Item #46: Water Yield Change from Timber Harvest

Evaluation Objectives: To determine if changes are occurring in water quantity from land management activities.

Methods: Increases in water yield is a concern because this can directly or indirectly impact stream channels. Therefore, the condition of stream channels can serve as a surrogate for water yield increases that may be associated with timber harvest. The PACFISH/INFISH Biological Opinion (PIBO) data set is used to evaluate stream channel conditions that may be affected by increases in water yield.

Evaluation: Determination of how timber harvest affects water yield requires a paired watershed study (Troendle and King 1985). This approach has been widely used during the last several decades in hydrologic research. Such a study requires a 5-10 year calibration period, then several years of monitoring to isolate the effects of harvest. Current budgets cannot possibly support such a study. However, one attempt was made to assess changes in water yield from land management activities in the 1990s, but failed due to a large forest fire in the study area and lack of data correlation (Forest Plan Monitoring Report 1993-1997). Since then, no attempt has been made to establish other study areas due to funding constraints. However, during the early 1990s, a Colorado State University study was initiated to address water yield issues in northwest Montana. A five year forest plan review recommended that this study identify "water yield thresholds" to be adopted in the forest plan (Sirucek 1992). The study was completed in 1995 (MacDonald et al. 1995), and concluded that *"establishment of specific management thresholds rapidly expands into the arena of economic and social values. Key questions - - how much change is acceptable, or how much risk is acceptable – do not have a technical answer. The plot of exposed bank versus predicted peak monthly water yield increase shows that a basin with minimal management can have the same percent exposed bank as an intensively managed basin (Figure 4-1). There is a clear and statistically significant trend, but the noise in the data precludes designating a threshold that can be applied in all cases.* This study found no relationship between channel dimensions and management indices related to water yield increases. In contrast, significant correlations were found between water yield indices and channel characteristics including bank stability and median particle size.

To determine if water yield increases may be affecting channel characteristics, three habitat parameters were identified for analysis. These include median particle size, bank angle, and percent undercut banks. A review of the PIBO monitoring sites indicate that most of the managed sites are in locations where large wildfires have occurred within the last 10 years. This makes it extremely difficult to make a distinction between fire effects and timber harvest effects. Timber harvest has occurred upstream of all managed sites, while fire has occurred in many of them. Fire has also occurred upstream of reference sites within the last several years, particularly in the Bob Marshall Wilderness. Tables 46-1 and 46-2 summarize the statistical analysis results using the ANCOVA and regression approaches, respectively.

Table 46-1. ANCOVA of Habitat Variables in Managed and Reference Sites That Could Be Affected by Changes in Water Yield.

Variable	Mean Managed (n=42)	Managed SE	Mean Reference (n=28)	Reference SE	*P*-value
Median Particle Size	0.047	0.004	0.052	0.01	0.42
Bank Angle	97.6	2.9	113.5	3.8	0.002
Percent Undercut Banks	32.3	2.8	22.0	3.6	0.03

Table 46-2: Regression Analysis of Habitat Variables in Managed and Reference Sites That Could be Affected by Changes in Water Yield.

Variable	Mean Residuals Managed (n=42)	Managed SE	Mean Residuals Reference (n=28)	Reference SE	*P*-value
Median Particle Size	-0.014	0.005	0	0.004	0.003
Bank Angle	-19	23.4	0	18.6	0.0001
Percent Undercut Banks	5.77	3.64	0	2.88	0.12

The ANCOVA approach (Table 46-1) shows that significant differences exist between reference and managed sites for streambank characteristics, but not for median particle size. Interestingly, the results show unexpected differences in the mean values for bank angle and percent of undercut banks, with managed sites having significantly steeper banks and more undercut banks than reference sites. This would indicate that managed sites are not be affected by changes in water yield. During the past several years, increases in water yield has been a concern because of bank erosion. However, the results of this analysis do not support this theory. The regression approach yielded significance differences ($P<0.10$) for median particle size and bank angle, but not for undercut banks. This analysis shows that bank angle may be the most sensitive parameter to management activities, since it is significantly different in both statistical approaches. However, it was expected that bank angle would higher in managed sites, instead of less than reference sites.

Recommended Action: Reporting of this item should be discontinued. This monitoring item was developed when the Flathead National Forest was doing relatively large scale timber harvest, and much of it was in the form of clearcuts. This type of management caused concern about water yield. However, this type of management does not occur as often, and the annual volume of timber produced by the forest has decreased since the Forest Plan was developed.

From 1998 to 2007, around 34% of the timber volume produced by the forest has been in the form of post-fire salvage, a practice that does not affect water yield. This is because removal of dead or dying trees does not reduce evapotranspiration. Harvest of green trees has generally been focused on fuel reduction in the wildland urban interface. The amount of harvest needed to

measurably affect water yield is not likely to occur in the future because of other management direction that limits timber harvest (i.e. grizzly bear security and bull trout habitat).