Northwest Power and Conservation Council



July 26, 2012

# MEMORANDUM

**TO:** Council members

**FROM:** Jim Ruff -- Manager, Mainstem Passage and River Operations
Peter Paquet – Manager, Wildlife and Ecosystem
Patty O'Toole – Program Implementation Manager

**SUBJECT:** Summary of Predation Effects in the Columbia River Basin

## Background

Predation is part of the cycle of nature and its effects can ripple through the ecosystem. However, several species, taking advantage of human changes to the environment, have become successful in preying on Columbia River salmon and steelhead stocks, as well as on native resident fish species. Such predators include native and non-native fish, birds, and marine mammals. For example, migrating juvenile and adult salmon and steelhead, both listed and non-listed under ESA, fall prey to a number of predators. In preparation for the August 9, 2012, Science-Policy Workshop on Predation, at the Council meeting in Spokane staff will summarize the predation effects on juvenile or adult salmonids and on native resident fish in the Columbia River Basin (CRB) by each of these three major groups of predators.

Council staff will identify some of the main research results and programs the federal action agencies are undertaking to reduce the impact of key predators on salmonids and other species in the Columbia and Snake rivers. These efforts are part of the action agencies' responsibility to mitigate impacts on fish and wildlife due to the construction and operation of the Federal Columbia River Power System (FCRPS) projects under the Council's Fish and Wildlife Program, as well as actions called for under the NOAA Fisheries 2008 FCRPS Biological Opinion.

Currently, approximately $6.8 million is invested annually in predation management actions by Bonneville through direct implementation of the Council's Fish and Wildlife Program. In addition, about $6.6 million is expected to be invested next year through the Corps of Engineers' Anadromous Fish Evaluation Program (AFEP) on predation management projects.[1] Following is a summary of predation effects on juvenile or adult salmonids and on native resident fish species in the CRB by each of these three groups of predators.

[1] The Corps' avian predation management projects are implemented under the Columbia River Fish Mitigation (CRFM) Program, which is funded by Congressional appropriations and reimbursed by the Bonneville Power Administration. The Corps' pinniped predation and deterrent actions at Bonneville Dam are implemented using the Corps' O&M funds, which are also reimbursable.

**Native and Non-Native Fish Predators**

Northern pikeminnow, which are the most abundant and significant native fish predator, eat millions of salmon and steelhead juveniles each year in the Columbia and Snake River basins. Development of the hydropower system resulted in an increase in habitat favoring pikeminnow and, among other impacts, delays the downstream migration of salmon smolts and makes them more vulnerable to fish predation. Northern pikeminnow congregate in the tailraces and forebays of the mainstem dams (Poe et al. 1991, Ward et al. 1995), where they feed on disoriented and delayed salmon smolts, as well as at sites where hatchery-origin salmonids are released (Collis et al. 1995). Early studies in the CRB suggested predation by northern pikeminnow on juvenile salmonids might account for much of the 10-20% mortality[2] juvenile salmonids experience in each of eight Columbia and Snake river reservoirs.

The goal of Bonneville's Development of Systemwide Predator Control project is to remove between 10-20 percent of predatory-sized pikeminnow each year. The project is not trying to eliminate northern pikeminnow, but rather reduce the average size of the population and lower the number of larger, older fish.[3] It is expected that, by reducing the number of the largest pikeminnow, it will increase the numbers of salmon and steelhead juveniles making it through the hydropower system and out to sea.

Bonneville funds the Development of Systemwide Predator Control project at about $3.7 million annually to partially mitigate for the impact of the Columbia River hydroelectric system on salmon. Results to date indicate the project has been successful. Raymond et al. (1996) estimated that, prior to the start of this predator control project, pikeminnow consumed about 8 percent of the roughly 200 million juvenile salmonids migrating downstream in the CRB each year.

Since the start of the predator control project in 1990, over 3.5 million northern pikeminnow have been removed by the Sport Reward Fishery and annual exploitation rates have averaged about 13 percent (CBFWA SOTR, 2011). As a result, it is estimated predation on juvenile salmonids has been reduced by about 40 percent, resulting in an estimated savings of 4 to 6 million juvenile salmon annually that otherwise would have been consumed by this predator (CBFWA SOTR, 2011). Moreover, there is no evidence of compensation in predation, growth, or reproduction of surviving pikeminnow, or by other resident fish predators (CBFWA SOTR, 2011).

Reservoirs provide favorable habitat for a number of piscivorous predators. Besides northern pikeminnow, predation by non-native species such as smallmouth bass and walleye is also significant in some mainstem Columbia and Snake reservoirs and tributaries. One of the first studies to examine the relative impacts of non-native predators on juvenile salmonid mortality was conducted from 1983-86 in John Day Reservoir on the mainstem Columbia River to determine the significance of predation on emigrating juvenile salmonids (Rieman et al. 1991; Vigg et al. 1991; Poe et al. 1991). Results indicated that three non-native fishes -- walleye, smallmouth bass and channel catfish -- consumed significant numbers of juvenile salmon and steelhead, although the native fish predator (northern pikeminnow) accounted for the highest losses of smolts. In contrast, smallmouth bass in the McNary pool on the Columbia River near the Tri-cities area consume juvenile salmon at a higher rate than do northern pikeminnow (Tabor et al. 1993).

Comparisons of diets and abundances of northern pikeminnow, smallmouth bass and walleye in the Snake and Columbia rivers between 1990 and 1996 showed northern pikeminnow consumed mostly juvenile salmonids,

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[2] This estimate includes fish and avian predation, as well as natural smolt mortality.

[3] To be eligible under the Sport Reward Fishery program, northern pikeminnow must have a total length greater than or equal to 9 inches, i.e., fish less than 9 inches total length are ineligible for reward payment.

whereas smallmouth bass and walleye ate primarily non-salmonid fishes (Zimmerman 1999). Smallmouth bass were much more abundant in the impounded reaches of the Snake River than in the free-flowing reaches of the lower Columbia River. In contrast, walleye appear to be found more in the impounded reaches of the Columbia River (Zimmerman and Parker 1995). Other non-native fishes which have been documented to prey on juvenile salmonids include largemouth bass, yellow perch, and crappie (Bennett et al. 1983; Poe et al. 1994).

Non-native fish species are ubiquitous throughout Washington, Oregon and Idaho, with their highest densities in southeastern Oregon and southern Idaho (Sanderson et al. 2008). Sanderson et al. (2008) conclude that predation was the best documented of all non-native fish impacts on salmonids in the Pacific Northwest and that in some habitats or locations non-native fishes can consume significant numbers of emigrating juvenile salmon. Non-native fish have been identified as one of the causes, e.g., limiting factors, of native salmonid listings in the three Northwest states.

**Avian Predators**

Predation on juvenile salmonids by piscivorous colonial waterbirds in the CRB has been investigated in field studies funded by the Corps of Engineers for over a decade. These studies have assessed the impact of predation by Caspian terns, double-crested cormorants, and other piscivorous colonial waterbirds on juvenile salmonids in the CRB.

A Columbia Basin-wide assessment of avian predation on juvenile salmonids indicates the most significant impacts to juvenile salmonid survival occur in the Columbia River estuary, with the combined consumption of juvenile fish by Caspian terns and double-crested cormorants nesting on East Sand Island estimated at between 6 and 25 million smolts annually during 2003-10 (BRNW 2012 *draft*). This represents about 5 to 20 percent of all salmonid smolts that survive to the estuary in an average year (BRNW 2011). Estimated smolt losses to piscivorous colonial waterbirds nesting in the estuary are more than an order of magnitude greater than those observed elsewhere in the CRB (BRNW 2011, Lyons et al. 2011). Moreover, when compared to the impact of avian predation on the Columbia Plateau, bird predation in the estuary affects juvenile salmonids from every ESA-listed stock throughout the basin that have survived freshwater migration to saltwater, which should have a higher probability of returning as adults.

However, there are also Caspian tern colonies on Crescent Island near the Tri-Cities and on Goose Island (in Potholes Reservoir in eastern Washington), and a double-crested cormorant colony on Foundation Island (mid-Columbia River). These relatively small colonies on or near the Columbia River confluence with the Snake River are preying on certain salmonid populations, particularly juvenile steelhead.

Research has shown that steelhead smolts are the most susceptible to predation by birds nesting along the Columbia River (Collis et al. 2001; Ryan et al. 2003; Antolos et al. 2005). Predation rates by Crescent Island terns on Snake River steelhead smolts is about 8 to 12 percent, which is a similar predation rate on the same stock as Caspian terns nesting on East Sand Island in the estuary. Researchers have found that steelhead smolts in poorer condition and migrating during low flow periods were more likely to be preyed upon by Caspian terns (BRNW 2011).

<u>Avian Predators in the Columbia River Estuary</u>

The Caspian tern colony on East Sand Island in the Columbia River estuary is the largest of its kind in the world. It consisted of about 7,000 breeding pairs in 2011, which is a substantial decline from 2010 and 2009 (about 8,300 and 9,854 breeding pairs, respectively). Caspian terns did not exist in any significant numbers east of the Cascade Mountains until East Sand Island was formed from the dumping of dredge spoils by the Corps of Engineers, which provided ideal breeding habitat for the terns and other piscivorous colonial waterbirds.

In 2011, the tern colony on East Sand Island did not produce any fledglings, largely due to disturbance by bald eagles and associated gull predation on tern eggs and chicks. Juvenile salmonids continue to be a large portion of the diet of terns nesting on East Sand Island, comprising 36 percent of their diet in 2011, which is somewhat higher than the average of 30 percent over the previous decade (BRNW 2012 *draft*).

Even with the colony failure, Caspian terns nesting at the East Sand Island colony consumed about 4.8 million juvenile salmonids in 2011, which is lower than the 11-year average but similar to the smolt consumption estimates from the previous two years. Consumption of juvenile salmonids by Caspian terns over the last 10 years has averaged approximately 5.4 million smolts per year (BRNW 2011). Future management plans are designed to reduce the size of the East Sand Island tern colony to about one-third its pre-management size of about 9,500 breeding pairs. This action is expected to reduce annual consumption of juvenile salmonids from the CRB by a similar amount, i.e., by about two-thirds.

Management of Caspian tern nesting habitat at the East Sand Island colony continued last year, with the Corps of Engineers further reducing the area of suitable tern nesting habitat on the island to 2.0 acres, or 40 percent of the original area of tern nesting habitat (BRNW 2012 *draft*). This habitat reduction, however, caused the terns to nest at higher densities than previously seen in the Columbia River estuary. Since early 2008, the Corps has constructed eight new islands as alternative Caspian tern nesting sites to compensate for reductions in Caspian tern nesting habitat on East Sand Island; five of these new tern islands are in interior Oregon and three are in the Upper Klamath Basin of northeastern California. Six of the eight new tern islands were surrounded by water throughout the 2011 nesting season, and thus were suitable as tern nesting habitat. Four of these six suitable islands have supported nesting Caspian terns. A substantial number of terns banded at East Sand Island in the Columbia River estuary visited these alternative nesting sites, including 92 banded terns that were seen at the Upper Klamath Basin tern islands during the 2011 breeding season (BRNW 2012 *draft*).

East Sand Island is also home to the largest double-crested cormorant colony in western North America, consisting of about 13,000 breeding pairs in 2011, which is similar to the 2010 population and about 8 percent larger than it was in 2009. Juvenile salmonids represented about 19 percent of the diet of double-crested cormorants nesting on East Sand Island in 2011, which was the highest percentage observed since 1999. Double-crested cormorants nesting at this colony consumed about 20.5 million juvenile salmonids in 2011, the highest annual consumption estimate for cormorants ever recorded (BRNW 2012 draft). The birds' diet consisted mostly of sub-yearling Chinook salmon.

In 2011, smolt consumption by double-crested cormorants nesting on East Sand Island was significantly greater than smolt consumption by Caspian terns nesting on East Sand Island. Taken together, the loss of juvenile salmonids in 2011 to these two species of fish-eating birds nesting on East Sand Island was about 25 million smolts, or roughly 20 percent of all juvenile salmonids estimated to reach the estuary last year.

In 2011, a pilot study was conducted to test the feasibility of a management strategy to limit the amount of nesting habitat available to double-crested cormorants at East Sand Island. An eight-foot-tall privacy fence was built at the colony to visually separate 15 percent of the nesting area used by cormorants in 2010 from the remainder of the colony. Hazing of the cormorants during their nest initiation period (late April to mid-May) was successful in dissuading the birds from using this 15 percent of their former nesting area. Cormorants on the other side of the fence nested normally, apparently unaffected by the hazing activities. No detrimental effects of hazing activities were observed on non-target species using this portion of the island (BRNW 2012 *draft*).

Avian Predators on the Columbia River Plateau

As noted above, Caspian terns and double-crested cormorants are also responsible for most losses of salmonid smolts to avian predators along the mid-Columbia River near the confluence of the Snake River. The largest breeding colonies of Caspian terns in the Columbia Plateau region were found on Crescent Island on the mid-Columbia River (in the McNary Pool) and on Goose Island on Potholes Reservoir (near Othello, WA), where

nearly equal numbers of breeding pairs (about 420) nested in 2011. During the 2011 breeding season, salmonid smolts represented 84 percent of tern prey items at the Crescent Island colony, the highest percentage ever recorded at that colony, and 24 percent of tern prey items at the Goose Island/Potholes colony. Estimated consumption of juvenile salmonids by Caspian terns nesting at these two colonies was 440,000 smolts and 111,000 smolts, respectively (BRNW 2012 *draft*).

The largest colony of double-crested cormorants on the mid-Columbia River was found on Foundation Island in the McNary Pool, where about 318 pairs nested in 2011. Diet sampling during 2005-2010 indicated about 50 percent (by mass) of the diet of Foundation Island cormorants was juvenile salmonids during May (the peak of smolt out-migration), while less than 10 percent of the cormorant diet was salmonids during early April, June, and July. Based on diet data, colony size and productivity, researchers have estimated that Foundation Island cormorants consumed about 24,700 kg (54,450 pounds) of juvenile salmonids in 2011. As in previous years, this was significantly greater than the salmonid consumption by the Crescent Island Caspian tern colony, which was estimated at 14,700 kg (32,400 pounds) (BRNW 2012 *draft*).

