Fisheries and Oceans Canada | Pêches et Océans Canada
Science | Sciences

C S A S | ***S C C S***

Canadian Science Advisory Secretariat | **Secrétariat canadien de consultation scientifique**

Research Document 2002/123 | **Document de recherche 2002/123**

Not to be cited without permission of the authors * | Ne pas citer sans autorisation des auteurs *

A review of the biology and fishery of the Embiotocids of British Columbia

Examen de la biologie et de la pêche des Embiotocidés de la Colombie-Britannique

E. David Lane[1], W. Wulff[2], A. McDiarmid[2], D.E. Hay[2] and B. Rusch[3]

[1] Department of Fisheries and Aquaculture
Malaspina University College
900 5th Street
Nanaimo, BC V9R 5S5

[2] Pacific Biological Station
3190 Hammond Bay Road
Nanaimo, BC V9R 5K6

[3]South Coast Division
3225 Stephenson Point Road
Nanaimo, BC V9T 1K3

ISSN 1480-4883

Canada

Abstract

This paper reviews and summarizes available information on the biology and fisheries on British Columbia surfperch species (Embiotocidae). Surfperches are found only in the North Pacific, and eighteen of the 20 species occur in North America waters, from Northern Mexico to southern Alaska. There are eight species of surfperch (Embiotocidae) in British Columbia (BC) waters and some species have been harvested for over 100 years, mainly by recreational anglers. No reliable quantitative information is available on the recreational or commercial catches in BC but from California to BC the recreational catch is considerably larger than the commercial surfperch fishery.

In BC, recreational fishing is almost totally confined to wharves. The present commercial fishery in BC is small, but expanding. The current commercial fishery fluctuates with market demand. The most targeted species is probably the pile perch caught for the Asian live fish restaurant trade. There also appears to be a small demand for two species of surfperch (striped and pile) for the fresh fish market.

The unique biology and life history of surfperches requires special consideration in the further development of directed fisheries. Viviparity, or the birth of few highly developed, live young could limit the ability of surfperch species to recover from population depletion. Information regarding distribution of species within BC is limited with most information based on incidental capture of surfperch in fisheries or surveys for other species. Information on abundance, either relative or absolute, is not available for BC populations.

We recommend that more basic data be collected on surfperch populations to further our knowledge on their distribution, abundance and basic biology. A substantial increase in information could be gained by better documentation of catches at the species level. Presently most incidental capture information of surfperches is noted only at the family level. Further we recommend initiation of some stock identification studies because of concern that the combination of widespread distribution and low fecundity could have fostered the development of a number of genetically distinct populations within BC.

Occasional creel census should be conducted to determine the magnitude of recreational fisheries. Regulations of the current commercial fishery in BC should be enforced to allow for the collection of accurate fishery based data. To protect females bearing live young, we recommend a commercial fishery closure between May 1 and August 31. We suggest that such a total closure could be modified if new information indicates that that such a closure is not required for conservation.

Résumé

Ce document constitue un examen et un résumé des données disponibles sur la biologie et la pêche des ditrèmes (Embiotocidés) de la Colombie-Britannique (C.-B.). Les ditrèmes se trouvent uniquement dans le Pacifique Nord, et 18 des 20 espèces sont présentes dans les eaux nord-américaines, du Nord du Mexique au Sud de l'Alaska. Huit espèces vivent dans les eaux de la C.-B., et certaines sont pêchées depuis plus de 100 ans, principalement par des pêcheurs sportifs à la ligne. Il n'existe aucune donnée quantitative fiable sur les pêches récréative ou commerciale en C.-B., mais de cette

province à la Californie, la pêche récréative est beaucoup plus importante que la pêche commerciale.

En C.-B., la pêche récréative est presque entièrement limitée aux quais, et la pêche commerciale est actuellement de faible envergure, mais en expansion. Cette pêche commerciale varie en fonction de la demande du marché. L'espèce la plus recherchée est probablement la perche de pilotis destinée à l'approvisionnement des restaurants asiatiques en poissons vivants. Il semble y avoir une faible demande pour deux espèces (ditrème rayé et perche de pilotis) sur le marché du poisson frais.

La biologie et le cycle vital uniques des ditrèmes requièrent une attention particulière dans l'amélioration de la pêche dirigée. La viviparité, ou la naissance d'un nombre limité de jeunes très développés, pourrait nuire à la capacité de rétablissement des ditrèmes à la suite d'un appauvrissement de leur population. Il existe peu de données sur la répartition des espèces en C.-B., et la majorité de celles-ci est basée sur des prises accessoires de ditrèmes ou sur des relevés d'autres espèces. Aucune information n'est disponible sur l'abondance, relative ou absolue, des populations de la C.-B.

Nous recommandons de recueillir un plus grand nombre de données de base sur les populations de ditrèmes afin d'approfondir nos connaissances sur leur distribution, leur abondance et leur biologie. La préparation de rapports plus détaillés sur les prises, comprenant davantage de données propres aux espèces, contribuerait grandement à l'atteinte de cet objectif. Actuellement, la majorité des prises accessoires de ditrèmes est identifiée jusqu'à la famille seulement. Craignant que la combinaison de la distribution étendue et de la faible fécondité ait pu entraîner le développement d'un certain nombre de populations génétiquement différentes en C.-B., nous recommandons également la mise en oeuvre d'études d'identification des stocks.

Il faudrait effectuer parfois des relevés des prises afin de déterminer l'ampleur de la pêche récréative. Le règlement sur la pêche commerciale actuelle en C.-B. devrait être appliqué afin de permettre la collecte de données précises sur cette pêche. Dans le but de protéger les femelles en gestation, nous recommandons la fermeture de la pêche commerciale du 1er mai au 31 août. On pourrait modifier les modalités de fermeture si de nouvelles données montraient que la fermeture totale de la pêche n'est pas nécessaire à la conservation.

Table of Contents

List of Tables and Figures

List of Appendices

1. Introduction

1.1 Overview

There are twenty marine and one freshwater species in the family Embiotocidae. Two are found in Korea and Japan, eighteen species are restricted to the Pacific coast of North America from Baja California to Alaska, and a single freshwater species is found in California (Eschmeyer *et al.* 1983, Robins *et al.* 1991). Two additional species have been described but at present do not appear to be accepted as valid species. Of the twenty marine species, eight are found on the coast of British Columbia (BC) (Eschmeyer *et al.* 1983) (Appendix 1). Tarp (1952) and Hubbs and Hubbs (1954) divided the family into two subfamilies: Embiotocinae and Amphistichinae. Nelson (1994), however, does not use this division and in this paper we follow Nelson. Common names vary with different studies: in this paper we will follow Robins *et al.* (1991).

Embiotocids have been fished commercially and for recreation from the 1800s to the present, especially along the California coast. In BC, some of the species have been harvested for over 100 years, primarily by recreational anglers. Little reliable quantitative information is available on the recreational or commercial catches in BC. The present commercial fishery in BC is thought to be small, but embiotocids are seen occasionally in supermarkets (A. Peden pers. com.). From California to BC, the recreational catch is considerably larger than the commercial catch. In BC, recreational fishing is almost totally confined to wharves. Quantitative data on the surfperch fishery in central and northern California and Oregon has been reported by Miller and Gotshall (1965) and Karpov *et al.* (1995).

In the Pacific Region of the Department of Fisheries and Oceans Canada (DFO), the policy for possible new and/or developing fisheries provides for a precautionary approach to ensure the sustainable development of new fisheries (DFO 2001). The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is responsible for the identification of possible endangered species in Canada. Of the eight species of surfperch that are found on the Pacific coast of Canada, there is an existing or potential fishery for five species and the possibility that three others may be of interest to COSEWIC (see below).

1.2 Plan for the Development of a Surfperch Fishery

Perry *et al.* (1999) developed a framework for the provision of scientific advice for precautionary management of new and developing fisheries. This framework has three phases:

Phase 0: (a) Collect available biological and fisheries information on the species in the region proposed for the fishery and elsewhere. In this report it involves a review of the existing biological and fishery information relevant to eight species of surfperch that live along the BC coast.

(b) Review the commercial and recreational fisheries relative to endangered species concerns.

(c) Identify areas where information is lacking.

Phase 1: The collection of data necessary to fill the information gaps identified in the Phase 0 report and to examine the possibility of a sustainable fishery.

Phase 2: The development of both recreational and commercial fisheries allowing for the monitoring of stocks and evaluation of management strategies.

This paper is Phase 0 of this process, following the format used by Lauzier (1999). It attempts to summarize the information on eight species of surfperch that live on the coast of BC. There are five species that support present or potential fisheries: pile and shiner perch, striped seaperch, redtail surfperch, and kelp perch. There may be concerns of interest to COSEWIC regarding three species: white seaperch, and silver and walleye surfperch. Species specific life history summaries are given in Appendix 1 and general embiotocid life history is summarized below.

1.3 Biological Objectives

The biological objective of any fishery is to maintain a viable reproductive stock and to avoid the possibility of overfishing. Rice *et al*. (1995) proposed three biological objectives for the management of fisheries in the Pacific Region. This framework, when applied to surf perch species, is as follows:

1. To ensure that the populations of the various surfperch species on the BC coast do not become threatened, as defined by COSEWIC, within their range.
2. To ensure sustainable reproduction and the survival of offspring throughout their range, at a level sufficient to allow sustainable recreational and commercial fisheries. This objective is especially important with respect to surfperch as all species are viviparous and have a very low fecundity. Recovery from overfishing will likely be very slow.
3. To ensure that any fishery targeting surfperch does not violate the two previous objectives for other sympatric species of surfperch or other species.

2. Current Knowledge of the BC Surfperch Species

2.1 Overview

The surfperches are members of the Family Embiotocidae (Order Perciformes). They are marine, except for one freshwater species. All are found in the North Pacific, along the coast of North America, except for two species restricted to Korean and Japanese waters. Most North American species occur along the coast of California, (Karpov *et al.* 1995, Robins *et al.* 1991) which is considered the center of evolution for the family. Eight species occur in the coastal waters of BC, but only four species are found along the entire coast: the pile perch (*Rhacochilus vacca*), shiner perch (*Cymatogaster aggregata*), striped seaperch (*Embiotoca lateralis*), and kelp perch (*Brachyisticus*

frenatus). Four other species occur mainly in US waters, but are found as far north as southwest Vancouver Island, their northern range limit. These species are the redtail surfperch (*Amphistichus rhodoterus*), walleye surfperch (*Hyperprosopon argenteum*), silver surfperch (*Hyperprosopon ellipticum*), and white seaperch (*Phanerodon furcatus*) (Eschmeyer *et al.* 1983).

Surfperches have elliptical, laterally compressed bodies and a forked tail; many have bars or stripes on the sides of the body. They have a single dorsal fin with 9-11 spines and 19-28 soft rays. The anal fin has three spines and from 15-35 soft rays. Their diet mainly consists of small invertebrates, including isopods, amphipods, small shrimp, small crabs, gastropods, small bivalve mollusks, and polychaete worms. They are usually benthic or pile grazers but have been known to feed throughout the water column (DeMartini 1969).

Surfperches are viviparous (Turner 1947), giving birth to highly developed, free-swimming young. Consequently, surfperch have a very low fecundity, rarely over 45 young per female per year (Cannon 1956). This characteristic makes them prone to very slow population recovery from overfishing.

2.2 Geographic Distribution and Habitat

Eighteen marine species range from subtropical Baja California to cool temperate Alaskan waters. Temperature appears to be the primary factor affecting distribution of individual species (Karpov et al. 1995). All are inshore species and can be found in a variety of shoreline habitats, including sandy beaches, rocky shorelines and reefs, kelp beds, and estuaries (Roedel 1953, Tarp 1952). The ranges of each of the eight species found in BC varies but all are between Baja California (28° north latitude) and south central Alaska (56° north) (Table 1).

Species that are currently fished or may be targeted with increased fishing effort in the future include pile, shiner, and kelp perch, striped seaperch, and redtail surfperch. The majority of the BC catch is recreational, taken by hook and line from wharves. All species except the kelp perch utilize piling habitat around wharves to a considerable degree. Striped seaperch are typically concentrated over rocky bottoms and around rock faces, but can be found in piling habitats. Pile and shiner perch and striped seaperch are found where there is algal growth or eelgrass and are most common in inside waters, such as the Strait of Georgia. Redtail surfperch, however, are primarily found on open sandy areas, but are reported and captured around pilings in bays and estuaries. This species has a rather limited distribution in BC but is captured from wharves in unknown numbers within its range (central west Vancouver Island north to Tofino). The kelp perch do not frequent pilings and is the only surfperch species restricted to the kelp forest habitat (Roedel 1953; Hubbs and Hubbs 1954; Hobson 1971; Anderson 1994; Anderson and Sabado 1999). Fish live in small aggregations or solitary under the kelp canopy in the water column, often near the surface (Hobson and Chess 1986). Due to the lack of sampling in these habitats, the species has not been well documented in BC.

Water temperature appears to affect the seasonal distribution of pile and shiner perch. In BC these two species occupy shallow water habitats in the summer, often in bays and estuaries. In winter they move into deeper water. In the southern part of their range (Southern California) they appear to have the opposite movement pattern, moving

into shallows in winter and deeper water in summer. This pattern of movement is consistent with avoiding water that is too warm in summer (southern populations) and too cold in winter (northern populations).

The remaining three species (silver and walleye surfperch and white seaperch) have a very limited distribution in BC, and are currently not targeted in fisheries (Table 1). This restricted range is perhaps due to environmental factors or lack of suitable habitat, and therefore may consist of a number of small populations. Silver surfperch and white seaperch appear to be restricted to the west coast of Vancouver Island from the Tofino region south (Lamb and Edgell 1986, Peden 1966), while the walleye surfperch has only been taken from Esquimalt Harbour, on southern Vancouver Island (Hart 1973). White seaperch are bay dwelling, moving to deeper water in the late summer while the silver and walleye surfperch are primarily sand beach species (Feder *et al.* 1974). The recorded water temperature range for all three species is from 7 to 21°C. (Karpov *et al.* 1995). These three species may be of interest to COSEWIC as their current population status is unknown and their ranges are restricted in Canada.

2.3 Parasites and Diseases

No reports were found on the diseases of embiotocids but it is probable that existing populations host diseases. Comprehensive examination of parasites and parasite loads is available for the shiner perch (*Cymatogaster aggregata*) only (Arai 1967; 1969; Arai *et al.* 1988; Odenweller 1971). The parasite populations of other embiotocids have received little or no attention and therefore, lower numbers of parasites reported from other species is likely due to a lack of research (Appendix 2).

