Annex action E5
Technical protocol of evaluating response in fish to restoration in demonstration and reference streams using electrofishing


Photos Daniel Palm

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Forword

Numerous amounts of books, scientific reports and monitoring reports have been published describing how electrofishing should be conducted and how data should be processed in order to obtain information about fish populations of different species and environments, e.g. (Zippin 1956, Bohlin et al. 1989, Cowx and Fraser 2003, Cowx and Harvey 2003).This protocol is not written as another guide in how to conduct electrofishing. Instead, this protocol is written as a guide in how to obtain data on Atlantic salmon and Brown trout in streams of northern Sweden from electrofishing with higher accuracy compared to the standard procedure. The basis for the description is experiences gained from restoration project conducted from 2010 through 2015.

Monitoring sites

In order to evaluate the effects of demonstration restoration on fish abundance, we monitored seven demonstration reaches and compared them with their paired seven reference reaches (Figure 1). Reference reaches underwent best practice restoration around 2005. More details on the tributaries can be found in Table 1. Fish assemblages were assessed in August and September 2010 *(1 year before demonstration restoration)*, 2013 *(3 years after demonstration restoration)* and 2015 *(5 years after demonstration restoration).*

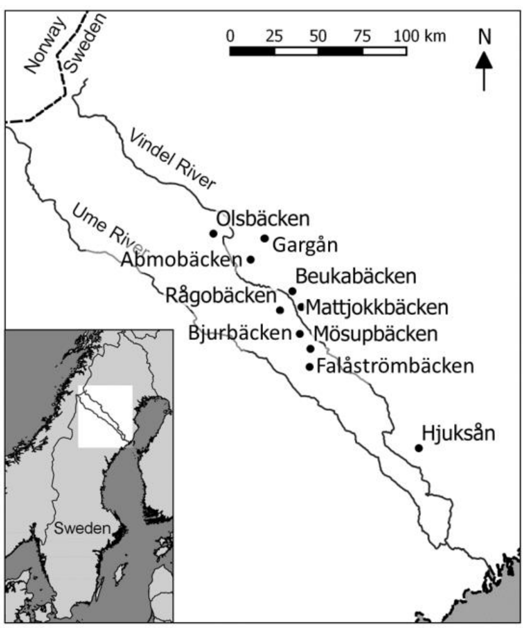

Figure 1: Tributaries in which demonstration and best practise restoration was conducted.

*Table 1: **Study reach information. Water level fluctuation (WLF) is the difference between the 95% high** and 5% low water levels measured between October 2011- August 2014. Shaded rows indicate sites were electrofishing was used.*

Tributary	Reach restoration WLF velocity (ms^{-1})†	type (cm)	Year of restoration	Spawning beds	Channel width (m)†	Flow
Abmobäcken	Demonstration	2010	yes	11.4	0.30	28.5
Abmobäcken	Reference	1996	no	10.6	0.35	42.4
Beukabäcken	Demonstration	2010	yes	11.2	0.23	41.8
Beukabäcken	Reference	2003	no	13.4	0.25	38.6
Bjurbäcken	Demonstration	2010	yes	21.7	0.42	92.6
Bjurbäcken	Reference	2002	no	18.8	0.51	60.5
Falåströmsbäcken		Demonstration		2010	yes	15.8
	0.39	28.8				
Falåströmsbäcken*		Reference	2010	no	8.0	0.26
	14.8					
Gargån	Demonstration	2010	yes	21.6	0.51	82.6
Gargån**	Reference	2005	no	49.7	0.24	86.6
Hjuksån	Demonstration	2010	yes	16.7	0.29	48.5
Hjuksån	Reference	2004‡	no	11.5	0.53	88.0
Mattjokkbäcken	Demonstration	2010	yes	11.8	0.52	77.2
Mattjokkbäcken	Reference	2003	no	10.0	0.69	77.2
Mösupbäcken	Demonstration	2010	yes	11.4	0.37	29.6
Mösupbäcken	Reference	2005	no	10.1	0.35	24.4
Olsbäcken	Demonstration	2010	yes	17.5	0.57	73.1
Olsbäcken	Reference	2003	no	20.5	0.62	81.4
Rågobäcken	Demonstration	2010	yes	11.5	0.63	57.8
Rågobäcken	Reference	2002	no	11.2	0.51	51.3

† Gardeström et al. 2013, measured at medium flow conditions.

