AN ABSTRACT OF THE THESIS OF

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The Lamprey Eel Decline project conducted by the Confederated Tribes of Siletz Indians (CTSI) combined traditional ecological knowledge, scientific research and geographic information science. CTSI wanted to learn why the Pacific lamprey (*Lampetra tridentata*), a culturally and ecologically important species, was declining in the streams within their native land area. The project included interviewing native elders, characterizing stream habitat, monitoring water quality, creating a geographic information system (GIS) and educating tribal members on the cultural and ecological importance of the Pacific lamprey. Dynamic segmentation, a GIS data structure, was used to link standard stream survey data on the river unit scale to a base stream coverage (1:24,000). Dynamic segmentation efficiently associates georeferenced data to a linear feature, thus allowing the data to be readily assessable on desktop computer systems. To be more useful to the tribal and local resource managers, it is recommended that these GIS coverages of aquatic habitat should be used in

conjunction with additional data coverages and basic regional models for watershed analysis and better management of aquatic ecosystems.

The Potential of Dynamic Segmentation for Aquatic Ecosystem Management: Pacific Lamprey Decline in the Native Lands of the Confederated Tribes of Siletz Indians (Oregon, USA)

by
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Dean of Graduate School

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The Potential of Dynamic Segmentation for Aquatic Ecosystem Management: Pacific Lamprey Decline in the Native Lands of the Confederated Tribes of Siletz Indians (Oregon, USA)

Chapter 1
Introduction

The use of geographic information systems (GIS) as a management tool is becoming increasingly popular with resource managers. GIS are now well known for their ability to display, store and analyze spatial data. The decision-making process in natural resources lends itself well to the use of a GIS because the data are inherently spatial and models exist for ecosystem processes. Historically, the focus has been on descriptive mapping (inventory). However, as GIS becomes more powerful this focus has shifted to prescriptive mapping (analysis) as decision-making becomes increasingly more quantitative (Berry and Ripple 1996).

Wide, planar terrestrial systems are logical candidates for GIS because they are fairly well represented by raster cells or polygons. However, riverine systems pose a unique challenge because they do not generally cover wide areas on the ground, and are better represented using lines. Riverine systems may have many ecological attributes over a short distance, making them more challenging to associate to features. A relatively new data structure, dynamic segmentation, can be used to associate attributes with linear features (ESRI 1994). The Lamprey Eel Decline (LED) project begun by the Confederated Tribes of the Siletz Indians (CTSI) in 1996, is a prime example of the application of dynamic segmentation to natural resource management. The LED project combines traditional ecological knowledge (TEK) (tribal interviews), wildlife biology (compilation of biological and ecological requirements of the Pacific lamprey (*Lampetra tridentata*), habitat assessment (aquatic habitat survey data from Rock Creek, Oregon) and a GIS (using dynamic segmentation) to address resource management questions, such as: Why is the lamprey declining? What should we do the reverse the trend? Where are good restoration sites?

In 1994, CTSI conducted interviews of tribal elders which were published in a report entitled "SKWAKOL: The Decline of the Siletz Lamprey Eel Population During the 20th Century" (Downey et al. 1996). The interviews documented a recent population decline of the Pacific lamprey in creeks on historical tribal lands. The Pacific lamprey is an anadromous, jawless, eel-like vertebrate native to Pacific Northwest coastal streams. The lamprey was used by local tribes for food, ceremonial and medicinal purposes. CTSI tribal elders voiced concern that they were losing part of their cultural heritage and that the tribe should focus on restoring lamprey populations. In addition to serving as a guide for further research, these interviews provided valuable background information on the local lamprey populations. The completion of the interviews led to the LED project, which investigated factors of the lamprey decline in Rock Creek and Little Rock Creek of the Siletz River basin, Oregon (Figure 1).

The LED project focused on the Rock Creek watershed, located within the historical land base of the CTSI and on the Pacific lamprey, a traditional food source for the tribe. The LED was designed to address the following issues: causal factors of the lamprey population decline, healthy ecosystem requirements for the lamprey, design of a GIS for sustainable ecosystem management, and cultural and

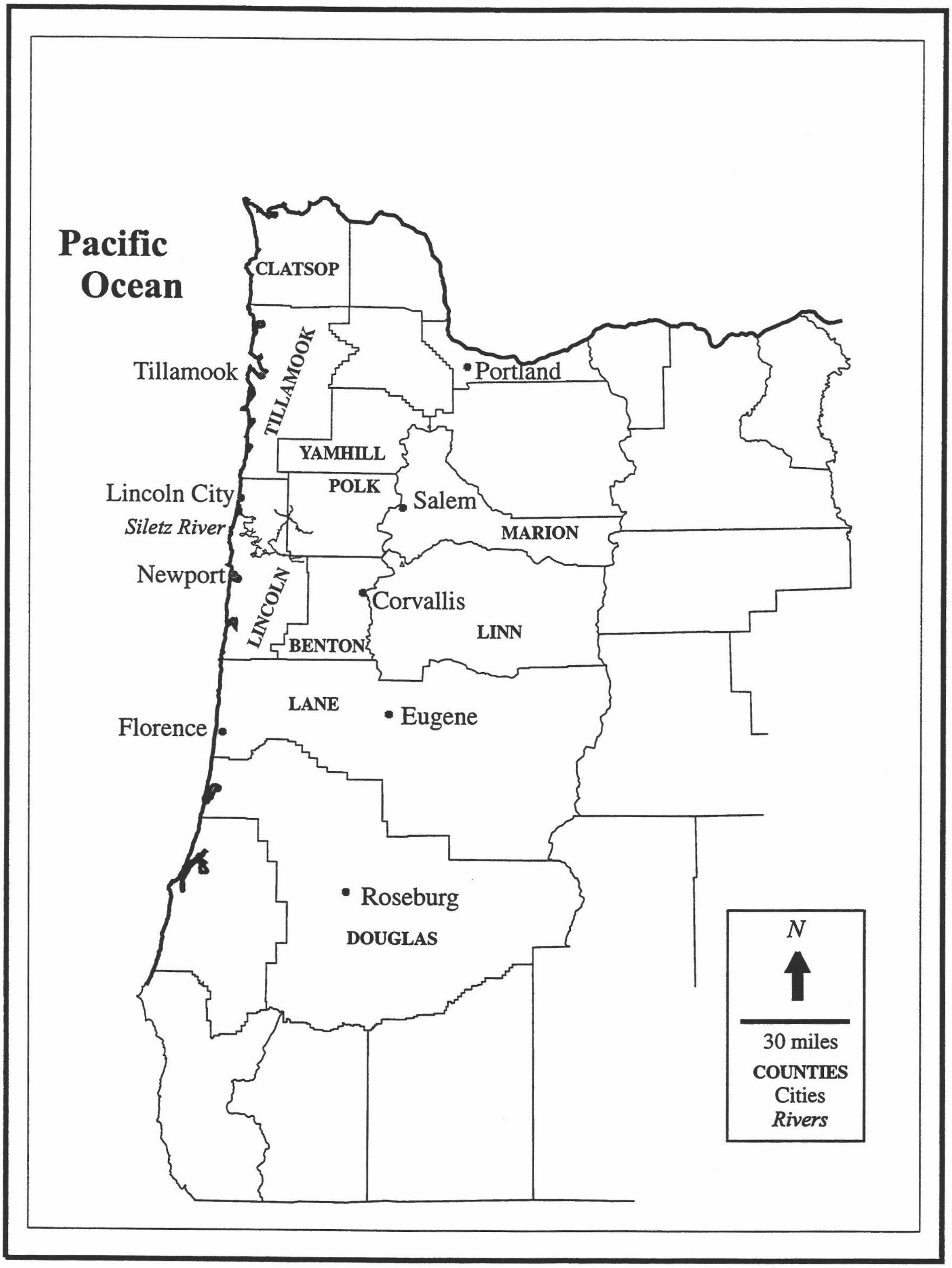


Figure 1 *Map of Western Oregon and the Siletz River (Reproduced with permission from Downey et al. 1996)*

environmental education for tribal members. The project was unique in that it integrated TEK with scientific research and modern-day GIS technology to understand the plight of the lamprey and make sound resource management decisions.

Before its decline, the lamprey was an important part of the Siletz Indian lifestyle. The lamprey is a high-energy food, packed with vitamins and minerals with four times the caloric value per weight of salmon (Whyte et al. 1993). Additionally, Pacific Northwest Native American tribes use the lamprey and its components for medicinal and ceremonial purposes (Close et al. 1995). The lamprey, just as any other native animal species, plays an important role in Pacific Northwest ecology. For example, pinnipeds (seals and sea lions) feeding in the Rogue River estuary, Oregon eat lamprey in larger quantities than salmon when available (Roffe and Mate 1984). CTSI members consider the population decline of the lamprey to be an indicator of greater ecological problems in their native region.

This paper describes the following contributions to the completed LED project: methods of data collection (TEK, wildlife biology, habitat surveys) and the creation of dynamic segmentation within the GIS. A further step, spatial analysis or modeling, is addressed by reviewing the types of ecological modeling available to the resource managers. And finally, suggestions for the expansion and improvement of the current database to create a more holistic description of the aquatic system and its surrounding land base are presented. Limitations of the data require the resource manager to understand GIS and make cautious inferences. Even so, a GIS still provides a valuable means for utilizing available spatial data to make resource management decisions.

Chapter 2
The Use of Traditional Ecological Knowledge

Cajete (1994, 1997) describes the foundations for traditional ecological knowledge from the viewpoint of the indigenous learner. These elements exemplify the complex and holistic nature of knowledge held by native peoples. Since these cultures do not have a literate base, their teaching and learning styles are based on stories, which keep the continuum of knowledge alive. The stories or teachings have an environmental foundation based on the community's relationship with the land, and adapt as that relationship changes. There is an artistic or visionary component, which deepens the understanding of those relationships. This "spiritual ecology" recognizes "all life is imbued with an animating energy to which we are all connected" (Cajete 1997). This holistic, experience-based knowledge, which has inherent historical information, is vital to the survival of a tribe.

The Inuit explain TEK as "a way of life, based on the experience of the individual and the community, as well as knowledge passed down from one's elders and incorporated in indigenous languages. This knowledge is constantly being adapted to the changing environment of each community and will remain current as long as people still use the land and sea and their resources" (Inuit Circumpolar Conference 1996). TEK includes the acquisition of ecological information, as well as the understanding and the practice of ecological principles. Often, only the "convenient" aspects of TEK are incorporated into western science and the holistic nature of the knowledge is lost. Because of this, a lack of mutual respect between parties can result in a failed attempt to combine the two methods of environmental research. However, this respect is critical for the success of any integrated research (Inuit Circumpolar Conference 1996).

Despite the difficulty in creating accessible TEK, there have been opportunities for western science and TEK to join and create stronger, more holistic environmental research and understanding. The First Nations of British Columbia, Canada have been using TEK and community maps to record and communicate their historical land base and TEK to the Canadian government (Olive and Carruthers 1996). TEK has been advocated as a qualitative, intuitive, holistic, moral and spiritual science, which can contribute to the quantitative, rational, experimental, value-free, and mechanical western science (Berkes 1993). Many resource management issues are approached by conveniently fitting TEK *into* western science results. However, CTSI has approached the LED project from a different angle. They are using their TEK as a *basis* for pursuing western scientific studies.

CTSI families began noticing the decline in the lamprey harvest during the late 1980's. They appealed to the tribe to do a study on the lamprey populations and traditional harvesting practices, so that an important part of their cultural heritage would not be lost. By documenting the decline of the lamprey, the tribal members hoped that additional research would be started to determine the cause of the decline and initiate restoration measures (Downey et al. 1996).

CTSI responded by preparing SKWAKOL, a compilation of literature reviews, historical research, oral histories and recommendations for further research. The oral histories were the most important part of SKWAKOL because tribal members, who participated in lamprey harvesting and processing, shared their knowledge on the subject. In SKWAKOL, the elders shared their knowledge on the traditional hooking sites and practices, as well as the habitat requirements, ecology and populations of the lamprey.

They described previous stream habitat conditions, ecological indicators of lamprey migration timing, and the best times and locations to "hook eel." Table 1 gives examples of standard questions and answers from these interviews with the tribal elders.

Table 1 *Sample Interview Questions Completed by CTSI*

Question	Answer	Interviewee
How far back do you remember that people fished on the Siletz?	As far back as I can remember. I think the first time I went to the river I was about three years old.	Pete Downey
Where were the traditional eel hooking grounds located on the Siletz?	Rock Creek, at the mouth of Rock Creek where the flat rock is, about a hundred feet up Rock Creek.	Everett Butler
How was the eels prepared after they were caught?	You had to clean them, take the back bone out. You could bake fresh or fry them. We used to soak them overnight in salt water, then hang them in the smoke house.	Gladys Muschamp
Can you describe what the eels look like? Color, size and general appearance?	Night eels are dark. They are longer. The sun eels are kind of a lighter color. The night eel is always longer, and they come in from the ocean, but the sun eel is always in the river.	Nellie Orton
What other types of animals did you observe that were abundant in and on the Siletz River?	There is such a thing as a river mussel in the river, but you can't chew it, it was really tough. There used to be a lot of crawfish as well, but I was told that they are coming back.	Vicki Ben

The information attained from the interviews was interpreted and transcribed into a GIS map by the CTSI interviewers (Figure 2). These interviews constitute

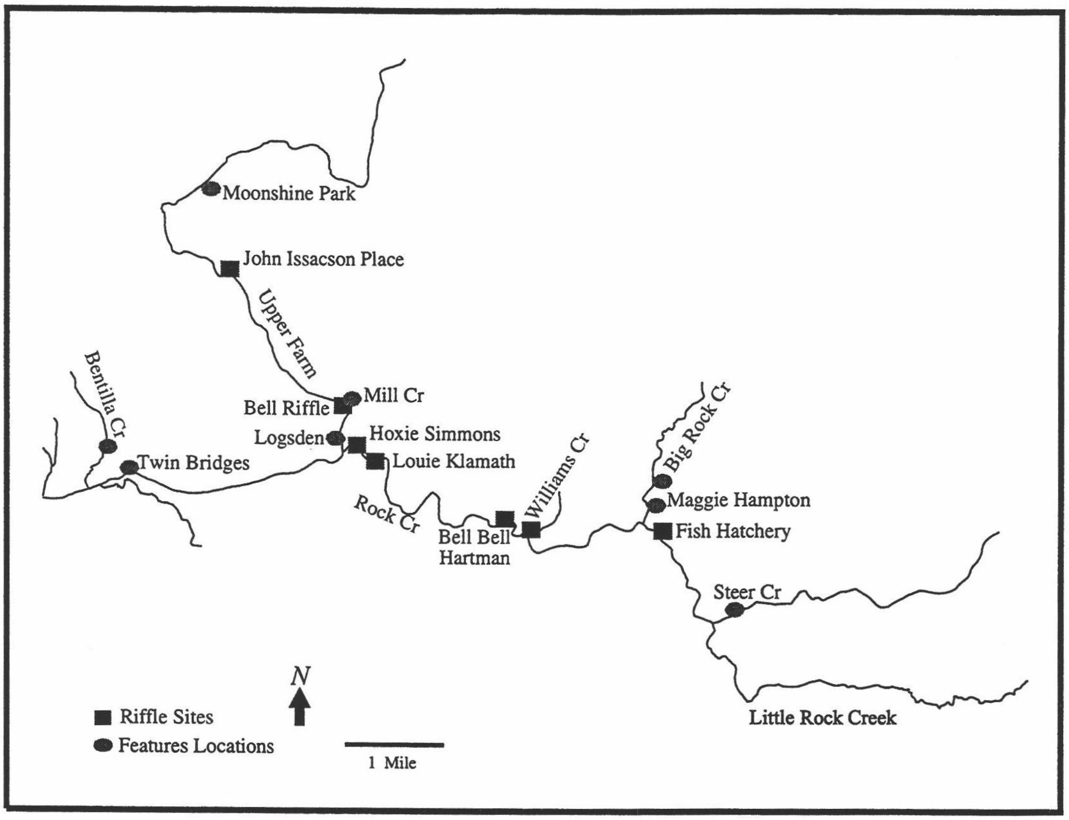


Figure 2 *Map of Riffle Sites and Important Tribal Feature Locations (Reproduced with Permission from Downey et al. 1996)*

valuable historical information for resource management, which would not otherwise available. Most importantly for the tribe, the information found in SKWAKOL led to the LED proposal and subsequent work in the Rock Creek watershed.

Since the beginning of the LED project, the CTSI have applied TEK and an aquatic habitat GIS for sustaining lamprey populations. They have found a common goal with the Mid-Coast Watershed Council (a local citizen group interested in improving watershed health) in seeking to improve environmental conditions within area watersheds. CTSI collaboration with the watershed council has resulted in on-the-ground restoration activities. This is a classic case of people's knowledge about their environment influencing what they will do for it (Eythorsson 1993).

Chapter 3
Background Research on Pacific Lamprey

As a preliminary step, a thorough review of available information on the biology and ecology of the Pacific Lamprey was conducted and can be found in Appendix A (Chapin 1998). A solid understanding of the lamprey was needed in order to utilize the GIS to determine suitable or desirable lamprey spawning and rearing habitat for restoration and conservation purposes. Most of the information available on the Pacific lamprey came from British Columbia, Canada, while additional information on lampreys was extrapolated from similar species. Little research has been completed on the Pacific lamprey in Oregon. This created challenges in data compilation, because assumptions had to be made concerning which information was most relevant. It was recommended that the CTSI gather additional local biological and ecological information on their Pacific lamprey population. Since the LED report, CTSI has obtained funding and continued researching lamprey habitat preferences, distribution, spawning, temperature and sediment tolerances within the Rock Creek watershed (Stan van de Wetering, CTSI, personal communication, May 2000).

Chapter 4
Aquatic Habitat Surveys

At the onset of the LED project, the CTSI planned to conduct their own habitat surveys along Rock and Little Rock Creeks. Research on stream habitat survey methods led the author to learn about the well-established protocols for the Aquatic Inventory Project underway by the Oregon Department of Fish and Wildlife (ODFW). These methods of data collection aim to record terrestrial and aquatic habitat parameters that are important to the survival of native fish species. Penny Nolan, a Siletz tribal member, assisted the author with stream surveys during the summer of 1996. We began by attending a two-day training session led by Kim Jones (ODFW) on the stream survey protocol. Since CTSI was only interested in certain aquatic habitat parameters, the ODFW survey was downsized to meet CTSI requests. Appendix B lists a summary of measured habitat parameters included in our summer surveys and Appendix C lists the results of the aquatic surveys (Chapin 1996).

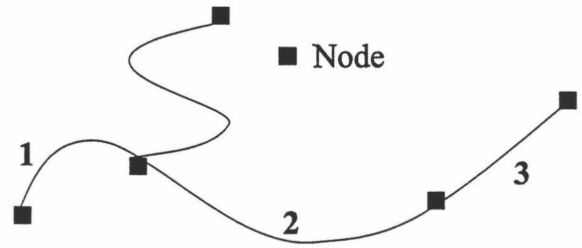
Since the CTSI works closely with federal, state and local agencies, as well as local organizations such as the Mid-Coast Watershed Council, it was decided to use aquatic habitat surveys produced by ODFW's Aquatic Inventory Project instead of the abbreviated survey completed by the author. An ODFW field crew surveyed Rock Creek in July 1994, and a Hire the Fishers crew surveyed Little Rock Creek in September 1995. Field crews walked the entire length of the stream recording data on channel and valley morphology, riparian characteristics and condition, and instream habitat. The habitat unit data includes parameters such as substrate type, riparian vegetation, available wood structure, and river unit type and length (Jones 1997). The details of the survey protocols are fully described in Methods for Stream Habitat Surveys (Moore et al. 1995). These survey data were entered by ODFW into a database file, which was made available for use in the LED project. Due to quality concerns, ODFW does not include the Little Rock Creek data in their statewide aquatic database.

Depending on the application of the resource management decisions, stream data can be categorized at the *stream* scale, the *reach* scale or the *river* unit scale. The river unit is the smallest descriptor of the geomorphic features in a given stream (e.g., pools, riffles) recorded by ODFW in their stream surveys. The reach scale is made by grouping the results of river units along an area of some functional characteristic (e.g., distance between tributaries, areas of similar land use, consistent valley or channel form). The stream scale combines all river or reach units contained within the entire stream. The river unit scale provides the most detailed information, because it is defined by the physical form of the stream bed and is not a combination of observations. ODFW used dynamic segmentation to link their data to arc stream coverages, but they worked at the reach scale on a 1:100,000 coverage (Jones 1997). This scale, which has an effective resolution of 500 m (Goodchild 1993), is too small to use for the local resource management purposes desired by the CTSI (i.e., to choose critical restoration sites). In order to make a more adequate and useful product for CTSI, a river unit coverage was created with an effective resolution of 12 m, on a larger scale base map (1:24,000), based on the survey data provided by ODFW.

Chapter 5
Dynamic Segmentation

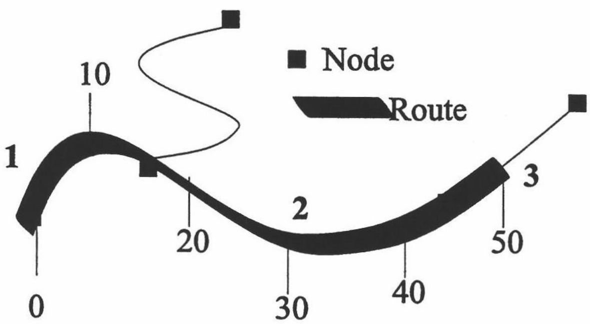
Linear features such as streams present a challenge when associating multiple attributes. In the case of Rock Creek, there are many surveyed attributes that describe the riverine and riparian habitat. The arc-node structure represents the linear feature as an arc using a cartesian coordinate system and is one option for handling linear features and their attributes. Each arc is a set of point coordinates with nodes representing the ends. The attributes associated with the arc are stored within an arc attribute table and are referenced via the coordinate system (Figure 3). Since it is necessary to have one arc for each set of attributes, linear features with many or dynamic attributes do not work well in the arc-node structure, as the compilations of the single arc attribute tables become too large and cumbersome to manage with limited computing resources.

