Recommended Restoration Projects for the Dungeness River

Dungeness River Restoration Work Group

July 1, 1997

Dungeness River Restoration Work Group

(formerly known as the Dungeness Habitat Work Group)

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TABLE OF CONTENTS

TABLES

APPENDICES

Executive Summary

A River Restoration Work Group consisting of federal, tribal, state, and county fisheries biologists and engineers met from 1994 to 1997 to develop a scientifically credible approach to habitat restoration for the salmonids in the Dungeness watershed. The Restoration Plan has put much emphasis on pink and chinook stocks because of their Critical status based upon depressed escapement estimates, because they are considered at risk of extinction (Washington Department of Fish and Wildlife et al. 1993). Restoring self-sustaining salmon stocks in the Dungeness will require an approach that recognizes and restores important river functions in transporting water and sediment from the mountains to the mouth (The Independent Scientific Group 1996). Proper functioning of the Dungeness River floodplain has been altered by many human activities including diking, bridge and road constrictions, removal of log jams and large woody debris, forest and agricultural land management, and water withdrawals (Orsborn and Ralph 1994). The resulting impacts have been deleterious to both property owners and fish.

Restoration activities are complicated by the fact that most of the river bed in the lower Dungeness River is privately owned. These same lower stretches of the river are believed to be the most degraded providing unstable spawning habitat as well as poor migratory routes for up-river stocks. Habitat restoration activities in the river will require cooperation and permission from property owners. Therefore, public involvement and support is considered a critical component of this restoration process.

Problems Affecting Fish Habitat Quality in the Lower 10.8 Miles - An Overview

The lower 10.8 miles of the river are the primary focus of restoration recommendations because of their high habitat value and sensitivity to disturbance. Virtually all of the bank hardening, diking, water withdrawals, gravel mining, bed aggradation, floodplain development, riparian clearing and woody debris removal has occurred in the lower river (Orsborn and Ralph 1994). Upriver habitat has been altered by bridge crossings and sediment input associated with timber harvesting, chronic landslides and road failures, but overall the effect has been far less persistent than that occurring in the lower river (Orsborn and Ralph 1994). Limiting factors that have contributed to the decline of critical stocks of pink and chinook salmon include:

1. **Absence of stable mainstem spawning habitat.**

2. **Lack of high flow refugia and good quality pool habitat for juvenile rearing, adult holding and stream energy dissipation.**

3. **Low stream flow conditions**

<u>The Seven Pillars of River Restoration</u>

Restoring salmonid habitat in the Dungeness River will require the following seven

elements applied throughout the lower 10.8 miles:

1. **Reestablish functional floodplain in lower 2.6 miles through dike management and constriction abatement.**

2. **Abate man-made constrictions upstream of the Corps dike (everything above RM 2.6).**

3. **Create numerous stable, long-term log jams.**

4. **Manage sediment to stabilize the channel and reduce the risk of flooding.**

5. **Construct and/or protect side channels.**

6. **Restore suitable riparian vegetation and riparian-adjacent upland vegetation.**

7. **Conserve instream flows.**

I. INTRODUCTION: Altered River Processes Cause Flooding and Fisheries Declines

The historical development of the Dungeness River and valley reflect geological, biological and human processes that are fundamental to understanding the river today (Lichatowich 1993). Problems such as flooding and declining stocks of salmon have developed because of the alteration of important river functions. A restoration strategy for resolving these problems requires an understanding of the ways that the river has been altered and an unraveling of the complex problems that have consequently developed (National Research Council 1995).

Natural river processes include the migration of a meandering river across the landscape, floodplains that develop from the spillage of flood waters and sediment over the banks, and the development of complex in-channel habitat functions from the creation of log jams that once were numerous throughout the river (Leopold et al. 1994) (See Figure 1, for a map of the historic changes to the Dungeness River channel).

Problems arise when a channel is "fixed" into place, for example, by a bridge. The natural lateral migration of the river or meander development is inhibited resulting in exacerbated channel instabilities upstream and downstream (Williams, P. and Associates 1996).

Chinook and pink salmon populations in the Dungeness River have declined precipitously to a fraction of their former abundance. Based on chronically low numbers of fish returning to the river to spawn,* chinook and fall pink salmon stocks have been given a "Critical" status designation in the 1992 Washington State Salmon and Steelhead Stock Inventory (Washington Department of Fish and Wildlife et al. 1994). A stock of fish is considered critical if they are experiencing production levels so low that permanent damage to the stock is likely or has already occurred.

The summer pink stock - identified as a separate stock from the lower river fall pink population based on its distinct spawning distribution and earlier run-timing difference - has been given a "Depressed" status designation based on chronically low numbers of spawning adults.** A depressed stock of fish is below expected levels of production based on available habitat and natural variations in survival levels.

The steep decline in the watershed's pink population has not paralleled the population trends of other pink salmon stocks in the Puget Sound Basin. The Dungeness River Area Watershed report (1991) stated that the "lack of correlation suggest this major drop... is due to events in the river rather than regional factors."

A recovery program for Dungeness chinook salmon began in 1992 with a goal of providing for a healthy self-sustaining population. An enhancement program for the Dungeness fall pink salmon will begin this year. A concern for the future of these two stocks is heightened by the unstable ecological conditions in the Dungeness River. The chinook recovery program recognizes that long-term success is dependent upon significant restoration of essential habitat in the Dungeness River. The chinook recovery program is scheduled to sunset in the year 2000. Habitat conditions contributing to the decline must be restored within this time frame.

This Restoration Plan recognizes this urgency and recommends actions that are necessary to restore habitat conditions in the river which will restore healthy self-sustaining stocks of pink and chinook salmon, as well as other aquatic species.

* Since 1986, the numbers of spawning chinook salmon have ranged from a high of 335 fish to a low of 43 fish. Estimates of lower Dungeness River pink salmon escapements have ranged over the last 30 years from a low of 138 to a high of 210,000. Both stocks are showing continuing declines in numbers of returning spawning adults.

** Escapements of the upper pink stock have ranged from 1,700 to 190,000 over the past 30 years. In recent years this stock has continued to show chronically low numbers of returning spawning adults.

Important river processes are altered when a dike is built that doesn't allow flood waters to dissipate energy by spreading out across the floodplain, or that inhibits the river’s natural ability to store excessive sediment outside of the channel (Williams, P. and Associates 1996). These problems are the primary causes for increased flooding risks and declining fish populations in the Dungeness. Both humans and fish are suffering from the problems we have identified in the Dungeness.

These problems are not unique to the Dungeness River. Throughout the country, from the Mississippi to the Big Quilcene River in the Puget Sound Basin, a similar set of problems of flooding and declining fish populations are facing local residents, landowners and fisheries managers. Many rivers share problems in common because of similar human impacts that have ignored important river processes (Williams, P. and Associates 1996). It has become clear to the River Restoration Work Group that solutions to the fisheries problems will also provide solutions to the increasing risks of flooding. This will entail reversing as much as possible the disturbances that are creating these problems**,** along with a successful integration of human activities and river processes.

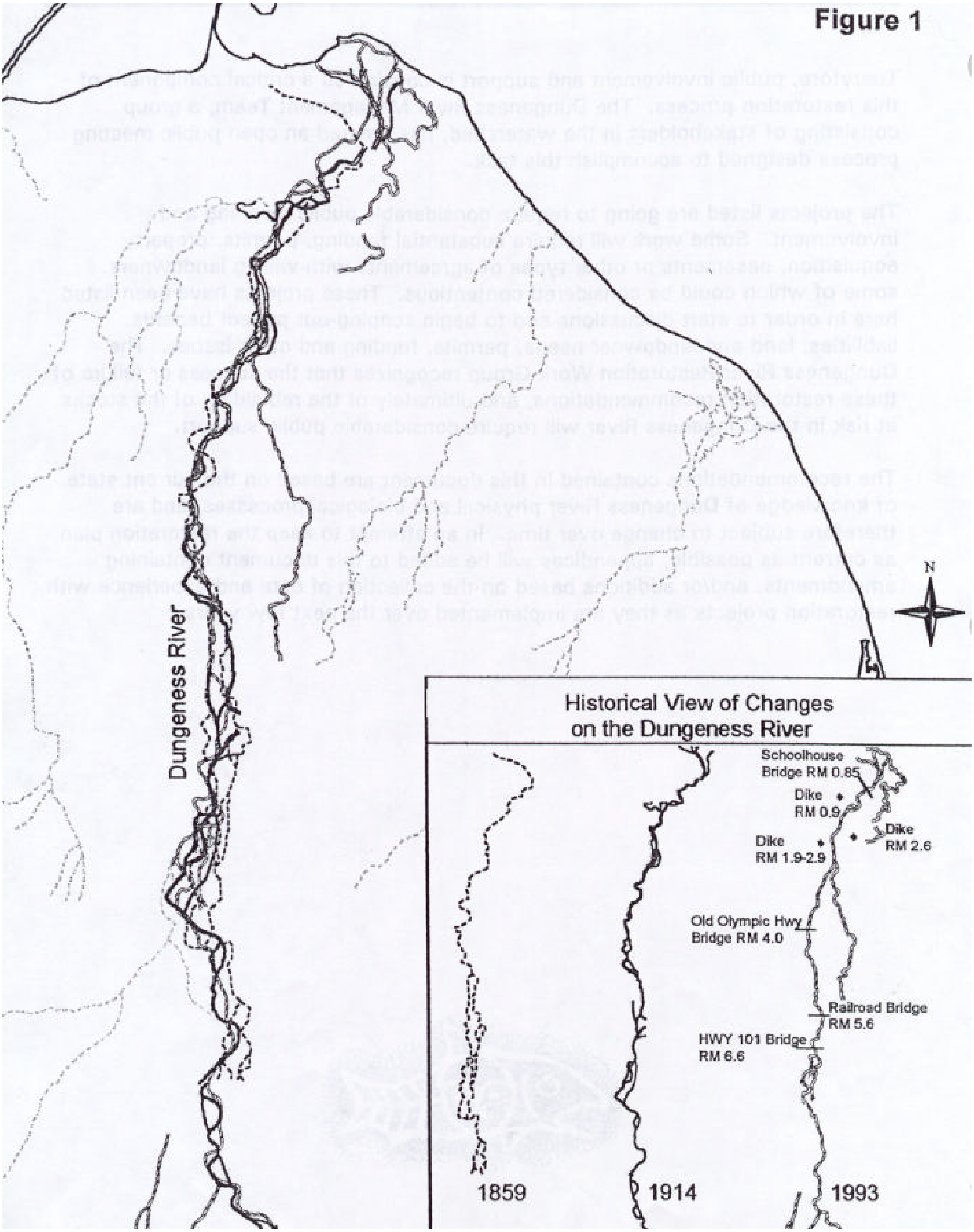
While flooding and other related property damage issues have increased over the years in the Dungeness, an added concern has been the decline of salmonid stocks. The Dungeness lower river fall pink and chinook salmon stocks have experienced severe production and escapement declines in recent years. The Washington Department of Fish and Wildlife and managing Tribes have classified both stocks as Critical, identifying both as stocks with production levels so low that permanent damage to the stock is likely or may have occurred (Washington Department of Fish and Wildlife et al. 1993). A cooperative rebuilding program has been developed and initiated to address the restoration of these stocks. Success of the rebuilding program relies upon implementation of three major strategic components: stock enhancement, habitat restoration, and harvest management. It has been recognized that the long-term success of the rebuilding program is dependent upon significant restoration of salmon habitat in the Dungeness River. Due to the precipitous declines of salmon populations over the years, an aggressive habitat restoration approach is necessary. This report recommends the habitat restoration components necessary to rebuild the stocks at risk.

Restoration activities are challenged by the fact that most of the property surrounding the lower Dungeness River is privately owned. The lower stretches of the river are believed to have the most degraded habitat, and have an influence on all of the critical stocks by providing unstable spawning habitat, low quality rearing habitat and poor migratory routes for up-river stocks. Habitat restoration activities in the river will require cooperation and permission from property owners. Therefore, public involvement and support is considered a critical component of this restoration process. The Dungeness River Management Team, a group consisting of stakeholders in the watershed, has created an open public meeting process designed to accomplish this task.

The projects listed are going to require considerable public planning and involvement. Some work will require substantial funding, permits, property acquisition, easements or other types of agreements with willing landowners, some of which could be considered contentious. These projects have been listed here in order to start discussions and to begin scoping-out project benefits, liabilities, land and landowner needs, permits, funding and other issues. The Dungeness River Restoration Work Group recognizes that the success or failure of these restoration recommendations, and ultimately of the rebuilding of the stocks at risk in the Dungeness River will require considerable public support.

