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2. Conclusions and Recommendations

2.1 Introduction

Many conclusions have been drawn from this investigation and the preparation of this report. The conclusions presented below represent a selection of the more significant observations concerning the opportunities for mutually beneficial management of floodplains, for protection and recovery of salmon resources and flood risk reduction. Conclusions and associated recommendations are intended to support the development of an Integrated River Management Strategy (IRMS).

Since a strong emphasis of this investigation was placed on the use of spatial analysis, the conclusions and recommendations are grouped in a progressive sequence of spatial scales paralleling those presented in the remainder of this report. The most detailed conclusions and recommendations are made at the spatial extent of the Tillamook Basin lowland floodplain. Planning level recommended actions are mapped at this extent to illustrate a potential combination of strategies and actions that could comprise an IRMS for the Tillamook lowlands (Figure 2-1). The main areas mapped in this figure are the Active Floodplain Zone, the Floodplain Zone, and the Tidal Zone. Distinctions were made between these zones because of the unique set of physical processes and geomorphic responses that occur in each area. The mapped Tidal Zone is a subset of the estuary where opportunities to restore tidal processes and estuary ecosystems are present. The mapped Floodplain Zone and Active Floodplain Zone are subsets of the lowland portion of the Tillamook Basin where opportunities to preserve and restore Fluvial and flood processes are present. More general conclusions and recommendations are made at the spatial extent of the Tillamook Bay Basin and the State of Oregon.

Conclusions derived from work within the Tillamook Basin are grouped according to the broad spatial division of the river system, including the estuary, lowlands and uplands. These landscape divisions are intended to identify areas within the Basin with similar natural processes and geomorphologies. These commonalities allow for the identification of a number of strategies and actions that are appropriate in a general areas with out having to identify a specific project site or problem set.

Conclusions from non-spatial aspects of this investigation, including observations on public policy and flood response permitting, are then described followed by a summary of general conclusions concerning future work on Integrated River Management Strategies (IRMS) in Tillamook and elsewhere. Since issues associated with flood response permitting were the primary catalyst for the USFWS to initiate this project, conclusions and recommendations for this subject have been kept separate from more general public policy findings.

2.2 Tillamook Bay Basin Scale

2.2.1 The Estuary

Tidal saltmarshes are some the most productive ecosystems in terms of biomass. Drainage basins with proportionally larger estuaries may be inherently more productive for salmon than basins with smaller estuaries, at least for those species with extended periods of estuarine residency. At the turn of the century, the Tillamook Bay estuary system had the highest productivity for salmon on the Oregon Coast. The most abundant species was chum salmon, which spawn in the lowland river systems and rear in tidal habitats.

