Bigelow | Laboratory for Ocean Sciences

Implementation of a Scientific Specimen Management Plan

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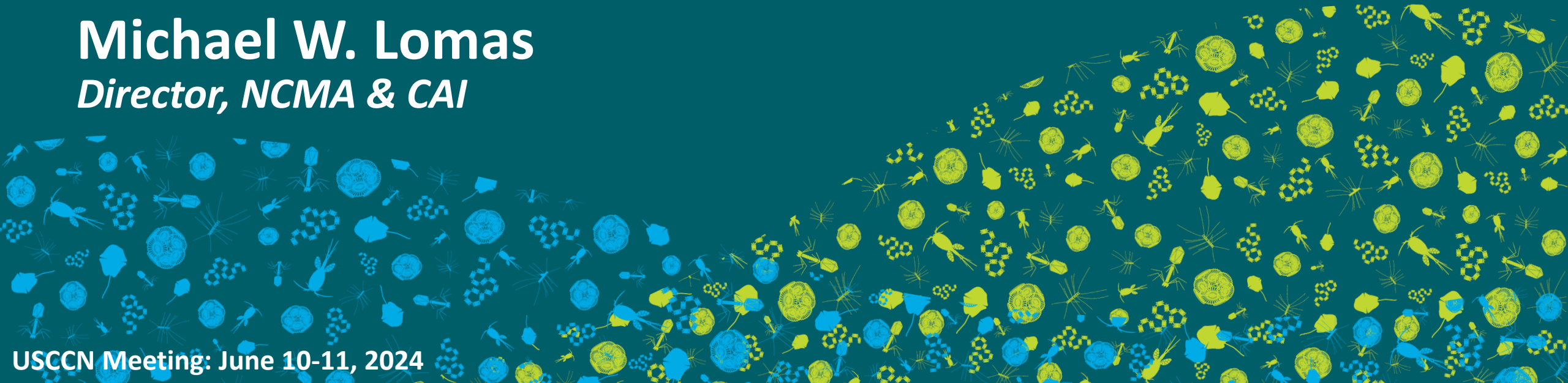
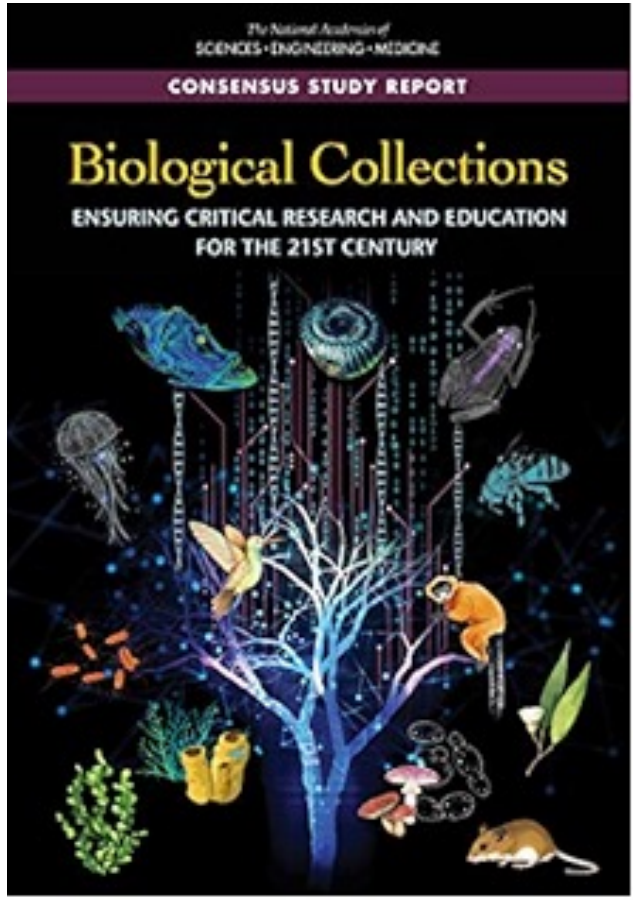


USCCN Meeting: June 10-11, 2024

Problem Statement:

1) Who (individual researchers, repositories, federal agencies) maintains biological specimens (living or preserved), collected under federal grants, and ensures that they are curated, managed and distributed as needed?

2) How is the curation, maintenance and distribution process implemented and funded (assuming its not under a federal agency)?



Origins (Current Discussion):

1) National Academies of Sciences, Engineering, and Medicine (NASEM) Report on Biological Collections: “funding agencies should require a specimen management plan for all research proposals that include collecting or generating specimens. SMP should describe how the specimens and associated data will be accessioned into and permanently maintained in an established biological collection, *and how it will be made available*”.

2) This same recommendation amplified as a fundamental research priority in the now enacted CHIPS and Science Act (P.L. 117-167) that includes a robust reauthorization for the National Science Foundation (NSF).