Dynamic segmentation, a second kind of structure for linear features, is also comprised of arcs created with cartesian coordinates. However, the arcs have *routes* with an associated measurement system of relative distances from a specified starting location along a route. Attributes (events) are not stored in the arc attribute tables, but in a separate relational database making the storage, display, query and analysis distinct from the original arc coordinate system, and thus more efficient. Each attribute is associated to the route through the measurement system using to and from measurements (ESRI 1994, 1996); (Figure 4).



.AAT				Aquatic Habitat Attributes								
1												
2												
3												

Figure 3 *Schematic of the Arc/Node Data Structure and the Resulting Arc Attribute Table (.AAT)*



.AAT			
1			
2			
3			

Related
Based on
Measurements

Aquatic Habitat Attributes								

Figure 4 *Schematic of the Dynamic Segmentation Data Structure and the Resulting Arc Attribute Table (.AAT) and INFO Table*

The surveyed streams had 300 - 800 river units ranging from less than 0.1 m to over 250 m with the majority of the units less than 60 m. The high number of small, variable river units would produce very inefficient arc attribute tables, if the arc-node structure were used. Additionally, it would not be feasible to accurately create one arc for each river unit. Dynamic segmentation allowed the data to reside in a separate database table by creating relational measurements with the route system, thereby improving the accuracy, reducing the file size and allowing for quick and effective queries of the aquatic habitat attributes.

The primary users of the GIS are the CTSI natural resources department and the local watershed council, the Mid-Coast Watersheds Council. However, additional users could include local, state and federal agencies. The two primary users have desktop computers available and limited GIS resources and experience. Additionally, the CTSI desires the capability to query the habitat data based on habitat type (continuous features), as well as physical location on the streams (discrete points). Dynamic segmentation, which can be viewed and analyzed using ArcView, provides this type of query flexibility.

There are three essential parts to dynamic segmentation: a georeferenced database, a calibration point coverage, and a clean arc coverage. The calibration point coverage is used to link the georeferenced database to the clean arc coverage. Having all of these items in order before beginning the dynamic segmentation process facilitates the linking process. The flow chart in Figure 5 outlines the steps and processes needed to complete the dynamic segmentation using ArcTools within UNIX Arc/Info.

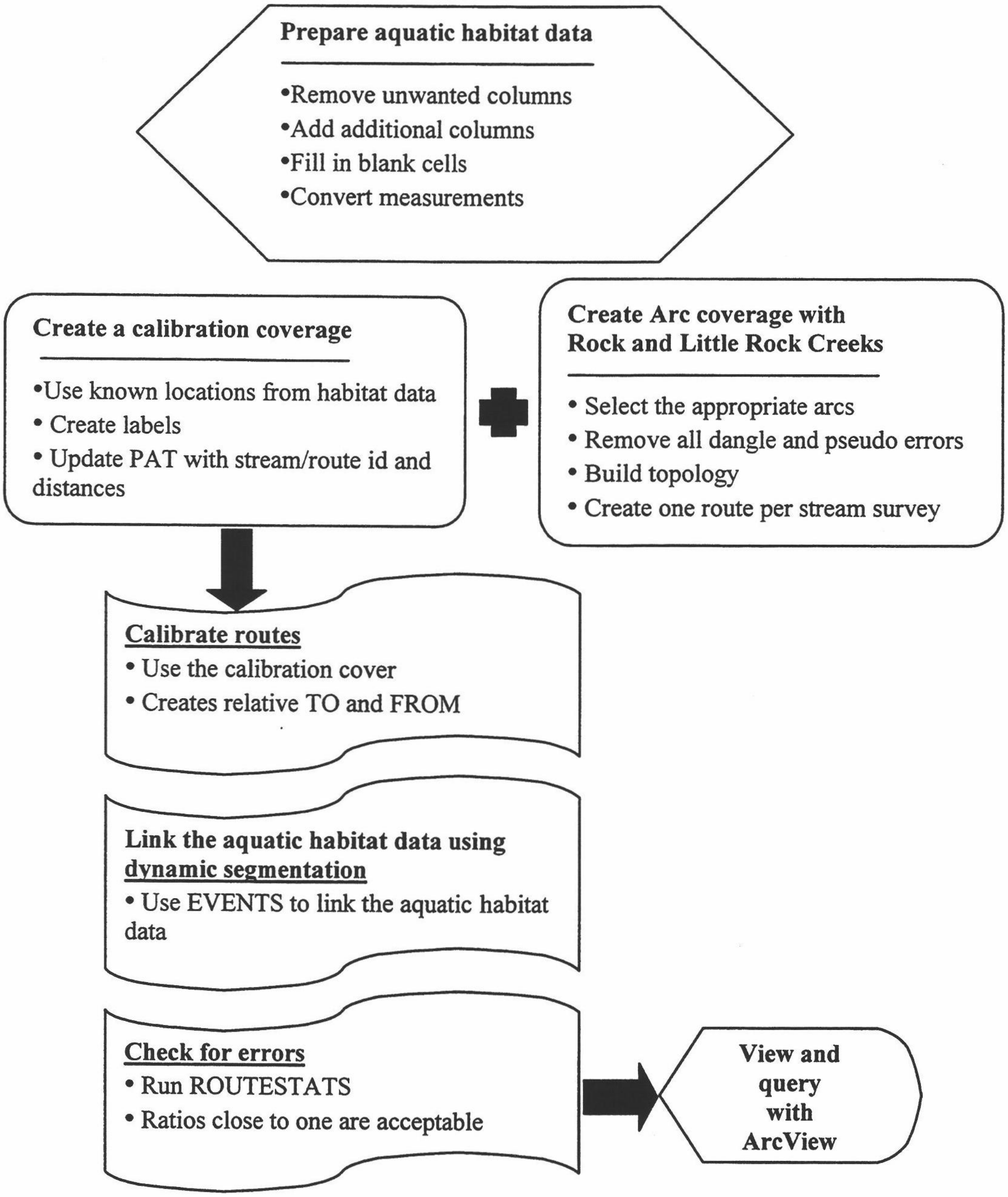


Figure 5 *Flowchart of the Steps Used to Create Dynamic Segmentation*

More detail on each of the steps is provided below. Arc/Info commands and definitions, as well as my coverage and table names are listed in all capital letters.

5.1 *Modifying the Aquatic Habitat Database*

Some minor modifications of the aquatic habitat data from ODFW were necessary before they could be used for dynamic segmentation. Dynamic segmentation requires that the data are georeferenced to the start location of the route. The mouths of Rock Creek and Little Rock Creek were used as the starting reference points. The ODFW surveys contained measurements of each consecutive river unit. However, the ODFW data were recorded in meters and the arc coverage was in feet. All columns containing measurements of unit length only were converted to feet. "TODIST" and "FROMDIST" columns held the calculations needed to georeference the data to the routes. The "FROMDIST" column is the measurement from the mouth of the creek to the beginning of the river unit, while the "TODIST" column is the measurement from the mouth of the creek to the end of the river unit. A stream code was entered into the "STREAM_ID" column for each river unit. This code needs to coincide with the identification code created in the route and calibration coverages. Once the database was modified and found to be correct, it was imported into an INFO table (STRMDATA).

5.2 *Creating the Base Stream Coverage*

The original arc coverage was provided by the CTSI and included every stream arc within Lincoln County (Table 2). The stream coverages were edited using the Arc

Table 2 *Description of the Base Stream Coverage (arcs) Provided by CTSI*

Creator	Atterbury Consultants, Inc.
Year	Base Map – 1991, Attribute table modified in 1996
Guidelines	Consistent with USGS and State Mapping Advisory Council
Attributes	Type, Name, and Size (of stream), plus Or_class (fish use)
Projection	State plane
Units	Feet
Datum	NAD 27

edit pop-up menu (Figure 6). All streams not in the Rock Creek watershed were removed and a new coverage with only the watershed streams was created (ROCKWTR). Then, a separate coverage containing only stream arcs representing Rock Creek and Little Rock Creek was created (CREEKS) (Figure 7). Pseudo-nodes were removed and all the arc directions were FLIPped to point in one direction (upstream). After these modifications, the final clean coverage was BUILT to re-create the correct topology.

5.3 *Creating the Calibration Point Coverage*

The calibration coverage, although very simple, is one of the most important aspects of dynamic segmentation. Both the base stream coverage and the stream survey data had inherent, unknown spatial errors. These errors included those which developed during data collection (e.g., measuring the length of the stream accurately),

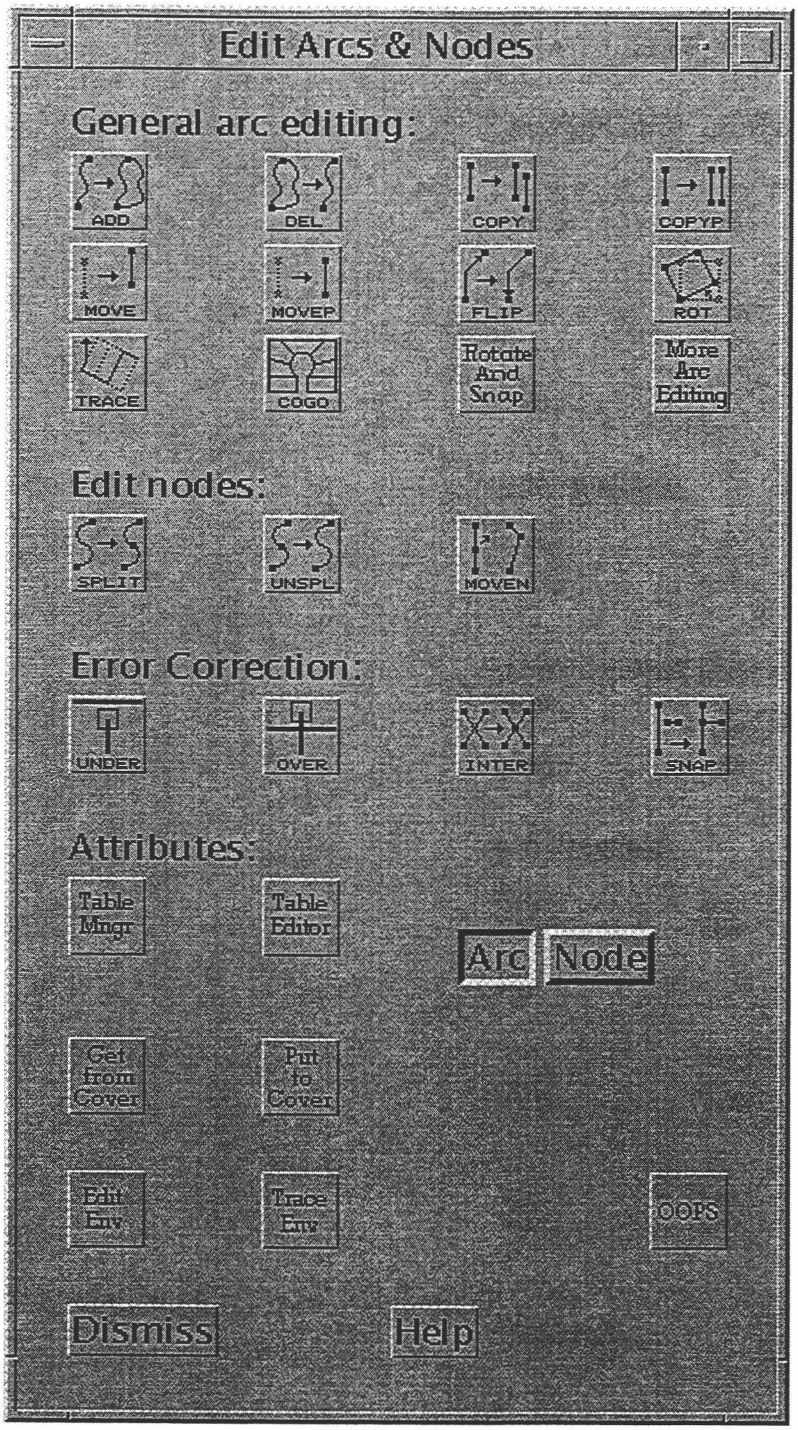
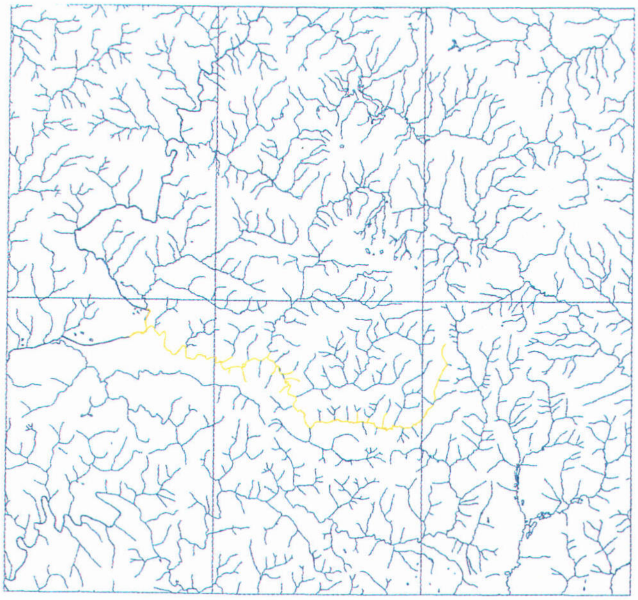
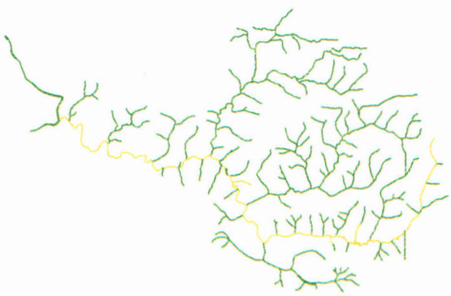


Figure 6 *Screen Snapshot of the Arc Edit Menu from an ArcTools Session*



Original Coverage provided by CTSI (Rock and Little Rock Creeks are Highlighted)

All Creeks in the Rock Creek Watershed (Rock and Little Rock Creeks are Highlighted)



Final Coverage with Rock Creek (Green) and Little Rock Creek (Red)

Figure 7 *Coverage Modifications to Create the CREEKS Coverage*

determining location (e.g., global positioning system (GPS) error), and digitizing (e.g., human inaccuracy). The calibration coverage helped the joining of the coverage with the data by providing a point of reference for the smoothing of the spatial error. The necessary number of calibration points will vary with the amount of inherent error present and the size of the coverage area. It is always important to obtain evenly spaced, well-defined calibration points. The Rock Creek calibrations were done with eight calibration points for 17 miles (27 km) of stream.

The points used on the calibration coverage were known, locatable positions, both on the ground (listed within the surveys) and on the GIS coverage (Table 3). To create the calibration points that correspond with stream junctions, a new point coverage was created using the Label edit menu (Figure 8). The backcover ROCKWTR displayed to locate the tributary junctions and create a correct label point. For more obscure locations like the fish hatchery steps, GPS coordinates were obtained from readings in the field and entered into the coverage. The calibration .PAT was modified to contain a stream identification code and the distance (derived from the survey data) from the start location (Table 3). The backcover was changed to CREEKS and the label points were SNAPped to it for route calibrations (Figure 9).

Table 3 *Data Included in the Calibration Point Coverage*

Label ID	STREAM_ID	FROMDIST	On the Ground Location
1	65055	0.0	Mouth of Rock Creek (at Siletz River)
2	65055	19943.1	Junction of Rock Creek and Williams Creek
3	65055	32796.4	Siletz fish hatchery steps
4	65055	38727.3	End of Rock Creek at Little Rock Creek
5	65056	0.0	Mouth of Little Rock Creek (at Rock Creek)
6	65056	6894.2	Junction of Little Rock Creek and Brush Creek
7	65056	24774.5	Logsden road bridge over Little Rock Creek
8	65056	42909.9	End of survey; steep topography

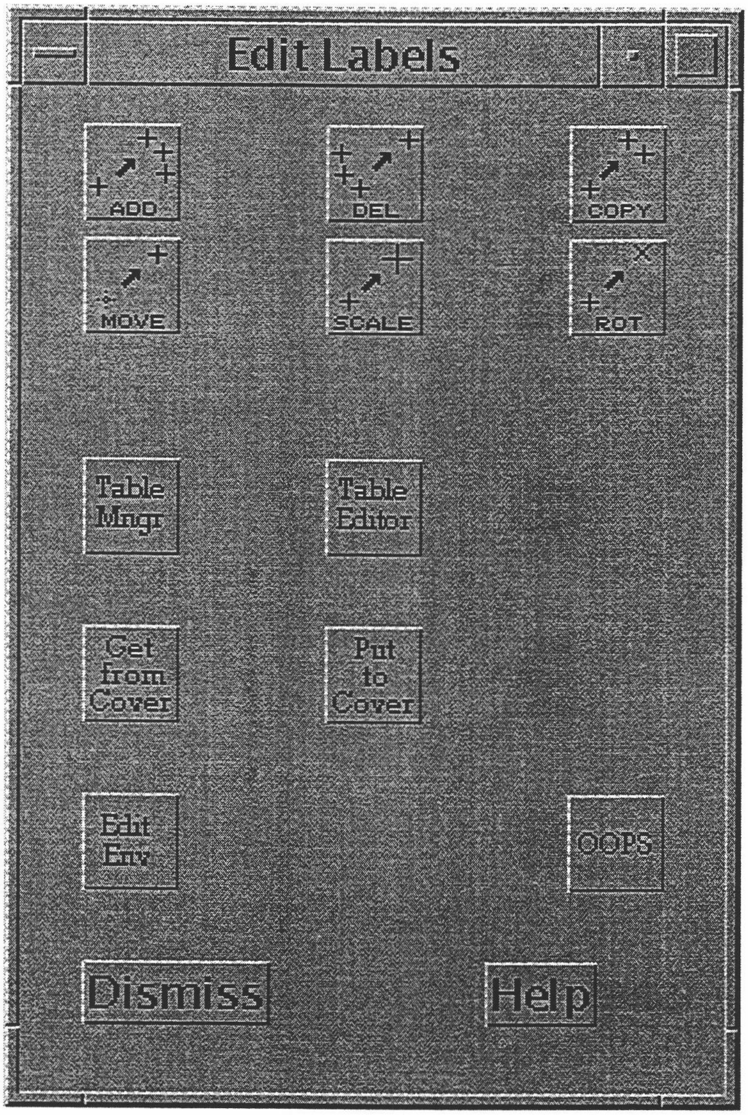


Figure 8 *Screen Snapshot of the Point Edit Menu from an ArcTools Session*

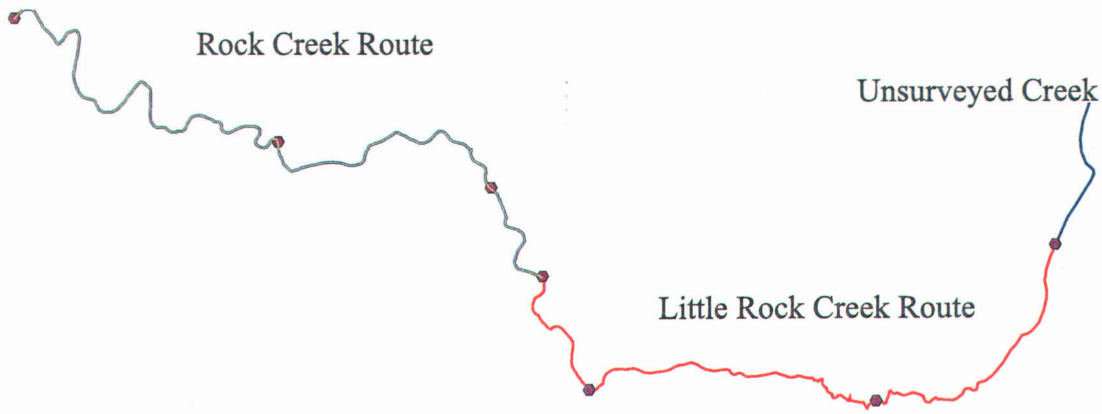


Figure 9 *Calibration Point Locations*

5.4 *Creating the Routes and Sections*

The routes were created on the stream coverage (CREEKS) using the Arc edit menu. The ROCKWTR and the CALIBPTS coverages were displayed for reference as backcovers. All the arcs in Rock Creek were selected and the command line window initiated. The MAKEROUTE command with subclass, STREAMS and route-id, 65055 was executed to create the route. The same procedure was followed for Little Rock Creek, except only the arcs, which included the survey route, were selected and the route-id was 65056. This process creates two new INFO tables: the route attribute table (.RAT) and the section attribute table (.SEC). When the route is created, the sections are equal to the selected arcs.

