

Monitoring DESIGN

(Majority summarised from Roni et al. 2013 *in* Roni & Beechie 2013)

A monitoring design (Figure 5) is a continuous process and should take place at several stages throughout the project cycle:

- Project formulation
- Project implementation (depending on timescale of rehabilitation works)
- Post-project monitoring

Spatial & long term monitoring will account for:

- Target species or communities and their response to changes in habitat.
- Natural variability in species population dynamics.
- Natural variation due to weather, predation, disease etc.
- The lag time associated with the response to rehabilitation activities.
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Monitoring techniques

A variety of monitoring techniques are available for detecting environmental impacts of restoration project whose data collection methods differ spatially and temporally. Monitoring assessment techniques:

- 1) *Before/After (BA) contrasts at a single site* focuses monitoring at the impact/restored site before and after rehabilitation and is generally, replicated in time rather than space.
- 2) *Before/After and Control/Impact (BACI)* focuses monitoring before and after at the impacted/restored site and also at a control site.

The addition of a control(s) is intended to account for environmental variability and temporal trends found in both the control and treatment areas and therefore, increase the ability to differentiate treatment effects from natural (Smith et al. 1993; Roni et al. 2005a).

- 3) *Repeated BACI* focus monitoring before and after, at several impacted/restored sites, in addition to several control sites.
- 4) *Post-treatment* where monitoring takes place at impacted/restored site, after restoration and compared to control site. Post-treatment designs tend to apply spatial replication more than temporal replication.

Post-treatment designs have frequently been used for monitoring of many river rehabilitation projects where the collection of pre-data has not been an option. Insufficient or no prior data from the impacted site may limit the scope of the design and reduce the efficiency of the analysis.

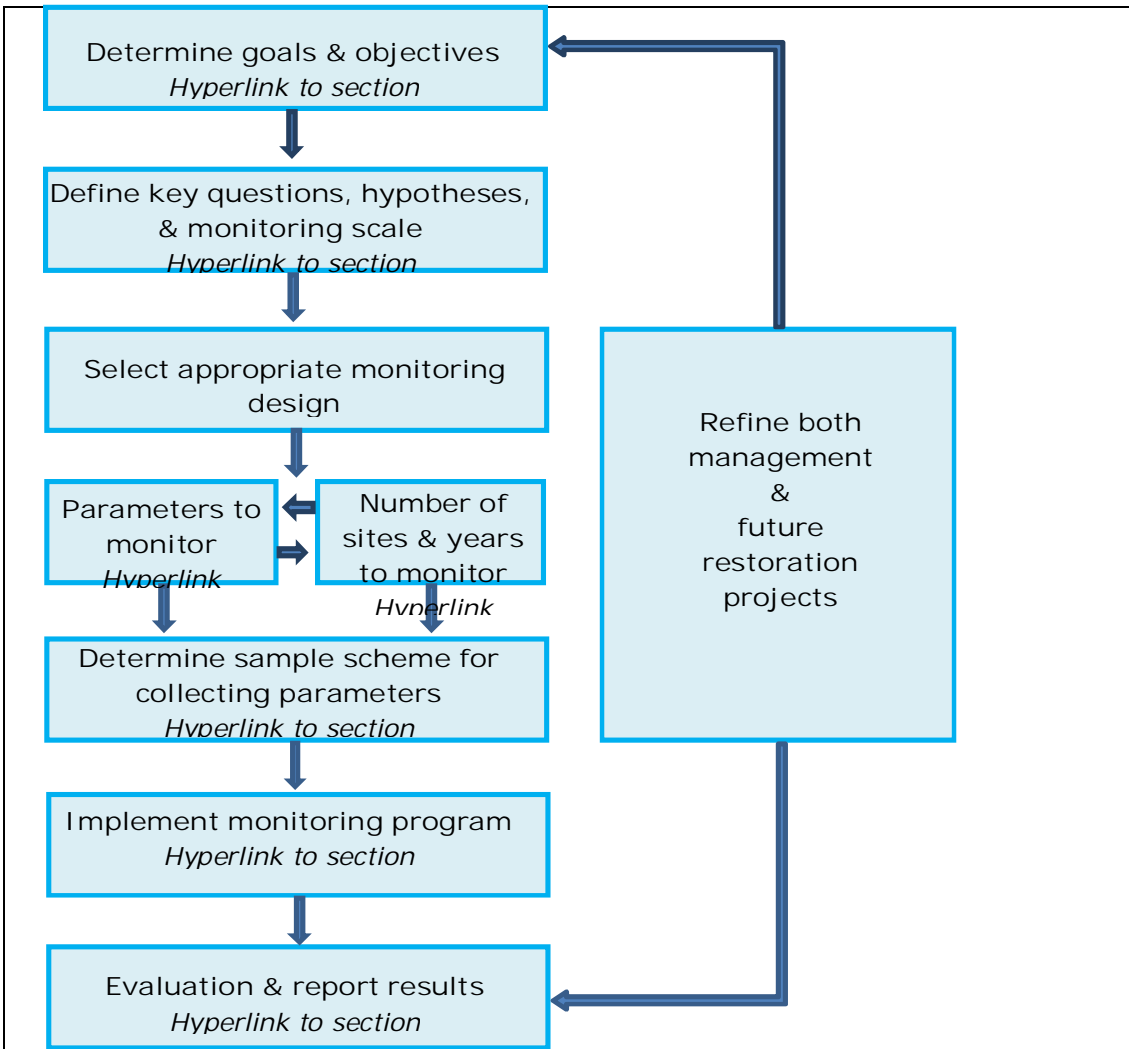


Figure 5. Steps for designing a monitoring program (Roni et al. 2005).

What design is most appropriate will depend on a number of things:

- 1) Project objectives.
- 2) Monitoring question.
- 3) Financial constraints.
- 4) Availability on the number of controls, impact and baseline data.
- 5) Determining if there are enough sites to test monitoring hypothesis and will require estimates of sample size and statistical power.
- 6) Depend on the number of impact and control sites for post-treatment.
- 7) Project scale.

Determining how many sites

In conjunction with selecting parameters, we need to determine the level of spatial and temporal replication, or the number of years and numbers of projects or locations (sites, reaches, watersheds) to monitor.

- 1) For BA & BACI designs with no spatial replication, only the number of year's needs to be

- considered.
- 2) Conversely for Post-treatment design, only the number of sites must be determined.
 - 3) Both the number of year and number of sites need to be considered for multiple BA and BACI designs.

Estimates of sample size or monitoring duration can be found in most statistical hand books or statistical software packages.

**If pre-project data or adequate treatments and controls are not available, then development of an effective monitoring program may not be possible. In summary, it is wise to accept the advice of Anderson & Dugger (1998) who concluded:*

"Almost as bad as no evaluation are poorly planned efforts that waste limited resources while providing meaningless or even misleading information"

Here the important stages for monitoring design are overviewed, for more detailed information visit:

Roni et al. 2013 *in* Roni & Beechie 2013

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