
July-Aug. 1983	Net	NFS	14,133	32,986	Robinson & Jamieson (1984)
	Jig	NFS	26	64	
July-Sep. 1985	Net	NFS	338,188*	771,130	Sloan (1984)
June-Sep. 1986	Net	NFS	488,738	1,110,527	Jamieson & Heritage (1987)
		BCS	5	6	
June-Aug. 1987	Net	NFS	655,603	1,527,476	Jamieson & Heritage (1988)
	Jig	NFS	40	71	
June-Sep. 1990	Jig	NFS	161,415	320,274	Shaw & Smith (1995)
		BCS	99	92	
		EAS	113	103	
		SGS	1	1	
Aug.-Sep. 1990	Jig	NFS	8,395	18,587	June & Wilkins (1991)***
		BCS	1,450	961	
		EAS	117	83	
		RCS	18	68	
		OS	6	1	
		SGS	1	1	
July-Aug. 1991	Jig	NFS	1,746	3,820	Shaw & Smith (1995)
		BCS	29	17	
		EAS	54	41	

Aug. 1996	Jig	NFS	4,433	7,434*	Gillespie & Shaw (1997)
		BCS	46	-	
		EAS	14	-	
		SGS	35**	-	
		PFS	36	-	

Table 12: Comparison of driftnet CPUE of neon flying squid in the exploratory fishery off west coast of North America.

Vessel	Date	CPUE (kg/km)	Source
Kohoku Maru 18	Sep.-Oct. 1979	112.4	Bernard (1980)
Tenyo Maru 37	Sep. 1979	61.5	Bernard (1980)
Tomi Maru 88	Aug. 1980	165.8	Bernard (1981)
Tenyo Maru 37	July-Aug. 1980	332.0	Bernard (1981)
Tomi Maru 88	July-Aug. 1983	232.3	Sloan (1984)
Simstar	July-Aug. 1983	339.2	Robinson & Jamieson (1984)
Tomi Maru 88	July-Sep. 1985	311.5	Jamieson & Heritage (1987)
La Porsche	Aug.-Sep. 1986	153.8	Jamieson & Heritage (1987)
Ocean Pearl	July-Aug. 1986	270.5	Jamieson & Heritage (1987)
Tomi Maru 88	June-Sep. 1986	266.3	Jamieson & Heritage (1987)
Ocean Pearl	June-Aug. 1987	259.8	Jamieson & Heritage (1988)
Tomi Maru 88	June-Aug. 1987	383.1	Jamieson & Heritage (1988)

Table 13: Comparison of jig CPUE (jig or machine) for neon flying squid in the exploratory fishery off west coast of North America.

Vessel	Date	CPUE (kg/jig/h)	CPUE (kg/machine/h)	Source
Simstar	July-Aug. 1982	-	1.33	Robinson & Jamieson (1984)
Tomi Maru 88	July-Aug. 1983	-	2.20	Robinson & Jamieson (1984)
Tomi Maru 88	June-Aug. 1987	0.01	-	Jamieson & Heritage (1988)
5 vessels	June-Sep. 1990	0.09	-	Shaw & Smith (1995)
Sanko Maru 18	July-Aug. 1991	0.06	-	Shaw & Smith (1995)
6 vessels	July-Sep. 1996	0.04	-	Gillespie & Shaw (1997)

Gillespie, G.E., and Shaw, W. 1997. Review of the 1996 pilot commercial fishery for neon flying squid (*Ommastrephes bartrami*) off the west coast of Canada. Canadian Industry Report of Fisheries and Aquatic Sciences 241: 30p.

This report summarizes the pilot commercial jig fishery for neon flying squid in 1996, the purpose of which was to determine the feasibility of an automatic jig fishery. It was intended that this exploratory fishery would be for three years, 1996-1998. Catch, effort, CPUE, location and oceanographic data are provided. The results of this pilot fishery are compared to the Canada-Japan fishery conducted in 1990 and 1991 (Tables 14, and 15). In addition to the table reproduced below, there are many figures of CPUE by location, temperature, effort etc.in the document.

Table 14: Mean CPUE (kg/jig/h) from the 1996 fishery inside and outside Canada's Fisheries Conservation Zone (FCZ) off the west coast of Canada.