Since the survey did not encompass the entire stream, there were arcs present on the coverage after the survey distance (marked by the final calibration point). After the routes were created the edit feature was changed to route and the route edit menus (Figure 10) were used to correct and measure the routes. Route 65055 (Rock Creek) was selected first, then all the sections were subselected. The REMEASURE function was used to create the route measurements of 0 to 38,727.3 feet (equal to the length of the aquatic survey). Next, route 65056 (Little Rock Creek) was selected. The aquatic survey did not conclude at the end of the last arc, so the last section of the route was subselected. The MOVEEND function was initiated and the end of the section was moved graphically to equal the end of the aquatic survey at the last calibration point. The route was REMEASUREed as 0 to 42,909.9 feet. All the sections in one route were subselected and the table editor LIST function was used to make sure all the T-meas and F-meas were in consecutive order. Lastly, the .RAT table was updated by

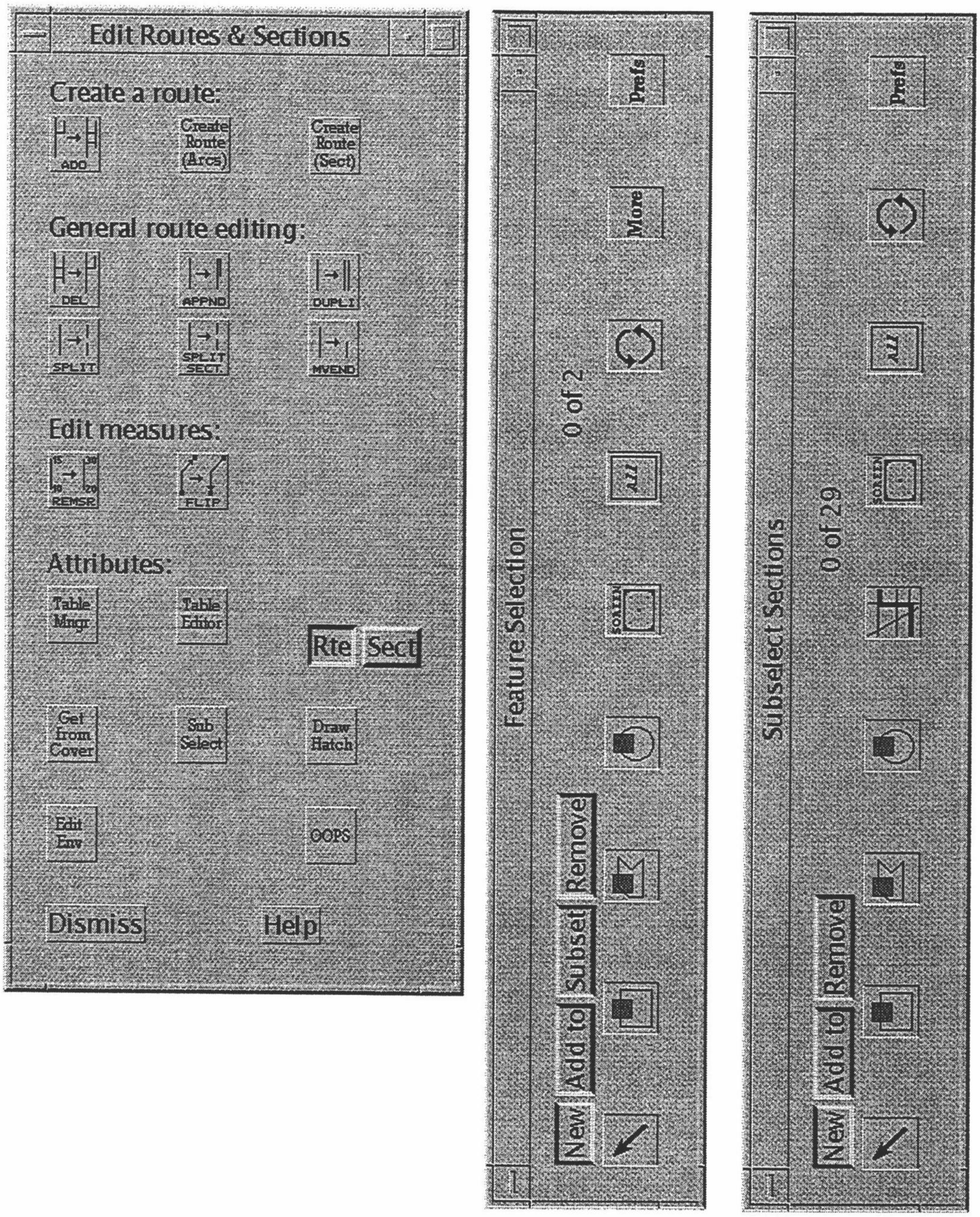


Figure 10 *Screen Snapshots of the Route Edit Menus from an ArcTools Session*

adding the STREAM_ID item. This is the same number as the route number and is needed in order to complete the dynamic segmentation with the aquatic data and the calibration table.

5.5 *Calibrating the Route*

CALIBRATEROUTES was used to smooth the errors between the arc coverage and the aquatic survey data. At the Arc command line the STREAMS route on the CREEKS arc coverage was calibrated with the CALIBPTS point coverage. The calibration split sections when necessary and performed partial measurement calibrations, in order to keep the entire route distance equal to the survey distance. The records in the .SECSTREAMS INFO table were LISTed to make sure the F-meas and T-meas were still consecutive.

5.6 *Linking the Stream Survey Data*

An event table contains attributes, which describe portions of the routes. Data for creating an event were entered using the interactive EVENTSOURCE dialog box. STRMHAB served as the source name, STRMDATA was the INFO table, the relate was linear based on the STREAM_ID column in the route and data tables and FROMDIST and TODIST were the measurement items. EVENTSOURCE SAVE AQUAHAB created a usable event file (.EVA) for viewing the data. EVENTARC HABITAT built a dynamically segmented stream coverage from CREEKS with the arc coverage, route system and event source. It was necessary to BUILD the topology of the .EVA file.

5.7 *Detecting Error*

Before continuing, the error should be calculated using ROUTESTATS. This command calculated ratios of the measurements provided in the stream survey INFO coverage with the coverage unit measurements. Ratios close to one are preferable. Each project should decide on acceptable levels of error. The habitat, stream and calibration coverages should be reviewed to make sure that everything still matches up (i.e. calibration points still lie on the streams or streams no longer exist).

5.8 *Viewing the Dynamic Segmentation Coverage*

The new event coverage (HABITAT) was exported to an Arc/Info .e00 file and imported into ArcView, using Import71. A new view was started by opening the theme called habitat. The query builder tool allows users to customize queries based on their needs. Figure 11 shows an example of the potential use of the LED GIS for aquatic habitat management. More details on the uses of dynamic segmentation are described in the next section.

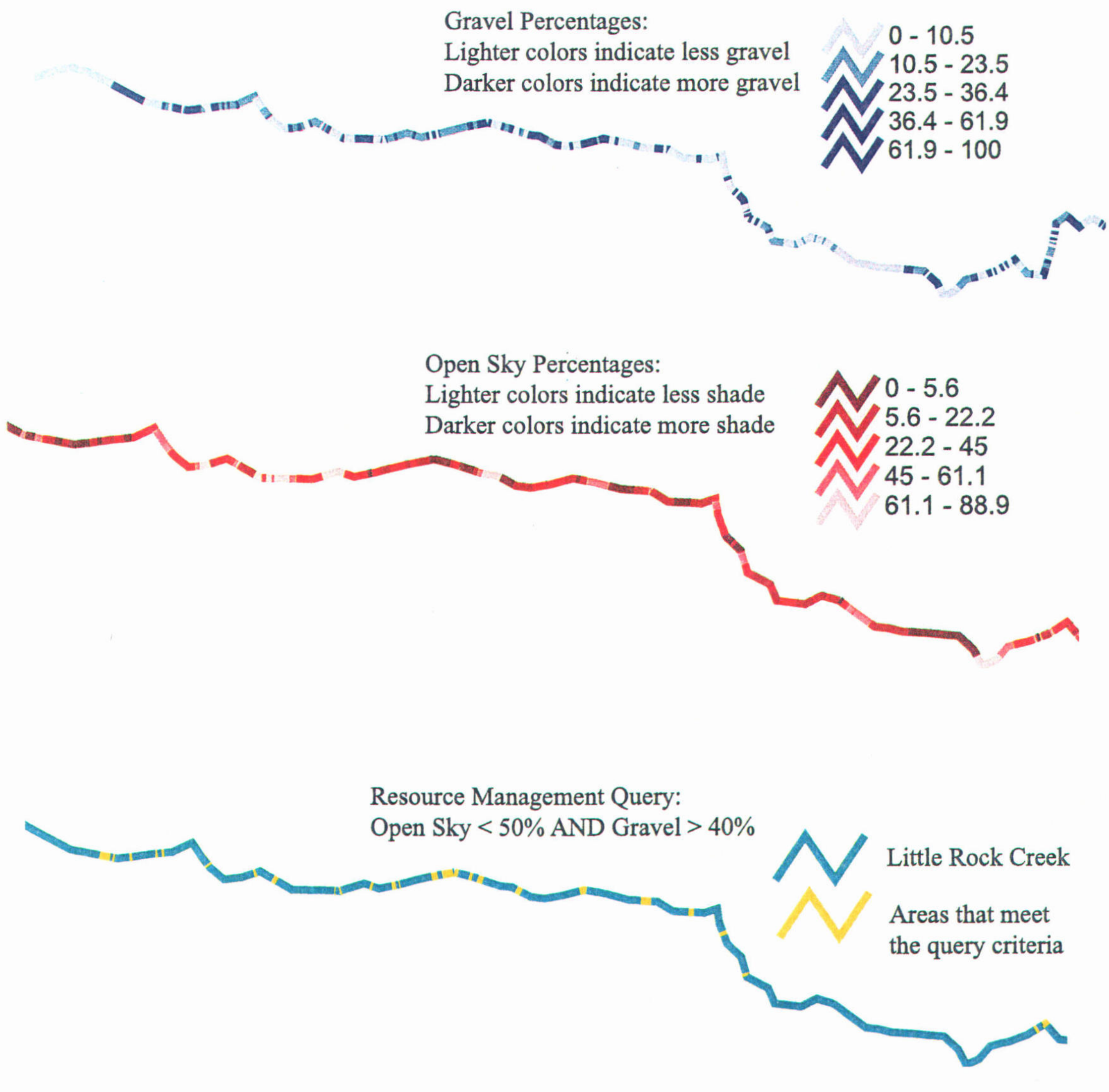


Figure 11 *A Resource Management Query related to Pacific Lamprey*

Chapter 6
Conclusion: Aquatic Resource Management Potential

Traditionally, a GIS has been used mostly as a descriptive mapping tool. However, the power of a GIS lies in its ability to perform spatial analysis and modeling, thus providing essential information to resource managers. With the dynamic segmentation data structure complete, CTSI has begun to build a powerful resource management tool. Currently, most of the anticipated uses of the LED GIS are descriptive rather than prescriptive, but the needs of the tribe and the watershed council are expected to grow. The next steps for expanding the GIS, so that it can provide more holistic resource information, involve adding more historical, social and habitat data, and creating spatial and ecological models (Figure 12). Appendix D contains the preliminary compilation of potential data and model sources compiled by the author (Chapin 1998). Since the completion of LED project, Earth Design Consultants (Corvallis, OR) have continued to build the Rock Creek watershed GIS through a watershed and catchment analyses (Garono and Brophy 1999, Garono and Schooler 1999). Prescriptive analyses (mathematical manipulation) of an expanded LED project GIS could provide resource managers valuable information for effective decisions. A vision for a more effective GIS for the CTSI is outlined in this section.

Techniques such as single and multiple layer operations (e.g., Chou 1997) can help the CTSI answer descriptive questions regarding habitat availability and restoration suitability in Rock Creek with regards to the Pacific lamprey. Single layer operations are simple queries on the attributes. Understanding the ecological

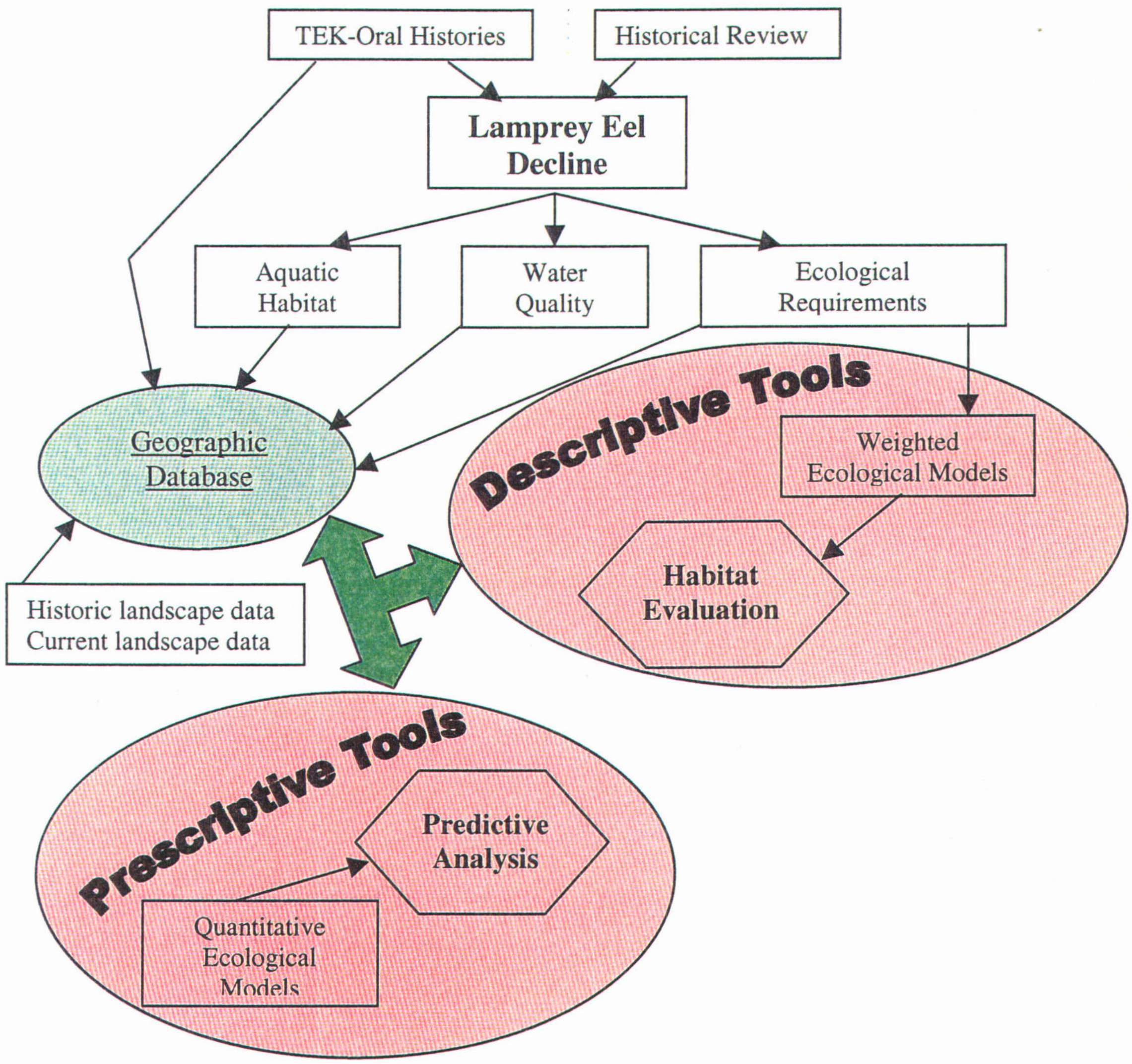


Figure 12 *Flowchart of the Lamprey Eel Decline Project and Resource Management GIS Potential*

requirements of the Pacific lamprey is vital to creating effective management queries. For example, spawning lamprey prefer substrate with gravel to build their redds and like moderate amounts of shade. Therefore, queries which show the locations of areas with these criteria are valuable for narrowing the search for restoration sites (Figure 11). These potential restoration sites should be visited to determine if they are already suitable or if they could be improved. If desired, the queried attributes could be weighted or ranked based on their ecological importance. For example, gravel is critical to lamprey nesting success, so the model should give greater importance (weight) to that attribute (e.g., Berry 1995). When planning restoration projects, it is important to choose sites with the highest possibility of success.

Overlays (multiple layer operations) of ownership, water rights and or land use could help narrow the site choices to those most likely to succeed. Overlays of the information from TEK (Figure 12) provide historical information on areas previously important to lampreys and the CTSI members. These operations are descriptive in nature, but still provide the resource manager with the necessary information for effective decisions.

Prescriptive analysis moves GIS from an inventory tool to an analytical tool. It allows the user to ask for more detailed quantitative information (Berry and Ripple 1996). Spatial modeling, point pattern analysis and network analysis (e.g., Chou 1997) are techniques used in spatial analysis. Historical change analysis and predictive models can be used in conjunction with dynamic segmentation coverages and other land use coverages. Since precise historical data are lacking for the Rock Creek watershed, predictive analyses are more attainable with the LED GIS than historical change analyses. To create predictive analyses, it is necessary to expand the GIS data layers to include terrestrial environmental and social data. For example, land use in Rock Creek includes active forestry. As patches of forest are clear-cut, the runoff and sedimentation rates can affect the aquatic habitat. Knowing the future harvest plan, a resource manager can now use ecological runoff models to quantitatively obtain information on the potential influence of the harvest on the aquatic habitat. With this information, a resource manager could plan restoration projects accordingly, or work with the local foresters to mediate the effects of clear-cutting by altering timber practices or harvest scheduling.

Errors in GIS are often overlooked because they are "hidden" from the end user, but they are essential to understanding the limitations of the GIS. The real world is represented in the GIS by a spatial component (coordinates) and a tabular component (attributes) and errors can occur in both (Bolstad and Smith 1992). The accuracy of the GIS is limited by the measuring device used to collect the data (Goodchild 1993), as well as the methods for creating the GIS layers (Congalton and Green 1992). For the LED GIS, the base map was digitized by Atterbury Consultants, Inc. and the aquatic habitat data were collected and estimated by research crews (Moore et al. 1995). Therefore, errors can be expected in both the base coverage and the attributes of the LED GIS. Depending on the types of analysis needed by the end user, the usefulness of the information could be limited if the amount and types of error are not considered.

One of the largest problems, both with GIS and its use in resource management, is that the descriptive GIS represents a static view of a dynamic system.

It is an abstraction of a naturally variable ecological system. In this case, riverine systems are extremely variable at large and small spatial and temporal scales. The static representation of a dynamic system is another important consideration for the resource manager. For example, the data represent a static view of Rock Creek (summer 1994) and Little Rock Creek (fall 1995). These data can only provide a snapshot of the actual stream habitat conditions. Resource managers in the Oregon Coast Range can expect stream conditions to change seasonally, especially with the swollen stream conditions experienced during the winter rains. For example, current stream conditions are probably quite altered due to a 100-year flooding event in the winter of 1996. However, conceptual and predictive models can increase the value of the information resource management by providing potential stream conditions.

Information is the key to effective management decisions. A GIS can provide resource managers with descriptive and prescriptive information. Using the LED GIS, resource managers can search for suitable habitat restoration sites and locate traditional hooking sites. With additional data layers and basic ecological models, managers can predict potential habitat changes, as well as analyze historical changes. GIS does not produce resource management decisions. It merely enhances the information available. It is still necessary for managers to combine the GIS information with their "on the ground" knowledge of the ecological system and their understanding of the error included in the GIS to produce sound resource management decisions.

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Appendices

Appendix A
Biology and Ecology of the Pacific Lamprey

A.1 *Classification*

The Pacific lamprey (*Lampetra tridentata*) classification by Nelson (1994) is as follows:

KINGDOM - Animalia
  SUPERPHYLUM - Bilateralia
    PHYLUM - Chordata
      SUBPHYLUM - Vertebrata
        SUPERCLASS - Agnatha (jawless vertebrates)
          CLASS Cephalaspidomorphi (lamprey - 41 species)
            FAMILY - Petromyzonidae
              ORDER - Petromyzoniformes
                GENUS - Lampetra
                  SPECIES - tridentata

A.2 *Distribution*

The Pacific lamprey is found primarily in the high latitude, colder regions of the Pacific Ocean (Hubbs and Potter 1971). It occurs both northward and southward of the 20°C annual isotherm in an antitropical distribution. On the eastern coast of the north Pacific, the Pacific lamprey is found from Baja California to the Aleutians. The lamprey distribution extends inland in major river systems to their headwaters (Scott and Crossman 1973). Pacific lampreys have been found as far inland as Idaho Snake River basin. There have been some Pacific lamprey identified on the west Pacific coast in Hokkaido, Japan (Wydoski and Whitney 1979). In Oregon, the Pacific lamprey is common in all coastal and inland watersheds which have appropriate habitat and connections to the ocean (Kan 1975).

A.3 *Morphology*

Lampreys are primitive animals with highly specialized characteristics. As an adult, the Pacific lamprey is an external parasite of mid-water marine teleost fishes (Figure A1). As a juvenile, it is a filter feeder (Figure A2), which requires a drastic metamorphosis to become a parasitic adult. Few vertebrate species undergo such a radical metamorphosis between the juvenile and adult stages. Parasitic lampreys can be anadromous or restricted to freshwater habitat and the mature adults are larger in size than the non-parasitic species (Hubbs and Potter 1971).

