Do you value science that has broad benefits?

Do you value knowledge that applies widely?

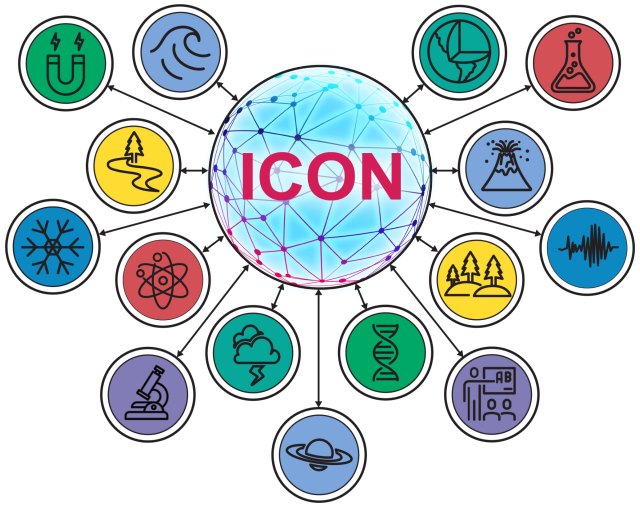
We invite you to explore ICON…

Integrated Coordinated Open Networked
SCIENCE COOPERATIVE
Science for and by the community

ICON is a **framework** to guide any scientific endeavor motivated by the pursuit of **mutual benefit** and **transferable knowledge**

Work that aligns with ICON principles **is intentionally…**

- **Integrated** across physical, chemical, biological, and/or social attributes and scales
- **Coordinated** with consistent protocols and methods to enable transferability
- **Open** and FAIR throughout the research lifecycle from ideation to publication
- **Networked** whereby research is designed and/or implemented with a broad range of stakeholders to ensure mutual benefit



Explore more at https://ICON-science.pnnl.gov and Goldman et al. 2022 https://doi.org/10.1029/2021EA002099.

How do you want to ICON?

This worksheet is for anyone with a science idea for a new or existing project. You can begin with any level of ICON knowledge and at any project stage.

Instructions: Below are two questions for each ICON principle and two about ICON as an integrated concept. We suggest that each team member answer the questions independently and then discuss them as a team. Taking your time now and thinking deeply will set up your project for the successful use of ICON. After answering and discussing these initial questions with your team, you can delve deeper using the second set of more detailed questions. Consider follow-on team discussion to identify how the outcomes from your discussions can be used to shape your project. Here, the term 'stakeholder' refers to any individual, team, institution, community, or other entity that may be interested in and/or impacted by (negatively or positively) your work.

Initial Questions

Integrated *across disciplines and scales*	**Coordinated** *with consistent methods*	**Open** *across the entire research lifecycle*	**Networked** *for mutual benefit*
1 - What disciplines are represented or will be represented in your (1) team's expertise, (2) study design, and (3) (meta)data? 2 - What spatial, temporal, and other scales are you or will you be studying? Are other scales relevant to your research and if so, what strategies could you use to connect to other scales?	1 - How are your chosen protocols/methods/communication modes/governance structures being selected (e.g., by experts on your team, through stakeholder engagement, or something else)? 2 - What opportunities are there to use established protocol(s) to enhance transferability and interoperability of project outcomes (e.g., (meta)data)?	1 - What parts of the research life cycle are your team and stakeholders comfortable with being open? For example, openly sharing ideas/project plans/protocols as they develop, pre-registering studies, openly publishing data before manuscript development, developing manuscripts on open platforms, etc? 2 - Is your team familiar with the concept of the FAIR (findable, accessible, interoperable, reusable) principles for data management and stewardship (Wilkinson et al., 2016)? What is your plan for using FAIR principles in your project?	1 - Whose perspectives, experiences, and/or values are (and are not) being considered as you design your project? Who is contributing ideas, insights, information, data, software, land access, and/or sample access in your project? Are there other people, groups, or entities you consider as stakeholders? 2 - How might you increase the value and mutual benefit of your project to stakeholders? For example, are you able to add meta(data) of value to stakeholders, and how will you know what is valuable and beneficial to them?

