DRAFT

Data Management in Support of the Fish & Wildlife Program Summary

October 24, 2002

Prepared for the
Northwest Power Planning Council

Subbasin Team Leader
Bruce Schmidt, StreamNet Project Leader
Pacific States Marine Fisheries Commission

Contributors (in alphabetical order):
Jim Anderson, University of Washington
Bart Butterfield, Idaho Department of Fish and Game
Cedric Cooney, Oregon Department of Fish and Wildlife
Phil Roger, Columbia River Intertribal Fish Commission

DRAFT: This document has not yet been reviewed or approved by the Northwest Power Planning Council

Data Management Summary

Table of Contents

Table of Figures

Data Management Summary

Introduction

Multiple agencies (state, tribal and federal), academic institutions, organizations and individuals are actively engaged in assessment, habitat restoration, research, management and planning in the Columbia River basin. Accomplishing their respective missions requires a broad range of information about the resources in the basin. Some entities collect needed information directly as part of their responsibilities, and many require information originally collected by others. No single agency or program, however, can gather all the information needed to effectively fulfill its mission. Therefore, a cooperative, comprehensive basin-wide data management program is essential to facilitate the necessary data flow to meet program needs, minimize duplication of effort, and assure data are available and useful beyond the original entity and purpose for which they were collected. This program summary is intended to describe the current state of systemwide data management, outline the individual data management projects that currently function within the program, and identify key actions necessary to improve and coordinate data management efforts.

Sharing essential information in consistent, usable form over an area the size of the Columbia Basin is made difficult by the multiple entities involved, gaps in the data being collected, and a frequent lack of standardization in data collection methodologies, data definitions, data storage formats, and data dissemination. In general, much fish and wildlife related data are collected by entities focused on meeting their own needs and mandates, with providing data for regional use a secondary or lesser priority.

There are many challenges that must be addressed in order to provide for consistent delivery of data from multiple sources over a wide area. These can be grouped in three categories: Policy support, Technical development, and Local coordination.

1. Multiple agencies / missions
    - Agencies have different scopes of authority and responsibility. Geographic scope may encompass local areas, tribal lands, statewide or region wide. Taxonomic scope may range from all fish and wildlife in an area to only specific species.
    - Agencies are independent. None has a universal overriding authority encompassing the entire Columbia Basin and it's full range of resources.
    - Agencies serve different missions, sometimes even within themselves, and therefore have different information needs.
    - Agencies collect information to meet their own needs, not regional needs. Consequently, there is often no inherent agency need to seek or adhere to regional standardization.
    - There is often no agency mandate or support for providing data regionally.
    - Data management is often a low priority for agencies facing other challenges (exceptions would include specific programs called for under treaty).
    - There is no inherent agency need to coordinate the data collection methodology, storage, or reporting that are needed to meet regional data needs.

2. Inconsistencies in how data are collected and recorded in the field
    - Field methods were often selected by individual agencies before there was a recognized need to share data regionally. There is often reluctance to break long-term trend lines by adopting new regionally standardized methods.
    - Methods are/were often selected to meet only an agency's immediate need and/or budget.
    - Methods are/were often selected to fit local conditions and circumstances.
    - Local biologists gain little from regional data collection standardization, since their needs are already being met with existing methods.

3. Data management tools and resources are lacking at the data sources
    - In some cases, flow of data from source to regional databases is difficult and ineffective
    - Agencies often have few resources committed to data management or dissemination. Many lack comprehensive data management programs.
    - In many cases, data are not available on the Web, or they are not in usable or consistent format.
    - Many data reside in files of individual biologists.
    - Biologists often have little time or interest for making their data available, or are reluctant to share data before they have analyzed them fully for fear they may be misused.
    - More data are collected than are made available in standardized electronic format.
    - Individual agency or organization policy may limit the ability to share data.
    - Some data are stored only in hard copy of other less usable format, particularly legacy data

4. Different coding and data formats for similar kinds of data
    - Data codes / formats were often selected individually before there was a recognized need for regional standardization. Adopting new regional standards would require considerable effort within existing programs.
    - Adopting new regional standards could require considerable time and effort to bring existing programs into compliance.
    - In some cases there may be no agency wide codes or data format standards.
    - There is often no inherent agency need for regional data standards.
    - Data can not be combined and analyzed until they are in the same format. Migrating disparate data into standardized formats takes a considerable amount of time and coordination.
    - Data from multiple sources must include the same parameters and adhere to the same definitions to be comparable.
5. Data are often needed for purposes other than what they were collected for
    - Data usually are collected to meet a specific agency need.
    - Entities with a regional perspective often need to make broader inferences from existing locally focused data.

- Biologists are concerned about potentially improper use of data, which is made more likely when the are inadequate data descriptions (metadata) and data limitations are not well described.

6. There is no regional consensus on priority data needs for use in region-wide programs or addressing regional questions.

    - There is no articulation of the primary information needs under the Hydrosystem Biological Opinion, BPA Implementation Plan and other broad regional programs.
    - Data needs often vary by area and/or species.
    - Without a clear statement of priority regional data needs, it is difficult to make sure the key needs are being met.
    - Different regional programs require different kinds of data. There are no priorities among these programs.
    - Data priorities sometimes change rapidly, leading to inconsistency or lack of long term support for collecting, standardizing and disseminating data.
    - 'Brush-fire' management or the latest modeling or analysis strategy often drives the development of data needs rather than long-term development and assessment of critical questions.

7. Some essential data elements are not routinely collected.
    - Without accepted regional data priorities, there is no mechanism to determine whether all needed data are being collected or disseminated, although having accepted priorities alone will not assure that all of the needed data are collected.
    - Some needed data are not being collected in the field, or are collected only sporadically or in limited locations.
    - Data needed for regional purposes may not be priority needs for individual agencies.
    - Regional management techniques have not always been applied to local populations, e.g., evaluating population health based on brood year rather than annual run strength.
    - Local data collectors may be unaware of other data needs.
    - Data collection priorities may be dictated by funding sources or limitations, contractual obligations, or legal mandates.

8. There is no comprehensive systemwide approach to data management. (This refers to an approach to managing data regionally, not specific systemwide data management projects, of which there are several.)
    - Most contracts do not require data to be reported
    - Database management projects are only loosely coordinated
    - There is no specific mechanism to screen data management funding proposals to assure that similar work is not already going on, or to determine whether existing projects could do the same work for less cost.

These challenges illustrate why developing a comprehensive data management program is difficult. If these basic challenges are not addressed, even the latest data management technology will not achieve the desired results. Major emphasis must be placed on data content before leaping toward the alluring technological promises of easy data dissemination, since the most advanced information system is useless without quality data.

Program Description

Regional data management in support of the Fish & Wildlife Program currently consists of a number of loosely coordinated and independent database management projects that serve different specific data needs within the basin. The projects provide services that address many of the challenges listed above. Data are acquired from various entities and/or locations, converted to consistent structures and formats (in the cases where there are no region-wide standards), and made universally available. These data are then available for a variety of regional purposes, including assessing population trends and species status, modeling, monitoring management and restoration effectiveness, tracking environmental or hydrologic conditions, research, and making management or policy decisions.

The primary database projects under this program are funded by the Bonneville Power Administration (BPA) through the Northwest Power Planning Council's (NWPPC) Fish and Wildlife Program (FWP). The primary projects that constitute the "Data Management Program" under FWP funding are:

- Coded-Wire Tag Recovery Program The Coded Wire Tag project maintains the Regional Mark Information System, a data repository for anadromous fish mark release and recovery data coast wide, including the Columbia River Basin. This project is addressed in the Mainstem Harvest Monitoring Program summary.
- Columbia River Basin PIT Tag Information Systems The PIT Tag project manages the distribution of Passive Integrated Transponder (PIT) tags throughout the Columbia Basin and maintains a database of all PIT Tag release and detection data. This project is addressed in the Juvenile Fish Passage program summary.
- Fish Passage Center The Fish Passage Center (FPC) provides current and historic data on mainstem/systemwide salmon and steelhead passage at Columbia Basin hydro facilities. Data from the Smolt Monitoring Program (SMP), the Comparative Survival Study (CSS), and the Gas Bubble Trauma Study (GBT) provide the information base for federal, state and tribal recommendations for fish passage in the Federal Columbia River Hydro-Electric System. In addition to real-time access to SMP and GBT data, the FPC web site archives and provides access to real-time and historic data about river conditions, hatchery releases, smolt migration and condition, and adult returns. The FPC web site also provides access to on-line analysis of real-time and historical data, as well as data from other regional data providers. Services include: fish travel-time and survival analysis from PIT tag data, real-time and historical tracking of juvenile and adult hydrosystem passage, real-time and historical tracking of mainstem/systemwide hatchery releases, real-time and historical tracking of water quality, and an assortment of graphical and tabular query, display and analysis tools. The FPC staff also provides specialized analyses for Fish & Wildlife program entities upon request. This project is addressed in the Juvenile and Adult Fish Passage program summaries.

- StreamNet The StreamNet Project consists of a network of staff members placed within six state, tribal and federal fish and wildlife agencies to acquire, standardize and provide fish related data for regional distribution. Over a dozen kinds of fisheries related data commonly developed and used by fish management agencies are routinely provided in the database. Once in a standardized format, data are submitted to a regional database and are distributed through a web-based query system on the Internet (www.streamnet.org), as maps, as custom developed data products, and direct downloadable data files. The project also provides data support on request to other projects within the FWP and maintains a full service library on fish and wildlife topics. This project is addressed in more detail in Section 2 of this summary.
- Second-Tier Database Support The DART (Data Access in Real Time) data site archives data and provides online analysis of real-time and historical data gathered from regional databases. Services include: fish travel-time and survival analysis from PIT tag data, real-time tracking and predictions of juvenile and adult hydrosystem passage and water quality, graphical query, display, and analysis tools for salmon passage and water quality data from 1949 through the present. DART staff also provide specialized analyses for regional scientists and managers upon request. This project is addressed in more detail in Section 3 of this summary.
- Subbasin Planning The Power Planning Council will begin subbasin planning activities in 62 subbasins in 2002. The work required for this effort is described in several Council documents and memoranda (Technical Guide for Subbasin Planners, Subbasin Planning Overview and associated files available on the Council's web site <www.nwcouncil.org>). This effort will require and generate a large amount of information, especially for watershed assessments, which should be captured into and managed by a regional system. The specific activities are presently being identified by local state/tribal teams, but will have to build upon the existing data management programs to realize operational efficiency and meet short time lines.