Based on PIT tag recovery data alone, smolt losses in 2011 were highest due to Crescent Island Caspian terns (11,734 PIT tags), followed by Foundation Island double-crested cormorants (8,376 PIT tags) and Goose Island Caspian terns (6,387 PIT tags). However, PIT tags recovered from the Caspian tern colony on Goose Island in Potholes Reservoir were almost exclusively from upper Columbia River salmonid evolutionarily significant units (ESUs), while PIT tags recovered on other bird colonies in the Columbia Plateau region consisted of smolts from the Upper Columbia, Snake and Middle Columbia ESUs (BRNW 2012 *draft*).

PIT tag recovery results show that Caspian terns from the Goose Island colony in Potholes Reservoir consumed nearly 9 percent of the ESA-listed Upper Columbia steelhead smolts that were PIT-tagged and released at Rock Island Dam in the mid-Columbia River. This was the highest ESU-specific predation rate measured in 2011for birds nesting at a colony in the Columbia Plateau region. Predation rates by Crescent Island terns on Snake River steelhead was about 1.9 percent and the predation rate for Foundation Island cormorants on Snake River steelhead was about 1.8 percent, which were also notable in 2011 and comparable to those reported in previous years (2007-2010) (BRNW 2012 *draft*).

On the other hand, predation on salmonid smolts by American white pelicans nesting on Badger Island and California and ring-billed gulls nesting on Crescent Island and Miller Rocks during 2011 was relatively minor (generally less than a half percent per ESU) compared to that of Caspian terns and double-crested cormorants nesting at colonies in the Columbia Plateau region (BRNW 2012 *draft*).

California and ring-billed gulls nest in large numbers on various islands on or near the lower and mid-Columbia River, but these gulls have generally consumed few fish and even fewer juvenile salmonids compared to Caspian terns or double-crested cormorants nesting along the mid-Columbia River. In 2011, the number of gulls counted on the Miller Rocks colony in The Dalles reservoir near Biggs, Oregon, was 5,750, up slightly from the 5,533 gulls counted on the colony during the 2010 breeding season. The number of gulls nesting on Miller Rocks has apparently increased by about 160 percent since 1998 (BRNW 2012, *draft*). Some of the gulls nesting on Miller Rocks commute over 10 miles either up-river or down-river to forage on juvenile salmonids in the tailraces of the John Day Dam and The Dalles Dam, respectively.

Similarly, the American white pelican colony on Badger Island in the McNary pool has undergone dramatic growth since the late 1990s, increasing from only 100 adults in 1999 to about 2,200 adults on-colony in 2011. The numbers of smolt PIT tags recovered from both the Miller Rocks gull colony and the Badger Island pelican colony have increased commensurate with increases in colony size (BRNW 2012 *draft*). Continued monitoring of these and other new or growing colonies of piscivorous waterbirds in the Columbia River basin will be necessary to determine the magnitude and trend for total losses of juvenile salmonids to avian predators in the basin.

**Marine Mammal Predation**

Within the last decade, California and Steller[4] sea lions, both of which are protected under the Marine Mammal Protection Act, have been observed swimming over 140 miles up the Columbia River to Bonneville Dam to prey on adult spring Chinook salmon, winter steelhead, white sturgeon and Pacific lamprey. Generally arriving below Bonneville Dam in February and leaving by the first week in June, these large male sea lions are consuming fish to gain weight in preparation for their summer mating season.

Predation by marine mammals on adult salmonids has been observed and documented each year since 2002 by Corps of Engineers biologists in the tailrace area immediately below Bonneville Dam on the lower Columbia River under the Pinniped Observation Project. On average, roughly 100 pinnipeds have been observed in the tailrace area below Bonneville Dam during the 2002-2011 period, ranging from a low of 31 in 2002 to a high of 166 in 2010 (Stansell et al. 2011). Over the 10-year period, the majority (about 73 percent) of pinnipeds arriving below Bonneville Dam have been California sea lions (CSLs), with about 25 percent Steller sea lions (SSLs) and less than 2 percent harbor seals.

Based on preliminary data, the 40 individual CSLs identified in 2012 is the lowest total since 2002. On the other hand, the number of individual SSLs observed below Bonneville Dam has increased greatly within the last three years (with a 3-year average of 78), compared to the 2002-2009 average number of only 12 SSLs (Stansell et al. 2011). The maximum number of total pinnipeds observed in the tailrace on any day in 2012 was 38 on April 25th, while the maximum number of pinnipeds seen during 2011 was 48 (Stansell et al. 2011). The maximum daily number of SSL and CSL observed in the tailrace during 2012 was 29 and 14 animals (Stansell et al. May 25, 2012, weekly report), respectively, while the maximum daily number of SSL and CSL observed in the tailrace in 2011 was 48 and 25 animals, respectively (Stansell et al. 2011).

The average number of CSLs present below Bonneville Dam per day in 2012 is lower than it was in 2011 and is the lowest number of CSLs since 2002, the first full year of monitoring. This number was likely influenced by the removal of a number of CSLs this spring which would otherwise have added to the daily abundance estimates. In 2012, at least 25 CSLs were confirmed as having been seen at the dam in past years, along with 34 of the SSLs. However, SSLs outnumbered CSLs nearly every day this year. No harbor seals were observed at Bonneville Dam this year (Stansell et al. May 25, 2012, weekly report).

The estimated percentage of the total adult salmon run consumed (1.6 percent) in 2011 by pinnipeds was the third lowest since 2002, as 2011 had the third largest total salmonid passage count at Bonneville Dam from January through May in the last 10 years. The expanded salmonid consumption by all pinnipeds of 3,557 adults in 2011 was down from the peak number of 6,081 salmonids consumed in 2010 (Stansell et al. 2011).

For 2012, the Corps' preliminary total salmonid consumption estimate by pinnipeds through May 9th of 1,216 adults[5] is lower than in any previous year except 2002. Predation on salmonids by CSLs this year is also much lower than in any previous year since 2002. On the other hand, SSL predation on salmonids this year is higher than it was in any previous year, and was higher than predation by CSL for the first time ever (Stansell et al. May 25, 2012, weekly report). Although data are preliminary, the percentage of the total adult run consumed by pinnipeds is estimated to be about 1.3 percent for 2012, with CSLs contributing 0.6 percent and SSLs contributing 0.7 percent (Stansell et al. May 25, 2012, weekly report).

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[4] Steller sea lions are also listed as threatened under the Endangered Species Act.

[5] These numbers represent *minimum* salmon take estimates, as they are based on observations of fish being consumed. Also, an estimate is not available for total salmonid consumption by pinnipeds from Bonneville Dam to the river mouth.

The expanded consumption estimate of white sturgeon in 2011 was 2,178, which continued an upward trend in pinniped predation on sturgeon in the Bonneville Dam tailrace (Stansell et al. 2011). White sturgeon have been the most commonly observed prey species for SSLs, comprising over 99 percent of the observed sturgeon catches in 2011. However, the Corps indicated that SSLs were known to have been catching and consuming sturgeon below Bonneville Dam as early as October 2010, so the expanded catch estimate represents a minimum catch and does not include predation outside the normal observation period. Pinniped predation on sturgeon dropped off dramatically after the last week in March 2011 when spring Chinook salmon began to arrive at the dam and became the preferred prey item of both types of sea lions (Stansell et al. 2011).

For 2012, the expanded preliminary pinniped predation estimates on white sturgeon is more than the 2011 estimate identified above. However, when the Corps adjusted its estimates for additional unknown prey taken, the sturgeon predation estimate in 2012 is less than last year's estimate (Stansell et al. May 25, 2012).

In 2011, the expanded Pacific lamprey consumption estimate by pinnipeds was 33 fish, which was fewer than in any previous year. CSLs had 14 of the 16 observed lamprey catches in the Bonneville Dam observation area. The pinnipeds' 2011 catch of lamprey had the lowest proportion of total observed catch (0.4 percent) since observations began in 2002.[6] According to the Corps, the drop in observed lamprey predation is likely due to lower numbers of lamprey available to be preyed upon (Stansell et al. 2011).

Preliminary data on observed pinniped predation on Pacific lamprey in 2012 was 36 fish, which is similar to the 2011 estimate. CSLs consumed 30 lamprey, while SSLs took the remainder (Stansell et al. May 25, 2012, weekly report).

In general, most salmonid predation by pinnipeds occurs in the Bonneville First Powerhouse tailrace while most sturgeon predation occurs in Bonneville Second Powerhouse tailrace. In March 2012, the states of Idaho, Oregon and Washington again received authority from NOAA Fisheries under Section 120 of the Marine Mammal Protection Act to remove up to 92 CSLs per year that are identified as having a significant impact on the recovery of listed salmonid stocks. Subsequent legal proceedings resulted in the removal limit being reduced to a maximum of 30 CSLs this year. The states' trapping and removal efforts resulted in the lethal removal of 11 CSLs this spring, while one other animal was trapped and placed in a captive care facility at the Shedd Aquarium in Chicago, Illinois.



[6] Due to small body size and presumed vulnerability of lamprey to predation, the Corps' surface observation approach may significantly underestimate the actual predation rate on lamprey, although this underestimate should be similar among years.

# Summary of Predation Effects in the Columbia River Basin

Upcoming workshop:

**Predation in the Columbia River Basin, What are the Management Alternatives?**

Science-Policy Exchange Series

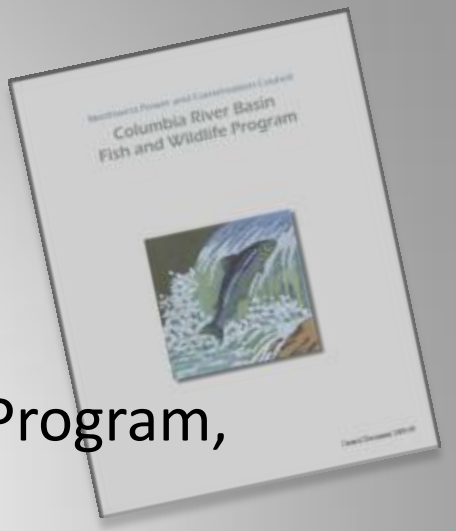
Thursday, August 9, 2012

Portland, Oregon

Ambridge Event Center

Northwest Power and Conservation Council

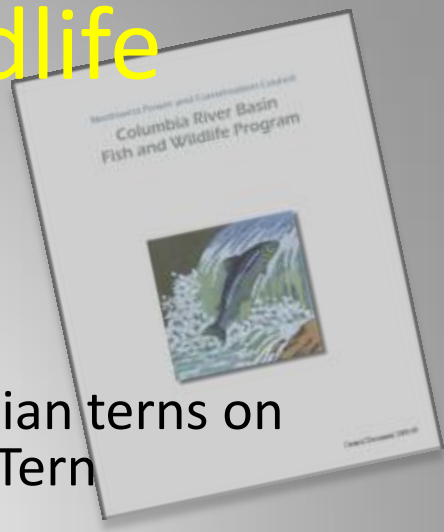
# Council's 2009 Fish and Wildlife Program




**Piscivorous Predator Control**

- Implement the Pikeminnow Predator Control Program, evaluate its effectiveness
- FAA, with others should review, evaluate, develop, implement strategies to reduce non-native fish predation on salmonids.
- Lethal take to control non-native fish predators is appropriate when non-lethal methods are unsuccessful and adverse impacts are significant.

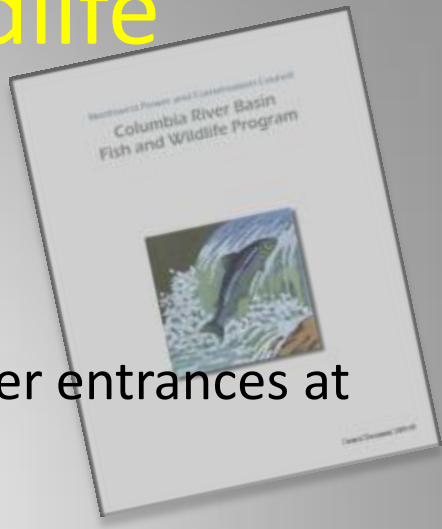
# Council's 2009 Fish and Wildlife Program




**Avian Predator Control**

- Federal AAs should continue to reduce number of Caspian terns on East Sand Island by implementing the USFWS' Caspian Tern Management Plan.
- Federal AAs should develop a double-crested cormorant management plan (lower Columbia River and estuary).
- Federal AAs should develop an inland avian management plan for Caspian terns, double-crested cormorants, other avian species in the mid-Columbia region.
- Corps should continue to implement, improve avian deterrent programs at all federal lower Snake and Columbia River dams.

# Council's 2009 Fish and Wildlife Program




**Pinniped Predator Control**

- Corps should exclude sea lions at all main adult fish ladder entrances at Bonneville Dam
- Corps should support non-lethal pinniped deterrent efforts by states and tribes to keep sea lions away from area immediately below BON Dam
- Federal and state agencies should evaluate extent of pinniped predation on salmonids, sturgeon , Pacific lamprey in lower Columbia River (BON Dam to mouth).
- Lethal take to control pinniped predation is appropriate when non-lethal methods of control are unsuccessful and adverse impacts to salmonids are significant

# Native and Non-native Fish Predators

Fish predators include:

- Northern pikeminnow
- Walleye
- Smallmouth bass
- Northern pike
- Others

# Northern pikeminnow

- At dams, juvenile salmonids are concentrated in forebays and tailraces, causing increased predation and salmonid loss
- Migration past dams can causes injury and physiological stress, increase the vulnerability to predators
- Impoundments enhance populations of some resident predatory fish, and increase travel time for migrating juvenile salmonids, prolonging their exposure to predators

# Northern pikeminnow

- Estimated annual losses of juvenile salmon - approximately 16.4 million
- Pikeminnow Management Program began in 1990, has evolved and focused
- Program implemented a public-sport reward fishery on the mainstem river.

