Oregon State University

Institute for Natural Resources

Oregon State University, 234 Strand Agricultural Hall | Corvallis, Oregon 97331

Phone 541-737-9918 | Fax 541-737-1887 | http://inr.oregonstate.edu

IRST Intake Questionnaire: Compiled Reponses

21 December 2023

Having a common language will be essential to how the IRST will work together. The Adaptive Management Program rules contain key definitions; however, there are others that are worth exploring. The intent of this questionnaire is to obtain your initial thoughts, collate all responses, and share them with the IRST. None of your responses will be associated with you. We will establish a due date once we have set our 1.5-day meeting, as the anonymous responses will be part of the meeting materials. Meeting materials need to be posted on our website at least one week prior to the meeting. You can either send your responses to Sean and me in the body of an email or as an attachment.

Reference materials, if needed

- For the full rules about the Adaptive Management Program, go to Department of Forestry, Chapter 629, Division 603 ADAPTIVE MANAGEMENT
- Link to INR IRST webpages
- Key Definitions mentioned in rule (highlighted for easy reference)

Questions

1. "Adaptive management" per se is not defined in the rules, although the adaptive management process in OAR 629-603-0200 describes how it is done. The Private Forest Accord (PFA) Report, which is technically statute since it's incorporated by reference in SB1501, has the following excerpt at the beginning of the AM chapter (10), although it doesn't explicitly state that this definition is adopted by statute and rules:

   The National Research Council (2004) defines adaptive management as "flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process."

   The [PFA] Authors support establishment of an adaptive management framework to provide science and technical information to support Board of Forestry decisions when needed to adapt rules, guidance, and training programs to achieve the resource goals and objectives identified in the Habitat Conservation Plan (HCP).

   Note that "resource goals and objectives" is an older term for "biological goals and objectives" defined in rule.

Adaptive Management

a. What else should be considered for a definition of "adaptive management"?

IRST Responses

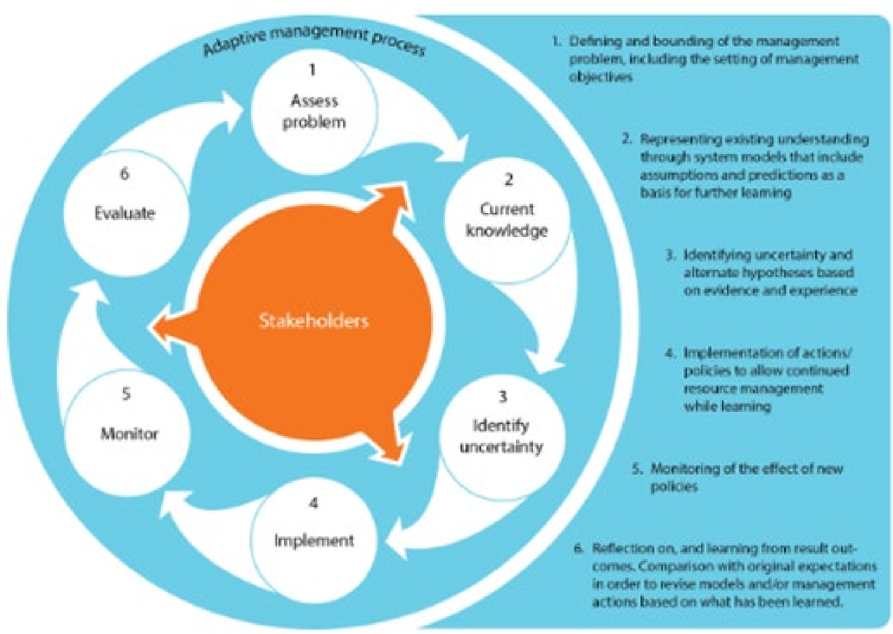
- This seems like a fairly standard sort of definition of adaptive management. In OAR 629-603-0200, the timelines and goals for development of science products is logical, although some elements are unclear. There are no specific timelines for action decisions after the AMPC provides recommendations. The concern there would be HOW findings will be implemented by the Board. That's outside this topic of adaptive management though. How the research topics themselves, and the research questions linked to those topics, are developed, is likely the nexus of our challenge now as the IRST develops its own charter to move forward.

- Nothing to suggest. This will get us started. Plus, it seems this question is in the realm of the AMPC, not the IRST.

- I suggest that the definition consider the iterative approach of adaptive management and the circular flow of information gained through monitoring after a change that is re-incorporated into the adaptive management system. There is also a possibility that the formalized process of Structured Decision Making (SDM) confuses how the IRST and AMPC consider adaptive management. I suggest the IRST be very clear about whether we define adaptive management outside of the structured decision-making process or whether we include aspects of SDM in the definition of adaptive management. Because many of the federal agencies, in particular USGS and USFWS, are leaders in SDM, we may consider how this would be beneficial in the long-term to the success of the PFA. I think there is also space to ensure that the biological goals and objectives as defined in rule are translated into questions that are appropriate for an adaptive management framework, for example is uncertainty high and controllability high. There are many, many resources about SDM and Adaptive Management, such as this DOI report: https://www.doi.gov/sites/doi.gov/files/migrated/ppa/upload/TechGuide.pdf

  I also think defining Adaptive Management in terms of the stakeholders that are involved at various parts of the process cycle, including the Board, IRST, etc are discussed and likely outlined in the definition.

  One of many examples of the process cycle figures:



From: https://www.jstor.org/stable/26269449?seq=1

- Suggest better defining "and other events" to include *flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions,* ***scientifically valid/credible research, public concerns/input, changing economic parameters, evident changes in geological, biological and ecological conditions*** *and other* ***information and*** *events* ***are evident.*** ~~*become better understood*~~*. Careful monitoring of* ~~*these*~~ *outcomes* ***from management change****s* ~~*both*~~ *advances scientific understanding and helps adjust policies or operations as part of an iterative learning process.*

- For clarity, it's not about a trial-and-error approach to changing management. It is a thoughtful strategy for identifying and filling knowledge gaps as the basis for deciding if and how management should be altered. It involves evaluating detailed scientific questions to reduce uncertainty. Key topics would include species characteristics and distribution, physical/ecological processes likely affected by management, and evaluating the effectiveness of specific management prescriptions.

Charter

2. One of the first tasks for the IRST is to create operating procedures through a charter for itself. Required elements of the charter are written in OAR 629-603-0400.

    a. What other topics do you think should be included in the IRST charter?

IRST Responses

- There seems to me to be three different types of science products that will be relevant to adaptive management and research topics. However, not all of them necessarily have a testable hypothesis which is most relevant for type 1 below. Differentiating among each of these different types of products, their required deliverables, and how they might be funded may be useful to include in the charter to avoid confusion about products later. These three categories of science products (but there could be more) include:
    1. Research projects focusing on a targeted hypothesis that creates new knowledge.
    2. Monitoring that is ongoing, perhaps linked to a specific management-related question. This type of trend information does not generally generate new knowledge but allows for assessment of management actions.
    3. Development of datasets that provide information such as where all the roads are, where all the culverts are, what condition (e.g., passage status of culvert), age classes of forest stands, location and type of underlying landslides or slop stability, etc. These datasets that directly inform management may be a product of a research project, or come from monitoring, but may also be a specific type of contracted product.

- Guidelines for how (regular) decisions will be made (separate from "substantial decisions")? Besides that, it seems like there's plenty in our charter elements list already. We'll need time to see what we're missing.