The recommendations contained in this document are based on the current state of knowledge of Dungeness River physical and biological processes, and are therefore subject to change over time. In an attempt to keep the restoration plan as current as possible, appendices will be added to this document containing amendments, and/or additions based on the collection of data and experience with restoration projects as they are implemented over the next few years.

Figure 1


Dungeness River
N
Historical View of Changes on the Dungeness River
Schoolhouse Bridge RM 0.85
Dike RM 0.9
Dike RM 2.6
Dike RM 1.9-2.9
Old Olympic Hwy Bridge RM 4.0
Railroad Bridge RM 5.6
HWY 101 Bridge RM 6.6
1859
1914
1993

II. BACKGROUND: Development of Recommendations

Dungeness River Restoration Work Group

History

The Dungeness River Restoration Work Group (DRRWG or Work Group) was formed in 1994 based on recommendations (#C.7.1) from the Dungeness-Quilcene Water Resources Management Plan to form an ad hoc habitat Work Group. Formation of a group of biologists and other technical advisors to assess habitat conditions in the Dungeness River and make recommendations for river restoration was also part of an informal agreement between the Jamestown S'Klallam Tribe and the Dungeness Agricultural Water Users Association. In exchange for continued irrigation water conservation and shared sacrifice of river water during dry months, the Water Users insisted that action be taken on other parameters affecting fisheries production. Accordingly, the Jamestown S'Klallam Tribe invited biologists and engineers from Federal, State and County agencies having expertise and/or jurisdiction on Dungeness River fisheries resources. Once convened, the Work Group immediately requested that a local property owner be invited to each meeting to lend his experience as a long-term resident, to represent the concerns of the landowners, and to promote open communication between agencies and landowners.

Role

The role of the River Restoration Work Group as outlined in the Dungeness-Quilcene plan was to, "achieve on-going continuity of regional habitat management and to coordinate and guide research efforts." The Work Group was given the task of making recommendations to an overall watershed council, now known as the Dungeness River Management Team. In addition to the preparation of a comprehensive fish habitat restoration plan with goals, objectives, priorities and actions, the River Restoration Work Group defined its role to include:

1) integrating projects with each other on a watershed perspective;
2) peer review, coordination and cooperation;
3) habitat problem definition;
4) recognition of information needs; and
5) promotion of habitat restoration to facilitate critical stock recovery and flood hazard reduction in tandem with other river goals.

The River Restoration Work Group met from 1994 to 1997 to develop a scientifically credible habitat restoration strategy for the salmonids in the Dungeness watershed, with a focus on pink and chinook stocks at risk. Restoring self-sustaining salmon stocks in the Dungeness will require an approach that protects and restores important river, riparian and floodplain functions (The Independent Scientific Group 1996). Projects will be designed to meet these goals while at the same time addressing other equally important issues such as minimizing risk to property and avoiding impacts to other species. These important factors have been developed into decision-making criteria, **Goals and Objectives** and **Evaluation and Selection Criteria** (found in the following pages), which are intended to guide restoration efforts on the river.

The draft restoration strategy was presented at two public meetings including the

Dungeness River Management Team and the public in 1996. These presentations increased public exposure of the river restoration needs, concerns and possible solutions. Since that time, the DRRWG has focused on specific projects planned for the river, including implementation of Large Woody Debris projects recommended in the plan.

Figure 2.

Recommendation C.7.1.11 from the Dungeness - Quilcene Water Resources Management Plan

The Habitat Work Group should develop for Watershed Council consideration a comprehensive habitat management plan, taking into account the natural, historical processes which have and are occurring on the river systems. The plan should include:

- *a. A comprehensive habitat inventory for the Dungeness River to make recommendations to begin to resolve the problem of unstable river channels caused by gravel aggradation;*
- *b. A description of why restoration and enhancement are needed and the potential benefits of the projects to the river and its community;*
- *c. An identification of the most critical sections of the river for restoration including what projects are needed and their estimated results, costs and benefits;*
- *d. A definition of the relationship to critical and depressed stocks to fish and stock recovery efforts;*
- *e. A recommendation for changes in watershed forest practices, including management of riparian corridors, snowpack retention and recharge activities;*
- *f. A recommendation for changes in local critical areas, flood control and land use ordinances related to habitat and salmonid needs;*
- *g. A recommendation for a program for on-going monitoring of restoration projects, a system for analyzing the results and a mechanism to re-adjust the restoration efforts as needed.*

Goals and Objectives for River Restoration

***Goal*: Restore conditions in the Dungeness watershed that promote self-sustaining populations of river dependent species within a diverse and resilient environment.**

The goal is to create river conditions that are resilient to natural disturbances, to make the river bed and channel more stable, reduce flood damage, and provide for the distribution, abundance, and connectivity of habitat types that will allow for the full expression of life history strategies of salmon and other river dependent species.

Objectives

1. Restore river, riparian and floodplain functions that are self-sustaining and resilient to natural disturbances.
2. Correct problems that inhibit the migration of adults and juveniles to traditional spawning grounds and rearing habitat.
3. Correct problems that inhibit the ability of juveniles to emigrate out of the river at optimum times.
4. Improve the stability of spawning habitat in areas that are detrimental to the egg to fry survival of stocks/species at risk.
5. Improve the quantity of productive spawning habitat.
6. Ensure adequate water quality and quantity during adult migration, spawning, incubation, juvenile rearing and fry emigration.
7. Improve the quality, quantity and stability of rearing habitat in areas that are limiting to stocks/species at risk.
8. Create a wide range of spawning conditions including refuge spawning, e.g. side channels.
9. Decrease sediment input occurring above acceptable natural levels that has the potential to create unstable bed and channel conditions in the lower river.

Criteria for Evaluating and Selecting Restoration Projects

The following evaluation and selection criteria were developed by the Dungeness River Restoration Work Group. These criteria were used by the group to evaluate, prioritize and compare proposed habitat restoration projects within the Dungeness Watershed. The criteria stress risk assessment with regard to project failures and possible impacts of those failures on riverine habitat, private/public property, and potential loss of public faith. The emphasis given to risk assessment in the criteria reflects the understanding of the group that failures will likely occur. It is the groups's intention to take precautionary measures to minimize the potential negative effects of these potential failures.

Proposed Projects Should

1. Be linked to the goals and objectives developed by the Dungeness River Restoration Work Group and/or the Dungeness River Management Team,

2. Address the cause(s) of the degradation rather than the symptoms,

3. Address the effect of the project on other river processes such as increased sediment transport/recruitment and erosion,

4. Decrease, where possible, flooding risk and structural damage to residences, activity centers (e.g. Railroad Bridge Interpretive Center), bridges, dikes or other structures along the river,

5. Increase fish and wildlife habitat,

6. Be self-sustaining, requiring minimum maintenance and additional human intervention to the fullest extent possible,

7. Be expected to function long enough to achieve the goals of the project, and

8. Include sufficient evaluation and monitoring to assess the success or failure of the project.

Other Considerations Should Include the Potential:

1. To increase our knowledge of the effects of a specific project type on river/channel functions and processes. Pilot project benefits should only be credited if the project results can be used within the time scale necessary for the Dungeness restoration.

2. To provide learning opportunities to the general public (i.e., landowners, decision-makers, etc.), which could have long-term benefits to river habitat restoration, both on the ground and for our group.

3. To project setbacks including: permit difficulties, study needs, property acquisition requirements and project feasibility based on the gravel market.

4. For interagency cooperation.

Recent Studies, Plans and Projects in the Dungeness Watershed

The recommendations of the Dungeness River Restoration Work Group are based on a number of studies and planning efforts which were undertaken during the past decade. These documents and analyzes are too voluminous to repeat, but are available for review at the Clallam County Water Quality Office and the Natural Resources Department of the Jamestown S'Klallam Tribe, and are listed below. The efforts of planning groups such as the original Dungeness River Management Team (1988-1991), Dungeness Watershed Management Committee (1991-1993) and Dungeness-Quilcene Regional Planning Group (1992-1994), as well as the many studies that have been conducted as a result of their discussions have enhanced our knowledge of the distribution and abundance of chinook and pink salmon, instream flows, water use and conservation, aggradation, bedload instability, gravel management, and many other related issues in the Dungeness watershed.

TABLE 1

DUNGENESS WATERSHED RESTORATION PLANS & ACTIVITIES 1989 - 1996
(Updated April 2, 1997)

I. PLANS AND STUDIES

A. *Major Plans and Documents*

- Dungeness River Comprehensive Flood Control Management Plan (1989) - Kramer, Chin & Mayo for Clallam County.
- Dungeness River Area Watershed (1991) - Puget Sound Cooperative River Basin Team for Clallam County.
- Dungeness River Area Watershed Management Plan (1993) - Clallam County.
- Dungeness-Quilcene Water Resources Management Plan (1994) - Jamestown S'Klallam Tribe (as Coordinating Entity).
- Dungeness Watershed Analysis (1995) - U.S.D.A. Forest Service.

B. *Habitat Assessment*

- An Aquatic Resource Assessment of the Dungeness River Basin System: Phase 1 (1992) - Orsborn and Ralph for the Jamestown S'Klallam Tribe.
- An Aquatic Resource Assessment of the Dungeness River System - Phase II and III (1994) - Orsborn and Ralph prepared for the Jamestown S'Klallam Tribe, Sequim, WA. and the Quilcene Ranger District USFS, Quilcene, WA.
- Review of the Influence Exerted by Environmental Factors on Spring Chinook Salmon in the Dungeness River (1993) - Lichatowich for the Jamestown S'Klallam Tribe.

C. *Stock Analysis/Rebuilding*

- 1992 Washington State Salmon and Steelhead Stock Inventory (SASSI) (1993) - Washington Department of Fish and Wildlife (WDFW) and Washington Tribes.
- Dungeness River Pink and Chinook Salmon Historical Abundance, Current Status and Restoration (1993) - Lichatowich for the Jamestown S'Klallam Tribe.
- Dungeness Pink Outmigration (1994) - U.S. Dept. of Interior Fish and Wildlife Service (USFWS).
- Dungeness Chinook Salmon Rebuilding Project Progress Report 1992-1993 (1995) - Smith, WDFW and Wampler, USFWS.

D. *Instream Flow & Water Conservation Studies*

- Fish Habitat Analysis for the Dungeness River Using the Instream Flow Incremental Methodology (1991) - Wampler and Hiss, USFWS.
- Instream Flow Recommendations for Dungeness-Quilcene Area Salmon and Steelhead Streams (1993) - Hiss, USFWS.
- Recommended Instream Flows for the Lower Dungeness River (1993) - Hiss USFWS.
- Dungeness River Irrigation Ditch Leakage Assessment (1993) - Montgomery Water Group.

II. RESTORATION AND EDUCATION PROJECTS

A. Restoration Projects

- Dungeness River Bank Stabilization - Clallam County has implemented several bio-engineered projects to stabilize eroding banks in the lower river using funds from the Environmental Protection Agency (EPA), WDFW/DNR Jobs for the Environment program, and County roads/bridges projects.
- Dungeness Irrigation System Improvements - The Jamestown S'Klallam Tribe, Dungeness River Agricultural Water Users Association and WDFW have conducted several projects to improve water conveyance efficiency and fisheries survival using Jobs for the Environment grants (State and Federal) and out-of-pocket funds by the Water Users. Fish screens were replaced at two irrigation out-takes, ditches were lined, leaking siphons replaced and other conservation improvements made.
- Stream Restoration Projects (Jobs for the Environment) - Clallam County, Clallam County Conservation District, Jamestown S'Klallam Tribe, Youth Conservation Corps projects to restore stream habitat through fencing and re-vegetation along several area creeks.
- Dungeness Chinook Captive Broodstock Program (1992- ongoing) - WDFW (Dungeness/Hurd Creek Hatchery), Jamestown S'Klallam Tribe, USFWS, volunteers.
- Dungeness Fall Pink Captive Broodstock Program (1995- ongoing) - WDFW (Dungeness/Hurd Creek Hatchery), Jamestown S'Klallam Tribe, USFWS.

