PROJECT SHARE RESTORATION WORKING GROUP

Cherryfield, Maine

BMP GUIDELINES FOR ROADS IN ATLANTIC SALMON WATERSHEDS

VOLUME I

INTRODUCTION

SEPTEMBER 2004

Prepared by:

Kleinschmidt

Energy & Water Resource Consultants

Pittsfield, Maine

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF PHOTOS

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IN ATLANTIC SALMON WATERSHEDS

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1.0 INTRODUCTION

1.1 Statement of Purpose

These Best Management Practices (BMPs) provide guidance to regulators, contractors, state and federal agencies, conservation organizations and other groups when planning or permitting road construction and maintenance activities within Atlantic salmon watersheds. These guidelines provide methods to minimize road-related impact on stream stability, water quality, and habitat and therefore support the restoration of endangered wild Atlantic salmon. In addition, these guidelines may be applicable to other coldwater streams in Maine and elsewhere with similar stream geomorphology and road requirements. This document is a result of a widespread literature search on BMPs for constructing and maintaining unpaved roads, culverts and bridges in watersheds with migratory salmonids such as federally endangered Atlantic salmon.

One important component of Atlantic salmon restoration and conservation is to avoid impairing habitat by poorly constructed or maintained infrastructure such as roads, culvert crossings or bridges. Such structures may impair habitat by triggering erosion, increasing substrate embededdness, promoting excessive nonpoint source runoff, reducing distribution of nutrients, altering runoff patterns, and/or eliminating free-swim passage between habitats. These problems affect both mainstem river segments and smaller tributaries. Small streams, which occupy most of the watershed drainage area, may contain significant spawning and rearing habitat, and are extremely fragile.

1.2 Definition of BMP

BMPs are, in the case of this manual, practical siting, design, construction, or operational procedures that prevent or reduce sedimentation, nutrient loading, impeded fish passage or other habitat impacts. This BMP guidance manual provides information on an assortment of BMP measures from streambank stabilization to culvert sizing and placement that are protective of Atlantic salmon habitat. BMP manuals are like toolboxes containing a variety of tools for people to consider using to minimize impacts to habitat or water quality.

1.3 Disclaimer

The information contained in this manual has been compiled from various organizations and agencies. This manual was developed with salmonids and unpaved roads as the focus, but other information has been referenced as it applies. This manual contains guidelines for fish-friendly development or maintenance of stream crossings and roads. Abiding by these guidelines does not guarantee the approval of project permits. However, road and bridge projects that incorporate these guidelines may more readily receive agency-permitting approval.

1.4 Application of the Document

State and federal agencies issuing permits for proposed public and private construction (*i.e.,* roads, crossings, streambank restorations) must make decisions that are protective of aquatic resources and consistent with state-of-the-art criteria. Further, landowners, contractors and transportation agencies proposing new road projects or road maintenance require information on the most cost-effective alternatives acceptable to natural resource and permitting agencies. These agencies share responsibility for supporting the Endangered Species Act (ESA) when considering permit applications. The ESA, as it pertains to BMPs, is discussed in more detail in Volume II, Section 2.1.1.

Various standards and BMPs employed in Maine by various institutions have evolved independently over time. These standards and BMPs are not always consistent and have not been specifically evaluated or reviewed relative to requirements of Atlantic salmon habitat in rivers and streams. Further, the state-of-the-art BMPs are constantly advancing. As of 2004, this manual includes guidelines which are consistent with Atlantic salmon habitat protection. This document provides guidelines for both permitting agencies as well as permit applicants during the planning stages of projects based on incorporation of the most appropriate existing BMPs currently applied in Maine and throughout the nation.

