United States Department of the Interior

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Memorandum

To: Ecological Services Project Leaders, Region 6
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State Private Lands Coordinators, Region 6

Through: Assistant Regional Director, Ecological Services, Region 6
Assistant Regional Director, Fisheries Resources, Region 6

Acting
From: Regional Director, Region 6

Subject: Guidelines for Instream Habitat Restoration Projects

Introduction

This document provides guidance for U.S. Fish and Wildlife Service, Region 6 Partners for Fish and Wildlife and Fish and Wildlife Management Assistance biologists to use when planning and implementing instream habitat restoration projects to correct human-caused stream changes which are disruptive to natural stability and known to be detrimental to fish and wildlife. The goal of this guidance is to achieve consistent application of good science for instream habitat restoration projects.

The bankfull discharge concept described by Dr. Luna Leopold in his book, A View of the River, is fully endorsed. According to the bankfull concept, single-thread channels tend to migrate by erosion of one bank balanced by deposition on the opposite bank. The erosion rate, sediment transport rate, and the bar-building deposition are most active when the discharge is near bankfull. Bankfull is therefore the channel forming flow. High flood flows carry the most sediment during their passage, but occur too infrequently to accomplish as much work as the bankfull flow. This guidance relies on the bankfull concept as the basis for restoration of stream function. Information on the application of the bankfull concept for stream assessment and restoration design is available through appropriately trained Service personnel. The Region 6 Partners for Fish and Wildlife website, www.r6.fws.gov/pfw, is the information source for background on the bankfull concept and a list of appropriately trained Region 6 personnel.

There is a difference between the use of natural rock, logs, and vegetation, below bankfull, to restore natural stream stability and fish habitat and the use of hard materials above bankfull for bank stabilization. This document addresses instream habitat restoration. Bank stabilization issues will be dealt with in a separate Region 6 policy.

Background

Development pressures have significantly changed river systems throughout the Region 6 States. Rivers in Region 6 are adjusting to human-caused changes in the watersheds and in the channels. As a result, rivers are often over-widened or incised as a consequence of changes such as irrigation diversions, cross-channel dams in second- and third-order streams, bridge crossings, grassland conversion to cropland, and riparian willow and cottonwood removal. In an over widened or incised state, rivers transport the watershed's flow and sediment in ways that accelerate bank erosion beyond normal ranges. Traditional engineering concepts of control and containment have been applied to solve problems caused by accelerated bank erosion. This approach has failed to adequately incorporate natural river geometry, channel behavior, riparian function, aesthetic value, and the comparative financial value of different alternatives. Control and containment engineering concepts, manifested in river alterations throughout the Region, have resulted in significant individual and cumulative adverse habitat changes for many fish and wildlife species and probably have contributed to major declines in native fish populations in some locations.

Guidance

Region 6 takes a more ecologically defensible view of instream projects than traditional engineering approaches have demonstrated. In Region 6, all instream habitat restoration projects within the Partners for Fish and Wildlife and Fish and Wildlife Assistance programs should be screened through an assessment that links cause and consequence for determination of the appropriate corrective action.

Region 6 Guidance Statement: Actions the Partners for Fish and Wildlife and Fish and Wildlife Management Assistance programs take in streambeds to restore fish and wildlife habitat should support a stream's central tendency to adjust towards the most probable natural state. Proposed actions should be evaluated as to effects on dimension, pattern, and profile, based on the bankfull concept.

The most probable natural state, or natural stability, is exhibited by a single-channel stream when over time, in the present climate, the stream adjusts towards dimension, pattern, and profile within stream type limits, without aggrading or degrading, even as the stream may move across its floodplain. An exception to recognize is the presence of naturally occurring braided streams (D stream type) consisting of interconnected distributory channels formed in depositional environments. This stream type is characterized by high sediment supply, excessive deposition occurring as both longitudinal and transverse bars, and annual shifts of the bed locations.

Guidance Implementation

The bankfull concept is not universally accepted among river engineers. Criticism of the concept and its application exists in published literature. In addition, river restoration techniques utilizing the bankfull concept are incompletely understood within conservation agencies. For those reasons, every instream habitat project completed within these guidelines will be a "demonstration project." Skepticism should be anticipated and opposed with carefully collected data and defensible restoration designs.

