Co-leading large interdisciplinary research teams: *Lessons from LAGOS*

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Emerging Frontiers:
Macrosystems Biology Program

Our research program: *Big-data lake ecology*

GOAL

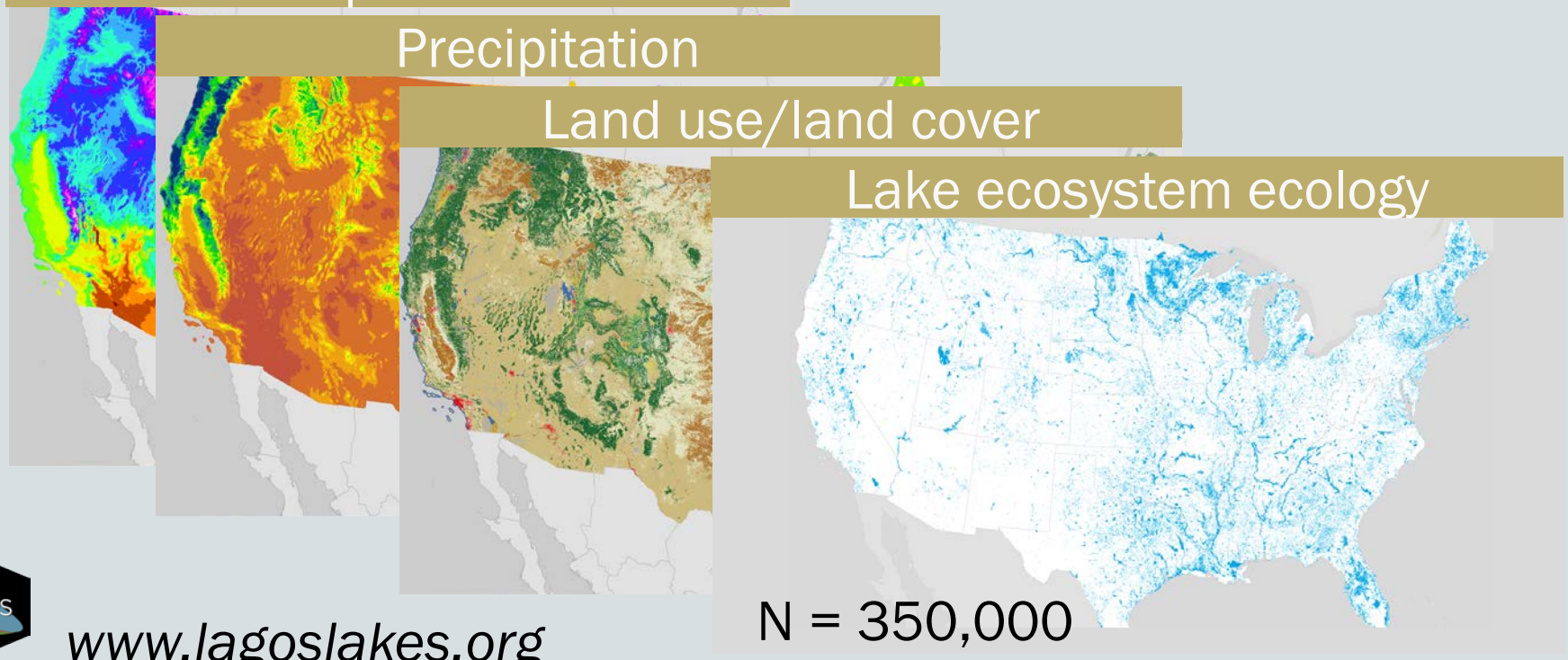
To study water quality and its controls in all 350,000 U.S. lakes

Temperature

Precipitation

Land use/land cover

Lake ecosystem ecology



N = 350,000

www.lagoslakes.org

Our research program: *Big-data lake ecology*

Strategy:

- **Create** LAGOS = *lake & landscape database for 350,000 lakes*
  - Build technical infrastructure
  - Compile and harmonize 100's of disparate datasets
  - Document workflow for accessibility and use

- **Use** LAGOS to advance research in ecology & data science
  - Develop novel algorithms
  - Answer foundational ecological questions
  - Predict lake responses to environmental change

