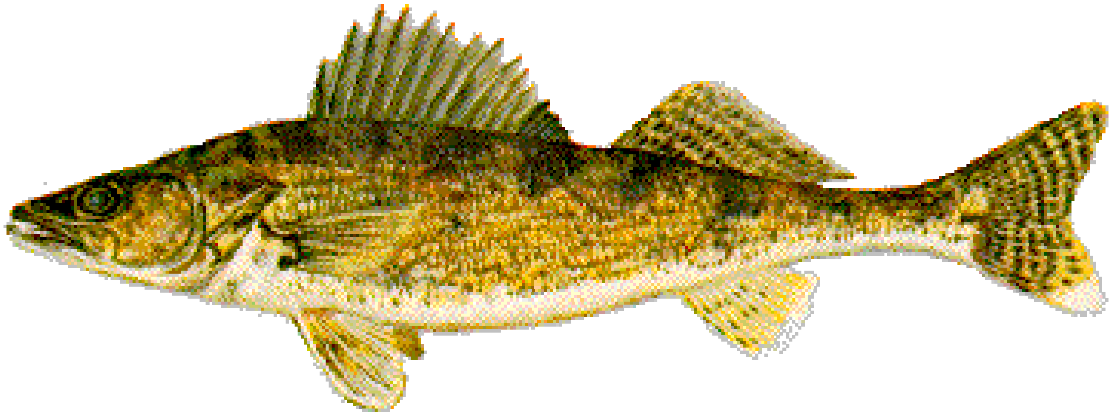
Volume III, Chapter 7
Walleye

TABLE OF CONTENTS



7.0 Walleye *(Stizostedium vitreum)*

7.1 Introduction

The 71 families of fishes in the order Perciformes can be found throughout North American and Europe (Scott and Crossman 1998). The family Percidae (the perches) is made up of two subfamilies, nine genera, and 121 species. The Percids can be distinguished by two well-separated dorsal fins. In North America, Percids are found in warm temperate to cold subarctic lakes and streams (Scott and Crossman 1998). Although the family is distributed circumpolarly, most species are confined to North America (Scott and Crossman 1998).

7.2 Distribution

Walleye *(Stizostedium vitreum)* [1] are native to the Great Lakes and the upper Mississippi River basin. They are found only in fresh water, as illustrated by the map in Figure 7-1 (Scott and Crossman 1998).Walleye also have been introduced along the East Coast and to most states west of their natural range (Scott and Crossman 1998).

Figure 7-1. Original distribution of walleye in North America[1].

Over the past 40+ years, the walleye (*Stizostedium vitreum*) has become one of Washington's most popular and valued game fish species. It is still unclear when the walleye were first introduced into Washington. The first theory has USFWS releasing walleye fry from Lake Oneida (New York) into Lake Roosevelt (Williams and Brown

[1] The walleye illustration is by Virgil Beck, courtesy of the Wisconsin Department of Natural Resources (DNR).

1983). The second theory has unknown sources planting walleye in the 1930s into Devil's Lake; when Devil's Lake was inundated by the Columbia basin irrigation project, these walleye found their way into Banks Lake and the Columbia River (Beamesderfer and Nigro 1989). Although the origin of the first walleye introductions into Washington is uncertain, since 1960, walleye have become widely dispersed throughout the Columbia River basin, including all of the major reservoirs of the Columbia basin irrigation project (Figure 7-2).