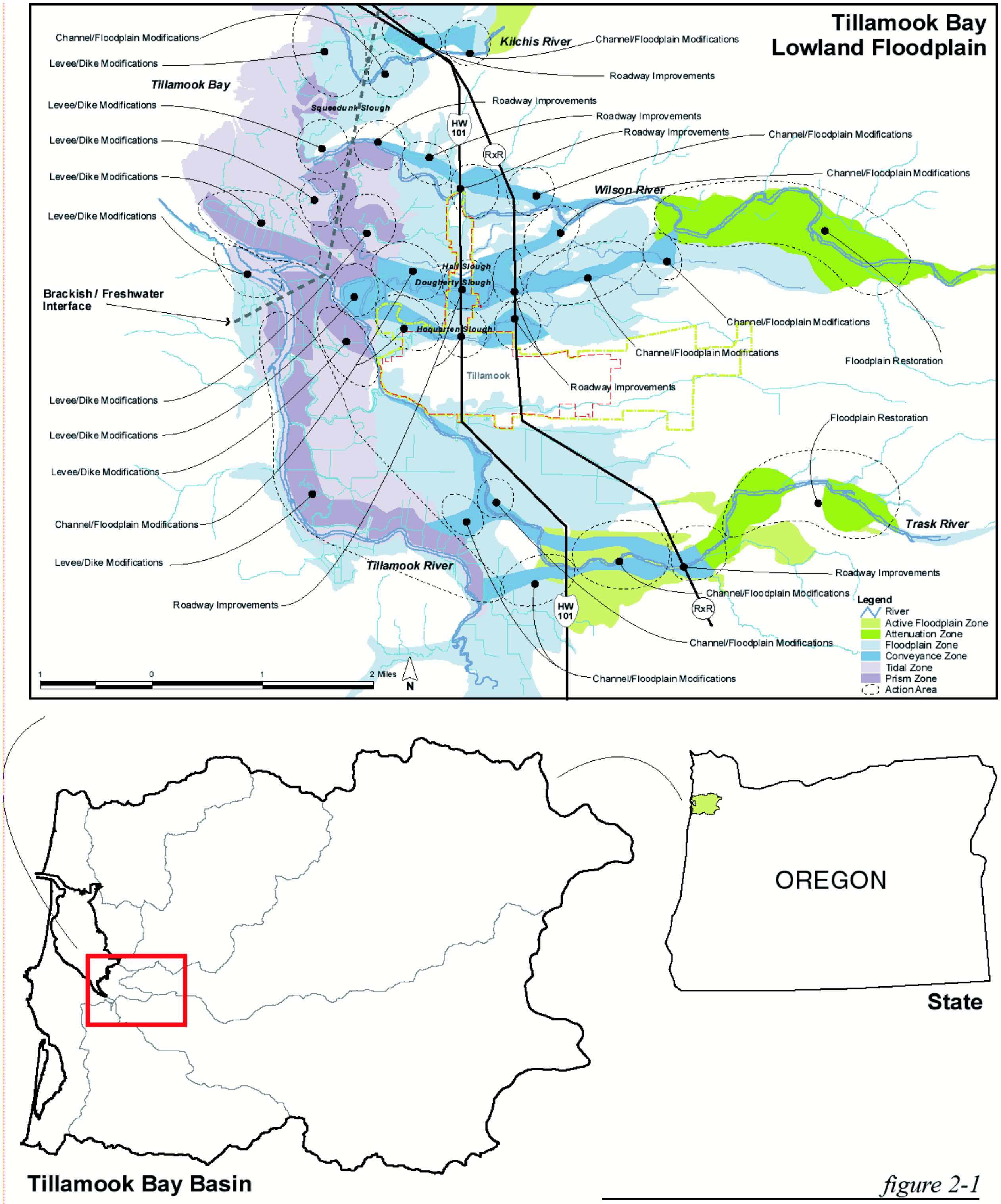

figure 2-1

Tillamook Bay Lowland Floodplain
Integrated River Management Strategy and Concept Plan

PWA

Recommendation: Prioritize tidal marshes and tidaly influenced floodplains for flood management efforts, because of the potential for relatively quick gains in salmon production with the restoration of natural processes from the daily ebb and flood of tides, compared to non-tidal parts of the system.

Along the Oregon coast, the effects of a rising sea level are most pronounced in the Tillamook area. The Oregon coast is experiencing a range of positive and negative sea level trends due to sea level rise, as tempered by tectonic movement. Coastal uplift is relatively less in the Tillamook Bay area of the Oregon coast and this area is therefore being inundated by a rising sea level faster than other coastal areas, by about 2-millimeters per year. In a 100-year time span this would amount to 200 millimeters, or about an 8 inch rise in sea level. For a typical intertidal mudflat slope in Tillamook Bay, assumed at one foot vertical to 250 feet horizontal, this implies marsh vegetation could retreat inland up to 170 feet.
Recommendation: In developing IRMS strategies in coastal areas, include serious consideration of relative sea level rise and its effect on invalidating design assumptions and the life expectancy of public works and ecosystem restoration projects. Plan and design ecosystem projects to work with long term processes, such as sea level rise, as well as shorter term processes, such as flooding and tidal action.

There is a lack of long-term tidal elevation data and hydraulic data for the lowland tidal river reaches. There is no direct monitoring of streamflows in the lowland valley reaches of the river systems, where the bulk of flood damages occur and where floodplain management needs are most pressing, because the lowland rivers can be tidally-influenced. Tidal monitoring in the bay has been sporadic and of short duration. This lack of basic hydrologic data inhibits the effective development of flood management efforts. The recent installation of additional streamflow and tidal gauges by the TBNEP will benefit future monitoring and adaptive management actions for flood management efforts.
Recommendation: Prioritize development of the basic hydrologic data necessary for making informed decisions on management of lowland floodplain lands and resources. Pursue funding for long-term operation of tide and streamflow gauges.