- Defining the roles, duties, and responsibilities of the Chairperson vs Member vs on subcommittees as they may form. What are some subcommittees that may be needed in the future, and how many people would be part of one? How do they interact with the full IRST.
- Responsibility (and mechanism) for public outreach if, and when, desirable. Responsibility and mechanism for communication with other agencies and entities if, and when, desirable.
- How meetings are conducted, how decisions are made, how minority opinions are represented in decisions if not made by consensus, how the charter is changed, process for disclosing and addressing conflicts of interest, process for soliciting and selecting studies, peer-review process, best available science criteria, how study results (internally or externally generated) are accepted and reported.

b. **Do you have any examples of text from other charters (or full charters) that might help us develop the charter?** If so, please forward those to us or tell us the organization or board, and we will find them.

IRST Responses

- Unfortunately, I do not.
- No
- Professional societies may be very different in scope that this charter, but may also offer insights into procedures and subcommittees. I'm most familiar with the Bylaws for The Wildlife Society, for example: https://wildlife.org/wp-content/uploads/2023/01/TWS_Bylaws_2021-07_FINAL.pdf
- Not at this time.

Substantial Decision

3. In creating an IRST charter, the rules state that the charter shall include a "determination of what constitutes a substantial decision." A "substantial decision" requires a formal vote. We understand that you may not be completely familiar with the adaptive management process in OAR 629-603-0200 and the role of the IRST in OAR 629-603-0400, but we'd still like to gather your initial thoughts.

   a. **In your opinion, what would constitute a "substantial decision" of the IRST?**

IRST Responses

- After reading both of these statutes, it seems that there may be several places that would be useful for the IRST to vote related to substantial decisions. Here's some things:
  1) Definition of a substantial decision. In my mind, a substantial decision relates to a variety of different things. Some might be:
     - relevance for forest management science discovery (as in a vote on research questions to develop/explore)
     - anything the board will need to spend extensive time on (such as developing the research question packet).
  2) Definition of best available science

3) Research questions (after negotiation with AMPC.
4) Proposed approach to responding to research questions (I'm assuming we'll come up with some sort of plan that is unique for each topic that will likely include several questions and perhaps different science products)
5) Summary products to be delivered to AMPC after research is completed
6) Proposed new members of the IRST
7) Extension of appointment of IRST members
8) Election of the IRST chair

- [Some things to include:]
  1) Ratifying the IRST charter.
  2) Final approval for selection of research proposals
  3) Final approval of what information the IRST submits to the AMPC to address their research questions.
  4) There will undoubtedly be other "substantial" decisions within our IRST workings, but these probably won't be apparent until we encounter them. So, votes on decisions that constitute "substantial decisions"?
- One way to address this is to identify actions in the OAR 629-603-0400 that would require a vote. My first glance would pull out these actions for a substantial vote:
  1) Selection of the chairperson
  2) Updates to the IRST charter
  3) New member selections
  4) Selection of proposals to fund from RFPs
- Approving and changing the charter, voting on the chair, soliciting and selecting studies, approving a peer-review process, decisions to accept and report study findings, membership decisions, criteria for best available science.

<u>Best Available Science</u>

4. The rules state that the IRST shall develop standards for "best available science" that include: (i) types of sources of best available science; (ii) process for determining what is best available science based on IRST-set criteria including an assessment of science quality and relevance; (iii) testable hypotheses as a crucial element successful research; (iv) a peer review process that is transparent and addresses both study designs and study reports (no anonymity to authors, handling editors, or peer-reviewers before Jan 1, 2028); (v) Other elements the IRST deem necessary.

   a. **How would you define "best available science" in the context of the adaptive management program?**

   IRST Responses

   - How the term "best available science" is used is a bit confusing to me (as demonstrated by our very first IRST call!) The confusion is that it's being used to describe a thing (e.g., best available science), and a process (e.g., how one develops best available science – often informed, in places, *by* best available science).
     1) types of sources of best available science - this seems fairly straight forward.

2) process for determining what is best available science based on IRST-set criteria including an assessment of science quality and relevance – this doesn't actually make much sense to me. All of the things in bold conflict in some way. At first, there's a *process* (isn't that related to (i)?). Does this mean specific web of science search requirements for finding existing best available science? Then a *criteria* (criteria for what? Is that related to (i)?). Then some sort of *assessment* of science quality. Again, this might be related to (i), but (i) doesn't ask us to determine quality of sources. And then there's judgements about *relevance*. Relevance to what exactly? To individual research questions or perhaps to forest management? This seems like it might be something to use for individual research products (like a manuscript), but not about a category of best available science (such as agency technical reports).
3) testable hypotheses as a crucial element successful research – this is part of the process of developing some forms of best available science (e.g, research manuscripts and findings), but may not be relevant for things like monitoring products (that seek trends rather than hypothesis testing analysis), or data products.
4) a peer review process that is transparent and addresses both study designs and study reports (no anonymity to authors, handling editors, or peer-reviewers before Jan 1, 2028) – this relates to the process of developing and creating best available science, but not is, in and of itself, best available science. Also, this is the first time "study design" comes up. In other places, the text asks for a research proposal that responds to a specific research question. Is there a formal review process for study designs (this is a large step and hurdle in federal research, so jumps out to me here). Study designs seem like they would be a requirement of outside parties who are selected to do a specific applied project, but may not be necessary for the IRST on everything.
5) Other elements the IRST deem necessary – catch all for who knows what.

- I believe we should view this broadly, so as to capture all relevant information for our decision-making. If we define this too narrowly, we run the risk of missing key information from unpublished research or monitoring results, or "grey" literature. Emphasis should be on quality and relevance of information, with quality being judged on the basis of study design, acceptable practices (e.g., field measurements, analysis), etc.

- The American Fisheries Society has a helpful report on this topic. Link: https://fisheries.org/policy-media/science-guidelines/defining-and-implementing-best-available-science-for-fisheries-and-environmental-science-policy-and-management/. The aspects included in this report under the Science and Scientific Process are relevant components of a definition:

  1) A clear statement of objectives;
  2) A conceptual model, which is a framework for characterizing systems, stating assumptions, making predictions, and testing hypotheses;
  3) A good (*I'd change the wording here to appropriate*) experimental design and a standardized method for collecting data;
  4) Statistical rigor and sound logic for analysis and interpretation;

5) Clear documentation of methods, results, and conclusions; and
6) Peer review (I'd add by experts in the topic areas)

Table 1 in the report may also be helpful in identifying best available science for the IRST, which will often be at the regional scale. However, the ability to do that work will depend on whether the base knowledge from lab experiments or field sites has been conducted.

- [Some things to include:]
  1) Clear statement of the scope and objective of the study, and definition of the problem.
  2) Clear references and acknowledgement of previous work by others and the author(s)
  3) Detailed description/documentation of methods
  4) Clear statements of findings, including questions left unresolved, and questions for further investigation,
  5) Applies current research techniques, including whatever chemical, physical and/or statistical parameters /data are appropriate to the subject/study.
  6) Peer review
  7) Publication in what would be considered a reputable journal or other venue, including thesis/dissertation.
  8) Completed recently.
  9) Funding source(s) with no conflicts of interests in the subject at hand.

b. What are the other elements (the last item mentioned above [v]) you would deem necessary to ensure "best available science"?

IRST Responses

- My concern is again the same, what's being meant by best available science. The science that's available to be brought to bear for a specific management action or decision, or the DEVELOPMENT of science that could be used for that purpose? These two things seem quite different to me.

- Nothing I can think of at the outset.

- I believe we have an obligation to examine the definition of best available science that also acknowledges a very western-centric bias towards science. I would like to determine ways to include indigenous knowledge or other forms of knowing, and not be "gate keepers" of information that should be considered and included. I've recently learned a lot from Mateen Hessami, and he may be a good resource for the IRST learning more about how to connect and include indigenous knowledge into scientific process. Here are two of his recent publications on related topics: https://doi.org/10.1139/facets-2020-0088; https://www.cclmportal.ca/sites/default/files/2023-06/Braiding%20Indigenous%20Rights%20and%20Endangered%20Species%20Law.pdf

- Acknowledging uncertainty in the scientific process by project is also important for critiquing results based on how they attempt to minimize this and what the inferences will be. In addition, how we will consider gray literature that may not have been peer reviewed (do we review it ourselves or with experts?) and expert opinion will be considered is important too.