Several of these projects serve specific system-wide programs and are covered in detail in the summaries for those programs. The remaining two projects, StreamNet and Second-Tier Database Support, are outlined as part of this summary in Sections 2 and 3.

In addition to the above projects that are funded as part of the FWP, there are multiple projects that contain data of value to fish and wildlife programs but that are part of other programs. Some of these projects also provide data on a larger scale beyond the Columbia Basin. While funded through other sources, these projects are able to provide valuable information of use within the basin. These projects include:

- The Alaska Fisheries Information Network (AKFIN) provides commercial fishery information for Alaska. Some Columbia River salmon stocks are harvested in the Alaskan fishery.
- The Pacific Fisheries Information Network (PacFIN) provides marine commercial fishery information for Washington, Oregon, and California. Columbia River stocks are harvested in these fisheries.
- The Fisheries Economics Data Program (EFIN) contains data series, publications, and surveys of interest to fisheries economists.

- The Recreational Fisheries Information Network (RecFIN) provides marine sport fishery information for Washington, Oregon, and California.
- The Yakima / Klikitat Fisheries Project (YKFP) is working to organize fisheries data in these drainages.
- The Pacific Salmon Commission has a Data Sharing Committee which exchanges information needed for analyses performed by several technical committees.
- The *U.S. v Oregon* Technical Advisory Committee and Production Advisory Committee annually share hatchery, natural escapement, and harvest data on stocks covered by treaties with the basin's Indian Tribes.
- The Oregon Watershed Enhancement Board (OWEB) has a database with information on watershed enhancement projects conducted under OWEB funding.
- The U. S. Army Corps of Engineers posts raw data related to dam operations and environmental programs on the Internet, including information on water levels, water quality, and adult fish counts.
- The USDA Forest Service and USDI Bureau of Land Management have two planning projects that include databases of information of value for fish and wildlife management in the Columbia Basin. These are:
    - The Interior Columbia Basin Ecosystem Management Plan (ICBEMP) has collected and organized a broad array of information for the Columbia Basin east of the Cascades.
    - The Regional Ecosystem Office (REO) has collected and organized information under the Northwest Forest Plan for lands west of the Cascades, including federal restoration project information.
- The USDA Forest Service is completing development of a Natural Resource Information System, which will include a wide array of data in a nationally standardized format for all National Forest lands.
- The EPA STORET system is a national repository for a wide range of water quality data.
- The state departments of environmental quality maintain databases that include information on water quality and aquatic macroinvertebrates.
- Natural Heritage programs in each state maintain data on occurrence of non game fish and wildlife species.
- State and tribal fish and wildlife agencies generate much data, but usually have only limited data management programs.

A partial overview of the many disparate sources of fish, wildlife and habitat related information is presented in Table 1, Appendix A.

Purpose of Program - *technical and/or scientific background*

The database projects making up this data management program exist to provide specific information to meet various FWP needs within the basin. The Coded Wire Tag, PIT Tag and Fish Passage Center projects each serve specific programs with specific data needs. While the information provided by these projects also has other uses, the specific need for these data led to early realization of the need to have them consistent and available region

wide. The StreamNet Project provides a variety of fisheries data types to meet a wide array of information needs across the basin (Section 2). The Second-Tier Database Support project provides value added services for data developed by other database projects so that data can be more easily accessed and used (Section 3).

All of these projects strive to overcome many of the challenges listed in the Introduction. They assure that related data are available at one location, that data from different agencies or areas are consistent and compatible, and that the data are widely available to all potential users. In some cases they provide coordination services among data users, such as assigning tag codes, ordering tags, etc. They are not able, however, to establish regional priorities for what data are needed, determine what data are collected by the various management agencies, determine what methods will be used to collect data, or provide adequate data management at the source to facilitate flow of data to regional systems.

The database management projects contribute added value to the data they manage. The process of compiling data often uncovers errors, which are corrected in conjunction with the data originators. Web-based query systems allow data users to sort and select from the databases only the data most relevant to their needs. Readily accessible data systems reduce the number of individual requests for the same data from data originators. Georeferencing the data by tying them to specific locations (for example, on the regional 1:100,000 hydrography) allows data to be depicted on maps and data of different kinds to be compared and analyzed on a geographic basis. Mapping and graphing functions allow users easy review of data. Some raw data are summarized or analyzed to make them more useful.

Scope of Program – *management application, geographic scope, and species populations affected/benefited (include a description of the area that is affected by this effort in relationship to the mainstem dams – identify if the program has a systemwide impact affecting all or most fish populations, an impact on all or most populations above a dam or an impact on all or most populations below a dams or between a set of dams.)*

The database management projects that support the Fish and Wildlife Program encompass the full scope of the Columbia Basin, from local areas to mainstem and systemwide. Data are managed so that information can be obtained for specific locations, individual streams, watersheds, subbasins or the entire basin. Specific data categories may relate to the mainstem dams while others relate to other point locations or to rivers and streams in the basin. In total they serve the entire basin.

Information within each of the databases is consistent basin wide so that data from different locations or entities can be combined, analyzed or compared regardless of the original data source or original format. Not only are similar and related data from multiple entities or locations readily available at a single source, but the individual data users do not have to each deal with the problem of standardizing the data so that they can be used to address region wide issues.

The scope of species coverage primarily relates to fish and fish habitat. Heaviest emphasis is on anadromous salmonids and species that are listed or candidates for listing

under the Endangered Species Act. The level of interest in resident species, particularly listed species, is increasing.

The scope of management application is extensive. Basic fisheries related information is an essential component of nearly all research, monitoring and management activities in the Columbia Basin. The systemwide data management projects support all those activities, particularly those activities with multi-agency or systemwide scope (such as recovery planning, population status monitoring or assessment, etc.), activities that rely on information collected by other agencies (such as watershed level assessment and habitat restoration planning), or mainstem management decisions (such as water releases, transportation, etc.).

Accomplishments/Results

Adaptive Management Implications – *historic and current changes in management, future applications*

The information management projects that support the Fish & Wildlife Program are essential routes of communication within the adaptive management process (Figure 1, Appendix B). They function as the "nervous system" of adaptive management, providing many types of information necessary for planning, developing projects, evaluating results from management actions, and providing the feedback necessary for modifying goals and strategies. If the projects did not exist, other means of obtaining the same information would have to be put in place to complete the monitoring and assessment essential under the adaptive management process.

The projects have themselves evolved (i.e., were adaptively managed) over time as management needs and priorities have evolved. More frequent communication between managers and data suppliers can increase the effectiveness of these projects and improve their ability to adjust to the needs of resource managers and decision makers, particularly when initiated during project development.

Benefits to fish and wildlife – *role of program efforts in the Council's Program*

The database management projects provide data of many kinds to support multiple research, assessment, management, restoration and planning efforts to benefit fish and wildlife. Without these projects, many kinds of information would be difficult to obtain, and much effort would be needed to put them into usable form by the individuals needing the information.

Project funding to date – *total amount of BPA funding since program inception*

Funding for the individual projects within this program are presented within the individual project summaries (Sections 2 and 3).

Reports and Technical Papers – *reports or scientific papers produced as a result of this program and how they have been disseminated*

The reports and papers produced by the projects within this program are presented within the individual project summaries (Sections 2 and 3).

Relationship with other projects/programs

The projects within this program provide a linking mechanism between the various entities that generate the data and the many agencies, institutions, projects and individuals that utilize the data. Some of these relationships are very specific, while others are more general. These relationships are described in greater detail in the individual project summaries (Sections 2 and 3).

The individual data management projects maintain a general level of coordination among themselves to minimize overlap and maximize data availability. In some cases data from one project are acquired directly by another project, value added and then posted. For

example, the Regional Mark Information System obtains and distributes annual information on hatchery releases in the basin as part of the hatchery marking data. The StreamNet Project obtains that information from RMIS (rather than collecting them a second time at the source agencies), adds value by linking the release data to the hydrography, and then posts the data in the StreamNet information system for use with other fisheries data. In other cases similar data are obtained in different ways for different purposes. The Fish Passage Center also provides hatchery release information, but that data is obtained weekly directly from the hatcheries and is provided near to real-time. Such data serve immediate needs, but these data are not subject to ongoing data review processes within the agencies and may not include subsequent corrections and changes made as the data are finalized and then officially released.

Relationship of program to USFWS/NMFS Biological Opinion – RPAs

The data management projects that support the Fish and Wildlife Program provide information and services that relate to several of the Reasonable and Prudent Alternatives (RPA) contained in the Biological Opinion. Since each of the database projects in the current program address specific types of information, they individually address RPAs that require those specific types of data. Details are provided in the individual project summaries, which are contained in the other summaries mentioned above and in Sections 2 and 3 of this summary for the StreamNet and Second-Tier Database Support projects.

Of particular importance to the overall program of Database Support for the Fish and Wildlife Program is **RPA Action 198**, which states: "The Action Agencies, in coordination with NMFS, USFWS, and other Federal agencies, NWPPC, states, and Tribes, shall develop a common data management system for fish populations, water quality, and habitat data." As stated previously, the current program consists of a number of loosely coordinated database projects. It does not yet rise to the level of a "common data management system", but it does form a solid basis for development of such a system.

The data managed by the current database projects will continue to be needed or will grow in need, and the functions of the existing projects will be able to contribute directly to development of a more comprehensive system. Such a system should include: greater coordination among data management entities; a mechanism for establishing priorities among regional data needs; a mechanism to work with and support the information infrastructure of the data collecting entities to deal with priority data gaps, adoption of specific field methodology standards, data standards and data sharing; a coordinated data dissemination approach; long term support for the basic data compilation and dissemination functions, and support for local data management at the source to provide electronic data flow to regional systems. The system would not need to be a centralized database but could involve a number of coordinated distributed data systems with an overall coordination mechanism.

The need identified in RPA Action 198 is discussed more fully under the Future Needs section.

Future Needs

Immediate Program Recommendations – *program needs requiring additional Bonneville funding or NWPPC action (for next 3 years)*
The ecosystem management concept emphasizes a need to understand and address the relationships between and among all natural resources within the basin. To this end, increased support is needed to expand and / or develop information management systems that address habitat plus wildlife and non-game species.

A general program need for the immediate term is a mechanism (a committee, task force or other collaborative effort) charged with initiating and guiding a process to develop the comprehensive data management program called for in RPA Action 198. This will not be a straightforward or easy task because of the many structural and technical considerations described above. Nevertheless, the following actions during the next three years would establish a solid base upon which a regional information collection, management and sharing program could evolve.

