Narrowing the knowledge-action gap for infrastructure

The role for science policy



Christine J. Kirchhoff, James C. Arnott, & John W. Katzenberger

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Our team

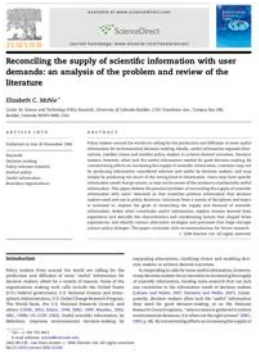
John **Katzenberger** (PI)
Director, AGCI

Christine **Kirchhoff** (Co-PI)
Assistant Professor, UConn

James **Arnott** (Co-PI)
Associate Director, AGCI
PhD Candidate, UMich

Bets **McNie** (Co-PI)
Assistant Prof, Cal. State Univ. Maritime

Moss et al. 2013, "…Practice relevant adaptation science." *Science*



McNie 2007, "Reconciling the supply of sci info with user demands." *Env. Sci. & Pol.*

Kirchhoff et al. 2013 "Actionable knowledge for env. decision-making." *Annual reviews*

Infrastructure for what?

“Infrastructure for science”

Building blocks of good research
(British Ecological Society 2013)

Provided by society in support of scientists

2, 120 returns on Google Scholar

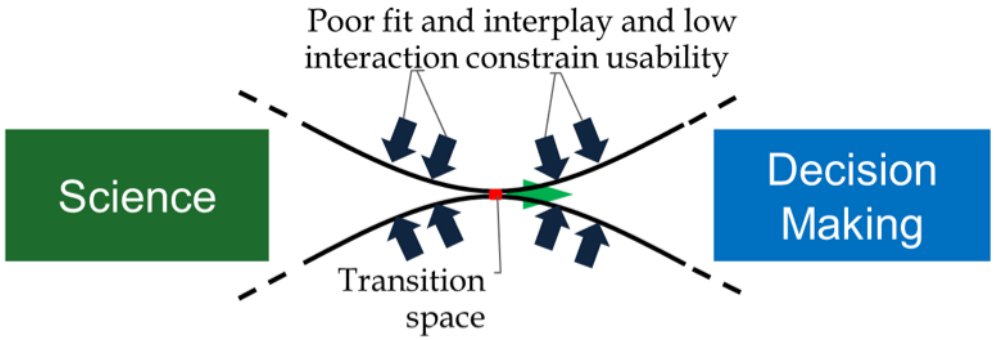
“Science for infrastructure”

Knowledge for building blocks to support a thriving society

Provided by scientists in service of society

28 returns on Google Scholar

The challenges we address



Adapted from Lemos, Kirchhoff, & Ramprasad 2012

Infrastructure in crisis

- Built and designed for the 20th Century
- Underinvestment: $3T to 2025; $11T to 2040 (ASCE 2016)

Science in crisis

- Crisis' in how we produce usable/ actionable science in service to society

Our Aim – Review & Recommend Science Policy & Science Management Approaches to Support 21st Century Infrastructure

Approach

Sources & Methods

- *Inspiration & fodder:* 4 AGCI workshops on science-policy interaction (2009-2016)
- Systematic searches on WoK, Scopus. Screened for relevancy & empirical basis.
- Snowballs & priors

Did we miss something? Please let us know!

Literatures encountered

- Science policy
- Research evaluation
- Knowledge utilization*
- Political science
- Public policy
- Psychology
- Engineering
- Management
- + multi/inter-disciplinary

Research Questions:

1. **What processes or conditions for doing science are more likely to yield actionable knowledge? What science policies needed to support the production of actionable knowledge?**

Science Policy to change how we do science

e.g., organizational and institutional changes in how we do science

Research Questions:

2. **What science policy levers are possible for changing the scientific enterprise to support the production of more actionable knowledge?**

Science Policy to change how we do science	Science Policy to change how we fund and evaluate science
e.g., organizational and institutional changes in how we do science	e.g., changes in solicitation and competition design, program support, and evaluation

SP for doing science that is actionable

Evidence base

- Usable/actionable knowledge - Rich body of literature that has transitioned from qualitative case studies to more empirical and mixed method approaches