2.0 BACKGROUND INFORMATION

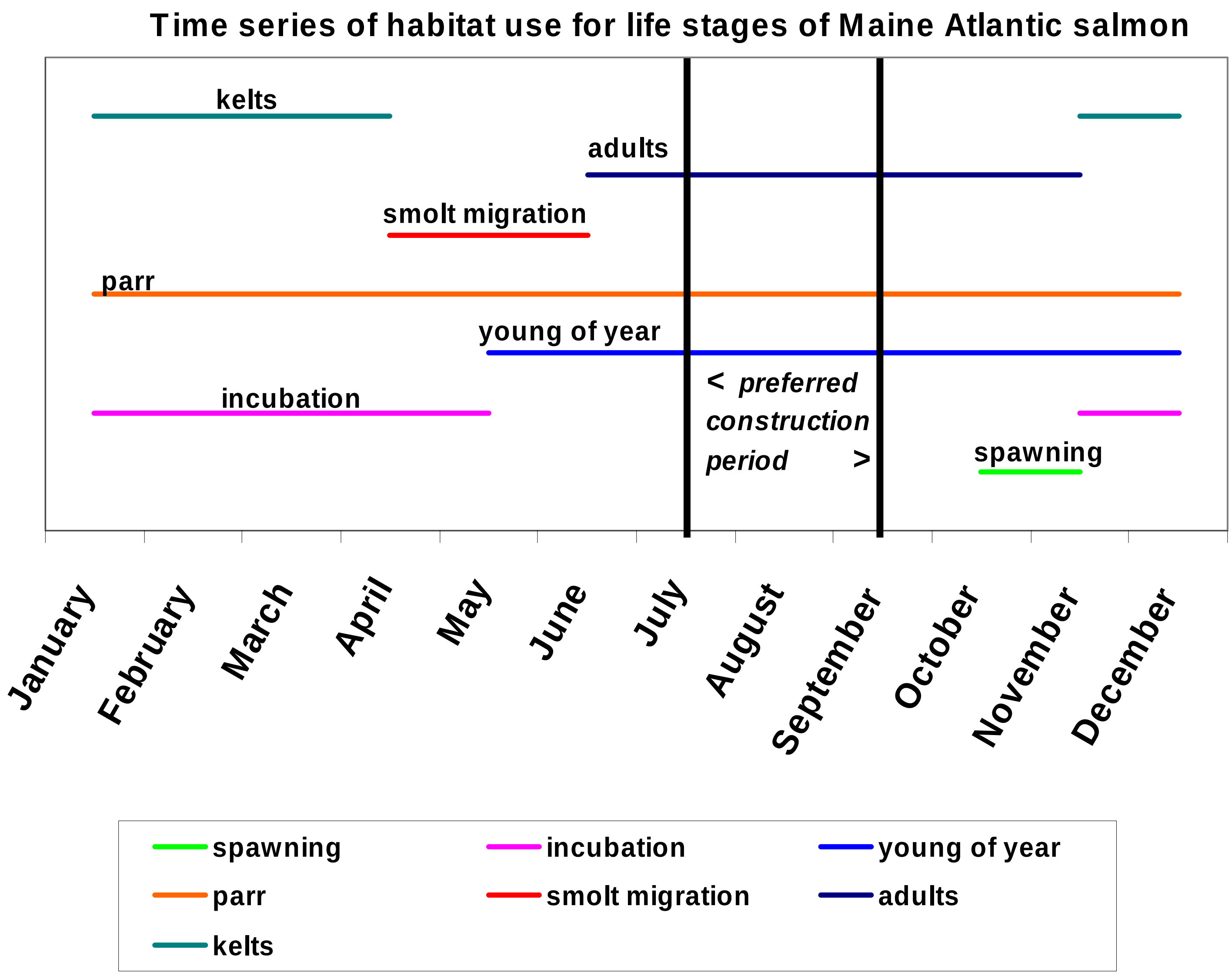
2.1 Atlantic Salmon Stream Habitat Requirements

Rivers and streams with naturally reproducing Atlantic salmon populations vary widely in physical characteristics. However, for Atlantic salmon to survive and reproduce, habitat must exist within a river or stream for the following:

- Spawning in late autumn
- Egg incubation during winter and early spring
- Feeding and sheltering during the growing period in the spring, summer, and autumn
- Overwintering
- Free migration among these habitats and the sea (all year)

Figure 2.1 defines the time of year critical life stages for Atlantic salmon are taking place.

