LPS 2022

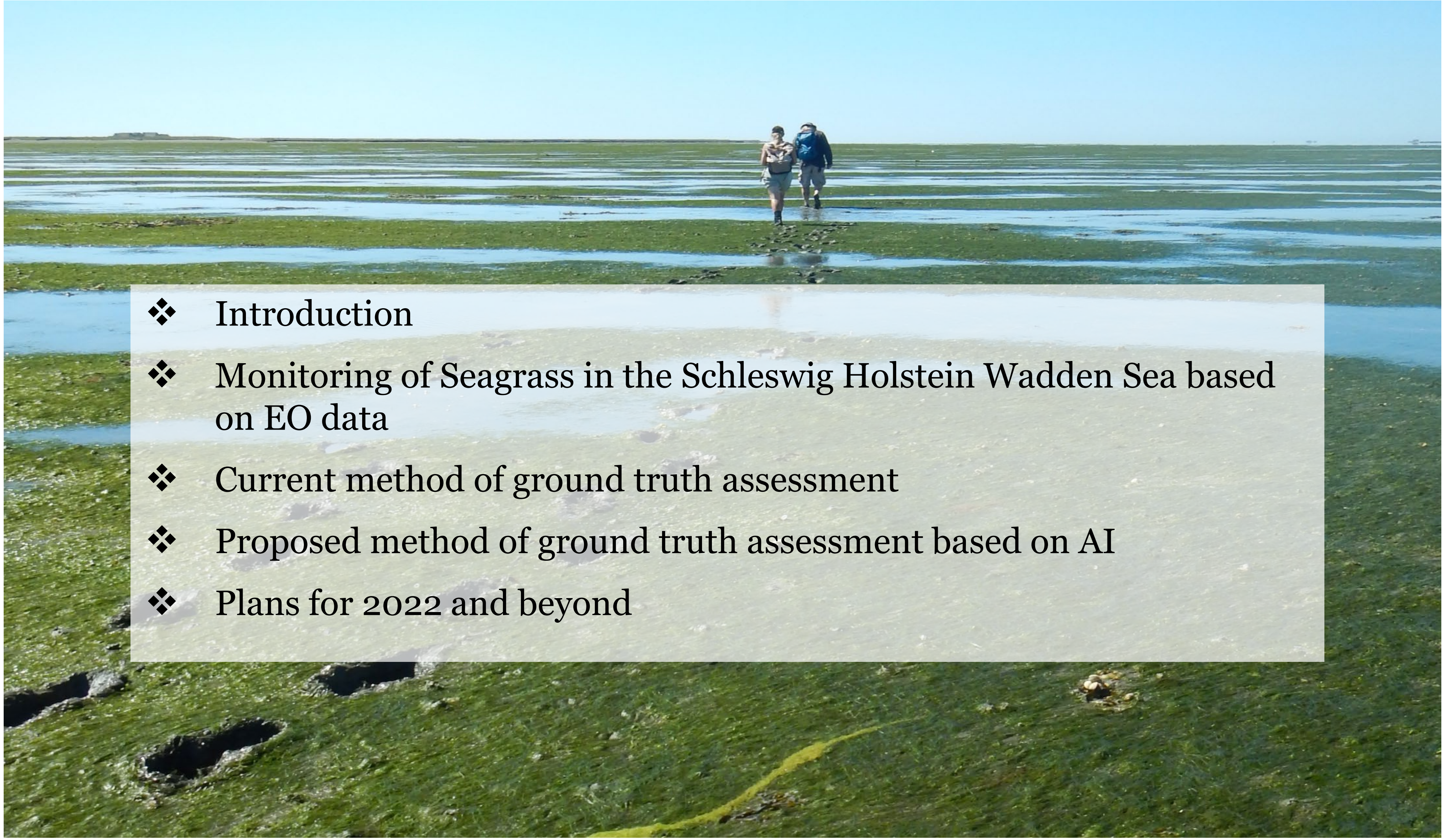
Refinement of remote sensing information on the coast using verification data via AI

