PHYSIOLOGICAL STRESS RESPONSES

OF STREAM DWELLING RAINBOW TROUT

TO CLEAR-CUT LOGGING

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EXTENDED ABSTRACT ONLY – DO NOT CITE

Introduction

Stress in fish affects a variety of functions, including reproduction, growth and resistance to disease (Wedemeyer et al. 1984). Because clear-cut logging remains the most common logging practice in British Columbia, Canada, the potential exists for impacts associated with the removal of riparian vegetation to be stressful to stream dwelling fish. We examined the effects of clear-cut logging on the health of rainbow trout (*Oncorhynchus mykiss*) in the central interior of BC, a region characterized by a temperate climate. Indicators of fish health comprised body condition and physiological stress responses (both acute and chronic).

Methods

Fish were sampled in September/October 1996 from 15 small (bankfull width 2.4-4.7m) streams divided into 3 categories: unlogged (control), recently logged (clear-cut to both stream banks within the last 5-10 years), and older logged (clear cut more than 25 years ago). We did not measure potential stressors in our streams, and instead assumed that our categorization of logging integrated all

associated impacts, whatever they may be. However, high temperatures (resulting from reductions in riparian canopy cover) and increased suspended sediment levels (resulting from recent road building activities) were likely the primary stressors acting on fish in streams with recently harvested riparian zones. Likewise, habitat alterations (resulting from long-term reductions in large organic debris recruitment) were likely the primary stressors operating in older clear-cut streams. We chose plasma cortisol, glucose and chloride concentrations as indicators of acute stress (Wedemeyer et al. 1984), and interrenal nuclear diameters (IRND; Donaldson et al. 1984), impairment of the plasma cortisol response (Hontela et al. 1992), and fish condition as indicators of chronic stress. If clear-cut logging is stressful to stream dwelling fish, then we predict plasma cortisol and glucose levels, as well as interrenal nuclear diameters, would be greater in fish from logged streams compared to fish from control streams. In addition, we predict that fish from the two logged categories would show lower plasma chloride concentrations and body condition, as well as showing evidence of impairment of the cortisol response system. Mean values for IRND and for each haematological indicator were grouped according to treatment and were compared using analysis of variance (ANOVA). Fish condition was assessed by comparing length-weight relationships across our three treatments using analysis of covariance (ANCOVA).

Results and Discussion

Plasma glucose concentration was the only acute stress indicator that showed a response to clear-cut logging, with fish from older logged streams exhibiting significantly higher ($p<0.001$) levels than fish from either the recently logged or control streams. However, blood glucose levels are influenced by diet and satiation levels (Barton et al. 1988), and these are factors we could not control for in our study. We therefore urge caution in interpreting the glucose results, and because cortisol concentrations do not appear to be influenced by diet and satiation level (Barton et al. 1988), we instead place greater emphasis on our cortisol results (which showed no acute responses to clear-cut logging).

With respect to our chronic stress indicators, no impairment of the cortisol response was evident in the treatment streams. On the other hand, fish from recently logged streams had significantly larger ($p<0.001$) mean IRND values than fish from either the control or older logged streams (Fig. 1), suggesting the presence of a chronic stressor(s) within that treatment category. However, the average increase in IRND was approximately 3% relative to the control streams,

compared to increases of 9-25% reported in the literature for chronically stressed fish. In addition, Donaldson et al. (1984) and Brown et al. (18984) found increases in plasma cortisol concentrations that were concomitant with increases in IRND, a finding not supported by our results. (Because interrenal cells are the cells that produce cortisol, an increase in IRND is expected to be accompanied by an increase in cortisol levels). Therefore, while our IRND results are statistically significant, we question their biological validity.

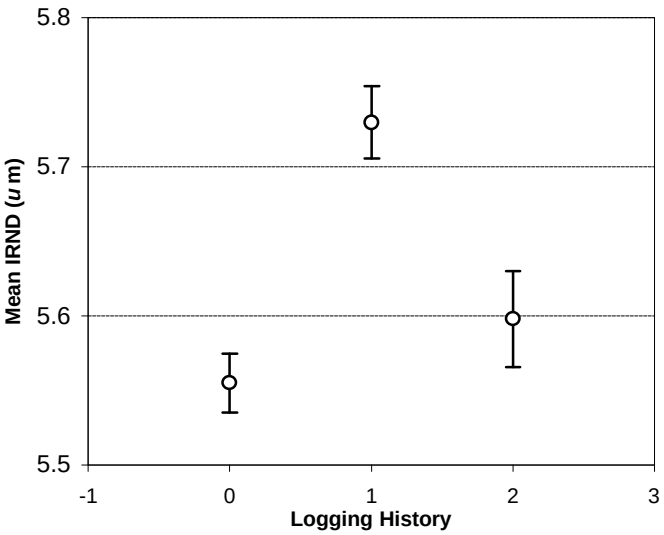

Fig. 1. Mean interrenal cell size in rainbow trout grouped into three logging categories. The categories (and sample sizes) are: 0=Unlogged (223 fish);

With respect to fish condition, the ANCOVA results showed that the slopes of all three length-weight regressions were homogeneous, and that the regression intercepts (treatment effects) were significantly higher ($p<0.001$) for newly logged and older logged streams when compared to the control streams (Fig. 2). This suggests that fish from streams that were clear-cut (either recently or over 25 years ago) were significantly heavier across all lengths compared to fish from unlogged streams.

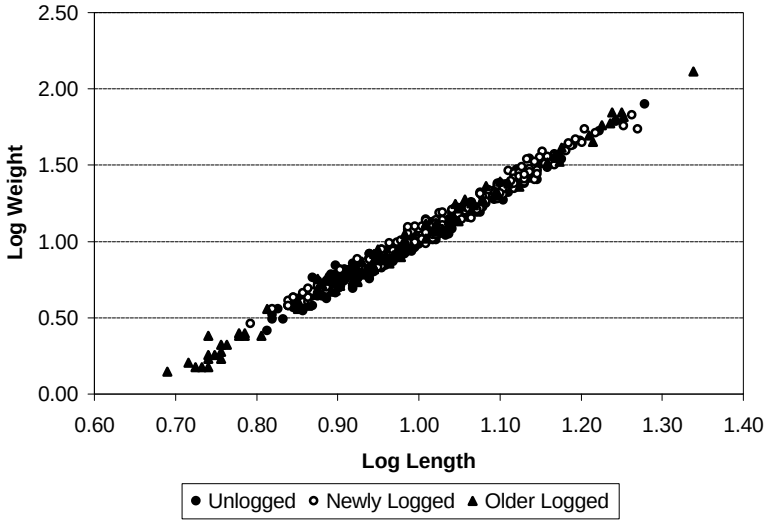

Fig. 2. Length-weight relationships for rainbow trout grouped into three logging categories. Regression lines have been omitted for clarity. ANCOVA results indicated the regressions slopes for all categories were parallel, and that the slopes representing the newly logged and older logged streams were significantly higher when compared to the unlogged streams. Sample sizes as in Fig. 1.

Conclusions

Our results suggest that clear-cut logging (even without riparian buffer strips) may not be detrimental to fish health (as measured by our acute and chronic stress indicators) in central interior streams of British Columbia. Furthermore, streamside harvesting may confer some benefit to fish growth (as measured using fish condition) over the time interval covered by our study. However, in the absence of further analyses (incorporating fish abundance and size distributions, as well as stream physical attributes), we must emphasize the preliminary nature of our conclusions.

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