

SpaDES

a flexible tool to **PERFECT** your workflow



Tati **Micheletti**, Eliot **McIntire**, Alex **Chubaty**, Ceres **Barros**, Frances **Stewart**, Ian **Eddy**, Celine **Boisvenue**, Steve **Cumming**, and many others...

The **PERFICT** principles and **SpaDES**

Opening complex black-boxes, revealing secret-handshakes, and
making sure you can do it all over again, and fast



SCIENTIFIC DATA

A graphic of binary code (0s and 1s) is positioned to the right of the journal title. It consists of four lines of binary digits: 110110, 0111101, 11011110, and 011101101.

Amended: Addendum

OPEN

SUBJECT CATEGORIES

- » Research data
- » Publication characteristics

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Comment: The FAIR Guiding Principles for scientific data management and stewardship

Mark D. Wilkinson *et al.*^{*}

There is an urgent need to improve the infrastructure supporting the reuse of scholarly data. A diverse set of stakeholders—representing academia, industry, funding agencies, and scholarly publishers—have come together to design and jointly endorse a concise and measurable set of principles that we refer to as the FAIR Data Principles. The intent is that these may act as a guideline for those wishing to enhance the reusability of their data holdings. Distinct from peer initiatives that focus on the human scholar, the FAIR Principles put specific emphasis on enhancing the ability of machines to automatically find and use the data, in addition to supporting its reuse by individuals. This Comment is the first formal publication of the FAIR Principles, and includes the rationale behind them, and some exemplar implementations in the community.

PERFECT

Make Predictions, Evaluate models,
make models Reusable, Freely
accessible and Interoperable, built
within Continuous workflows that are
routinely

ECOLOGY LETTERS

VIEWPOINT |  Open Access |  

PERFECT: A Re-imagined foundation for predictive ecology

Eliot J. B. McIntire , Alex M. Chubaty, Steven G. Cumming, Dave Andison, Ceres Barros, Céline Boisvenue, Samuel Haché, Yong Luo, Tatiane Micheletti, Frances E. C. Stewart

First published: 22 March 2022 | <https://doi.org/10.1111/ele.13994> | Citations: 9

 SECTIONS

 PDF

 0 COMMENTS

 TOOLS

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Abstract

Making predictions from ecological models—and comparing them to data—offers a coherent approach to evaluate model quality, regardless of model complexity or modelling paradigm. To date, our ability to use predictions for developing, validating, updating, integrating and applying models across scientific disciplines while influencing management decisions, policies, and the public has been hampered by disparate perspectives on prediction and inadequately integrated approaches. We present an updated foundation for Predictive Ecology based on seven principles applied to ecological modelling: make frequent Predictions, Evaluate models, make models Reusable, Freely accessible and Interoperable, built within Continuous workflows that are routinely Tested (PERFECT). We outline some benefits of working with these principles: accelerating science; linking with data science; and improving science-policy integration.

♠ **PERFECT:** FAIR Principles brought to a

modelling workflow context

♠ Foundational principles for which **SpaDES** was

built

The PERFECT principle & SpADES

1

Start with raw blocks

Functions



Packages



2

Make your own structures

Modules



3

Re-use pre-build structures

Models

A + B + C

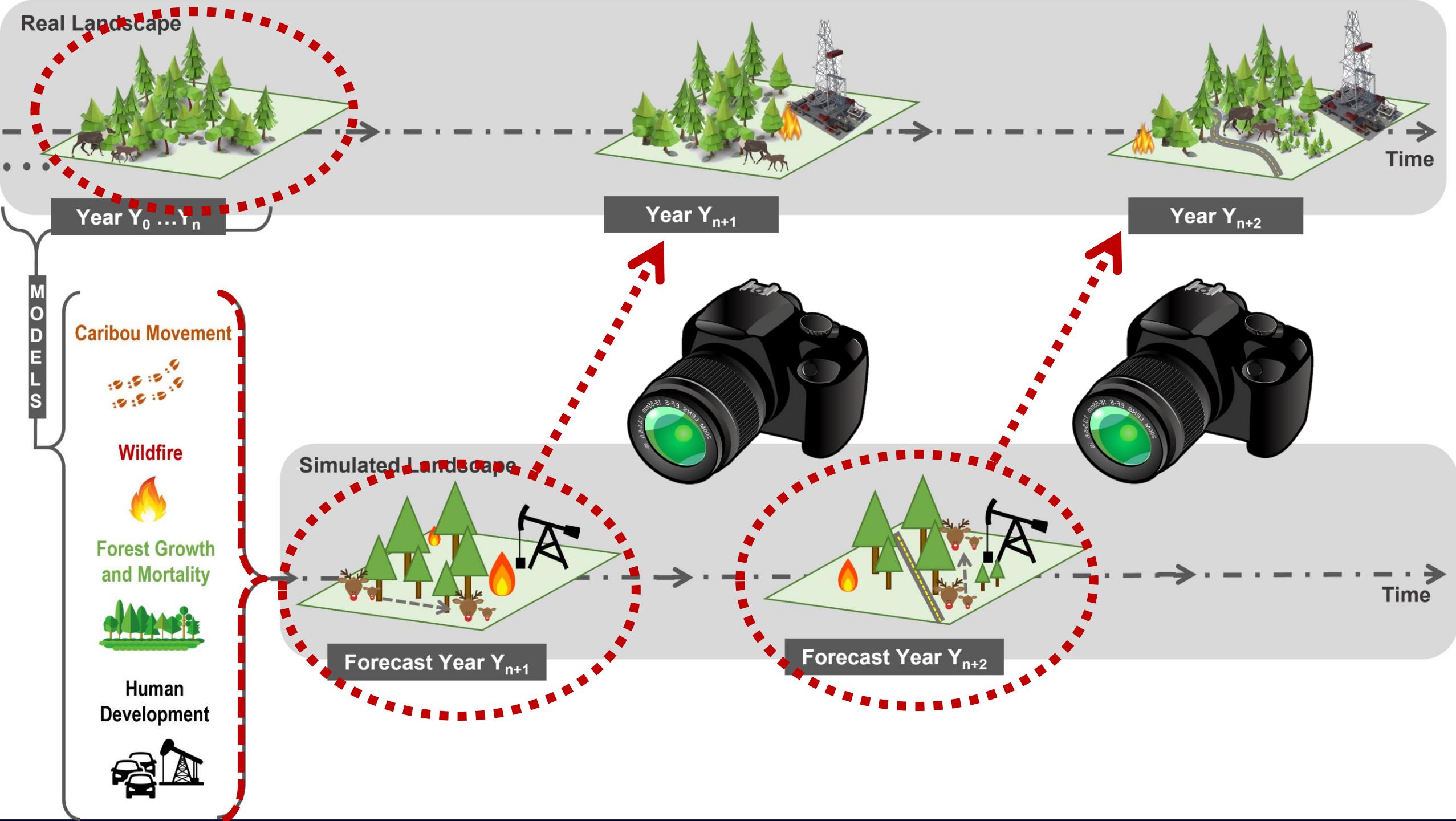


A + B + D + E



♠ **SpaDES**: Spatially Discrete Event System

♠ Initial focus on forecasting landscape changes



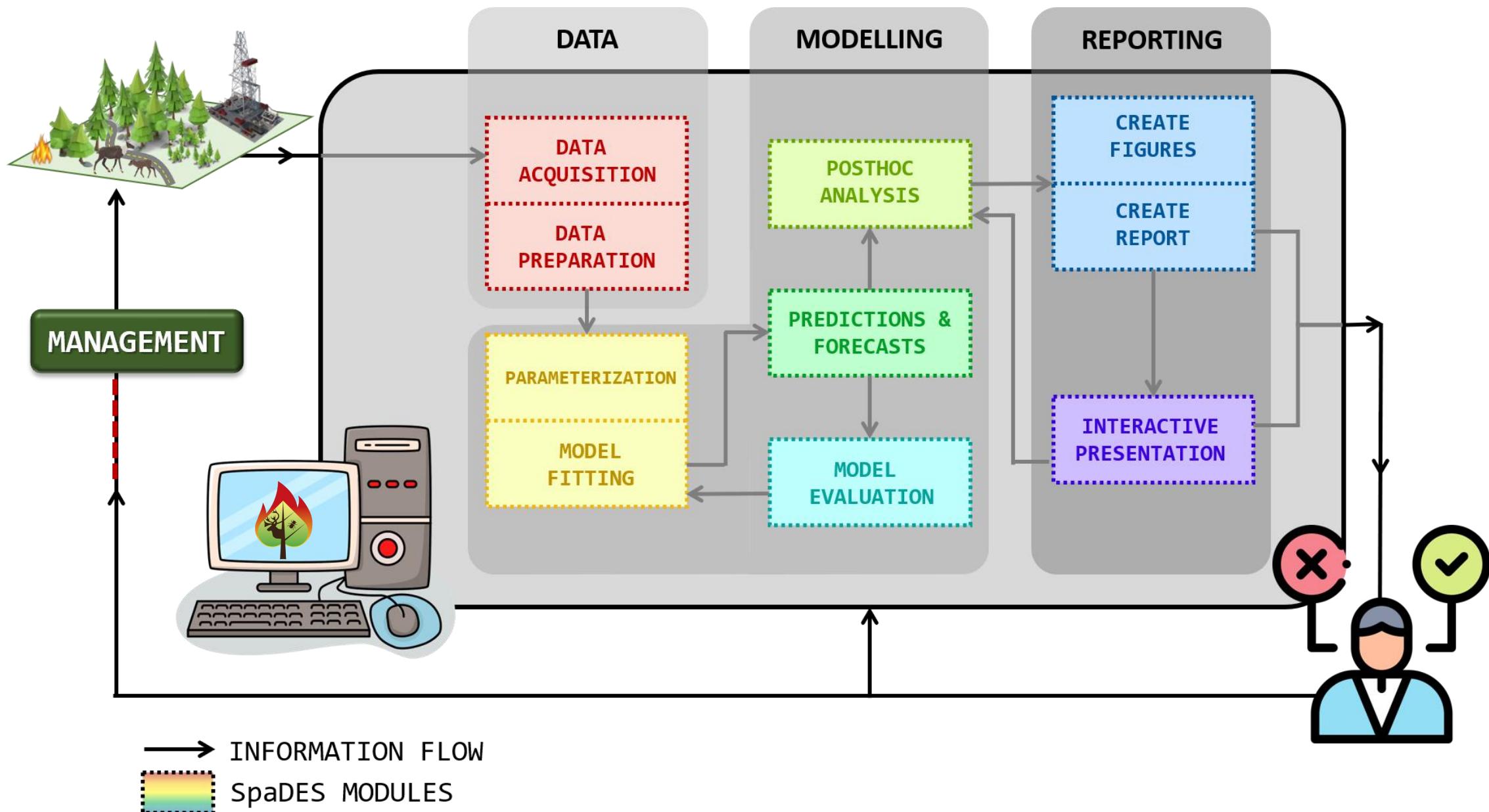
- ♠ **SpaDES**: Spatially Discrete Event System
- ♠ Initial focus on forecasting landscape changes
- ♠ But... SpaDES is useful for full workflows
- ♠ Agnostic to modelling approach
- ♠ It enables the implementation of the **PERFECT** principles to workflows from the start

- ♠ **SpaDES** is a tool for developing and sharing modular code based on the **PERFECT** principles
- ♠ **SpaDES** supports the creation of SpaDES compatible **modules** and orchestrate their interactions to **PERFECT** workflows



Central piece!

