Biofilm Response to Nutrient Mitigation Using Salmon Carcass Analog in Central Idaho Streams

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Background

• Spawning salmon are an important source of nutrients for stream biofilms1.
• In the Pacific Northwest, salmon returns have declined 10 to 20-fold due to overharvesting, habitat degradation, hatchery management and dams2.
• Nutrient additions are a widely proposed mitigation technique in Idaho, as streams receive 5-7% of historic salmon nutrient loads3.
• Objective: To determine the benthic biofilm response to nutrient mitigation in the upper Salmon River basin.

Figure 1. Study streams (blue) are located in tributary drainages of the Salmon river in central Idaho.

Methods

Hypothesis I: Biofilm biomass will increase in stream reaches following SCA addition.

Methods: We scrubbed biofilms from haphazardly collected rocks from U, M, L reaches before and after SCA addition, and the resultant slurry was filtered onto glass fiber filters.

Figure 3. Biofilm chlorophyll a and ash free dry mass (AFDM) increased following treatment with high SCA, but responded variably to low SCA. Chlorophyll a response was not proportional to AFDM. Error bars ± 1 S.E., n = 2 for each bar.

Hypothesis II: Nutrient limitation of biofilm biomass changes following SCA addition.

Methods: Biofilm nutrient limitation was measured before and after SCA addition using nutrient diffusing substrates (NDS).

Figure 4. Example of chlorophyll a responses on nutrient diffusing substrates in one stream following treatment with high SCA. Chlorophyll a was highest on N-enriched substrates in the treatment reach, suggesting an increase in N-limitation with SCA addition. Error bars are ± 1 S.E., n = 6 for each bar.

Hypothesis III. Gross primary production (GPP) and ecosystem respiration (ER) will increase following SCA addition.

Methods: We quantified GPP and ER by measuring changes in dissolved oxygen (DO2) concentration from day to night periods (~36 hours) with YSI sondes.

Figure 5. DO2 and temperature curves for Basin Creek (low SCA). Treatment segment is shown in blue and control segment in orange. Solid lines indicate %DO2, dashed lines indicate temperature.

Figure 6. Predicted DPR for habitat (left) and reach (right) scales4.

Discussion

Hypothesis I

• Lack of consistent responses between chlorophyll a and AFDM suggests that algae and heterotrophs may have responded differently to SCA additions.
• High among-stream variability in short-term chlorophyll a and AFDM indicate biofilm response may be stream-specific and nutrient mitigation could require consideration of local habitat conditions.

Hypothesis II

• Preliminary analysis suggests study streams are primarily N-limited and SCA treatment does not dramatically alter limitation patterns.

Future Directions

Objectives:
(i) To quantify shifts in biofilm community structure following SCA addition.
• Hypothesis: SCA alters the relative proportions of microbial functional groups (e.g., algae, bacteria, fungi).
(ii) To examine the effect of spatial scale on the relationship between biofilm functional diversity and productivity (DPR).
• Hypothesis: The relationship between biofilm functional diversity and net ecosystem productivity is scale-dependent (Figure 6).

Hypothesis III

• Nutrients added as salmon carcass analog (SCA; made from dried and pasteurized marine fish meal).
• Annual additions began in August 2010
• Two streams received high (150g/m2) SCA, two received low (30g/m2) SCA, two streams were untreated controls.

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Literature Cited