- **Publish** multi-authored research articles

www.lagoslakes.org

Teams to create LAGOS

2011-2016: *~11-15 people*

- 3 institutions

2016-2021: *~25 people*

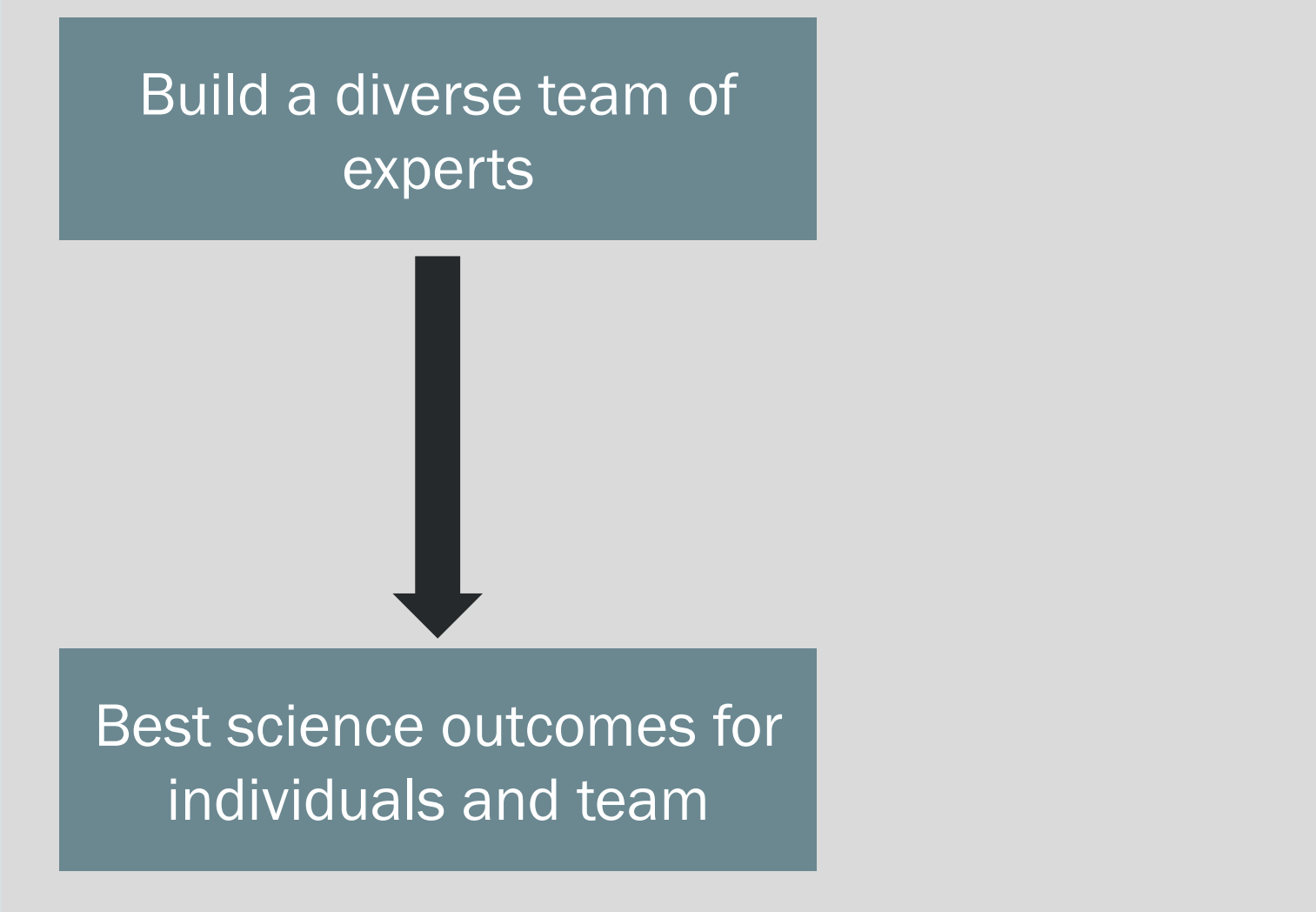
- 4 institutions

Interdisciplinary:

- Aquatic ecologists
- GIS professionals
- Database experts
- Data scientists

NSF Macrosystems Biology Program

Conduct original research using LAGOS



Modified from Cheruvelil et al. 2014

Challenge to conducting research in large & interdisciplinary teams

How to understand, value, and capitalize on different disciplinary cultures and practices?

Ways to deal with this challenge?