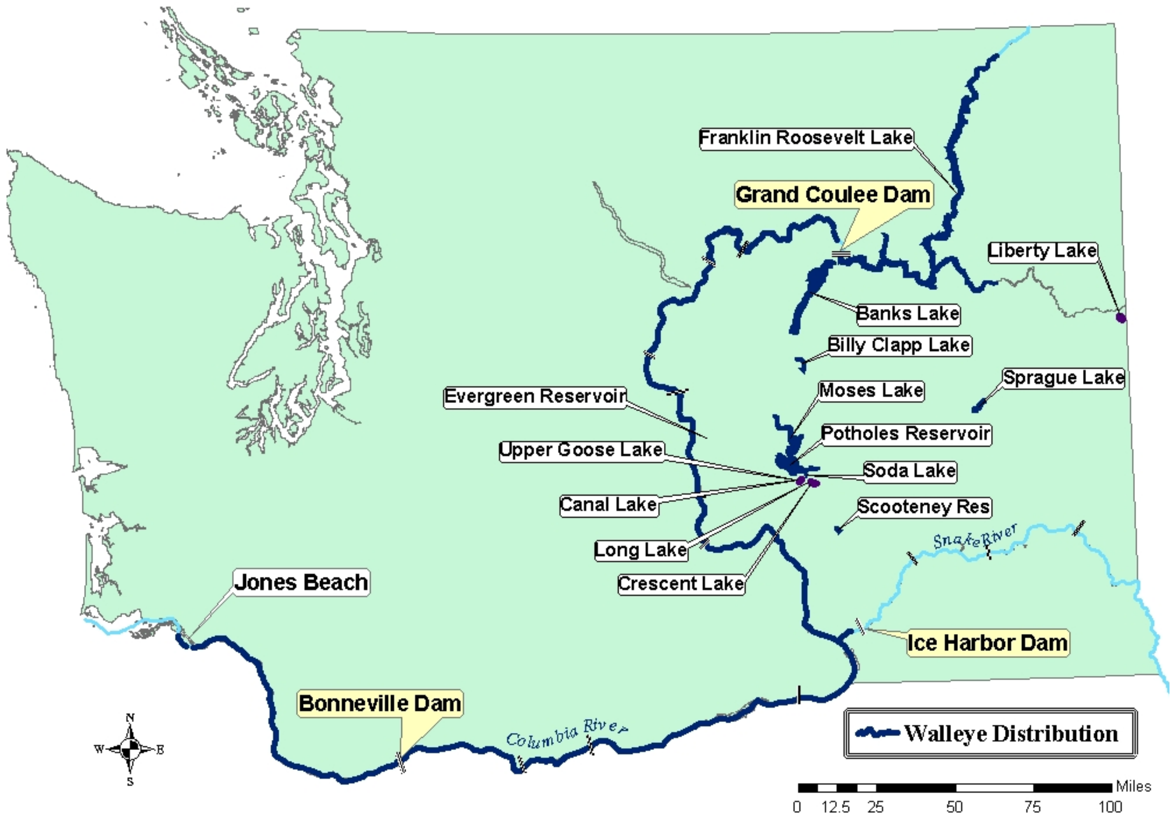


Figure 7-2. Walleye distribution in Washington

Until the early 1980s, walleye management efforts focused on documenting the distribution of expanding populations, regulating harvest, and monitoring the catch from major fisheries. Before 1974, Washington had no regulations for legal catch or size limits for walleye. In 1974, the daily catch limit was set at 15 fish with no more than 5 over 20 inches (51 cm) long (Tinus and Beamesderfer 1994) (see Table 7-1 outlining sport fishing regulations). The fishery focused on Lake Roosevelt and, to a lesser extent, on other Columbia River reservoirs above Rocky Reach Dam, Banks Lake, and Potholes Reservoir. In the early 1980s, the relatively new walleye fisheries of the lower Columbia River reservoirs began to attract national attention and experience a rapid increase in angling pressure and harvest.

From 1973–82, the average size of walleye caught in Lake Roosevelt—by far Washington's most productive and popular walleye fishery—declined from 18.5 to 13.5 inches (47 to 34 cm) (Nigro et al. 1983). At the same time, walleye fisheries in Columbia River reservoirs immediately downstream from Lake Roosevelt experienced a similar decline in average fish size and catch rate (Williams and Brown 1983). The decline of these established walleye fisheries and the desire to protect newly-emerging walleye fisheries from overharvest prompted WDFW to reevaluate walleye management and harvest regulations during the early 1980s.

As a result, in 1986 the walleye catch limit for the lower Columbia River was reduced to 5 fish per day with an 18-inch (46 cm) minimum size. In 1990, modified regulations for the lower Columbia kept the same minimum size, but only one fish could exceed 24 inches. Growing concern over increased predation by walleye on young salmonids migrating through and rearing in the lower Columbia River led to the modification of sport fishing regulations for 2000 to allow increased harvest of smaller walleye.

The presence or absence of suitable early rearing habitat plays a major role in the ability of Washington's walleye populations to sustain levels adequate to support expanding recreational demand. The most important components of good early rearing habitat include a relatively stable water level and temperature, and the presence of nutrient-rich nursery areas adjacent to spawning areas where newly hatched walleye fry can find plankton and develop swimming proficiency.