The adult Pacific lamprey is an eel-like vertebrate with an elongate, cylindrical shape, round in cross-section, but somewhat laterally compressed towards the dorsal end (Figure A1). It lacks jaws, internal ossification, scales and paired fins. The jawless head has a large, nearly circular, buccal funnel fringed with concentric rows of sharp teeth, which opens ventrally. The eyes are small with no eyelids and located approximately 10% of the total body length from the snout. Behind the eyes, there are 7 gill slits. There is a small nasal aperture slightly before and between the eyes. The anus is below the origin of the second anal finfold. There are no true fins. The dorsal finfold begins about mid-section and abruptly passes into the second finfold. The second dorsal finfold is continuous with the caudal finfold, which is predominantly on the ventral side of the body. The finfolds have cartilaginous ray-like supports. There are no pectoral or pelvic finfolds. The skin is scaleless, but it is protected by slime produced by unicellular glands. The color is a dark bluish-grey, almost black. The median length of adults tends to be 27 inches (68.6 cm) (Hart 1973).

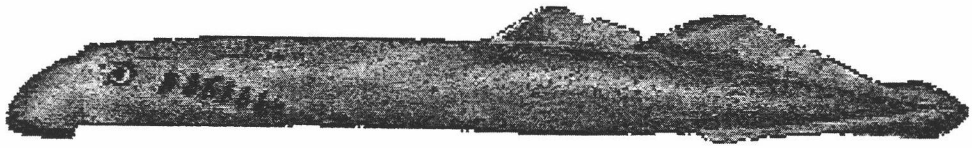

Figure A.1 *Drawing of a Lamprey Adult (from http://www.eartsea.org/lampreys/LS-2-1-0-0.html)*

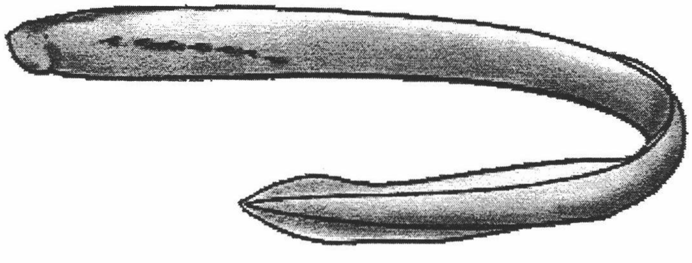

Figure A.2 *Drawing of a Lamprey Ammocoete (from http://www.earthsea.org/lampreys/LS-2-2-1-0.html)*

A.5 *Juvenile Stage*

The juvenile stages are the larval stage (the short period of time that the young lampreys live in the redd) and the ammocoete stage (Figure A2) (the burrowing stage until metamorphosis). The juvenile stages are considered the main reason for the success of the species. The eggs of *Petromyzon marinus* hatch after two weeks at 12 - 26°C. The larvae leave the redd after 1 - 3 weeks. They are approximately 7 mm long and deposit themselves in a slackening current (Potter 1980). Ammocoetes usually burrow into soft substrate composed of mud, silt or sand. The preferred habitat is dependent on stream gradient, current velocity, type of substrate particles, and accumulation of organic debris. Favorable conditions are often found in eddies, backwaters, insides of bends, or behind obstructions (Kan 1975). The ammocoetes of British lamprey species prefer stream gradients of 10 - 30 ft/mi and rarely >40 ft/mi. Flow over *Lampetra planeri* and *Eudontomyzon danfordi* burrows averaged 0.5 m/s at the surface and 0.4 m/s at a depth of 25 cm. *P. marinus* and *Lampetra lamottenii* would not burrow in currents >0.6 - 0.8 m/s (Hardisty and Potter 1971).

The ammocoete survives the first 4-6 years as a filter feeder on suspended organic matter. The limit to growth is the capacity of the feeding mechanisms in the ammocoete, not the availability of food. Rivers are considered rich in suitable organic matter for ammocoete consumption. Partially shaded areas, which encourage high diatom growth, are also desirable locations. Diatoms and desmids (green algae) are common food sources for the juvenile lamprey. It is believed that they also eat protozoa, ciliates, rhizopods, bacteria and fungi, but these preys are rapidly digested and rarely found in gut samples (Moore and Mallatt 1980).

Predation can occur as the larvae emerge from the redd, but once they have concealed themselves in silt beds, predation and mortality levels are believed to be low. For additional safety, juvenile lampreys only swim at night (Potter 1980, Beamish and Levings 1991). Juvenile lamprey can not actively swim upstream and against the current for any substantial distance. Therefore, the locations of ammocoetes can indicate the upper limits of spawning by adults (van de Wetering 1999). Ammocoetes prefer passive downstream migration (Hardisty and Potter 1971).

In addition to predation, physical factors can contribute to ammocoete mortality. Ammocoetes can only tolerate low temperatures and anoxia for a few hours. At 15.5°C, ammocoetes will remain in the burrow for oxygen tensions of 18 - 20 mm Hg, but as the oxygen tensions drop to 12 -16 mm Hg the ammocoetes must emerge from their burrows to survive. The ammocoetes emerge from their burrows and die within a few hours during oxygen tensions of 7 - 10 mm Hg (Hardisty and Potter 1971). Lamprey ammocoetes respond to low oxygen and high carbon dioxide levels by increasing the flow of water through the branchial basket. Although this is a survival response it also increases the amount of energy a juvenile expends toward survival (Potter et al. 1970).

A.6 *Metamorphosis*

The juvenile life stages of the Pacific lamprey are believed to last 4 - 6 years (Kan 1975). At the end of that time the ammocoetes undergo drastic metamorphosis to become parasitic adults. The metamorphosis includes physical external changes to allow parasitism, as well as internal changes that allow osmoregulation. Lampreys complete their metamorphosis in fresh water and then migrate to the marine environment (Hardisty and Potter 1971).

Richards and Beamish (1981) found most transforming Pacific lamprey larvae in coarse substrate or gravel with higher levels of dissolved oxygen. The metamorphosis generally took 12 weeks. The metamorphosis of *P. marinus* can last 3 - 10 months (Hubbs and Potter 1971). The onset of metamorphosis in individuals is fairly simultaneous (within a month) and is triggered by environmental factors. Often metamorphosis corresponds to trends or sequences of environmental indicators (i.e. temperature) rather than a critical level (Potter 1980).

In Canada, the Pacific lamprey commences metamorphosis in July and begins downstream migration between September and December. However, the peak downstream migration occurs in March to May of the following year (Beamish and Levings 1991). This time frame fits estimates from Clarke and Beamish (1988), who found that entry to salt water may be delayed up to 10 months in the Pacific lamprey. In a coastal watershed of Oregon, the downstream migration occurred mostly between August and December (van de Wetering 1999). Potter (1980) found juvenile movement coincides with environmental factors such as water discharge, temperature, season and light (i.e. movement at night). Richards and Beamish (1981) found a positive correlation between the increased water levels and the increased downstream migration by ammocoetes. Parasitic feeding may commence in fresh or salt water (Beamish 1980), but Richards and Beamish (1981) only noticed parasitic feeding in salt water.

A.7 *Adult Stage (Marine)*

The average size of lamprey entering the marine environment is 13 cm (Beamish 1980). Currently, the estimate for the duration of the adult marine stage is 2.5 years (Beamish and Levings 1991). The mean length of adults returning to spawn in their natal rivers in Oregon is 42.1 cm (Kan 1975). Pacific lampreys are present in all major Canadian fishing grounds. Adults have been found off the coast of Japan and in water 100-250 m deep. Pacific lampreys undergo the majority of their growth while at sea (Beamish 1980).

During the marine life segment, Pacific lampreys are externally parasitic on marine teleost fishes. The attachment sites tend to be anterior and ventral. The Pacific lampreys are probably not prey selective, but more opportunistic feeders. Generally, *P. marinus* prefer larger to smaller fish. In contrast to *P. marinus* and brook lamprey species, the Pacific lamprey prefers to consume body fluids rather than chunks of flesh. That preference combined with the tendency of a Pacific lamprey to release its hold on its prey once it is satiated reduces the likelyhood of prey death. Pacific lampreys leave scars of 1 - 3 cm diameter. It is estimated that mortality due to Pacific lamprey wounds is 1.6 to 1.8%. Off the West Coast of Canada, Pollock is the most common prey species. Sockeye and pink salmon have a high incidence of lamprey predation during the congregation for spawning runs. However, the Pacific lampreys do not remain attached during the spawning runs. Table A1 gives a list of known lamprey prey species (Beamish 1980).

Table A.1 *Known Prey Species of Pacific Lamprey in Canadian Waters*

Common Name	Scientific Name
Rockfish	*Sebastes aleutianus* and *S. reedi*
Coho Salmon	*Oncorhynchus kisutch*
Chinook Salmon	*Oncorhynchus tshawytscha*
Lingcod	*Ophiodon elongatus*
Sablefish	*Anoplopoma fimbria*
Steelhead Trout	*Salmo gairdneri*
Pacific Cod	*Gadus macrocephalus*
Pacific Halibut	*Hippoglossus stenolepis*

From Beamish 1980

A.8 *Adult Stage (Fresh)*

Because Pacific lampreys are anadromous, they return to their natal river to spawn. In Canada, the lampreys begin their spawning runs in April and have completed their migrations by September. Beamish and Levings (1991) found that the Pacific lamprey in the Fraser River system returned during the lowest river levels, usually around August. The average rate of upstream travel for *P. marinus* is 2 mi/day. This can be reduced to 0.33 mi/day in high velocity areas (Hardisty and Potter 1971). Lampreys are tenacious migrators and often return to the headwater streams in river basins. Stan van de Wetering (CTSI) found Pacific lamprey ammocoetes close to the headwaters of Little Rock Creek, which indicates the distance up the Rock Creek drainage adult lampreys swim to spawn (approximately 15 miles from the confluence of Rock Creek and the Siletz River).

Lampreys appear to be somewhat particular about spawning location and environmental conditions. *P. marinus* begins spawning at temperatures between 9 -

22°C. *L. planeri* and *P. marinus* show a positive relationship between temperature and the number of animals at the spawning site (Hardisty and Potter 1971). For *P. marinus* the presence of sufficient appropriately sized gravel is crucial to spawning occurrence even if water temperature, depth and velocity are favorable (Manion and Hanson 1980). The same holds true for Pacific lamprey, since they build their spawning redds from gravel, pebbles and sand. The water temperature during redd construction and spawning ranges from 10°-15°C and the water velocity is 0.5-1.0 m/s (Kan 1975).

Some researchers believe that the male lamprey builds the redd, while others believe the male begins redd building and the female joins later. Manion and Hanson (1980) described the redd construction of *P. marinus*. The adult lamprey begins by lifting stones to form a depression in the bed. The completed *P. marinus* redd had a downstream crescent shaped mound of rocks, and the total redd measurement was 45 cm wide (perpendicular to the current) and 40 cm long (parallel to the current). Each redd took 1-3 days to complete. To finish the redd, the adults attach to an upstream stone and vibrate rapidly to clean out loose sediment (Manion and Hanson 1980). Personal observations of the author confirm that Pacific lamprey in Rock Creek construct similar redds out of gravel, although no on-site redd measurements were taken.

Morphological changes in adult lampreys during upstream migration have been observed in anadromous lampreys. Some of the more prominent changes observed are: weight loss and reduction in total body length due to cessation in feeding and degeneration of both internal and external organs. Weight loss for male lamprey is generally 40%, and 54% for females. Length is reduced by 11% in males and 18% in females (Hubbs and Potter 1971). Beamish (1980) determined shrinkage rates of 15% for males and 23% for females. The extreme degeneration of internal organs and external appearance signifies certain death after spawning (Manion and Hanson 1980).

A.9 *Additional Information*

The invasion of *P. marinus* into the Great Lakes has prompted research regarding barriers. Hunn and Youngs (1980) report that barriers between 46 - 79 cm with an overhanging lip have been successful at deterring lamprey migration. The Siletz River, Rock Creek and Little Rock creek do not have any known barriers to lamprey migration.

There are predators of the adult lamprey. Sea lions, seals, mink, and sperm whales have all had lamprey found in their gut contents (Close et al. 1995). At the Rogue River, stomach contents showed Pacific lamprey to make up 69% of the California sea lion diet and 56% of the harbor seal diet (Roffe and Mate 1984). Locally, otters have been seen carrying adult lampreys over the banks (Mr. Murl Bright, local resident, personal communication, Summer 1996).

ODFW has previously engaged in the “rehabilitation of desirable fish populations” by poisoning streams with a toxicant called Rotenone (a piscicide). Ray Beamesderfer, an information specialist with ODFW, could not find evidence of Rotenone use in any of the waters in the Siletz River basin. Most Rotenone use in Oregon was restricted to standing water bodies and a few eastern Oregon rivers (R. Beamesderfer, personal communcation, 1996).

Appendix B
CTSI Aquatic Survey Protocol

The original purpose of creating the LED aquatic habitat GIS was to make resource management decisions and to prioritize restoration projects. Although the aquatic habitat data used in the final GIS were collected by ODFW, other aquatic habitat surveys were completed by the author for CTSI. The following section describes the protocol used by CTSI. A list of results from these surveys can be found in Appendix C.

Our sampling design was based on the well-established survey protocol designed by ODFW for the aquatic inventory project. Their methodology was created by multiple wildlife biologists to be compatible with other stream habitat assessment systems and to be used by both resource managers and scientists. Since the expected uses of the CTSI LED GIS included both scientific and managerial objectives, the ODFW protocols were more than sufficient.

We began our field season by participating in a training workshop on the aquatic habitat inventory protocols conducted by ODFW personnel. The workshop covered definitions of habitat parameters, as well as in the field practice of survey techniques. The original ODFW protocols were too comprehensive for the needs of CTSI, so they were modified to highlight aquatic habitat parameters, which have known direct impacts on lamprey spawning habitat. The following habitat parameters were measured during the CTSI survey: shade, substrate, riparian width, riparian vegetation type, land use, bank erosion, stream unit type, unit length and woody debris. This condensed aquatic survey was completed during the summer of 1996 by the author and Penny Noland, a Siletz tribal member and Native American in Marine

Science participant. The data from this survey were not incorporated into the LED GIS in its current form, but is included here for completeness.

B.1 *Description of Survey Parameters*

In general, the ODFW protocols were followed for each of the habitat parameters measured (Moore et al. 1995). The following list includes CTSI deviations from the original ODFW protocols. The results of these surveys were entered into Microsoft Access as three tables linked by <u>unit number</u>. The unit number represents the order the river units were surveyed. <u>GeoCode</u> lists the units in sequential order along the stream, beginning with the mouth of Rock Creek.

<u>Unit Type</u> - Geomorphic channel units. For small riffles, which separated large pools, were often included in the total length of the pool unit. The riffle type and length was recorded in the comments section.

<u>Unit Length</u> - The length in meters from the beginning to end of each unit was measured through the center of the unit with a fiberglass measuring tape. For impassable units, the measurement was estimated by measuring along the shore. Estimated lengths are noted in the comments section.

<u>Channel Exposure</u> - A clinometer was used to determine the amount of shade produced by vegetation or land forms on each side of the stream. Readings, in degrees, were taken from the center of the unit, perpendicular from the center of the channel to an average canopy height.

<u>Bank Classification</u> - A description of the stream bank (i.e. stable, undercut).

Land Use - The land use was determined by observing the area surrounding the riparian zone. Many times it was difficult to distinguish surrounding land use due to reduced visibility. Educated guesses and additional observations from a vehicle enhanced guesses from the stream. Aerial surveys would be helpful in determining land use in the valley. CTSI has some aerial photographs of the Rock Creek area from 1993.

Riparian Width - The width of the surrounding riparian vegetation was estimated in meters to show the highly variable widths of the dominant riparian vegetation. Measurements over 10-15 m were difficult to estimate, since the end of the riparian zone could not be seen. Again, aerial photographs may assist in determining true riparian width.

Riparian Vegetation - The dominant classes of riparian vegetation were noted for each side of the channel.

Substrate - 100% of the substrate was estimated into five classes.

Woody Debris - Large pieces or conglomerates of wood, which could affect channel morphology were recorded. Length was estimated in three meter incremental size classes. Diameter was estimated in the following size classes: 0-15 cm diameter at breast height (dbh), 15-30 cm dbh, 30-50 cm dbh, 50-90 cm dbh and +90 cm dbh. Position in the channel was noted.

B.2 *Location of Larval Lamprey*

In addition to the aquatic surveys we were able to sample five locations for the presence of Pacific lamprey ammocetes. This sampling was conducted on August 2, 1996 by Stan van de Wetering (Oregon State University, Department of Fisheries and Wildlife). Table B1 outlines the locations of the electroshocking sites. Lamprey ammocetes were collected in a net from each site and a few ammocetes were preserved in alcohol for later identification and age classing.

Table B.1 *Electroshocking Sites in the Rock Creek Watershed*

Site Number	Creek Name	Site Location
1	Rock	100 m W of the CTSI hatchery buildings
2	Steere	10 m E of the confluence with Rock and Little Rock Creeks
3	Little Rock	Simpson Timber property between the Moore and Kerr properties
4	Little Rock	First bridge, E of Wischnofske property
5	Little Rock	West entrance to Simpson Timber property, 200 m past the gate

Appendix C
CTSI Aquatic Survey Results

Table C.1, *CTSI Stream Survey Results*

Date	Stream	Unit Number	Geo Code	Unit Type	Length	Shade-L	Shade-R	Bank-L	Bank-R	Land-L	Land-R
6/21/96	2	1	262	SR	0	90	90	VS	VS	HG	LG
6/21/96	2	2	263	RI	13	90	90	VS	VS	HG	LG
6/21/96	2	3	264	SP	26	90	90	VS	VS	HG	HG
6/21/96	2	4	265	LP	10	60	80	AE	VS	HG	HG
6/21/96	2	5	266	RI	7	90	90	AE	VS	HG	HG
6/21/96	2	6	267	LP	28	90	90	AE	VS	HG	LT
6/21/96	2	7	268	SP	26	90	90	VS	VS	HG	YT
6/21/96	2	8	269	DP	38	70	90	AE	AE	HG	YT
6/21/96	2	9	270	LP	29	15	25	AE	AE	HG	YT
6/21/96	2	10	271	LP	14	90	85	AE	AE	HG	YT
6/21/96	2	11	272	GL	21	80	90	AE	AE	HG	YT
6/21/96	2	12	273	LP	20	70	40	AE	AE	HG	YT
6/21/96	2	13	274	LP	23	90	65	AE	AE	HG	YT
7/1/96	1	14	37	SP	25	60	60	VS	VS	YT	ST
7/1/96	1	15	38	LP	33	70	85	VS	VS	YT	ST
7/1/96	1	16	39	RI	21	90	40	VS	VS	YT	ST
7/1/96	1	17	40	SP	25	85	75	VS	VS	YT	ST
7/1/96	1	18	41	RI	20	85	60	VS	VS	YT	ST
7/1/96	1	19	42	LP	32	90	60	VS	VS	YT	ST
7/1/96	1	20	43	LP	10	80	60	VS	VS	YT	ST
7/1/96	1	21	44	RI	63	75	65	VS	VS	YT	ST
7/1/96	1	22	45	SP	125	55	50	VS	VS	YT	ST
7/1/96	1	23	46	RI	72	65	75	VS	VS	YT	ST
7/1/96	1	24	47	LP	94	45	40	VS	VS	YT	ST
7/1/96	1	25	48	SP	100	55	90	AE	VS	YT	ST
7/1/96	1	26	49	SR	17	60	60	VS	VS	YT	ST
7/1/96	1	27	50	SP	48	60	75	VS	VS	YT	ST
7/1/96	1	28	51	RI	23	70	85	VS	VS	YT	ST
7/1/96	1	29	52	SP	108	65	60	VS	VS	YT	ST
7/1/96	1	30	53	GL	35	75	65	VS	VS	YT	ST

Table C.1, *Continued*

Unit Number	Riparian-W-L	Riparian-W-R	Riparian-V-L	Riparian-V-R	Comment1	Comment2
1	3	3	D	D	SMALL UNIT, SHOULD BE COMBINED WITH UNIT 1	
2	0	3	G	D	ALDER RIPARIAN, SMALL CATTLE ENTRY W/ DUNG	SECTION IS MOSTLY POOLS WITH SHORT RIFFLES BETWEEN
3	1	3	G	D	CATTLE ENTRY, UNIT ENDS AT SMALL LEFT STRUCTURE	
4	1	4	G	D	CATTLE ENTRY	
5	1	5	G	D		
6	0	10	G	D	CATTLE CROSSING W/ HIGH EROSION	
7	2	7	G	D		END AT STRUCTURE
8	3	10	G	D	THERE IS LIGHT GRAZING ON THE YT SIDE	
9	0	7	G	S		
10	10	5	D	S		END AT STRUCTURE
11	15	4	D	D	END AT TRIB RT	
12	9	20	D	D		
13	15	15	D	D		ENDS JUST PAST BRIDGE
14	10	20	D	D		
15	15	30	D	D		
16	20	40	D	D		
17	20	40	D	D		
18	20	40	D	D		
19	20	50	D	D	ROCK FLOOR	GLIDE, ISLAND IN CREEK, OTHER SIDE IS SILT COVERED BR
20	20	50	D	D		
21	15	50	D	D		RT- SLOWER WATER W/ BR ISLANDS W/ RCG
22	15	15	M	D	40M LEFT BR-------FALLS DEEP WATERS-KELLYS WET!	
23	20	10	D	D		LEFT - DEEP TRENCH W/ COBBLE BOTTOM
24	20	20	D	S		
25	20	20	D	D	L-SIDE DEER TRAILS (AE)	
26	20	30	D	D	FALLS	
27	10	10	D	D		
28	10	10	D	D		
29	10	10	D	D	(AE) DEER TRAILS	FLAG AT END
30	20	10	D	D		LOOKS GOOD

