“Limiting Factors” Analysis

Once the key populations of salmon and steelhead have been identified, attention must turn to the factors that limit the ability of the streams associated with those populations to support numbers of fish at optimum levels. Obviously, there are external factors—hydropower, ocean conditions and fishing—that may prevent the return of adequate numbers of fish to streams in Idaho. However, this paper addresses local factors which, if they can be corrected, minimized or mitigated, will allow the fish that do return from the ocean to successfully spawn and complete the stages of their lives that occur in inland streams and rivers.

This analysis is based upon previous efforts and existing data, including:

- Streams that have “salmonid spawning” as their beneficial use and where streams not meeting “full support” of that general standard are now on Idaho’s list of “water quality limited” streams pursuant to section 303(d) of the federal Clean Water Act amendments,

- Data collected by various state and federal agencies that describe a variety of instream conditions reflective of both habitat values and water quality and that are maintained through “Streamnet”,

- Landscape level information developed as part of the Interior Columbia Basin Ecosystem Management Plan (ICBEMP) that indicate both intensities of various land uses and various terrestrial parameters that might have a future effect on instream conditions, and,

- Information from state or federal agencies that indicate levels of irrigation use, points of diversions and culverts that might be a barrier to fish passage.

This data was first summarized in the “subbasin plans” sponsored by the Northwest Power Planning and Conservation Council. The plan for the Clearwater subbasin relied heavily on the Streamnet data and 303(d) list of streams that do not support salmonid spawning. The Salmon subbasin planning team focused more on the landscape level information provided through ICBEMP. However, all the aforementioned data exists for both subbasins, and, therefore, this analysis is based upon a combination of all data sets applied to each subbasin.

“Threats” Versus “Instream Conditions”

It is tempting to view such traditional land uses as forest management, livestock production or mining as constituting the entire spectrum of local factors that might limit fish production within a watershed. Without question, those activities can create a number of limitations, ranging from sedimentation of spawning beds, loss of bank cover and stability, high water temperatures, inadequate flows or water chemistry that is toxic to fish. However, the existence of a given land use does not necessarily mean that the conditions of the streams flowing through that watershed pose limitations to fish spawning or rearing. Much depends on how those activities are managed and how the threats that they may pose or either minimized or mitigated.

This analysis makes a clear distinction between those land use activities and terrestrial conditions that pose a potential threat to fish versus those instream conditions that constitute existing limiting factors. Intense fires can create watershed and stream conditions that are just as limiting as a poorly managed land uses. Therefore vegetative conditions that might lead to uncommonly intense fires must be viewed as no less a threat than the potential for livestock damage to riparian areas. Both lead to streambank degradation, increased water temperature and sedimentation that would limit salmonid spawning and the fish cannot distinguish between the effects of the "natural" wildlfire versus those of the human land use. In both cases, the potential for undesirable instream effects must be minimized before they become limiting factors. "Threats", then, are those land uses and terrestrial conditions that are not now unacceptably impacting salmon or steelhead production, but which have the potential to do so if not properly managed.

On the other hand, "instream conditions" indicate a situation where, for whatever reason, previous land uses or natural events have manifested themselves as conditions within a stream that have in the past or continue to minimize or in some cases eliminate fish production. Where these situations exist, minimizing and mitigating risks is no longer an option. Remedial actions are now required. It should be noted that not all existing instream limiting factors can be repaired. Some are natural—barrier falls, steep stream gradients or high velocities, for example. Others are human caused but access and land use restrictions make restoration difficult or impossible, i.e., repair of legacy mining impacts in designated wilderness where motorized vehicles or equipment are not allowed.

This analysis of limiting factors should be considered as one of the elements of a comprehensive recovery plan, with correcting those unacceptable conditions as one component of the implementation of that plan. This analysis will serve as a coarse screen to help identify correctable instream conditions and threats which may lead to future limitations. This information, coupled with the identification of high priority populations, land ownership and specific reaches of individual streams that are important to various life stages of the high priority populations, will become the basis for identifying specific individual recovery projects and the priority for completing them.