1. Policy-Level Needs:
   - Obtain policy-level support within agencies (state, tribal and federal) for participation in development and implementation of regional information collection, management, and sharing protocols
   - Form an *ad hoc* policy group to, in collaboration with a technical group, identify key regional questions, data priorities, protocols and standards to meet the information needs of the FWP, recovery plans under the ESA, tribal restoration plans and region-wide fish and wildlife objectives.

2. Technical Needs:
   - Develop and manage information management tools to support subbasin planning in 2002 and beyond.
   - Provide information management services to local subbasin planning groups.
   - Use the Regional Assessment Advisory Committee (RAAC) as a technical group to collaborate with the policy group and tasks listed above.
   - Direct the RAAC to develop draft statistical criteria for data to meet the management decision needs of the FWP and ESA recovery plans by 9/30/02.
   - Review existing data collection methods against the statistical criteria and recommend preferred protocols.
   - Assist agencies to develop data collection, QA/QC, management, and sharing practices that meet regional needs.
   - Incorporate regional protocols into BPA contracts.

3. Local Needs:

- Direct the StreamNet Project to develop data collection, management, and sharing tools that meet regional protocols without requiring undue changes to existing programs.
- Direct the StreamNet Project to develop training and support programs for local data collectors.
- Provide resources necessary to implement changes at the local and agency levels.

In addition to the large need of developing a comprehensive approach to database support, there are already specific known data and data management program needs that should be addressed as soon as funding will permit. Such needs would include the following:

- Data management to implement subbasin planning.
- Expand the initial efforts by StreamNet to capture and regionally standardize information on habitat restoration projects being conducted throughout the Columbia Basin by the various agencies and groups and as funded by various funding agencies and mechanisms.
- Support improvement of data compilation and data management within data collection agencies to facilitate electronic flow of data to regional systems.

Individual project needs for the next 3 years are contained in the individual project summaries in Sections 2 and 3 and in the other summaries mentioned at the beginning of this summary.

Needed Future Actions – *new program needs within the basin needing Bonneville funding and how these needs fit with the overall basinwide goals and objectives*

A primary future need is development of a more comprehensive approach to data management basin wide, as called for in RPA Action 198. Similar needs were identified for the regional database management projects under the Council's Fish and Wildlife Program by the Independent Scientific Review Panel (Coutant, et. al., 2000), and a more comprehensive data management approach should incorporate many of the recommendations from that report. Such a systemwide approach should include the following:

- Development of regional agreement on the priority questions that must be addressed to assure recovery of ESA listed species, avoid decline of non-listed species to levels requiring listing, and assure an abundance of fish and wildlife populations suitable for providing economic, cultural, treaty and recreational benefits to the region. There will be priority questions needed within each of multiple areas, such as stock assessment/modeling, population response monitoring, project compliance monitoring, project effectiveness monitoring, planning (including systemwide, subbasin and restoration project level planning), and management decision making.
- Development of regional agreement on the priority data needed to address the questions identified in the above action. It will never be possible to develop all information that would be useful in this endeavor, so emphasis needs to be placed on identifying the highest priority data needs.
- Identification of all relevant data that currently exist or are being collected, and an assessment of how well the data are being disseminated.

- Identification of highest priority data needs that are currently not available.
- Development and implementation of data collection and data management projects to address the priority data gaps identified in the above action.
- Support of data management programs within the data collecting agencies to assure the flow of data beyond the agency. Development of data management programs within the agencies would significantly improve data development and dissemination.
- A mechanism to assure coordination among data management programs to avoid duplication of effort, maximize synergy among data management programs, and to assure as many priority data needs are met as possible in an efficient manner.
- Continued support of data management programs that provide regional data. The comprehensive data management approach should incorporate mechanisms to review the currently functioning data management programs to assure they focus on priority data needs, address newly prioritized data needs within their areas of expertise, and assure efficient operation.
- Maintenance of a directory of data management projects and data sources throughout the basin, regardless of funding source.

The approach should recognize that the largest effort and operational costs are likely to be associated with the collection, acquisition, quality assurance and standardization of the data rather than the technological means of disseminating the data.

Development and implementation of such a comprehensive program must involve the agencies and programs that would participate in it, including the state, tribal and federal management agencies that collect much of the fish and wildlife data, the existing regional database projects, and the entities with a region-wide perspective like NMFS, FWS, NWPPC and BPA. A regional perspective is necessary for identification of the broad management questions that need to be addressed and the data that are needed. The database projects are needed to contribute their experience and expertise in database technology and the realities of managing complex data over large areas and across jurisdictional lines. The management agencies are needed to describe current sampling programs and advise on data needs and the practical requirements of any new or modified data collection effort.

Data management technology is advancing rapidly, but the greatest impediments to effective data management region wide are more related to coordination, prioritization, data collection, standardization, and lack of data management programs at the data sources. A comprehensive, coordinated approach to data collection and management is needed to assure that: the priority data are being collected, appropriate sampling methods are used, data management programs in the data collecting agencies assure continuous data flow, data management projects are well structured to meet priority needs, and haphazard implementation of projects is avoided.

Specific caution is needed when evaluating proposals based on new technology that may not deal fully with the data management challenges outlined earlier in this summary in the Introduction. For example, future use of new technologies to locate and serve data from the Internet will require that the target data actually exist, that they adhere to common

data standards and collection techniques, and that they are already available via the Internet. Careful review in a regional context is important before committing resources to proposed projects because a technologically advanced system is useless without high-quality pertinent data that address the real information needs.

References

Coutant, C., D. Goodman, S. Hanna, N. Huntly, D. Lettenmaier, L. McDonald, B. Ridell, W. Smoker, R. Whitney, R. Williams, S. Urquhart. 2000. Review of Databases Funded through the Columbia River Basin Fish and Wildlife Program. Northwest Power Planning Council Document ISRP 2000-3.

Section 2: The StreamNet Project

Project Description

StreamNet is a cooperative project among the four state fish and wildlife agencies in the Columbia Basin, the Columbia River Intertribal Fish Commission, the U. S. Fish and Wildlife Service, and Pacific States Marine Fisheries Commission. It is funded by Bonneville Power Administration and is part of the NWPPC Fish and Wildlife Program. The project supports staff within each of the cooperating agencies to acquire, geo-reference and standardize a specific suite of data types and then provide them to a regional database. The regional portion of the project manages the regional database and GIS system and distributes the information via an on-line database query system, by custom response to data requests, and by downloadable data files. The project also manages a full service library.

Purpose of Project

The StreamNet Project functions to make a suite of fisheries related information routinely collected by fisheries management agencies available system-wide in a consistent, standardized format. In so doing, it addresses a number of the challenges identified at the beginning of this program summary. Because the management agencies do not have a mandate or funding to standardize and provide data regionally or to make them available over the Internet, the StreamNet Project provides staff and equipment within the agencies to acquire the data being collected by the agencies, convert them into a regional data exchange format, geo-reference the data to the 1:100,000 hydrography, and enter them into a regional database for dissemination. Thus, similar kinds of data are made compatible across agency and geographic lines and data are made available outside the agencies that collected them. Data are limited to the kinds of information collected by the agencies and to the sampling methods employed by each agency.

Data in the StreamNet database are available for review on-line as tables, graphs, charts or maps, or for download via File Transfer Protocol (FTP). Also available are photographs of various fish species and facilities (dams, hatcheries, fishways, etc.). Data contained in StreamNet are linked to references documenting where the data originated. This type of metadata allows data users to validate and/or further evaluate the utility of the data to their specific needs. These documents are available to the public through the StreamNet Library. StreamNet also provides data assistance directly on request, within available staff capability, for members of the Fish and Wildlife Program. The intent is to have data readily available for use in various modeling, monitoring, restoration planning and region-wide management efforts to benefit fish resources.

Scope of Project

The StreamNet information system provides fisheries related data from multiple agencies throughout the Columbia Basin. The scale of data ranges from local to basin wide. Primary coverage is for anadromous salmonids and fish species listed or proposed for listing under the ESA. Lesser amounts of data exist for resident fish species, primarily because the priority for resident species has only recently increased due to ESA considerations. The information types distributed through the StreamNet on-line database are the basic kinds of fishery related information used by many management agencies and are useful in a variety of systemwide efforts (StreamNet, 2001a, StreamNet, 2001b):

- Time series information includes: adult abundance (redd counts, peak spawner counts, estimated spawner populations, spawner/recruit estimates); fish counts at dams or weirs; hatchery returns; hatchery releases; and marine and freshwater harvest. Some of these data types (such as spawner population estimates, spawner/recruit estimates, and harvest estimates) are available only when calculated and published by the management agencies.
- Non-time series information includes: fish distribution by species and habitat type; hatchery facilities; dam facilities; and NWPPC designated hydropower protected areas. The project has also provided information on fish and wildlife projects conducted in the basin. StreamNet maintains the 1:100,000 scale regional hydrography (streams layer) and makes it available for download. Smolt density model results are posted and will be updated if they are revised by the management agencies.
- New information currently being developed in conjunction with cooperating agencies includes: barriers to fish migration; habitat restoration projects; stream temperatures beyond those contained in the EPA STORET system; and macroinvertebrates. Only partial data sets are available so far. The temperature and invertebrate data were obtained as part of a prototype project to develop database structures for these data types, but additional funding would be necessary to obtain all such data that exist basin wide.
- Independent data sets, those not developed by StreamNet Project participants or not covered by the formal Data Exchange Format, are also available on the StreamNet website as a convenience to users. These data sets are posted in the format provided by the developer, and may not be regionally standardized. These data sets currently include some mainstem temperature data, stream habitat inventory data, and adipose fin clipping rates for hatchery salmon released in 2000. StreamNet anticipates acquiring and posting data sets from many BPA funded projects in the future, with particular emphasis on resident fish species.
- The StreamNet Library is a full-service library. Its collection focuses on materials relevant to fish and wildlife restoration in the Columbia Basin. The Library contains references for all data held in the StreamNet database, as well as published literature and an extensive collection of fish and wildlife agency ‘gray’ literature, a feature unique to the StreamNet Library. The library has an

on-line catalog that can be accessed via the StreamNet web site. The Library is a repository for the type of documents that receive limited distribution and are often lost without a systematic effort to maintain them. There is no similar alternative collection of this material.

Accomplishments/Results – StreamNet Project

Adaptive Management Implications – *historic and current changes in management, future applications*

The StreamNet Project provides region-wide access to multiple trend data types, including various adult abundance indices, hatchery releases and hatchery returns, that are essential for monitoring and adaptive management. Without this project, some other similar project would be needed to accumulate the same data from the data collecting agencies (the data are not available on the Web) and make them available in regionally consistent formats.