Shiner perch support a large number of parasite species (Appendix 2). If the parasite load in shiner perch is indicative of the load in many embiotocid species, the importance of parasites to surfperch populations is likely to be considerable. It is possible that parasite numbers are sufficient to become a significant factor in natural mortality. Because surfperch are viviparous there may be an opportunity for vertical transfer of parasites from the mother to their offspring at birth. This may increase juvenile mortality. These comments are highly speculative, however, and no work exists on this aspect of embiotocid parasitology.

Seasonal and geographic variations in parasite infection levels were found in *C. aggregata* (Arai *et al.* 1988). They found that infestation rates of some parasite species peaked in summer (e.g. *Holobomolochus embiotocae*), while others peaked in spring (e.g. *Phyllobothrium*), or winter (e.g. *Lironeca californicus*). Other parasite species appear to have little seasonal variation. Arai *et al.* (1988) found latitudinal variations in parasite species between BC and southern California. *Cucullanellus kanabus* was most prevalent in BC, while the incidence of other parasite species tends to be higher in San Diego surfperch populations.

2.4 Food and Feeding Habits

Surfperch are primarily opportunistic small invertebrate carnivores. They also feed on minor quantities of fish eggs and postlarval fish (Table 2). DeMartini (1969) discussed the evolution of jaw structures, habitat, and feeding niches in embiotocids.

Most nearshore marine habitats are occupied by at least one and often two or more species of surfperch found in the same area. This occurs most notably in protected waters around wharves and pilings. Feeding niches are restricted by prey size, location, and shell hardness (DeMartini 1969). For example, pile perch are able to crush hard shells, thus utilizing prey not available to other embiotocids. Shiner perch do not have this ability, so they largely feed on small, softer prey. Because of this niche specialization, these species are able to cohabit the same space.

2.5 Reproduction

The most notable facet of surfperch reproduction is that all species are viviparous and all have very low fecundity. Viviparity, in the broad sense, is found in about 2–3% of teleostean fishes, approximately 14–15 families (Wourms and Lombardi 1992). In the embiotocids, viviparity is very advanced and the egg is very small (0.3mm) (Eigenmann 1894). The female supplies all prenatal metabolic needs of the embryo until birth. Eggs are fertilized internally and after a gestation period of approximately 5 months, females bear fully formed live young. Shiner perch and walleye surfperch produce sexually mature males and occasionally females at birth (DeMartini *et al.* 1983; Weibe 1968a,b).

Prior to mating, the anal fin of reproductive males develops a gland-like structure with a duct that points forward (Eigermann 1894). In mature females the oviduct extends about 5 mm in a ventral and posterior direction (Hubbs 1917). Males in some species also form a serrated triangular plate from a modified anal ray and an area of thickened epithelial tissue forming a puffy bulb (Tarp 1952). These modifications are thought to enhance sperm transfer from male to female. Both sexes mate more than once during the breeding season (DeMartini 1969, Karpov *et al.* 1995).

All species school to mate but mating usually occurs in loosely associated pairs within the school. Sperm transfer to the female occurs during the summer in shiner perch and striped seaperch and is stored in the female until fertilization in winter. When surfperch mate in successive years, sperm transfer is at the same time or just after parturition of the young (Karpov *et al.* 1995). Redtail, walleye, and silver surfperch, white seaperch, and pile perch mate in the fall and winter. Sperm storage in these species is brief, followed by winter fertilization (Gnose 1967; Wiebe 1968a,b; Bennett and Wydoski 1977; Leet *et al.* 1992; Karpov *et al.* 1995). Kelp perch mating time is unknown but fertilization is almost certainly in winter. The timing of birth varies geographically and with species, with parturition in spring (March through May) in southern California (Rechnitzer and Limbaugh 1952; Eckmayer 1975; Odenweller 1975), late spring to summer in Oregon (Swedberg 1965; Gnose 1967; Wares 1971; Wydoski and Bennett 1973; Bennett and Wydoski 1977), and summer (June through August) in Washington and BC (Suomela 1931; Gordon 1965; Wiebe 1968a; Birtwell *et al.* 1983; Quinnell 1986).

The low fecundity of surfperches is a potential concern for fisheries. All species have very low fecundity and may not have the potential to rapidly rebuild a depleted population. The number of young born to females varies among species and is size and age dependant (Table 3).

2.6 Age and Growth

Surfperches can be aged from scales. Attempts have been made to estimate age with otoliths but this method was found to be difficult (Suomela 1931; Swedberg 1965; Anderson and Bryan 1970; Odenweller 1975; Bennett and Wydoski 1977; Eckmayer 1979; Baltz 1984). No independent aging validation was noted in the literature. Annuli are formed between February and June, the more southern the population the earlier (Bennett and Wydoski 1977). In most reports January 1 is taken as the birthday. The scales bear a marking at birth, called a metamorphic annulus.

Embiotocid young have no larval period. They are born completely developed, free swimming, and at considerable size. While fecundity is low (Table 3), survival of the young may be high. No information is available on post partum natural mortality. At birth, young vary from 27 mm (shiner perch) to 85.7 mm (pile perch). As the gestation period is approximately 5 months, the young can be considered to be 0.4 years of age at birth. The maximum ages vary with species from six years (walleye surfperch and shiner perch) to ten years (pile perch) (Table 4).

In the redtail surfperch, kelp perch, and white seaperch, no differences in growth or size are apparent between the sexes. In shiner and pile perch, walleye and silver surfperch, and striped seaperch, females are slightly larger than males, especially in older fish. However, it appears that this difference does not occur in all populations (Hubbs and Hubbs 1954; Gordon 1965; Gnose 1967; Anderson and Bryan 1970; Wydoski and Bennett 1973; Eckmayer 1975; DiMartini *et al.* 1983). In populations where the females are larger the differences are slight and may not be statistically significant.

There are few reports that calculate the theoretical growth limits. Eckmayer (1975, 1979) and Wares (1971) reported von Bertlanffy growth parameters for shiner and pile perch, walleye surfperch, and white seaperch and Gordon (1965) discussed variations of instantaneous growth rates in the shiner perch (Table 5).

2.7 Recruitment and Mortality

Embiotocid young are born fully developed and newborns tend to recruit directly into the parental populations (Schmidt and Holbrook 1990). Due to extremely low fecundity, maintenance of populations is likely dependent upon a high survival of the young (Quinnel 1986). There is little information available on mortality rates immediately after parturition.

Eckmayer (1975, 1979) estimated instantaneous mortality rates for walleye surfperch and white seaperch using Ricker's (1975) equation:

$$Z = \ln(N_o) - \ln(N_t)$$

where Z is the instantaneous mortality rate, N_0 is the initial abundance, and N_t is the abundance at time (t). Mean instantaneous mortality of walleye surfperch from Anaheim Bay California, between the ages I and IV was 1.280, or about 72.2% annual mortality. In white seaperch the instantaneous mortality rate varied considerably between ages II and V: II = 0.765 (53.4%), III = 0.588 (44.2%), IV = 1.792 (83.3%) and V = 1.609 (80.0%). While mortalities were not calculated in other reports it would appear that mortality after the second or third years increases rapidly.

2.8 Density and Standing Crop

Quast (1968) estimated the biomass of some embiotocids in three surveys on three southern California kelp beds. Water depths on these kelp beds varied between 30 and 90 ft. (9-27.5 m). Quast (1968) estimated biomass by species: pile perch varied between 0.28 and 14.62 lb/ac (0.03 – 1.67 g/m^2), kelp perch varied between 0 and 12.39 lb/ac (0 and 1.4 g/m^2), striped seaperch between 7.98 and 11.32 lb/ac (0.91 – 1.29 g/m^2), white seaperch varied between 0 and 5.08 lb/ac (0 – 0.58 g/m^2), and redtail surfperch varied between 0 and 2.82 lb/ac (0 – 0.32 g/m^2). While these figures provide some sense of embiotocid densities, each reef was only surveyed on one day either in June, July, or August. As embiotocids undergo considerable seasonal movements, one should consider these results to be estimates only. It would take several years of data to fully understand population dynamics.

3. Fisheries

3.1 Embiotocid Fisheries in BC

3.1.1 Overview

In BC there is little information on embiotocid fisheries and little reliable quantitative data. The Nuu Chah Nulth first nation on the west coast of Vancouver Island report that shiner and pile perch and striped seaperch were fished historically but there is no information to indicate that these species are utilized today (D. Hall pers. com.). The surfperch fishery, both recreational and commercial, is concentrated in California, with catches decreasing from Oregon north to Alaska.

3.1.2 Recreational Fishery in BC.

Embiotocids support a loosely regulated recreational fishery. The Tidal Waters Sports Fishing Guide (DFO) categorizes all species of embiotocids as “perch.” The daily limit of “perch” is eight with a possession limit of sixteen. Fishers must have a current Tidal Waters Sports Fishing license while fishing for perch using hook and line gear only. There are no seasonal restrictions and young people primarily pursue this fishery from docks with floats and pilings. The species generally caught along the entire coast are shiner and pile perch and striped seaperch. On the southwest coast of Vancouver Island, especially in the Ucluelet-Tofino area, redtail surfperch are also taken (J. Morgan pers. com.). Silver and walleye surfperch, white seaperch and kelp perch would rarely be caught in the recreational fishery due to their restricted ranges and habitat preferences.

In support of this report in 2001 we conducted a survey of 48 public and private docks throughout the entire BC coast to provide a rough estimate of the magnitude of the recreational perch catch (Table 6). For each dock, the harbourmaster was contacted and questioned regarding fishing activity on their dock (Appendix 3). Since harbourmasters usually do not keep logs of such fishing activity, their estimates of effort were calculated as the average number of fishers seen on a typical day from May through September. We extrapolated this value to determine an estimate of the average number of

fishers/dock/year for any dock in BC, and then multiplied by an estimated 219 public docks and accessible marinas. Using an estimate of three perch caught per day (an average based on harbourmaster information), we calculated an estimated annual surfperch catch of approximately 265,000 fish. While this survey lacks precision and detail it indicates a direction that future work might take to estimate recreational catch (See Recommendations p. 19-20). ctual total catch in the recreational fishery in BC is almost certainly greater than indicated in Table 6 as many of the docks with obvious fishing activity reported zero fishers and therefore zero catch (i.e. Campbell River, Deep Cove, Sidney, Sooke). Young fishers often release their catch after holding fish in a bucket for considerable periods while continuing to fish. Therefore, the mortality of released fish is probably quite high.

3.1.3 Commercial Fishery in BC

Reports on the early years of the commercial surfperch fishery in BC are sparse. In the 1890 federal Fisheries Report a "Mixed Fish" category was defined, which included many species such as sardines, anchovies, and flounders. Surfperch are not specifically mentioned, but there was a general increase in fishing for minor species due to a growing human population (Mowat 1891). These species were used only for local consumption, as foreign markets had not developed (McNab 1892). The common attitude of the time was that these "Mixed Fish" were of such unlimited quantity their stocks could not suffer from overfishing.

In 1912 the category "Perch" was created in the fisheries reports; however, the species included in this category were never defined. The proportion of Embiotocidae in this category is unknown, as there is a strong possibility that landings of Pacific Ocean perch (*Sebastes alutus*) were also included. It was only in 1957 that Pacific Ocean perch were recorded separately from "Perch." Also, the landed catch from 1912 to 1950 only represented the perch that were actually marketed; no data were recorded for the amount caught for home consumption. Recorded catches from 1954 to 1977 represent all commercial landings of "perch," recorded by fish slips. Despite these limitations, Table 7 and Figure 1 show the annual recorded landings of "perch" from 1912 to 1977 and landings of Embiotocidae specifically from 1984 to 1999. No attempt was made to correct for uncertainties in species composition of older data, or to separate individual species of Embiotocidae of more recent landings.

Since 1983, a separate "ZL" license has been required to fish for Embiotocids. The "ZL" license must be designated a commercial fishing vessel as a secondary license. As such, the designated vessel must have a valid vessel based harvesting license for some other fishery. The completion of harvest logs is a condition of this license, but compliance has not been actively enforced. Today, the commercial fishery is closed year round by regulation, but may be opened by variation order at the request of a licensed fisherman. Variation orders have been issued in each of the last several years to allow commercial perch fishing. There is currently no designated closed time for the commercial fishery, therefore the fishery remains open by variation order for the remainder of the year once an opening has been requested. Table 8 outlines the catch by area recorded from 1984 to 1999 under this license.

The commercial fishery is small and fluctuates with market demand. Fishers are limited by regulation to troll, drag (beach) seine, or dip net gear but restrictions on gear dimensions (i.e. length or mesh size of the drag seine) do not presently exist. Currently, this fishery is conducted almost exclusively with beach seine gear in shallow bays and channels. With this gear type, significant by-catch of non-target fish and invertebrate species would be expected. The potential for habitat impacts on sensitive, near shore environments such as within estuaries or eelgrass beds also exists with this gear type. Information regarding by-catch in the BC surfperch fishery is extremely limited, with only one unpublished trip report (Brouwer 1993) documenting the catch of red rock crab, small gunnels, sculpins, moon snail and flounders in unspecified numbers during two days of fishing in June of 1993. Most by-catch was reported to have been released in good condition with the exception of several red rock crabs that had become tangled in the net.

The most targeted species probably is the pile perch, caught for the Asian live fish restaurant trade. There also appears to be a small demand for striped seaperch and pile perch for the fresh fish market. A. Peden (pers. com.) has on occasion noted such fish in Victoria supermarkets. Perch are also used in limited quantities as bait in other fisheries, and are sometimes sold directly to the public either as live or fresh fish. Brett (1979) mentions pile perch as a possible aquaculture species, but due to its low growth rate and low market demand, it is unlikely that the aquaculture industry would consider this species in the near future.

We contacted five licensed surfperch fishers to obtain their views on the commercial fishery (Appendix 4). The majority hold their license not for active fishing, but for the prospect of a viable surfperch fishery in the future. Most want to catch large surfperch for the Vancouver restaurant trade. Two are active salmon fishers, who are interested in surfperch fishing as a means of supplementing their income. Only one of the interviewees actively fishes each year for surfperch using a beach seine to capture mainly shiner perch and striped seaperch, and smaller numbers of pile and kelp perch, all for the aquarium trade. Only large adults are captured, unless smaller juveniles are required. All other fish, including a large number of bycatch species, are released with, in the opinion of the fisher, low mortality. This fishing takes place sporadically from May through September, depending on the number of surfperch ordered.

The only other active fisher interviewed fished using a combination of SCUBA and a modified herring bait seine. The fisher uses SCUBA in December and January to find pile perch in deep water, and then uses the seine to fish them. This method is still in development but the fisher wishes to catch pile perch for Vancouver restaurants.