Jörn Kohlus (LKN Schleswig-Holstein) & Hannah Böhm, Friederike Nowak et al. (dataport), Kerstin Stelzer (Brockmann Consult)

Nationalpark Wattenmeer
SCHLESWIG-HOLSTEIN

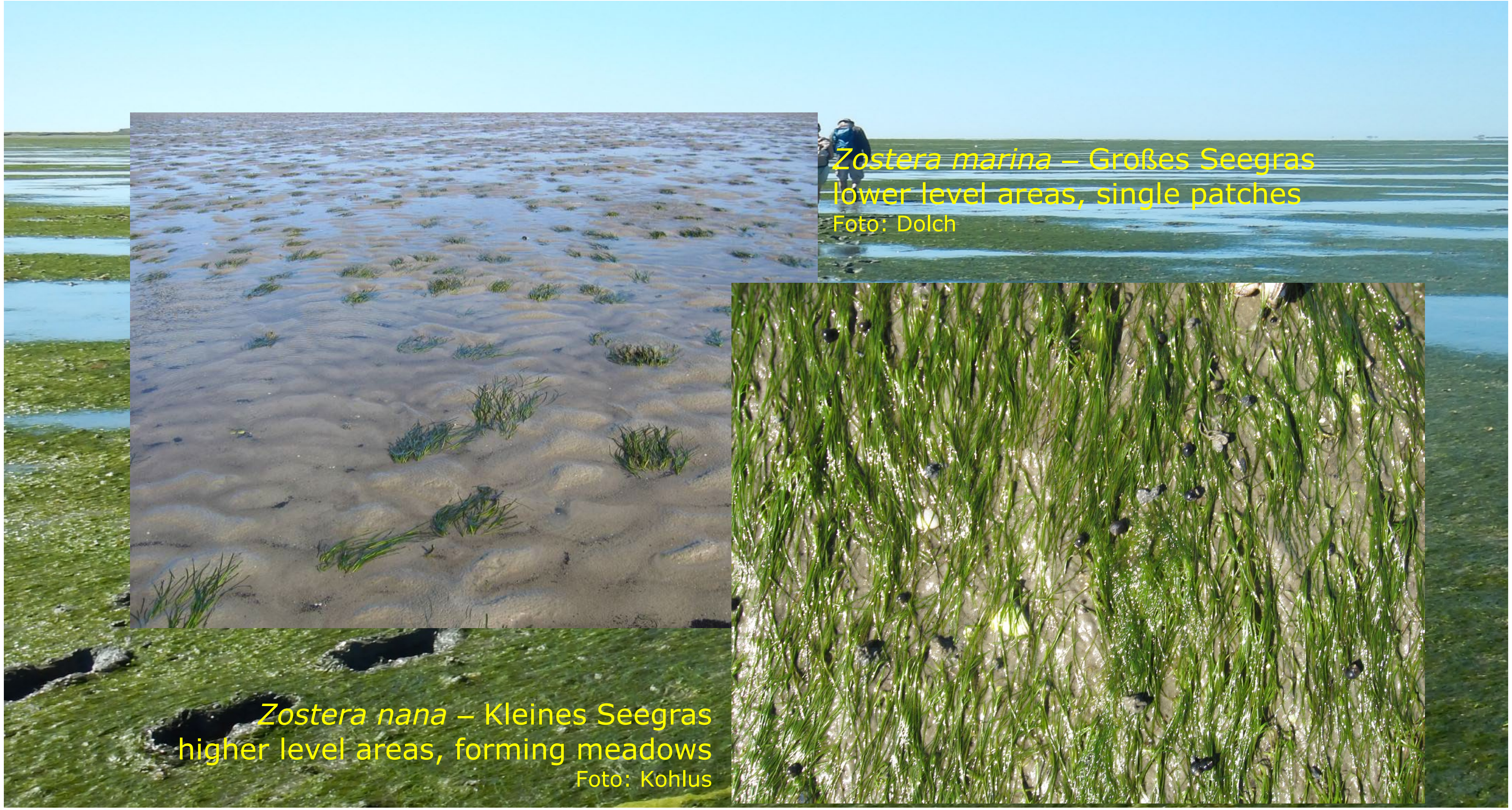
BROCKMANN CONSULT GMBH

Overview

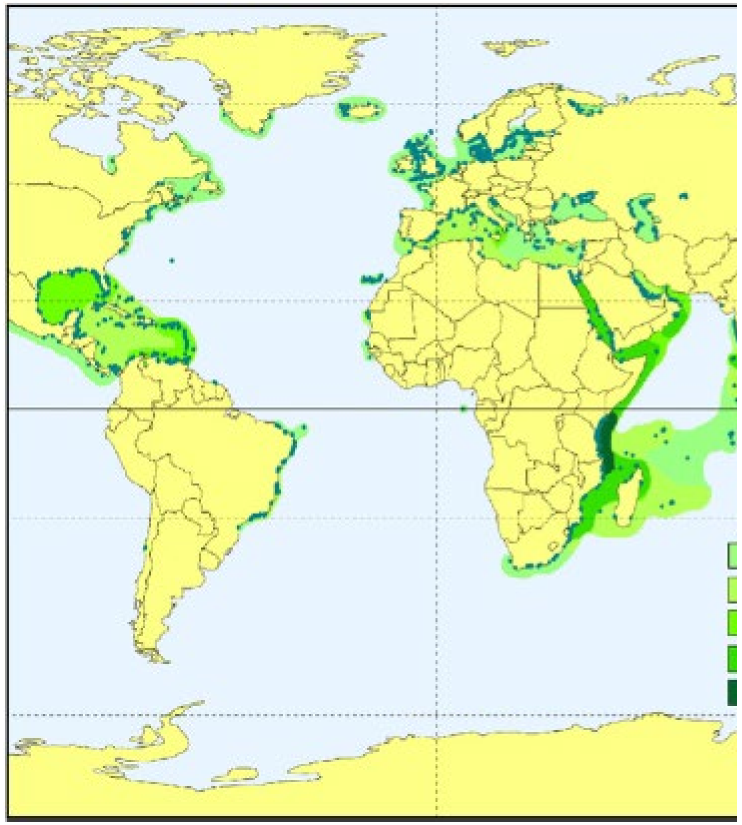


