FISH HABITAT ASSESSMENT IN THE OREGON DEPARTMENT OF FORESTRY MIAMI STUDY AREA

July 11, 2005

Peggy Kavanagh
Charlie Stein
Andy Talabere
Kim Jones

Oregon Department of Fish and Wildlife
Aquatic Inventories Project
28655 Highway 34
Corvallis, Oregon 97333

Table of Contents

List of Tables

List of Figures

Fish Habitat Assessment in the Oregon Department of Forestry Miami Study Area

Project Description

A collaborative project between the Oregon Department of Forestry (ODF) and the Oregon Department of Fish and Wildlife (ODFW) was initiated to synthesize aquatic habitat and fisheries information for the Miami River drainage to assist in the development of operational management plans, stream habitat restoration projects, habitat conservation planning, and watershed analysis. The project summarizes the condition of stream habitat, the distribution and abundance of salmonid fishes, and the potential for restoration. The ODFW Aquatic Inventories Project has conducted stream habitat surveys as part of its basin survey project and habitat assessment project under the Oregon Plan for Salmon and Watersheds. The goal of these surveys was to document the status and trends of stream conditions in coastal drainages. These surveys in conjunction with fish distribution, fish presence, potential barriers to passage, and past restoration activities will be the basis of the analyses.

The Miami River study area (delineated by ODF) is a subbasin of the Tillamook River watershed on the north Oregon coast (Figure 1). The Miami River study area is comprised of the Miami drainage and a few small streams southeast of the Miami River that flow directly into Tillamook Bay. ODF ownership (approximately 27,600 acres) is located primarily in the upper and southeast portions of the Miami drainage. In addition to state forest land, ownerships in the drainage include private industrial, private non-industrial, agricultural, and urban and rural residential. Land use in the drainage is dominated by forest and agricultural related activities.

The majority of the Miami River is underlain by Tillamook volcanic lithology, although the western side of the basin is underlain by tuffaceous siltstones and sandstones. As a result the channel geology is a mix of sand and pebbles and boulders (Figure 2). Overall, the gradient of streams in the Miami River basin was low (0-2%), with higher gradients found in some of the upper stream reaches. Upland vegetation in the drainage is dominated by conifer trees of varying sizes and ages. The upper portion of the drainage burned in the mid-20th century, although the balance of the basin also contains trees less than 100 years old as a result of earlier fires. Currently, surveys indicate predominant coniferous tree sizes are in the 15 – 50cm size classes. Historic wetland maps indicated extensive wetlands and floodplains up to Prouty Creek along the mainstem Miami River. Though no ODF land is within historical wetland distribution (Figure 2), the wetlands provide an important habitat function for migrating juvenile salmonids that reared further upstream. Currently, wetlands and floodplains are more restricted to the lower tidally influenced portion of the basin.

GIS coverages – sources and scales

Three digitized maps layers were used for different features of this synthesis. The primary layer is the 1:100,000 USGS stream layer. It is a standardized and routed coverage, and has a unique latitude and longitude field associated with each stream (Hupperts, 1998). Fish distribution and aquatic habitat data are joined to the 1:100,000 coverage. The Coastal Landscape and Analysis and Modeling Study (CLAMS: http://www.fsl.orst.edu/clams/) provided a 1:24,000 coverage and a standardized 6th field Hydrologic Unit coverage. The CLAMS coverages displayed all streams at a 1:24,000 scale, and determined the valley width, mean annual flow, channel size, and gradient of streams less than 7% gradient. The highest resolution coverage was developed for ODF at the 1:12,000 scale. We used this layer to display a generalized (no species information) map of salmonid distribution. Because of the different development processes, the data cannot be integrated across scales, but are displayed in the same projection (Figure 3).

Fish Distribution and Abundance

The fish species distributed throughout the mainstem and tributaries of the Miami basin, are coho salmon (*Oncorhynchus kisutch*), fall Chinook salmon (*O. tshawytscha*), chum salmon (*O. keta*), and winter steelhead (*O. mykiss*) (Figure 4). Additionally, resident and anadromous cutthroat trout (*O. clarki clarki*) (Figure 4) and Pacific lamprey (*Lampetra tridentata*) are present. Non-salmonid native species are present in the drainage, but their distributions are not documented. Non-native fish (e.g. shad (*Alosa sapidissima)*) and non-local stocks of salmonids (e.g. summer steelhead) have not been documented in the Miami basin, although some may be present. Fish sampling has not focused on the presence of non-salmonid species in the basin.

ESA Designations

Two fish species are listed under the federal Endangered Species Act (http://www.nwr.noaa.gov/); coho salmon were listed as threatened in 1998 and steelhead trout are considered a species of concern. Others species are not listed at this time.

Fish Populations in the Miami River study area

Chum salmon are found in the mainstem Miami River from the mouth to approximately 3.5 miles upstream of Prouty Creek and in all of the major tributaries in the lower reaches of the Miami River. The peak spawning activity occurs from mid November to early December, predominantly in the tributaries but they are also observed spawning in the mainstem. Spawning surveys were conducted from 1996 to 2003. Peak spawning counts in the Miami River were 39 chum per mile in 2003. Prouty Creek had an average of 53.7 fish per mile for the years 1996 to 2003 (Table 2).

Coho salmon begin returning to the watershed in October and early November after spending 2 to 3 years in the ocean. The peak spawning counts occur between mid-November and mid-January. Coho are distributed throughout the entire Miami River watershed with exception to the upper reaches of the tributaries due to barriers or high gradient. Coho prefer to spawn in the smaller tributaries and have been observed in the upper reaches of the mainstem as well. Spawning surveys have been conducted from 1996 to 2003 by the ODFW Coastal Salmon

Inventory Project. The number of coho salmon seen throughout these survey reaches averaged approximately 16.7 per mile with a range of 0 to 60 fish per mile (Table 2 and Figures 9 & 10). Surveys for juvenile coho salmon were limited to one or two sites per year. Densities ranged from zero to 1.2 m^2 (Table 3 and Figure 9).

Chinook salmon return early September to early November with peak spawning activity observed in mid November to mid December. Chinook salmon are observed primarily in the mainstem of the Miami River but are noted to use the lower reaches of Waldron, Peterson, Minich, Prouty, and Moss Creeks. Spawning surveys have been conducted from 1996 to 2003 by the ODFW Coastal Salmon Inventory Project. The peak counts of Chinook salmon throughout these reaches was 18 fish per mile in 1996 (Table 2).

There are two major seasonal populations of steelhead – a summer run and a winter run. Only winter steelhead return to the Miami basin. A hatchery program does exist for summer steelhead on the Wilson River and occasionally a few of these fish may stray into the Miami River (personal conversation with ODFW district biologist). The ODFW Coastal Salmon Inventory Project has a Steelhead monitoring component. Survey sites are randomly selected and very few sites have occurred in the Miami Basin. The steelhead numbers listed in Table 2 were live fish observed during spawning surveys for coho salmon. In 2005, a survey occurred on the Miami River between Prouty and Diamond Creeks. The peak count was 11 fish and 76 redds per mile.

Anadromous and resident cutthroat trout are not the focus of any population monitoring program; therefore, counts of adults are unknown.

Pacific lamprey are thought to have a distribution similar to Chinook salmon (Keith Braun, ODFW, personal communication). No abundance data exists. During the 2005 Steelhead spawning season, 24 lamprey redds were noted.

Historical Fish Distribution

Lacking historic fish distribution information, we used a map of stream size and gradient developed by the Coastal Landscape Analysis and Modeling Study (CLAMS: http://www.fsl.orst.edu/clams/) to identify areas above current fish distribution that could have potentially supported salmon in the past. We assumed that fish distribution in the Miami basin would be limited by stream gradient if impediments such as physical barriers or poor habitat were not present. Comparing current maps of fish distribution with the CLAMS-generated maps of intrinsic potential (representing potential historic distribution) indicated that historic fish composition and distribution may have been similar to that at present (Figures 5 & 6).

Salmon and Lamprey life history in coastal basins

Chum salmon seek the larger rivers and streams of a watershed. They return to the Miami River in the fall after spending 2 to 6 years in the ocean. The majority of the fish (peak count) arrive mid to late October. These fish are found in the mainstem Miami River from the mouth to approximately 3.5 miles upstream of Prouty Creek and in all of the major tributaries in the lower reaches of the Miami. The peak spawning activity occurs from mid November to early December. The young emerge from the gravel in approximately 18 to 20 weeks after spawning and almost immediately begin migrating to the estuary and ocean. Habitat requirements for the young are minimal since so little time is spent in fresh water; however, the adults need clean, ample spawning gravel, access to spawning grounds, cold and clean water, and cover to avoid predators. Access to high quality estuarine habitat such as emergent wetlands is particularly important for juvenile chum salmon. Streams utilized by chum salmon within ODF ownership include Moss, Minich, Illingsworth, Stuart, and Prouty Creeks, and sections of the mainstem Miami River. The habitat survey reaches that correspond to these streams are reaches 9 and 10 of the upper Miami River. For these two reaches the habitat attributes rated moderate or high with exceptions of fines in riffles, large woody debris volume, and keypieces of large wood.

Coho salmon begin returning to the watershed in October and early November after spending 2 to 3 years in the ocean. The peak spawning counts occur between mid November and mid January, depending on precipitation, as that is the signal that coho key in on to migrate upstream. Coho are distributed throughout the entire Miami River watershed with exception to the upper reaches of the tributaries due to barriers or high gradient. Coho prefer to spawn in the smaller tributaries and have been observed in the upper reaches of the mainstem as well. The fry emerge in early spring and remain in their freshwater environment for a complete year. Thus, due to this life history trait, high quality habitat conditions are desirable in order to insure over-winter survival; such as off channel habitat which provides refuge high velocity winter flows, large wood debris to provide cover from predators, and low levels of fine sediment in spawning gravel. The one year old juveniles then migrate to the ocean and spend approximately 18 months before returning to their native streams to spawn and die. The surveyed habitat reaches on ODF land where coho salmon are observed include reaches 9, 10, 11, and 12 of the mainstem Miami River. Habitat attributes important to coho salmon are pools, slackwater pools, off channel habitat, and large wood debris. The four reaches rated moderate for all these attributes.

Chinook salmon return early September to early November with peak spawning activity observed in mid-November to mid December. Chinook salmon are observed primarily in the mainstem of the Miami River but are noted to use the lower reaches of Waldron, Peterson, Minich, Prouty, and Moss Creeks. Chinook salmon prefer to spawn in larger streams at the tail crest of pools and glides and tend to use larger substrate in which to build redds. The fry emerge in early spring. Some will migrate immediately to the estuary while others will remain in freshwater until early summer. After spending the summer and early fall in the estuary they will migrate to the ocean. Most will remain in the ocean an average of 3 to 4 years and then come back to their native streams to repeat the cycle. Habitat requirements for adult Chinook are clean, ample gravel for spawning, cold, clean, well-oxygenated water, and deep pools for cover. Juvenile Chinook need cool, clean water, pools, and large wood debris for cover while in their freshwater environment. They need estuaries and their associated wetlands which provide vital nursery areas for the fish prior to their departure to the open ocean.

The distribution of winter steelhead in the Miami basin is very similar to coho. They are observed in the mainstem and all the main tributaries and tend to migrate slightly higher in the watershed then coho. Winter steelhead return to their natal streams from November to April after spending from 1 to 3 years in the ocean and unlike other Pacific salmonids, some may survive after spawning and return to the ocean and become repeat spawners. Spawning occurs in the winter and early spring, and when the fry emerge they remain close by or occasionally migrate to the upper or lower reaches of streams and rivers. Like other salmon species, juveniles and adults rely on streams, rivers, and marine habitat during their lifecycle. Juveniles usually stay in their freshwater environment for two to five years and then migrate to the estuary and ocean in the spring. Habitat requirements include clean, ample gravel for spawning, cold, clean, well oxygenated water, deep pools and large wood debris for cover. There is no data to estimate the numbers of winter steelhead in the Miami basin. The ODFW Coastal Salmon Inventory Project's steelhead program started inventories of steelhead in coastal basins but no sites have been selected in the Miami basin at this time.

Coastal cutthroat trout may exhibit four main life history strategies; an anadromous form that migrates to the estuary and/or ocean before returning to freshwater to spawn, an adfluvial form that migrates from a lake to smaller tributaries to spawn, a fluvial form that migrates to small streams from other parts of the watershed to spawn, and a resident form that both resides and spawns in small streams. Both anadromous and resident cutthroat trout are found throughout the mainstem and tributaries of the Miami basin but specifically resident cutthroat tend to be found in the upper headwater reaches of the tributaries. Anadromous adults enter streams during the fall. These adults will spawn from December through May depending on water conditions. Fry emerge from the gravel in about 2 months. The young utilize slow flowing backwater areas, low velocity pools, and side channels for rearing. Young cutthroat can spend 1 to 9 years in fresh water before they migrate to the estuaries and ocean in the spring, but most commonly it is three years from emergence. Adults usually spend less than one year in the ocean before returning to spawn. Like steelhead, sea-run cutthroat trout usually survive after spawning and will return to the ocean in late March or early April. In freshwater, adult cutthroat typically reside in large pools while the young reside in riffles. All stocking of hatchery cutthroat trout was ceased in 1994, however the residual effects of hatchery cutthroat on wild coastal cutthroat have not been determined. There is no ODFW data to assess the abundance of anadromous and resident cutthroat trout in the Miami basin however reports from anglers have indicated that the number of large cutthroat, presumably anadromous, has increased in the last several years.

Pacific lamprey use the Miami basin and are thought to be distributed similar to Chinook salmon (Keith Braun, ODFW, personal communication). Pacific lamprey are anadromous. Mating pairs construct a nest by digging together using rapid vibrations of their tails and by moving stones using their suction mouths. Adults die within days of spawning and the young hatch in 2-3 weeks. The juveniles swim to backwater or eddy areas of low stream velocity where sediments are soft and rich in dead plant materials. They burrow into the muddy bottom where they filter the mud and water, eating microscopic plants (mostly diatoms) and animals. The juvenile lamprey will stay burrowed in the mud for 4 to 6 years and stay in the same habitat, rarely migrating within the stream system. They metamorphose into adults averaging 4.5 inches long. Lamprey migrate to the ocean in late winter during periods of high water. After 2 to 3 years in the ocean they will return to freshwater to spawn.

Habitat Survey Approach and Methods

ODFW Aquatic habitat surveys were conducted in the Miami drainage from 1993 – 2003 (Table 3 and Figure 10). All surveys described the channel morphology, riparian characteristics, and features and quality of instream habitat during summer flow, following methods described in Moore et al. (1999) (http://osu.orst.edu/Dept/ODFW/freshwater/inventory/publicatn.htm). Each habitat unit is an area of relatively homogeneous slope, depth, and flow pattern representing different channel forming processes. The units are classified into 22 hierarchically organized types of pools, glides, riffles, rapids, steps, and cascades, including slow water and off-channel pool habitat. Length, width, and depth was estimated or measured for each habitat unit. In addition, water surface slope, woody debris, shade, cover, and bank stability were recorded. Substrate characteristics were visually estimated at every habitat unit. Estimates of percent silt, sand, and gravel in low gradient (1-2%) riffles were be used to describe gravel quantity and quality. The surveys also provided an inventory of site-specific features such as barriers to fish passage (e.g., falls or culverts). Riparian transects described tree type and size, canopy closure, and ground cover associated with the floodplain, terraces, and hillslopes adjacent to the stream. Each transect was 5m wide and extended 30m perpendicular to the stream.

Descriptions of channel and valley morphology followed methods developed at Oregon State University and described in detail in Moore et al. (1999). Valley and channel morphology defined the stream configuration and level of constraint that local landforms such as hillslopes or terraces imposed upon the stream channel (Gregory et al. 1989; Moore and Gregory 1989). The channel was described as hillslope constrained, terrace constrained, or unconstrained. Channel dimensions included active (or bankfull) channel width and depth, floodprone width and height, and terrace widths and height. These descriptions of channel morphology have equivalents within the OWEB and Rosgen channel typing system (Rosgen 1994).

Two survey designs were used within the Miami study area. Surveys conducted in 1993 – 1997 in the Miami drainage followed a basin, or census, survey design. The basin survey followed methodology proposed by Hankin (1984) and Hankin and Reeves (1988). The sampling design is based on a continuous walking survey from the mouth or confluence of a stream to the headwaters. Each stream is stratified into a series of long sections called reaches and into short habitat units within each reach. Within a watershed, field crews surveyed major streams and a selection of small tributaries. The methodology provided flexibility of scale, allowing information to be summarized at the level of microhabitat, associations of habitat, portions or reaches of streams, watersheds, and subunits within regions. The continuous-survey approach provided field-based estimates of habitat conditions throughout a stream, described habitat and hydrologic relationships among streams or landscape features, and permitted stream-wide estimates of fish distribution and abundance.

The second survey design was intended to provide estimates of habitat conditions across a broad geographic region. To accomplish this, we randomly selected sites each year from 1998-2003 in coastal drainages north of the Nestucca River. Of the total, six sites fell within the Miami study area and are reported here. Field protocol was similar to the basin surveys except that sites were 500 to 1,000 meters in length. The randomly selected sites were combined with the basin survey reaches to describe aquatic conditions in the Miami study area.

The basin and random surveys were integrated into coverages in a Geographical Information System (Jones et al 2001). The basin surveys were routed and displayed at the channel reach and habitat unit scales, and the random surveys were displayed as points with reach summary data.

The methods manual for basin and random surveys is available online at http://oregonstate.edu/Dept/ODFW/freshwater/inventory/index.htm.

