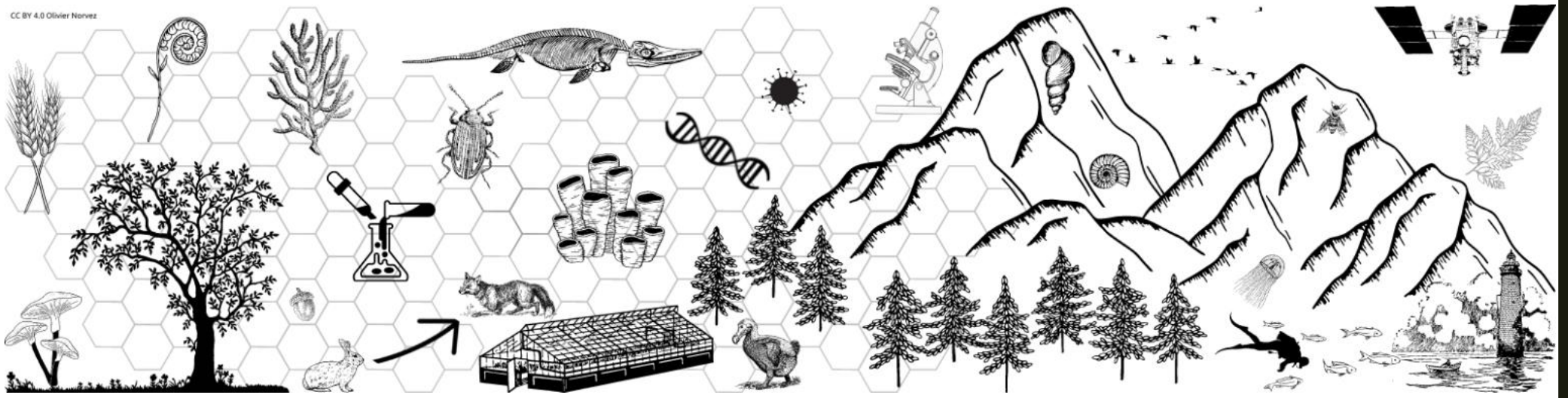
Galaxy Ecology Kesako



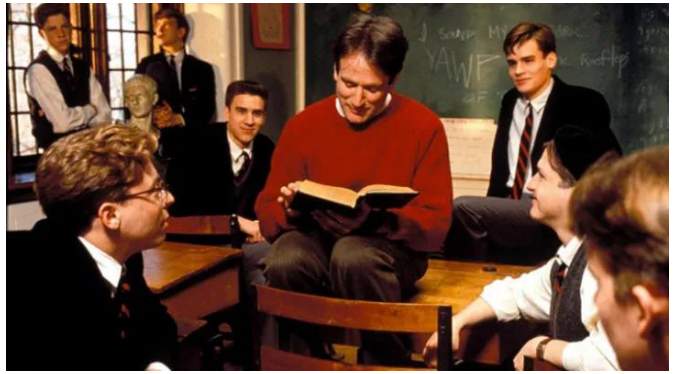
By Coline Royaux, Marie Jossé, Pauline Seguineau, Arhur Barreau, Jean Le Cras, Elouan Le Mestric, Olivier Norvez, Francis Clément, Nicolas Buisine, Jian-Sheng Sun, Yvan Le Bras, The Galaxy Ecology Community

Contexte

Les résultats dépendent des orientations d’origine

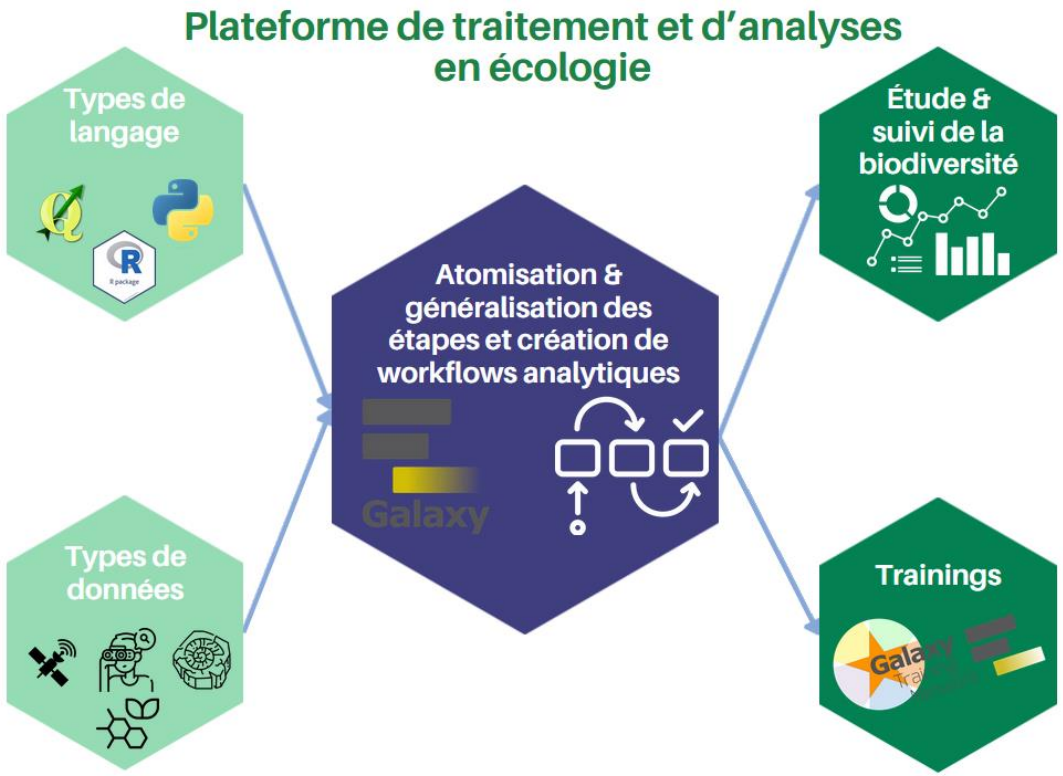
« Hier est derrière, demain est un mystère, mais aujourd’hui est un cadeau,
C’est pour cela qu’on l’appelle présent ! »

https://www.flickr.com/photos/27474697@N08/2556889078



https://www.vitav.fr/le-cercle-des-poetes-disparus-une-ode-a-la-liberte/

« Carpediem »



Galaxy Ecology: Origins

Proposer de transformer « un rêve » en réalité

Du déluge des données aux sciences participatives

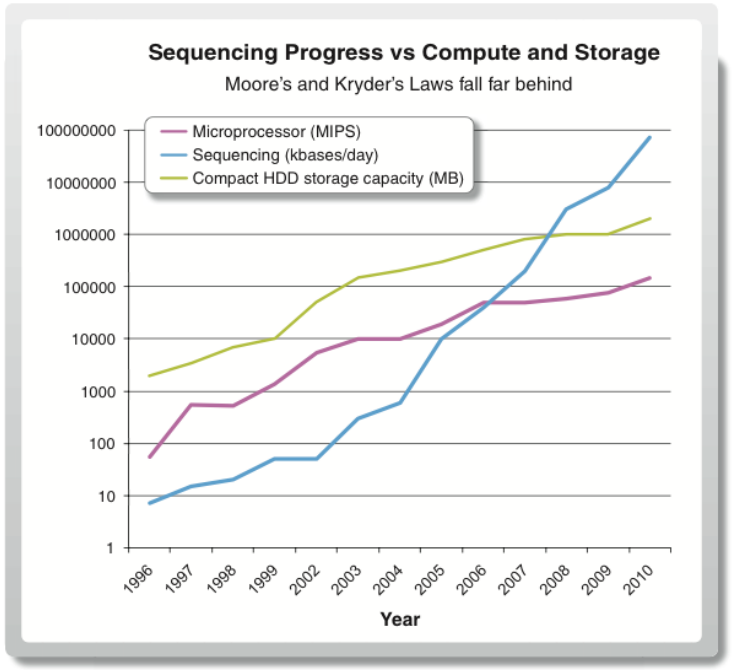
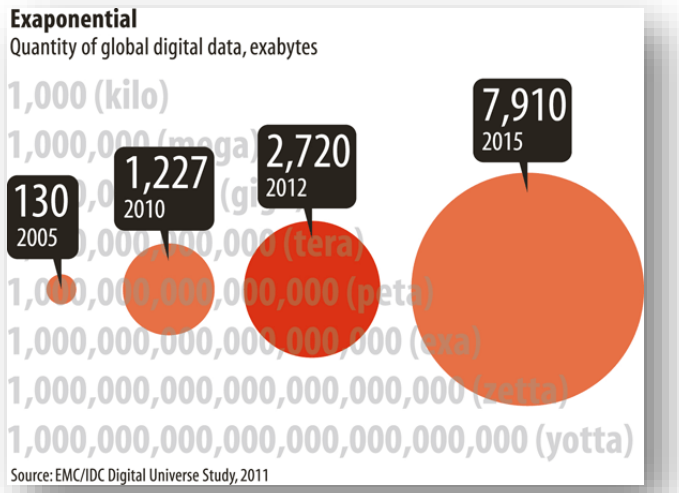
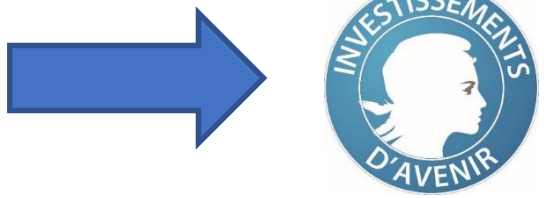
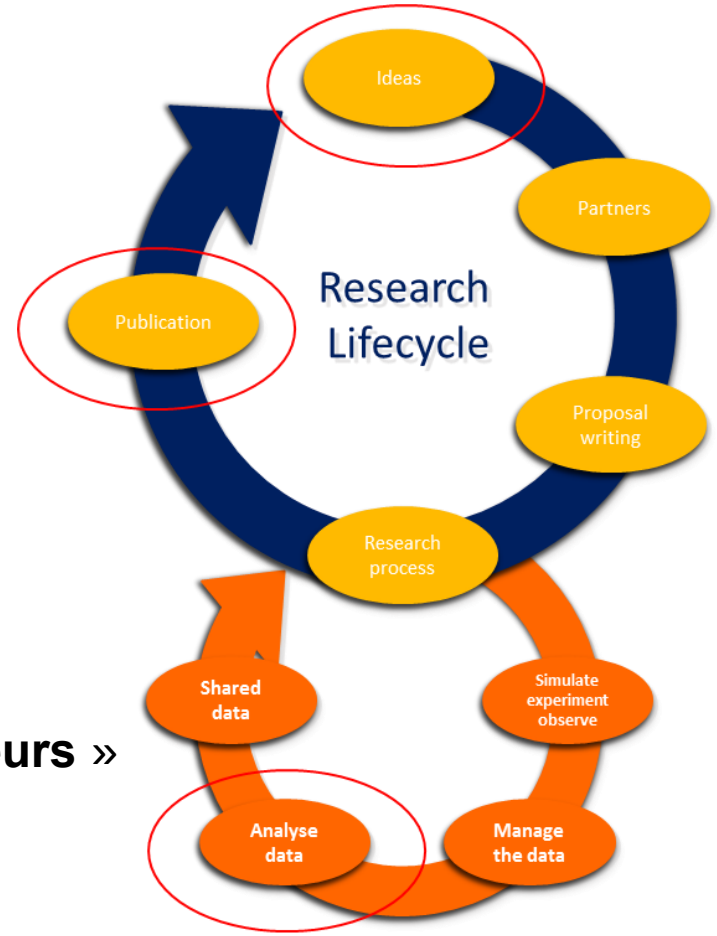


Fig. 1. A doubling of sequencing output every 9 months has outpaced and overtaken performance improvements within the disk storage and high-performance computation fields.