3.1.4 Surfperch by-catch In Other BC Fisheries

Shiner perch are caught as bycatch by the shrimp trawl fishery (Hay *et al.* 1999). Based on surveys in 1999 the shiner perch were ranked as the sixteenth most common species captured in trawls and accounted for 0.35 % of total catch. Catch rates varied by area, however and made up only 0.20 % of the catch on the west coast of Vancouver Island, 0.58% in the Prince Rupert District but 2.65% in the Strait of Georgia, where they ranked as the eighth most common species caught (Hay et al. 1999, Table 6). In the Strait of Georgia, the total catch of shrimp (excluding all other bycatch species was about 500 tonnes in 1998 and 1999, so if the surf perch were estimated only as a percentage of total

shrimp weight, the estimated bycatch would be about 13 tonnes. Based on a mean weight of about 25 grams (Gordon 1965) the number of individuals would be over 500,000, considerably more than the estimates for the recreational catch. Even this estimate is low however, because the estimated percentage of surf perch as bycatch is made on the total catch of all species, which often is 20% or more of the shrimp catches in the Strait of Georgia. Therefore the estimate of 500,000 would be low, at least by 20%.

Pile perch are taken off the west coast of Vancouver Island and in the Strait of Georgia but make up only a very small component of bycatch in these areas (0.0025% of total catch).

3.1.4 Illegal Fishing

We heard of instances of illegal fishing for embiotocids from a wharf in Vancouver Island. A harbormaster noted over 10 people fishing the dock at night, retaining everything, mainly embiotocids and sculpin. The harbour authority suspects that these fish were marketed as the catch appeared to exceed requirements for personal consumption. If accurate, such activities may cause rapid local depletion of surfperch.

3.2 Embiotocid Fisheries in the United States

3.2.1 Overview

In the United States surfperch are actively pursued in both recreational and commercial fisheries. The recreational fishery is the largest and occurs in Washington and Oregon, but is greatest in California. Most quantitative data on both fisheries and status of embiotocid populations comes from California (Miller and Gotshall 1965; Karpov *et al.* 1995). There is a recent website maintained by the California Dept. of Fish and Game (Fritzsche and Collier 2001), but the data in the surfperch section is rather sparse. (www.dfg.ca.gov/mrd/status/entire_book_v2.pdf).

3.2.2 Washington Embiotocid Fisheries

Recreational fishing for surfperch is permitted year round in Washington State to licensed recreational fishers. Catch limits vary with management area, and fishers may retain either 10 or 15 surfperch not including shiner perch, subject to local limits (WDFW 2002). There is no catch limit for shiner perch in the recreational fishery in Washington State.

In the commercial fishery, pile perch are most heavily harvested, followed by striped seaperch, on the inside waters of Washington (Quinnell 1986). The fishery is closed from May 15 to August 31 to protect fish during parturition. This closure in theory protects many of the spawning adult embiotocids. The fishery is also closed from May 15 to December 31 in portions of south Puget Sound to prevent high incidental catches of adult salmon. Despite this closure time, there was a significant drop in catch in the 1970s (Quinnell 1986). The reasons for this may include a decline in fish abundance, loss of fishing grounds due to coastal development, decrease in demand, a greater percentage of inexperienced fishermen, and/or change in fish distribution (Quinnell 1986). It appears that the spring/summer closure did not improve catch levels during the open period.

3.2.3 Oregon State Embiotocid Fisheries

Oregon State supports a small commercial fishery and a larger recreational fishery for surfperch. The recreational fishery occurs throughout the year and is managed through a 25 fish daily bag limit that applies to an aggregate of cabezon, greenling, tuna, flounder and surfperch of all species (ODFW 2002). Landings of the recreational surfperch fishery are believed to represent a significant portion of the coastal recreational fishery, however, catch is not well documented through the existing creel survey (ODFW 2002).

There are no available historical records of commercial catch in Oregon. The size of the commercial fishery is understood to be increasing, especially in southern Oregon, however catch data is unavailable and believed to be aggregated in unspecified species categories within existing data (ODFW 2002). Commercial fishing regulations in Oregon state require a personal commercial fishing license and prohibit the harvest of perch within coastal bays or within 200 yards seaward of any jetty or bay unless specifically provided for by a rule. The commercial take of surfperch is also prohibited from August 1 to September 30 to coincide with the breeding season (ODFW 2002;2003). The permitted gear types are those described under the Ocean Food Fishery Regulations (ODFW 2003) and consist of trawl nets, pots or trap, longlines, vertical hook and line, set nets, drift or set gill nets, handline, pole-and-line, pole-reel-and-line, dipnets, spear and seines. Not all gear types are permitted in all areas, and are subject to local regulations.

3.2.4 California Embiotocid Fisheries.

The California fisheries for various species of embiotocids are by far the largest on the North American coast, and surfperch catches dominate shore based fisheries in California. Recreational landings are over four times larger than the commercial catch. Between 1957 and 1961, the recreational fishery averaged 420 metric tonnes (t) each year and the commercial catches averaged 86 t; the total number of surfperch caught was 1,254,000 fish (Miller and Gotshall 1965). From 1980 to 1986 the recreational catch dropped to 240 t per year while the commercial catch dropped to an annual average of 55 t. The number of fish in the recreational catch averaged 875,000, while the commercial catch was approximately 200,000. The most important commercial species are the barred surfperch, pile perch, redtail and walleye surfperch, and white seaperch (Karpov *et al.* 1995). By number, the most important recreational species were, in descending order, barred surfperch, shiner perch, walleye surfperch, and pile perch. By weight, in descending order, the dominant species were the barred surfperch, pile perch, rubberlip seaperch, and redtail surfperch. Between 1993 and 1999 the annual recreational catch was 864,000 fish, similar to the catches in the 1980s, but the commercial catches in the 1990s were significantly lower, with an approximate 1999 catch of 22 t (Fritzsche and Collier 2001).

Recreational fishing regulations in California allow fishing throughout the year in all areas except San Francisco Bay and San Pablo Bay which is closed from April 1 to July 31 (GDFG 2002). There is a bag limit of 5 fish in any combination of species except for shiner perch, which have a daily limit of 20 and may be retained during the closed time in San Francisco and San Pablo Bays. There is also a minimum size restriction for redtail surfperch of 10.5 inches (26.7 cm) (CDFG 2002). The commercial fishery is closed from May 1 through July 15, except shiner perch, which are open all year.

The decline of surfperch catches over time may have been caused by several factors. Nearshore distribution combined with schooling in bays and inlets make most species vulnerable to overfishing. Intense fishing combined with low fecundity greatly reduces the possibility of strong year classes. Royce (1975) warned that species with low fecundity are vulnerable to over-harvest. Over time there has been considerable development of inshore uplands due to increased population and industry. Such development may have reduced the amount of coastal habitat available to surfperch and added pollutants. The environmental consequences of increased human activity along the California coast have not been quantified.

3.2.5 BC Species in the California Fishery

There are eighteen species of embiotocids in California; only eight of these species are in BC. The barred surfperch forms a major part of the Californian fishery but its range does not include BC. Therefore, the following section separates out only the eight BC species in the California fishery.

The species of greatest importance in BC fisheries are the pile, shiner, and kelp perch, striped seaperch, and redtail surfperch. In the 1957–1961 California catch an average of 452,000 fish per year in this species group were taken in the recreational fishery. In terms of numbers the shiner perch was the most frequently caught, followed by the redtail surfperch, striped seaperch and pile perch. The landed weight from greatest to least was the redtail surfperch, equal amounts of striped seaperch and pile perch, and finally shiner perch (Miller and Gotshall 1965). By 1980–1986 the total annual catch of the recreational fishery of these species dropped to 279,000 fish per year and the order by numbers caught was shiner perch, pile perch, redtail surfperch and striped seaperch. By weight, pile perch became the most important, followed by redtail surfperch, striped seaperch, and shiner perch (Karpov *et al.* 1995). In the 1990s there was no comprehensive data published but the sequence of importance by number in the recreational fishery appears to be striped seaperch, redtail surfperch, and pile perch. There was no comment on the shiner perch (Fritzsche and Collier 2001).

For commercial catches, redtail surfperch and pile perch were listed as having commercial value, striped seaperch was listed as minor or incidental, while shiner perch was listed as a bait species (Karpov *et al.* 1995).

3.3 BC Surfperch Species of Potential Interest to COSEWIC

Three species of surfperch have very restricted ranges in BC, specifically along the southwest coast of Vancouver Island. These species are silver and walleye surfperch and white seapeach. The white seaperch and walleye surfperch have commercial value in California (Karpov *et al.* 1995) and all three are taken in the recreational fishery in that state. In BC, they appear to be restricted in both distribution and numbers however, no current information is available on the population status of these species. It is possible that their Canadian range represents the northern population of a larger gene pool and as such is not unique. Alternately, they may be genetically unique, and if their sustainability is uncertain, these species may be of interest to COSEWIC. Genetic comparisons between

northern and southern populations could be used to determine if these populations have adequate gene flow, or have been isolated such that differentiation has occurred.

Kelp perch are considered to be restricted to kelp beds and not part of the recreational fishery. Interviews with commercial fishers revealed that they are taken in minor amounts for the aquarium trade. There is no information on their abundance, but no reason to expect that populations are depressed. It may be useful to sample their habitat to determine the geographic extent of populations, especially if they continue to be taken for the aquarium trade.

4. Conclusions

This report has attempted to bring together the available biological, commercial and recreational fisheries knowledge of the Embiotocidae in British Columbia and elsewhere. This was completed through a thorough literature survey and interviews of harbormasters and licensed surfperch fishers. In section 1.2, we explained that a Phase 0 report has three objectives: to describe available biological information, to describe recreational and commercial fisheries, and to identify information gaps. The first two objectives were addressed with the literature survey and interviews. Identification of information gaps, the third objective, has occurred throughout the paper, and also is addressed directly in this section and the Recommendations section.

In British Columbia there are eight species (all marine) belonging to the Family Embiotocidae. Shiner, pile, and kelp perch, striped seaperch, and redtail surfperch are targets of recreational and/or commercial fisheries. The other three species, walleye and silver surfperch, and white seaperch, have restricted ranges, and are not targeted in current fisheries. Although all BC embiotocid species have varying preferences of habitat, feeding, geographical distributions and migratory behaviors, they share the important physiological trait of viviparity. As a result, embiotocid species may be prone to overfishing and slow population recovery. Overfishing may have already occurred in California, where recreational and commercial catches have steadily dropped since the 1960s.

There are many aspects of embiotocid biology and distribution that are not understood, in BC or elsewhere. For example, we do not know the time of year that each species mates, fertilizes their eggs, and undergoes parturition. There are few data on rates of growth (except for shiner perch), mortality, or abundance. We do not know if aggregations of surfperch species, targeted by commercial and recreational fishers in the spring and summer, consist of gravid females as suggested by Quinnell (1986) for Puget Sound. Such information is essential in determining the timing of fishery closures that would best protect stocks from exploitation during critical periods.

The recreational catch in British Columbia primarily targets the shiner and pile perch, both common to pile habitats where people fish with hook and line from the dock above. The striped seaperch is also caught, as it frequents pilings and rocky shores. The redtail surfperch is the least important to the recreational fishery, as it is only reported to be caught from the Tofino area on southwestern Vancouver Island. The number of surfperch caught in the recreational fishery is unknown, but rough estimation in 2001 was a catch of approximately 265,000 fish/year made in the vicinity of wharves. If a more accurate estimate of recreational catch were made, it could assist with determination of catch limits.

Commercial fishermen are permitted to use troll gear, drag (beach) seine, and dip net. They are primarily interested in fishing for pile perch for restaurants. The aquarium trade also targets pile perch, along with shiner and kelp perch, and striped seaperch. This fishery is considered to be much smaller than the recreational fishery, although compliance with harvest log books and regulations may not be complete. Therefore, recorded commercial landings probably are under-reported. Accurate reporting of catch in the commercial fishery and improved estimation of catch in the recreational fishery is needed to assess fishery impacts on the embiotocid populations.

5. Recommendations

Within the framework of the DFO policy on developing fisheries and precautionary management of new and developing fisheries (DFO 2001, Perry *et al.* 1999), and to ensure that possible concerns of COSEWIC regarding sustainability of any species of surfperch are taken into account, the following recommendations are provided for consideration. These recommendations are divided into four sections: life history and distribution, recreational fisheries, commercial fisheries, and rare and endangered species concerns.

5.1 Recommendations Regarding Information on Life Histories and Distribution of Surfperch in BC

1. Information should be gathered on fecundity, spawning times, age distribution, growth rates, and mortality (including natural, post partum, and fishing).
2. Data should be collected on the distribution of Embiotocidae in British Columbia waters, including habitat usage, diel and seasonal movements and geographical distribution.
3. Research should be conducted to provide information on abundance and densities of surfperch in BC.

5.2. Recommendations Regarding the Recreational Fishery on Surfperches in BC

1. A creel census from a specific number of wharves along the BC coast should be conducted to quantify catch data. We further recommend that identification sheets be prepared to enable census takers to identify surfperch by species.
2. As this fishery is largely pursued by young fishers, it is recommended that no change be made in the present regulations with respect to summer fishing. While a summer fishery for surfperch occurs during the spawning period, a young fisher would likely be unaware of any closure.
3. No change in the present catch limits are recommended at this time.

5.3 Recommendations on Commercial Fisheries in BC

1. Existing commercial regulations should be reviewed and/or enforcement improved. DFO should enforce the mandatory harvest logs to allow catch estimation.
2. It is recommended that directed commercial fishery for embiotocid species be closed from May 1 to August 31 to protect spawning populations. This total closure could be modified when new data are available to suggest otherwise.
3. No directed commercial fishery should be allowed for white seaperch, silver or walleye surfperch until there are sufficient data and understanding to ensure that existing populations are sustainable. Any commercial fishery on redtail surfperch should be closely monitored due to that species limited range in BC.
4. Reports of illegal fishing should be investigated to ascertain their accuracy and the numbers and species in the catch (see 3.1.4).

5.4 Recommendations Regarding Possible COSEWIC Concerns

1. Stock identity information should be gathered to determine the uniqueness of populations that have limited distributions in Canada. Species with limited populations may be of concern to COSEWIC.

6. Acknowledgements

Drs. J. Morgan and A. Peden are acknowledged for their information. Ms. J.M. Lane is thanked for manuscript preparation. Kristen Daniel helped with final proofing of the manuscript.

7. References

Alevizon, W.S. 1975. Comparative feeding ecology of a kelp-bed embiotocid (*Embiotoca lateralis*). Copeia 1975(4): 608 – 615.

Anderson, R. D. and C.F. Bryan. 1970. Age and growth of three surfperches (Embiotocidae) off Santa Barbara, California. Trans Am. Fish. Soc. 99(3): 475 – 482.

Anderson, R. D. and C.F. Chew. 1972. Preliminary study on the transient species of fish in Big Reef Harbor. Trans. Am. Fish. Soc. 101(4): 726 – 729.

Anderson, T.W. 1994. Role of macroalgal structure in the distribution and abundance of a temperate reef fish. Mar. Ecol. Prog. Ser. 113(3): 279 – 290.