Analysis

Habitat data were summarized at the reach (basin surveys) or site (random surveys) scale to describe channel morphology, habitat structure, sediment supply and quality, riparian forest connectivity and health, and in-stream habitat complexity. Individual attributes include:

Channel morphology	Channel dimensions
	Channel constraint features, if any
	Gradient
	Percent secondary channels
	Floodplain connectivity
Pool habitat	Percent pool
	Percent slow, backwater, and off-channel pools
	Deep Pools (>1m deep)
	Complex pools (contain > 3 pieces large wood)
Large Wood	Pieces of large wood (>0.15 diameter and >3m length)
	Volume of large wood (m3)
	Key pieces of wood (>0.6m diameter and >12m length)
Substrate	Percent fines, gravel, cobble, boulder, bedrock
	Percent fines and gravel in low gradient riffles
Riparian	Shade
	Density of conifer trees, by size category
	Density of hardwood trees, by size category

Results are presented in tables and as frequency distribution graphs, and in GIS coverages. Values were standardized as a percent or by reach length. Information from a reference database was used to provide a standard point of comparison.

Metadata for the GIS coverages is available online at
http://oregonstate.edu/Dept/ODFW/freshwater/inventory/index.htm

An interpretation guide for aquatic habitat data is available online at
http://oregonstate.edu/Dept/ODFW/freshwater/inventory/index.htm

Individual stream survey reports for the Miami are available from the Aquatic Inventories Project in Corvallis.

Habitat quality

Individual habitat attributes, whether expressed as reach or site averages, or displayed at the habitat unit level portrays a view of stream characteristics without the context of a fish, landscape, or historic perspective. We viewed the integration of habitat attributes in three different fashions. The first is in comparison to a historic context, expressed in the character of streams located in minimally human disturbed areas. These sites are referred to as reference sites, and while they provide a general context and range of stream attributes, are not intended to be prescriptive in nature. Rather, they provide a point of comparison to view the relative differences between streams and reaches within a drainage network.

The second and third perspectives express stream quality in terms of potential carrying capacity of a reach for juvenile coho salmon (Habitat Limiting Factors Model), and potential survival of coho salmon at each life stage (HabRate). We collected information on attributes relevant to determining the potential quality and carrying capacity of aquatic habitat for different life stages of coho salmon: stream substrate (fine sediment, gravel, and cobble), habitat unit type (scour, beaver, and off-channel pools), cover (large wood, undercut banks), and channel morphology (secondary channels, gradient). Again each model provides a comparison of stream attributes from a salmonid biology perspective.

Reference conditions

Reference values (Table 4) were drawn from streams in areas with low impact from human activities. We used a reference database that is most similar to the lower gradient streams predominant in the Miami study area. A total of 124 “reference” sites, surveyed between 1992 and 2003, were selected within the Oregon Coast Coho ESU (from Sixes River to the Necanicum) to represent conditions within the range of coho salmon. The Cascades eco-region encompasses coho salmon in the Umpqua. A summary of the reference site characteristics are as follows:

Attribute	Value
Number of Reaches or Sites	124
Distance Surveyed - Total (km)	161.9
Reach or Site Length (m)	
Mean (median)	1306 (971)
Range	174 - 6776
Active Channel Width (m)	
Mean (median)	9.28 (7.28)
Range	1.5 – 31.5
Gradient (%)	
Mean (median)	2.8 (2.3)
Range	0.5 – 19.2
Ownership	primarily federal
Ecoregions	Coastal 80% Cascades 20%
Geology	Sedimentary 72% Volcanic 21% Mixed 7%

Reference sites were selected using methods outlined in Thom et al. (2001). A thorough discussion of the site characteristics and locations of the reference sites used in this report will be available at ftp://nrimp.dfw.state.or.us/OregonPlan/ (in press). Sites were initially selected based on land use and riparian classifications potentially associated with low human impact (e.g. wilderness or roadless area, late-successional or mature forest). Each site was inspected using USGS 7.5 minute topographic maps for human-caused stressors such as roads, development, and forest management. These sites are not meant to predict historic conditions in the Miami Study Area, but to more broadly represent the potential range of conditions in lower gradient (<5%) fish-bearing streams in coastal Oregon.

The range of data for each variable was subdivided into quartiles, 0-25%, 25-75%, and 75-100%. The values within each of the 3 quartiles was labeled as low, moderate, and high. While few of the sites were completely absent of human influence, we assumed that the reference sites represented a natural range of conditions. Thus, we considered that the 25th and 75th quartile breakpoints represented the values we considered low or high within a natural context. The middle 50% quartile was considered a moderate or average level.

Habitat Limiting Factors Model (HLFM)

The HLFM model estimates the potential carrying capacity of stream habitat and identifies the limiting factors for coho salmon production (Nickelson et al 1992, Nickelson 1998). We used this model to quantify critical habitat factors for juvenile coho salmon during the summer and winter, and highlight differences between reaches. The HLFM model focuses on the amount of pool habitat in a reach, particularly the beaver pool and off-channel pool habitat. Summer habitat capacity is a function of the amount of total pool habitat, and winter habitat is governed by the amount of beaver and off-channel pool habitat.

HabRate

HabRate (Burke et al. 2001) describes the quality of aquatic habitat in relation to survival of coho salmon at a particular life stage. HabRate was based on our interpretations of the published literature. Habitat requirements for discrete early life history stages (i.e. spawning, egg survival, emergence, summer rearing, and winter rearing) were summarized and used to rate the quality of reaches as poor, fair, or good, based on attributes relating to stream substrate, habitat unit type, cover (large wood, undercut banks), and gradient.. Reach level summaries of stream habitat were entered into a computer spreadsheet, and interpreted by logical statements to provide a limiting factor assessment of potential egg-to-fry and fry-to-parr survival for each reach. The model is a decision making tool that is intended only to provide a qualitative assessment of the habitat potential of stream reaches within a basin context. Information not common to standard stream survey designs, such as seasonal flow or temperature extremes were excluded from this analysis.

Aquatic Habitat Conditions

Aquatic Habitat overview

The ODFW Aquatic Inventories Project has conducted aquatic habitat surveys in the Miami Basin since 1993. To date, thirty-six percent of the stream miles nested within ODF land ownership have been surveyed (Figure 10 and Table 4). The surveys on ODF land conducted in 1993, 2002, and 2003 were concentrated in the mainstem Miami River and Prouty Creek. Surveys were not conducted in smaller tributaries on ODF land in the study area. Figures 15a and b provide an overall graphical picture of the conditions of stream habitat on ODF and other lands in the Miami study area relative to reference conditions. The number of habitat surveys was few. Additional surveys in the Miami basin would be beneficial to evaluate the overall habitat conditions.

The habitat analysis focused on thirteen key habitat attributes considered important for successful spawning, rearing, and survival throughout various life history stages. These key attributes are identified as the amount of pool habitat, quantity of deep pools per kilometer, percent of slack water habitat, percent of secondary channel area, percent of fines and gravel found in riffle substrate, percent bedrock substrate, large wood pieces, volume and key pieces, shade, and large conifers in the riparian zone. These attributes are compared to habitat values derived from reference stream reaches and conditions. Reference sites provide a general context and range of stream attributes of minimally human-influenced sites, and they are intended to provide a point of comparison to view the relative differences between streams and reaches within a drainage network. Reference values are not meant to be prescriptive, that is, to indicate the value each reach of stream must attain. Table 6 compares the median value of the 13 key attributes in relation to the reference reach's habitat reference values. In addition, Figures 15a and b are cumulative frequency graphs of these attributes within the identified watershed regions.

These graphs help visualize the condition of the habitat relative to the reference conditions at the low and high reference values (25th and 75th percentiles).

The surveyed sections of streams had high levels of pool habitat and deep pools, and a moderate amount of slow water pools. The amount of secondary channel habitat was high. The amount of gravel in the streambed was moderate. The amount of fine sediments was very high, except in the most recent survey of reach 10. Structural complexity was low to moderate in the drainage, primarily due to the lack of large pieces of wood. Riparian zones lacked large conifer trees in all of the surveyed reaches, and shade levels were low in the wider reaches of stream.

It is difficult to speculate as to the character of the unsurveyed streams because no small tributaries were surveyed. However, the valley width is moderate (suggesting a lack of hillslope constraint) and gradient is low in many of the tributary streams (Figure 6). This suggests a potential for abundant pools and adequate fish habitat. Structural complexity and riparian conditions are unknown.

We are unable to assess the effects of the 1996 flood event. Streams on the north coast of Oregon experienced some large scale debris torrents, channel morphology adjustments, and redistribution of habitat units, sediment, and wood. A resurvey of randomly selected reaches indicated that up to 3% of the streams in the region experienced debris torrents and 25% had moderate changes in channel character (Jones et al. 1996). None of the randomly selected surveys were in the Miami drainage.

Reach descriptions

The following descriptions are based on a 1993 basin survey on the upper portion of the Miami River (reaches 9 to 13) and two Oregon Plan surveys (Prouty Creek–NC1902 and Miami River-NC1878). The description of the basin survey reaches (surveyed in 1993) are followed by the Oregon Plan sites (surveyed in 2002-03). Reach values relative to reference are presented in Table 6. Maps of characteristics in the basin survey reaches are presented in Figure 11. There are few surveys on ODF land in the Miami basin; therefore, we looked at the individual reaches on ODF land and compared those to the reference conditions for coho streams. The thirteen habitat attributes are those most critical to salmon survival throughout its life stages. Although a reach may be lacking in one area, it could simultaneously have positive attributes to salmon survival.

Reach 9 (T2N-R10W-36NE): Reach 9 began at the Prouty Creek confluence and extended upstream 2,318 meters. Reach 9 had an additional 1,023 meters of secondary channel units. The main channel was unconstrained within a broad valley. The valley width index was 4.1 (range 3.0 - 5.0). The primary land use was rural residential. The average gradient was 0.5 percent. Stream habitat was predominantly riffles and scour pools (40% and 41% respectively). Overall stream substrate percentages were silt (15%), sand (26%), gravel (38%), and cobble (20%). The stream banks were predominantly vegetatively-stabilized and undercut bank was minimal at 5%. There were 11 pieces of large wood debris per 100 meters with a volume of 12.5

cubic meters. The trees found most frequently in the riparian zone were deciduous species 3-30 cm dbh (based on 4 riparian transects).

Reach 10 (T2N-R10W-36NE): The main channel of Reach 10 extends 1,207 meters; there were 375 meters of secondary channel units. The main channel was constrained by hillslopes and high terraces within the valley floor. The valley width index was 2.8 (range 2.0 - 4.0). The primary land use was second growth timber and large timber. The average gradient was 0.7 percent. Stream habitat was predominantly riffles, rapids, and scour pools (39%, 10%, and 42%, respectively). Overall stream substrate percentages were silt (10%), sand (20%), gravel (34%), cobble (30%), and a small amount of boulder (6%). The stream banks were predominantly vegetatively-stabilized and approximately 9% had undercut banks. There were 12 pieces of large wood debris per 100 meters with a volume of 16.7 cubic meters. The trees found most frequently in the riparian zone were deciduous species 3-30 cm dbh (based on 2 riparian transects).

Reach 11 (T2N-R9W-29SW): Reach 11 extends 971 meters. Reach 11 also had 486 meters of secondary channel units. The main channel was unconstrained within a broad valley. The valley width index was 2.6 (range 2.0 - 3.0). The primary land use was second growth and large timber. The average gradient was 0.8 percent. Stream habitat was predominantly riffles, rapids, and scour pools (36%, 10%, and 34%, respectively). Overall stream substrate percentages were silt (12%), sand (23%), gravel (31%), cobble (27%), and a small amount of boulder (7%). The stream banks were predominantly vegetation stabilized (80%) and undercut bank was 9%. There were 12 pieces of large wood debris per 100 meters with a volume of 14.2 cubic meters. The trees found most frequently in the riparian zone were deciduous species 3-30 cm dbh (based on 3 riparian transects).

Reach 12 (T2N-R9W-29NE): Reach 12 extends 5,977 meters. Reach 12 also had 1,359 meters of secondary channel units. The channel was constrained by hillslopes within a moderate V-shaped valley. The valley width index was 2.1 (range 1.5 – 2.5). The primary land use was second growth timber and large timber. The average gradient was 1.8 percent. Stream habitat was predominantly riffles, rapids, and scour pools (33%, 30%, and 17% respectively). Overall stream substrate percentages were silt (10%), sand (17%), gravel (19%), cobble (27%), and boulder (25%). The stream banks were predominantly vegetation stabilized (83%) and undercut bank was minimal at 7%. There were 7 pieces of large wood debris per 100 meters with a volume of 8.1 cubic meters. The trees found most frequently in the riparian zone were deciduous species 3-30 cm dbh (based on 8 riparian transects). Numerous habitat structures were observed in this reach when surveyed in 1993.

Reach 13 (T2N-R9W-23SW): Reach 13 is high gradient and extends 2,779 meters. Reach 13 had an additional 479 meters of secondary channel units. The channel was constrained by hillslopes within a moderate V-shaped valley. The valley width index was 1.3 (range 1.0 – 2.0). The primary land use was second growth timber and large timber. The average gradient increased substantially from the previous reaches to 13.5 percent. Stream habitat was comprised predominantly of rapids, cascades, and dry units (13%, 20%, and 44% respectively). Overall stream substrate percentages were silt (9%), sand (19%), gravel (17%), cobble (22%), boulder (28%), and a small amount of bedrock (5%). The stream banks were predominantly vegetation stabilized (82%) and undercut bank was minimal at 6%. Large wood debris increased substantially in this reach as well to 34 pieces per 100 meters with a volume of 58.4 cubic meters. The trees found most frequently in the riparian zone were deciduous species 3-30 cm dbh (based on 4 riparian transects) but small conifers (3-15 cm dbh) were observed as well.

Miami River – Oregon Plan Site NC-1878 – surveyed in the summer of 2002: The Miami River habitat survey extended 1,102 meters. This survey was nested within the boundaries of reach 10 of the 1993 basin survey. The channel was constrained by high terraces in the valley floor. The average valley width index was 4.9 (range: 4.0-6.0). Land uses for the reach were second growth (15-30 cm dbh) and young (up to 15 cm dbh) trees. The average unit gradient was 0.7 percent. Scour pools (45%) and riffles (28%) dominated stream habitat. Cobble (39%) and gravel (36%) dominated stream substrate. Wood volume was high at 125.6 m3/100m. The trees found most frequently in the riparian zone were conifers and hardwoods 3-15 cm dbh and 30-50 cm dbh (based on 3 riparian transects). There was a significant portion of secondary channels throughout the survey. Several debris jams were observed. One habitat structure was noted near the end of the survey. Beaver activity was noted midway through the survey.

Prouty Creek - Oregon Plan Site NC- 1902 – surveyed in the summer of 2003: The Prouty Creek habitat survey extended 517 meters. The channel was alternatively constrained by high terraces and hillslopes in a broad valley. The average valley width index was 3.3 (range: 1.2 – 5.0). Land use for the reach was second growth (15-30 cm dbh) and rural residential property. The average unit gradient was 7.8 percent. The habitat units in the entire reach were puddled or dry. Cobble (50%) was the prominent instream substrate. Wood volume was low 15.3m^3/100m. The trees found most frequently in the riparian zone were conifers and hardwoods 3-15 cm dbh (based on 3 riparian transects). There was a very little secondary channel throughout the survey (10 meters). There were no potential barriers to upstream fish migration observed throughout the survey.

Coho salmon, juvenile trout, and sculpin were observed throughout the mainstem Miami River survey. The habitat structures observed throughout reach 12 consisted of cabled boulder weirs, rock gabions, and cabled large wood placement. Several high steps 1.2 – 2.5 meters high were observed approximately 11,500 meters upstream from Prouty Creek. No fish were observed above these steps; however, a fish survey was not conducted to establish upstream distribution of salmonids.

Reach 10 of the 1993 basin survey and Oregon Plan site NC-1878 almost directly overlap and thus provide an opportunity to compare the same section of stream after 9 years of natural and anthropomorphic influences. A significant event within this time frame was the 1996 floods. High levels of precipitation occurred which caused widespread flooding throughout most of northwest Oregon. Timber harvest activities also occurred throughout the watershed within this time frame, as well as habitat restoration efforts and decommissioning of roads in the watershed. Comparison between the two data analysis indicated that beneficial changes occurred within the reach. Pools were deeper on average, the amount of large wood pieces and volume increased, and percentage of fine sediment decreased. To tie these positive changes to the flooding, habitat restoration projects, or improved timber harvest practices is difficult to determine since a complete survey of the watershed has not been conducted since the 1993 survey.

The Miami River upstream from Prouty Creek is still a fairly wide stream with an active channel width average of 18 meters and a high amount of secondary channel units (reaches 9 to 12). In reach 13 the active channel width narrows considerably to an average of 7 meters and there is less secondary channel units observed. The geomorphologic channel constraints and gradient correspond to these observations very well. The channel is within a broad valley in reaches 9 to 11, slightly meandering and unconstrained in some areas, with a low gradient. But in reach 12 the hillslopes are closer to the channel, the gradient increases slightly, and the channel meanders less within the confines of the hillslopes. In reach 13 the gradient increases substantially and becomes even more restricted within the constraining hillslopes.

Relationship of fish populations to aquatic habitat

The surveys described components and processes that contribute to the structure and productivity of a stream and fish community. The Aquatic Inventories Project selected attributes to describe important indicators of sediment supply and quality, instream habitat complexity, and riparian forest community. These variables were summarized for reaches and sites on ODF lands in Table 6. Table 7 summarizes the reach variables for the entire Miami study area. We also used frequency distributions to examine the survey data on ODF lands (Figure 14a and b). The frequency distribution graphs are useful for determining medians and percentile values, and for comparing the differences in distribution of values between multiple databases. Figure 15a and b illustrates the habitat values at reference sites, ODF sites, and Miami study area sites. Habitat capacity and quality indices calculated using the HLFM and Habrate models area are presented in Table 8.

The response of salmonid fishes to the character of aquatic habitat varies by life stage and time of year. Adult fish seek deep pools for holding areas while preparing to spawn; they need gravel and cobble substrate free of fine materials to build redds and deposit eggs. Furthermore, redds require a steady flow of oxygenated water to allow the eggs and alevins to mature. Increasing amounts of fine sediments (<2mm) increases the mortality of eggs in the gravel (Everest et al. 1987). The amount of silts and fines associated with riffles is an indicator of embeddedness in spawning areas. A high percentage of fine sediment can settle (embed) in the interstitial spaces of the gravel and armor it such that it is difficult for spawning fish to dig an adequate redd (nest), and prevent oxygenated water from reaching the eggs. In reaches 9 through 11, the percent fines found in riffles was rated as poor in relationship to salmonid requirements; reach 12 rated as fair. Fine sediments value less than 8% are desirable – no surveyed reaches met this criteria. Data analysis indicates that the amount of gravel and cobble are not a limiting factor for adult salmon in the Miami study area. Reaches 10 and 12 are considered to be of moderate to high quality for spawning, but excessive fine sediments in the other areas cause overall rating to be poor.