The PERFECT principle & SpaDES





Metapackage:

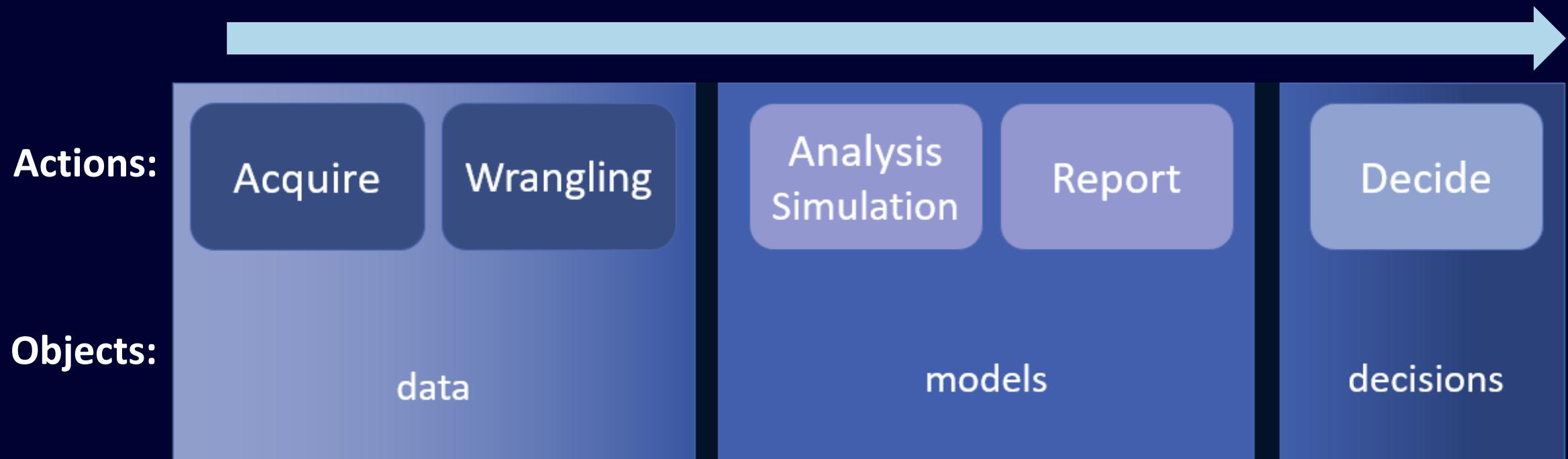
- reproducible
- SpaDES.core

Other packages from the PERFECT Universe:

- SpaDES.tools
- SpaDES.project
- SpaDES.experiment
- SpaDES.shiny
- quickPlot



The PERFECT principle & SpaDES



disjunct and performed in separate chunks

The PERFECT principle & SpaDES



disjunct and performed in separate chunks

Is SpaDES for me?

Asking and answering the right questions



♠SpaDES: much easier to learn with R knowledge

- Forecasting or landscape modelling are a part of my work
- My analysis scripts are very long or subdivided in many parts or steps
- I want others to be able to understand, reproduce and reuse my work
- I want to integrate my work with other researchers'
- I want to be able to reuse and build on other researcher's works
- I could use help to make my work more transparent and accessible

Is SpaDES for me?



Workflow *emerges* from modules

Focus on *controlling* the workflow



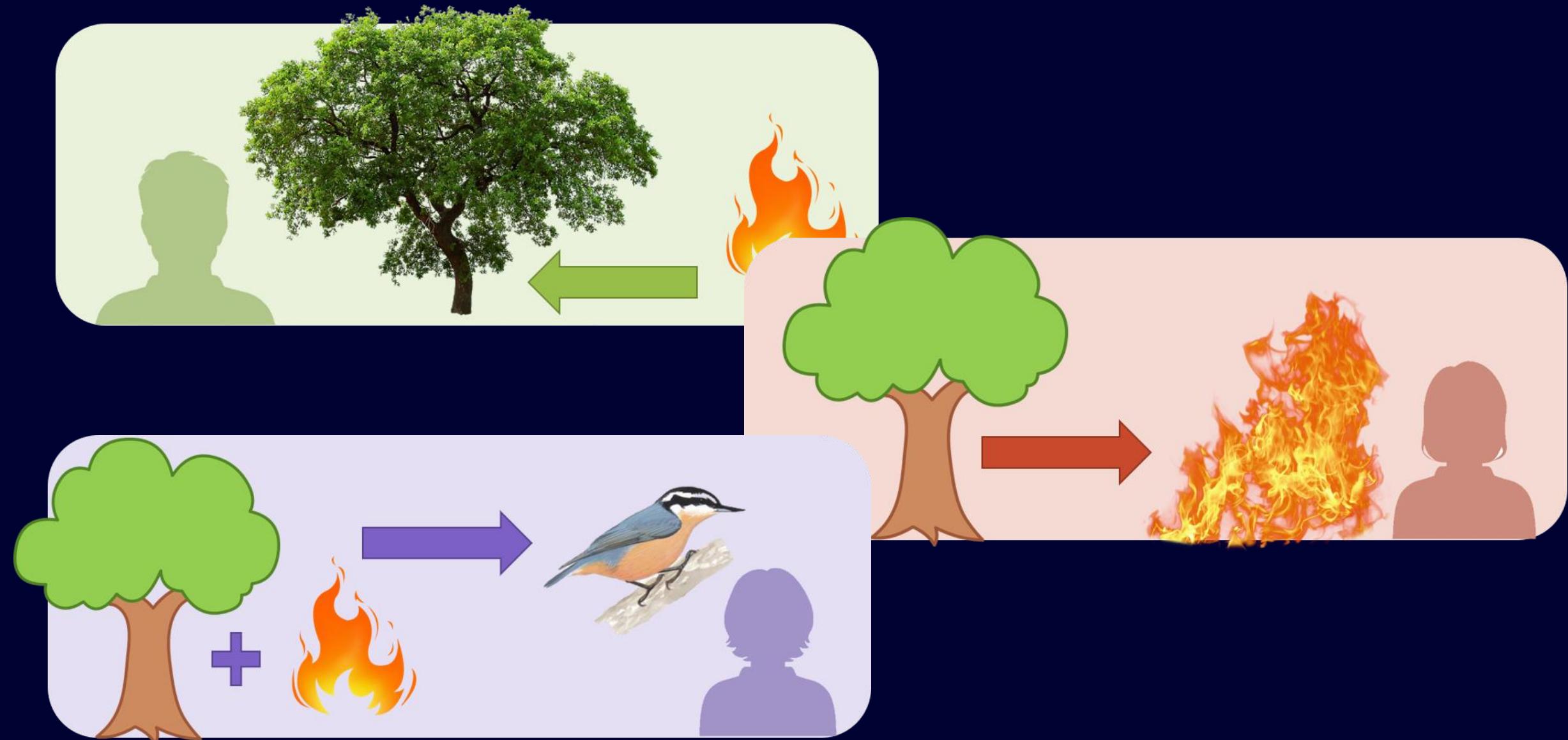
ACTIVE

SpaDES can speed-up science and management

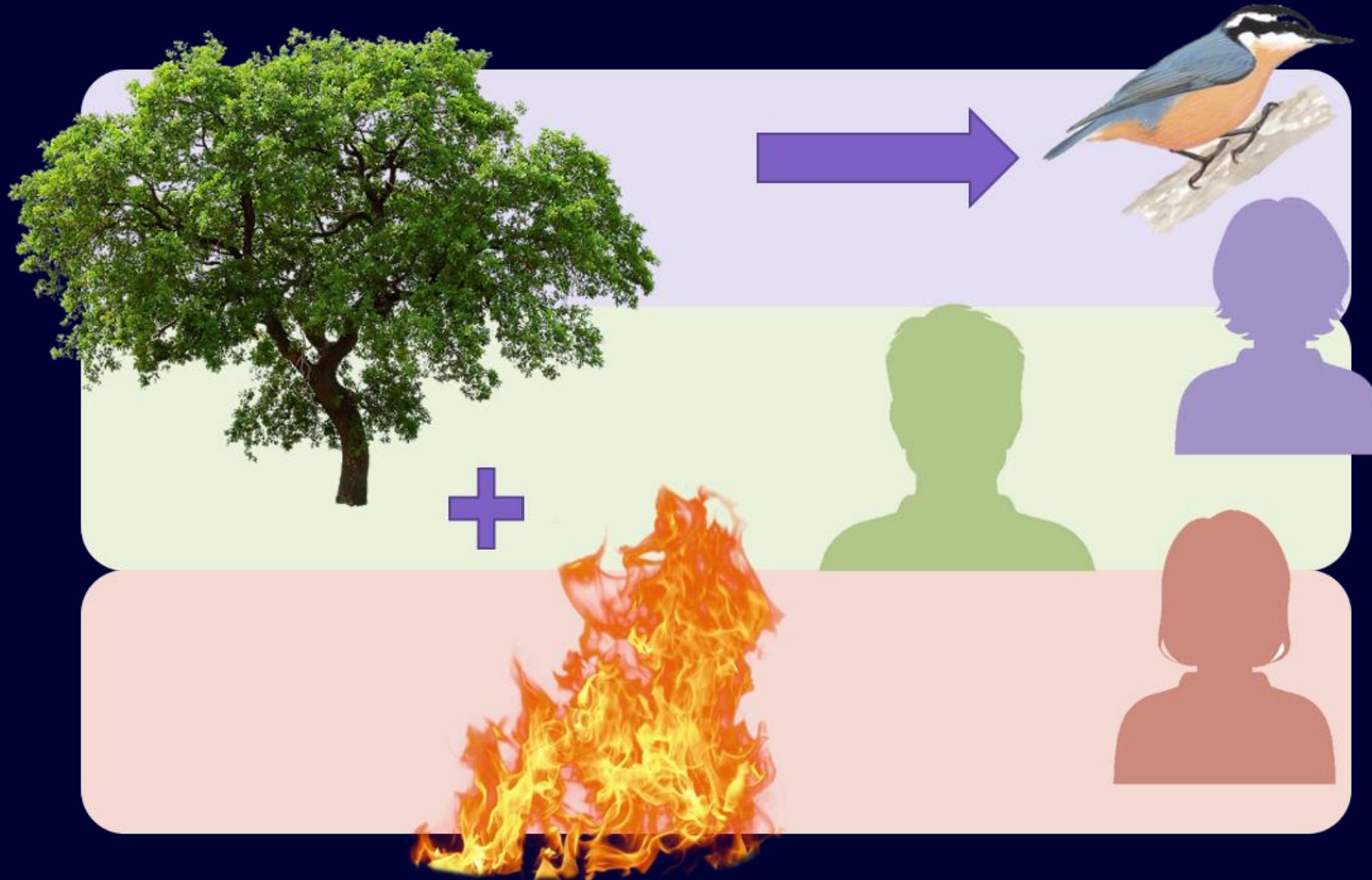
Sharing your work is good for you, for science and for the world



