Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale

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Footnote:

1) The species narrative is intended to provide the biologist or evaluator with an up-to-date source of information on the general biological parameters associated with the particular species being evaluated. References for additional information sources are provided.

OVERVIEW

The following guidelines are designed to facilitate and standardize determinations of effect for Endangered Species Act (ESA) conferencing, consultations and permits focusing on anadromous salmonids. We recommend that this process be applied to individual or grouped actions at the watershed scale. When the National Marine Fisheries Service (NMFS) conducts an analysis of a proposed activity it involves the following steps: (1) Define the biological requirements of the listed species; (2) evaluate the relevance of the environmental baseline to the species' current status; (3) determine the effects of the proposed or continuing action on listed species; and (4) determine whether the species can be expected to survive with an adequate potential for recovery under the effects of the proposed or continuing action, the environmental baseline and any cumulative effects, and considering measures for survival and recovery specific to other life stages. The last item (item 4) addresses considerations given during a jeopardy analysis.

This document provides a consistent, logical line of reasoning to determine when and where adverse effects occur and why they occur. Please recognize that this document does not address jeopardy or identify the level of take or adverse effects which would constitute jeopardy. Jeopardy is determined on a case by case basis involving the specific information on habitat conditions and the health and status of the fish population. NMFS is currently preparing a set of guidelines, to be used in conjunction with this document, to help in the determination of jeopardy.

This document contains definitions of ESA effects and examples of effects determinations, a matrix of pathways of effects and indicators of those effects, a checklist for documenting the environmental baseline and effects of the proposed action(s) on the relevant indicators, and a dichotomous key for making determinations of effect. None of the tools identified in this document are new inventions. The matrix, checklist, and dichotomous key format were developed by the US Fish and Wildlife Service (USFWS) Region 2 and the USDA Forest Service Region 3 for a programmatic ESA section 7 consultation on effects of grazing (USFWS, May 5, 1995). The matrix developed here reflects the information needed to implement the Aquatic Conservation Strategy (ACS)(appendix D) and to evaluate effects relative to the Northwest Forest Plan ACS Objectives, and the Ecological Goals in the Proposed Recovery Plan for Snake River Salmon (appendix D) and the LRMP consultation on the eight National Forests in Idaho and Oregon.

Using these tools, the Federal agencies and Non-Federal Parties (referred to as evaluators in the remainder of this document) can make determinations of effect for proposed projects (i.e. "no effect"/"may affect" and "may affect, not likely to adversely affect"/"may affect, likely to adversely affect"). As explained below, these determinations of effect will depend on whether a proposed action (or group of actions) hinders the attainment of relevant environmental conditions (identified in the matrix as pathways and indicators) and/or results in "take", as defined in ESA, section 3 (18) of a proposed or listed species.

Finally, this document was designed to be applied to a wide range of environmental conditions. This means it must be flexible. It also means that a certain degree of professional judgement will be required in its application. **There will be circumstances where the ranges of numerics or descriptions in the matrix simply do not apply to a specific watershed or basin. In such a case, the evaluator will need to provide more biologically appropriate values. When this occurs, documentation justifying these changes should be presented in the biological assessment, habitat conservation plan, or other appropriate document so that NMFS can use it in preparation of a section 7 consultation, habitat conservation plan, or other appropriate biologically based document.**

Description of the Matrix:

The "Matrix of Pathways and Indicators" (Table 1) is designed to summarize important environmental parameters and levels of condition for each. This matrix is divided into six overall pathways (major rows in the matrix):

-- Water Quality
-- Habitat Access
-- Habitat Elements
-- Channel Condition and Dynamics
-- Flow/Hydrology
-- Watershed Conditions

Each of the above represents a significant pathway by which actions can have potential effects on anadromous salmonids and their habitats. The pathways are further broken down into "indicators." Indicators are generally of two types: (1) Metrics that have associated numeric values (e.g. "six pools per mile"); and (2) descriptions (e.g. "adequate habitat refugia do not exist"). The purpose of having both types of indicators in the matrix is that numeric data are not always readily available for making determinations (or there are no reliable numeric indicators of the factor under consideration). In this case, a description of overall condition may be the only appropriate method available.

The columns in the matrix correspond to levels of condition of the indicator. There are three condition levels: "properly functioning," "at risk," and "not properly functioning." For each indicator, there is either a numeric value or range for a metric that describes the condition, a description of the condition, or both. When a numeric value and a description are combined in the same cell in the matrix, it is because accurate assessment of the indicator requires attention to both.

Description of the Checklist:

The "Checklist for Documenting Environmental Baseline and Effects of Proposed Action(s) on Relevant Indicators" (Table 2) is designed to be used in conjunction with the matrix. The checklist has six columns. The first three describe the condition of each indicator (which when taken together encompass the environmental baseline), and the second three describe the effects of the proposed action(s) on each indicator.

Description of the Dichotomous Key for Making ESA Determinations of Effect:

The "Dichotomous Key for Making ESA Determinations of Effect" (p. 15) is designed to guide determinations of effect for proposed actions that require a section 7 consultation or permit under Section 10 of the ESA. Once the matrix has been tailored (if necessary) to meet the needs of the evaluators, and the checklist has been filled out, the evaluators should use the key to help make their ESA determinations of effect.

How to Use the Matrix, Checklist, and Dichotomous Key

1) Group projects that are within a watershed.

2) Using the Matrix provided (or a version modified by the evaluator) **evaluate environmental baseline conditions** (mark on checklist), use all 6 pathways (identified in the matrix).

Matrix of Pathways and Indicators

Use to describe the Environmental Baseline Conditions

Water Quality, Habitat Access, Habitat Elements, Channel Condition and Dynamics, Flow/Hydrology, Watershed Condition

and

Then use the same Pathways and Indicators to evaluate the Proposed Projects

3) **Evaluate effects of the proposed action** using the matrix. Do they restore, maintain or degrade existing baseline conditions? Mark on checklist.