Figure 2.1 Time Series of Habitat Use for Life Stages of Maine Atlantic Salmon



- 5 -

Young Atlantic salmon prefer riffles or rapids with velocities ranging from 1.6 feet/second (ft/sec) to 2.1 ft/sec, depths of 4 to 14 inches (in.), and substrate consisting of gravel and cobble (fry) or cobble and boulder (parr). To overwinter, young Atlantic salmon move into pools or the crevices between larger substrate. Spawning occurs on gravel bars or tails of pools where the current (1.0 - 2.6 ft/sec) is accelerating and water depth (8 - 20 in.) is decreasing. Adult Atlantic salmon require resting and holding pools as they migrate upstream. Adult holding pools are deep (> 2 ft), well shaded and have cool summer temperatures (spring holes or groundwater seeps). Resting pools, used by Atlantic salmon after navigating high velocity riffles and waterfalls, typically lack depth, cover, or cool temperatures.

An Atlantic salmon stream's gradient is characteristically moderately low (10 ft/mile 0.2%) to moderately steep (75 ft/mile, 1.4%). Substrate is composed of gravel, cobble, and boulder, although there is usually some bedrock outcrop in steeper sections and fine gravel to coarse sand in lower gradient sections. It is critical that bottom materials be sufficiently permeable to permit percolation of water, especially in spawning reaches. There should also be a regular occurrence of riffles and pools. Typically, the average spacing of pools or riffles is about five to seven times the channel width. Boulders, large woody debris, and coarse-textured bottom material over at least some channel sections ensure a high degree of oxygen saturation and microhabitat features essential to Atlantic salmon growth and survival (WUMP, 2001).

2.2 Potential Stream Crossing Impacts to Atlantic Salmon Habitat

Stream crossings pose several potential direct and indirect impacts to Atlantic salmon habitat that can be eliminated or minimized by careful planning and implementation of proper BMPs. These potential impacts include:

- Bank erosion
- Sedimentation
- Nutrient/pollutant loading
- Stream warming (temperature)

- Reductions in large woody debris and fine organic matter inputs
- Direct habitat loss
- Passage barriers

2.2.1 Bank Erosion

Improperly designed or installed culverts, bridges or other crossings can cause stream bank erosion which can lead to more serious impacts such as:

- Stream widening can occur when a culvert or bridge is either too narrow for the stream or if the culvert or bridge is oriented skew to the natural stream. In the case of a constricted culvert or bridge stream bank erosion results from increased water velocity as it flows through the stream crossing. When the water exits the crossing, this increased velocity often erodes the stream bottom and/or a stream bank adjacent and downstream of the crossing.

  Culverts or bridges that are placed skew to the natural stream slope have a similar problem. In this instance, the skewed orientation can both increase the velocity of the water and direct the exiting water toward a stream bank that previously had not experienced the direct flow impact (Figures 2.2.1-1 and 2.2.1-2).

- Erosion and sedimentation can change flow regimes, and vice versa. The process of unnatural erosion and deposition changes the stream cross section which also changes the flow patterns and velocity. These changes can destroy Atlantic salmon habitat because they can create flows that are too high for spawning or rearing, cover habitat due to new sediment deposition characteristics, or create areas where there is not enough flow thus affecting aspects of Atlantic salmon habitat such as dissolved oxygen and substrate composition (Figures 2.2.1-1, 2.2.1-2, 2.2.1-3, and Photos 2.2-1 and 2.2-2.).

- Loss of vegetation and shading related to unnatural stream bank erosion or vegetation removal related to grading work as part of stream crossings or flow alterations that cause bank erosion.

- Long-term bank instability, since an improperly placed culvert or bridge is not typically a temporary installation.

Properly designed culverts are placed a few inches below the natural stream bed at a level elevation, adequately-sized and perpendicular to stream flow (Figure 2.2.1-4).