After emergence in the spring, salmonid fry typically remain in freshwater from a few weeks to two years before migrating to the ocean, species-dependent. Edge cover and backwater habitats are particularly important to the survival of fry in the spring, though less so as they grow and move into larger pools during the summer. The distribution of juvenile salmonids is limited primarily by the availability of pool habitat, food resources, and acceptable water quality. In the winter, coho salmon parr prefer complex pool habitat which has low velocity refugia from high winter streamflows. This habitat is often found in the form of off-channel alcoves, dam pools, and beaver ponds (Nickelson 1992). Complex off-channel habitats are also important in these large stream reaches during the winter. Large wood is an important structural component contributing to the complexity of these preferred habitats (Sedell 1984). Juvenile coho salmon extend their distribution downstream in the winter to inhabit areas previously limited by high water temperature, including tidally-influenced wetlands. Juvenile steelhead and cutthroat trout are more opportunistic in regards to habitat type, residing in pools, riffles, rapids, and cascades.

Pools provide resting places and over-wintering habitat for fish. Deep pools, those greater than or equal to 1 meter deep, provide temperature refugia and provide year-round cover. They were present in reaches 9 – 12 of the upper Miami River. Miami River (NC 1878) met the good level of deep pools (4 or more per kilometer of stream) and the good level of pool habitat, greater than 45 percent of primary channel area as pool habitat. Slackwater pools include backwater habitat, dammed pool, and beaver ponds. A good level is >7%; Miami River (NC 1878) was the only reach which met this level. Pools are very abundant in the lower gradient reaches (reaches 9-11) of the Miami, and deep pools are common, with over 6 deep pools per kilometer. The higher gradient reaches are dominated by fast water habitat types, not pools.

Instream wood serves many functions in a stream channel. The wood helps to scour deep pools, provide cover and nutrients, trap sediment, and provide cover from predators. Wood acts as an obstacle at higher flows, forcing the stream to cut new channels, to scour new pools, and to create undercut banks. The pools in the Miami study area are relatively simple, with low to moderate amounts of large wood. Overall, the rating of summer habitat for coho salmon is high for habitat capacity (large and abundant pool habitat), and fair to high for quality (deep, complex pools). In addition, the channel morphology and amount of secondary channel indicates relatively high connectivity to the floodplain. Secondary channels increase the potential habitat available to fishes, particularly to juveniles. Often the habitat has slower moving water than the primary channel. It provides over-wintering and summer rearing habitat for juvenile fish. An acceptable level of secondary channels was 5.3% of the total channel length; Miami River (NC 1878) and Miami River reaches 9-13 met this level.

Reach 13 has a higher gradient than the lower reaches (average was 13.5) and is fairly confined within hillslopes. The amount of large wood pieces and volume was high and the level of fine sediment was low; conditions good for cutthroat trout. A high percentage of the wood that the survey crew recorded had evidence of cut ends. The wood in this area of the watershed was likely remnants of past logging which occurred in the early 1900's and after the Tillamook burn in the 1930's.

Summer habitat capacity and quality is rated fair to high for juvenile coho salmon in the mainstem of the Miami River (Table 8). The amount of pool habitat, number of deep pools, and amount of secondary channels provide good rearing habitat. The number of low gradient stream miles in the tributaries (Figures 5 and 6) also indicates good rearing potential. Additional complexity would increase the quality of summer habitat.

Over-winter habitat capacity for coho salmon is rated as fair to high because of the abundance of pool habitat and size of stream, but the quality is low to fair (Table 8). The streams lack slow-water pool habitat. Only Reach 10 contained beaver pond habitat (10% of the habitat) in the 2002 survey. Beaver ponds coexist with coho salmon and their ponds are refugia for young salmon. Few of the pools contained sufficient large wood needed to create complex habitats.

Riparian vegetation is indirectly an important component of fish habitat. The riparian trees stabilize the bank, recruitment source of woody debris, buffer against flood impacts, and provide shade. Stabilized stream banks are more likely to develop undercut banks, which serve as important cover for fish, and less likely to contribute fine sediments. The canopy cover (shade) in reaches 9 to 11 rated as poor in relation to the reference conditions but is considerably better in reaches 12 and 13. The higher shade cover is due to a riparian composition consisting predominantly of hardwood species (red alder) 3-30 cm dbh and a narrow active channel. In contrast, the wide active channel in reaches 9-11 and the young deciduous trees allow more sunlight into the channel. There were very few coniferous species observed in the riparian zones of these reaches, which is a limiting factor for recruitment of large wood (greater than 60 cm dbh) into the channel.

Access to suitable habitat influences both the survival and distribution of juvenile and adult coho salmon. For example, human or natural barriers prevent juvenile salmon from moving upstream to avoid increasing water temperatures in the summer. At the same time, barriers to adult salmon migration reduce the amount of available spawning habitat, and subsequently juvenile rearing opportunities. Human caused barriers do not appear to prevent the movement of fish in streams flowing through ODF lands. Barriers lower in the drainage may reduce, but not prevent passage.

Barriers

Barriers and potential barriers to anadromous and resident fish exist in most riverine systems due either to man-made or natural processes. A barrier, which includes culverts, dams, velocity barriers, natural falls, lack of sufficient water flow, etc., is defined as an impediment to the movement of any fish at any life stage. The Miami basin has 25 recorded barriers, as determined by Streamnet and ODF (Figure 13 and Table 1). These barriers are found both within and outside known fish distribution (Figure 13). Fish distribution may extend beyond a potential barrier because the barrier may be specific to a species or life stage, or at a particular time of year.

The Streamnet barrier database incorporated the culvert inventory database; therefore, culverts in the dataset are those which do not meet acceptable fish passage criteria, not necessarily those which prevent all fish at all times. Of the 21 listed barriers (Streamnet), 19 are culverts. These barriers are rated as to the degree, or lack thereof, of fish passage. Three are thought to have partial passage, 11 are thought to be non-blocking, and 7 have unknown passage. Movement may be prevented due to high velocity of water through the culvert, incorrectly sized culvert, or debris blocking the culvert. Data are not available to access presence above all of the potential barriers.

Seven potential barriers are on ODF lands; three as reported by Streamnet and four as reported by ODF. The Streamnet barriers include a dam, a natural fall, and a culvert. The four ODF barriers identified are natural and are upstream of Streamnet and ODF fish distribution. Adult coho salmon and winter steelhead manage to get above two of the three Streamnet barriers (fall and culvert). Fish are not present above the ODF barriers, which are situated higher in the stream than the Streamnet barriers. The areas upstream are high gradient and may not be suitable for some salmonid species, but resident cutthroat trout and sculpin utilize such habitat, as well as amphibians (Figure 13).

The barriers identified which prevent fish passage to ODF land are close to the mouth of the stream (Streamnet barriers 10, 11, 12, 5, 6), thereby precluding fish use of the majority of the waterway. Based on the presence of fishes in neighboring streams, fish should inhabit these blocked streams, so long as they have year-round water and suitable habitat characteristics. The distance of ODF habitat potentially inaccessible by the listed Streamnet barriers (#5, 6, 12) totals approximately 3.8 kilometers; this includes barriers on non-state owned land which excludes fish from habitat on state land.

The amount of aquatic habitat with restricted access in the Miami drainage may total 14.2 kilometers. The amount on ODF land resulting from passage problems may total 2.0 kilometers and the amount potentially blocked to ODF streams because of barriers downstream may be an additional 3.8 kilometers. Documentation as to the species and life stage affected by each barrier is limited (Table 1).

Restoration

Restoration is a technique and process used in an attempt to improve stream habitat in the short term and to achieve long-term recovery goals. The goals of restoration range from improving spawning and rearing habitat, to improving natural stream processes. Treatment projects focus on improving summer and winter rearing for juvenile salmonids, improving spawning habitat, increasing nutrients in the stream, reducing sedimentation and bank erosion, and replanting native streamside vegetation. Instream habitat improvement projects to improve rearing conditions for juvenile salmon target increasing complexity of pools (large wood additions) and creating off-channel and slow water pool habitat. Monitoring is a critical aspect of the restoration effort, as it is important to gauge whether the methods employed helped to achieve the desired effects. Achieving noticeable response may take several high flow events; biological response could take longer.

Since 1996, nine projects have been completed on ODF lands (Table 9) and another sixteen on other lands in the Miami River basin. The projects on ODF lands focused on instream enhancement, passage issues, and road/drainage improvements in the Miami River and Prouty, Illingsworth, Minich, and Diamond creeks. Three projects placed large wood in the streams, and the others improved the road and drainage system, and fish passage.

In 1997, 16 stream reaches (approximately 21 kilometers) in the Miami watershed were identified for instream enhancement (Table 10 and Figure 16; Thom and Moore. 1997). Many of the selected stream segments for restoration were upstream of the Peterson Creek confluence on the Miami River, stream segments important for coho salmon. Candidate streams were selected based on numerous criteria, through both in-house techniques and field verifications (Table 11). Overall, stream areas suitable for coho habitat enhancement are those areas flowing through an unconstrained valley, gradient <5%, moderate size - channel width 4-12 meters, and either have or are adjacent to a known coho population area. Some habitat enhancement work was conducted on Moss Creek, Prouty Creek, and the mainstem Miami River prior to 1997.

Reaches of stream within ODF ownership include potential areas for restoration that will improve survival of salmonids at different life stages and improve the natural function of the stream system. Miami River reaches 9, 10, and 11 were lacking adequate shade, large conifers in the riparian zone, as well as woody debris in the stream. Riparian plantings and instream wood placement would address these factors, and provide additional shade. The former would help stabilize the soil and decrease the high percent of fine sediment in riffle units, as well as provide a natural source of woody debris in the future. The percentage of slackwater units was low as well. Instream wood would help to increase the complexity of the habitat units and create the habitat (backwater and dammed pools) necessary for juvenile fish. Instream wood, riparian conifers, and pools – deep pools, slackwater, pool habitat – are limited in Miami River reach 12. The levels of fine sediments are excessive and amount of gravel substrate is low. Additional restoration to address the input of fine sediment would be beneficial. Reach 13 instream woody debris meets acceptable quantities, yet the riparian zone could benefit from more large conifers. The reach has little pool habitat, high level of fines in riffle units, and low levels of gravel. The lower than desired levels of pools could be due to the gradient (average 13%) of the reach. Please keep in mind that these are reach summaries and there may be localized areas which could benefit from restoration and other areas which are suitable. Also, the gradient, ease of accessing the stream, and channel morphology should be considered. For example, reach 13 is a hillslope-constrained reach with an average gradient of 13% and overall may not benefit from restoration as other sections of the Miami River.

Figure 16 displays reaches of stream that have a potential to respond to instream restoration treatments. Few of the reaches selected in 1997 (Thom and Moore 1997) have been treated. The priorities (high, medium, and low) and locations are still appropriate, although sites should be verified in the field. To date, treated restoration sites have not been formally monitored. Documentation of site location and condition of past projects will help direct future restoration at these or adjacent sites. Criteria for instream restoration treatments within the mainstem Miami River will require consideration of the dynamics of the large river system.

Summary of fish populations and aquatic habitat conditions in the Miami study area

Fish distribution

What fish species are documented in the watershed?

- Coho, fall Chinook, chum, winter steelhead, resident and anadromous cutthroat, and Pacific lamprey. The occurrence and distribution of other native fishes is not documented.

Are any of these species currently state- or federally listed as endangered, threatened, or candidates?

- Coho is listed as threatened, while steelhead are considered a species of concern (see NOAA Fisheries web site for current status - http://www.nwr.noaa.gov/). The State of Oregon does not list any species in the Miami study area.

Are there any fish species that historically occurred in the watershed that no longer occur there? Map potential historical fish distribution.

- No species have been extirpated from the Miami study area.
- We believe current distribution is similar to historical distribution.

Which salmonid species are native to the watershed, and which have been introduced?

- All of the aforementioned salmonid species are native to the watershed. Non-native fish, including non-native salmonid stocks, may be present but have not been documented.

Are there potential interactions between native and introduced species?

- Because no introduced species have been documented, there are no known interactions between native and introduced fish.

Current habitat conditions

Show current condition of key habitat characteristics.

- Habitat surveys were conducted on reaches of the mainstem Miami River and Prouty Creek. Other tributary streams were not surveyed and are not reported here.
- Habitat characteristics are listed in Table 6, graphed in Figures 15 & 15, and examples mapped in Figure 11.

Compare to benchmarks and/or reference streams for each characteristic.

- Reference sites provide a general context and range of stream attributes of minimally human-influenced sites, and are intended to provide a point of comparison to view the relative differences between streams and reaches within a drainage network. Reference values are not meant to be prescriptive, that is, to indicate the value each reach of stream must attain.
- Key benchmarks are presented in Table 5 and individual stream reaches are compared to these benchmarks in Tables 6 and 7.
- The amount of pool habitat, number of deep pools, and area of secondary channel in the surveyed reaches is high, and the number of pieces of wood in and associated with the streams is comparable to reference conditions. However, the amount of fine sediment is high, and the number of key pieces of wood and the volume of large wood is much lower

than reference conditions. Streamside vegetation contains few large conifers, and the amount of shade varies with stream size.

What stream reaches have high, moderate, and low levels of key pieces of large wood (>24-in) in the channel.

- One reach (Site 1878) on the mainstem Miami River has high number of key pieces of large wood. Levels of large wood increased in reach 10 following the 1996 flood. Other surveyed reaches have low to moderate amounts of key pieces of large wood. Overall, key wood pieces are lacking relative to reference conditions.

What is the condition of the fish habitat in the watershed (by 6th field) according to existing habitat data?

- Summer rearing habitat for juvenile coho salmon is ample, given the high percent of pool habitat in the mainstem reaches, and the area of low gradient (<5%) stream area in the tributaries. However, summer rearing would benefit from additional pool depth and complexity.
- Winter rearing habitat is the most limiting component for coho salmon in the Miami study area. This is largely caused by low pool complexity (lack of large wood) and little slow-water pool habitat (beaver ponds and off-channel pool habitats such as alcoves). Detailed ratings are provided in Table 8.
- Spawning habitat is good in reach 10 (Site 1878) because of availability of gravel and low levels of fine sediment. Other reaches have poor to fair spawning habitat. Fish survival during incubation may be reduced by high levels of fines in spawning gravel.

How many miles of fish-bearing or potentially fish-bearing streams are blocked by culverts, and where are these blockages?

- Approximately two miles of habitat are blocked by all types of barriers, particularly culverts. If partial restrictions are included, this amount increases to 8.8 miles throughout the study area.
- The few fish barriers identified on ODF lands are high in the drainage where fish passage is likely not an issue. However, the blockages may impede the movement of sediment and wood through the system.
- The ODF and Streamnet barrier databases do not provide a lot of detail. Site checks are necessary to verify the nature and extent of the passage issues.

Are there 6th-field basins where the current level of instream wood is a limiting factor for achieving properly functioning aquatic systems?

- The only reach surveyed where instream wood (combination of total pieces, volume, and key pieces) is comparable to reference conditions is in reach 10 in the upper watershed on ODF ownership. Additional large wood would increase the opportunity for complex instream habitat, creation of off-channel habitat, and sediment sorting.
- Large wood is a limiting factor in the Miami for creation of high quality winter rearing habitat for salmonids.

Restoration potential

Which reaches have the most potential to increase fish populations?

- Restoration should be focused on the mainstem Miami River and on ODF-owned reaches of Moss Creek. Potential exists to improve habitat complexity and floodplain connectivity. Opportunities may also exist to reduce the amount of fine sediment in the system.
- Site selection will require an in-depth analysis of the unit level GIS and Oregon Plan site data coupled with field verification. Habitat complexity and floodplain connectivity requires the placement of large wood in selected stream segment to create complex pool and bank overflow opportunities. Taking advantage of the existing secondary channels will accelerate the process. Because the Miami River is large, instream restoration in the main channel with large wood will require large trees, or smaller trees in the secondary channels.
- Reduction of fine sediment will require a detailed hydrologic study to determine source, transport, and storage of sediment in the basin. The data available through the stream surveys only identify areas collecting excessive amounts of fine sediment.
- Site verification prior to restoration planning is necessary because most of the surveys are 10 years old, and proper implementation depends on site-specific factors.

Which reaches have the most potential to meet or exceed benchmark levels?

- All of the reaches have the potential to meet many of the benchmark conditions over time. Restoration and protection strategies can expedite the opportunity to improve aquatic habitat complexity, sediment, and riparian structure in the Miami drainage.

What is the magnitude of possible additional habitat with restoration of access?

- An additional two miles of habitat could be opened to fish on ODF lands. If partial barriers are removed, this could increase to about 9 miles across all ownerships in the study area.

What is the relative priority of barriers for removal, replacement, or repair?

- The ODF and Streamnet barrier databases do not provide a lot of detail. Site checks are necessary to verify the nature and extent of the passage issues.

Describe the types and locations of potential enhancement projects?

- Priorities related to fish habitat are discussed above – improving habitat complexity, floodplain connectivity, and reduction of fine sediment.
- Riparian plantings to increase the number, size, and species of conifer trees in the riparian zone would benefit floodplain stability, and increase shade levels and long-term large wood recruitment. Riparian enhancement for larger and greater mix of conifer species will again require site visits to identify appropriate floodplain and terrace sites within the Miami River corridor.
- The riparian surveys are a sample (not a census) of conditions along the Miami River, and hence only indicate the need for restoration.

Describe confidence level in restoration analysis.

