5.1.2 Are there subwatersheds where stream sediment deposition (associated with hillslopes and/or road erosion) is a limiting factor for achieving properly functioning aquatic systems?

Inherent rates of erosion and sedimentation in the Coast Range are well documented to be relatively high naturally, and the background sediment is highly variable. Post-fire increases in the rate of inherent surface and landslide erosion in western Oregon can be significant after large, intense fires. In the portion of the upper Miami subwatershed that was burned over by the Tillamook fire of 1933, and again in 1939, it is inferred that for a time sediment inputs increased substantially above background rates. Logging practices and road construction customary for that time period were not expressly intent on minimizing sedimentation compared to current day standards, so subsequent salvage of fire killed timber likely exacerbated accelerated erosion further, particularly in the South Fork. A high level of timber harvest and road construction continued into the late 1970's (ODF 2005).

Surveys conducted in the early 1950's noted a number of reaches with high quality substrate in the Miami River above Prouty Creek, two decades after the Tillamook Burn entered the watershed. Ocular estimates of the proportion of fine sediment consistently averaged about10 percent in observed reaches. Anecdotal observations noted fine sediment and turbid water just downstream from logging near the confluence of the South Fork, and multiple locations where large deposits of "loose logging debris" including dirt and rocks were piled across the river in the upper reaches of the South Fork (ODF 2004b).

Since the Tillamook fires and the rigorous post-burn salvage operations of the 1940's and 1950's most of the area that originally burned has developed a dense, heavy forest cover. Additionally, the high level of timber harvest in the 1960's and 1970's has declined substantially in recent decades. Thus, associated sediment production and delivery on ODF land is believed to have also declined markedly. Current sediment inputs attributable to management on ODF lands are associated primarily with roads. Based on RIMS data however, road related sediment is considered to be relatively nominal. Some problems do exist, and there are critical locations where road segments pose a risk to aquatic and riparian resources, but the majority of the road system is in good condition.

Recent data of in-stream sediment has been assessed in the project area by the DEQ in the TMDL process, in the E&S study (2001), and in habitat surveys conducted by ODFW (2005). Water quality was not listed by DEQ as impaired due to fine sediment (as indexed by turbidity). Most of the sampling occurred in low gradient reaches in the lower Miami on private non industrial lands. As summarized by the E&S study, none of the 154 samples of turbidity taken in the Miami exceeded the evaluation criteria. However the data is somewhat limited because few samples were collected during high runoff events when loading of suspended sediment is at its greatest. Additional data collection would be favorable to more clearly characterize the range of suspended sediment yield so that it could be stratified by ownership.

Based on benchmark indicators, ODFW (2005) survey data rated the level of in-stream fine sediment as moderate to high in riffles, and rated gravels in pools as moderate on ODF land. The report did not conclude that fine sediment is a limiting factor to fish production. Instead, winter habitat (i.e., complexity, side channel habitat, LWD, etc.) was identified as the primary limiting factor for fish production.

Although the surveys rate the proportion of in-stream sediment as moderate to high compared to the ODFW reference standards, it is not overwhelmingly clear as to whether or not these ratings can be directly correlated to sediment being a factor that is limiting properly functioning conditions. Correlation of the reference standards to the success of salmonid production has not been verified. In the Coast Range, the background range of in-stream sediment is naturally high. Coast Range salmonids are adapted to this variability and are subjected to intense periodic pulses of sedimentation that often result from natural disturbance (Everest et. al. 1987). Despite probable historical increases in sediment yield attributed to past wildfire, logging, and road construction, which may account for the moderate to high ratings, the level of in-stream sediment on ODF lands is not an obvious, single defining factor considered to be limiting. Although it may play a minor role, other factors such as LWD and conditions downstream on non-ODF lands are believed to be more significant and evident factors limiting achievement of PFC.

5.1.3 Given the stream temperatures that are reasonably achievable, what is the likelihood (rate as high, moderate, low, or unknown) that stream temperatures and/or shade conditions are a limiting factor for achieving properly functioning aquatic systems?

Actual measurements of stream temperature to describe the historical temperature regime in the Miami River watershed, specifically on ODF lands, are not available. The best approximation of temperature conditions can only be determined through a comparison of current and historical estimates of riparian shade. Recognize that many factors can influence stream temperatures, including but not limited to: topographic shade angle, understory vegetation and shrubs, channel complexity (bankfull width), groundwater seeps, and other land uses such as water withdrawals.

Consider the estimated historical distribution of forest types and associated shade presented conceptually in ODF (2002). Here the age of riparian forests was assigned to a range of potential shade categories from very low to very high (Table 27).

Table 1. Estimated historical distribution of forest types by age class and relative shade levels (adapted from ODF 2002).

	Age of Riparian Forests (years)				
	0-3	**4-50**	**50-100**	**100-200**	**200+**
Portion of Landscape Historically in this Age Class (adapted from Botkin et.al. 1995)	5-15%	10-15%	15-20%	15-20%	40-50%
Relative shade levels (based on forest successional dynamics)	Very Low to Moderate	Moderate to Very High	High to Very High	Moderately High to High	Moderately High

Obviously, variables affected the spatial and temporal distribution of historic vegetation patterns. Natural disturbances such as fire, windthrow, landslides, insects and disease, and floods influenced forest stands throughout the landscape. This changing landscape

certainly resulted in changing shade levels through time. It appears evident, however, that there has been a shift in age-class distribution resulting in a reduction of very young (0-3 years) and very old (200+ years), and an increase in the 4-50 year category (ODF 2002). Based on Table 27, this would indicate a decrease in the “very low to moderate” shade category (age 0-3 years), and a decrease in “moderately high” shade category (age 200+ years), with an associated increase in the “moderate to very high” shade category (age 4-50 years).

The existing distribution of vegetation cover types on ODF lands was categorized into low, moderate or high shade condition depending on vegetation type, tree size, and stand density (Table 28, Figure 10).

Table 2. Acres and percent of ODF lands categorized by low, moderate and high shade levels.