2.2.2 The Lowlands

An extensive amount of lowland floodplain vegetation has been converted to agricultural lands, but relatively large contiguous wetlands exist in tidal portions of the lowlands. Large areas of intact wetland plant communities exist in the tidal portions of the lowlands. The brackish-to-freshwater reaches of the marshes, sloughs and rivers present habitat opportunities for osmotic transition, highly productive foraging environment and deep channels for predator avoidance. Tidal forest is still found in very limited areas of the Tillamook lowlands. The largest remaining area is the forest surrounding Hoquarton Slough within the Urban Growth Boundary of the City of Tillamook.
Recommendation: Protect these existing lowland natural areas, and consider restoration efforts for contiguous land parcels to expand the natural functions of these resources for habitat and flood management.

About two-thirds of all low-gradient stream channels in the Tillamook Bay basin, with high aquatic habitat potential, are found in lowland areas. This is important because such channels tend to be those most responsive to inputs of wood and sediment, and are generally recognized as being capable of providing the most complex and productive aquatic habitats when in properly functioning condition.
Recommendation: Implement flood response actions to manage wood and sediment in lowland river reaches with consideration for habitat impacts.

The extent of lowland forests and the abundance of large wood in the Tillamook lowlands had been significantly affected by agricultural land conversion and stream cleaning activities prior to 1939. An analysis of historic air photos confirm the perceptions of older basin residents that most dramatic changes to lowland riparian forests occurred a very long time ago. Riparian forests along each of the lower rivers and sloughs examined had been highly fragmented by 1939, the date of the first comprehensive aerial photography effort. Most areas they once occupied have been dominated by sparsely forested, highly discontinuous, or treeless conditions since that time. The presence and abundance of large wood in the tidal reaches of the Tillamook Bay rivers and sloughs declined steadily from 1939 to 1994. Flooding should continue to deliver large wood and other organic materials to the lowlands. ***Recommendation:*** Make provisions to accommodate the deposition and movement of large wood in the lowland rivers to restore ecosystem complexity.

The intensity of human land use increases dramatically in the lowlands. Interventions are more prevalent and significant in this part the river system and the potential for flood and fish impacts is greater. Constraints to the development of an IRMS are more prevalent and inflexible because of the longevity of the human presence and established infrastructure. ***Recommendation:*** Apply a bold and creative vision to allow the restoration of floodplain features and natural processes to demonstrate the natural resiliency of a river system to restore aquatic habitats and provide natural flood reduction capabilities.

The historic construction of levees and dikes often violated engineering design recommendations at the time. Tillamook lowland river and slough channels were channelized and simplified as the population grew and floodplain lands were converted to agriculture. Levee and dikes were built alongside the channels to protect investments in farming and maximize the land area farmed. Flood control structures built on the immediate bank of a river channel and on opposite banks of the channels violated the design guidelines provided in the early 1900s. ***Recommendation:*** Consider the restoration benefits of setting back levees to reduce flood elevations and protecting setback levees with vegetation to reduce erosion, especially since both techniques were advocated 100 years ago.

The high intensity of water use in the lowlands is likely a factor influencing water quality (including temperatures) in many lowland streams. Most of the documented water quality problems in the Tillamook Bay basin are spatially associated with lowland areas. Sources of water quality problems include confined animal feeding operations and municipal and other sites with pollution discharge (NPDES) permits. Water diversions are also most abundant in or near the lowlands.
Recommendation: Give equal consideration to habitat impacts from reduced water quality and the more evident physical expressions of habitat, such as riparian and stream channel conditions, in addressing lowland water use issues.