Speeding-up science and management



Speeding-up science and management

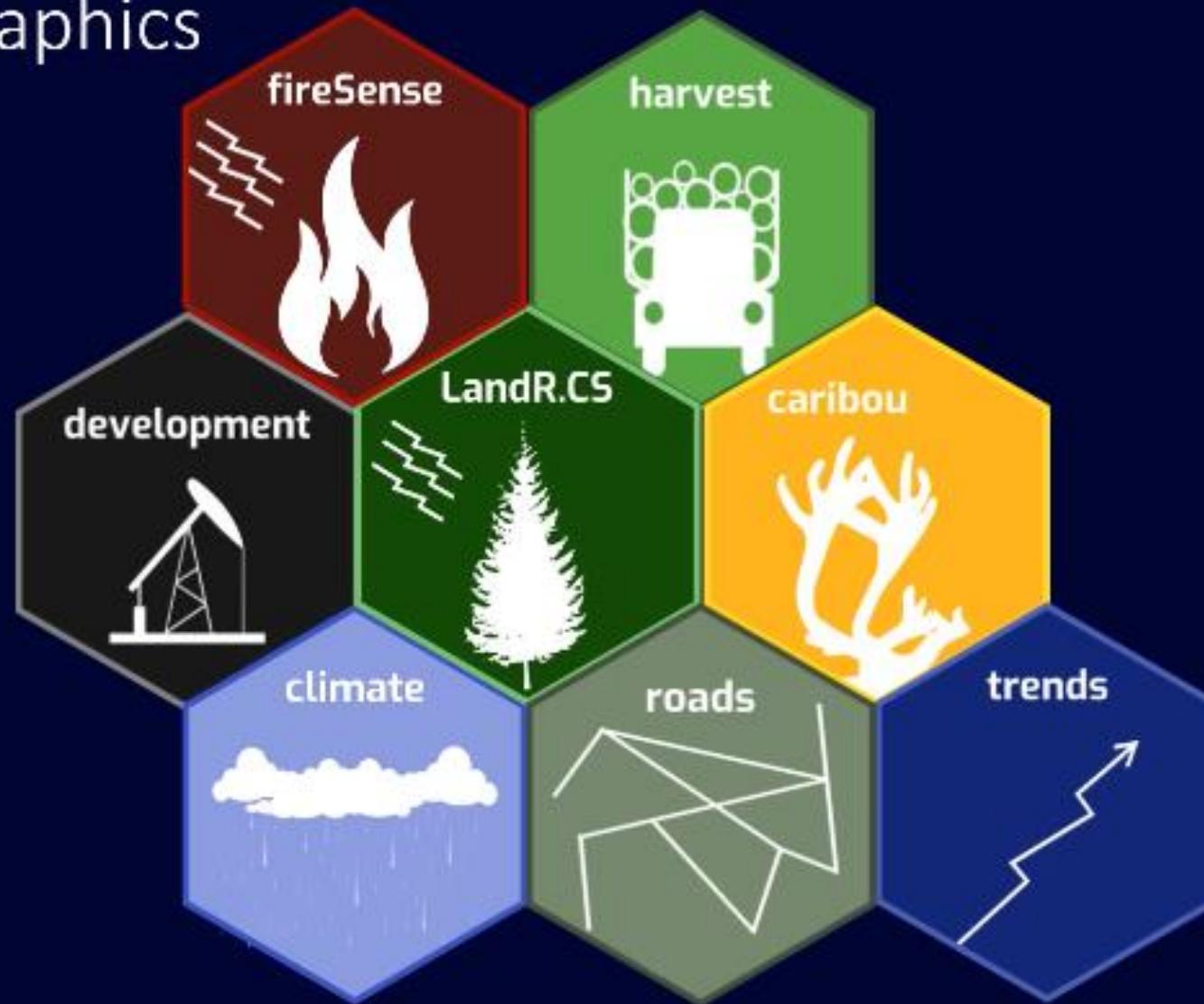


Speeding-up science and management

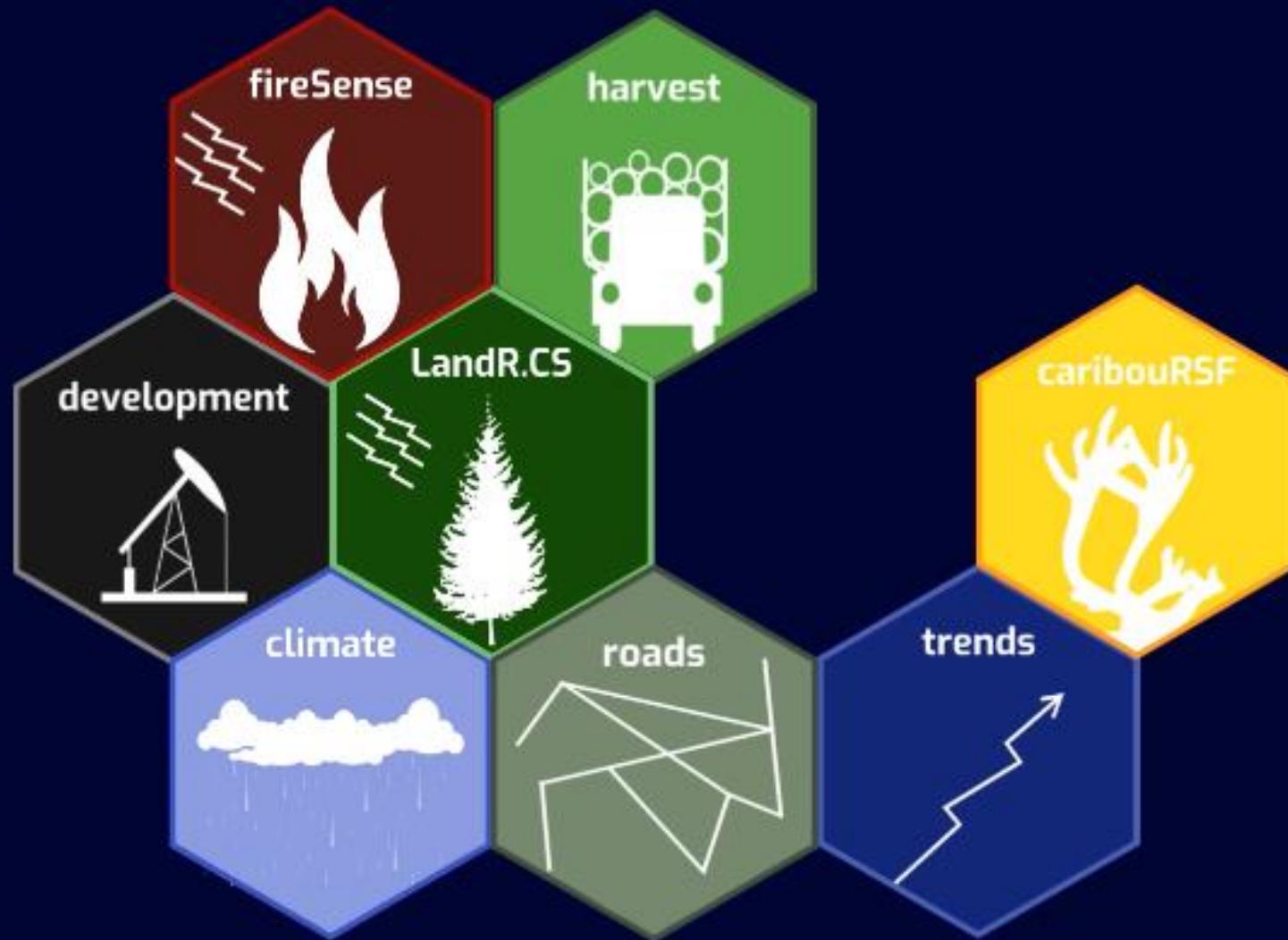




Caribou demographics



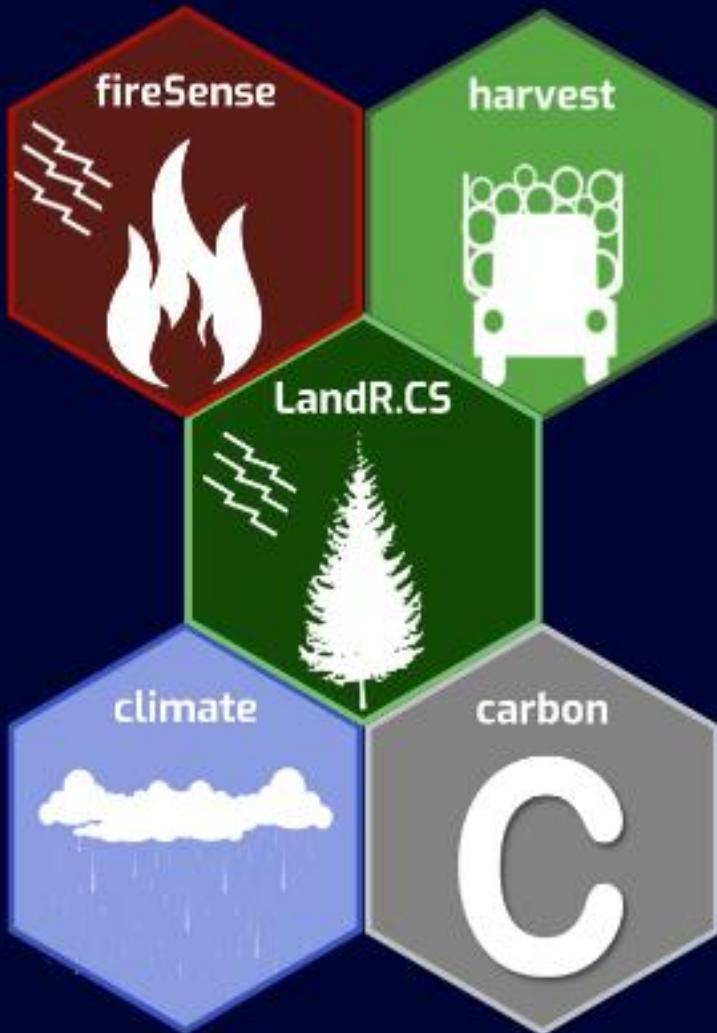
Caribou habitat forecasts



Weaving Indigenous Knowledge



Carbon budgets under climate change



SpaDES helps bringing data to decisions

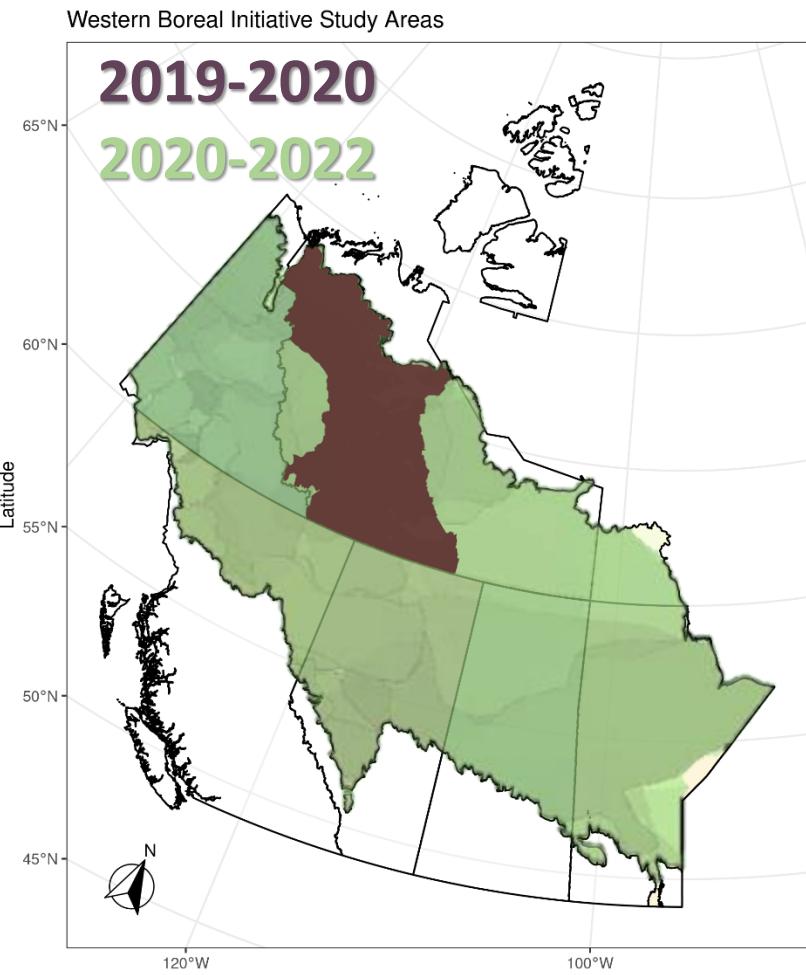
The story of the caribou, the songbirds, and
their connection to wildlife management in Northern Canada