While lack of early rearing habitat appears to be the major factor limiting walleye production in the Columbia River, other habitat conditions are important as well. Some include availability and access to spawning habitat; suitable water temperature for growth and development; and an adequate food supply. In some cases, it may be possible to enhance walleye populations in Washington by implementing habitat improvement measures such as stabilizing water levels, providing more off-channel rearing habitat, and improving forage conditions.

Table 7-1. History of WDFW sport fishing regulations for the Lower Columbia River *

	Daily Bag	Size	
	Limit	Minimum	Maximum
1970–73	none	none	none
1974–85	15	none	no more than 5 >20 in
1986–89	5	18 in	none
1990–99	5	18 in	not more than 1 >24 in
2000–present	10	none	no more than 5 >18 in no more than 1 >24 in

* Information on state regulations is from Tinus and Beamesderfer (1994), and WDFW regulations, 1994–2002.

7.3 Life History & Requirements

7.3.1 Spawn Timing & Conditions

Walleye normally spawn from late March through early May, depending primarily on water temperatures. The preferred spawning temperature range is 4.4-10°C. The males arrive at the spawning grounds before the females and tend to stay a little later (Scott and Crossman 1998; Wydoski and Whitney 1979). Spawning generally occurs in water less than 15 feet deep over a variety of substrates such as flooded vegetation, coarse gravel, and boulders. Although walleye do not have a restricted home range, they tend to spawn in the same location each year (Wydoski and Whitney 1979). Walleye have been known to spawn along shoreline areas of lakes and reservoirs, but most often prefer moderately-flowing streams (Becker 1983).

7.3.2 Incubation

Egg development varies with water temperature (Wydoski and Whitney 1979). Depending on the water temperature, eggs can hatch after 7 (>12.8°C) to 26 (4.4°C) days. Above Bonneville Dam, walleye spawning areas tend to be on the windward side of the impoundment where wave action helps keep the water free of silt, which can suffocate eggs. For the same reason, walleye tend to spawn in areas of moderate current below Bonneville Dam (Steve

Jackson, WDFW, personal communication). If there is too much wind or current, the eggs can be washed ashore (Rook 1999) or preyed upon by various species cohabitating the area, although this is not thought to be significant (Becker 1983; Steve Jackson, WDFW, personal communication).

7.3.3 Larvae & Juveniles

The yolk-sac of walleye fry is relatively small and is usually fully absorbed within 2 to 3 days (Becker 1983). For that reason, the survival of walleye fry depends largely on their first 3 to 5 days of life (Becker 1983). Newly-hatched fry do not develop paired fins for several weeks after hatching, restricting their mobility to vertical swimming movements utilizing the whip-like action of their tails. Because of their limited mobility, early rearing habitat must be located close to spawning areas. Walleye fry start out utilizing zooplankton and progress rapidly to larger forms of invertebrates and small fish within the first few months of life. From that point on, their diet is composed almost exclusively of fish (Becker 1983). The dietary transition from invertebrates to fish coincides with a change from a surface to a bottom habitat (Scott and Crossman 1998).

It is believed that this period in life history of walleye most limits their reproductive success in the Columbia River. Lower Columbia River reservoirs typically are shallower, warmer, and more productive than those of the mid-Columbia. However, even with these apparent advantages, reproductive success in the lower Columbia River is highly variable, most likely because of the effects of high flows and extreme fluctuations in water level and temperature during and after spawning (Rieman and Beamesderfer 1988). These conditions coincide with spring run-off and are at times aggravated by the operation of mainstem dams for hydropower production and/or smolt passage (Beamesderfer and Nigro 1989). Although the fry are subject to predation by other species of fish, the flushing of prey items out of the rearing area due to flow and water level changes is thought to affect fry more significantly (Steve Jackson, WDFW, personal communication).

7.3.4 Adult

Walleye have been found to live longer than 15 years. The oldest reported walleye taken in Washington waters was taken from Banks Lake, and was estimated to be 19 years old (Lucinda Morrow, scientific technician, WDFW, April 3, 2003 personal communication).

