GlobalHAB symposium on automated in situ observations of plankton
Fiskebäckskil, Sweden 22-27 August 2022

SMHI

# INTRODUCTION TO AUTOMATED HAB OBSERVATIONS

Bengt Karlson
Oceanographic Research Unit
Swedish Meteorological and Hydrological Institute
Gothenburg, Sweden

# A plethophora of methods

SMHI

- Satellite remote sensing of ocean colour
- Absorbance from photosynthetic pigments
  - Single or multiple wavelengths
  - Hyperspectral
- In vivo fluorescence of pigments
  - Chlorophyll
  - Phycocyanin
  - Phycoerythrin
  - Multi-wavelength
- Flow cytometry
- **Imaging in flow systems**
- Molecular methods

# Why automated imaging systems?

SMHI

**Some advantages**

- Data in near time - early warning of Harmful Algae Events possible
- Lower cost per sample compared to manual sampling and microscopy?
  - At least if many samples are analysed
- Expert trained
  - Standardised output
- Fast sample throughput - if there are are morphological features that disting gushes the HAB organisms from other plankton

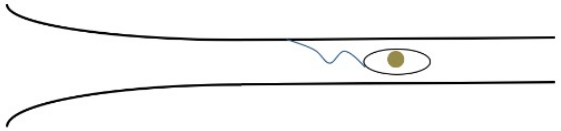
**Some disadvantages**

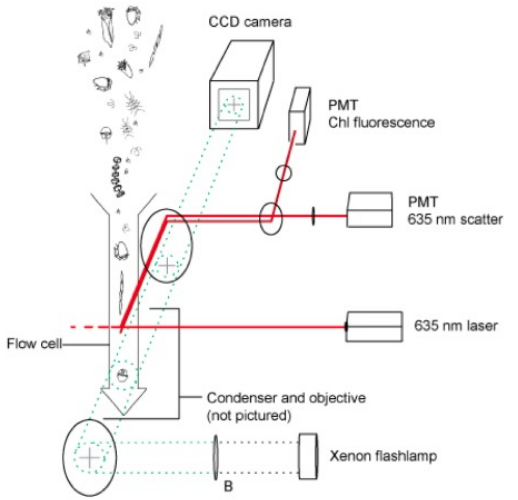
- Based on morphological features
  - Small cells often not possible to identify

# Some approaches

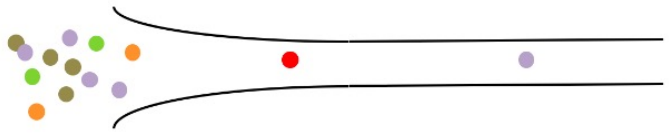
SMHI

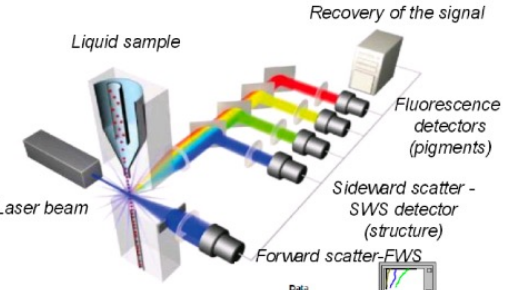
**Imaging/in flow**
Single cells – size and morphology of organisms



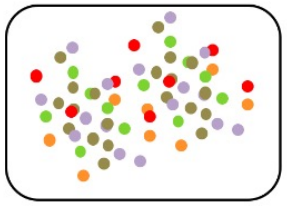


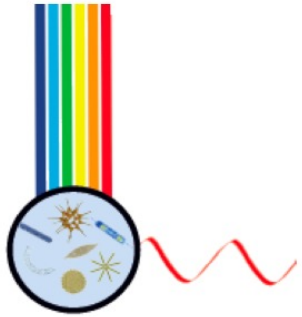

**Automated flow cytometry (pulse shape-recording)**
Single cells – fluorescence –pigment content and scattering (size, shape)

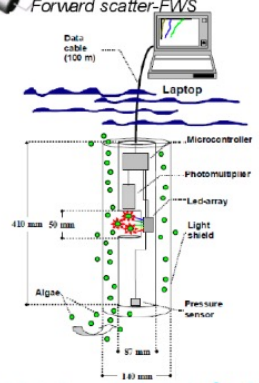





**Fluorescence and absorption (multi-spectral)**
Pigment based methods – bulk properties +
**Variable fluorescence**
(photosynthetic parameters)