# Pikeminnow Management Program Goals:

Goals:

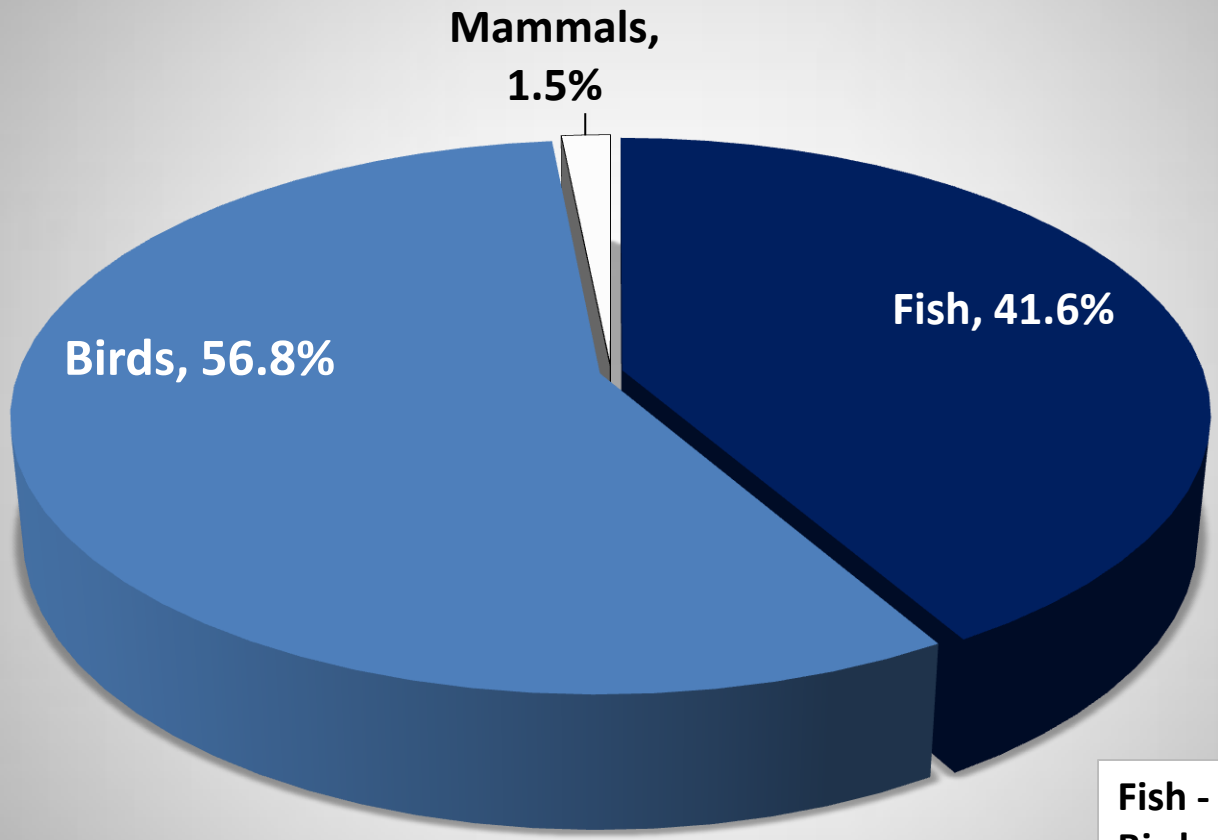
- Remove 10-20% of predatory-sized pikeminnow per year
- Evaluate response of pikeminnow to sustained fisheries
- Check for compensatory predation by smallmouth bass and walleye
- Evaluate effect of program on salmonid predation

# Lake Roosevelt Predator Issues

- Altered river environment encouraged spread of non-native predators like walleye and smallmouth bass
- Studies showed predation on kokanee and rainbow trout was threatening these populations
- Colville Tribe began a predator reduction program in 2011

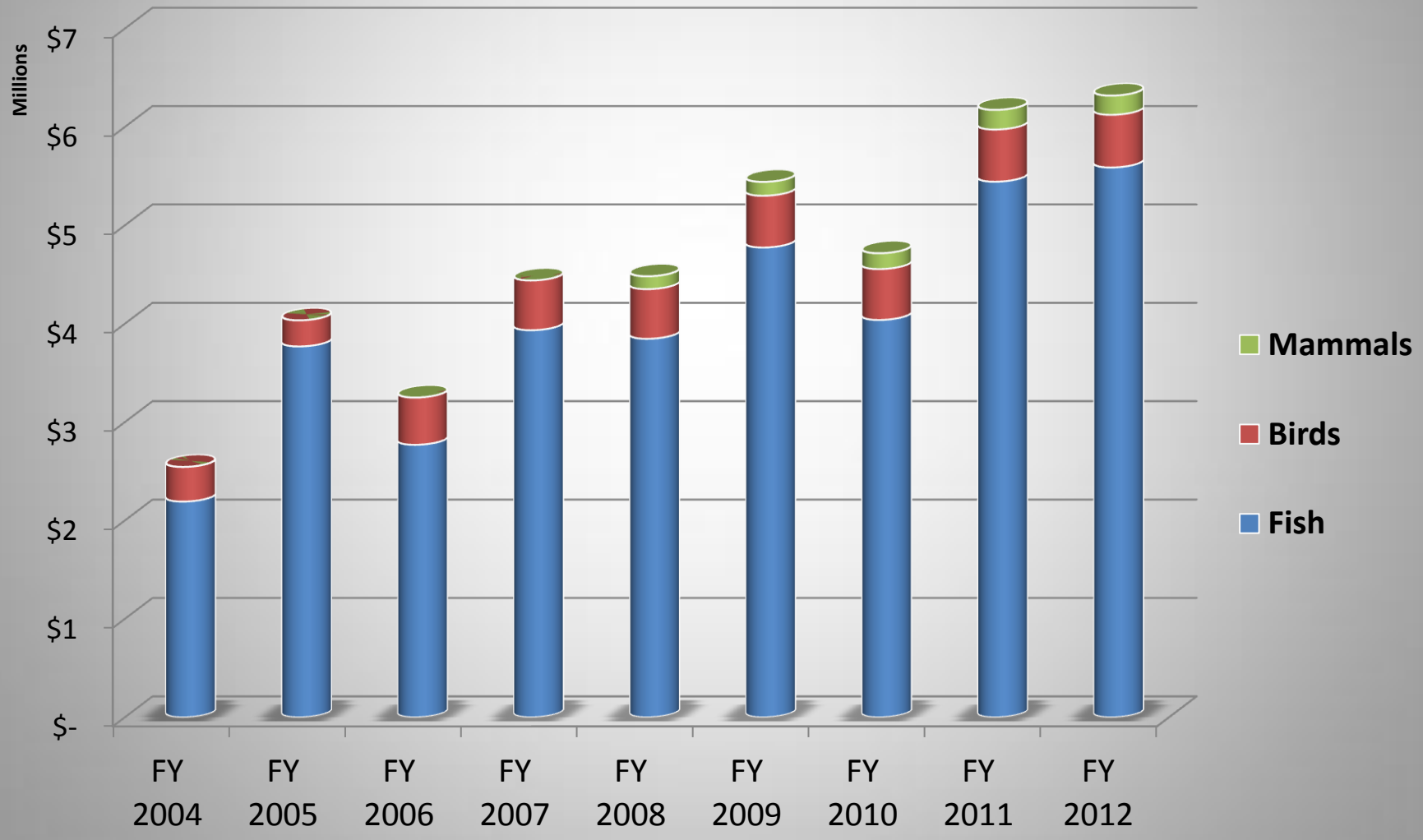
# End Part 1

# Total 2012 funding category percentages
# Direct and Reimbursable Programs combined



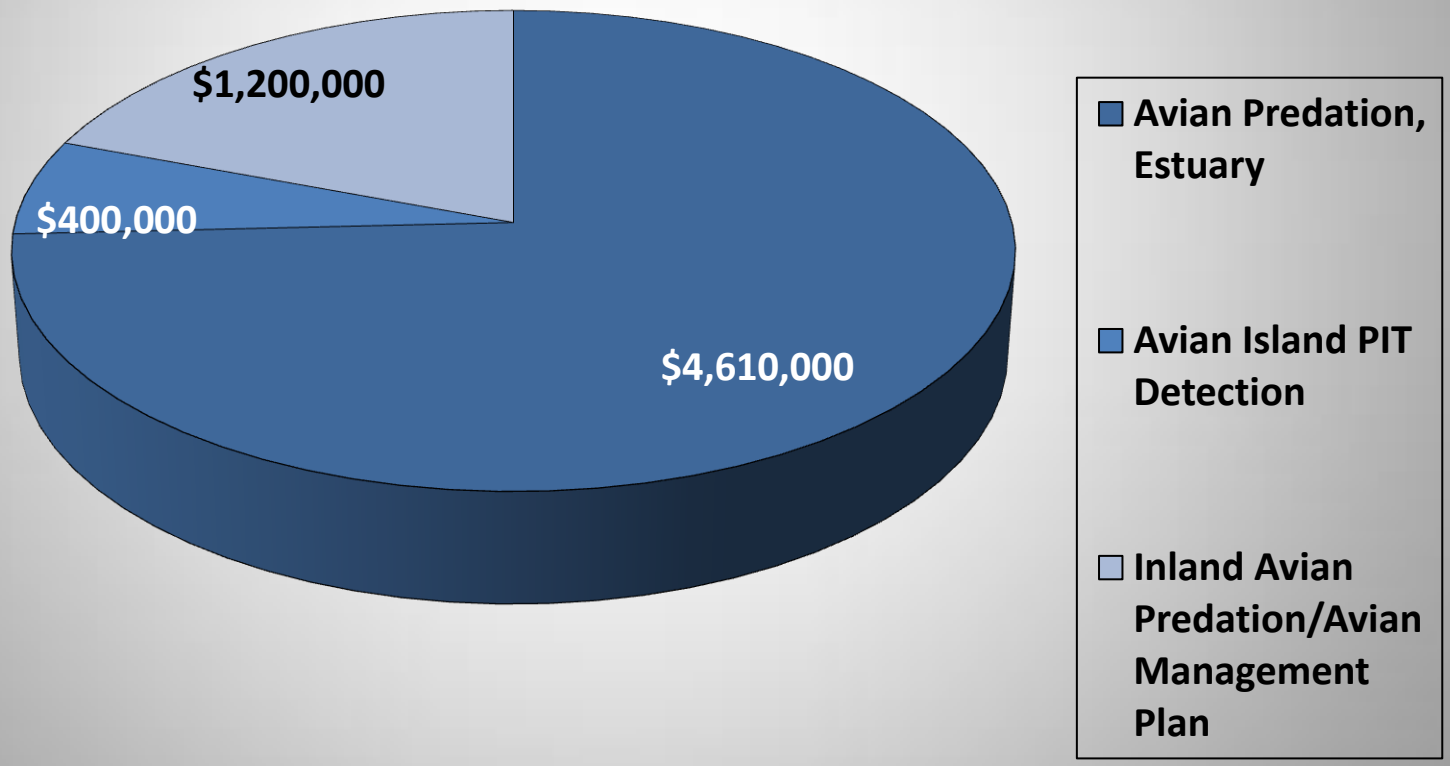

| | |
|---|---|
| Fish - | $5.6 M |
| Birds - | $7.6 M |
| Mammals- | $ .2 M |
| Total - | $13.4 M |

# Funding of Predation Projects, Direct Program, 2004-2012



# Optional slides

# Avian Predation funding by project - FY 2013
## Corps of Engineers
## Total: $6,210,000



# Pikeminnow management program

**Principles of program:**

- Habitat change has increased predation,
- N. pikeminnow responsible for majority of losses
- Can get large reductions in predation from low exploitation
- Compensation is unlikely

# Avian Predation in the Columbia River Basin

Information from:

Oregon State University

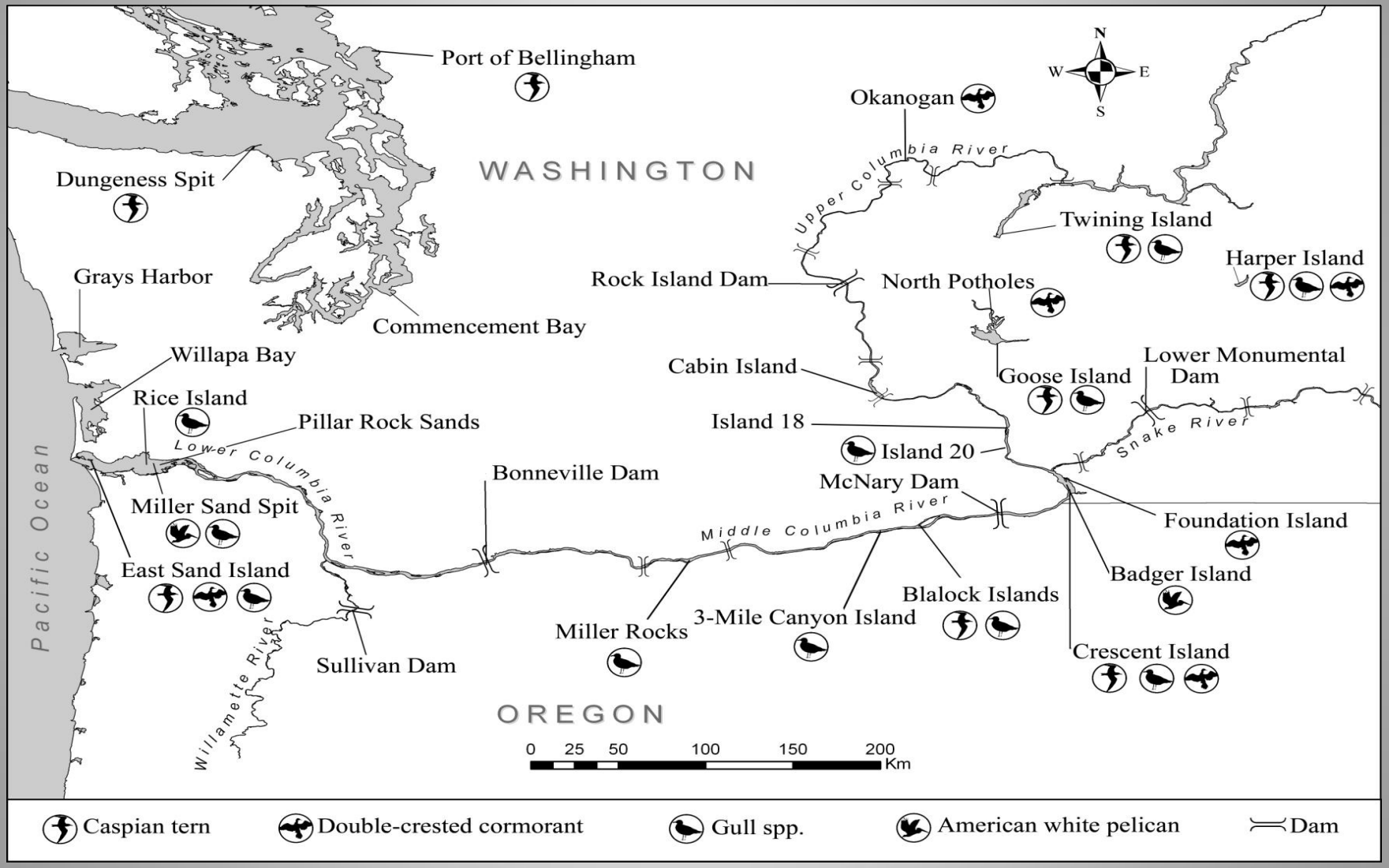
Real Time Research, Inc.

USGS-Oregon Cooperative Fish & Wildlife Research Unit

# Topics Covered

- Objectives:
  - Monitor Avian Abundance
  - Estimate Avian Predation on Juvenile Salmonids
  - Evaluate Effectiveness of Deterrent and Relocation actions
- Study Site
- Results
  - Abundance Estimates, Predation Estimates
  - Deterrent Actions, Relocation Program

# Study Area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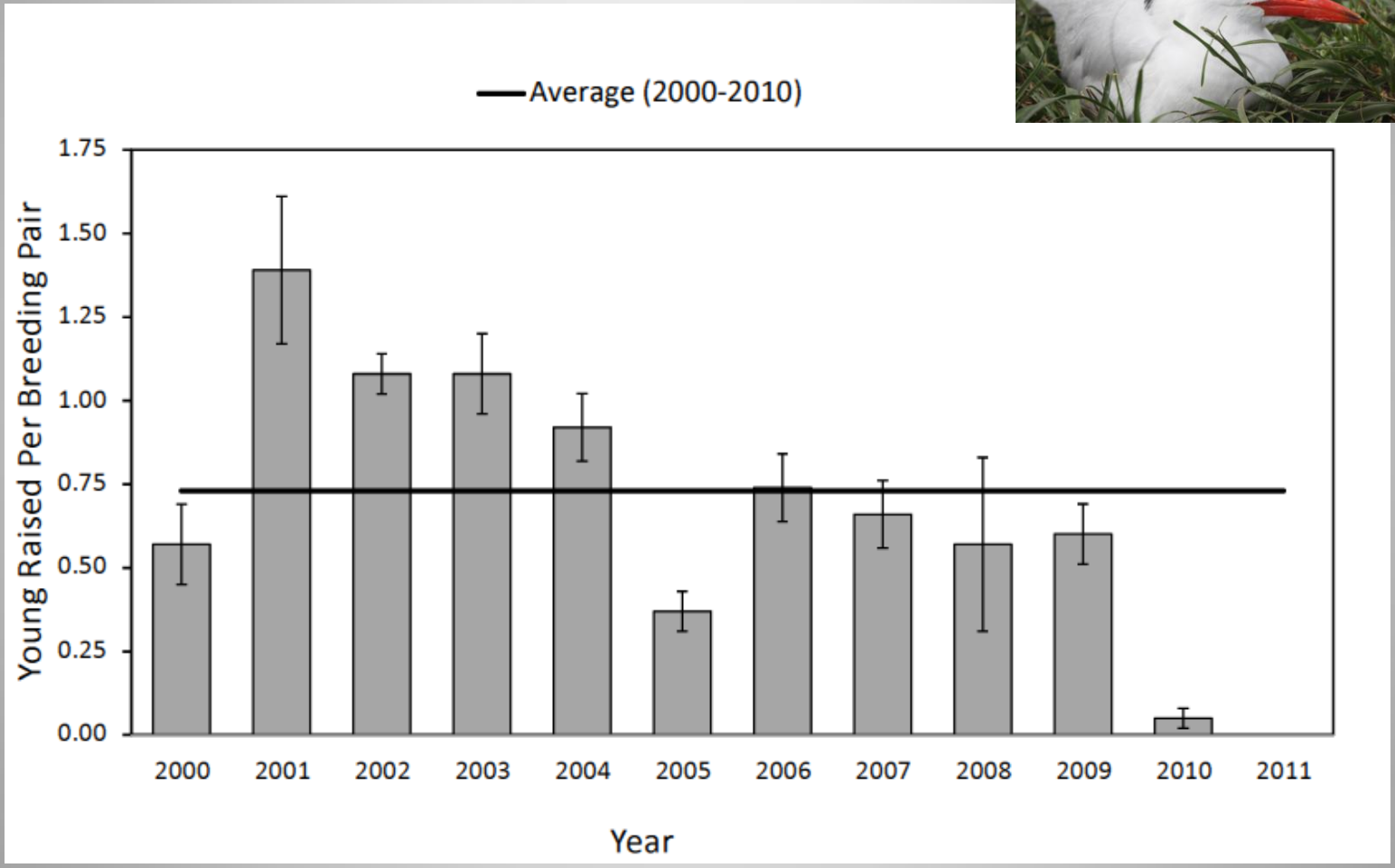
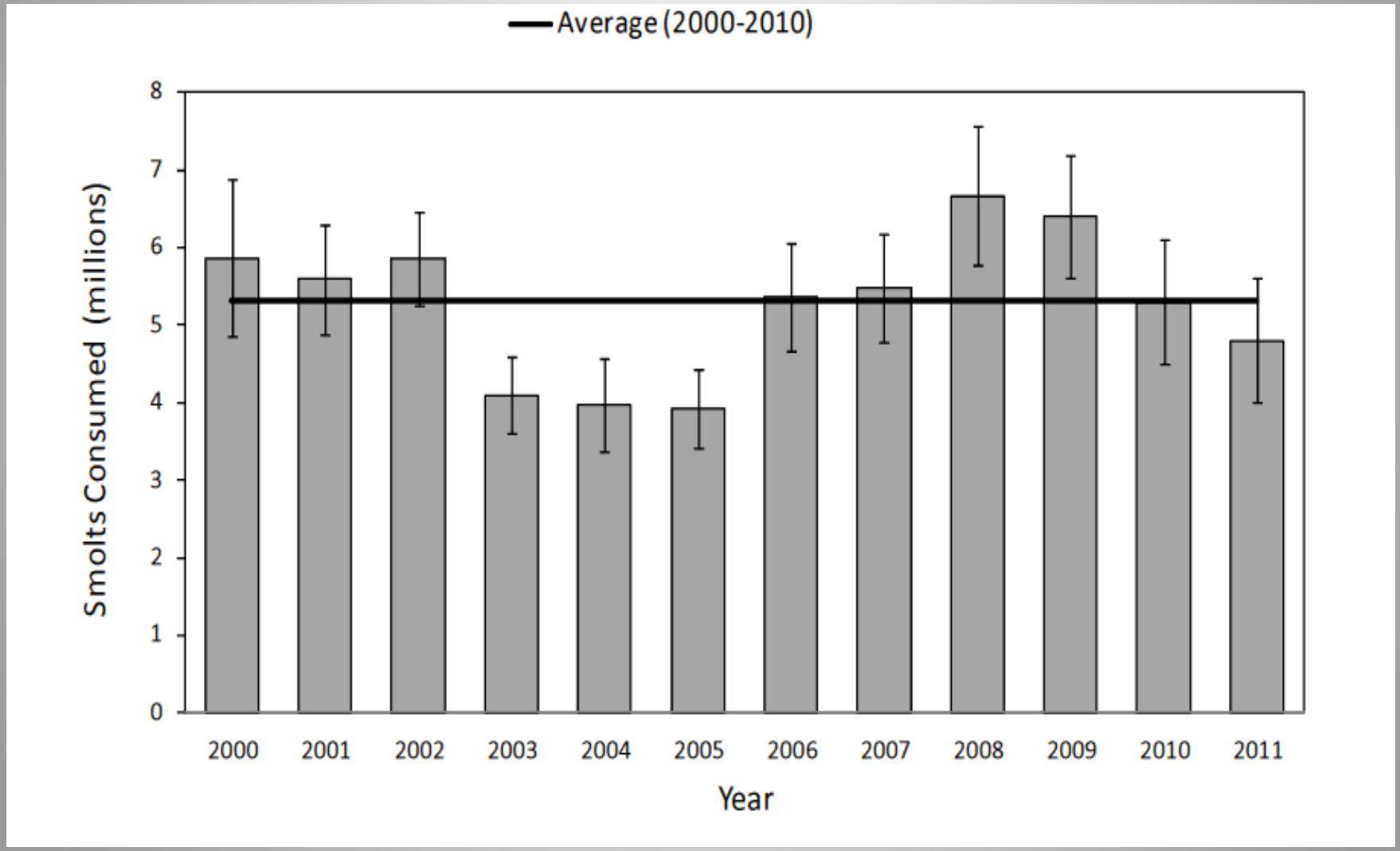
WASHINGTON
Upper Columbia River
Dungeness Spit
Twining Island
Harper Island
Grays Harbor
Rock Island Dam
North Potholes
Commencement Bay
Willapa Bay
Cabin Island
Lower Monumental Dam
Goose Island
Rice Island
Pillar Rock Sands
Island 18
Island 20
Snake River
Lower Columbia River
Bonneville Dam
McNary Dam
Pacific Ocean
Miller Sand Spit
Middle Columbia River
Foundation Island
East Sand Island
Badger Island
Blalock Islands
3-Mile Canyon Island
Miller Rocks
Crescent Island
Sullivan Dam
Willamette River
OREGON
0 25 50 100 150 200
Km
Caspian tern
Double-crested cormorant
Gull spp.
American white pelican
Dam

# Caspian Tern Nesting Success at East Sand Island



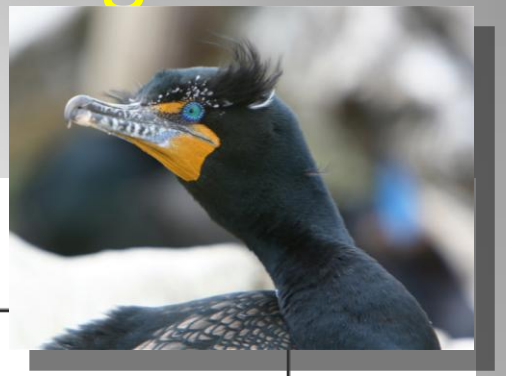
# Estimated Total Annual Consumption of Juvenile Salmonids by Caspian Terns on East Sand Island



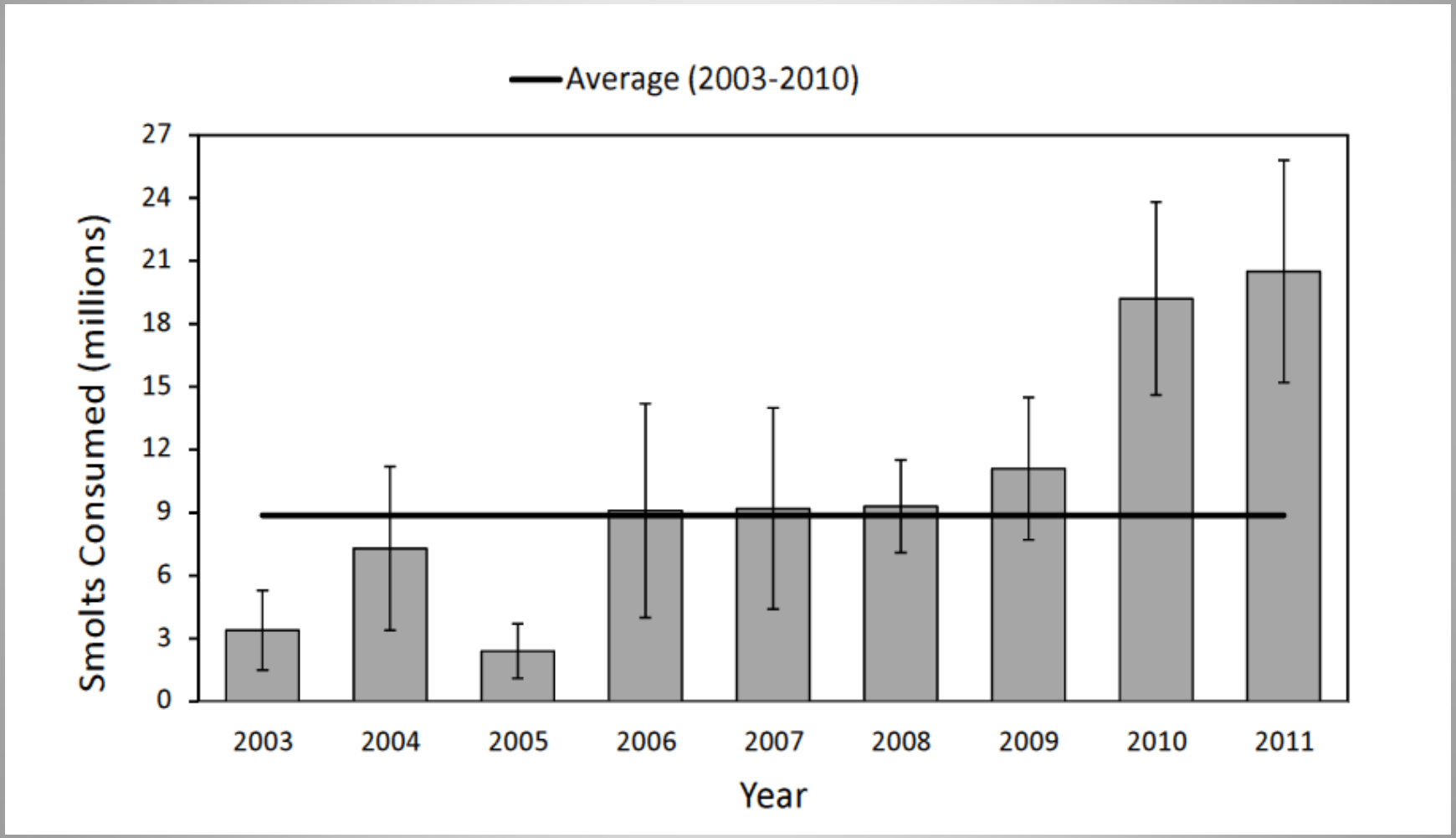
# Double-crested Cormorant
## Predation on Salmonids in the Columbia River Estuary