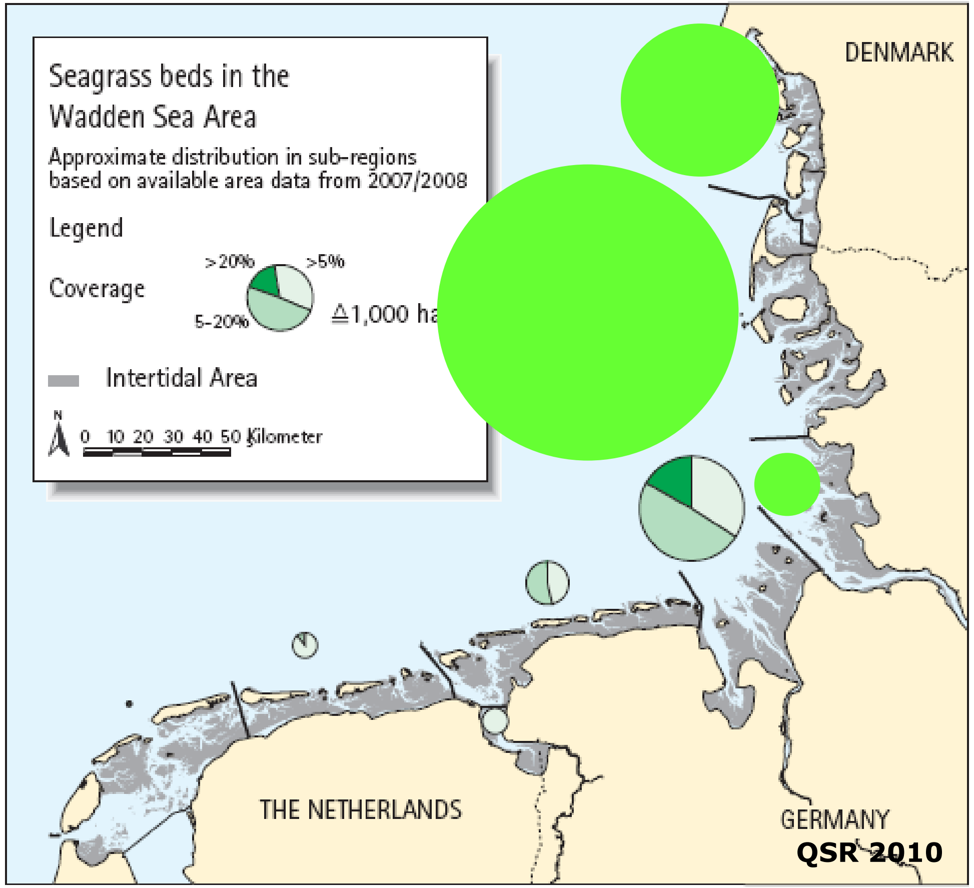
- Introduction
- Monitoring of Seagrass in the Schleswig Holstein Wadden Sea based on EO data
- Current method of ground truth assessment
- Proposed method of ground truth assessment based on AI
- Plans for 2022 and beyond

