From:	Greg Anderson
To:	Smith, Kimberly
Subject:	RE: Roanoke Logperch Abundance Estimates
Date:	Tuesday, May 31, 2016 4:41:16 PM
Attachments:	MVP_20160519_USFWS_RoanokeLogperch_AbunEst.

Thanks, Kim. I appreciate you taking the time to read through it. If you have any questions, feel free to call me anytime. My cell is 706-247-6462 and my direct line at work is 513-591-4303.

I should note that I miscited a report by Jamie Roberts in the document. I accidently cited a report of the same year rather than his dissertation. I am attaching a new document to this email with this correction, but the only change is the one citation.

I hope things are well in Virginia. I look forward to talking later this week.

Greg

From: Smith, Kimberly [mailto:kimberly_smith@fws.gov]
Sent: Tuesday, May 31, 2016 4:22 PM
To: Greg Anderson <ganderson@envsi.com>
Subject: Re: Roanoke Logperch Abundance Estimates

Hi Greg,

I have not had a chance to review this. Will get back to you this week.

Kim

On Thu, May 19, 2016 at 5:54 PM, Greg Anderson <ganderson@envsi.com> wrote:

> Hi Kim,
>
> This is Greg Anderson at Environmental Solutions and Innovations. With field surveys for aquatic endangered species coming close to an end for the Mountain Valley Pipeline, we are currently working on incorporating the U.S. Fish and Wildlife's comments and thoughts from our meeting in Virginia on 7 April 2016.
>
> One main item that we have been struggling with is how to estimate impacts to Roanoke logperch in watersheds where the species has not been captured (e.g., Blackwater River) and in waterbodies that are on the periphery of the range but occurrence is still possible. In our original draft of a Biological Assessment for the project, impacts to the species were largely restricted to waterbodies with known occurrence (e.g., North Fork Roanoke River); however, based on your comments during our meeting and from the Roanoke logperch habitat surveys, we are now assuming presence in many more waterbodies (e.g., Blackwater River, Harpen Creek, Maggodee Creek) in the upper Roanoke, Pigg, and Blackwater drainages. You may recall that we previously used density estimates derived from Roberts (2012) to assess impacts to Roanoke logperch, but it is unclear to us how to use these density estimates in waterbodies that were not included in his analysis. After

thinking about this problem for some time, we derived an approach to estimate Roanoke logperch using a model-based method that combines publicly available fish survey data in conjunction with an estimate of capture probability of the species (including uncertainty about this estimate). Before proceeding with this approach, I wanted to get your thoughts and opinions and to ensure this approach seems reasonable. I am attaching a quick write-up of the approach that also includes more information regarding the density estimates made previously by Roberts (2012). I know that your office is tight on time, but I would greatly appreciate it if you could take a few minutes and look this over and provide comments.

If you have any questions, please let me know.

Sincerely,

Greg

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Pesi 593.25 19 May 2016

Ms. Kimberly Smith
Fish & Wildlife Biologist
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Dear Ms. Smith:

RE: Density Estimates of Roanoke Logperch

As discussed in a previous consultation with the U.S. Fish and Wildlife Service, Mountain Valley Pipeline, LLC (MVP; Project) proposes to cross portions of the Roanoke-Chowan basin as part of its route from the existing Equitrans, L.P. transmission system and other natural gas facilities Wetzel County, West Virginia to the existing Transcontinental Gas Pipe Line Company, LLC's Zone 5 compressor station 165 in Pittsylvania County, Virginia. As part of the proposed route, the pipeline will traverse several stream catchments and streams within the upper Roanoke sub-basin (U.S. Geological Survey's hydrologic unit code [HUC] 8 03010101) where Roanoke Logperch (*Percina rex*) are known to occur. Potential impacts in streams include both direct effects within the Limits of Disturbance (LOD) as well as indirect effects of sedimentation increases downstream of the LOD. Environmental Solutions & Innovations, Inc. (ESI) is responsible for drafting the Biological Assessment to evaluate the potential effects that the project may have on the Roanoke logperch. Per conversations with you in April 2016, we are seeking guidance/comments regarding our proposed methods of determining population densities of Roanoke logperch in watersheds where the species occur, or may potentially occur but have not been recorded (e.g., Blackwater River system).

Background

Our Former approach to assessing impacts to the Roanoke logperch involved adopting density estimates (i.e., number of individuals per stream kilometer) previously made for the species in both the upper Roanoke River drainage and Pigg River drainage by Roberts (2012). However, these density estimates were made exclusively based on the known extent of the species and estimates were made using only a select few surveys (i.e., those surveys that were sampled using a quadrat-based experimental design; see below).

In areas such as the upper and lower Blackwater River watersheds, where the species has not be observed, it is not clear how to apply the density estimates made by Roberts (2012). Similarly, in waterbodies that are not within the current known extent of the species but are presumed-occupied based on the Lahey and Angermeier (2007) screening model, the density estimates made by Roberts (2012) may not be appropriate.

Below, ESI outlines an Alternative approach to estimate densities throughout the Roanoke logperch distributional range that bisects MVP proposed route including watersheds where Roanoke logperch are present (e.g., upper Roanoke and Pigg rivers) as well as watersheds where Roanoke logperch have not be captured but are assumed occupied (e.g., Blackwater River, North Fork Blackwater River, Bradshaw Creek). We first present the Former approach beginning with a brief summarization of the approach taken by Roberts (2012) to estimate population densities. Then, we present the Alternative approach using available data as well as a statistical model that incorporates both prior information on capture probabilities as well as an approach to relate abundance to environmental covariates (e.g., catchment area).

Before proceeding with the Alternative approach, ESI is respectfully requesting a review of the proposed methods and concurrence with the approach. We believe these methods represent the best available science; however, if a more appropriate approach is available, guidance would be appreciated.