Table C.1, *Continued*

Date	Stream	Unit Number	Geo Code	Unit Type	Length	Shade-L	Shade-R	Bank-L	Bank-R	Land-L	Land-R
7/1/96	1	31	54	LP	62	60	45	VS	AE	YT	ST
7/3/96	1	32	55	SP	80	70	60	VS	VS	YT	YT
7/3/96	1	33	56	LP	319	70	65	AE	VS	YT	YT
7/3/96	1	34	57	LP	101	75	70	AE	AE	YT	YT
7/3/96	1	35	58	GL	36	70	65	AE	AE	YT	HG
7/3/96	1	36	59	SP	97	85	80	AE	AE	YT	HG
7/3/96	1	37	60	SP	70	55	80	VS	AE	YT	HG
7/3/96	1	38	61	RI	45	55	40	AE	AE	LG	HG
7/3/96	1	39	62	LP	27	90	30	AE	AE	LG	HG
7/3/96	1	40	63	GL	66	85	50	AE	AE	YT	HG
7/4/96	1	42	115	RI	15	30	75	AE	AE		LT
7/4/96	1	43	116	LP	46	35	25	AE	AE		LT
7/4/96	1	44	117	GL	41	50	45	AE	AE		
7/4/96	1	45	118	SP	56	25	25	AE	AE	ST	
7/4/96	1	46	119	RI	28	15	25	AE	AE	ST	
7/4/96	1	47	120	GL	58	45	45	AE	AE	LT	
7/4/96	1	48	121	SP	49	55	70	AE	AE	LT	
7/4/96	1	49	122	RI	24	40	45	AE	VS	LT	
7/4/96	1	50	123	LP	45	50	65	AE	VS	LT	
7/4/96	1	51	124	RI	23	45	45	VS	VS	LT	
7/4/96	1	52	125	SP	63	65	45	VS	AE	LT	
7/4/96	1	53	126	SB	12	75	70	VS	VS	LT	
7/4/96	1	54	127	LP	84	75	60	AE	AE	LT	LT
7/4/96	1	55	128	LP	53	35	45	AE	AE	LT	LT
7/4/96	1	56	129	LP	47	45	45	AE	AE	LT	LT
7/4/96	1	57	130	RI	26	60	65	VS	VS	LT	LT
7/4/96	1	58	131	SP	52	80	45	VS	AE	LT	LT
7/4/96	1	59	132	LP	48	80	40	AE	AE	LT	LT

Table C.1, *Continued*

Unit Number	Riparian-W-L	Riparian-W-R	Riparian-V-L	Riparian-V-R	Comment1	Comment2
31	20	10	D	D		FLAG AT END, RIPARIAN #S FROM UNIT 30 NOT RECORDED IN FIELD, ESTIMATION
32	40	40	D	D	COULDNT WALK POOL	LENGTH APPROX, SR .2 M HIGH AT BEG
33	20	40	D	D	LEFT BANK BC (I AREA)	SHARP BEND RT, LT BANK GRAVEL
34	20	5	D	D	COW LAND	LAND USE CHANGE ON RT
35	40	5	D	D	COW LAND	FLAG FOR 34-35 AT END OF 35
36	20	5	D	D		RD ON LT, CATTLE ENTRY RT
37	20	5	D	D	COW LAND RT. SIDE	BEG. W/ BR GL/RI
38	2	2	D	S	LG BY FENCE	
39	2	2	D	S	POSSIBLE EEL REDDS, LG BY FENCE	
40	5	2	D	S	POSSIBLE EEL REDDS	FLAG 10M BEFORE END (SR) LT
42	40	5	S	D	LT- NO APPARENT USE	DIFFICULT TO TELL LAND USE- NO APPARENT USE
43	50	50	D	D		R-L TO ROAD R-R NO SURROUNDING LAND USE, 1 SMALL RI BEG, ISLANDS IN CENTER
44	50	20	D	D		START W/ RI, LOG W/ SP, SIDE RI TO POOL
45	50	10	S	S	POSS. EEL REDDS, LG. WOOD R- BANK	2 DEEPER AREAS W/ GL BETWEEN
46	50	10	S	S		BEND LT AROUND ISLAND, END AT BACKWATER
47	30	20	S	D	POSS. EEL REDDS	
48	10	30	D	D		
49	5	30	S	D		
50	10	30	D	S		
51	5	30	S	D		
52	10	5	D	S	POSS. EEL REDDS	UNIT ENDS AT SB AT BRIDGE
53	20	20	D	D	BRIDGE	
54	30	50	D	D	POSS. EEL REDDS	
55	20	50	G	D	2 TRIBS RIGHT	FLAG AT THE END OF THE UNIT
56	10	50	D	D	POSSIBLE EEL REDDS	START W/ RI, RCG ON SANDBAR-RT, L BUFFER TO ROAD
57	10	50	D	D		LOTS OF RCG ON BANKS
58	10	20	D	D	BOULDERS IN WATER	OPEN AREA ON RT W/ RCG
59	10	20	D	S	NEAR ROAD, LOG JAM ON LEFT BEHIND BOULDER	

Table C.1, *Continued*

Date	Stream	Unit Number	Geo Code	Unit Type	Length	Shade-L	Shade-R	Bank-L	Bank-R	Land-L	Land-R
7/4/96	1	60	133	LP	60	65	50	AE	AE	LT	LT
7/4/96	1	61	134	LP	63	50	75	AE	AE	LT	LT
7/4/96	1	62	135	LP	34	55	65	AE	AE	LT	LT
7/4/96	1	63	136	RI	42	40	70	AE	AE	LT	
7/22/96	1	64	1	RI	58	60	50	VS	VS		
7/22/96	1	65	2	DP	16	55	75	VS	VS		
7/22/96	1	66	3	GL	68	55	55	VS	VS		
7/22/96	1	67	4	RI	44	70	65	VS	VS	HG	
7/22/96	1	68	5	RI	55	70	65	VS	VS	HG	
7/22/96	1	69	6	SP	163	75	70	VS	VS	HG	
7/22/96	1	70	7	SP	28	55	50	VS	VS	HG	
7/22/96	1	71	8	RI	26	60	50	VS	VS	HG	
7/22/96	1	72	9	SP	116	60	65	VS	VS	HG	
7/22/96	1	73	10	SP	64	60	55	VS	VS	HG	
7/22/96	1	74	11	RI	92	65	60	VS	VS	HG	
7/22/96	1	75	12	GL	249	60	40	AE	AE	HG	ST
7/22/96	1	76	13	RI	43	80	30	VS	VS	HG	ST
7/26/96	1	77	14	LP	69	75	35	BR	VS	ST	YT
7/26/96	1	78	15	LP	114	65	50	VS	VS	ST	YT
7/26/96	1	79	16	LP	68	50	55	VS	BR	ST	YT
7/22/96	1	80	17	RI	35	50	75	AE	BR	HG	YT
7/26/96	1	81	18	SP	35	80	75	AE	BR	HG	YT
7/26/96	1	82	19	DP	30	50	50	AE	VS	HG	YT

Table C.1, *Continued*

Unit Number	Riparian-W-L	Riparian-W-R	Riparian-V-L	Riparian-V-R	Comment1	Comment2
60	20	10	D	D		START W/ SMALL POOL BEFORE RI, END UNDER WIRES
61	0	20	G	D	POSSIBLE EEL REDDS	BEG OF OPEN HATCHERY AREA (FLAG AT THE BEGINNING), START WITH RI, END AT RI PAST SMALL BUILDING
62	5	40	D	D		
63	5	40	D	D		LANDSLIDE ON THE RT, FLAG AT THE END BY RI-L
64	10	5	D	D	TAPE MEASURE IN FEET	STARTS WITH STEP BEDROCK, KINGFISHER
65	10	10	D	D		DIPPER, START W/ DIAGONAL SR
66	20	10	C	D		STARTS WITH RIFFLES/BOULDERS
67	5	5	D	D		RIPARIAN R TO STRUCTURE (BARN) (STEEP SLOPE)
68	5	30	D	D		MIX OF RI, POOLS, GL
69	5	10	D	M	END OF UNIT CATTLE ENTRY	3 POOLS TOETHER, SOME CATTLE ENTRY, GR ON LT
70	5	20	D	D	L-SIDE TRIBUTARY	START W/SR, END TRIB RT
71	5	40	D	D	SMALL TRIB RT	LEFT BANK-GRAZED BUT FENCED UP TRIB, ALONG ROCK
72	5	40	D	D		RIPARIAN R MAY EXTEND FURTHER
73	5	40	D	D		FIP. R MAY EXTEND FURTHER, START W/SR, STILL FENCED LT
74	5	40	D	D		RIP. R MAY EXTEND FURTHER, START W/ SR, HAS POOL, VERY DIVERGENT
75	5	10	D	D	COW AREA	53M TO CATTLE ENTRY AT BR LT SMALL GRAVEL BAR BEFORE
76	5	10	D	G		
77	10	5	D	S		UNITS 64-76 MAY HAVE HAD BR SIDES THAT WEREN'T NOTED
78	10	5	D	D		
79	5	10	D	D		
80	5	10	D	M	COW ENTRY	LARGE CATTLE ENTRY LEFT
81	0	5	D	D		OPEN GRASS WITH SOME TREES LEFT ENDS AT DIAGONAL BR- RIFFLE
82	10	20	D	D		

Table C.1, *Continued*

Date	Stream	Unit Number	Geo Code	Unit Type	Length	Shade-L	Shade-R	Bank-L	Bank-R	Land-L	Land-R
7/26/96	1	83	20	DP	40	45	60	AE	VS	HG	YT
7/26/96	1	84	21	GL	109	40	60	AE	VS	HG	YT
7/26/96	1	85	22	SP	60	65	60	AE	BR	HG	YT
7/26/96	1	86	23	DP	32	65	70	VS	BR	HG	YT
7/26/96	1	87	24	RI	25	55	65	VS	BR	HG	YT
7/26/96	1	88	25	SP	156	65	70	BR	BR	HG	YT
7/26/96	1	89	26	RI	60	65	75	VS	VS	HG	YT
7/26/96	1	90	27	LP	210	85	75	BR	VS	HG	ST
7/26/96	1	91	28	SP	218	40	75	AE	BR	HG	LG
7/26/96	1	92	29	SP	160	60	85	AE	BR	HG	ST
7/26/96	1	93	30	SP	66	50	90	BR	AE	HG	ST
7/26/96	1	94	31	SP	163	55	70	VS	VS	ST	ST
7/29/96	1	95	32	SP	45	60	75	AE	AE	ST	YT
7/29/96	1	96	33	SP	37	45	65	AE	BR	ST	YT
7/29/96	1	97	34	SP	68	85	55	AE	AE	ST	YT
7/29/96	1	98	35	DP	330	55	45	BR	AE	ST	YT
7/31/96	1	99	36	RI	10	60	60	AE	VS	YT	YT
7/31/96	2	100	208	SP	24	75	55	AE	AE	YT	YT
7/31/96	2	101	209	RI	11	85	50	AE	AE	YT	YT
7/31/96	2	102	210	SP	19	80	85	BC	AE	YT	YT
7/31/96	2	103	211	SP	45	55	60	BC	AE	YT	YT
7/31/96	2	104	212	RI	11	35	45	AE	AE	YT	YT
7/31/96	2	105	213	LP	0	40	45	AE	AE	YT	YT
7/31/96	2	106	214	DP	75	50	55	AE	AE	YT	HG

Table C.1, *Continued*

Unit Number	Riparian-W-L	Riparian-W-R	Riparian-V-L	Riparian-V-R	Comment1	Comment2
83	1	20	D	D		SHED/WORK AREA LT
84	5	30	S	D		LOOKS GOOD
85	5	30	D	D		STARTS WITH SMALL SR FIRST 1/2 POOL,SECOND 1/2 RIFFLE
86	10	20	D	D		
87	10	20	D	D		
88	5	20	D	D		
89	5	20	D	D		CATTLE
90	5	20	D	D	A/E WHERE COW ENTRY IS-L	CATTLE
91	5	20	D	D	CATTLE CROSSING IN WATER	PUMP, LT GREEN PREFAB HOUSE, 85M FENCEPOSTS ONLY, COWS BOTH SIDES, ERODED LT
92	5	20	D	D		
93	5	30	D	D		
94	5	10	D	D	FLAG AT END	TAN PREFAB LEFT AT 60 SMALL RI, NO TREES LT NEAR HOUSE, RCE, FLAG AT END OF UNIT
95	5	10	D	D		LT BUFFER TO RD, FLAG AT BEG
96	5	10	S	D		LT BUFFER TO RD
97	5	10	D	D		LT BUFFER TO RD
98	5	5	D	D	ALL ESTIMATED, COULDN'T PASS THROUGH	ESTIMATION, COULDN'T TRAVERSE, SPAWNING HABITAT AT END
99	5	10	D	D	RI ENDS AT UNIT 14	RI ENDS AT UNIT 14
100	10	20	D	S		STARTS WITH DOWN WOOD, LOTS OF OVER HANG AND MEDIUM WOOD
101	3	20	D	S	BC END OF UNIT	LEFT-BUFFER TO ROAD --2 MUSSLE SHELLS ON ROCKS--DEAD
102	3	20	D	D		STARTS WITH DOWN WOOD--TWO MORE PC. AT DRY DRAINING PIPE.
103	2	10	D	D	BOULDERS AT END OF UNIT	SHORT RI IN BIG LEFT BUFFER---10M OPENING TO ROAD
104	2	10	G	S		LARGE BOULDERS LEFT AT 8M --- WOOD OUT FROM BOULDER
105	5	10	D	S		LENGTH NOT COMPLETE, AROUND BEND, NARROW W/ WOOD, LOTS OF SILT AT END
106	20	20	G	S		

Table C.1, *Continued*

Date	Stream	Unit Number	Geo Code	Unit Type	Length	Shade-L	Shade-R	Bank-L	Bank-R	Land-L	Land-R
7/31/96	2	107	215	LP	22	75	40	AE	AE	YT	HG
8/5/96	1	108	64	LP	67	50	45	AE	AE	ST	HG
8/5/96	1	109	65	GL	47	25	60	AE	AE	HG	HG
8/5/96	1	110	66	SP	74	35	75	AE	BR	HG	HG
8/5/96	1	111	67	GL	68	30	70	AE	BR	HG	HG
8/5/96	1	112	68	SP	31	40	70	AE	BR	HG	HG
8/5/96	1	113	69	SP	42	45	80	AE	BR	HG	HG
8/5/96	1	114	70	LP	33	80	80	AE	BR	HG	HG
8/5/96	1	115	71	RI	34	65	65	AE	AE	HG	HG
8/5/96	1	116	72	LP	90	70	60	AE	AE	HG	HG
8/5/96	1	117	73	SP	126	50	65	AE	AE	HG	HG
8/5/96	1	118	74	RI	32	25	80	AE	AE	HG	HG
8/5/96	1	119	75	SP	33	55	80	AE	AE	HG	HG
8/5/96	1	120	76	GL	128	50	60	AE	AE	HG	HG
8/5/96	1	121	77	LP	44	45	80	AE	AE	HG	HG
8/5/96	1	122	78	GL	32	60	75	AE	BR	HG	HG
8/5/96	1	123	79	GL	38	25	70	AE	BR	HG	HG
8/5/96	1	124	80	SP	232	75	60	AE	AE	HG	HG
8/5/96	1	125	81	RI	37	65	40	AE	AE	HG	YT
8/5/96	1	126	82	SP	208	50	60	AE	AE	HG	YT
8/7/96	2	127	216	SP	43	55	30	AE	AE	YT	HG
8/7/96	2	128	217	SP	120	65	60	AE	AE	YT	HG
8/7/96	2	129	218	SP	35	50	35	AE	AE	YT	HG
8/7/96	2	130	219	SP	100	25	40	AE	AE	HG	HG
8/7/96	2	131	220	RI	30	20	60	AE	AE	HG	HG
8/7/96	2	132	221	SP	64	15	50	AE	AE	HG	HG
8/7/96	2	133	222	RI	18	15	40	AE	AE	HG	HG
8/7/96	2	134	223	SP	43	15	30	AE	AE	HG	HG
8/7/96	2	135	224	SP	63	10	35	AE	AE	HG	HG
8/7/96	2	136	225	SP	17	10	35	AE	AE	HG	HG
8/7/96	2	137	226	SP	29	15	45	AE	AE	HG	HG
8/7/96	2	138	227	SP	37	10	75	AE	AE	HG	HG

Table C.1, *Continued*

Unit Number	Riparian-W-L	Riparian-W-R	Riparian-V-L	Riparian-V-R	Comment1	Comment2
107	5	0	D	G	END AT FLAG	
108	3	0	D	D		
109	0	3	G	D	POSS. EEL REDDS	AFTER SHARP BEND R (IN UNIT 108), FLAG AT END OF UNIT
110	0	3	G	D		AROUND BEND LT
111	0	5	G	D		
112	3	10	S	D		
113	3	3	D	D		CATTLE ENTRY NOW FENCED OFF L AT BEGINING, START WITH SM. BO,RI
114	3	3	D	D		
115	3	3	D	D		LARGE CATTLE,CROSSING, BARE DIRT, FENCE L STOPS
116	3	3	D	D	POSS. EEL REDDS	FLAG AT END GRAVEL BAR L
117	3	3	D	D		TRIBUTARY LEFT AT 60M
118	0	3	G	D		
119	3	5	D	D	POSS. EEL REDDS	
120	3	20	D	D		
121	0	20	G	D		
122	0	10	D	D		
123	3	20	S	D		
124	3	10	D	D		
125	3	10	D	D		
126	5	10	S	D		
127	10	3	S	S		SHARP BEND RT
128	10	10	S	S	ESTIMATED, COULDNT GET THROUGH CREEK	
129	5	0	S	G		
130	0	0	G	G		
131	0	0	G	G		
132	0	0	G	G		
133	0	0	G	G		
134	0	0	G	G		
135	0	0	G	G		
136	0	0	G	G		
137	0	0	G	G		
138	0	3	G	D		

Table C.1, *Continued*

Date	Stream	Unit Number	Geo Code	Unit Type	Length	Shade-L	Shade-R	Bank-L	Bank-R	Land-L	Land-R
8/7/96	2	139	228	SP	40	10	35	AE	AE	HG	HG
8/7/96	2	140	229	SP	66	15	25	AE	AE	HG	HG
8/7/96	2	141	230	SP	20	15	30	AE	AE	HG	HG
8/7/96	2	142	231	RI	16	10	45	AE	AE	HG	HG
8/7/96	2	143	232	SP	51	15	30	AE	AE	HG	HG
8/7/06	2	144	233	SP	23	15	60	AE	AE	HG	HG
8/7/96	2	145	234	SP	29	40	40	AE	AE	HG	HG
8/7/96	2	146	235	SP	25	25	35	AE	AE	HG	HG
8/7/96	2	147	236	SP	16	15	40	AE	AE	HG	HG
8/7/96	2	148	237	RI	55	15	30	AE	AE	HG	HG
8/7/96	2	149	238	SP	40	10	20	AE	AE	HG	HG
8/7/96	2	150	239	RI	21	15	20	AE	AE	HG	HG
9/7/96	2	151	240	SP	35	25	40	AE	AE	HG	HG
7/8/96	2	152	241	RI	35	30	20	AE	AE	HG	HG
8/7/96	1	153	148	SP	17	70	35	AE	AE	HG	HG
8/7/96	1	154	149	LP	63	50	30	AE	AE	HG	HG
8/7/96	1	155	150	GL	47	15	45	AE	AE	HG	HG
8/7/96	1	156	151	SP	26	65	75	AE	BR	HG	ST
8/7/96	1	157	152	RI	31	85	65	AE	BR	HG	ST
8/7/96	1	158	153	SP	29	15	75	AE	AE	HG	ST
8/7/96	1	159	154	SP	45	20	70	AE	AE	HG	ST
8/7/96	1	160	155	SP	68	30	65	AE	AE	HG	ST
8/7/96	1	161	156	DP	150	60	55	BR	AE	HG	ST
8/7/96	1	162	157	RI	26	50	25	VS	AE	HG	HG
8/7/96	1	163	158	SP	26	75	30	VS	AE	HG	HG
8/7/96	1	164	159	SP	34	60	65	AE	AE	ST	HG
8/7/96	1	165	160	LP	33	55	15	AE	AE	HG	HG
8/7/96	1	166	161	RI	35	60	45	AE	AE	HG	HG
8/7/96	1	167	162	GL	40	30	25	VS	VS	HG	HG
8/7/96	1	168	163	RI	47	85	80	VS	AE	HG	HG
8/7/96	1	169	164	RI	60	35	60	AE	AE	HG	HG
8/7/96	1	170	165	SP	39	65	70	AE	AE	HG	ST
8/7/96	1	171	166	RI	45	20	55	AE	VS	HG	ST

Table C.1, *Continued*

Unit Number	Riparian-W-L	Riparian-W-R	Riparian-V-L	Riparian-V-R	Comment1	Comment2
139	0	0	G	G		
140	0	0	G	G		
141	0	0	G	G		
142	0	0	G	G		
143	0	0	G	G		
144	0	2	G	S		START W/5 M RI
145	2	0	S	G		
146	0	0	G	G		RIGHT BANK VERY STEEP W/NO VEG. 5FT. HIGH SLOUGH
147	0	0	G	G		SMALL TRIB RT AT END
148	0	0	G	G		
149	0	0	G	G		
150	0	0	G	G		
151	2	2	S	S		
152	5	3	S	S		
153	20	3	D	S		RIPARIAN L GOES TO ROAD
154	5	0	S	G		
155	0	5	G	D		
156	0	20	G	D		LEFT BANK OPEN TO COWS, RT STEEP BEDROCK
157	0	20	G	D		A FEW LG. ALDER BACK 5M POSS. REDDS
158	0	10	G	D	POSS. REDDS	
159	0	20	G	D		STARTS WITH 2M RI
160	5	10	S	S		
161	5	3	S	S	POSS. REDDS	
162	10	2	D	S		BUFFER L TO ROAD
163	10	2	D	S		BUFFER -L-TO ROAD
164	10	2	D	D		
165	0	2	G	S		HOOF IMPACT
166	2	2	D	D		HOOF IMPACT
167	2	2	D	D		
168	2	2	D	D		23 M AT FOOTBRIDGE, LAST 24 M GLIDE LIKE
169	2	20	D	D		
170	2	20	G	D		FEW TREES LEFT
171	2	20	G	D		

