Gap 1
No formal definition of phytoplankton community composition (PCC) and its quantities for remote sensing.

Gap 2
Taxonomic data are largely underutilized for algorithm development and validation. We are also lacking picoplankton data.

Gap 3
Phytoplankton taxonomy and morphology are necessary to partition phytoplankton from total carbon and create conversion tables.

Final product
Data tables necessary to build and validate hyperspectral satellite algorithms.
<table>
<thead>
<tr>
<th>Definition</th>
<th>Pros*</th>
<th>Cons*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size Class</td>
<td>Simplest; informative for carbon export</td>
<td>Information on biogeochemistry and taxonomy is limiting</td>
</tr>
<tr>
<td>Biogeochemical function</td>
<td>Informative to understand ecosystem function</td>
<td>Not always informative to taxonomy and morphology</td>
</tr>
<tr>
<td>Pigment Type</td>
<td>Relates back to what the satellite 'sees'</td>
<td>Pigments between taxonomic groups largely overlap</td>
</tr>
<tr>
<td>Taxonomy</td>
<td>Provides morphological and direct community composition information</td>
<td>Time consuming to collect; not widely available</td>
</tr>
</tbody>
</table>

What variables are we measuring?

- Presence/absence/dominance
- Qualitative vs quantitative
- Carbon abundances
- Cell abundances/biovolume

*not all inclusive
Solution 2: Make phytoplankton taxonomic data accessible

A **standardize procedure** for formatting and archiving imagery data was developed to make these data more accessible for model/algorithm development. This pathway is described in the graphic below.

The **full size spectrum** of phytoplankton taxonomy (picoplankton to microplankton) are necessary to define and detect PCC. Taxonomy data should be traceable to a known **taxonomic authority**, such as WoRMs or AlgaeBase.

**Under development:** Standardized procedure for formatting and archiving standard flow cytometry and microscopy data.
Solution 3: Make phytoplankton taxonomic data accessible

Morphology characteristics from flow cytometry, in-flow imagery, and microscopy can be converted to carbon using various empirical relationships (e.g., Menden-Deuer et al. 2000; Lomas et al. 2019 (cold water diatoms)).

*Phytoplankton taxonomy/morphology + AOPs/IOPs =

Algorithms and models would benefit from the development of standardized conversion tables that convert phytoplankton morphological characteristics to carbon.
Development and validation of hyperspectral algorithms to derive the different definitions of PCC (green) would benefit from **phytoplankton taxonomy information** determined by microscopy, standard flow cytometry and advanced in-flow imaging technology (e.g., IFCB, FlowCAM).
Advanced PCC algorithms that utilize hyperspectral data are the future. The Ocean Color Instrument on NASA’s PACE* mission will pave the way with 5nm spectral resolution.

**Final Product: Development of hyperspectral PCC algorithms**

1 year
- Collect phytoplankton variables and develop carbon conversion tables for algorithm development and validation

5 year
- Expand phytoplankton taxonomy and carbon data tables; algorithm evaluations/improvements

10 year
- Support PCC products from future hyperspectral ocean color missions (e.g., SBG, GLIMR)

*Plankton, Aerosol, Cloud, ocean Ecosystem*