- That there are no conflicts of interest, or that the study was not influenced by the potential for economic or other gain by the researchers and/or funders.

Term Definitions

5. How would you define the following terms:

   a. A “research question”?

   IRST Responses

   - A “research questions’ implies to me 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.
   - This could be any question requiring technical information to answer. Usually supported by testable hypothesis.
   - I would define a research question as something clear, specific, and concise that 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 problem that 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.
   - 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.

   b. A “researchable question”?

   IRST Responses

   - 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 it’s own researchable question.
   - This would be a question that is suitable for answering through scientific inquiry, i.e., with a testable hypothesis, and use of the scientific method. An “unresearchable” question would fall into the realm of opinion, policy, idealogy, etc.
   - 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 general questions that may be posed by the public, managers, or researchers that is not narrowly defined in scope or location, but is valuable to providing 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 (not policy) that is capable of being studied using the methods described above.

<u>Outcomes, Effectiveness Monitoring, And Adaptive Management</u>

6. How do you envision relationships between metric outcomes, effectiveness monitoring, and adaptive management?

IRST Responses

- This seems like a monitoring (and not a research) topic. Also, I think when you say "metric outcome", you mean metrics that are identified for data collection, and the actual data collected. In this case, metrics themselves need to be linked to specific management goals, or have relationships with specific management goals, as established by best available science (in particular, by peer-reviewed research publications). Monitoring is different from research. Perhaps this is something that the IRST needs to define.

  Effectiveness monitoring is intended to monitor how well specific management outcomes meet goals. It's much easier to do implementation monitoring (x buffer width was maintained, x number of trees removed, x number of pieces of wood put in the stream). It's quite another effort to determine if the buffer itself resulted in the goal of keeping the stream cool, or reducing sedimentation, or maintaining functioning aquatic ecosystems. There are some metrics that can be gathered to determine effectiveness, but clearly differentiating between TYPES of monitoring is key. Most monitoring is essentially trend detection and may not tell you WHY a specific trend is there. Usually, a research question is there to help understand the WHY questions.

  Adaptive management relies on both monitoring (to evaluate effectiveness) and new discovery (from research) that will help answer some of the "why" questions that inevitably arise from monitoring.

- I view metrics as specifically related to Biological Goals and Objectives in the HCP. If metrics describe the means by which achievement of BGOs will be judged, then research and monitoring (status and trends) of the metrics should inform whether rule sets are contributing to meeting BGOs. Effectiveness monitoring is the type of monitoring that looks specifically at how a particular prescription, rule set, etc. is performing to achieve the outcomes intended by the prescription or rule set. Done well, monitoring results or research could reveal broadly whether prescriptions are effective, as well as inform what aspect of the prescription or rule may be inadequate (and a basis for change). This is wholly separate from compliance monitoring, which informs whether a prescription or rule set is being implemented – a required step to measuring effectiveness. The information from the research and monitoring program can enable the AMPC to make informed decisions and recommendations to the Board of Forestry regarding adequacy of the forest practice rules. All of this is part of adaptive management; moving forward in the face of uncertainty, learning by doing, information feedback, etc.

- I expect in the future that the Effectiveness Monitoring data will be useful for identifying future research questions based on uncertain outcomes or from monitoring the outcomes of rule changes, including the newly adopted set of Forest Practice Rules. Effectiveness monitoring is one part of the cycle of adaptive management (see flow chart above) that tie back to achieving biological goals and objectives (and 1A in 629-603-0100). It should be a source of questions for the IRST.
- Needs clear communication between researchers and managers. This may require some "translation" of science into understandable terms, and achievable goals.
- Status and trends monitoring document the direction a metric is heading and when heading in the "wrong" direction or at the "wrong" rate may indicate the need to change management. However, status and trends monitoring typically cannot reveal what specifically needs to change. It may point to a subset of management prescriptions to evaluate further by specific designed studies. Because status and trends monitoring may require many years to detect a problem, effectiveness monitoring can immediately be undertaken to target prescriptions for which scientific underpinnings are less certain. The results of effectiveness monitoring would suggest how a specific prescription might be changed to increase the likelihood of achieving a desired policy outcome.

Reducing uncertainty

7. Reducing uncertainty is a primary rationale for AM. Different forms of uncertainty have been described. The new OFPA rules direct the AMPC and IRST to focus on *scientific* uncertainty, which includes incomplete understanding of ecosystem processes, species life histories and responses to management actions, natural environmental variability and, increasingly, changing environmental conditions. *Social* uncertainty pertains to issues such as the level of confidence that managers will implement actions as specified in management plans, and social license in support of these actions and goals.

    a. In the context of the Adaptive Management Program, how would you personally define uncertainty? Alternatively, which aspects of uncertainty do you feel are most important for the IRST to address?

    IRST Responses

    - It seems to me that scientific uncertainty includes physical, biological, and social science topics (the social uncertainty described here seems like something a social scientist could possibly quantify). How any specific topic is researched or monitored ties closely to the uncertainty that we have about the findings. This is a fundamental aspect of statistical analysis that provides a framework to understand imperfect data collection. Ideally, we'd be able to always have census of available data to understand a question, but that is generally the exception and not the rule. As such, sample size, sample design, and statistical analysis work together to inform our understanding of the merits of a research or monitoring product. The IRST can focus on some specific elements here:
        1) Tractability of a research project through evaluation of study plans and research proposals
        2) Sample size to answer questions

3) Sample design and links to research goals.

Many of these topics should be part of that research proposal that's developed by the IRST.

- I believe the role of the IRST, and the AMP overall, is to address scientific uncertainty. Within that, though difficult, I believe our greatest challenge is to address uncertainty regarding cause-effect linkages between forest management and effects on aquatic resources. That is, to go beyond simply measuring change in the environment, and instead to interpret whether observed changes have meaningful ecological effects on fish and amphibian populations.
- From the perspective of the IRST, I believe that we address uncertainty in throughout the adaptive management process. Uncertainty in whether the forest practice measures meet the biological objectives becomes a research question for example. We use the scientific process and measures of variability or knowledge gaps to identify areas of uncertainty.
- Generally, science may be specific to a particular site, but outcomes may vary from location to location. Also, the very nature of science is uncertain—with new technologies and techniques, and applications of other studies, understanding of a place, subject or mechanism will change. Furthermore, application of any finding or expected outcome to any particular location/problem in the natural world will change as conditions change. Especially now, we live on a planet that is changing rapidly, often outside of the scope of previous studies/predictions. We should expect that outcomes and management will need to change (adapt!) sometimes rapidly and radically.
- In the context of the PFA and draft HCP, scientific uncertainty is the most important to address. For previously well-studied species, how management affects the creation and maintenance of their habitats, given underlying environmental variability is of primary interest. Reducing scientific uncertainty for less-well understood species is also a key area of inquiry. Reducing scientific uncertainty regarding climate change by downscaling models and examining how habitats and species are likely to respond in the face of management will be critical over the long term.

<u>Other Topics</u>

8. Are there any other topics or terms that you'd like us to consider for discussion during these meetings?

IRST Responses

- I've seen the start of some flow charts for how the IRST and AMPC interact, but would be helpful for us to develop some visuals of how the IRST functions in more detail. There'd definitely some good starts on this, but it would be helpful. Also, might need some of our own definitions. For example, some items that could use definition:
  - Effectiveness monitoring
  - Implementation monitoring
  - Study plans

  Things like researchable questions and best available science are already on our to-do list for a definition!