The StreamNet Project has itself been adaptively managed to improve data services and data distribution. The project adopted Internet based data dissemination several years ago, thereby increasing data availability. Recent recognition that some data users are less skilled than others in using the Internet and the Web-based query system, along with the adoption of subbasin scale planning, prompted the project to also develop compilations of data by subbasin and make them available in spreadsheet format on CD and through File Transfer Protocol (FTP). Expressions of concern over how to locate data through the Web-based data query system by inexperienced users prompted the project to prepare a User Guide, with tips on using the system, and post it at the query site. All stream-based data in the StreamNet database are location coded to the 1:100,000 scale hydrography (streams) layer, and all data were recently converted to the Longitude-Latitude Identifier (LLID) system, which is simpler and provides increased capabilities over the older river reach system. When a decision was made to make the new National Hydrographic Dataset (NHD) the national standard hydrography, the project developed an application to convert data between the NHD and the LLID routing systems.

The StreamNet Project anticipates continuing adaptation to regional priorities and needs as they are articulated.

Benefits to fish and wildlife – *role of program efforts in the Council's Program*

The StreamNet Project benefits fish resources by providing fisheries related data that support the research, management, monitoring, planning and restoration efforts in the basin. The fish and wildlife agencies that are responsible for collecting much of the original fisheries related data in the Columbia Basin generally have limited data management programs. Many kinds of data are not managed on a regional or sometimes even an agency-wide basis. Even when they are managed on an agency-wide basis, the data are usually not available over the Internet. StreamNet overcomes this data availability problem by supporting staff directly inside the data collecting agencies to acquire, consolidate and standardize them into a regional Data Exchange Format and then provide them to the regional database for use throughout the basin.

A partial list of specific examples of recent uses of the information and services provided by StreamNet includes:

- Fisheries, fish distribution and habitat-use data have been included in Subbasin Summaries;

- Special literature collections, in electronic format, were developed to support subbasin planning and watershed assessments;
- Population trend data is being used by NMFS in their Salmon Watershed Analysis Model to support recovery planning by the Technical Review Teams;
- Fish distribution data is routinely used by agencies and consultants for the preparation of environmental or biological assessments.
- USFWS is using state agency/StreamNet bull trout data to develop recovery plans and identify critical habitat.
- Specific data not already available in the database is being obtained from individual agency offices and provided to NMFS for use in a Viable Salmon Population assessment;
- Fish distribution data were included in an EPA interactive mapping application;
- Mapping of man-made and natural migration barriers was done for ODFW as part of an effort to develop a barrier removal prioritization model;
- StreamNet provided an appended (all HUCs joined) hydrography layer to NOAA;
- Chinook distribution data were used by U. Washington to assess fish production in relation to agriculture production districts;
- The StreamNet lakes GIS layer is being used as a base for an EPA lakes nutrient assessment project;
- Custom subbasin maps were created for the Northwest Power Planning Council web site;
- The StreamNet Event Mapper tool is being tested by NMFS (Seattle) as a method for georeferencing data, and is already in use with a umber of other data compilation tools, including ODFW's Incidental Fish Observation Database;
- Bull trout distribution data are being used for a mapping project by an environmental non-profit group (The Ecology Center);
- Hatchery location information is being utilized in a University of Idaho project to characterize regional antibiotic use by fish hatcheries;
- Hydrography data layers (stream reach files) were provided to BLM on custom CDs because DOI access to the Internet was closed;
- State DOTs are using fish distribution information as part of the planning and prioritization of culvert improvements;
- A railroad in Washington is using distribution information to help form emergency response plans in case of spills in listed species habitat;
- A linguist uses distribution information from StreamNet to try and work out Native American names of fishes in different areas of the Northwest;
- USFWS has contacted the StreamNet Project to help with collecting, defining, and managing fish barrier information;
- A consultant for the BLM and USFS uses distribution information from StreamNet for writing EISs;
- NMFS in Seattle requested information on which dams had passage facilities and which didn't;
- The StreamNet Library provides research services and access to other state, national, and international library collections through inter-library loans. The Library is the only

source of these services for managers and researchers in the Portland-Columbia Gorge area. These services are available online, by phone, by fax, or in person;
- The Library is currently managing the Northwest Power Planning Council's Fish and Wildlife Library, the USGS-Columbia River Research Laboratory's library, and various materials from other federal agencies;
- Database use logs (monthly average 21,000 visits and 135,000 hits in 2001) show thousands of uses of the data query system and data downloads monthly from state, federal and academic Internet addresses and from an even larger number of Internet addresses that can not be ascribed to specific types of user. However, the anonymous nature of the Internet does not allow us to learn exactly who acquired the data or the purpose it was intended to serve; and
- StreamNet is being increasingly relied upon by fish and wildlife agencies for direct data management support, to begin development of fish and wildlife information systems, and for general data management and GIS services.

Project funding to date – *total amount of BPA funding since program inception*

The StreamNet Project was created by the merger of the Coordinated Information System and the Northwest Environmental Database in 1996. Expenditures under BPA funding since then have been as follows:

FY1996	$1,506,069
FY1997	$1,850,198
FY1998	$1,741,095
FY1999	$1,743,678
FY2000	$2,034,551
FY2001 (budgeted)	$2,071,025

Three fourths of project funding supports data developers/data managers within the cooperating agencies, while one fourth supports the regional database, computer systems, GIS and data services portions of the project. In addition, the cooperating agencies provide in-kind support, which may include salary support, computer equipment and/or services, office supplies, in-state travel, etc. The amount and kind of in-kind support varies by agency.

Reports and Technical Papers – *reports or scientific papers produced as a result of this program and how they have been disseminated*
The primary means of distributing information is through the StreamNet website at www.streamnet.org. The project also provides electronic and paper maps. The project does not publish formal technical papers or reports, but does occasionally produce data summary reports and documentation of the project database, as well as quarterly and annual progress reports. These are mailed or emailed directly to the target agency and are made available through the StreamNet Library or on the StreamNet website at http://www.streamnet.org/about-sn/project_management.html. A partial list of such reports includes:

1. Anderson, D. A., G. Christofferson, R. Beamesderfer, B. Woodard, M. Rowe, and J. Hansen, 1996. Report on the Status of Salmon and Steelhead in the Columbia River Basin
2. Brodeur, S., J. Bowers, C. Cooney, 2000. Data Documentation for the Distribution of Native Sensitive, Threatened and Endangered Anadromous Salmonids in the Willamette Basin. Completion report.
3. Graves, D., 2001. Geographic Information Systems Data: A Description of the StreamNet GIS Data
4. O'Connor, Dick, Rich Tomsinski, Stan Allen, Doug Reece. 1993. Columbia River Coordinated Information System Data Catalog. Bonneville Power Administration contract no. DE-FC79-89BP94402
5. Olsen, Erik, Paige Peirce, Mike McLean, Keith Hatch. [1992]. Stock summary reports for Columbia River anadromous salmonids. 5 v. Bonneville Power Administration contract no.88-108.
6. Roseberry, Ann. 1992. Library resource options: Columbia River Coordinated Information System, phase II.
7. Schmidt, B., 2002. Overview of Adipose Fin Clipping in the Columbia Basin
8. Schmidt, B., 2001 StreamNet Project FY2002 Work Statement
9. Schmidt, B., 2001. StreamNet Fiscal Year 2001First, Second, Third and Fourth Quarter Progress Reports
10. Schmidt, B., 2000. Comments on the Northwest Power Planning Council's Draft Amended Fish and Wildlife Program
11. StreamNet, 2001. StreamNet Online Data Query User Guide
12. StreamNet, 2001. FY 2000Annual Report StreamNet Project
13. StreamNet Steering Committee, 2000. Data Management Issues for Consideration During the NWPPC Fish and Wildlife Program Amendment Process
14. Weber, Earl, Charlie Petrosky, William J. Kinney, Mike Rowe. 1993. Columbia River Coordinated Information System Report on Information Needs. Bonneville Power Administration contract no. DE-FC79-89BP94402.

Relationship with other projects/programs

The StreamNet project maintains close relationships with the fisheries management agencies in the Columbia Basin in order to obtain data for inclusion in the project database. The project also supports the agencies by relieving individual biologists from the need to respond to repetitive requests for information. The project coordinates with other database projects to share data and services, as needed. The project supports other agencies by locating and providing specific data on request. In addition, the Library supports the research of other projects by providing documents and reference services.

Relationship of StreamNet to USFWS/NMFS Biological Opinion – RPAs

In addition to RPA 198, which is specific to development of a regional database program, the StreamNet Project is able to contribute to a number of information and database needs identified in the Biological Opinion:

> ***Action 143:*** *By June 30, 2001, the Action Agencies shall develop and coordinate with NMFS and EPA on a plan to model the water temperature effects of alternative Snake River operations. The modeling plan shall include a temperature data collection strategy developed in consultation with EPA, NMFS, and state and Tribal water quality agencies. The data collection strategy shall be sufficient to develop and operate the model and to document the effects of project operations.*

StreamNet has already developed a database structure (along with temperature data from portions of the Columbia Basin) for storing and managing water temperature data from sources besides the EPA STORET system and the STORET compatible state systems. This database is available for use in the temperature data collection strategy. StreamNet's experience in collecting data from field agencies could be of value in acquiring and organizing temperature data that are already being collected by various agencies as part of the effort under this RPA.

> ***Action 149:*** *BOR shall initiate programs in three priority subbasins (identified in the Basinwide Recovery Strategy) per year over 5 years, in coordination with NMFS, FWS, the states and others, to address all flow, passage, and screening problems in each subbasin over 10 years. The Corps shall implement demonstration projects to improve habitat in subbasins where water-diversion-related problems could cause take of listed species. Under the NWPPC program, BPA addresses passage, screening, and flow problems, where they are not the responsibility of others. BPA expects to expand on these measures in coordination with the NWPPC process to complement BOR actions described in the action above.*

StreamNet has already begun collecting and organizing information on barriers to fish migration, and is exploring the availability of data on diversion screening needs and accomplishments. One state StreamNet project has already developed a database and data entry interface to capture screening related data with the state. NMFS is also considering utilizing this structure to capture Mitchell Act funded project data basin-wide. This database structure and existing information are available for use under this effort.