Anderson, T.W. and B.D. Sabado. 1999. Effects of kinship on growth of a live bearing reef fish. Mar Biol. 133(1):115-121.

Arai, H.P. 1967. Ecological specificity of parasites of some embiotocid fishes. J. Fish. Res. Board Can. 24(10):2161-2168.

Arai, H.P. 1969. Preliminary report on the parasites of certain marine fishes of British Columbia. J. Fish. Res. Board Can. 26(9): 2319-2337.

Arai, H.P., Z. Kabata and D. Noakes 1988. Studies on seasonal changes and latitudinal differences in the metazoan fauna of the shiner perch, *Cymatogaster aggregata,* along the west coast of North America. Can. J. Zool. 37(Suppl. A):261-262.

Baltz, D.M. 1984. Life history variation among female surfperches. Environ. Biol. Fish. 10(3):159 – 171.

Banerjee, T. 1971. Maturity and fecundity of the white seaperch (*Phanerodon furcatus*) from Tomales Bay, California. J. Fish. Res. Broad Can. 28:1051 – 1053.

Banerjee, T. 1973. Age and rate of growth of the white seaperch (*Phanerodon furcatus*) from Tomales Bay, California. Trans Am. Fish. Soc. 102(2): 448 – 450.

Barry, J.P., M.M. Yaklavich, G M. Cailliet, D.A. Ambrose and B.S. Atrim. 1996. Trophic ecology of the dominant fishes in Elkhorn Slough. Estuaries 19(1): 115 – 138.

Bayer, RD. 1981. Shallow-water intertidal ichthyofauna of the Yaquina Estuary, Oregon. Northwest Sci. 55(3); 182 – 193.

Bennett, D.E. and R.S. Wydoski. 1977. Biology of the redtail surfperch (*Amphistichus rhodoterus*) from the Oregon coast. U. S. Fish Wildl. Sur. Tech. Pap. 90, 23p.

Birtwell, I.K., S. Nelles and R.M. Harbo. 1983. A brief investigation of fish in the surface waters of the Somass River Estuary, Port Alberni, British Columbia. Can. Man. Rep. Fish. Aquat. Sci. No 1799.

Boulding, E.G. 1999. Regulation of wave sheltered *Littorina sitkana* populations by pile perch, *Rhacochilus vacca*. J. Shellfish Res. 18(2): 692.

Boulding, E.G.D. Pakes and S. Kamel. 2001. Predation by the pile perch, *Rhacochilus vacca,* on aggregations of the gastropod *Littorina sitkana.* J. Shellfish Res. 20(1):403-409.

Bray, R.N. and A.W. Ebling. 1975. Food, activity and habitat of three picker-type microcarnivorous fishes in the kelp forests off Santa Barbara, California. Fish Bull. 73(4): 815 – 829.

Brett, J.R. 1979. Some morphological and behavioral adaptations of pile perch *(Rhacochilus vacca)* feeding on mussels (*Mytilus edulis*). Can. J. Zool. 57:658-664.

Brookins, K.G. 1995. Population dynamics and reproductive ecology of the redtail surfperch *Amphistichus rhodoterus* (Embiotocidae). Ph. D. thesis, Oregon State Univ. Corvallis.

Brouwer, D. 1993. Trip Report – Surf/Pile Perch. June 1-2, 1993. Unpublished Data.

Buckley, R.M. and G.J. Hueckel. 1985. Biological processes and ecological development on an artificial reef in Puget Sound, Washington. Bull. Mar. Sci. 37(1): 50 – 69.

California Department of Fish and Game. 2002. 2002 California Ocean Sport Fishing Regulations. www.dfg.ca.gov/mrd/sportfishing regs. pdf. Accessed January 20, 2003

Canada Department of Fisheries. 1913. Forty-sixth annual report of the Department of Marine and Fisheries: 1912-1913 Fisheries. King's Printer, Ottawa.

Canada Department of Fisheries. 1915-1918. [Forty-seventh – Fifty-first] annual report of the Fisheries Branch, Department of the Naval Service [1914-15 – 1917]. King's Printer, Ottawa. 4 vols.

Cannon, R. 1956. How to fish the Pacific Coast. Lane Pub. Co. Menlo Park. 337p.

Csepp, D.J. and B.L. Wing. 1999. Northern range extensions and habitat observations for blackeye goby *Rhinogobiops nicholsi* and kelp perch *Brachyistius frenatus* in southeastern Alaska. Alsk. Fish Res. Bull. 6(2): 78 – 84.

Culver, B. 1980. The 1977 and 1978 recreational fishery for redtail surfperch (*Amphistichus rhodoterus*) at Daman Point, Washington. Wash. Dep. Fish. Prog. Rept. 118

Darling, J.D.S., M.L. Noble and E. Shaw. 1980. Reproductive strategies in the surfperches. 1. Multiple inseminations in natural populations of the shiner perch, *Cymatogaster aggregata.* Evolution 34(2): 271 – 277.

DeMartini, E.E. 1969. A correlative study of the ecology and comparitive feeding mechanism morphology of the Embiotocidae (surf-perches) as evidence of the family's adaptive radiation into available ecological niches. Wasmann J. Biol. 27(2):177-247.

De Martini, E.E. 1988. Size-assortative courtship and competition in two embiotocid fishes. Copeia 1988(2): 336 – 344.

De Martini, E.E., T.O. Moore and K.M. Plummer. 1983. Reproductive and growth dynamics of *Hyperprosopon argenteum* (Embiotocidae) near San Diego, California. Env. Biol. Fish. 8(1): 29–38.

Department of Fisheries and Forestry of Canada: Fisheries Service. 1970-1971. British Columbia catch statistics [1969-1970]. Queen's Printer, Ottawa. 2 vols.

Department of Fisheries of Canada. 1955-1969. British Columbia catch statistics [1954-1968]. Queen's Printer, Ottawa. 15 vols.

Department of Fisheries and Oceans Canada. 2001. New and emerging fishery policy. Website Reference: www.ncr.dfo.ca/communic/fish_man/nefp_e.htm. Accessed Jan 11, 2003.

Department of the Environment: Fisheries and Marine Service. 1973-1976. British Columbia catch statistics [1972-1975]. Queen's Printer, Ottawa. 4 vols.

Department of the Environment: Fisheries Service. 1972. British Columbia catch statistics 1971. Queen's Printer, Ottawa.

Dominion Bureau of Statistics (Fisheries Division) 1922-1949. Fisheries statistics of Canada [1920-1948]. King's Printer, Ottawa. 21 vols.

Eckmayer, W.J. 1975. The age and growth of the surfperch (Embiotocidae) from the outer harbor of Anaheim Bay, California. M.S. thesis, Calif. State Univ. Long Beach. 112p.

Eckmayer, W.J. 1979. Age and growth of four surfperches (Embiotocidae) from the outer harbor of Anaheim Bay, California. Calif. Fish Game 65(4): 265 – 272.

Eigenmann, C.H. 1894. On the viviparous fishes of the Pacific Coast of North America. Bull. U. S. Fish Comm. XII: 478p.

Ellison, J.P., C. Terry and J.S. Stephens Jr. 1979. Food resource utilization among five species of embiotocids at King Harbour, California, with preliminary estimates of caloric intake. Mar. Biol. 52(2): 161 – 169.

Eschmeyer, W.N., E.S. Herald and H. Hammann. 1983. A Field Guide to Pacific Coast Fishes of North America. Houghton Mifflin Co. Boston. 336p.

Engen, P.C. 1968. Organogenesis in the walleye surfperch, *Hyperprosopon argenteum* (gibbons). Calif. Fish Game 54(3): 156 – 169.

Feder, F.M., C.H.Turner and C. Limbaugh. 1974. Observations on fish associated with kelp beds in southern California. Calif. Dept. Fish Game, Fish Bull. 160. 144p.

Fisheries and Environment: Fisheries Management Pacific Region. 1977-1978. British Columbia catch statistics [1976-1977]. Queen's Printer, Ottawa. 2 vols.

Frey, H.W., [ed.]. 1971. California's living marine resources and their utilization. Calif. Fish game. Sacramento.

Fritzsche, R.A. and P. Collier. 2001. Surfperches. California Marine Living Resources: A Status Report. Calif. Fish Game. Dec. 2002. Access by: www.dfg.gov.ca/mrd/status/surfperches/pdf. 13 p.

Garrison, K.J. and B.S. Miller. 1982. Review of the early life history of Puget Sound fishes. Fish. Res. Inst. Rep. FRI-UW – 8216. Univ. Wash. Seattle

Gnose, C.E. 1967. Ecology of the striped seaperch, *Embiotoca lateralis*, in Yaquina Bay, Oregon. M. S. thesis, Oregon State Univ. Corvallis Or. 53p.

Goldberg, S.R. 1978. Reproductive cycle of the white seaperch, *Phanerodon furcatus* (Embiotocidae). Copeia 1978(2): 334 – 336

Gordon, C.D. 1965. Aspects of the life history of *Cymatogaster aggergata* Gibbons. M.Sc. Thesis, U. BC, 90p.

Gotshall, D.W., G.H. Allen and R.A. Barnhart. 1980. An annotated checklist of fishes from Humboldt Bay, California. Calif. Fish Game. 66: 220 – 232.

Greer, G. L., C. D. Levings, R. Harbo, B. Hillaby and T. Brown. 1980. Distribution of fish species on Roberts and Sturgeon Banks recorded in seine and trawl surveys. Can. Man. Rep. Fish. Aquat. Sci. 1596.

Halderson, L. and M. Moser. 1979. Geographic patterns of prey utilization in two species of surfperch (Embiotocidae). Copeia 1979(4): 567 – 572.

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

Hay, D.E., R. Harbo, J. Boutillier, E. Wylie, L. Convey, and P.B. McCarter. 1999. Assessment of bycatch in the 1997 and 1998 shrimp trawl fishery in British Columbia, with emphasis on eulachons. Can. Stock Asses. Sec. Res. Doc. 99/179: 44p.

Hobson, E.S. 1971. Cleaning symbiosis among California inshore fishes. Fish. Bull. 69(3):491-523.

Hobson, E.S. and J.R. Chess. 1976. Trophic interactions among fishes and zooplankters near shore at Santa Catalina Island, California. Fish. Bull. 74(3):567-598.

Hobson, E.S. and J.R. Chess. 1986. Relationship among fishes and their prey in a nearshore sand community off southern California. Environ. Biol. Fish. 17(3): 201 – 226.

Holbrook, S.J., M. H. Carr, R. J. Schmitt, and J.A. Coyer. 1990. Effects of giant kelp on local abundance of reef fishes: The importance of ontogenetic resource requirements. Bull. Mar. Sci. 47(1): 104 – 114.

Holbrook, S.J. and R.J. Schmitt. 1992. Causes and consequences of dietary specialization in surfperches: patch choice and intraspecific competition. Ecology 73(2): 402 – 412.

Hubbs, C.L. 1917. The breeding habits of the viviparous perch *Cymatogaster*. Copeia 47: 72 – 74.

Hubbs, C.L., and Hubbs, L.C. 1954. Data on the life history, variation, ecology and relationships of the kelp perch, *Brachyisticus frenatus*, an embiotocid fish of the Californias. Cal. Fish Game 40(2): 183-198.

Karpov, K.A., D.P. Albin and W.H. van Buskirk. 1995. The Marine Recreational Fishery in Northern and Central California. A historical comparison (1958-86), Status of the stocks (1980-1986) and effects of changes in the California current. Cal. Dept. Fish Game , Fish. Bull. 176. 192p.

Klingbeil, R A. 1972. A comparative study of the food and feeding of the teleostean fishes in Anaheim Bay, California. M. S. thesis, California State Univ. Long Beach. Long Beach Ca. 129p.

Lamb, A and P. Edgell. 1986. Coastal Fishes of the Pacific Northwest. Harbour Pub. Co., Madeira Park. 224p.

Larson, R.J. and E.E. DeMartini. 1984. Abundance and vertical distribution of fishes in a cobble-bottom kelp forest off San Onofre, California. Fish. Bull. 82(1): 37 – 55.

Lauzier, R.B. 1999. A review of the biology and fisheries of the Goose Barnacle (*Pollicipes polymerus* Sowerby, 1833). Canadian Stock Assessment Sec. Research Doc. 99/111. 30p.

Leet, W.S., C.M. Dewees and C.W. Haugen. 1992. California's living marine resources and their utilization. Calif. Sea Grant Exten. (UCSGEP) 92 – 12.

Low, C.J. and R.J. Beamish. 1978. Study of the nesting behavior of lingcod (*Ophiodon elongates*) in the Strait of Georgia British Columbia. Fish. Mar. Serv. Tech. Rep. Can. 843. 27p.

McCormack, S.M.D. 1982. The maintenance of shore-level size gradients in an intertidal snail (*Littorina sitkana*). Oecologia 54(2): 177 – 183.

McNab, J. 1892. Annual report on the fisheries of British Columbia for the year 1891. *In* Annual report of the Department of Fisheries of the Dominion of Canada, 1891. Queen's Printer, Ottawa.

Miller, D.J. and D. Gotshall. 1965. Ocean sportsfish catch and effort from Oregon to Point Arguello, California. July 1, 1957-June 30, 1961. Calif. Dept. Fish. Game, Fish Bull. 130. 135p.

Miller, D.L. and R.N. Lea. 1972. Guide to the coastal marine fishes of California. Calif. Dept. Fish. Game Fish Bull. 157. 235p.

Moring, J.R. 1984. Feeding of underyearling walleye surfperch, *Hyperprosopon argenteum,* in a northern Californian bay. Estuaries 7(1): 102 – 104.

Mowat, T. 1891. Annual report on the fisheries of British Columbia for the year 1890. *In* Annual report of the Department of Fisheries, Dominion of Canada, for the calendar year 1890. Queen's Printer, Ottawa.

Nelson, J.S. 1994. Fishes of the World. 3rd . Ed. John Wiley & Sons, New York. 600p.

Odenweller, D.B. 1971. The life history of the shiner perch, *Cymatogaster aggregata,* Gibbons, in Anaheim Bay. M.S. thesis, Calif State Univ, Long Beach. 66p.

Odenweller, D.B. 1975. The life history of the shiner perch, *Cymatogaster aggregata* Gibbons, in Anaheim Bay, California: 107 – 115, In Lane E. D. and C. W. Hill [eds.]. The marine resources of Anaheim Bay. Calif. Fish Game Fish Bull. 165, 195p.

Oregon Department of Fish and Wildlife. 2002. An Interim Management Plan for Oregon's Nearshore Commercial Fisheries. Internet Reference: www.hmsc.oregonstate.edu/odfw/ Accessed January 17, 2003.