B. Public Education Projects

- Every River Has Its People (The 1993 State of the Dungeness River Report) - Jamestown S'Klallam Tribe via a Public Involvement and Education (PIE) Grant from the Puget Sound Water Quality Authority.
- Understanding the Natural History of the Dungeness River Watershed: A Manual of Tools and Keys (1995) - W. Clark, V. Clark & Jamestown S'Klallam Tribe, PIE Grant.
- Pollution Prevention Outreach Program - Clallam County Conservation District, Jefferson County Conservation District, WSU Cooperative Extension Service funded by the Jamestown S'Klallam Tribe under an EPA grant.
- Dungeness River Greenway Plan - Clallam Co., Centennial Clean Water Fund (CCWF).
- Dungeness River Landowners Educational Assistance Project - Clallam County, CCWF.
- Dungeness Bay Stewardship Initiative - Clallam County, CCWF.
- Businesses for Clean Water - Clallam County, CCWF.
- Matriotti Creek Environmental Learning Area - Clallam County

C. Projects Planned or In Progress 1996-1997

- Dungeness Irrigation Comprehensive Water Conservation & Management Plan - Water Users, Washington Department of Ecology.
- Jobs for the Environment Projects: Clallam Conservation District - Matriotti Creek, Hurd Creek, Gray Wolf river stream restoration; Jamestown S'Klallam Tribe - Chinook Acclimation Ponds, Large Woody Debris Placement.
- Sequim Irrigation Festival - Increasing Awareness of the Dungeness River: Parade entry & RIVER GONE RUN play; Jamestown S'Klallam Tribe and Olympic Theatre Arts.
- Dungeness Salmonid Life History Study - EPA.
- Model of changes to Dungeness River Channel and bedload for management purposes - Bureau of Reclamation.
- Hydrogeologic Assessment of the Sequim-Dungeness Area - US Geological Survey for Clallam County, CCWF, 1996-1998.

III. PROBLEMS AFFECTING FISH HABITAT QUALITY IN THE LOWER 10.8 MILES

An Overview

The Dungeness River watershed drains 198 square miles with the headwaters of the Dungeness and the Gray Wolf rivers originating at about 4,000 feet in the Olympic Mountain Range. The river drops through steep gradients to the foothills opening onto an alluvial fan in the lower 10 miles of the river. The Sequim-Dungeness Valley is comprised of glacial and post glacial sediments deposited by the river as it has slowly shifted its position from east to west over the past 10,000 years (Clark, W. and V. Clark 1996). Traces of old channels show that the Dungeness River has flowed in a number of routes across the Valley in the past - at the mouth of Bell Creek at Washington Harbor, out the present Gierin Creek and Cassalery Creek channels, and as far west as McDonald Creek.

The lower 10.8 miles of the river have been the primary focus of the restoration recommendations because of the *high habitat value and sensitivity to disturbances originating in other parts of the watershed.* This is not to say that the Dungeness River Restoration Work Group has downplayed the importance of focusing on the upper watershed or the estuary. The lower river is judged to be the reach most altered by and most susceptible to human alteration. Virtually all of the bank hardening (rip rap), diking, water withdrawals, gravel mining, channel alignment, bed aggradation from upriver input sources, floodplain development, riparian clearing and woody debris removal has occurred in this terminal section of river (Orsborn and Ralph 1994). Upriver habitat has been altered by bridge crossings, sediment input associated with timber harvesting, chronic landslides and road failures. But overall the effect has been far less persistent than that occurring in the lower river (Orsborn and Ralph 1994).

The DRRWG recognizes that in order for restoration efforts to succeed, sediment inputs must be in balance with sediment extraction and the sediment transport and storage capacity of the river channel, floodplain and estuary. Increased sediment recruitment and the loss of floodplain have been well recognized; changes at the river mouth and estuary have received less attention. Since 1855, the river mouth has moved to a location approximately 2,000 feet northeast of its earlier location, and approximately 75 acres of river delta have been formed. The river that once ran through an intertidal salt marsh estuary at its mouth now bisects the delta cone that has developed since agricultural diking along the bay began. Tidal prism, (an important sediment transporting feature) in the vicinity of the river mouth appears to have decreased in size by over 100 acres during this time period. The implications of these changes and the need for estuary-related restoration actions have not yet been assessed. *(See Appendix C for description of information needs).*

Limiting factors that have contributed to the decline of pink and chinook include

1. **Absence of stable mainstem spawning habitat**
   This is caused by horizontal (channel shifting) and/or vertical (scour and deposition) bed instability which has been validated by post-flood salmon redd sampling data (Smith and Wampler 1995), scour chain data (Orsborn

and Ralph 1994), aerial photo analysis (Orsborn and Ralph 1994), river cross sections (Washington Department of Fish and Wildlife 1997), and field observations of channel location over time.

2. **Lack of high flow refugia and good quality pool habitat for juvenile rearing, adult holding and stream energy dissipation**
   This has been attributed primarily to the depletion of stable log jams, loss of historical floodplain and the concentration of flows by diking and man-made constrictions, the decline of suitable riparian vegetation, bed instability and truncation of meanders (Orsborn and Ralph 1994).

3. **Low stream flow conditions**
   This has been attributed to irrigation withdrawals that have been exacerbated by the aggraded riverbed (Jamestown S'Klallam Tribe 1994). This has caused limitations in the availability and quality of spawning and rearing habitat and has generally been responsible for impediments to adult salmonid migration (Hiss and Lichatowich 1990).

These limiting factors are directly related to a number of human related impacts throughout the watershed which can be summarized briefly as follows:

<u>Human Activities Affecting Habitat and Flooding</u>

The Dungeness River Restoration Work Group does not suggest that human influences can or should be eliminated outright. Growth and development of the Dungeness floodplain is expected to continue. Many of the problems associated with past human activities on the Dungeness have occurred without an understanding of its affects on channel stability. A thorough understanding of these impacts and how to mitigate for them is needed. The following activities have impacted habitat and flooding on the Dungeness River:

1. **Diking**
   Dikes have reduced or eliminated the floodplain and therefore concentrated all of the energy and sediment of floods into the main channel (Washington Department of Fish and Wildlife 1997). This has led to bed and channel instability from increased velocities, and a loss of resilience and flexibility of the channel to respond to flood events and changing sediment loads (Orsborn and Ralph 1994). It has exacerbated the extent and rate of channel aggradation by eliminating floodplain sediment storage capacity. By inhibiting normal meander development, important stable side channel habitat has been eliminated, as well as the opportunity for the creation of new side channel habitat.

2. **Constrictions and confinements**
   Artificial structures such as levees and narrow bridges constrict and confine the channel. Constrictions back up flood waters causing increased sediment deposition and the associated consequences of bed aggradation, bank erosion and increased flooding risk (Orsborn and Ralph 1994).

   River channels naturally evolve by moving gradually and predictably across the landscape in a dynamic equilibrium. Channel confinements such as bridges and intrusive bank protection projects fix a point of the channel rigidly into a given location. Eventually the result is rapid and convoluted channel changes, as the upstream and downstream channels continue to evolve and are forced to respond to the fixed portion of the channel.

3. **Log jam and large woody debris removal**

Historically, removal of large woody debris (LWD) and log jams was a prominent element of flood control activities on the Dungeness river. Stable log jams are now scarce throughout this lower section of river (Orsborn and Ralph 1994).

In a sand and gravel bedded river such as the Dungeness, much of the structure that defines the channel is provided by imbedded wood and debris jams (Abbe and Montgomery 1996). Removal of debris jams perceived as being a flood hazard has resulted in increased velocities, with associated channel instability and bank erosion.

4. **Forest management, agricultural and land development**

The cumulative result of historic and on-going land uses have led to increased sediment routing and storage problems already exacerbated by diking and depletion of stable log jams and LWD. Land clearing adjacent to the river channel results in weakened river banks that are then vulnerable to erosion and exacerbate sediment problems in the river.

5. **Withdrawal of irrigation water**

Withdrawal of Dungeness river water for the purposes of irrigation has led to the low-flow related problems identified above, as well as degraded water quality (temperature and pollution) (Orsborn and Ralph 1994).

6. **Gravel Removal**

Removal of sand and gravel from river channels has historically been a method used for managing flood risks. The real benefit of the practice is not clear at this time. During the period 1992 through 1996, roughly 200,000 cubic yards of sediment were removed from the river channel. This volume likely exceeds the cumulative total of all gravel extractions occurring on the river in the previous 150 years. At one location in the vicinity of the most intensive gravel removal operations (RM 7.0 - 8.0) the channel down-cut eight feet between August 1992 and April 1996. This down-cutting caused repeated damage to the Dungeness Meadows dike extension and was associated with possibly the greatest channel instability observed on the river in recent memory. Although many riparian owners along the Dungeness River view gravel accumulations as the underlying cause of their bank erosion problems, high rates of bank erosion are also seen on vertically stable rivers (Hoh, Bogachiel and upper Quinault Rivers) and sediment-starved rivers (lower Elwha River). Sand and gravel removal can affect habitats by destabilizing the channel locally, flattening the channel and eliminating vegetation and debris important for shading, bank stabilization and large woody debris formation (Collins, B. and Associates 1993).

Restoration Strategy: A Sub-reach Analysis

A strategy for restoring Dungeness River salmonid habitat will be based on reversing or reducing human impacts responsible for the degradation throughout the lower 10.8 miles. Some projects will need to be applied throughout the lower river in order to restore in-channel and floodplain functions, i.e. riparian planting, large woody debris (LWD) placement or side channel creation/ stabilization. Other projects will be more "sub-reach" specific due to the location of the problem area, i.e. dikes.

While the entire 10.8 miles of lower river have severe habitat problems, there are sub-reach concerns that need to be understood in order to determine the necessary approaches and cautions that should be taken with each project. These can be understood to be: (1) Sediment transport and deposition zones, (2) Different life history strategies between pink and chinook, and (3) Different habitat functions.

1. **Sediment Transport and Deposition**
   Sediment recruitment, transport and deposition occur at varying rates throughout the lower 10.8 river miles. Designs for sediment management should recognize that the options of controlling sediment sources, stream energy management, and especially gravel extraction may be more appropriate and beneficial in certain reaches than others.

2. **Pink and Chinook Life History Strategies**
   Pink and chinook salmon have different life history strategies in the lower river. For example, 85% to 90% of the lower river fall pink salmon spawn between the mouth and RM 3.0 (Jim Uehara, personal communication), while chinook spawn throughout both the lower and upper reaches of the river (Smith and Wampler 1995). Restoration work in each sub-reach should be designed to benefit specific life history strategies for each stock.

3. **Habitat Functions**
   There are important habitat features that function differently depending on where they are in the watershed. Floodplains are one example. In order to provide meaningful restoration of important floodplain functions at RM 2.0 for example, dike setback in excess of a thousand feet may be required. Whereas at RM 9 for example, where historical river-floodplain interactions are far less, perhaps only 10% to 20% of that distance would be needed for a setback that would allow for the restoration of floodplain functions.

In order to discuss in greater detail proposals to restore habitat conditions in the Dungeness River, the lower river has been divided into four sub-reaches: Mouth to Old Olympic Highway, Old Olympic Highway to Highway 101, Highway 101 to the Powerline Crossing, and the Powerline Crossing to Canyon Creek. (Note: An "Upper River" section has been added as a fifth reach to ensure that conditions and habitat recommendations for the upper watershed are not ignored. These will be addressed in much greater detail in the future. An assessment of the estuary will also be added at a later date.)