**Western
Boreal
Initiative**



Bringing data to decisions



Natural Resources
Canada

Canada



Ressources naturelles
Canada



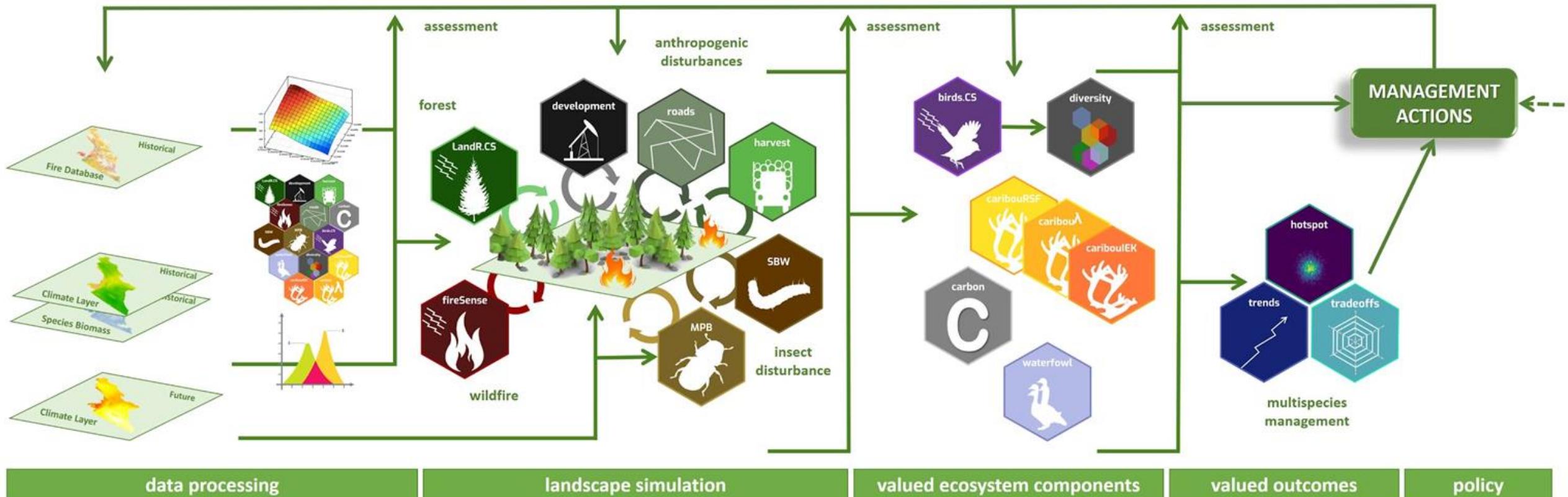
Environment and
Climate Change Canada
Environnement et
Changement climatique Canada

<https://native-land.ca/>

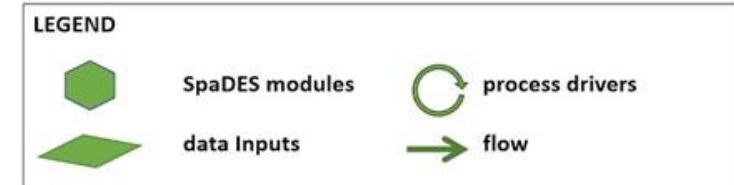
Bringing data to decisions



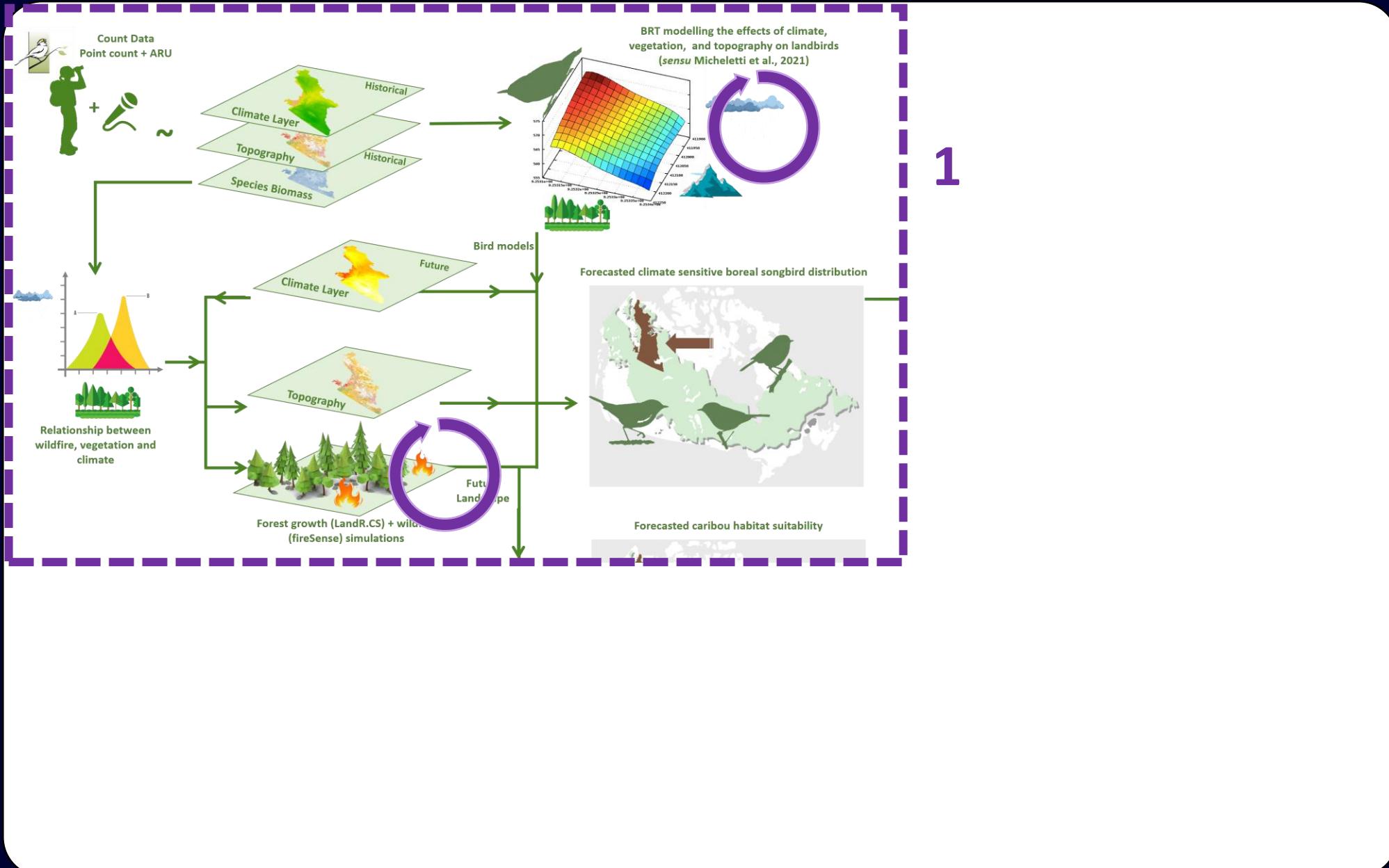
Western
Boreal
Initiative



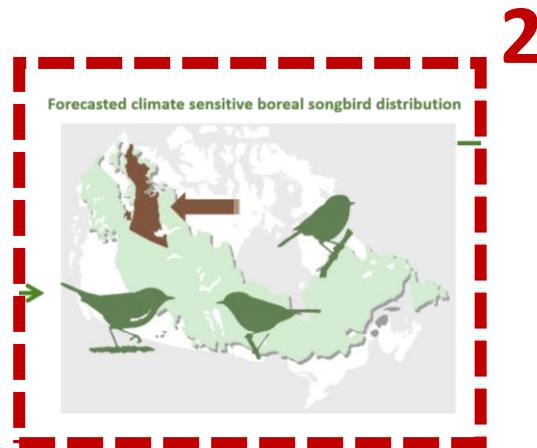
a) Overview of data and simulation module component integration



