Terrestrial Biosphere
the WP6 activities

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Terrestrial biosphere – WP6

- Seven Research Infrastructures involved
- Large heterogeneity in aims, scale, readiness, size, competences. A challenge for the integration and HUB
- Four multi-RIs integration activities
  - Nature Based Solution
  - Functional biodiversity and changes
  - Sustainable agriculture and biotechnology
  - Remote sensing calibration and validation

ITINERIS

IBISBA

DISSCO
Distributed System of Scientific Collections

eLTER

ICOS
INTEGRATED CARBON OBSERVATION SYSTEM

AnaEE
Analysis and Experimentation on Ecosystems

LifeWatch ERIC

EMPHASIS

Terrestrial biosphere – WP6

Three presentations

- Sentinel plants with sensors for environmental stresses

  Emanuela Pedrazzini (CNR-IBBA) - IBISBA

- From physical to FAIR digital specimens: methods and perspectives of the RI DiSSCo in the ITINERIS project

  Simona Armeli Minicante (CNR-ISMAR) - DiSSCo

- The Castelporziano observatory cluster: an example of cross-RIs collaboration

  Gabriele Guidolotti (CNR-IRET) – ICOS, eLTER

Sentinel plants with sensors for environmental stresses

Emanuela Pedrazzini

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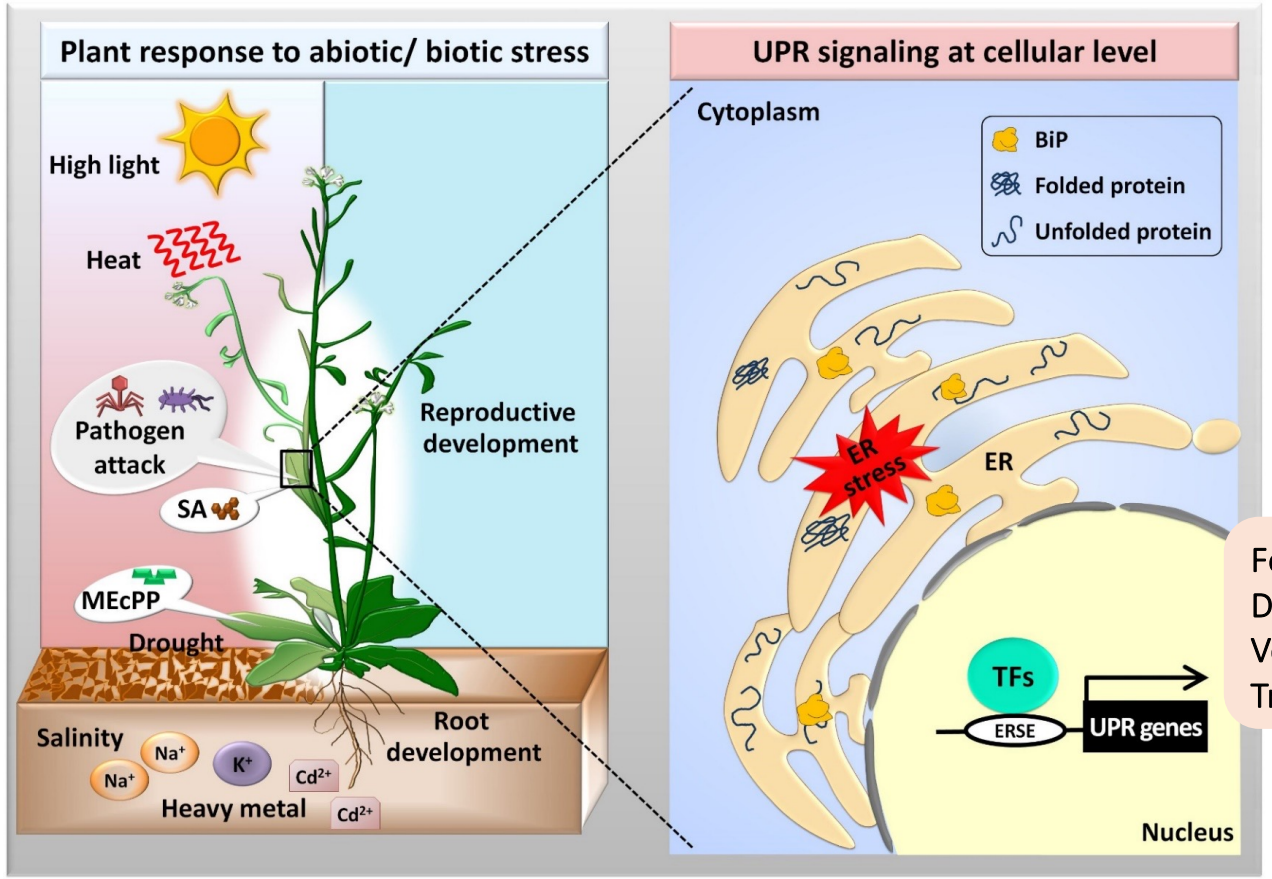
Sentinel plants with biosensors that quickly respond to environmental stresses