Putting ICON Together
1 - Are some principles a higher priority than others, for your team? 2 - (ICON-together) What are the relative amounts of energy your team will put into each ICON principle, given the resources that are available to your team?

3 - Thinking about how you answered the questions above, what opportunities are there to use ICON to enhance diversity, equity, inclusion, justice, and accountability?

Part II: Advanced Questions

Instructions: After answering the initial questions, read through the advanced questions as a team. You do not need to answer all of them. Instead, decide which ones to focus on based on what is most relevant to your project's goals and how your team envisions using ICON. We suggest that each team member answer the chosen questions on their own and then discuss them as a team.

Integrated

1. What tangible steps are you taking to ensure that processes, concepts, theory, (meta)data, and/or models are truly linked across disciplines in your study? For example, does evaluation of a specific hypothesis require merging (meta)data from disparate disciplines and if so, how will you do that?

2. Beyond the core (meta)data needed to answer questions and test hypotheses, are there other types of (meta)data that could be generated (within your resource and fiscal realities) that would be of interest to those beyond your project's primary discipline and/or team? If so, how will you identify, select, and develop protocols for such (meta)data? *Note the connections here to Coordinated and Networked*.

3. What do you see as the biggest barrier to being Integrated in your project and team?

Coordinated

1. Will your protocols/methods allow your research outcomes (e.g., (meta)data) to be interoperable with other efforts?

2. If you identify that you need to change approaches after already implementing protocol(s), how will you consider the interoperability of past and future results? How will you communicate any concerns about consistency to future data users?

3. How are you sharing/communicating your protocols/methods? How might you make these protocols accessible to anyone on your team, and will they be made openly accessible as well? How do you plan to keep the team invested in using the chosen protocols? Can you co-design systems of accountability with your team for the chosen protocols?

4. How will modifications to the protocol be communicated and maintained (like version control)?

5. Are there established research efforts that can provide guidance on protocol selection and/or modification?

6. Is there sufficient detail in the protocols that they can be replicated by anyone within or outside of your core project team, and how will you evaluate this?

7. Do any of your data generation activities not follow an established or standard protocol that is also used by others groups/projects? If yes, are there opportunities to use or align more closely with established or standardized protocols? If there are no community established or standardized protocols, will you publish your protocol and propose it as a community approach or standard?

8. Do you plan to do cross comparisons between your protocols and those used by others to enhance interoperability of data across research efforts?
9. What do you see as the biggest barrier to being Coordinated in your project and team?

Open

1. Are there concerns about sharing too much or too early? For example, are there researchers on the team that have concerns about being scooped, and/or are there needs to consider stakeholders' authority-to-control data sharing (e.g., as described in the CARE Principles for Indigenous Data Governance; Carroll et al. 2020)? If so, have you written out the concerns, evaluated the level of risk, and written out clear mitigation strategies (e.g., data use agreements, data publishing licenses and DOIs, review-and-release process with stakeholders, data subsets that will remain private)?

2. Have you reviewed the sub-points for each of the FAIR principles? They are quoted directly from Wilkinson et al., 2016 for your reference below:
    - *"To be Findable:*
        - *F1. (Meta)data are assigned a globally unique and persistent identifier*
        - *F2. Data are described with rich metadata (defined by R1 below)*
        - *F3. Metadata clearly and explicitly include the identifier of the data they describe*
        - *F4. (Meta)data are registered or indexed in a searchable resource*
    - *To be Accessible:*
        - *A1. (Meta)data are retrievable by their identifier using a standardized communications protocol*
        - *A1.1 The protocol is open, free, and universally implementable*
        - *A1.2 The protocol allows for an authentication and authorisation procedure, where necessary*
        - *A2. Metadata are accessible, even when the data are no longer available*
    - *To be Interoperable:*
        - *I1. (Meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation.*
        - *I2. (Meta)data use vocabularies that follow FAIR principles*
        - *I3. (Meta)data include qualified references to other (meta)data*
    - *To be Reusable:*
        - *R1. (Meta)data are richly described with a plurality of accurate and relevant attributes*
        - *R1.1. (Meta)data are released with a clear and accessible data usage license*
        - *R1.2. (Meta)data are associated with detailed provenance*

- *R1.3. (Meta)data meet domain-relevant community standards"*

3. What aspects of your data management and publishing strategy are designed to facilitate 'Findability' of your (meta)data? For example, what search functions are available in your selected repository; what keywords will you use; and how will you let others know that your (meta)data exists?