- The aquatic surveys, conducted in 1993 and 2002-03, described the overall conditions within each reach at the time of the survey. Restoration recommendations were based on existing habitat surveys (although selected attributes of the habitat data may out of date for this use), channel and valley configuration, and digital elevation models. Because successful restoration depends on site-specific characteristics, we recommend: 1) site visits prior to final planning, 2) analysis of habitat data (available in GIS and database) at the habitat unit scale, 3) re-examination of gradient and valley form, 4) more comprehensive road and barrier information, and 5) more detailed description of riparian conditions.

References

Burke, J. L, K. K. Jones, and J. M. Dambacher. 2001. HabRate: A Stream Habitat Evaluation Methodology for Assessing Potential Production of Salmon and Steelhead in the Middle Deschutes River Basin. Oregon Department of Fish and Wildlife, Corvallis.

Everest, F., R. Beschta, J. Scrivener, K. Koski, J. Sedell, and C. Cedarholm. 1987. Fine sediment and salmonid production: A paradox. Pp. 98-142 in E.O. Salo and T.W. Cundy, eds. Streamside Management: Forestry and Fishery Interactions. University of Washington, Seattle.

Hupperts, K. 1998. Managing Oregon's aquatic resources: a dynamic segmentation application. Masters thesis. Portland State University, Portland, Oregon.

Jones, K.K., R.L. Flitcroft, and B.A. Thom. 2001. Spatial patterns of aquatic habitat in Oregon. Pages 266–280 In First International Symposium on GIS in Fisheries Science. T. Nishida, Editor.

Jones, K.K., Foster, S, and K.M.S. Moore. 1996. Preliminary assessment of 1996 flood impacts: Channel morpholocy and fish habitat. Oregon Department of Fish and Wildlife, Corvallis.

Nickelson, T.E., Solazzi, M.F., Johnson, S.L., and Rodgers, J.D. 1992. An approach to determining stream carrying capacity and limiting habitat for coho salmon (Oncorhynchus kisutch). p. 251-260 In Proceedings of the coho workshop. Edited by L. Berg and P.W. Delaney. Nanaimo, B.C., May 26-28, 1992.

Nickelson, T. E. 1998. A Habitat-Based Assessment of Coho Salmon Production Potential and Spawner Escapement Needs for Oregon Coastal Streams. Oregon Dept. Fish and Wildlife, Fish Div., Fish. Info. Rep. 98-4 Portland, OR.

Sedell, J. R. 1984. "Habitats and salmonid distribution in pristine, sediment-rich valley systems: S. Fork Hoh and Queets River, Olympic National Park," pp. 33-46 in Meehan, W. R., T. R. Merrell, and T. A. Hanley, eds., Fish and Wildlife Relationships in Old-Growth Forests, American Institute of Fishery Research Biologists, December, 1984.

Thom, B. and K. Moore. 1997. North Coast Stream Project Guide to Instream and Riparian Restoration Sites and Site Selection. Oregon Department of Fish and Wildlife

Table 1. Barriers and associated features as identified by Streamnet. ID number is a location identifier used in conjunction with Figure 7.

ID #	Stream LLID	Barrier type	Passage*	Comments
1	1239230455475	natural falls	99	Fishway data provided by the North Coast District offices. Passage status reported as marginal by Ref. 50080.
2	1238567456209	culvert	2	Culvert is too small for this good sized creek
3	1238283456245	culvert	99	This culvert scheduled for replacement as per Keith Braun, ODFW, 12-11-01.
4	1238765456051	culvert	2	Very high velocity water through culvert impedes/prohibits fish passage at most flows.
5	1238755455837	culvert	99	Rocky debris at upper end contributes to fish passage problems here. High velocity water.
6	1238713455745	culvert	4	Co Rd log lists two 12" culverts at mp. 0.13 and 0.14.
7	1238917455595	culvert	4	Road in front of Flea market next to Miami River Rd.
8	1239001455637	culvert	4	
9	1238917455595	culvert	4	
10	1238855455629	culvert	4	
11	1238964455597	culvert	99	Upstream end of culvert has an impassable, debis filled chainlink fence across it. The downstream end appears level, but water can be heard falling inside it. Slope of culvert couldn't be determined.
12	1238964455597	dam	99	This dam may be removed.
13	1239074455075	culvert	4	
14	1239005454978	culvert	99	Probably a velocity barrier. No pool.
15	1239005454978	culvert	2	Velocity will impede fish passage. 1.2 miles from W end of road.
16	1238699455135	culvert	99	High velocity water and pipe section broken off pose fish barrier. Ag land below.
17	1239074455075	culvert	4	
18	1238739455110	culvert	4	
19	1239074455075	culvert	4	
20	1238753455098	culvert	4	Not on straight-line chart.
21	1239074455075	culvert	4	

*Passage 1=complete 2=parital 4=nonblocking 99=unknown

Table 2a-f. Peak count by year of adult spawning Chinook, coho, and chum salmon and total count of steelhead. The "/" divides counts among multiple segments of a single survey.

A- 1998.

Spawning Survey No.	Oregon Plan Survey No.	Stream	Chinook	Coho	Chum	Steelhead
25789	1833, 1896	Minich Cr	2	0	23	0
25793.5	1834	Peterson Cr, Trib B	0	0	0	0
25800	1873, 1878, 1879	Miami R	1	0	2	0
25795	1899, 1905, 1906	Stuart Cr	0	0	0	0
25797	1902, 1907	Unnamed Trib	4	0	18	0
25787	1959, 1960, 1963, 1965, 1966	Moss Cr	3	0	30	0

B- 1999

Spawning Survey No.	Oregon Plan Survey No.	Stream	Chinook	Coho	Chum	Steelhead
25800	1873, 1878, 1879	Miami R	6	4	3	12
25791	1890, 1891	Waldron Cr	0	0	3	0
25795	1899, 1905, 1906	Stuart Cr	1	0	0	0
25797	1902, 1907	Prouty Cr	1	0	35	0
25787	1959, 1960, 1963, 1965, 1966	Moss Cr	0	0	181	0

C- 2000

Spawning Survey No.	Oregon Plan Survey No.	Stream	Chinook	Coho	Chum	Steelhead
25789	1833, 1896	Minich Cr	2	0	0	0
25794.3	1836, 1898, 1900	Margary Cr	0	0	0	0
25802	1874, 1883, 1886, 1887	Miami R	2	13	0	4
25795	1899, 1905, 1906	Stuart Cr	0	0	0	0
25797	1902, 1907	Prouty Cr	0	1	1	0
25798	1903, 1904, 1908	Miami R	9	9	6	1
25787	1959, 1960, 1963, 1965, 1966	Moss Cr	0	0	69	0

D- 2001

Spawning Survey No.	Oregon Plan Survey No.	Stream	Chinook	Coho	Chum	Steelhead
25795	1899, 1905, 1906	Stuart Cr	0	1	0	0
25797	1902, 1907	Prouty Cr	3	4	151	0
25774.3	1913, 1915	Jacoby Cr	0	0	0	0
25781	1956, 1957	Hobson Cr	0	0	0	0
25787	1959, 1960, 1963, 1965, 1966	Moss Cr	1/2	1	555/63	0

E- 2002

Spawning Survey No.	Oregon Plan Survey No.	Stream	Chinook	Coho	Chum	Steelhead
25802	1874, 1883, 1886, 1887	Miami R	10	20	0	11
25795	1899, 1905, 1906	Stuart Cr	0	0	0	0
25797	1902, 1907	Prouty Cr	1	6	44	1
25787	1959, 1960, 1963, 1965, 1966	Moss Cr	0	7/2	0/109	1/2

F- 2003

Spawning Survey No.	Oregon Plan Survey No.	Stream	Chinook	Coho	Chum	Steelhead
25802.3	1727, 1747	Unnamed Trib	0	3	0	0
25795	1899, 1905, 1906	Stuart Cr	0	2	0	0
25797	1902, 1907	Prouty Cr	1	3	57	0
25798	1903, 1904, 1908	Miami R	14/15	4/14	1/39	0
25787	1959, 1960, 1963, 1965, 1966	Moss Cr	0	1	220	1

Table 3. Juvenile coho and steelhead density (fish/m2) by site and year (1998 – 2003).

Oregon Plan Survey No.	**Year**	**Coho**	**Steelhead**
1899	1998	0.00	0.00
1904	1998	0.09	0.04
1905	1998	0.97	0.00
1896	1999	0.00	0.00
1905	1999	0.48	0.02
1945	1999	0.01	0.00
1878	2000	0.43	0.03
1891	2000	0.00	0.17
1905	2000	0.96	0.00
1907	2000	0.00	0.00
1904	2001	1.19	0.10
1905	2001	1.72	0.01
1905	2002	2.02	0.02
1907	2002	0.00	0.00
1945	2002	0.35	0.00
1965	2002	0.53	0.05
1834	2003	0.31	0.00
1834	2003	0.02	0.01
1879	2003	0.00	0.00
1903	2003	1.57	0.02
1905	2003	2.26	0.00
1908	2003	0.00	0.02

Table 4. Habitat survey sites, reaches and sites within the Miami study area

Stream	Survey year	Survey type	Survey distance (m)	Land ownership
Miami River (upper)	1993	basin	13,252	state
Prouty Creek (NC 1902)	2003	OR Plan	517	state
Miami River (NC 1878)	2000	OR Plan	1,102	state
			14,871	total distance surveyed
			36%	percent of state land surveyed
Peterson Creek	1993	basin	3,043	private industrial
Margary Creek	1993	basin	1,579	private industrial
Moss Creek	1995	basin	2,422	private industrial
Waldron Creek (NC 1891)	2000	OR Plan	965	private industrial
Miami River (lower)	1997	basin	7,400	private non-industrial
Minich Creek (NC 1896)	1999	OR Plan	966	private non-industrial
Miami River (NC 1954)	1998	OR Plan	1,055	private non-industrial
Vaughn Creek (NC 1945)	1999 + 2002	OR Plan	766	private non-industrial
			18,196	total distance surveyed
			41%	percent of basin surveyed

Table 5. Frequency distribution of key habitat variables for reference stream reaches. ODFW habitat surveys during the summers 1992 - 2003 (n = 124 reaches). Quality of habitat feature increases to the right.

	Percentile		
	25th	Median	75th
Fines[1] in riffles units (%)	22	13	8
Gravel[2] in riffle units (%)	26	37	54
Shade[3] (% of 180)	76	85	91
Large riparian conifers[4]	22	80	153
Wood pieces[5]	8	14	21
Key wood pieces[6]	0.5	1.5	3
Pools (%)[7]	19	35	45
Deep pools[8]	0	1	3
Secondary channels[9] (m^2)	50	120	320

1 Fines are sediments <2mm diameter; ocular estimates of surface composition

2 Gravels are 2-64mm diameter; ocular estimates of surface composition

3 Measured with a clinometer; percent of 180% that topography or vegetation visually occludes the sky

4 Conifer trees >= 50cm dbh along 305m (1000 feet) length of stream

5 Large wood debris >= 3m length and >=15cm diameter per 100m of stream length

6 Large wood debris >=10m length and >=60cm diameter per 100m of stream length

7 Percent of stream habitat

8 Pools >= 1m deep per 1km of stream length

9 Percent secondary channel area

Table 6. Habitat survey reach values and habitat parameter breakpoints relative to 2004 Reference Conditions.

		Miami River (upper reaches)					Prouty Creek	Miami River
		reach 9	reach 10	reach 11	reach 12	reach 13	NC 1902	NC 1878
Parameter	Habitat Breakpoints	2318m	1207m	971m	5977m	2779m	517m	1102m
percent pools	Low <19%					9.2%		
	Moderate	43%	42.6%	37.5%	20.9%		*	
	High >45%							54%
deep pools/km	Low 0							
	Mod				2	0.3	*	
	High >3	6.6	6.3	7.5				7.9
% slackwater pools	Low 0					0		
	Moderate	2.0%	0.2%	0.8%	0.6%		*	
	High >7%							9.6%
% secondary channel	Low <0.8%							
	Moderate						1.9%	
	High >5.3%	31%	24%	33%	19%	15%		42%
% fines in riffles	High >22%	30%	26%	26%		60%**		
	Moderate				22%		*	9%
	Low <8%							
% gravel in riffles	Low <26%					25%**		
	Moderate	45%	42%	35%	27%		*	37%
	High >54%							
% bedrock	High >11%							
	Moderate				1%	5%		
	Low <1%	0	0	0			0	0
pieces LWD/100m	Low <8				6.9			
	Moderate	11.5	12	11.9			8.1	
	High >21					34.1		45.3
volume LWD/100m	Low <17	12.5	16.7	14.2	8.1		15.3	
	Moderate							
	High >58					58.4		125.6
key pieces/100m	Low <0.5	0.2		0.3	0.2			
	Moderate		0.5			1.3	0.6	
	High >3							11.9
# conifers >50cm dbh	Low <22	0	0		6	0	0	20
	Moderate			42.2				
	High >153							
# conifers >90cm dbh	Low 0	0	0	0		0	0	0
	Moderate				24.1			
	High >79							
% shade	Low <76%	64%	75%	71%				55%
	Moderate						82%	
	High >91%				92%	99%		

* Prouty Creek was puddled at the time of the survey; these attributes do not apply.

** Miami River reach 13 is represented by one riffle unit. The fine sediment level is misrepresented as higher than is actual for fast water units. The level of gravel more accurately represents the fast water units.

Table 7. Habitat survey reach values and habitat parameter breakpoints (2004 Reference Conditions) displayed by reach.

		Habitat surveys on state-owned land							Habtiat surveys on private industrial-owned land							Habitat surveys on private non-industrial-owned land								
		Miami River (upper reaches)					Prouty Creek	Miami River	Peterson Creek			Margary Creek		Moss Creek	Waldron Creek	Miami River (lower reaches)						Minich Creek	Miami River	Vaughn Creek
Parameter	Habitat Breakpoints	reach 9 2318m	reach 10 1207m	reach 11 971m	reach 12 5977m	reach 13 2779m	NC 1902 517m	NC 1878 1102m	reach 1 1975m	reach 2 531m	reach 3 537m	reach 1 881m	reach 2 698m	2422m	NC 1891 965m	reach 1 551m	reach 2 1521m	reach 3 2496m	reach 4 1764m	reach 6 456m	reach 8 612m	NC 1896 966m	NC 1954 1055m	NC 1945 766m
	Low <19%					9.2%				0	0		2.6%	6.8%		7.6%							2.5%	
percent pools	Moderate	43%	42.6%	37.5%	20.9%		*		27.5%			31%			21%			38.7%	32.4%	21.9%	41.3%	31%		21%
	High >45%							54%									49.5%							
	Low 0									0	0	0	0		0							0		0
deep pools/km	Moderate				2	0.3	*		2					0.8		1				2.2			0.8	
	High >3	6.6	6.3	7.5				7.9									10	6.2	3.8		3.3			
	Low 0					0				0	0		0	0				0.3%	0	0	0	0		
% slackwater pools	Moderate	2.0%	0.2%	0.8%	0.6%		*		.3%						.5%		1.1%						2.3%	0.4%
	High >7%							9.6%				29.2%				7.6%								
	Low <0.8%								3.0%		0		0											0.5%
% secondary channel	Moderate						1.9%			5%		5%		5%	1.2%							1.3%		
	High >5.3%	31%	24%	33%	19%	15%		42%								40%	5%	9%	17%				19.5%	
	High >22%	30%	26%	26%		60%**			24%	38%	40%					90%							30%	
% fines in riffles	Moderate				22%		*	9%				18%	20%	8%	11%		14%	17%	15%	12%	11%	27%		9%
	Low <8%																							
	Low <26%					25%**								21%	25%	0	20%		19%	20%	15%			
% gravel in riffles	Moderate	45%	42%	35%	27%		*	37%		48%	50%							24%						
	High >54%								74%			77%	60%									61%	65%	90%
	High >11%												15%											
% bedrock	Moderate				1%	5%			2%		6%	1%		4%										
	Low <1%	0	0	0			0	0		0					0	0	0	0	0	0	0	0	0	0
	Low <8				6.9									7	4.5			7.1	6.5	2.0	1.5			0.7
pieces LWD/100m	Moderate	11.5	12	11.9			8.1		10			17.1				19.6	9.4					9.7	8.1	
	High >21					34.1		45.3		24.5	30.9		36.9											
	Low <17	12.5	16.7	14.2	8.1		15.3		11.2			16.4			3.5	10	5.2	8.6	5.5	1.8	0.4	9	10.3	0.4
volume LWD/100m	Moderate									25.4				17.5										
	High >58					58.4		125.6			68.9		84.5											
	Low <0.5	0.2		0.3	0.2				0.4						0	0	0.4	0.1	0.1	0	0	0.1	0.1	0
key pieces/100m	Moderate		0.5			1.3	0.6			0.8	2.4	0.9		0.5										
	High >3							11.9					4											
	Low <22	0	0		6	0	0	20	0	0		0	0	0		0	0	0	0	0	0	20	0	0
# conifers >50cm dbh	Moderate			42.2							63.3				41									
	High >153																							
	Low 0	0	0	0		0	0	0	0	0	0		0	0	0	0	0	0	0	0	0		0	
# conifers >90cm dbh	Moderate				24.1																	41		10
	High >79											120.7												
	Low <76%	64%	75%	71%				55%								36%	61%	45%	43%	36%	70%		34%	55%
% shade	Moderate						82%		80%		91%	86%		81%	86%									
	High >91%				92%	99%				95%			94%									92%		

* Prouty Creek was puddled at the time of the survey; these attributes do not apply.

** Miami River reach 13 is represented by one riffle unit. Substrate not representative of reach.

Table 8. Summary of HLFM and Habrate model results.