2.2.3 The Uplands

Successful management of the lowlands begins with proper management of the uplands. Upland areas represent the largest portion of the Tillamook Basin and serve as source areas for many of the river system physical and biological processes. The large expanse of the upland landscape collects precipitation and conveys water, sediment and organic materials through the river system to the lowlands.
Recommendation: Implement fundamental strategies for managing the uplands to improve the success of a lowland IRMS. These strategies would include: 1) Managing the runoff of water where it first falls as precipitation; 2) Managing the availability, recruitment

and movement of large wood in upland river reaches; and, 3) Managing impacts at stream crossings.

Opportunities for large-scale salmon recovery may be most practical where species diversity and availability of productive habitat exists on public lands. Large scale salmon recovery efforts on private lands may face difficulty because of the variety of land ownership, land uses and land management techniques. However, ecosystem restoration is most effective if actions are implemented at a watershed scale, without the constraints of imposed property boundaries.
Recommendation: Prioritize opportunities for large-scale salmon recovery efforts in the uplands where salmon habitat exists on public lands.

2.2.4 The Basin

The Tillamook Bay Basin has some of the most pronounced interactions of salmon and flood issues in Oregon and is a priority river system for integrated management of fishery resources and flood risk reduction. Five salmon species are distributed within the Tillamook Bay Basin and their abundance has dramatically declined since the turn of the century. Tillamook County has experienced repetitive flood damages and had the highest damages of any Oregon county during the 1996 floods.
Recommendation: Review and refine the IRMS developed in this investigation, and incorporate into the Corps Feasibility Study efforts in Tillamook to assist in efforts to identify solutions for achieving common objectives for flood risk reduction and salmon recovery.

Seasonal flooding, which helped to shape the lush Tillamook lowland landscapes that have attracted human populations over the centuries, has also sustained salmon populations over the millennia. The physical features of the basin provide opportunities for human use of natural resources throughout the river system and sustain the economy and lifestyle of the residents and tourists to the area. Human use of the land initially evolved with recognition of constraints imposed by the natural environment, such as flooding. Flooding now represents one of the predominant natural constraints to human land use in the river system. Conversely, it represents the one of best natural opportunities for recovery of salmon.
Recommendation: Make a concerted public education effort to place the natural role of flooding in a proper context, so that provisions of an IRMS may be better understood, debated and decided by the local governments, land owners and the public at large.

2.3 State and Ecoregion Scale

FEMA regulatory floodplains are the primary tool for land use management in floodplains, yet these data may become rapidly outdated as river systems adjust over time and impart error and uncertainty in the land use planning process. FEMA regulatory floodplains are based on a statistical 1 in a 100 annual chance of a flood occurring within a designated boundary. Many assumptions are used to establish regulatory floodplains and subsequent floods often invalidate the land use information provided on floodplain maps. Geomorphic floodplains, or floodplains based on mapped soil units having an annual one to five percent chance of flooding, generally coincide with mapped FEMA regulatory 100-year floodplains, but are based on observed soil conditions and reflect land areas where flooding is known to have occurred.
Recommendation: Consider soils data and geomorphic analysis to augment traditional FEMA floodplain mapping procedures to identify flood hazard areas.

The distribution of salmon species in Oregon is pervasive throughout regulated floodplains in the state. The floodplain as defined by the National Flood Insurance Program (NFIP) encompasses the area with a 1% annual chance of flooding. It was established as a

tool to delineate risk for purposes of administering programs to reduce public and private losses due to flood hazards. FEMA is currently proposing that the purpose of the flood hazard reduction ordinance be expanded to also maintain streams in their natural state to the maximum extent possible as a way to assure that the natural floodplain functions related to protecting riparian habitat for fish are protected; and to assure no net loss of ecological functions of floodplains.
Recommendation: Consider conservation and restoration of salmon habitats in managing Oregon floodplains and enforcing floodplain regulations. In many instances, these activities would lend support to the objectives of the NFIP and contribute to the reduction of flood risk to human life and property. The new FEMA model ordinance is currently under review by the USFWS and NMFS (Carey, 2001). Even if it is approved, its adoption will remain voluntary for members of the National Flood Insurance Program; however, adoption and compliance of the ordinance is anticipated to reduce the risk of non-compliance with provisions of the ESA and streamline consultations with federal agencies, should they be required for floodplain development projects.