RA1	Shade Levels on ODF Lands							
	Low		Moderate		High		Total	
Subwatershed	**acres**	**%**	**acres**	**%**	**acres**	**%**	**Acres**	**%**
Upper Miami	50	3%	61	4%	1311	92%	1421	100%
Lower Miami	34	9%	29	8%	316	83%	378	100%
Tillamook Bay	22	10%	33	15%	168	75%	222	100%
Total	**106**	**5%**	**122**	**6%**	**1794**	**89%**	**2022**	**100%**

RA1+RA2	Shade Levels on ODF Lands							
	Low		Moderate		High		Total	
Subwatershed	**acres**	**%**	**acres**	**%**	**acres**	**%**	**Acres**	**%**
Upper Miami	144	3%	234	4%	4941	93%	5318	100%
Lower Miami	142	10%	95	7%	1188	83%	1425	100%
Tillamook Bay	89	11%	95	11%	654	78%	838	100%
Total	**375**	**5%**	**424**	**6%**	**6783**	**89%**	**7582**	**100%**

ODF170	Shade Levels on ODF Lands							
	Low		Moderate		High		Total	
Subwatershed	**acres**	**%**	**acres**	**%**	**acres**	**%**	**acres**	**%**
Upper Miami	212	3%	354	4%	7532	93%	8097	100%
Lower Miami	228	10%	168	7%	1886	83%	2282	100%
Tillamook Bay	138	11%	140	11%	1015	79%	1293	100%
Total	**578**	**5%**	**661**	**6%**	**10432**	**89%**	**11672**	**100%**

Consistent with large wood recruitment, the influence of streamside buffers diminishes farther from the stream. A comparison of current riparian shade estimates for varying buffer widths on ODF lands in the Miami River watershed showed that overall shade conditions do not change with increasing buffer width (i.e. RA1 = 89% high, RA1+RA2 = 89%, and ODF170 = 89% high; Table 28). For this analysis, shade estimates for ODF170 buffer widths was used.

The categories of historical forest type and shade level (Table 27) were modified slightly (collapsed into low, moderate and high) in order to compare with the estimates of existing vegetation cover and corresponding shade level determination (Figure 39). Results indicate that the overall shade condition across ODF lands is likely higher today than historically. Current estimated levels for the Upper Miami subwatershed and overall

total acres of ODF lands are higher than those estimated historically. The Lower Miami and Tillamook Bay subwatersheds are consistent with historic levels.

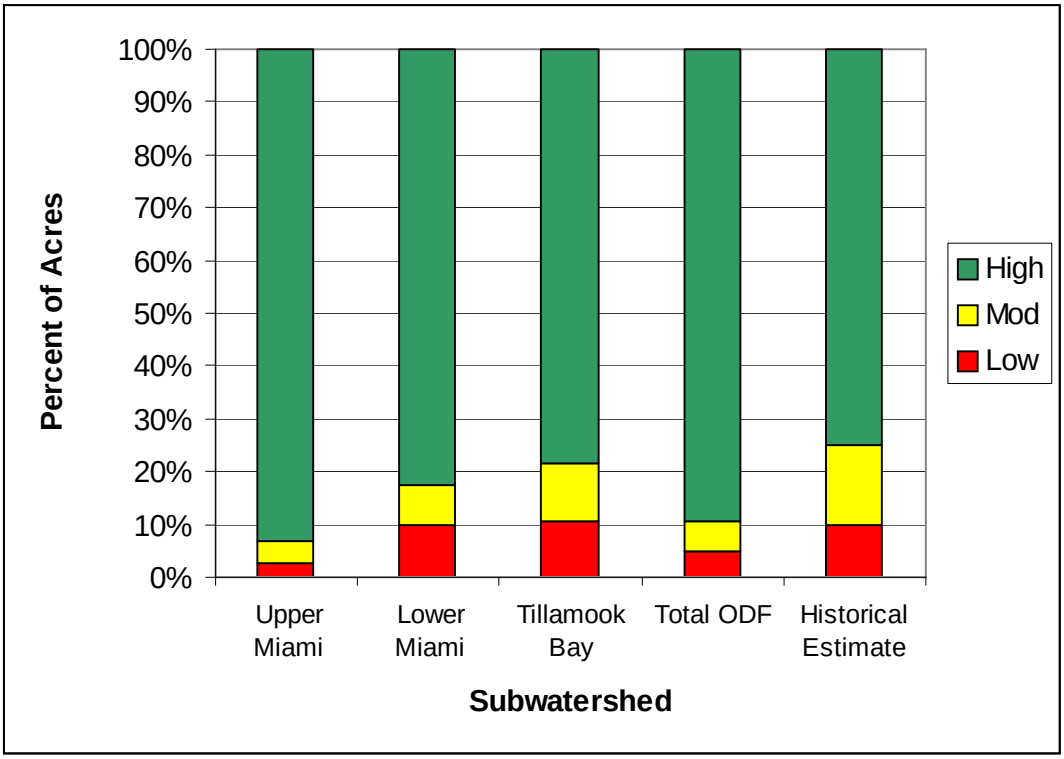

Figure 1. Estimated levels of shade as a percent of total ODF lands in mapped riparian buffers.

Given that current estimates of shade on ODF lands are higher than historical estimates, it is unlikely that streamside shade conditions are limiting the attainment of a "properly functioning" aquatic system on ODF lands. The possibility exists that the increased levels of shade could have reduced the amount of primary production, thus indirectly limiting fish production. Given that these historical estimates are interpreted at a landscape scale, there is no data or information to predict with any level of certainty that shade in this case is a limiting factor. Based on professional opinion, the shade estimates predicted here and the measurements taken during aquatic habitat surveys indicate that there are adequate levels of shade to protect water quality concerns and beneficial uses.