Origins (further back in time):

WOODS HOLE OCEANOGRAPHIC INSTITUTION

WOODS HOLE, MASSACHUSETTS 02543

Phone (617) 548-1400
TWX 710-346-6601

January 29, 1979

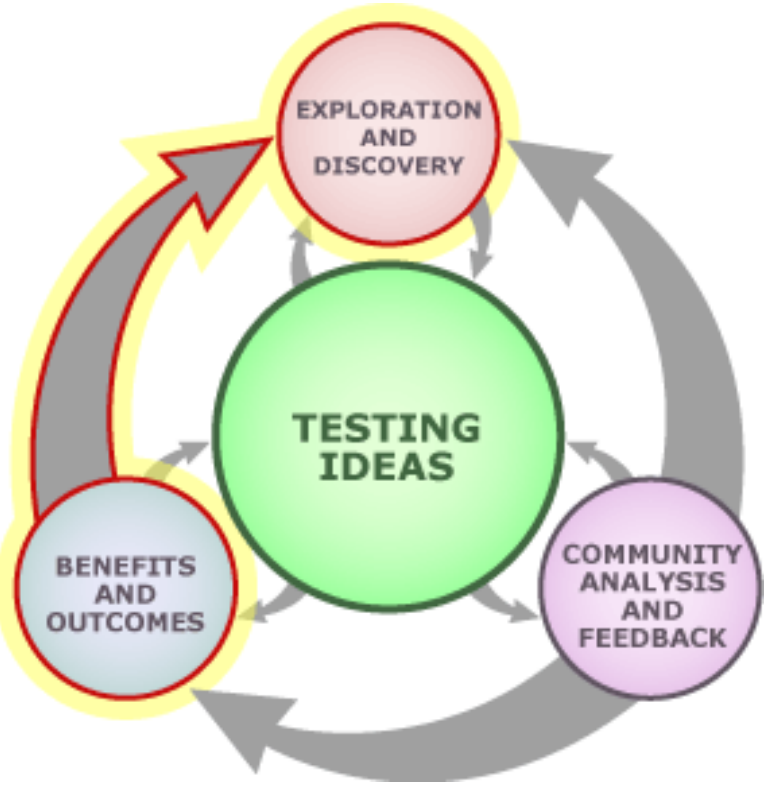
Users of Phytoplankton Cultures
World-wide

Dear Colleagues:

Reduced support for research makes it impossible for me to continue supplying phytoplankton cultures to other workers, at least in the numbers requested lately - over 300 cultures per year. Salary support for Mrs. H. I. Stanley, who has cared for the cultures for over 15 years, is no longer available. In order that I may continue to supply cultures where they are critically needed I suggest the following:

High Level Benefits:

- Incentivize researchers to deposit biological specimens and associated data.
- Proactive plan for the curation and digitization of the specimens reduces risk of their being cut from the budget.
- Provide support funds to collections improving budget planning processes.
- Prevent the loss of specimens when a researcher moves, retires, or passes away, **and/or** the institution/funding agency doesn't have interest in maintaining.
- Critical link in the process that enables the implementation of the Extended Specimen concept.



UC-Berkeley:
Understanding Science 101

System Challenges (1): What to do and How?

1) Cursory mention of specimen curation in the required DMP associated with NSF Biological Sciences proposals (https://www.nsf.gov/bio/pubs/BIODMP_Guidance.pdf).

2) As physical objects that differ widely in size, shape and method of preservation, they have very diverse requirements and prerequisites, especially with respect to infrastructure needs.


Smithsonian Institution

California Academy of Sciences


National Center for Marine Algae

System Challenges (2): Stakeholder Needs?

Long term maintenance requires curatorial expertise and knowledge, but also requires knowledge on how to handle the distribution side of the equation.

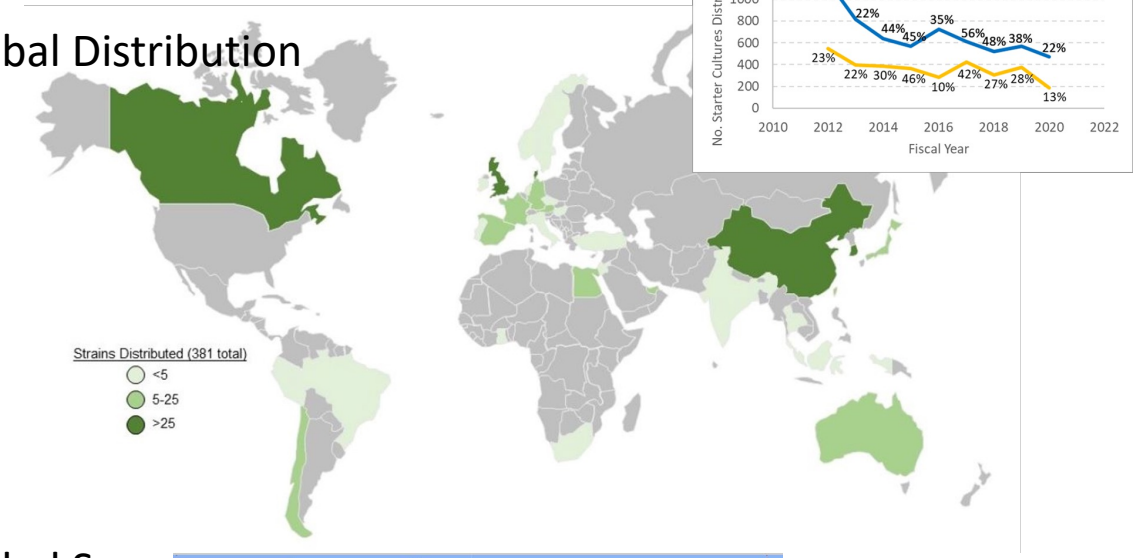
Stakeholder Group	Interaction
Academics	Answer growth questions, help in strain choice, discuss new product options, discuss science advances
Fee-for-service clients	Procedures, legal obligations, future-planning, cost models
Companies (Consultancy)	Answer growth questions, help in strain choice (based upon our knowledge), development of a phenotypic trait database that would be behind a paywall for companies?
Companies (licensing, sponsored projects)	R&D scope/scale, cost models, legal obligations, partnership development, new products, co-developed products/tools

System Challenges (3): Treaties and Regulations?