> ***Action 152:*** *The Action Agencies shall coordinate their efforts and support offsite habitat enhancement measures undertaken by other Federal agencies, states, Tribes, and local governments by the following:*

- *Supporting development of state or Tribal 303(d) lists and TMDLs by sharing water quality and biological monitoring information, project reports and data from existing programs, and subbasin or watershed assessment products.*
- *Participating, as appropriate, in TMDL coordination or consultation meetings or work groups.*
- *Using or building on existing data management structures, so all agencies will share water quality and habitat, data, databases, data management, and quality assurance.*
- *Participating in the NWPPC's Provincial Review meetings and Subbasin Assessment and Planning efforts, including work groups.*
- *Sharing technical expertise and training with Federal, state, Tribal, regional, and local entities (such as watershed councils or private landowners).*
- *Leveraging funding resources through cooperative projects, agreements and policy development (e.g., cooperation on a whole-river temperature or water quality monitoring or modeling project).*

The StreamNet Project has begun synthesizing 303(d) listings with anadromous fish distribution for use in Subbasin Summaries and Subbasin Planning. The project's experience with water quality and fisheries monitoring data and general expertise with databases can contribute to this cooperative effort, if requested.

> ***Action 163:*** *The Action Agencies and NMFS, in conjunction with the Habitat Coordination Team, will develop a compliance monitoring program for inclusion in the first 1- and 5-year plans.*

The existing StreamNet database structure for habitat restoration projects can be used as a means of tracking the actual conduct of specific habitat restoration actions. This could be included as part of the compliance monitoring program, if requested.

> ***Action 166:*** *The Action Agencies shall work with NMFS, USFWS, the Pacific States Marine Fisheries Commission, and Tribal and state fishery management agencies to implement and/or enable changes in catch sampling programs and data recovery systems, including any required changes in current databases (e.g., reformatting) and associated data retrieval systems, pursuant to the time frame necessary to implement and monitor mass marking programs and/or selective fishery regimes in the Columbia River basin. Specifically, the Action Agencies shall facilitate the revision of programs and systems, as needed, by the 3-year check-in.*

StreamNet conducted a prototype compilation of hatchery mass marking and release data for CY 2000. Based on this experience, the project is available to work with the Coded Wire Tag Recovery Program (both administered by PSMFC) to develop an ongoing system of tracking mass marking data for the Columbia Basin.

Action 180: *The Action Agencies and NMFS shall work within regional prioritization and congressional appropriation processes to establish and provide the level of FCRPS funding to develop and implement a basinwide hierarchical monitoring program. This program shall be developed collaboratively with appropriate regional agencies and shall determine population and environmental status (including assessment of performance measures and standards) and allow ground-truthing of regional databases. A draft program including protocols for specific data to be collected, frequency of samples, and sampling sites shall be developed by September 2001. Implementation should begin no later than the spring of 2002 and will be fully implemented no later than 2003.*

The StreamNet Project is experienced in obtaining, organizing and distributing some of the fisheries related data from the management agencies that will be useful in a regional monitoring program. Its links with the management agencies and experience with managing large databases would be particularly useful in contributing to a comprehensive monitoring program.

Action 198: *The Action Agencies, in coordination with NMFS, USFWS, and other Federal agencies, NWPPC, states, and Tribes, shall develop a common data management system for fish populations, water quality, and habitat data.*

The StreamNet Project has supported the need for a comprehensive data management system in various forums, including its comments on the newly revised NWPPC Fish and Wildlife Program and the ISRP review of database projects. It's experience with managing fisheries data across jurisdictions throughout the basin can contribute significantly to development and implementation of such a system. This action can specifically address and resolve a number of the data management challenges listed in the Introduction of this summary, particularly determining priority data needs, filling data gaps, standard approaches to data collection and management, coordination among agencies and database projects, and effective utilization of data management technology. The project is ready to assist with this effort, as requested.

Future Needs – StreamNet Project

Project Recommendations – *existing program needs requiring additional Bonneville funding (for next 3 years)*

Support is needed to assure the continued flow of fisheries related information from the data collecting agencies to address regional data needs. Specific recommendations are listed below. In addition, other data types could be addressed by the StreamNet project at any time priority is established for the data. Actual program scope and cost for new data types would depend on the specific kinds of data needed, their availability within the collecting agencies, and the difficulty of standardization across agency jurisdictions.

1. **Maintain the existing scope and quality of the StreamNet project** over the next 3 years. This will require an estimated 5 percent budget increase each year to cover inflation and other increased operating expenses. Specific additional activities that would contribute to meeting specific regional fisheries information needs would require additional increments in funding.
2. **Enhance functionality of the StreamNet Project**
   a. **Implement interactive online mapping data delivery**. The StreamNet Project is currently developing this capability, but progress is slowed by the fact that the StreamNet GIS Specialist and Programmer are each supported only ¾ of the time by the StreamNet contract. Additional support of these positions would speed implementation of this new technology, thereby improving the ability to provide rapid customized mapping of data on line and simpler access to data through a map based query system. This approach would provide faster access to information, more easily understood output, and a more intuitive approach to locating data.
   b. **Finish development of new databases**, including initial data acquisition. Progress has already been made on database structures and partial initial data acquisition for habitat restoration projects, water temperature, stream invertebrates, culvert and juvenile barrier data, screening and passage, juvenile outmigrant data, hatchery release disposition information, and carcass placement information. However, the work has been slowed by the fact that the project biologist is funded only ¾ time by the StreamNet contract, and additional data technician time will be needed at the state project and regional level to acquire and format data that would be rolled into the existing StreamNet Data Exchange Format.
   c. **Create an information management support team to assist subbasin stakeholders**. A two- to three-person team of technicians would be tasked to respond to detailed requests for information. They would actively pursue acquisition of data from Fish and Wildlife Program funded projects and develop applications to connect with regional data systems. Detailed requests for data are already being received but can be handled only sporadically as current staffing levels allow. This effort could be particularly helpful in providing data to and archiving data from watershed analyses and subbasin planning.

d. **Systematic comprehensive data collection inventory.** There is a tremendous need to inventory all data collection activities in the Columbia Basin regardless of whether they are funded by the FWP or not. An inventory that addresses the 5-w's (who, what, when, where, and why) would allow better coordination between projects and more informed evaluation of existing and new project proposals.

3. Expand data acquisition

a. **Capture resident fish data from FWP funded projects**. StreamNet has already begun reviewing BPA funded projects that may be collecting data about resident fish species. Additional technician support is needed to make it possible to contact all resident fish projects and work with them to capture their fish data and make them available in the online database

b. **Acquire data for Viable Salmon Population determinations**. A pilot project in the Willamette and Lower Columbia Province demonstrated that significant amounts of data useful for the NMFS VSP analysis exist in various agency offices but are not readily available. A data acquisition specialist is needed in each of the three anadromous basin states to work within the management agencies to locate, acquire and organize these data and provide them to NMFS and the Technical Review Teams developing recovery plans. The work would be conducted by subbasin and thus would also support Subbasin Planning. These would be temporary positions lasting only until all subbasins were complete.

c. **Develop resident and non-game fish species distribution data**. StreamNet has developed anadromous fish / habitat distribution data and parts of certain resident species distribution. Additional support at the state project level is needed to compile data for resident fish species (to finish for salmonids and extend to non-game native species) and make them available via the StreamNet on-line query system.

4 Maintain and Improve Library services

a. **Provide adequate storage and access for Library materials**. Recent addition of the NWPPC collection, the USGS CRRL collection and other collections of regional importance have increased Library space needs. Shelf space is almost completely utilized at present, and additional space will be needed for additional references for new data added to the StreamNet database.

b. **Digitize key reference materials**. Demand is increasing for access to library material in electronic format. Given the size of the basin, many people can not visit the StreamNet library in person. The temporary addition of 1.5 FTE will enable the library to scan an array of existing and historic reports and data and make them available on-line or on CD to meet the growing need. This will greatly expand access to the unique materials in the library. Also, many agencies have archive copies of old reports and publications that are not widely available and in some cases are rare and in danger of being lost. These materials would be preserved by scanning into electronic format.

Needed Future Actions – *new program needs within the basin needing Bonneville funding and how these needs fit with the overall basinwide goals and objectives*

The flow of fisheries related data from the data collecting agencies to region-wide distribution is hampered by the lack of comprehensive data management programs within many of the state, tribal and federal fish management agencies. Despite the existence of some hatchery program databases and individual data management efforts, most agencies have not been able to fund comprehensive approaches to data management. This is the result of many of the challenges described in the Introduction of this summary, particularly the fact that most of these agencies are funded and mandated to meet their own specific management responsibilities, not necessarily regional data needs. In many cases, comprehensive data management has not been seen as essential to meeting agency responsibilities, since agency responsibility stops at agency boundaries.

Development of data management programs within the data collecting agencies would facilitate flow of information to meet regional needs as well as benefit direct agency operation. Such programs would facilitate analysis of data on a statewide or agency-wide basis, reducing the time currently required. Such systems would also create an efficient electronic flow of data from the field to the regional data system, facilitate the use of standards in data collection and coding, and remove the burden of data system development from field biologists. Since there would be both agency and regional benefits, a shared approach toward funding such programs would seem logical.

Discussion of this need should be considered in regional and interagency efforts to develop a comprehensive regional approach to data management as called for under RPA Action 198.

StreamNet References

StreamNet, 2001a. StreamNet Data Inventory By Province/Subbasin

StreamNet, 2001b. Exchange Format Documentation - Version 2001.1

Section 3: Second-Tier Database Support

Program Description

The DART (Data Access in Real Time) data site archives data and provides online analysis of real-time and historical data gathered from other regional databases. Services include: fish travel-time and survival analysis from PIT tag data, real-time tracking and predictions of juvenile and adult hydrosystem passage and water quality, graphical query, display, and analysis tools for salmon passage and water quality data from 1949 through the present. DART staff also provide specialized analyses for regional scientists and managers upon request.

Purpose of Program – technical and/or scientific background

DART has developed a number of tools to assist researchers in assembling data through their web site. These include:

- *Release and observation summary*: This new DART tool allows users to examine summaries of PIT-tagged fish by release information, observation information, or a combination of both. Summaries can be generated by species, run, rearing-type, release year, tag coordinator, release location, detection year, and detection site. It provides the total number of PIT-tag releases, the number of fish released in the user-selected group, and a summary of their detection history including adult returns.
- *JavaDart*: A JAVA-based data extraction tool allows users to query the fish passage and river properties database in a more powerful and flexible manner. It contains expanded graphing capabilities, error removal and data-smoothing algorithms. (http://www.cbr.washington.edu/dart/javadart/)
- DART provides daily information on the in-season passage for smolt and adult salmon (http://www.cbr.washington.edu/crisprt/index.html). The information includes historical passage prediction information and in-season predictions generated by models:
    - RealTime (http://www.cbr.washington.edu/rt/rt.html), CRiSP (http://www.cbr.washington.edu/crisp/crisp.html) and
    - Adult upstream model (http://www.cbr.washington.edu/crisprt/info_adult.html). These derived data are intended to provide managers with information to assess fish performance during hydrosystem passage.

