SMOLT DENSITY MODEL

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This section describes the procedures developed by the Monitoring and Evaluation Group in conjunction with the System Planning Group to calculate the smolt carrying capacity for the subbasins under analysis. The resulting procedure was incorporated into a computerized model known as the Smolt Density Model, which was written by Duane Anderson.

Overview

Subbasin planners were charged with developing estimates of the current capacities (assuming full seeding) for natural fish production of salmon and steelhead in 31 subbasins of the Columbia River Basin.

One of the key parameters necessary for evaluating production potential in the subbasins is the smolt carrying capacity. A variety of methods has been used to estimate smolt carrying capacity for specific drainages and runs in the Columbia Basin. In some drainages no estimates are available, and there may be very little information to derive an estimate. Based upon a review of available techniques and information, the SPG and MEG developed the **Smolt Density Model (SDM)** for estimating smolt carrying capacity by subbasin for application in the planning process. This model incorporates a standard method for estimating smolt capacity which was developed by the **System Planning Group (SPG)**.

The SPG used several criteria in selecting a standard method for estimating current production capacity levels. The selected method had to be simple to use and applicable to all subbasins. It had to require no additional data collection beyond currently existing information (available for <u>all</u> subbasins), and it had to allow incorporation of subbasin-specific information where it is available.

The standard method selected was a habitat-based, smolt-density approach. Requisite data for this method are smolt density estimates (number of smolts per unit of usable habitat area) and estimates of the availability of usable smolt spawning and rearing habitat.

Generic estimates of smolt density for species, races and key stocks of salmon and steelhead to be used as standard estimates were selected by the SPG following a review of available information. These values are presented in Table 3. The estimates selected for each species, race and stock and for each production area type fall within the range of estimates present in the literature reviewed. Adjustment of density estimates for application to specific production area types (described below) was based upon a subjective, negotiated assessment by the SPG. Generally speaking, density estimates from the higher end of the ranges presented in the literature were selected for production area types classified as spawning and rearing areas and higher quality habitat areas. Estimates from the lower end of the ranges presented in the literature were selected for production area types classified as rearing-only areas and lower quality habitat areas.

One standard smolt density estimate (0.40) was initially identified for application to all production areas identified for coho salmon. When the below Bonneville work began, it became obvious that this was inadequate and Chuck Willis researched a range of smolt density values for Coho based on studies of smolt production in the Alsea River (see Table 3). Two standard smolt density estimates were identified for application to all production areas containing mid-Columbia fall chinook salmon, Snake River fall chinook salmon, and mid-Columbia summer chinook salmon. However, a series of standard smolt density estimates was developed for application to each of eight specific types of production areas for steelhead trout, spring chinook salmon and Snake River summer chinook salmon. Two specific types of production areas were identified as 1) areas where both spawning and rearing occur, and 2) areas where only rearing occurs in the subbasin. Each of these types of production areas is divided into four additional categories (excellent, good, fair or poor) based upon an assessment of habitat quality. Each group of subbasin planners should describe the criteria it has selected for classifying production areas into each of these four categories.

Very little information on the maximum juvenile densities of summer or fall chinook is available. The standard approach developed for these races is based on the assumption that age '0' juvenile rearing area is a limiting factor. The standard density estimates for application to fall and Mid-Columbia summer chinook are taken from Everest and Chapman (1972) and Marshall , et al. (1980). The estimates are expressed in terms of age '0' smolts in late summer. As with spring chinook and steelhead, the density factors are intended to be applied to specific estimates of the amount of available rearing habitat in a given system or reach. The production potential of certain reaches, for example, the north fork Lewis River and the Hanford Reach of the Columbia mainstem, may be significantly higher (Don McIssac, personal communication). Specific production estimates, including documentation, for those areas should be provided in the appropriate subbasin plan.

Current capacity or current production capacity was defined as the present capacity for a given habitat, area, stream reach, or subbasin area for the natural production of anadromous salmon and steelhead smolts, assuming full seeding and no enhancement of existing passage barriers or habitat conditions. Estimates of current production capacity generated for each species, race or stock within each subbasin were intended to serve as an index of the subbasin's general production capability comparable to production indices generated for other subbasins.

One aspect of the standard method which was emphasized in its design was an attempt to reduce overestimates of production which result when entire stream lengths or major portions of streams are used in combination with smolt density estimates for generating production estimates rather than giving adequate consideration to areas actually used for production within these large reaches. Habitat which is not classified as usable production area may be occupied by salmonids for brief periods of time but would not be considered to be habitat where either spawning or rearing takes place. Some areas, for example, such as lower subbasin mainstem areas, may serve only as migration routes and do not directly contribute to smolt production.