Figure 2.2.1-1 Stream Crossing at Steep Slope with Undersized Culvert

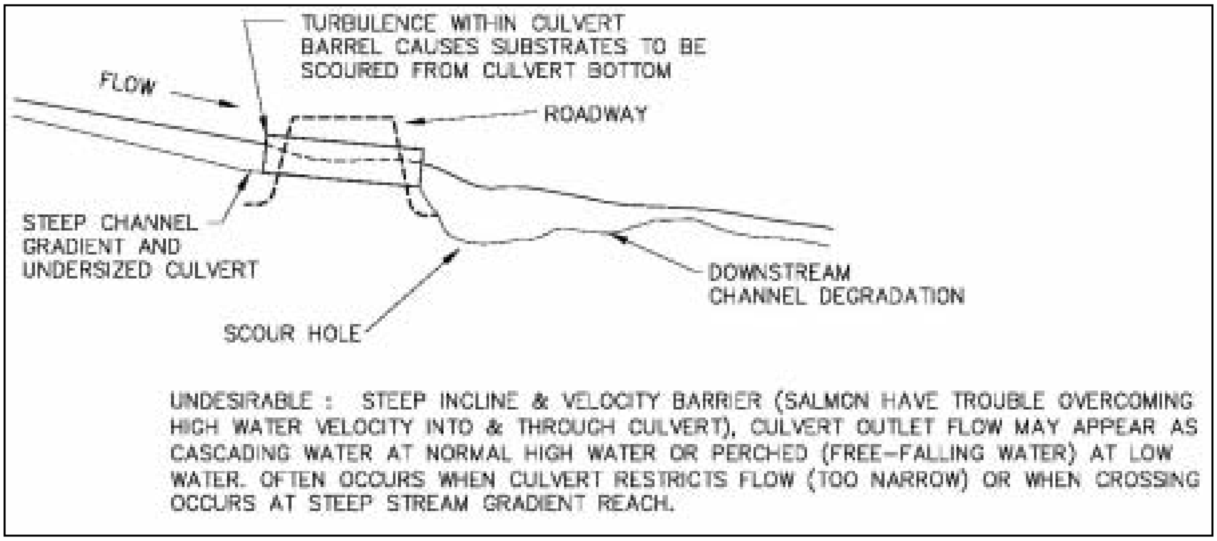


Figure 2.2.1-2 Stream Crossing with Perched Culvert

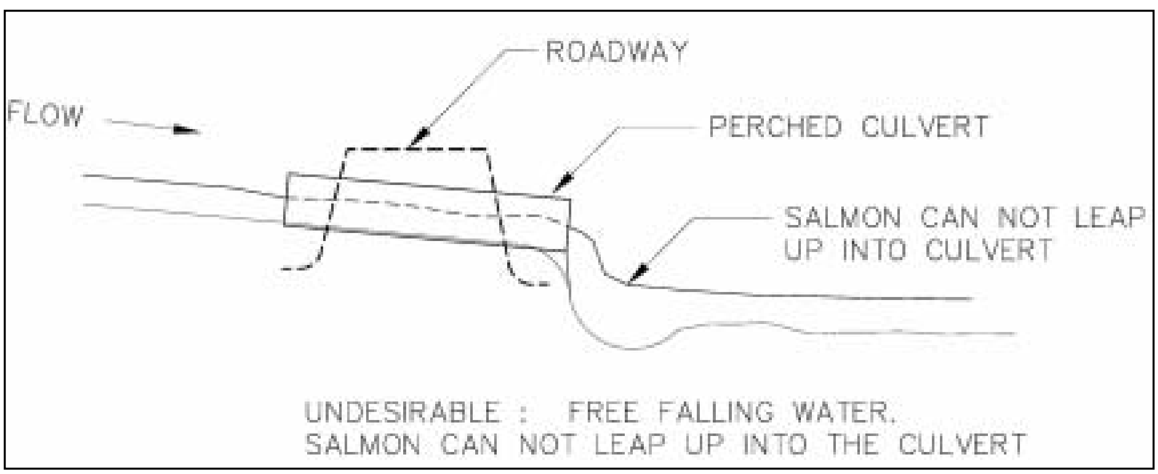


Figure 2.2.1-3 Stream Crossing too Narrow