* The reference site of Falåströmsbäcken was located in Västibäcken.

**The reference site of Gargån was located in Jörbokkforsen.

‡ The restoration of Hjuksån reference was very light, as the stream was not heavily impacted.

Electrofishing equipment

Fish were captured using a generator-powered electroshocker (Lugab, Luleå, Sweden) that produced constant direct current of 800 V.

Sampling procedure

Fish assemblages were assessed by thoroughly fishing each site (c. 40 meter of stream length) from downstream to upstream in three separate runs. Electrofishing was carried out by two persons. The first person carried the anode and the collection net. The second person carried the holding bucket. All fish collected were kept in the bucket during each run and was then placed in separate holding net until the three runs were completed. Prior to data collection fish was amnestied using MS-222. After data collection the fish was recovered in a recovery holding net and then returned back to the streams.

Data collection

All fish collected were identified to species and measured to the nearest mm. Totally, nine species of fish (brown trout, *Salmo trutta* L.; Atlantic salmon, *Salmo salar* L.; bullhead, *Cottus gobio* L.; minnow, *Phoxinus phoxinus* L.; grayling, *Thymallus thymallus* L.; northern pike *Esox lucius* L.; roach, *Rutilus rutilus* L.; burbot, *Lota lota* L.; and perch, *Perca fluviatilis* L.) were collected cumulatively across all sites.

Data processing

By applying the model described by Zippin (1956) the density of Brown trout and Atlantic salmon was estimated. To test if statistical differences in abundance in trout or salmon occurred between the two types of treatment (*demonstration* or *best practice restoration*) we used the statistical test ANOVA. We used *year*, *treatment* and *treatment***year* as factors and *stream* as a random factor.

Results

Two streams (Beukabäcken and Mattjokkbäcken) showed positive development in salmonid density at the enhanced sites whereas the other four streams showed negative development. However, no general statistical differences between demonstration restoration and best practise restoration were detected with respect to salmonids (brown trout and Atlantic salmon) abundance (Figure 2.) or biomass between the years 2010 and 2015.