Growth rates for walleye in Washington generally exceed those reported for walleye in its native range (Becker 1983). On the average, Washington walleye attain a length of 5-7 inches (13 cm) at age 1, 10-14 inches (25-36 cm) at age 2, 15-18 inches (38-46 cm) at age 3, 16-20 inches (41-51 cm) by age 4, 17-22 inches (43-56 cm) at age 5, 19-25 inches (48-63 cm) at age 6, and 20-26 inches (51-66 cm) at age 7 (Fletcher 1992; Williams and Brown 1983, Nigro et al. 1983, Connolly and Rieman 1988). As expected, the fastest growth occurs in the lower Columbia River and in some of the warmer, more productive habitats of the Columbia Basin irrigation project, while the slowest growth rates occur in colder, more densely-populated waters like Lake Roosevelt (Nigro et al. 1983; Williams and Brown 1983; Connolly and Rieman 1988).

Adult walleye prefer to inhabit areas where the water temperature is around 77°F (25°C), but can be found in water temperatures as low as 32°F (0°C) and as high as 90° F (32.2°C) (Wydoski and Whitney 1979). In the lower Columbia River reservoirs, walleye are most abundant in tailraces, somewhat less abundant in mid-reservoir, and least abundant in forebays (Zimmerman and Parker 1995). Downstream from Bonneville Dam, walleye can be found as low as RKm 137, but they are most numerous from RKm 178 to 234 (Zimmerman and Parker 1995).

Walleye can tolerate a variety of environmental conditions, but prefer shallow, turbid areas (Scott and Crossman 1998). Because walleye have a special layer of the eye (*tapetum lucidum*, see Ali and Anctil 1968 cited in Scott and Crossman 1998) that is sensitive to bright daylight (Scott and Crossman 1998), in habitats with very clear water or during periods of the year where there is intense daylight, walleye most often feed at dawn, dusk, and night. In addition to daily movements in response to light intensity, walleye also move annually for spring spawning and daily and seasonally according to water temperature and prey availability (Scott and Crossman 1998). In open water, walleye travel in loose aggregations and schooling is common when feeding and spawning (Becker 1983).

In Washington, first spawning occurs at ages 2 or 3 for males and ages 3 or 4 for females (Williams and Brown 1983), and appears to be mainly size- rather than age-dependent. Female walleye will deposit between 25,000-40,000 eggs per pound of body weight (Becker 1983).

Spawning occurs at night and usually involves a group of one female and up to two males, or two females and up to six males (Scott and Crossman 1998). Walleye are broadcast spawners and exhibit no parental care. Some form of courtship behavior takes place before spawning (Scott and Crossman 1998); the following description of courtship and spawning behavior is taken from Ellis and Giles (1965).

> *Overt courtship began by either males or females approaching another of either sex from behind or laterally and pushing sideways against it or drifting back and circling around pushing the approached fish backwards. The first dorsal fin was alternately erected and flattened during these approaches. The approached fish would either hold position or withdraw. Approaches and contact of this sort appeared to be the preliminary essentials of courtship and were promiscuous, i.e., there was no continued relationship between any particular pair of fish. Activity increased in frequency and intensity and individuals began to make preliminary darts forward and upward. Finally one or more females and one or more males came closely together and the compact group rushed upward. At the surface the group swam vigorously around the compound until the moment of orgasm when swimming stopped and the females frequently turned or were pushed violently onto their sides. This sideways movement by the females was taken as an indicator of spawning even when no eggs or milt were seen. On one occasion during orgasm a male was clearly seen to have the first dorsal fin fully erected.*

When spawning is ready to take place, the group heads to shallow water (Scott and Crossman 1998). Most females release the majority of their eggs in one night, while males can spawn over a longer period (Ellis and Giles 1965). The egg diameter is 0.05-0.08 in (1.5-2.0 mm) and they have an adhesive surface (Scott and Crossman 1998). After release, the eggs attach to one another and to adjacent vegetation or streambed material. After an hour or two, they water-harden, lose their adhesive properties, and settle onto weedmats or drop into crevices in the substrate (Scott and Crossman 1998) for protection from predators.

Adult walleye are predominantly piscivorous, but are opportunistic feeders and will consume crustaceans and insects if the opportunity is presented (Gray et al. 1984; Zimmerman 1999). Suckers, minnows, sculpins, and salmonids are the walleye’s most important prey items (Gray et al. 1984; Zimmerman 1999) (Table 7-2), but they also will become cannibalistic if prey is scarce (Scott and Crossman 1998).