Nagoya Protocol on Access and Benefit Sharing: fair and equitable sharing of benefits arising out of the utilization of genetic resources, thereby contributing to the conservation and sustainable use of biodiversity *held by repositories*.

Which genetic resources are ‘grandfathered’ and which resources are from Areas Beyond National Jurisdiction and which countries have/not ratified Nagoya.

Global Distribution



Global Source

Data from NCMA: 2022

System Challenges (4): Treaties and Regulations?

An example specific to macroalgae germplasm repositories now (but terrestrial germplasms in the 1970's).

- Regulatory permit processes continue to be a major hurdle
- State regulations on macroalgae 'imports' yet climate change is moving distributions of natural populations.

NOAA fisheries

System Challenges (5): Intellectual Property Valuation?

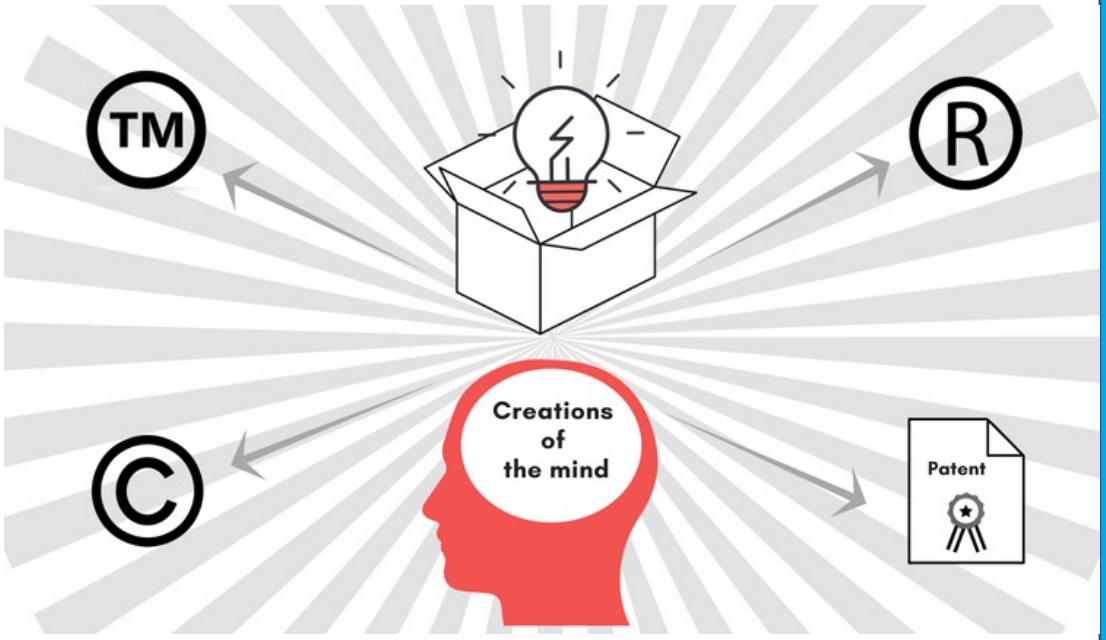
(as part of equitable sharing of benefits)

Academic – Corporate:

- Contract Research – the company owns the IP
- Sponsored Research – likely to be joint ownership, value of **in-kind** contributions

Academic – Academic:

- Commonly divided by value of **in-kind** contributions.



Elements of the SMP:

- Specimens [provided by PI]:
  - a) type and anticipated number;
  - b) how prepared;
  - c) minimum metadata;
  - d) other associated data that would be deposited;
  - e) copy of collection permits (if needed).
- Best practice guidelines for depositing specimens and data standards[provided by PI].
- Funding to curate, digitize, and care for the material once formally accessioned [provided by repository], and
- Distribution plan for specimens and associated data, in accord with all relevant collecting, import and export permitting agreements [provided by repository]

Implementation: Metadata standards

Metadata is the **who, what, when, where, why**, and how it relates to their research. It to data identification, classification and aggregation across different data platforms.

