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Document 3b

For the 23 April 2024 IRST Meeting

NOTE: This text is excerpted from Document 10 (Standards for Best Available Science: Amendment Information) from the 13 March 2024 IRST Meeting. The information is in track changes.

Research and Monitoring

Initial IRST input (November 2023): What is a research question?

Note: The below bullet points are the consolidated IRST responses to questions from the November 2023 intake questionnaire regarding what a research question is. INR did not attempt to incorporate these into the text of the following sub-section so that the IRST can see some of their initial responses to the November 2023 questions; and (2) so that the IRST can collaborate to refine their definition, context, and examples of "What is a researchable question?" based on this and the above input.

IRST consolidated responses to "What is a research question?"

- A "research question" implies that there is need for science discovery and the addition of new knowledge. Sometimes, research questions are not "researchable", meaning we either do not yet have the technology or baseline fundamental understanding to be able to answer the question (e.g., "Where did life come from?"). Fundamentally, a research question requires a testable hypothesis, with data collection and analysis that is transparent and could be repeated by another researcher.
- A research question is clear, specific, and concise. It aims to build understanding of the unknown or uncertain. It would often aim to understand the influence of specific factors on an outcome, for example.
- A specific question stated as a hypothesis or a knowledge gap that can be addressed by a designed study, field survey, modeling, literature review, or another means of scientific inquiry. In this context, research questions would relate predominantly to species, processes, or management effectiveness.
- A research question arises from gaps in previous studies and can be explicitly defined, with an expected outcome/answer that advances understanding of a specific subject. Generally proposed by a qualified researcher in the field.

NOTE: INR approached Becky Flitcroft based on her input at the 22 January 2024 Joint AMPC-IRST Meeting (conversation 0:58 min - 1:05 in the 22 January meeting video) and information from a literature that Jeff Behan provided on the types of monitoring associated with adaptive management. INR asked Becky to review a verbatim transcript of what she said at the meeting, sent her the monitoring definitions, and requested her input as a written starting point for IRST discussion to amend the standards of BAS guidance document to include information on research, monitoring, and researchable questions.

Science

Science is both a structured, systematic way to learn about the world and the body of information and knowledge that results. Science can be either basic or applied and includes both research and monitoring.

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What is Research?

Research contributes to the development of new knowledge to answer questions not well understood in the broader scientific literature. Research is designed to answer "why", "what", or "how" questions. ~~New k~~Knowledge creation may include the development of new tools, methods, or approaches to answer~~ing~~ questions as well as new insights into physical and biological phenomena.

Research ~~generally~~ falls into the two ~~scientific~~broad categories of science mentioned above: ~~applied and~~ basic and applied. Basic research~~science~~ generally explores fundamental relationships that allow us to understand how systems work. For example, exploring how amphibians use habitat patches along corridors is an example of basic science ~~(it becomes applied science when we want to understand how habitat patches created by land use, such as timber harvest, affect amphibian movement).~~ Applied ~~scientific~~ research generally has a direct application, which in the context of the IRST will typcially relat~~ionship with~~ to some form of management or land use action. For example, questions about how amphibian movement responds to habitat patches created by land use, such as timber harvest,~~research exploring the effects of river restoration (a management action) on fish or amphibians~~ would be applied science. ~~Basic science generally explores fundamental relationships that allow us to understand how systems work. For example, exploring how amphibians use habitat patches along corridors is an example of basic science (it becomes applied science when we want to understand how habitat patches created by land use, such as timber harvest, affect amphibian movement).~~

Basic or ~~A~~applied ~~or basic~~ research requires developing a~~the use of~~ clear hypotheses (e.g., researchable questions) that are explored with~~using~~ transparent methods, often using a null hypothesis-based framework. It is critical that all aspects of a research effort are described and communicated in a way that can be repeated by others, and with enough detail to evaluate the robustness of the design and the relevance of the results through peer review.

What is Monitoring?

Monitoring is key to adaptive management, providing an empirical understanding of the effects of management over time. Developing a ~~rigourous~~rigorous and defensible m~~M~~onitoring strategy relies on insights developed by basic and applied research investigations. A variety of tools and designs are available to facilitate monitoring that aligns with the questions of interest (https://www.nnrg.org/resources/monitoring-and-inventory-tools/). ~~Effective m~~Monitoring does not generally develop new knowledge ~~in the form~~ by ~~answeing~~answering ~~of~~ "why" questions, but does involve collecting data to ~~can~~ answer a variety of other questions, often associated with current status, or trends over time. Such monitoring can facilitate evaluation of~~, or related to the outcome of~~ specific management ~~actions~~outcomes and ecological effects. Different types of monitoring are defined in the literature:

- ~~**Implementation or c**~~**Compliance** ~~**monitoring**~~ – this form ~~key to this type~~ of monitoring is an evaluation of whether we are doing what we said we would (Price & Daust 2009). For example, ~~this type of~~compliance monitoring would ask whether riparian buffers are being consistently implemented as prescribed in rule?~~. "Implementation (including compliance) monitoring asks whether designed strategies are being followed (e.g., Does stand-level retention meet target levels?)" (Price & Daust 2009).~~
- **Status and trend** – this form of monitoring evaluates how conditions are changing from baseline and may or may not include a trigger condition for re-evaluation of management actions (Hutto and Belote 2013). An example of status and trend monitoring would be a range-wide ~~population~~ assessment of habitat conditions for~~s of~~ target amphibians.