The major task regarding estimation of current production capacities for subbasin planners was to determine as accurately as possible the types and amounts of usable spawning and rearing area in each subbasin. To facilitate this process, a computerized data entry and calculation system, the **Smolt Density Model**, was developed by MEG for use by the Subbasin Planners.

Baseline Data and Equation

The baseline dataset for the SDM was derived from a dataset developed by the Council as part of the Hydro Assessment Study that it conducted in 1985-1987. Part of this study was a survey of the entire region for anadromous fish presence or absence. To catalog all of this data on a regionally consistent scale, the Council obtained a copy of the Environmental Protection Agencies River Reach File. This is a system which subdivides rivers into 'reaches' which are uniquely identified with a 16 digit number and linked to their upstream and downstream reaches. A host of other information is provided as well, including reach name, length, latitude/longitude, etc. The system proves ideal for data acquisition of water related types of information on a large scale and was used for the original anadromous presence/absence data file. The specific data items in this file include the reaches low summer flow width, total length, and percentage of the reach that is occupied at any time of the year for any reason for eight stocks of anadromous fish. This file was then subdivided into individual subbasins and provided to the subbasin planners, in a computerized format, for the input of the other SDM values.

Within each stream reach, subbasin planners first reviewed and corrected (if necessary) the percentage of the reach shown to be accessible to fish (i.e. no physical barriers) and the low flow reach width from the presence/absence data file. For chinook and coho, this <u>usable area</u>, as it was coined, was defined as equivalent to accessible area where the mean stream width during low flow periods is 60 feet or less. Where mean stream width exceeded 60 feet, usable area was defined as the accessible area within 30 feet of each bank. For steelhead, usable area was defined as equivalent to accessible area for all stream reaches regardless of stream width. After defining the usable area in a reach, the planners then assigned a <u>use type</u> to each reach. There were 3 values; 1) Spawning and Rearing, 2) Rearing Only, 3) Migration or no use.

Finally, the planners assigned a habitat quality factor to each reach based upon relative comparisons of the present fish producing potential of habitat <u>within</u> the subbasin they were working on (<u>not</u> based on comparisons of the their subbasin to habitat in other subbasins.) <u>Excellent</u> habitat was described as that which would support the highest productivity for a species within the subbasin. <u>Poor</u> was the classification for habitat which would support the lowest level of productivity of some reasonable number of fish. <u>Good</u> and <u>Fair</u> classifications were used to describe habitat which was intermediate relative to the other two categories.

Based on these data and the set of density values for each stock in each production category (Table 3), the model calculated a smolt production estimate for the reach. For example, if a reach was 2 miles long and 35 feet wide, with a presence/absence value of .75 for spring chinook, a habitat quality rating of 2, and a use type value of 1 (Spawning and Rearing) the calculation of potential smolt production would be:

$$(.75 * 2 \text{ mi} * 5280 \text{ ft/mi} * 35 \text{ ft}) / 10.764 \text{ ft/m}^2 = 34{,}336 \text{ m}^2$$

From the table below we see that the density value for spawning and rearing habitat of quality value 2 for spring chinook is 0.64, therefore:

$$34{,}336 \text{ m}^2 * .64 \text{ smolts/m}^2 = 21{,}975 \text{ smolts}$$

Table 3. Standard smolt density estimates (smolts/m^2) used in the SDM.

STOCK	**SPAWNING AND REARING HABITAT QUALITY**				**REARING ONLY HABITAT QUALITY**			
	EX	**GO**	**FA**	**PO**	**EX**	**GO**	**FA**	**PO**
SPRING CHINOOK	.90	.64	.37	.10	.40	.27	.15	.03
SUMMER CHINOOK(COL)	1.8	1.8	.66	.66	1.8	1.8	.66	.66
SUMMER CHINOOK(SNK)	.90	.64	.37	.10	.40	.27	.15	.03
FALL CHINOOK	1.8	1.8	.66	.66	1.8	1.8	.66	.66
SUMMER STEELHEAD	.10	.07	.05	.03	.04	.03	.02	.01
WINTER STEELHEAD	.10	.07	.05	.03	.04	.03	.02	.01
COHO	.30	.226	.150	.075	.030	.023	.015	.008

When the reach by reach entries were completed, the SDM calculated a total smolt production capacity for the entire subbasin. This value was used as input for the Natural Smolt Carrying Capacity in the System Planning Model.

A users guide for the SDM is provided in Appendix G.

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