Mark Results on Checklist

4) Take the checklist you marked and the dichotomous key and answer the questions in the key **to reach a determination of effects.**

Checklist

Environmental Baseline			Effects of the Action		
Properly Funct.	At Risk	Not Properly Funct.	Maintain	Restore	Degrade

Use Professional Judgement

and the Checklist to

Work through the Dichotomous Key

Dichotomous Key

Yes/No

No Effect
May Effect
Not Likely to Adversely Affect
Likely to Adversely Affect

(Note: Actual Matrix is on page 9,10,& 11. Actual Checklist on page 13. Actual Dichotomous key on page 14)

DEFINITIONS OF ESA EFFECTS AND EXAMPLES

Definitions of Effects Thresholds

Following are definitions of ESA effects (sources in *italics*). The first three ("no effect," "may affect, not likely to adversely affect," and "may affect, likely to adversely affect") are not defined in the ESA or implementing regulations. However, "likely to jeopardize" is defined in the implementing regulations:

"No effect:"

This determination is only appropriate "if the proposed action will literally have no effect whatsoever on the species and/or critical habitat, not a small effect or an effect that is unlikely to occur." (From "*Common flaws in developing an effects determination*", Olympia Field Office, U.S. Fish and Wildlife Service). Furthermore, actions that result in a "beneficial effect" do not qualify as a no effect determination.

"May affect, not likely to adversely affect:"

"The appropriate conclusion when effects on the species or critical habitat are expected to be beneficial, discountable, or insignificant. Beneficial effects have contemporaneous positive effects without any adverse effects to the species or habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. Based on best judgement, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur." (From "*Draft Endangered Species Consultation Handbook; Procedures for Conducting Section 7 Consultations and Conferences*," USFWS/NMFS, 1994). The term "negligible" has been used in many ESA consultations involving anadromous fish in the Snake River basin. The definition of this term is the same as "insignificant."

"May affect, likely to adversely affect"

The appropriate conclusion when there is "more than a negligible potential to have adverse effects on the species or critical habitat" (*NMFS draft internal guidelines*). Unfortunately, there is no definition of adverse effects in the ESA or its implementing regulations. The draft Endangered Species Handbook (NMFS/USFWS, June 1994) provides this definition for "Is likely to adversely affect": "This conclusion is reached if any adverse effect to listed species or critical habitat may occur as a direct or indirect result of the proposed action or its interrelated or interdependent actions. In the event the overall effect of the proposed action is beneficial to the listed species or critical habitat, but may also cause some adverse effects to individuals of the listed species or segments of the critical habitat, then the proposed action 'is likely to adversely affect' the listed species or critical habitat."

The following is a definition specific to anadromous salmonids developed by NMFS, the FS, and the BLM during the PACFISH consultation; "Adverse effects include short or long-term, direct or indirect management-related, impacts of an individual or cumulative nature such as mortality, reduced growth or other adverse physiological changes, harassment of fish, physical disturbance of redds, reduced reproductive success, delayed or premature migration, or other adverse behavioral changes to listed anadromous salmonids at any life stage. Adverse effects to designated critical habitat include effects to any of the essential features of critical habitat that would diminish the value of the habitat for the survival and recovery of listed anadromous salmonids" (From *NMFS' Pacfish Biological Opinion, 1/23/95*). Interpretation of part of the preceding quotation has been problematic. The statement "...impacts of an individual or cumulative nature..." has often been applied only to actions and impacts, not organisms. NMFS' concern with this definition is that it does not clearly state that the described impacts include those to individual eggs or fish. However, this definition is useful if it is applied on the individual level as well as on the subpopulation and population levels.

For the purposes of Section 7, any action which has more than a negligible potential to result in "take" (see definition at bottom of Dichotomous Key, p. 14 of this document) is likely to adversely affect a proposed/listed species. It is not possible for NMFS or USFWS to concur on a "not likely to adversely affect" determination if the proposed action will cause take of the listed species. Take can be authorized in the Incidental Take Statement of a Biological Opinion after the anticipated extent and amount of take has been described, and the effects of the take are analyzed with respect to jeopardizing the species or adversely modifying critical habitat. Take, as defined in the ESA, clearly applies to the individual level, thus actions that have more than a negligible potential to cause take of individual eggs and/or fish are "likely to adversely affect."

"Likely to jeopardize the continued existence of"

The regulations define jeopardy as "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (*50 CFR §402.02*).

"Take"

The ESA (Section 3) defines take as "to harass, harm, pursue, hunt, shoot, wound, trap, capture, collect or attempt to engage in any such conduct". The USFWS further defines "harm" as "significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering", and "harass" as "actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering".

Examples of Effects Determinations

"No effect"

NMFS is encouraging evaluators to conference/consult at the watershed scale (i.e., on all proposed actions in a particular watershed) rather than on individual projects. Due to the strict definition of "no effect" (above), the interrelated nature of in-stream conditions and watershed conditions, and the watershed scale of these conferences, consultations, and activities "no effect" determinations for all actions in a watershed could be rare when proposed/listed species are present in or downstream from a given watershed. This is reflected in the dichotomous key, however the evaluator may identify some legitimate exceptions to this general rule.

Example:

The proposed project is in a watershed where available monitoring information indicates that in-stream habitat is in good functioning condition and riparian vegetation is at or near potential. The proposed activity will take place on stable soils and will not result in increased sediment production. No activity will take place in the riparian zone.

"May affect, not likely to adversely affect"

Example:

The proposed action is in a watershed where available monitoring information indicates that in-stream habitat is in good functioning condition and riparian vegetation is at or near potential. Past monitoring indicates that this type of action has led to the present condition (i.e., timely recovery has been achieved with the kind of management proposed in the action). Given available information, the potential for take to occur is negligible.

"May affect, likely to adversely affect"

Example:

The proposed action is in a watershed that has degraded baseline conditions such as excess fine sediment, high cobble embeddedness, or poor pool frequency/quality. If the action will further degrade any of these pathways, the determination is clearly "likely to adversely affect".

A less obvious example would be a proposed action in the same watershed that is designed to improve baseline conditions, such as road obliteration or culvert repair. Even though the intent is to improve the degraded conditions over the long-term, if any short-term impacts (such as temporary turbidity and sedimentation) will cause take (adverse effects), then the determination is "likely to adversely affect."