« 65 Millions d'observateurs »



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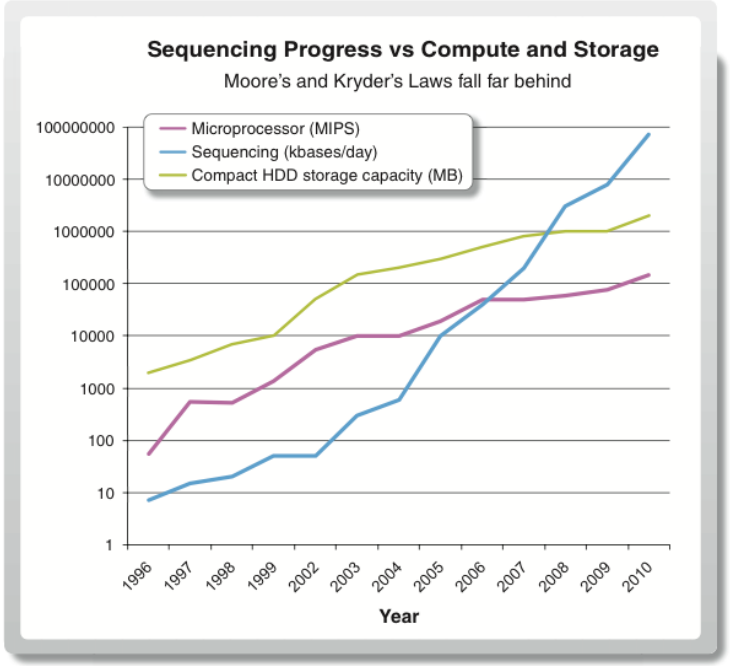

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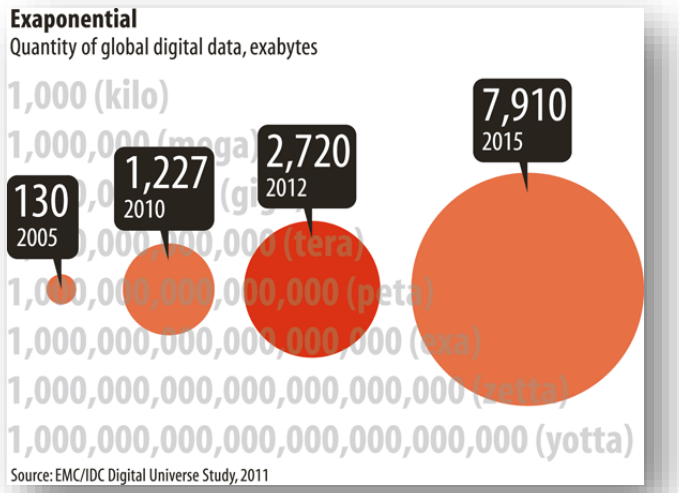
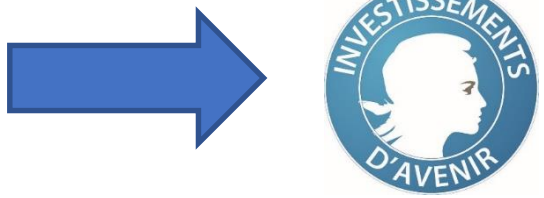
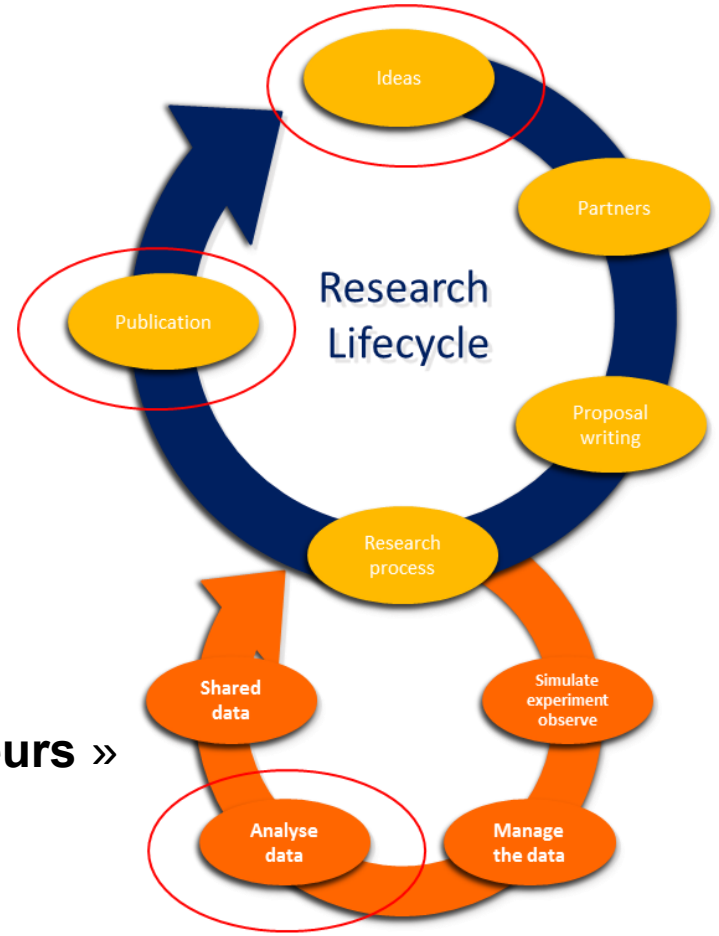




« **65 Millions d'observateurs** »



"L'un des grands défis de la science intenssivement orientée données consiste à faciliter la découverte de connaissances en aidant les humains et les machines à découvrir, accéder, intégrer et analyser des données scientifiques adaptées à leurs tâches, ainsi que les algorithmes et les flux de travail associés."

FORCE11 Future of Research Communication & e-Scholarship (2016)
The FAIR principles https://www.force11.org/group/fairgroup/fairprinciples

Proposer de transformer « un rêve » en réalité

Une plateforme d’analyse collaborative pour les sciences participatives

Objectifs :

- Renforcer l'équipe de recherche avec des citoyens pour faire face à la datanami.
- Sortir du formalisme des chercheurs.
- Améliorer les connaissances mondiales sur l'environnement afin de mieux le protéger.

Conclusions :

- Nous devons donner accès aux vraies données scientifiques brutes et aux codes sources
- Nous devons tirer parti des initiatives, des outils et des services existants en matière d'infrastructures numériques de recherche

2017: Naissance de l’initiative « Galaxy for Ecology »

Proposer de transformer « un rêve » en réalité

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2017: Naissance de l’initiative « Galaxy for Ecology »

Galaxy PROJECT

2018: Naissance de l’instance Galaxy Ecology Europe

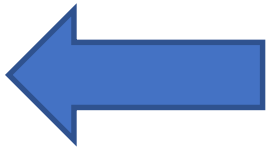
Galaxy Galaxy / Ecology Europe

useGalaxy.eu

Brique essentielle infrastructure numérique dédiée biodiversité

Galaxy-E comme une composante essentielle du PNDB

2018: Naissance de l'infrastructure numérique dédiée biodiversité PNDB



useGalaxy.eu

Brique essentielle infrastructure numérique dédiée biodiversité

Galaxy-E comme une composante essentielle du PNDB

2018

Avantages :

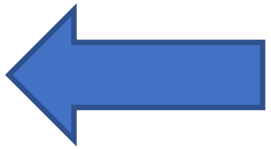
- Démarrage rapide, sur système en production, même avec des ressources limitées
- Pas besoin de ressources humaines pour l'administration du système
- Pas besoin de ressources informatiques
- « Il suffit » de développer des composants lorsque cela est nécessaire / lorsque les ressources humaines sont financées.
- Bénéficier d'une grande communauté existante et y contribuer.

« Devoir » :

- Disposer d'un processus de qualité minimum => meilleures pratiques / principes FAIR, ce qui est également un avantage !

2018: Naissance de l'infrastructure numérique dédiée biodiversité PNDB

PNDB Pôle National de Données de Biodiversité



Galaxy Galaxy / Ecology Europe

useGalaxy.eu

Galaxy Ecology: D’une plateforme aux meilleures pratiques en analyse de données de Biodiversité

Des pratiques “Galaxy-E” pour la réutilisation!

Atomisation & Généralisation pour réutiliser / transposer

GigaScience, 2025, 14, 1–12
DOI: 10.1093/gigascience/giae122
Review

Guidance framework to apply best practices in ecological data analysis: lessons learned from building Galaxy-Ecology

Coline Royaux[1,2,*], Jean-Baptiste Mihoub[3], Marie Jossé[4], Dominique Pelletier[5], Olivier Norvez[6], Yves Anne Fouilloux[9], Helena Rasche[10], Saskia Hiltemann[11], Bérénice Batut[12,13], Eléaume Marc[14,15], Pauli Guillaume Massé[16], Alan Amossé[17], Claire Bissery[8,18], Romain Lorrilliere[3], Alexis Martin[19], Yves Bas[3,20], Thimothée Virgoulay[21,22], Valentin Chambon[17], Elie Arnaud[2], Elisa Michon[23], Clara Urfer[2,24], Eloïse Trigodet[21], Gregoire Loïs[3], Romain Julliard[3], Björn Grüning[25], Yvan Le Bras[2], and The Galaxy-E community

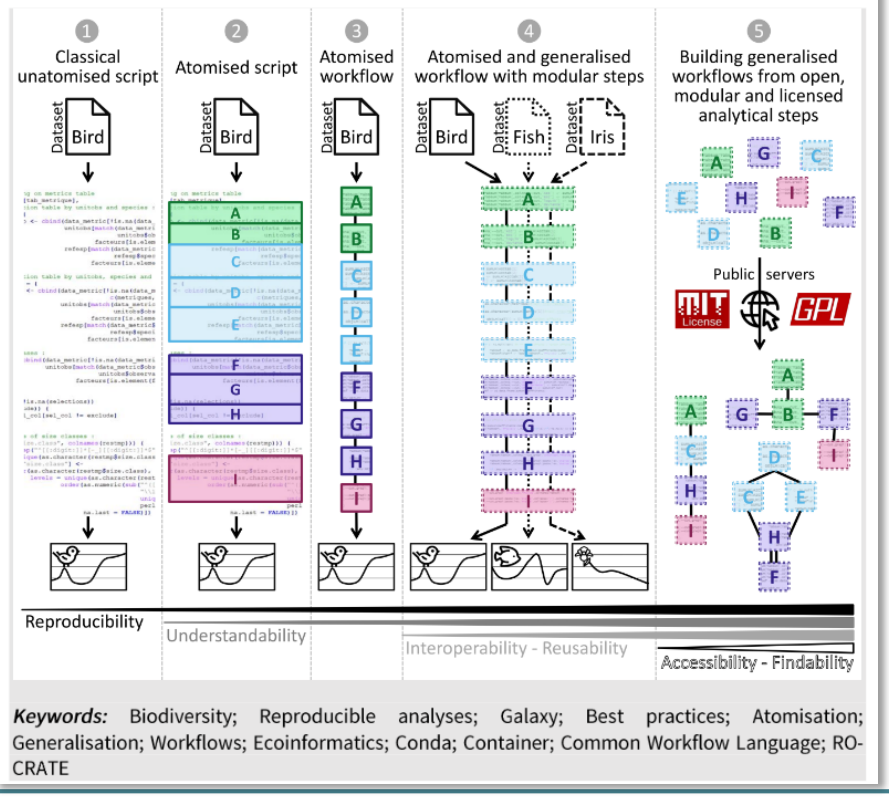
Guidance framework to apply best practices in ecological data analysis: Lessons learned from building Galaxy-Ecology

PCI recommendation : https://doi.org/10.24072/pci.ecology.100694

Royaux Coline[1,2*], Mihoub Jean-Baptiste[3], Jossé Marie[4], Pelletier Dominique[5], Norvez Olivier[6], Reecht Yves[7,8], Fouilloux Anne[9], Rasche Helena[10], Hiltemann Saskia[11], Batut Bérénice[12,13], Eléaume Marc[14,15], Seguineau Pauline[14,15], Massé Guillaume[16], Amossé Alan[17], Bissery Claire[8,18], Lorrilliere Romain[3], Martin Alexis[19], Bas Yves[3,20], Virgoulay Thimothée[21,22], Chambon Valentin[17], Arnaud Elie[2], Michon Elisa[23], Urfer Clara[2,24], Trigodet Eloïse[21,24], Delannoy Marie[3], Loïs Gregoire[3], Julliard Romain[3], Grüning Björn[25], The Galaxy-E community, Le Bras Yvan[2]

