Puget Sound steelhead[19]

Listed ESU/DPS

This report covers the Distinct Population Segment (DPS) of Puget Sound steelhead (*Oncorhynchus mykiss*). These fish are the anadromous form of *O. mykiss* that occur in rivers, below natural barriers to migration, in northwestern Washington State that drain to Puget Sound, Hood Canal, and the Strait of Juan de Fuca between the U.S./Canada border and the Elwha River, inclusive.

ESU/DPS Boundary Delineation The DPS boundary delineation for Puget Sound steelhead has not been reviewed since the Biological Review Team's (BRT) 2007 status review of this DPS (Hard et al. 2007). The Puget Sound Technical Recovery Team (TRT) considered genetic and life history information from steelhead on the Olympic Peninsula and Washington coast but concluded that there is no compelling evidence to alter the DPS boundaries described above.

Summary of Previous BRT Conclusions

The initial review of this DPS—then called the Puget Sound Evolutionarily Significant Unit (ESU)—by a BRT was completed in 1996 in response to two listing petitions received by NOAA in 1993 and 1994 (Busby et al. 1996). Subsequent to that BRT review, NOAA issued a determination that listing of Puget Sound steelhead was not warranted (61 FR 41451). In response to a petition to list Puget Sound steelhead received in September 2004, a newly convened BRT completed its report summarizing the status of the Puget Sound steelhead DPS in June 2007 (Hard et al. 2007). Subsequent to the BRT review, NOAA issued its final determination to list the Puget Sound steelhead DPS as a threatened species under the ESA on 11 May 2007 (72 FR 26722); the effective date of the listing was 11 June 2007.

Brief Review of Technical Recovery Team Documents and Findings

The Puget Sound Steelhead Technical Recovery Team (TRT) was formed in March 2008. It has not yet finalized its viability criteria for the Puget Sound steelhead DPS; the TRT is still conducting analyses of these data to identify Demographically Independent Populations (DIPs) and Major Population Groups (MPGs) within the DPS. The TRT expects to complete its report summarizing these criteria in early 2011. Consequently, this report focuses on assessing viability of populations in the DPS for which demographic data are available, and which might reflect a *draft* set of putative DIPs and MPGs thought to represent historical population structure within the DPS. The viability assessment incorporates 1) basic analyses of abundance and trend, followed by 2) a set of simple Population Viability Analyses (PVAs) for these draft DIPs and MPGs within the DPS.

New Data and Updated Analyses

Abundance and trends

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The data considered in this report include estimates of steelhead natural escapement and/or total run size, as calculated from redd count and catch statistics obtained from the Washington Department of Fish and Wildlife. These data are for winter-run steelhead primarily (the sole summer-run exception is from the Tolt River), and date from 1985. At this point, these populations are considered by the Technical Recovery Team to be potential DIPs; however, they do not include all potential DIPS under consideration by the TRT, so the populations evaluated herein should be considered *draft* DIPs. We present basic analyses of natural escapement data in Table 63 - Table 65 below; these analyses focus on a) data from the entire time series, b) data since 1995, and c) from the most recent five years.

a) Data from the entire series

Since 1985, Puget Sound winter-run steelhead abundance has shown a widespread declining trend over much of the DPS (Table 1). Only four of the 16 populations evaluated exhibit estimates of long-term population growth rate ($\lambda = R_0 = e^r$, where is R_0 is the net birth rate and r is the intrinsic geometric growth rate) that are positive (East Hood Canal, Port Angeles, Samish River, and West Hood Canal), and only one of these is significantly ($P < 0.05$) greater than one (indicating positive population growth): West Hood Canal. These four populations are all small. The highest growth rates over the entire series occur in East Hood Canal, the Green River, Port Angeles, the Samish and Skagit rivers, and West Hood Canal; the lowest rates occur in the Elwha River, Lake Washington, and the Stillaguamish, Nisqually, and Puyallup rivers. Trends could not be calculated for south Puget Sound tributaries.

Table 63 -- Estimates of exponential trend in the natural logarithm (ln) of natural spawners (λ) for several winter-run populations of steelhead in the Puget Sound DPS over the entire data series (1985-2009). NC, not calculated.