TABLE 1. MATRIX of PATHWAYS AND INDICATORS

(Remember, the ranges of criteria presented here are not absolute, they may be adjusted for unique watersheds. See p. 3)

PATHWAY	INDICATORS	PROPERLY FUNCTIONING	AT RISK	NOT PROPERLY FUNCTIONING
Water Quality:	Temperature	50-57° F[1]	57-60° (spawning) 57-64° (migration &rearing)[2]	> 60° (spawning) > 64° (migration & rearing)[2]
	Sediment/Turbidity	< 12% fines (<0.85mm) in gravel[3], turbidity low	12-17% (west-side)[3], 12-20% (east-side)[2], turbidity moderate	>17% (west-side)[3], >20% (east side)[2] fines at surface or depth in spawning habitat[2], turbidity high
	Chemical Contamination/ Nutrients	low levels of chemical contamination from agricultural, industrial and other sources, no excess nutrients, no CWA 303d designated reaches[5]	moderate levels of chemical contamination from agricultural, industrial and other sources, some excess nutrients, one CWA 303d designated reach[5]	high levels of chemical contamination from agricultural, industrial and other sources, high levels of excess nutrients, more than one CWA 303d designated reach[5]
Habitat Access:	Physical Barriers	any man-made barriers present in watershed allow upstream and downstream fish passage at all flows	any man-made barriers present in watershed do not allow upstream and/or downstream fish passage at base/low flows	any man-made barriers present in watershed do not allow upstream and/or downstream fish passage at a range of flows
Habitat Elements:	Substrate	dominant substrate is gravel or cobble (interstitial spaces clear), or embeddedness <20%[3]	gravel and cobble is subdominant, or if dominant, embeddedness 20-30%[3]	bedrock, sand, silt or small gravel dominant, or if gravel and cobble dominant, embeddedness >30%[2]
	Large Woody Debris	Coast: >80 pieces/mile >24"diameter >50 ft. length[4]; East-side: >20 pieces/ mile >12"diameter >35 ft. length[2]; and adequate sources of woody debris recruitment in riparian areas	currently meets standards for properly functioning, but lacks potential sources from riparian areas of woody debris recruitment to maintain that standard	does not meet standards for properly functioning and lacks potential large woody debris recruitment

	Pool Frequency channel width # pools/mile[6] 5 feet 184 10 " 96 15 " 70 20 " 56 25 " 47 50 " 26 75 " 23 100 " 18	meets pool frequency standards (left) and large woody debris recruitment standards for properly functioning habitat (above)	meets pool frequency standards but large woody debris recruitment inadequate to maintain pools over time	does not meet pool frequency standards
	Pool Quality	pools >1 meter deep (holding pools) with good cover and cool water[3], minor reduction of pool volume by fine sediment	few deeper pools (>1 meter) present or inadequate cover/temperature[3], moderate reduction of pool volume by fine sediment	no deep pools (>1 meter) and inadequate cover/temperature[3], major reduction of pool volume by fine sediment
	Off-channel Habitat	backwaters with cover, and low energy off-channel areas (ponds, oxbows, etc.)[3]	some backwaters and high energy side channels[3]	few or no backwaters, no off-channel ponds[3]
	Refugia (important remnant habitat for sensitive aquatic species)	habitat refugia exist and are adequately buffered (e.g., by intact riparian reserves); existing refugia are sufficient in size, number and connectivity to maintain viable populations or sub-populations[7]	habitat refugia exist but are not adequately buffered (e.g., by intact riparian reserves); existing refugia are insufficient in size, number and connectivity to maintain viable populations or sub-populations[7]	adequate habitat refugia do not exist[7]
Channel Condition & Dynamics:	Width/Depth Ratio	<10[2,4]	10-12 (we are unaware of any criteria to reference)	>12 (we are unaware of any criteria to reference)
	Streambank Condition	>90% stable; i.e., on average, less than 10% of banks are actively eroding[2]	80-90% stable	<80% stable
	Floodplain Connectivity	off-channel areas are frequently hydrologically linked to main channel; overbank flows occur and maintain wetland functions, riparian vegetation and succession	reduced linkage of wetland, floodplains and riparian areas to main channel; overbank flows are reduced relative to historic frequency, as evidenced by moderate degradation of wetland function, riparian vegetation/succession	severe reduction in hydrologic connectivity between off-channel, wetland, floodplain and riparian areas; wetland extent drastically reduced and riparian vegetation/succession altered significantly

Flow/Hydrology:	Change in Peak/ Base Flows	watershed hydrograph indicates peak flow, base flow and flow timing characteristics comparable to an undisturbed watershed of similar size, geology and geography	some evidence of altered peak flow, baseflow and/or flow timing relative to an undisturbed watershed of similar size, geology and geography	pronounced changes in peak flow, baseflow and/or flow timing relative to an undisturbed watershed of similar size, geology and geography
	Increase in Drainage Network	zero or minimum increases in drainage network density due to roads[8,9]	moderate increases in drainage network density due to roads (e.g., 5%)[8,9]	significant increases in drainage network density due to roads (e.g., 20-25%)[8,9]
Watershed Conditions:	Road Density & Location	<2 mi/mi^2[11], no valley bottom roads	2-3 mi/mi^2, some valley bottom roads	>3 mi/mi^2, many valley bottom roads
	Disturbance History	<15% ECA (entire watershed) with no concentration of disturbance in unstable or potentially unstable areas, and/or refugia, and/or riparian area; and for NWFP area (except AMAs), 15% retention of LSOG in watershed[10]	<15% ECA (entire watershed) but disturbance concentrated in unstable or potentially unstable areas, and/or refugia, and/or riparian area; and for NWFP area (except AMAs), 15% retention of LSOG in watershed[10]	>15% ECA (entire watershed) and disturbance concentrated in unstable or potentially unstable areas, and/or refugia, and/or riparian area; does not meet NWFP standard for LSOG retention
	Riparian Reserves	the riparian reserve system provides adequate shade, large woody debris recruitment, and habitat protection and connectivity in all subwatersheds, and buffers or includes known refugia for sensitive aquatic species (>80% intact),and/or for grazing impacts: percent similarity of riparian vegetation to the potential natural community/ composition >50%[12]	moderate loss of connectivity or function (shade, LWD recruitment, etc.) of riparian reserve system, or incomplete protection of habitats and refugia for sensitive aquatic species (70-80% intact), and/or for grazing impacts: percent similarity of riparian vegetation to the potential natural community/composition 25-50% or better[12]	riparian reserve system is fragmented, poorly connected, or provides inadequate protection of habitats and refugia for sensitive aquatic species (<70% intact), and/or for grazing impacts: percent similarity of riparian vegetation to the potential natural community/composition <25%[12]