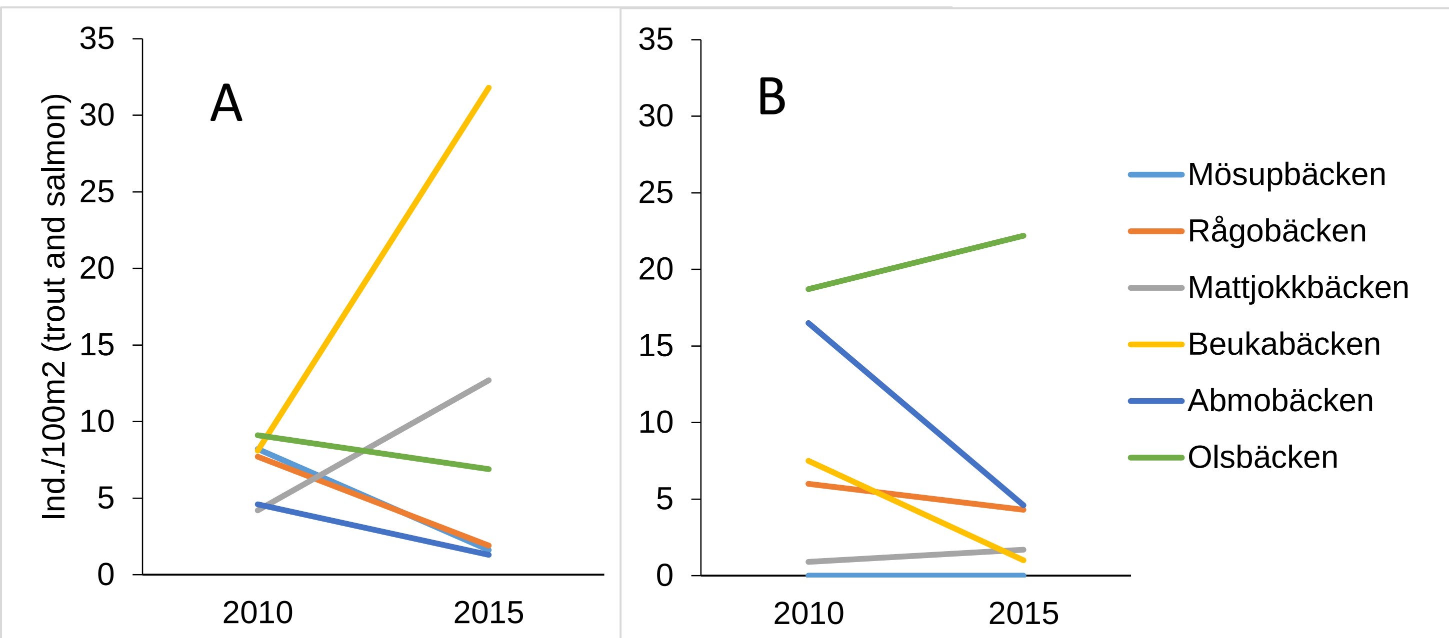

Figure 2. Salmonid (brown trout and Atlantic salmon) density (ind./100m^2) in six tributaries to the Vindel River. The capitals A and B indicates data from enhanced and basic restoration sites respectively.

Analyses of fish movement

To evaluate if fish movements could mask the effects of restoration on fish abundance estimates we carefully monitored fish movements in two tributaries of the Vindel River 2015 using Passive Integrated Transponders (*PIT-tag*). In total 838 individuals of trout and salmon were tagged. We also conducted several electrofishing trials within the same electrofishing reaches in the two streams during 2015.

The number of captured fish in each 50 m elctrofishing reach showed large variation between electrofishing occasions. For instance, the portion of trout that moved from their initial electrofishing section to another from one month to another was 53% in one of the streams. The majority of the migration from the tributaries into main river occurred between the end of August until mid November. The numbers of migrating individuals correspond to following portions: 60% for salmon in Beukabäcken, 11% for trout in Beukabäcken and 2% for trout in Nackbäcken of the tagged population.

Protocol for electrofishing in the future

Given our findings, movement of individuals is an aspect that needs to be considered when conducting electrofishing-based monitoring. The results also indicate that one should be careful when drawing general conclusions about salmonid density within specific reaches and how it might change over time. Our gained experiences from restoration project conducted from 2010 through 2015 condensate to the following four points:

1. Monitoring programs should in general increase the length of electrofishing reaches from the standard of a maximum 50 m to a minimum of 100m.
2. Electrofishing-based monitoring that aims to generate time series at specific reaches must be particularly careful when selecting date for sampling and that the sampling date should be consistent throughout the time series. Date is however not a guarantee to avoid for environmental variability as discharge and water temperature (triggers of migration) might vary considerably at the same date between different years.
3. To avoid for variability, due to fish movement, in catch per unit effort at specific reaches electrofishing should not be conducted later than August in streams of northern Sweden.
4. To increase the accuracy of the data, the same electrofishing reach should be repeatedly electrofished three times prior to the end of August whereby a mean estimate with a known variability can be achieved. This mean and variability will give a better possibility do detect population changes over time.

   If this data would have been collected during the Vindel River LIFE project we would have had a better possibility to detect true differences in our analyses of population changes of *demonstration restoration* and *best practice restoration* sites.

References

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