Biotic and abiotic stresses alter cell proteostasis



Nawkar GM et al, Front. Plant Sci. 2018

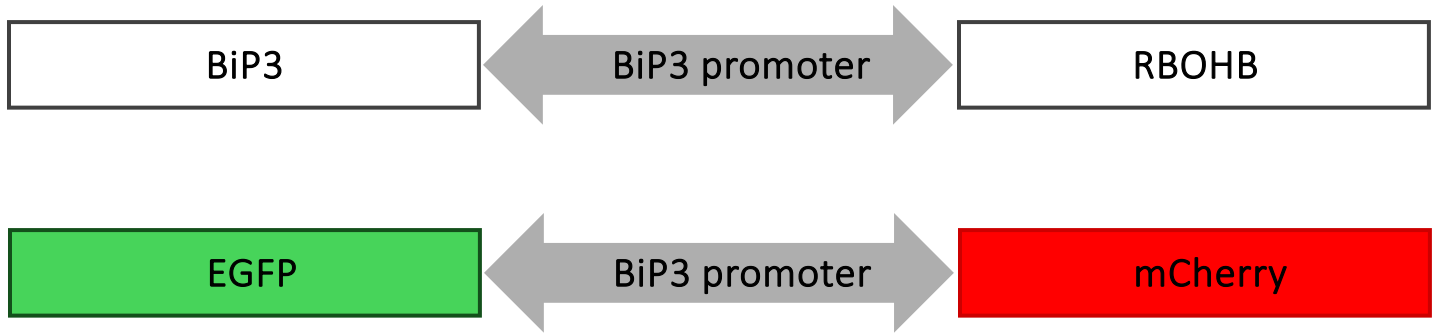
Biotic and abiotic stresses alter the cell proteostasis by excessive accumulation of unfolded proteins (mainly in the endoplasmic reticulum - ER) or by imbalance in the supply of energy or amino acids.

Folding ↑	**Chaperones**
Degradation ↑	**Enzymes**
Vesicular traffic ↑	**Lectins**
Translation ↓	

These events trigger the Unfolded Protein Response (UPR), a signaling pathway that maintains ER homeostasis mainly by increasing the synthesis of folding helpers, attenuating protein synthesis and degrading misfolded polypeptides.

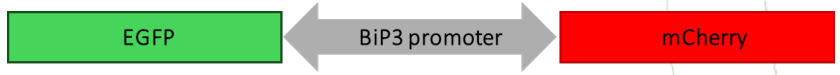
Looking for stress biosensors: BiP, the HSP70 of the endoplasmic reticulum

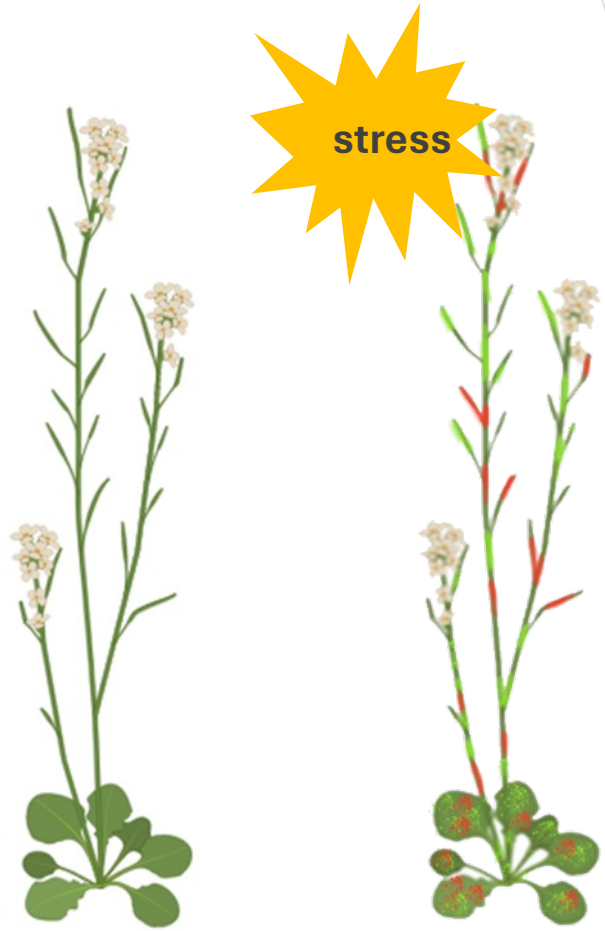
- The major UPR sensor is the binding protein (BiP), a major ER chaperone of HSP70 class.
  By competitively interacting with unfolded polypeptides or with signal transducers, BiP regulates the UPR signalling cascade.
- Plants have several BiP isoforms, most of which are constitutively expressed and take care folding of all proteins of the secretory pathway.
- However, BiP isoforms whose expression is exclusively induced under stress conditions exist.
- In the model plant *Arabidopsis thaliana* the isoform BiP3 is induced by several biotic and abiotic stresses.
- The BiP3 promoter has dual activity, governing both BiP3 and RBOHB (a Respiratory Burst Oxidase induced by oxidative stress) genes.