- **Validation -** this form of monitoring focuses on articulating and validating underlying assumptions and can become applied research (Price & Daust 2009). An example of ~~this form of~~validation monitoring would be ~~an assessment~~exploring ~~of~~ the assumed relationship between stream temperature ~~soil moisture~~ and specific amphibian movement pathways that underlie riparian buffer prescriptions.
- **Effectiveness ~~monitoring~~** – this form~~type~~ of monitoring is often linked to a specific management action and whether~~how~~ it achieves its objectives ~~"asks whether objectives are being met (e.g., Are old-growth species maintained in the stands with target levels of retention?)"~~ (Price & Daust 2009). This monitoring can become applied research when the target ~~of the work~~ is to develop new knowledge and is often used after status and trend monitoring if results indicate management objectives are not being met. For example, if status and trend monitoring identifies that water temperatures in small, perennial non-fish-bearing streams are increasing beyond desired thresholds for target amphibians, then ~~this type~~effectiveness ~~of~~ monitoring could evaluate whether riparian buffer prescriptions~~s~~ are providing shade sufficient to maintain water temperatures within the desired range~~are protecting movement pathways for amphibians~~.

~~**Validation monitoring: "(or monitoring to learn) investigates the relationship between implemented strategies and objectives (e.g., Are the old-growth species maintained in the stands because of stand-level or landscape-level retention?)" (Price & Daust 2009)**~~

~~**Status and trend monitoring – "Well-distributed (geographically stratified) locations are surveyed repeatedly across years in an on-going effort to uncover trends in target response variables…the purpose of this type of monitoring is to assess whether any change in a response variable exceeds some pre-determined threshold requiring management action" (Hutto and Belote 2013).**~~

~~**Ecological effects monitoring – "Ecological effects monitoring seeks to uncover unintended ecological consequences of management activity and should be an integral part of any program designed to monitor management practices…Explicitly considering and monitoring potential ecological effects will help agencies and stakeholders make more informed decisions to minimize tradeoffs, seek complementarities among values, and optimize benefits among objectives" (Hutto and Belote 2013).**~~

Monitoring and Research Intersect in an Adaptive Management Framework

Research and monitoring are strongly connected in an adaptive management framework. Through time, information collected during ~~monitoring~~monitoring can lead to ~~-~~knowledge development through research. ~~associated with t~~The intersection of monitoring and research is intended to guide the perpetuation, or modification, of management actions to align with long-term objectives (Figure 1).

Basic research often provides the relationships that are then used to target specific metrics in monitoring efforts. Additionally, applied research may develop out of an interest in understanding why trends were observed in long-term monitoring. This becomes particularly relevant when unanticipated ecological effects are observed by status and trend monitoring, or when such monitoring indicates that management objectives are not being reached. Thus, research can be used as a tool for validation and evaluation of the effectiveness of management goals.

"A fundamental part of the adaptive monitoring paradigm is that the question setting, experimental design, data collection, analysis and interpretation are iterative steps…A monitoring program can then evolve and develop in response to new information or new questions" (Lindenmayer and Likens 2009).