Table C.1, *Continued*

Date	Stream	Unit Number	Geo Code	Unit Type	Length	Shade-L	Shade-R	Bank-L	Bank-R	Land-L	Land-R
8/7/96	1	172	167	LP	25	50	55	AE	VS	HG	ST
8/7/96	1	173	168	LP	25	80	60	AE	BR	HG	ST
8/7/96	1	174	169	RI	56	80	75	AE	VS	HG	ST
8/7/96	1	175	170	SP	30	85	80	AE	VS	HG	ST
8/7/96	1	176	171	LP	49	45	65	AE	AE	HG	ST
8/7/96	1	177	172	RI	21	50	45	AE	AE	HG	HG
8/7/96	1	178	173	DP	28	75	45	BR	AE	HG	HG
8/7/96	1	179	174	LP	24	65	35	AE	AE	HG	HG
8/7/96	1	180	175	SP	48	75	30	AE	AE	HG	HG
8/7/96	1	181	176	RI	21	70	30	AE	AE	ST	HG
8/7/96	1	182	177	LP	27	65	45	AE	AE	ST	HG
8/7/96	1	183	178	SP	64	60	65	AE	AE	ST	HG
8/7/96	1	184	179	RI	26	75	60	AE	AE	ST	HG
8/7/96	1	185	180	SP	30	85	65	BC	VS	ST	HG
8/7/96	1	186	181	SP	37	75	75	BC	AE	ST	ST
8/7/96	1	187	182	SP	26	30	60	BC	AE	YT	ST
8/9/96	2	188	183	RI	43	25	50	VS	VS	YT	HG
8/9/96	2	189	184	SP	22	30	45	BC	AE	YT	HG
8/9/96	2	190	185	LP	31	40	60	VS	AE	ST	HG
8/9/96	2	191	186	RI	30	65	50	VS	VS	ST	HG
8/9/96	2	192	187	SP	19	80	45	BC	VS	ST	HG
8/9/96	2	193	188	SP	8	75	45	VS	VS	ST	HG
8/9/96	2	194	189	SP	15	70	40	VS	VS	ST	HG
8/9/96	2	195	190	RI	17	55	45	VS	VS	ST	HG
8/9/96	2	196	191	SP	48	55	50	VS	VS	ST	ST
8/9/96	2	197	192	RI	32	85	65	VS	VS	ST	ST
8/9/96	2	198	193	SP	28	70	90	VS	VS	ST	ST
8/9/96	2	199	194	RI	21	85	90	AE	VS	ST	ST
8/9/96	2	200	195	SP	25	60	90	VS	VS	ST	ST
8/9/96	2	201	196	RI	18	35	50	VS	VS	ST	ST
8/9/96	2	202	197	GL	73	50	55	AE	AE	ST	ST
8/9/96	2	203	198	SP	49	40	55	AE	AE	ST	ST
8/9/96	2	204	199	RI	22	65	80	AE	AE	HG	HG

Table C.1, *Continued*

Unit Number	Riparian-W-L	Riparian-W-R	Riparian-V-L	Riparian-V-R	Comment1	Comment2
172	2	20	D	D		
173	2	20	D	D		
174	2	20	D	D		
175	2	20	D	D		
176	5	20	D	S		
177	5	5	S	D		
178	5	5	D	S		
179	5	5	D	S		
180	10	5	D	S		
181	10	5	D	S		
182	10	10	D	S		L-BUFFER TO ROAD
183	5	20	D	D		
184	5	20	D	D		
185	5	20	D	D		STARTS W/ 3M BR,RI
186	5	20	S	D		
187	3	20	S	D	COWS GRAZING	
188	3	5	S	S	BANK HAS ABOUT 60% BC THROUGH OUT CREEK AREA	END JUST PAST BRIDGE
189	0	10	G	S	EEL HABITAT	
190	2	20	S	D	EEL HABITAT	
191	5	10	S	S		
192	10	10	D	S	COWS MAY BE ON BANK -HARD TO TELL BANK LOCATION	L-BUFFER TO ROAD
193	10	5	D	S		L SHADE, OVERHANGE CREEK
194	10	0	D	G		L SHADE, OVERHANG CREEK
195	10	3	D	S		L SHADE, OVERHANG CREEK
196	10	10	S	S		L SHADE, OVERHANG CREEK
197	10	20	D	D		L BUFFER TO ROAD
198	10	20	D	D		L BUFFER TO ROAD, LOTS OF CRAWDADS
199	10	20	D	D		
200	15	20	D	D		
201	0	20	G	D		
202	5	10	S	S		
203	5	10	S	S		
204	2	5	D	D		

Table C.1, *Continued*

Date	Stream	Unit Number	Geo Code	Unit Type	Length	Shade-L	Shade-R	Bank-L	Bank-R	Land-L	Land-R
8/9/96	2	205	200	LP	15	45	65	AE	AE	HG	HG
8/9/96	2	206	201	RI	19	30	75	AE	AE	HG	HG
8/9/96	2	207	202	SP	34	55	75	AE	VS	HG	HG
8/9/96	2	208	203	RI	49	50	60	AE	VS	HG	HG
8/9/96	2	209	204	SP	10	55	70	VS	VS	HG	HG
8/9/96	2	210	205	RI	28	85	75	AE	AE	ST	HG
8/9/96	2	211	206	SP	291	60	60	AE	AE	HG	HG
8/9/96	2	212	207	SP	133	75	30	AE	AE	HG	HG
9/4/96	1	214	137	RI	7	40	35	AE	AE	ST	ST
9/4/96	1	215	138	SP	16	55	40	VS	AE	ST	ST
9/4/96	1	216	139	RI	82	60	50	BC	BC	ST	ST
9/4/96	1	217	140	SP	22	45	65	VS	BC	ST	ST
9/4/96	1	218	141	RI	40	70	50	BC	VS	ST	ST
9/4/96	1	219	142	SB	6	60	50	AE	AE	ST	ST
9/4/96	1	220	143	DP	30	60	50	AE	AE	ST	ST
9/4/96	1	221	144	RI	75	70	65	BC	AE	ST	ST
9/4/96	1	222	145	LP	24	35	55	BC	AE	ST	ST
9/4/96	1	223	146	SR	2	50	45	AE	AE	ST	ST
9/4/96	1	224	147	DP	191	50	45	AE	AE	ST	ST
9/4/96	2	225	275	LP	33	50	75	AE	AE	HG	HG
9/4/96	2	226	276	SP	34	60	55	AE	AE	HG	HG
9/4/96	2	227	277	SP	13	50	70	AE	AE	HG	HG
9/4/96	2	228	278	SP	28	75	80	AE	AE	HG	HG
9/4/96	2	229	279	LP	25	70	65	AE	AE	HG	HG
9/4/96	2	230	280	RI	28	75	80	AE	AE	HG	HG
9/4/96	2	231	281	LP	80	75	80	AE	AE	HG	HG

Table C.1, *Continued*

Unit Number	Riparian- W-L	Riparian- W-R	Riparian- V-L	Riparian- V-R	Comment1	Comment2
205	0	5	G	S		
206	0	5	G	D		
207	2	10	S	D		
208	5	15	S	D		
209	10	20	D	D		
210	10	15	M	D		L-BUFFER TO ROAD
211	10	15	S	D		VERY LONG UNIT, HARD TO ESTIMATE
212	0	0	G	G		
214	5	20	D	D		AFTER LANDSLIDE
215	5	20	D	D		
216	5	30	D	D		
217	5	30	D	D		
218	5	30	D	D		
219	0	30	G	D		
220	2	20	D	D	1/2 LEFT BANK CONCRETE HATCHERY WALL	
221	2	20	D	D		
222	2	10	S	D		
223	2	10	C	D		1 M HIGH
224	10	10	S	S	DUNG	26 M TO TREE, COWS, COULDN'T FINISH MEASURING--HAD TO MEASURE ROAD
225	20	5	D	D	START AT SIMPSON LAND FIRST BRIDGE	START MEASURING AT END OF BRIDGE TO LWD
226	20	5	S	S		
227	20	5	S	S		
228	20	10	S	D		
229	20	20	S	D		
230	20	20	D	D	COW ENTRY	
231	5	20	S	S	COW ENTRY	OPEN AREA LEFT (END AFTERWARD)- TO THE CROSSING W/LOGSDEN RD. LITTLE ROCK IS BASICALLY IMPASSIBLE, NARROW CREEK MOSTLY SILT SUBSTRATE W/ SOME GRAVEL COVERED W/BRUSH-ALMOST ALL SHADED EXCEPT CATTLE ENTRIES - BRUSH COLLECTED, AT 25 M ODFW FLAG R10, 9/12/96, U240

Table C.1, *Continued*

Date	Stream	Unit Number	Geo Code	Unit Type	Length	Shade-L	Shade-R	Bank-L	Bank-R	Land-L	Land-R
9/9/96	2	232	290	LP	10	15	80	AE	AE	HG	HG
9/9/96	2	233	291	SP	25	50	90	AE	AE	HG	HG
9/9/96	2	234	292	RI	25	55	45	AE	AE	HG	HG
9/9/96	2	235	293	SP	19	75	80	AE	AE	HG	HG
9/9/96	2	236	294	RI	21	90	75	AE	AE	HG	HG
9/9/96	2	237	295	SP	35	90	85	AE	AE	HG	HG
9/9/96	2	238	296	SP	19	70	80	AE	AE	HG	HG
9/9/96	2	239	297	SP	19	70	80	AE	AE	HG	HG
9/9/96	2	240	298	SP	30	55	65	AE	AE	HG	HG
9/9/96	2	241	299	RI	15	50	60	AE	AE	HG	HG
9/9/96	2	242	300	SP	55	75	70	AE	AE	HG	HG
9/9/96	2	243	301	SP	17	70	75	AE	AE	HG	HG
9/9/96	2	244	302	SP	12	80	70	AE	AE	HG	HG
9/9/96	2	245	303	SP	46	75	75	AE	AE	HG	HG
9/9/96	2	246	304	SP	30	70	75	AE	AE	HG	HG
9/9/96	2	247	305	SP	22	75	70	AE	AE	HG	HG
9/9/96	2	248	306	SP	14	65	80	AE	AE	HG	HG
9/9/96	2	249	307	SP	37	75	65	AE	AE	HG	HG
9/9/96	2	250	308	RI	18	70	70	AE	AE	HG	HG
9/9/96	2	251	309	SP	17	85	90	AE	AE	HG	HG
9/9/96	2	252	310	GL	32	75	80	AE	AE	HG	HG
9/9/96	2	253	311	LP	31	45	45	AE	AE	HG	HG
9/9/96	2	254	312	GL	24	60	70	AE	AE	HG	HG
9/9/96	2	255	313	SP	30	50	40	AE	AE	HG	HG
9/9/96	2	256	314	SP	30	65	80	AE	AE	HG	HG
9/9/96	2	257	315	BP	68	65	55	AE	AE	HG	HG
9/9/96	2	258	242	SP	82	45	50	AE	AE	HG	HG
9/9/96	2	259	243	RI	5	35	15	AE	AE	HG	HG
9/9/96	2	260	244	SP	66	40	45	AE	AE	HG	HG
9/9/96	2	261	245	RI	10	35	45	AE	AE	HG	HG
9/9/96	2	262	246	SP	47	50	70	AE	AE	HG	HG

Table C.1, *Continued*

Unit Number	Riparian-W-L	Riparian-W-R	Riparian-V-L	Riparian-V-R	Comment1	Comment2
232	0	2	G	D		
233	0	2	G	S		
234	0	0	G	S		
235	5	5	S	S		
236	10	5	S	S		
237	2	2	S	S		
238	0	2	G	S		
239	2	5	S	S		
240	5	2	S	S		
241	2	2	S	S		
242	10	2	S	S		
243	10	5	S	S		
244	10	2	S	S	POSS. BEAVER DAM FULL CHANNEL	
245	20	5	D	S		
246	20	5	D	S		
247	2	5	D	S		
248	10	5	D	S		
249	20	5	S	S		
250	5	5	D	S		
251	10	5	S	S		
252	5	5	C	S		
253	5	0	S	G		
254	5	5	S	S		
255	5	5	S	S		SMALL BEAVER DAM TWD THE BEGINNING
256	5	5	S	S		LENGTH APPROX. IMPASSIBLE, PICTURE
257	10	10	S	S		
258	5	5	S	S		SIDES VERY ERODED, HIGH CATTLE IMPACT, END A T LOG, SMAL ISLAND TWD END
259	5	10	S	S		END AT SMALL TWIG DAM (BEAVER?), OTHER BEAVER SIGN AROUND
260	2	10	G	S		L BUFFER TO ROAD, LOGS MAKE A LARGE CORNER POOL
261	5	5	S	S		
262	5	5	S	S	3 TREES FALLEND TOGETHER W/ROOT WAD	PICTURE L BANK, VARIED UNIT SOME SHALLOW AREAS W/ POOLS

Table C.1, *Continued*

Date	Stream	Unit Number	Geo Code	Unit Type	Length	Shade-L	Shade-R	Bank-L	Bank-R	Land-L	Land-R
9/9/96	2	263	247	RI	8	35	60	AE	AE	HG	HG
9/9/96	2	264	282	SP	81	35	50	AE	AE	HG	HG
9/9/96	2	265	283	RI	8	45	45	AE	AE	HG	HG
9/9/96	2	266	284	BP	79	75	80	AE	AE	HG	HG
9/9/96	2	267	285	SP	51	85	90	AE	AE	HG	HG
9/9/96	2	268	286	SP	16	40	45	AE	AE	HG	HG
9/9/96	2	269	287	RI	5	80	90	AE	AE	HG	HG
9/9/96	2	270	288	SP	13	80	85	AE	AE	HG	HG
9/9/96	2	271	289	RI	13	90	90	AE	AE	HG	HG
9/12/96	1	272	83	RI	6	60	90	AE	AE	ST	YT
9/12/96	1	273	84	SP	21	80	65	AE	AE	ST	YT
9/12/96	1	274	85	RI	10	90	60	AE	AE	ST	YT
9/12/96	1	275	86	SP	16	80	55	AE	AE	ST	YT
9/12/96	1	276	87	RI	31	75	65	AE	AE	ST	YT
9/12/96	1	277	88	SP	32	80	80	AE	AE	ST	YT
9/12/96	1	278	89	RI	10	90	90	VS	VS	ST	YT
9/12/96	1	279	90	SP	80	75	80	AE	VS	ST	YT
9/12/96	1	280	91	RI	18	90	35	AE	VS	ST	YT
9/12/96	1	281	92	GL	135	65	70	AE	VS	ST	YT
9/12/96	1	282	93	SP	90	45	90	AE	AE	ST	YT
9/12/96	1	283	94	RI	30	20	90	AE	AE	ST	YT
9/12/96	1	284	95	SP	30	75	90	AE	AE	ST	YT
9/12/96	1	285	96	SP	28	30	75	AE	AE	ST	YT
9/12/96	1	286	97	SP	25	80	85	AE	AE	ST	YT
9/12/96	1	287	98	RI	20	75	85	AE	AE	ST	YT
9/12/96	1	288	99	SP	31	85	85	AE	AE	ST	YT
9/12/96	1	289	100	RI	38	80	45	VS	VS	ST	YT
9/12/96	1	290	101	DP	13	65	35	VS	VS	ST	YT
9/12/96	1	291	102	RI	11	85	40	VS	VS	ST	YT
9/12/96	1	292	103	SP	57	75	65	AE	AE	ST	YT
9/12/96	1	293	104	SP	42	80	55	AE	AE	HG	YT
9/12/96	1	294	105	SP	87	60	80	AE	AE	HG	YT
9/12/96	1	295	106	RI	20	25	60	AE	AE	HG	YT

Table C.1, *Continued*

Unit Number	Riparian-W-L	Riparian-W-R	Riparian-V-L	Riparian-V-R	Comment1	Comment2
263	10	2	S	D		END JUST BEFORE SIMPSON BRIDGE
264	0	10	G	S		AT 49M ODFW FLAG (R-11, U440, 9/12/95)
265	0	10	G	S		END AT BEAVER DAM, SM RI CREATED BY DAM
266	2	10	S	S		2 POSS. BEAVER DAMS AT 73 AND 59
267	2	10	G	S		START WITH SHALLOW AREA (LIKE AN RI)
268	2	10	G	S		START W/ 4M RI
269	5	10	S	S		
270	10	10	S	S		
271	10	10	S	S		EXIT BETWEEN 2T POLES BEFORE THE RT TURN TO LOG POND
272	10	10	D	D		
273	7	10	D	D		L-BUFFER TO ROAD
274	7	10	D	D		
275	7	15	D	D		
276	5	15	D	D		
277	5	10	D	D		
278	5	5	D	D		
279	10	10	D	D		
280	5	10	D	S		
281	5	15	D	D		
282	5	10	G	D		
283	2	5	D	D		
284	5	10	D	D		
285	5	10	S	D		
286	5	10	D	D		
287	2	20	D	D		LT BUFFER TO FENCE, FLAG IN MIDDLE
288	5	15	D	D		
289	5	10	D	S		
290	2	10	D	S		
291	5	10	D	S		
292	5	10	D	S		
293	2	5	D	D	POSS. EEL REDDS	
294	5	10	S	D		
295	2	10	S	D		

Table C.1, *Continued*

Date	Stream	Unit Number	Geo Code	Unit Type	Length	Shade-L	Shade-R	Bank-L	Bank-R	Land-L	Land-R
9/12/96	1	296	107	SP	73	35	55	VS	VS	HG	YT
9/12/96	1	297	108	RI	23	80	40	VS	VS	HG	YT
9/12/96	1	298	109	SP	118	50	45	VS	VS	HG	YT
9/12/96	1	299	110	RI	28	30	60	BR	AE	HG	YT
9/12/96	1	300	111	SP	33	90	50	BR	AE	HG	YT
9/12/96	1	301	112	SP	100	70	75	AE	BR	HG	YT
9/12/96	1	302	113	RI	60	85	80	AE	VS	HG	YT
9/12/96	1	303	114	SP	29	75	80	AE	VS	HG	YT
9/12/96	2	304	248	SP	45	80	85	AE	AE	HG	YT
9/12/96	2	305	249	DP	8	90	50	AE	AE	HG	YT
9/12/96	2	306	250	DP	90	60	70	AE	AE	HG	YT
9/12/96	2	307	251	DP	36	40	60	AE	AE	HG	YT
9/12/96	2	308	252	RI	12	45	65	AE	AE	HG	YT
9/12/96	2	309	253	SP	95	60	70	AE	AE	HG	YT
9/12/96	2	310	254	RI	14	55	75	AE	AE	HG	YT
9/12/96	2	311	255	SP	26	50	90	AE	AE	HG	YT
9/12/96	2	312	256		0	0	0	AE	AE	HG	YT
9/12/96	2	313	257	SP	30	50	45	AE	AE	HG	YT
9/12/96	2	314	258	RI	68	40	35	AE	AE	HG	YT
9/12/96	2	315	259	SP	19	75	45	AE	AE	HG	YT
9/12/96	2	316	260	SP	114	65	75	AE	AE	HG	YT
9/12/96	2	317	261	SP	105	75	75	AE	AE	HG	YT

Table C.1, *Continued*

Unit Number	Riparian-W-L	Riparian-W-R	Riparian-V-L	Riparian-V-R	Comment1	Comment2
296	5	15	S	D		L-BUFFER TO FENCE
297	5	10	D	S		
298	5	10	D	D		
299	5	10	S	D		
300	5	20	D	D		
301	5	20	D	D		
302	5	20	D	D		
303	5	20	D	D		END AT NO TRASPASSING SIGN-L
304	2	5	S	D		
305	5	5	S	S		VERY OVER GROWN WITH NINEBARK
306	5	5	S	S		
307	5	5	S	S		
308	10	10	S	S		
309	5	5	S	S		
310	5	10	S	S		
311	2	10	S	S		
312	0	0				NOT FOLLOWING CORRECT STREAM BED, LENGTH APPROX 50M
313	5	10	S	S		
314	0	0	G	G		60M BRIDGE, SOME TREES LEFT BANK, LOTS OF HORSE IMPACT
315	0	0	G	S		
316	5	20	S	D		
317	10	10	S	D		

Table C.2 *CTSI Substrate Survey Results*

Unit Number	Bedrock	Boulders	Cobble	Gravel	Silt	Comments-S
1	100	0	0	0	0	
2	0	0	0	70	30	
3	0	0	10	40	50	
4	0	0	0	50	50	
5	0	0	0	90	10	
6	0	0	10	30	60	
7	0	0	0	40	60	
8	0	0	15	20	65	
9	0	0	0	30	70	
10	10	0	0	10	80	
11	5	0	0	75	20	
12	0	0	0	50	50	
13	0	0	10	30	60	
14	10	10	20	50	10	
15	10	20	20	40	20	
16	10	30	20	30	10	
17	2	5	50	25	20	
18	0	10	60	20	10	
19	0	5	60	25	10	
20	50	10	10	10	20	
21	70	15	5	5	5	R-SIDE SLOWER WATER W/SMALL ISLAND OF RCG
22	40	30	20	5	5	
23	90	0	5	0	5	LEFT SIDE DEEP TRENCH W/COBBLE BOTTOM
24	70	20	0	0	10	SMALL AREA W/GOOD GRAVEL AT BEGINNING
25	10	20	0	0	70	SMALL BEDROCK RIFFLE AT THE BEG. OF POOL
26	80	0	10	5	5	
27	60	30	0	0	10	
28	90	0	10	0	0	
29	0	20	20	40	20	FLAG AT END
30	0	15	5	40	30	LOOKS GOOD
31	60	5	5	20	10	

