

## Response to Policy regarding Amphibian Viability

Q. "Viability" was equated with "density" at the monitored sites. What other metrics could be used?

Viability is the language used in Schedule L-1 and the CMER Work Plan; however, details about how to evaluate "viability" were not provided. Several metrics other than density could have been used, including occupancy, body condition, and genetics (e.g., genetic diversity), and all of these are reported on as a part of the current study analysis:

**Occupancy:** Though we include an evaluation of occupancy in the report (see **Section 15-9.1**), we did not use occupancy as a surrogate for viability in our evaluation of treatment performance since this metric is relatively coarse and does not reflect smaller changes in a population that are more likely to occur in the two years post-harvest. One would only expect a change in occupancy if there was complete emigration out of a site or all animals were locally extirpated; see **Section 15-10.1**. Further, we had no way of addressing the potential confound between low abundance (density) and detection: "While the light-touch method has been demonstrated to be effective for sampling stream-associated amphibians (Lowe and Bolger 2002; Hayes et al. 2006; Quinn et al. 2007; Kroll et al. 2008; Kroll et al. 2010), failure to detect a species when present can be an issue when the population size is small or density is low, or when individuals are difficult to sample and thus detect (Gu and Swihart 2004)... detection probability may be strongly associated with density (Royle and Nichols 2003; MacKenzie et al. 2005) and failing to allow for the possibility that focal species were present, but undetected, could lead to biased estimates of site occupancy (MacKenzie et al. 2003). For these reasons we interpret changes in detection of occupancy with caution. We conclude no evidence of local extirpation along headwater streams in the two-year period immediately following timber harvest, regardless of the degree of protection afforded to the stream by the riparian buffer." (**Section 15-10.1**)

**Body Condition:** An evaluation of body condition can be useful for detecting short-term responses. "Amphibian body condition in terms of nutrient storage has been correlated with movement (Lowe et al. 2006) and survival (Reading 2007; Scott et al. 2007), and may be considered a sign of both overall health as well as reproductive success (Moya-Larano et al. 2008). In theory, body condition reflects an animal's energy reserves and can be associated with environmental characteristics such as habitat quality and prey availability (Stevenson and Woods 2006; Pope and Matthews 2009)." We had no evidence of a treatment effect on body condition for any species. However, we found these results less informative and did not report on these findings in the presentation to Policy because: (1) we were unable to include tailed frog post-metamorphs in our analysis due to a very small sample size; (2) since we removed animals with evidence of injury from our analyses of body condition we may have inadvertently introduced bias if the injury was the result of treatment and those injuries caused reduced fitness (we believe the potential for this is slight); and (3) the precision of our scales (0.1 g) limited our ability to detect small changes in body condition reflected by individual body weight changes of less than 0.1 g. (see **Section 15-10.4**).

**Genetics:** Genetic data can also be used to assess "viability", but genetic changes typically occur over multiple generations and stream-associated amphibians have generation times on the order of 7+ years. Results from this component of the study required genetic resampling in post-harvest years 7 and 8. A report has been developed and is currently in ISPR review.

**Density**: We used density as the focal response to evaluate viability for the following reasons: (1) it has the capacity to reflect both positive and negative impacts (unlike occupancy, which can only detect negative impacts); (2) it has the capacity to detect small responses (increases and/or decreases) rather than requiring a large response (local extirpation); and (3) since we incorporated estimates of detection to adjust animal counts, density reflects the response of the entire headwater amphibian population, and not just the individuals that were detected during sampling. However, like all potential viability metrics listed above, the point at which density is equated with viability has not been established.