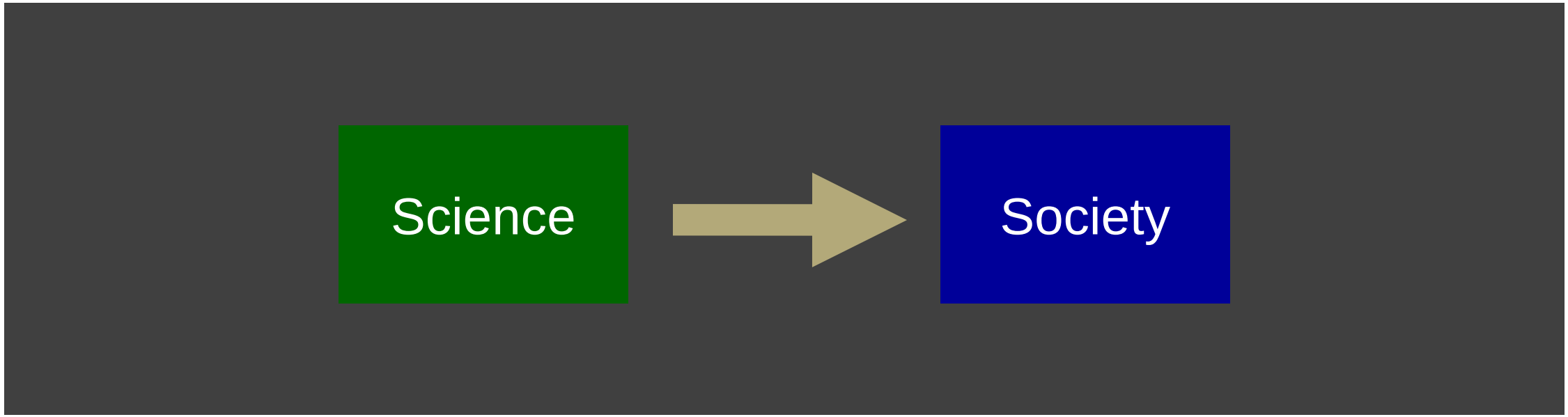
- Transdisciplinary research – emerging body of literature dominated by small n studies but offering promising results; great diversity in studies so findings less robust

Evidence base

- Usable/actionable knowledge - Rich body of literature that has transitioned from qualitative case studies to more empirical and mixed method approaches
  - A relatively young body of literature - there are underlying conceptual / philosophical debates and tensions
  - This body research focuses on : 1) the quality and nature of the science, 2) the quality and nature of interaction between scientists and potential users, and 3) the context of use and how 1 – 3 influence whether or not science is actionable