5.1.4 Are there any other conditions limiting the achievement of properly functioning aquatic systems?

Other conditions or factors within the watershed could be limiting the achievement of properly functioning aquatic systems on ODF lands to varying degrees:

- Current and future habitat conditions on downstream non-ODF lands are likely limiting fish production on ODF lands for a variety of reasons. Wetland and floodplain modifications have occurred in support of residential and agricultural development. In addition to simplifying habitat, these modifications have resulted in a reduction of estuarine habitats essential to both chum and chinook salmon. Channels on private lands have been heavily modified and habitat complexity is low. Water withdrawals on private lands downstream from ODF lands in the lower Miami and the frontal subwatershed have been identified as potentially

affecting summer low flows. Water quality in the lower Miami is considered limited for temperature and bacteria.

- The potential for dewatering streams with documented fish presence during low flow periods is a concern. This echoes concerns of ODFW and OWRD, which designated the Miami River a state priority for streamflow restoration to support anadromous species. Considering the greater number of permitted withdrawals rates of use recorded for the Tillamook Bay subwatershed where streams are small and annual available water much less compared to the Miami River, it is logical to assume that dewatering effects to aquatic species would be a concern in the frontal streams as well.

- Current management direction on ODF lands is to avoid riparian areas that are complicated to plan or operate in, even when activities are permitted under the FMP and Salmon Anchor Habitat Strategy. There are streamside stands however, where management could benefit riparian resources if they were more actively managed. Not aggressively managing streamside forests entails a risk that streamside forests may not achieve mature conditions that according to the FMP, is desired for riparian areas.

- Fish passage barriers have been identified on and off of ODF lands that could be limiting the distribution and production of salmonids (discussed later in this chapter).

- Permitting requirements are constraining the implementation of instream aquatic habitat restoration projects. The Regional General Permit (RGP) in which ODF and ODFW conform for implementation of instream projects is limited to streams less than 42 feet wide. The priority stream reaches identified in this analysis for placement of large wood exceed 42 feet in width. Additionally, trees within 25 feet of the stream may not be used for these projects, leading to logistical difficulties in getting trees to the stream.

- Channel modifications on ODF lands, specifically along several segments of the Miami River Road where it encroaches into the mainstem river channel, have simplified and constrained critical habitat and affected floodplains and side channels used by salmonids. These include the segments between the Diamond Creek and the North Fork crossing. Other locations on ODF lands where roads that impinge on the channel have affected habitat include lower Buehner Creek and the middle reach of Moss Creek.

Based on the information presented here, levels of in-stream LWD and current and future recruitment from streamside forests combine to be the number one factor limiting the achievement of PFC in the short and long term.

Forest stands along fish bearing streams that currently have low to moderate large wood recruitment potentials are limiting the achievement of properly functioning condition. Likewise, debris flow prone channels that could be expected to deliver large wood to downstream fish bearing streams in the event of failure but do not contain large conifers in which to transport, are limiting the achievement of properly functioning condition. In addition, channel modifications due to roads adjacent to the mainstem Miami River and Moss Creek could be affecting channel functions. These locations are summarized in Figure 40 and identified on Figure 41.

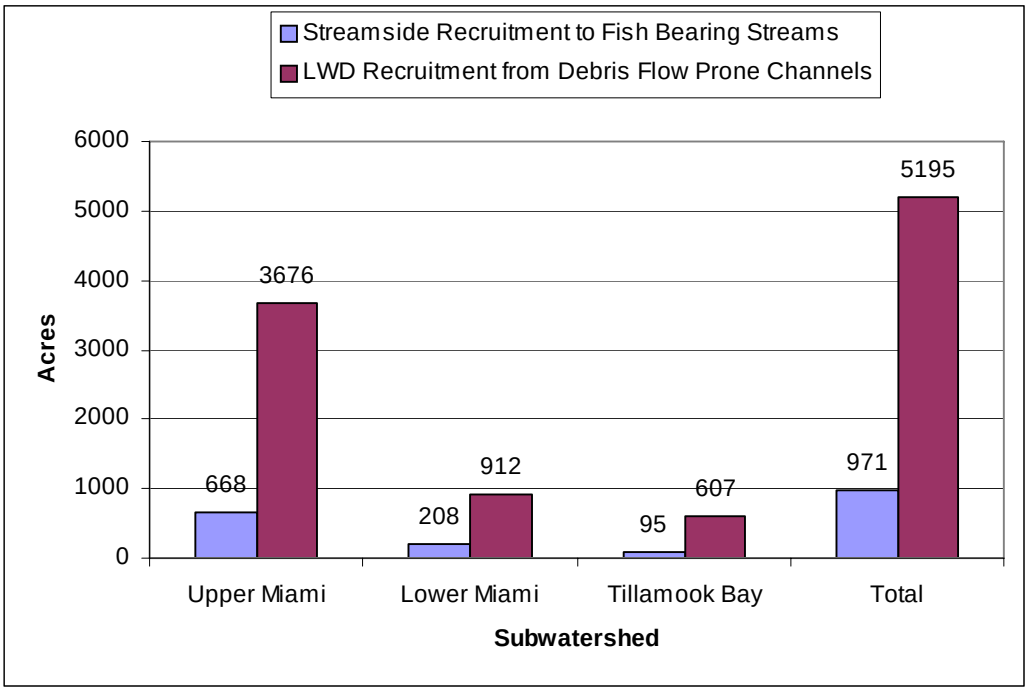

Figure 2. Acres of riparian management area along fish bearing streams and debris flow prone channels potentially limiting the achievement of properly functioning condition.