The job is to restore stream form and function, not pristine conditions. Restoration decisions will be based on the current stream type; the position of the current stream type within the evolutionary sequence of stream types; and from that, the stream type that should be restored as the most probable state.

The appropriate procedure for instream habitat restoration projects is to measure the dimension, pattern, profile, and channel materials of the existing condition. Do the same on a reference reach of the same stream type. Conduct a departure analysis utilizing gauge data and the reference reach. Decide on the level of intervention needed to restore stability to the existing channel and to meet habitat objectives for the guild of native fish and wildlife species. Design and build the appropriate restoration for the stream type. Hardening of the banks above bankfull is not appropriate. However, it is consistent with these guidelines to use rock, vegetation, and logs at bankfull and below bankfull for restoration of proper dimension, pattern, and profile; bank erosion reduction to within natural limits for the stream type; and improvement of instream habitat for the desired fish and wildlife species guild over existing conditions. The placement of hard materials in first-order channels, such as embankments in coulees, is an exception to this guidance and is supported as an appropriate technique to improve habitat for wetland-dependent wildlife.

A Service biologist or hydrologist trained in the bankfull concept of fluvial morphology and stream restoration should review proposed construction during the planning stage. Eventually, all Region 6 instream projects should be technically reviewed and approved by staff who have been trained in the bankfull concept through completion of the Wildland Hydrology, Inc. course series, or equivalent training approved in advance by the Regional Office. This objective will be achieved through time as more Service personnel are trained. In the meantime, **all questions regarding project technical specifications, data collection and monitoring should be directed to the Regional Office to the attention of Rick Dornfeld, Regional Partners for Fish and Wildlife Coordinator, or Meg Estep, Hydrologist in Water Resources.**

Because of the importance of riverine and riparian habitats and because they occupy a small portion of our landscape, every reasonable effort will be made to look at proposed instream habitat restoration projects as opportunities to restore natural stream stability. Within the array of broadstream categories, two categories, incised streams and overwidened or aggrading streams, will be encountered in many instream restoration situations in Region 6. (See

"A Geomorphological Approach to Restoration of Incised Rivers" by David Rosgen.) This publication describes the three multipurpose intervention techniques, which are the core of the overall regional guidelines, and which should be utilized when planning any proposed instream habitat project on incised or overwidened rivers. An abbreviated version of the intervention techniques is located in Appendix A.

Cautions on the Use of Published References

Some published references provide restoration guidelines that, if used, could result in channel instability. Be wary of restoration guidelines unless they are derived from natural stability concepts based on bankfull. Appendix B provides further information regarding these concerns.

Data Collection and Monitoring

The publication "Applied River Morphology" provides guidance on data collection and monitoring. Appendix C in this guidance provides information,

Disclaimer

This guidance does not directly apply to anyone but personnel of Region 6 of the U.S. Fish and Wildlife Service. It has no legal standing in and of itself and is subject to all existing Service mandates and policies. Questions may be directed to Rick Domfeld at (303) 236-7400, ext. 241, or Rick_Dornfeld@fws.gov.

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Appendix A

Intervention Techniques for Incised and Overwidened Rivers

These techniques should be employed by Region 6 Partners for Fish and Wildlife and Fish and Wildlife Management Assistance personnel when planning instream habitat restoration projects on incised or overwidened rivers.

Incised Rivers

The incised river is a vertically contained stream that has abandoned previous floodplains due to a lowering of the local base level, and it is characterized by high streambanks bounded by alluvial terraces. An incised condition is measured as a bank height ratio beyond the stable range for the stream type. Incised rivers are caused by channelization, straightening, encroachment, confinement (lateral containment), urban development, change in flow and sediment regime, and watershed and riparian vegetation conversion.

The consequences of channel incision include accelerated bank erosion, land loss, aquatic habitat loss, lowering of water tables, land productivity reduction, and accelerated downstream sedimentation. In an incised condition, rivers may have lost access to the floodplain and, therefore, no longer receive the benefits from overbank flooding. Riprap is commonly used to reduce the consequences of channel incision. However, riprap is a single purpose action that usually results in negative values for fish and wildlife, when compared with a stream adjusting toward the most probable state.