Incorporate team (1) **culture**, (2) **policy**, and (3) **practice** to maximize team function

Conduct original research using LAGOS

Build a diverse team of experts

Incorporate team culture, policy, and practice to maximize team function

Best science outcomes for individuals and team

2 examples from co-leading LAGOS:

1) Identify research questions that engage experts from multiple disciplines
2) Balance individual and team needs when writing co-authored publications

Modified from Cheruvelil et al. 2014

(1) Identify research questions that engage experts in multiple disciplines, thus advancing more than one discipline

Example: Collaborating to advance data science AND ecology

First, what ‘counts’ as research in big-data science?

Conceptions of Good Science in Our Data-Rich World

2016

BioScience

KEVIN C. ELLIOTT, KENDRA S. CHERUVELIL, GEORGINA M. MONTGOMERY, AND PATRICIA A. SORANNO

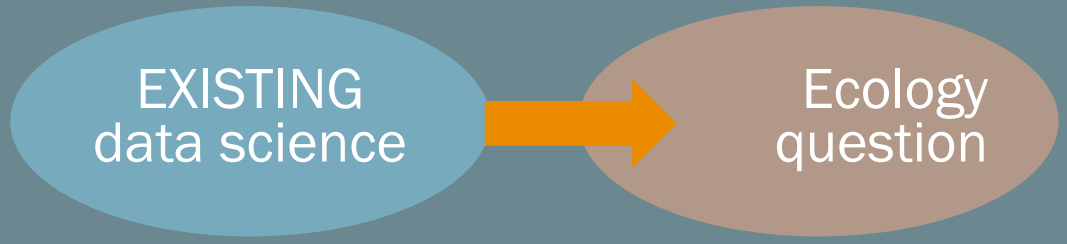
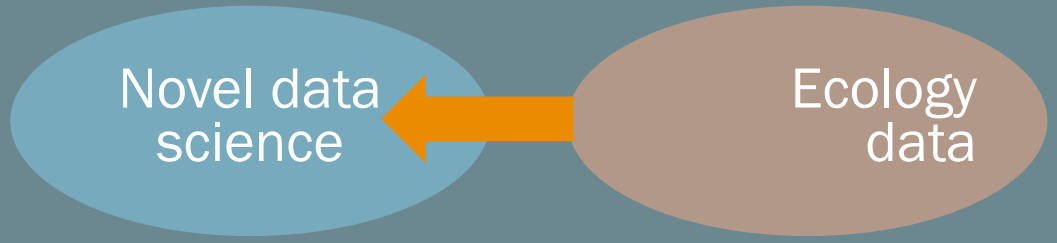
- We need to broaden our definition of what is good and valued science

Example: Collaborating to advance data science AND ecology

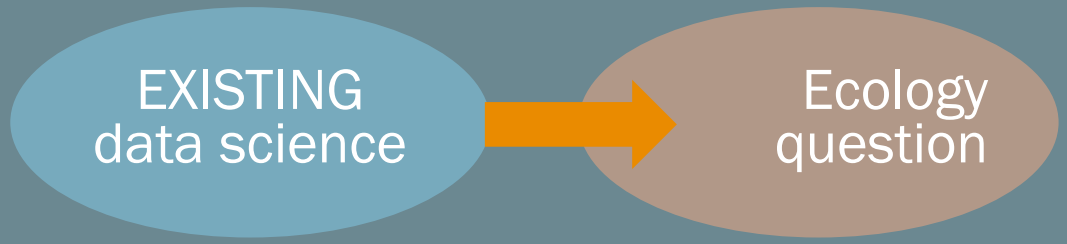
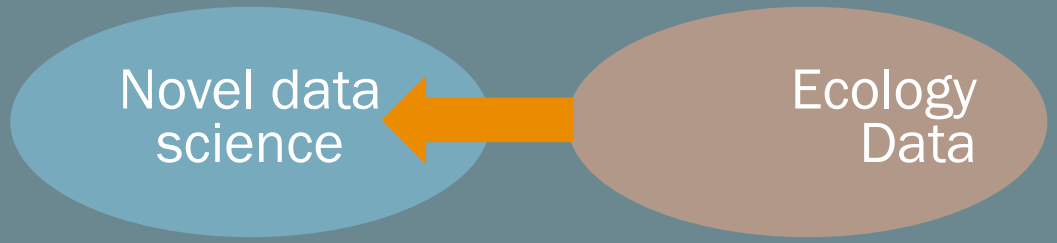
Second, we cannot always achieve PERFECTLY interdisciplinary research products