			Habitat characteristics			Habitat Limiting Factors Model (Capacity)				Habitat Limiting Factors Model (Quality)			HABRATE rating		
Ownership	Stream	Basin Survey	Gradient	Channel Width	% BP & AL**	Summer parr/km	Summer capacity	Winter parr/km	Winter capacity	Summer parr/m2	Winter parr/m2	Winter Habitat Quality	Spawn & Emergence	Summer Rearing	Winter Rearing
ODF	Miami River	9	0.5	20.4	0.2	12,607	high	2,664	high	0.62	0.13	moderate	low	moderate	low
ODF	Miami River	10	0.7	18.3	0.0	11,689	high	2,437	high	0.64	0.13	moderate	high	high	low
ODF	Miami River	10*	0.7	20.7	9.7	12,276	high	4,624	high	0.59	0.22	moderate	high	moderate	low
ODF	Miami River	11	0.8	19.4	0.0	9,046	high	2,033	moderate	0.47	0.10	low	low	low	moderate
ODF	Miami River	12	1.8	14.1	0.4	4,161	high	1,176	moderate	0.30	0.08	low	moderate	low	low

*Oregon Plan site NC-1878 **Beaver Ponds and Alcoves

Table 9 . OWEB funded restoration projects on ODF land, highlighting some actions and goals and the species benefitting from the restoration project.

				Targeted Species				
Stream name	Year	Project Description	Project Goals	coho	steelhead	chinook	cutthroat	chum
Prouty Creek	1996	place instream wood	increase rearing habitat increase overwintering habitat provide refuge cover	x	x			
Miami River and Buehner Creek	1996	remove rock weir improve peak flow passage improve surface drainage with rock seed disturbed area	increase water availability decrease erosion	x	x	x	x	x
Miami River and Barnsdale Creek	1996	place boulders and rootwads improve peak flow passage	increase fish passage decrease erosion	x	x	x	x	
Illingsworth Creek	1996	improve surface drainage with rock seed disturbed area	increase upslope stability increase road drainage decrease erosion decrease runoff	x	x	x	x	x
Minich Creek	1998	improve surface drainage with rock	decrease erosion	x	x	x	x	
Miami River	2000	close road + road fords replace culvert with bridge open previously inaccessible habitat place habitat structures	increase complexity + floodplain interaction increase gravel recruitment increase habitat - rearing, overwintering, summer improve passage	x	x			
Diamond Creek	2002	place habitat structures	increase rearing + overwintering habitat increase complexity	x	x		x	
Miami River and tributaries	2003	improve surface drainage construct sediment catch basins seed disturbed area open previously inaccessible habitat	improve passage decrease erosion decrease runoff decrease potential washout at road fords	x	x	x	x	x
Diamond Creek and tributaries	2002	place instream wood vacate road seed disturbed area remove culverts open previously inaccessible/improve habitat	increase complexity improve passage decrease potential washout at road fords decrease erosion decrease runoff	x	x	x	x	

Table 10. Potential Instream Enhancement Sites on ODF land for the Miami River Basin, according to the 1997 Restoration Guide.

Stream Segment	Length (m)	Length (ft)	Channel Width	ODF Ownership	Habitat Survey	Field Verified	From Location	To Location
Miami River	1535	5034	12-20m	X	yes		Prouty Creek	ODF Boundary
Miami River	6321	20732	12-20m	X	yes	X	ODF Boundary	TJ on left at T2N-R9W-21
Miami River	1793	5882	4-12m	X	yes	X	TJ on left at T2N-R9W-21	Falls at T2N-R9W-23
Minich Creek	49	161	4-12m	X			ODF Boundary	upstream 40m
Moss Creek	1331	4364	4-12m	X			Lower ODF Boundary	Upper ODF Boundary
Prouty Creek	668	2190	4-12m	X		X	Mouth	TJ on left past Miami For. Rd
Stuart Creek	822	2697	4-12m	X			ODF Boundary	TJ on left at T2N-R10W-36
N Fk Miami River	1486	4874	4-12m	X		X	Mouth	TJ on left at T2N-R9W-14

Table 11. Criteria for selecting restoration sites

Best stream reaches for restoration	Poor stream reaches for restoration	Rational	Solution
low gradient (<5%)	high gradient (>5%)	Structures placed in steep reaches will probably get washed down stream.	Although the overall gradient may be steep, it may be possible to locate flats or benches of low gradient. Instream work should be limited to such areas.
moderate channel size (<12m)	large channel size (>12m)	Structures placed in wide channels will probably get washed down stream.	Large channel restoration should use very large pieces of wood that partially extend into the channel.
moderate valley type	steep valley shape	Streams in steep valleys are constrained by the valley walls. During high flow events, there is limited over-wintering habitat potential.	Instream structures should be limited to sections of wider valley where stream energy can be dissipated.
water temperature cool enough for juvenile salmon summer survival	water too warm for juvenile salmon summer survival	Fish have water temperature tolerances.	Efforts to restore or improve streamside shading may result in water temperature suitable to salmonids.
water supply adequate to support young salmon summer survival	inadequate water supply to support young salmon summer survival	Fish need adequate water supply for survival	Although inadequate water supply during the summer, these reaches may provide over-wintering opportunities. However, if the stream is too steep, has inadequate water parameters, or not adjacent to summer rearing areas, there is little restoration potential. Restoration efforts in such streams should carefully assess winter rearing potential.
unobstructed access by juvenile and adult salmon during migration	restricted access to juvenile and adult migration	Salmon need access to the stream system	Streams blocked by culverts or other physical properties make them desirable for restoration.

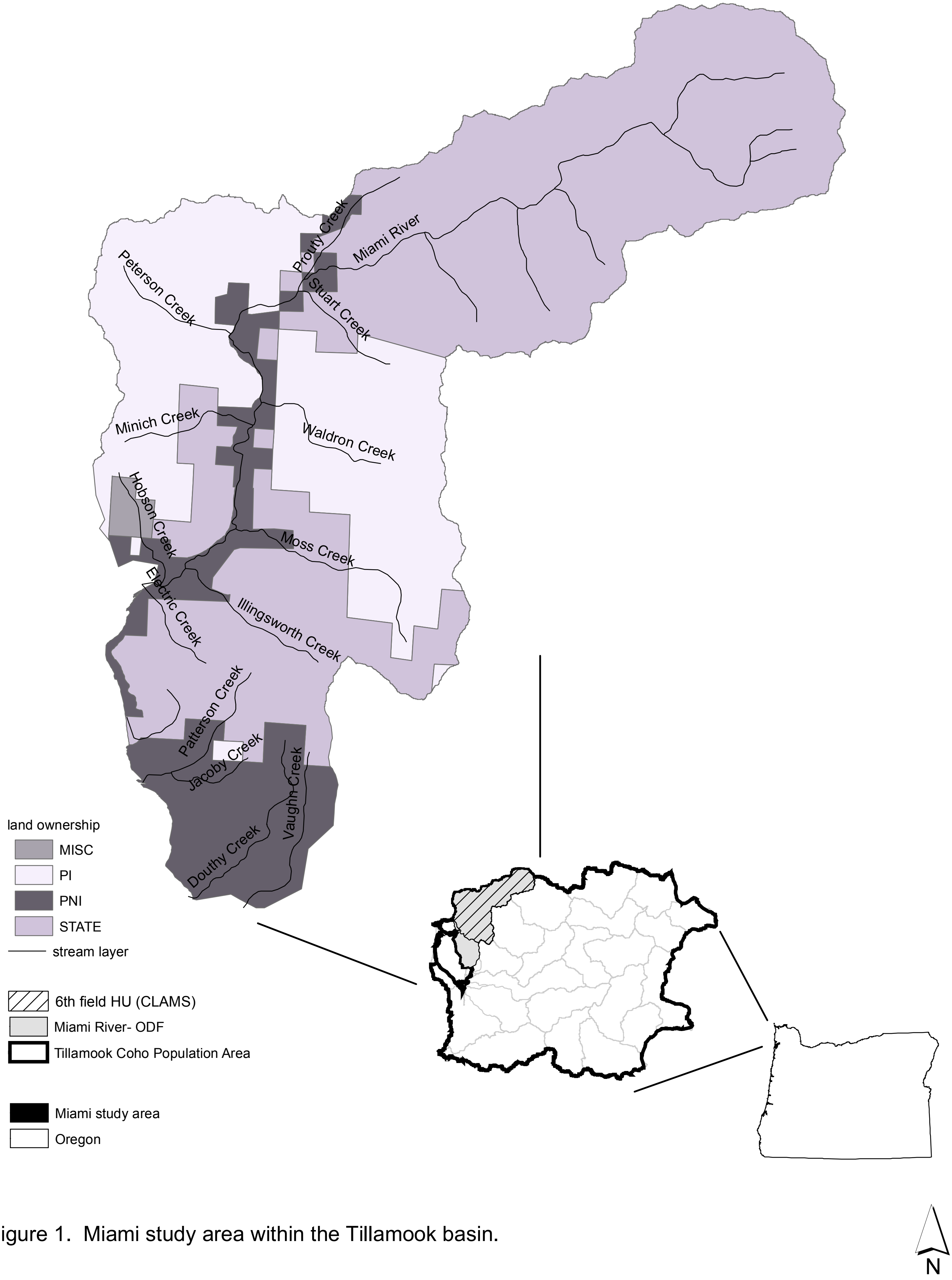

Figure 1. Miami study area within the Tillamook basin.

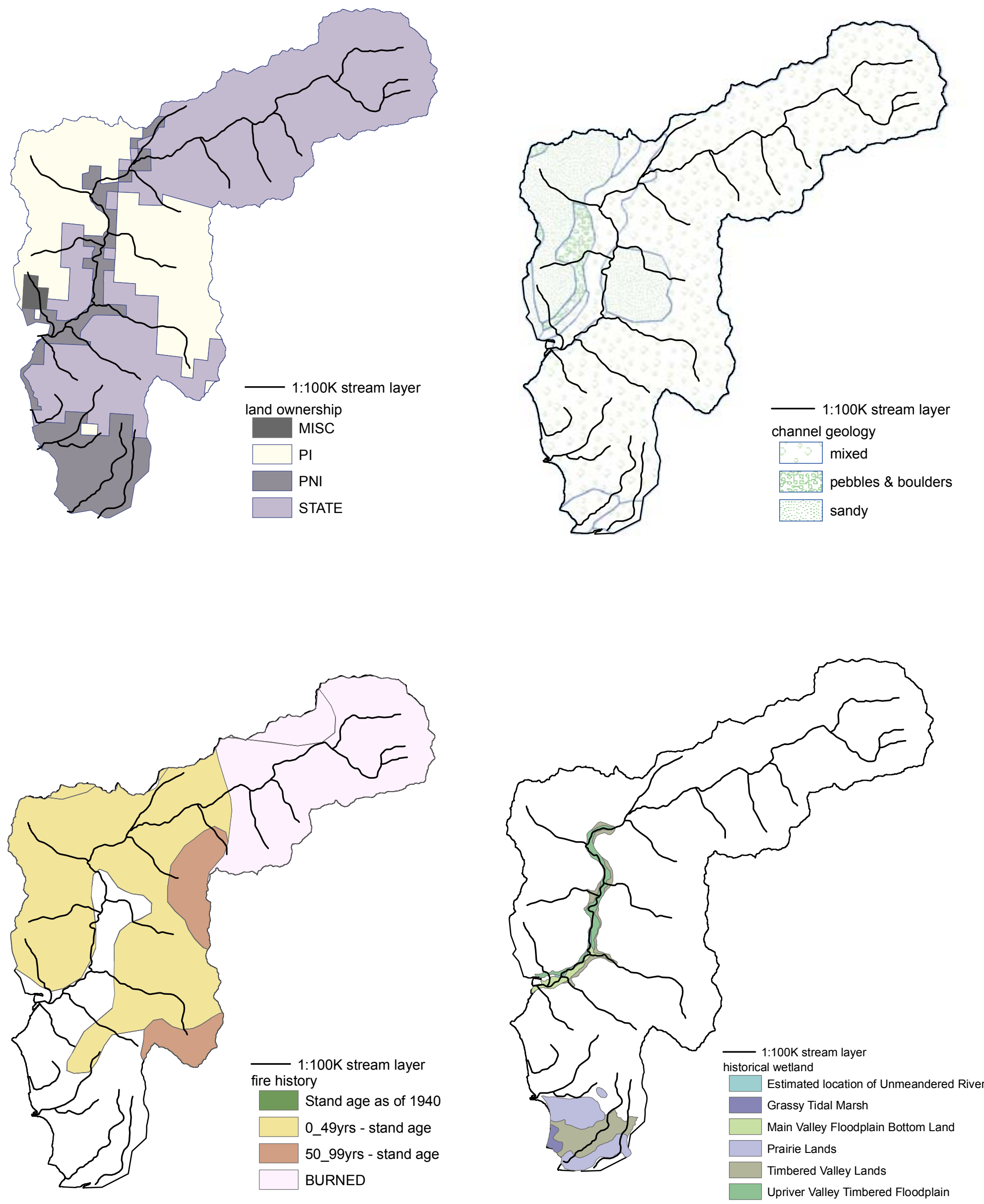

Figure 2. Land ownership, channel geology, fire history, and historical wetland distribution within the Miami basin study area.

N

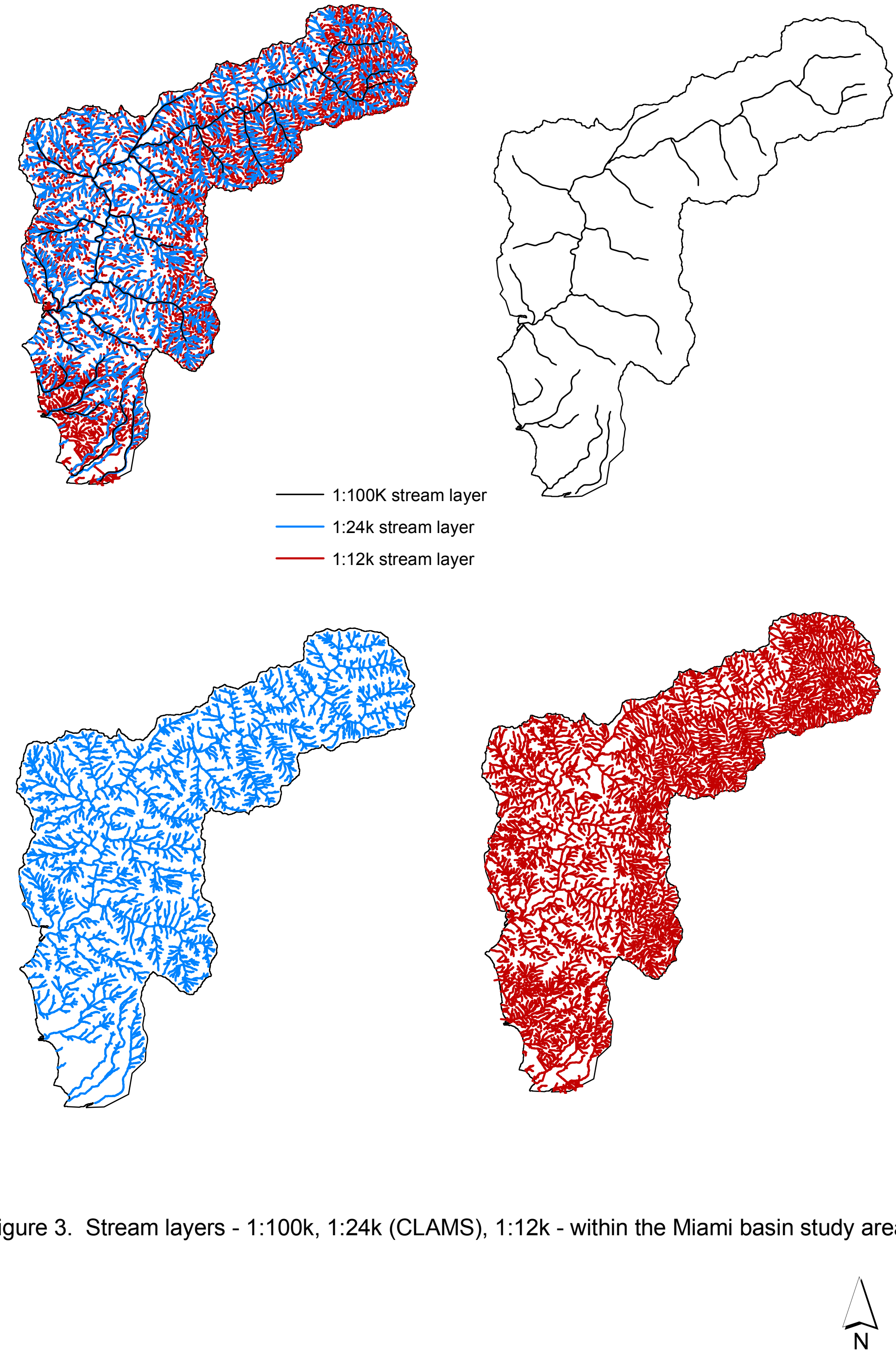

Figure 3. Stream layers - 1:100k, 1:24k (CLAMS), 1:12k - within the Miami basin study area.