The coastal ecoregion presents a high potential for impacts between salmon habitats and human land use. Salmon distributions are highly concentrated along the coast and habitats are highly diverse and complex in the larger estuarine systems. Significant amounts of precipitation occur on the coastal uplands and runoff processes are susceptible to change from human land use practices. Population growth and tourism is increasing in coastal areas and development is increasing in floodplain areas to accommodate this trend.
Recommendation: Give coastal river systems priority consideration for integrated river management strategies for flood risk reduction and salmon recovery.

Estuaries provide vital habitat for salmonids, but public policy and regulatory recognition of this role of estuaries is lacking. Studies in several Oregon and Washington estuaries (particularly the Salmon River and South Slough of Coos Bay) have provided strong evidence of the importance of estuarine habitat to salmonids (Simenstad and Bottom, 2001). Results of recent studies increasingly support this conclusion. Tidal habitats provide a very favorable environment for salmonid rearing, and increased estuarine residence time often translates into increased smolt survival. However, protocols for evaluating in-stream and watershed conditions (for example, the ODFW's Aquatic Habitat Inventory methodology, and OWEB's 1999 Watershed Assessment Manual) and agency recognition of important salmon habitat (for example, ODFW's designated Core Areas and DSL's Essential Salmon Habitat maps) have almost completely omitted consideration of tidal channels. This omission creates potential problems throughout the range of anadromous salmonids, but particularly in basins such as Tillamook Bay, where the estuary is large in proportion to its drainage basin. In the Tillamook Bay basin, the estuary is central to flood management decisions and also central to salmonid production, yet policy recognition of the estuary's role in salmonid production is lacking, so community decisions on flood management are not fully informed by knowledge of the importance of estuarine resources to salmon.
Recommendation: Prioritize the inventory and assessment of tidal habitats with the same consideration given to freshwater habitats, so that flood management and other land-use decisions may not conflict with salmonid conservation goals.

2.4 Public Policy

Public planning and policy structure is non-spatial and/or is often incompatible with spatial correlation. The Oregon Plan for salmon and watersheds provides statewide benchmarks for natural resource management.

The Tillamook Bay Comprehensive Conservation Management Plan (CCMP) lays out 62 actions intended to address the most significant environmental problems in the Tillamook watershed. A review of these plans reveals little relationship to existing spatially defined policies intended to regulate land use actions. ***Recommendation:*** Develop and make available spatial information in a format that can be used to refine the implementation framework of these and other initiatives to achieve flood hazard reductions and habitat restoration.

There is a lack of a multi-objective policy framework. Flood hazard reduction efforts administered by the COE and FEMA are often solely based on hydraulic criteria and can be in conflict with habitat restoration/ESA related issues that are based on biological and geomorphic criteria. The term "multi-objective management" has not been addressed by the regulatory framework. Regulations and programs of individual agencies have been established to meet specific mandates, which are typically single objective task oriented. The complex mission of an IRMS is to balance ESA objectives with flood hazard reduction objectives. Local governments are mandated to develop a program to achieve Goal 5 for all significant resources sites through the adoption of comprehensive plan provisions and land use regulations. The Goal 5 resources include water bodies, fish habitat, wildlife habitat, riparian corridors, and wetlands. ***Recommendation:*** Consider Goal 5 provisions as a vehicle to implement the multi-objective IRMS approach.

There is a lack of an integrated comprehensive planning viewpoint. Both flood hazard reduction planning and salmon restoration efforts have emphasized restrictions on property uses within the floodplain. Not only is there a currently notable lack of incentive to develop in a manner that conserves and restores habitat, but government actions often tend to encourage additional encroachments in the floodplain. ***Recommendation:*** Use land use policies to creatively strengthen existing established commercial centers outside of flood prone areas and increase their drawing power, instead of increasing sprawl onto floodplains, as a way to alleviate the ever-increasing development pressures on the floodplain.

2.5 Flood Response and Waterway Permitting

Flood response actions are often uncoordinated and inefficient. Typically, public policy authority for investigation is at the federal level, while authority for review is at the state level, and authority for implementation is at the local level. These authorities often remain segregated to their respective levels and mechanisms for interaction or support are lacking. This has, in part, led to uncoordinated and inefficient flood response actions. ***Recommendation:*** Improve interagency flood response coordination.