Seagrass meadows in the Wadden Sea

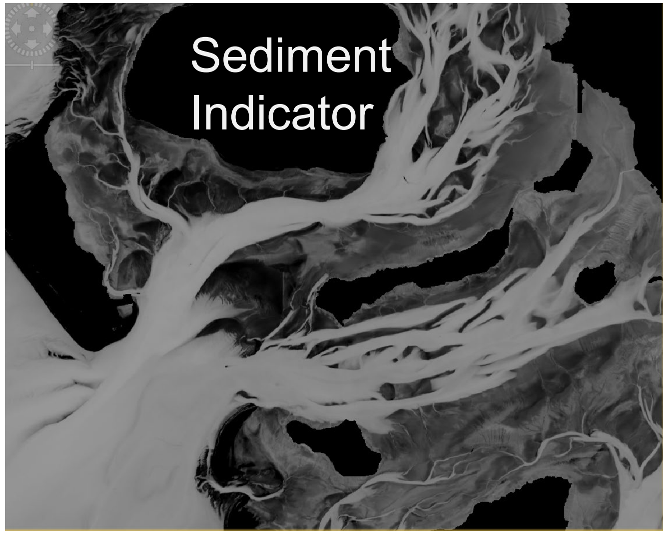


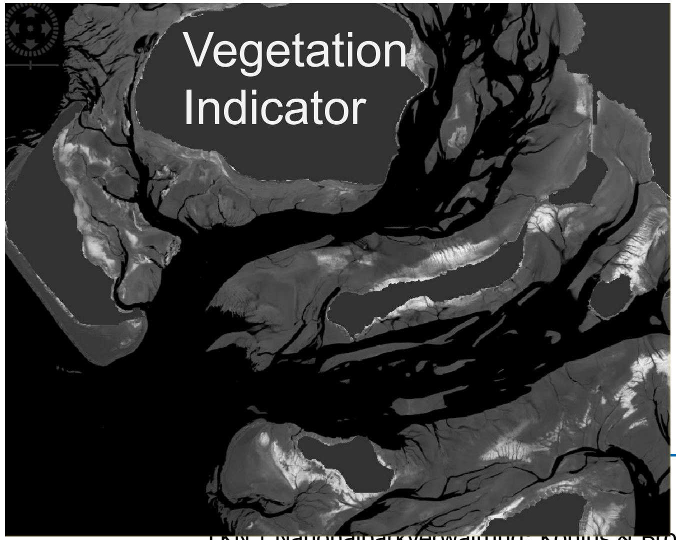
Seagras occurence

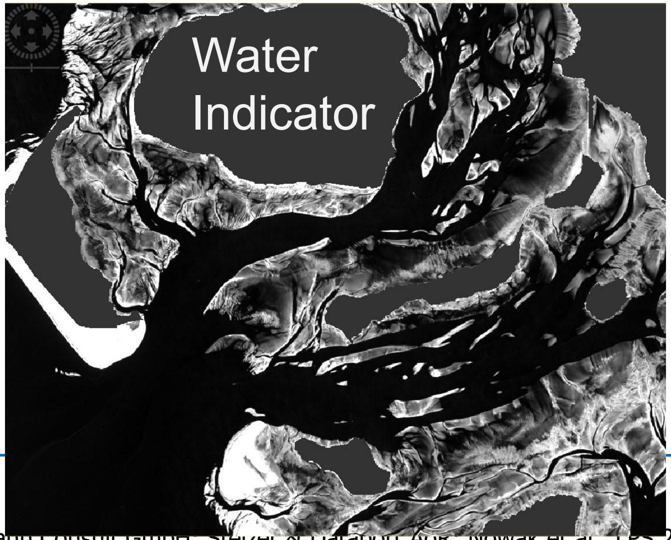




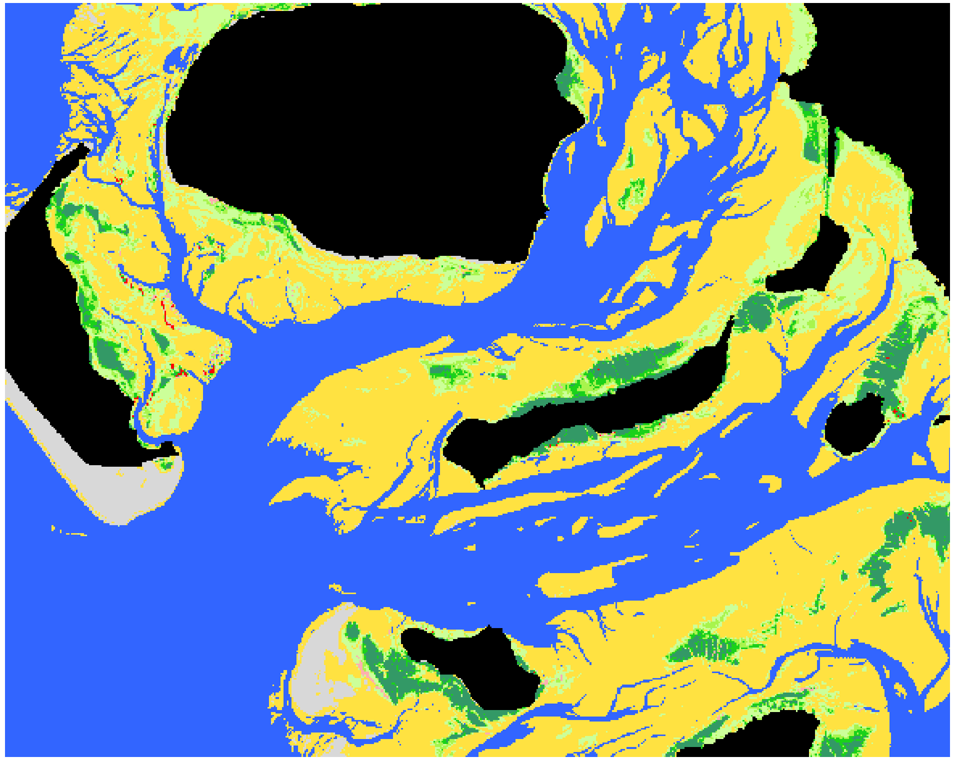