- Data scientists need to develop NOVEL methods
- Ecologists can do novel research using EXISTING methods

Example: Collaborating to advance data science AND ecology

TYPE OF RESEARCH	OUTCOME
	Novel method published in data science journal AND original research published in ‘ecology’ journal
	Original research in ‘ecology’ discipline
	Original research in the data science discipline

Example: Collaborating to advance data science AND ecology

TYPE OF RESEARCH	OUTCOME
	• TOPIC 1: Yuan et al. 2015; Cheruvelil et al. 2017 • TOPIC 2: Yuan et al. 2017; Liu et al. 2018; [tbd] • TOPIC 3: Wang et al 2019; Boudreau et al in prep
	• TOPIC 4: Lottig et al. 2017 • TOPIC 5: Wagner & Schliep 2018 • TOPIC 6: Collins et al 2019 } Ecology scientists
	• TOPIC 7: Yuan et al. 2017 • TOPIC 8: Wang et al. 2018 • TOPIC 9: Liu et al. in prep } Data scientists

Conduct original research using LAGOS

Build a diverse team of experts

Incorporate team culture, policy, and practice to maximize team function

Best science outcomes for individuals and team

2 examples from co-leading LAGOS:

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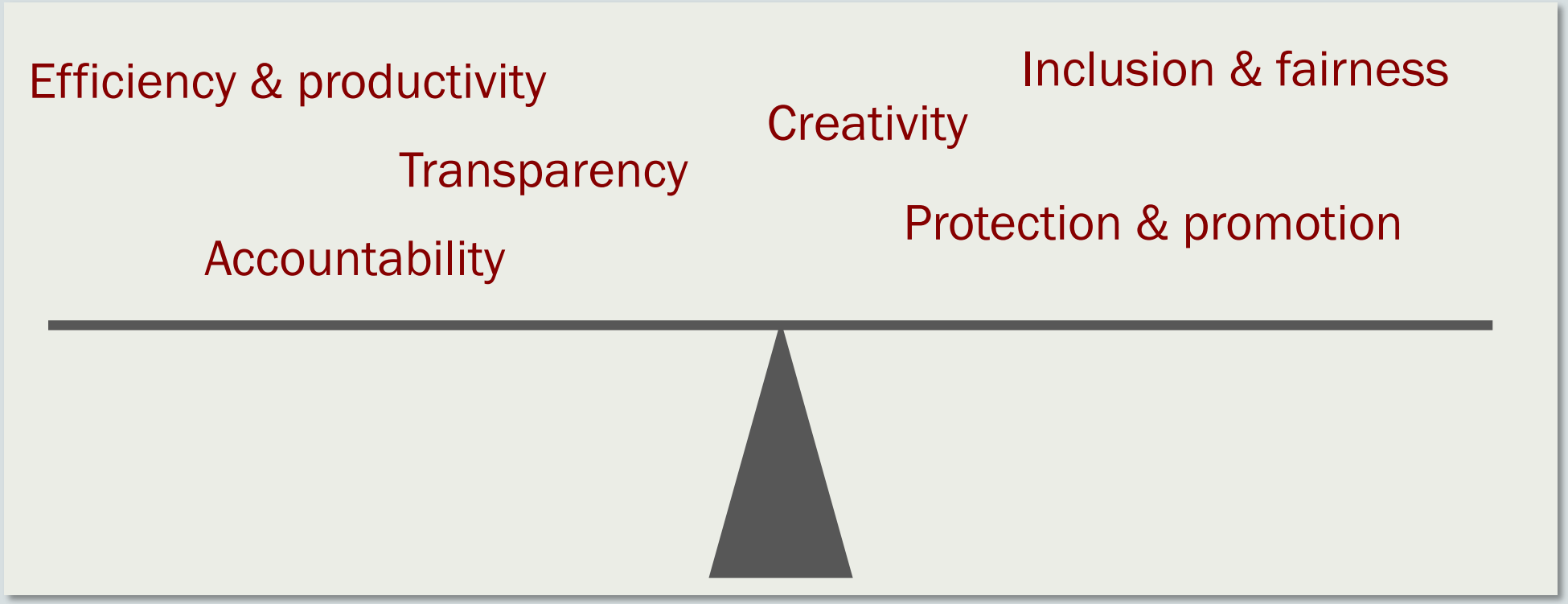
LAGOS guiding principles for co-authored publications



Challenge: How to balance all of these, sometimes competing, principles and maximize benefits for individuals and team?