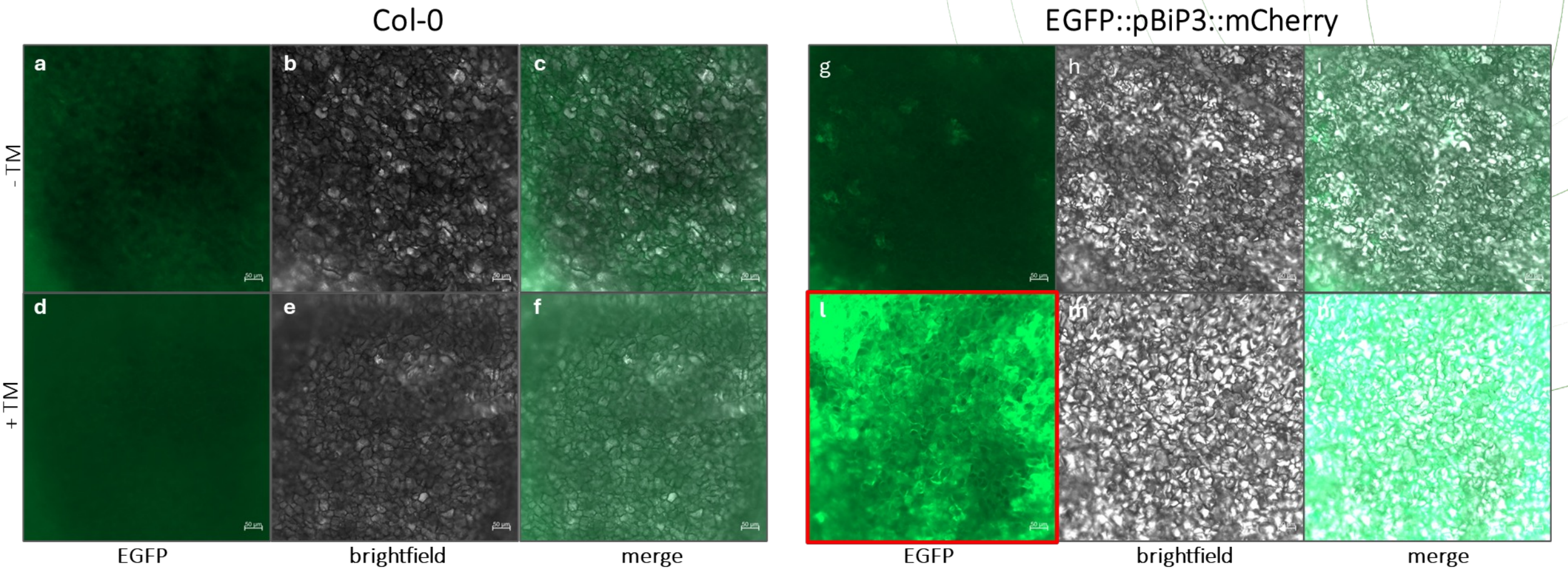
monitor different types of stress via the same promoter

Arabidopsis thaliana plants expressing the stress biosensor EGFP::pBiP3::mCherry





The pBiP3 promoter guides the EGFP expression under stress condition



Leaves from *A. thaliana* Col-0 (left images) or EGFP::pBiP3::mCherry (right images) plants are incubated in the absence (-TM) or presence (+TM) of the stressor tunicamycin (TM). EGFP expression is observed by epifluorescence microscopy, and it is directly related to BiP3 promoter activity under TM stress.
(a, d, g, l): EGFP signal; (b, e, h, m): brightfield; (c, f, i, m): merge

Data sharing in ITINERIS hub

Genetic Constructs and Sequence Data:

- **Format:** DNA sequence files (FASTA), plasmid maps (GenBank or similar).
- **Description:** Sequences of promoters, genes or genetic constructs that can function as biosensors. This includes the coding sequence of the protein or peptide of interest, promoters, terminators, and any other regulatory elements

Plant Transformation and Transgene Integration Data:

- **Format:** PCR results (CSV), sequencing data (e.g., Sanger sequencing traces, FASTA).
- **Description:** Data confirming successful transformation of plant hosts with the genetic constructs. This includes PCR validation of transgene integration sites and sequences, ensuring the presence and integrity of the recombinant DNA in the plant genome.

Cell Biology/Expression Analysis Data:

- Format: Optical or Florescence microscopy images (TIFF); SDS-PAGE and Protein blot images (TIFF); gel band densitometry (CSV); signal quantification (CSV)
- Description: Data from plant cell biology experiments assessing the biosensor activation under stress conditions. Quantitative and qualitative data on the biosensor expression levels in physiological or stressed conditions. This includes biosensor expression levels (western blot, fluorescence microscopy), signal quantification (fluorescence microscopy, TECAN)

From physical to FAIR digital specimens: methods and perspectives of the RI DiSSCo in the ITINERIS project

Simona Armeli Minicante

Istituto di Scienze Marine (CNR-ISMAR)