Year/Area	Time	CPUE (kg/jig/h)			
		June	July	August	September
1990 Inside FCZ	Day	-	0.047	0.065	0.038
	Night	-	0.078	0.089	0.098
1990 Outside FCZ	Day	-	0.064	0.028	-
	Night	0.056	0.101	0.034	-
1991 Inside FCZ	Night	-	0.053	0.092	-
1996 Inside FCZ	Night	-	0.003	0.053	0.032
1996 Outside FCZ	Night	-	0.002	0.021	0.040

Table 15: Total catch reported in logbooks and estimated whole round weight from verified landings from the 1996 pilot fishery for neon flying squid (*=incomplete).

Species	Number	Logbook weight (kg)	Estimated weight (kg)
Neon flying squid	4,317	4,337*	7,561
Nail squid	46	10*	-
Purpleback flying squid	36	-	-
Red squid	35*	585*	-
Eight-armed squid	14	-	-
Opal squid	2	-	-
Blue shark (retained)	1	5	-
Unidentified shark (retained)	1	4	-

Gong, Y., Kim, Y.S., and An, D.H. 1991. Synopsis on the squid fisheries resources in the north Pacific. National Fisheries Research and Development Agency, Republic of Korea. 176p.

This document was only available in hard copy, and it was requested from the library located at IOS in Sidney, BC. Monthly distribution of catch per unit effort (kg/net) of neon flying squid by year from 1983 to 1989. Maps are included which indicate the CPUE. General information on

the biology of the species, the fishery, gear and regulations are provided. The majority of the text is in Korean, although the tables and charts are provided in English as well. Some bycatch data are included.

Harbo, R.M., and Jamieson, G.S. [Eds.]. 1987. Status of invertebrate fisheries off the Pacific coast of Canada (1985/86). Canadian Technical Report of Fisheries and Aquatic Sciences 1576: 158p.

This document summarizes the status reports for those species commercially fished in BC in 1986. This document forms the first annual report of the Shellfish Stock Assessment Subcommittee for the Pacific Stock Assessment Review Committee (PSARC). Each year, updates will be made based on this document. Status updates are provided for net fisheries (plankton/euphausiids, inshore squid, offshore squid, shrimp inshore/offshore), trap fisheries (Dungeness crab, crab (sp.), octopus, prawn), diving fisheries (abalone, geoduck, horse clam, red sea urchin, sea cucumber, scallops). Landings are provided for all species for 1984 and 1985 by area (Table 16). Landing data are provided by statistical area for the inshore fishery. They are presented in a summarized table (below) based on generalized area.

Table 16: Landings for the inshore squid fishery, 1984 and 1985.

Area	1984 landings	1985 landings
North Coast	41.7	3.1
South Coast	13.6	123
Fraser Area	15.0	0.1
Total	70.3	126
Volume (10^{-3})	86	139

The offshore squid fishery data provided are for the Tomi Maru #88 in 1985 and include bycatch. CPUE calculated for offshore squid were summarized previously in Gillespie (1997).

International North Pacific Fisheries Commission. 1991. Final report of 1990 observations of the Japanese high seas driftnet fisheries in the North Pacific Ocean. Joint report by the National Sections of Canada, Japan and the United States. 198p.

This document was only available in hard copy, and it was requested from the library located at IOS in Sidney, BC. This report provides a record of all the observer information for the 1990 fishing season. There are observer data on all bycatch species including mammals, birds and fish by location. Observer reports of squid and neon flying squid are also included. The introduction provides a description of the extent of observer coverage.

Jamieson, G.S., and Francis, K. [Eds.]. 1986. Invertebrate and marine plant fish resources of British Columbia. Canadian Special Publications of Fisheries and Aquatic Sciences 91: 89p.

This report describes the biology and fisheries of all invertebrate species fished in BC at the time. It provides an excellent description of each species including life history and fishing

methods. Landings, quantity and value by species are presented in the Appendices, however no data are provided for squid. There is a chapter on squid written by G.D. Heritage which primarily describes the fishery.

Jamieson, G.S., and Heritage, G.D. 1987. Experimental flying squid fishing off British Columbia, 1985 and 1986. Canadian Industry Report of Fisheries and Aquatic Sciences 179: 103p.