Agreement is important because:

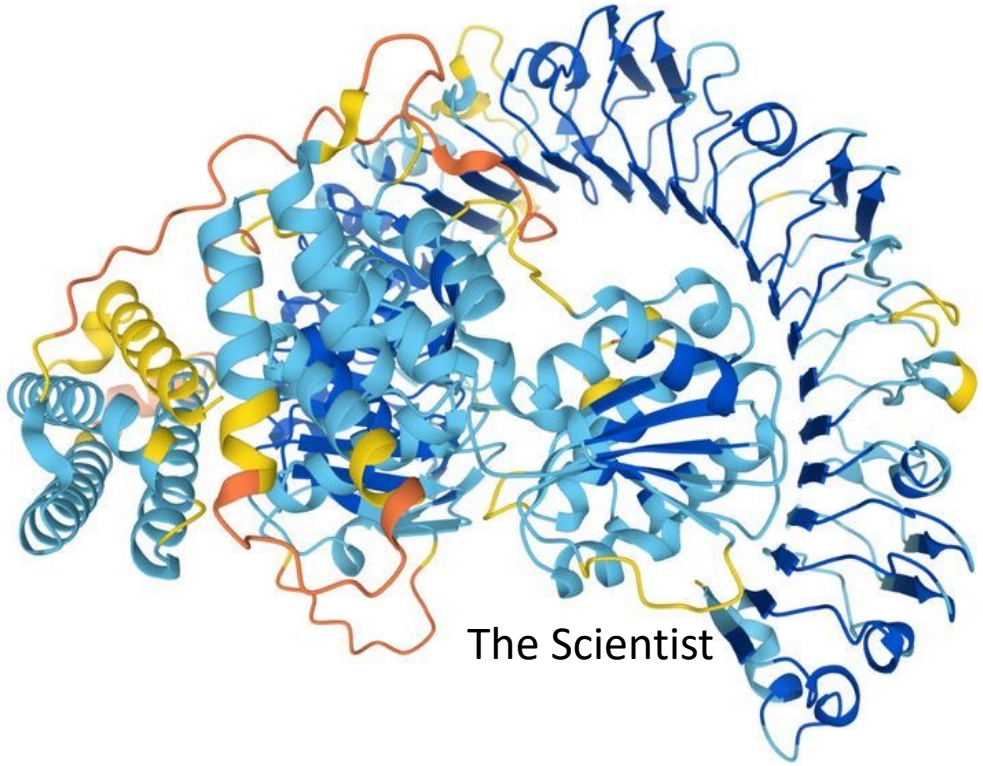
- Taxonomic names can/do change
- Many specimens may have multiple IDs (*Nannochloropsis oculate:* Millport66, CCAP849/1, UTEX2164, SMBA 66, NIVA-3/04, CCMP525)
- Specimen/data repositories don't share the same database ontologies

Repositories should provide a metadata form BEFORE a project starts to help the downstream process

Implementation: Biological Data - don’t let your data get dark

Different Protein Databases

DB name	DB website	DB type
ENA	European Nucleotide Archive	Sequence databases
GenBank	GenBank nucleotide sequence database	Sequence databases
Refseq	NCBI Reference Sequence Database	Sequence databases
UniGene	Database of computationally identifies transcripts from the same locus	Sequence databases

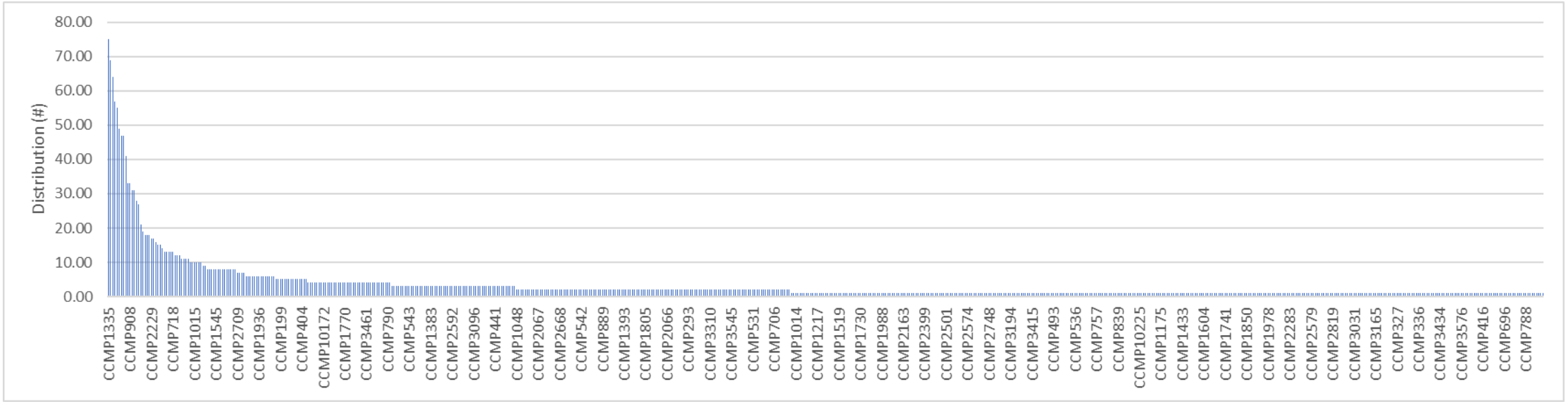


Need effective ‘correction/editing’ measures/processes

Implementation: How to Model Costs?