It should be emphasized that the entire 10.8 miles of the lower river have severe habitat problems. Describing habitat restoration projects on a reach by reach approach should *not detract from the need to restore habitat conditions in a concerted effort throughout the entire lower river. Coordination among state agencies, local governments, tribes and landowners is essential for solving the problems in the lower river.*

The Seven Pillars of River Restoration

Restoring salmonid habitat in the Dungeness River will require that the following seven elements be applied throughout the lower 10.8 miles (Figure 3):

1. **Reestablish functional channel and floodplain in the lower 2.6 miles through dike management and constriction abatement.**

2. **Abate man-made constrictions upstream of the Corps dike (everything above RM 2.6).**

3. **Create numerous stable, long-term log jams.**

4. **Manage sediment to stabilize the channel and reduce the risk of flooding.**

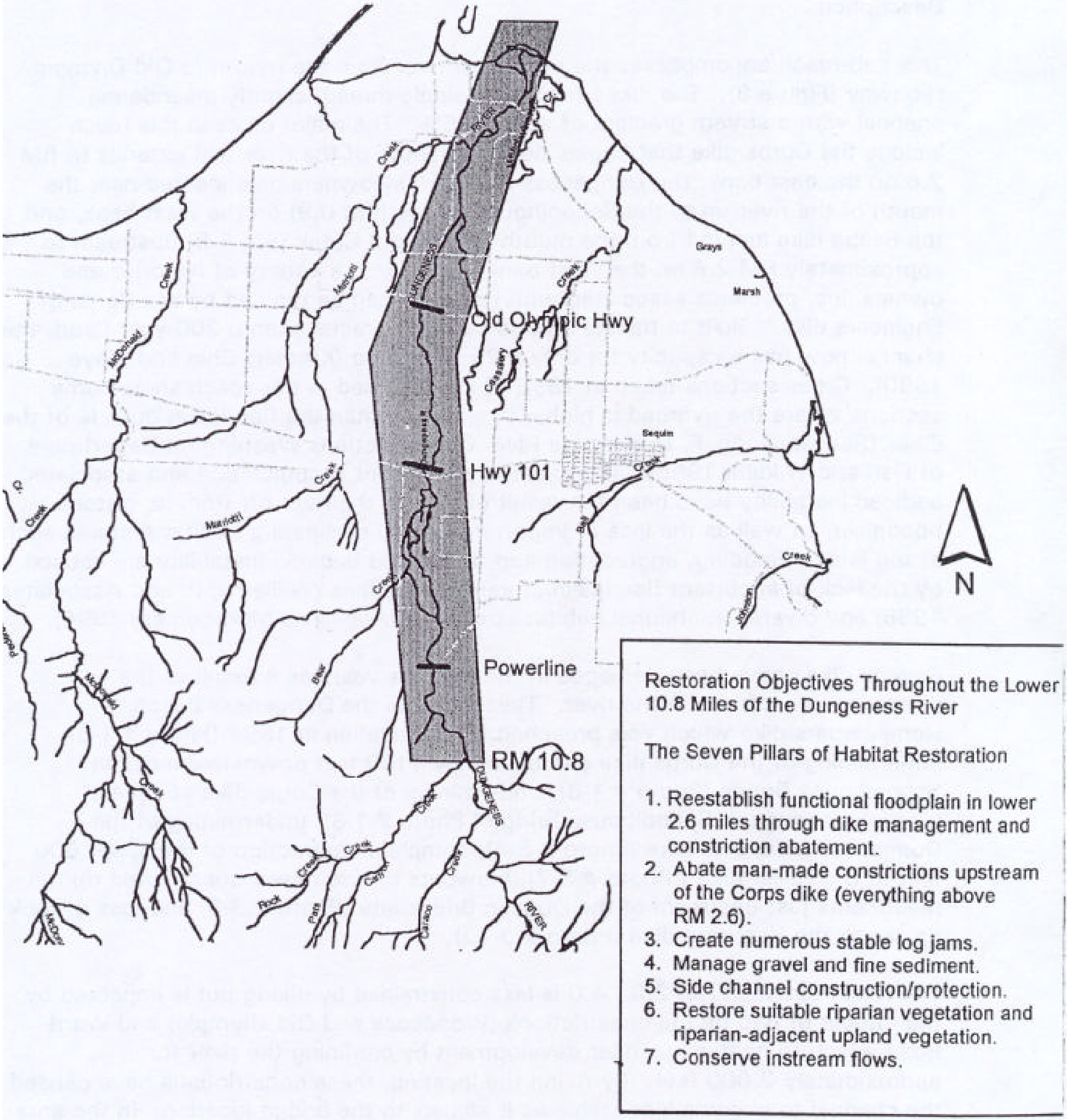
5. **Construct and/or protect side channels.**

6. **Restore suitable riparian vegetation and riparian-adjacent upland vegetation.**

7. **Conserve instream flows.**

All of these elements must be implemented throughout the lower river in order to achieve success in restoring salmonid habitat restoration and reducing flooding in the Dungeness. The Work Group believes that considerable effort is focused on conserving instream flows in the Dungeness. As a result, instream flows will not be dealt with in detail in this document. The following sub-reaches will clarify the rest of the recommendations in more detail.

FIGURE 3. The Lower Dungeness Watershed



IV. REACH-BY-REACH RECOMMENDATIONS FOR RIVER RESTORATION

RIVER REACH - RM 0.0 - 4.0 (MOUTH TO OLD OLYMPIC HIGHWAY)

Description

This sub-reach encompasses the section of river from the mouth to Old Olympic Highway (Figure 8). The diked reach is a single-thread, slightly meandering channel with a stream gradient of about 0.5%. The major dikes in this reach include the Corps dike that begins near the mouth of the river and extends to RM 2.6 on the east bank, the Dungeness Beach Homeowners dike located near the mouth of the river up to the Schoolhouse Bridge (RM 0.9) on the west bank, and the Beebe dike located from the mouth of Matriotti Creek (RM 1.9) upstream to approximately RM 2.6 on the west bank. Even with a variety of histories and ownerships, problems associated with the dikes can be typified by the Corps of Engineers dike. Built to handle a flood capacity greater than a 200-year flood, the channel now has a capacity for only a 25 year flood (Kramer, Chin and Mayo 1990). Cross sections taken in 1996 of the river bed in this reach show some sections where the riverbed is higher in elevation than the floodplain outside of the dikes (See Appendix F, Dungeness River Cross Sections Washington Department of Fish and Wildlife 1996). The excessive sediment accumulation and associated bedload instability have been the result of cutting the river off from its historic floodplain, as well as the loss of important energy dissipating habitat features such as log jams. Flooding, aggradation and the related bedload instability are caused by the lack of important floodplain/stream interactions (Williams, P. and Associates 1996) and diverse in-channel habitat structures (Abbe and Montgomery 1996).

Several dikes have been damaged in the last few years as a result of the deleterious conditions in the river. These include the Dungeness Beach Homeowners dike which was breached in one location in 1996 (Photo # 1-3), undermining of the Corps dike approximately 1100 feet downstream of the Schoolhouse Bridge (Photo # 1-3), undermining of the Corps dike at several locations above the Schoolhouse Bridge (Photo # 1-3), undermining of the Dungeness Meadows dike (Photo # 3-4), complete destruction of the lower 600 feet of the Haller dike (Photo # 3-7), blowouts of two newly constructed rip rap revetments just upstream of the Duncan Bridge site (Photo # 3-8) and loss of rock rip rap to the Hatchery dike (Photo # 3-12).

The reach between RM 2.6 - 4.0 is less constrained by diking but is impacted by the effects of two bridge constrictions (Woodcock and Old Olympic) and Ward Road which truncates meander development by confining the river for approximately 2,000 feet. By fixing the location, these constrictions have caused the channel to become less stable as it adjusts to the bridge location. In the area both above and below Woodcock Bridge for example, thalweg location has changed significantly with virtually every flood.

Profiles of the bed and water surface slopes up- and downstream of the Schoolhouse, Woodcock and Old Olympic Highway Bridges are shown in Figures 4 5, and 6. The bridges act to reduce the channel area forcing the flow to slow down, drop sediment load, and raise the upstream bed and the water surface so that flow can accelerate through the opening. The "backwater" effects of the bridges cause sediment to aggrade and steepen the channels upstream of the bridges (Orsborn and Ralph 1994).

To examine the degree to which salmon redds are affected by channel instability in the lower river 29 scour-monitor chains were installed (Orsborn and Ralph 1994). Scour monitors were installed adjacent to twelve active redd locations (5 pink, 1 steelhead, and 6 chinook) as well as in areas where no redds were located. As part of the chinook restoration project currently underway, each chinook redd was later "pumped" of its alevins in an attempt to transfer these fry to a captive brood facility. This procedure served as a check on the occurrence of scour and/or fill that the redd was subjected too, and of survival from egg and alevins stage. Information provided by these two approaches revealed that all but one chinook redd in the lower 10.8 miles of river failed to yield viable alevins or emergent juveniles. Data collected from this monitoring program revealed that spawning riffles in the lower river tend to be scoured deeply by even moderate high-flow events (est. < 2 yr, recurrence interval storm event = < 2,000 cfs discharge) causing a high percentage of the salmon eggs and alevins to be scoured from the bed (Table 2).

Mainstem spawning anadromous salmonids have inhabited the Dungeness River for millennia. Current levels of bed scour appear incompatible with continued survival of fall-spawning salmon stocks whose life histories require that they spawn exclusively in the mainstem river. The depth of bed scour revealed by the scour-monitor data must be viewed as a contemporary rather than historic phenomenon.

This reach of the river is where the primary spawning of lower pink salmon occur with 85% to 90% of the population spawning between the mouth and RM 3.0 (Jim Uehara, personal communication). The precipitous decline of this stock is mirrored by the decline in channel stability throughout this reach. Declines of the fall pink salmon population coincide with the construction of the dikes in the lower river.

While a riparian forest is nearly continuous throughout this reach, it is dominated primarily by young deciduous trees. Instream habitat complexity is minimal in some places because of the lack of woody debris accumulation; where log jams do accumulate, they are dominated by small pieces. Wood does not appear to stay in

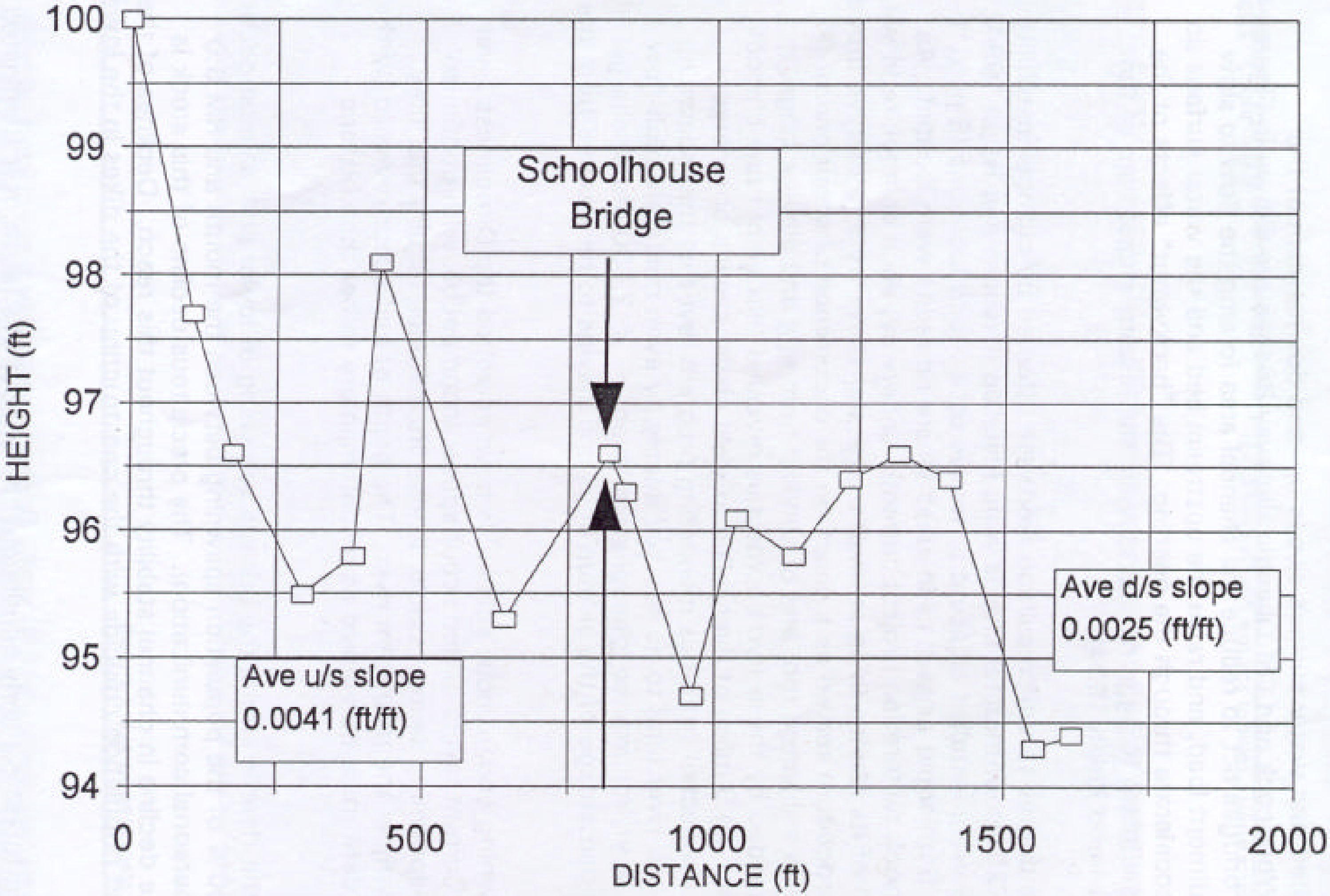


Figure 4. Side view of thalweg profile at Schoolhouse Bridge showing gravel accumulation upstream of bridge.