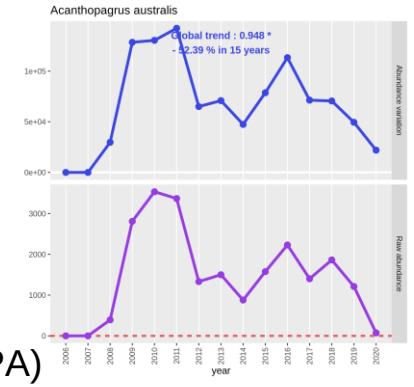
PAMPA

Graphical abstract – Levels of attainable best practices through the atomisation – generalisation framework

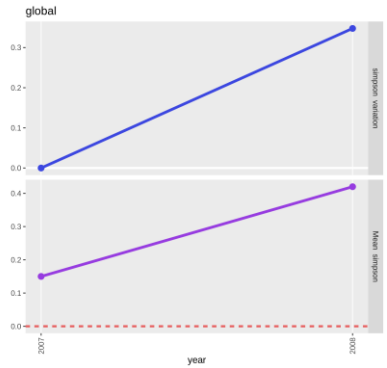


Keywords: Biodiversity; Reproducible analyses; Galaxy; Best practices; Atomisation; Generalisation; Workflows; Ecoinformatics; Conda; Container; Common Workflow Language; RO-CRATE

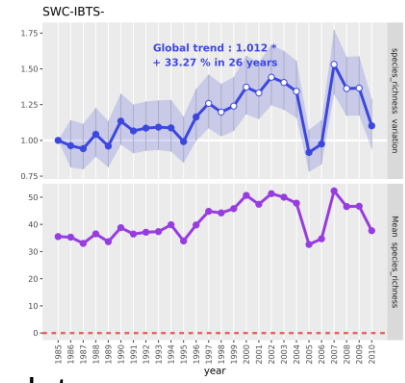
REEF LIFE SURVEY fishes data



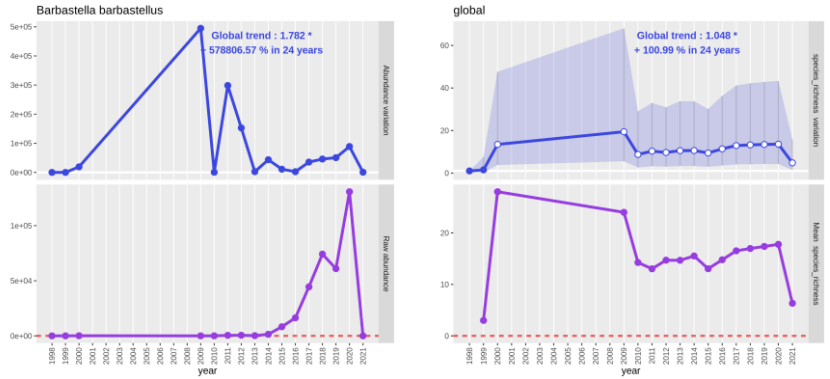
Marine Protecterd Areas (PAMPA) fishes data



DATRAS fishing data



VIGIE CHIRO bats data



Des pratiques “Galaxy-E” pour la réutilisation!

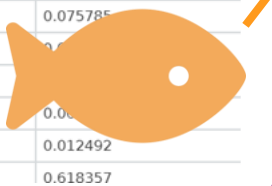
Données différentes, mêmes variables, même workflow

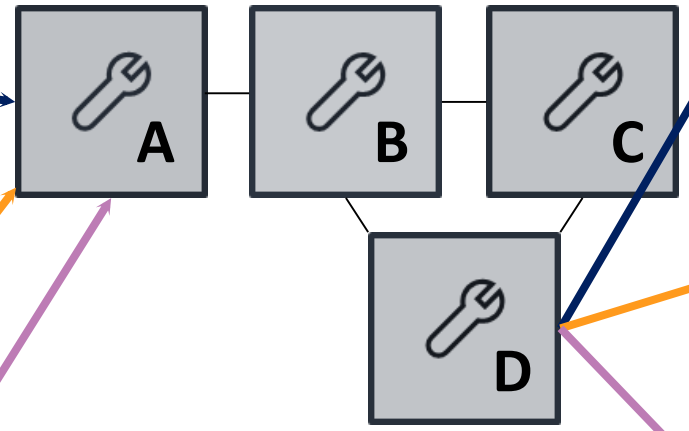
Lieu **Année** **Espèce** **Occurrence**

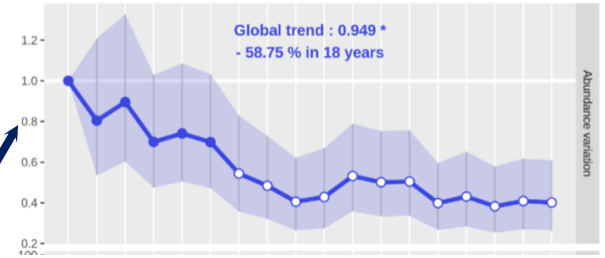
	carre	annee	espece	abond
1	2	2016	ACCGEN	0
2	2	2017	ACCGEN	0
3	2	2018	ACCGEN	0
4	2	2019	ACCGEN	0
5	183	2016	ACCGEN	0
6	183	2017	ACCGEN	0

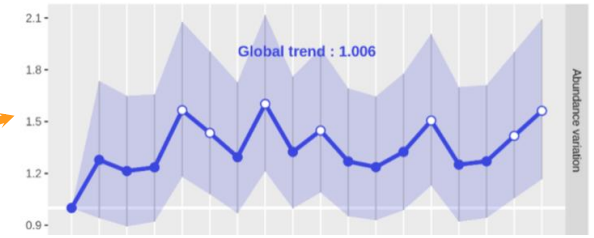
	Survey	Year	Quarter	Area	AphiaID	Species	LngtClass	CPUE_number_per_hour
1	BITS	1991	1	22	126281	Anguilla anguilla	0	0.000000
2	BITS	1991	1	22	126281	Anguilla anguilla	720	0.009160
3	BITS	1991	1	22	126417	Clupea harengus	0	0.000000
4	BITS	1991	1	22	126417	Clupea harengus	80	0.075785
5	BITS	1991	1	22	126417	Clupea harengus	85	
6	BITS	1991	1	22	126417	Clupea harengus	95	
7	BITS	1991	1	22	126417	Clupea harengus	100	
8	BITS	1991	1	22	126417	Clupea harengus	105	0.012492
9	BITS	1991	1	22	126417	Clupea harengus	110	0.618357

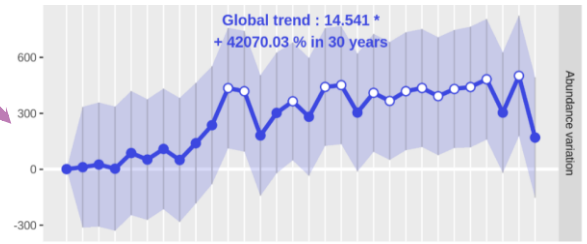
	Unit	bs	rotation	codeSp	sexe	taille	classe_taille	poids	nb_ind
1	AS140155	3		Hemifasc	-999	-999	P	-999	1
2	AS140159	1		Nasosp.	-999	-999	P	-999	3
3	AS140159	3		Gompvari	-999	-999	P	-999	1
4	AS140160	3		Gompvari	-999	-999	P	-999	1











Des pratiques “Galaxy-E” pour la réutilisation!

Données différentes, mêmes variables, même workflow

2024

Transposer à un contexte autre (taxonomique et/ou géographique et/ou temporel)

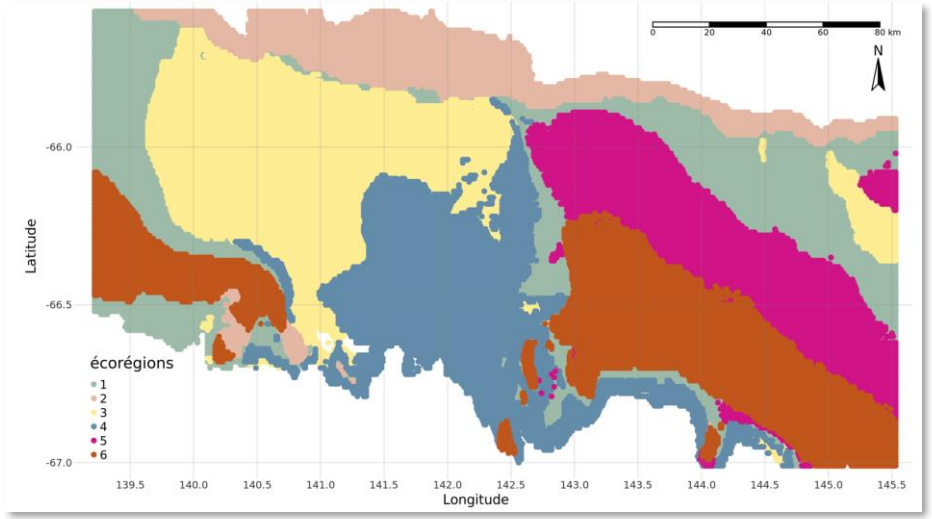
De l’ Antarctique à l’Atlantique Nord Est

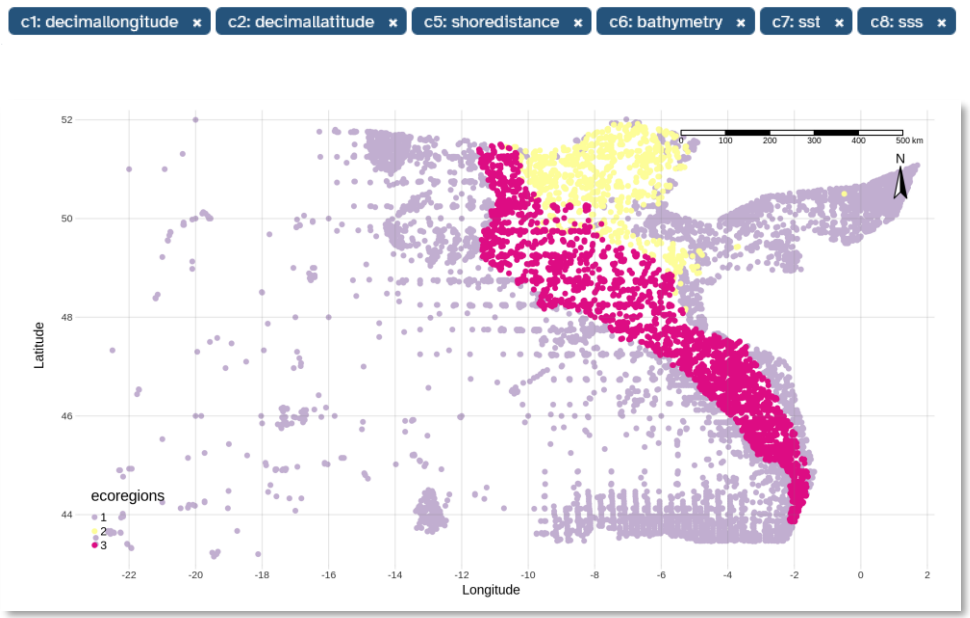
Des invertébrés aux poissons

Nord Atlantique

OBIS occurrences de données marines (poissons)
OBIS données environnementales (tous)

Données « espèces » (invertebrés)
Données environmentales





Des pratiques “Galaxy-E” pour la réutilisation!