Fish and wildlife values will be protected by the application of three incised river intervention techniques, all of which have high value when compared with riprap. Priority 1 is restoration of the appropriate stream-type channel on the original floodplain by use of a relic channel or construction of a new bankfull discharge channel. Priority 2 is to restore the appropriate stream-type channel at the existing level or higher, but below the original floodplain. Priority 3 is conversion to a different stream type at the existing or higher level. From a fish and wildlife habitat viewpoint, Priority 1, 2, or 3 may be equally appropriate corrections for dealing with the consequences of incised channels, depending on site conditions and the species of concern.

Overwidened Rivers

In addition to application on incised rivers, Priority 1, 2, and 3 techniques are appropriate interventions for the consequences of overwidened rivers. An overwidened condition is measured as a width to depth ratio beyond the stable range for the stream type. A common occurrence in western States is for flow-depleted streams to over-widen in response to stream power reduction and increased sediment deposition, which increases shear stress in the near bank region, resulting in accelerated bank erosion.

Priority 1, 2, or 3 are appropriate corrections for the consequences of stream incision or stream overwidening.

- Priority 1, 2, or 3 can be full, end-to-end, stream-reach restoration. This work includes reconfiguration of the channel over long reaches, pool excavation, riffle grade changes, point bar construction, instream structures, and extensive vegetation management.

- Priority 1, 2, or 3 can be localized application of channel sizing in combination with instream structures designed and placed in ways to restore channel stability. The appropriate minimum stream length is a case-by-case decision. An example of site-specific application is the shaping of a short stream reach to restore proper channel geometry, followed by the placement of a cross-vane for grade control, near bank shear stress reduction, and instream habitat improvement.

- The use of structures that do not support channel stability and placement of those structures in improperly sized channels are not consistent with these guidelines and should be avoided. An example is placement of a typical barb in an overwidened channel. This is a high risk treatment that may not support stream stability.

- Riprap is not consistent with these guidelines. It is destabilizing and leads to more riprap. It is important to actively look for opportunities to restore past damages caused by bank stabilization practices through Priority 1, 2, or 3 restoration. Consideration for restoration should be given in situations where there are still active problems associated with an existing riprap structure.

Phased Approach

Phased intervention is often appropriate to correct the consequences of human-caused changes. This concept is discussed in the introduction to Stream Corridor Restoration: Principles, Processes. and Practices, a Federal interagency guideline. In general, it is appropriate to take one of three basic approaches to intervention: (1) nonintervention and undisturbed recovery, (2) partial intervention for assisted recovery, or (3) substantial intervention for managed recovery. The appropriate intervention should be determined for each project by conducting a departure analysis which compares measured values at the project location with a reference reach of the same stream type. It is also important to keep in mind that streams may have the capacity to heal themselves over geologic time but not within our fish and wildlife management time line. The phased approach is as follows:

- Nonintervention and undisturbed recovery where a stream corridor is recovering rapidly, and active restoration is unnecessary and perhaps even detrimental.

- Partial intervention for assisted recovery where a stream corridor is attempting to recover, but it is doing so slowly or uncertainly. In such a case, action may facilitate natural processes already occurring. An example would be riparian corridor fencing on an active cattle ranch for willow recovery.

- Substantial intervention for managed recovery where recovery of desired functions is beyond the timely repair capacity of the ecosystem, and active restoration measures are needed. For example, a project might involve a Priority 2 restoration of a riffle-pool stream inside an existing incised channel. Restoration elements would include (a) channel shaping to proper dimension, pattern, and profile, (b) bank shaping and replanting; and (c) the installation of cross-vanes and J-hook vanes for grade control and instream habitat.