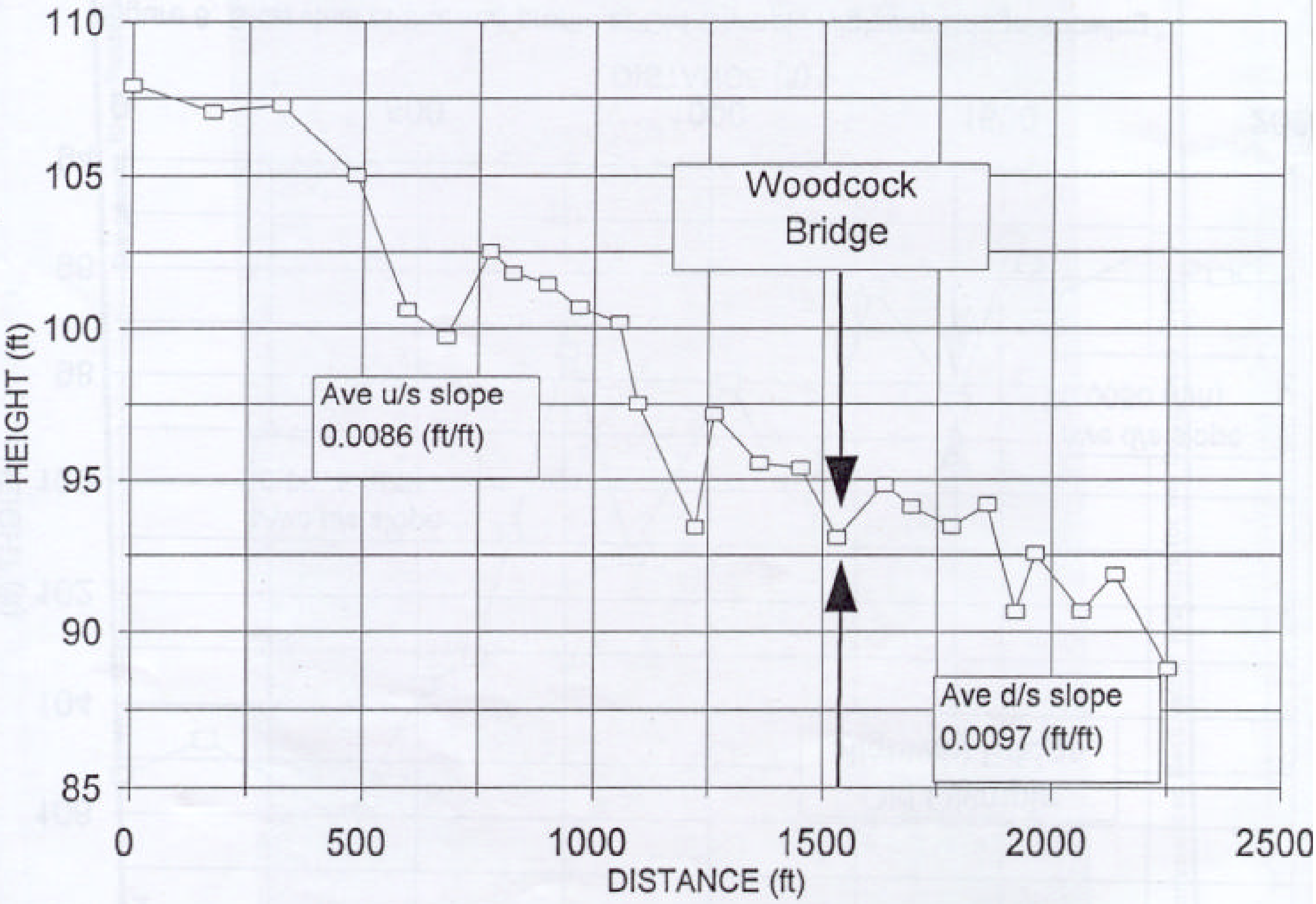


Figure 5. Side view of thalweg profile at Woodcock Bridge showing gravel accumulation upstream of the bridge.

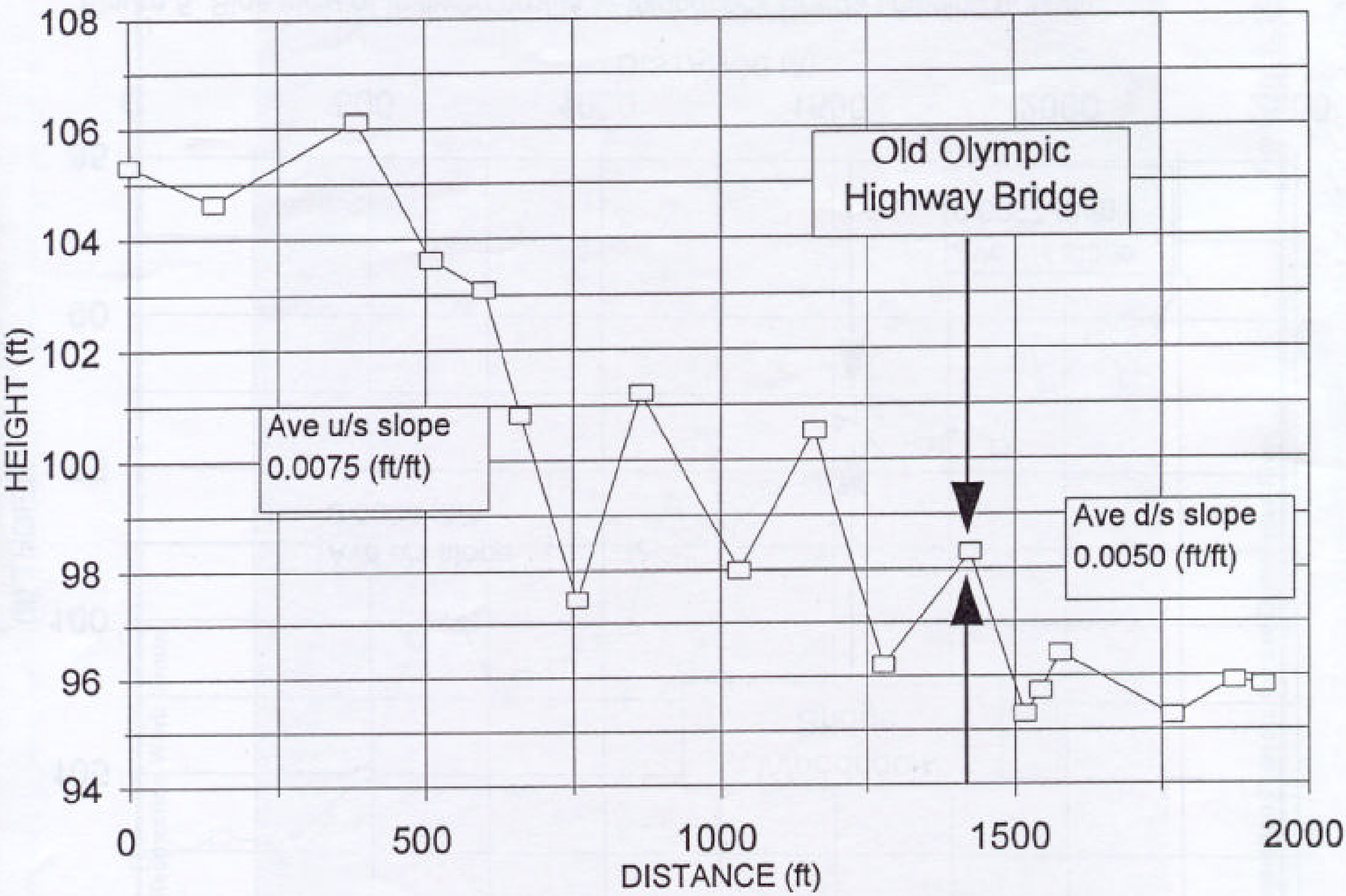


Figure 6. Side view of thalweg profile at Old Olympic Highway Bridge showing gravel accumulation upstream of bridge.

the river for very long. It is unknown whether this is due to the smaller sized pieces being moved out of the system at flood stage, being buried by bedload or being cut up for firewood.

Low flow discharge over riffles is shallow in some places (<.5ft). In the vicinity between the School House Bridge and Matriotti Creek (RM 0.85 - 1.9), passage of adult fish is generally believed to be aided by a well-defined thalweg. Between RM 2.7 and RM 3.25 (Hurd Creek to u/s side of Woodcock Bridge) diagonal bars (slipface cascades) that form where channel shifts occur have presented an obstacle to upstream migration for adults during periods of extended low flows.

Table 2. DUNGENESS RIVER - SCOUR MONITOR PROJECT
Summary and results of 1993 scour monitor installation locations.

Location	# Monitor	Installed	Riv. Mi.	Redd?	Scour/Fill Depth	Site Description
1	# 4 # 5	30 Sept. 30 Sept.	RM 0.8 RM 0.8	no redd - in riffle no redd - in riffle	Scour > 32cm No scour or fill	SH Brdg. d/s, chain in riffle u/s chain mid-channel below S. House Br.
2	#27 #28	6 Oct. 6 Oct.	RM 2.4 RM 2.4	CHINOOK CHINOOK	sc not found - Fill? Scour > 40cm	D/S of first site at Beebe's dike D/S of first site at redd on LB
3	#26 #29	6 Oct. 6 Oct.	RM 2.5 RM 2.5	PINK PINK	Fill > 10cm * sc no found - Fill?	Dike at Beebe's RB u/s unit w/2 balls removed " " dug pond is d/s on LB (10 balls installed)
4	#33 #34	7 Oct. 7 Oct.	RM 3.1 RM 3.1	CHINOOK CHINOOK	Scour > 20cm Scour > 32cm	On LB approx. 200' d/s of Woodcock Br. " " u/s unit on outside of redd
5	#11 #12	20 Sept. 20 Sept.	RM 3.2 RM 3.2	PINK PINK	Fill (monit. not visible) Fill (monit. not visible)	D/S of Woodcock B., on r/b " "
6	#13 #14	20 Sept. 20 Sept.	RM 3.4 RM 3.4	PINK PINK	Fill? Bank eroded, pins gone Fill? Pin gone	600' u/s Woodcock Br. On RB bar " "
7	#17	30 Sept.	RM 5.8	no redd - grv. br.	Scour > 40cm	Above RR Br. in dry point bar on RB
8	#19 #16	1 Oct. 1 Oct.	RM 6.5 RM 6.5	STEELHEAD STEELHEAD	vandalized? Unit gone - vandalized!	D/S of 101 Br. at Rt. Bend 140' u/s fence corner " "
9	#18 #20	1 Oct. 1 Oct.	RM 7.3 RM 7.3	CHINOOK CHINOOK	Scour = 12cm Scour = 4cm	U/S in LB riffle across from D. Meadows D/S " "
10	greenie	1 Oct.	RM 7.3	no redd - grv. br.	Scour = 4cm	Old style monitor
11	#31 #32 #35	7 Oct. 7 Oct. 7 Oct.	RM 8.8 RM 8.8 RM 8.8	CHINOOK CHINOOK CHINOOK	20cm fill - alevins ok could not find chain found it = no scour or fill	U/S of powerline crossing 900' on RB pt. bar " " unit is u/s of redd cluster " " unit is most d/s of redd cluster
12	# 1 # 2	13 Sept. 13 Sept.	RM 10.2 RM 10.2	PINK PINK	Scour > 40cm Fill > (monit. Not visible)	D/S of hatchery, RB u/s of gravel pit in channel
13	# 6 # 7	21 Sept. 21 Sept.	RM 10.4 RM 10.4	CHINOOK CHINOOK	Fill > 15cm Fill > 15cm	LB u/s of house below hatchery; on d/s end of point bar
14	$10	21 Sept.	RM 10.5	PINK	Site not visited	200" u/s Hatchery weir on BL channel margin
15	# 3	22 Sept.	RM 12	PINK	Unit scoured out	20' d/s Klink bridge LB (5 balls inserted)
16	# 8 # 9	22 Sept. 22 Sept.	RM 15.9 RM 15.9	CHINOOK CHINOOK	scour < 4cm - alevins ok scour < 4cm - alevins ok	200" d/s of Dung. Forks in chin. Redd behind boulder

Scour = unit either visible w/o excavation, or was excavated to determine depth of scour.
Fill = unit excavated and depth of fill estimated.
Fill ? = means that unit could not be seen and is likely buried under new fill.

Recommendations

The dominant problems in this reach are flooding, bed instability (aggradation, scour, horizontal shifting) and a lack of deep, complex pools. The DRRWG believes that these problems are caused primarily by man-made constrictions of the channel, meander belt and floodplain, and the lack of instream habitat features such as side channels and stable large woody debris. Allowing the river greater access to the floodplain by dike setback/removal, bridge lengthening and road setback will help increase bed stability by decreasing channel velocities. It will provide additional sediment storage outside the main channel and increased flood protection, as well as a more stable fit of meander amplitude to channel width. Spawning habitat stability in the mainstem will be increased while flooding will be greatly reduced. This can only be accomplished by the setback and removal of the dikes in conjunction with large woody debris placement/log jam construction, side channel protection, riparian vegetation rehabilitation, and sediment management (See Figure 8 for the location of projects).