Oregon Department of Fish and Wildlife. 2003. 2003 Synopsis: Oregon Commercial Fishing Regulations. Internet Reference: www.dfw.state.or.us/ODFWhtml.Regulations/2003_commercial .pdf. Accessed January 17, 2003.

Peden, A.E. 1966. Rare marine fishes from British Columbia with first records of silver perch, *Hyperprosopon ellipticum*, and shanny, *Leptoclinus maculates*. J. Fish. Res. Board Can. 23(8):1277-1280.

Perry, I.R., C.J. Walters, and J.A. Boutillier. 1999. A framework for providing scientific advice for the management of new and developing invertebrate fisheries. Rev. Fish Biol. Fish. 9: 125-150.

Quast, J.C. 1968. Estimates of the populations and standing crops of fishes: 57 – 108. In, North, W.J. and C.L. Hubbs, [eds.]. Utilization of kelp-bed resources in southern California. Calif. Fish. Game. Fish Bull. 139.264p.

Quinnell, S. 1986. Trends in the drag seine fishery for surfperch (Embiotocidae) of the inside waters of Washington State and related management concerns. Wash. Dep. Fish. Prog. Rep. No. 240.

Rechnitzer, A.B. and Limbaugh, C. 1952. Breeding habits of *Hyperprosopon argenteum,* a viviparous fish of California. Copeia 1952(1): 41 – 42.

Rice, J., R.D. Humphreys, L. Richards, R. Kadowaki, D Welch, M. Stocker, B. Turris, G.A. McFarlane, F. Dickson and D. Ware. 1995. Pacific Stock Assessment Review Committee Annual Report for 1994. Appendix 3. Biological objectives working group report. Can. MS Rep. Fish. Aquat. Sci. 2318:16-52.

Richards, L.J., H.I. McEldery, J. Carolsfeld, and C.P. Lauridsen. 1986. SCUBA survey of rockfish assemblages in the Strait of Georgia, B. C. (Statistical areas 15 and 16), September to November 1985. Can. Data. Rep. Fish. Aquat. Sci. 586.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Fish Res. Board Can. Bull. 191. 382p.

Robins, C.R., Chair., 1991. Common and Scientific Names of Fishes from the United States and Canada. 5th Ed. Amer. Fish Soc. Spec. Pub. 20. Bethesda, Maryland. 183p.

Roedel, P M. 1953. Common Ocean Fishes of the California Coast. Cal. Dept. Fish. Game, Fish Bull. 91 :102-113.

Royce, W F. 1975. Use of yield models in fishery management: 9–12 In, Roedel, P. M. ed., Optimum sustainable yield as a concept in fishery management. Amer. Fish. Soc., Spec. Pub. 9.

Schmitt, R.J. and S.J. Holbrook. 1986. Seasonally fluctuating resources and temporal variability of interspecific competition. Oecologia 69(1): 1–11.

Schmitt, R.J. and S.J. Holbrook. 1990. Population responses of surf perch released from competition. Ecology 71(5): 1653–1665.

Stenson, G.B., G.A. Badgero and H.D. Fisher. 1984. Food habits of the river otter *Lutra Canadensis* in the marine environment of British Columbia. Can. J. Zool. 62(1): 88–91.

Suomela, A.J. 1931. The age and growth of *Cymatogaster aggregata* Gibbons collected in Puget Sound, Washington. M.S. thesis, Univ. of Wash., Seattle Washington. 43p.

Swedberg, S.E. 1965. Age-fecundity relationships in the striped seaperch *Embiotoca lateralis* from Yaquina Bay, Oregon. M.S. thesis, Oregon State Univ., Corvallis Oregon.

Tarp, F.H. 1952. A Revision of the Family Embiotocidae (the surfperches). Cal. Fish. Game Fish Bull. 88. 99p.

Terry, C.B. and J.S. Stephens Jr. 1977. A study of the orientation of selected embiotocid fishes to depth and shifting seasonal vertical temperature gradients. Bull. South Calif. Acad. Sci. 75(2): 170 – 183.

Turner, C.L. 1947. Viviparity in teleost fishes. Scientific Monthly, 65(6):508-518.

Wares, P.G. 1971. Biology of the pile perch, *Rhacochilus vacca* , in Yaquina Bay, Oregon. U. S. Dept. Interior Tech. Papers Bur. Sportfish and Wildlife. 57. 21p.

Weibe, J.P., 1968a. The effects of temperature and daylight on the reproductive physiology of the viviparous seaperch, *Cymatogaster aggregata* Gibbons. Can J. Zool. 46(6):
1207–1219.

Weibe, J.P. 1968b. The reproductive cycle of the viviparous seaperch, *Cymatogaster aggregata* Gibbons. Can. J. Zool. 46(6):1221–1234.

Wilson, D.C., and R.E. Millemann. 1969. Relationships of female age and size in the shiner perch, *Cymatogaster aggregata.* J. Fish. Res. Board Can. 26(9): 2339–1234.

Wourms, J.P. and J. Lombardi. 1992. Reflections on the evolution of piscine viviparity. Am. Zool. 32:276.

Wydoski, R.S. and D.E. Bennett. 1973. Contributions to the life history of the silver surfperch (*Hyperprosopon ellipticum*) from the Oregon coast. Calif. Fish Gamer 59(3):178-190.

Yoklavich, M.M., G.M. Calliet, J.P. Barry, D.A. Ambrose and B.S. Atrim. 1991. Temporal and spatial patterns in abundance and diversity of fish assemblages in Elkhorn Slough, California. Estuaries 14(4): 465–480.

Table 1. Latitudinal Ranges of BC Embiotocids[1]

Species along the whole BC coast	Southern Limit	Northern Limit
Shiner perch	San Quintin Bay, Baja California	Port Wrangell, Alaska
Pile perch	Guadalupe Is., Baja California	Port Wrangell, Alaska
Striped seaperch	Pt. Cabras, Baja California.	Port Wrangell, Alaska
Kelp perch	Turtle Bay, Baja California	North BC into SE Alaska
Species with limited distribution in BC		
Redtail surfperch	Monterey Bay, California	Halfmoon Bay, Central Vanc. Is. BC
White seaperch	Pt. Cabras, Baja California	Southern Vancouver Is. BC
Silver surfperch	Rio San Vincente, Baja California	Ucluelet area, BC. Vancouver Is. BC
Walleye surfperch	Pt. San Rosarito, Baja California	South Vancouver Is. Esquimalt Hb. BC

[1]Distribution data taken from Hart (1973), Karpov *et al.* (1995), Lamb and Edgell (1986) and
Miller and Lea (1972)

Table 2. Surfperch Species, Habitats, and Diets[1]

Species	Habitats	Diets
Redtail surfperch	Sandy open coast, bays and wharves, often turbid waters	Mollusks, small fish, isopods amphipods, decapods polychaetes
Walleye surfperch	Sandy open coast, bays and wharves	Amphipods, isopods decapod shrimp
Silver surfperch	Sandy open coast, sandy surf around piers	Small amphipods, cirripeda small decapods-shrimp/crabs
Striped seaperch	Along rocky coasts with algal growth, piling community in bays	Amphipods, molluscs, cirrepeda, decapod shrimp fish eggs
White seaperch	Generalized, sandy, rocky muddy shallows, pilings, mud/rock benthos	Decapod shrimp, cirripeda occasionally bivalves polychaetes, bryozoans
Shiner perch	Demersal in sandy muddy shallows especially near wharves, protected water	Amphipods, cumaceans small mollusca, polychaetes copepods, cirripeds
Pile perch	Open and protected rocky coast, shallow mud/sand and rock areas near wharves	Hard shelled mollusca, decapod crabs, crushes hard shells
Kelp perch	Kelp beds, in water column, rarely in other areas	Amphipods, isopods bryozoans, interspecific ectoparasite cleaner

[1]Data from Hubbs and Hubbs 1954; Gordon 1965,1967; DeMartini 1969; Feder et al 1974; Hobson 1971; Bennett and Wydoski 1977; Low and Beamish 1978; Brett 1979; McCormack 1982; Boulding 1999.

Table 3. Mean Fecundity with Mean Standard Length (SL, in mm) and Age in Surfperch by Species[1]

	Pile perch		Redtail Surfperch		Striped Seaperch		White seaperch	
Age	SL	Fecundity	SL	Fecundity	SL	Fecundity	SL	Fecundity
I	87.0	0	78.1	0	130.0	0	110.2	0
11	145.0	0	124.3	0	173.0	0	160.1	10.1
III	192.0	0	203.5	0	216.0	17.0	186.7	16.8
IV	224.0	18.0	218.2	8.7	233.0	21.0	203.8	21.0
V	255.0	22.4	227.0	11.9	262.0	30.0	215.5	24.0
VI	274.0	28.7	251.0	18.4	277.0	31.0	231.5	28.0
VII	292.0	31.7	275.7	25.4	297.0	32.0	233.7	28.5
VIII	312.0	39.8	292.2	33.7				
IX	328.0	52.5						
X	332.0	52.0						

	Walleye surfperch		Silver surfperch		Shiner perch		Kelp perch
Age	SL	Fecundity	SL	Fecundity	SL	Fecundity	
I	110.0	6.0	81.8	0	82.3	5.8	No data
II	130.0	8.0	127.5	3.4	98.8	9.3	
III	140.0	10.0	147.9	8.0	105.0	11.1	
IV	151.0	11.0	165.9	12.1	115.8	15.4	
V			184.3	16.3	119.4	15.0	
VI					122.2	20.0	

[1]Data from Swedberg 1965; Gnose 1967; Wilson and Millemann1969; Miller and Lea 1972; Bennett and Wydoski 1977; Baltz 1984.

Table 4. Maximum Age (years), Maximum Standard Length (SL, in mm), and Weight (kg) of Embiotocids Found in BC[1]

Species	Max. Age	Max. SL	Max. Weight
Pile perch	10	342	1.16
Redtail surfperch	8	322	1.34
Striped seaperch	7	299	0.87
White seaperch	7	261	0.69
Walleye surfperch	6	245	0.25
Silver surfperch	7	237	0.21
Shiner perch	6	162	0.17
Kelp perch	No data	153	0.17

[1]Length data calculated from Miller and Lea (1972). Weight data based on information in Swedberg 1965; Anderson and Bryan 1970; Eckmayer 1975.

Table 5. Simple von Bertalanffy Growth Parameters Based on the Ford Walford Model (Ricker 1975) in Four Embiotocids from California (Wares 1971; Eckmayer 1975, 1979)

Species	Shiner perch	Pile perch	White seaperch	Walleye surfperch
L_∞	128.7	322.5 –328.6	201.95	173.7
K	0.063	0.180	0.425	-0.538
t_o	-0.045	- 0.882	-0.782	0.257

Table 6. **Preliminary Estimation of the Recreational Catch of Embiotocids from Public and Private Docks in BC in 2001.**

Dock location	Fisher/year	Dock location	Fisher/year
Alert Bay	306	Klemtu	0
Bamfield	612	Maple Bay	688
Bamfield	131	Massett	536
Bella Bella	918	Pender Harbour	22
Bella Bella	306	Port Alberni	918
Bella Coola	12	Port Clements	765
Brentwood Bay	230	Port Edward	0
Campbell River	0	Port McNeill	1071
Chemainus	688	Powell River	994.5
Coal Harbour	459	Powell River (Priv.)	1683
Comox	612	Powell River	229
Cowichan Bay	6	Quadra Island	230
Croften	689	Queen Charlotte City	536
Deep Cove	0	Refuge Cove	1912
Esquimalt	153	Saltspring Is	0
False Creek	0	Sandspit	612
Fanny Bay	55	Shearwater	12
Gibbsons	488	Sidney	0
Gold River	0	Sooke	0
Hartley Bay	230	Stewert	22
Hopkins Landing	1683	Tofino	383
Kelsey Bay	22	Tofino (Priv.)	306
Kitimat	20	Ucluelet	0
Moon Bay	229	Zeballos	612

Average number of fishers /dock/year = 403.8

Estimated number of marine dock in BC = 219 (excluding small private docks not available to the public)

Number surveyed = 48, Percent surveyed = 22%

Average catch per dock, based on three fish/fisher/day = 1211.4. (the average number of fishers per dock per year times three fish per fisher).

Estimated total dockside catch in BC = 265,297 surfperch. (Average catch per dock times estimated number of docks).

Table 7. Recorded surfperch catch data for Statistical Management Areas 1-10, 11-27, and 28-29 between 1912 and 1999[1]

Year	Catch (kg)			
	Areas 1-10	Areas 11-27	Areas 28-29	Total (kg)
1912	*	*	59240	59240
1913	*	*	*	*
1914	*	*	15604	15604
1915	*	*	22090	22090
1916	*	*	33566	33566
1917	*	*	*	22317
1918	*	*	*	*
1919	*	*	*	*
1920	0	54568	37104	54568
1921	0	52754	44770	52754
1922	0	41822	39690	81512
1923	0	38102	39010	77112
1924	0	24449	34474	58923
1925	0	27352	19913	47265
1926	0	19732	22136	41868
1927	0	34927	27715	62642
1928	0	26263	38375	64638
1929	0	33702	65182	98884
1930	0	28123	47900	76023
1931	0	17418	25674	43092
1932	0	12383	20049	32432
1933	0	9843	14107	23950
1934	0	7847	16965	24812
1935	0	12338	23859	36197
1936	0	24358	28622	52980
1937	0	4037	19051	23088
1938	0	7167	17509	24676
1939	0	2767	20321	23088
1940	0	4808	17872	22680
1941	0	4355	11703	16058
1942	0	17418	12429	29847
1943	0	20276	17600	37876
1944	0	28758	23587	52345
1945	0	48989	20866	69855
1946	0	48354	4264	52618
1947	*	*	*	28577
1948	*	*	*	20866
1949	*	*	*	16330
1950	*	*	*	28123
1951	*	*	*	*
1952	*	*	*	*
1953	*	*	*	*
1954	195683	0	0	195683
1955	32659	19890	635	20525
1956	0	21070	2087	23157
1957	47673	18915	1043	19958
1958	0	19686	363	20049
1959	0	21228	454	21682
1960	45	15581	227	15808

Table 7.- Continued

1961	0	12429	91	12520
1962	0	13218	318	13536
1963	0	13245	680	13925
1964	0	8460	454	8914
1965	0	13676	363	14039
1966	0	11658	91	11749
1967	0	17146	272	17418
1968	0	14402	136	14538
1969	3130	16692	227	16919
1970	0	20253	91	20344
1971	1043	17872	0	17872
1972	227	15649	0	15649
1973	1814	5670	0	5670
1974	227	14651	0	14651
1975	454	13835	0	13835
1976	0	8845	0	8845
1977	227	15422	0	15422
1978	*	*	*	*
1979	*	*	*	*
1980	*	*	*	*
1981	*	*	*	*
1982	*	*	*	*
1983	0	0	0	0
1984	0	12501	0	12501
1985	0	5223	454	5677
1986	0	106	0	106
1987	0	249	0	249
1988	0	0	0	0
1989	0	1542	0	1542
1990	0	1049	175	1224
1991	0	1959	1169	3128
1992	0	11286	0	11286
1993	0	2438	0	2438
1994	0	2030	0	2030
1995	0	3056	255	3311
1996	0	3552	0	3552
1997	0	39	0	39
1998	0	111	0	111
1999	0	107	0	107

Note: * denotes lack of information. Landings may have occurred, but no record available.