- Predation rates on PIT-tagged up-river stocks ranged from 1% to 8%
- Recent estimates of annual consumption of juvenile salmonids have ranged from 2 million smolts (2005) to 18 million smolts (2010)
- In most years, consumption of sub-yearling Chinook smolts far exceeded that of other species/run types
- In 2010, the salmonid consumption estimate for East Sand Island cormorants was higher than in any other year this decade

# Double-crested Cormorant Nesting Success at East Sand Island



# Estimated Total Annual Consumption of Juvenile Salmonids by Double-crested Cormorants on East Sand Island

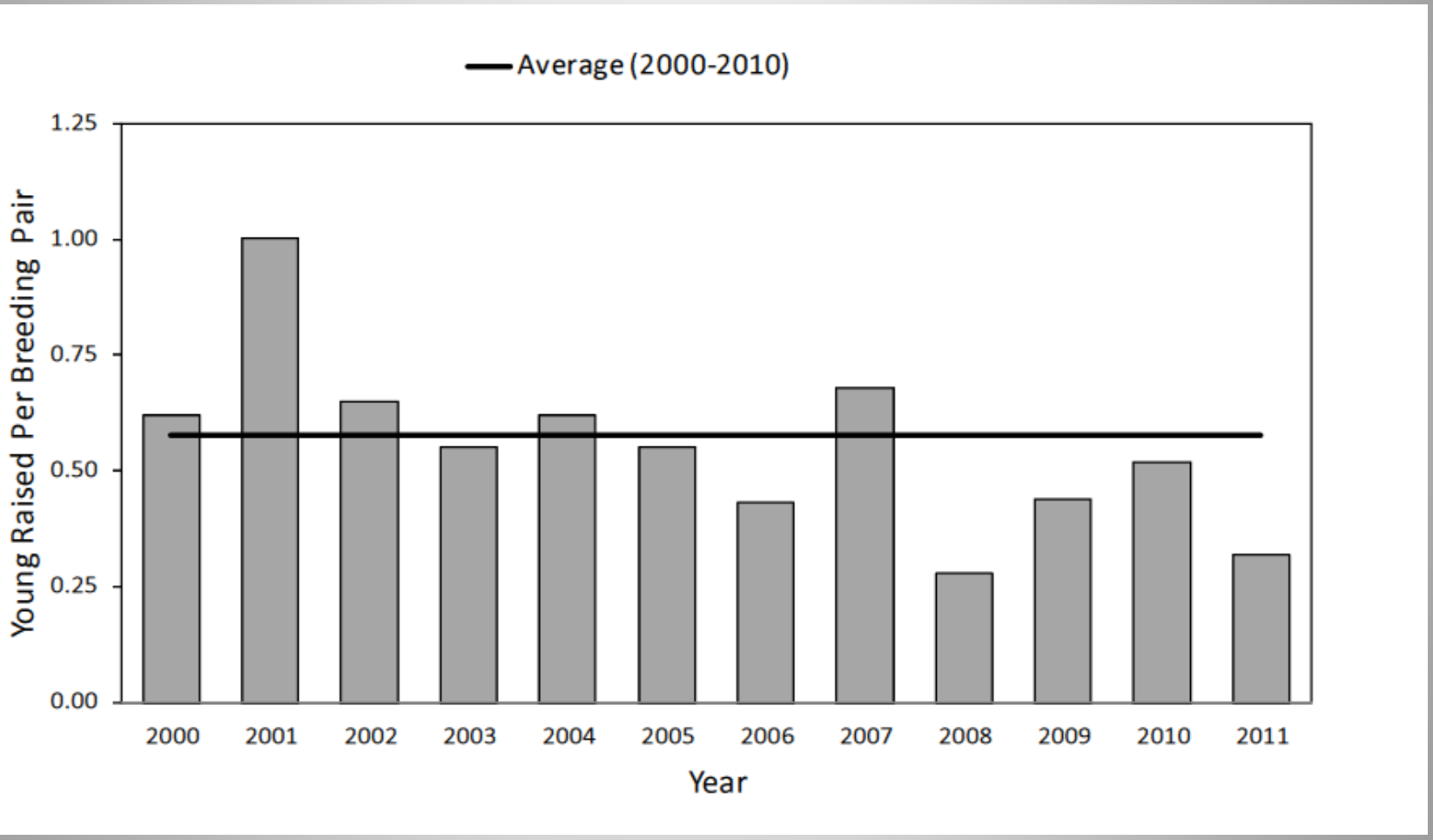


# Conclusions - Estuary

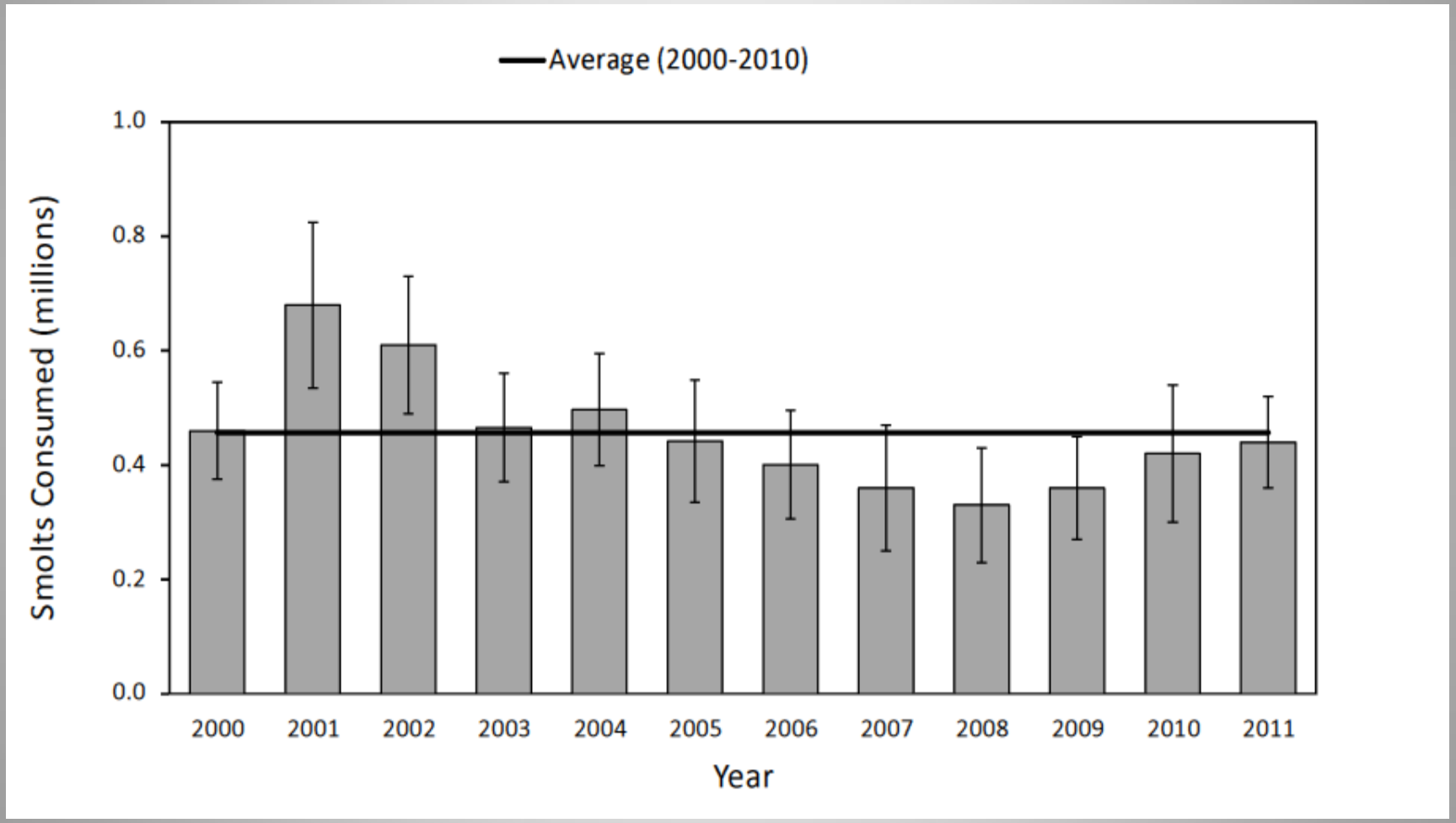
- Combined losses of juvenile salmonids to predation by Caspian terns and double-crested cormorants in the Columbia River estuary were 19 - 29 million smolts in 2010 (preliminary estimate)
- Smolt losses to double-crested cormorants far exceeded smolt losses to Caspian terns in 2010
- Habitat for Caspian terns on East Sand Island was reduced by 38% from former area, but reduction in colony size was less
- Potential redistribution of a portion of the East Sand Island cormorant colony is in planning stage

# Primary Inland Colonial Waterbird Nesting Sites

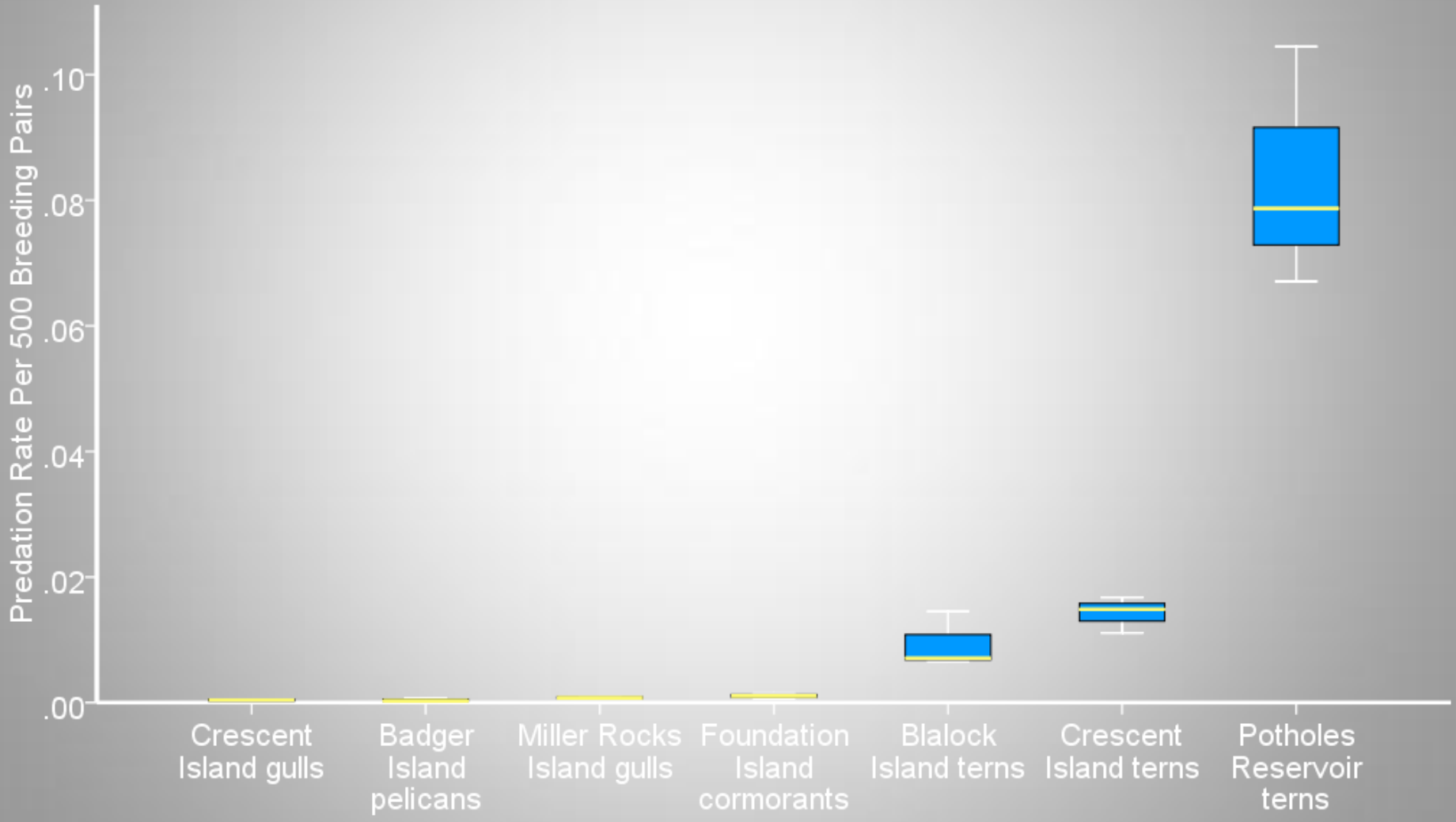
# Caspian Tern Nesting Success on Crescent Island – Mid Columbia



# Estimated Total Consumption of Juvenile Salmonids by Caspian Terns on Crescent Island



# Per Capita Predation Rate Estimates on Upper Columbia River Smolts



# Conclusions – Up-river


- Data from this project are being use to evaluate the need for and scope of inland avian predation management initiatives

- Predation rates are variable based on the fish species, fish stock, avian predator species, and year

- Over-all (all colonies) predation rates in 2010 were down slightly relative to years past, with the greatest impacts on steelhead from the Snake and Upper Columbia ESUs

- Per capita predation rates indicate that management of Caspian terns (Crescent, Potholes, Blalocks) and cormorants (Foundation) would be the most beneficial to salmonid recovery efforts


Questions?