Données différentes, mêmes variables, même workflow

2024

Tester plusieurs scenarios

De l’ Antarctique à l’Atlantique Nord Est

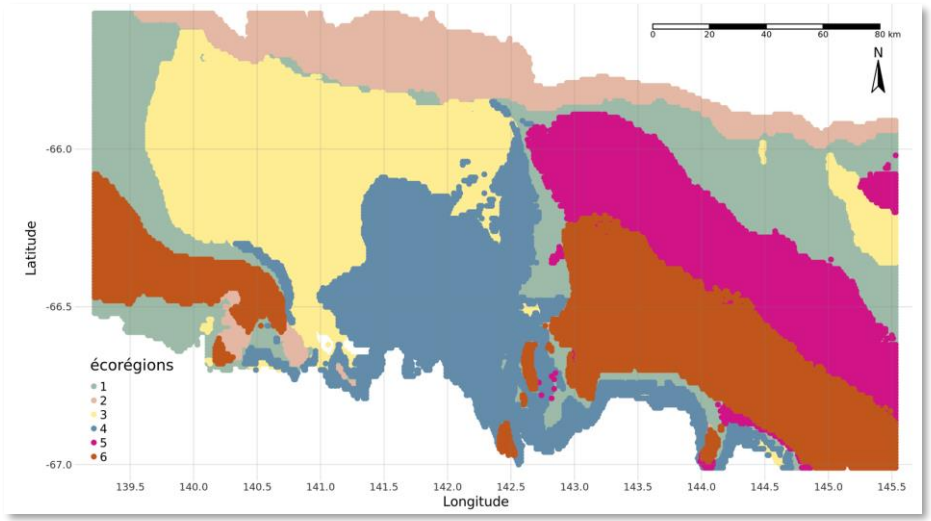
Des invertébrés aux poissons

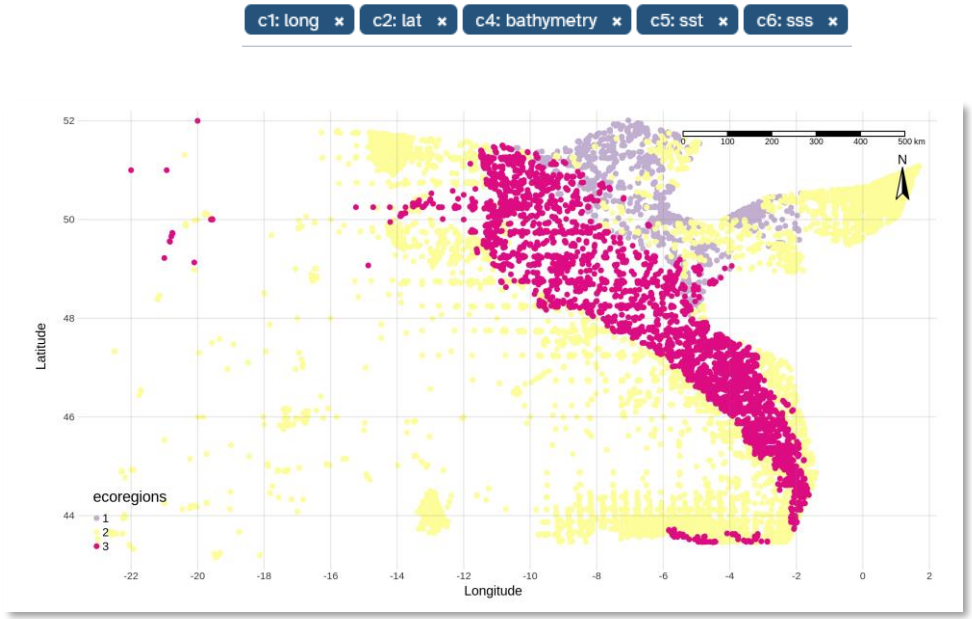
Modification des paramètres de modélisation

Nord Atlantique

OBIS occurrences de données marines (poissons)
OBIS données environnementales (sst/bathy/sss)

Données « espèces » (invertebrés)
Données environmentales

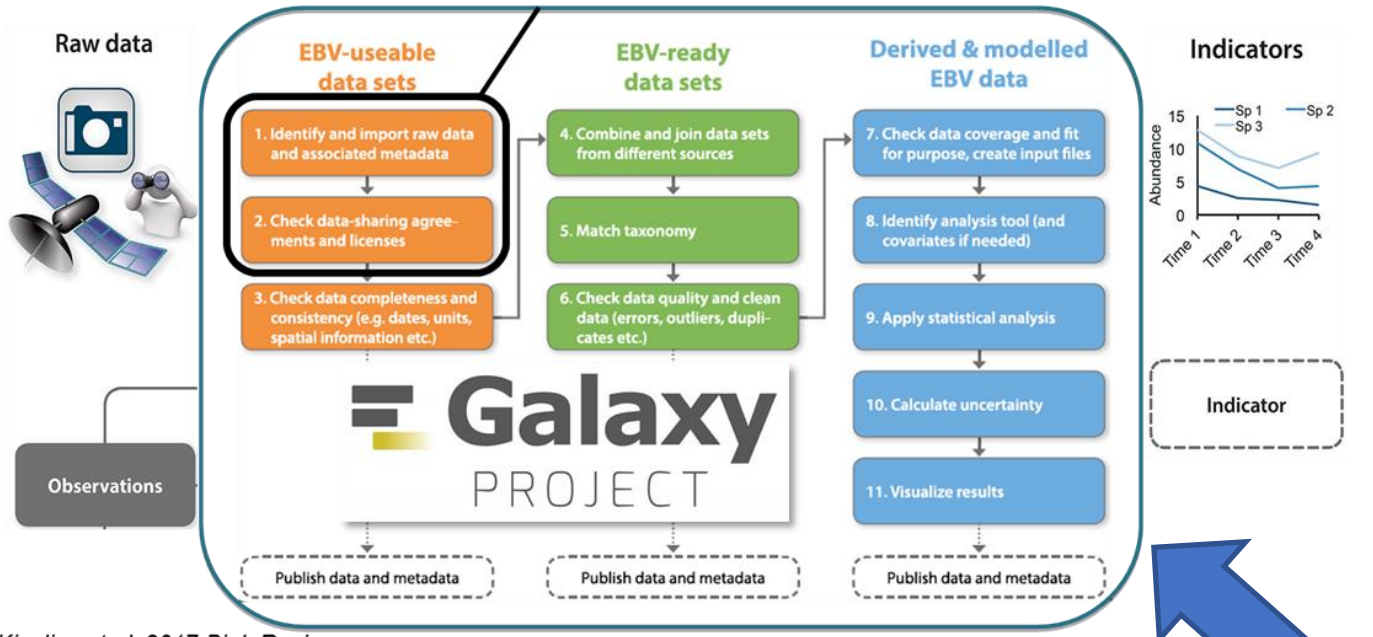




Brique essentielle pour contribuer à des initiatives de grande ampleur

Participation au réseau mondial d'observation de la terre dédié biodiversité

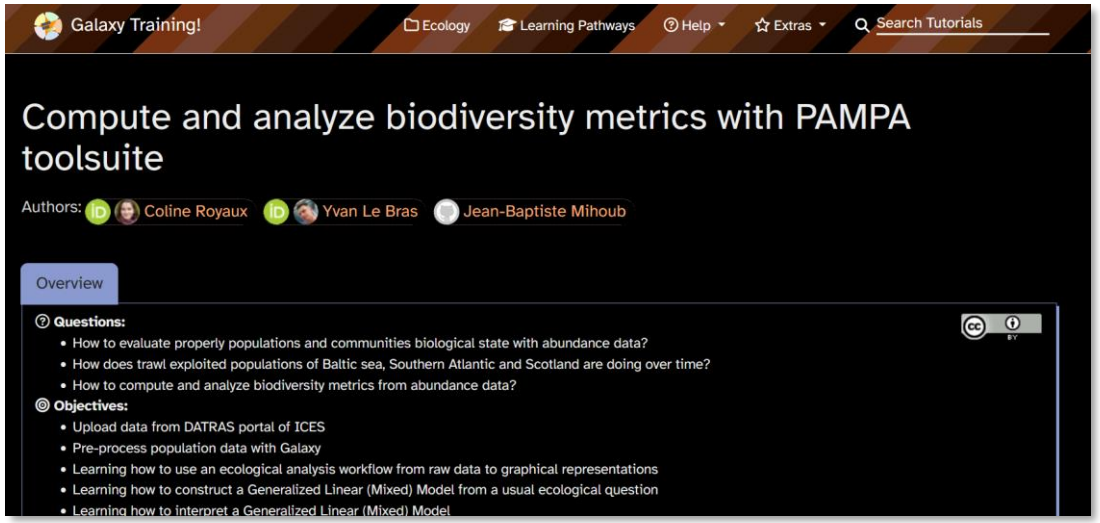
2019



Kissling et al. 2017 Biol. Reviews

GEO BON
Group on Earth Observations
Biodiversity Observation Network

French BON EBV operationalization pilot



PNDB Pôle National de Données de Biodiversité

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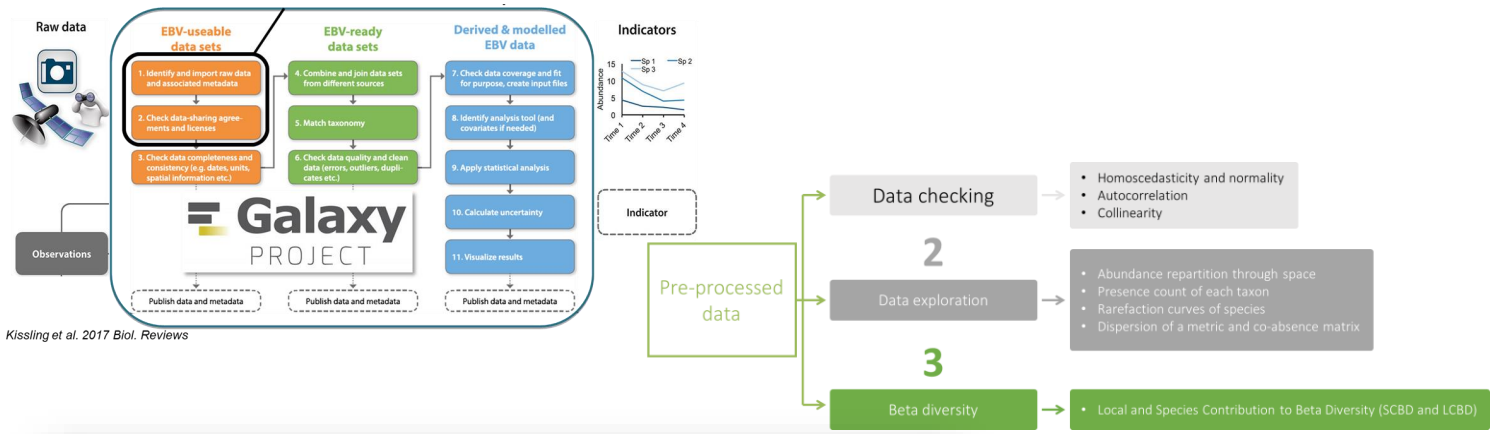
Participation au réseau mondial d'observation de la terre dédié biodiversité

2019-2022



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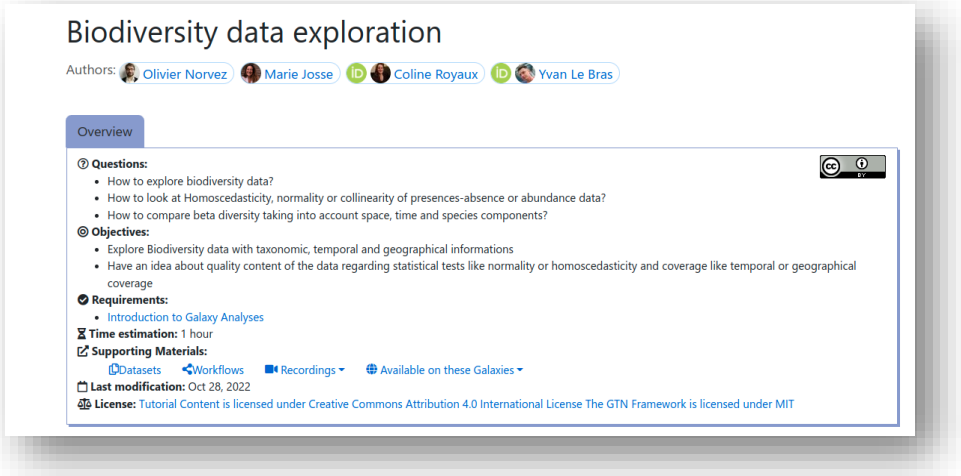

Biodiversity data exploration

Authors: Olivier Norvez, Marie Josse, Coline Royaux, Yvan Le Bras

Overview

Questions:
- How to explore biodiversity data?
- How to look at Homoscedasticity, normality or collinearity of presences-absence or abundance data?
- How to compare beta diversity taking into account space, time and species components?

