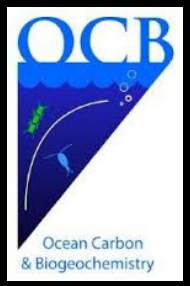
Improving biogeochemical models through single-cell and taxon-specific analyses of marine plankton physiological plasticity, genetic diversity and evolutionary processes

Michael Lomas
(workshop steering committee: Susanne Neuer, Steph Dutkiewicz, Steve Giovanonni, Adam Martiny, Ben Twining, Ramunas Stepanauskas, Adrian Marchetti, Alison Taylor)

Bigelow Laboratory for Ocean Sciences
May 28-30th, 2014



Motivation?

Emergent Biogeography of Microbial Communities in a Model Ocean

Michael J. Follows,[1]* Stephanie Dutkiewicz,[1] Scott Grant,[1,2] Sallie W. Chisholm[3]

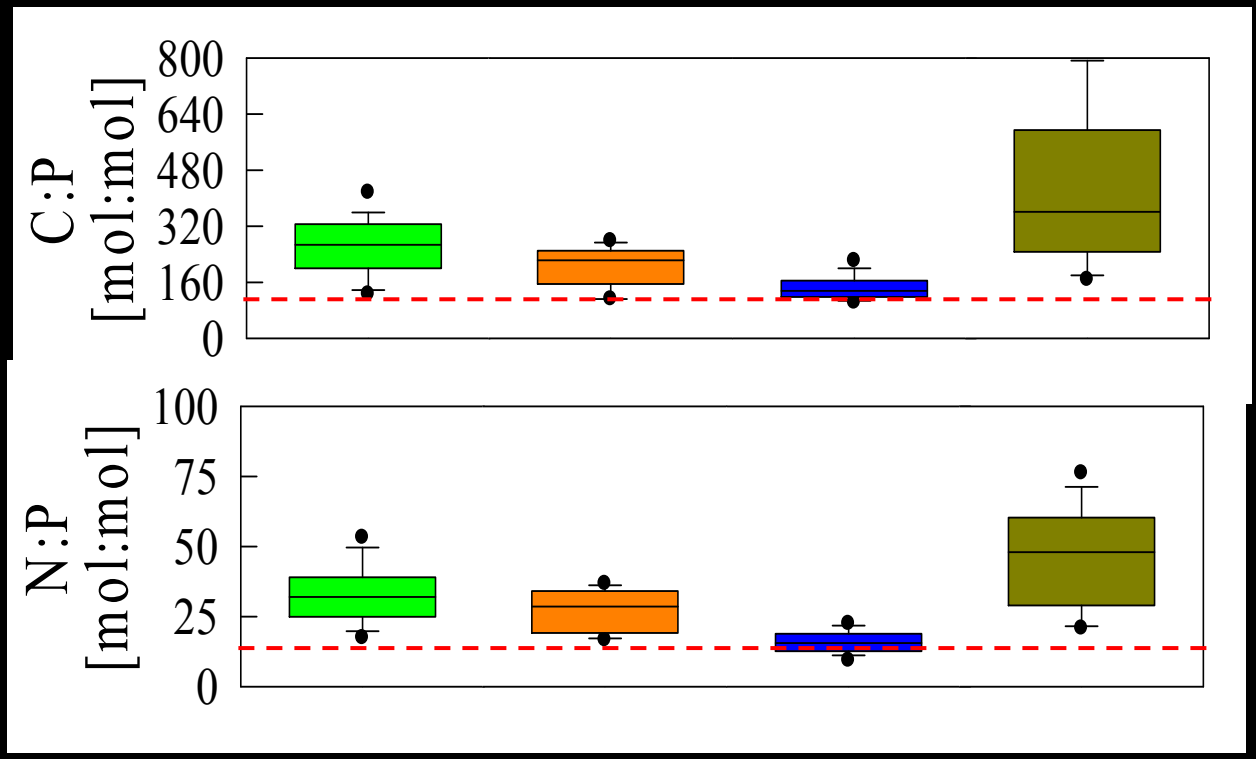
Variations in *Synechococcus* cell quotas of phosphorus, sulfur, manganese, iron, nickel, and zinc within mesoscale eddies in the Sargasso Sea