- Not at this time.
- Whew. That was a lot to cover already. I'm sure more will come up organically, but nothing else to add currently.
- Should there be any guidelines for how and when the IRST communicates with others?

Oregon State University

Institute for Natural Resources

Oregon State University, 234 Strand Agricultural Hall | Corvallis, Oregon 97331

Phone 541-737-9918 | Fax 541-737-1887 | http://inr.oregonstate.edu

Independent Research and Science Team Charter

WORKING DRAFT (27 December 2023)

NOTE ABOUT THE DRAFT: black font = wording from the rules; *black font italic* = information from ODF; blue font = suggested wording, example from another group (noted in the comments, or elements to consider (noted in the comments).

This charter is the operating procedures of the Independent Research and Science Team, approved on _______________.

ARTICLE I. GENERAL PROVISIONS

Section 1: Name.

The Independent Research and Science Team (IRST)

Section 2: Purpose.

The purpose of the Oregon Department of Forestry's Adaptive Management Program rules is to provide science-based recommendations and technical information to assist the Board of Forestry in determining when it is necessary or advisable to adjust rules, guidance, and training programs to achieve the biological goals and objectives. Within the framework of legislation providing for the Oregon Department of Forestry Adaptative Management Program, the Independent Research and Science Team (IRST) is a group of scientists appointed by Oregon Board of Forestry to provide science-based recommendations and technical information to assist them in determining when it is necessary or advisable to adjust rules, guidance, and training programs to achieve the biological goals and objectives. The Institute for Natural Resources (INR) was selected as the housing agency for IRST and provides staff support.

Section 3: Value Statement.

The core values of CMER are predicated upon the agreement of each CMER participant that adaptive management is based upon sound science and it is the responsibility of every participant to follow sound scientific principles and procedures. Participants will also adhere to the purpose of the adaptive management program, as defined in WAC 222-12-045(1):

Individual policy positions should not be the basis for CMER decisions; if they are, the credibility of CMER research can be questioned and CMER will fail in its function to provide impartial results to the adaptive management program.

Section 3: Ground Rules.

IRST members and IRST meeting participants will engage in actions that promote productive meetings and will encourage the active participation of each individual member. Examples of these actions are:

1. Speak to educate, listen to understand.
2. Pursue win/win solutions.
3. State motivations and justifications clearly. Discuss issues openly with all concerns on the table.
4. Avoid hidden agendas.
5. Ensure that each individual has a chance to be heard.
6. Help others move tangent issues to appropriate venues by scheduling a time to discuss these issues later.
7. Start and stop meetings on time.
8. Take side conversations outside – listen respectfully.
9. Define clear outcomes for each agenda item and designate a discussion leader.
10. Respect discussion leaders.
11. Be trusting and trustworthy.
12. Acknowledge and appreciate the contributions of others, even when you disagree.

Section 4: Long-term Effectiveness of the IRST.

(A) Succession management procedures;

(B) Onboarding of new IRST members; and

(C) Regular review and updating of the IRST charter.

ARTICLE II. MEMBERS, AUTHORITY, AND RESPONSIBILITIES

Section 1: Members.

The members of the IRST shall be (a) those persons who have (i) submitted an application for membership to the IRST, and (ii) been accepted as a member of the IRST by the current IRST members and approval/ratification by the Oregon Board of Forestry. Any member may resign at any time by written notice to the current members of the IRST and the Board of Forestry. The members of the IRST do not represent their organizations. Members make decisions and vote on matters according to their professional expertise and reasoned judgments. Proxies for IRST members are not allowed for conducting IRST business, including attending meetings and voting.

Section 2: Responsibilities and Expectations.

The IRST and INR is responsible for working with the Adaptive Management Program Committee to refine research questions, drafting requests for proposals to address research questions, recommending proposals for funding, administering proposals selected, preparing summaries of the results of funded research, and drafting and maintaining the IRST charter. It is expected that IRST members prepare for and attend all scheduled meetings, be timely and responsive with communications, be actively engaged in ensuring the fairness and transparency of the process, actively participate in productive exchanges, work collegially to produce quality deliverables, and openly acknowledge any potential conflict of interest.

Section 3: Chairperson.

The chairperson has the usual duties and powers of a presiding officer, including but not limited to setting meeting agendas, leading meetings, maintaining order at the meeting, ensuring the conventions of the meeting are being followed, ensuring fairness and equality at the meeting, and represent the group to the public. The chair serves for 12 months.

Section 4: Chair-elect.

The chair-elect has duties and powers of the chair during the chair's absence, disability, or disqualification, or during any vacancy in the position of chair, and such other powers or duties assigned by the chair or the members of the IRST. The chair-elect is elected at the election of a new chair and participates in all meetings of the chair. The chair-elect serves for 12 months then assumes the chair position.

Section 5: Subcommittees.

Scientific Advisory Groups (SAGs) are subcommittees formed by CMER to recommend, manage, conduct or facilitate, and evaluate scientific research projects and programs to help CMER fulfill its mission. This chapter outlines the formation, roles, responsibilities, operation, and dissolution of SAGs.

Formation: CMER may create a SAG whenever it determines a need for a subcommittee to address a particular science-related question or set of questions. CMER will define a clear purpose, desired outcome and focus of the SAG. CMER may recommend the type of expertise required of participants in the SAG. All caucuses are encouraged to appoint representatives to each SAG. SAG participants are scientists and practitioners qualified in the scientific discipline that the SAG is intended to address. No confirmation is necessary for participation; however, the SAG should provide CMER a list of participants and their qualifications.

Dissolution: CMER may be dissolved or integrated into another SAG when (1) a subcommittee has completed the work for which it was formed; (2) CMER finds that a SAG is not performing its duties adequately; (3) workload changes. CMER may split one SAG into two or merge two SAGs into one; or (4) the programs on which a SAG is working receive a low priority or are dropped from the work plan.

ARTICLE III. MEMBER NOMINATIONS, ELECTIONS, AND EXTERNAL EXPERTISE

Section 1: Term of Office.

Each member serves a four-year term. A member’s term may be renewed upon a two-thirds vote of the rest of the IRST and then ratification by the Board of Forestry.

Section 2: Apportionment.

Section 3: Nomination and Election Procedure.

New IRST members may be nominated if there is a vacancy on the team, or if the team determines that a new scientific or technical discipline must be represented on the team in order for the team to perform its research duties.

Any member may broach the topic of adding additional team members to the IRST at any meeting or by email to the Housing Agency between meetings. The member should describe the rationale for the addition. The topic will then be added to the agenda of a subsequent meeting, allowing members to consider the rationale and identify possible candidates. Members should consult possible candidates and obtain their permission before nominating them. The Housing Agency will compile a list of candidates and their background information and share this with the IRST as part of the pre-meeting materials. The IRST will then vote on whether to add a new member, and if affirmed, vote on whether to include each candidate on the list to be sent to the Board of Forestry.

(a) The team shall submit a list of candidates to the board;
(b) The board may appoint one or more of the candidates as voting members of the team;

(c) If the board does not select one or more voting members from the list of candidates, the team shall submit a new list of candidates to the board until such time as the board appoints one or more candidates as voting members of the team.

Section 4: Onboarding Process.

Onboarding new members will consist of:

- meeting with the Housing Agency staff and IRST chair and chair-elect for orientation to the IRST—discussing and providing up-to-date background materials;
- connecting with Adaptive Management Program Coordinator for topics related to participation grants;
- taking the State of Oregon board and commission training;
- meeting the members of the IRST; and,
- giving a presentation about oneself at an IRST meeting.

Section 6: Resignation and Removal.