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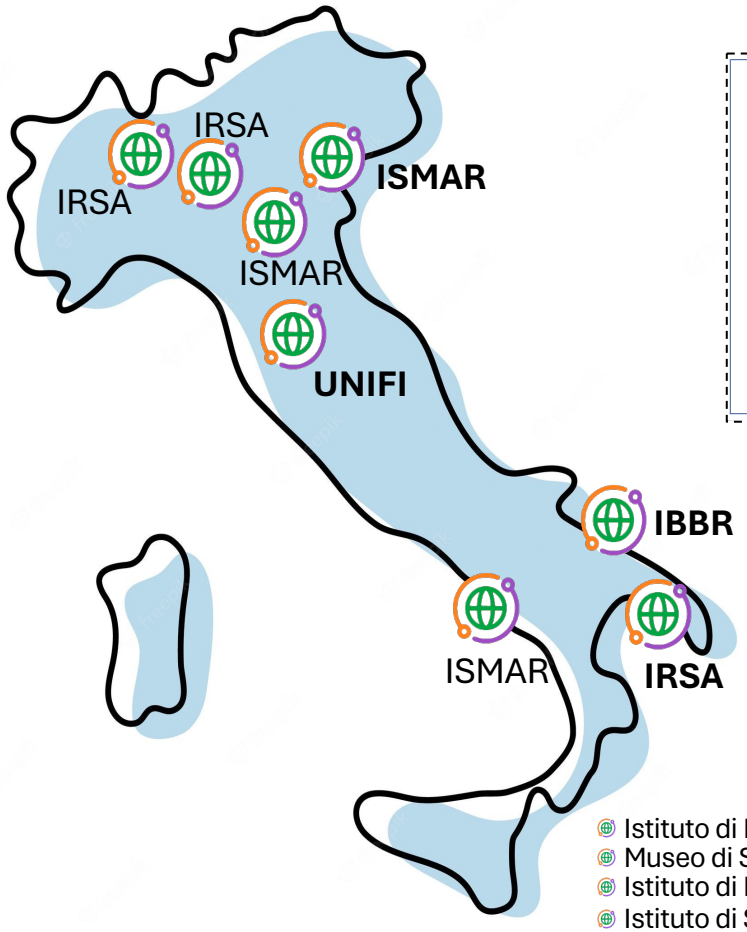
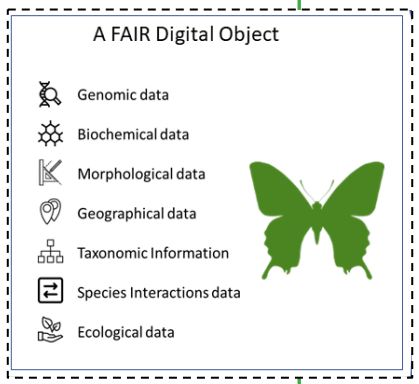
The OUs involved in ITINERIS

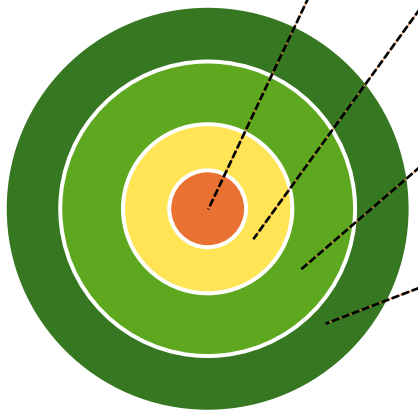
The Distributed System of Scientific Collections (DiSSCo) is a new world-class RI for Natural Science Collections



- Istituto di Bioscienze e BioRisorse (CNR-IBBR)
- Museo di Storia Naturale (UNIFI-SMA)
- Istituto di Ricerca sulle Acque (CNR-IRSA)
- Istituto di Scienze Marine (CNR-ISMAR)



Quality indicators:
***Minimum Informations about a Digital Specimens* (MIDS)**



Level 0 (Bare record): the association between an identifier of a physical specimen and its initial digital representation (PhysicalSpecimenID)

Level 1 (Basic record): a limited set of information about the specimen; for example, physical specimen identifier and barcode details, and details of the collection it belongs to

Level 2 (Regular record): a set of information describing the specimen; for example, physical specimen identifier, barcode details, taxon name collection date and place, collector, etc.

Level 3 (Extended record): a comprehensive set of elements describing the specimen; for example: all label data, annotations and determination history

Goal To Reach

https://github.com/tdwg/mids/blob/working-draft/current-draft%20/MIDS-definition-v0.17-13Jul2023.md

Findable Accessible Interoperable Reusable

Activity 6.4 Italian Natural History Collections (NHCs)

UNIFI-SMA

Targets

- Digitisation from scratch or from existing DBs and their publication on GBIF.
- Focus on Italian flora and fauna, terrestrial and aquatic, with attention to species involved in climate change investigations.

Methods

- Census and selection of collections.
- Definition of procedural standards > direct intervention by ITINERIS staff + collaboration with curators from other museums (training course, loan to use).
- Various equipment (especially simple photographic workstations).

Present results and perspectives

- By May 2023, approx. 150,000 samples already digitised between vertebrates, invertebrates and cryptogams.
- From autumn 2024, publication of datasets on GBIF.
- Temporarily, local data-storage.

Activity 6.5 Mining and mapping the functional biodiversity in «in vivo» and «ex situ» research collections

