Table 3. Hatcheries, location, SAR, release mass, and number of fish and years released for Chinook salmon.

Estuary	Hatchery	Location	SAR (%)	Release mass (g)	CWT total	Total no. of fish released	Total years of data	Release years
UC	Kendall Creek	North	3.40 (2.60)	7.08 (1.35)	5.20×10^5	3.50×10^6	4	1972, 1975–1976, 1986
UC	Skookum Creek	North	0.37 (0.29)	5.47 (1.75)	2.97×10^5	6.68×10^6	5	1975, 1976, 1980–1982
UC	Samish	North	0.89 (1.06)	4.92 (0.81)	7.00×10^6	2.88×10^7	27	1973, 1975–1976, 1980, 1986–2008
UC	Bernie Gobin	North PS	0.58 (0.25)	5.57 (0.58)	2.43×10^6	1.70×10^7	15	1987–1992, 1999–2006, 2008
UC	Harvey Creek	North PS	0.90 (0.68)	5.78 (0.82)	7.92×10^5	9.22×10^5	9	1987–1995
UC	Whitehorse Ponds	North PS	0.46 (0.21)	6.14 (1.31)	2.09×10^6	2.23×10^6	12	1995–2000, 2003–2008
C	Wallace River	North PS	0.25 (0.18)	6.22 (1.12)	3.59×10^6	3.83×10^6	10	1973, 1986, 2001–2008
UC	Grovers Creek	Mid-PS	1.02 (0.73)	7.42 (1.77)	5.86×10^6	1.28×10^7	24	1982, 1985–1994, 1996–2008
UC	Issaquah	Mid-PS	0.75 (0.63)	4.74 (1.25)	2.45×10^6	1.42×10^7	14	1972–1973, 1979–1982, 1985–1988, 2003–2007
UC	Portage bay	Mid-PS	2.26 (1.35)	7.42 (1.53)	5.18×10^5	5.29×10^5	6	1975, 1979–1982, 2001
C	Puyallup Tribal	Mid-PS	0.19 (0.13)	7.14 (2.01)	6.92×10^5	1.47×10^6	7	1985–1987, 1998, 2000–2002
C	Voights Creek	Mid-PS	0.38 (0.29)	5.67 (1.71)	1.94×10^6	6.39×10^6	13	1972, 1979–1982, 1998–1999, 2003–2008
C	Soos Creek	Mid-PS	0.65 (0.71)	5.56 (1.07)	8.28×10^6	5.20×10^7	29	1972, 1973, 1975, 1976, 1979, 1980, 1982, 1986–2005, 2007, 2008
C	Gorst Creek Rearing Pond	Mid-PS	0.50 (0.22)	7.39 (2.91)	7.71×10^5	6.48×10^6	4	1973, 2002–2004
C	Capitol Lake Rearing	South PS	0.77 (1.06)	5.54 (1.32)	6.77×10^5	1.19×10^7	5	1972, 1980, 1986–1988
C	Tumwater Falls	South PS	0.20 (0.10)	5.08 (0.44)	5.98×10^5	6.01×10^5	4	2001, 2003–2005
C	Garrison	South PS	0.50 (0.46)	9.01 (2.46)	7.81×10^5	3.21×10^6	8	1980–1982, 1988, 1990–1992, 2004
UC	Minter Creek	South PS	0.46 (0.36)	5.62 (1.68)	1.09×10^6	4.37×10^6	7	1973, 1979, 1980, 1982, 2003–2005
UC	Clear Creek	South PS	0.86 (0.55)	8.66 (1.07)	4.89×10^6	3.45×10^7	17	1991–1994, 1996–2008
UC	Kalama Creek	South PS	0.54 (0.41)	7.71 (1.85)	3.07×10^6	1.95×10^7	24	1980–1982, 1985–1995, 1999–2008

Note: Values for smolt-to-adult return rate (SAR) and release wet mass are means and standard deviation for all years. Estuary indicates contaminated (C) or uncontaminated (UC). Locations are North (northern Washington portion of Salish Sea), north Puget Sound (PS), mid-PS, and south PS. Total years of data, years of release, total number of fish released, and fish with coded wire tags (CWT) are shown for each hatchery. Total number of fish released was 2.3×10^8, and the number with CWT was 4.8×10^7 (21% of the total).

Table 4. Hatcheries, location, SAR, release mass, and number of fish years released for coho salmon.