[1] Bjornn, T.C. and D.W. Reiser, 1991. Habitat Requirements of Salmonids in Streams. American Fisheries Society Special Publication 19:83-138. Meehan, W.R., ed.

[2] Biological Opinion on Land and Resource Management Plans for the: Boise, Challis, Nez Perce, Payette, Salmon, Sawtooth, Umatilla, and Wallowa-Whitman National Forests. March 1, 1995.

[3] Washington Timber/Fish Wildlife Cooperative Monitoring Evaluation and Research Committee, 1993. Watershed Analysis Manual (Version 2.0). Washington Department of Natural Resources.

[4] Biological Opinion on Implementation of Interim Strategies for Managing Anadromous Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California (PACFISH). National Marine Fisheries Service, Northwest Region, January 23, 1995.

[5] A Federal Agency Guide for Pilot Watershed Analysis (Version 1.2), 1994.

[6] USDA Forest Service, 1994. Section 7 Fish Habitat Monitoring Protocol for the Upper Columbia River Basin.

[7] Frissell, C.A., Liss, W.J., and David Bayles, 1993. An Integrated Biophysical Strategy for Ecological Restoration of Large Watersheds. Proceedings from the Symposium on

Changing Roles in Water Resources Management and Policy, June 27-30, 1993 (American Water Resources Association), p. 449-456.

[8] Wemple, B.C., 1994. Hydrologic Integration of Forest Roads with Stream Networks in Two Basins, Western Cascades, Oregon. M.S. Thesis, Geosciences Department, Oregon State University.

[9] e.g., see Elk River Watershed Analysis Report, 1995. Siskiyou National Forest, Oregon.

[10] Northwest Forest Plan, 1994. Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl. USDA Forest Service and USDI Bureau of Land Management.

[11] USDA Forest Service, 1993. Determining the Risk of Cumulative Watershed Effects Resulting from Multiple Activities.

[12] Winward, A.H., 1989 Ecological Status of Vegetation as a base for Multiple Product Management. Abstracts 42nd annual meeting, Society for Range Management, Billings MT, Denver CO: Society For Range Management: p277.

TABLE 2. CHECKLIST FOR DOCUMENTING ENVIRONMENTAL BASELINE AND EFFECTS OF PROPOSED ACTION(S) ON RELEVANT INDICATORS

PATHWAYS:	ENVIRONMENTAL BASELINE			EFFECTS OF THE ACTION(S)		
INDICATORS	Properly Functioning[1]	At Risk[1]	Not Propr. Functioning[1]	Restore[2]	. . Maintain[3]	Degrade[4]
Water Quality: Temperature						
Sediment						
Chem. Contam./Nut.						
Habitat Access: Physical Barriers						
Habitat Elements: Substrate						
Large Woody Debris						
Pool Frequency						
Pool Quality						
Off-channel Habitat						
Refugia						
Channel Cond. & Dyn: Width/Depth Ratio						
Streambank Cond.						
Floodplain Connectivity						
Flow/Hydrology: Peak/Base Flows						
Drainage Network Increase						
Watershed Conditions: Road Dens. & Loc.						
Disturbance History						
Riparian Reserves						

Watershed Name:______________________________ Location:____________________

1 These three categories of function ("properly functioning", "at risk", and "not properly functioning") are defined for each indicator in the "Matrix of Pathways and Indicators" (Table 1 on p. 10).

2 For the purposes of this checklist, "restore" means to change the function of an "at risk" indicator to "properly functioning", or to change the function of a "not properly functioning" indicator to "at risk" or "properly functioning" (i.e., it does not apply to "properly functioning" indicators).

3 For the purposes of this checklist, "maintain" means that the function of an indicator does not change (i.e., it applies to all indicators regardless of functional level).

4 For the purposes of this checklist, "degrade" means to change the function of an indicator for the worse (i.e., it applies to all indicators regardless of functional level). In some cases, a "not properly functioning" indicator may be further worsened, and this should be noted.

FIGURE 1. DICHOTOMOUS KEY FOR MAKING ESA DETERMINATION OF EFFECTS

1. Are there any proposed/listed anadromous salmonids and/or proposed/designated critical habitat in the watershed or downstream from the watershed?

   NO . . . . No effect

   YES . . . . May affect, go to 2

2. Does the proposed action(s) have the potential to hinder attainment of relevant properly functioning indicators (from table 2)?

   YES . . . . Likely to adversely affect

   NO . . . . Go to 3

3. Does the proposed action(s) have the potential to result in "take"[1] of proposed/listed anadromous salmonids or destruction/adverse modification of proposed/designated critical habitat?

   A. There is a negligible (extremely low) probability of take of proposed/listed anadromous salmonids or destruction/adverse modification of habitat . . . . Not likely to adversely affect

   B. There is more than a negligible probability of take of proposed/listed anadromous salmonids or destruction/adverse modification of habitat. . . Likely to adversely affect

[1] "Take" - The ESA (Section 3) defines take as "to harass, harm, pursue, hunt, shoot, wound, trap, capture, collect or attempt to engage in any such conduct". The USFWS (USFWS, 1994) further defines "harm" as "significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering", and "harass" as "actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering".