In order for dike setback/removal to occur, the River Restoration Work Group recognizes that property acquisition, easements or other types of mechanisms that landowners agree to must be worked out. This will require considerable public planning, involvement, and support through the Dungeness River Management Team.

Dramatic changes have taken place at the river mouth/estuary area since the occurrence of agricultural diking along the bay. Similar changes at other river mouths (Big Quilcene, Little Quilcene and Skokomish Rivers, Jackson, Snow, Jimmycomelately and Morse Creeks) appear to have led to problems of flooding, stream channel aggradation and fish habitat degradation similar to those seen on the Dungeness River. The DRRWG recognizes that this is an area that needs further assessment.

The River Restoration Work Group recognizes that all of these measures must occur. A "do nothing" option will lead not only to continued decline in salmonid habitat quality, but will also ultimately result in overtopping of the dikes and increased flooding because of aggradation of the over-narrowed floodplain.

Projects (See Appendix A for Photos)

1. **Reestablish a Functional Channel and Floodplain in the Lower 2.6 Miles Through Dike Setback and Constriction Abatement**, (Figure 8) Restoration of the lower Dungeness River cannot occur without implementation of this “pillar.” Abatement of flood hazards and implementation of other restoration elements are entirely dependent upon reestablishment of an adequate floodplain. This project will require substantial public involvement, design, construction activity and property acquisition and easements or other types of agreements with willing landowners. Planning and community involvement should be started right away for the project to be completed in time for it to be effective. This project is supported by other recommended projects listed below - side channel habitat creation/protection and sediment management for lowering the channel to "fit" the floodplain.

   By reducing or eliminating the floodplain, the dikes have concentrated all of the energy and sediment from the floods into the main channel. The severity of floods has increased in recent years as the channel has aggraded. Lack of floodplain sediment storage area also appears implicated in the filling-in of Dungeness Bay.

The following measures are designed to 1) increase channel stability, 2) increase floodplain sediment storage capacity, and 3) allow for unimpeded meander development. The projects should be sequenced to recognize project and channel interactions and dependencies and to minimize risk to existing habitats and other land uses.

Property owner involvement and support is considered a critical component for dike setback. Areas where floodplain restoration needs to occur should be: 1) purchased at fair market value plus all appropriate relocation, replacement, and/or closing expenses per federal guidelines, or 2) traded for functionally equivalent or better property, plus associated expenses, or 3) purchased/negotiated for a floodplain easement, or 4) other arrangements agreeable to the landowner.

a. **Set-back the section of the Corps dike extending from the Schoolhouse Bridge to the dike's northern end to re-establish floodway processes and improve flood protection for the community of Dungeness. This section of dike would not be shortened or made discontinuous. Several houses located close to the dike could be adversely affected by this action (Photo #1-3, #1-4, #1-5).**

b. **All diking and non-flood-compatible structures west of the Dungeness River downstream of the Schoolhouse Bridge should be removed subject to property owner discussion noted above. The current configuration does not allow the river to meet the criteria for sediment storage and channel stability (Photo #1-3).**

c. **Lengthen the Schoolhouse Bridge to span the floodway (Photo #1-3).**

d. **Reconfigure the Corps dike upstream of the Schoolhouse Bridge to re-establish a functional floodplain and provide increased flood protection for the community of Dungeness and Sequim-Dungeness Way (Photo #1-4, #1-5).**

e. **Set-back approximately 2500 feet of the northern end of the Beebe dike to a location immediately river-ward of Beebe Creek and Matriotti Creek (Photo #1-5, #1-6).**

f. **Set-back the southern-most 1800 feet of Ward Road to the outside of the historical meander belt and provide a buffer between Ward Road and the meander belt (Photo #2-1).**

g. **Lengthen the Old Olympic Highway bridge to span the river's meander belt (Photo #2-2).**

Species life history strategy benefits - If dike setback (coupled with stable large woody debris inputs) provides greater channel stability, spawning habitat for pink, chum, and chinook will be restored. This project will also improve migration for all salmonid spawning adults during summer low flows.

Restoration Objectives - This project will improve spawning bed quality, quantity, and stability, refuge spawning, channel resiliency to habitat disturbance, and it will improve riparian functions.

2. **<u>Side Channel Habitat Creation and Protection</u>** Rearing and spawning habitat are at risk in the mainstem during high flow events. Side channel habitat appears to be naturally protected from high flow events by structures such as large woody debris accumulations. It is believed that these side channels provide a "refuge habitat;" they are spawning and rearing areas that are somewhat protected during high flow events. Recent floods, coupled with channel aggradation, have altered the river course, and have put some of these habitats at risk. Several effective side channel habitats have been identified, and a general woody debris placement plan could be designed for each site to help prevent major shifts of river flow into the off-channels during high flow events. Existing LWD accumulations may need to be cabled and reinforced with additional wood, or new accumulations created to prevent river encroachment at vulnerable locations. The debris accumulations should not be designed to prevent river water from entering the side channels. Instead they should serve to meter high flows, and discourage wholesale channel excursions into the side channels. Wherever possible, the large woody debris used, for placement should be found in the project vicinity and used if it is not already providing an aquatic ecosystem function. However, it may be necessary to bring in debris pieces when appropriate sized wood cannot be located. This project must be linked with dike removal and setback.

   The specific projects and/or sites identified in this reach include:

   a. **A side channel above the Schoolhouse Bridge on the right bank along the Corps dike (Photo #1-4). This side channel habitat has an intact riparian forest of different species, age and size classes. LWD structures should be placed at the head of the side channel, in addition to the placement of a series of structures located at intervals, in order to provide continuous protection throughout the side channel. This will provide protection by metering flows into the side channel. Due to the confined nature of the main channel in this diked reach, care should be given to insuring that flood risk or structural damage to the dike will not occur. LWD structures should be designed such that they protect the side channel while minimizing these risks.**

   b. **A side channel above the Woodcock Bridge on the right bank (Photo #2-1). This side channel also flows through an intact forest that**

could provide ideal shading and instream habitat functions. At the present time a large proportion of the river flow, (almost 50%) is flowing through the channel, making it an unlikely effective side channel. Efforts should be made to put woody debris at the head of the channel to meter the flows.

c. **Construct a spawning channel in the right bank floodplain behind the Corps dike near the site described in "a" (Photo #1-4). This would be a managed side channel with facilities for control of flow and fish into the channel. The channel would be used as a spawning refuge to allow aggressive gravel removal activities and disturbance in the main channel. The intent would be to convert the channel to a natural side channel and/or main river channel after the current river channel is effectively lowered as described under <u>Sediment Removal</u>, and the dikes are set back behind it as described in Figure 8. The floodplain restoration for the spawning channel could be initiated as soon as property is secured.**

This is a large scale project; considerable design would have to accommodate a degrading river channel elevation and flood backwater protection. In addition, the location must be compatible with a temperature regime, channel stability and other factors that affect incubation and outmigration. The channel would likely require either a pumped water supply or some drainage for at least part of its life. During Dungeness River floods, the channel would be closed from the river and water pumped from it. Planning as described in Figure 7 would have to occur prior to this project.

d. **Excavate to create a new side channel in the left bank floodplain opposite the site described in "a" (Photo #1-4). The floodplain is several hundred feet wide and vegetated with mature alders. Channel excavation would require four to six feet of excavation. Since the site is opposite another potential site, the cumulative flow affect would have to be considered.**

Species life history strategy benefits - This project would benefit spawning habitat for fall pink, chum, and chinook.

Restoration Objectives - This project would protect and improve spawning bed stability, quantity and quality; water quality and quantity; rearing habitat; refuge spawning areas and be resilient to disturbances.

3. **<u>Sediment Management</u>** Channel constrictions and the loss of floodplain, possibly coupled with changes in the estuary, have caused the streambed to seriously aggrade in portions of this reach. (Washington Department of Fish and Wildlife 1997). This, together with the dike confinement, has decreased the channel's flood conveyance capacity, leading to higher bed instability, creating problems for both fish, (e.g. destroying incubating eggs) and

landowners, (e.g. flooding). In some places the channel bed is higher in elevation than the surrounding floodplain outside the dikes.

While there will need to be efforts to gradually lower the channel within the confined reaches in order to "fit" the floodplain, *sediment management will entail more than gravel removal*. Sediment management in the floodplain will necessitate actions that dissipate the destructive energy of the river along with bank stabilization. This will require control of sediment sources and extraction in upstream areas, the use of log jams and debris retention structures (DRS's), de-concentration of the force of the river's energy and sediment deposition through dike management, and retention of existing fine sediment deposits in the floodway to serve as a natural flood-berm in post dike management times.

The Work Group recognizes that gravel removal efforts in this sub-reach must be tied with dike setback or the benefits will be short-lived.

Species life history strategy benefits - If successful, Sediment Management would provide for increased vertical and horizontal channel stability with the resultant improvement in spawning and incubation conditions beneficial for lower river pinks and rearing habitat beneficial for all other salmonids.

Restoration Objectives - The long-term objectives of Sediment Management are to protect and improve spawning bed stability, quantity, and quality; water quality and quantity; rearing habitat; refuge spawning; create more resilience to disturbances; and possibly provide riparian functions not available in the main channel.

4. **Large Woody Debris/Log Jam Placement** In general this reach exhibits a lack of large woody debris (LWD), (See photo #s 1-3, 1-4, 1-5, 1-6, 2-1, 2-2). Log jams and debris retention structures can be strategically located to fulfill one or more of the following functions: improve low flow migration barriers, assist in pool formation/maintenance, dissipate stream energy by creating pools and channel roughness, provide physical habitat and/or cover for fish, stabilize side channel inlets, protect highly erosive banklines, capture and stabilize naturally recruiting LWD (Abbe and Montgomery 1996) and small woody debris (SWD), and direct stream flow in a manner beneficial to landowner needs, fish habitat or overall river process (for example, to maintain channel sinuosity at a given location and stabilize mid-channel bars).

   The recommendation is to create numerous stable log jams throughout this sub-reach as well as throughout the entire 10.8 miles.

Species life history strategy benefits - This project would most benefit juvenile and adult salmonids by providing both cover and deep, complex pools and helping stabilize spawning gravels.

Restoration Objectives - This project would meet the objectives of improving the stability, quantity, and quality of spawning and rearing habitat by decreasing bank erosion and sediment inputs.

Figure 7. Dike Setback Example

OBJECTIVE: Restore critical floodplain function

DESCRIPTION: A rock levee is installed at the edge of the floodplain to contain flood waters. Height of the levee depends on the level of the flood protection to be provided.

REQUIREMENT: Requires property acquisition or easement

SKETCH:

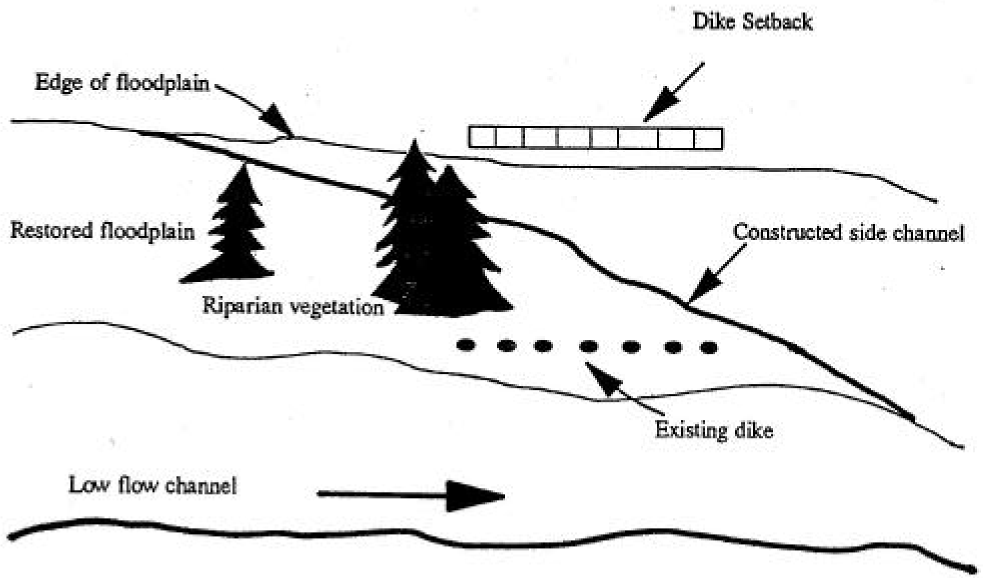
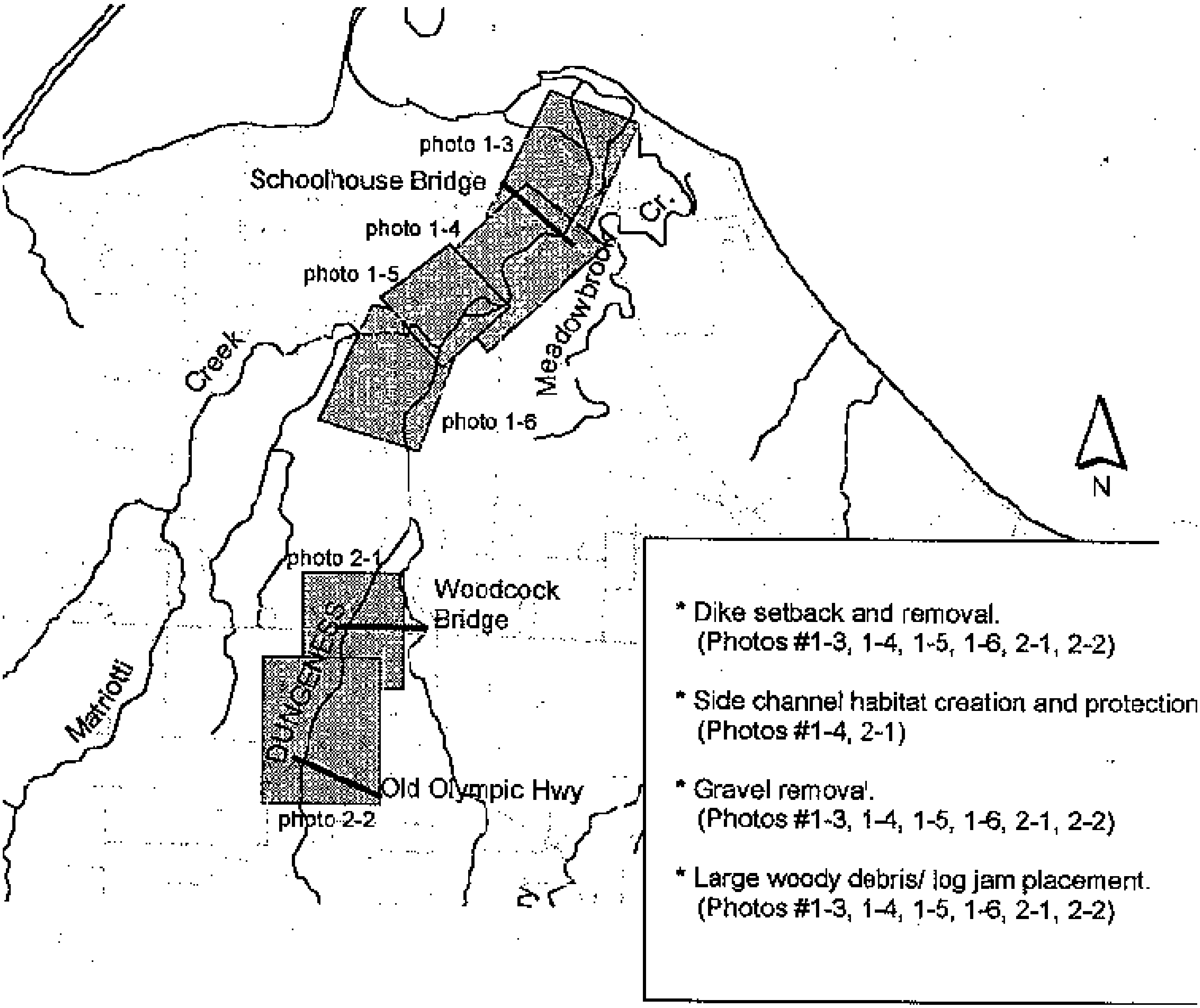


Figure 8. RM 0.0 - 4.0 (Mouth to Old Olympic Hwy.)



RIVER REACH - RM 4.0 - 6.6 (OLD OLYMPIC HIGHWAY TO 101)

Description

This sub-reach covers the section of river from the Old Olympic Highway to Highway 101 (Figure 11). This sub-reach has been characterized by a wide, braided, and unstable river channel. Stream gradient is about 0.95%. The riparian forest is continuous along both banks except for about 1,500 ft along the left bank at RM 5.5 (just below the R.R. bridge at the Severson property). This location, which was cleared for agricultural usage, had been undergoing rapid erosion for many years along the exposed bank. The erosion was arrested by a bio-engineered bank stabilization project sponsored by Clallam County. The channel has recently shifted away from this bank and is now focused on a bank farther downstream.

Aerial photo analysis between 1966 and 1993 showed that this reach underwent major channel changes, including shifting of the channel location, formation of mid-channel bars and substantial channel widening (See Orsborn and Ralph, 1994, pp. 2.12 - 2.23). This has been attributed to an input of bedload in excess of the stream's capacity for sediment transport, lack of stream energy dissipaters in the form of large woody debris and constrictions in the channel.

This reach is less constrained by diking but is impacted by the effects of three bridge constrictions - Old Olympic Highway, the Railroad Bridge and the Highway 101 Bridge. Profiles of the bed and water surface slopes up- and downstream of the Railroad and Highway 101 Bridges (profiles of the Old Olympic Highway are shown in the previous river reach section) are shown in Figures 9 and 10. Like the bridges in the lower reaches, these constrictions have created problems by reducing the channel area, causing the flow to slow down and drop its sediment load above the bridges.

Scour chain monitoring has revealed that channel instability is high in this reach (Table 2). Spawning riffles tend to be scoured deeply by even moderate high-flow events.

Recommendations

The objective of treatments in this reach should be similar to that of the other reaches - stabilization of spawning habitat, the creation of high quality pool and high flow refugia features by increasing instream and riparian habitat diversity, the protection and creation of side channel habitat and the reduction of constrictions. Stream energy and erosion should be managed through log jam construction, and in some cases debris retention structure construction specifically located to halt or prevent bank erosion. Widening of the Railroad Bridge has been recommended in order to allow for a more stable fit of meander amplitude to channel width (See Figure 11 for locations of projects).

Projects (See Appendix A for photos)

5. <u>**Riparian Planting**</u> Riparian vegetation is the key to channel and floodplain stability in the coarse, non-cohesive alluvium soils occurring throughout this reach. **Revegetate exposed sediment on the floodplains and mid-**

channel bars and augment this by planting conifers in adjacent uplands, since these areas are an important source of LWD recruitment (Photo #s 2-3, 2-4, 2-5). This will begin the important long term process of developing bank strength sufficient to withstand the shear force exerted by high flows. If bank stability can be achieved, the channel can narrow and deepen and establish stable flow routes.

In addition to creating bank strength directly, riparian vegetation contributes to channel structure and instream diversity by inputs of large woody debris. Large woody debris can have a variety of effects on the physical structure of a stream, depending on the size of the debris and the size of the stream. It can stabilize bed material by anchoring or shielding it, create roughness and pools for energy dissipation, and it can sort and accumulate bed material grain sizes suitable for spawning. The overall effect will be to narrow, deepen and concentrate the channel. This will eliminate the low flow migration barrier problems that we now are facing in this channel.

Failure rates will be high on this project because we are working in an active floodplain and a dry environment. Efforts should be extended through several years.

Species life history strategy benefits - This project would improve quality, quantity, and stability of spawning and incubation habitat, rearing habitat, upstream adult migration, and the downstream migration of juvenile fish.

Restoration Objectives - This project would provide adult and juvenile fish passage and long term restoration of spawning bed stability (quantity and quality), rearing habitat, refuge spawning, and it would provide resiliency to disturbances, and possibly provide riparian functions not available in the main channel.

6. **Large Woody Debris/Log Jam Placement** Debris jams have been found to be particularly effective in braided channels where they often protect islands of vegetation that can extend for considerable distances downstream (Abbe and Montgomery 1996). Debris jams are a necessary component to riparian planting within the channel.

Figure 9: Railroad Bridge

Figure 10: Hwy. 101 Bridge

Debris jams that are designed to reduce stream energy and bank erosion will allow for riparian development.

This reach is similar to the other reaches in the river in that there are few large woody debris jams. *There is a need to approach this lack of wood by creating numerous stable debris jams throughout the lower river (See Recommendation #4)*. **There are two areas where immediate placement would help mitigate severely widened and braided sections of this reach - above Highway 101 (Photo #2-9, 3-3) and on both sides of the R.R. Bridge (Photo #2-6, 2-7).** Different methods for anchoring the debris jams (e.g. use of pilings and anchor designs) should be explored. Where woody debris placement is not possible, boulder clusters should be considered.

> *It would be realistic to expect to repeat these treatments for several years to achieve satisfactory results.*

Species life history strategy benefits - This project would benefit migrating adult salmonids by providing cover and creating holding pools for juvenile and adult use. By stabilizing the channel, spawning bed stability, quality and quantity would increase.

Restoration Objectives - This project would improve spawning bed stability, quantity and quality, and rearing habitat, and stabilize the river channel by increasing horizontal bed stability.

7. <u>**Side Channel Habitat Creation and Protection**</u> As explained in project #2, rearing and spawning habitat are at risk in the mainstem during high flow events. Existing side channel habitat has been identified in this reach. This includes:

   a. **The reach immediately above the Railroad Bridge has side channels on both the left and right bank (Photo #2-7). Changes occurring in this reach with the translation of the river meander downstream and accumulation of bed material upstream of the bridge constriction may change the functions and utility of these side channels (i.e., the river is diverting more and more of its flow into the left bank side channel, indicating that there is a strong likelihood that it could become the new river channel. This would draw much of the river flow away from the right bank side channel).**

   b. **On the right bank directly across from the northern-most section of the County bank stabilization project (Photo #2-6) is a side channel that originates in the forest. There are opportunities to stabilize functional side channel habitats in various locations all the way to the Old Olympic Highway Bridge. A side channel on the left bank beginning downstream of the bank stabilization project also has the potential to protect side channel habitat north to the Old Olympic Highway. The broad riparian forest on both sides of the river provides important bank stabilization and shading functions that make these side channels important refuge habitat for spawning and rearing salmon.**

Species life history strategy benefits - This project would benefit spawning and incubation habitat for fall pink and chinook, and rearing habitat for all endemic salmonids with extended freshwater rearing life history strategies.

Restoration Objectives - This project would protect and improve spawning bed stability, quantity and quality; water quality and quantity; rearing habitat; refuge spawning; provide resiliency to disturbances, and possibly riparian functions not available in the main channel.

8. **<u>Redesign Support Structures of Railroad Bridge and Approach Trestle</u>** This project would be designed to allow for meander evolution and floodway processes to occur. Allowing meanders to translate efficiently through the bridge opening would reduce the constriction-related problems contributing towards a more stable channel.

Species life history strategy benefits - This would improve spawning and incubation conditions for chinook, steelhead and chum, as well as rearing conditions for all other species.

Restoration Objectives - By abating constriction-related problems and reducing sediment deposition, and by allowing meander development, the project would provide the following restoration objectives: protect and improve spawning bed stability, quantity and quality; water quality and quantity; yearling habitat, refuge spawning as a result of side-channel development, and provide resiliency to disturbances.

Figure 11. RM 4.0 - 6.6 (Old Olympic Hwy. to Hwy. 101)

RIVER REACH - RM 6.6 - 8.8 (HIGHWAY 101 TO POWERLINE CROSSING)

Description

This sub-reach covers the section of river from Highway 101 to the Powerline Crossing (Figure 12). This reach is wide, shallow, shifting, and braided. In the last year there has been significant downcutting of the streambed observed in portions of this reach. Stream gradient is about 1.15%. The right bank is diked between RM 7.7 and 8.2. A riparian forest is lacking in a number of sections along this reach.

Major channel changes have occurred throughout much of this reach (See Orsborn and Ralph 1994 pp. 2.12 - 2.23). Changes have included a transition from a single channel to a braided channel, with accompanying widening with major shifts of channel location occurring. Channel downcutting documented during the years 1992 through 1995 is associated with extremely high levels of vertical and horizontal bed instability. Perhaps the most dramatic current examples of instability anywhere on the Dungeness River are found in this reach.

This reach includes the dike that was built to protect the Dungeness Meadows residential subdivision. The channel is substantially straightened in this area and habitat diversity is very limited. The steep riffle directly adjacent to the 2500 ft dike may present a passage problem for upstream migrating adults during periods of low flow. In the past the straightened channel has directed high velocities and streamflow momentum towards Taylor Cutoff Road (Kramer, Chin and Mayo 1990). Little or no resting habitat or cover habitat occurs in this long stretch of steep riffle. This reach has undergone significant changes since the December flood of 1995 including downcutting of the streambed in some sections. The downcutting of approximately eight vertical feet at the lower end of the Dungeness Meadows dike extension occurred between the time of its construction in 1992 and the spring of 1996. This has undermined this section of dike necessitating several reconstruction projects.