Objectives:
- Explore Biodiversity data with taxonomic, temporal and geographical informations
- Have an idea about quality content of the data regarding statistical tests like normality or homoscedasticity and coverage like temporal or geographical coverage

Requirements:
- Introduction to Galaxy Analyses

Time estimation: 1 hour

Supporting Materials:
Datasets Workflows Recordings Available on these Galaxies

Last modification: Oct 28, 2022

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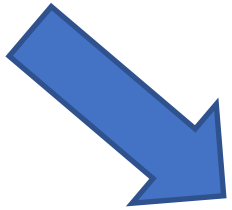

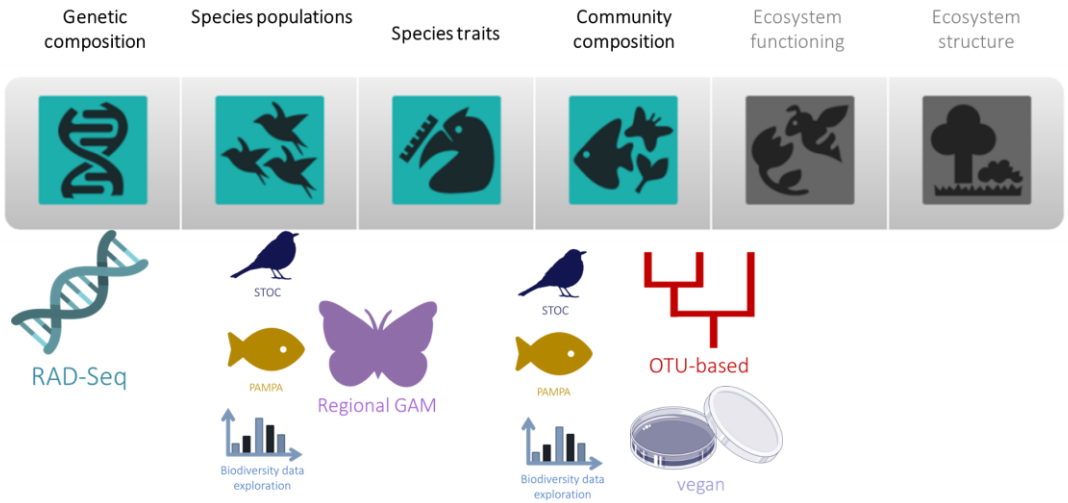

PNDB Pôle National de Données de Biodiversité

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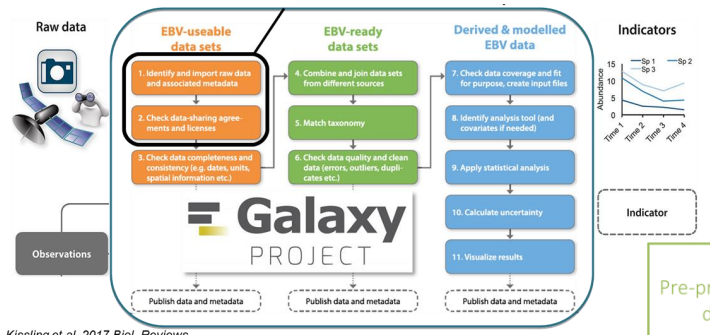
2023



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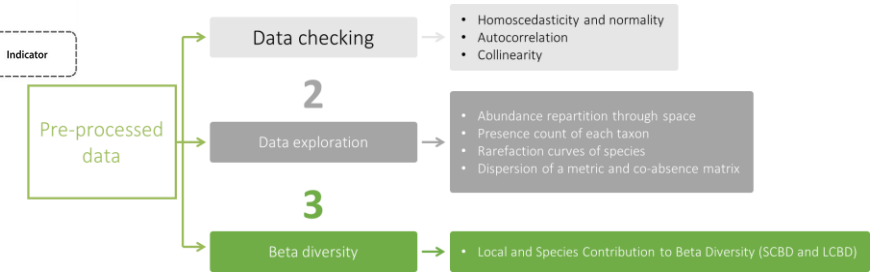

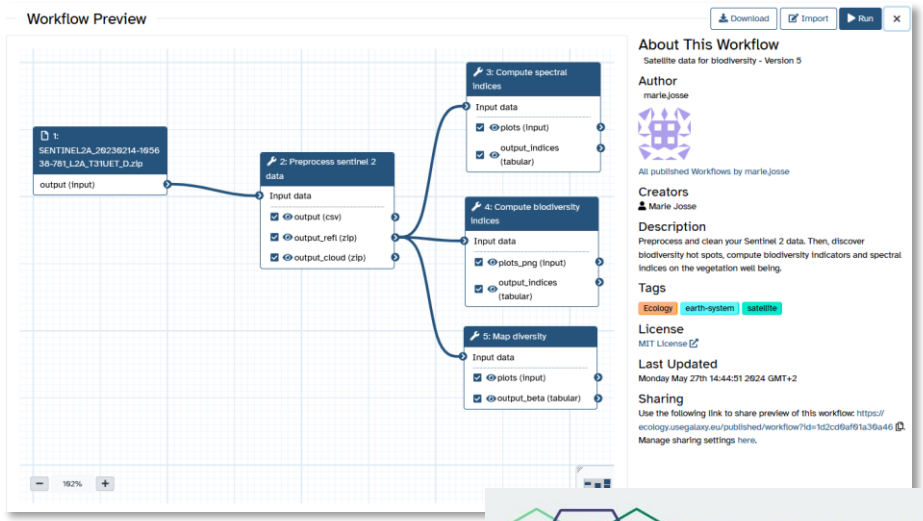

PNDB Pôle National de Données de Biodiversité

GEO BON
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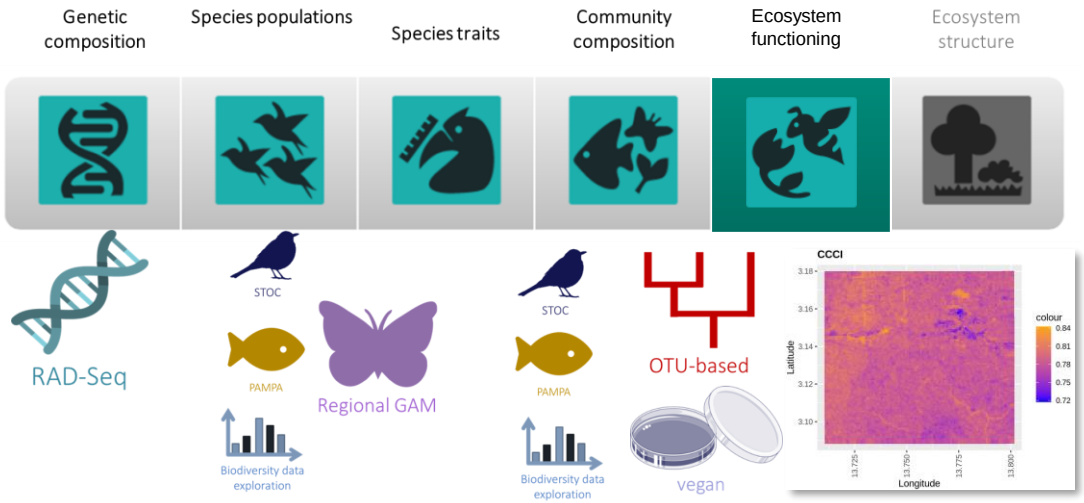
French BON EBV operationalization pilot