Scope of Program

Management application, geographic scope, and species populations affected/benefited (include a description of the area that is affected by this effort in relationship to the mainstem dams – identify if the program has a systemwide impact affecting all or most fish

populations, an impact on all or most populations above a dam or an impact on all or most populations below a dams or between a set of dams.)

The DART database provides fisheries related data from multiple agencies throughout the Columbia Basin. The DART website collects data from regional data sites on a daily basis and uses the information to characterize the progress of the juvenile and adult salmon passage through the Columbia River system. Using DART's historical and real time data and projections of the flow for a season, the DART website provides in-season forecasts on fish passage and water quality. Specific forecasts within a passage season are listed below:

- Snake River Smolt Passage (PIT Tag) daily timing, survival, and transport predictions
- Columbia River Smolt Passage (Passage Index) passage predictions and historical timing graphs
- Columbia River Smolt ESU Passage (PIT Tag) passage predictions and historical timing graphs
- Water Quality total dissolved gas and water temperature forecasts and historical observed data
- Columbia / Snake River Adult Passage predictions at dams

DART has a variety of data analysis features that are integrated with the database and allows web users to perform preliminary data analyses of fish passage information directly through the database and analysis tools. These include:

- *Standard DART tools*: The DART database has a variety of standard data extraction and graphing tools that allow web users to query data by location and time plot data. These have been in use five years and are frequently used by web users to track the status of fish runs and flows in the Columbia / Snake River system.
- *Travel Time analysis*: This new DART tool allows users to generate the mean travel time of pit-tagged fish based on the selection criteria in the Release and Observation summary. Mean travel time estimates can be generated for PIT-tag groups as defined by user selections for species, run, rear-type, release year, tag coordinator, release location, detection year, and detection site.
- *Survival analysis*: This new DART tool allows users to generate Cormack/Jolly-Seber estimates of the survival fractions of pit-tagged fish based on the selection criteria in the Release and Observation summary. Survival estimates can be generated for PIT-tag groups as defined by user selections for species, run, rear-type, release year, tag coordinator, release location, detection year, and detection site.
- *10 year averages*: As data are collected, DART automatically calculates the 10 year averages for a given month and day based on the current year's data and the preceding nine years data on that date. These 10 year averages are made available the following year.
- *Endangered Species Data*: This DART suite of tools provides information about ESU populations as defined by NMFS and based on PIT-tagged fish. The ESU report and analysis tools include: detailed detection histories, graphical and tabular detection summaries, mean travel time estimates, and run predictions presented in graphical form.

- *Northwestern Regional Temperature Data Analysis*: A specialized analysis within DART derives seasonal stream temperature profiles using primary data from the EPA STORET database. Algorithms fit the temperatures with three and six parameter algorithms to generate complete seasonal profiles for hundreds of streams in the NW.
- *Exposure Analysis*: this service, available for spring 2002, integrates river flow, temperature, and total dissolved gas distributions with fish distributions to provide a real-time spatially explicit picture of the exposure of juvenile and adult salmon to water quality properties. The analysis includes tools for synthesizing environmental and biological data. Temperature profiles for NW regional streams are developed in a systematic manner and applied to fish presence. Daily water temperatures for the mainstem of the Columbia and Snake rivers are used directly where daily fish distributions are also known. Annual temperature profile parameters are related to surveyed presence / absence information for other streams and temperature compliance in streams is illustrated with spatial temporal mapping tools.

Accomplishments / Results – Second-Tier Database Support

Adaptive Management Implications – *historic and current changes in management, future applications*

The DART site provides web accessible real-time and historical databases to regional researchers for analysis, and for managers to track the status of fish migration and water quality. For example, DART's in-season real-time prediction tools have been used to coordinate spill operations during the smolt migration. DART's graphical tools allow users to easily review and compare historical data to in-season fish migration and water quality information. These tools have been used to evaluate the impacts of hydrosystem operations on juvenile and adult fish passage by a number of Agencies.

Benefits to fish and wildlife – *role of program efforts in the Council's Program*

DART provides the research and management communities and the public with valuable information related to the Columbia River hydrosystem and its fisheries. The site brings together information from various databases and presents the data in formats useful to issues related to Columbia River fisheries. This information can be accessed directly through the DART website using the GUI and interface tools. Other benefits involve assisting users. The main benefits to the fish and wildlife are through the assistance provided to researchers and managers. The main contributions are listed below.

- *Forecast tools* provide preseason and in season forecasts of the passage of juvenile and adult salmon and steelhead through the river system as well as river properties including temperature and dissolved gas levels. These tools are used by managers to coordinate in season hydrosystem operations. The tools are listed in the description of DART in the Section A.2.d "Data management projects within the Fish and Wildlife Program".
- *Analysis tools* provide researchers access to web-based analysis of fish migration and river conditions. The tools are listed in the description of DART in the Introduction under "Data management projects within the Fish and Wildlife Program".
- *DART Databases* provide users a single portal of information relevant to specific interests of researchers, managers and the public. The databases are listed in the description of DART in the Introduction under "Data management projects within the Fish and Wildlife Program"
- DART staff provides *data assembly and analysis assistance* to users in the region. A partial list of requests for 2001 is below:
    - Assemble Snake River PIT-tagged data, D. Goodman, Montana State U.
    - Bonneville Temperatures, L. Weiland, Columbia River Research Lab
    - Running totals for adult passage, G. Kladis, (Assoc. unknown)
    - Fish passage metadata, Michele Ferry, Olympic Natural Resource Center
    - Adult return data, Aida Kelsaw-Rashad, BPA
    - 10yr av. for coho & sockeye, J. Rowan, Fish and Wildlife Division BPA
    - Added multiple river parameter graphing capability, C. Ross, NOAA
    - Temperature & temperature metadata, A. Matter, NOAA

- Carson Hatchery SAR data, Dr. R. N. Williams, ISRP
- Columbia Basin Flow data, M., Miller, Tabors Caramanis and Associates
- Jack counts, J. Thomson, Washington State University
- Spill data, Dr. R. N. Williams, IDFG
- Lower Granite flow summaries, S. Hannula, Resources
- Columbia monthly flow averages, Wa. State Senator R. Morton
- LGR temperature metadata, C. A. Haskell, USGS
- Turbidity data from 2000, S. Smith, NOAA
- RRH forebay data corrections, H. Owen, Chelan County PUD
- CWT metadata, P. Pira, (Assoc. unknown)
- Adult passage metadata, R. Dick Jr, Yakima Nation
- Turbidity metadata, M. Miller, BioAnalysts, Inc.
- Project pool elevation report, E. Schrepel, NW Power Planning Council
- Adult counts, Dr. E. Buettner, IDFG
- Adult passage, M. L. Keefer, Idaho Cooperative Fish and Wildlife Unit
- Adult data corrections, G. Matthews, NOAA
- Adult Migration rates, S. O'Brien, (Assoc. unknown)
- Adult passage, D. Venditti, IDFG
- Adult passage, M. McLean, C.T.U.I.R
- PTAGIS metadata, R. P. Mueller, Battelle PNNL
- Release and observation summaries for Yakima Basin, D. Larsen, NOAA
- Lower Granite flows, S. Addis, NewsData Corp
- Adult passage, R. Garrett, Western White Water Assoc.
- PTAGIS metadata, A. Reischauer, Eastern Oregon University
- River Environment queries, R. Igau, El Paso Corporation
- PIT-tag passage, B. Jonasson, Oregon Department of Fish and Wildlife
- Release and observation summaries, R. Reagan, USGS
- Spill and smolt passage, R. Walton, PPC
- PTAGIS metadata, R. Bayer, OSU Hatfield Marine Science Center
- Survival estimates, M. Blenden, NezPerce Tribe
- Add run variable to release site report, G. McMichael, Battelle- PNL
- Lake Roosevelt elevations, A. Squier, Lake Roosevelt Forum
- TDA flows, T. Chommany, Utilicorp
- Historical data on the returns at Bonneville, Vernon B Jeremica,
- Graphics capabilities, S. Yonce, MTPower
- Flow data, T. Zeppetella, AE global markets

- Web usage: Total DART weekly accesses exhibited an upwardly increasing seasonal cycle of use corresponding with the salmon migration season. System shutdowns due to equipment failure and a security attack illustrate the essential need for adequate hardware and software maintenance. Figure 2 shows the monthly increase DART usage over the past four years. The usage nearly doubling each year.

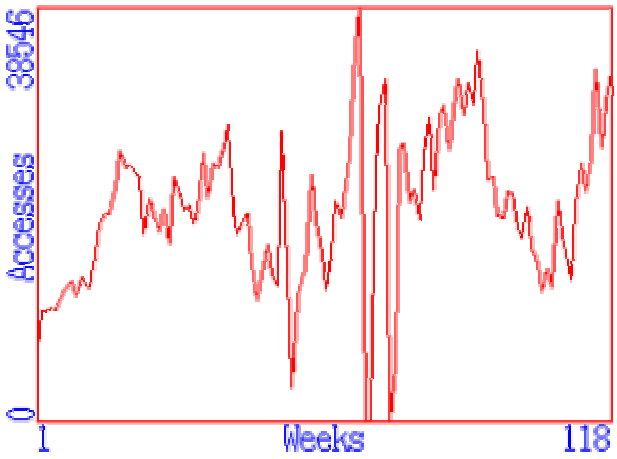

Figure 1. Weekly accesses to web server. Week 1 begins January 1, 2000; Week 88 begins September 1, 2001.