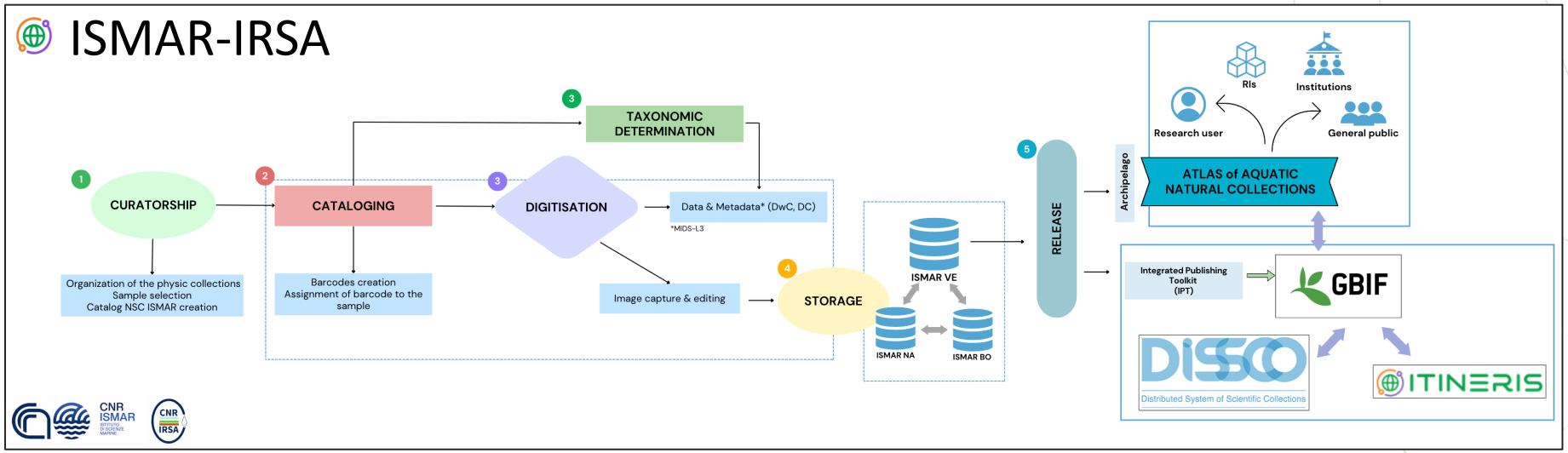
CNR-IBBR

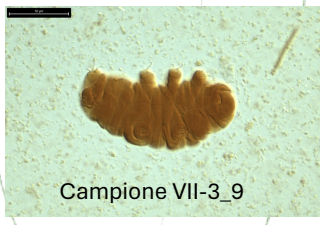
- Some **56 collections of living organisms** (plants, invertebrates, fungi, bacteria, viruses) are maintained and studied at 27 institutes of CNR-DiSBA.
- More than **50,000 records** digitized so far, following the DarwinCore standards and vocabularies, including links to images, DNA sequences, references, etc.
- Datasets will be freely available through the **DiSSCo-IT portal** hosted by the Global Biodiversity Information Facility (GBIF – https://www.gbif.org) under CC-BY-NC 4.0.

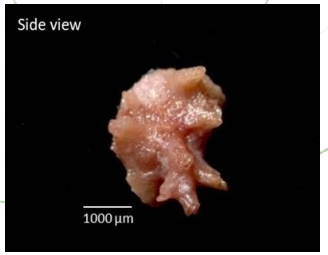
CNR-IBBR on GRSciColl: https://scientific-collections.gbif.org/institution/a2561001-476a-4aa3-a741-a68d4feaf094/collections

Activity 6.6 National network of the aquatic scientific collections

ISMAR-IRSA







Preliminary results

- Start of metadating and digitisation of **9 Marine Natural Collections** and **3 Freshwater Natural Collections** (zoological, botanical, and paleontological fields), following the DarwinCore and DublinCore standards.
- Definition of **Guidelines for metadata management** of the aquatic natural collections.
- ISMAR and IRSA are endorsed by GBIF as **publisher institutions** (3/10 dataset published).
- Partecipation in the “Training course on the digitalization of naturalistic heritage” (by UNIFI-SMA).

More details

POSTER SECTION

- The activities for the national network of aquatic science collections (WP6 – Terrestrial Biosphere, ITINERIS project)
- The herbaria of the CNR Thalassographic Institute of Taranto "A. Cerruti": digitization and sharing activities within the DiSSCo project (PNRR-ITINERIS)
- Foraminifera Natural Science Collection: a multiyear repository of biodiversity data from the Northern Adriatic Sea
- Marine invertebrate collections: the contribution of CNR-ISMAR Venice to the progress of DiSSCo Italia

Perspectives

Deliverables

BM12 >>> ***D6.4 (IBBR)*** *Shared protocols and best practices for acquisition, organization, standardization and long-term maintenance of (meta)data related to NSC; set-up of the centralized IT platform including a bioinformatic toolbox with web-GIS and modeling facilities*

BM13 >>> ***D6.14 (ISMAR-IRSA)*** *Climate-related prioritization of the aquatic NSC and taxa/specimens selection for the "extended digital specimen" descriptors. Digitization of selected NSC and return of the digital dataset and metadata. Networking of digitized (meta)data*

BM14 >>> ***D6.19 (UNIFI)*** *Climate-related prioritization for the museum's natural history collections (NHCs) and taxa/specimens selection for the "extended digital specimen" descriptors. Digitization of selected NHCs and return of the digital dataset and metadata. Networking of digitized (meta)data*

Joint data paper

- Creation of «**DiSSCo-IT Portal**», hosted on the GBIF platform and containing the datasets released with ITINERIS project
- Link and integration with other **RIs** (cross Ris inititives) and **National Biodiversity Future Centre** (NBFC) platforms
- Agreement for the creation of a **National Network of Natural Science Collections** and the establishment of an **Italian Joint Research Unit** (JRU)

The Castelporziano observatory cluster: an example of cross-RIs collaboration

Gabriele Guidolotti

Istituto di Ricerca sugli Ecosistemi Terrestri (CNR-IRET)