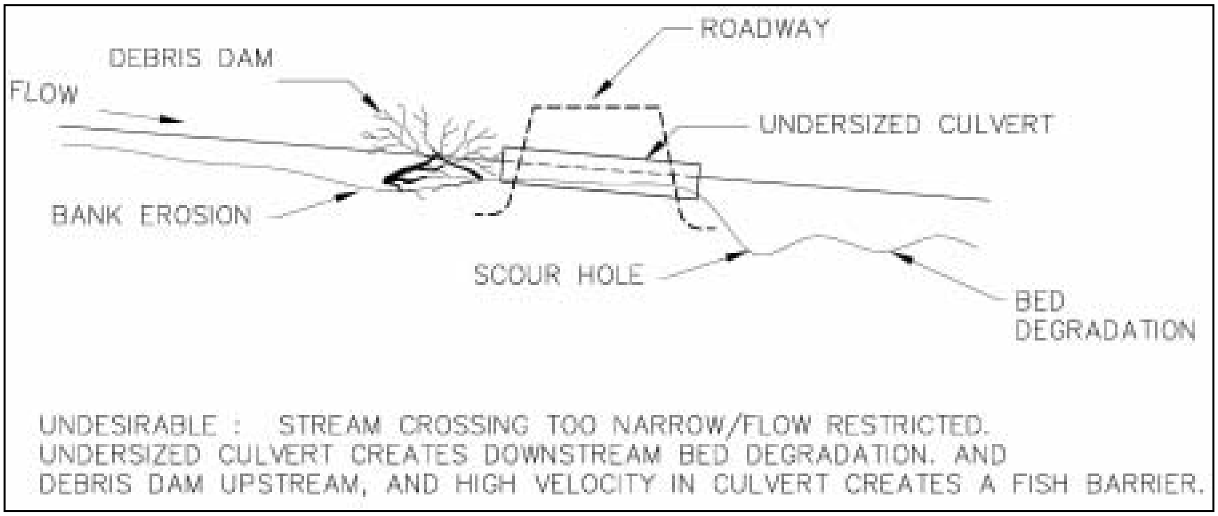


Figure 2.2.1-4 Acceptable Culvert Installation

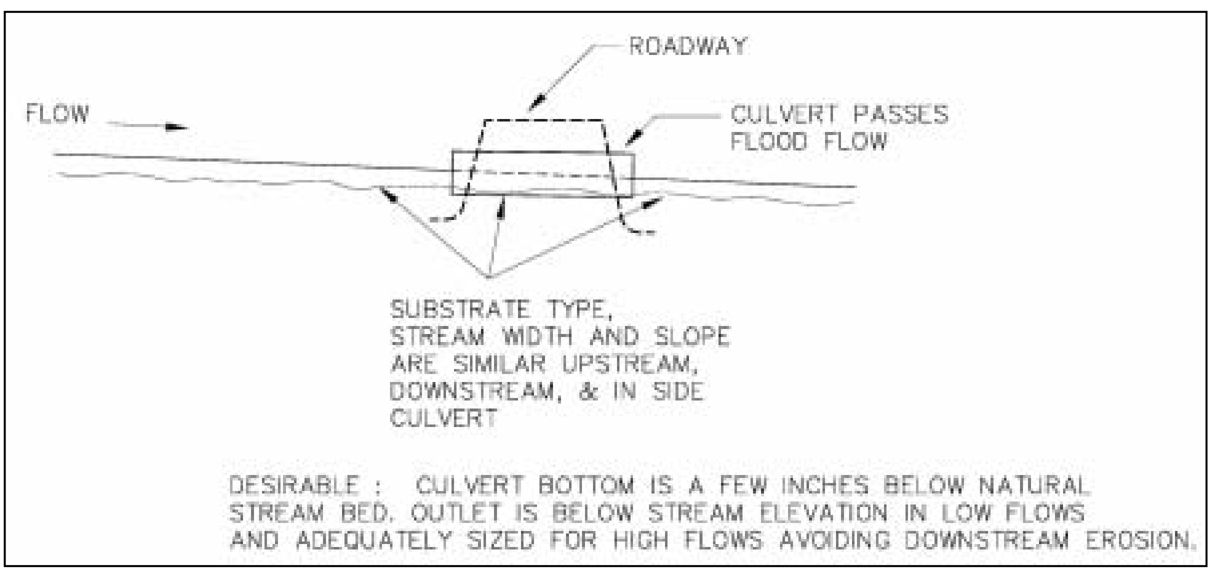


Photo 2.2-1 Example of a perched culvert; notice the upper culvert designed to accommodate higher spring flows. Perched culverts block upstream fish migration.