Scour chain data revealed that channel instability is high in this reach (**Table 2**). Chinook redd sites monitored with scour chains during Fall of 1993 were scoured during high-flow events.

Recommendations

Before the December 1995 flood, conditions were such that treatments were recommended for controlling the sediment load before it affected the downstream reaches. It was believed that off-channel removal of bedload material from depositional zones would support downstream stabilization efforts. With the recent down-cutting of the streambed in major portions of this reach, this may not be the dominant issue at this time. But there are sections of this reach where controlling sediment transport may still be important, particularly in the depositional areas above the bridges. Modeling has indicated that the Highway 101 Bridge causes backwater effects at high flows due to the constriction of flow (Northwest Hydraulic Consultants 1987). The Railroad Bridge was shown to have the same affect. Another identified need is the creation of instream habitat diversity, or "roughness" in the reaches with shallow riffles and side channel protection (See Figure 12 for location of projects).

Projects (See Appendix A for photos)

8. <u>**Gravel Removal at the County Gravel Traps**</u>* **Continue to remove gravel at the County gravel traps (Photo # 3-4)**. Determine if this is sufficient for controlling sediment load before it affects the downstream reaches, or if additional sites such as the depositional zone above the Highway 101 Bridge would be necessary.

* *Observations have been made that the streambed has recently lowered from the Powerline Crossing (RM 8.8) down through to the lower end of the Dungeness Meadows dike. Downcutting appears to be occurring farther downstream as well. Gravel removal may not be as big of a concern in this portion of the reach as was previously thought. The County property is in a stretch of the river where other priorities exist such as the need for instream habitat diversity (log jams) and side channel habitat. These other needs should be given consideration in addition to gravel removal.*

Species life history strategy benefits - This project would improve adult migration for chinook and rearing conditions for all other species.

Restoration Objectives - This project would improve conditions for the migration of adults to spawning grounds and water quality and quantity.

9. <u>**Large Woody Debris/Log Jam Placement**</u> This is a sub-reach with sections having long, shallow riffles creating potential problems for migrating adults (the vicinity between the County Gravel traps and the upper end of the Dungeness Meadows Dike), (Photo #2-9, 3-4, 3-6, 3-7). In these sections, flow deflectors such as large boulders, boulder clusters, root wads, LWD piles/debris jams and/or exposed pilings can be placed in a staggered pattern to convert the riffle-passage barrier into a functional migration corridor. This would work towards the creation of:

   a. **A sinuous, deeper thalweg down the face of the riffle during low flows to promote upstream migration;**

   b. **Resting places in the wakes of the structures;**

   c. **Passage from structure to structure (i.e. boulder to boulder) for adults;**

   and would:

   d. **Provide for the accumulation of gravels suitable for spawning;**

   e. **Create pools;**

   f. **Enhance bank stability through stream energy management.**

The flow deflecting, gravel capturing and stabilizing structures should be placed in a manner that does not increase the likelihood of flood-related problems.

Species life history strategy benefits - This project would most benefit migrating adult salmonids (all) by providing cover, and helping in the accumulation of spawning gravels beneficial for all salmonids. This would also benefit rearing chinook, coho, steelhead, cutthroat and Dolly Varden.

Restoration Objectives - This project would improve spawning bed stability, quantity and quality, and improve adult and juvenile fish passage and rearing habitat.

10. **<u>Side Channel Habitat Creation and Protection</u>** The lack of instream habitat and the long, shallow riffle characteristic of this reach make identifying and protecting existing side channels a priority. **A side channel identified for protection is located upstream of the Dungeness Meadows on the right bank just upstream of the Powerlines Crossing.** It is fed partially by the Highland Ditch return flow, as well as a continuous flow from the Dungeness River (Photo #3-7).

Species life history strategy benefits - It is believed that this project would benefit spawning and incubation habitat for chinook.

Restoration Objectives - This project would protect and improve spawning bed stability, quantity and quality; water quality and quantity; rearing habitat; refuge spawning; provide resiliency to disturbances, and possibly riparian functions not available in the main channel.

Figure 12. RM 6.6 - 8.8 (Hwy. 101 - Powerline Crossing)

RIVER REACH - RM 8.8 - 10.8 (POWERLINE CROSSING TO CANYON CREEK)

Description

The river channel upstream of the Haller Dike (approximately a quarter of a mile south of the powerlines that cross the Dungeness River) resumes a more distinct meander pattern than that found downstream. Slopes are steeper in this reach (1.5%). The river has given the appearance that it has been regrading over the years throughout this section. This has led some to believe that the bed material has been transported through this reach. There are concerns that the two bluffs just upstream of the powerline at about RM 10 near Hatchery Road contribute substantial sediment to the river (See Figure 13).

Extensive rip rapping and diking have occurred along both banks of this reach. Of the 4.0 miles of bankline in this reach, approximately 3,000 lineal feet have been hardened with rip rap, and approximately 4,800 feet of armored dike, and at least 1,200 feet of unarmored dike have been built. At least two dikes (lower Haller Dike and the Hatchery Stub Dike adjacent to the mouth of Canyon Creek) have seriously constricted the channel, causing the development of circular meander features and bank erosion. In other cases (Kincade Island Dike, upper Haller Dike) dikes appear to be forcing the river towards sites of bank erosion and damaged capital improvements. Damage to river control structures occurring during the flood of March 1997 include the destruction of 600 feet of the lower Haller Dike, extensive damage to the upper Haller Dike, the loss of two relatively new rip rap bank revetments near May Road, and undermining the damage to the Hatchery Stub Dike.

Channel down-cutting in 1997 left the Highland Irrigation head gate perched above the river and unable to divert water. This necessitated at least two large-scale channel modification projects to elevate the riverbed so that water could be temporarily diverted down the irrigation intake.

Riparian vegetation is abundant along the right bank, but clearing and residential development along the left bank have significantly reduced riparian vegetation there.

Recommendations

This reach has similar recommendations to the other reaches - constriction abatement, creation of important off-channel refugia and placement of large woody debris structures. The objective in this reach is to improve fisheries habitat while at the same time reducing the causes of flooding and property damage. Setting back the Haller dike will reduce gravel aggradation, a major cause of vertical and horizontal channel instability. The addition of large woody debris structures will add roughness to the channel creating not only important habitat features such as pools, but also helping to slow the erosive power of the river in this reach which will assist landowners with flooding concerns.

Projects (See Appendix A for photos)

11. **<u>Setback Haller dike</u>** This bank armored structure (Photo #3-8) has created a constriction in the river causing problems - gravel buildup and the resulting channel instability similar to those seen in other constricted areas of the river. It is recommended that dike setback should be designed to accomplish similar objectives identified in the lower reach, i.e. reduced constriction with associated reduced bedload aggradation, increased channel stability, and reduced risk of flooding.

Species life history strategy benefits - This project would improve spawning and incubation conditions for chinook and steelhead, and rearing conditions for all other species.

Restoration Objectives - By abating constriction-related bank erosion and sediment deposition, and by allowing meander development this project would protect and improve spawning bed stability, quantity and quality; water quality and quantity; rearing habitat; refuge spawning as a result of side channel development; provide resiliency to disturbances, and possibly riparian functions not available in the main channel.

12. **Off-Channel Habitat Creation on the DNR Property** The Department of Natural Resources owns property along the right bank in this reach (Photo # 3-8). This piece is large enough that it would allow for the creation of off-channel rearing habitat that would likely be protected from flooding and movement of the river channel for years to come.

Species life history strategy benefits - It is believed that this project would benefit rearing habitat for steelhead, coho and possibly chinook.

Restoration Objectives - This project would protect and improve spawning bed stability, quantity and quality; water quality and quantity; rearing habitat; refuge spawning; provide resiliency to disturbances; and possibly riparian functions not available in the main channel.

13. **Large Woody Debris/Log Jam Placement** This river reach is lacking in large wood debris (Photo #3-8). With the relatively steeper gradient, energy dissipation and pool formation are important issues in this reach. Placement of large woody debris jams would add roughness to the channel, helping to dissipate the highly erosive energy of the river benefitting landowners in this reach. Fisheries would benefit with the creation of pool habitat.

Species life history strategy benefits - This project would most benefit migrating adult salmonids (all) by providing cover and helping in the accumulation of spawning gravels beneficial for all salmonids. This would also benefit rearing chinook, coho, steelhead, cutthroat and Dolly Varden.

Restoration Objectives - This project would improve spawning bed stability, quantity, and quality; adult and juvenile fish passage; and rearing habitat.

Figure 13. RM 8.8 - 10.8 (Powerline Crossing to Canyon Creek)

UPPER RIVER (EVERYTHING ABOVE CANYON CREEK)

Description

The river throughout this reach is typified by steep side slopes, narrow valleys and high gradients. These conditions are conducive to exporting sediment into downstream depositional areas. The cumulative effects of sediment recruitment and human activities in the lower river include increased flood hazard, channel and bed instability, and degraded fish habitat. The dominant land use in this upper reach has been timber harvesting, with the Forest Service being the largest landowner.

Recommendations

The DRRWG has not focused significant attention on the upper river. Areas that need assessment include sediment production, large woody debris loading and stream nutrient status and recovery (from fish carcasses). It is recommended that sediment production on Forest Service lands be examined with the goal of ensuring that sediment export to the lower river not exceed natural levels. There are several sediment-related information needs:

M determine existing sources of sediment input (slope failures and road washouts) associated with past forest land management within the basin,

M conduct an analysis of erosion and mass wasting potential for the upper watershed that gives a hazard rating revealing areas most likely to contribute sediment if disturbed by management activities,

M complete a road stability inventory to identify problem areas,

M evaluate stream crossing (culvert) capacity,

M identify sidecast instability problem areas, and

M conduct an orphaned road survey.

Problem areas that are identified by the surveys outlined above should be translated into specific actions which have the greatest potential to reduce delivery of sediment and gravel into the river.

A monitoring plan should also be established to measure the annual amount of material input from such sources to judge the effectiveness of erosion control and restoration efforts.

In terms of stream rehabilitation, the Work Group has recommended that the USFS concentrate initial restoration efforts in the Gold Creek sub-basin. This is where upriver pink salmon historically spawned and this basin contributes a disproportionate amount of sediment throughout the lower Dungeness watershed.

Projects

13. **<u>Restore spawning gravel quality and quantity in the lower portion of Gold Creek</u>** The lower Gold Creek was heavily used by summer run pink salmon prior to the mass wasting events in the late 1960s and early 1970s, but has been underutilized since then. Attempts should be made to increase spawning gravel quality and quantity by utilizing habitat features such as large woody debris jams that can have an influence on sediment deposition in lower Gold Creek.

Species life history strategy benefits - Summer pinks would benefit from the restoration of spawning gravel quality and quantity.

Restoration Objectives - This project would benefit spawning bed stability, quantity and quality.

14. **<u>Reduce sediment input from upper Gold Creek by increasing channel roughness and reducing stream energy</u>** Restoration projects should focus on reducing sediment input from upper Gold Creek by increasing channel roughness and reducing stream energy. Additional efforts should include providing for upstream migration and spawning in the upper part of the basin. The possibility that there may not have been a blockage at the site of the slide, as well as the coincidental nature of the slide and the heavy local timber harvest leads to the belief that there may have been a change in the hydrology at this location. This change is suspected to be of such severity that summer low flows are no longer sufficient to support upstream migration and spawning. Spawning habitat will benefit from efforts to reduce stream energy through the addition of increasing channel roughness. Efforts to reduce stream energy should include decreasing runoff from the road network in this part of the basin. This could include decreasing the road drainage. Some recommendations in the Golder report are applicable in this reach (Preliminary Geotechnical Investigation of the Gold Creek Slide Complex, A Report Prepared for the Olympic National Forest, Quilcene, Washington, Golder Associates Inc., 1993).

Species life history strategy benefits - Upper river summer pink salmon spawning would be encouraged by this project.

Restoration Objectives - This project would encourage adult and juvenile fish passage, spawning bed stability, quality and quantity, water quality and quantity, and habitat and channel resiliency to disturbances.

15. **<u>Trap spawnable size materials on USFS reaches</u>** Increasing spawning habitat might result in better utilization of the upper river when the chinook captive broodstock program is complete. Explore the possibility of trapping and/or stabilizing spawnable size materials within the upper reaches of the mainstem Dungeness (above RM 12) and accessible areas in the lower Gray Wolf.

Species life history strategy benefits - Upriver summer pink and chinook spawning in the upper portions of the river would be encouraged.

Restoration Objectives - This project would attempt to increase spawning bed availability.

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