Appendix A
Overview of Some Key Habitat Elements and Activities Affecting Them

The following are excerpts from A Coarse Screening Process For Potential Application in ESA Consultations (CRITFC, 1994). The excerpts are intended to stimulate the biologist's thought processes into evaluating all of the pathways through which habitat degradation could occur. Unfortunately this is not an all inclusive list. However, it is a start. We recommend that biologists review the entire "Coarse Screening" document and any other documents that are available to them. The "Coarse screening" document is available from The National Marine Fisheries Service, Portland, Oregon. We also highly recommend reviewing a report prepared by ManTech Environmental Research Services Corporation while under contract to the National Marine Fisheries Service (NMFS), Environmental Protection Agency and US Fish and Wildlife Service. The document is entitled "An Ecosystem Approach to Salmonid Conservation". This document is also available from the NMFS in Portland, Oregon.

Channel Substrate:

"Salmon survival and production are reduced as fine sediment increases, producing multiple negative impacts on salmon at several life stages. Increased fine sediment entombs incubating salmon in redds, reduces egg survival by reducing oxygen flow,
alters the food web, reduces pool volumes for adult and juvenile salmon, and reduces the availability of rearing space for juveniles rendering them more susceptible to predation. Reduced survival-to-emergence (STE) for salmon caused by elevated fine sediment increases is of particular concern because it is a source of density-independent mortality that can have extremely significant negative effects on salmon populations even at low seeding.

The rearing capacity of salmon habitat is decreased as cobble embeddedness levels increase. Overwinter rearing habitat may be a major limiting factor to salmon production and survival. The loss of overwintering habitat may result in increased levels of mortality during rearing life stages."

Channel Morphology

"Available data indicate that the production of salmon is reduced as pool frequency and volume decrease. Large pools are required by salmon during rearing, spawning, and migration. Pools provide thermal refugia, velocity refugia during storm events, resting habitat for migrating salmon, and important rearing habitat for juvenile salmon."

"Fine sediment is deposited in pools during waning flows. Residual pool volume is the volume of a pool not filled by fine sediment accumulations. Fine sediment volumes in pools reduce pool quality and reduce residual pool volumes (the pool volume available for salmon use)."

"Available data indicate that salmon production increases as Large Woody Debris (LWD) increases. LWD provides cover, velocity refugia, and plays a vital role in pool formation and the maintenance of channel complexity required by salmon in natal habitat. LWD also aids in reducing channel erosion and buffering sediment inputs by providing sediment storage in headwater streams."

Bank Stability
"Bank stability is of prime importance in maintaining habitat conditions favoring salmon survival. Bank instability increases channel erosion that can lead to increased levels of fine sediment and the in-filling of pools. Unstable banks can lead to stream incisement that can reduce baseflow contributions from groundwater and increase water temperature. Bank instability can cause channel widening that can significantly exacerbate seasonal water temperature extremes and destabilize LWD."

Water Temperature
"Available information indicates that the elevation of summer water temperatures impairs salmon production at scales ranging from the reach to the stream network and puts fish at greater risk through a variety of effects that operate at scales ranging from the individual organism to the aquatic community level. Maximum summer water temperatures in excess of 60°F impair salmon production. However, many smaller streams naturally have much lower temperatures and these conditions are critical to maintaining downstream water temperatures. At the stream system level, elevated water temperatures reduce the area of usable habitat during the summer and can render the most potentially productive and structurally complex habitats unusable. Decreases in winter water temperatures also put salmon at additional risk. The loss of vegetative shading is the predominant cause of anthropogenically elevated summer water temperature. Channel widening and reduced baseflows exacerbate seasonal water temperature extremes. Elevated summer water temperatures also reduce the diversity of coldwater fish assemblages."

Water Quantity and Timing
"The frequency and magnitude of stream discharge strongly influence substrate and channel morphology conditions, as well as the amount of available spawning and rearing area for salmon. Increased peak flows can cause redd scouring, channel widening, stream incisement, increased sedimentation. Lower streamflows are more susceptible to seasonal temperature extremes in both winter and summer. The dewatering of reaches can block salmon passage."

<u>Some Major Activities and their Effects</u>

Logging
Regional differences in climate, geomorphology, soils, and vegetation may greatly influence timber harvest effects on streams of a given size. However, some broad generalizations can be made on how timber harvest affects the hydrologic cycle, sediment input, and channel morphology of streams:

1. Hydrologic cycle. Timber harvest often alters normal streamflow patterns, particularly the volume of peak flows (maximum volume of water in the stream) and base flows (the volume of water in the stream representing the groundwater contribution). The degree these parameters change depend on the percentage of total tree cover removed from the watershed and the amount of soil disturbance caused by the harvest, among other things. For example, if harvest activities remove a high percentage of tree cover and cause light soil disturbance and compaction, rain falling on the soil will infiltrate normally. However, due to the loss of tree cover, evapotranspiration (the loss of water by plants to the atmosphere) will be much lower than before. Thus, the combination of normal water infiltration into the soil and greatly decreased uptake and loss of water by the tree cover results in substantially higher, sustained streamflows. Hence, this type of harvest results in higher base flows during dry times of the year when evapotranspiration is high, but does not greatly affect peak flows during wet times of the year because infiltration has not decreased and evapotranspiration is low. On the other hand, if the harvest activities cause high soil disturbance and compaction, little rainfall will be able to penetrate the soil and recharge groundwater. This results in higher surface runoff and equal or slightly higher base flows during dry times of the year. During wet times of the year, the compacted soils deliver high amounts of surface runoff, substantially increasing peak flows. In general, timber harvest on a watershed-wide scale results in water moving more quickly through the watershed (i.e., higher runoff rates, higher peak and base flows) because of decreased soil infiltration and evapotranspiration. This greatly simplified model only partly illustrates the complex hydrologic responses to timber harvest (Chamberlain et al. 1991, Gordon et al. 1992).