Table C.2, *Continued*

Unit Number	Bedrock	Boulders	Cobble	Gravel	Silt	Comments-S
32	0	0	0	0	0	MOSTLY BEDROCK - HT. O.2M (WATER TO WATER) SR AT BEGINNING
33	50	20	10	10	10	POSSIBLE EEL REDDS
34	0	0	30	50	20	LAND USE ON RT
35	0	0	20	50	30	
36	5	5	15	25	50	ROAD ON LEFT, CATTLE ENTRY ON RT.
37	5	25	15	10	45	BEGINS WITH BEDROCK GL/RI
38	20	20	15	25	20	
39	0	5	10	45	40	
40	5	0	10	60	25	FLAG 10M BEFORE END (SR) LEFT
42	60	5	15	15	5	
43	5	0	5	50	40	
44	0	0	10	70	20	LARGE LAND BARS IN CENTER, UNIT HAS RI IN BEG. LOG W/SP SIDE RIFFLE TO POOL
45	0	0	10	60	30	UNIT HAS TWO DEEPER AREAS GL BETWEEN
46	0	0	0	70	30	UNIT BENDS R- AROUND ISLAND, UNIT END AT BACK WATER
47	0	0	0	70	30	
48	0	0	0	70	30	START W/SMALL RI
49	0	0	10	80	10	
50	40	0	20	30	10	
51	0	0	20	60	20	
52	20	0	20	30	30	
53	0	90	10	0	0	UNDER BRIDGE
54	0	20	10	30	40	
55	0	0	30	50	20	
56	0	5	5	60	30	
57	0	5	15	70	10	
58	0	5	10	55	30	
59	0	20	40	10	30	
60	0	30	30	30	10	

Table C.2, *Continued*

Unit Number	Bedrock	Boulders	Cobble	Gravel	Silt	Comments-S
61	0	5	15	50	30	
62	0	5	15	30	50	
63	0	50	30	10	10	
64	5	30	50	10	5	BR-SIDES
65	50	30	10	5	5	STARTS WITH STEP BEDROCK (DIAGONAL)
66	90	5	0	0	5	
67	100	0	0	0	0	
68	80	5	5	5	5	MIX RI,POOLS, AND GRAVEL
69	40	5	5	20	30	3-POOLS TOGETHER- GRAZING ON LEFT, SOME CATTLE ENTRY
70	40	0	0	20	40	STARTS W/SR- ENDSAT TRIBUTARY LEFT
71	70	10	0	0	20	
72	40	5	5	20	30	
73	5	5	10	5	75	STARTS WITH SR-STILL FENCED LEFT
74	70	5	5	5	15	START WITH SR-HAS A POOL, VERY DIVERGENT
75	30	5	5	10	50	CATTLE ENTRY LOTS OF SILT- MOUNDS AND COATINGS BR
76	80	0	0	10	10	BR-SIDES
77	40	5	0	0	55	UNIT-76-BEDROCK RIFFLE
78	60	0	5	5	30	STARTS WITH BEDROCK RIFFLE
79	55	0	0	5	40	STARTS WITH BEDROCK RIFFLE
80	60	0	5	25	10	
81	60	0	5	30	55	ENDS AT DIAGONAL BR RIFFLE
82	30	0	5	50	15	BEGINS W/BR FIFFLE DIRECTS WATER LEFT------SMALL ISLAND GR LEFT
83	20	0	10	30	40	SHED WORK AREA LEFT
84	5	5	10	60	10	STARTS WITH BR RIFFLE
85	40	5	10	35	10	START WITH SMALL SR, FIRS .5 POOL, 2ND .5 RI
86	5	5	15	60	15	GRAVEL BAR IS CENTER (DEPOSIT IN FLOOD)
87	40	5	5	45	5	RIFFLE TURNS RIGHT AROUND GRAVEL BAR
88	50	30	10	5	5	BR-NARROWS THE POOL AND INCREASES WATER SPEED

Table C.2, *Continued*

Unit Number	Bedrock	Boulders	Cobble	Gravel	Silt	Comments-S
89	50	5	5	35	5	
90	30	20	5	5	40	
91	30	20	20	5	25	STARTS W/ BR RIFFLE
92	20	20	20	5	35	STARTS WITH BR RIFFLE SMALL DEEP RI, 2 POOLS
93	20	5	10	40	25	STARTS WITH SMALL SR
94	5	5	10	60	20	AT 60M, SMALL RI
95	5	5	5	65	20	STARTS WITH BR RI
96	10	5	10	50	25	STARTS WITH BR RI
97	30	10	5	40	15	STARTS WITH BR RI
98	20	5	5	20	50	START W/ 1M SR, 180M TO BRIDGE
99	30	10	10	30	20	
100	0	0	0	0	100	SOFT AND SQUISHY
101	0	5	5	50	40	
102	0	10	10	20	60	
103	0	10	10	30	50	
104	0	5	0	50	45	JAM= SMALLER PC. IN FRONT OF M LOG
105	0	0	0	5	90	AROUND BEND, NARROW WITH WOOD AT BEND, LOTS OF SILT AT END
106	0	5	0	10	85	STARTS WITH WOOD AND SMALL RI, LOTS OF RCG, AT 39M BANK R SLOUGH INTO STREAM, HEAVY GRAZING
107	0	0	0	20	80	FIRST 10M SHALLOW RI, END AT SMALL SHALLOW AREA--- WHICH COULD BE IN THE MIDDLE OF THE UNIT
108	20	0	10	30	40	END WHERE GRAVEL STARTS TO SHALLOW--ORANGE NET--L
109	10	0	10	60	20	
110	20	0	10	20	50	
111	50	20	10	10	10	VARIABLE TERRAIN -BR MOVES WATER L
112	50	0	0	30	20	START AT SR-DIAGONAL
113	40	0	10	10	40	START W/ SMALL BO RI
114	10	0	10	40	40	STARTS AT SMALL BO RI, RIGHT BANK BR
115	0	0	10	80	10	

Table C.2, *Continued*

Unit Number	Bedrock	Boulders	Cobble	Gravel	Silt	Comments-S
116	40	0	10	40	10	
117	30	5	5	30	30	
118	5	5	20	60	10	START AT END W/RI ,OPEN GRAZED AREA
119	10	0	5	75	10	
120	5	0	30	55	10	STARTS W/ SM. RI, AT 85M COW TRAIL RT. (BROKEN FENCE)
121	30	0	30	20	20	STARTS WITH SMALL RI --OPEN LEFT
122	40	5	5	40	10	STARTS WITH BORI
123	40	0	5	40	15	SILT ORGANICS COVERING BOTTOM, BARE DIRT COWS -L
124	5	0	25	30	40	NOT VERY GOOD HABITAT, BUT ENOUGH GRAVEL
125	5	0	15	70	10	DEEP AREA LEFT BECAUSE OF LOG,GRAVEL SAND BAR
126	5	5	20	40	30	CEDAR WAXWINGS (6), VARYING DEPTHS, SOME GOOD HABITAT --END AT RI JUST E OF HARRIET BRIDGE -SM. SR
127	0	0	0	10	90	
128	0	0	0	30	70	3M RI CORNER TO LEFT-RT BANK SLOUGH (PICTURE #8) WE WERE NOT ABLE TO FOLLOW CREEK-BRUSH TO THICK-ALL APROX.
129	0	0	0	10	90	PICTURE TAKEN E #9, END AT LARGE LOG IN STREAM
130	0	0	0	10	90	STARTS W SMALL RI, PICTURE #10--MAJOR SIDE SLOUGH
131	0	0	0	50	50	SM. GRAVEL
132	0	0	0	30	70	LIVE MUSLES -ALL LG. SEEN
133	0	0	0	40	60	
134	0	0	0	20	80	23M. AT FOOT BRIDGE
135	0	0	0	70	30	
136	0	0	0	60	40	
137	5	0	0	15	80	STARTS W/ 5M RI--------GRAVEL IN RI
138	5	0	0	25	75	
139	0	0	0	20	80	27M BRUSH CREEK-R, END UNDER BRIDGE
140	0	0	5	5	90	CB UNDER BRIDGE
141	5	0	0	35	60	

Table C.2, *Continued*

Unit Number	Bedrock	Boulders	Cobble	Gravel	Silt	Comments-S
142	50	0	0	30	20	LOTS OF FILAMENTUS GREEN ALGAE - SHADED AT 11:30 A.M.
143	0	0	0	30	70	
144	0	0	5	15	80	
145	0	0	0	10	90	
146	0	0	0	10	90	
147	0	0	0	40	60	
148	10	0	0	30	60	
149	0	0	0	20	80	
150	0	0	5	45	50	
151	5	0	0	15	80	
152	0	0	5	70	25	WE STOPED AT END OF RI,SHARP BEND LEFT- LO WIDE POOL. RIGHT BANK HIGH W/NO VEG.
153	20	30	0	0	50	
154	10	20	20	0	50	STARTS WITH 8M OF BR,RI
155	70	5	5	60	10	BETWEEN BEND RT AND LEFT POSS. EEL REDDS,--INC. RI AFTER BEND L
156	5	5	20	30	40	
157	10	0	20	60	10	
158	20	5	15	30	30	SPOTTED SAND PIPER
159	0	5	25	30	40	
160	40	0	10	20	30	COW CROSSING--DIA. W/RI 2M BEG. MAY BE A LITTLE GOOD HABITAT, HIGH COW IMPACT
161	10	5	15	40	30	STARTS WITH BR,RI HOLDING BACK WATER
162	5	5	30	50	10	MIGHT BE GOOD BUT,LARGER GRAVEL
163	30	10	10	30	20	
164	20	10	10	30	30	
165	10	0	10	60	20	
166	0	20	20	60	0	
167	10	0	20	50	20	
168	0	10	10	60	20	LAST 24M GLIDE LIKE

Table C.2, *Continued*

Unit Number	Bedrock	Boulders	Cobble	Gravel	Silt	Comments-S
169	0	30	50	20	0	BEG. AT GRAVEL BAR AND CORNER POST FOR FENCE AT HOUSE
170	5	15	20	30	20	
171	0	30	30	30	10	
172	60	10	10	10	10	
173	70	10	10	0	10	
174	10	20	30	40	0	CB BAR IN CENTER
175	30	10	10	20	30	
176	30	10	0	0	60	STARTS WITH SR
177	40	5	25	20	10	ENDS WITH BR DIAGONAL
178	30	0	0	0	70	
179	50	0	0	0	50	
180	10	5	10	0	75	
181	20	10	30	30	10	
182	10	10	40	20	20	
183	0	20	40	0	40	STARTS W/ SM. RI,STILL COW EVIDENCE
184	60	5	15	10	0	
185	0	40	20	0	40	START W/ 3 M BR RI
186	0	40	20	0	40	
187	20	40	10	10	20	STARTS W/7M BR-RI
188	80	0	0	0	20	
189	5	5	50	10	30	
190	50	0	10	10	30	STARTS W/ 2M RI
191	5	5	60	20	10	
192	20	10	25	15	30	
193	0	25	25	20	30	STARTS W/SM. RI
194	0	20	20	20	40	STARTS W/ SM RI
195	0	30	40	20	10	
196	5	20	30	15	30	
197	5	45	30	10	10	
198	0	30	20	20	30	

Table C.2, *Continued*

Unit Number	Bedrock	Boulders	Cobble	Gravel	Silt	Comments-S
199	0	20	40	30	10	
200	0	5	15	30	50	
201	0	5	70	20	5	BIG OPEN PASTURE LEFT
202	40	0	25	15	20	ALL THE BEDROCK IN FIRST 30M-POSE HABITAT SECOND HALF
203	0	5	10	25	60	SECOND HALF LEFT-OPEN PASTURE, STARTS W/SM. RI
204	10	0	60	20	10	STARTS WITH SMALL RI,ENDS WITH LOG OVER CHANNEL
205	20	0	10	50	20	END AT TRIB. RIGHT
206	0	5	25	30	20	
207	40	0	10	5	25	BR-COVERED WIYH SILT LAYER
208	5	40	30	20	5	17-23 ,SMALL SP
209	0	50	30	10	10	
210	0	30	20	20	10	
211	0	10	10	10	70	30M LOG, 14M PAST 2 LOGS OVER CREEK, LOG ENDS AT BEND LEFT, TRIB. RIGHT
212	0	0	0	20	80	BIG AT JAM -END AT KERR PROPERTY
214	0	5	60	25	5	
215	0	0	10	40	50	
216	0	60	30	10	0	SPLITS AROUND AND ENTERS BO ISLAND
217	0	60	20	10	10	
218	0	40	30	20	10	END AT HATCHERY DAM-COW PATTY IN H20 NEAR DAM
219	0	100	0	0	0	2 M HIGH, LEFT HATCHERY WALL
220	0	5	0	5	90	SHALLOW, SUBSTRATE BUILD UP
221	0	70	20	5	5	
222	0	10	0	0	90	CENTER UNIT BEND AT T-POLE NEAR ROAD
223	100	0	0	0	0	
224	10	5	0	0	85	
225	0	0	0	20	80	
226	10	0	0	20	70	STARTS WITH 2 M RI
227	10	0	20	20	50	STARTS WITH 2 M RI-100% GR-RIGHT BANK 6M HIGH-AE
228	30	0	0	10	60	STARTS WITH 1M RI -100% RI-END AT LWD ACC.

Table C.2, *Continued*

Unit Number	Bedrock	Boulders	Cobble	Gravel	Silt	Comments-S
229	5	0	0	20	75	AFTER WOOD, BEND LEFT- CATTLE CLEARED OUT UNDER BRUSH
230	40	0	0	20	40	HIGH CATTLE IMPACT, SMALL SR AT END
231	0	0	0	10	90	
232	0	0	0	20	80	STARTS AT SMALL IM RI, JUST PAST BIDGE, COWS
233	0	0	0	40	60	STARTS WITH 3M RI, HELD UP BY DOWNED WOOD, GR MOSTLY IN RI
234	0	0	0	70	30	UNIT STARTS WHERE CREEK BENDS AWAY FROM ROAD
235	0	0	0	50	50	WOOD AT 6M, CREATES 2 POOLS W/ SHALLOW AREA BEFORE, PICTURE FROM E END
236	0	0	0	60	40	UNIT IS PATCHY RI W/GR-NINEBARK IS SHRUB
237	0	0	0	30	70	AT 19 WOOD CREATES DP, ENDS AT S WOOD ON L TO FULL
238	0	0	0	30	70	LOTS OF MED. WOOD PIECES, STARTS W/4M RI
239	0	0	0	30	70	STARTS W/STEP OVER LOG, CREATES SMALL RI
240	0	0	0	30	70	R BANK 4M WALL OF ERODING SANDSTONE
241	0	0	0	80	20	BEGINS W/STEP OVER LOG-SL-, CATTLE ENTRY
242	0	0	0	10	90	ENDS W/ACC. OF MED. WOOD-ODFW FLAG S20, R12, GL 9/17 LCSWCD
243	0	0	0	30	70	START W/ 4 M RI
244	0	0	0	50	50	STARTS W/SMALL RI
245	0	0	0	10	90	STARTS W/3M RI, ACC. OF WOOD NEAR END OF UNIT
246	0	0	0	10	90	IMPASSABLE-PICTURE FROM E END, THICK W/NINEBARK
247	0	0	0	60	40	STARTS W/SM. RI-PC-, CATTLE ENTRY
248	0	0	0	20	80	STARTS W/2M RI
249	0	0	0	20	80	STARTS W/2M RI, SM. FISH
250	0	0	0	60	40	14M ODFW FLAG - REACH A13, UNIT 539
251	0	0	0	20	80	

Table C.2, *Continued*

Unit Number	Bedrock	Boulders	Cobble	Gravel	Silt	Comments-S
252	0	0	0	60	40	START AT FOOTBRIDGE, CATTLE ENTRY, FLAG AT END, WE WENT ON W/OUT MEASURING BECAUSE IMPASSABLE W/NINEBARK-SHADE 100%, BOTTOM W/SILT, LOTS OF TWIGS, SOME OPEN AREAS DUE TO CATTLE -PICTURE
253	0	0	0	10	90	START AT LOG (FULL), BEAVER DAM AT 19M
254	0	0	0	30	70	
255	0	0	0	10	90	
256	0	0	0	0	100	
257	0	0	0	0	100	
258	20	0	0	10	70	
259	0	0	0	50	50	
260	10	0	0	20	70	
261	30	0	0	50	20	
262	0	0	0	30	70	
263	0	0	0	70	30	
264	0	0	0	0	100	
265	0	0	0	30	70	
266	0	0	0	0	100	
267	0	0	0	10	90	
268	0	0	0	30	70	
269	0	0	0	80	20	VERY SMALL STONES
270	0	0	0	10	90	
271	0	0	0	50	50	
272	40	5	40	10	5	
273	0	20	50	20	10	
274	20	10	50	20	0	
275	30	0	20	40	10	
276	30	30	20	20	0	AT 17M SMALL 6M SP IN RI
277	30	0	20	30	20	
278	50	0	10	40	0	
279	30	10	20	20	20	

Table C.2, *Continued*

Unit Number	Bedrock	Boulders	Cobble	Gravel	Silt	Comments-S
280	10	20	60	10	0	
281	20	10	30	20	20	PC FOR LAST 15M
282	20	10	30	20	20	PC FOR FIRST 17M (SHALLOW ALMOST RI) AT 30 TRIB. RIGHT, AT 60 BEAVER. FLAG AT BEG.
283	60	0	10	20	10	
284	20	0	30	30	20	AT 15M TRIB RT.
285	30	10	10	30	20	STARTS WITH SMALL RI,WATER STILL MOVING QUICK BUT DEEP
286	10	5	5	20	60	STARTS WITH 3M LONG SR
287	30	5	5	60	0	
288	60	0	10	10	20	
289	60	0	10	30	0	MOST H2O CHANNELED RT., HAS SPOTS W/GR OK FOR SPAWNING
290	40	0	10	40	10	DP CREATED BY BR BEFORE AND AFTER, RIGHT SIDE FASTER H2O
291	50	0	10	40	0	STEEP RI
292	70	0	0	20	10	DEEP AND SHALLOW AREAS CREATED BR
293	20	5	15	20	40	STARTS WITH 5M RI, LEFT BANK OPEN WITH FEW TREES (GRAZING)
294	40	5	10	5	40	STARTS WITH 2M RI
295	0	0	30	60	10	L-BANK AT END ERODED STRAIGHT UP TO CORNER FENCE POST
296	30	5	5	10	50	
297	70	0	20	10	0	
298	10	0	30	40	20	
299	40	10	10	10	30	
300	50	10	20	0	20	
301	30	10	30	10	20	STARTS WITH 3M RI, THAT GOES AROUND BEND, OPEN PLAY AREA LEFT
302	0	10	40	40	10	END AT SB, PUMP AT END L, BEHIND BUCY? GREEN HOUSE, PUMPS AT BOTH HOUSES BEFORE HUCKLEBERRY

Table C.2, *Continued*

Unit Number	Bedrock	Boulders	Cobble	Gravel	Silt	Comments-S
303	40	0	20	20	20	
304	0	0	0	20	80	END AT SL
305	0	0	0	20	80	
306	0	0	0	30	70	STARTS WITH 3M RI AND BEAVER JAM, AT 82 TRIB RT.
307	0	0	0	40	60	STARTS WITH SHORT RI AND BEAVER JAM, 26 TUNNEL RT. (HOME?)
308	0	0	0	60	40	
309	20	0	0	0	80	ERODING SIDES
310	60	0	20	20	0	LEFT BANK TO RD.
311	10	20	20	0	50	ENDS AT FULL BARRIER, WATER GOES AROUND SOMEWHERE ELSE
312	0	0	0	0	0	
313	0	0	10	10	80	STARTS WITH 10M RI, 20M STICK JAM
314	0	10	40	50	0	
315	0	0	60	40	0	
316	0	0	0	0	100	STARTS WITH SHORT RI, DEEP, ENDED ACROSS FROM JHONSON GATE, LEFT DOWNED WOOD AT END
317	0	0	0	0	100	STARTS AT E JOHNSON FENCE, AFTER DOWN WOOD, END AT BEAVER DAM

Table C.3 *CTSI Wood Survey Results*

Unit Number	Type	Location	Diameter	Length	Comment-W
3	S	L	0	3	ABOVE WATER LEVEL
8	S	R	15	3	ONE MAIN SINGLE PIECE, JAM MORE TO LEFT
10	A	F	50	6	
10	A	R	15	0	
12	S	R	30	6	RUNS W/ CURRENT, HAS BACKWATER
36	A	L	50	15	NEXT TO ROAD
36	A	L	15	15	NEXT TO ROAD
36	S	M	30	18	
36	S	M	30	18	SECOND PIECE FURTHER DOWN STREAM
43	A	R	50	9	ALDER W/ROOT,UPPER
43	A	R	50	18	ALDER
43	A	M	50	18	ALDER W/ROOT
44	S	R	30	3	ALDER W/ROOT
44	A	M	30	6	
44	A	M	30	12	
46	J	R	0	0	10 SMALL PIECES
46	S	L	15	6	POSS. EEL RED AREA
48	S	R	30	6	
48	A	R	15	15	
48	A	R	30	9	
52	F	R	30	12	
63	A	F	15	15	ABOVE WATER
63	A	F	15	15	ABOVE WATER
63	A	R	15	12	ABOVE WATER
89	A	M	30	6	ALL TREES ARE ALIVE
89	A	M	30	12	
89	A	M	50	9	
89	A	M	30	9	
90	S	L	15	12	
92	S	R	30	15	
95	J	L	15	6	

Table C.3, *Continued*

Unit Number	Type	Location	Diameter	Length	Comment-W
95	J	L	30	6	4 PIECES
95	J	L	30	9	HALF LEFT SIDE ROCK WALLS
98	A	L	30	12	PART BC BANK
98	A	L	30	12	
98	A	L	30	9	
100	S	F	50	9	WATER RUNS OVER LOG
101	S	F	50	6	BC END OF UNIT
102	S	M	30	3	
102	S	R	15	0	
102	S	R	50	3	
102	S	L	15	0	
104	J	M	50	3	JAM W/ SMALLER PIECES AGAINST M LOG
104	J	R	30	0	
105	J	M	30	9	
105	J	R	15	6	
105	J	F	15	3	PILE UP ON LEFT, MED WOOD
106	S	M	50	9	
107	S	R	50	3	
121	S	O	15	9	LIVE ALDER ROOT WAD ON RIGHT SIDE
125	S	M	30	9	
126	S	L	30	15	
129	S	M	15	6	
129	S	R	50	3	
132	S	R	50	3	
130	S	O	50	9	
140	S	L	15	3	
140	S	L	30	0	
145	S	L	30	3	
196	S	M	50	3	
196	S	M	90	3	ROOT WAD
196	J	O	50	6	JAM BETWEEN 2 . BOULDERS 9 ADD. PC.