Appendix B

<u>Use of Published References on Instream Projects</u>

Guidelines for structures should be used with caution if the guidelines are not based on maintenance of proper dimension, pattern, and profile. Guidelines for structures such as, check-dams, barbs, gabions, boulder clusters, weirs or sills, log/brush/rock shelters, crib walls, toe-rock, riprap, and sediment basins should be viewed as incomplete unless the guidelines clearly address the need to restore proper dimension, pattern, and profile as a necessary prerequisite to structure placement. Be particularly skeptical of the Restoration Design chapter in <u>Stream Corridor Restoration</u> because the approaches to achieving final design shown in that chapter may not result in channel stability as defined in these guidelines. The reasonable and prudent course of action is to collect enough field data to assess existing stream condition and potential stream condition expected to result from a proposed project.

Listed below are some common engineering tools and techniques that derive from traditional control and containment concepts. Please use these with caution because they can result in stream instability.

- Hydrologic models used to calculate a peak flow hydrograph as a basis to design a “flood flow” channel will lead to overwidened channels. A channel that is too large will not effectively move the flows and sediment. The proper channel size is determined by bankfull flows, not flood flows.

- The use of “critical depth to move the D50 (diameter of the fiftieth percentile of the stream bed material)” will result in a channel that is too wide. It is not correct to design for a shear stress to move the D50 because the channel will destabilize. Instead, the design must be based on a slope and depth to move the D84 material size, which is the size generally entrained at bankfull flows.

- Reliance on standard critical shear stress will result in improperly sized channels. Instead, the adjusted critical shear stress must be used. The adjusted critical shear stress must be derived from measured bed material, a measured bar sample, the riffle slope, and the measured largest particle in the bar sample.

- Reliance on permissible velocity limits will result in overwidened channels. Instead, the width to depth ratio from the reference reach should be relied upon.

- A “design storm hydrograph” should not be used to determine design flows for stream restoration. Design storm flows generally go beyond bankfull. The intended use of a design storm hydrograph is to assist in the design of dams or other structures.

- The use of "regime equations" that derive width from slope and discharge leads to the lumping of all stream types into one equation for width. Instead, the multiple variables related to morphology should be determined, and then regime equations should be developed that are stratified by stream type. These relationships are called regional curves.

- The reliance on a "desk derived" slope calculation of velocity squared over two times gravitational acceleration is an erroneous generalization. It is preferable to develop slope ranges from field measurements on reference reaches that have been stratified by stream type.

- The use of effective discharge in place of field measured bankfull discharge should be avoided. Effective discharge, which is based on a sediment rating curve, is unreliable when applied to incised streams. Sediment rating curves change radically when streams down cut, which is a reflection of increased bank erosion. If effective discharges were used as a design tool for a down cut stream, increasing the discharge would be shown to be the solution, something that would be impossible to implement in nearly all cases. The more appropriate design approach is to use a set of regional relationships which relate bankfull discharge and channel geometry to drainage area, by stream type (i.e., regional curves).

Appendix C

Data Collection and Monitoring

Field data collection is an important element of these guidelines. Different levels of data can be collected depending on the complexity of the project. Data collection is defined and discussed in Applied River Morphology. This reference book provides guidance that should be used for data collection. In addition, there may be data collection requirements that are pertinent to a permit application process or a policy requirement. The type of information to collect will be determined by consultation among Service personnel at the Field and Regional Office levels.

Data collection levels are defined as follows:

1. A geomorphological characterization of the stream and its watershed based on remote sensing. This is an office procedure for characterization of a stream and its watershed.

2. A morphological description that describes existing conditions. This is the stream classification level, determined from data collected at the project reach.

3. An assessment of stream condition and a departure analysis. This level builds on level 2 with the addition of field collected data on hydrological, biological, ecological, or human factors that influence the state of a stream. Data are collected at the project reach and compared with data from a reference reach of the same stream type. This level of data collection is the basis for most Region 6 private land instream habitat restoration.

4. Verification of field data. This level is a stream reach-specific analysis of sediment, condition, stream flow, and stability measurements. After stream reach conditions are verified, the data are used to establish empirical relationships for future tests and predictions of velocity, hydraulic geometry, sediment transport characteristics, bank erosion rates, and channel stability. This is a monitoring level of data collection. Monitoring should be used on at least one instream habitat restoration project of each stream type restored per state.