Any IRST member may resign by delivering a written resignation to the IRST chair, the Housing Agency, and the Board of Forestry. The resignation shall be effective upon receipt unless it is specified to be effective at some later time. A two-thirds vote of the other IRST members, or a majority vote of the board, may remove an IRST member before the end of their term.

Section 7: Vacancies.

If an IRST member resigns or is removed, the remaining IRST members may vote on whether to fill the position. The position will be filled following the nomination procedure described in Article III Section 3 of this charter.

Section 8: Succession.

- **Identify key areas and positions** – the roles and/or areas of expertise that are critical to the success of the IRST and for which it would be difficult or impossible to find a replacement if they were vacant
- **Identify/forecast the capabilities needed for the areas and positions** – have a clear understanding of the skills, knowledge, and experience required for each critical role; focus on how many people will be required in critical roles to meet future needs. What experiences and skills are you looking for? How will you choose the right people to fill these roles?
- **Inventory of current expertise and conduct gap analysis --** What is each individual's potential and for what roles? What could be done to improve your current approach to learning and development? What resources do you need to make that happen?
- **Identify interested candidates and assess them against the capabilities** – how will you choose the right people to fill these roles?
- Ensure ongoing commitment

Section 9: External Expertise.

The IRST can consult external, subject matter expertise to inform the IRST about a particular subject area during meetings and/or review of draft documents.

An up-to-date list/database of subject matter experts based on__________________________

Obtaining external expertise may also use the subcommittee procedures described in Article II Section 5 of this charter.

ARTICLE IV. MEETINGS

Section 1: Oregon Public Meetings Law.

All IRST meetings shall be conducted as public meetings consistent with Oregon Public Meetings Law.

Section 2: Meeting Management.

The majority of the voting IRST members must be present in order to have a quorum for a meeting. Meetings are managed by the IRST chair and chair-elect. The IRST Chair starts and adjourns the meeting, ensures that the meeting follows the agenda, introduces the agenda topic presenters, and guides the discussions. When many members want to speak on the same topic, the chair recognizes the speakers in order and prevents interruptions. The chair ensures that everyone present has an equal opportunity to participate in the conversation.

Action items, issues, and proposals are presented or reviewed consistent with the agenda distributed before the meeting (unless a change in the agenda is agreed to at the start of the meeting). The presenters elaborate on the facts as necessary and answer any clarification questions that members ask. The group then discusses issues and identifies concerns. Individuals expressing concerns are responsible for working productively with the group to resolve them. The co-chairs formally call for [vote] on the decision/action being discussed, and read the specific language that will record the decision/action. The chair may delegate all or part of the management of the meeting to a facilitator, the chair-elect, or INR. The IRST will provide for public testimony at meetings unless the chairperson determines that doing so would be detrimental to the conduct of the IRST's business.

Section 3: Voting.

SB 1501 Section 38(8)(b) provides that the IRST "shall make substantial decisions by a vote of at least two-thirds of the team members." Since the IRST statutes do not establish how many members make a quorum, the general rule in ORS 174.130 requires that any actions of the IRST can only be exercised if a majority of the members are in agreement on the issue. This is a "majority of members" and not a "majority of quorum." This position is supported by the language in Section 38(8)(b) which requires a vote of "at least two-thirds of the team members" (not "two-thirds of the quorum").

And, as provided in SB 1501, the IRST would need to have at least four members (i.e., two-thirds of the team) vote together to make any substantial decision. Other decisions could be made with the support of at least three members (i.e., a majority of the team). If a member abstains, the abstention does not count as a vote in favor or against the motion, but the member's presence can be counted toward making up a quorum. In practice, this results in the following possible scenarios for a 5-person IRST.

Meeting attendance:	*1 - 2 people attend*	*3 people attend meeting*	*4 people attend meeting*	*5 people attend meeting*
Quorum?	*No*	*Yes*	*Yes*	*Yes*
Substantial decisions?	*No*	*No, since there are not two-thirds of five members to vote in favor*	*Yes, if all four members vote in favor*	*Yes, if four members vote in favor* *(one may vote against or abstain)*

Other decisions?	*No*	*Yes, if all three members vote in favor*	*Yes, if three members vote in favor* *(one may vote against or abstain)*	*Yes, if three members vote in favor* *(two may vote against or abstain)*

Section 3: Substantial Decision.

Ideas of

Substantial Decisions

Timeframe to complete Research question scoping

Research question scoping (lit review, need, budget, sow)

Final RFP

Final research/summary reports for AMPC/BoF

Election of chairperson

Removal of IRST members

Nomination of new IRST members

Non-Substantial Decisions

Engagement of external expertise

Substantial Decisions

The AMPC is authorized to determine what constitutes a "substantial decision[1]." The following are substantial decisions:

1. Initial nominations to the IRST per section (37)(3), chapter 33, Oregon Laws 2022;
2. Research topics;
3. Preliminary research questions per OAR 629-603-0200(3)(c);
4. Input on the IRST's final research questions per OAR 629-603-0200(4)(b);
5. Research agendas sent to the Board per OAR 629-603-0200(5)(c);
6. Approval of reports and recommendations to the Board per OAR 629-603-0200(8)(a);
7. Selection of co-chairperson(s);
8. Adoption of and changes to this AMPC charter per OAR 629-603-0300(2)(g)(C);
9. Approval of AMPC contribution to State Forester annual reports to the Board per OAR 629-603-0100(4).

The above list is not exclusive. If a member makes a motion for a vote and it is seconded, the decision is a substantial decision.

Results of substantial decisions will be maintained in a database of decisions available on the AMPC website and communicated to AMPC members via email.

An AMPC member may appoint a proxy to be present at a meeting for the purpose of casting the member's vote, consistent with the rules for interim members stated in OAR 629-603-0300(5).

Non-Substantial Decisions

Non-substantial decisions by the AMPC are made by informal agreement and without a formal vote.

---

[1] Section 36(8), Chapter 33, Oregon Laws 2022

Section 4: Cancelling Meetings.

ARTICLE VI. REVIEW AND UPDATING THE CHARTER

Section 1: Review and Update.

The charter shall be reviewed annually.

Section 2. Amendments.

The charter may be amended, in whole or in part, by a two-thirds vote of the members, provided that the substance of any proposed change must be stated in the notice of the meeting at which such action is to be taken.

The Use of Best Available Science in Adaptive Forest Management and Environmental Conservation: An Overview

DRAFT 29 December 2023

Jeff Behan, INR

A key initial task for the IRST is to develop standards for *best available science* (BAS) for the adaptive management program. Among other provisions, the Oregon Forest Practice (FPA) rules stipulate that these standards shall include *types of sources* of BAS, and *a process for determining what BAS is* including an assessment of study quality and relevance. In support of IRST work on this task, background information on identification and assessment of BAS is compiled below. This compilation is intended to complement a template document for the IRST to use in laying out the BAS standards, which will be provided at the January 5 IRST meeting.

The federal Endangered Species Act (ESA), Clean Water Act (CWA) and other statutes require identification and use of "best available science" (BAS) but rarely specify what BAS means or provide guidance on identifying and applying it (Lowell et al. 2016). The use of BAS is broadly supported in principle, so scholars and land management agencies have since worked to clarify what BAS is and is not, and how to integrate it into decision making and management. Because science knowledge is constantly being revised, BAS and adaptive management approaches are often used together, as with the state of Washington's Cooperative Monitoring, Evaluation, and Research (CMER) Committee charged with implementing the state's forest practices adaptive management program and envisioned for the similarly structured Oregon AMPC and IRST. In support of this vision, key definitions and findings from the resulting body of literature on identification and use of BAS in adaptive natural resource management are summarized below.