Population	Exp. Trend ln(nat. spawners) (95% CI)
South Sound tributaries winter-run	NC
Dungeness River winter-run	0.926 (0.909 - 0.943)
East Hood Canal winter-run	1.022 (0.997 - 1.048)
Elwha River winter-run	0.840 (0.749 - 0.943)
Green River winter-run	0.992 (0.969 - 1.016)
Lake Washington winter-run	0.807 (0.770 - 0.845)
Nisqually River winter-run	0.914 (0.890 - 0.940)
Port Angeles winter-run	1.016 (0.983 - 1.050)
Puyallup River winter-run	0.919 (0.899 - 0.938)
Samish River winter-run	1.008 (0.972 - 1.045)
Skagit River winter-run	0.969 (0.954 - 0.985)
Skokomish River winter-run	0.956 (0.932 - 0.979)
Snohomish River winter-run	0.963 (0.941 - 0.985)

Stillaguamish River winter-run	0.910 (0.887 - 0.934)
West Hood Canal winter-run	1.101 (1.046 - 1.160)
White River winter-run	0.938 (0.923 - 0.952)

b) Data since 1995

Since 1995, Puget Sound winter-run steelhead abundance has also shown a widespread declining trend over much of the DPS (Table 2). Only three of the 16 populations evaluated exhibit point estimates of growth rate that are positive (East Hood Canal, Skokomish River, and West Hood Canal), and only one of these is significantly greater ($P < 0.05$) than one (positive population growth): West Hood Canal. These four populations are all small. The highest growth rates over the entire series occur in East Hood Canal, the Skokomish River, and the Samish and Skagit rivers; the lowest rates occur in the Elwha and Dungeness rivers, Lake Washington, and the Stillaguamish, Nisqually, and Puyallup rivers. Trends could not be calculated for south Puget Sound tributaries.

Table 64 -- Estimates of exponential trend in the natural logarithm (ln) of natural spawners (λ) for several winter-run populations of steelhead in the Puget Sound DPS since 1995 (1995-2009). NC, not calculated.

Population	Exp. Trend ln(nat. spawners) (95% CI)
South Sound tributaries winter-run	NC
Dungeness River winter-run	0.919 (0.786 - 1.075)
East Hood Canal winter-run	1.033 (0.976 - 1.092)
Elwha River winter-run	0.750 (0.020 - 28.503)
Green River winter-run	0.953 (0.892 - 1.019)
Lake Washington winter-run	0.731 (0.656 - 0.815)
Nisqually River winter-run	0.935 (0.876 - 0.997)
Port Angeles winter-run	0.964 (0.899 - 1.031)
Puyallup River winter-run	0.902 (0.850 - 0.957)
Samish River winter-run	0.966 (0.934 - 0.998)
Skagit River winter-run	0.978 (0.931 - 1.029)
Skokomish River winter-run	1.006 (0.958 - 1.057)
Snohomish River winter-run	0.961 (0.878 - 1.050)
Stillaguamish River winter-run	0.879 (0.820 - 0.943)
West Hood Canal winter-run	1.101 (1.046 - 1.160)
White River winter-run	0.933 (0.905 - 0.963)

c) Data from the most recent five years

Over the most recent five years (2005-2009), Puget Sound winter-run steelhead abundance has been low over much of the DPS, with a geometric mean less than 250 fish annually for all but eight populations of the 15 evaluated (Table 57). Four of these are in northern Puget Sound (Samish, Skagit, Snohomish and Stillaguamish rivers), three are in southern Puget Sound (Nisqually, Puyallup, and White rivers), and one is on the Olympic Peninsula (Skokomish River). Only three populations have a geometric mean greater than 500 fish—Green, Skagit and Samish rivers—and two of these are in northern Puget Sound. The Elwha River, Lake Washington, and South Sound tributaries populations all have very low recent mean abundances (< 15 fish).

Table 65 -- Geometric means of natural spawners for several winter-run populations of steelhead in the Puget Sound DPS over the most recent five years (2005-2009). NC, not calculated.

Population	Geometric mean (95% CI)
South Sound tributaries winter-run	NC
East Hood Canal winter-run	213 (122 - 372)
Elwha River winter-run	NC
Green River winter-run	986 (401 - 2428)
Lake Washington winter-run	12 (3 - 55)
Nisqually River winter-run	402 (178 - 908)
Port Angeles winter-run	147 (53 - 405)
Puyallup River winter-run	326 (178 - 596)
Samish River winter-run	534 (389 - 732)
Skagit River winter-run	4648 (2827 - 7642)
Skokomish River winter-run	355 (183 - 686)
Snohomish River winter-run	4573 (500 - 41865)
Stillaguamish River winter-run	327 (100 - 1067)
West Hood Canal winter-run	208 (118 - 366)
White River winter-run	265 (206 - 342)

Collectively, these data indicate relatively low abundance (4 of 15 populations with fewer than 500 spawners annually) and declining trends (6 of 16 populations) in natural escapement of winter-run steelhead throughout Puget Sound, particularly in southern Puget Sound and on the Olympic Peninsula.