Table 7-2. Prey items of walleye from lower Columbia River.

Scientific name	Common name
Family/*Genus species*	
Catostomidea/*Catostomus sp.*	suckers
Cottitdae/*Cottus sp.*	sculpins
Cyprinidae	
Acrocheilus alutaceas	chisel mouth
Mylocheilus caurinus	peamouth
Ptychocheilus oregonensis	northern pikeminnow
Richardsonius balteatus	redside shiner
Percopsidae/*Percopsis transmontana*	sand roller
Salmonidae/*Oncorhynchus sp.*	salmon

7.3.5 Movements

Above Bonneville Dam, walleye move up the reservoir during the spring (March and April) and as summer progresses, move back down the reservoir (Beamesderfer and Nigro 1989). The upriver movement may be a spawning migration (Colby et al. 1979). Walleye also will move into an area below an impassable dam to spawn (Scott and Crossman 1998).

Individual walleye can be highly mobile (Beamesderfer 1989). In 1984–86, mark and recapture studies were conducted in the John Day Reservoir from March to September (Nigro et al. 1985a; Nigro et al. 1985b; Beamesderfer et al. 1987). The range of movement for individual walleye during the entire season was 3 to 70 miles (5 to 113 km), with average daily movement of 0.2 to 1.9 miles (0.4 to 3 km). Beamesderfer and Nigro (1989) stated that 68% of the walleye were recaptured 0.3 miles (0.5 km) from the point of release, and 20% were recaptured at least 3.7 miles (6 km) away.

7.4 Factors Affecting Population Status

7.4.1 Harvest

The reported commercial harvest of walleye in tribal net fisheries between 1993–2002 ranged from 662 to 3,667 lbs. (300 to 1663 kg) per year with a mean of 2,118 lbs. (961 kg) (Table 7-3). Because walleye in the lower Columbia River exhibit highly variable reproductive success (Rieman and Beamesderfer 1988), population size is relatively low (Beamesderfer and Rieman 1988). Additionally, net fisheries are selective for large walleye (Hallock and Fletcher 1991). Tribal harvest therefore remains an important consideration in the management of lower Columbia River walleye populations. However, the overall impact of these commercial fisheries on the lower Columbia River walleye populations remains unknown.

Sport fishing for walleyes has occurred in the lower Columbia River since the early 1980s (Tinus and Beamesderfer 1994). Estimates of harvest and effort for the sport fishery were calculated for the years 1982–93 for Bonneville Pool and below Bonneville Dam from angler surveys (Tinus and Beamesderfer 1994). Unfortunately, surveys were not conducted every year or in every month, nor did they necessarily represent all areas of the impoundment (Tinus and Beamesderfer 1994). However, it is apparent that harvest rates are low because for the years 1982–93, the average minimum harvest of walleye was 423 fish per year (Tinus and Beamesderfer 1994). From 1991–2002, creel survey data for walleye was collected during sturgeon creel surveys at Bonneville Pool and below Bonneville Dam (Dennis Gilliland, WDFW, personal communication; Eric Winthrop, WDFW, personal communication). The data collected at Bonneville Pool (1993–2001) suggests that the low exploitation rate continues (Table 7-4). Although 44% of the total catch was harvested, the catch per unit effort (CPUE) was less than one fish per angler trip (0.77).

The walleye tournaments are catch-and-release fishing with some low-level mortalities, but these tournaments have a negligible effect on the walleye population. CPUE is low (average=0.05 from 1999–2001) and the percent of the fish caught that are released alive is quite high (average=96.8% from 1999–2001).

7.4.2 Supplementation

One hatchery in Washington (Ringold Hatchery) has the facilities for rearing walleye. The walleye population in the lower Columbia River is healthy and there are issues with walleye interaction with salmonids. Therefore, there are no plans for supplementation of walleye in the lower Columbia River.

Table 7-3. Commercial harvest of walleye from the Zone 6 fishery, 1993–2002*.