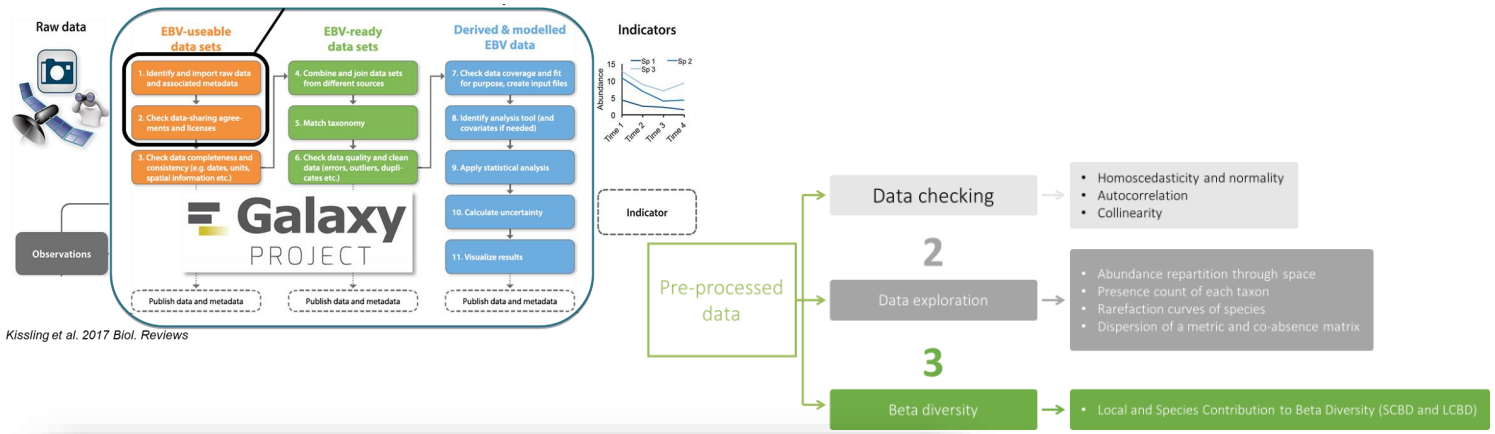
Sentinel2



Brique essentielle pour contribuer à des initiatives de grande ampleur

Participation au réseau mondial d'observation de la terre dédié biodiversité

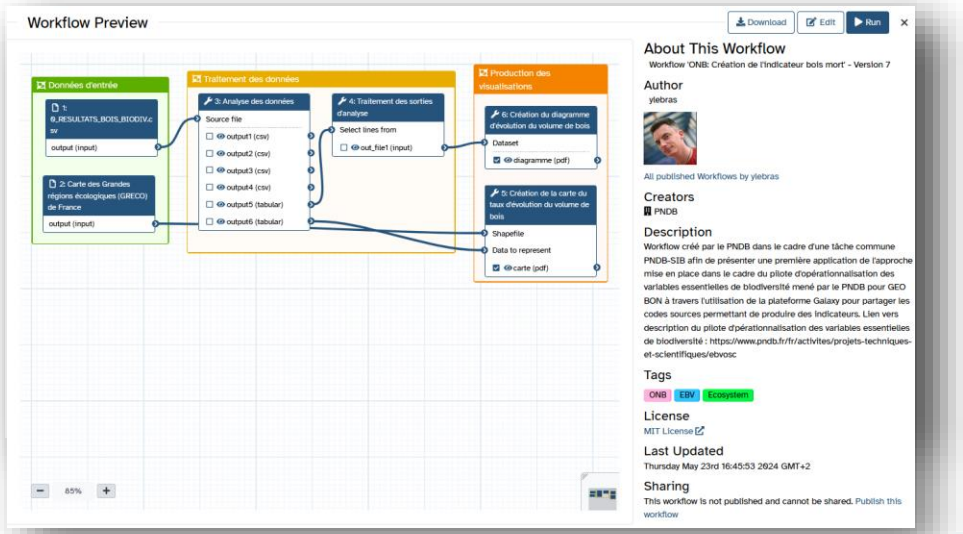
2023



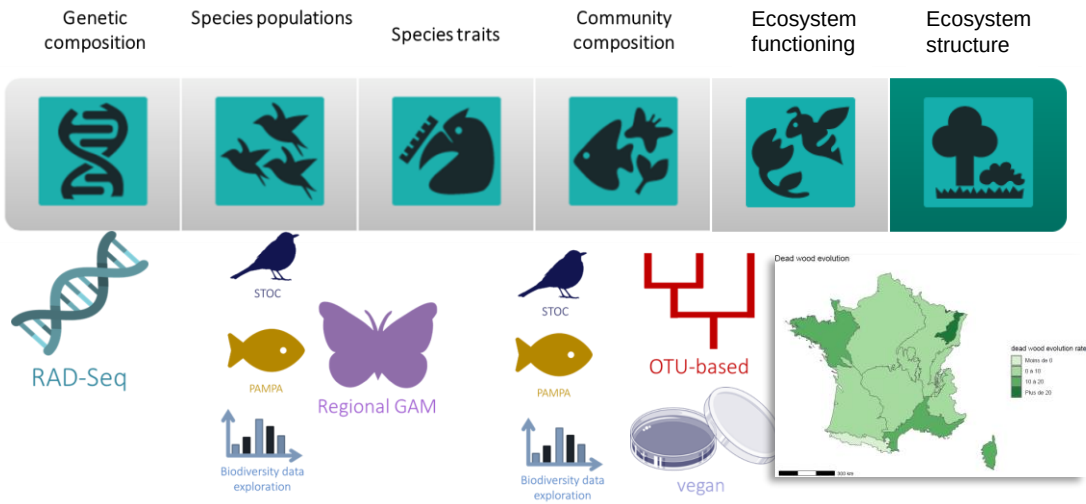
Kissling et al. 2017 Biol. Reviews

GEO BON
Group on Earth Observations
Biodiversity Observation Network

French BON EBV operationalization pilot



PNDB Pôle National de Données de Biodiversité



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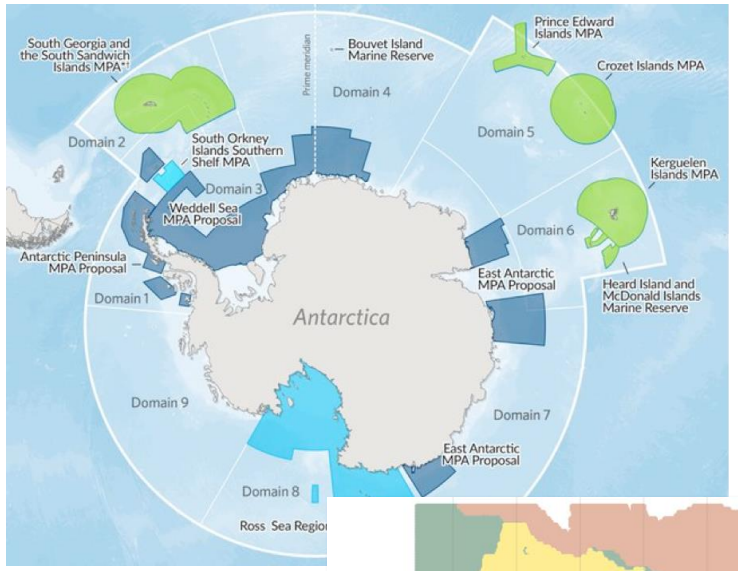
2023

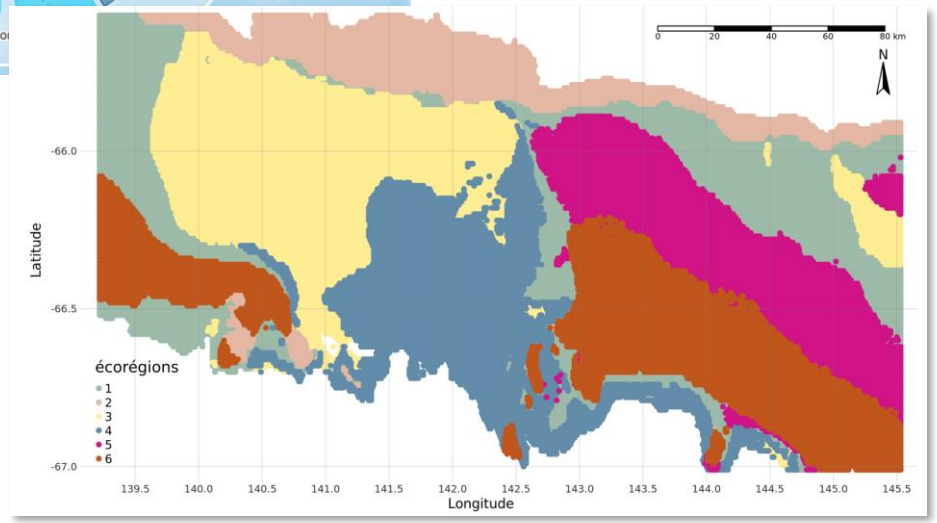


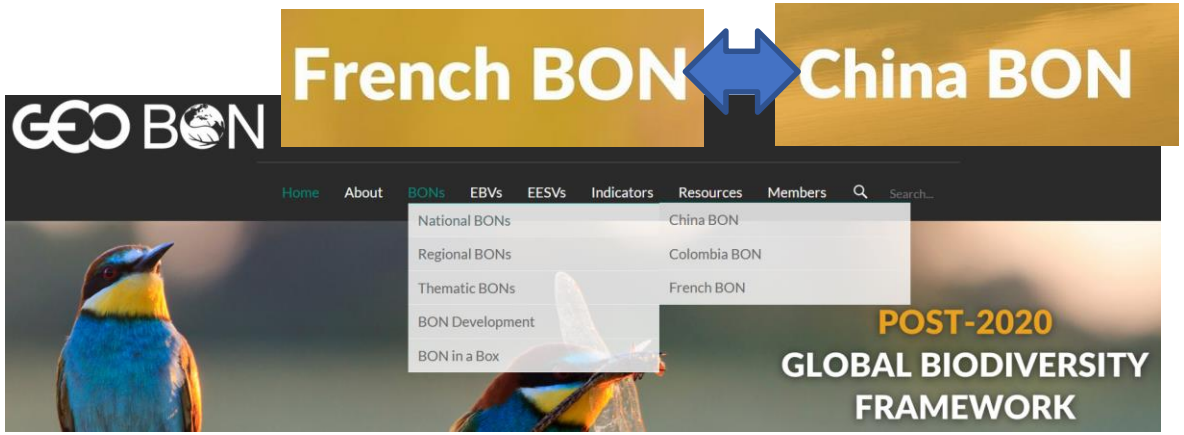
AMP nationales
AMP CCAMLR
AMP en projet

CCAMLR

today,

- 2 MPA already there
- 3 projects in discussion





Tutoriels en ligne dédiés Ecologie

Data and Metadata Management

These tutorials are focusing on data and metadata management in Ecology.

Lesson	Slides	Hands-on	Recordings	Input dataset	Workflows
Cleaning GBIF data using OpenRefine biodiversity					
Creating FAIR Quality assessment reports and draft of Data Papers from EML metadata with MetaShRIMPS Metadata EML FAIR Data Paper biodiversity					
Creating metadata using Ecological Metadata Language (EML) standard with EML Assembly Line functionalities Metadata EML Ecology Biodiversity FAIR Data Paper					
Data submission using ENA upload Tool					

Data access

These lessons focus on ways to access data classicaly used in Ecology

Lesson	Slides	Hands-on	Recordings	Input dataset	Workflows
QGIS Web Feature Services earth-system GIS Geographical Information System WFS Spatial data Maps OGC biodiversity					

Data preprocessing

These lessons focus on manners to preprocess data used in Ecology

Lesson	Slides	Hands-on	Recordings	Input dataset	Workflows
Biodiversity data exploration taxonomic data data quality biodiversity					
Checking expected species and contamination in bacterial isolate illumina bacteria microgalaxy					
Cleaning GBIF data for the use in Ecology gbif data management data cleaning biodiversity					

Data visualization

These tutorials showcase data visualization in Ecology

Lesson	Slides	Hands-on	Recordings	Input dataset	Workflows
Visualization of Climate Data using NetCDF xarray Map Plotting pangeo					
Visualize EBV cube data with Panoply netCDF viewer interactive-tools EBV cube Data visualization					

Data analysis

These lessons focus on ways to analyse data in Ecology

Lesson	Slides	Hands-on	Recordings	Input dataset	Workflows
Champs blocs indicators Ecosystem EBV class EBV dataset EBV workflow Marine ecosystems biodiversity					
Compute and analyze biodiversity metrics with PAMPA toolsuite Species population EBV class Community composition EBV class EBV dataset EBV workflow modeling biodiversity					
Ecoregionalization workflow tutorial ecology taxonomic data EBV workflow modeling gbif ocean earth-system interactive-tools biodiversity					
From NDVI data with OpenEO to time series visualisation with Holoviews earth-system land degradation NDVI copernicus holoviews					
Life Traits Ecoregionalization workflow biodiversity					
Marine Omics identifying biosynthetic gene clusters earth-system ocean marine omics biodiversity					
Metabarcoding/eDNA through Obitools Genetic composition EBV class Community composition EBV class EBV dataset EBV workflow eDNA Metabarcoding biodiversity					
Obis marine indicators earth-system ocean marine omics biodiversity					
Phylodiversity analysis quick tutorial ecology taxonomic data					
Preparing genomic data for phylogeny reconstruction phylogeny data handling functional annotation biodiversity					
RAD-Seq Reference-based data analysis RAD-seq Genetic composition EBV class Species population EBV class EBV dataset EBV workflow biodiversity					
RAD-Seq de-novo data analysis RAD-seq Genetic composition EBV class Species populations EBV class EBV dataset EBV workflow biodiversity					
RAD-Seq to construct genetic maps RAD-seq Genetic composition EBV class EBV dataset EBV workflowz biodiversity					
Regional GAM Species populations EBV class Species traits EBV class EBV dataset EBV workflow biodiversity					
Sentinel 2 biodiversity Remote sensing biodiversity					
Species distribution modeling interactive-tools modeling gbif species populations EBV class biodiversity					
Taxonomic Analysis of eDNA biodiversity					

Alan Amossé

Claire Dussin

Elouan Le Mestric

Jean Le Cras

Clara Urfer

Elisa Michon

Timothée Virgoulay

Valentin Chambon

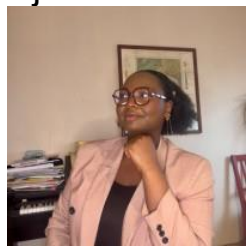
Eloïse Trigodet

Olivier Norvez

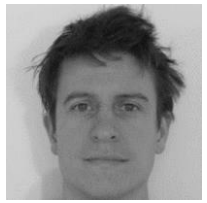
Elie Arnaud

Yassine Ankerl

Najat Amoukou



Simon Bénateau



Benjamin Yguel

Coline Royaux

Marie Jossé

Pauline Seguineau

Triskell Cumunel

Arthur Barreau

2018 2019 2020 2021 2022 2023 2024 2025

Annexes

Présentation martyre / provisoire !

et pourquoi pas vous ?

Navigateurs, scientifiques, citoyens et décideurs tous unis pour l'Océan

EN MER

Collecte, numérisation, transmission

FairScope

We,EXPLORE.

Plankton Planet

A TERRE

Réception, traitement et analyse

EcoTaxa 2.7

DATA TERRA

OneWeb

FDJ UNITED

PlayforPlankton

Présentation martyre / provisoire !

EXPLORE.

PROGRAMME SCIENCES CITOYENNES

Etapes du process & parties prenantes

COLLECTE PLANCTON → NUMERISATION RESULTATS → TRANSMISSION DONNEES → RECEPTION DONNEES → TRAITEMENT DONNEES → ANALYSES DONNEES → DIFFUSION DONNEES

We,EXPLORE.

