

Quantifying Benefits to Water Quality from Livestock Exclusion and Riparian Buffer Establishment for Stream Restoration

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When a stream restoration project is proposed in areas with grazing and/or row crops, water quality improvements from buffer restoration and livestock exclusion is always noted and emphasized by providers. The 2014 Monitoring Guidance and the 2015 Mitigation Plan Guidance both require that all claims for improvement be measurable. In the case of establishment of buffer and/or cattle exclusion, the performance standards and monitoring rarely include measurement. For the functional uplift associated with these water quality issues to be fully recognized, quantification of nutrient and/or fecal coliform reductions related to loading and filtering is required (see supplement document “Fecal Coliform Attenuation by Riparian Buffers” for more information). Using simple tools, these reductions can be estimated and included in the mitigation plan goals, monitoring plan and performance standards. NC Division of Mitigation Services (DMS) requires the use of the simple equations below to estimate reduction in nutrient and/or bacteria loading associated with restoring riparian buffers. These equations are applicable for a minimum width of 50ft riparian buffers and/or cattle exclusion (50ft from top of bank). Other innovative and alternative quantification tools can be submitted to DMS for consideration and approval.

Estimating Nutrients (Total Nitrogen and Total Phosphorus) Reduction

Agriculture (Row Crops): The annual rate of nutrient removal can be calculated by using “NC Division of Water Quality – Methodology and Calculation (1998) for determining nutrient reductions associated with Riparian Buffer Establishment.”. Under this methodology, one acre of restored riparian buffer area adjacent to row crop fields removes 75.77 lbs of total nitrogen (TN) and 4.88 lbs of total phosphorus (TP) annually.

Nutrient Reduction from Buffer Adjacent to Agricultural Fields

TN reduction (lbs/yr) = 75.77 (lbs/ac/yr) x Area (ac)

TP reduction (lbs/yr) = 4.88 (lbs/ac/yr) x Area (ac)

Where:

TN – total nitrogen;

TP – total phosphorus; and

Area – total area of restored riparian buffers adjacent to agricultural fields.

Cattle Exclusion (Grazing Pasture) : It is estimated that one acre of livestock exclusion areas removes 51.04 lbs of total nitrogen (TN) and 4.23 lbs of total phosphorus (TP) annually.

TN reduction (lbs/yr) = 51.04 (lbs/ac/yr) x Area (ac)

TP reduction (lbs/yr) = 4.23 (lbs/ac/yr) x Area (ac)

Where:

TN – total nitrogen;

TP – total phosphorus; and

Area – total area of restored riparian buffers inside of livestock exclusion fences.

Estimating Fecal Coliform Reduction due to Livestock Exclusion

Human and animal waste contribute to aquatic degradation through the introduction of pathogenic microorganisms and concentrated organic matter contributing to the biochemical oxygen demand (BOD), thereby contributing to the reduction of oxygen levels in the water. Fecal coliform is used as an indicator of these pollution sources/stressors. Agricultural practices such as allowing livestock to graze near water bodies, spreading [manure](#) as [fertilizer](#) on fields during wet periods, and allowing livestock to water in streams can all contribute to fecal coliform contamination. Fecal coliform reduction can be estimated by quantifying the amount of fecal coliform that would no longer be directly deposited in the subject stream as a result of excluding livestock and by estimating the amount filtered out as a result of the restored buffer. The combination of both types of reduction is described in the equation:

Total Fecal Coliform Reduction (col) = Fecal Coliform Reduction from Direct Input + Fecal Coliform Reduction from Riparian Buffer Filtration

1. Estimating the Amount of Fecal Coliform Prevented from Entering Stream due to Livestock Exclusion (Fecal Coliform Reduction from Direct Input)

Fecal Coliform Reduction from Direct Input (col) = 2.2×10^{11} (col/AU/day) x AU x 0.085

Where:

Quantities of Fecal Coliform bacteria as numbers of colonies (col).

It is estimated that one animal unit (AU) of cattle produces 2.2×10^{11} colonies of fecal coliform bacteria per day on average.

An animal unit (AU) is one thousand pounds of livestock. It can be calculated by Combined weight of all livestock / 1000.

It is estimated that between 6.7 to 10% of fecal coliform bacteria are directly deposited into a stream if livestock are not excluded, and the water from the

stream is the only source of the drinking water for livestock. An average of 8.5% is used in the equation.

2. Estimating Fecal Coliform Reduction Due to Riparian Buffer Filtration (Fecal Coliform Reduction from Riparian Buffer Filtering)

Fecal Coliform Reduction from Buffer Filtration (col) = Runoff's fecal coliform concentration (col/gal) x Runoff volume (Gal) x 0.85

Common Fecal Coliform Concentration from Grazed Pasture

Livestock Operation	Fecal Coliform Concentration (col/gal)
Pastures under Continually Grazing Year-round	1.894 x 10 ⁶
Pastures Grazed for Half of Year	3.295 x 10 ⁵
Pastures Grazed for Two Months of Year	3.409 x 10 ⁵

The volume of runoff from pastures can be estimated by using SCS runoff curve number (USDA Natural Resources Conservation Service).

$$Q = (P - 0.2S)^2 / (P + 0.8S)$$

$$S = (1000 / CN) - 10$$

Where:

- Q – accumulated direct runoff (in);
- P – accumulated rainfall (in);
- S – Potential maximum retention; and
- CN – the runoff curve number.

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