Sources of Data and Limitations

Although collected at different times and for reasons unrelated to salmon and steelhead recovery, there is a large amount of data available to help assess the conditions in individual streams and identify threats or limitations to fish recovery. There is also a wide range in the type of data available, how it was collected and the confidence one might have in using it. Following is a summary of the data used in this analysis and possible limitations to its use, as excerpted from the documents of the relevant agencies.

303(d) Water Quality Limited Stream Segments—The source of this data is the Idaho Department of Environmental Quality, which prepares a list of streams not meeting state water quality standards every two years, as required by the federal Clean Water Act amendments. In 1993, DEQ embarked on a pilot monitoring program, the Beneficial Use Reconnaissance Project, nicknamed “BURP,” which combined biological monitoring and habitat assessment to determine the quality of Idaho's waters. The purpose of BURP is to help Idaho meet the requirements of the federal Clean Water Act by providing data to use in determining the existing uses and beneficial use support status of Idaho's water bodies. The program has been implemented statewide since 1994.

At the end of the 2003 BURP season, a total of 5,182 stream sites had been sampled in Idaho, making Idaho a national leader in bioassessment monitoring. Each summer, DEQ BURP technicians follow standardized procedures to collect aquatic insects, conduct fish surveys, measure water chemistry, and document habitat conditions in streams, rivers, and lakes. The BURP surveys are performed during the same time period each year so the information is comparable from one year to the next. Aquatic insects and fish are very sensitive to changes in water quality, so their presence, abundance, and health serve as indicators of the overall quality of a water body.

The BURP data are evaluated against Idaho's water quality standards using Idaho's Water Body Assessment Guidance to determine if the water body is meeting standards and supporting beneficial uses. If a water body is found to not be meeting water quality standards, a water quality plan, or total maximum daily load (TMDL), is developed. If a water body is found to be meeting standards, it will be monitored again in the future to ensure it continues to meet standards. DEQ ensures quality BURP data by providing centralized training for BURP crews, using a standardized manual, following annual work plans, conducting annual field reviews, and following a quality assurance plan.
In addition, a one-day field audit is held each year with each BURP field crew as it samples a stream reach. The purpose of the audits is to ensure that all protocols are being followed.

The Water Body Assessment Guidance (WBAG) describes DEQ's methods for evaluating data and determining beneficial use support of Idaho water bodies. Assessing a water body involves analyzing and integrating multiple types of data to determine the degree of beneficial use support and biological integrity of the water body and compile descriptive information about the water body. The current WBAG, published in 2002, is referred to as “WBAG II,” as it replaced the original WBAG published in 1996.
DEQ recognizes three categories of beneficial use support status: fully supporting, not fully supporting, and not assessed. “Fully supporting” means that a water body is in compliance with water quality standards and criteria and supports all designated and existing beneficial uses. “Not fully supporting” refers to a water body that is not in compliance with all water quality standards or criteria or is not supporting all beneficial uses. The “not assessed” category describes water bodies that have either not been monitored by DEQ at all or have been monitored to some extent, but are missing critical information needed to complete an assessment.

Interior Columbia Basin Ecosystem Management Plan (ICBEMP)**—**In July 1993, President Clinton directed the Forest Service to "develop a scientifically sound and ecosystem-based strategy for management of eastside forests." Responding to this direction, the project was initiated by the United States Department of Agriculture Forest Service and the United States Department of Interior Bureau of Land Management. The ICBEMP was charged with developing a scientifically based broad-scale ecosystem management strategy on over 60 million acres of lands administered by the Forest Service and Bureau of Land Management (BLM). The project is a combined science and management effort. Scientists developed a framework for ecosystem management and a scientific assessment of the ecological, biophysical, social and economic conditions of the Columbia basin. Land managers are using the science information to develop management strategies and provide context for Forest Service and BLM land management plans. Scientists are providing credible information to managers on current conditions, risks, and opportunities, as well as the environmental consequences associated with several management alternatives for the EIS. More than 300 different Geographic Information System (GIS) data layers or themes were compiled or created in support of the ICBEMP assessment and development of the EIS. In addition numerous databases were created.