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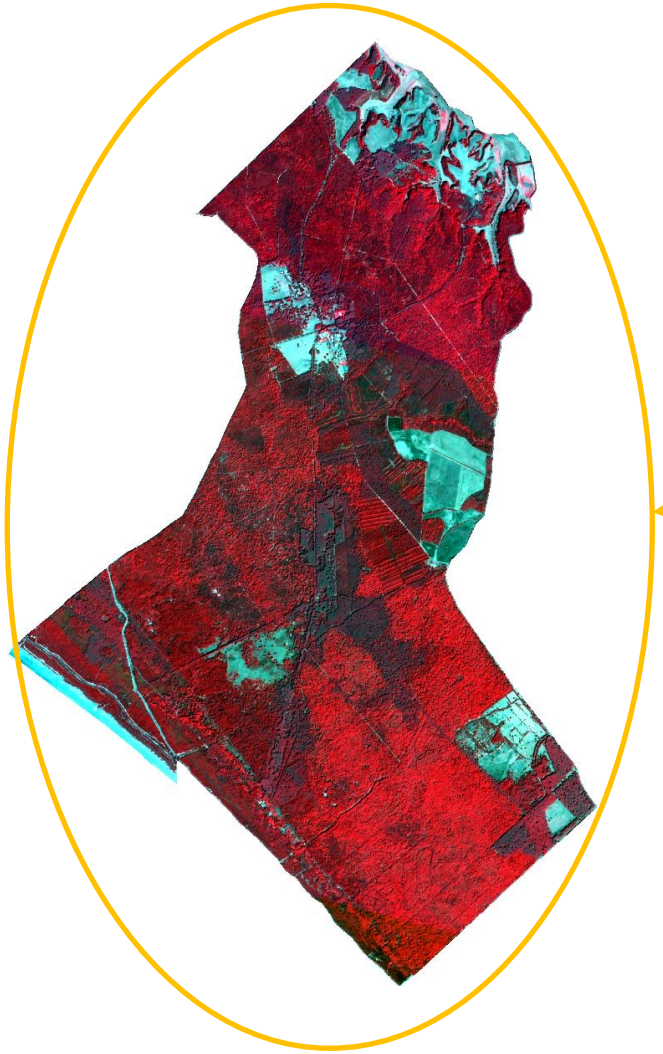
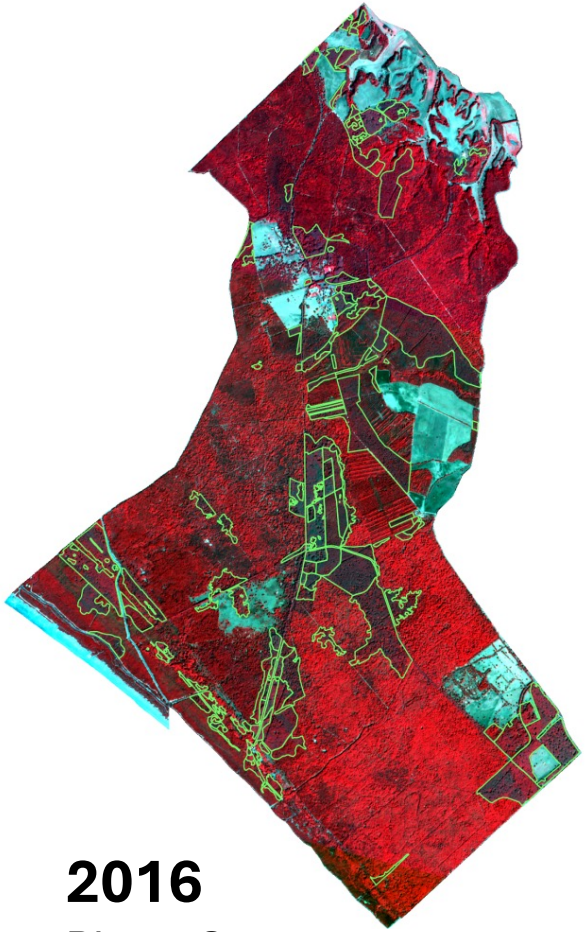
Presidential Estate of Castelporziano



- Covered area about 6100 ha
- Typical Mediterranean ecosystems (relicts lowland forest with hygrophilous vegetation, mixed deciduous and evergreen oak forests, Mediterranean scrubs, dune vegetation and pine forests)