Photo 2.2-2 Another two-culvert design. Severe embededdness has resulted in reduced flow and passage.

2.2.2 Sedimentation

Erosion of exposed soil at crossings can result in downstream sedimentation to Atlantic salmon habitat. Sedimentation is the most widespread impact associated with stream crossings. Sediment that fills in gravel beds can smother Atlantic salmon eggs, and impair aquatic insect populations that are important forage for Atlantic salmon. Increased turbidity (over background rates) from erosion and sedimentation can injure Atlantic salmon gills and limit feeding success. Sediment can damage a stream's natural riffle and pool habitat pattern and can make streams (especially holding or resting pools) shallower, and warmed excessively by the sun (Figure 2.2.1-1). Sediment deposits can also cause stream aggradation, widening, and ultimately bank destabilization.

Sediment can also add excessive nutrients to streams (Section 2.2.3). Many pollutants (*e.g.*, phosphorous, heavy metals and agrochemicals) readily adhere to sediment particles and can degrade water quality.

2.2.3 Nutrients/Pollutant Loading

Sediment-bound pollutants include phosphorous and many chemical pollutants such as road salts and some pesticides. These pollutants typically enter the stream environment during runoff events attached to eroded sediments (Section 2.2.1). Other nutrients and pollutants, including nitrogen and some forms of pesticides, are soluble and can enter the receiving stream dissolved in groundwater or surface water runoff. Nutrient loading in streams can result in excessive algal growth that reduces water clarity and dissolved oxygen levels, thereby compromising the clear and highly oxygenated waters required by Atlantic salmon (Sochasky, 2004). Effects from pesticides and other toxins may include toxicity problems that affect reproductive success or fitness. Some pesticides used for right-of-way maintenance, blueberry cultivation or forest management are relatively benign in terrestrial ecosystems but can have more important consequences in aquatic systems (Spaulding, 2004).

2.2.4 Temperature and Organic Matter Inputs

Cool, well-oxygenated water maintained by canopy shading is another important aspect of Atlantic salmon habitat. Woody riparian vegetation is important as a source of woody debris and detritus (*e.g.*, leaves and twigs) that contribute to habitat and food for the aquatic ecosystem. Large woody debris inputs also influence flow patterns and provide structural habitat. Excessive tree removal can result in increased summer water temperatures and reduce overhanging woody vegetation.

2.2.5 Direct Habitat Loss

Improperly constructed or maintained stream crossings that affect specific Atlantic salmon habitat sites could result in direct habitat loss or alteration (Volume III, Section 2.0). Likewise, improperly designed crossings that are within close proximity or upstream of known habitat areas can negatively affect habitat. As such, any stream crossing plan in an Atlantic salmon watershed should contact the Maine Atlantic Salmon Commission (ASC) about habitat. The ASC, NOAA Fisheries and U.S. Fish and Wildlife Service (USFWS) maintain maps of suitable Atlantic salmon spawning and juvenile rearing habitat.[1]

2.2.6 Passage Barriers

Improperly designed or installed culverts, bridges or other crossings can impact seasonal movements of Atlantic salmon as well as other fish. Physical blockage of passage can result from pole fords, perched culvert openings, accumulation of debris within a culvert, or other physical barriers associated with

[1] Note that these maps depict known habitat areas, but unmapped areas may also contain important habitat, as the mapping is not complete.

crossings (Figures 2.2.1-1, 2.2.1-2, 2.2.1-3). Undersized or poorly located culverts can:

- Create velocity barriers
- Cause road wash-out or erosion
- Impede passage at low flows where the culvert does not pass adequate base flows (*e.g.*, design elevations that are too high or excessive low channel widths at passage point)

2.3 Unpaved Roads

The majority of unpaved roads in Distinct Population Segment (DPS) Atlantic salmon watersheds are located in Washington County and eastern Hancock County (USFWS GIS Data, 2002). Common uses of unpaved roads are to access interior lands for forest management/harvesting, agriculture, residential access, and recreation. Most of these roads follow local topography (*i.e.*, minimal cuts through hills and fills across hollows), and thus may have steep gradients and sharp curvature relative to paved roads. The composition of these roads reflects the glacial-origin of geologic deposits in this portion of Maine and consists of a mix of coarse (gravel and sand) and fine (silt and clay) particles. To avoid impacts to streams, these roads must be properly engineered, constructed and maintained.