Solution 1 (POLICY): Team authorship policy

A document that describes the team's procedures and guidelines related to MS development

What does an authorship policy provide?

- Best-practices for the team to strive for
- Opportunities to discuss authorship
- Opportunity for those with less power to contribute to decision-making
- Clarity of expectations, roles, and responsibilities
- Transparency in authorship decisions
- Help in assigning credit

What is included in an authorship policy?

1. Date or version number (living document!)
2. Goal & guiding principles of the policy
3. Description of the activities to warrant authorship
4. Strategy for assigning authorship
5. Description of article types and needs
6. Expectations of 'lead' author(s) and 'co-authors'

* Best when the policy is co-created by ALL team members
* Best when ALL MSs have an author-contribution statement

For our example, see: https://lagoslakes.org/cont-limno-team-policies/

Solution 2 (PRACTICE): Manuscript management strategies

*How the **lead author(s)** manage the MS tasks, including decision-making, timelines, soliciting contributions, and delegating tasks*

What difference do these strategies make?

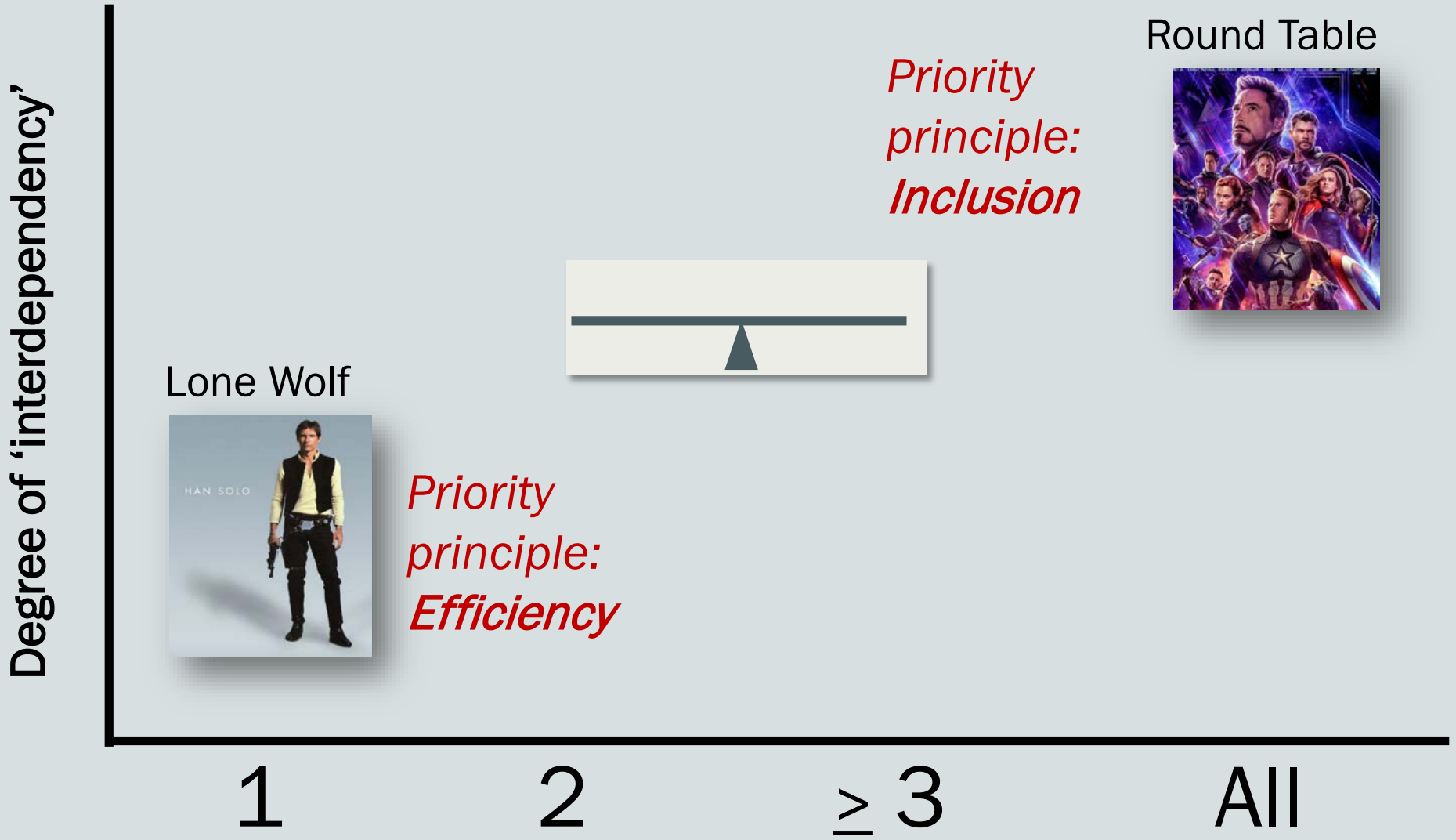
- Provides clarity for co-author contributions & expectations
- Allows for diverse range of lead author working styles
- Facilitates alignment of manuscript type (e.g., *dissertation chapter, essays, data papers)* with best-suited strategy
- Allows team to balance sometimes competing goals & principles