This document summarizes the 1985 and 1986 neon flying squid gillnet fishery conducted from Japanese and Canadian vessels off the coast of British Columbia. Catches have been presented previously (Gillespie, 1997). This document does also provide all the bycatch weights (and some pieces) by species including mammals, birds and fish for each vessel. Fishing data for each set are summarized in tables and include: start time, duration, location, depth and squid (kg).

Jamieson, G.S., and Heritage, G.D. 1988. Experimental flying squid fishing off British Columbia, 1987. Canadian Industry Report of Fisheries and Aquatic Sciences 186: 79p.

This document summarizes the 1987 neon flying squid fishery conducted from Japanese and Canadian vessels off the coast of British Columbia. It is a continuation of the 1986, 1987 squid fishery described in Jamieson and Heritage (1987). Both drift gillnets and jig fishing were used in 1987. The jig fishery was not considered a great success, apart from significant bycatch, the driftnet fishery was considered successful and potentially profitable. Catch data are summarized in Gillespie (1997). This document does also provide all the bycatch weights (and some pieces) by species including mammals, birds and fish for each vessel. Fishing data for each set are summarized in tables and include: start time, duration, location, depth and squid (kg).

Macfarlane, S.A., and Yamamoto, M. 1974. The squid of British Columbia as a potential fishery resource-A preliminary report. Fisheries Research Board of Canada Technical Report 447: 36p.

This document provides a detailed description of the fishing methods which may be used to catch squid for example, mechanical jigging, trapnets, seine nets, lampara nets, spearing, hooking and the “new” Japanese conveyor belt with barbless hooks. A table of world cephalopod catches is provided for squid, cuttlefish and octopus for the years 1965 to 1971. Individual country landings are not reported, just total for the year. Japanese catch statistics are provided in another table for the years 1959 to 1969. There are descriptions of other squid fisheries in Asia and the North Western Atlantic as well as an update on the status of squid in British Columbia by region. The document refers to references by Taylor (which will be summarized below) for catch off the west coast of Vancouver Island. For the southeast coast of Vancouver Island, a table of incidental catches of squid from a seining survey for salmon, herring and smelt (1973) are summarized. The squid catch varies from 1 to 100 individuals. In Hecate Strait and Queen Charlotte Sound, several reports are described of squid being captured as bycatch for example 1100 squid incidentally caught in a shrimp trawl. There were also reports of “large sightings” of squid in 1972 by commercial fishers based on sounder readings. There were many of these types of reports of squid or one off catches of squid described in the document in various regions of British Columbia.

MBC Applied Environmental Service. 1994. North Pacific transition zone multispecies interaction study. Prepared for NOAA. 106p.

This document was only available in hard copy, and it was requested from the library located at IOS in Sidney, BC. This report includes all species within the transition zone in the North Pacific Ocean. Models of their interactions were applied within the area in order to examine interactions. Specific to this squid review, data provided are broken down by country and year (1990 and 1991) and are available for both the flying squid as well as bycatch (birds, fish, mammals).

McKinnell, S.M., Shaw, W., and Ladell, J. 1990. The 1990 pelagic research cruise of the W.E. Ricker. Annual meeting of the International North Pacific Fisheries Commission. 23p.

This document was only available in hard copy, and it was requested from the library located at IOS in Sidney, BC. Data from all catches of the 1990 pelagic research cruise are presented, including squid which was the majority of the catch.

Nichol, L.M., Hall, A.M., Ellis, G.M., Stredulinsky, E., Boogaards, M., and Ford, J.K.B. 2013. Dietary overlap and niche partitioning of sympatric harbour porpoises and Dall's porpoises in the Salish Sea. Progress in Oceanography 115:202-210.

This paper was provided by the Marine Mammals Research Group at PBS as a good reference as to the importance of squid in diets of these species. Stomach contents of harbour (n=31) and Dall's (n=11) porpoises from Juan de Fuca Strait, Strait of Georgia and Johnstone Strait were examined. Cephalopods were identified in the stomach contents of both species of porpoise, which is consistent with the literature of porpoises in other geographic areas. The frequency of occurrence of squid in stomach of Dall's porpoises was near 50%, but less than 5% in harbour porpoises.