[1] **Canada Department of Fisheries 1913**
Canada Department of Fisheries 1915-1918
Dominion Bureau of Statistics (Fisheries Division) 1922-1949
Department of Fisheries of Canada 1955-1969
Department of Fisheries and Forestry of Canada: Fisheries Service 1970-1971
Department of the Environment: Fisheries Service 1972
Department of the Environment: Fisheries and Marine Service 1973-1976
Fisheries and Environment: Fisheries Management Pacific Region 1977-1978.
Catch data from 1983 to 1999 from DFO database.

Table 8. Landings of surfperch between 1984 and 1999 in BC reported by Statistical Management Area

Year	Total Catch (kg)												Total
	13	14	15	16	17	18	19	20	23	24	28	29	
1984	266			44	5826	6365							12501
1985					4679	544						454	5677
1986	107												107
1987	249												249
1988													0
1989				1542									1542
1990			186	781		82						175	1224
1991	458			20	1290	193					35	1130	3126
1992					1576	91			1360	8259			11286
1993		360		270	1652	120		36					2438
1994					1840		28	162					2030
1995		104	0	150	2691	5		107				255	3311
1996	400	0	113		2903	136							3552
1997						39							39
1998						111							111
1999						107							107
Total	1480	464	299	2807	22457	7793	28	305	1360	8259	35	2014	47300

Statistical Management Areas:

13 – Southern Johnstone Strait and Campbell River
14 – Courtney/Comox
15 – Powell River
16 – Malaspina Strait, Sechelt Peninsula, and Jervis Inlet
17 – Nanaimo
18 – Cowichan
19 – Victoria
20 – Juan de Fuca
23 – Barkley Sound
24 – Clayoquot Sound
28 – Howe Sound
29 – Fraser River

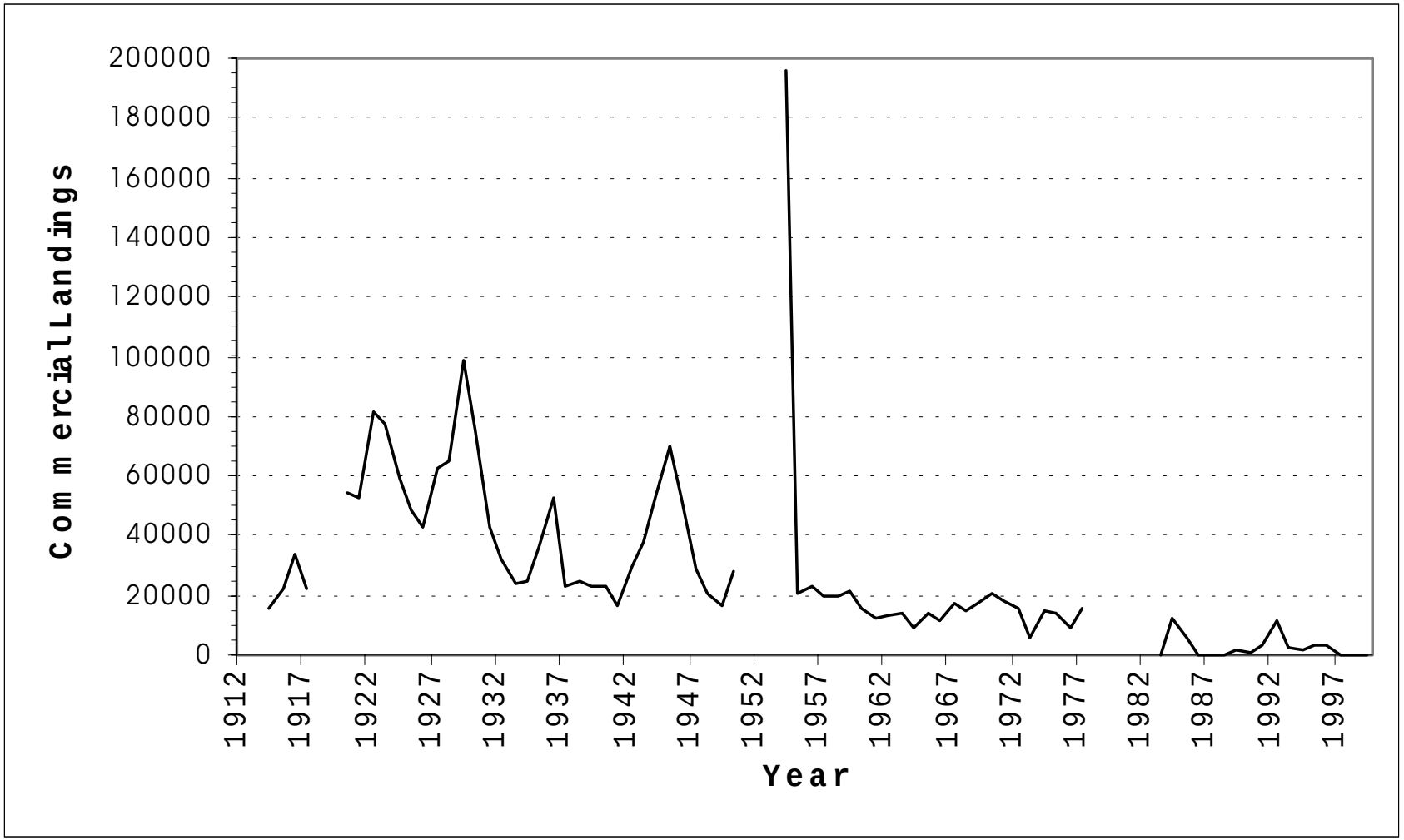
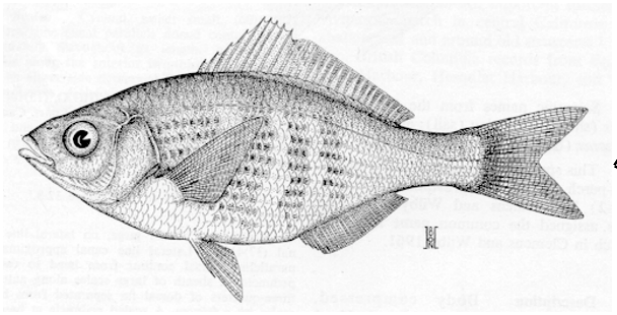


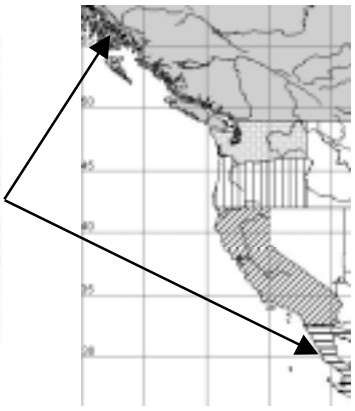
Figure 1. Reported surfperch catches for the BC coast from 1912 to 1999

APPENDIX 1

A synopsis of aspects of identification, distribution, life history and utilization of the eight species of surfperch found on the coast of BC. The illustrations of the species come from Hart (1973). References for each species are shortened to the authors' name and date. Complete citations can be found in the literature cited following the main text.

Cymatogaster aggregata. Shiner perch





Recognition: Large scales, yellowish bars on sides, slender caudal peduncle (4,15)

Range in Canada: Throughout coastal BC in marine and estuarine waters (13,15)

Habitat: In schools or aggregations (13). BC-–Summer, shallow waters, bays estuaries, eelgrass flats, wharves and pilings (6,20,24). Winter, some move to deeper water, recorded to 146 m (13,14). S. California--Leave shallow water for deeper cooler water in June, returns shallows in fall (10,19).

Temperature: Eurythermal from 4–21°C, usually below 18.5°C (19),

Salinity: Based on habitat, appears to be the most euryhaline embiotocid. From close to 0 ppt to 35 ppt.

Food: Small mouth adapted to feeding on small invertebrates; amphipods, cumaceans, polychaetes, copepods and tunicates and fish eggs, both in zooplankton and benthos (5, 9,14,19).

Age: Aged with scales and otoliths (19). Maximum age 6 years (4,22,24). Maximum size 20cm total length (TL); 16.26cm standard length (SL), 0.17kg weight (1,4,11). Most do not exceed 5 yrs. and 10-11cm SL In some populations females slightly larger than males (14,24).

Populations: Most common embiotocid in its range. Very common in BC (7,14).

Reproduction: Viviparous, Brood size 4–20 (24), increases with increasing size and age (7,10,24). Mature from age 1 (4). Mate in June/July (23), evidence of multiple mates (8). Sperm stored in female until winter fertilization, gestation 5 months, and young born between April/May (S. California) to July/August (BC) (9,12,14,22,23). SL at birth 27–38 mm.

Predators: Sea birds, river otters, seals and sea lions, large fish such as rockfish and lingcod (17,19,21)

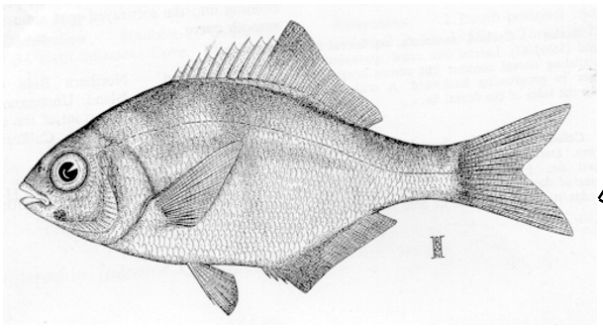
Parasites: Various ectoparasites including copepods and isopods. Endoparasites include cestodes, nematodes and acanthocephalids (2,3). No diseases reported.

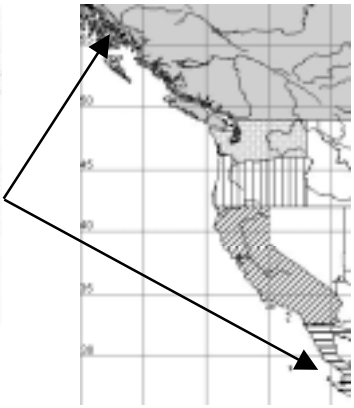
Utilization: Despite its small size the shiner surfperch is likely the most commonly caught embiotocid in the recreational fishery, usually from wharves. Used as bait, and eaten dried, pickled and occasionally in sushi (18). Commercial fishery only for aquarium trade, caught in shrimp trawl bycatch in significant numbers (16).

References:

1. Anderson and Bryan, 1970
2. Arai, 1969
3. Arai, Kabata and Noakes, 1988
4. Baltz, 1984
5. Barry, Yokavich, Cailliet, Ambrose and Antrim, 1996
6. Bayer, 1981
7. Buckley and Hueckel, 1985
8. Darling, Noble and Shaw, 1980
9. De Martini, 1969
10. Eckmayer, 1975
11. Eckmayer, 1979
12. Eigermann, 1894
13. Eschmeyer, Herald and Hammann, 1983
14. Gordon, 1965
15. Hart, 1973
16. Hay, Harbo, Boutillier, Wylie, Convey and McCarter, 1999
17. Karpov,Albin,and Buskirk, 1995.
18. Lamb and Edgell, 1986
19. Odenweller, 1975
20. Roedel, 1953
21. Stenson, Badgero and Fisher, 1984
22. Suometa, 1931
23. Wiebe, 1968a
24. Wilson and Millemann,1969

Rhacochilus = *Damalichthys vacca* Pile perch





Recognition: Dorsal fin anterior spines much shorter than rays, Caudal fin deeply forked, Usually broad dusky or dark bar(s) on midside.(13,19,24).

Range in Canada: Throughout coastal BC in marine waters (13,19)

Habitat: Aggregate all year, tend to be inshore in summer and move to deeper water in winter. Most common in protected waters along sandy and rocky shores, around pilings and kelp. Often near the bottom. Recorded to 74 m (13,14,17,21,22,25,28,29,30).

Temperature: Considered to be embiotocid with the least tolerance to high temperature. Chooses coolest water available. Rarely found in water above 16°C, lower limit 4°C (32).

Salinity: Largely marine salinities but has been taken in lower estuary areas (17).

Food: Pharyngeal teeth adapted for crushing and grinding. Gastropods, mussels, and decapod crustaceans main foods (4,6,8,9,12,14,18,20,23,26).

Age: In Canada the largest and longest lived surfperch. Max. length 44.5cm TL, 34.2 cm SL. Weight estimated to 1.16 kg. Aged to 10 years (1,10,11,16,25,33). Females slightly larger than male in fish 5 years and older (27).

Populations: Common along the northwest coast in suitable habitat (6,7,15). Considered to be a significant part of near shore fish fauna in BC (1,4,5).

Reproduction: Viviparous, brood size increases with age and size of female, from 18 to 52 young. Give birth from ages 4 to 10 (3). Gestation considered 5 months with birth May–September (28,33). Size at birth 76–85.7 mm TL.

Predators: Based on general embiotocid predators reported, sea birds, river otters, seals, sea lions and large fish such as rockfish and lingcod (22,31).

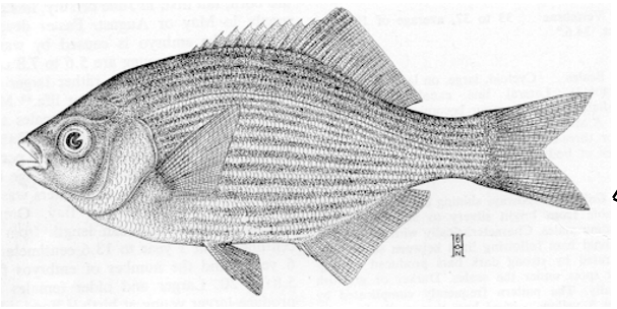
Parasites and Diseases: Digeneads reported at low infestations rates (2). No disease reports.

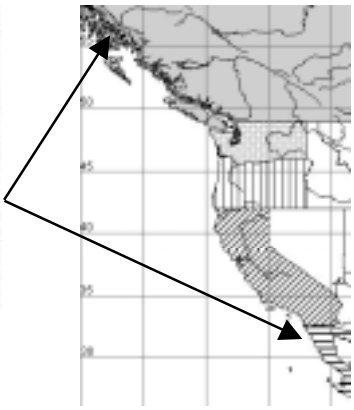
Utilization: In the U.S. important commercial species and recreational fishery.(22) In BC major catches are in recreational fishery mainly from wharves (24). Has been mentioned as potential aquaculture species (8).