For this analysis, four data sets and GIS layers from the ICEBMP project were employed to illustrate various potential limitations to salmon and steelhead recovery. They were: road density, forest management activity, potential for severe wildfire and total AUMs authorized through grazing permits. Excerpts from the metadata associated with each of these layers are as follows:

Disturbances (grazing, forest management)—The general logic and steps to build these layers included acquiring data on activities and disturbance from administrative units for the past 10 years, determine an average, allocate those activities to finer delineations of management and biophysical units, and then classify current relative levels by “low”, “medium”, “high” or similar categories. Current time period generally reflects the current year (1999) plus or minus 5 years (i.e. 1994 - 2004). The data generally reflects the disturbance from 1988 to 1997 (10 year average). The data for these 10 variables for Forest Service and BLM lands came from administrative unit reports and wildfire reports, while data for other lands came from general resource reports and extrapolation of assumptions.

The intent of current disturbance and activity data is to provide baseline information useful to understanding current activity and disturbance levels at the broad-scale. Future predictions of this information can be used at the broad-scale to evaluate scenarios or alternatives. The various disturbance and activity variables associated with this data can be used to address an understanding of the relative location and relative amounts of management. Consequently, the classes are only useful in a relative sense; i.e. comparing different areas or summarizing conditions within or across the whole area. These data were intended for use at the broad-scale, generally to summarize regional levels of activities and disturbance, prioritize or plan subbasin (4th field HUC) outcomes for a given level of activity or disturbance.

The attributes in this dataset are derived from a rule set linked to the input of treatment and disturbance acre or volume data. The reported treatment and disturbance data was only spatially specific to the administrative unit. Consequently, this reported data was spatially redistributed through modeling and assumptions to a finer scale. Because of the general nature of the reported data and the extrapolation approach, any one resulting subbasin variable class has approximately 15-25% chance of error into an adjacent class and 5-15% chance of error to non-adjacent classes. When classes are summarized at the basin or groups of subbasins scale, confidence in the class area summary is approximately plus or minus 10%. When classes are summarized at the subbasin scale, confidence in the class area summary is approximately plus or minus 20%. Confidence in correct classification of any one subbasin compared to ground truth is estimated to be 65% (2 out of 3 chances of being right). Confidence in composition of the different classes summarized across the basin is estimated at 90% (9 out of 10 chances of being right), 85% for a group of subbasins, 80% for subwatersheds within a subbasin, and 70% for a smaller group (10 to 20) of subwatersheds.

Road Density—This data is intended for use at the broad-scale, generally the regional, subbasin (4th field HUC), or possibly the subwatershed (6th field HUC) level. The attributes in this dataset are derived from modeling or analytical processes. Predicted road density for each 6^{th} order HUC was predicted and a midpoint value assigned for each of six classes. The statistical extrapolation rule set for the 1-sq km base road layer was generally conservative toward higher densities. Because the classes increased in width and size of midpoint, the weighted average for 6th HUCs also tended to be conservative toward higher densities. Overall, the 1-sq km layer can be rated good, as it was based on a 3% sample of 6th HUCs and had a fairly conservative rule set. The 6th HUC current road layer can be rated as fair, given the conservative nature of the rule set and that midpoints were averaged from unequal classes. Class ratings can be highly skewed in 6th HUCs. Roads could all be in one part of the 6th HUC with the rest of the HUC roadless. Significant misconceptions could result since the 6th HUCs range in size from 200 to 10,000 hectares.