FairScope

Plankton Planet

esa European Space Agency

CONNECTED BY eutelsat ONEWEB

EcoTaxa 2.7

COMMUNAUTE SCIENTIFIQUE

GAIA Data

OBIS OCEAN BIODIVERSITY INFORMATION SYSTEM

CITOYENS Application

PLAY PLANKTON

FDJ UNITED

SORBONNE UNIVERSITÉ

cnrs

MUSÉUM NAL HIST NATURELLE

SCIENTIFIQUES & GRAND PUBLIC

2025

ROUTE DU RHUM DESTINATION GUADELOUPE

2026

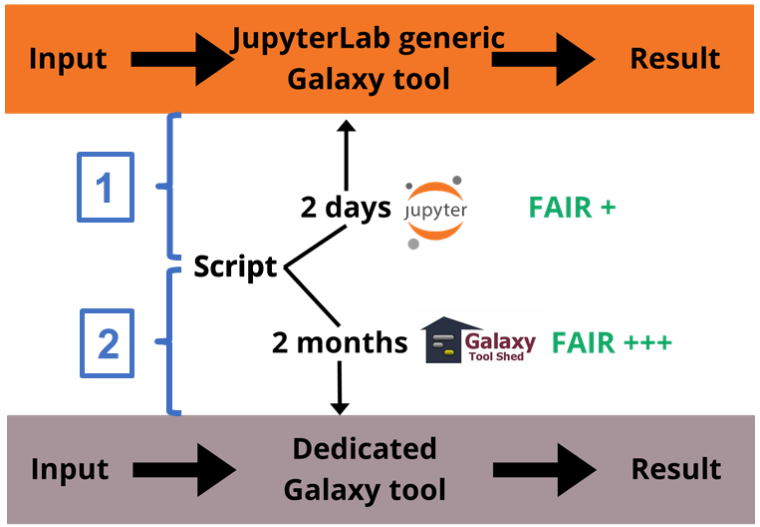
Support numérique

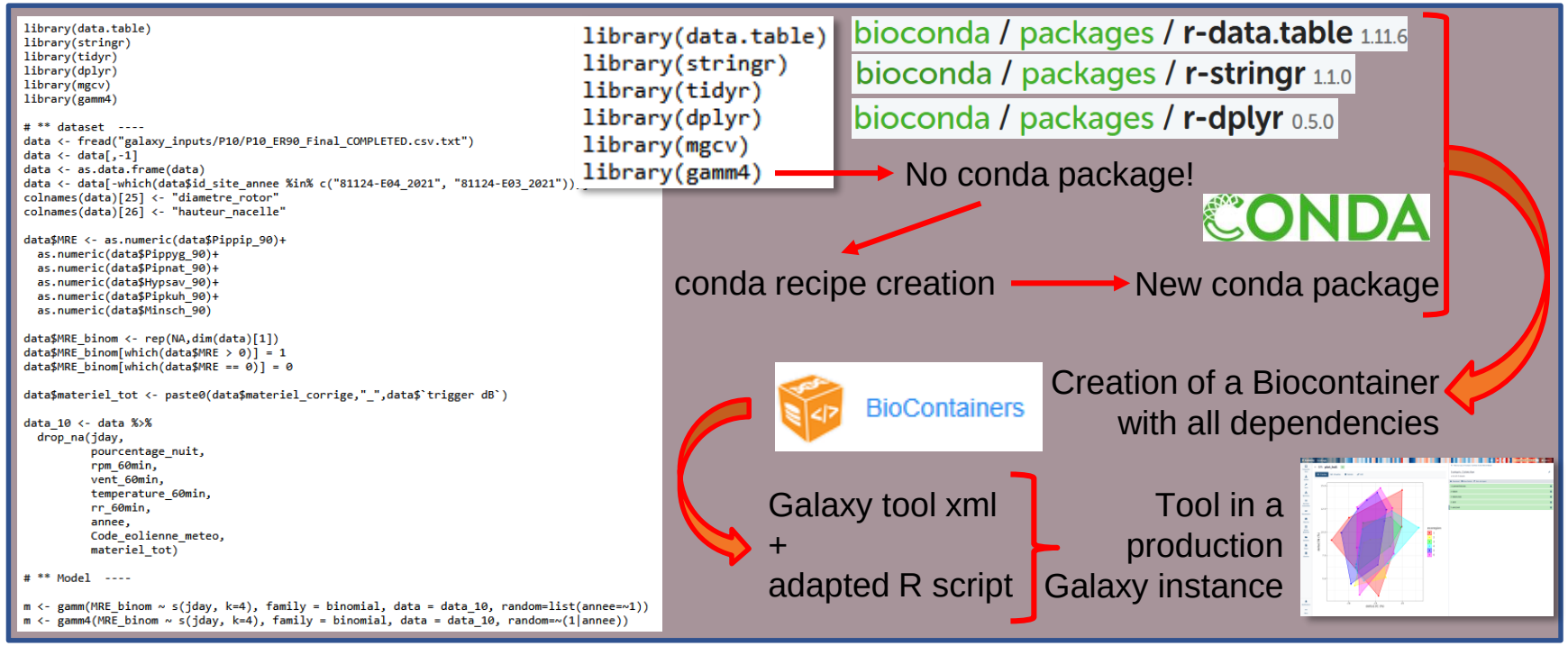
DATA TERRA

Outils et services

Nouvelle méthode pour créer et partager des workflows

Une nouvelle approche à 2 étapes pour proposer des workflows Galaxy à partir de scripts bruts / codes sources





Nouvelle méthode pour créer et partager des workflows

```
library(data.table)
library(stringr)
library(tidyr)
library(dplyr)
library(mgcv)
library(gamm4)

# ** dataset  ----
data <- fread("galaxy_inputs/P10/P10_ER90_Final_COMPLETED.csv.txt")
data <- data[,-1]
data <- as.data.frame(data)
data <- data[-which(data$id_site_annee %in% c("81124-E04_2021", "81124-E03_2021")),]
colnames(data)[25] <- "diametre_rotor"
colnames(data)[26] <- "hauteur_nacelle"

data$MRE <- as.numeric(data$Pippip_90)+
  as.numeric(data$Pippyg_90)+
  as.numeric(data$Pipnat_90)+
  as.numeric(data$Hypsav_90)+
  as.numeric(data$Pipkuh_90)+
  as.numeric(data$Minsch_90)

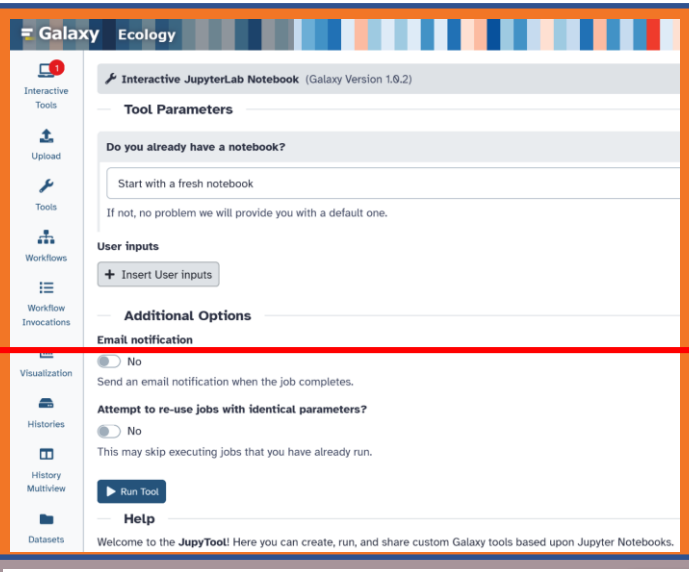
data$MRE_binom <- rep(NA,dim(data)[1])
data$MRE_binom[which(data$MRE > 0)] = 1
data$MRE_binom[which(data$MRE == 0)] = 0

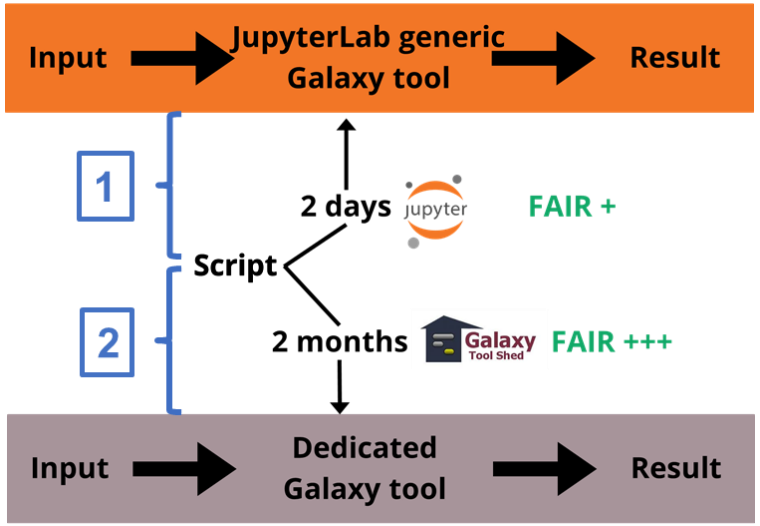
data$materiel_tot <- paste0(data$materiel_corrige,"_",data$`trigger dB`)

data_10 <- data %>%
  drop_na(jday,
          pourcentage_nuit,
          rpm_60min,
          vent_60min,
          temperature_60min,
          rr_60min,
          annee,
          Code_eolienne_meteo,
          materiel_tot)

# ** Model  ----

m <- gamm(MRE_binom ~ s(jday, k=4), family = binomial, data = data_10, random=list(annee=~1))
m <- gamm4(MRE_binom ~ s(jday, k=4), family = binomial, data = data_10, random=~(1|annee))
```