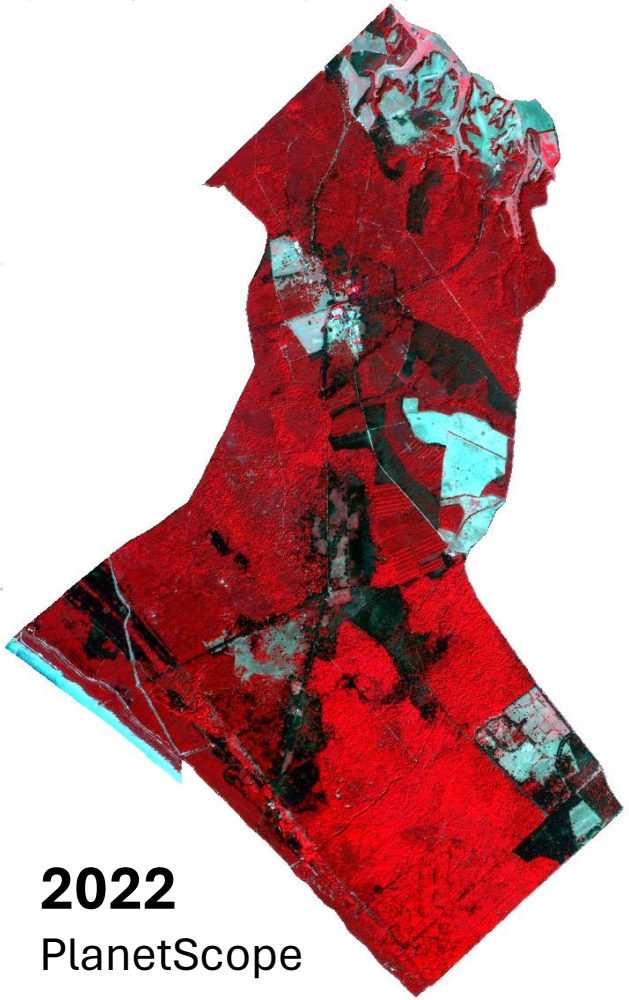
Stone pine forests in Castelporziano



2016
PlanetScope

Pine (*Pinus pinea* L.) dieback

Combined action of the alien parasite Toumeyella parvicornis (Cockerell, 1897) and Tomicus destruens (Wood & Bright, 1992)



2022
PlanetScope

Figures thanks to Chiara Zabeo and Anna Barbati

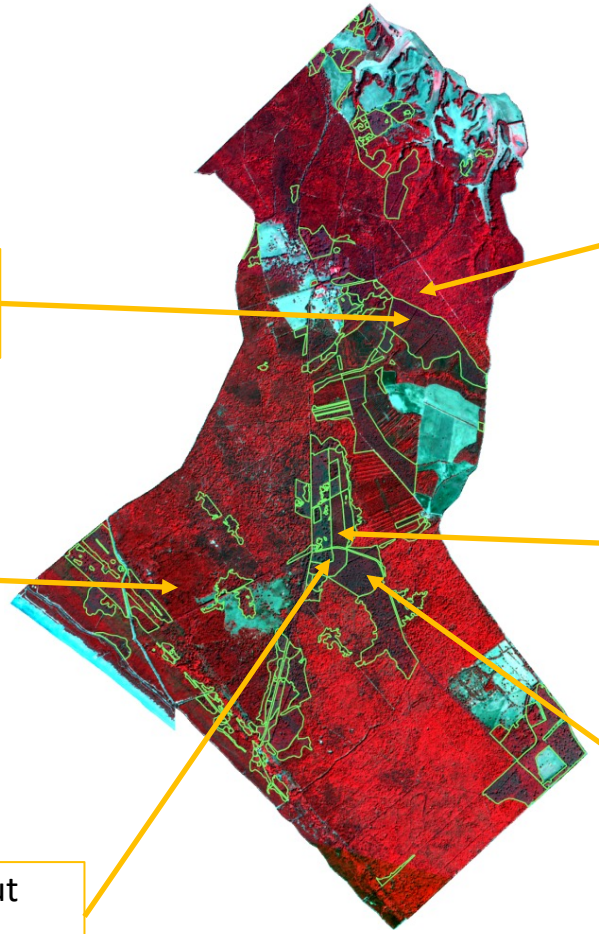
Replacement of pines

- A large-scale natural disaster in a reserve
- Over 200 hectares of pine dead, cut and removed as wood chips
- A reforestation plan with mixed deciduous species and clusters of Mediterranean scrub
- **A potential large-scale experiment to analyze ecosystem restoration and rewilding options**

Different ecosystems and restoration strategies

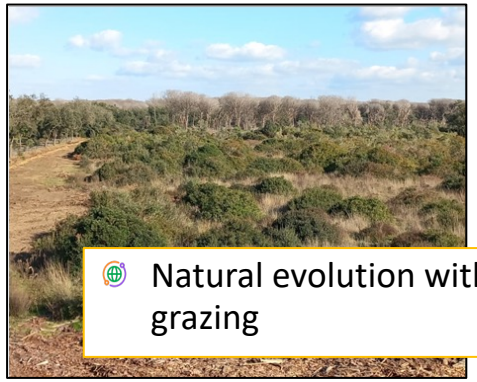
ICOS Station Evergreen oak forest

Quercus ilex reforestation under stone pine (20 year old)