Current Severe Fire Risks—This is a broad-scale index classifying subwatersheds into classes from very low to very high risk of severe effects from unwanted wildfire. Severe effects are considered to be those that are outside of the central 50% of the range of effects that occurred during the historical system. For this scale, the effects include consideration of the amount of change to earlier successional classes and severity of heating at the soil surface, A class of very low has little chance of effects that occur outside of normal regime, while a class of very high has substantial risk of having effects outside of the normal. The index is assigned to subwatersheds based on the concurrent high or low probability of wildfire occurrence and severe fire effects potential.
At the broad-scale, summary of the classes of this variable can be used to identify how much area may have relatively high opportunity for severe effects from unwanted wildfire. In addition, this variable could be summarized at a 4th HUC level to identify subbasins that could be prioritized for increased emphasis on wildfire protection and restoration. This broad-scale data should not be used to target specific subwatersheds for these purposes, since the very low to very high type of classification is relative and has a potential error of 20%. Since, these classes are relative to each other, this data should be used in this context and not as an absolute calculation of area of severe wildfire effects.

For example, if one subwatershed has a very high rating and the adjacent subwatershed has a low rating, the interpretation is that the one subwatershed has much higher probability of severe wildfire effects. Another way to consider this interpretation is that the absolute amount of opportunity for severe wildfire effects is unknown at this scale, but these data indicate that one subwatershed has much higher probability of severe effects than the other.

The rule set used to classify this variable into very low (VL), low (L), moderate (M), high (H) or very high (VH) severe wildfire effects risk is based on logical relationships developed from the literature as cited in the ICBEMP documents (Agee 1998;Anderson 1982;Chandler et al. 1983;Fischer 2000;Gardner et al. 1999;Huff et al. 1995;Keane et al. 1990;Keane et al. 1995;McNabb and Cromack Jr. 1990;McNabb and Swanson 1990;Reinhardt 1997;Rothermel 1995;Williams and Rothernel 1992;Wright and Bailey 1982). These relationships assumes that as risk of wildfire occurrence and severe fire effects potential increase concurrently, the risk of severe effects from wildfire will increase. The wildfire occurrence or frequency index was developed by combing information on fire regime pattern (Morgan et al. 1996) and fire occurrence (Hartford and Menakis 1994).

The spatial distribution of the high and very high classes for severe wildfire effects risk is spread widely across the Basin on much of the dry forest and rangeland types and in some of the moist forest zone. The attributes in this dataset are derived from a rule set linked to intermediate input variables. Because these intermediate input variables are predicted, any one resulting subwatershed variable class has approximately 15-25% chance of error into an adjacent class and 5-15% chance of error to non-adjacent classes. When classes are summarized at the Basin or groups of subbasins scale, confidence in the class area summary is approximately plus or minus 10%. When classes are summarized at the subbasin scale, confidence in the class area summary is approximately plus or minus 20%. This can be improved to plus or minus 10% by grouping classes into a coarser (3 class; low, moderate, high) classification which will improve accuracy. The classes are only applicable and accurate when considered in a relative sense to each other.

This data was processed at the subwatershed (6th code HUC) scale by assigning very low to very high classes to combinations of input intermediate variables. Input intermediate variables included vegetation and land management patterns, fire occurrence and fire regime pattern, vegetation and fuels, climate, elevation, fire behavior potential, and landscape fire behavior potential, Mapped classes for the current were compare to the historical which was considered the baseline. High and very high classes were assigned to concurrent combinations of high occurrence, fire behavior potential, and fire effects potentials. Very low and low classes were assigned to the opposing class combinations and moderate to the intermediate combinations.

[Insert information on culverts and irrigation pods]

StreamNet Data— StreamNet is a cooperative entity whose purpose is to consolidate, standardize and distribute fisheries-related data from across the Columbia Basin. Its participants include fish and wildlife agencies from Idaho, Montana, Oregon, and Washington, the Columbia River Inter-Tribal Fish Commission, the Shoshone-Bannock Tribes, and the U.S. Fish and Wildlife Service. It is administered by the Pacific States Marine Fisheries Commission and is a component of the Northwest Power Planning Council's Fish and Wildlife Program. Funding is through the Bonneville Power Administration (BPA) with additional funding from EPA and NMFS.