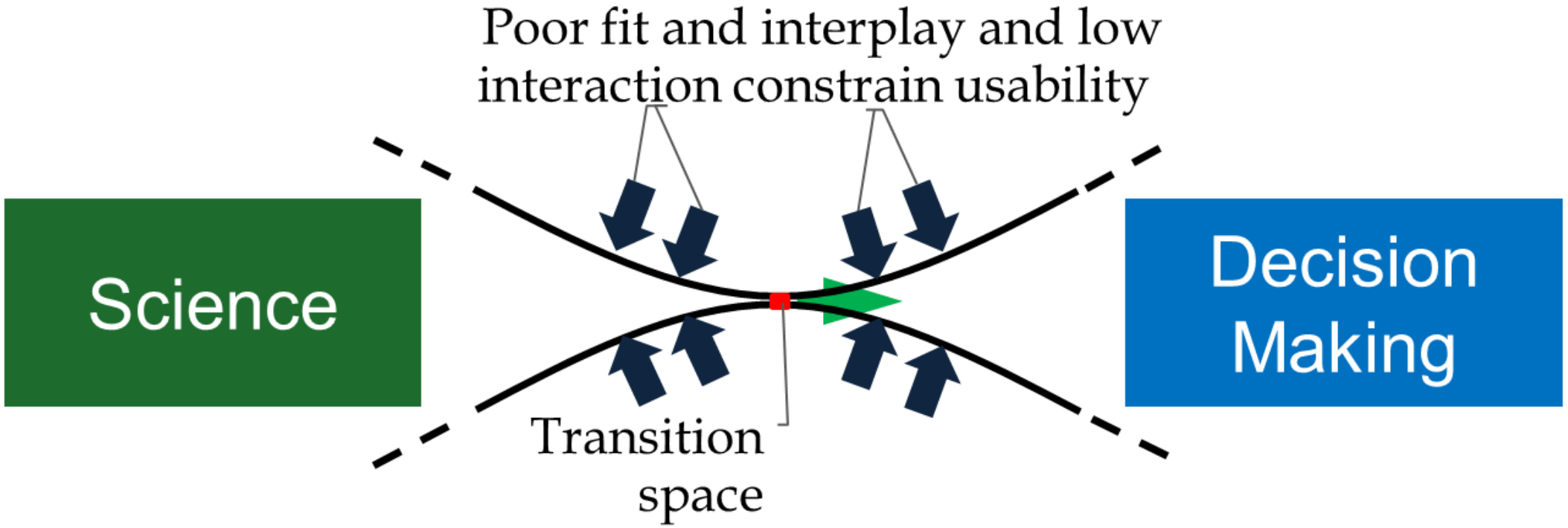
- Transdisciplinary research – emerging body of literature dominated by small n studies but offering promising results; great diversity in studies so findings less robust