References:

1. Anderson and Chew, 1972
2. Arai, 1969
3. Baltz, 1984
4. Bayer, 1981
5. Birtwell, Nelles and Harbo, 1983
6. Boulding, 1999
7. Boulding, Pakes and Kamel, 2001
8. Brett, 1979
9. DeMartini, 1969
10. Eckmayer, 1975
11. Eckmayer, 1979
12. Ellison, Terry and Stephens, 1979
13. Eschmeyer, Herald and Hermann, 1983
14. Feder, Turner and Limbaugh, 1974
15. Garrison and Miller, 1982
16. Gotshall, Allen and Barnhart, 1980
17. Greer, Levings, Harbo, Hillaby and Brown, 1980
18. Halderson and Moser, 1979
19. Hart, 1973
20. Holbrook, Carr, Schmitt and Coyer, 1990
21. Hubbs and Hubbs, 1954
22. Karpov, Albin, and Buskirk, 1995
23. Klingbeil, 1972
24. Lamb and Edgell 1986
25. Leet, Dewees and Haugen, 1992
26. McCormack, 1982
27. Quast, 1968
28. Quinnel, 1986
29. Richards, McElderry, Carolsfeld and Lauridsen, 1986
30. Roedel, 1953
31. Stenson, Badgero and Fisher, 1984
32. Terry and Stevens, 1977
33. Wares, 1971

Embiotoca lateralis – Striped Seaperch





Recognition: Approx. 15 to 17 horizontal blue and orange stripes on side, blue streaks and spots on head. Spinous portion of dorsal fin significantly lower than adjacent rayed portion of dorsal fin (8,14,17).

Range in Canada: Throughout BC in coastal marine waters (8,14,17).

Habitat: Adults solitary or in loose aggregations, closer aggregations at breeding time (9). Eel grass, rocky shore especially with foliose red algae (kelp), pilings, surf zone. Depth 0–24 m (1,6,8,9,11,15,19,20,21). In BC large aggregations reported along rock faces at 0–8 m depth. April 2002 (S. Voller pers. com.).

Temperature: Eurythermal from 4–21°C but appears to prefer below 16C (11).

Salinity: Usually above 26 ppt but does enter lower parts of estuaries (11).

Food: Predominantly amphipods but also feed on isopods, shrimp, mussels, barnacles and fish eggs (lingcod egg masses) (1,7,11,13,15,20).

Age: Aged by scales, otoliths claimed to be difficult to age (23). Maximum 38 cm TL, 29.9 cm SL. Maximum weight calculated 0.87 kg (3,8,12,20). Average adult size 13–22 cm SL, females slightly larger than males (23). Average life 7 years; maximum 10 years (24).

Populations: Common throughout most of its range, In Washington most common fish in surf zone (6), although tends to be along rocky shores.

Reproduction: Viviparous, breeding begins at age 2 or 3 (15). Mature males reported in September and females with small embryos in December (11). Parturition in May to September, most births June–July (4,11,23). Number of embryos increases with size and age, average 18–22 per female, maximum 45 (7 yr. female), average length of young 50 mm TL (3,6,23).

Predators: River otters, seals, sea lions, likely sea birds and large fish especially rockfish and lingcod. Young most vulnerable to predation (1,5,22).

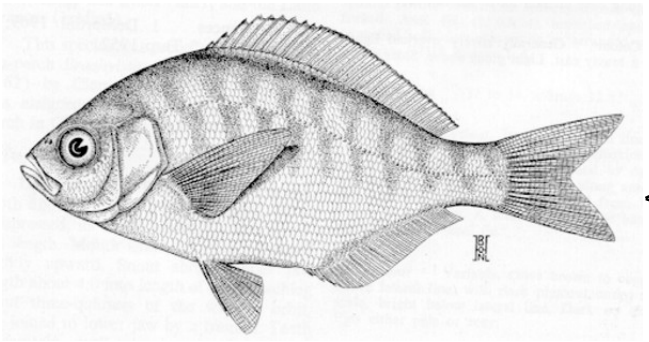
Parasites and Diseases: No reports on diseases. Digeneaids reported at moderate infestation rates (2)

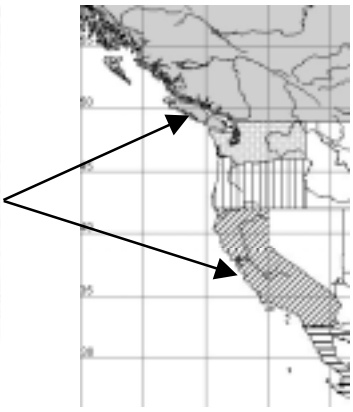
Utilization: Taken predominantly by recreational fishers, little commercial catch due to primary habitat (shallow rocky shoreline). However in Oregon, third in angler catch behind white and pile surfperch (11). Important in California (10,16,18). Washington catch large (13). In BC a part of the wharf fishery.

References:

1. Alevizon, 1975
2. Arai, Kabata and Noakes, 1998
3. Baltz, 1984
4. Bennett and Wydoski, 1977
5. Buckley and Hueckel, 1985
6. Culver, 1980
7. DeMartini, 1969
8. Eschmeyer, Herald and Hammann, 1983
9. Feder, Turner and Limbaugh 1974
10. Fritzsche and Collier, 2001
11. Gnose, 1967
12. Gotshall, Allen and Barnhart, 1980
13. Halderson and Moser,1979
14. Hart, 1973
15. Holbrook and Schmitt 1992
16. Karpov, Albin and Buskirk, 1995
17. Lamb and Edgell, 1986
18. Leet, Dewees and Haugen, 1992
19. Roedel, 1953
20. Schmitt and Holbrook, 1986
21. Schmitt and Holbrook, 1990
22. Stenson, Badgera and Fisher, 1984
23. Swedberg, 1965

Amphistichus rhodoterus Redtail surfperch





Recognition: Spinous portion of dorsal fin slightly higher than anterior rayed part. Caudal fin reddish. 8–10 vertical bars on sides, some staggered at lateral line (6,9,11,12).

Range in Canada: In BC Southwest coast of Vancouver Island (Tofino) (9,11). Possibly around the south Gulf Islands and from Vancouver south.

Habitat: In aggregations especially at mating and breeding times. Principal habitat sandy beaches in surf zone on exposed coasts; sometimes off river mouths and in bays (1,2,6,7,10,12,13). Females more common in estuaries (2). Often in turbid waters, shallow water to 7 m.

Temperature: Reported from 7-19°C (1,10). Likely lower limit colder than reported.

Salinity: From estuarial waters to 35 ppt.

Food: Opportunistic feeders. Organisms in drift and benthos. Polychaetes, small mollusks, barnacles, isopods, amphipods, small decapods and occasional small fish, hydroids and bryozoans. Seasonal changes with availability (2,5).

Age: Usually aged with scales, maximum age 8. Maximum length reported 41 TL, 32.2 cm SL, weight 1.34 kg. Average size at 8 years - 33.7 cm TL, 24.3 cm SL, 64 kg (1,2,3,8).

Populations: Populations in BC likely limited due to range restriction. It is reported commonly caught from wharves in the Tofino area (J. Morgan pers. com.). Maybe under reported in surf zone habitat as that habitat is not well sampled. Appears to be common along the US open coast (see Utilization).

Reproduction: Viviparous, mate in surf in winter (2). Fertilization in winter, at least some females move inshore to bays during gestation and parturition occurs in estuaries from May to October (2,12). Number of young correlated to female size, from 7 to 45 per female (12). Females give birth between 4 and 8 years (1). Young 66-83 mm TL at birth (12).

Predators: No reports but likely predators include river otters, seals and sea lion and sea birds.

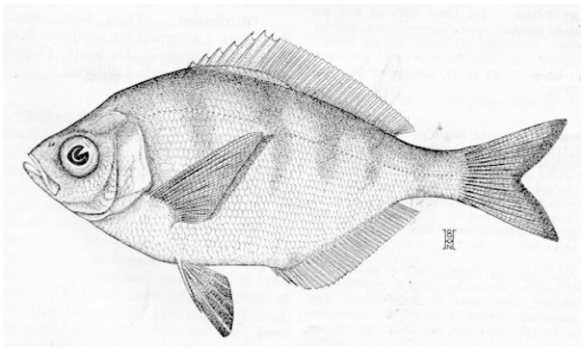
Parasites and Diseases: Nematodes, platyhelminthes, monogena and copepod parasites reported (2). No information on diseases.

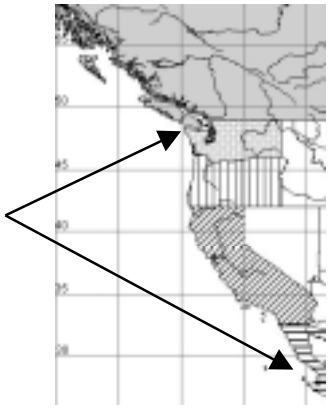
Utilization: In BC very low. In US historically one of the most important fishes in the surf zone recreational fishery (4,5,12). The major surf zone surfperch in California commercial catch, especially when concentrated for spawning (5,10,12,13).

References:

1. Baltz, 1984
2. Bennett and Wydoski, 1977
3. Brookins, 1995
4. Culver 1980
5. De Martini,1969
6. Eschmeyer, Herald and Hammann, 1983
7. Frey, 1971
8. Gotshall, Allen and Barnhart 1980
9. Hart, 1973
10. Karpov, Albin, and Buskirk, 1995
11. Lamb and Edgall,1976
12. Leet, Dewees and Haugen, 1992
13. Reodel, 1953

Hyperprosopon argenteum Walleye surfperch





Recognition: Black tip on pelvic fin, eye very large, spinous part of dorsal fin longer than anterior rayed portion (9,14,21).

Range in Canada: Very restricted, south Vancouver Island coast (9,19).

Habitat: In dense schools and aggregations most commonly on open coast sandy beaches but also found around wharves and kelp beds (9,10,12,15,21). Migrates to shallow protected waters in summer to bear young (11). Depth to 18 m (9).

Temperature: Reported from 7–21°C, however, likely in cooler temperatures in winter (2).

Salinity: Euryhaline, and tolerates a wide range of lower salinities in estuaries.

Food: Nocturnal feeders (15), rely on small invertebrates that enter the water column at night, gammarids, isopods, small shrimp and copepods common foods (4,15,19).

Age: Aged by scales to 6 years (3). Females slightly larger than males (1). Maximum size 30 cm TL, 25.4 cm SL, calculated weight 0.25 kg (6,7,13,21).

Populations: Common in California along sandy beaches (9). Does not appear to be common in BC due to very restricted range.

Reproduction: Viviparous. In California give birth in dense schools and aggregations in shallow water. Mate in November/December when eggs are released to ovarian cavity (8,17). Parturition March to July (3,20). Average number of young varies with age - 5 to 12 per female (2,9,17). Probably mature at age 1 (5). Young approximately 37.5 mm TL at birth (17).

Predators: Likely, river otters, seals, sea lions, sea birds and large fish. California halibut and sculpin reported predators (10).

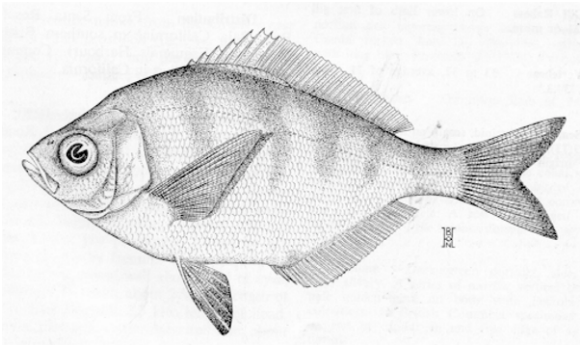
Parasites and Diseases: Ectoparasitic copepods and isopods reported (6). Also endoparsites, monogenea trematods (22). No disease reports.

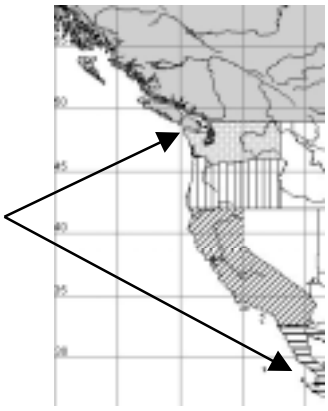
Utilization: Important commercial species in California due to schooling behaviour (15,16,17,18,21). Little commercial importance elsewhere. Caught in recreational fishery in US (9). Rarely caught in Canada due to range restriction.

References:

1. Anderson and Bryan, 1970.
2. Baltz, 1984.
3. Bennett and Wydoski, 1977.
4. DeMartini, 1969
5. DeMartini, Moore, and Plummer, 1983.
6. Eckmayer, 1975.
7. Eckmayer, 1979.
8. Engen, 1968.
9. Eschmeyer, Herald and Hammann, 1983.
10. Feder, Turner and Limbaugh, 1974.
11. Frey, 1971.
12. Fritzsche and Collier, 2001
13. Gotshall, Allen and Barnhart, 1980.
14. Hart, 1973.
15. Hobson and Chess, 1986.
16. Karpov, Albin and Buskirk, 1995.
17. Leet, Dewees, and Haugen, 1992.
18. Miller and Gotshall, 1965
19. Moring, 1984.
20. Rechnitzer and Limbaugh, 1952.
21. Roedel, 1953.
22. Wydowski and Bennett, 1973

Hyperprosopon ellipicum Silver surfperch





Recognition: Caudal fin pinkish, pelvic fin not black tipped. Spinous portion of dorsal fin higher than rayed portion (4,9,12,14).

Range in Canada: Very restricted, from Ucluelet south on Vancouver Island (4,9,12,13,14).

Habitat: Inshore, open coast over sand; also around steeply sloping rocks near seaweed, in surf zone and surf around piers. Depths to 110 m (1,4,5,6,10,11,12,13).

Temperature: Recorded from 7-21°C, likely lower in winter (1,10).

Salinity: Marine to outer estuarine conditions.

Food: Opportunistic; small invertebrates, amphipods, cirripeada, small shrimp and crabs (3).

Age: One of the smaller surfperch--ages reported to 7 years. Maximum length 27 cm TL, 23.7 cm SL; maximum estimated weight 0.21 kg (1,8).

Populations: Uncommon in Puget Sound (7), and likely also in BC as this is the extreme north end of the range. Appears to be fairly common in California (11).

Reproduction: Viviparous, moves inshore to spawn. Mating occurs in fall or winter (11). Age at first spawning 2 yrs, produces 3 to 16 young per female. The number of young produced increases with age from 2 to 5 years (1) . Parturition in July – August (2,15,)

Predators: No reports, likely similar to other surfperch, i.e. sea birds, seals, sea lions, river otters, large fish.