Northridge, S. 1995. Environmental mismanagement on the high seas: a retrospective analysis of the squid and tuna driftnet fisheries of the north Pacific. Report to: The Marine Mammal Commission, Washington, D.C. 76p.

This document was only available in hard copy, and it was requested from the library located at IOS in Sidney, BC. This document reviews the impacts from both the high seas driftnet fisheries for tuna and squid on marine mammals and fisheries in general. Several figures of particular interest include trends in catches of neon flying squid and Japanese flying squid taken by Japanese jig and driftnet fisheries, 1960-1990 (approximately) and catches of neon flying squid by driftnet by nation, 1978-1990. Impacts on cephalopods, marine mammals, birds and fishes are discussed. A description of the food web in the fishing area as well as oceanographic drivers are provided.

Pella, J., Rumbaugh, R., and Dahlberg, M. 1995. Incidental catches of salmonids in the 1991 north Pacific squid driftnet fisheries. NOAA Technical Memorandum NMFS-AFSC-55 33p.

This document was only available in hard copy, and it was requested from the library located at IOS in Sidney, BC. A description of the methodologies to assess the incidental salmon catch in

the Japan/Korea/Taiwan high seas squid driftnet fisheries in the North Pacific Ocean. The methodologies were then applied to the fishery and salmon bycatch estimated. No squid data are provided, however, maps of the fishing areas are included in the report as well as a description of the fishery.

Perez, M.A., and Bigg, M.A. 1986. Diet of northern fur seals, *Callorhinus ursinus*, off western North America. Fishery Bulletin 84: 957-971.

This paper was provided by the Marine Mammals Research Group at PBS as a good reference as to the importance of squid in diets of this species. From December to August, covering the area between western Alaska and California, northern fur seals (*Callorhinus ursinus*) consumed Northern Anchovy, *Engraulis mordax* (20%); Pacific Herring, *Clupea pallasii* (19%); Capelin, *Mallotus villosus* (8%); Pacific and lance, *Ammodytes hexapterus* (8%); Pacific Whiting, *Merluccius productus* (7%); salmon, *Oncorhynchus* spp. (6%); Pacific Saur, *Cololabis saira* (4%); rockfishes, *Sebastes* spp. (4%); squids sp. (17%) and other fishes (7%). Fur seals in the eastern Bering Sea in June to October were found to consume juvenile Walleye Pollock, *Theragra chalcogramma* (85%); Capelin (16%); Pacific Herring (11%); squids, gonatid squids/onychoteuthid squids/opal squid (80%). In all areas fishes were the main food consumed when the fur seals were in neritic waters and squids were the most important when they were in oceanic waters.

Robinson, S.M.C., and Jamieson, G.S. 1984. Report on a Canadian commercial fishery for flying squid using drifting gill nets off the coast of British Columbia. Canadian Industry Report of Fisheries and Aquatic Sciences 150: 25p.

This document reports on the commercial driftnet fishery for neon flying squid in July and August 1983. The total catch as 33 t, 25 sets were made. Bycatch included salmonids, tuna, pomfret, shark and "other". The average CPUE was 339.2 kg squid/km net. They did test out an electric squid jigging machine but it was not terribly successful. This document provides a detailed description of the fishing activities and data analysis. Sixteen species of squid were captured in the gill nets, neon flying squid was the most abundant. An evaluation of the catches from both jigging and drift net fishing are described including average size of squid, locations of capture and comparison between the Japanese catches and Canadian. Tables are provided for both bycatch and squid catch by numbers and weight according to set.

Shaw, W., and Smith, B.D. 1995. 1990 and 1991 experimental commercial jig fishery for neon flying squid (*Ommastrephes bartrami*) off the west coast of British Columbia. Canadian Technical Report of Fisheries and Aquatic Sciences 2045: 68p.

This document describes the fishing methods as well as the results of the joint Canada-Japan experimental commercial jig fishery off the west coast of Vancouver Island in 1990 and 1991. Fishing occurred in locations where sea surface temperatures were between 14 and 16°C. Both night (359) and day (149) operations were conducted in 1990, 14 night operations were conducted in 1991. Fishing occurred both inside the Fishery Conservation Zone and outside. Efforts were made to determine standardization methods for differences between machine and hand jig. The results of the 1990 and 1991 fishing activity have been described previously in Shaw & Jamieson (1990) and Shaw (1991) respectively.