Defining "science"

Science has been defined as the systematic enterprise of gathering knowledge about the world and organizing and condensing that knowledge into testable laws and theories (Gleick et al. 2010). Generally accepted hallmarks of "good" science include clearly-state objectives, inquiry grounded in hypothesis testing using standardized, well-documented, replicable methods; objectivity; use of analytical models; statistically rigorous analysis of results; disclosure of uncertainties and data limitations; and peer-review. Science may also be defined as knowledge derived from processes that utilize these practices (e.g., National Research Council 2004) or more broadly as a way of knowing where what is defined as knowledge is based on a mix of observation, intuition, experimentation, hypothesis testing, analysis, and prediction (Sullivan et al. 2006). Thus, while there are differences in how science is perceived by different people, the term is broadly understood to encompass both a body of organized *knowledge* and also an evidence-based, model and theory-building *process* that continually extends, refines, and revises that knowledge (NRC 2012). While both aspects are important, BAS mandates focus primarily on the knowledge derived from science processes. To clarify this, some BAS policy guidance refers to best available science *information* (BASI, USFS 2012; Esch et al. 2018).

Defining “science information”

Scientific research and information have been categorized in several ways. A basic distinction is that between *quantitative* and *qualitative* research. In general, quantitative research seeks to understand the causal or correlational relationship between variables through testing hypotheses, whereas qualitative research seeks to understand a phenomenon within a real-world context through observation and interviews. Both types of research yield valuable information. The AMPC and IRST may focus primarily on quantitative research and science information related to forest and stream ecology and forest management. However, qualitative (e.g., observational) scientific evidence and expert knowledge may complement quantitative information and, in some cases, may constitute the entirety of available evidence. Also, a degree of qualitative interpretation of study results is often inherent to forest ecology research, where there are usually at least some uncontrolled and potentially interacting variables.

In the context of fisheries ecology, Bisbal et al. (2002) categorize: 1) *scientific information,* which emerges from observation, identification, description, and testing of explanatory hypotheses about fundamental principles that govern cause-and-effect relationships; 2) *suggestive information*, including empirical data, outputs from modelling or simulations, monitoring data, and estimates that are gathered using scientific methods and 3), *supplementary information,* primarily expert knowledge gained through personal experience, training, research, and skill development, legitimized by factors such as educational and experiential background, accomplishments, publication record and reputation among peers (Charnley et al. 2017). Because all three types fall under the science umbrella, “scientific” information may be more accurately referred to as “research” information.

Science information may also be arrayed on a continuum from *emergent* to *established*. Established information is uncontroversial, taken for granted factual knowledge such as the notion that salmon are fish. Emergent information is that for which there is supporting evidence of varying strength, which relates to the degree of reliability and uncertainty associated with it. Emergent information may be supported by strong scientific evidence and therefore quite reliable, but is still open to further validation, revision and potential for controversy. Over time, science information initially characterized as emergent may become more widely accepted and established, with decreasing uncertainty as the evidence base becomes more robust.

Lastly, there are different scientific disciplines that are potentially relevant to the work of the IRST, e.g. geotechnical studies on physical processes, and biological studies on biotic processes, both of which affect stream ecology but vary substantially in research parameters, analysis, and interpretive methods. These methodological differences may, in turn, affect the criteria used and how they are applied to assess the technical merit and relevance of studies in each discipline.

What constitutes scientific evidence in forest ecology?

INR (2005) paraphrased Maurer (2004) and Scheiner (2004) on this topic, as follows:

> *"All sciences, but ecology in particular, rely on a range of types of data or empirical observations. Those observations may occur as part of a designed experiment, or as part of a survey of the natural world. This is not a simple dichotomy, but a continuum. At one end are experiments in which all extraneous factors are held constant, as far as possible, and the scientist varies one or more factors of interest in a controlled fashion. At the other end are observational surveys with no manipulation. Intermediate are field experiments in which some factors are manipulated, some are controlled, and others vary naturally. All observations coming from this range of situations are potentially important in understanding ecosystem processes and function, and all contribute to the evidence base.*
>
> *In other words, scientific evidence in ecology comes from a spectrum of experimental and observational data. Use and interpretation of statistics depends on whether the type of science being done is primarily observational (inductive) or experimental (deductive). Some statistical methods can be useful in one kind of inquiry but not in another. Other methods can used in either type of science but require different assumptions and imply different things about the data depending on whether an investigation is primarily inductive or deductive.*
>
> *Thus, sweeping generalizations about the appropriateness of any particular method of statistical inference over others are unwarranted, and laboratory experiments do not necessarily carry greater weight than field experiments. Laboratory experiments are more powerful for exploring the mechanistic bases of ecological processes, but field experiments have greater potential to be generalizable because, by incorporating more potentially interacting species, they can encompass a greater ecological scale.*
>
> *All types of data play a role. The weight given to a particular piece of evidence should not depend on the type of observation but on the match between the observation and the question being asked. Evidence can include observations made prior to questions being asked and do not have to be made by a scientist. Scientific decisions in ecology are based on the bringing together of different, even disparate kinds of evidence."* (INR 2005, p. 55.)

Sources of science information

Sources of science information include:

- ***Peer-reviewed literature*** in scientific journals and books where different scientists contribute individual chapters is readily available, often online and in a standardized format, and is considered most reliable mainly because it has undergone peer review.
- ***Gray literature*** may include reports of surveys, experimental or long-term historical data along with changes in protocols, meta-data, knowledge syntheses, and the progress and

findings of monitoring efforts. Such literature may be reviewed internally, e.g. by other agency scientists, but typically does not contain significantly new findings that would require broader or more independent review. Much of this science information is quite accessible. A good example is USFS General Technical Reports (GTRs).

Theses and dissertations are another type of gray literature. Graduate student research findings often subsequently appear in peer-reviewed science journals but for various reasons may also not be published in such a venue. In those cases, the original thesis or dissertation may be the only source of unique and otherwise unavailable science information. As of 2023, many scientific theses and dissertations are available via electronic databases such as OSU Scholars Archive, University of Oregon Scholars' Bank, and University of Washington ResearchWorks Archive. Additional effort is often needed to assess the veracity of science information from unpublished theses and dissertations that have not been subjected to science journal peer-review.

- ***Expert opinion*** supplied by professional experts such as university and government scientists, can be highly reliable, especially when it is based on the experience of multiple experts who collectively function as peer reviewers. Expert opinion may be the only science knowledge available for some crucial issues or local areas. Questions and judgments about the status and restoration of impacted ecosystems and recovery of imperiled species are often based largely on expert opinion.
- ***Anecdotal evidence*** is essentially a short narrative about a personal experience. In natural resource and environmental management, anecdotal evidence often emerges through public comments on government reports (e.g. a draft EIS), at agency meetings, through newspaper or popular journal coverage, or through letters sent to agencies or the media. It may reflect Indigenous Knowledge that is not generally available to the public but passed on from one generation to the next within various local communities. Scientists often put much less credence in this type of information because it can be difficult to access, verify, and review even when generated by the scientific community itself. However, especially when there is a paucity of other types of information, anecdotal evidence can still provide useful guidance. (Sullivan et al. 2006.)

The 2015 USFS Planning Directives for implementing the 2012 Planning Rule allow for a wide range of types of evidence to be used to meet BAS intent, including peer-reviewed publications, scientific assessments, expert opinion, observational data, and unpublished data from government agencies, academia, or public surveys.