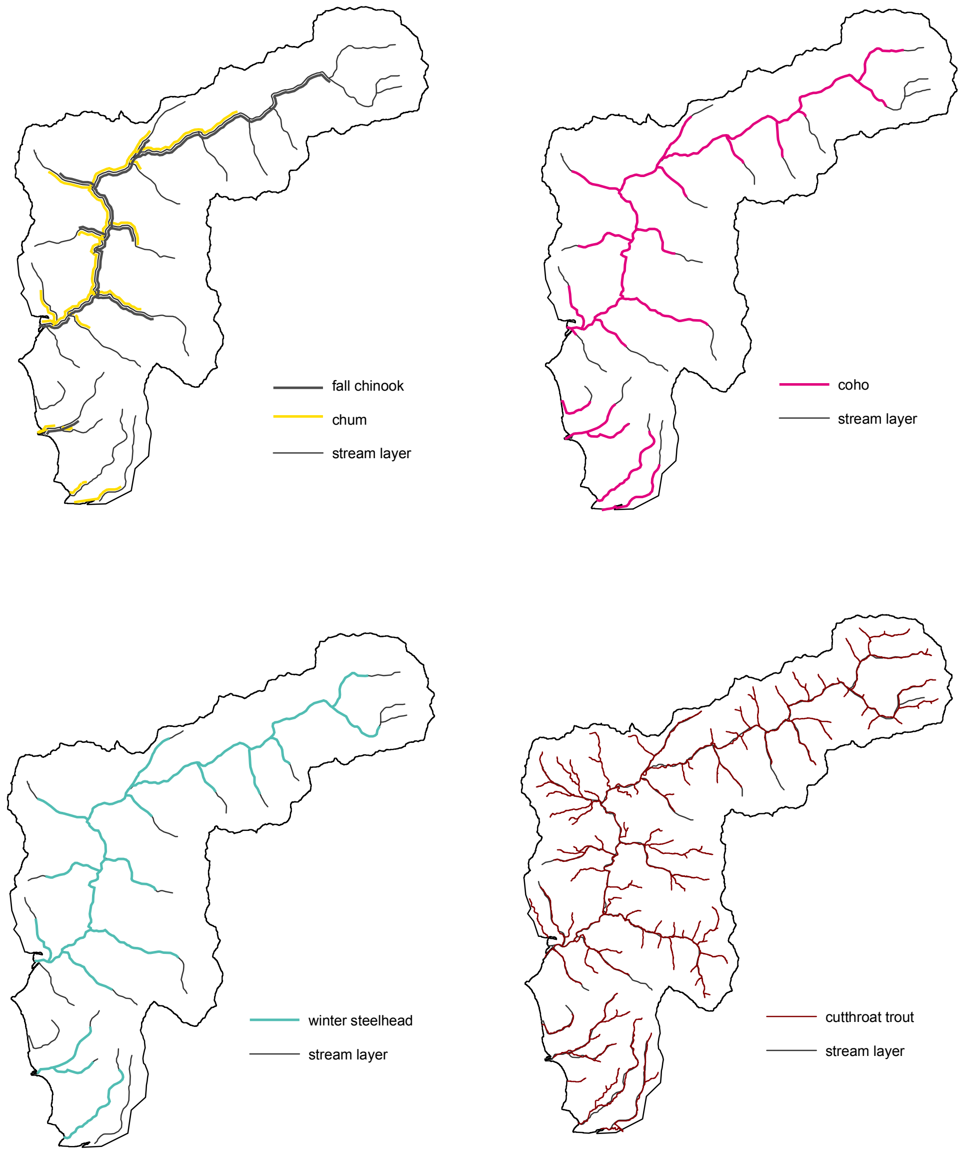

Figure 4. Fish distribution - chum, fall chinook, coho, winter steelhead, cutthroat - within the Miami basin study area.

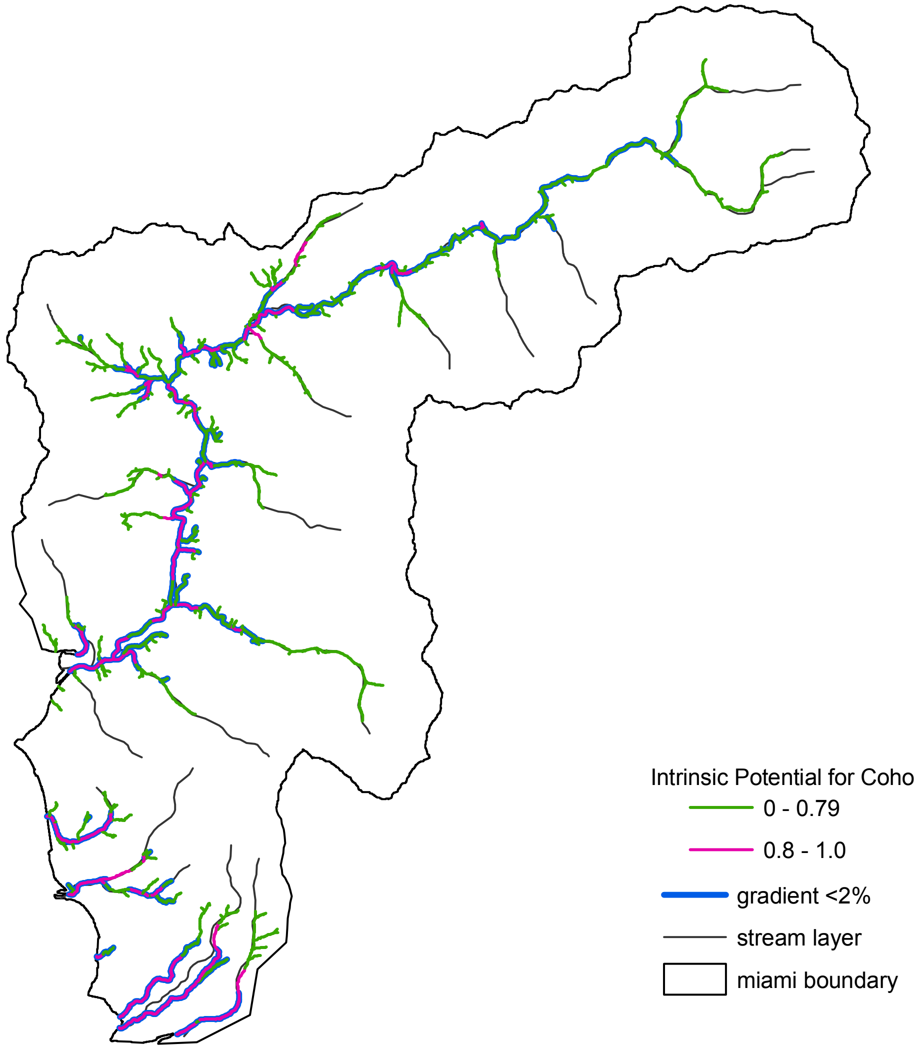

Figure 5. Intrinsic potential for coho salmon (>0.8 = high) within the Miami basin study area (source: CLAMS).

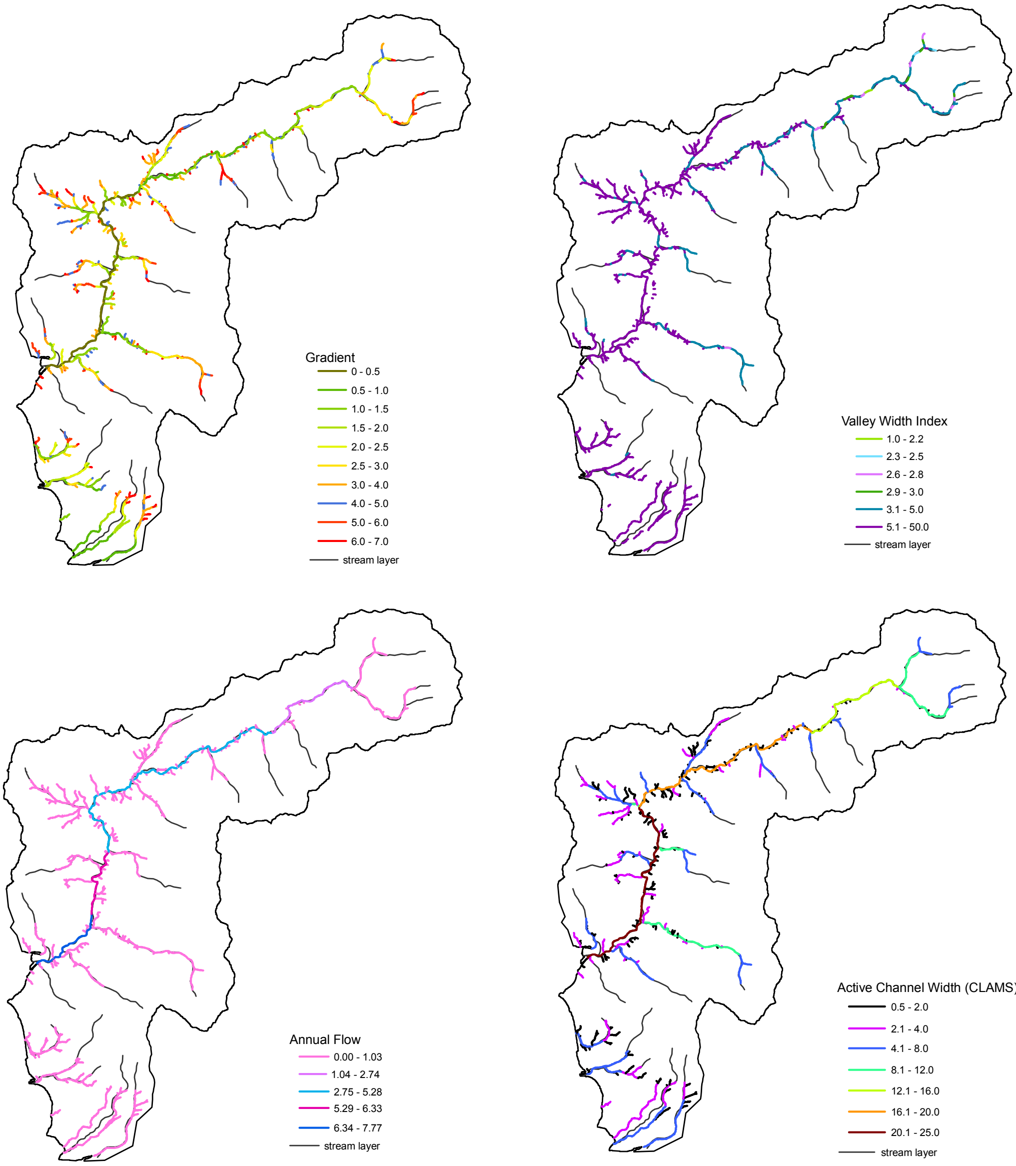

Figure 6. Gradient (%), valley width index, mean annual flow (cms), and active channel width (m) within the Miami basin study area (source: CLAMS).

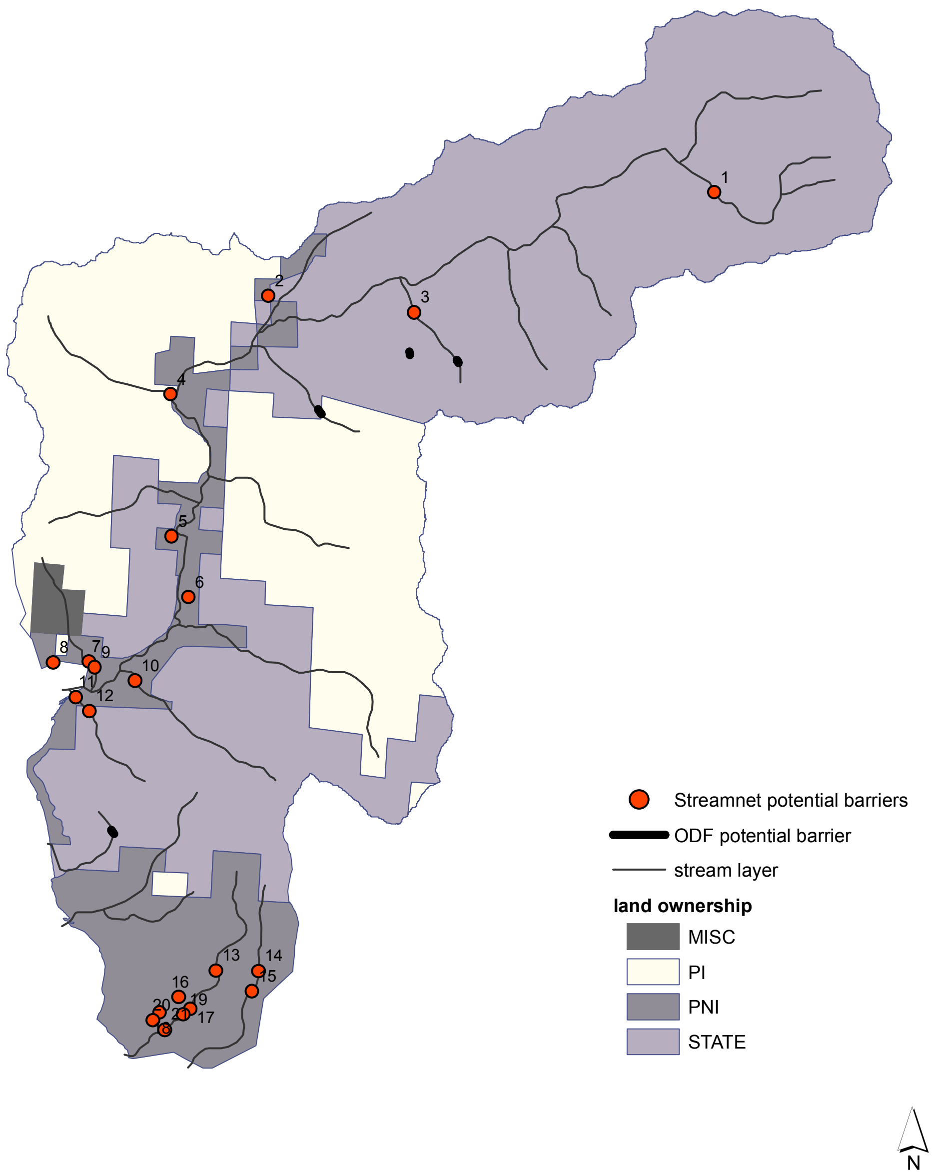

Figure 7. Barriers identified by Streamnet and ODF within the Miami basin study area.

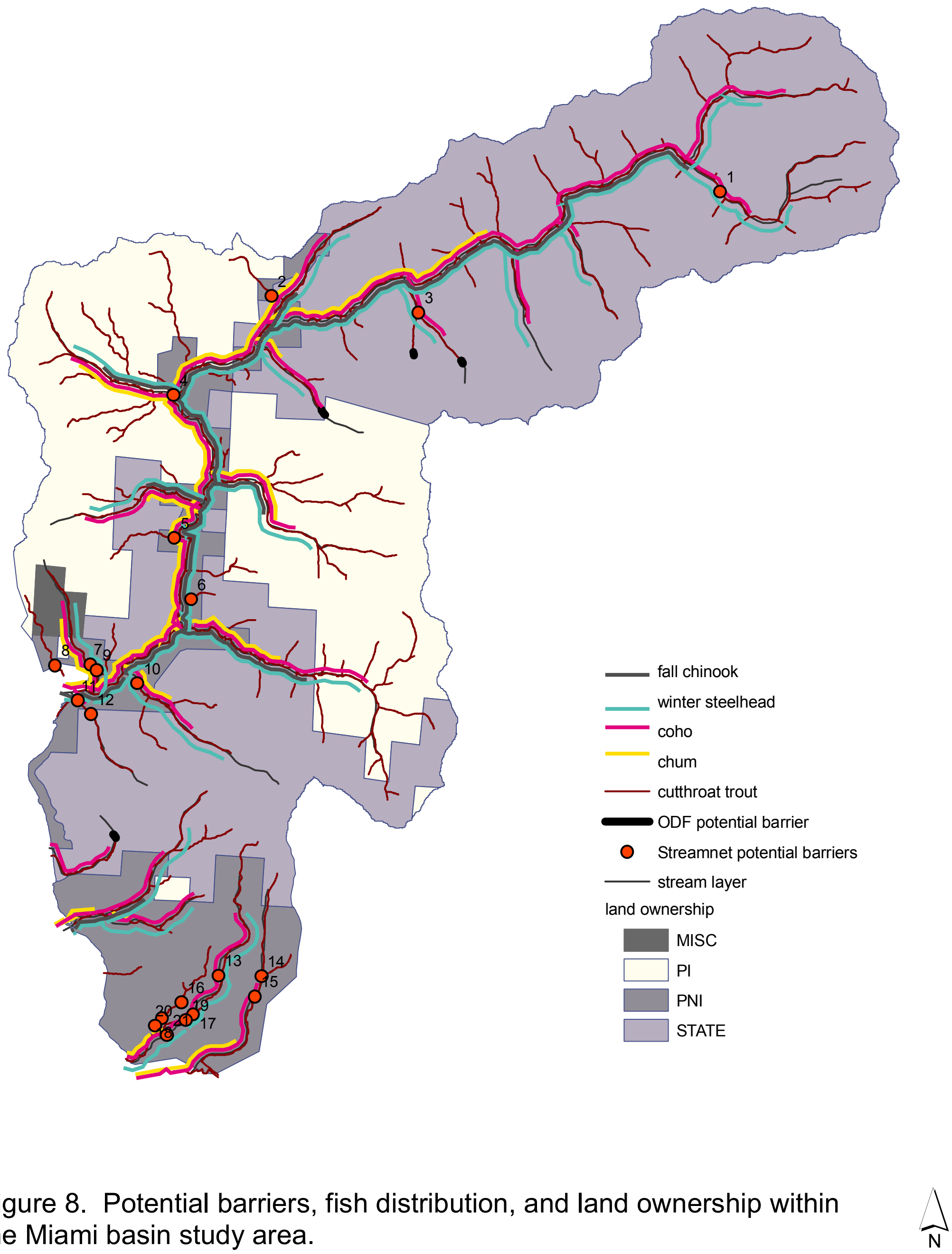

Figure 8. Potential barriers, fish distribution, and land ownership within the Miami basin study area.