2. Sediment input. Timber harvest activities such as road-building and use, skidding logs, clear-cutting, and burning increase the amount of bare compacted soil exposed to rainfall and runoff, resulting in higher rates of surface erosion. Some of this hillside sediment reaches streams via roads, skid trails, and/or ditches (Chamberlain et al. 1991). Appropriate management precautions such as avoiding timber harvest in very wet seasons, maintaining buffer zones below open slopes, and skidding over snow can decrease the amount of surface erosion (Packer 1967). Harvest activities can also greatly increase the likelihood of mass soil movements occurring, particularly along roads and on clear-cuts in steep terrain (Furniss et al. 1991, O'Loughlin 1972). Increased surface erosion and mass soil movements associated with timber harvest areas can result in an increase in sediment input to streams. Fine sediment may infiltrate into relatively clean streambed gravels or, if the supply of fine sediment is large, settle deeper into the streambed (Chamberlain et al. 1991).

3. Stream channel morphology. The hydrologic and sedimentation changes discussed above can influence a stream's morphology in many ways. Substantial increases in the volume and frequency of peak flows can cause streambed scour and bank erosion. A large sediment supply may cause aggradation of the stream channel, pool filling, and a reduction in gravel quality (Madej 1982). Streambank destabilization from vegetation removal, physical breakdown, or channel aggradation adds to sediment supply and generally results in a loss of stream channel complexity (Scrivener 1988). In addition, losses of in-stream large woody debris supplies (i.e., removal of riparian trees) also result in less channel complexity as wood-associated scour pools decrease in size and disappear (Chamberlain et al. 1991).

Roads

"Roads are one of the greatest sources of habitat degradation. Roads significantly elevate on-site erosion and sediment delivery, disrupt subsurface flows essential to the maintenance of baseflows, and can contribute to increased peak flows. Roads within riparian zones reduce shading and disrupt LWD sources for the life of the road. These effects degrade habitat by increasing fine sediment levels, reducing pool volumes, increasing channel width and exacerbating seasonal temperature extremes."

Grazing
The impacts of livestock grazing to stream habitat and fish populations can be separated into acute and chronic effects. Acute effects are those which contribute to the immediate loss of individual fish, and loss of specific habitat features (undercut banks, spawning beds, etc.) or localized reductions in habitat quality (sedimentation, loss of riparian vegetation, etc.). Chronic effects are those which, over a period of time, result in loss or reductions of entire populations of fish, or widespread reductions in habitat quantity and/or quality.

Acute Effects
Acute effects to habitat include compacting stream substrates, collapse of undercut banks, destabilized streambanks and localized reduction or removal of herbaceous and woody vegetation along streambanks and within riparian areas (Platts 1991). Increased levels of sediment can result through the resuspension of material within existing stream channels as well as increased contributions of sediment from adjacent streambanks and riparian areas. Impacts to stream and riparian areas resulting from grazing are dependent on the intensity, duration, and timing of grazing activities (Platts 1989) as well as the capacity of a given watershed to assimilate imposed activities, and the pre-activity condition of the watershed (Odum 1981).

Chronic Effects
Chronic effects of grazing result when upland and riparian areas are exposed to activity and disturbance levels that exceed assimilative abilities of a given watershed. Both direct and indirect fish mortality are possible, and the potential for mortality extends to all life cycle phases. As an example, following decades of high intensity season-long grazing on BLM lands in the Trout Creek Mountains of southeast Oregon, the Whitehorse Creek watershed had extensive areas of degraded upland and riparian habitat (BLM 1992). An extreme rain-on-snow event in late winter 1984 and subsequent flooding of area streams flushed adult and juvenile trout through area streams and into Whitehorse Ranch fields and the adjacent desert.

Although less extreme, increases in stream temperature and reduced allochthonous inputs following removal of riparian vegetation, increased sedimentation, and decreased water storage capacity work together to reduce the health and vigor of stream biotic communities (Armour et al. 1991, Platts 1991, Chaney et al. 1990). Increased sediment loads reduce primary production in streams. Reduced instream plant growth and riparian vegetation limits populations of terrestrial and aquatic insects. Persistent degraded conditions adversely influence resident fish populations (Meehan 1991).

Mining
"Mining activities can cause significant increases in sediment delivery. While mining may not be as geographically pervasive as other sediment-producing activities, surface mining typically increases sediment delivery much more per unit of disturbed area than other activities (Dunne and Leopold, 1978; USFS, 1980; Richards, 1982; Nelson et al. 1991) due to the level of disruption of soils, topography, and vegetation. Relatively small amounts of mining can increase sediment delivery significantly."

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Appendix B
Species Narrative

Umpqua River Sea-Run Cutthroat Trout (*Oncorhynchus clarki*)

Endangered Species Act Status:	Proposed Endangered, July 8, 1994, Umpqua River Basin, in Southwestern Oregon. All life forms are included in this proposal.

Description. Sea-run cutthroat trout is a profusely spotted fish which often has red or sometimes orange slash marks on each side of the lower jaw. Coastal sea-run cutthroat trout often lose the cutthroat marks when in seawater. Some other trouts, such as Apache trout, Gila trout and Redband trout may also have yellowish or red slash marks. Other identifying marks include; the presence of basibranchial teeth, located on the basibranchial plate behind the tongue. The upper jaw is typically more than half the length of the head with the eye being well forward of the back of the maxilla.

The spots on cutthroat trout are small to medium, irregularly shaped, dispersed evenly over the entire body including the belly and anal fin. Coloration of sea-run fish is often silvery with a slight yellow tint. This silver coloration often masks the spots. Sea-run fish darken and take on spots after a period in freshwater. Freshwater fish are often more colorful with pale yellow colors on the body and red-orange or yellow on the lower fins. The gill plates sides and ventral areas may tinted a rosy color as spawning time draws nearer (description from Stolz and Schnell, 1991).