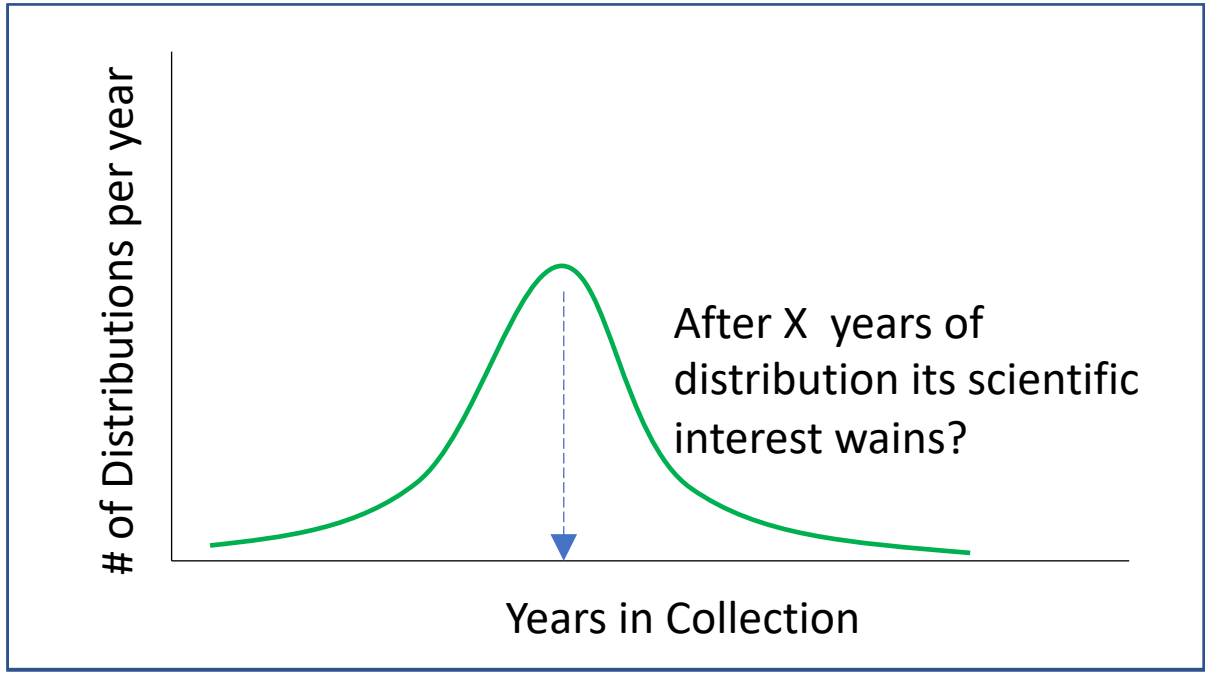
How to prorate the value of the few over the many? For NCMA:

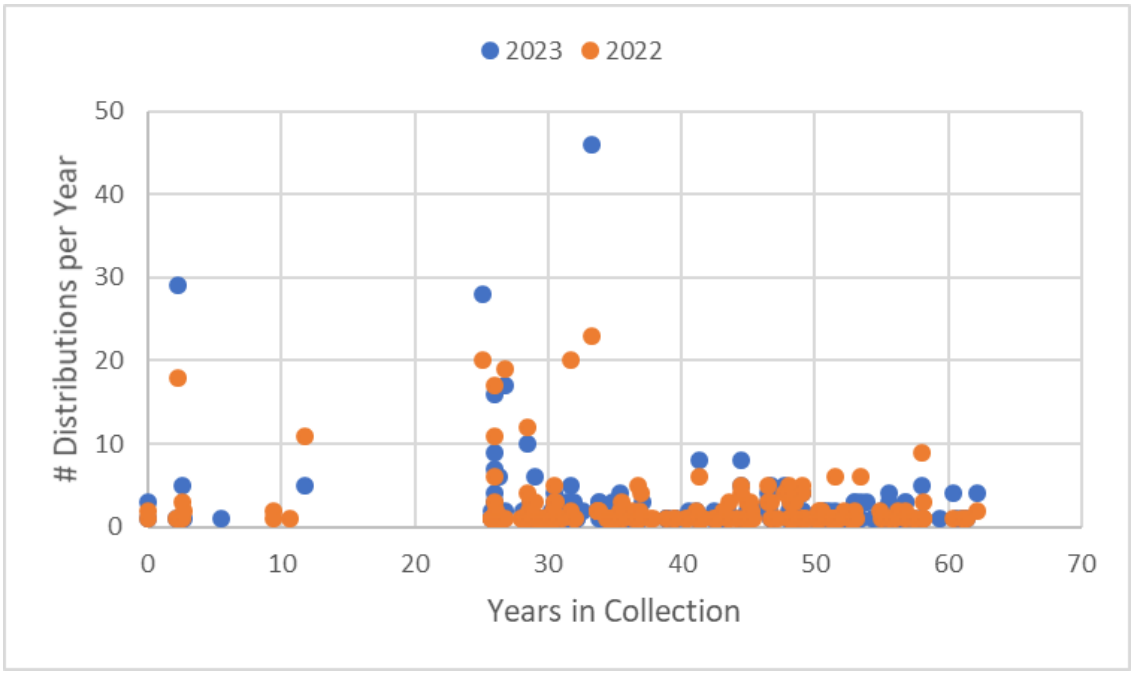
- ~16% of holdings distributed since 2018.
- 45% of distribution is accounted for by 1% of holdings.