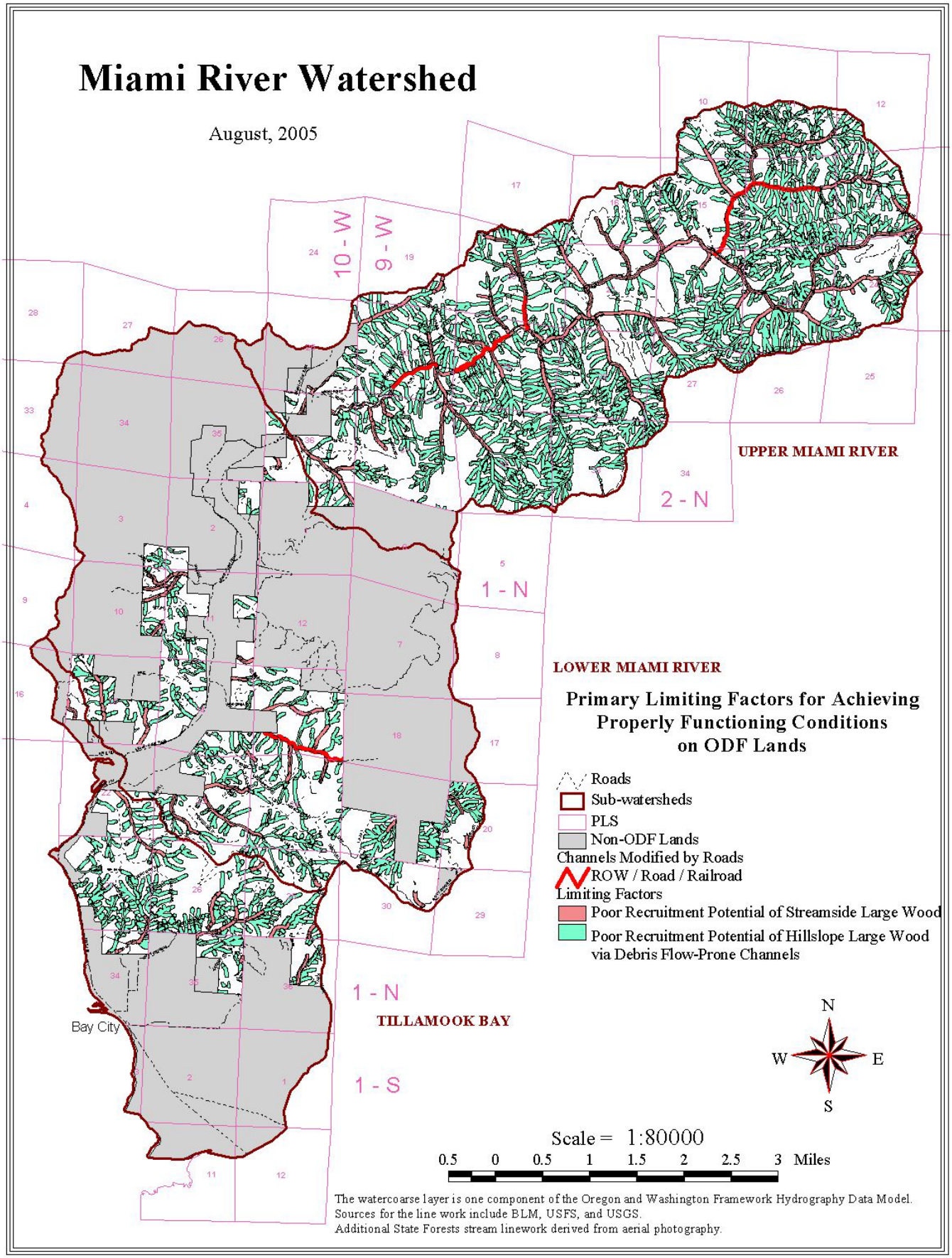

Figure 3. Limiting factors affecting the achievement of properly functioning condition for aquatic and riparian conditions.

5.2 Alternative Vegetation Management

Objective: Identify where in the project area the management standards for aquatic and riparian areas are likely to achieve properly functioning aquatic habitat conditions, and if they are not, then identify the alternative vegetation management needed to achieve this condition. The key analysis questions are addressed below. ODF defines PFC as "the range of diverse aquatic and riparian conditions over time and space that emulate the habitat conditions that resulted from natural disturbance regimes under which native species evolved; there is no one condition that is properly functioning".

The criteria used in this portion of the analysis to determine PFC achievement were:

- A focus on in-stream aquatic habitats and the adjacent upslope processes that affect them.
- Analysis results of existing data characterizing current conditions.
- Results of limiting factor analysis discussed earlier.
- Location and habitat condition of critical habitat for anadromous salmonids.

It is important to emphasize that this analysis has relied on data from surveyed streams, which are all considered fish bearing. No data exists for the other streams in the watershed, specifically headwater streams (type N). Therefore, interpretations about in-stream conditions can only be inferred from remotely sensed data about streamside forest characteristics.

5.2.1 Given current management strategies, which subwatersheds (6th-field HUC) have aquatic and riparian conditions that have already achieved the properly functioning condition (PFC)?

As previously discussed, the primary limiting factor for achieving PFC is poor channel complexity due to the lack of in-stream wood and inadequate recruitment potential from streamside and upslope forests, Based on the data available for this assessment and analysis of ODF lands, the Upper Miami River Subwatershed contains two segments of stream considered to have achieved the properly functioning condition. This is approximately 1% of the total mapped streams in the subwatershed (ODF only, 2.3 miles of 232 total miles) and 0.7% of the total mapped streams in the entire watershed (ODF only, 2.3 miles of 330 total miles).

Since no aquatic habitat data exists for ODF lands in the Lower Miami or Tillamook Bay Subwatersheds, the level to which properly functioning conditions have been achieved cannot be determined with certainty. However, as discussed earlier, an examination of aquatic habitat data on ODF compared to private industrial and non-industrial lands indicates that overall aquatic conditions are similar (Figure 34). The lack of large wood recruitment potential through time provides evidence that overall subwatershed conditions may not be conducive to achieving PFC at a watershed scale. It is expected that specific stream reaches or locations on ODF lands within the watershed have achieved a condition of properly functioning. They are just not detectable given the data currently available.

5.2.2 Which subwatersheds have aquatic and riparian conditions suitable for the development of the PFC in a 50-year timeframe? In a 100-year timeframe? Longer than a 100-year timeframe?