Systematic review

A systematic review is rigorous, transparent, reproducible process for assessing scientific and technical information that focuses tightly on a specific question, or small set of questions, which frame decisions about what evidence is relevant to the review, and what is not. When a systematic review is available, or can feasibly be conducted, it may serve as a highly useful “package” of BAS (Esch et al. 2018, Burnett et al. 2008, INR 2005). But systematic reviews are dependent on available and existing research, so this assessment approach is not possible for all management issues. Where sufficient research does exist, conducting a systematic literature review usually requires a high level of expertise and a significant investment of resources and time. Options for limiting the time and resources necessary to conduct a systematic review include tightly focused review questions and stringent study inclusion criteria (e.g. limited geographic or temporal extent, peer-reviewed studies only), or using only a subset of systematic review methods, e.g., a documented literature search strategy.

Availability of science information

“Available” science typically refers to that which already exists when a process to gather and use it is initiated. The information should be useful without further data collection, modification, or validation but may need additional synthesis or interpretation to place it in an appropriate form or context. Available science may also include any additional scientific information that can feasibly be generated during the assessment or decision-making process. Inherent in the concept of available science is that it is physically and conceptually accessible to the user. (Charnley et al. 2017; USFS 2015).

What is “best” available science?

After being introduced into federal statute via the ESA and CWA, the concept of “best available science” rapidly gained popularity in environmental law and policy (Bisbal 2002). Similar BAS provisions were enacted at state-level agencies, and staff across these jurisdictions then worked to clarify and operationalize its use. The crux of this revolves around parsing the available information then determining, in a documented, defensible manner, what science is “best”.

Definitions of BAS vary among agencies and academics, but most emphasize *accuracy*, *reliability*, and *relevance* (Esch et al. 2018, USFS 2015):

- ***Accurate*** scientific information estimates, identifies, or describes the true condition of its subject matter. This may be a measurement of specific conditions, a description of operating behaviors (physical, biological, social, or economic), or an estimation of trends. Statistically accurate information is near to the true value of its subject, quantitatively unbiased, and free of error in its methods. The extent to which scientific information is accurate depends on the relationship of the scientific findings to supportable evidence that identifies the relative accuracy or uncertainty of those findings. The accuracy of scientific information can be more easily evaluated if reliable statistical or other scientific methods have been used to establish the accuracy or uncertainty of any relevant findings.
- ***Reliability*** reflects how appropriately scientific methods have been applied and how consistent resulting information is with established scientific principles. Scientific information is more reliable if it results from an appropriate study design and well-

developed scientific methods, clearly described. Assumptions, analytical techniques, and conclusions should be well referenced with citations to relevant, credible literature, and other pertinent existing information. Conclusions should be based on reasonable assumptions supported by other studies and consistent with general theory underlying those assumptions or are logically and reasonably derived from data presented. Any gaps in information and inconsistencies with other pertinent scientific information should be adequately explained. Scientific information that describes statistical or other scientific methods used to determine both its accuracy and uncertainty are considered more reliable. Quantitative analysis that has known (and quantifiable) rates of errors and results improves this reliability. An accuracy assessment of the data supports the reliability of the quantitative analysis.

- ***Relevant*** information is that which pertains to the issues under consideration at the appropriate temporal and spatial scales. Both accurate and reliable science need to be assessed for applicability to the question at hand. This includes the ability to transfer results to a management question from different systems, species, or geographies or via different methodologies.

Thus, what constitutes "best" science is usually *context specific*. While accuracy and reliability are determined by the scientific research approach, determining what science is "best" depends in part on the question or intent, the geographic area or ecosystem being considered, the data available, any knowledge gaps, and if there is controversy or debate within the scientific community on a particular subject. Guidance in the 2012 USFS forest planning rule states that:

> *"In some circumstances, the BASI would be that which is developed using the scientific method, which includes clearly stated questions, well-designed investigations and logically analyzed results, documented clearly and subjected to peer review. However, in other circumstances the BASI for the matter under consideration may be information from analyses of data obtained from a local area, or studies to address a specific question in one area. In other circumstances, the BASI also could be the result of expert opinion, panel consensus, or observations, as long as the responsible official has a reasonable basis for relying on that scientific information as the best available. (77 FR 21192 [April 9, 2012].)*

The default standard for "best" scientific evidence is generally taken to be that published in top tier, peer-reviewed science journals. Scientific evidence quality "hierarchies" generally rank peer-reviewed science first, often with sub-categories based on methods and statistical rigor, followed by "gray" literature of various types, then expert opinion and finally, anecdotal evidence. In the real world, peer-reviewed science information may be limited, unavailable, or tangentially relevant due to limits on inferences that can be made beyond the research context. Weighing "best" science in forest management and ecology appears to usually require a balance of methodological considerations, availability of local information, and some sort of holistic or heuristic assessment of situational relevance.

BAS and the Washington state Cooperative Monitoring, Evaluation, and Research Committee

The state of Washington's Growth Management Act requires counties and cities to use BAS when developing policies and development regulations to protect critical areas, especially measures necessary to preserve or enhance anadromous fisheries (WAC Chapter 365-195, Sections 900-925). Under this directive, Washington's *Cooperative Monitoring, Evaluation, and Research* (CMER) Committee has refined procedures to identify, acquire and apply BAS as a key component in a monitoring and research program formed to implement recommendations in the state's Forests and Fish Report. Because Oregon's IRST and AMPC are modeled upon the CMER, details on assessing BAS for that program are provided below.

For the CMER, BAS is described as *"relevant science from all credible sources including peer-reviewed government and university research, other published studies, and CMER research products. Applicable historic information, privately produced technical reports, and unpublished data may have value and are considered as long as they can be assessed for accuracy and credibility."*

Table 1: Sources and characteristics of BAS. From WAC 365-195-905: Criteria for determining which information is the "best available science."

	CHARACTERISTICS					
SOURCES OF SCIENTIFIC INFORMATION	Peer review	Methods	Logical conclusions & reasonable inferences	Quantitative analysis	Context	References
A. Research. Research data collected and analyzed as part of a controlled experiment (or other appropriate methodology) to test a specific hypothesis.	**X**	**X**	**X**	**X**	**X**	**X**
B. Monitoring. Monitoring data collected periodically over time to determine a resource trend or evaluate a management program.		**X**	**X**	**Y**	**X**	**X**
C. Inventory. Inventory data collected from an entire population or population segment (e.g., individuals in a plant or animal species) or an entire ecosystem or ecosystem segment (e.g., the species in a particular wetland).		**X**	**X**	**Y**	**X**	**X**
D. Survey. Survey data collected from a statistical sample from a population or ecosystem.		**X**	**X**	**Y**	**X**	**X**
E. Modeling. Mathematical or symbolic simulation or representation of a natural system. Models generally are used to understand and explain occurrences that cannot be directly observed.	**X**	**X**	**X**	**X**	**X**	**X**
F. Assessment. Inspection and evaluation of site-specific information by a qualified scientific expert. An assessment may or may not involve collection of new data.		**X**	**X**		**X**	**X**

G. Synthesis. A comprehensive review and explanation of pertinent literature and other relevant existing knowledge by a qualified scientific expert.	X	X	X		X	X
H. Expert Opinion. Statement of a qualified scientific expert based on his or her best professional judgment and experience in the pertinent scientific discipline. The opinion may or may not be based on site-specific information.			X		X	X

X = characteristic must be present for information derived to be considered scientifically valid and reliable

Y = presence of characteristic strengthens scientific validity and reliability of information derived, but is not essential to ensure scientific validity and reliability

Including and assessing "gray" literature

The CMER also addressed issues associated with assessing the scientific relevance and technical merit of non-peer reviewed scientific information. This "gray" literature produced by government agencies, professional organizations, research centers, universities, public agencies, special interest groups, corporations and NGOs includes technical reports, academic theses, government documents, conference proceedings, and other publications that may not have been independently assessed for quality and technical rigor. Because gray literature can encompass specific, local, contextual, targeted information that is otherwise unavailable, assessing it for accuracy and credibility is a key issue when defining and collating BAS.