4. What aspects of your data management and publishing strategy are designed to facilitate 'Accessibility' of your (meta)data? For example, what (meta)data structures will you use to enhance access; will you develop any front-end tools to help others access, understand, visualize, etc. specific parts of your (meta)data?

5. What aspects of your data management and publishing strategy are designed to facilitate 'Interoperability' of your (meta)data? For example, what methods will you use to generate (meta)data and how do they relate to methods used by others (see Coordinated). In addition, what units and formats will your (meta)data use relative to what others use, and will you use community standards/reporting formats to structure your published (meta)data?

6. What aspects of your **data management and publishing strategy** are designed to facilitate 'Reusability' of your (meta)data? For example, will you publish detailed protocols spanning all methods used and sample-level metadata on storage times, quality checks, re-analyses, and deviations from the standard protocol? What data license will you use?

7. Are you aiming to apply FAIR principles across the entire research lifecycle? If yes, how will you take each principle into account when in the research stages that do not center around (meta)data and publishing? For example, do you use more than one approach to advertise opportunities; do you include text captions with your graphics ("alt text"); do your presentations have captions; are your materials in more than one language; do you consider color blindness when choosing colors and symbols in your plots; are your presentations openly available; and do your presentations have a doi?

8. What is your approach to authorship vs. acknowledgment? What is your approach to author order? What is your approach to identifying corresponding author(s)? Have you written down the publishing norms and expectations around authorship for your project and are they openly available? Have you identified a system to acknowledge and track author contributions (e.g., CRediT).

9. What do you see as the biggest barrier to being Open in your project and team?

Networked

1. What stakeholders exist for your project from local to global scales? Which of these stakeholders can you engage with and how? For example, can you hold open discussions about your study design and make modifications based on stakeholder input; are there educational opportunities you can host during your research; and have you discussed how you might share the results of your project with stakeholders?

2. How will you know if you've generated outcomes useful to those outside of your core project team? Are there metrics or 'signatures' you can use in this evaluation (e.g., number of times generated data are used by others)?

3. What approach is being used to to include contributors and stakeholders in project decisions and what approach is being used to acknowledge their contributions? Were the contributors also decision-makers when choosing the approaches? If not, how have the approaches been communicated to them?

4. Are you working in a community of people outside of your project team? How are you engaging with that community? What steps will you take to avoid extractive relationships (e.g., as described by David-Chavez et al., 2018)?

5. What can you do to communicate with your stakeholders about their needs and interests? What steps will you take to avoid offering solutions before listening to their needs?

6. How can you reduce the harm caused by your project to stakeholders? How will you know what is harmful to them?

7. Are there opportunities to generate mutually beneficial outcomes through some form of crowdsourcing, ranging from study design to sample collection to data analysis to manuscript development?

8. What do you see as the biggest barrier to being Networked in your project and team?

Putting ICON together

1. What is your team's plan for **navigating conflict** within your team in your plans for approaching ICON principles across your project? How have you recorded your plan and discussed it as a team? (Coordination-Networked)

2. What is your team's plan for navigating conflict among stakeholders? How have you or will you record your plan and discuss it with stakeholders? (Networked)

3. What aspects of your team and project are designed (and how are they designed) to **embody or facilitate equity?** What aspects of your team and project are designed (and how are they designed) to **embody or facilitate justice**? (Diversity and Inclusion…)How?

4. What aspects of your team and project are designed (and how are they designed) to embody or facilitate inclusion? What aspects of your team and project are designed (and how are they designed) to embody or facilitate diversity? (Diversity and Inclusion…)

5. What aspects of your team and project are designed (and how are they designed) to embody or facilitate accountability? (Networked)

6. How will you resolve tension within each ICON principle? (Overall- Reflection) Did you identify tension?

7. How will the ICON principles fit together into more than the sum of their parts?- Overall reflection about the plan.

References:

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