The development of streamside forests that contain large conifer trees were projected in 50 and 100 year timeframes (Figure 37 and 38) in order to provide an estimate of potential recruitment through time. Even though streamside forests are projected to develop large conifers in 50 and 100 years, large wood is not immediately recruited to the stream. Recruitment of large wood (key pieces) in sufficient amounts to achieve a functional aquatic and riparian condition could lag behind stand development by decades or even longer.

Figures 42 and 43 illustrate the likely development of PFC in 50-, 100-, and >100-year timeframes. This map was constructed by overlaying criteria used to develop woody debris recruitment estimates from streamside forests and debris flow prone channels through time. In addition, there is considered a time lag between when a streamside forest is capable of large wood recruitment and when that wood actually reaches the stream or floodplain. Specifically,

- Forests along fish bearing streams that currently have a high LWD recruitment potential and those debris flow prone channels that are likely to deliver large wood to downstream fish bearing streams over 50 years will likely exhibit conditions suitable for PFC development in the 50-year timeframe.
- Fish bearing streams projected to have high LWD recruitment potential in 50-years and where debris flow prone channels that are likely to deliver large wood to downstream fish bearing streams over 100 years will likely exhibit conditions suitable for PFC development in the 100-year timeframe.
- Streamside forests that reach a high recruitment potential in 100-years and beyond in conjunction with debris flow prone channels that are capable of delivering large wood to downstream fish bearing streams beyond 100 years are estimated to develop PFC beyond the 100-year timeframe.

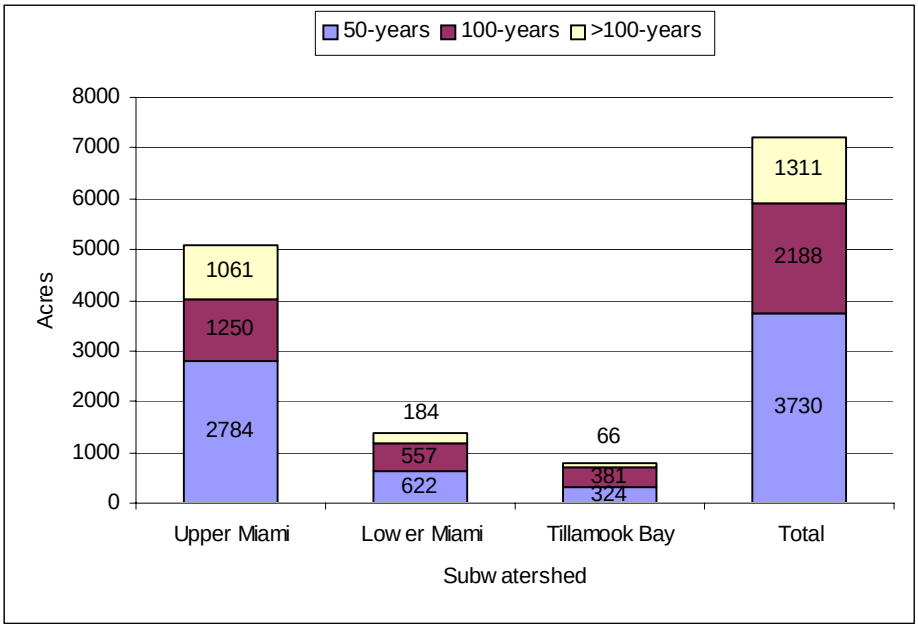

Figure 4. Mapped riparian acres of ODF lands projected to achieve PFC over the 50-, 100- and >100-year timeframes.

The calculations used to predict PFC (and LWD) through time assume that all riparian stands grow forward along a stand succession trajectory without accounting for future management in riparian areas. Appendix J, Management Standards for Aquatic and Riparian Areas, of the FMP provide direction to manage the inner RMA (25 – 100 feet) for mature forest conditions in all type F and large and medium type N streams. By FMP definition, desired mature forest conditions consist of stands dominated by large conifer trees, unless the natural plant community is expected to be hardwood-dominated (FMP 2001). This desired condition is consistent with the goal of producing large wood in streams and if actively implemented through time, would likely eliminate large wood as the primary limiting factor on ODF lands in the watershed. Site specific prescriptions would focus on achieving these conditions in the shortest timeframe possible.

If riparian stand management were actively implemented, the PFC and large wood recruitment projections presented here would likely look different depending on the temporal and spatial distribution of such activities. Current management in RMAs, however, is directed by the SAH strategy. SAH watersheds are a high priority for restoration projects in order to expedite fish recovery.

ODF's current management appears to be "hands off" and in most cases increases buffer widths to minimize risk near riparian areas. This interpretation means that limited management activities will be conducted in RMAs and therefore will have no effect on projections of PFC (and LWD) through time. Table 29 describes the potential outcomes, at least conceptually, of treatment activities in RMAs under direction of the SAH. The site specific effects can be determined at the project planning and implementation phase.

Table 3. Potential LWD and PFC outcomes under Salmon Anchor Habitat Strategy.

Stream Type	RMA (FT)	Treatment	Potential LWD and PFC Outcome Compared to the No Management Assumption*
F, Large N	0-100	No Harvest	Same as no management
Small N (Perennial)	0-50	Inner Zone: No Harvest	Same as no management
	50-100	Outer Zone: Retain 15-25 conifers, snags per acre	Fewer trees per acre remain for LWD than no management but trees get larger faster**
Small N (Seasonal)	0-50	Inner Zone: Retain 15-25 conifers, snags per acre	Fewer trees per acre remain for LWD than no management but trees get larger faster**
	50-100	Outer Zone: No restrictions on harvest	Potentially, no LWD contributions from this zone.**
Small N (Seasonal)	0-50	Inner Zone: No Harvest	Same as no management
(special case)***	50-100	Outer Zone: No restrictions on harvest	Potentially, no LWD contributions from this zone.****

*The calculations used to predict LWD and PFC through time assume that all riparian stands grow forward along a stand succession trajectory without future management in riparian areas.
**As with other Type N streams and RMAs, this will only matter if the stream is capable of transporting LWD downstream (likely through debris-flow channel processes) See Figure 45-47.
***Direct contributor to type F stream, AND one of the following: a seasonal high energy stream, OR potential debris flow track reach.
****By definition, this type of stream is likely to transport wood to a Type F stream. Thus, this is a potentially significant impact.