Tables of catch and CPUE of neon flying squid by area are provided. Differences in CPUE between day and night operations are provided in figures. Aggregated data for 1990 and 1991 has been reproduced in Gillespie (1997). Catch and CPUE of squid and bycatch are summarized in tables in Shaw & Smith (1995) based on inside and outside FCZ as well as by depth with corresponding temperatures.

Sloan, N. 1983. Salmonid by-catch during exploratory squid fishing off British Columbia, summer 1983. Department of Fisheries and Oceans Canada, unpublished report. 6p.

This document was only available in hard copy, and it was requested from the library located at IOS in Sidney, BC. It summarizes the salmonid bycatch from the joint Canada/Japan exploratory neon flying squid driftnet fishery in 1983 within the 200 mile fishing limit. Data are presented by the set and include temperature, time and location, catch of flying squid in kg, catch of salmonids by the species as pieces. The squid catch data for this year are also available in Sloan (1984) and are fully described in Sloan (1984).

Sloan, N.A. 1984. Canadian-Japanese experimental fishery for oceanic squid off British Columbia, summer 1983. Canadian Industry Report of Fisheries and Aquatic Sciences 152: 42p.

This document is a report of the joint Canada-Japan experimental gillnet fishery for neon flying squid which mostly occurred within the 200 mile fishing limit off BC in 1983. A Japanese vessel was used to determine the feasibility of the fishery for Canadian vessels. A Canadian captain was on-board the Japanese vessel. An automatic jig machine was tested on 42 nights resulting in poor catches. Fishing methods as well as processing are described. A short summary of flying squid in the North East, North West and North Central Pacific Ocean is provided. FAO statistics on squid catches from these areas are provided for 1976 to 1980. Gillnet catches, including bycatch are presented for the season. Details of each set are also described in tables and include: set position, haul time, water temperatures, catch and CPUE. A very good map is provided indicating set locations. There are also some photographs included at the end of the document which depict the gear and fishing.

Waddell, B.J., and McKinnell, S. 1994. Japanese squid driftnet fishery 1988-1990: What the observers saw versus the reported catches in the fleet. A study of flying squid, albacore tuna and Pacific pomfret catch statistics. Canadian Technical Report of Hydrography and Ocean Sciences 1968: 63p.

This document presents data from both the observers and fleet for the 1988-1990 large scale pelagic drift net fishery in the North Pacific Ocean, the target of which was squid. In 1989 and 1990 observers from Canada, Japan and the United States monitored the Japanese squid driftnet fishery. In 1988, only Japanese observers were on-board. The driftnet fishing zone extended from 170°E to 145°W longitude with a southern boundary of 20°N, excluding the 200 mile limit around Hawaii. The fishery was open June 1 to December 31 each year. There were significant differences between the observer data and fleet data. Observer effort was 1.7% (1988), 3.9% (1989) and 9.9% (1990). In 1992, the United Nations General Assembly imposed a 50% reduction in effort and a moratorium on all large-scale pelagic driftnet fishing as of December 31, 1992. There are a lot of data presented on squid and bycatch in order to compare the

differences reported between the observers and fleet. None of the fishing activities over these years took place within Canadian fishing waters.

Walthers, L.C., and Gillespie, G.E. 2002. A review of the biology of opal squid (*Loligo opalescens* Berry) and of selected Loliginid squid fisheries. Canadian Science Advisory Secretariat Research Document 131: 110p.

This document provides options to managers for a Loliginid squid fishery. Recommendations presented in the paper are: the fishery should not be allowed to expand in the absence of assessment and management frameworks; the development of a fishery should be within the context of the policy for New and Developing Fisheries; consider the ecosystem impacts of fishery development; continue monitoring the management systems in other *Loligo* fisheries to guide in decision making. A detailed summary of the biology of opal squid is provided. Loliginid squid fisheries in other jurisdictions (eg. Oregon, California, South Africa) as well as BC are described in terms of overview, effort, landings, bycatch and management. Specific to BC, landings of opal squid between 1984 and 2001 were 1,032 t according to logbooks, 1,192 t according to fish slips (Tables 17 and 18). There have been declining trends in landings over this time period. Several tables of opal squid data from this document have been reproduced below. Maturity data, length weight comparisons with other regions are available in the document.