Former Approach - Abundance Estimation Approach of Roberts (2012)
Recognizing that no estimates were available of absolute population sizes for Roanoke logperch, Roberts (2012) derived 'coarse' population estimates based on (1) estimates of range extent, (2) frequency and availability of habitat, (3) relative abundance in habitat patches, and (4) estimates of capture probability. The approach used was fairly simple, mean abundance in habitat patches for each population of Roanoke logperch (i.e., upper Roanoke, Pigg, Goose, Otter, Lower Smith, Upper Smith, and Nottoway) was estimated as the product of the mean relative abundance observed for the population and a capture probability. The capture probability was derived from a mark recapture study conducted by Roberts and Anderson (2013) and was estimated at 0.1 or 10 percent. Relative abundance estimates were derived from a variety of sources that had a common sampling approach of quadrat-based electrofishing (see Roberts and Anderson 2013). Using these estimates of abundance in habitat patches, densities of the species were estimated as the product of abundance and habitat patch frequency per kilometer. Like relative abundances, patch frequencies were derived from several literature sources. Using this Roanoke logperch density estimate, Roberts (2012) was able to estimate total population size as the product of the range extent and Roanoke logperch density.

The Roberts (2012) approach most likely provides a reasonable estimate of total population size for each respective population (e.g., Pigg), but lacks the ability to make site-specific estimates of abundance in different waterbodies. This is especially true for waterbodies at the periphery of the range extent or in waterbodies belonging to drainages outside the known range extent but may be occupied. Estimates of relative abundance in Roberts (2012) were derived mostly from localities where the species was expected to occur and occur in high numbers (e.g., Roanoke River). However, logperch have a moderately large extent within each population and can be found in streams as small as second-order (Lahey and Angermeier 2007). Thus, using population estimates derived from larger waterbodies may be a less appropriate use of the Roberts' (2012) estimate.

Alternative Approach

Abundance Estimation using N-mixture Models

An alternative approach to estimating site-specific or patch-specific estimates of Roanoke logperch is through the use of site-occupancy modeling; namely, N-mixture models (Royle 2004). The most standard N-mixture model utilizes replicated captures of a species at multiple sites in order to decompose per-individual detection probability (p) and site abundance (N). Using this class of models, abundance can be regressed against covariates to test hypotheses regarding variation in abundance using the Poisson distribution:

$$N_i \sim \text{Poisson}\ (\ln(\beta_0 + \beta_1 * x_i)), \qquad \text{Eq. 1}$$

where β_0 and β_1 are regression coefficients and x_i is a variable hypothesized to be correlated with abundance (e.g., watershed area). Note that in this model N is not a known variable but is estimated in conjunction with a process component (i.e., per-individual detection). However, in order to decompose N and p, repeated measures (i.e., samples over a period where population size is not expected to change) are required (but see Sólymos et al. 2012) and often a large number of samples is needed (>200). These requirements are mainly needed to estimate p, but if p is known or can be limited to a smaller range of values, this sample size can be reduced and abundances can be estimated using information from a single visit.

The advantage of this model-based approach to estimate population densities is three-fold. First, heterogeneity in abundance among populations and within populations can be accounted for using linear regression. Second, uncertainty regarding per-individual can be directly incorporated into the model by using both point estimates of capture probability (i.e., 0.1) as well as confidence bounds from available reports (e.g.,0.04-0.21 [Roberts and Anderson 2013]). Third, this approach allows the incorporation of fish capture data from multiple sources. By allowing detection to vary among these sources and accounting for this variation in the estimates of detection, information from surveys that did not incorporate a quadrat-based sampling design can be included.

In addition to these benefits, this approach can also be used to model abundance in watersheds and waterbodies where no captures of Roanoke logperch have been made but are assumed to be present (e.g., Blackwater River). To restrict abundance to be greater than zero, a zero-truncated Poisson distribution can be used in Eq. 1 rather than the typical Poisson. Such an adjustment restricts N to be one or greater.

Application to Roanoke Logperch Populations in the Upper Roanoke

The approach described above can easily be adapted to Roanoke logperch populations in the upper Roanoke subbasin. Within the upper Roanoke, several fish collections are publicly available from various reports, dissertations, theses, scientific papers, and databases, including: James (1979), Burkhead (1983), Simonson and Neves (1986), Ferguson et al. (1994), Stancil (2000), Lahey and Angermeier (2007), Roberts and Anderson (2013), VADEQ (2015), and Anderson and Angermeier (2015). In total, these collections provide 159 unique stream segments (i.e., reaches of stream between confluences of other streams) that have at least one sample for fish. However, using the Lahey and Angermeier (2007) screening model, only 118 are within the possible distribution of the species. These samples can be used in conjunction with prior information on estimates of capture rates (incorporating uncertainty bounds) to estimate abundance in occupied patches while accounting for heterogeneity among populations and within populations. More specifically, a few simplistic relationships using catchment area as a covariate of abundance will be fit. Using the best-supported model, abundance within habitat patches will be estimated and densities will be derived using the habitat frequencies available in Roberts (2012).

As mentioned above, it is our belief that this approach incorporates the best-available science and utilizes the best-available tools to estimate abundance of Roanoke logperch. **ESI is respectfully requesting a review of the proposed methods and concurrence with the Alternative approach.** However, if you have concerns about these methods or have a different approach available, please let us know.

Sincerely,

Gregory B. Anderson
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References

Anderson, G. B., and P. L. Angermeier. 2015. Assessing impacts of the Roanoke River Flood Reduction Project on the endangered Roanoke logperch. 2015 Annual Report to the Wilmington District, U. S. Army Corps of Engineers, Wilmington, NC.

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