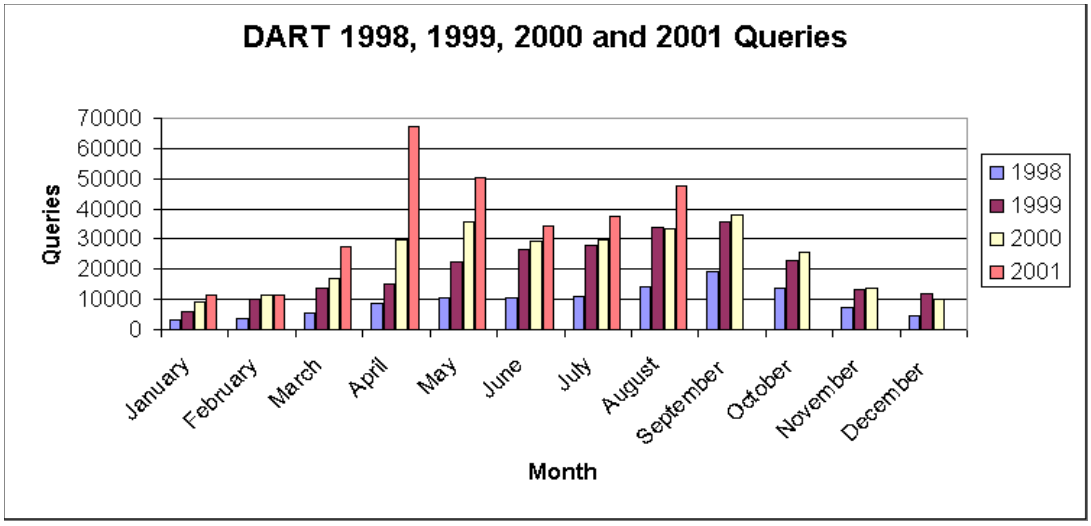

Figure 2. The chart represents Columbia River DART data query requests made during 1998, 1999, 2000 and 2001. Columbia Basin Research staff queries and other extraneous queries have been removed from the final counts.

Project funding to date – *total amount of BPA funding since program inception*
DART has provided web-based data to the region since 1994. Prior to this DART was not identified as a separate project. Funding over the last four years is below:

FY1998	$195,000
FY1999	$185,000
FY2000	$180,000
FY2001 (budgeted)	$250,111

Reports and Technical Papers – *reports or scientific papers produced as a result of this program and how they have been disseminated*

DART disseminates data via the web to researchers and managers. A library of papers and reports is available http://www.cbr.washington.edu/papers/. Web publications directly related to the real-time program are listed below.

1. Evaluation of the 2000 Predictions of the Run-Timing of Wild Migrant Yearling Chinook and Water Quality at Multiple Locations on the Snake and Columbia Rivers using CRiSP/RealTime W. Nicholas Beer
   Susannah Iltis, Chris Van Holmes, James J. Anderson.
2. Evaluation of the 1999 Predictions of the Run-Timing of Wild Migrant Yearling Chinook and Water Quality at Multiple Locations on the Snake and Columbia Rivers using CRiSP/RealTime W. Nicholas Beer
   Susannah Iltis, Chris Van Holmes, James J. Anderson.
3. Evaluation of the 1998 Predictions of the Run-Timing of Wild Migrant Yearling Chinook and Water Quality at Multiple Locations on the Snake and Columbia Rivers using CRiSP/RealTime W. Nicholas Beer, Joshua A. Hayes, Pamela Shaw, Richard Zabel, James J. Anderson
4. Evaluation of the 1996 Predictions of the Run-Timing of Wild Migrant Yearling Chinook at Multiple Locations in the Snake and Columbia River Basins using CRiSP/RealTime - Joshua A. Hayes, Richard Zabel, Pamela Shaw, James J. Anderson
5. Various reports continued within the website: Real-time Temperature Predictions, Brief description of TDG model and predictions

Relationship with other projects/programs

Relationship of Second Tier to USFWS/NMFS Biological Opinion – RPAs

DART can contribute to a number of the Reasonable and Prudent Alternatives detailed in the Biological Opinion.

> ***Action 143:*** By June 30, 2001, the Action Agencies shall develop and coordinate with NMFS and EPA on a plan to model the water temperature effects of alternative Snake River operations. The modeling plan shall include a temperature data collection strategy developed in consultation with EPA, NMFS, and state and Tribal water quality agencies. The data collection strategy shall be sufficient to develop and operate the model and to document the effects of project operations.

DART has under development a web page and associated tools to integrate water temperature with fish distributions (http://www.cbr.washington.edu/data/Streams/). Temperature profiles for NW regional streams are developed in a systematic manner and applied to fish presence. Daily water temperatures for the mainstem of the Columbia and Snake rivers are used directly where daily fish distributions are also known. Annual temperature profile parameters are related to surveyed presence/absence information for other streams.

> ***Action 152:*** The Action Agencies shall coordinate their efforts and support offsite habitat enhancement measures undertaken by other Federal agencies, states, Tribes, and local governments by the following:
>
> - Supporting development of state or Tribal 303(d) lists and TMDLs by sharing water quality and biological monitoring information, project reports and data from existing programs, and subbasin or watershed assessment products.
> - Participating, as appropriate, in TMDL coordination or consultation meetings or work groups.
> - Using or building on existing data management structures, so all agencies will share water quality and habitat, data, databases, data management, and quality assurance.
> - Participating in the NWPPC's Provincial Review meetings and Subbasin Assessment and Planning efforts, including work groups.
> - Sharing technical expertise and training with Federal, state, Tribal, regional, and local entities (such as watershed councils or private landowners).
> - Leveraging funding resources through cooperative projects, agreements and policy development (e.g., cooperation on a whole-river temperature or water quality monitoring or modeling project).

DART is an existing data management structure that provides to all agencies a portal to mainstem information that otherwise is distributed across a number of regional databases. DART has a significant number of users because it is tailored to present diverse information in forms the users require.

> ***Action 166:*** The Action Agencies shall work with NMFS, USFWS, the Pacific States Marine Fisheries Commission, and Tribal and state fishery management

agencies to implement and/or enable changes in catch sampling programs and data recovery systems, including any required changes in current databases (e.g., reformatting) and associated data retrieval systems, pursuant to the time frame necessary to implement and monitor mass marking programs and/or selective fishery regimes in the Columbia River basin. Specifically, the Action Agencies shall facilitate the revision of programs and systems, as needed, by the 3-year check-in.

DART in conjunction with the Adult Real-time forecaster is developing a system that will aid in selective fisheries management in the mainstem.

Action 180: The Action Agencies and NMFS shall work within regional prioritization and congressional appropriation processes to establish and provide the level of FCRPS funding to develop and implement a basinwide hierarchical monitoring program. This program shall be developed collaboratively with appropriate regional agencies and shall determine population and environmental status (including assessment of performance measures and standards) and allow ground-truthing of regional databases. A draft program including protocols for specific data to be collected, frequency of samples, and sampling sites shall be developed by September 2001. Implementation should begin no later than the spring of 2002 and will be fully implemented no later than 2003.

The DART project is developing analysis tools that query the DART database and provide real-time information on the performance of juvenile and adult passage through the mainstem. Information will include the fractions of specified stocks in which their passage through the hydrosystem is within selected temperature, flow and gas performance measures. This information will be updated on the web daily.

Action 198: The Action Agencies, in coordination with NMFS, USFWS, and other Federal agencies, NWPPC, states, and Tribes, shall develop a common data management system for fish populations, water quality, and habitat data.

Since DART was created by joining an INGRES database with custom html based GUI and went up on the web in 1994, six months after the birth of the worldwide web via the MOSAIC web browser, DART has had as its goal a comprehensive and common database management system for the region. In subsequent years the DART interface, analysis tools, and databases were steadily improved and expanded. With these eight years of experience, the DART staff is in position to contribute to the next evolution of distributed environmental databases.

Future Needs – Second-Tier Database Support

Project Recommendations – *existing program needs requiring additional Bonneville funding (for next 3 years)*

Five DART Objectives are identified over the next 3 years:

1) Maintenance of the existing DART system
2) Maintenance and expansion of the real-time prediction tools
3) Continued development of data analysis tools
4) Participate in regional planning and development of integrated database
5) Contribute to harvest management improvement.

Continuing with Objectives 1) and 2) will require current support with a 5% yearly increase to cover increasing costs and continued replacement of aging equipment. Objectives 3) and 4) together require an additional FTE. Objective 5) requires an FTE as well as additional support from other agencies. Brief details of the objectives are listed below.

- Maintenance of existing database system: Provide electronic data integration services to generate data sets needed by FWP and ESA modeling, monitoring, and evaluation efforts. This effort includes support to the Regional Forum, including the Technical Management Team (TMT) Internet information system. The effort generally involves coordination of access to and update of information already in digital form, possible "mirroring" of that data in the DART database service, and generation of required data sets.
- Continue and expand the Real-time monitoring and predictions of passage and river conditions. Currently DART, in a joint effort between Drs. Skalski and Anderson, provides real-time information and predictions on smolt and adult passage and water quality information. These activities will expand with the Exposure Analysis to quantify the exposure of the passing fish to temperature, gas spill, and flow conditions. The prototype Exposure Analysis tool will be available in the spring of 2002.
- Continue to develop tools to increase flexibility of web-based access to distributed databases and analysis through web browser tools. New web-based software will allow more complex analysis of fish survival and travel time properties and their exposures to water quality factors.
- Participate in the regional distributed database development. The ISRP review of regional fish and wildlife databases (June 2000 report on Databases http://www.nwcouncil.org/library/isrp/isrp2000-3.pdf) indicated the need for a distributed database system using the existing database services. Integration of regional data will involve new technologies (i.e., XLM, eXtensible Markup Language) and, as noted above, significant changes to the institutional framework that defines the goals and funding levels of the database centers. The DART staff believes that technological and institutional issues must be addressed simultaneously. The technological issues may be simpler, and here DART staff proposes to explore a number of XML flavors, including the Microsoft .NET framework and the Sun Microsystems' JavaBean (EJB).

Working within the DART system or in concert with a cooperating database center, a prototype distributed database example will be developed. We feel gaining a first hand knowledge of these technologies is required to address the institutional issues. At the institution level, DART staff will then be prepared to contribute to addressing the difficult issue of how database centers need to change to evolve the distributed coordinated database system.

- Over the next year, Columbia Basin Research will propose to expand activities to assist in database management and real-time prediction of ocean harvest. In this objective the DART database and real-time prediction concepts developed for real-time smolt and adult passage monitoring and predictions (CBR 2001a) will be applied to harvest management. The DART structure, in which diverse information from regional databases is gathered and used in real-time analysis, is directly configurable to the needs of river and ocean harvest. CBR's COAST harvest model (CBR 2001b), which is being adapted by the Chinook Technical Committee for harvest management, will be used for harvest modeling. Similar to the DART real-time passage projections, real-time harvest tasks are expected to involve preseason model configuration and calibration, followed by preseason and in-season predictions of ocean and river harvest impacts on stock recruitment. **Note:** harvest management is a very large, very complex activity involving multiple institutions. Previous efforts to develop a real-time in-season harvest capability have not been entirely successful. To successfully develop an in-season harvest capability the agencies with responsible for managing the regional harvest need to embrace and actively participate in the effort, which will involve data collection, real-time database management, model development, calibration, and web design and implementation. Multiple sources of support will be required to develop a real-time harvest management system, which extends beyond the purview of the Columbia River. The objective is noted here since part of the effort would fall under database activities.