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library(mgcv)
library(gamm4)
```

bioconda / packages / **r-data.table** 1.11.6

bioconda / packages / **r-stringr** 1.1.0

bioconda / packages / **r-dplyr** 0.5.0

No conda package!

CONDA

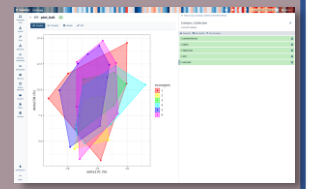
conda recipe creation → New conda package

BioContainers

Creation of a Biocontainer with all dependencies

Galaxy tool xml
+
adapted R script

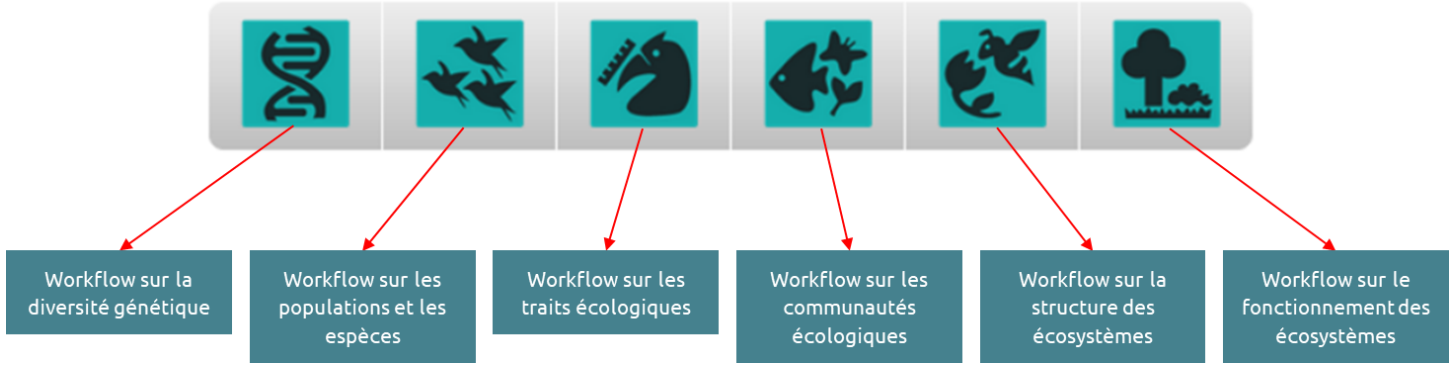
Tool in a production Galaxy instance



Besoins utilisateurs vs outils « analyse / traitement de données »

Opérationnalisation des EBVs

Mise à disposition workflows de production de métriques de biodiversité



https://www.pndb.fr/fr/activites/projets-techniques-et-scientifiques/ebvosc#Workflow%20examples

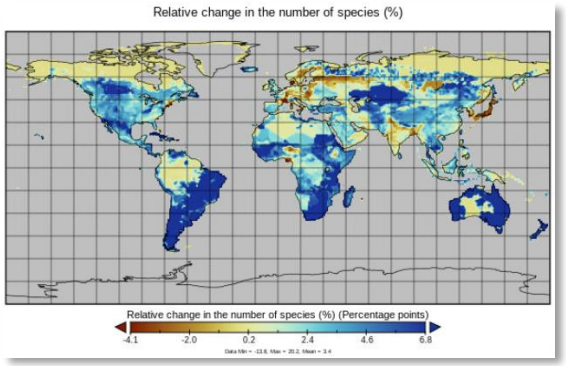
Accès banques de données internationales (occurrence, génétiques, satellites, climat..)

Lien recherche - expertise

Formation

Visualisation de données

Analyse scientifique de données



Ecosystème « Galaxy Ecology »

Galaxy / Ecology

Galaxy Training!

RStudio

jupyter

Besoins utilisateurs vs outils « analyse / traitement de données »

Opérationnalisation des EBVs

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Get species occurrences data from GBIF, OBIS, ALA, iNAT and others

OBIS occurences retrieve data

Argo data access for global ocean in situ observing system

SdmPredictors List Layers from environmental predictors for species distribution modeling

Adds environment variables From Copernicus and etopo given geolocalized and timestamped observations

Retrieve bold Functions to search in Bold and download the available sequences of each subtaxa (get_fasta)

Download and Extract Reads in FASTQ format from NCBI SRA

Sentinel-5P Level 2	Observations from the Sentinel-5 Precursor satellite of the Copernicus Earth Observation Programme. It contains a polar orbiting satellite that completes 14 orbits of the Earth a day.
Coupled Model Intercomparison Project 6	The sixth phase of global coupled ocean-atmosphere general circulation model ensemble
CMIP6 GCMs downscaled using WRF	High-resolution historical and future climate simulations from 1980-2100
GBIF European region public datasets	The Global Biodiversity Information Facility is an international network and data infrastructure aimed at providing anyone, anywhere, open access to data about all types of life on Earth.
NOAA Global Forecast System (GFS)	The Global Forecast System (GFS) is a weather forecast model produced by the National Centers for Environmental Prediction (NCEP).
NOAA Unified Forecast System Subseasonal to Seasonal Prototype 5	The Unified Forecast System Subseasonal to Seasonal prototype 5 (UFS S2Sp5) dataset is reforecast data from the UFS atmosphere-ocean.
Copernicus Digital Elevation Model (DEM)	The Copernicus DEM is a Digital Surface Model (DSM) which represents the surface of the Earth including buildings, infrastructure and vegetation.
ECMWF ERA5 Reanalysis	ERA5 is the fifth generation of ECMWF atmospheric reanalyses of the global climate created with the best available observation data from satellites, in-situ stations and ECMWF's Integrated Forecast System. The dataset provides atmospheric meteorological parameters.
Atmospheric Models from Météo-France	Global and high-resolution regional atmospheric models from Météo-France.

Galaxy / Ecology

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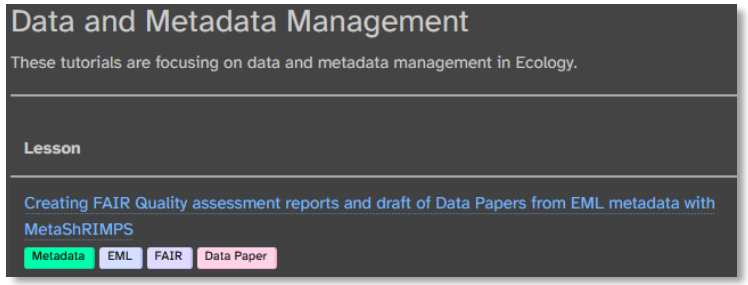

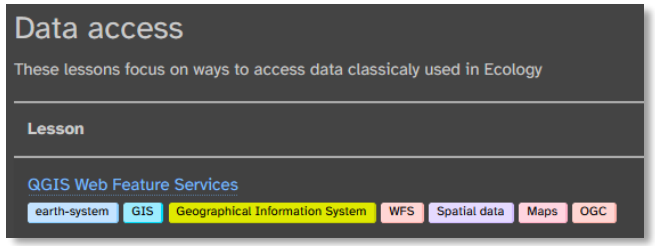

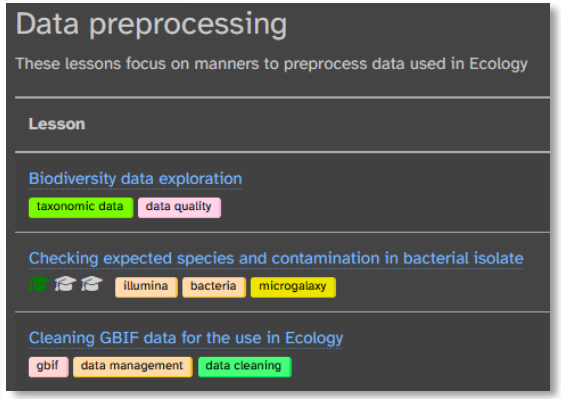

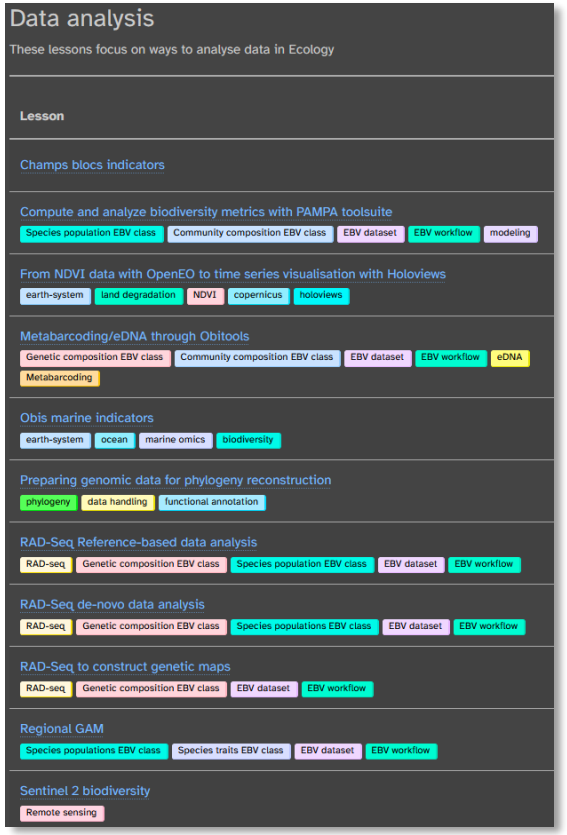

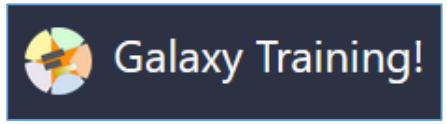

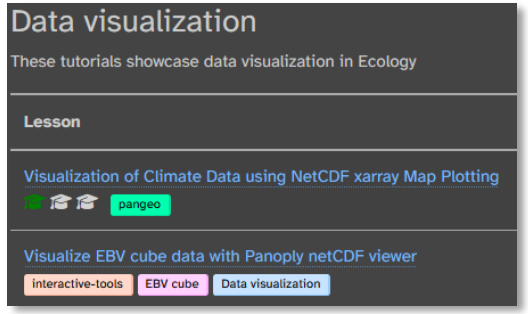

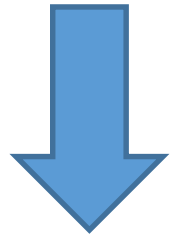

https://training.galaxyproject.org/training-material/topics/ecology/

Besoins utilisateurs vs outils « analyse / traitement de données »

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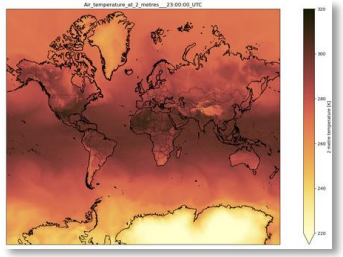
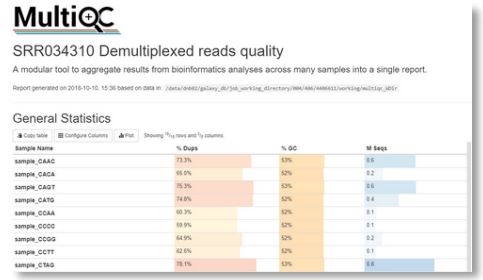
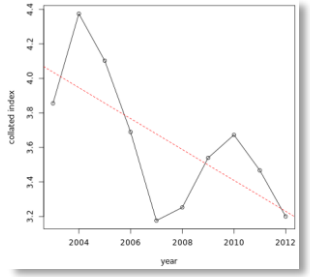
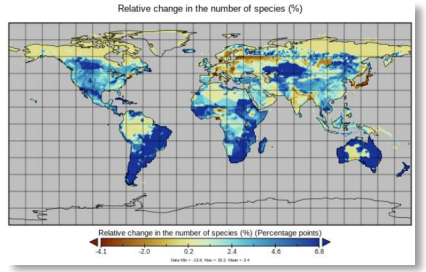
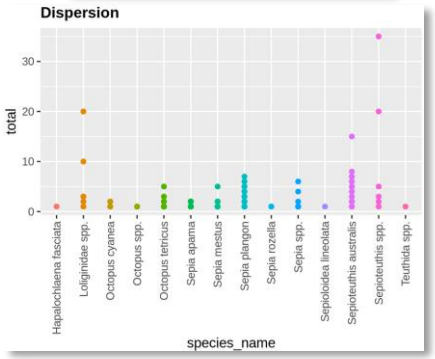
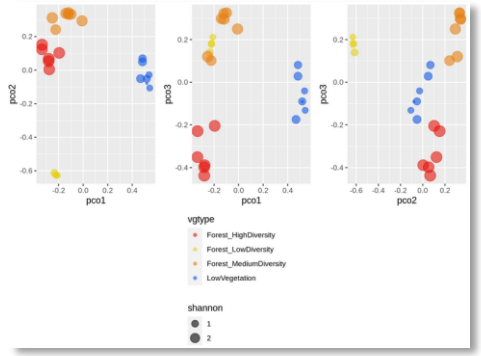


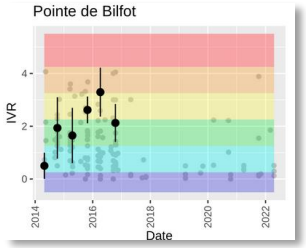


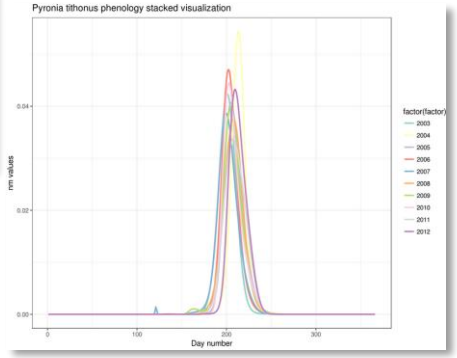


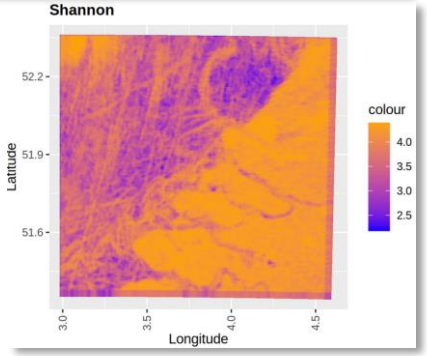






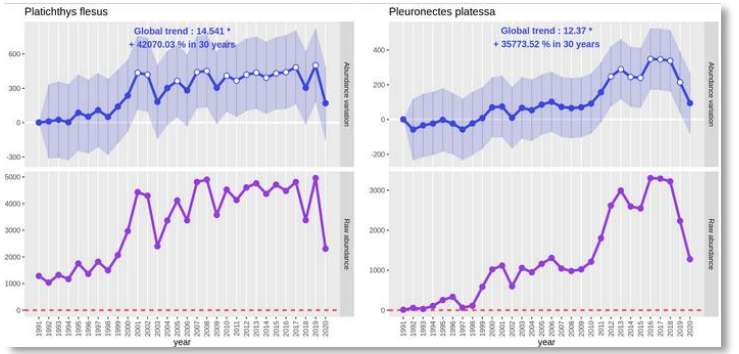


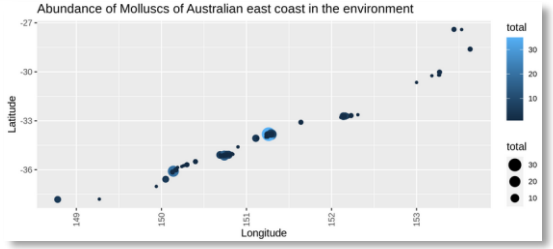




Galaxy / Ecology

Galaxy Training!

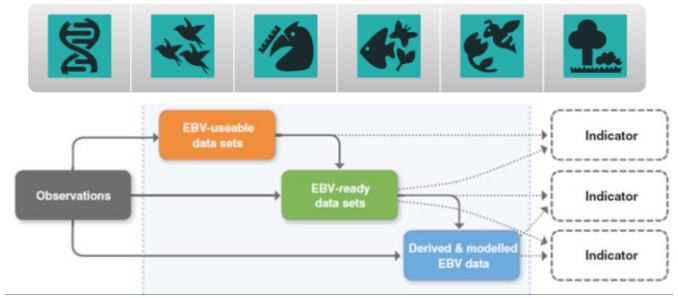




MOTTO

Rely on what already exists and has proven efficiency

Concepts and principles



GO FAIR

Adapt and apply
to help identify gaps and bias

Data

Use and reuse
to exploit full potential

Analytical processes

Atomize and generalize
to get plasticity and reproducibility

Technical solutions & related networks

Galaxy PROJECT

DataONE

Share and contribute
to enhance communication and networks

Global Open Science Cloud | **EBVOSC case study**

Build National BONs → **DigitalBON -> GBiOS**