Implementation: How to Model Costs?

How long a curation period is considered in the costing? For NCMA:





Implementation: How to Model Costs?

Assumptions:

- Only OPEX
- Cryopreserved

Costs:

LN2:	$2/strain/year
Curation Labor:	$2.5/strain/year
Data Labor:	$20/strain

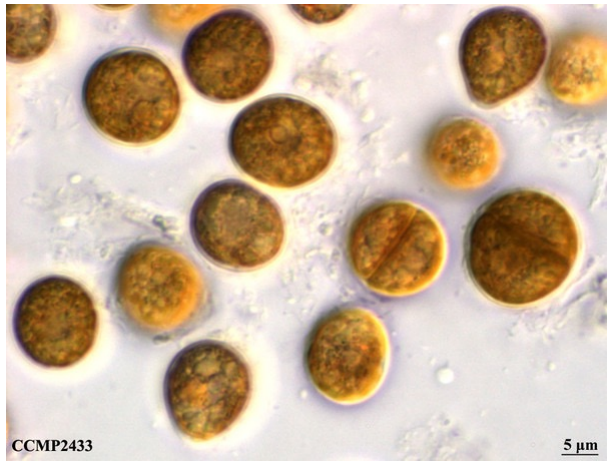
Term/Duration:

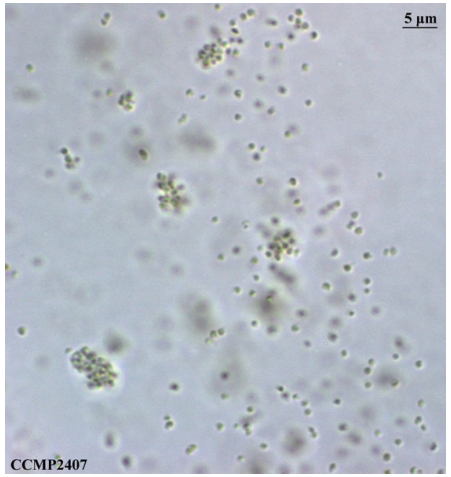
25 years

Examples:

Ostreococcus (15,000 mutant strains):	$1.99M
Symbiodinium (50 mutant strains):	$6.6K

Symbiodinium sp.





Ostreococcus lucimarinas

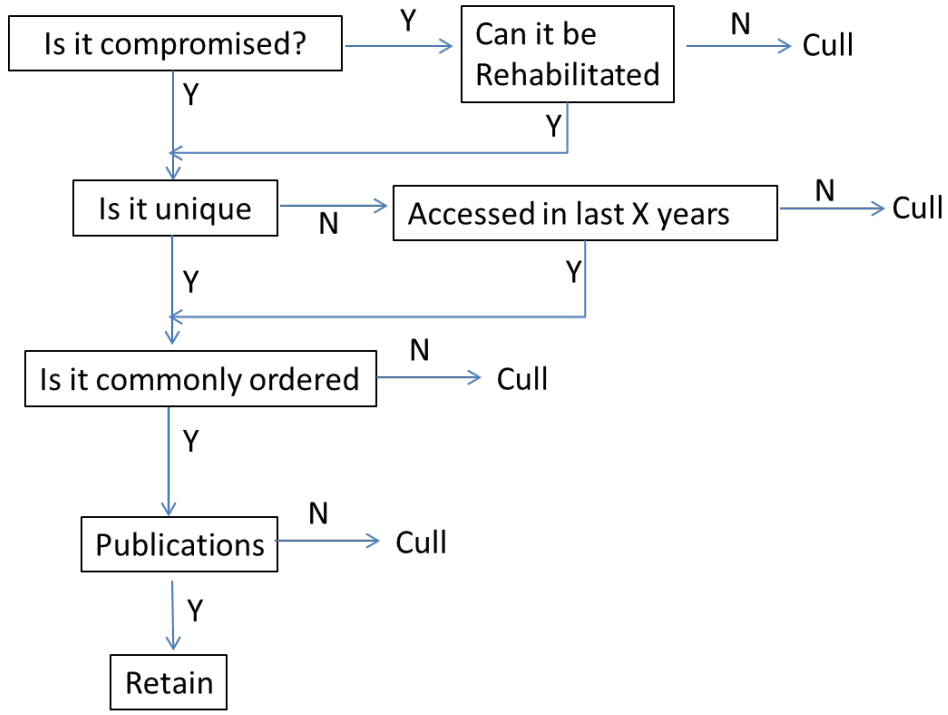
Implementation: What is/isn't Accepted & Maintained?

Living specimens and/or specimens that 'take up space'

- Does it provide unique value to science?
- How is value to science/society decided?
- How is value to science/society reported?
- Who makes the decision?
- When is a decision tree enacted?

Important as strain on resources increases and collections are increasingly asked to 'justify themselves', and hosting institutions may be looking to go in 'different directions'.