Benjamin S. Twining,[a,1,*] Daliangelis Nuñez-Milland,[a] Stefan Vogt,[b] Rodney S. Johnson,[c] and Peter N. Sedwick[d]

Single-Cell Genomics Reveals Hundreds of Coexisting Subpopulations in Wild *Prochlorococcus*

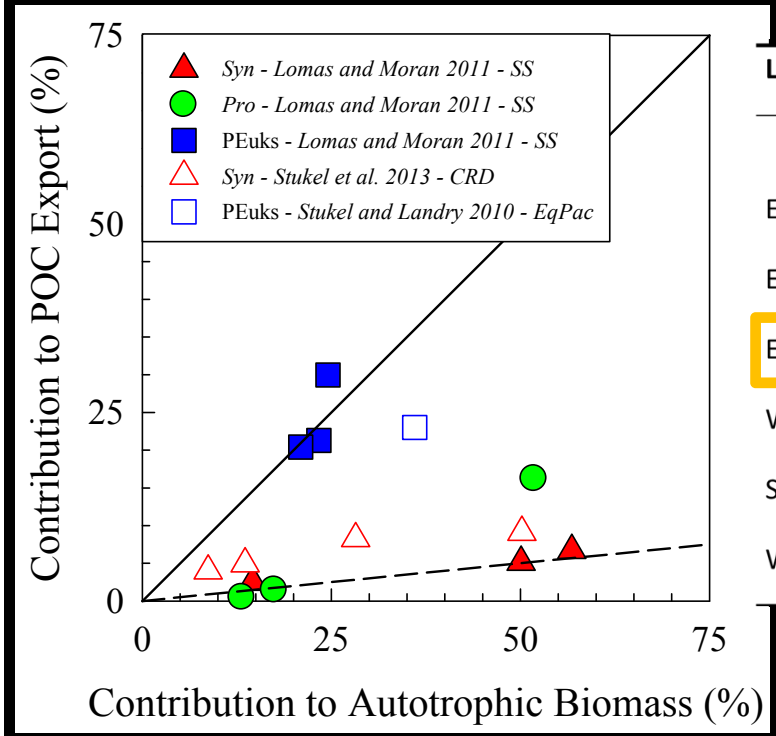
Nadav Kashtan,[1]* Sara E. Roggensack,[1] Sébastien Rodrigue,[1,2] Jessie W. Thompson,[1] Steven J. Biller,[1] Allison Coe,[1] Huiming Ding,[1,3] Pekka Marttinen,[4] Rex R. Malmstrom,[5] Roman Stocker,[1] Michael J. Follows,[6] Ramunas Stepanauskas,[7] Sallie W. Chisholm[1,3]*

Motivation?



Martiny et al. 2013
Lomas et al. unpubl. data

Motivation?



Location	Export Flux (mol C m^{-2} yr^{-1})		
	Ref	**C:P=110**	**VCP**
E. Subarctic N. Pac. (OSP) 50°N, 145°W	2.3±0.6	3.7±0.3	2.8±0.2
E. Subtropical N. Pac. (HOT) 23°N, 158°W	2.5±0.7	1.3±0.6	2.4±0.9
E. Equatorial Pac. 170°-95°W	3.3±1.8	3.0±0.5	2.7±0.4
W. Equatorial Pac. 150°E-140°W	1.5	2.5±0.7	2.0±0.5
Subarctic N. Atl. 40°N-65°N, 10°W-60°W	2.8±2.7	5.9±1.1	3.5±1.1
W. Subtropical N. Atl. (BATS) 32°N, 64°W	3.8±1.2	1.2±0.5	3.8±1.5