Needed Future Actions – *new program needs within the basin needing Bonneville funding and how these needs fit with the overall basinwide goals and objectives*

A large amount of effort is needed to meet the regional challenge of developing a common data management system for fish populations, water quality, and habitat data as called for in RPA Action 198. The DART staff is capable of providing significant experience toward that effort.

Second-Tier Database Support References

CBR 2001a. Inseason forecasts. http://www.cbr.washington.edu/crisprt/index.html

CBR 2001b. Coast Model Documentation Manual.
http://www.cbr.washington.edu/harvest/coastmodel.pdf

Appendix A. Partial Overview of Information Sources

Table 1. Partial overview of currently available information sources of relevance to Columbia Basin fish and wildlife (R=Real-time, F=fixed, P=Periodic updates, including historic time series data).

Climate, Weather, Ocean	
National Climate and Weather Center **(R)**	Historical and current climate and weather data worldwide. Numerous parameters available.
USDA NRCS **(R)**	Historical and current Snotel data from throughout the western states (accumulated precipitation, snow depth, snow-water equivalent, max temp, min temp, avg temp, temp at observation time.
National Weather Service (NWS), Boise, Portland, Seattle(**R**)	Daily temperatures and precipitation for NWS sites
National Data Buoy Center (**R**)	Current (Real-Time) and historical meteorological and oceanographic data Buoy reports include wind direction, speed, gust, significant wave height, swell and wind-wave heights and periods, air temperature, water temperature, and sea level pressure. Some buoys report wave directions. All C-MAN stations report the winds, air temperature, and pressure; some also report wave information, water temperature, visibility, and dew point.
Pacific Marine Environmental Laboratory TAO project(**R & P & F)**	Historical and Real-time data from moored ocean buoys for improved detection, understanding and prediction of El Niño and La Niña.
Pacific Fisheries Environmental Laboratory (**R & P & F)**	• Upwelling and transport Indices • Derived Wind and Ocean Transports • Northern/Southern Extratropical Oscillation Index (NOIx, SOIx) • 500mb Height • Surface Winds • GTS Surface Temperature and Anomaly GTSPP Subsurface Temperature
Shore Stations Program, University of California, San Diego **(R)**	Surface Water Temperature, Salinity and Densities at Shore Stations, U.S. West Coast
Fish Migration	
The Chelan County Public Utility District **(R)**	Adult Passage at Rock Island and Rocky Reach Dams

The Douglas County Public Utility District **(R)**	Adult Passage at Wells Dam
The Grant County Public Utility District **(R)**	Adult Passage at Priests Rapid Dam
Washington Department of Fish and Wildlife **(R)**	Ballard Locks Adult Sockeye counts
Oregon Department of Fish and Wildlife **(R)**	Adult passage at Leaburg Dam and Willamette Falls
US Army Corp of Engineers: (**R & F)**	Adult passage at 12 mainstem Dams
Yakima Klickitat Fisheries Project **(R)**	Adult and juvenile passage data for Yakima basin salmon
Umatilla Tribal Fisheries Program**(R)**	Adult passage data for Umatilla basin salmon
Pacific States Marine Fisheries Commission • RMIS: Regional Mark Information System **(P)** • PTAGIS: PIT tag Information System**(R)**	Contains coded-wire tag information for Alaska, Washington, Oregon, California, and British Columbia Contains PIT-Tag information for the Columbia Basin
Fish Passage Center (FPC) (**R & P)**	Current and historic data on salmon and steelhead smolt counts and indices, adult passage, and Gas Bubble Trauma at projects on the mainstem Snake and Columbia rivers.
Harvest	
Pacific States Marine Fisheries Commission • AKFIN: Alaska Fisheries Information Network **(P)** • RMIS: Regional Mark Information System **(P)**	Annual reports on Alaskan Fisheries Catch-Effort database
NOAA-NMFS: (**P**)	Commercial and Recreational Marine landings
StreamNet Project (**P**)	Freshwater/estuary sport harvest, marine harvest
Water	
United States Geological Survey: **(R)**	Flows, stage height, and temperatures from real-time stations throughout the NW.
State departments of water resources (**R**)	Water rights, stream flows, and water diversion in the respective states
StreamNet Project (**F**)	1:100,000 scale hydrography (stream layer)
Ground water data	
United States Army Corps of Engineers**(R)**	Project-specific flow and water quality data for Columbia Basin Projects

United States Bureau of Reclamation**(R)**	USBR project data
Fisheries	
StreamNet: Northwest Aquatic Information Network **(F & P)**	Contains historical fish and habitat data for Washington, Oregon, Idaho and western Montana • Hydrography • Adult Return-Estimates of Spawning Population • Peak/Other Spawning Counts • Redd Counts • Spawner/Recruit Estimates • Fish & Wildlife Projects • Fish Distribution • Habitat Restoration/Improvement Projects • Harvest-Freshwater/Estuary Marine Releases Returns • Protected Areas • Stream habitat, water quality, invertebrates (partial)
Habitat	
USGS data-sets: **(F)**	GIS Land use/groundwater/agricultural data/soils/chemical use
USDA NRCS **(F)**	NW Soils maps
Washington Department of Transportation: **(F)**	GIS data for transportation uses
US Forest service **(F)**	• Interior Columbia Basin Ecosystem Management Project GIS data on aquatic, atmospheric, cultural, demographic, disturbance, fisheries, and vegetation variables • Natural Resources Information System, under development, will include wide array of natural resource information on FS lands.
Northwest Habitat Institute**(F)**	GIS data on habitats, wildlife of the Columbia Basin
Oregon Department of Fish and Wildlife **(F)**	• Aquatic Habitat Inventory Project • Surveys freshwater salmonid habitat conditions statewide
Washington Department of Fish and Wildlife **(F)**	• The Salmon and Steelhead Habitat Inventory and Assessment Program • Characterizes freshwater and estuary habitat conditions and distribution of salmonid stocks in Washington at the 1:24,000 scale. In Progress
NatureMapping **(P)**	Community-based water quality monitoring from 200 (and growing) sites in Washington.
SalmonWeb **(P)**	Community-based monitoring of index of biological integrity in Northwest.

Appendix B. Adaptive Management Framework

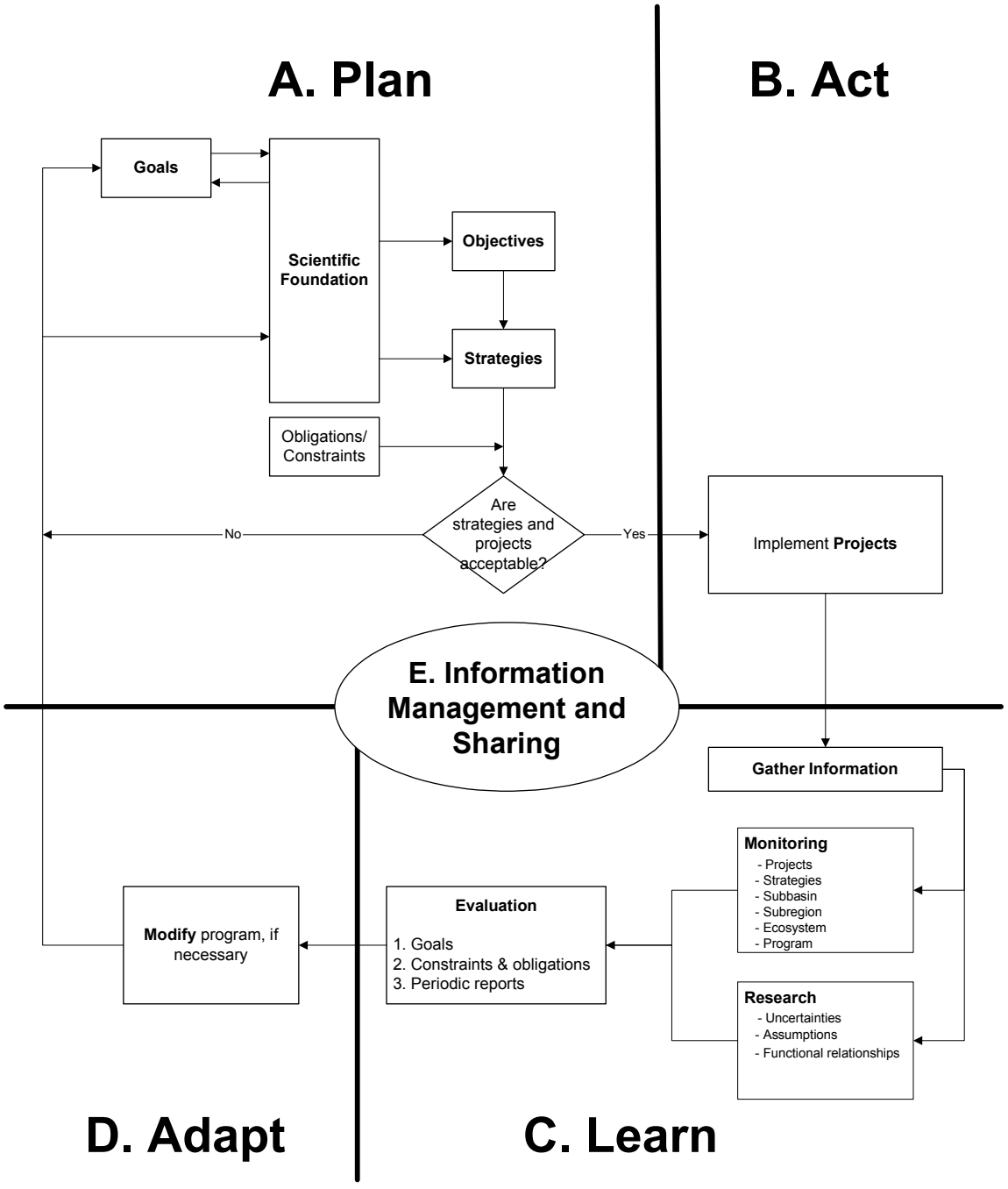

Figure 1. Detailed elements of an adaptive management program framework.