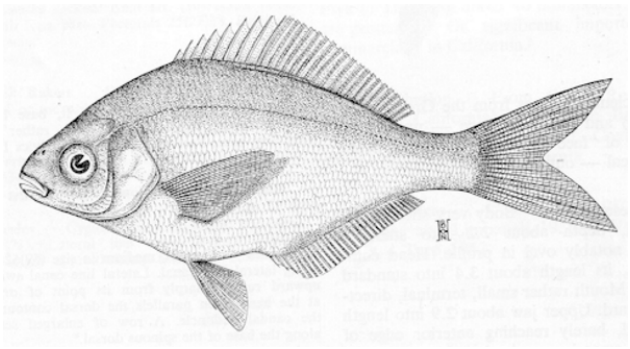
Parasites and Diseases: *Diclidophora* (Monogena) only reported parasite (15). Diseases: no reports.

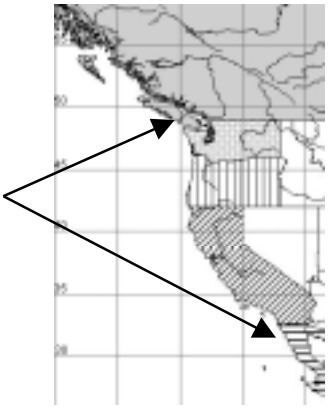
Utilization: Little utilization due to small size. Caught in recreational fishery, no commercial value (11).

References:

1. Baltz, 1984.
2. Bennett and Wydoski, 1977.
3. DeMartini, 1969
4. Eschmeyer, Herald and Hammann, 1983.
5. Feder, Turner and Limbaugh, 1974
6. Frey, 1971.
7. Garrison and Miller, 1982.
8. Gotshall, Allen and Barnhart, 1980.
9. Hart, 1973.
10. Hubbs and Hubbs, 1954.
11. Karpov, Albin, and Buskirk, 1995.
12. Lamb and Edgell, 1986.
13. Peden, 1966.
14. Reodel, 1953
15. Wydoski and Bennett, 1973.

Phanerodon furcatus White seaperch





Recognition: Black line at base of dorsal fin, spinous and rayed parts of dorsal fin run together to make a smooth curve caudal fin deeply forked (13,17,20).

Range in Canada: Extreme northern part of range, restricted in BC to South Vancouver Island (13,17).

Habitat: Generalized in loose shoals in quiet waters in bays usually over rock, sand and mud shallow bottoms. Adults move to deeper waters in late summer and fall and to shallow water in late winter and spring, younger fish in shallower waters. Depth from 0 to 46 m (3,7,13,14,19,21,22,23,26).

Temperature: Reported temperatures 7 to 21°C. Appear to avoid waters with temperatures greater than 16°C. Likely occur in lower temperatures in winter than reported (25,26).

Salinity: Marine and lower part of estuaries (25).

Food: Primarily benthic: small crustaceans, polychaetes, bryozoans, tunicates and occasional bivalves. Reported to be opportunistic cleaner of ectoparasites from other fish (6,8,9,12,18).

Age: Aged with scales. Maximum length 34 cm TL, 26.1 cm SL, calculated weight 0.69 kg. Oldest fish usually 7 years. Males and females the same size (1,3,5,11).

Populations: In BC population likely very low as the species is at the north end of its range in BC. Reported to be uncommon in Puget Sound. Large populations historically reported in California (1,15,19,24).

Reproduction: Viviparous, breeding occurs from October to December in California. Birth in late May to August, number of young increases with age from an average of 10 at age 2 to 28.5 at age 7. Mean length at birth 43.5 mm (4,16).

Predators: No reports, likely to be similar to other embiotocids: sea birds, river otters, sea lions and large fish.

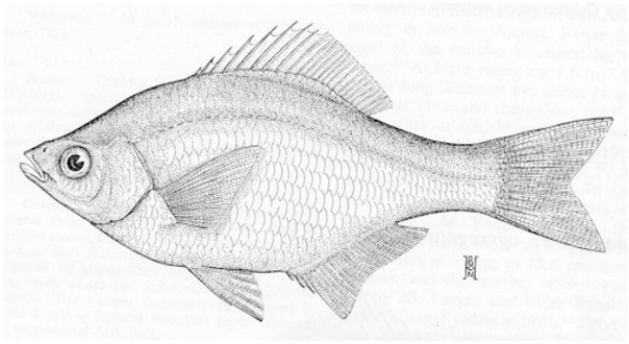
Parasites and Diseases: Ectoparasitic isopod noted (10). Also endoparasitic digenea trematod (2). No disease reports.

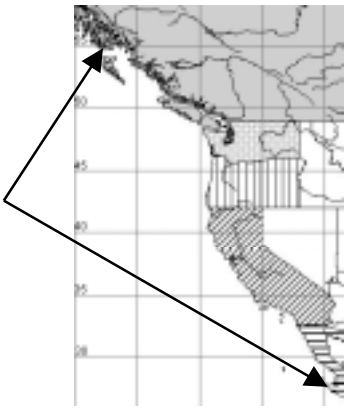
Utilization: In BC few caught in recreational fishery. In California historically a major commercial species. Presently taken in the recreational fishery (19,22,23,24).

References:

1. Anderson and Bryan, 1970
2. Arai, Kabata and Noakes, 1988
3. Baltz, 1984
4. Banerjee, 1971
5. Banerjee, 1973
6. Barry, Yokavich, Cailliet, Ambrose and Antrim, 1996
7. Bayer, 1981
8. Bray and Ebeling, 1975
9. DeMartini, 1969
10. Eckmayer, 1975
11. Eckmayer, 1979
12. Ellison, Terry and Stephens, 1979
13. Eschmeyer, Herald and Hammann, 1983
14. Feder, Turner and Limbaugh, 1974
15. Garrison and Miller, 1982
16. Goldberg, 1978
17. Hart, 1973
18. Hobson, 1971
19. Karpov, Albin and Buskirk, 1995.
20. Lamb and Edgell, 1986
21. Larson and DeMartini, 1984
22. Leet, Dewees and Haugen, 1992
23. Roedel, 1953
24. Tarp, 1952
25. Terry and Stephens, 1977
26. Yokavich, Cailliet, Barry, Ambrose and Antrim, 1991

Kelp perch, *Brachyistius frenatus*





Recognition: Upturned snout and oblique mouth with projecting lower jaw. Large scales. Coppery brown colour (8,9,17).

Range in Canada: Throughout coastal BC in marine waters (12,17).

Habitat: Aggregates in small schools (4,12). Rarely far from kelp beds (1,2,4,8,9,13,14,15,18,20). Occasionally on rocky bottoms (5). Lives in kelp canopy down to approximately 30 m (14).

Temperature: Temperature range reported 7-8 to 21°C (3,8,15).

Salinity: Marine, salinities from approximately 15–35 ppt. Not reported in estuaries.

Food: Isopods, copepods, amphipods, small shrimp, bryozoans and fish larvae. Cleaner species feeding on ectoparasites of other fish species (6,12,13,15,19).

Age: No data on age and growth. Maximum length 22 cm TL; 15.3 cm SL (3,11). Estimated maximum weight approximately 0.17 kg.

Populations: Little data on population numbers. Uncommon in Puget Sound and any area without kelp beds.(10).

Reproduction: Viviparous with low fecundity (7). Mature late in first year. Birth, May to July, (15). Young initially live near surface in kelp canopy (1). Young at birth 32–33 mm SL (15).

Predators: Likely predators, river otters, seals, sea lions and large fish living around kelp beds (16). Sea birds also probable predators.

Parasites and Diseases: Digenea, *Lecithaster Gipposus* reported (21). No disease reports.

Utilization: Of no importance in recreational fishery. Limited catch in commercial fishery in BC for aquarium trade. Minor utilization in California (16).

References:

1. Anderson, 1994.
2. Anderson and Sabado, 1999
3. Baltz, 1984.
4. Bray and Ebeling, 1975.
5. Csepp and Wing, 1999
6. DeMarini, 1969
7. DeMartini, 1988.
8. Eschmeyer, Herald and Hammann, 1983.
9. Frey, 1971.
10. Garrison and Miller, 1982.
11. Gotshall, Allen and Barnhart, 1980.
12. Hobson, 1971.
13. Hobson and Chess, 1976
14. Holbrook, Carr, Schmitt and Coyer, 1990.
15. Hubbs and Hubbs, 1954.
16. Karpov, Albin, Buskirk, 1995.
17. Lamb and Edgell, 1986.
18. Larson and DeMartini, 1984.
19. Leet, Dewees and Haugen, 1992.
20. Roedel, 1953.
21. Wydowski and Bennett, 1973

APPENDIX 2

Parasites Reported From Embiotocids. This appendix is based on studies by Arai (1967, 1969), Arai *et al*. (1988), Eckmayer (1975), Odenweller (1971), and Wydoski and Bennett (1973). The principle work upon which this appendix is based is Arai *et al.* (1988). NR indicates that no data on infestation rate was reported with respect to the proportion of fish examined that hosted the parasite. Percentages (%) indicate the proportion of the fish examined that hosted the specific parasite.

Embiotocid Species	Parasite	Infestation Rate (%)
Shiner perch	Myxosporida	
Cymatogaster aggregata	Myxidium oviforme	*not reported (NR)*
	Cestoidea	
	Eubothridum sp.	NR
	Lacistorhynchus tenuis	NR
	Monorygma sp.	0 - 1.7%
	Phyllobothrium sp.	0 – 100
	Tetraphyllidae gen. Sp.	NR
	Monogenea	
	Archigyrodactylus archigrodactylus	NR
	Encotyllabe embiotocae	*NR*
	Gyrodactylus aggregata	NR
	Gyrodactylus sp.	NR
	Gyrodactyloidea gen. Sp.	NR
	Digenea	
	Galactosomum sp	NR
	Genitocotyle acirrus	0 – 3.4
	Helicometrina nimia	0 – 6.9
	Lecithaster gibbosus	NR
	Neozoogonus californicus	0 – 5.4
	Phyllodistomum scrippsi	0 – 3.2
	Postmonorchis donacis	0 – 1.1
	Proctoeces macrovitellus	NR
	Pseudopecoelus umbrinae	1. 7
	Stephanostomum SP.	0 – 5
	Telolecithus pugetensis	0 – 14.0
	Tubulovesicula lindbergi	NR
	Nematoda	
	Anisakis sp	0 – 6.5
	Contracaecum sp.	NR
	Cucullanellus kanabus	0 – 69.0
	Acanthocephala	
	Corynosoma sp	0 – 96.0
	Echinorhynchus gadi	NR

Appendix 2 cont.

	Branchiura	
	Argulus borealis	0 – 5.1%
	Argulus pugettenis	NR
	Copepoda	
	Bomolochus cuneatus	0 – 32.3
	Bomolochus sp	NR
	Caligus cheilodactyli	0 – 1.1
	Caligus quadratus	0 – 1.1
	Caligus sp.	0 – 1.1
	Colobomatus embiotocae	0 – 34.0
	Ergaslinus lizae	NR
	Ergaslinus turgidus	0 – 5.1
	Haemobaphes diceraus	NR
	Holobomolochus embiotocae	0 – 100
	Lepeophtherius bifurcates	*NR*
	Lepeophthenius parvus	0- -2.0
	Peniculus fissipes	0 – 6.9
	Taeniacanthus haakeri	NR
	Isopoda	
	Lironeca californica	0 – 58.8
	Lironeca vulgaris	NR
Pile perch	Digenea	
Rhacochilus vacca	Telolecithus pugetensis	*7.1*
	Neozoogonus californicus	14.3
	Proctoeces macrovitellosus	7.1
Striped seaperch	Digenea	
Embiotoca lateralis	*Neozoogonus califorinica*	31.3
	Telolecithus pugetensis	5
White seaperch	Digenea	
Phanerodon furcatus	*Neozoogonus californicus*	*6.8*
	Telolecithus pugetensi	8.5
	Genitocolyles acirries	5.1
	Diplangus paxillus	1.7
	Proctoeces macrovitellosus	3.4
	Isopoda	
	Lironeca californica	0.1 – 36.4

Appendix 2 cont.

Silver surfperch	Monogenea		
Hyperporsopon ellipticum	*Diclidophora*		0.0 – 66.7%
Redtail surfperch	Monogenea		
Amphistichus argenteus	*Diclidophora*		NR
Walleye surfperch	Digenea		
Hyperprosopon argenteum	*Genitocolyles acirries*		*2.0*
	Neochasmus sp		1.0
	Sckikhobalolrema girella		2.0
	Copepoda		
	Clavella sp		21.0
	Isopoda		
	Lironeca californica		0.5
Kelp perch	Digenea		
Brachyistius frenatus		*Lecithaster gibbosus*	NR

APPENDIX 3

Survey questions for BC coast harbour masters

1. What is the size of your docks under the control of the Harbour Authority? (e.g. the number of slips or spaces to tie boats up)

2. How many boats tie up with you from May to September inclusive? This can be a rough estimate, and if possible please include a breakdown of the number of commercial vs. recreational craft that utilize the harbour.

3. Do you know if any people on these boats fish for surf or pile perch?

4. Are there many juveniles who fish off the dock for perch during the summer? If so, could you give a rough estimate as to the number of kids per day and/or per month who fish during the summer?

APPENDIX 4

Survey questions for commercial surfperch license holders

1. How long have you been fishing for perch?
2. Have you caught fish with your commercial license this year?
3. If so, which areas? If not, do you plan on fishing for surfperch this year and why?
4. In which areas have you fished for perch in the past?
5. How successful was each area? Why did you change?
6. Are there any other areas that you know of where surfperch live?
7. What is the earliest date that you begin surfperch fishing in a given year?
8. How late into the year do you fish for surfperch?
9. How would you describe the abundance of surfperch this year/last year compared to when you first started fishing for surfperch?
10. If there are changes, how? (size, density, distribution)
11. What gear have you been utilizing, and what is its size/length/mesh dimension, etc.? (hook and line, beach seine, drag seine).
12. Have you ever used another type of gear?
13. Do you or have you fished from a boat or onshore?
14. Do you fish surfperch in order to sell it or for personal use, or both?
15. If you've fished this year, approximately how much have you caught?
16. Approximately how much do you catch per year?
17. What is the average size of surfperch being caught?
18. When fishing, how many surfperch do you return to the water?
19. If yes, what percent of the returned surfperch do you think survive?
20. If yes, why were surfperch returned?
21. If yes, how does the amount of returned fish this year compare to all the other years you've fished surfperch?
22. While fishing for surfperch, did you catch any other species?
23. If yes, what species were they, and how old were the individuals?
24. If yes, what is the condition of these species when you released them?
25. Do you also fish for surfperch using a tidal waters sport fishing license? Why?
26. If yes, do you use the same gear? (Allowed to use dip net, herring jig, herring rake, and cast net)