CMER (Hotvedt et al. 2013) found that gray literature such as doctoral theses and conference proceedings can be valuable sources of scientific information. Advantages include quicker access to results, and more details regarding methods and analysis compared to peer-reviewed publications. The CMER recommended that all credible sources and types of scientific information should be used in CMER's research and monitoring program and processes, including gray literature, as long as it can be evaluated for accuracy and credibility and is available to CMER and the general public.

The CMER report provided a list of factors to consider when evaluating non-peer-reviewed literature for potential inclusion in a synthesis of BAS and appropriate use in decision-making:

- Relevance to the primary literature review or study question;
- Adherence to scientific method;
- Degree to which study is original work (e.g., not literature review, overviews);
- Prospective or experimental vs. retrospective;
- Appropriateness of study design to the research question;
- Degree of bias: in study design, data collection, review of data, analysis, interpretation, and publication;
- Timing of measurements after an activity occurred;
- Number of years of follow up;

- Statistical issues (e.g., adequately powered to detect an effect and adjustments for confounding factors);
- Quality of reporting;
- Generalizability (e.g., strength of inferences);
- Level of peer review; and,
- Publication type/status (e.g., national/international scientific journal, federal and state agency peer-reviewed technical reports (e.g., USDA Forest Service, USGS), proprietary studies, university cooperative extension reports, consultant's reports, and so forth).

Assessing the "quality" of scientific information

Decisions regarding inclusion and weighting of a particular set of research findings or other information when synthesizing "best" science hinge on the *quality* of that scientific evidence. The weight implicitly or explicitly assigned to individual studies or "packets" of evidence for their quality, and the integration of those evaluations into a documented, defensible, holistic assessment, is where the rubber meets the road when implementing BAS mandates.

Scientific information "quality" is generally taken to be comprised of a combination of its technical merit, and applicability (relevance) to the location and science question(s) at hand. The CMER laid out some guidance for elements that should be assessed when evaluating the quality of scientific information: its source; spatial scale; temporal scale; and also adherence to the scientific process, i.e., study design; methods; data; quantitative analysis; context; references; logical conclusions and reasonable inferences; and peer review.

The general goal of assessing the quality of a study is to establish how reliable its findings are based on methodological rigor, and the strength of linkages between study results and conclusions drawn from them. A fundamental, complementary consideration is the degree to which the findings are relevant to a particular setting or area of interest. Aspects of this include the degree of alignment between the questions or hypotheses addressed in the study and the science questions or issues for which BAS is being compiled, and also the extent to which the effects observed in a study are applicable outside of the study area (e.g., generalizability), such as strength of inferences. Quality also relates to the extent to which a study design is likely to prevent systematic error, or bias.

Although no single definition of study "quality" exists, absent an ability to independently review the quality of a study, one basic parameter for quality is the level of expected rigor of scientific review, based on different sources of information, which are commonly viewed as reflecting different levels of rigor, quality and respectability:

1. Peer-reviewed literature,
2. Gray literature,
3. Expert opinion (i.e., opinion and broadly held beliefs), and
4. Anecdotal evidence (e.g., personal observations and beliefs).

Building on this notion of ranking different types of science information in hierarchical fashion, the CMER noted that keying in on study designs is a further, more refined step for assessing quality. For example, a hierarchy of study designs might be based on the following, in general order of quality:

1. Experimental studies (i.e., randomized control trials),
2. Quasi-experimental studies (i.e., studies without randomization),
3. Controlled observational studies,
4. Cohort studies,
5. Case control studies,
6. Observational studies without control groups, and
7. Expert opinion based on theory, laboratory research, or consensus.

The CMER also noted a similar hierarchy of study designs used by Burnett et al. (2008) in a pilot test of systematic review methods commissioned by ODF:

1. Replicated sampling, replicated controls, sampling before and after treatment;
2. Unreplicated, controlled, sampling before and after treatment;
3. Unreplicated, uncontrolled, sampling before and after treatment; OR Unreplicated, controlled, sampling after treatment;
4. Unreplicated, uncontrolled, sampling after treatment; and
5. Unreplicated, uncontrolled, anecdotal observation after treatment.

The CMER (Hotvedt et al. 2013) recommended that references for a synthesis of BAS should be selected based on relevance, availability, and quality, with preference given to peer-reviewed publications that are widely available and referenced in the area of scientific inquiry of interest. Gray literature (e.g., internal reports, papers presented at conferences, articles in preparation) can be acceptable and may provide unique and valuable information but should be treated as unpublished and given additional scrutiny for quality (accuracy and credibility). Regardless of source, authors of CMER reports should be able to provide, or direct access to, literature referenced in a study design or report if requested during a CMER review process. The CMER (Hotvedt et al. 2013) also recommended the use of hierarchical ranking of science information quality. However, a hierarchical approach is not sufficient for assessing all aspects of relevance, such as alignment between study hypotheses and science questions for which BAS is being compiled, or scope of inference and generalizability beyond the study area.

References cited

Burnett, K.M., Giannico, G.R. and Behan, J. 2008. A pilot test of systematic review techniques: evaluating whether wood placements in streams of the Pacific northwest affect salmon abundance, growth, survival, or habitat complexity. Institute for Natural Resources, Oregon State University.

Esch, B.E., Waltz, A.E., Wasserman, T.N. and Kalies, E.L. 2018. Using best available science information: Determining best and available. Journal of Forestry, 116(5), pp.473-480.

Gleick, P.H., Adams, R.M., Amasino, R.M., Anders, E., Anderson, D.J., Anderson, W.W., Anselin, L.E., Arroyo, M.K., Asfaw, B., Ayala, F.J. and Bax, A. 2010. Climate change and the integrity of science. Science, 328(5979), pp.689-690.

Hotvedt, J., Hayes, M., Hicks, M., Kroll, A., Lingley, L., Martin, D., Mendoza, C., Sturhan, N. 2013. Use of Non-CMER Science in the Forest Practices Adaptive Management Program. Washington Cooperative Monitoring, Evaluation, and Research Committee (CMER).

INR (Institute for Natural Resources). 2005. Applying systematic evidence reviews in Oregon forest policy: Opportunities and challenges. Behan, J., Crawford, S. and Kleiner, E. preparers. Institute for Natural Resources, Oregon State University.

Lowell, N. and Kelly, R.P., 2016. Evaluating agency use of “best available science” under the United States Endangered Species Act. Biological Conservation, 196, pp.53-59.

Maurer, B. 2004. Chapter 2: Models of scientific inquiry and statistical practice: Implications for the structure of scientific knowledge in Taper, M. and Lele, S. (eds.) The Nature of Scientific Evidence: statistical, philosophical, and empirical considerations. University of Chicago Press.

NRC (National Research Council). 2012. A framework for K-12 science education: Practices, crosscutting concepts, and core ideas. National Academies Press.

Ryan, C.M., Cerveny, L.K., Robinson, T.L. and Blahna, D.J., 2018. Implementing the 2012 forest planning rule: Best available scientific information in forest planning assessments. Forest Science, 64(2), pp.159-169.

Scheiner, S. 2004. Chapter 3: Experiments, observations, and other kinds of evidence in Taper, M. and Lele, S. (eds.) The Nature of Scientific Evidence: statistical, philosophical, and empirical considerations. University of Chicago Press.

Sullivan, P.J., Acheson, J., Angermeier, P.L., Faast, T., Flemma, J., Jones, C.M., Knudsen, E.E., Minello, T.J., Secor, D.H., Wunderlich, R. and Zanetell, B.A. 2006. Defining and implementing best available science for fisheries and environmental science, policy, and management. Fisheries, 31(9), p.460.

USDA (United States Department of Agriculture) Forest Service. 2015. Forest Service Handbook.