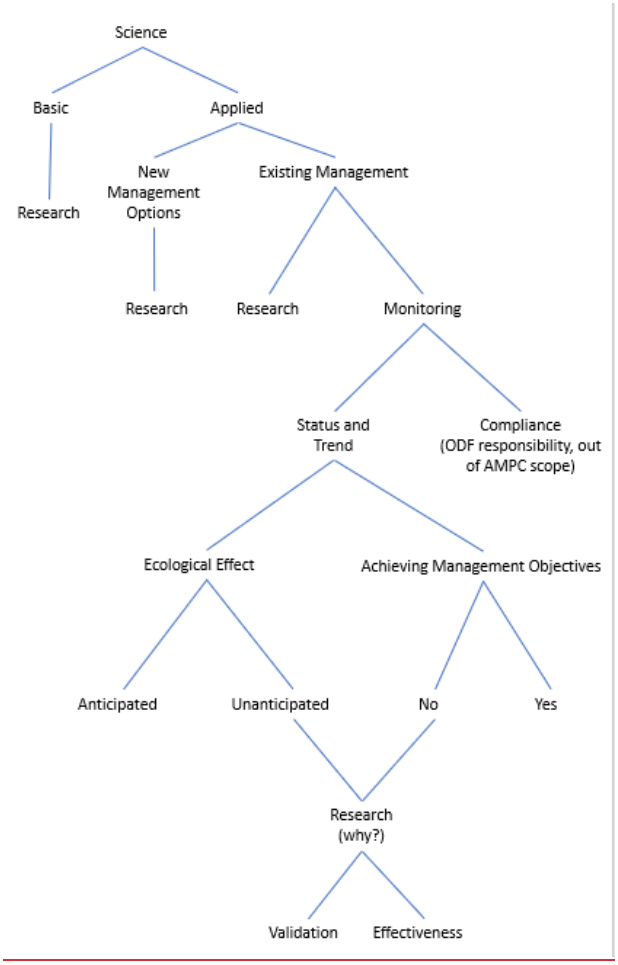

Figure 1. Basic and applied science contribute to management of forest systems through a variety of pathways and relationships, as illustrated in the context of the current Adaptive Management Program ~~demonstrated by this figure~~. "Existing management" is the Oregon Forest Practices Act and the ~~implmenenting~~implementing rules. Research under "New management" would explore options for changing these rules if existing management is determined not to meet stated management objectives. "Management Objectives" are those expressed as desired future conditions (OAR 629-643-0000) and as the Biological Goals and Objectives of the Private Forest Accord Habitat Conservation Plan. "Ecological Effect" are consequences of management actions that are not explicitly stated as management objectives.

References

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Researchable Questions

Initial IRST input (November 2023): What is a researchable question?

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IRST consolidated responses to "What is a researchable question?"

- A researchable question is a tractable "research question". This means that there are statistical methods, data collection methods, analysis techniques, that are available to answer the question. Sometimes, new techniques must be developed, and very often that novel technique is its own researchable question.
- A researchable question is one that is suitable for answering through scientific inquiry, i.e., with a testable hypothesis, and use of the scientific method.
- A researchable question must be able to be answered by a reasonable amount of research/resources and addressed through collection of data, analysis and interpretation (uses the process of science to generate evidence for or in conflict with a hypothesis).
- A researchable question is a general question that may be posed by the public, managers, or researchers that is not narrowly defined in scope or location but is valuable to provide information about a site or sites, or resolving a management issue. Researchable questions will require narrowing of scope and definition of goal and outcome, discovery and application of previous work, and development of a specific focus by qualified researchers in the field.
- In this context, a question of science that is capable of being studied using the methods described above. An "unresearchable" question would fall into the realm of opinion, policy, ideology, etc.

What is a researchable question?

Note: Input from Becky as part of the research and monitoring request above. This does not incorporate the IRST consolidated responses regarding what a researchable question is.

A researchable question may represent an individual topic to be tested or frame a series of related topics that are individually tested. In either case, an effective researchable question is specific enough to be quantified and tested through analysis supported by robust project design. Researchable questions may form hypotheses (e.g., questions that can be tested), using a diverse array of statistical tools that depend on factors such as sample design, sample size, and the time frame of the project. Study design, statistical analysis and results all rely on the researchable question that is being asked.

A researchable question guides the development of either research or monitoring efforts. Effective research and monitoring questions clearly frame the parameters of the effort by isolating what is being explored. Well-designed research and monitoring questions provide transparency in what can be learned through the effort. For example, most monitoring efforts will not answer "why" questions. Ideally, monitoring will inform management of changes and trends in different aspects of the system being evaluated. This compares to research questions that, when answered, may inform why specific trends are observed, or provide substantive support for the development of specific and targeted metrics to be followed using monitoring.

A poor researchable question uses terms that cannot be quantified, or that can be interpreted differently by different individuals. For example, terms such as resilience, healthy, effective, or natural lack specificity, and as stand-alone terms, cannot be measured or assessed. Researchable questions can provide the level of specificity needed to quantify and assess elements of health and resilience.

> A non-specific researchable question:
>
> *What is the health of riparian forests over time?*
>
> A specific researchable question:
>
> *How does canopy cover, air temperature, soil moisture and downed wood change over time in managed compared with unmanaged riparian forests?*

In the specific researchable question, the terms canopy cover, air temperature, soil moisture and downed wood are used (rather than "health" in the non-specific researchable question). Likewise, the specific researchable question includes the comparison of managed and unmanaged riparian forests, compared with simply riparian forests in the non-specific researchable question.

In the above example of a specific researchable question, there are four aspects of the riparian forest that are offered for exploration (canopy cover, air temperature, soil moisture and downed wood). There may be companion researchable questions developed for each one, or for interactions among components of the riparian forest environment being explored.