1. With which mechanism will climate change impact boreal landbirds?

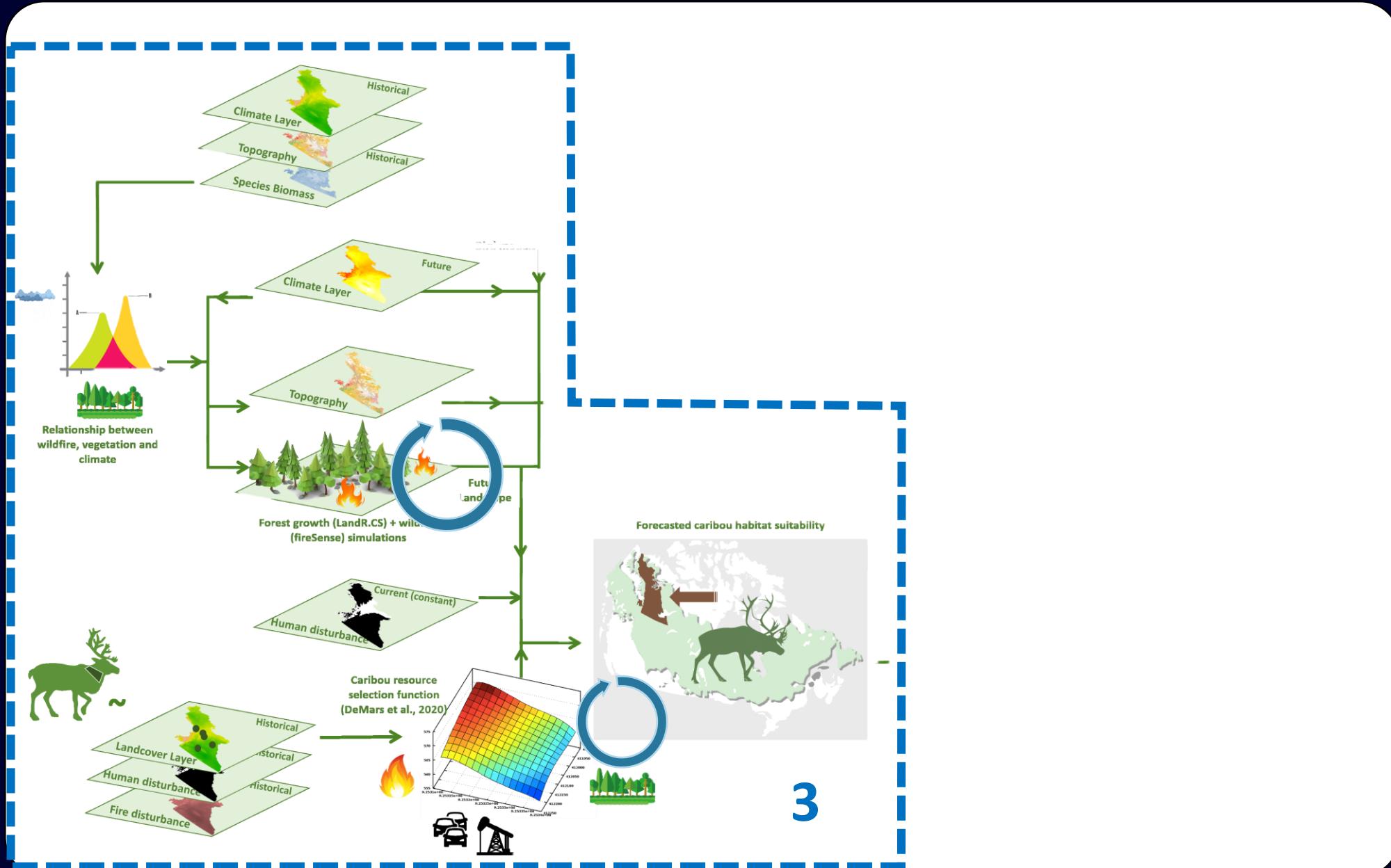


2. How will boreal landbird **abundance and distribution** change throughout the century?



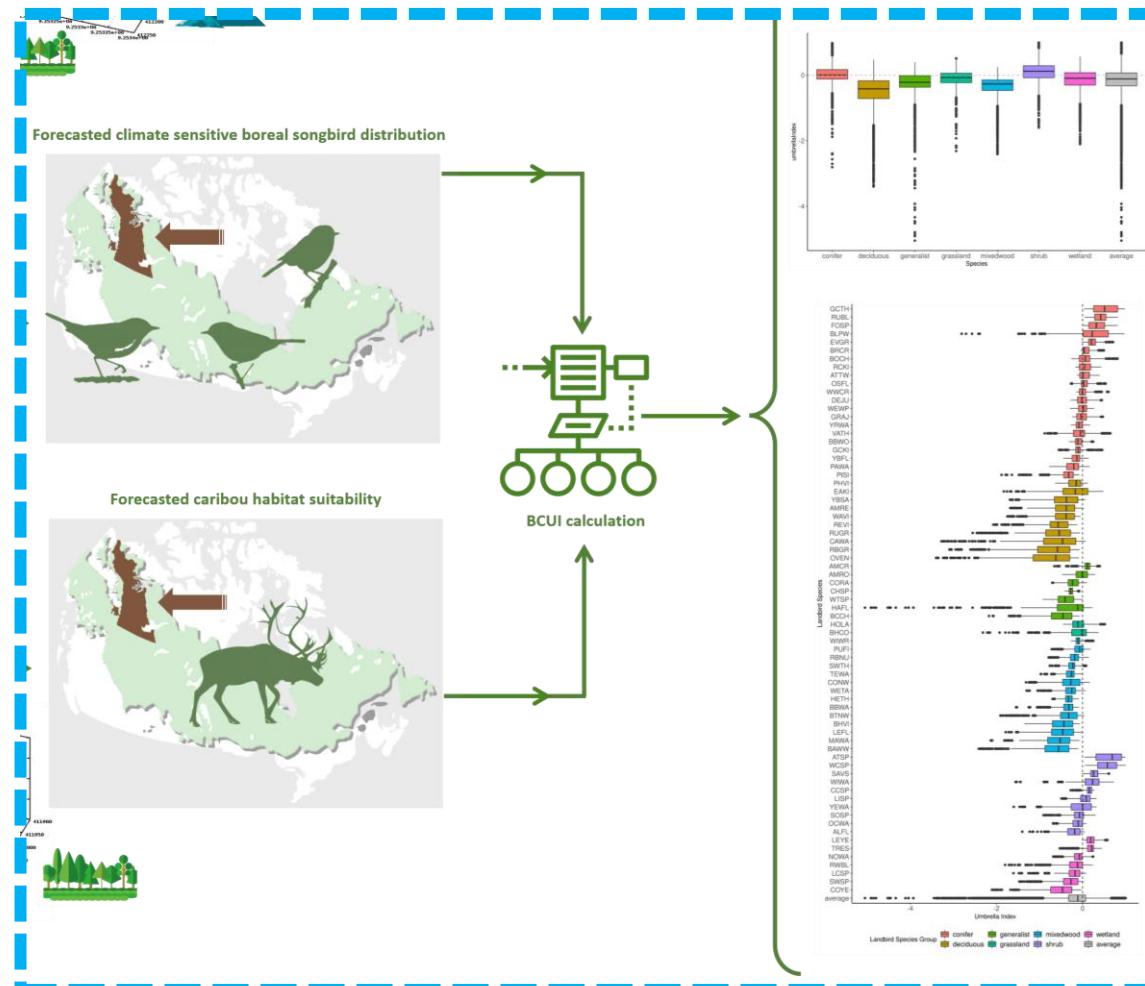
2

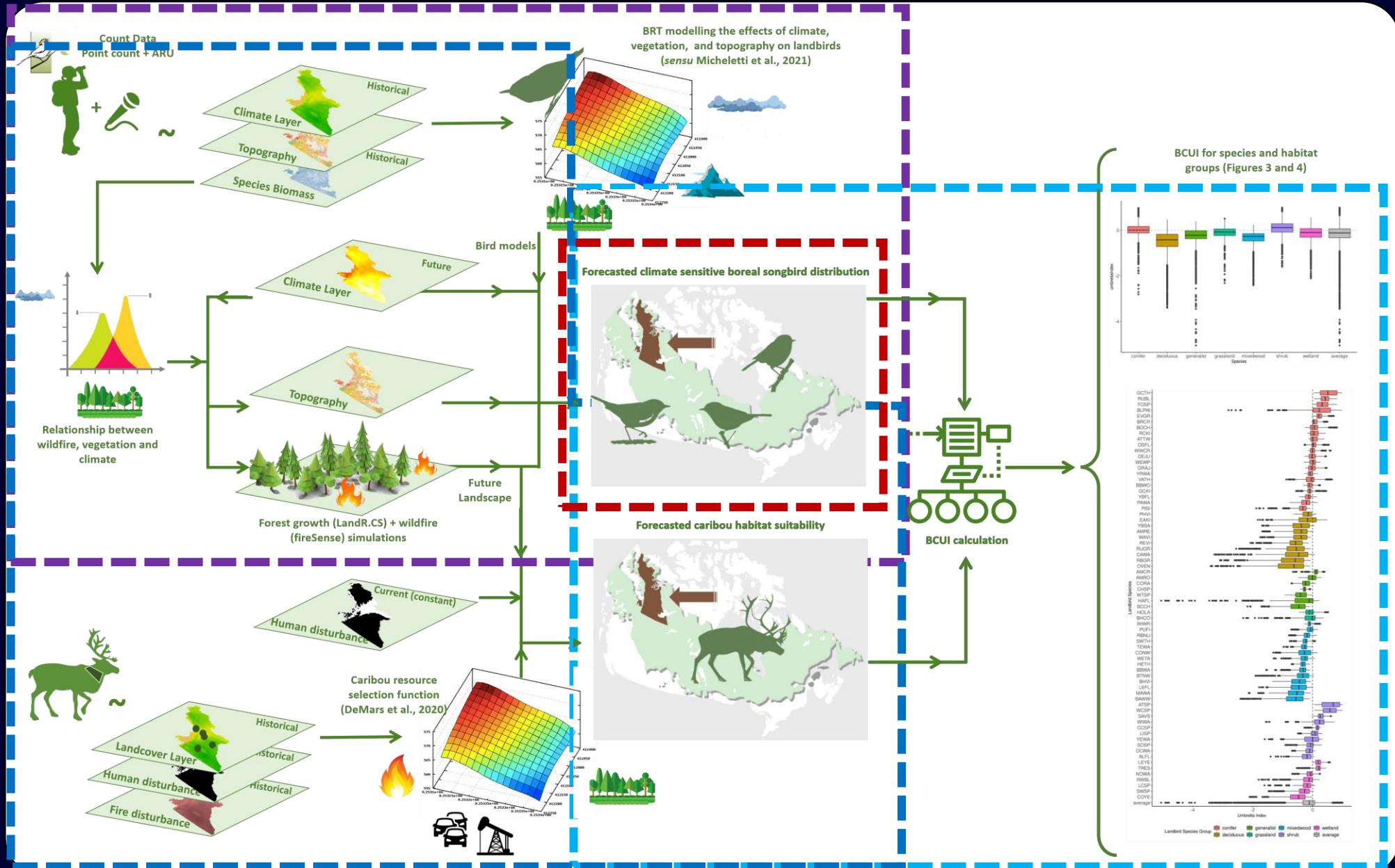
3. How will climate change impact boreal caribou?