Year	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1993	240	132				298	1,464	659	117			2,910
1994	105	18					105	230	204			662
1995	854	1,858					398	557				3,667
1996	84	410						1243				1,737
1997	783	964					182	553				2,482
1998	618	443					38	211				1,310
1999	238	1,193						119	17			1,567
2000	1,252	1,723		360			64	196				3,595
2001	334	838	251	190	56	67	35	108		19		1,898
2002	296	670	215	59		13	27	80				1,360
Total	*4,804*	*8,249*	*466*	*609*	*56*	*378*	*2,313*	*3,956*	*338*	*19*		*21,188*

* The Zone 6 Fishery is the Columbia River between Bonneville Dam and McNary Dam.

7.4.3 Water Development

7.4.3.1 Dams

Hydropower development affected the walleye population in the Columbia River basin positively. The numbers of walleye in the free-flowing portion of the lower Columbia River are lower than those in the impoundment areas. By creating pools and reducing water flow, the dams have actually created habitat that is more suitable for walleye.

7.4.3.2 Flow Alterations

Flow alterations in the lower Columbia can limit walleye production (Beamesderfer and Nigro 1989; Connolly and Rieman 1988; Corbett and Powles 1986; and Mion et al. 1998). Decreased water flows can decrease habitat suitable for both spawning and rearing, and can strand eggs after spawning. High flows can wash eggs ashore or downstream, can also flush out zooplankton as food for larval walleye, and can displace larval walleye from nearshore and backwater rearing areas. Larval walleye also can suffer in times of high discharge because an increase in suspended sediments and turbulence can damage the fish.

Table 7-4. Walleye harvest, catch, and effort estimates from creel surveys at Bonneville Pool (1993–2001) and below Bonneville Dam (1991–2002)

	Bonneville Reservoir			Below Bonneville Dam		
Year	**Harvest**	**Catch**	**Trips**	**Harvest**	**Catch**	**Trips**
1991						
1992						
1993	82	180	1,009			
1994	206	1,190	797			
1995	852	1,297	1,231			
1996	288	406	653			
1997	60	75	248			
1998	219	415	597			
1999	183	244	702			
2000	127	238	575			
2001	39	676	341			
2002				46	63	
Total	*2,056*	*4,721*	*6,153*			

7.4.4 In-Channel Habitat Conditions

7.4.4.1 Channel Maintenance & Dredging

Below Bonneville Dam, walleye have been found downstream to the limit of the saltwater intrusion zone—normally about 31 miles (50 km) upstream from the mouth of the Columbia River. Under low flows, this area can be as far upstream as 20 miles (33 km) (Jimmy Watts, ODFW, personal communication). It is unclear what the impacts of dredging will have on walleye.

7.4.4.2 Water Quality

Low oxygen levels can have a deleterious affect on walleye and on walleye embryo development (Niemuth et al. 1959; Priegel 1970).

7.4.4.3 Temperature

Walleye can tolerate a wide temperature range (32-90°F [0-32.2°C]), though they prefer the warmest water (77°F [25°C]) (Wydoski and Whitney 1979). Lower water temperatures can inhibit egg and larval development. Higher temperatures will lead to increased metabolism and increased predation.

7.4.4.4 Turbidity

Turbidity probably would benefit walleye; although they prefer clear water (Ali and Anctil 1968), they seem to reach their greatest abundance in large, shallow, turbid lakes (Scott and Crossman 1998). Since walleye have very sensitive eyes, turbidity would reduce the amount of sunlight passing through the water, enabling the walleye to inhabit shallower areas of the lower Columbia where prey items are more likely to occur, and allowing feeding throughout the day instead of only at twilight or during the night (Scott and Crossman 1998).

7.4.4.5 Dissolved Gas

Dissolved gas supersaturation can be detrimental to walleye because the increased gases can create gas bubbles under the skin, fin rays, and gills (Becker 1983). The capillaries within the gills can then become obstructed and blood prevented from flowing through (Becker 1983).

The result would be mortality caused by respiratory failure (Becker 1983). Walleye inhabiting the tailraces below McNary and Bonneville Dams can be subject to an increase in dissolved gases during spillover events.

7.4.4.6 Chemicals

Mercury occurs naturally in aquatic ecosystems and methylated mercury (methylmercury) is highly bioavailable for aquatic organisms. Methylmercury is accumulated quickly, but slowly depurated, which allows it to be biomagnified in higher trophic levels (Beckvar et al. 1996). Fish-eating predators tend to have the highest levels of methylmercury (Beckvar 1996). Methylmercury can affect reproduction, growth, behavior, and development in walleye.