# Pinniped Predation in the Bonneville Dam Tailrace

Information provided by:
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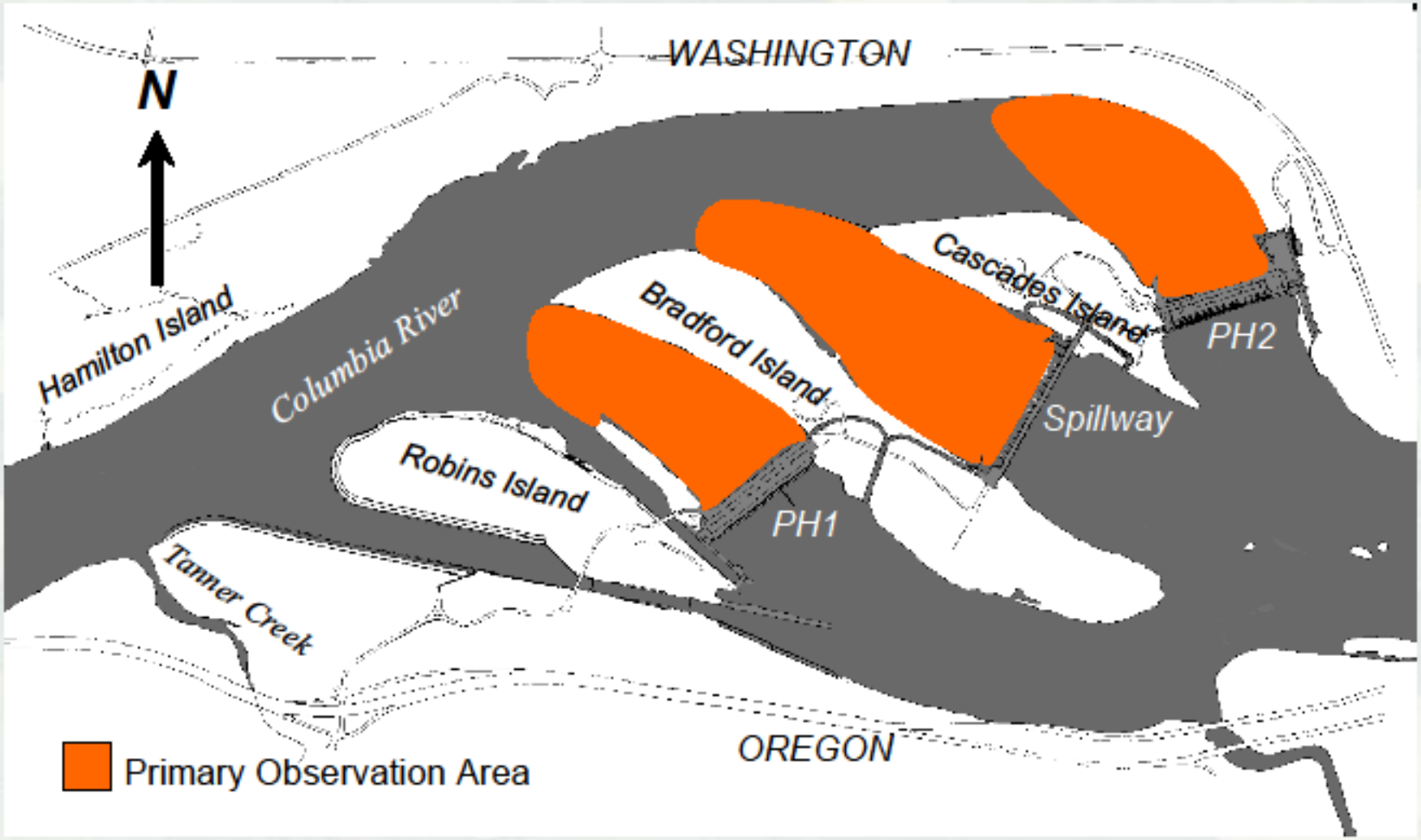
USACE-Portland District

# Topics Covered

- Objectives:
  - Monitor Pinniped Abundance
  - Estimate Pinniped Predation
  - Evaluate Effectiveness of Deterrent and Removal actions
- Study Site
- Results
  - Abundance Estimates, Predation Estimates
  - Removal Program

# Observation Area - Bonneville Dam



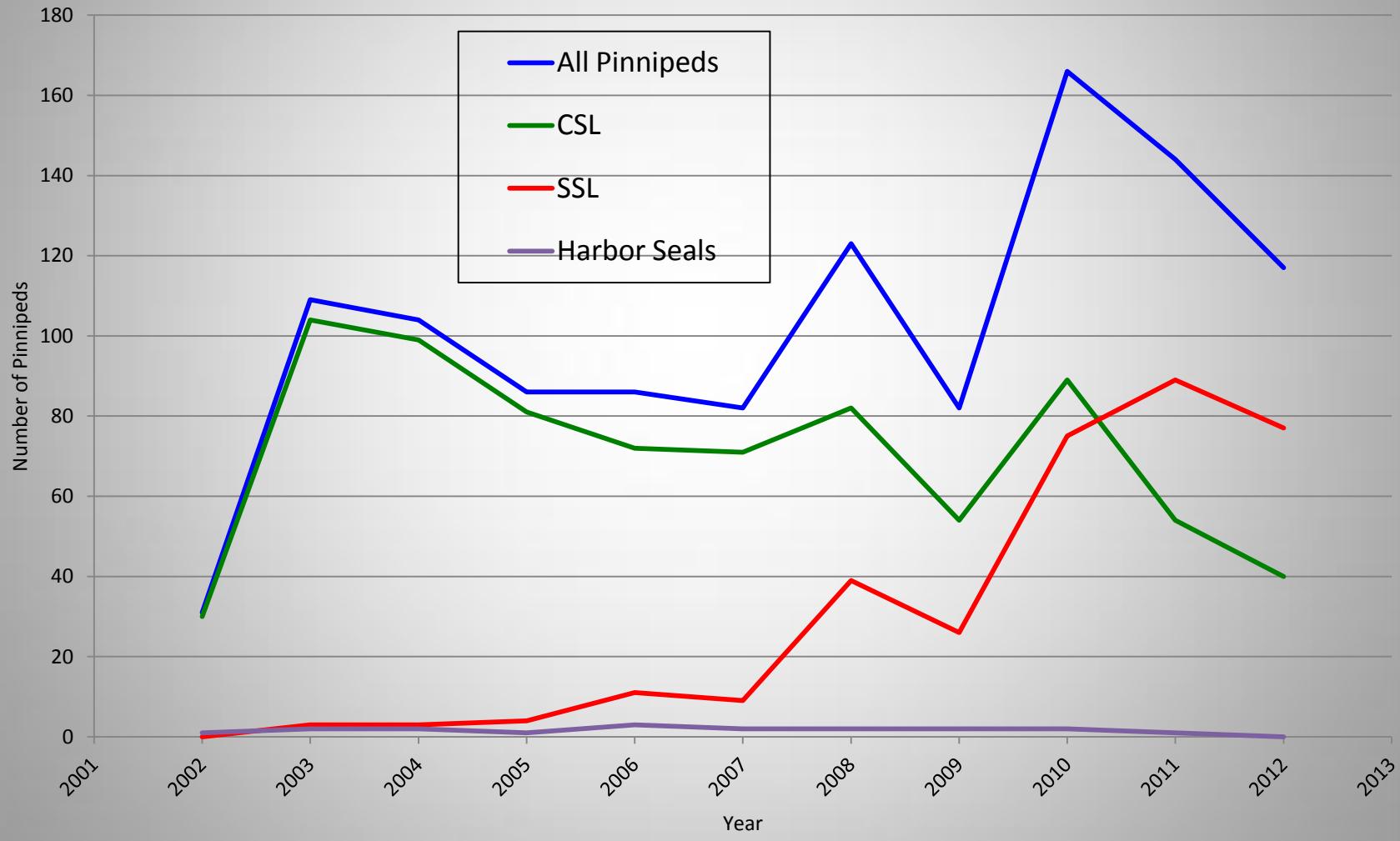
# Results: Pinniped Abundance

California sea lion
(CSL)
*Zalophus californianus*

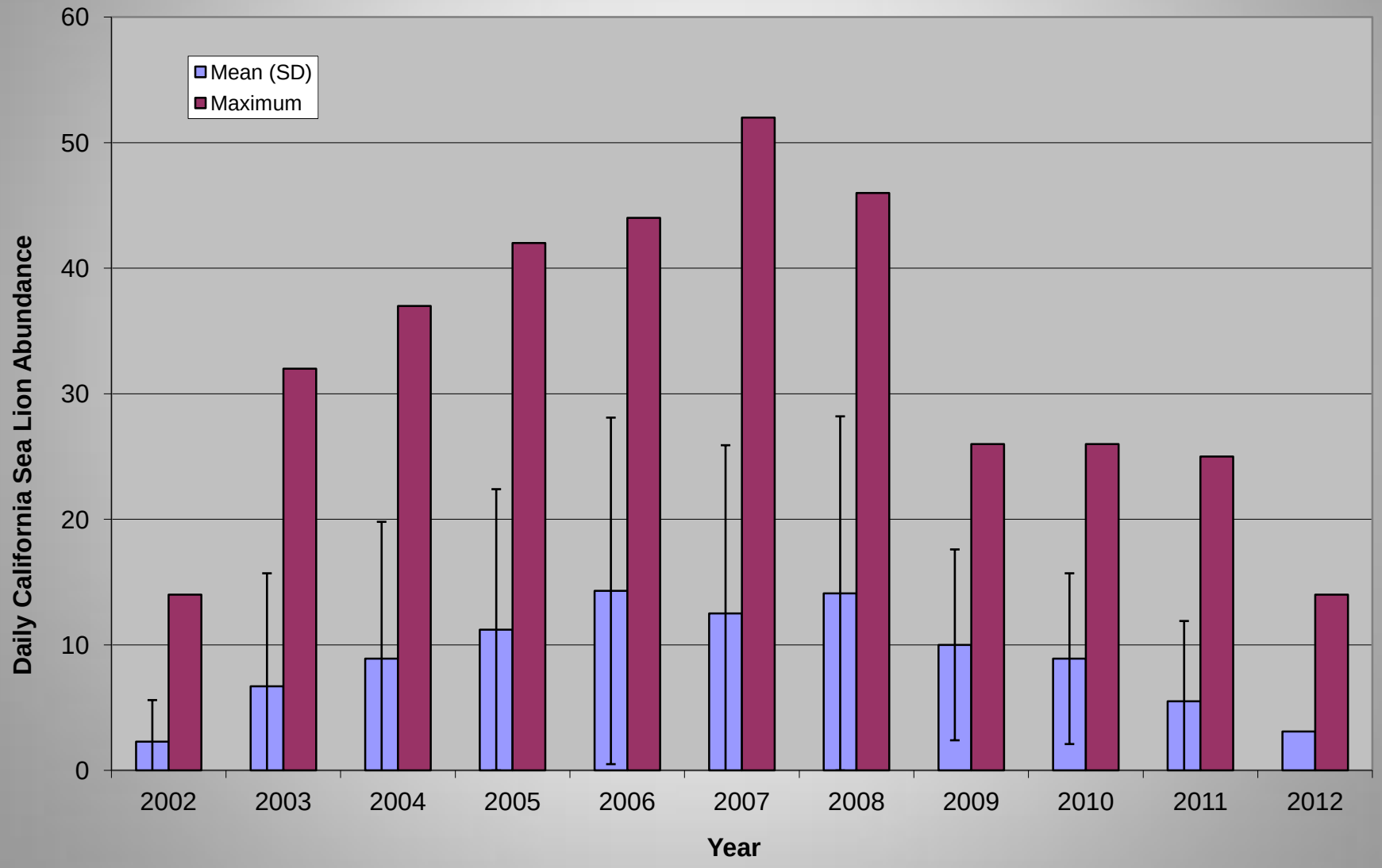
Steller's sea lion
(SSL)
*Eumetopias jubatus*