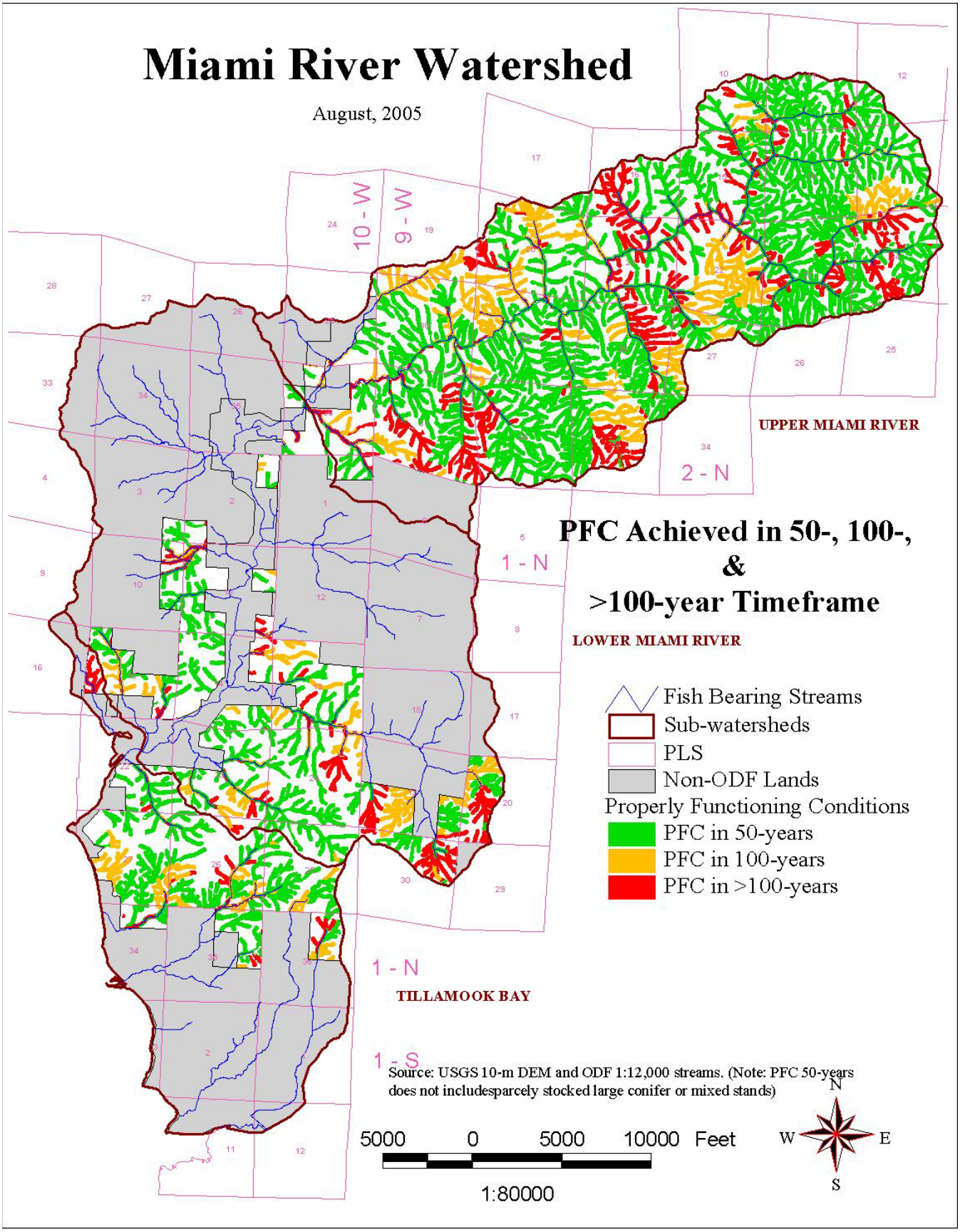

Figure 5. Projected achievement of PFC on ODF lands over the 50-, 100- and >100-year timeframes.

5.2.3 For those subwatersheds where it will take longer than 100 years to develop PFC, prioritize by stream reach (and map) for alternative vegetation management to achieve the PFC.

The areas likely to achieve PFC at a time beyond 100 years (Figure 43) were stratified with critical habitat reaches (Figure 28) as a means to prioritize their need for additional investigation and likely alternative vegetation management. **The areas with the longest timeframe to develop PFC conditions are also the most critical habitats for anadromous salmonids on ODF lands in the watershed.** These areas include 141 acres of the mainstem and North Fork Miami River and Stuart Creek in the Upper Miami Subwatershed and 23 Acres of Moss Creek in the Lower Miami Subwatershed (Figure 44).