Table 17: Landings of opal squid from logbooks and fish slips for 1984 to 2001. Values indicated as “-” could not be provided due to Privacy Act.

Year	Landings		Landed value (\$Cdn x 10 ³)	Average price (\$Cdn/kg)
	Fish slips	Logbooks		
1984	69	75	25	0.36
1985	111	86	184	1.66
1986	89	87	127	1.43
1987	86	85	132	1.53
1988	88	88	113	1.28
1989	70	43	94	1.34
1990	71	49	81	1.13
1991	116	107	148	1.28
1992	93	72	135	1.46
1993	175	16	17	1.3
1994	76	116	199	1.14
1995	78	65	95	1.25
1996	-	70	97	1.25
1997	22	6	9	1.43
1998	-	23	44	2.05
1999	-	9	17	2.08
2000	-	-	-	2.76
2001	-	-	-	1.96

Table 18: Total landings of opal squid by Fisheries Management Area 1982-2001. (VI= Vancouver Island).

Area	PFMA	Landings (t)	Percentage of Total (%)
North coast (old)	1-10, 130, 142	164.1	14.05
	11-29	1004.2	85.95
North coast (new)	1-6	41.1	3.52
Central coast (new)	7-13	167.3	14.32
South coast (new)	14-29	959.8	82.16
East coast VI	11-19, 28, 29	66.6	5.7
Strait of Georgia	14-19, 28, 29	22.3	1.91
West coast VI	20-27	937.6	80.25
Southwest coast VI	23 and 24	919.3	78.69
Barkley sound	23	809.7	69.3

CONCLUSIONS

From the 1970's until approximately 2002 considerable efforts were made to explore experimental and test fisheries for several squid species, primarily neon flying squid and to a lesser extent opal squid. From the late 1970's to 1991, Canada worked in partnership with Japanese fishing vessels to demonstrate the feasibility of a neon flying squid fishery. A combination of Canadian and Japanese vessels was used both inside and outside the Fishery Conservation Zone off the coast of British Columbia to conduct test fisheries and to test machine jig and driftnet fishing methods. Although both methods met with some success, a commercial fishery was not developed off the coast of Canada for several reasons. Driftnet fisheries, although used extensively by Japan and Korea for squid capture were banned by the United Nations General Assembly in 1992 in most part due to the non-selective nature of this fishing method resulting in considerable by-catch and entanglement. Methods aside, the unpredictable nature of squid populations in British Columbia waters made it difficult to open a commercial fishery.

Because of all of these efforts to exploit various squid species over a time span in excess of thirty years, considerable data were collected on catches of squid. The majority of these test fishery data are collated in government documents such as technical reports and manuscript reports (e.g. Bernard 1980, 1981; Robinson & Jamieson, 1984; Jamieson & Heritage 1987, 1988; Shaw & Smith, 1995, Waddell & McKinnell, 1994; Gillespie & Shaw, 1997; Campagna et al., 2000) and re-appear again summarized in later documents such as Canadian Science Advisory Secretariat Documents (e.g. Walther & Gillespie, 2002). It is these documents which provide the most information regarding targeted fishing methods and catches of squid in British Columbia waters.

Other sources of data are available in the various databases that the Department maintains. The shellfish databases consist of a commercial squid logbook database and a shrimp research database. The commercial squid logbook database has records from 1982 to 2005. These catches

are only for opal squid. The shrimp research database consists of survey data from the west coast of Vancouver Island north to Alaska from 1953 to 2014. As squid were not the target species, they would be captured as bycatch and were often not identified to species.

The groundfish databases consist of both research and commercial log book information. Five different databases were searched for squid entries. The two commercial fishery databases, Fishery Operations System and PacharvTrawl database provided the greatest information on squid. Generally speaking, the squid were usually identified to species and either counts or weights were provided for each entry.

In summary, the Government of Canada documents in addition to the groundfish and shellfish databases are good sources of data on some squid species present within British Columbia waters. Although concerted fishing efforts in the 1970's, 80's and 90's were for the development of a fishery, by-catch information from research and commercial fishing activities is still being reported to the Department and are a valuable resource.

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