Harbor seal
*Phoca vitulina*

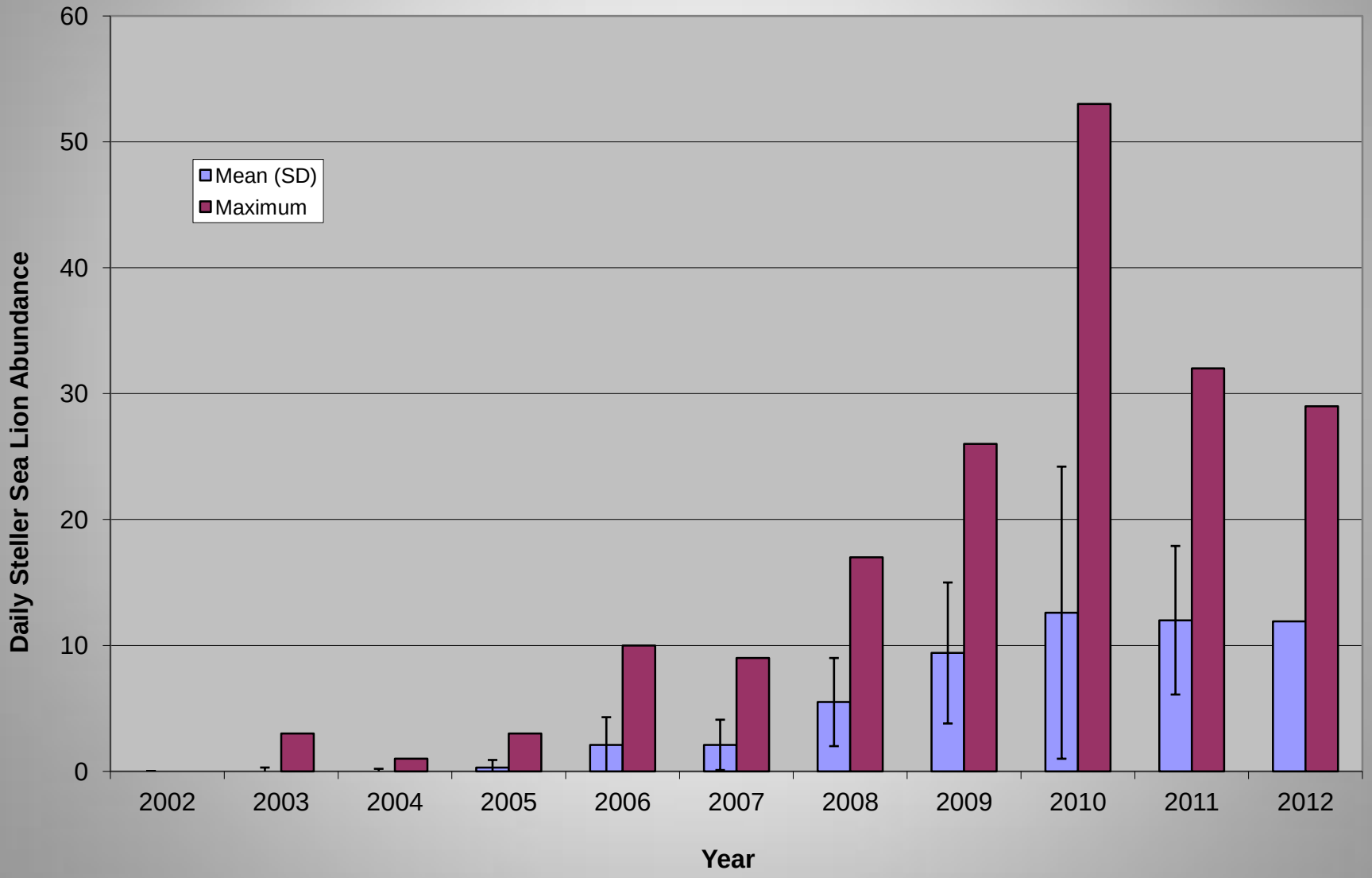
# Minimum Annual Pinniped Abundance Estimates



# Daily Average and Maximum California Sea Lion Abundance, 2002-2012



# Daily Average and Maximum Steller Sea Lion Abundance, 2002-2012

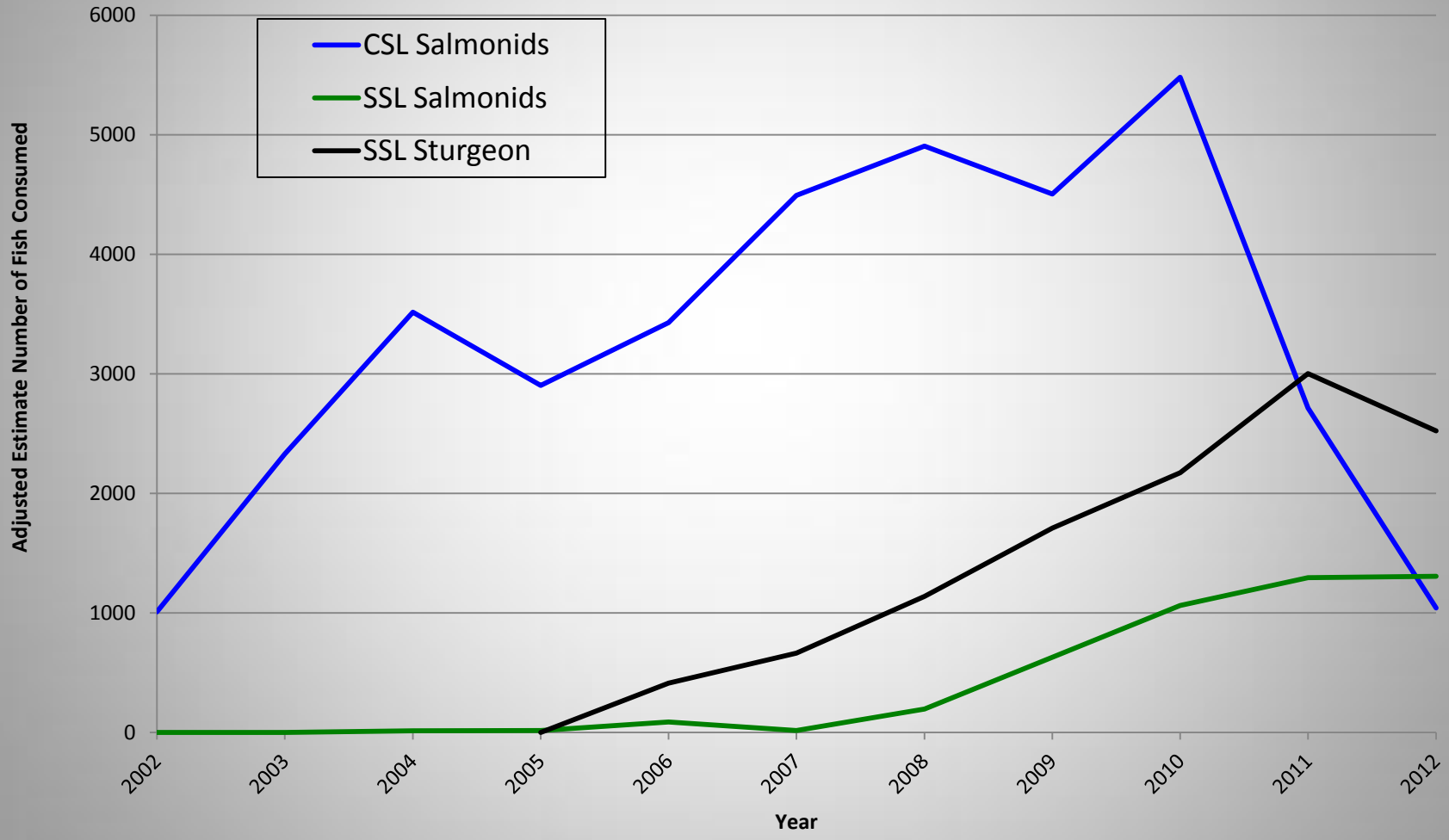


# Pinniped Predation Results

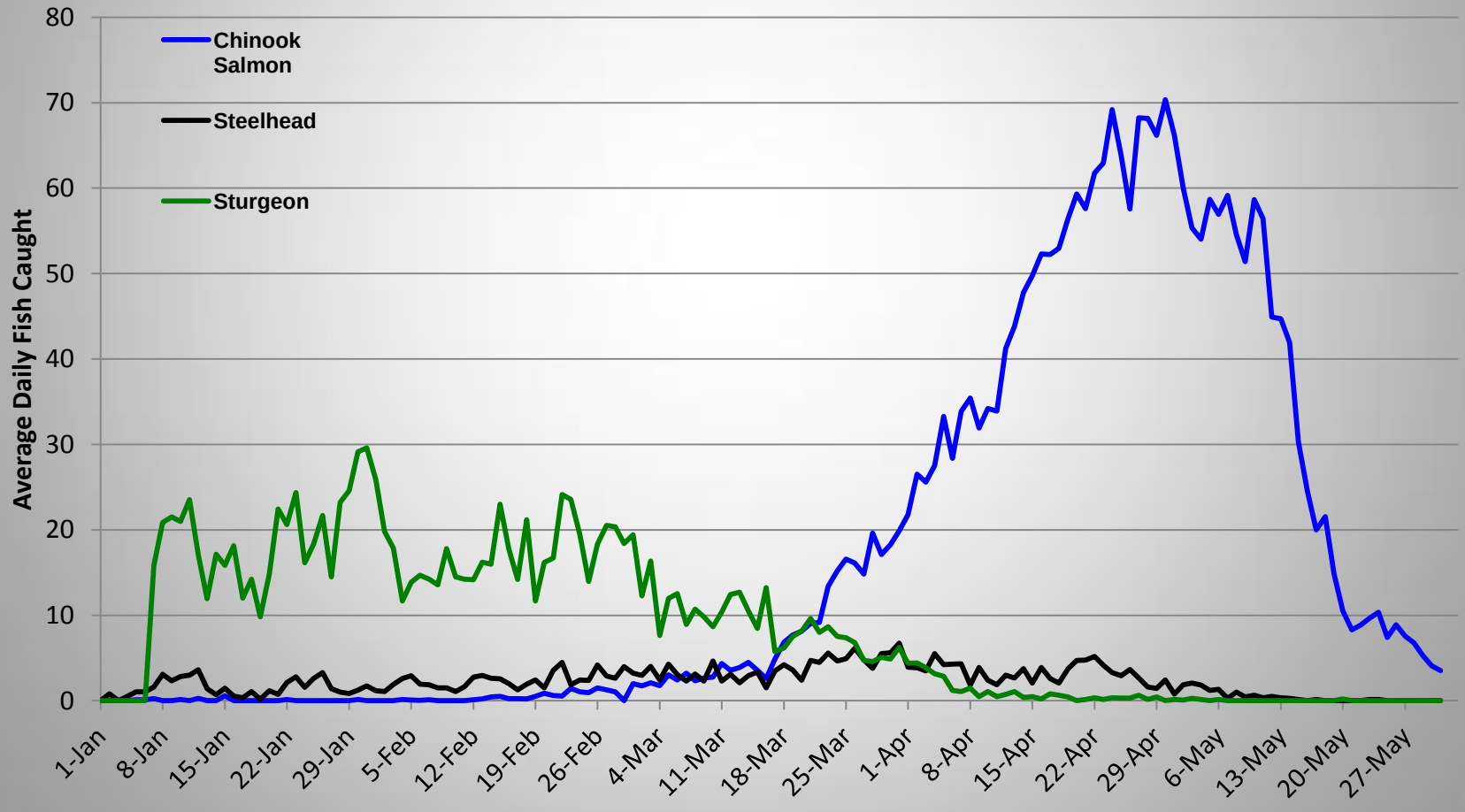
# Annual Salmonid Passage and Estimated Consumption by Pinnipeds

| Year | Bonneville Dam Salmonid Passage | Estimated Salmonid Consumption | % of Run (Jan 1-May31) |
|---|---|---|---|
| **2002** | 284,733 | 1,010 | 0.4% |
| **2003** | 217,185 | 2,329 | 1.1% |
| **2004** | 186,804 | 3,533 | 1.9% |
| **2005** | 82,006 | 2,920 | 3.5% |
| **2006** | 105,063 | 3,520 | 3.2% |
| **2007** | 88,474 | 4,507 | 4.9% |
| **2008** | 147,543 | 5,099 | 3.3% |
| **2009** | 186,060 | 5,134 | 2.7% |
| **2010** | 267,194 | 6,542 | 2.4 % |
| **2011** | 223,380 | 4,007 | 1.8% |
| **2012** | 171,665 | 2,382 | 1.4% |

# Estimated Salmonid and Sturgeon Consumption by Pinnipeds



# Average Daily Chinook, Steelhead, and Sturgeon Predation by Pinnipeds at Bonneville Dam, (averaged 2006-2012)



# Predation on White Sturgeon and Pacific Lamprey by Pinnipeds at Bonneville Dam, January 1-May 31

| Year | Estimated Sturgeon Consumed | Estimated Lamprey Consumed |
|---|---|---|
| 2002 | | 47 |
| 2003 | | 317 |
| 2004 | | 816 |
| 2005 | 1 | 810 |
| 2006 | 413 | 424 |
| 2007 | 664 | 143 |
| 2008 | 1,139 | 145 |
| 2009 | 1,710 | 102 |
| 2010 | 2,172 | 77 |
| 2011 | 3,003 | 33 |
| 2012 | 2,498 | 79 |