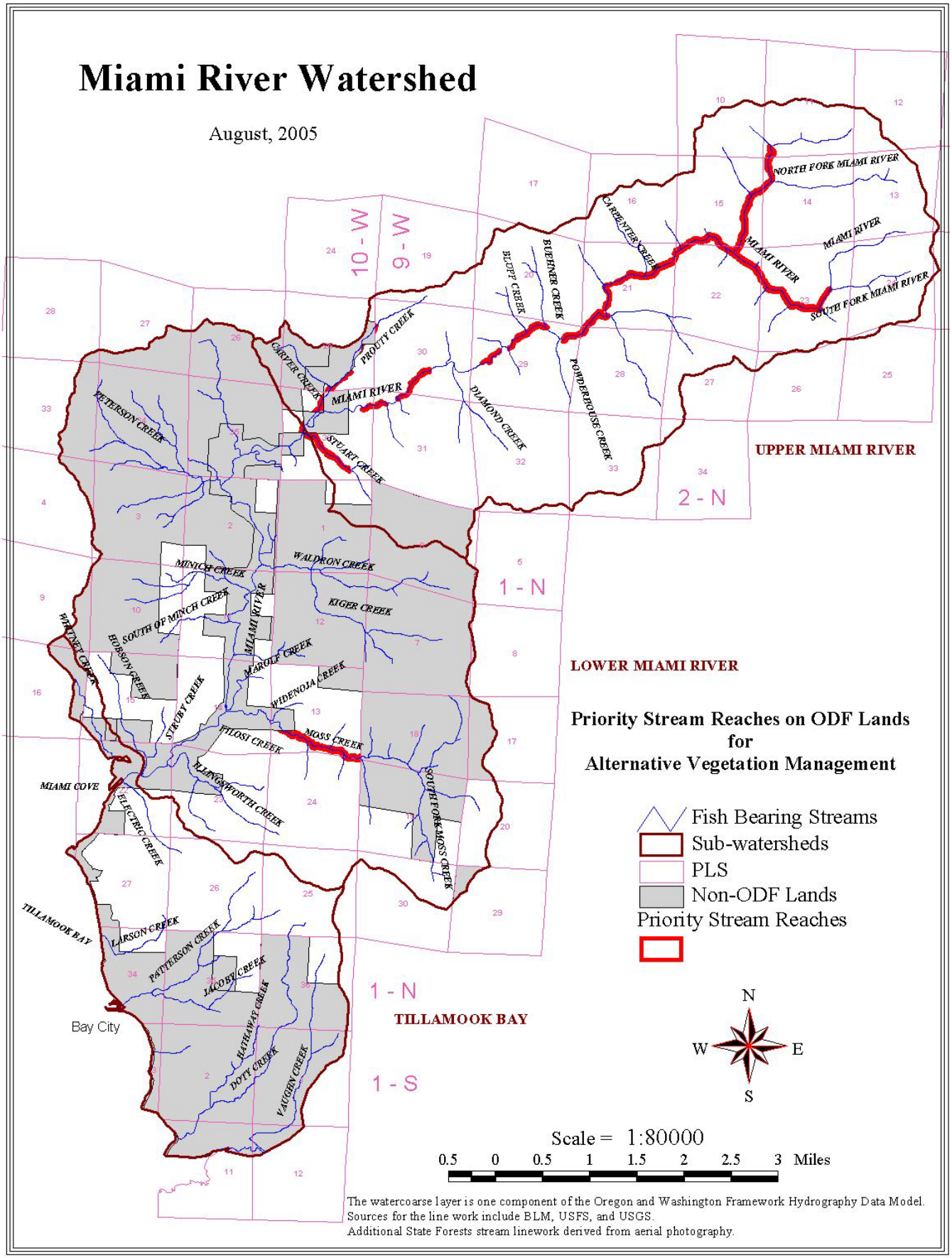

Figure 6. Areas with a high priority for further study and likely vegetation management opportunities.

5.3 Slope Stability

Objective: Produce a map of the project area that categorizes landslide hazards into high, moderate, and low hazard categories, as defined by the ODF. Identify if the project area is unusually prone to landslides. If so, identify where these landslides occur and their effect on delivery of wood and sediment to streams, channel scour, and aggradation. The key analysis questions are addressed below.

5.3.1 Are there landslide-prone hillslopes that pose a high risk of downstream sediment or scour impacts? If so, identify the specific hillslopes and stream reaches, describe why they pose a high risk to streams, and describe how management will affect possible stream sediment or scour impacts.

The relative extent of landslide prone terrain in the project area is analogous to other neighboring watersheds such as the Kilchis, Wilson, and Trask; and considered to be characteristic to the region. Steep (60-79% slopes) and very steep (>79%) slopes are rated as exhibiting a high, and very high landslide hazard respectively. Where these hillslopes are in association with steep (≥60% channel gradient), confined, headwater channels they pose a potential risk of downstream impacts. In the steep, highly dissected Coast Range, the association between steep slopes and steep drainageways is inextricable and widely accepted as areas prone to shallow, rapid landslides (i.e., debris flows).

Figure 14 illustrates that debris flow prone features are abundant on ODF land in the project area. They are most common in the Upper Miami subwatershed and are present in every principle tributary, particularly upper headwater reaches where first and second order streams originate. They are also common on ODF land in the Lower Miami, namely the middle reaches of the Illingsworth drainage, and in the Moss Creek canyon. In the Tillamook Bay subwatershed, they are primarily in the upper most reaches of the Larsen, Patterson, and Vaughn drainages. These naturally occurring debris flow-prone channels are considered to pose an inherent high risk of downstream sediment and scour impacts in the project area. The majority of these features are Type N streams.

Landslide processes and the occurrence of debris flows in western Oregon have been documented at length. Their temporal occurrence is primarily related to periodic intense precipitation events, and they serve as natural mechanisms for transporting and delivering large wood, coarse substrate, and fine sediment to the fluvial system. They typically can cause extensive scour to moderate and steep gradient channel types, and deposit large volumes of material at tributary junctions or in reaches where there is an appreciable decline in channel gradient. These effects can have profound impacts on channel morphology, and can have both positive and negative influences on aquatic and riparian resources.