StreamNet focuses on historical and current information related to fish abundance and fish habitat. Data are acquired from management agencies across the basin and standardized into consistent formats. The data are distributed primarily through StreamNet's online database at http://www.streamnet.org. Data related to habitat constraints that is maintained by StreamNet includes the following:

- Streambank degradation
- Passage blocked
- Passage impeded
- Low flows
- Sedimentation
- High temperatures
- Chemical pollution
- Poor instream covere
- Pool to riffle ratio
- Gravel quantity
- Gravel quality
- Inter-species competition
- Unscreened or poor diversion
- Winter cover inadequate
- Low winter water temperatures
- Channelization
- Flash flooding
- Ice flows/icing conditions
- Steep gradient
- Large stream size
- Upper end steep
- Insufficient edge habitat
- Insufficient riparian vegetation
- Disease
- Predation
- Turbidity from glacial runoff
- Insufficient adult holding water
- Low biological productivity

It should be remembered that StreamNet's SDM encompassed the entire Columbia Basin, and not all of these constraints are necessarily present in the Salmon or Clearwater subbasins which are treated in this analysis. These constraints were initially mapped to the PNW (Pacific Northwest) 1:100,000 scale hydrography layer, and were later transferred to the 1:250,000 scale EPA river reach files. As a result of this scale shift some stream segments were lost from the database, but the effect on the Salmon and Clearwater subbasins is negligible: in the Salmon subbasin, about 2% of the stream segments were lost, and in the Clearwater only 1%.

In response to a need for a Columbia Basin-wide evaluation of anadromous production potential, two StreamNet work groups, the System Planning Group (SPG) and the Monitoring and Evaluation Group (MEG), developed the Smolt Density Model (SDM). The primary output of this model was an estimate of smolt carrying capacity by subbasin and stock which was used in the Northwest Power Planning Council's System Planning Model (SPM). The SPM was a life cycle model used to predict effects on salmon and steelhead due to various strategies proposed by the planners. This model also provided an updated distribution dataset, along with a subjective habitat rating by species/run. The

Smolt Density Model data were utilized for this analysis because it links specific habitat constraint types to river reaches.

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 all 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 ______. 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. 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.

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 usable area, 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 use type 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 within the subbasin they were working on (not based on comparisons of the their subbasin to habitat in other subbasins.) Excellent habitat was described as that which would support the highest productivity for a species within the subbasin. Poor was the classification for habitat which would support the lowest level of productivity of some reasonable number of fish. Good and Fair 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 (see table below), 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 mi * 5280 ft/mi * 35 ft)/ 10.764 ft/m2 = 34,336 m2

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 m2 * .64 smolts/m2 = 21,975 smolts

Standard smolt density estimates (smolts/m2) 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.

SDM Bibliography [Probably not the place for this—just didn't want it to get lost]

Bjornn, T. 1978. Survival, Production and Yield of Trout and Chinook Salmon in the Lemhi River, Idaho. Bull. 27. Col. Forest. Wildl. - Range Sci., Univ. ID. Moscow, ID.

Cannon, W. 1970. Evaluation of Changes in Species Composition and Abundance of Game Fish Above Dworshak Reservoir. Idaho Dept. Fish-Game, Job Prof. Rept. Boise, ID.

Chilcote, M., S. Leider and S. Loch. 1984. Kalama River Salmonid Studies. Progress Rept. 1983. Wash. Dept. Game, Olympia, WA.

Edmundson, E., F. Everest and D. Chapman. 1968. Permanence of Station in Juvenile Chinook Salmon and Steelhead Trout. Journ. Fish. Res. Bd. Can. 25(7):1453-1464.