Deciduous mixed oak forest

Reforestation and biodiversity islands protected by grazing

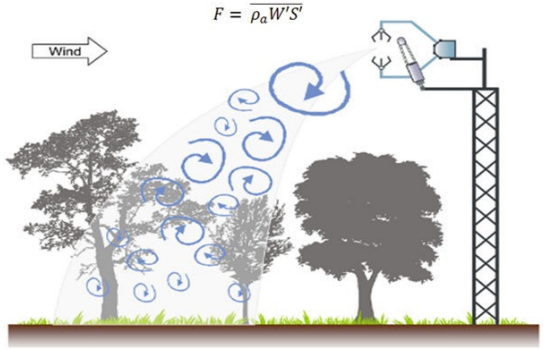


Natural evolution without grazing

Dead pine forest with cutting expected in winter

Monitoring carbon balance, water and energy

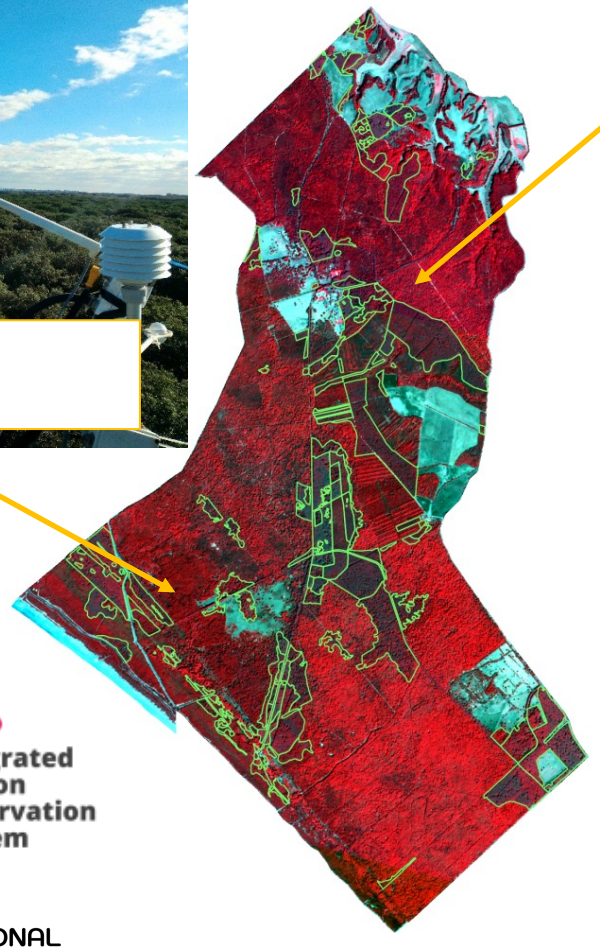
Eddy Covariance Sites
CO_2 H_2O Energy Fluxes

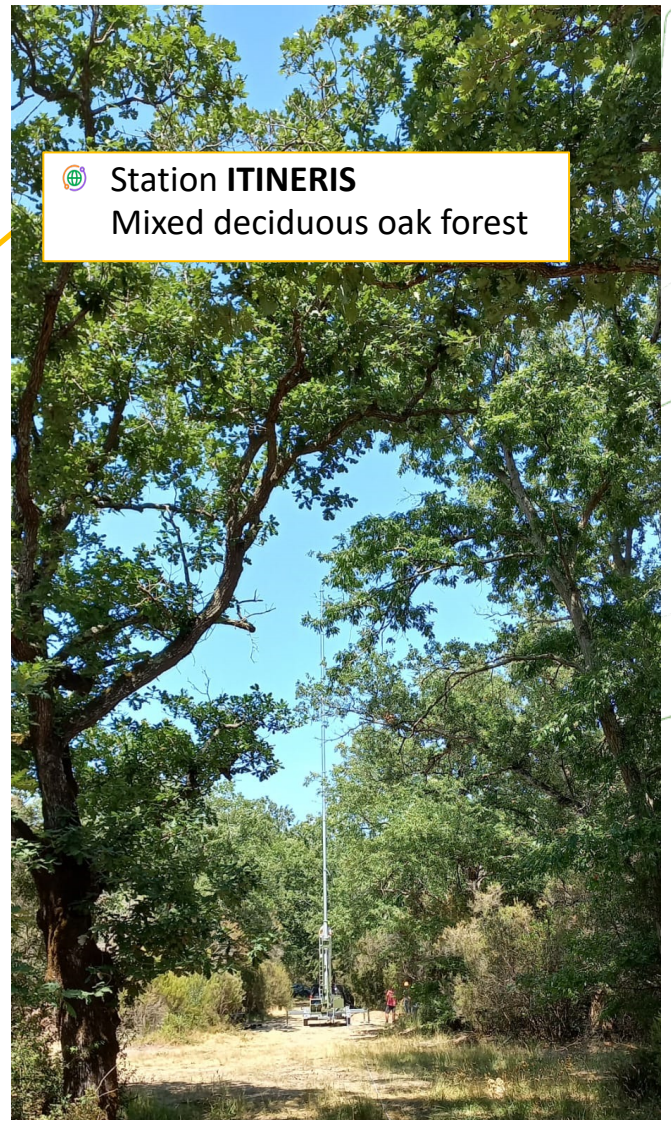


(Modified from Wolf 2010)

- ICOS Monitoring Site- **Operational**
- Mixed deciduous Oak Forest Site- **Ready**
- Rewilding and Reforestation sites – **Ready by summer**

Station **ICOS Class 1**
evergreen oak forest





Station **ITINERIS**
Mixed deciduous oak forest

ICOS Integrated Carbon Observation System

eLTER

NATIONAL BIODIVERSITY FUTURE CENTER

Large-scale experiment on ecosystem restoration and rewilding

- Opportunity for the creation of a **long-term ecosystem monitoring system and cluster** (six stations and plots)
- Monitoring of **greenhouse gas exchanges** and meteo
- **Possibility for other RIs**
  - Study of the functionality of different oak genotypes
  - Biodiversity monitoring
- **Full openness** to the participation of other researchers, institutions and IRs

Data sharing and ITINERIS HUB

- All the data collected will be clearly shared through the ITINERIS HUB
- Fluxes and meteorological data through the ICOS Carbon Portal or ICOS Italian HUB
- Vegetation and soil analysis will be also performed and shared through the same hub and system
- Participation to others open, infrastructure available, but **sharing required**…

WP6 status and future

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The WP6 status and future

- Common data solutions found in WP6 would probably be applicable to all the other domains due to the large diversity
- The link with the VRE (WP8) is still not strong enough but has large potentials
- Data collection is ongoing and it is the first and unique priority at the moment. Strong interaction with the HUB is expected
- There are delays in some OUs and some RIs, a detailed action plan will be prepared and presented to the EB

THANKS!

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