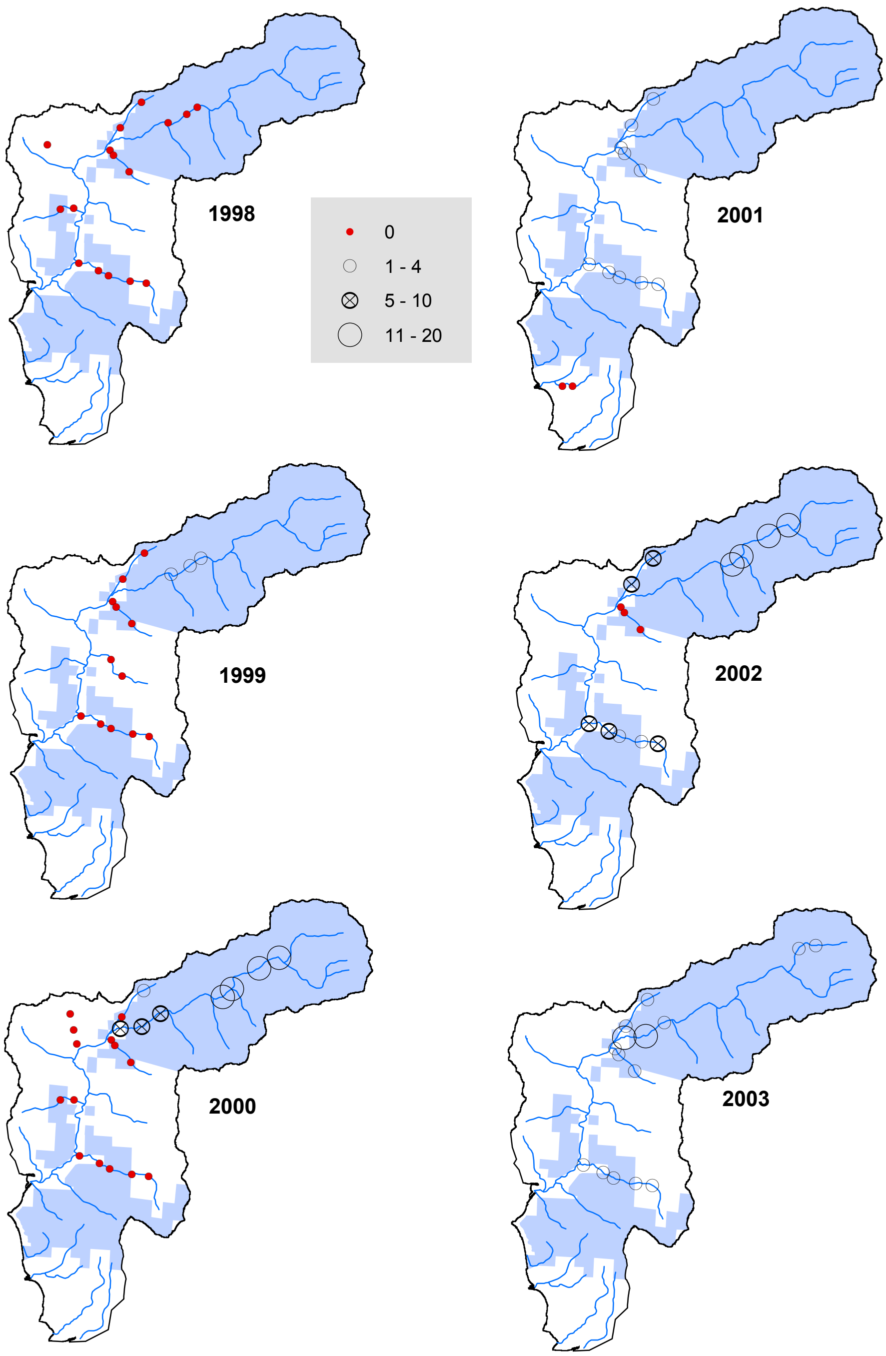

Figure 9. Peak counts of spawning adult coho salmon within the Miami basin study area.

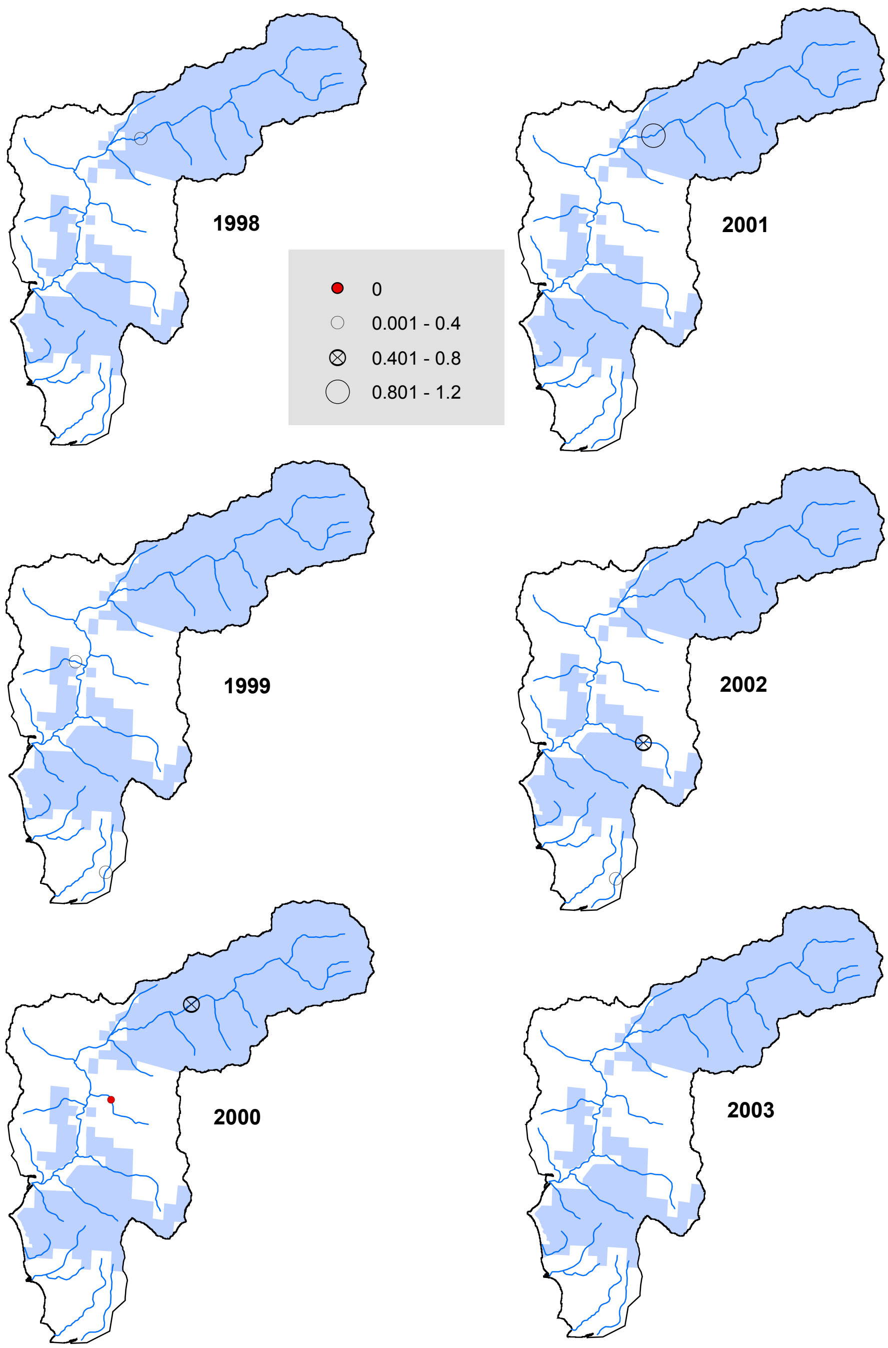

Figure 11. Density (fish/m2) of juvenile coho salmon within the Miami basin study area.

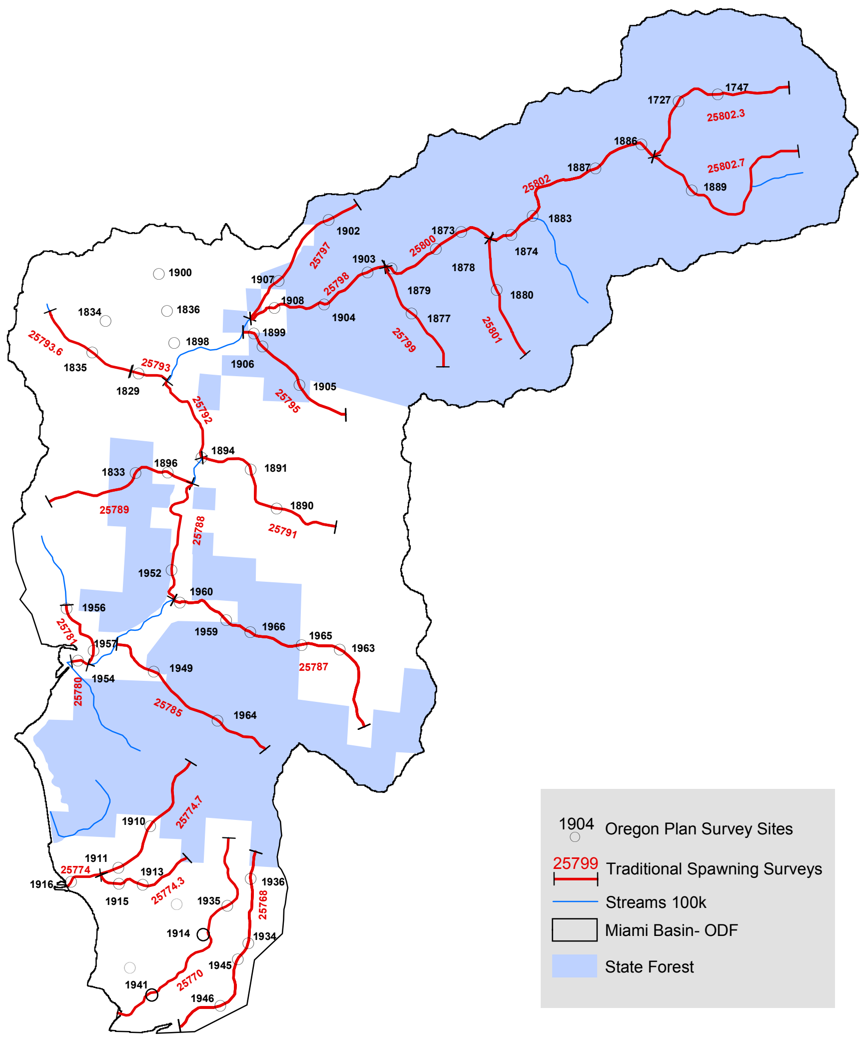

Figure 10. Spawning survey sites 1998 - 2003 within the Miami basin study area.

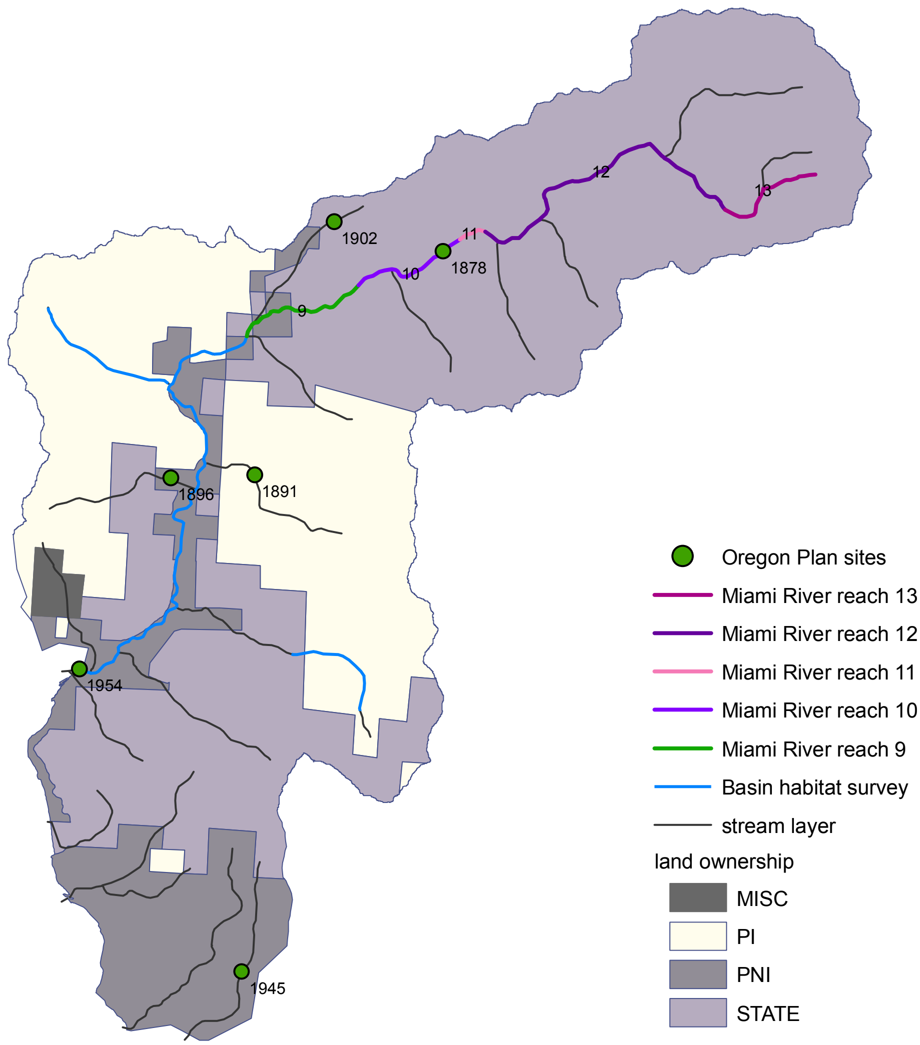

Figure 12. Habitat survey sites within the Miami basin study area.

N

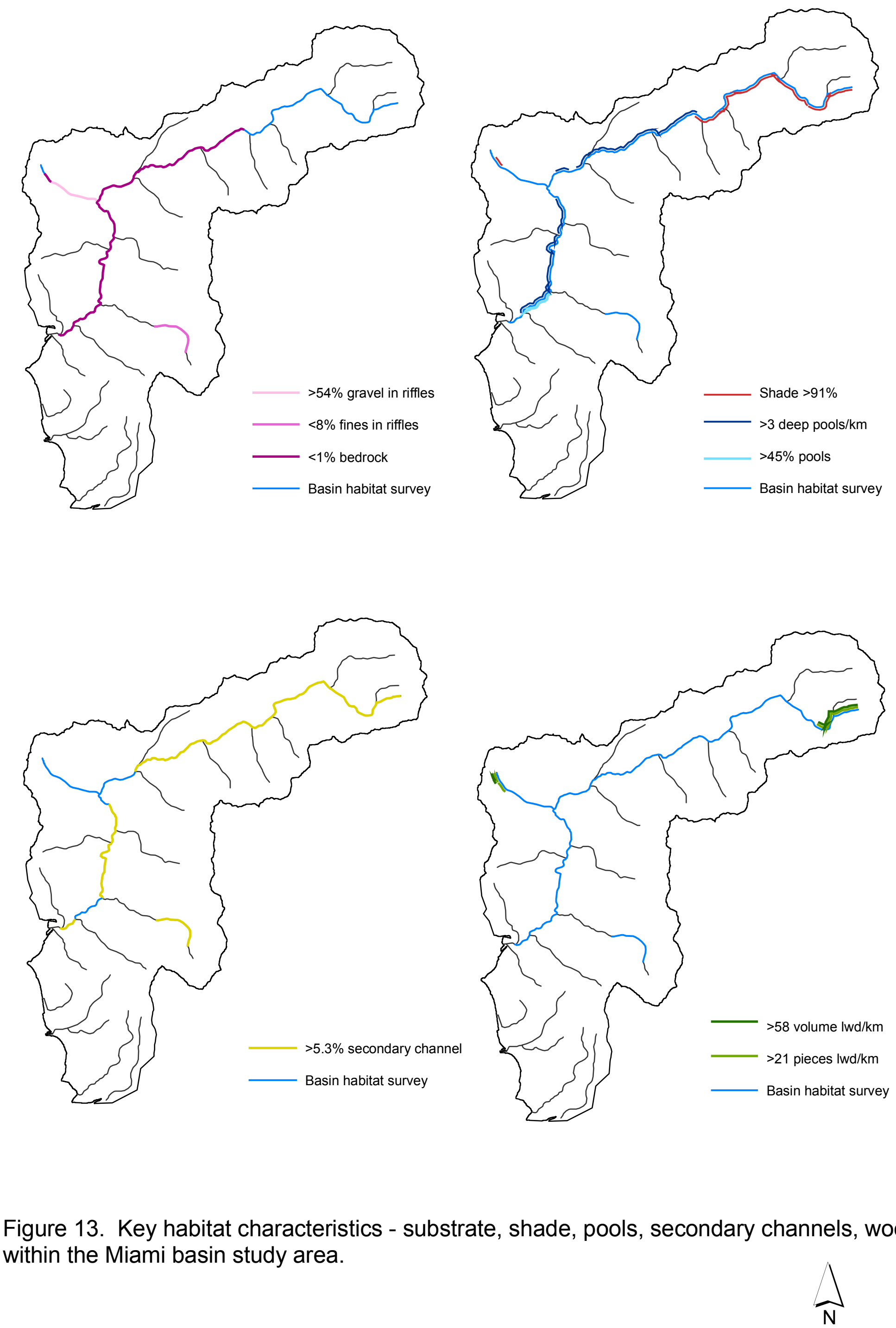

Figure 13. Key habitat characteristics - substrate, shade, pools, secondary channels, wood - within the Miami basin study area.