Everest, F.H., G.H. Reeves, J.R. Sedel, D.B. Hohler, and T. Cain. 1987. The effects of habitat enhancement on steelhead trout and coho salmon smolt production, habitat utilization, and habitat availability in Fish Creek, Oregon, 1983-86. Annual Report 1986. Bonneville Power Administration. 128 pp.

Everest, F. 1969. Habitat Selection and Special Introduction by Juvenile Chinook and Steelhead Trout in Two Idaho Streams. Ph.D. Thesis, University of ID., Moscow, ID.

Fuller, R.K., P.A. Kucera, and D.B. Johnson. 1986. Synopsis of three years of stream inventory on the Nez Perce Reservation. Final Report submitted to the Bonneville Power Administration. 147 pp.

Fuller, R.K., J.H. Johnson and M.A. Bear. 1984. A biological and physical inventory of the streams within the lower Clearwater River. Boise, ID. Annual Report for 1983 submitted to Bonneville Power Administration. 206 pp.

Johnson, J.H. and P.A. Kucera. 1985. Summer-autumn habitat utilization of subyearling steelhead trout in tributaries of the Clearwater River, Idaho. Canadian J. Zool. 63:2283-2290.

Kucera, P.A. and D.B. Johnson. 1986. A biological and physical inventory of streams within the Nez Perce Reservation. Bonneville Power administration. Final Report.

Kucera, P.A., J.H. Johnson, and M.A. Bear. 1983. A biological and physical inventory of streams within the Nez Perce Reservation. Bonneville Power Administration.

MacHugh, N.W. 1987. Memorandum on steelhead trout smolt density estimates in mainstem and tributary areas of streams. Fish Division, Oregon Department of Fish and Wildlife.

Marshal, D., H. Mandie, P. Slaney and G. Taylor. 1980. Preliminary Review of the Predictability of Smolt Yield for Wild Stocks of Chinook Salmon, Steelhead Trout and Coho Salmon. Workshop, Stream Enhancement Res. Comm. Vanc., B.C., Can.

Nichelson, T.E. 1987. Memorandum on spring chinook salmon smolt density estimates in mainstem and tributary areas of streams. Research and Development Section, Oregon Department of Fish and Wildlife.

Northwest Power Planning Council. 1986. Council Staff: Technical Planning Report. Attachment 1. Density Data Base Summary. 139 pp.

Shepard, B. 1983. Evaluation of a Combined Methodology for Estimating Fish Abundance and Letic Habitat in Mountain Streams of Idaho. Masters Thesis. U. of ID., Moscow, ID.

Slaney, P. 1981. An Empirical Model for Estuaries Steelhead Trout Production Capability of Streams. B.C. Fish-Wildl. Br., Univ. B.C., Can.

Thurow, R. 1987. Evaluation of the South Fork Salmon River Steelhead Trout Fishery Restoration Program. ID. Dept. Fish-Game, Fishery Research. May 1987. Boise, ID. 154 pp.

Conclusions

The data that is available to help define existing and possible future limiting factors serves as a coarse screen to identify possible problems as well as opportunities for actions that would enhance recovery efforts. It is not perfect data, for definitive, quantitative segment by segment information for each stream in the Salmon and Clearwater subbasins simply doesn't exist. It also has limitations, for much of it is the product of professional judgment, computer modeling and or extrapolated data. However, it is the best available and, with an understanding of it limits, is extremely useful in building an approach for the habitat related aspects of salmon and steelhead recovery that are based upon identifying where there are habitat limitations and devising strategies to overcome them.

Existing Limiting Factors

Basin/Population Group	Total Stream Miles	Miles of 303(d) Impairments					Miles of StreamNet Limitations									
		Sediment	Temperature	pH	Toxics	Other	Sediment	Temperature	Bank Degradation, cover	Passage Issues	Flow Issues	Pool and Gravel Quality	Exotic Competition	Chanelization	Gradient, stream size	Other

Potential Threats and Future Limiting Factors

Stream Basin/Population Group	Total Acres	Timber Management			Grazing			Severe Fire Risks			Road Density		
		High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low