Table C.3, *Continued*

Unit Number	Type	Location	Diameter	Length	Comment-W
196	J	R	50	6	
196	J	R	30	6	
211	A	L	30	6	TOGETHER THEY SPAN FULL CHANNEL
211	A	R	50	6	
211	S	R	50	9	
212	J	0	0	0	DEBRI
222	S	O	30	12	
224	A	R	50	9	COW PIES
224	A	R	30	12	
224	A	R	15	3	
224	A	R	15	6	
225	S	F	50	3	
225	A	R	15	3	
225	A	L	0	0	
225	S	L	15	0	
225	S	L	50	3	MAKES UP LEFT BANK
226	A	L	15	6	
226	A	L	50	0	
226	A	L	15	3	
226	A	L	30	3	
226	S	F	30	6	
226	S	R	15	3	ACC. OF WOODY DEBRI
228	S	L	15	3	
228	S	R	30	3	
228	S	M	15	3	
229	A	O	50	6	ACC. OF OTHER DEBRI
229	A	M	15	3	
229	A	R	15	3	
229	S	L	50	3	
230	S	L	15	3	COW ENTRY
231	A	O	30	9	

Table C.3, *Continued*

Unit Number	Type	Location	Diameter	Length	Comment-W
231	A	O	30	15	
231	A	L	30	3	
231	S	R	30	0	
232	S	L	50	3	
233	S	M	50	3	
234	S	0	15	6	
235	S	F	15	3	
236	A	O	30	6	
236	A	F	15	6	
236	A	R	30	0	
236	S	0	30	9	
237	A	O	30	9	
237	A	O	50	12	
237	A	F	50	3	
237	A	F	15	3	
237	A	O	15	6	
237	A	R	30	6	RUNS ALONG BANK
237	A	R	15	6	ACC. OF MED. SIZE PIECES
237	S	L	30	6	ALMOST FULL
238	S	O	15	9	
238	S	O	15	9	ACC. OF MED. SIZE WOOD
238	S	O	30	9	
239	S	F	30	3	
239	S	O	15	6	JAM OF TWIGS LEFT SIDE
240	S	O	15	3	ACC. OF MED. PIECES
242	S	O	30	9	
242	S	O	30	9	
241	S	F	30	0	
245	S	F	30	6	
245	A	O	30	9	
245	A	O	30	9	

Table C.3, *Continued*

Unit Number	Type	Location	Diameter	Length	Comment-W
245	A	L	50	3	
247	A	F	30	9	
247	A	M	15	15	
247	A	S	15	3	
248	S	O	30	9	
248	J		0	0	6 PIECE MED. SIZE PLUS SM. WOOD
250	A	R	30	3	
250	A	O	15	6	
253	S	F	15	3	
257	S	R	15	3	
258	S	F	30	3	
260	A	O	50	3	
260	A	O	30	9	
262	S	O	50	6	
262	A	O	50	6	
262	A	O	50	9	
262	A	O	50	12	
263	S	R	50	3	
263	S	R	30	3	
264	A	M	50	15	STARTS ON RT BANK
264	A	F	30	15	
264	A	F	30	9	
265	S	M	30	6	TWIG JAM AROUND LOG STOPPING WATER
276	A	L	30	12	
276	A	L	30	12	
281	S	R	30	9	
281	S	L	50	9	
287	S	R	50	9	
304	S	L	15	6	
304	S	R	50	6	
305	S	F	30	6	

Table C.3, *Continued*

Unit Number	Type	Location	Diameter	Length	Comment-W
306	A	R	50	9	
306	A	M	30	3	
306	A	R	50	9	
306	A	M	30	3	LARGE ROOT WAD IN CENTER
306	S	M	50	3	
306	S	M	30	3	
307	A	F	15	6	
307	A	L	15	3	ACC. OF SMALLER PIECES
307	S	R	50	9	
307	S	L	15	6	
308	S	R	15	6	
316	A	O	90	9	
316	A	R	50	3	
316	A	F	50	9	CABLES ATTACHED
316	A	L	30	6	
316	A	R	30	6	
316	A	L	30	3	CABLES ATTACHED
316	A	L	30	3	CABLES ATTACHED
316	A	L	30	3	CABLES ATTACHED
316	A	O	50	9	
317	A	L	50	6	
317	S	F	30	12	
317	S	O	30	6	
95	J	L	50	9	
212	J		0	0	3-5 LOGS HOLDING UP SMALL DEBRIS
212	S	F	30	9	
270	S	O	15	6	

Appendix D
Summary of Relevant Ecological Information

D.1 *Local Land Use and Information*

This section provides a preliminary search for local land use information. This information regarding the current and historical local land use is important to properly characterize the Rock Creek watershed and understand how today's landscape differs from that of the past. Landscapes will change as the natural resources are consumed or modified. The CTSI Natural Resource Department is using the assumption that the surrounding land use has degraded the aquatic habitat in Rock and Little Rock Creeks. To base restoration plans on that assumption, the land use changes need to be quantified, in order to determine a goal for restoration or enhancement.

The Rock Creek watershed has three major land uses associated with it: timber harvest, range and residential. Each of these land uses has impacts of various severity and magnitude on the riparian and aquatic habitats. As with any habitat modifier, the results may be deleterious for some species and not for others. The Pacific lamprey habitat requirements are considered similar to salmon habitat requirements. Both species prefer cool, clear, oxygenated water in a complex lotic habitat for spawning and juvenile survival success. Because of these requirements, sediment deposition caused by erosion, fecal contamination, riparian and stream bank degradation, and water level decline are the processes of major concern for the Rock Creek watershed.

To determine the local information available for Rock Creek watershed, I began by reviewing the ownership patterns (provided by CTSI and obtained from the county tax records). The Simpson Timber Company owns the majority of the land in the upper watershed area. According to Tom Downey, the company will exhaust its timber resources in the Rock Creek watershed within the next few years. The Oregon

Department of Forestry and the U. S. Bureau of Land Management (BLM) have small parcels located near the headwaters of Little Rock Creek. There is no other state owned land in the watershed. The remaining land in the watershed belongs to CTSI, Lincoln County or is in private ownership.

D.1.1 Federal

Generally, federal agencies do not have area information unless they own land in the vicinity. However, in the wake of ecosystem management, more agencies, both federal and state, are compiling more complete ecological profiles of their ecoregion. There is only one small holding by a federal agency, the BLM, in the Rock Creek watershed. The BLM does not have information regarding the Rock Creek watershed, but they have completed a watershed assessment on the Upper Siletz River. The U.S. Fish and Wildlife Service (USFWS) has not done any research in the Rock Creek area. The Natural Resource Conservation Service (NRCS) does not have any local information on their web site. However, the local Lincoln County NRCS office in Newport was very helpful and provided me with some watershed reports. They also have soil maps available for use.

D.1.2 State

For the state agencies, I began at the state web page (http://www.state.or.us/governme.html) to survey the relevant web pages. If the web page indicated that there might be additional information on the local area, I contacted the agency personally, by phone.

The Oregon Department of Fish and Wildlife (http://dfw.state.or.us) provided me with paper and digital copies of their Aquatic Inventory on Rock and Little Rock creeks. In 1975, a report on logging in the nearby Alsea watershed was completed (Moring and Lantz 1975). The ODFW library in Portland, Oregon would be another good source for historical information. I discovered an older survey of the Middle Coast Basin (1965) (held jointly by ODFW and StreamNet). The report and its accompanying recommendations were compiled for the Oregon State Water Resources Board. This type of historical information will be very important to help characterize the previous condition of the Rock Creek watershed. The basin investigation focused on fish and aquatic habitat, but also included some census of associated mammals. For example, the black-tailed deer population was increasing due to the increased browse habitat associated with the timber industry. Furbearers were also plentiful. In 1964, approximately 1,000 pelts were removed from beaver, mink, racoon, muskrat and otter. Two species of lamprey were mentioned, the brook and the Pacific. However, there was not a formal survey and identification of lamprey species (Hutchison 1965).

One of the concerns outlined in this report included low flows. Georgia Pacific (timber company) and the City of Toledo already had the right to remove water from the Siletz. However, they only needed to allow 75 cubic feet per second (cfs) to pass the pumps. The report stated that 100 cfs was probably the lowest flow that would not impede upstream fish migrations. Siltation, warm water temperatures and decreased dissolved oxygen were also recognized as potential problems for fish populations. Debris, in the form of large log jams, was considered a barrier to fish migration and was removed by heavy equipment such as bulldozers (Hutchison 1965). Today, log jams are uncommon due to current logging practices. However, the historical removal also eliminated single pieces of downed wood, which had positive benefits to the aquatic system by creating habitat diversity.

The Oregon State Archives (http://arcweb.sos.state.or.us) has a searchable index for county records. This may be useful if historical research is desired.

The Oregon Department of Environmental Quality (http://www.deq.state.or.us) has information that is most relevant to Tom Downey's water quality work. The water quality limited streams are listed in an on-line database. It can be searched from http://www.deq.state.or.us/wq/303dlist/303dpage.htm.

The Water Resources Division (http://www.wrd.state.or.us) has an on-line mapping service that will output maps of wells and water rights. I surveyed Rock Creek on the Siletz River and all its tributaries for water rights. During the stream surveys, I noticed several pumps at local residences. It is undetermined whether these pumps are actually functional. Most likely water collected from small residential pumps would be classified for an exemption.

The Oregon Department of Forestry (http://www.odf.state.or.us) does not have any local records on-line which relate to the Rock Creek area, but they do have some general maps which illustrate forest types and fire history (http://www.odf.state.or.us/FACTFIG/index2.htm). These will be useful for historical references.

D.1.3 Simpson Timber Company

Simpson Timber Company has large holdings and has area specific information. They have a GIS department and can provide maps of past timber harvest. Some of their current employees previously worked for Publishers Paper and have experience in this area during the last 20-30 years and would also be good sources for information through interviews.

D.1.4 Confederated Tribes of the Siletz Indians

The oral histories have valuable information regarding the Rock Creek area. The interviewers and participants did not cover this topic very thoroughly since it was not the focus of the report. It may be interesting and helpful to document more of the local and native impressions of the changes along the creeks and in the entire watershed area. The GIS division also has some aerial photos that could provide additional habitat information.

D.2 *Regional Land Use and Information*

Since much of the data useful for watershed characterizations has not been completed on the Rock Creek watershed, it will be necessary to extrapolate information from research in similar areas. By understanding the biological processes in other similar habitats, educated assumptions can be made to estimate the environmental change in the Rock Creek watershed. For example, if the rate of siltation is known for another small, geologically similar watershed in the coast range, then an approximate rate of siltation can be estimated for Rock Creek. While this can give managers a feel for the potential changes to occur in the Rock Creek watershed, it is necessary to have good base-line data. Also, understanding the historical condition and change of aquatic habitat available to Pacific lampreys provides additional insight to the present-day "health" of the habitat.

My goal in this section is to provide examples of smaller scale data and models available for the Siletz region. This type of information will be valuable for characterizing the previous habitat in the Rock Creek drainage and predicting future changes. Here, I outline broad information that is available for the Siletz Basin and I will present examples of specific information that can be collected from previous research in the Oregon Coast Range.

The U.S. Environmental Protection Agency (EPA) advocates the use of ecoregions as a framework for recovery criteria. Omernik (1987) examined terrestrial characteristics, such as soils, land use, sand surface form and potential natural vegetation. By assessing the relative homogeneity of these characteristics, Omernik delineated 76 ecoregions in the counterminous United States. The Coast Range ecoregion extends south from the Olympic Peninsula into Northern California and it extends east to the top of the Coast Range. Ecoregions assist progressive water resource management with realistic biological goals and objectives (Hughes et al. 1990). Regional information on aquatic systems could be used from anywhere in the ecoregion to understand the biological processes.

One supplier of many ecological models and studies conducted in the Oregon Coast Range is the Coastal Oregon Productivity Enhancement (COPE). The goal of COPE is to “develop knowledge that will contribute to increased economic and social benefits derived from the forests and streams of the Oregon Coast Range" (http://www.cof.orst.edu/coops/cope/).

The results of fire, both natural and prescribed, are explained in Natural and Prescribed Fire in Pacific Northwest Forests. The book, edited by Walstad et al. (1990), is a collection of chapters by forest and fire experts. The most useful chapters explain the historical role of fire, ecological relationships of vegetation and fire, effects of fire on water quantity and quality and the effects of fire on fish and wildlife. Each chapter has a supplemental bibliography with more detailed research results.

The Tillamook Bay National Estuary Project published An Environmental History of the Tillamook Bay Estuary and Watershed. This is a detailed account of as much historical and environmental information as was available. The report is invaluable for determining the changes in the Tillamook landscape. The geomorphic history of the watershed provides a baseline for recording the historical changes. The results of Native American land use, pre- and post- 1800, as well as European land uses are described. Woody debris and sea-level rise, issues of importance for Tillamook, were researched in detail (Coulton et al. 1996). Even though Tillamook lies within the same EPA ecoregion as Rock Creek, conclusions based on this report should be carefully examined since the report is so specialized. A similar report for the Siletz area would be beneficial.

The NOAA Coastal Ocean Program, Decision Analysis Series produced a report describing the forestry impacts on freshwater salmonid habitat in the Pacific Northwest and Alaska. This report is a comprehensive review and analysis of forestry practices, salmonid habitat requirements and restoration topics. It addresses each state individually, since the forest practices vary. Both restoration suggestions and current programs are presented. Chapter 10 gives specific recommendations for buffer zones, best management practices, watershed analysis, and community outreach (Murphy 1995). Tables and figures make the report easy to read and understand. The reference section is very complete and would be a good beginning for more specific research related to forest practices.

Two watershed analyses have been done in the Siletz basin. One conducted by the USFS concentrates on Drift Creek (U. S. Forest Service 1996). The second includes the Upper Siletz watershed and was completed by the BLM (U. S. Bureau of Land Management1996). The watershed analyses include the following sections: habitat characterization, issues and key questions, reference and current habitat conditions, interpretation of results and recommendations. If other watershed analyses have been completed within the ecoregion, they would provide additional information for determining biological processes in the Siletz basin.

The Klamath ecoregion has produced guidelines for restoration strategies. The goals of the restoration strategy include: represent a system of protected areas that include all native ecosystem types, maintain viable populations of all native species, maintain natural ecological and evolutionary processes (disturbance regimes, hydrological processes, nutrient cycles and biotic interactions), and manage landscapes to be responsive to environmental change and to provide social and economic well-being to all residents. The approach includes describing the ecoregion, developing a strategy, involving all agencies, and producing public literature and maps (Cooperrider and Garrett 1996).

D.3 *Aquatic Habitat Considerations and Concerns*

Wetlands, riparian habitat and bottomlands which are associated with rivers and streams are essential to healthy ecosystem functions. However, due to human alterations they are also some of the rarest and most degraded of all habitats. The salmon crisis in the Pacific Northwest is an example of the consequences of the degrading of aquatic and riverine habitats. Rivers in our nation have been diverted, dammed, channelized, polluted, silted in with erosion and have had much of their wetland and riparian areas removed or destroyed. "More than half of the nation's rivers have fish communities adversely affected by turbidity, high temperature, toxins and low levels of dissolved oxygen" (National Research Council (NRC) 1992). In order to solve these problems, we must examine deleterious land management practices and improve land management in order to rectify the damage (NRC 1992).

It is necessary to consider both the river and its floodplain as one ecosystem, to effectively manage riverine and riparian areas for conservation. Perturbations in the associated floodplains are as damaging as perturbations within the aquatic system. The riverine system is a dynamic environment where both the structural and functional organization must be included in any conservation or monitoring effort. It is necessary to be flexible and continually reevaluate the goals of the conservation activities (NRC 1992).

The following concepts are important to consider for riverine conservation and management (NRC 1992):

Flow and Retention - Rivers and streams are characterized by a unidirectional flow of water that cycles nutrients, sediments, pollutants and organisms in a spiral downstream direction. Interruptions of the flow retain nutrients and increase the productivity of the system.

Openness - Materials and energy are exchanged throughout the system. The surrounding systems will have a greater impact than those further away. It is more cost-effective to improve the riparian rather than the upland habitat.

Dynamism - Riverine systems are rarely stable throughout the entire year. The high water levels have an important ability to scour and wash out fine sediments from gravel bed systems. Restoration of the temporal and spatial flow regime is critical for success.

Patchiness - The riverine environment is not uniform throughout. Rivers have distinct habitats occupied by characteristic biotic communities, which interact with one another to create a functioning ecosystem.

Aquatic systems suffer from the following stresses: water quantity or flow alterations, morphological modifications of the channel and riparian zones, excessive erosion and sedimentation, deterioration of substrate and water quality, decline of native species, and the introduction of alien species. Stresses on riverine systems are caused by anthropogenic activities such as agriculture (extensive and intensive), mining, timber harvest, urbanization, and drainage, channelization or damming (NRC 1992).

The NRC (1992) addresses some of the more damaging land use practices on aquatic systems. Overgrazing can result in reduced stream side vegetation, caving/trampling of banks, channel widening, channel aggradation, lowering of the water table and a decline in downstream water quality from turbidity, sedimentation and animal wastes. Suspended solids constitute 47 percent of the non-point materials introduced to aquatic systems. The resulting increase in turbidity decreases the amount of usable light, which reduces plant growth. The reduction in the macrophytic and algal aquatic plant base can exacerbate the problems with increased suspended solids and reduce the food base for aquatic herbivores. Sediment deposition can result in the covering of needed habitat for aquatic organisms. For example, sediment can fill in gravel beds needed by salmon and lamprey for spawning. Annual flow patterns can be altered by consumptive uses of in stream water and by the acceleration of runoff. Water drains more rapidly from logged areas, resulting in longer durations of higher flood stages and lower low stages.

One of the major concerns in the Rock Creek watershed is suspended sediment and siltation. In the United States, the Environmental Protection Agency lists siltation as the foremost pollutant in rivers, half-again higher than nutrients, the second highest polluter. Anthropogenic sources of sediment include: agriculture (row-crop, cultivation, livestock grazing), forestry (timber harvest, logging roads, landslides), mining (spoil piles, tailing dumps, sand and gravel extraction), urban development (residential, commercial, road construction, stream channelization), recreation (boating, swimming, fishing). All types of road construction produce the highest quantities of sediment (Waters 1995).

Excess sediment affects many aspects of the aquatic system. Turbidity causes decreased light penetration, which reduces photosynthesis by the primary producers. The primary producers constitute the base of the trophic chain in the aquatic system.

Invertebrates, the next trophic level, also respond negatively to turbidity. They expend more energy moving to "false" light periods and the benthic invertebrates, generally filter feeders, "choke" on the suspended sediment. Excess sediment also has as a significant effect on fish. Sediment can fill the interstitial spaces in the stream bed and reduce the flow of water and oxygen around fish eggs and fry (Waters 1995).

When considering riverine, riparian, floodplain and wetland conservation, it is important to consider fluvial restoration. The goal, returning the riverine system to its previous dynamic equilibrium, includes four objectives:

1) Restore the natural sediment and water regime (Daily/Seasonal and Annual/Decadal).
2) Restore a natural channel geomorphology.
3) Restore the natural riparian plant community, if it does not restore itself.
4) Restore native aquatic plants and animals, if they do not recolonize on their own.

Project goals should be clearly determined before embarking on a conservation effort. If possible, monitoring should begin before the restoration projects are begun. As the project progresses, the monitoring results should be evaluated for effectiveness. If the goals are not being met, then the restoration activities need to be modified. CTSI should determine areas suitable for restoration, set restoration goals and monitor the results. Appropriate changes in restoration strategies should be made if the restoration efforts are not successful.