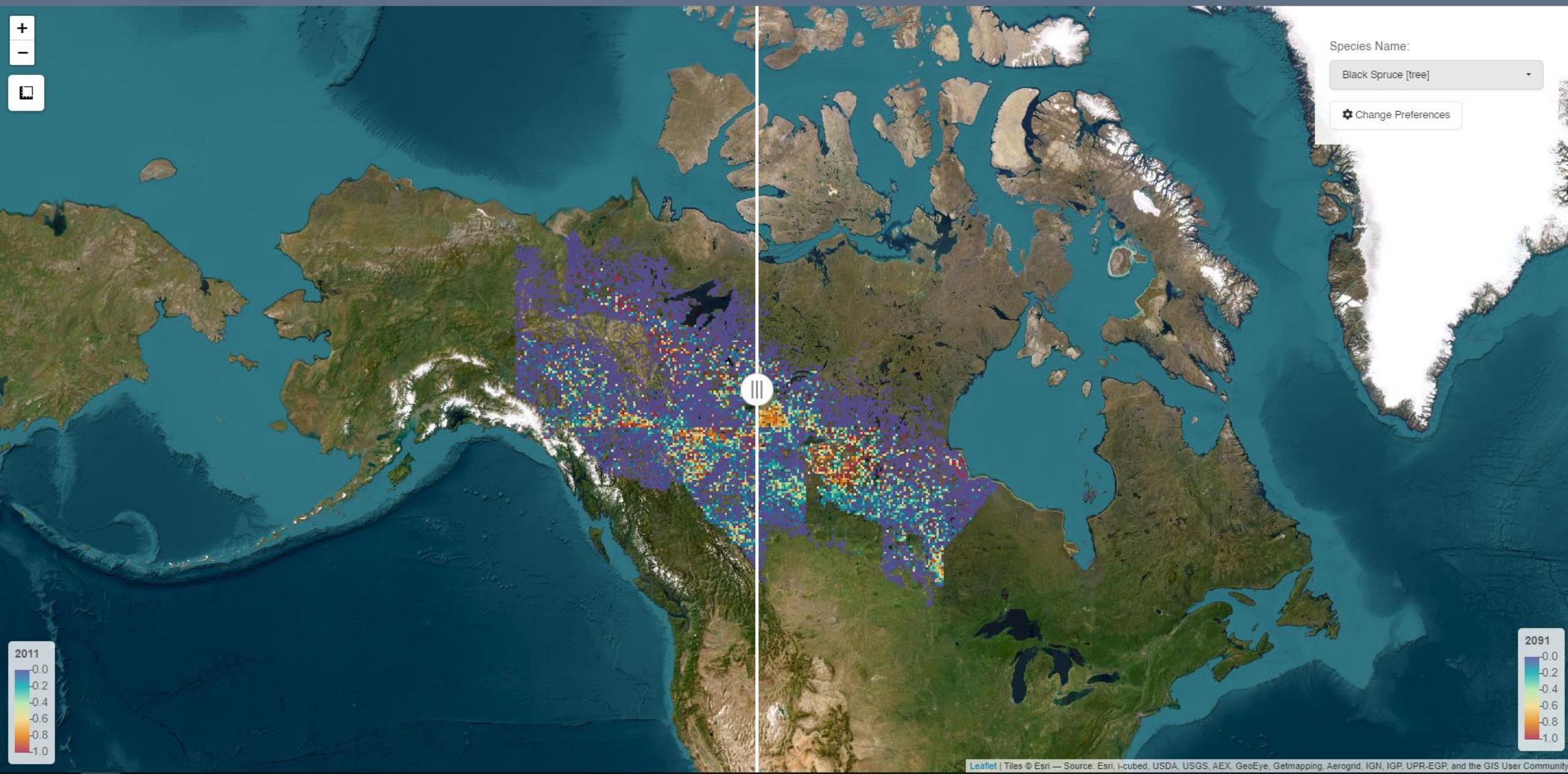
4. Are there **synergies** for boreal caribou and landbird conservation?

4





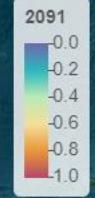
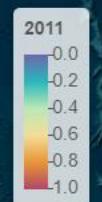
[Map](#) [Side-by-Side](#) [Regions](#) [Birds](#) [Caribou](#) [Methods](#) [Download](#)



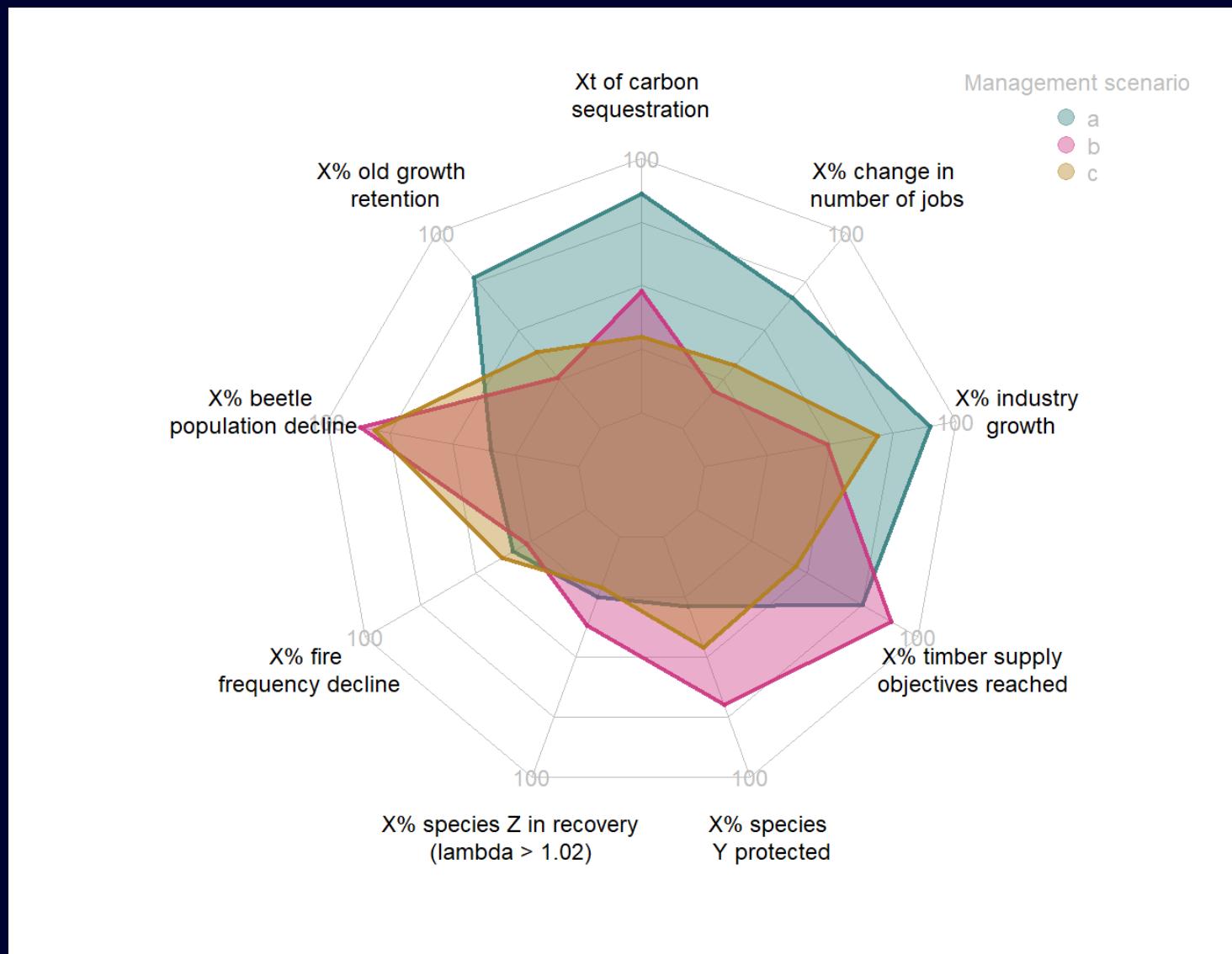
Species Name:

Black Spruce [tree]

 Change Preferences



Speeding-up science and management



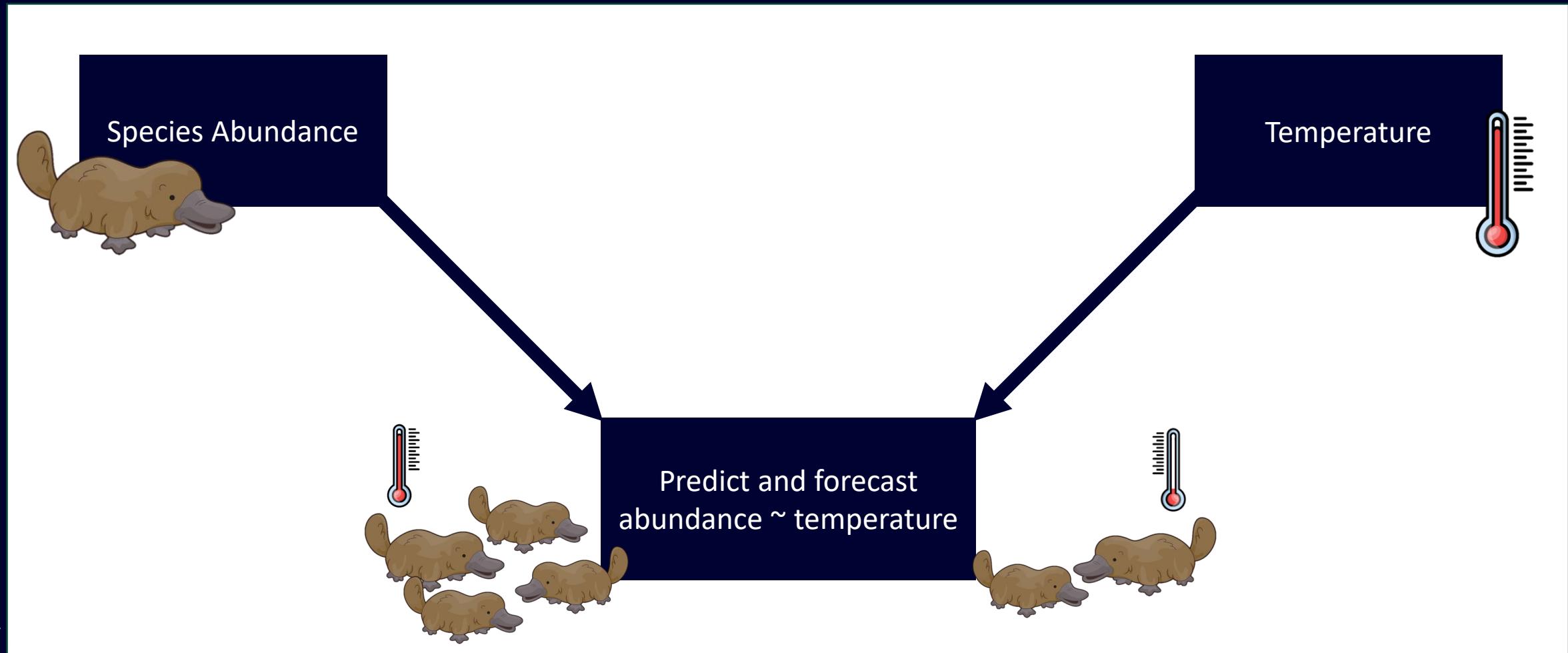
SpaDES can help you PERFECT your workflow

Quick hands-on demonstration of SpaDES potential



SpaDES to PERFECT your workflow

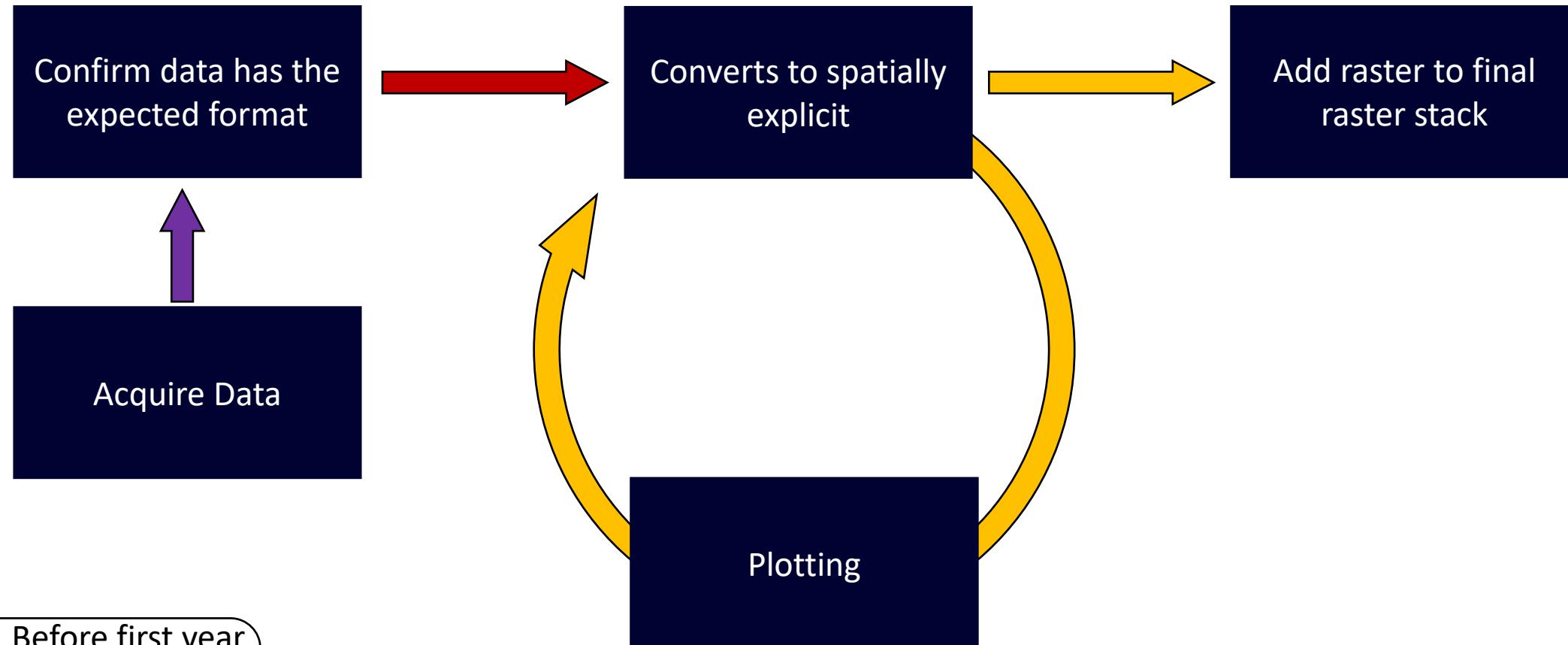
OBJECTIVE: Integrate 3 SpaDES modules - *how does abundance of a species changes over time and as a function of temperature?*