Distribution. Coastal cutthroat trout range from northern California to the Gulf of Alaska. The distribution of the proposed Umpqua River Sea-run cutthroat trout is the greater Umpqua River Basin located in Douglas County in southwestern Oregon. The Umpqua River Basin stretches from the Cascade Mountains in the east to the Pacific Ocean at Reedsport, Oregon. The drainages of the North and South Umpqua Rivers together make up about 2/3 of the greater Basin drainage, and each river is about 170 km long. The mainstem Umpqua River flows in a northwesterly direction another 180 km to the ocean. Together, the three rivers form one of the longest coastal basins in Oregon, approximately 340 km in length, with a drainage area of over 12,200 sq. km. Major tributaries of the mainstem Umpqua River include Calapooya (River Kilometer [RKm] 164), Elk (RKm 78), and Scholfield Creeks (Rkm 18) and the Smith River (Rkm 18). The estuary of the Umpqua River is one of largest on the Oregon coast and has a large seawater wedge that extends as far inland as Scottsburg, Oregon at Rkm 45. (From Status Review For Oregon's Umpqua River Sea-Run Cutthroat Trout, Johnson et al. 1994)

Life Forms
Sea-Run (anadromous) cutthroat trout

Cutthroat trout have evolved to exploit habitats least preferred by other salmonid species

(Johnston 1981). Unlike other anadromous salmonids, sea-run cutthroat trout do not over-winter in the ocean and only rarely make long extended migrations across large bodies of water. They migrate in the near-shore marine habitat and usually remain within 10 km of land (Sumner 1972, Giger 1972, Jones 1976, Johnston 1981). While most anadromous cutthroat trout enter seawater as 2- or 3-year-olds, some may remain in fresh water for up to 5 years before entering the sea (Sumner 1972, Giger 1972).

Resident (nonmigratory) cutthroat trout

Some cutthroat trout do not migrate long distances; instead, they remain in upper tributaries near spawning and rearing areas and maintain small home territories (Trotter 1989). Resident cutthroat trout have been observed in the upper Umpqua River drainage (Roth 1937, FCO and OSGC 1946 , ODFW 1993a)

During a radio tagging study Waters (1993) found that fish smaller than 180mm maintained home ranges of less than 14m of stream length and moved about an average of 27m during the study. Fish larger than 180mm had home ranges of about 76m and moved and average total distance of about 166m. This study was conducted in three tributaries of Rock Creek on the North Umpqua River drainage. (In Johnson et al. 1994)

River-Migrating (Potamodromous) cutthroat trout

Some cutthroat trout move within large river basins but do not migrate to the sea.

Life History/Migration.
The following descriptions are condensed from status review (Johnson et al. 1994)

Cutthroat trout spawning occurs between December and May and eggs begin to hatch within 6-7 weeks of spawning, depending on temperature. Alevins remain in the redds for a further few weeks and emerge as fry between March and June, with peak emergence in mid-April (Giger 1972, Scott and Crossman 1973). Newly emerged fry are about 25 mm long. They prefer low velocity margins, backwaters, and side channels, gradually moving into pools if competing species are absent. If coho fry are present they will drive the smaller cutthroat fry into riffles, where they will remain until decreasing water temperatures reduce the assertiveness of the coho fry (Stolz and Schnell, 1991). In winter , cutthroat trout go to pools near log jams or overhanging banks (Bustrad and Narver 1975).

Parr Movements
After emergence from redds, cutthroat trout juveniles generally remain in upper tributaries until they are 1 year of age, when they may begin extensive movement up and down streams.

Directed downstream movement by parr usually begins with the first spring rains (Giger 1972) but has been documented in every month of the year (Sumner 1953, 1962, 1972; Giger 1972; Moring and Lantz 1975; Johnston and Mercer 1976; Johnston 1981). As an example, from 1960 to 1963 (Lowry 1965) and from 1966 to 1970 (Giger 1972) in the Alsea River drainage, large downstream migrations of juvenile fish began in mid-April with peak movement in mid-May. Some juveniles (parr) even entered the estuary and remained there over the summer, although they did not smolt nor migrate to the open ocean (Giger 1972). In Oregon, upstream movement of juveniles from estuaries and mainstem to tributaries begins with the onset of winter freshets during November, December, and January (Giger 1972, Moring and Lantz 1975). At this time, these 1-year and older juvenile fish averaged less than 200 mm in length.

Smoltification

Time of initial seawater entry of smolts bound for the ocean varies by locality and may be related to marine conditions or food sources (Lowry 1965, 1966; Giger 1972; Johnston and Mercer 1976; Trotter 1989). In Washington and Oregon, entry begins as early as March, peaks in mid-May, and is essentially over by mid-June (Sumner 1953, 1972; Lowry 1965; Giger 1972; Moring and Lantz 1975; Johnston 1981). Seaward migration of smolts to protected areas appears to occur at an earlier age and a smaller size than to more exposed areas. On the less protected Oregon coast, cutthroat trout tend to migrate at an older age (age 3 and 4) and at a size of 200 to 255 mm (Lowry 1965, 1966; Giger 1972).

Timing of smolt migrations in the Umpqua River

Trap data from seven locations in the North Umpqua River in 1958 and from three locations in Steamboat Creek (a tributary of the North Umpqua River downstream of Soda Springs Dam) between 1958 and 1973 indicate that juvenile movement is similar to that reported by Lowry (1965) and Giger (1972) in other Oregon coastal rivers. Movement peaked in May and June, with a sharp decline in July, although some juveniles continued to be trapped through September and October. It is unknown whether Umpqua River cutthroat trout juveniles migrate from the upper basin areas to the estuary, but it seems unlikely considering the distance (well over 185 km) and the river conditions (average August river temperature at Winchester Dam (located on the main Umpqua River where the Interstate 5 highway crosses the Umpqua) since 1957 is 23.3° C) (ODFW 1993a).

Estuary and Ocean Migration

Migratory patterns of sea-run cutthroat trout differ from Pacific salmon in two major ways: few, if any, cutthroat overwinter in the ocean, and the fish do not usually make long open-ocean migrations, although they may travel considerable distances along the shoreline (Johnston 1981, Trotter 1989, Pauley et al. 1989). Studies by Giger (1972) and Jones (1973, 1974, 1975) indicated that cutthroat trout, whether initial or seasoned migrants, remained at sea an average of only 91 days, with a range of 5 to 158 days.

Adult Freshwater Migrations

In the Umpqua River, it is reported (ODFW 1993a) that cutthroat trout historically began upstream migrations in late June and continued to return through January with bimodal peaks in late-July and October. Giger (1972) reported a similar return pattern, but with slightly later modal peaks (mid-August and late-October to mid-November) on the Alsea River.