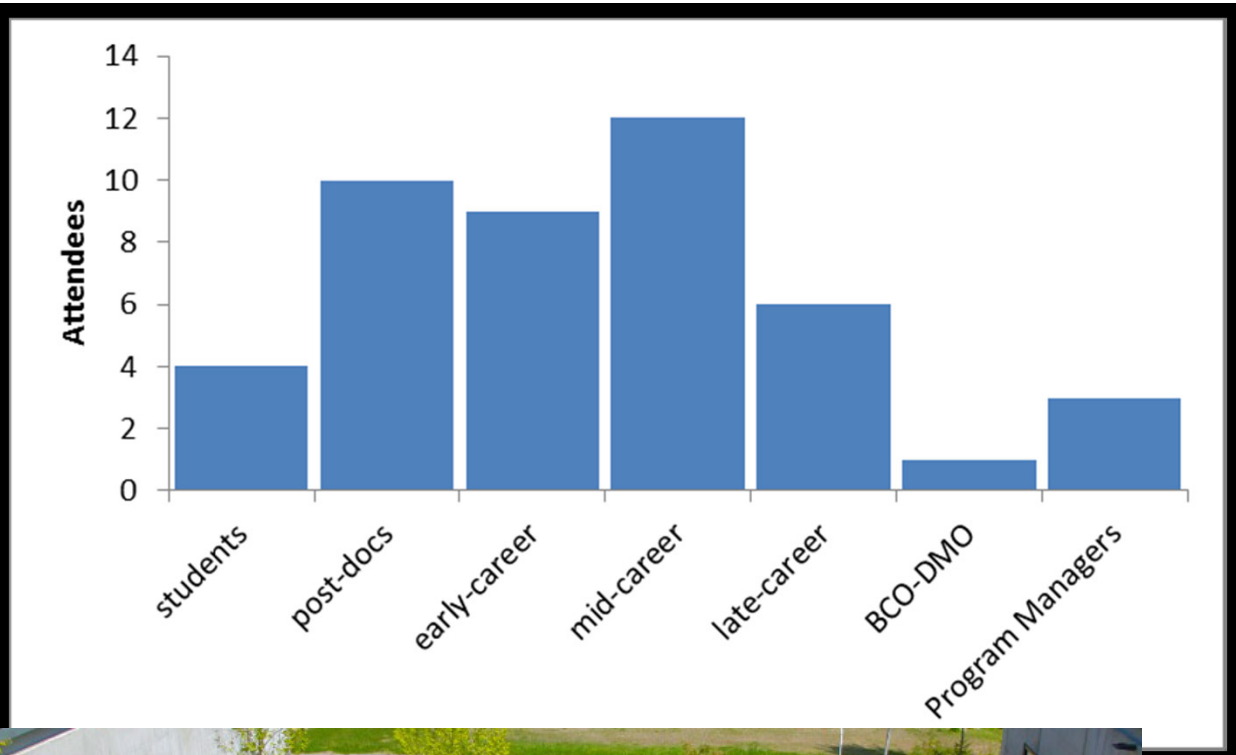
'Ref' from Emerson 2014
Teng et al. 2014, ASLO abstract

Motivation?

To understand cell- and taxon-specific physiological responses of marine microbes and phytoplankton in the current and a changing environment;

To understand the interactions and feedbacks between plankton physiological plasticity, genetic potential and evolution and the impacts on global ocean biogeochemical cycles

Attendees:


Attendees
14
12
10
8
6
4
2
0
students
post-docs
early-career
mid-career
late-career
BCO-DMO
Program Managers

Questions we tried to address:

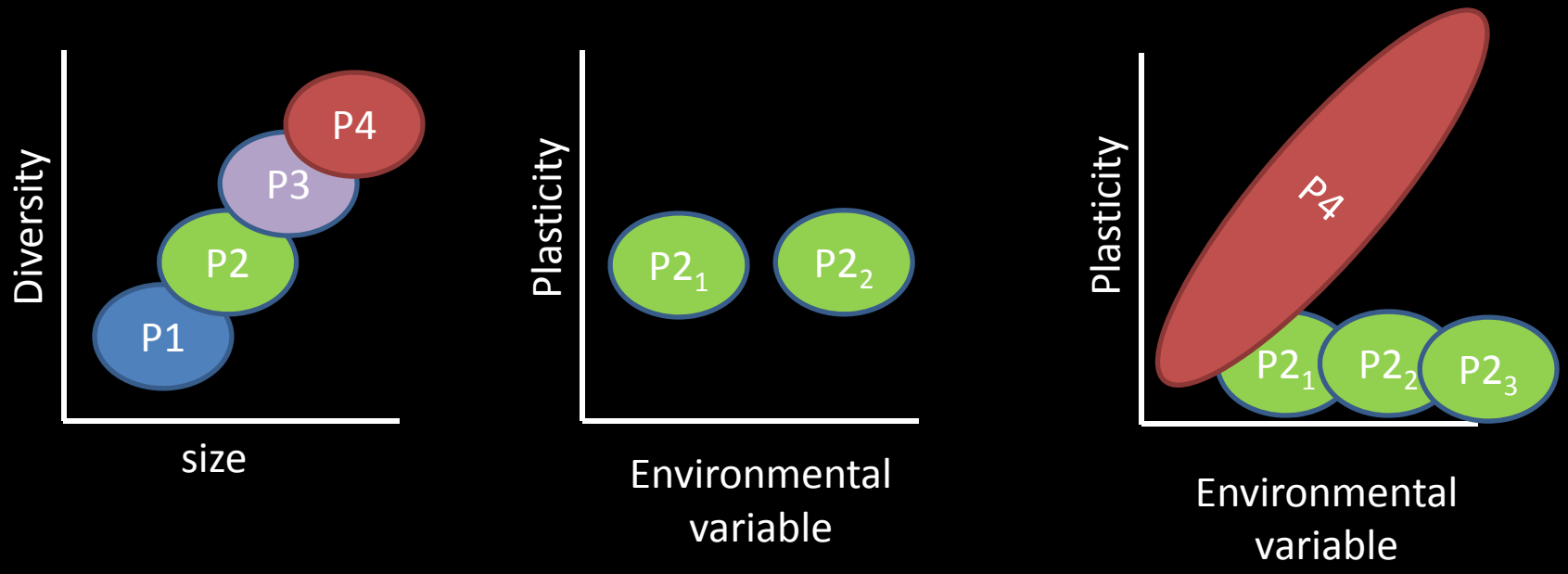
What are the single cell-specific and population-level traits required for parameterizing microbial “plasticity” in marine biogeochemical models of the current ocean?

Do genetic diversity, evolution and physiological plasticity have similar or different impacts on ocean biogeochemistry, particularly the production and export of particulate organic matter from the surface ocean?

What roles do taxonomic diversity and physiological plasticity play in controlling the response of microbial communities to current and future environmental stressors, for example, oxygen minimum zones, ocean acidification, ocean warming, stratification and changing nutrient concentrations or supply rates?