Supplementary analyses

We present several additional analyses of steelhead abundance data that rely on multivariate auto-regressive state-space models (MARSS; Holmes and Ward 2010) to estimate quasi-extinction risk metrics from estimates of total natural run size. The MARSS analyses were conducted in R, version 2.10 (RDCT 2009). These stochastic models evaluate

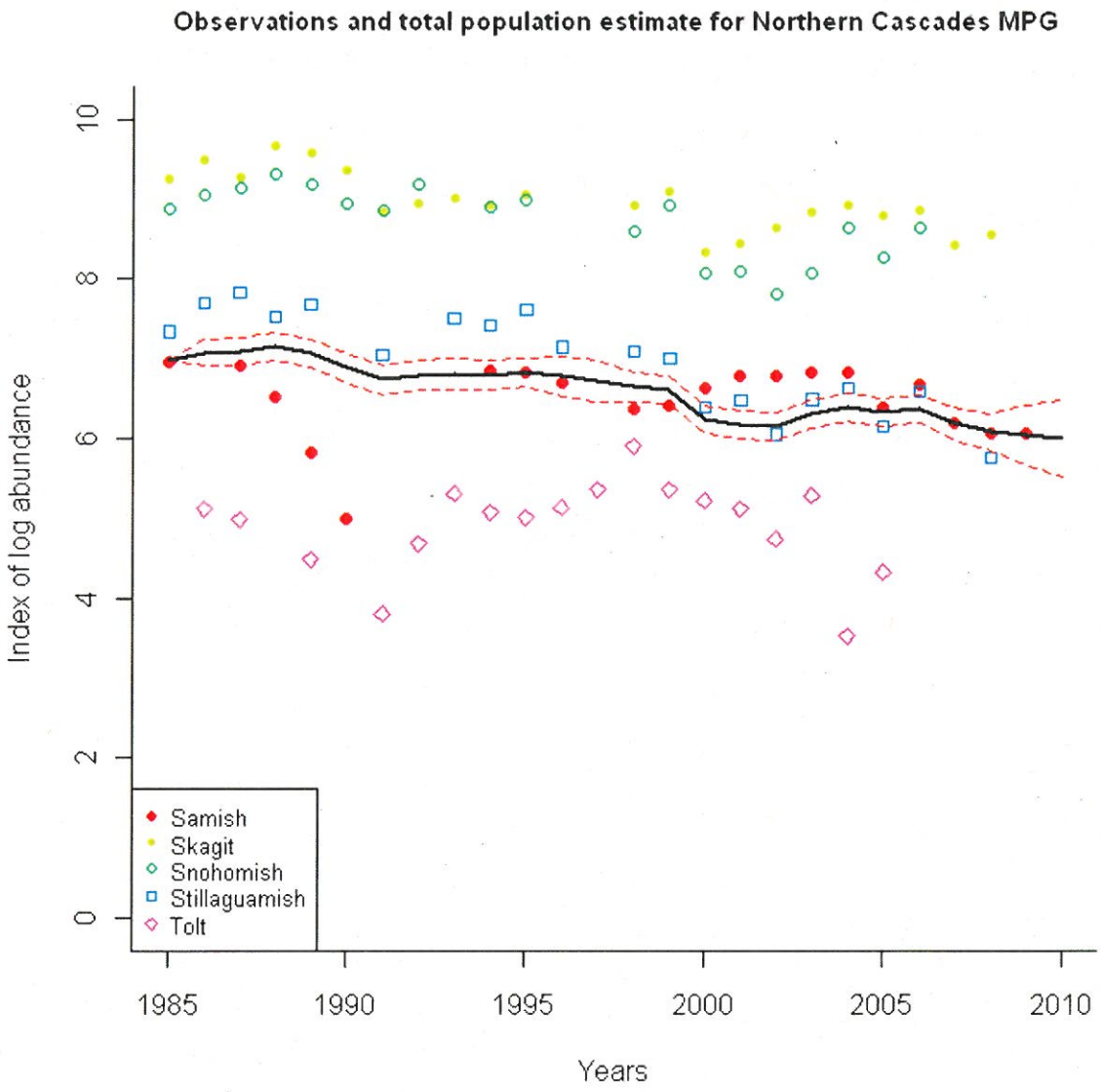

Figure 85 -- Plot of the estimate of total Puget Sound winter-run steelhead for a putative Northern Cascades Major Population Group (MPG). The graph plots the maximum-likelihood estimate of log(total no. steelhead) in the MPG against the observed data, assuming a single-population model for the MPG. The estimate of the log(total MPG count) (solid black line) has been scaled relative to the Samish River population. The 95% confidence intervals around the total MPG estimate are given by the red dashed lines (note: these are not the confidence intervals around the observed data, which are expected to fall outside the CI, depending on population-specific non-process error). See text for details. No suitable data were available for Nooksack River steelhead.