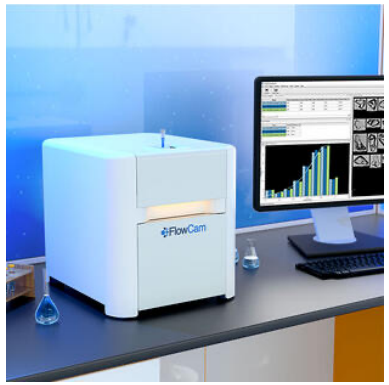






# Instruments

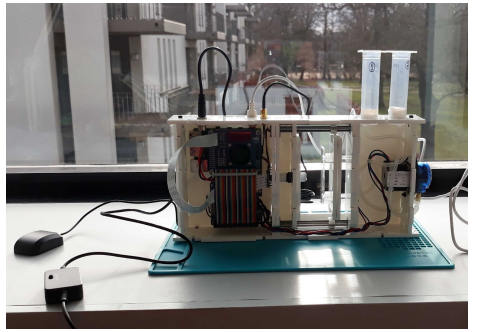
SMHI




FlowCam

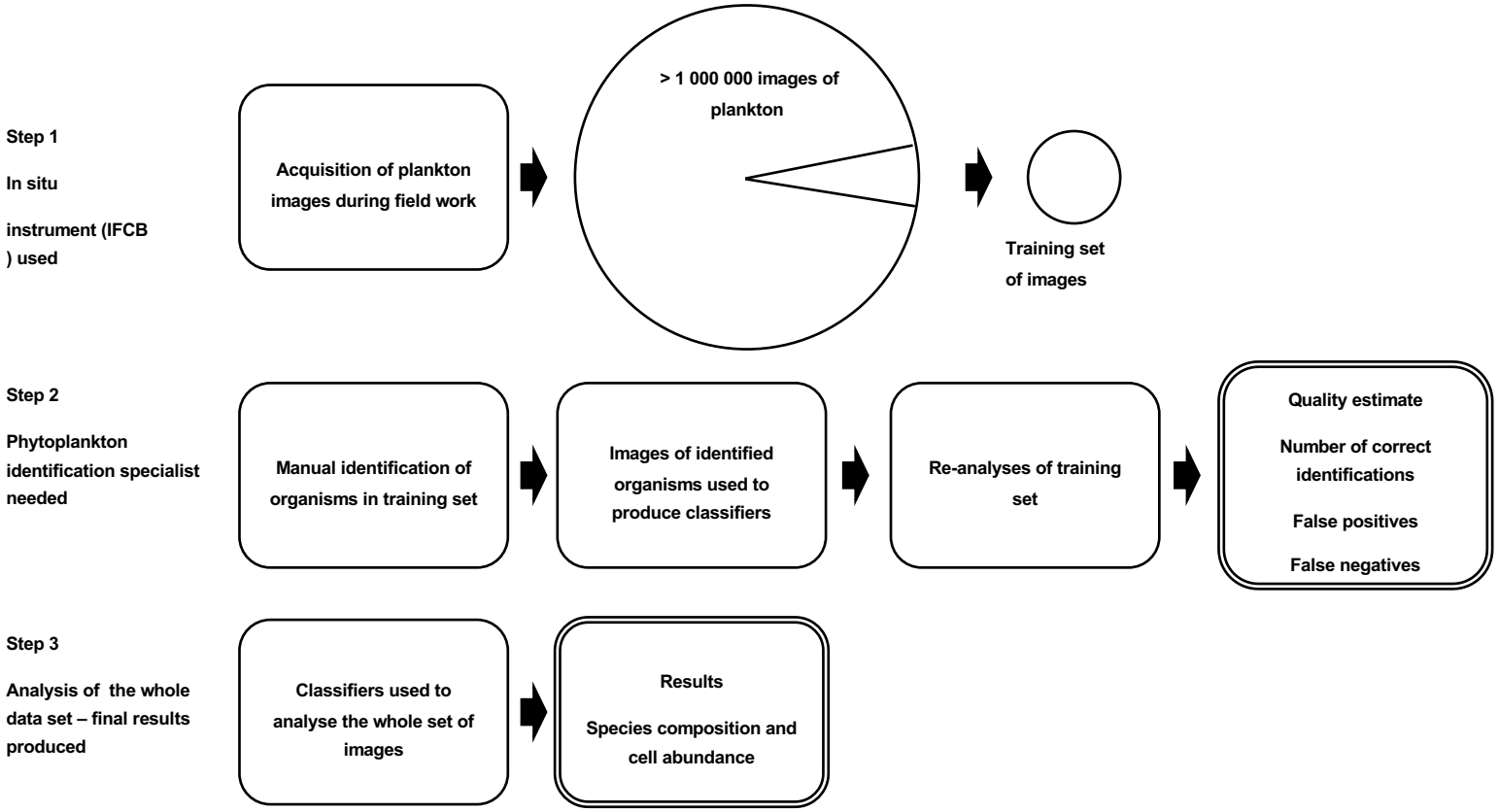

Imaging FlowCytobot

CytoSense



PlanktoScope (IOW)

# Data flow and production of classifiers



# Articles that may be of interest

Campbell, L., Henrichs, D.W., Olson, R.J., Sosik, H.M., 2013. Continuous automated imaging-in-flow cytometry for detection and early warning of Karenia brevis blooms in the Gulf of Mexico. Environmental Science and Pollution Research 20(10), 6896-6902.

Kraft, K., Seppälä, J., Hällfors, H., Suikkanen, S., Ylöstalo, P., Anglès, S., Kielosto, S., Kuosa, H., Laakso, L., Honkanen, M., Lehtinen, S., Oja, J., Tamminen, T., 2021. First Application of IFCB High-Frequency Imaging-in-Flow Cytometry to Investigate Bloom-Forming Filamentous Cyanobacteria in the Baltic Sea. Frontiers in Marine Science 8(282).

Kudela, R.M., Anderson, C., Ruhl, H., 2021. The California Harmful Algal Bloom Monitoring and Alert Program: A Success Story for Coordinated Ocean Observing. OCEANOGRAPHY 34(4), 84-85.

Olson, R.J., Sosik, H.M., 2007. A submersible imaging-in-flow instrument to analyze nano-and microplankton: Imaging FlowCytobot. Limnology and Oceanography-Methods 5, 195-203.

Sieracki, C.K., Sieracki, M.E., Yentsch, C.S., 1998. An imaging-in-flow system for automated analysis of marine microplankton. Marine Ecology Progress Series, 285-296.

Sosik, H.M., Olson, R.J., 2007. Automated taxonomic classification of phytoplankton sampled with imaging-in-flow cytometry. Limnology and Oceanography-Methods 5, 204-216.

Thyssen, M., Alvain, S., Lefèbvre, A., Dessailly, D., Rijkeboer, M., Guiselin, N., Creach, V., Artigas, L.-F., 2015. High-resolution analysis of a North Sea phytoplankton community structure based on in situ flow cytometry observations and potential implication for remote sensing. Biogeosciences 12(13), 4051-4066.