# Results of Trapping and Removal


# California Sea Lion Removals in Columbia River, 2008-2012

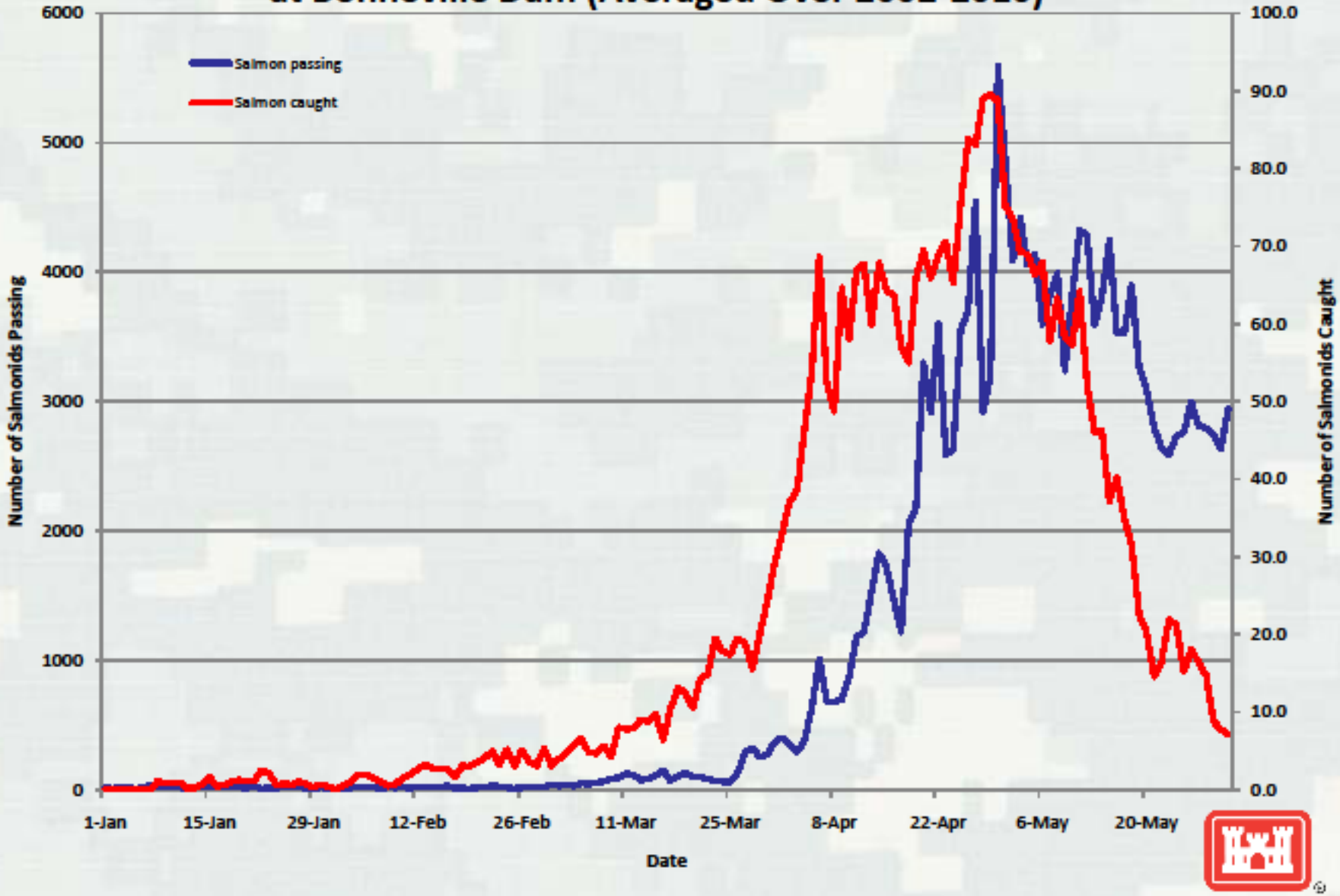
| Year | Zoo/Aquaria | Accidental Trapping Incident | Euthanized | Trapped in Astoria and Euthanized | Total |
|---|---|---|---|---|---|
| 2008 | 6 | 4 | 1 | 0 | 11 |
| 2009 | 4 | 0 | 10 | 1 | 15 |
| 2010 | 0 | 0 | 12 | 2 | 14 |
| 2011 | 0 | 0 | 0 | 1 | 1 |
| 2012 | 1 | 0 | 11 | 0 | 12 |
| Total | 11 | 4 | 34 | 4 | 53 |


MAY 2008 ~ Astoria, OR
Bonneville residents
Astoria residents
Photo by M. Tennis

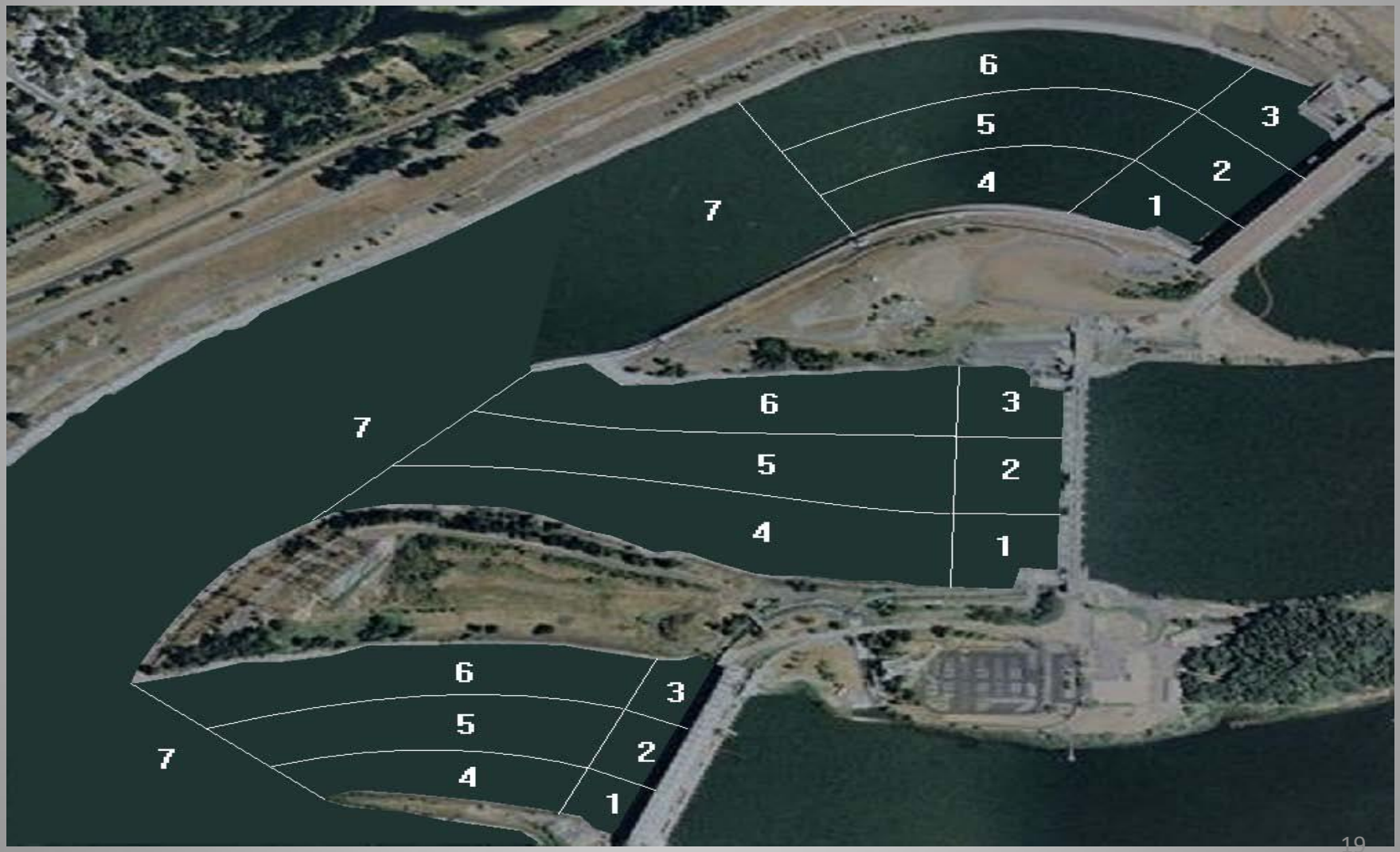
# Summary – Key Points on Pinniped Predation

- Physical barriers effectively block CSL access to fishways.
- Active non-lethal deterrence efforts have failed to reduce predation on salmonids and sturgeon at the dam.
- Trapping/removal program seems to be working by reducing both CSL abundance and amount of predation on salmonids. Without 53 removals, salmonid predation would have been higher.
- Salmonid catch totals has decreased (2,382; 1.4% of run in 2012).
- SSLs have become more of a problem with increasing abundance and more predation on both white sturgeon and salmon species, as well as stealing prey from CSLs.
- Sea lions are impacting the early season spring Chinook stocks.
- SSLs are also coming earlier each year and having an impact on white sturgeon below BON Dam.

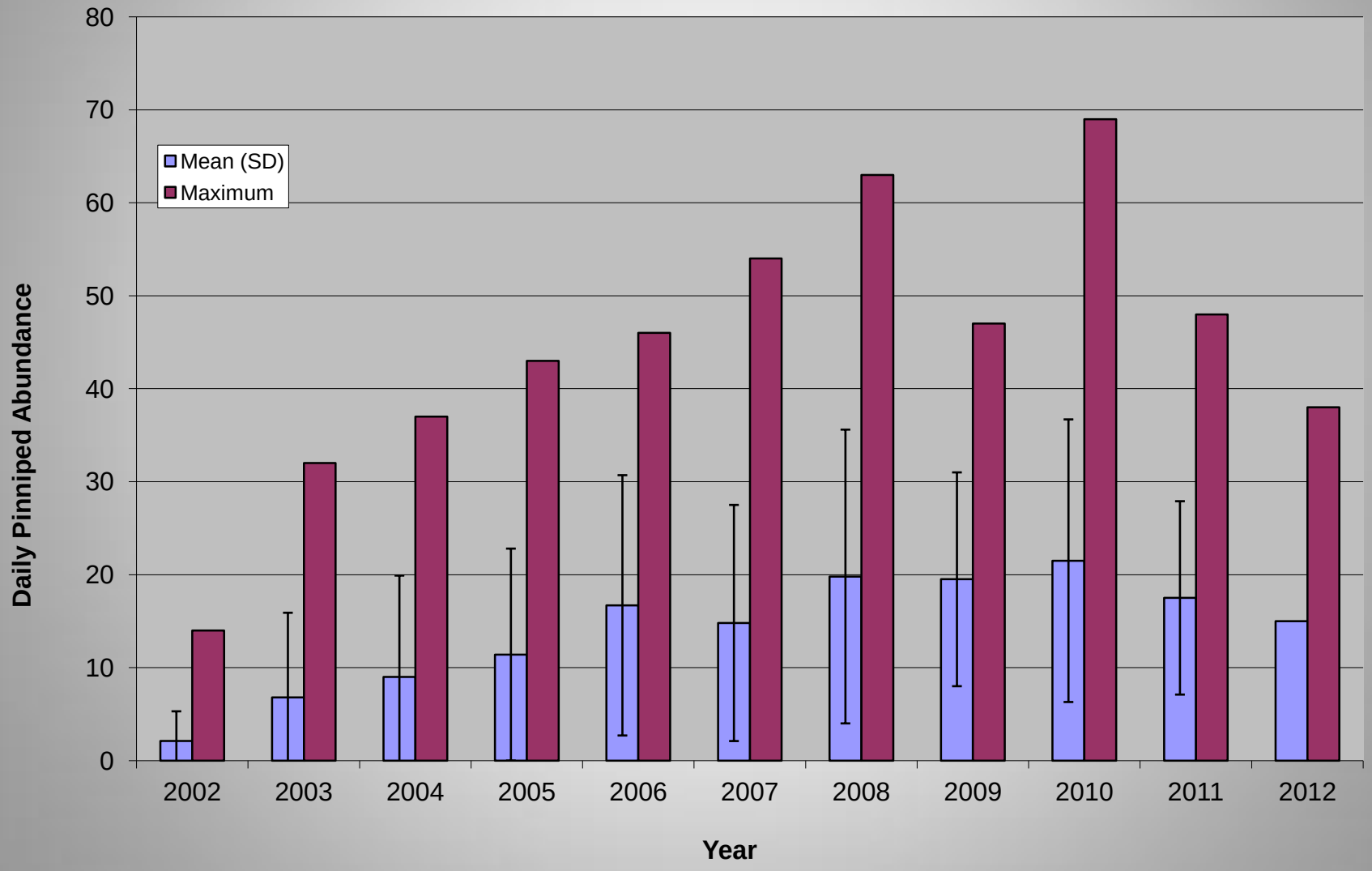
# Timing of Salmonid Predation by Pinnipeds and Salmon Passage at Bonneville Dam (Averaged Over 2002-2010)



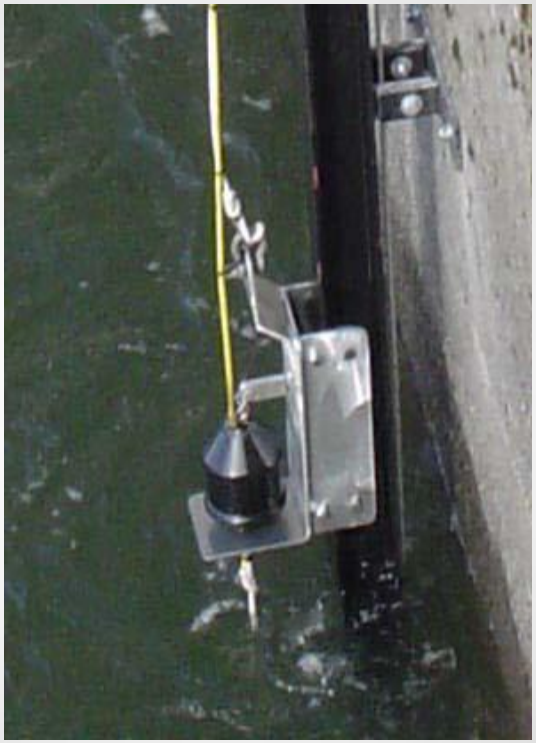
# Location of Predation Zones at Bonneville Dam



# Daily Average and Maximum Pinniped Abundance, 2002-2012



# Results of Non-Lethal Deterrents

# Deterrent Measures at Bonneville Dam, 2008-2010

- SLED's and FOG's installed and still effective (no entry into fishways observed after installation).
- Acoustic Deterrent Devices installed near ladder entrances and activated, no effect noticed.
- Hazing by USDA (land) and States/CRITFC (boat) has continued, but with limited effectiveness.
- Concrete blocks appear successful in preventing sea lions from hauling out on concrete apron, but not from resting nearby.