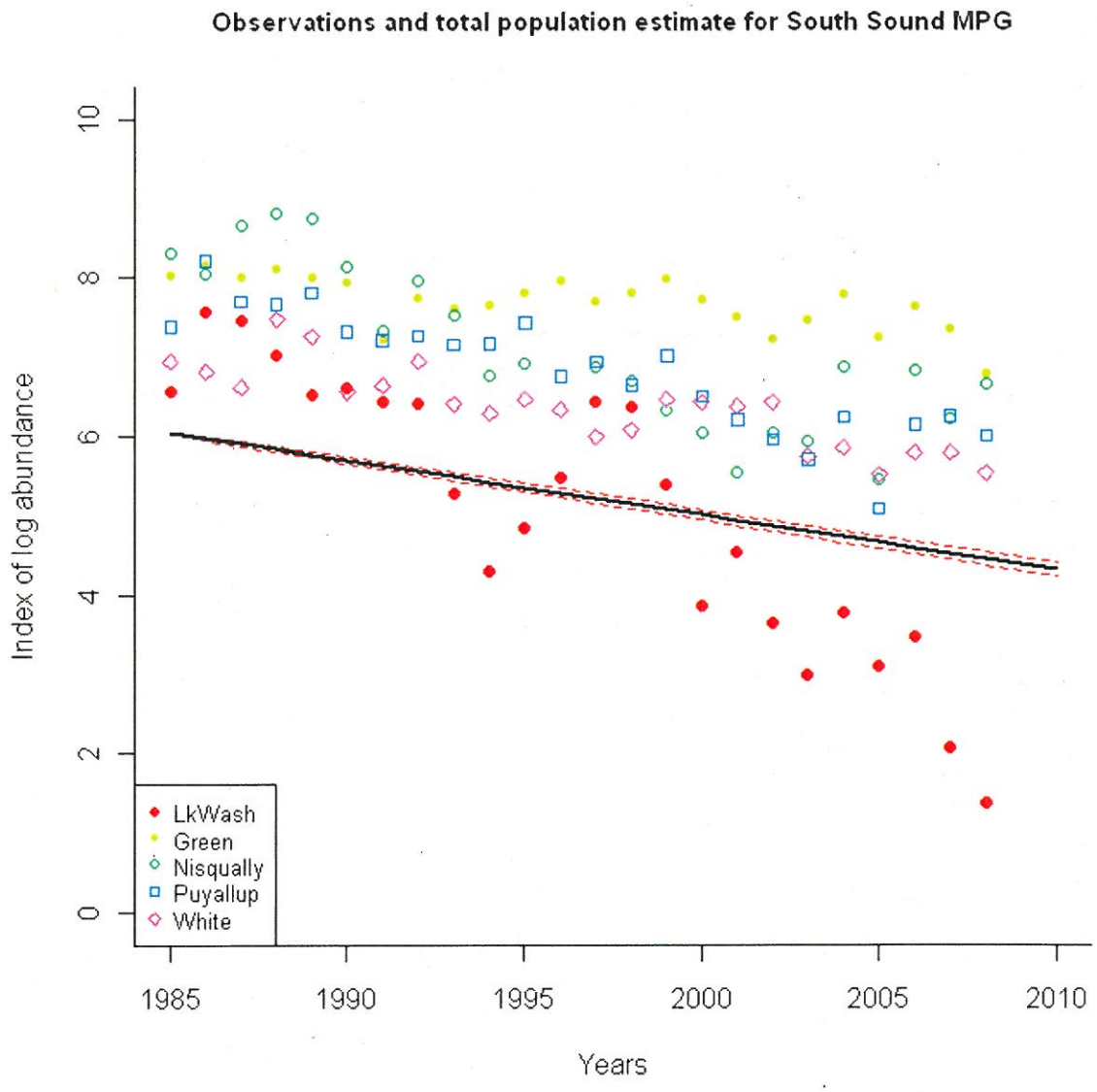

Figure 86 -- Plot of the estimate of total Puget Sound winter-run steelhead for a putative South Sound Major Population Group (MPG). The graph plots the maximum-likelihood estimate of log(total no. steelhead) in the MPG against the observed data. The estimate of the log(total MPG count) (solid black line) has been scaled relative to the Lake Washington population. The 95% confidence intervals around the total MPG estimate are given by the red dashed lines (note: these are not the confidence intervals around the observed data, which are expected to fall outside the CI, depending on population-specific non-process error). See text for details. No suitable data were available for South Sound tributaries steelhead.