Spawning/Rearing

Cutthroat trout generally spawn in the tails of pools located in small tributaries at the upper limit of spawning and rearing sites of coho salmon and steelhead. Streams conditions are typically low stream gradient and low flows, usually less than 0.3 m^3/second during the summer (Johnston 1981). Spawn timing varies among streams, but generally occurs between December and May, with a peak in February (Trotter 1989).

Cutthroat trout are iteroparous and have been documented to spawn each year for at least 5 years (Giger 1972), although some cutthroat trout do not spawn every year (Giger 1972) and some do not return to seawater after spawning, but remain in fresh water for at least a year (Giger 1972, Tomasson 1978). Spawners may experience high post-spawning mortality due to weight loss of as much as 38% of pre-spawning mass (Sumner 1953) and other factors (Cramer 1940, Sumner 1953, Giger 1972, Scott and Crossman 1973).

Food.

In streams cutthroat trout feed mainly on terrestrial and aquatic insects that come to them in the drift. When in the marine environment cutthroat trout feed around gravel beaches, off the mouths of small creeks and beach trickles, around oyster beds and patches of eel grass. They primarily feed on amphipods, isopods, shrimp, stickleback, sand lance and other small fishes. (Stolz and Schnell, 1991)

Additional Information

Much of what is presented here was take from two sources. They are the Status Review for Oregon's Umpqua River Sea-Run Cutthroat Trout, June 1994, available from the National Marine Fisheries Service, Northwest Fisheries Science Center, Coastal Zone and Estuarine Studies Division, 2725 Montlake BLVD. E., Seattle, WA 98112-2097 and the book The Wildlife Series, Trout, Edited by Judith Stolz and Judith Schnell, Stackpole Books, Cameron and Kelker Streets, P.O. Box 1831, Harrisburg, PA 17105 (ISBN number 0-8117-1652-X). Both documents contain a lot more information for those that are interested.

Appendix C

A comparison between ACS Objectives, Ecological Goals, and the pathways and indicators used in the effects matrix.

Aquatic Conservation Strategy Objectives - Northwest Forest Plan	Ecological Goals - Snake River Recovery Plan/ LRMP	Pathways / Indicators
2,4,8,9	2,5,9,10	Water Quality / Temperature
4,5,6,8,9	5,6,7,9,10	Water Quality/Sediment./Turbidity.
2,4,8,9	2,5,9,10	Water Quality/Chemical Concentration/Nutrients
2,6,9	2,7,10	Habitat Access/ Physical Barriers
3,5,8,9	3,6,9,10	Habitat Elements/Substrate
3,6,8,9	3,4,7,9,10	Habitat Elements/Large Woody Debris
3,8,9	3,4,9,10	Habitat Elements/Pool Frequency
3,5,6,9	3,4,6,7,10	Habitat Elements/Pool Quality
1,2,3,6,8,9	1,2,3,7,9,10	Habitat Elements/Off-Channel Habitat
1,2,9	1,2,10	Habitat Elements/Refugia
3,8,9	3,9,10	Channel Condition/Dynamics/Width/Depth Ratio
3,8,9	3,9,10	Channel Condition/Dynamics/Streambank Condition
1,2,3,6,7,8,9	1,2,3,7,8,9,10	Channel Condition/Dynamics/Floodplain Connectivity.
5,6,7	6,7,8	Flow/Hydrology/Change in Peak/Base Flow
2,5,6,7	2,6,7,8	Flow/Hydrology/Increase in Drainage Network
1,3,5	1,3,6	Watershed Conditions/Road Density & Location
1,5	1,6	Watershed Conditions/Disturbance History
1,2,3,4,5,8,9	1,2,3,4,5,6,9,10	Watershed Conditions/Riparian Reserves

Appendix D
ACS Objectives and Ecological Goals

ACS Objectives

Forest Service and BLM-administered lands within the range of the northern spotted owl will be managed to:

1. Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations and communities are uniquely adapted.

2. Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life history requirements of aquatic and riparian-dependent species.

3. Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.

4. Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.

5. Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.

6. Maintain and restore in-stream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.

7. Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.

8. Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse woody debris sufficient to sustain physical complexity and stability.

9. Maintain and restore habitat to support well-distributed populations of native plant, invertebrate, and vertebrate riparian-dependent species.

Ecological Goals

NMFS restated, refined, and expanded the PACFISH goals to provide added detail on ecological function needed for listed salmon and to include landscape and habitat connectivity perspectives. These goals provide consistency with NMFS' basin-wide Ecological Goals for all Federal land management agencies contained in the Proposed Recovery Plan for Snake River Salmon. Consistency with these goals will help NMFS determine whether land management actions avoid jeopardy or adverse modification of critical habitat during watershed-scale and project-scale consultations. However, although consistency with the goals and their associated guidelines generally is necessary to achieve informal concurrence under section 7 of the Endangered Species Act, concurrence cannot be guaranteed since the goals and other guidance were not structured to eliminate short-term adverse effects. Also, some of the guidelines (particularly with regard to grazing, mining, and how to proceed following watershed analysis) are not specific enough to eliminate the requirement for project-specific interpretation and analysis. The goals and guidelines described below do not include NMFS' long-term expectations for the eastside environmental impact statements. The Ecological Goals are as follows:

1. Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations, and communities are uniquely adapted.

2. Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life history requirements of aquatic and riparian-dependent species.

3. Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.

4. Maintain and restore timing, volume and distribution of large woody debris (LWD) recruitment by protecting trees in riparian habitat conservation areas. Addition of LWD to streams is inappropriate unless the causes of LWD deficiency are understood and ameliorated.

5. Maintain and restore the water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival,

growth, reproduction, and migration of individuals composing aquatic and riparian communities.

6. Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.

7. Maintain and restore instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats, retain patterns of sediment, nutrient, and wood routing, and optimize the essential features of designated critical habitat. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows should be maintained, where optimum, and restored, where not optimum.

8. Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.

9. Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse woody debris sufficient to sustain physical complexity and stability.

10. Maintain and restore habitat to support well-distributed populations of native plant, invertebrate, and vertebrate riparian-dependent species.