Generic Maintenance Decision Tree (NCMA)



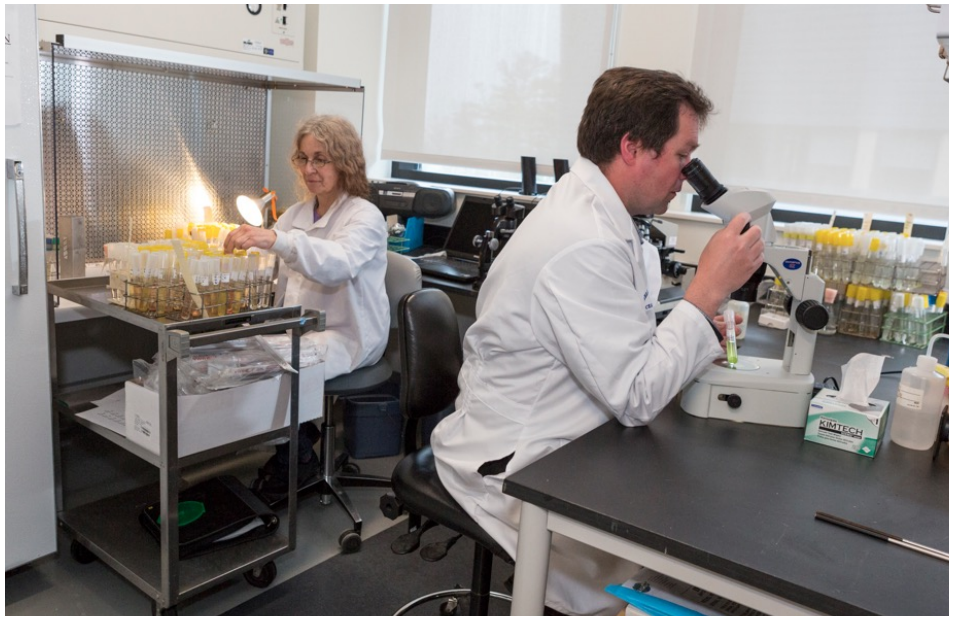
Outcomes: Advantages to researchers

- Proactive conversation - institution-specific protocols and best practices for collection and preservation are used.

- Advice on national and international laws and regulations, IACUC, IRB, biosafety/security/ethics.

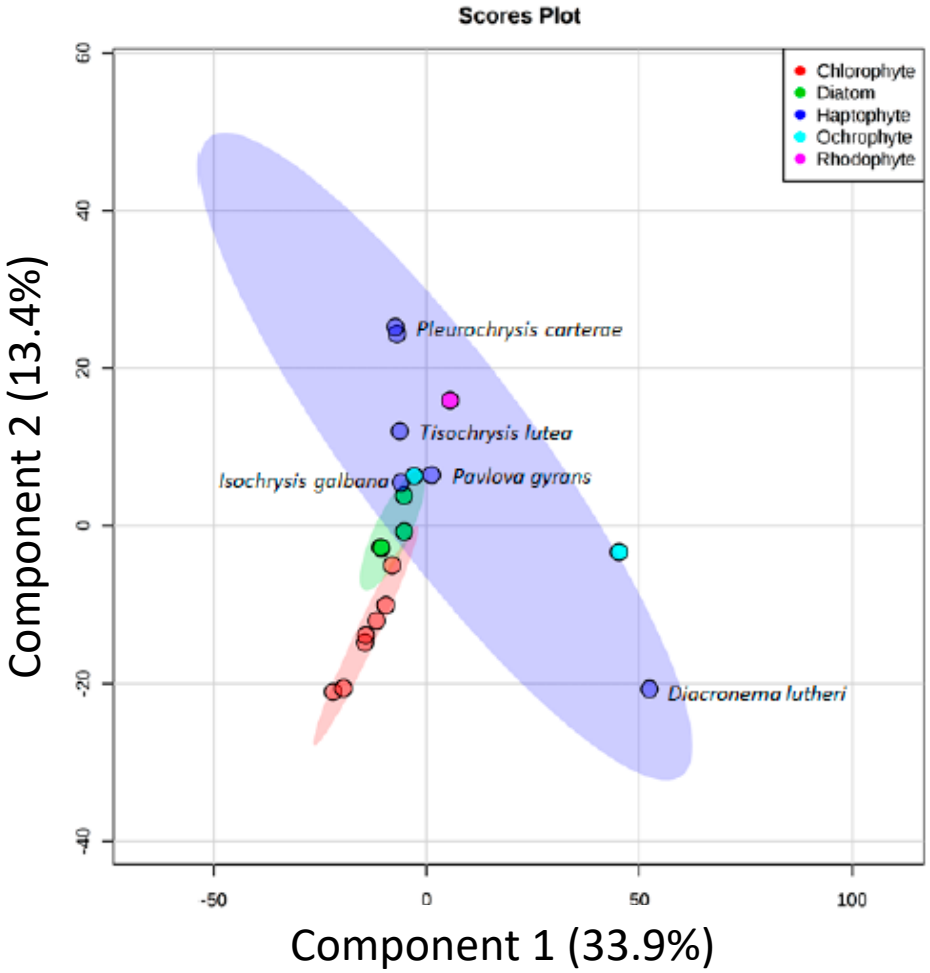
- Collections help with collaboration opportunities and minimize research duplication.