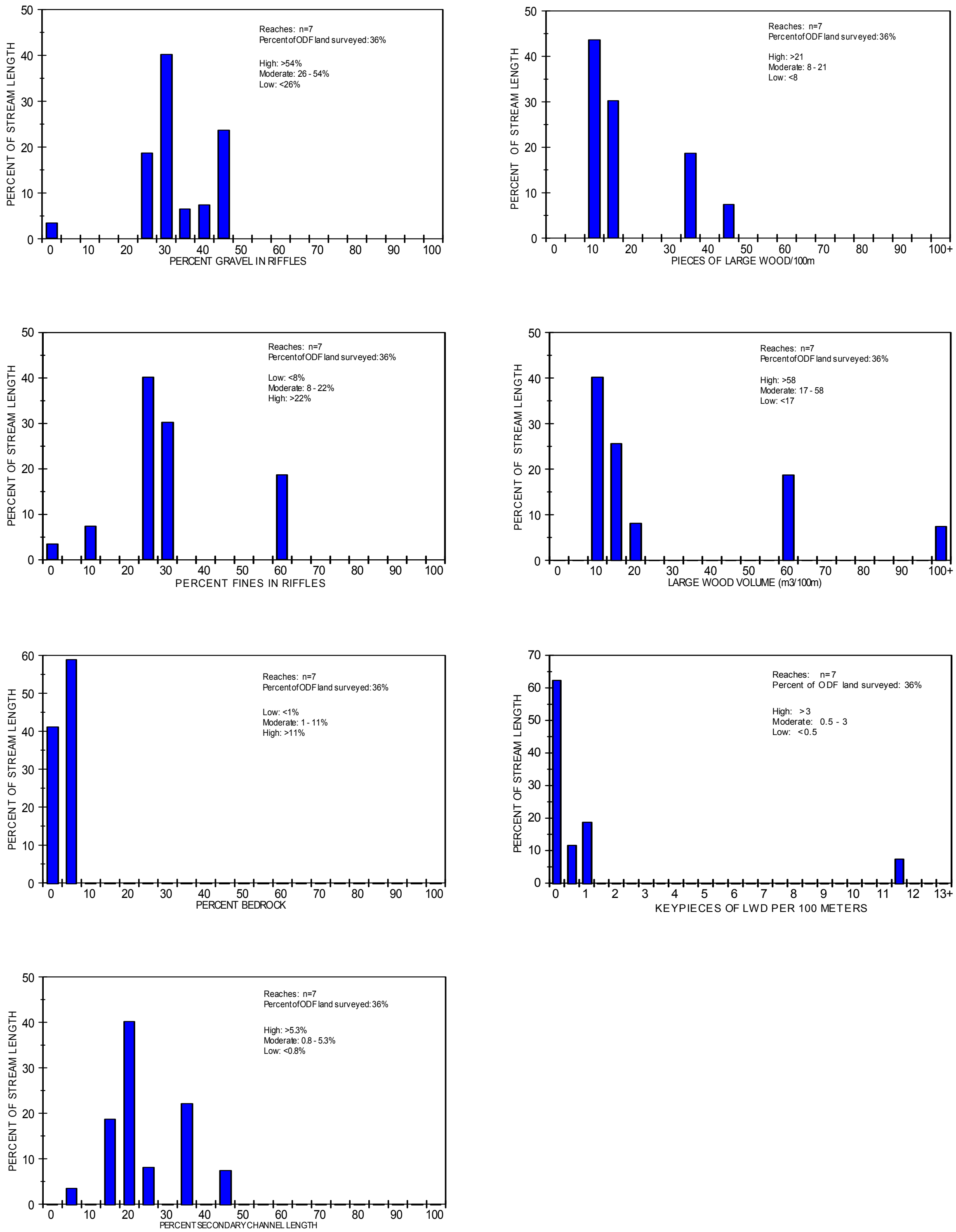

Figure 14a. Histogram of key habitat variables within surveyed reaches in the Miami basin study area (ODF land ownership only) High, moderate, and low values are derived from reference conditions.

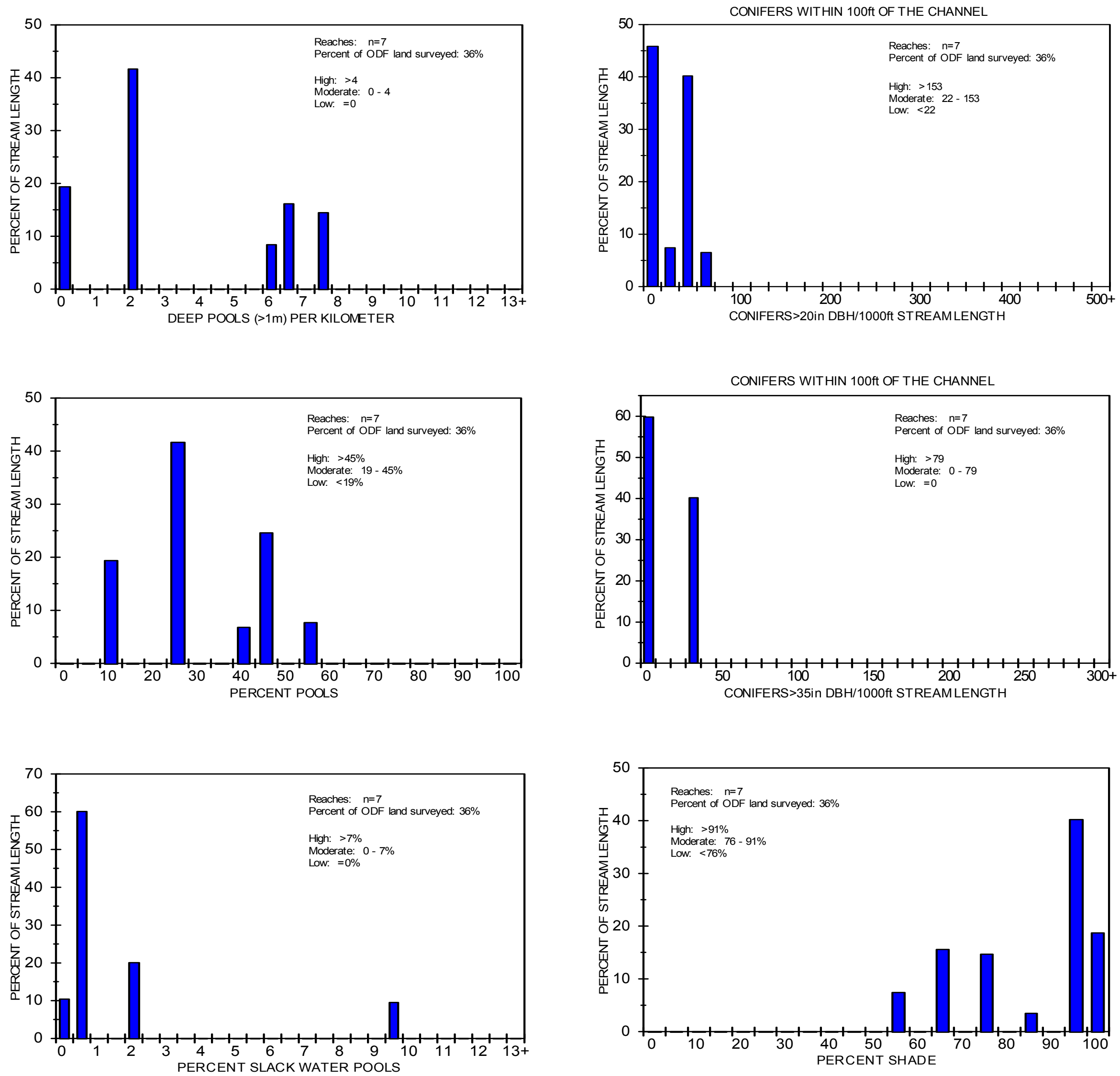

Figure 14b. Histogram of key habitat variables within surveyed reaches in the Miami basin study area (ODF land ownership only) High, moderate, and low values are derived from reference conditions.

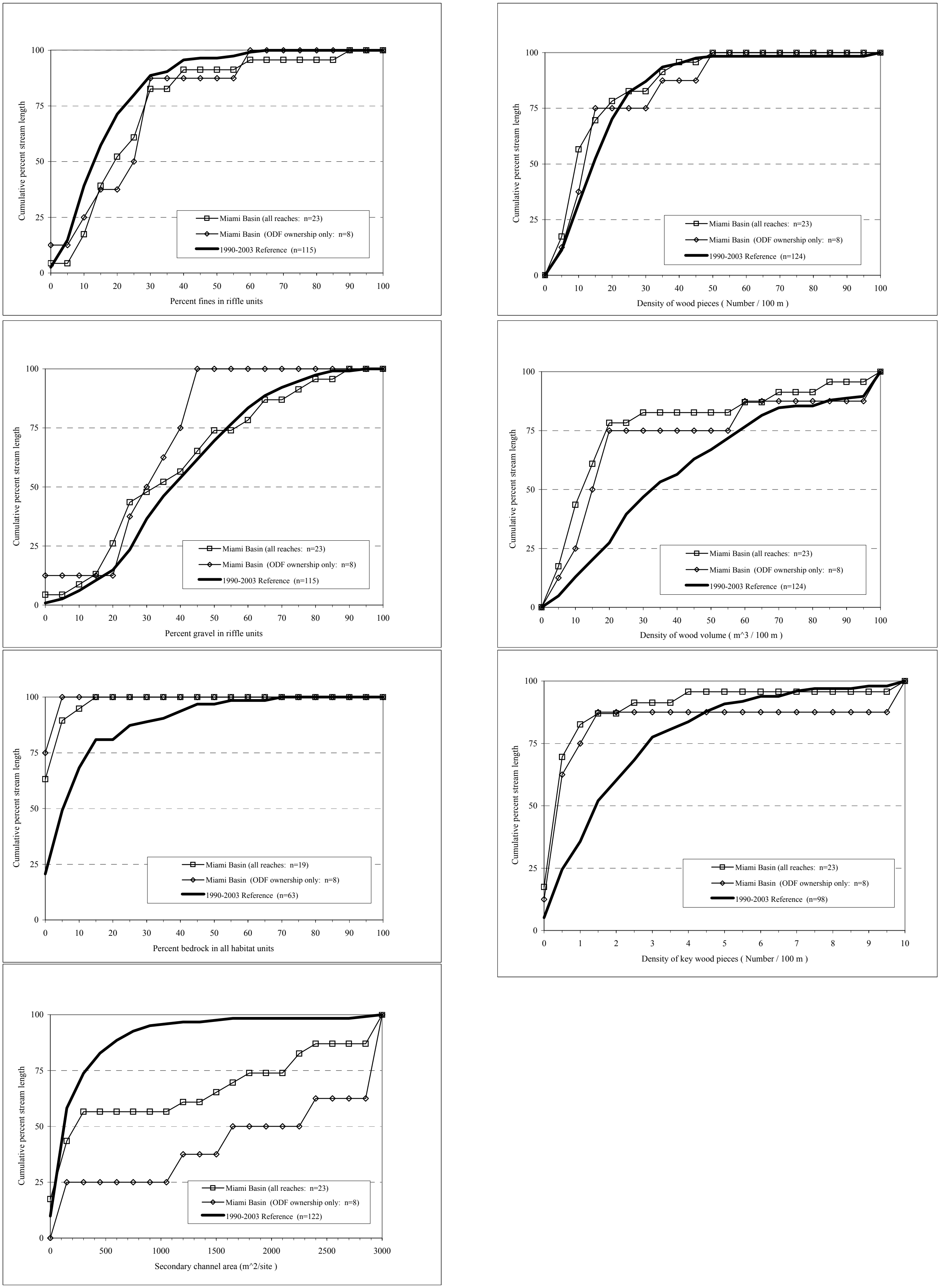

Figure 15a. Cumulative frequency dristributions of key habitat variables for comparing stream reaches of the Miami River.

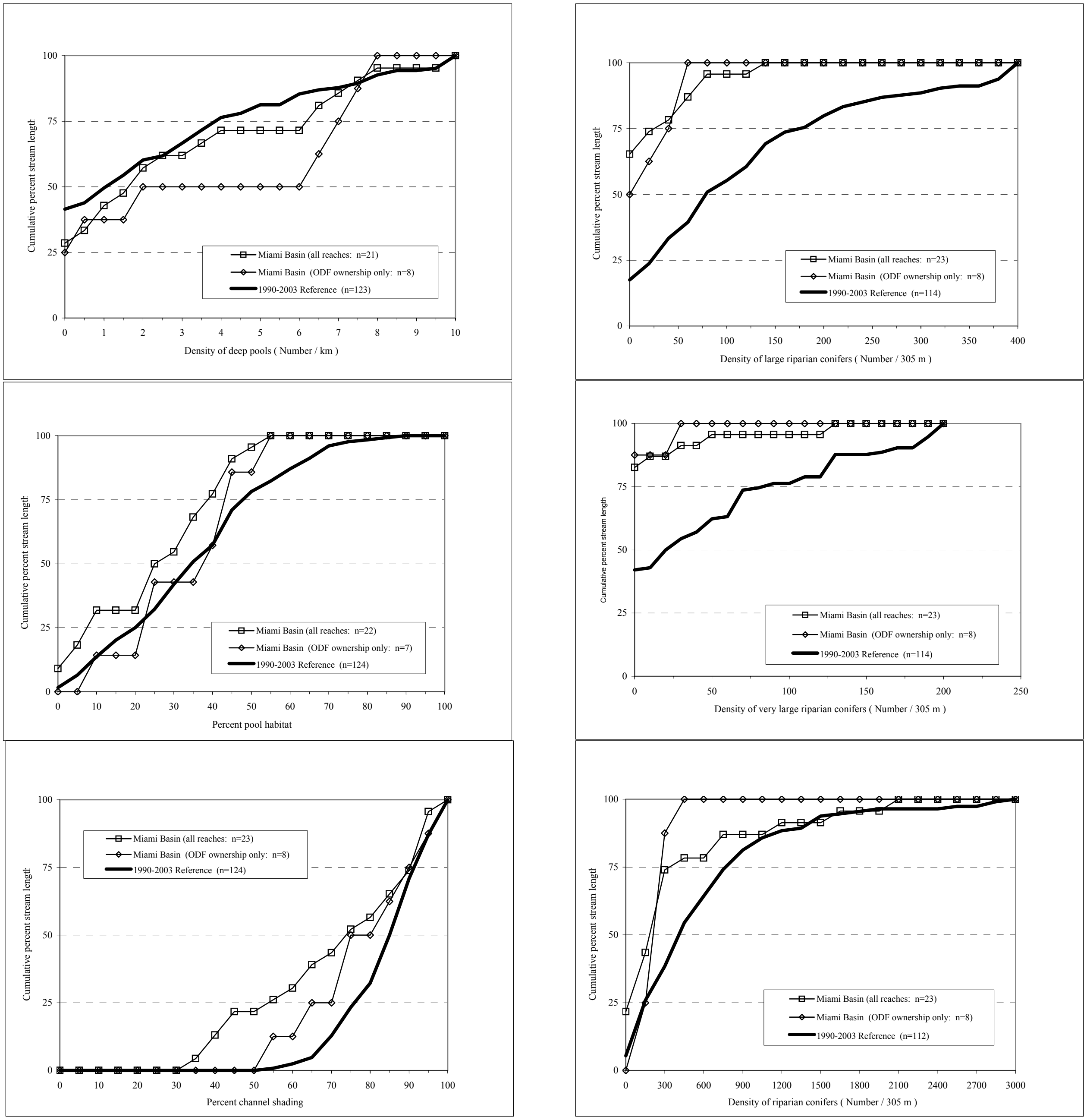

Figure 15b. Cumulative frequency distributions of key habitat variables for comparing stream reaches of the Miami River.

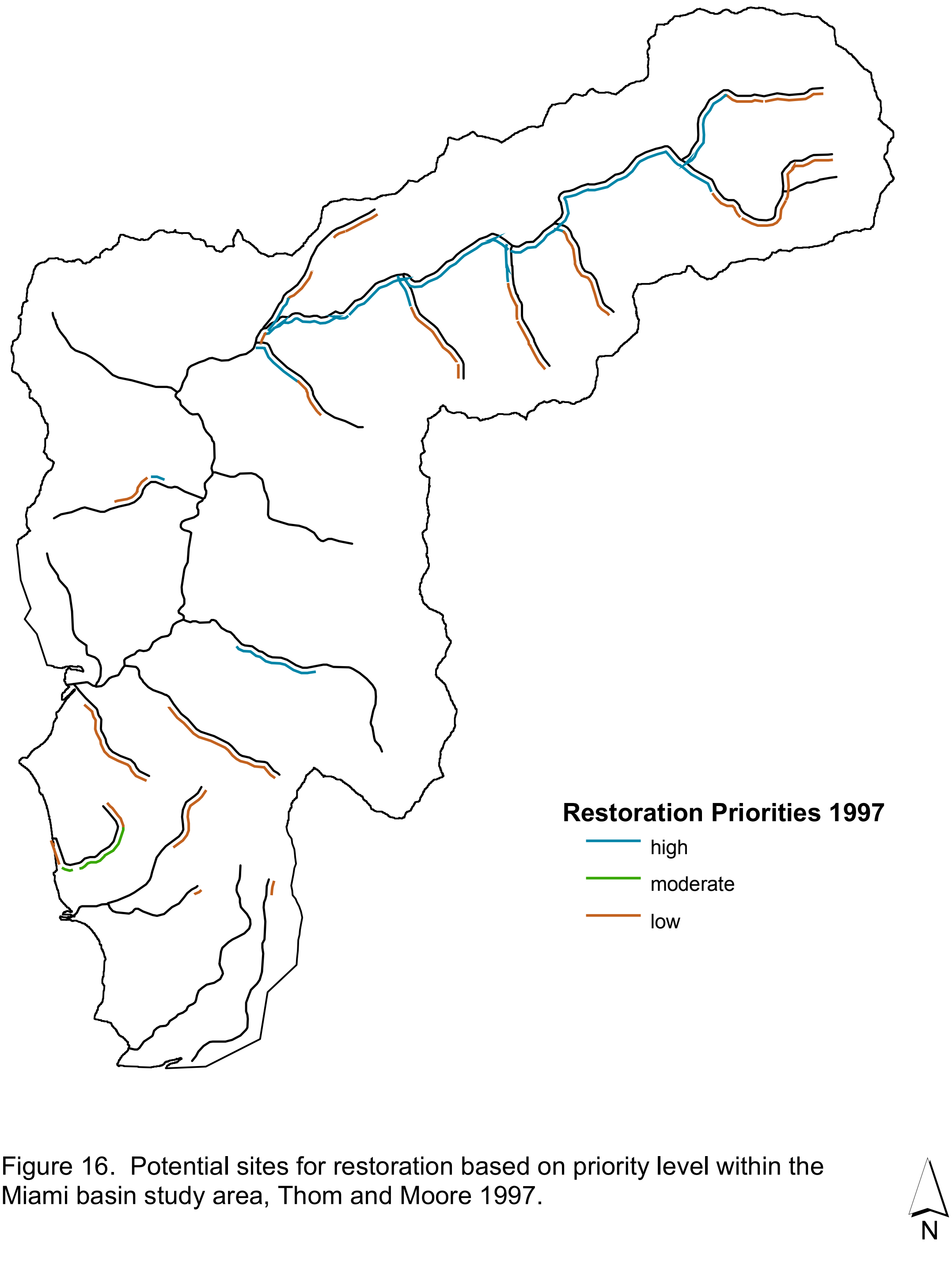

Figure 16. Potential sites for restoration based on priority level within the Miami basin study area, Thom and Moore 1997.