Some discontinuity appears to remain between the regulatory intent of waterway permits and recent regulations. The original intent of regulatory permits, often established decades ago, does not necessarily address current resource management concerns; e.g., requirements of the Section 404 removal/fill permit program and objectives of the Endangered Species Act. ***Recommendation:*** Undertake a comprehensive review to ensure that required permit actions support current regulations and change with changing regulations. For example, current Section 404 permit requirements should be reviewed to evaluate their consistency with the newer ESA 4(d) evaluation considerations for Limit 12: Municipal, Residential Commercial and Industrial (MRCI) Development and Redevelopment. The 404 application process tends to remain focused on the project site, with required documentation of offsite conditions limited to contact information for adjoining property owners, whereas the 4(d) rules promote a more comprehensive evaluation of potential impacts from a waterway project with respect to the geomorphic functions of the particular reach of the river system.

A lack of consistency, accuracy, compatibility and connectivity in existing databases impedes efforts to analyze cumulative biological impacts of permit actions. Spatial locations in the permit databases, which would be helpful to locate permit actions using a GIS, are inconsistent; for example, some are stated in lat/long coordinates (COE), others in township/range (NRCS). Some database entries are spatially inaccurate, showing permit locations on the equator or in the Pacific Ocean! Several disparate and disconnected agency permit databases exist because of the variations in jurisdiction among agencies that regulate waterway impacts, agencies that evaluate water quality, and agencies responsible for fish and wildlife resources. For instance, the FEMA database lists flood response actions not in waters of the United States and thus not permitted and recorded by COE or DSL. There are also issues of software and hardware incompatibility among these databases. USFWS uses Paradox, while DSL has used Wang, for example. These systems are inaccessible to each other without first converting to a common format. Meanwhile, the COE RAMS database is not transferrable to file at all, and can only be used on-screen or in print-outs.
Recommendation: Establish standardized interagency procedures to facilitate the recording, entry and transfer of permit data to and from databases and GIS. Encourage proper coordination between field staff, database staff, and GIS staff, to ensure that adequate QA/QC procedures are used to guide database development. Make efforts to consolidate and update databases to enable consistency and efficiency in the permit process.

Flood response permitting lacks a cumulative or interactive impact analysis. Fragmentation and complexity of the permitting process is an enormous and well documented problem. There are numerous examples of policy "disconnect." The underlying intent of these permits does not correspond to the primary concerns of an IRMS (habitat restoration; water quality; and quantity; fish passage; flood hazard reduction) and, consequently, cumulative impacts on the function of the river system can be significant.
Recommendation: Consider two existing vehicles to facilitate integrated planning and assessment: 1) the NEPA framework, together with; 2) the OWEB Watershed Assessment Manual. The cumulative impact analysis component of NEPA can be used to correlate actions with the three main ESA concerns (flow rates; water quality; habitat) and to define impacts on thresholds as specified by Oregon Plan benchmarks. The OWEB Manual provides tools for evaluating watershed functions and condition, and helps local and regional groups prioritize types and general locations for habitat restoration actions.

There is often a discrepancy between the resulting permit action and the recorded description. Permit data generally presents information on proposed actions; the completed actions are not well documented. For instance, an applicant is likely to use a different amount of riprap than what was requested in the permit application and permitted. There are likely many waterway flood response actions that are not documented in regulatory permits because they are not reported.
Recommendation: Expand the regulatory permit program to require documentation of the resulting "as-built" condition, possibly through the use of economic incentives borne by the permit applicant. Wetland removal/fill premit programs do require post-implementation monitoring of mitigation activities, but enforcement of those requirements is sometimes poor due to high staff workloads and low funding levels. Improved follow up in such cases is recommended, as is increased funding needed to implement followup.

Floods should be viewed as opportunities for monitoring to obtain valuable scientific data to refine river management strategies. Post flood activities primarily involve efforts to restore public safety and protect public infrastructure, as they should. ***Recommendation:*** Flood response plans should include planned efforts to document flood characteristics and post-flood conditions of habitat and channel/floodplain morphology. These efforts may include the identification of high water marks from designated locations using standard procedures, repetitive survey of river channel sections to assess scour and deposition trends, and aerial and ground level photography and videotaping of the dynamic processes at work during a flood event. These data could be used for adaptive management purposes and to refine assumptions made in the continuing development of hydrodynamic models.