Linear Model of Science Production



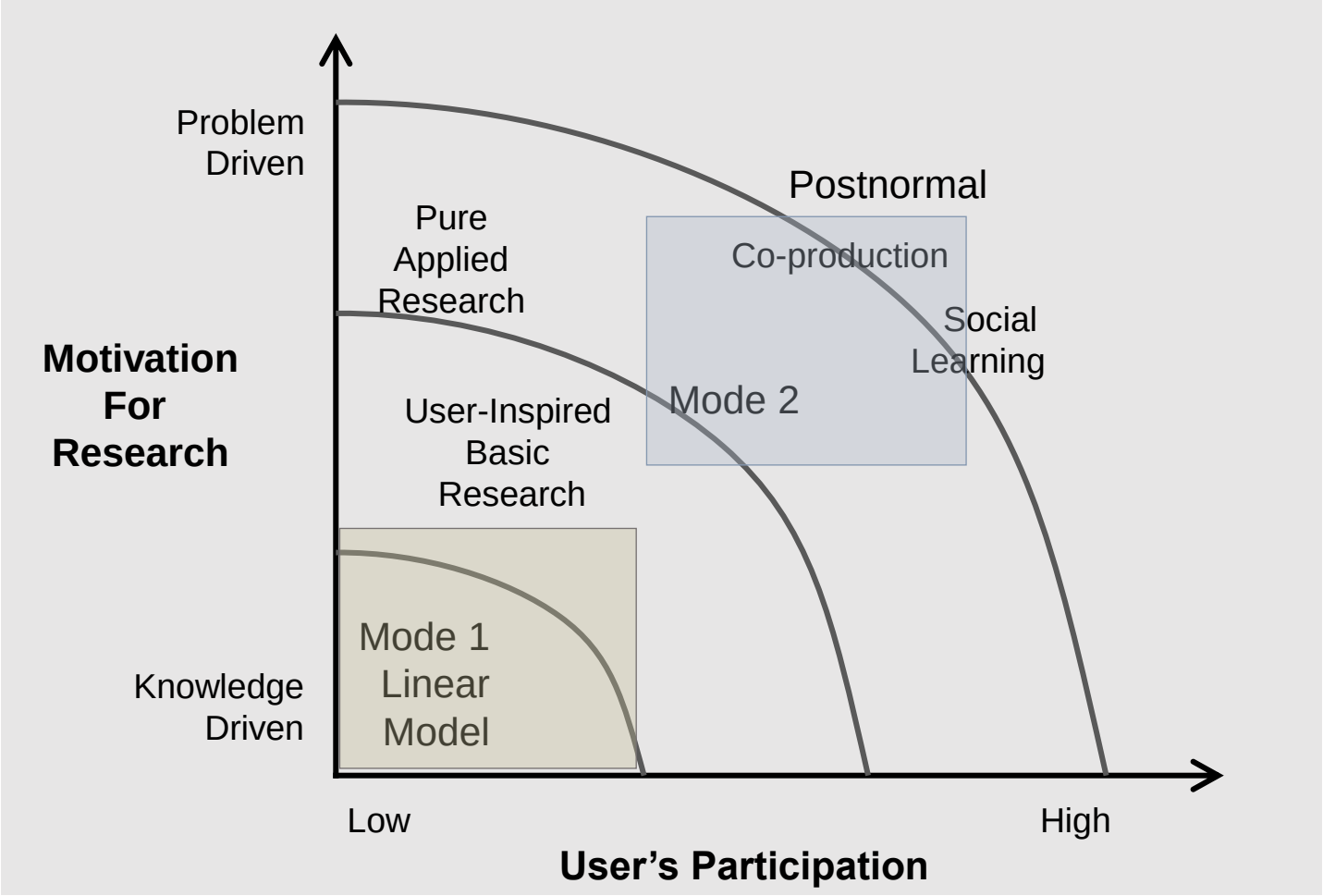
-- V. Bush 1945

Barriers to actionable knowledge



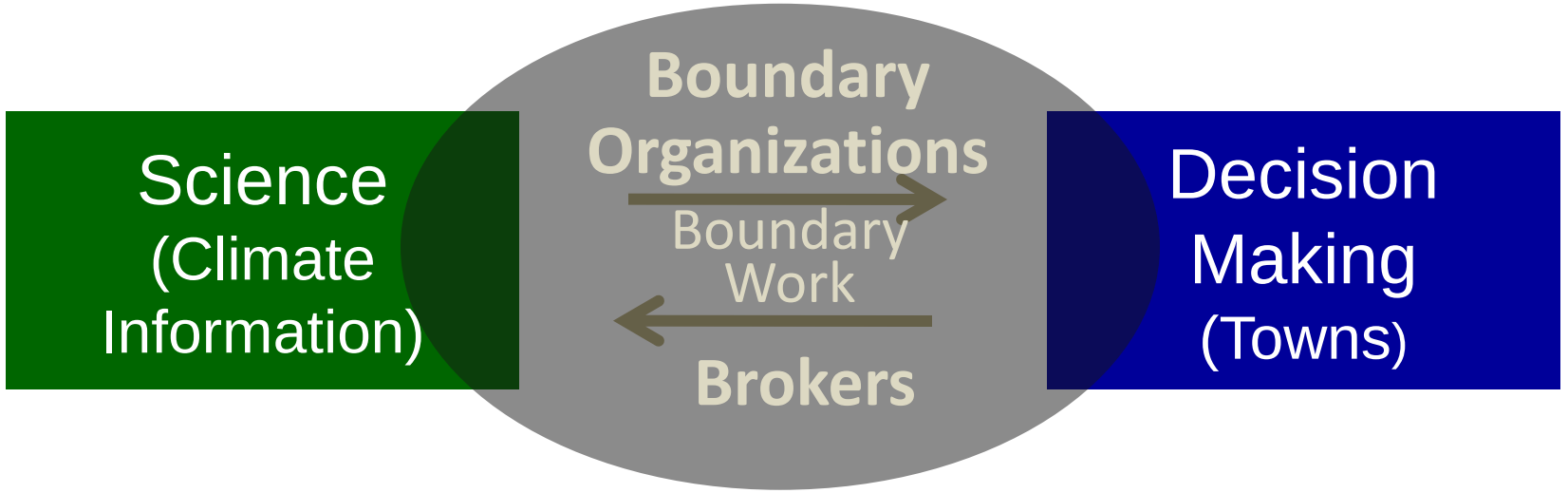
-- Lemos, Kirchhoff and Ramprasad 2012

Producing actionable knowledge means less linear science production, more collaborative science



-- Kirchhoff et al. 2013

Boundary organizations & brokers



Boundary organizations or brokers stabilize a space for knowledge production allowing each side to remain accountable to their core and provide a bridge for communication, translation and mediation of knowledge between production and use.