Permanent unpaved roads frequently cross small headwater streams that comprise most of the drainage area of each Atlantic salmon watershed. These small streams are highly sensitive to water quality impacts and ultimately drain to crucial Atlantic salmon spawning and rearing habitat downstream.

Unpaved roads require regular maintenance to ensure that they are not a source of erosion and sedimentation. Yearly inspections are recommended. Lack of maintenance of unpaved roads is listed as the greatest source of nonpoint source pollution in both the Dennys and Narraguagus River watersheds (Arter, 2003; Huckins, 2003).

2.4 Paved Roads

There are seven state-maintained paved roads in the Downeast watersheds that may potentially influence Atlantic salmon habitat. Routes 1 and 9 are primary east-west state routes and Routes 86, 191, 192, 193, and 214 are secondary north-south routes. Like unpaved roads, construction and maintenance of paved roads follow BMP standards established by the Maine Department of Transportation (DOT). Areas that require attention by the state should be documented and provided to the DOT. Town-owned paved roads are also a potential source of nonpoint source pollution and are often the most neglected due local budget constraints.

2.5 Road Ownership in Downeast Maine

There are a total of 22,700 miles of public roads in Maine. DOT is responsible for more than 8,300 miles of these roads, which have been summarized into two distinct categories - built and unbuilt. A built highway is one that has been built to modern design standards, including adequate sight distance, structural capacity, and safety. An unbuilt highway, also referred to as backlog, is usually a road that was constructed pre-1950 and does not meet modern design standards (DOT, 2000).

Town roads (paved and unpaved) have a higher potential for sediment loading than state highways because of differences in maintenance funding and staffing. Within the five Downeast watersheds (Dennys, East Machias, Machias, Pleasant and Narraguagus Rivers), town roads account for about 20-35% of the documented nonpoint source (NPS) sites (SHARE NPS Database, 2003) and are approximately 14% of the total ownership of roads (USFWS GIS Database, 2002) (Figure 2.5). There are over 2,200 miles of minor collectors in Maine spread throughout almost 400 municipalities. Municipalities share maintenance responsibilities with the state for these roads. Capital improvements require a 33% municipal match. Since municipalities have a major role in determining the location of an improvement project, state-municipal partnerships ensure public investments on minor collector highways that are most important to local communities (DOT, 2000).

The majority of roads in Washington and Hancock Counties, and a large percentage of roads in other counties containing DPS Atlantic salmon watersheds are private (Figure 2.5). Many of these roads are owned and maintained by major players in the forest industry in Maine. International Paper (IP), which purchased the lands from Champion International Paper in 2000, is the largest landowner in Washington and Hancock Counties. Since 2001, IP has divested themselves of large tracts of land in NPS watershed selling to interested investors in Maine. Several out-of-state buyers have also been involved in purchasing significant tracts of land. Much of this divested land has been the subject of liquidation harvesting, and appears to be increasingly targeted for subdivisions and second-home development. This trend means that increasingly, there will be more, small land-owners with private roads. Instead of primarily reaching out to relatively few, large landowners to promote BMPs, it is becoming increasingly important to target the larger population as well. Private camp roads and driveways are an important potential source of impacts to streams in Atlantic salmon watersheds. Private road owners are encouraged to contact one or more of the agencies and NGOs listed in Volume IV, Section 5.3 for technical advice and potential funding assistance for properly maintaining and constructing roads and stream crossings.

The application of most BMPs to reduce sediment transport into nearby surface water applies whether a road is paved or unpaved.

Figure 2.5 Road Ownership Composition in Hancock and Washington Counties, Maine by Total Length (USFWS GIS Database, 2002)