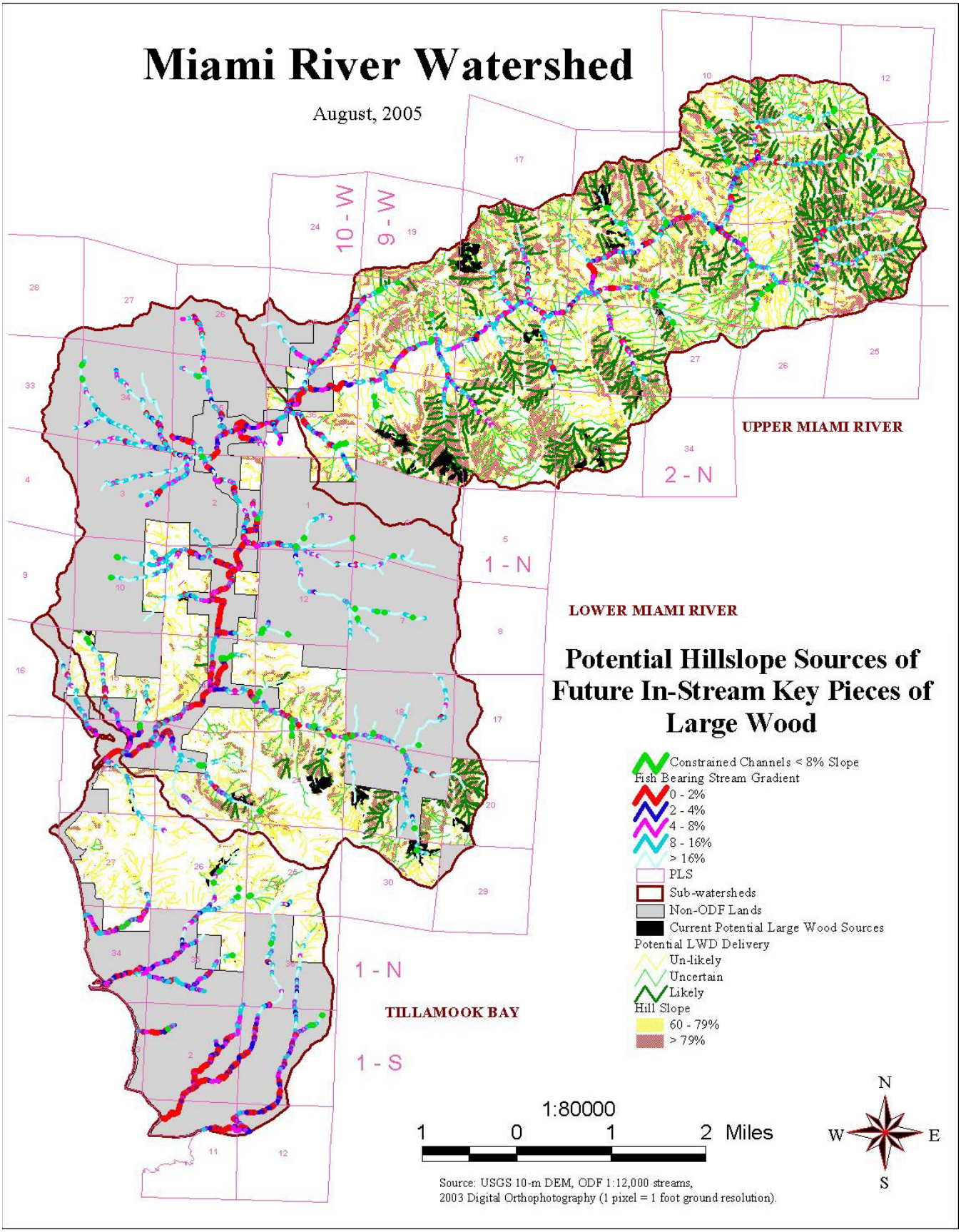

Figure 7. Potential hillslope sources of future in-stream key pieces of large wood debris.

Channels where potential scour impacts can be expected on ODF land in the project area are estimated to include all of the debris flow-prone channels. These are the very steep gradient headwater channel types (see Figure 14). Debris flows initiating in these channels could be expected to result in considerable downstream scour to a point where channel gradient and confinement decline (Figure 45).

First- and second- order Type N, debris flow-prone headwater channels that are directly tributary to the Miami River in the upper subwatershed are direct links between potential hillslope sources of large wood and critical habitat. An abundance of these channel types are located in the upper reaches of the North and South Forks. Evidence of excessive scour in some of these channels was observed in the field, along with debris fan features at their mouths in the bottom of the canyon. However, LWD recruitment potential along these channels is currently poor because of the predominance of hardwood and young forest cover types on the contributing hillslopes. Hence, the function of these Type N streams in particular to deliver large wood directly to critical habitat via shallow-rapid landslides is diminished.

Reaches represented by channel habitat types exhibiting a low (<2%) or moderate (2-8%) gradient that are downstream from steep channels, represent locations where slide deposits could potentially accumulate (Figure 45). These are the lowest reaches of many of the primary tributaries in the upper Miami that connect with the main valley floor, and are reaches where the potential for channel aggradation is high. Most are Type F streams that are directly tributary to critical habitat.

Examples where bedload deposits and debris fans were observed during field reconnaissance and in habitat surveys included the lower reaches of Diamond and Moss Creeks, and the base of several steep, first-order tributary channels to the North and South Forks. Such deposits can act as barriers to fish movement during periods of low flow in the smaller tributaries. Additionally, critical habitat in the Miami River is also where slide deposits can accumulate. Slide materials, particularly LWD originating from first- and second order debris flow-prone channels are often transported directly to the main river where they may become incorporated and provide key structural components beneficial to the complexity of aquatic habitat.

There is no inventory data specific to the project area that evaluates the natural range of landslide occurrence compared to the incidence of slides attributable to human disturbance. An inventory of landslides in the nearby West Fork of the Wilson River after the1996 flood concluded that the incidence of road-related landslides and washouts represented an elevated rate of occurrence above the natural range. On ODF lands past wildfire and timber harvest activities (including road construction) are inferred to have increased the incidence of shallow-rapid landslides where the forest cover was removed, particularly on the steep and very steep slopes in the upper Miami. Since then, the elevated rate of occurrence is believed to have declined markedly because of the reestablishment of a dense forest cover and refinements to timber harvest and road construction practices (Robison et al 1999).

At present, landslide initiation on ODF lands attributable to management is associated primarily with roads on steep slopes. The RIMS data identifies critical road locations considered to be a high potential of impending failure or washout and the relative risk to aquatic and riparian resources. These represent sites where unwanted sediment impacts could affect fish-bearing streams and critical habitat (see following sections for locations of high risk road segments).