-- Guston 2000
-- Cash et al. 2007
-- McNie 2013
- Kirchhoff et al 2013
- others

- Research shows that sustained boundary spanning (e.g., by boundary organizations) help make science more usable by:
  - Promoting interaction between scientists and potential users (Kirchhoff, Lemos, and Dessai 2013; Lemos, Kirchhoff, and Ramprasad 2012; Lemos and Morehouse 2005; McNie 2007; and others)
  - Fostering multiple ways of knowing (Turner et al. 2016)
  - Increasing capacity for knowledge utilization (Guston et al. 2000)
  - Creating effective public-private partnerships (Avery 2009; Kulig and Westlund 2015)
  - Supporting innovation (Pulwarty, Simpson, and Nirenberg 2009)

Example: Water Utility Climate Alliance

What: Water managers collaborate with scientists to understand how to adapt to an uncertain future.

Boundary spanning: Collaboration fostered by a boundary organization or consortium of research organizations.

Funding: Diverse funding model -- utilities, existing federal support of basic research *and* boundary organizations, and University-supported faculty.

Hetch Hetchy Regional Water System forms part of the water supply for San Francisco.
Photo source: Water Education Foundation

Science Policy Recommendations

1. **Support bridging and brokering organizations** and support pathways for scholars to work across the boundary of science and practice or policy

2. **Build capacity for sustained and productive interactions** between science and practice

3. **Support alternative modes of science production** that foster innovations in both basic and applied research and in application

Changes in Science Funding Program Management

Empirical evidence for science program management changes

A basket of approaches

1. **Modifications to funding competition structure and solicitation (i.e. RFP)**
2. Modifications to competitive grant selection process
3. Involvement in and support of knowledge transfer/translation functions (beyond financial)
4. New research evaluation schemes (both ex-post and across research funding life cycle)

Evidence base

- Surveys & interviews of PI’s, program officers, reviewers, end-users
- Content analysis of proposals, reports, abstracts
- Less formal analysis of program-related documents
- Case studies (observation)
- Case studies (self-reflection)
- Synthesis, meta-analysis, lit. review

Modifying competition structure (e.g., RFP)

- **Tactic:** Seed funding for collaboration on full proposals
  - *Example result: Unexpected, cross cutting collaboration; research results even among those that did not get full funding (Moser 2016)*

Case example: Co-design before funding

- In order to secure funding, a multi-year collaboration emerged between National Labs and stakeholders in public & private sector
- Development of model to assess energy-water system resilience in NYC region

Empire state building and Con Edison East River.
Photo credit: Axel Taferner.

Modifying competition structure (e.g., RFP)

- **Tactic:** Seed funding for collaboration on full proposals
  - *Example result: Unexpected, cross cutting collaboration; research results even among those that did not get full funding (Moser 2016)*
- **Tactic:** Required collaboration with end users during project
  - *Example result: Inclusion of more diverse partners; leadership of research activities by end users and stakeholders (Matso and Becker 2014). Barriers identified in literature do not always inhibit productive interactions (Sibbald, Tetroe, and Graham 2014)*
- **Tactic:** End user input to RFP
  - *Example result: Shifts in thinking among end user community about what kinds of research is most important (DeLorme et al. 2016)*