2.6 Conclusions Concerning Integrated River Management Strategies

There is a lack of basic scientific and technical data necessary for the effective management of floods and fishery resources. Our investigations in the Tillamook Basin began with expectations for an abundance of data for the river system because of the earlier efforts by the Tillamook National Estuary Project (TBNEP). While significant data were developed for the uplands at a compatible coarse spatial scale, we found a severe lack of data at a finer scale for the lowlands and estuary. ***Recommendation:*** Target data acquisition at the lowland and estuarine portions of the Tillamook Basin. Recent efforts by the Corps to obtain lowland topographic data as part of the Feasibility Study could be augmented by state-of-the-art airborne Light Detection and Ranging (LIDAR) surveys. Repetitive LIDAR surveys over time would be a cost-effective way to document changes in the lowlands to guide adaptive management actions for the IRMS.

The framework for an effective integrated river management strategy is already in place, developed from lessons learned by others. Much independent research has been done in the disciplines of flood management, salmon recovery and landscape ecology. It has been only recently that interdisciplinary investigations have begun in earnest and these have often been prompted by severe flood events. ***Recommendation:*** Make efforts in Tillamook, and other Pacific Northwest communities, to communicate and meet with other entities from the United States and overseas, who have dealt with similar experiences and developed aspects of river management strategies that could be adopted locally.

The hydrodynamic model currently being developed for the Tillamook Bay lowland river system will be a valuable decision making tool. The model is currently intended to be used to assess the effects of river management activities on hydrodynamic conditions including flood elevations, velocities, sedimentation, and channel scour. ***Recommendation:*** Extend model use to investigate salinity intrusion, temperature and other water quality parameters under different management strategies. Integrate this model with a 2-dimensional model of Tillamook Bay, in order to develop a better understanding of the link between the hydrodynamics of the bay and lowland river systems.

Multi-objective river management can imply multiple potential funding sources. As an example, the plans for a Napa River Flood Control project for the City of Napa in California was rejected three times by the local community because it benefited only those living in the floodplain. It also called for dredging and massive bank stabilization that would have dramatically impacted the ecology of the river system. Consequently, the project grew from an effort focused only on flood control for a few miles of channel, to a watershed-wide initiative, resulting in many benefits and funding sources for continued work.

Recommendation: Tillamook has an opportunity to be a similar nationally-recognized community capable of attracting the diverse range of funds achieved by the Napa Community.

A cornerstone of the proposed IRMS is the establishment of a clear set of performance criteria, and periodic monitoring standards to ensure that the IRMS is on a trajectory to achieve these criteria. The development of an IRMS is immensely complex and includes ecological, economic, social, hydrological, and cultural issues. The interaction and linkages of many of these issues are difficult to predict and unforeseen circumstances--positive and negative--may arise as an IRMS is implemented and becomes established over time. Secondly, the conditions in the watershed are not static in time and are subject to the geomorphic evolution of the river system, episodic events such as fire and flood, and external factors such as conditions in the ocean, changes in legislation or funding opportunities.

Recommendation: Make a commitment among participants in an IRMS to ensure availability of funding and resources for long-term monitoring to track the performance of an IRMS.

An IRMS should allow the accommodation of natural processes to reduce the long term operations and maintenance costs typically associated with traditional flood control endeavors. One of the guiding principles in the IRMS is to reduce costly frequent maintenance activities that would also disrupt key habitat.

Recommendation: Perform innovative and sound economic investigations during the development and evaluation of IRMS actions to equitably assess the economic benefit and cost of restoring natural processes relative to those associated with traditional flood control infrastructure.

Successful IRMS implementation will occur only with active, informed landowner involvement, and with public support and understanding of restoration goals and processes. Landowner involvement is essential from the very beginning of the site selection and site planning process.

Recommendation: Development of an IRMS should be a completely open process, perhaps updated through the TBNEP website.