7.4.5 Species Interactions

7.4.5.1 Competition

Little information exists on competition between walleye and other species in the lower Columbia River. However, Scott and Crossman (1998) mention that yellow perch and smallmouth bass (*Micropterus dolomieui*) compete with walleye for food.

7.4.5.2 Predation

Becker (1983) stated that there is little evidence of significant predation on walleye eggs by other species of fish, although it does occur (Colby et al. 1979; Corbet and Powles 1986). If carp are spawning where walleye eggs have been deposited, they can disturb the area (Becker 1983) by dislodging eggs that resettle on the silty bottom where they can die from lack of oxygen. Walleye fry are preyed upon by other fishes and larger invertebrates in the same habitat. They also can be cannibalized by larger walleye (Scott and Crossman 1998). Without many enemies, adult walleye are one of the top predators in their habitat. Predation most likely would occur from fish-eating birds and mammals (Scott and Crossman 1998).

7.5 Status & Abundance Trends

7.5.1 Abundance

Zimmerman and Parker (1995) captured walleye from RKm 137 and above. In July 1982, NMFS field personnel using a beach seine caught a walleye at Jones Beach (RKm 75) (Dawley et al. 1985). Walleye abundance for Bonneville Pool and below Bonneville Dam has not been estimated, and Zimmerman and Parker (1995) were unable to calculate density indices for walleye. However, extrapolations from research conducted on the John Day Pool give insight to the abundance of walleye in the Bonneville Pool (Steve Jackson, WDFW, personal communication). Therefore, walleye abundance in the Bonneville Pool is probably similar to that of the John Day Pool, estimated during 1983–86 at 15,000 fish (Tinus and Beamesderfer 1994).

7.5.2 Productivity

The lower Columbia River walleye population is self-sustaining (Tinus and Beamesderfer 1994) and the carrying capacity of the lower Columbia River walleye habitat is unknown. The condition of lower Columbia River walleye was evaluated by calculating relative weights (Tinus and Beamesderfer 1994) and the mean relative weight was 99%. An analysis of 113 walleye populations in 27 states and Canadian provinces (Murphy et al. 1990) revealed that 1/20 of these populations had a mean relative weight greater than 99%. Successful recruitment coincides with years of lower than average flows, while poor recruitment coincides with years of higher than average flows (Connolly and Rieman 1988).

7.5.3 Supplementation

There are no supplementation programs or efforts in the lower Columbia River.

7.5.4 Harvest

The current sport fishery harvest regulations for walleye in the lower Columbia River (Bonneville and below Bonneville Dam) is a 10 fish limit with no more than 5 fish over 18 inches and no more than one fish over 24 inches. Exploitation rates for the walleye sport fishery are low (Tinus and Beamesderfer 1994). The mean harvest per unit effort (fish per hour) for walleye below Bonneville Dam (from the dam to 35 miles downstream) from 1982 to 1993 was 0.322 and for Bonneville Pool, 0.085 (Tinus and Beamesderfer 1994). Creel survey data collected by WDFW from Bonneville Pool from 1993–2001 also suggests the low exploitation rate is continuing.

Since walleye have become established in Washington, fishing tournaments have become popular. The first recorded walleye tournament was held in 1994 and the first walleye tournament held on the lower Columbia River was in 1999 below Bonneville Dam (Divens 2001).

As walleye populations expanded into the lower Columbia River reservoirs where treaty tribes traditionally operated net fisheries for salmon and steelhead, walleye were caught and sold by tribal fishermen (Fletcher 1987). The harvest and sale of walleye taken in tribal fisheries first became a concern for both state and tribal fish managers in the mid-1980s. The issue was addressed in 1988 as part of the ongoing negotiations under US v Oregon. At that time, the court approved a settlement among Oregon, Washington, and Columbia River treaty tribes known as the Columbia River Salmon Management Plan. As part of this agreement, the right of treaty tribes to sell walleye caught incidental to legally-authorized fisheries for salmon and steelhead was affirmed (Fletcher 1987).

7.6 Inventory & Assessment of Existing Management Plans

Draft Warmwater Fish Management Plan (currently for WDFW internal discussion only).

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