SpaDES to PERFECT your workflow

2013 to 2022

Species Abundance

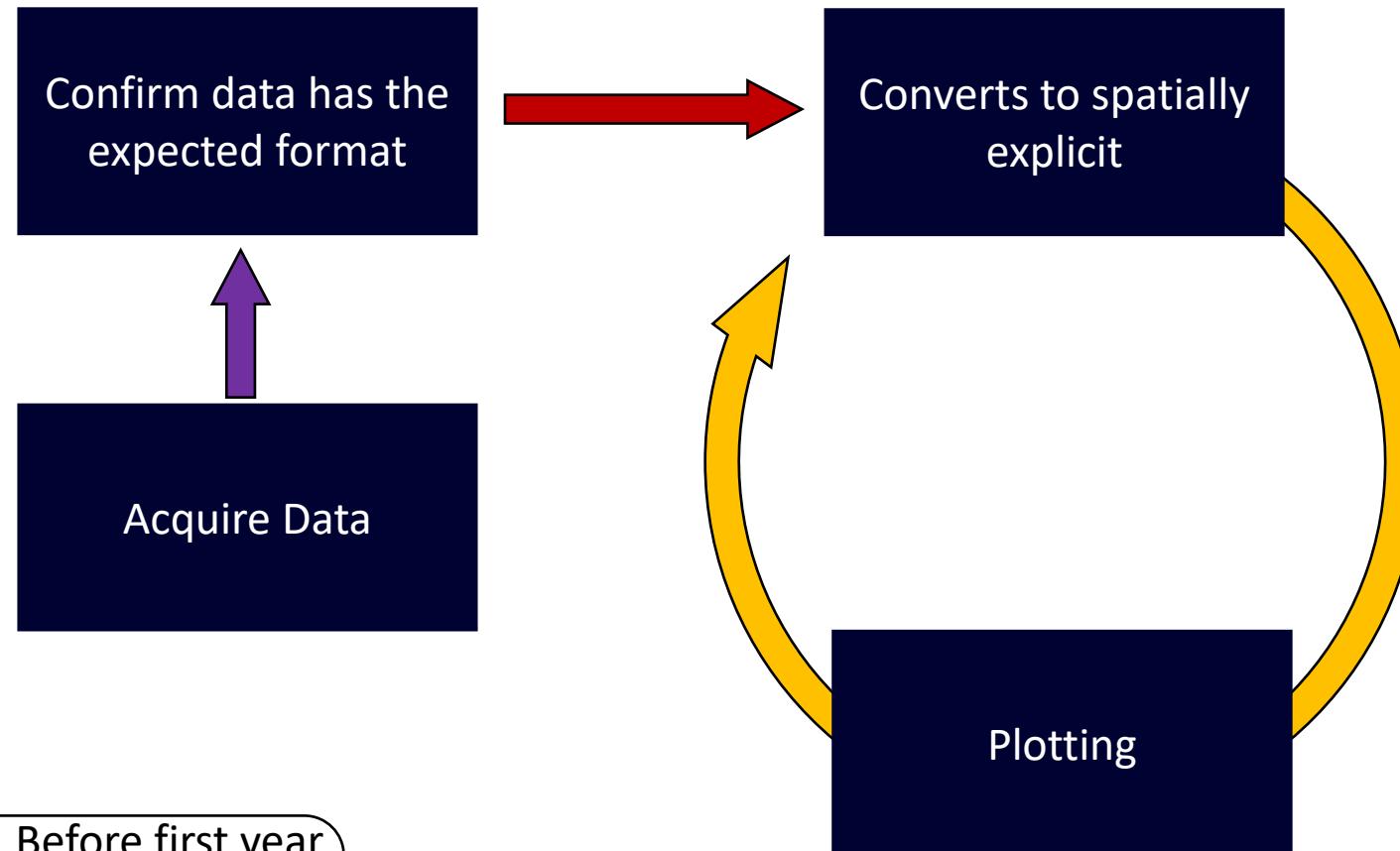


- Before first year
- First year
- Every year
- Last year
- A given year

SpaDES to PERFECT your workflow

2013 to 2032

Temperature

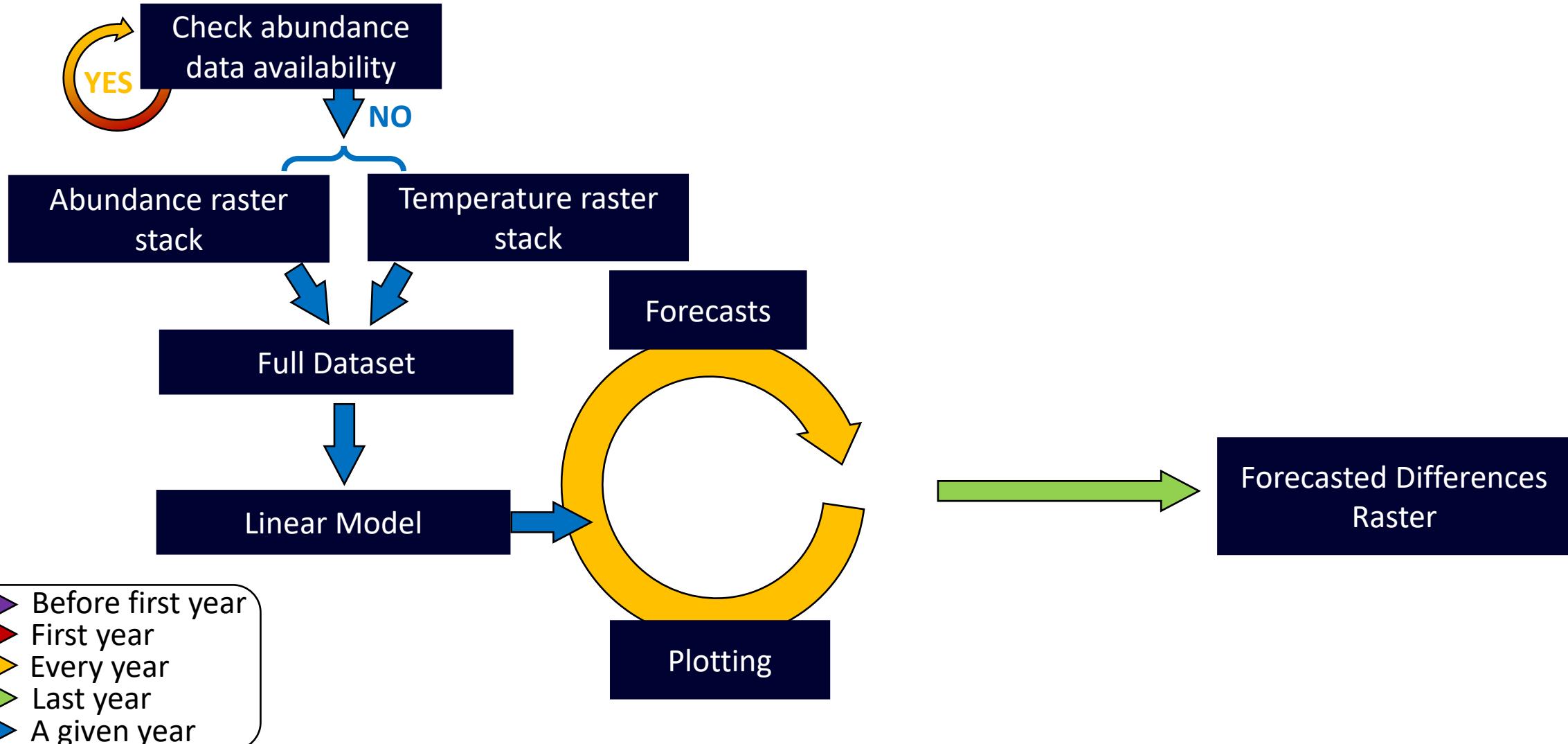


- Before first year
- First year
- Every year
- Last year
- A given year

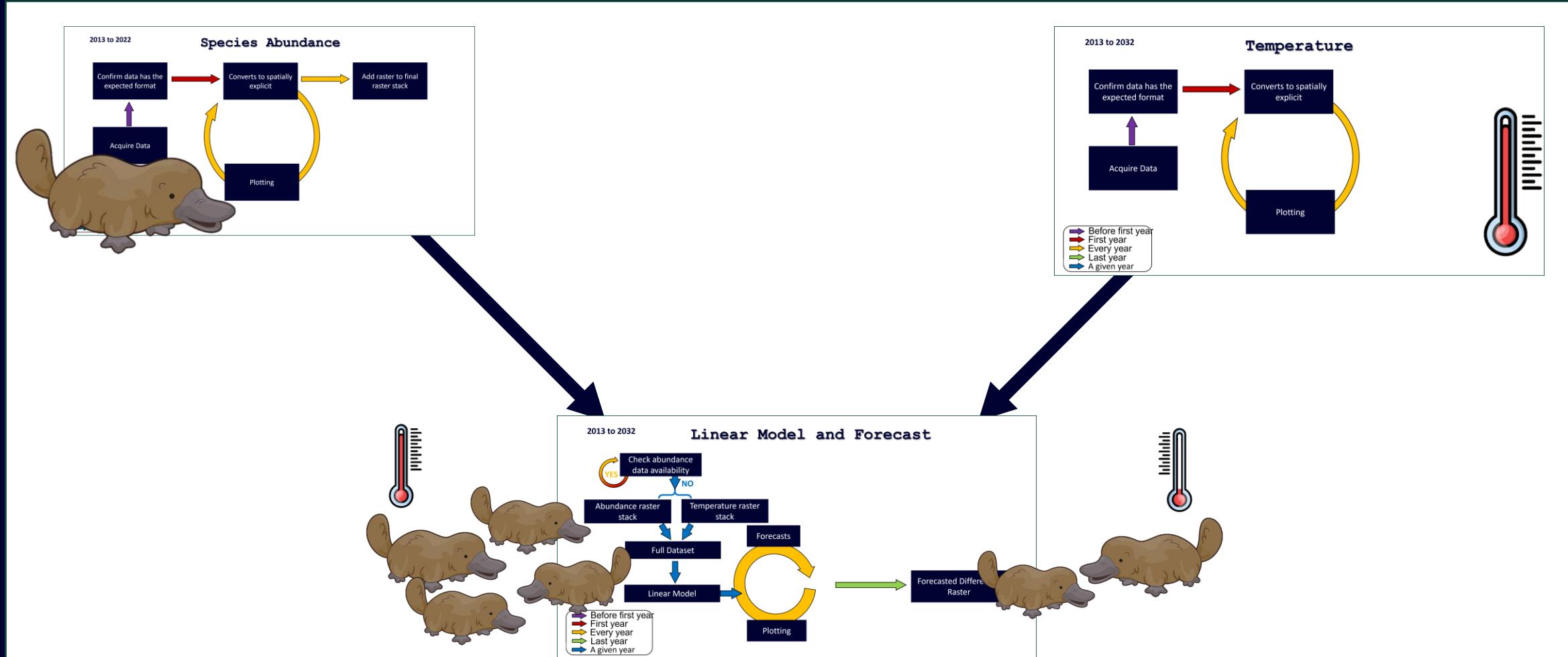
SpaDES to PERFECT your workflow

2013 to 2032

Linear Model and Forecast



SpaDES to PERFECT your workflow



All Hands on Deck !

Integrating simple models with SpaDES' help



♠PART I: install the installers

♠PART II: downloads modules and installs the packages required by these

♣PART III: run spades



tinyurl.com/webinarEFI
demo.R
tinyurl.com/webinarEFI2
exploringSpaDES.html



Predictions: completed project

Evaluated: evaluation module

Reusable: change in module's code

Freely accessible: download and full code access

Interoperable: stand-alone and module integration possible

Continuous Workflow: from data to completion in two function calls

Tested routinely: module integration tests



SpaDES under the hood

The nitty-gritty details



SpaDES module structure:

The screenshot shows a software interface with a menu bar (Files, Plots, Packages, Help, Viewer, Presentation) and a toolbar with icons for New Folder, New Blank File, Delete, Rename, and More. The navigation bar shows 'Home > EFI > speciesAbundance'. The main area is a file browser with columns for Name, Size, and Modified. The 'Name' column lists files and folders: .., speciesAbundance.R, citation.bib, LICENSE.md, NEWS.md, README.md, speciesAbundance.Rmd, .github, data, R, and tests. Arrows point from each item to its description in the adjacent columns. A yellow callout bubble labeled 'module' points to the 'speciesAbundance' folder icon. A yellow text box at the bottom right contains the text: 'Resembles an R package, and it can be converted to one!'

Name	Size	Modified
..		
speciesAbundance.R	8.3 KB	Mar 13, 2024, 1:20 PM
citation.bib	180 B	Mar 13, 2024, 1:18 PM
LICENSE.md	472 B	Mar 13, 2024, 1:18 PM
NEWS.md	70 B	Mar 13, 2024, 1:18 PM
README.md	272 B	Mar 13, 2024, 1:18 PM
speciesAbundance.Rmd	3.8 KB	Mar 13, 2024, 1:18 PM
.github		
data		
R		
tests		

Resembles an R package, and it can be converted to one!

♠ How to create a new module?

```
newModule("myCoolNewModule", getwd())
```



♠Module's anatomy

- Name
- Description
- Keywords
- Authors
- Version

DESCRIPTIVE
METADATA

- Packages
- Parameters
- Inputs
- Outputs

FUNCTIONAL
METADATA

doSomething = {

sim\$data2 <- aFunction(data)

}

EVENTS

- ♠ **SpaDES**: a tool that can help implement the **PERFICT** principles to modelling workflows
- ♠ In **SpaDES**, the workflow emerges from the module's metadata, regardless of how complex it is
- ♠ Module quality is responsibility of module developers, not users

SpaDES supports the development of **PERFICT FAIR** workflows with the right level of complexity and flexibility, helping researchers bring data to decisions.



Thank You !

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tinyurl.com/SpaDESSurvey