Estuary	Hatchery	Location	SAR (%)	Release mass (g)	CWT total	Total no. of fish released	Total years of data	Release years
UC	Kendall Creek	North	6.14 (4.99)	26.38 (1.82)	1.86×10^6	2.15×10^7	29	1975–1976, 1982–2008
UC	Skookum Creek	North	6.43 (5.45)	23.04 (4.02)	1.39×10^6	2.92×10^7	30	1975–1981, 1986–2008
UC	Samish	North	6.90 (0.52)	32.07 (3.98)	5.98×10^4	9.30×10^5	2	1975–1976
UC	Bernie Gobin	North PS	7.95 (4.06)	25.23 (1.77)	1.38×10^6	2.06×10^7	29	1975, 1980–1982, 1984–2008
C	Wallace River	North PS	9.63 (5.43)	24.68 (3.40)	1.62×10^6	6.45×10^6	28	1973, 1975–1976, 1983–2007
UC	Issaquah	Mid-PS	7.63 (3.23)	25.96 (2.44)	6.48×10^5	5.74×10^6	9	1973–1976, 1979–1980, 2002–2004
UC	Portage Bay	Mid-PS	8.35 (3.93)	17.17 (2.04)	2.06×10^5	2.12×10^5	6	1975, 1977, 1981, 1983, 1985–1986
C	Voights Creek	Mid-PS	8.17 (5.13)	26.54 (3.21)	2.41×10^7	2.37×10^7	33	1974–1976, 1978–1989, 1991–2008
C	Soos Creek	Mid-PS	7.08 (4.53)	25.79 (3.41)	2.70×10^6	1.39×10^7	33	1973, 1975–2005, 2007
C	Crisp Creek	Mid-PS	6.19 (3.88)	29.98 (8.31)	4.36×10^5	1.10×10^6	7	1993–1995, 2003, 2005–2007
C	Keta Creek	Mid-PS	8.36 (3.91)	32.38 (4.09)	2.38×10^5	1.15×10^6	5	1998–2001, 2008
UC	Minter Creek	South PS	6.66 (4.73)	27.71 (7.18)	7.53×10^5	8.76×10^6	15	1973, 1975–1976, 1979–1985, 2001–2005

Note: Values for smolt-to-adult return rate (SAR) and release wet mass are means and standard deviation for all years. Estuary indicates contaminated (C) or uncontaminated (UC). Locations are North (northern Washington portion of Salish Sea), north Puget Sound (PS), mid-PS, and south PS. Total years of data, years of release, total number of fish released, and fish with coded wire tags (CWT) are shown for each hatchery. Total number of fish released was 1.1×10^8, and the number with CWT was 3.4×10^7 (30% of the total).

were rerun for the uncontaminated group without Portage Bay and Kendall, and the results indicated that no one hatchery influenced the overall pattern of high survival for this group. Several hatcheries (Clear Creek, Grovers Creek, Harvey Creek, Issaquah, and Samish) all exhibited relatively high survival for Chinook (>0.75%). These hatcheries represented a large portion of the total hatchery–year data points and covered all four geographic areas (Table 1). The same analysis was conducted for hatcheries that released Chinook into contaminated estuaries and no undue influences were found.

The SAR values for Chinook (Fig. 2) indicate a general decline over the past several years; however, this pattern was not strong for either group. Trend analysis with a Mann–Kendall test returned high p values ($p > 0.8$), indicating no trend over this time frame. For coho, survival rates among all Puget Sound hatcheries declined in the late 1980s through the late 1990s, then improved in the late 1990s but at levels below earlier values (Fig. 3). There was no relationship between Chinook versus coho SAR values where they overlapped for hatchery and release year ($n = 107$, $R^2 \approx 0$). This comparison helped to assess potential differences among hatcheries, in that problems at a given hatchery would likely lead to anomalously low SAR values for both species.

Estuary characteristics

The density of fish (Table 1) was variable among local estuaries, and no relationship was observed between this value and mean adult survival ($R^2 \approx 0$, $n = 20$). There was also no relationship between Chinook SAR and distance to the estuary ($R^2 \approx 0$, $n = 20$), which may be a surrogate for differential freshwater mortality. Accurate residence times for fish in each estuary were not available; therefore the role of fish density on survival or reduced residence time is unknown. In some watersheds a high percentage of hatchery released fish may spend only a few days in the estuary before moving offshore (Ruggerone and Weitkamp 2004), which may be caused by high numbers of fish in the system (density-dependent migration) or estuary size. It is unknown