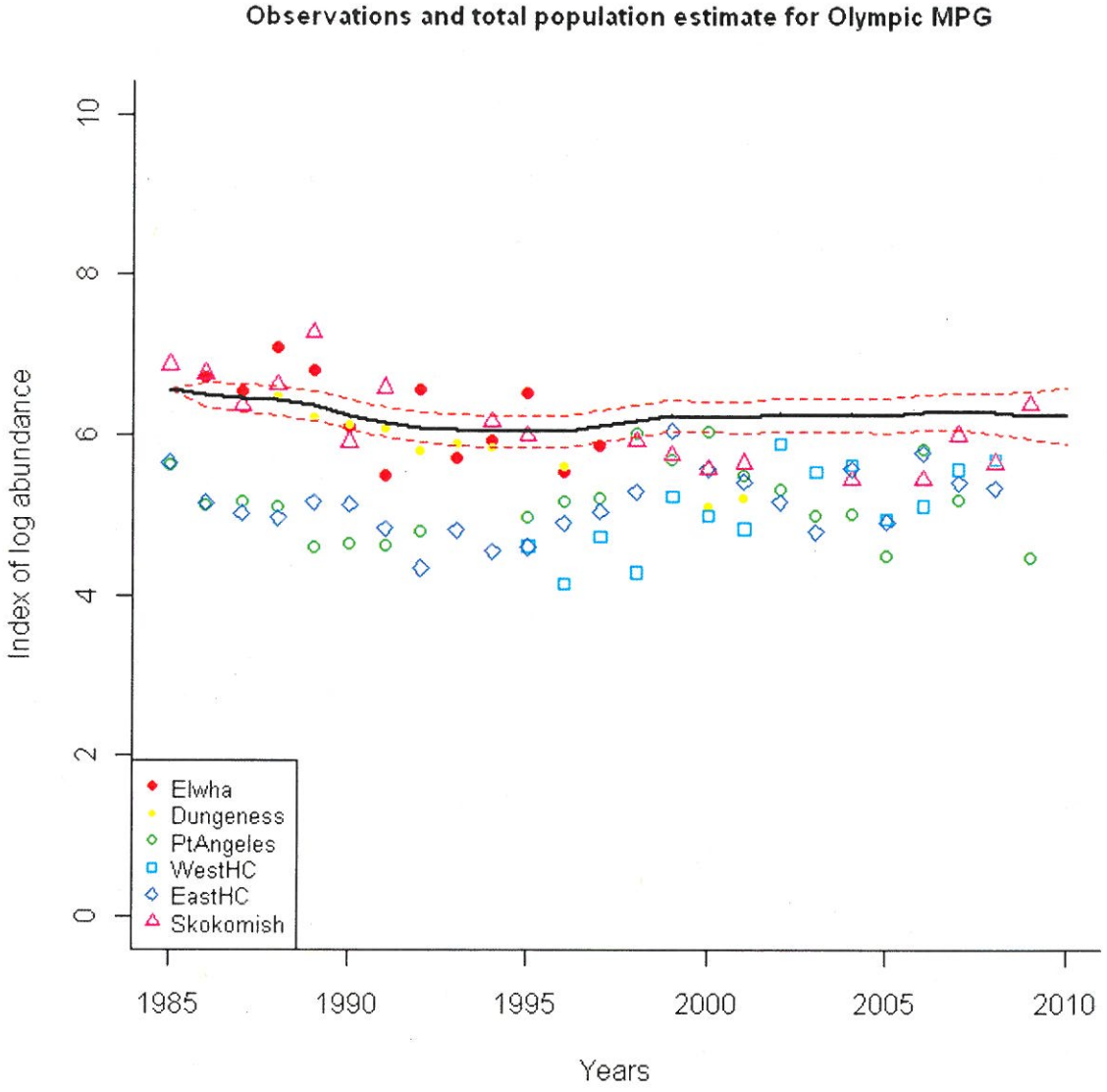

Figure 87 -- Plot of the maximum-likelihood estimate of total Puget Sound winter-run steelhead for a putative Olympic Major Population Group (MPG). The graph plots the estimate of log(total no. steelhead) in the MPG against the observed data. The estimate of the log(total MPG count) (solid black line) has been scaled relative to the Elwha River population. The 95% confidence intervals around the total MPG estimate are given by the red dashed lines (note: these are not the confidence intervals around the observed data, which are expected to fall outside the CI, depending on population-specific non-process error). See text for details.