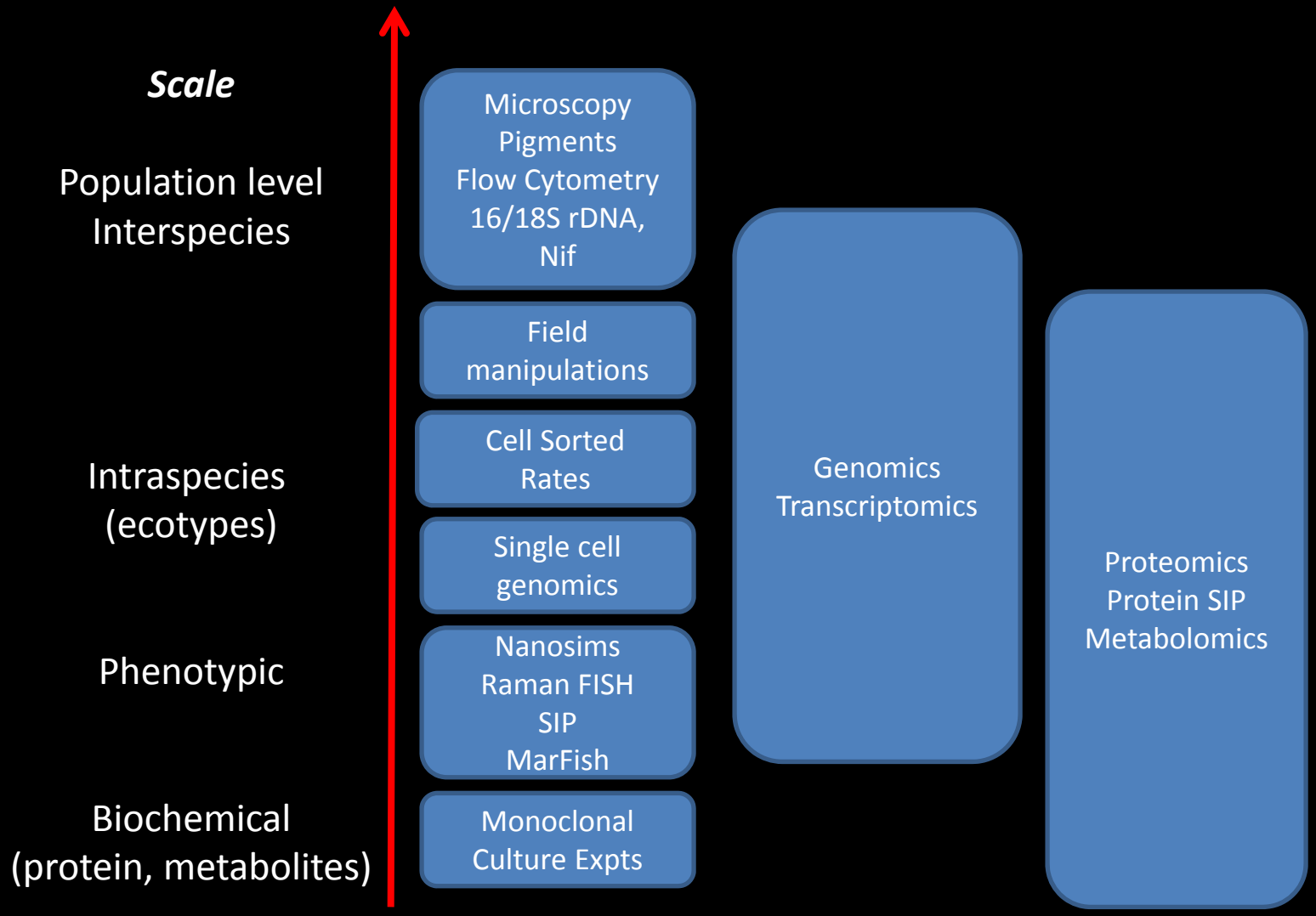
Preliminary summary of outcomes:

Types and scales of biodiversity

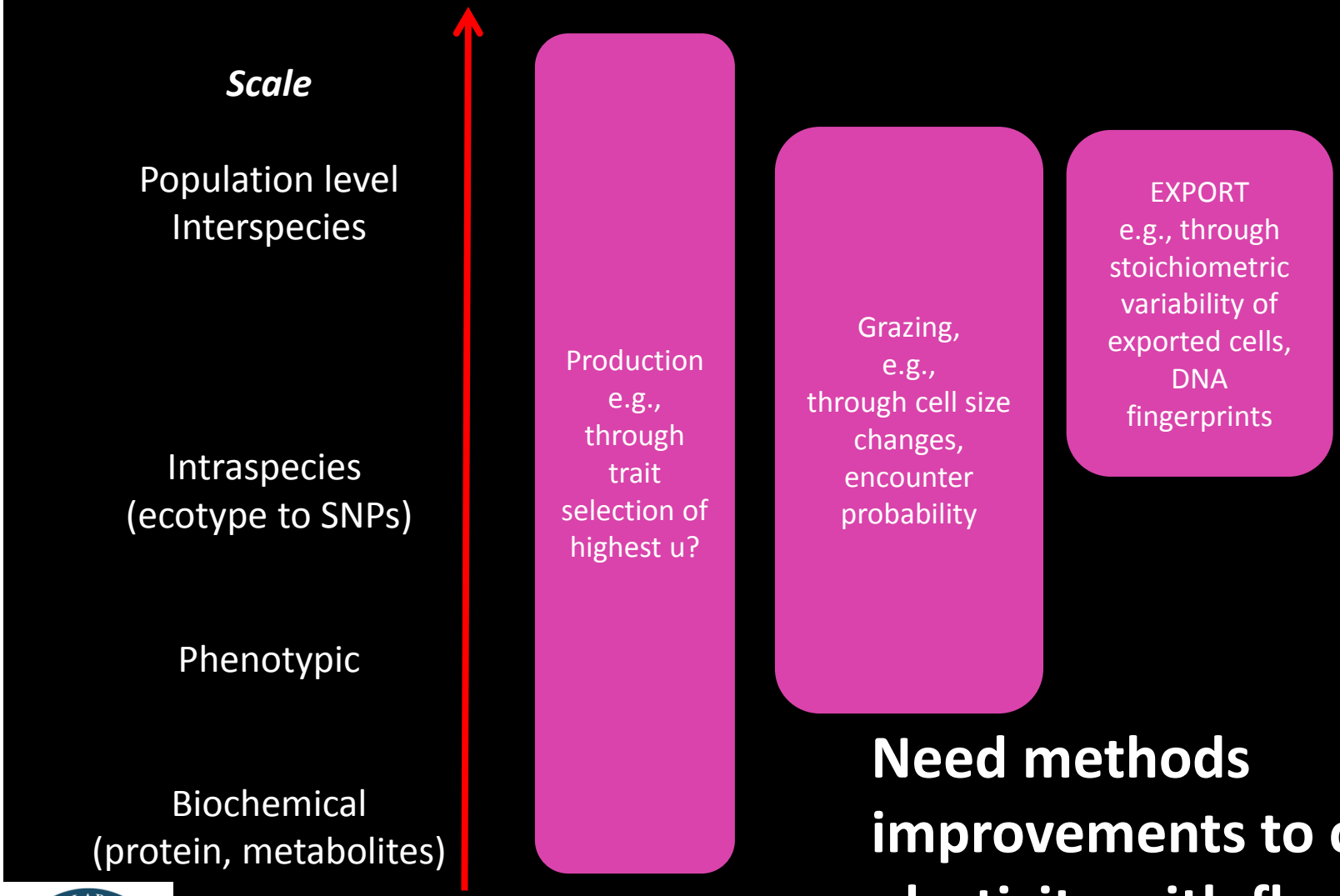


Preliminary summary of outcomes:

Linking biodiversity and measurements



Preliminary summary of outcomes:



Need methods improvements to connect plasticity with flux !

Potential products:

1) A formal workshop report to the OCB Office in the form of a white paper that communicates the vision and forward-looking priorities for this research.

2) An article for EOS highlighting the workshop conclusions and vision at a high level.

3) A detailed review publication in *L&O: Review, Frontiers in Aquatic Microbiology,* or similar journal.

4) Identification of key topics and possible speakers for a special session at the 2015 Aquatic Sciences meeting, potentially to include a town hall meeting to discuss the outcomes of the meeting and future research avenues.

For more information:

http://www.whoi.edu/website/taxon-specific-biogeochemistry/

mlomas@bigelow.org