Empirical evidence for science program management changes

1. Modifications to funding competition structure and solicitation (i.e. RFP)
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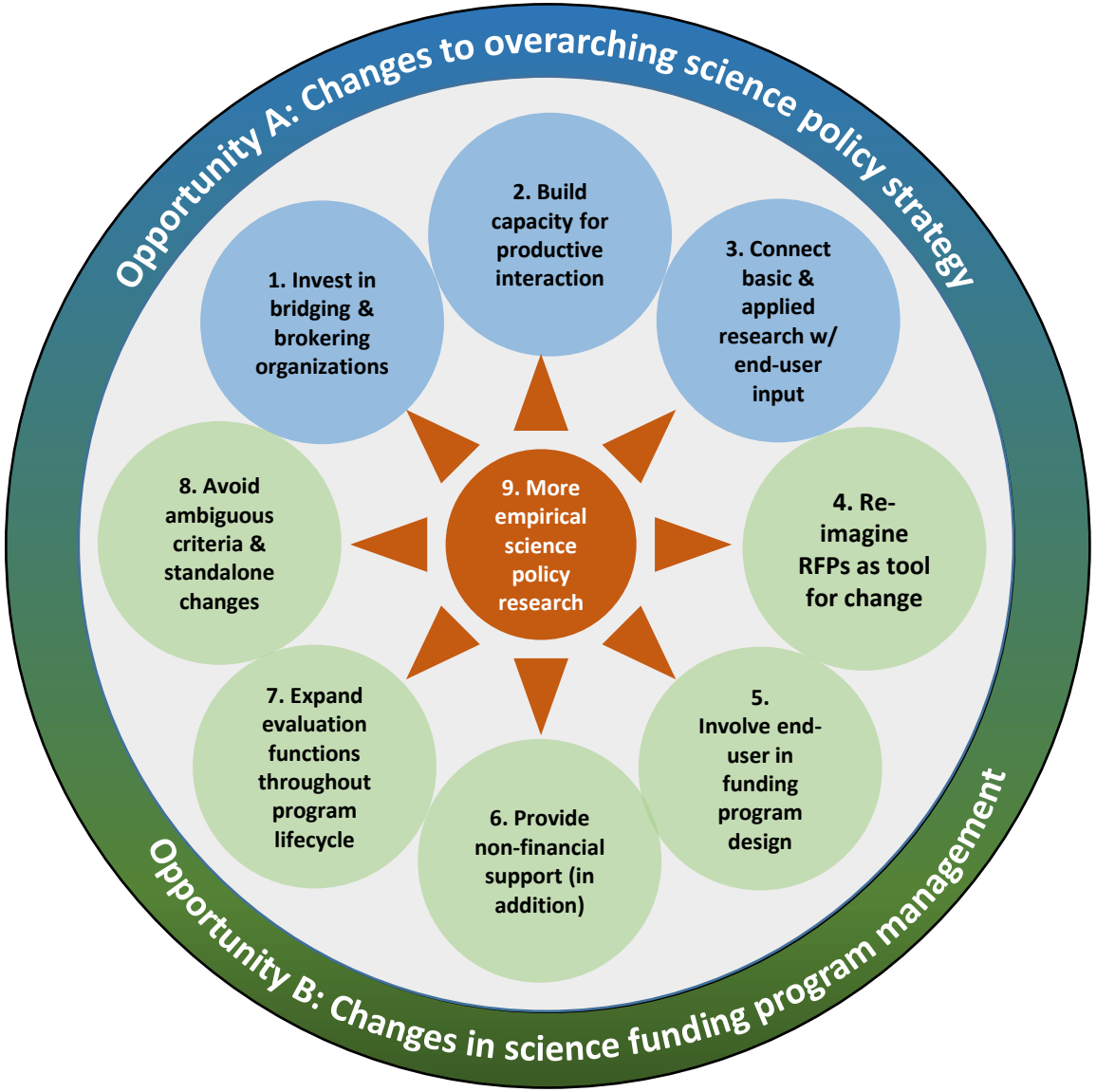
More mixed evidence. Resulting caution in recommendations.

Recommendations

4. **Re-imagine funding solicitation to encourage or require interaction with end-users**
5. **Involve stakeholders or end users in competition design**
6. Consider supporting broader impact goals beyond funding alone
7. Expand evaluation functions to track impact over program lifecycle
8. Avoid ambiguous, isolated, one-off tweaks

Summary of recommendations



Future directions

- Natural (and planned experiments)

Arnott, Neuenfeldt, and Lemos in prep

- Coordinating science policy research with science policy experimentation
- Research to understand the user/stakeholder ecosystem; how stakeholder involvement changes the science, etc.

Thank You!

We welcome comments and feedback. Please keep in touch.

Christine Kirchhoff
christine.kirchhoff@uconn.edu

James Arnott
jamesa@agci.org
www.agci.org
@jcarnott