EO classification system seagrass





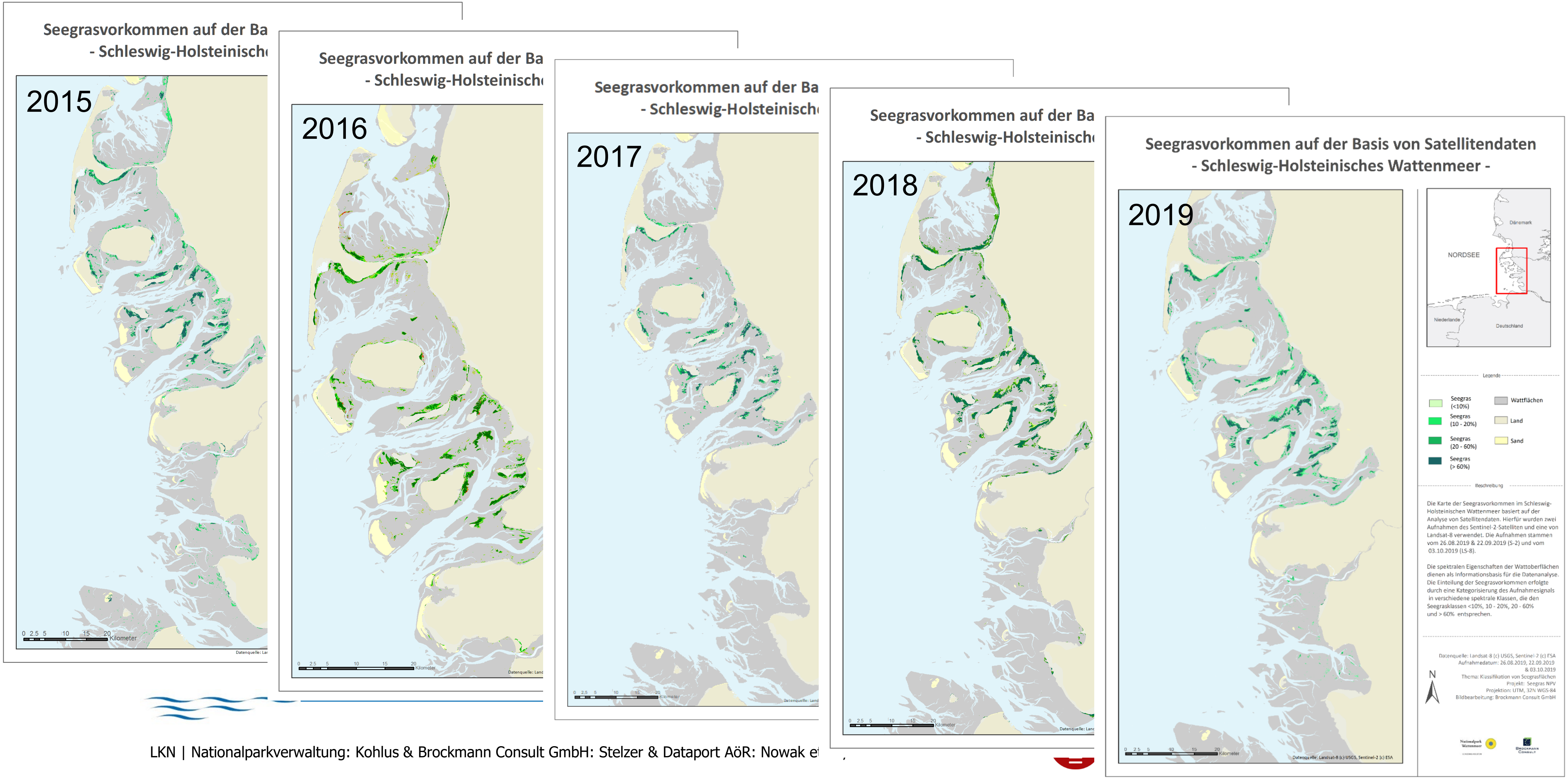


Classes of seagrass density



- 5-10%
- 10-20%
- 20-60%
- >60%

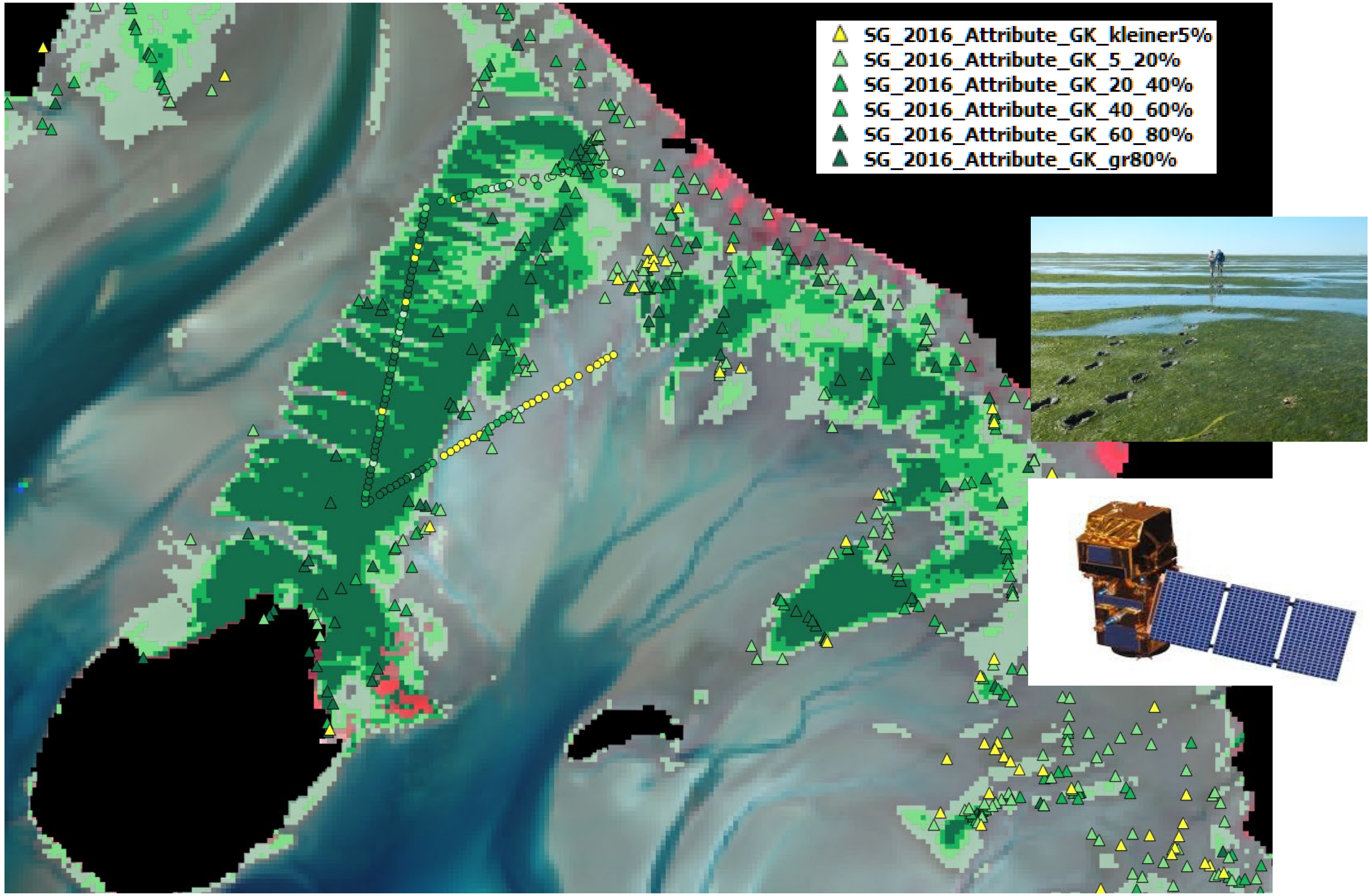
Monitoring of Seagrass with EO data since several years



LKN | Nationalparkverwaltung: Kohlus & Brockmann Consult GmbH: Stelzer & Dataport AöR: Nowak et

Seagrass classification verified with ground truth measurements

- Ground based assessment of the density of seagrass coverage
  - Monitoring program mapping seagrass meadows on ground
  - Dedicated transects assessing the seagrass density
- Assessment of seagrass density performed by experts
- Categories of seagrass density not harmonized between programms