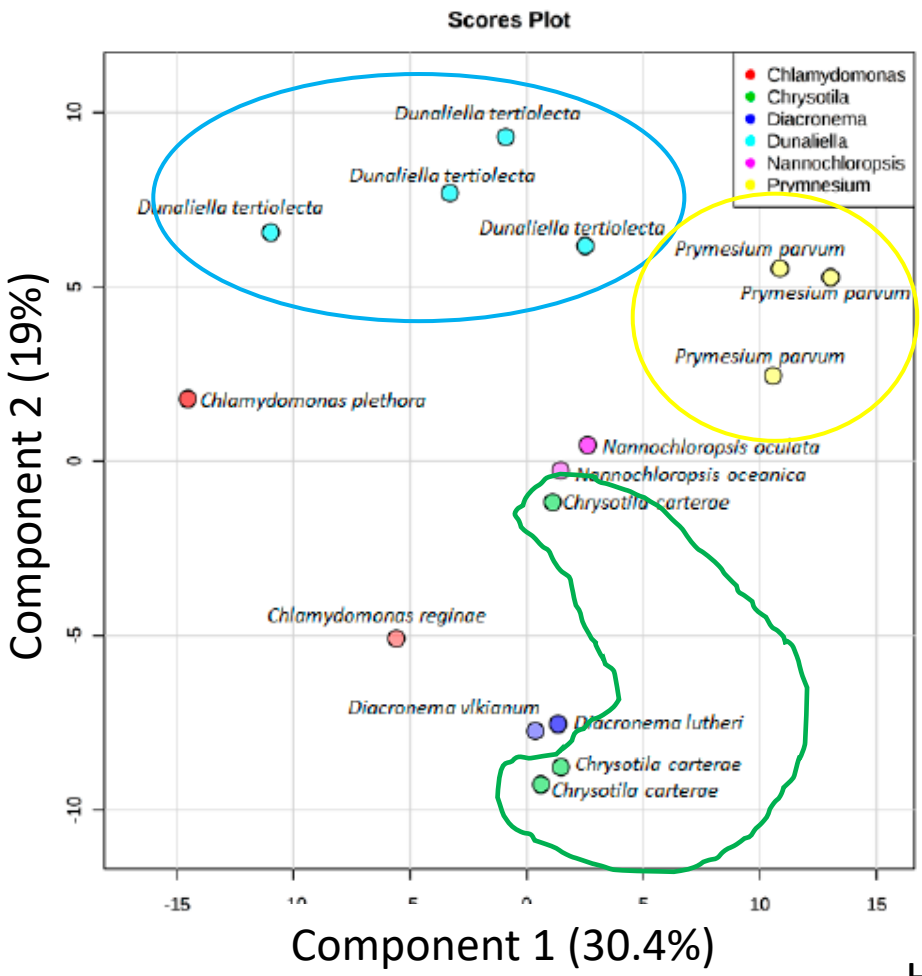
- A sound collection plan leads to effective use of funds and enhanced impact beyond the current research project.



Digression on duplication of the same ‘specimen’:

Algal metabolomic variability versus taxonomic assignments.





Hughes et al 2021

Outcomes: Advantages to Collections/Hosting Institutions

- Direct funds to collections that are in active use, outside of their own funding mechanisms, creating a more sustainable infrastructure
- Help fulfill the obligation to preserve and make available the outcomes of a funded grant.
- Collections receive high quality specimens with all necessary metadata.
- Data that adhere to standards and best practices and are compatible with collection management systems.
- Collections would get confidential, early access to information useful to their own plan for how to fulfill these emerging needs.

Outcomes: Advantages to the funding agencies

- Funding agencies would receive a larger and earlier return on their investments in leveraged future research.
- Funding agencies would have a clearer view of which repositories preserve specimens generated through research.
- Repositories can handle the confirmation of deposited strains and numbers.
- Better equity among all collections, including small and overlooked ones, as all would receive some NSF funding.
- Reinforces NSF's commitment to comprehensive and sustained support for reproducible, ethical and inclusive science.
- Get other agencies to share responsibility for support.

Outcomes: Advantages to publishers

- Publishers would be better equipped to fulfill their mandate of exposing reproducible science.
- Publishers would benefit from the guidance included in an SMP to increase uniformity of citation and attribution of specimen information in publications.
- Publishers would be empowered to make the links between research, funding dollars, and collections information more transparent.
- Publishers would be better equipped to assess and facilitate authors' compliance with applicable national and international permitting agreements.

Solicit Feedback/Take Action:

- Should all funding programs require an SMP?
- Engage with early adopters to improve the process, especially when it comes to new types of ‘specimens’ (mutant collections, MS spectra, etc.)
- Recognize the early adopters in some form/fashion.
- Report on these efforts in annual funding reports to Agencies.
- Do gaps exist for specimen repositories in particular fields?

Solicit Feedback/Take Action:

OXFORD

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Special Report

Community Action: Planning for Specimen Management in Funding Proposals

Andrew Bentley, Barbara Thiers, William E. Moser, Gregory J. Watkins-Colwell, Breda M. Zimkus, Anna K. Monfils, Nico M. Franz, John M. Bates, Kyria Boundy-Mills, Michael W. Lomas, Elizabeth R. Ellwood, Sinlan Poo, Dori L. Contreras, Michael S. Webster, Gil Nelson and Jyotsna L. Pandey