Oliver et al. 2018

What are manuscript management strategies?

Oliver et al. 2018

Manuscript management strategies help balance priorities



Oliver et al. 2018

Outcomes of these LAGOS policies & practices?

Collaborative research manuscripts -- 36

- Many are multi-disciplinary: **~40%**
- Average number of authors/paper: 8

Exporting LAGOS lessons to help other team leaders & the next generation of BIG data scientists

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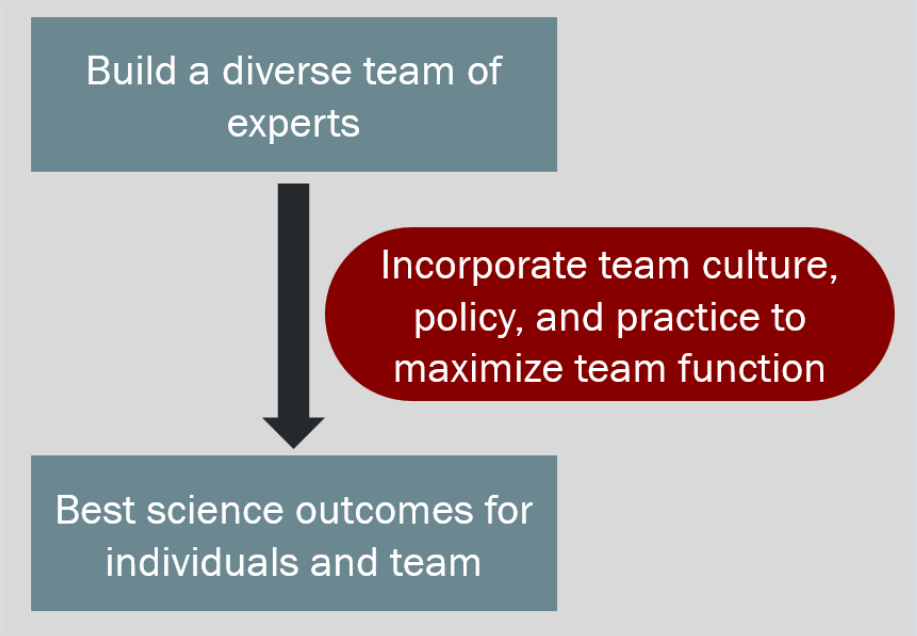
Team policies that we share on our website:

- Authorship policy
- Managing collaborative manuscripts
- Data sharing policy
- File-sharing, including code-sharing
- Personnel expectations

https://lagoslakes.org/cont-limno-team-policies/

Creating & using LAGOS to conduct big data ecology



1) Value and encourage the full range of types of research articles that support individuals & the team
2) Authorship POLICY & PRACTICES that balance individual & team needs

Engaging with ‘Team Science’ at 3 levels

(1) WITHIN OUR TEAM: Developing policies & processes based on SciTS to maximize team effectiveness

(2) WITHIN OUR DISCIPLINE: Write manuscripts that disseminate our SciTS approaches to our peers

(3) WITHIN THE SciTS DISCIPLINE: Collaborate with psychologists and science studies scholars to study science teams