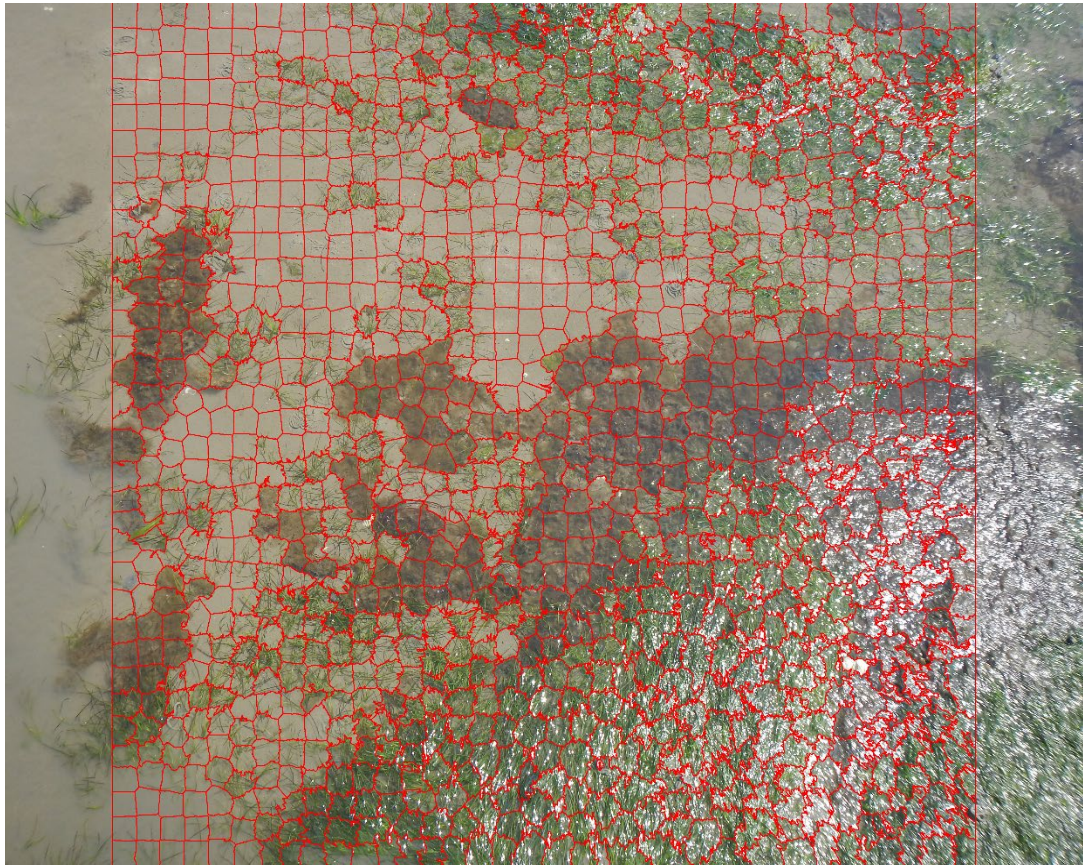
Current ground truth assessment

- Currently, ground based truth coverage data is done via transect or raster surveys
- This may lead to errors or reduced reproducibility due to
  - Fatigue
  - Changing environmental and light conditions
  - Changing personnel
  - No standardization between campaigns

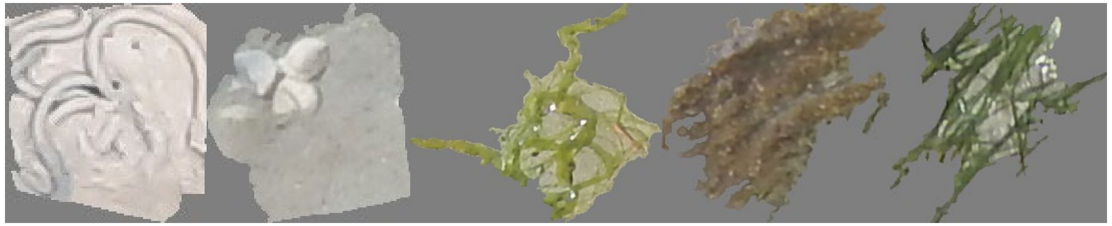
➢ Need for a more objective measurement

➢ Ansatz: AI-based coverage estimate on images taken in the field

AI-based estimate: approach



- Segmentation of original image
- Classification of segment images by a neural network



- Calculation of area and coverage of the classes
- Estimation of the uncertainties
- Average calculation from individual images as result for the transect point

AI-based estimate: Classification by a neural network

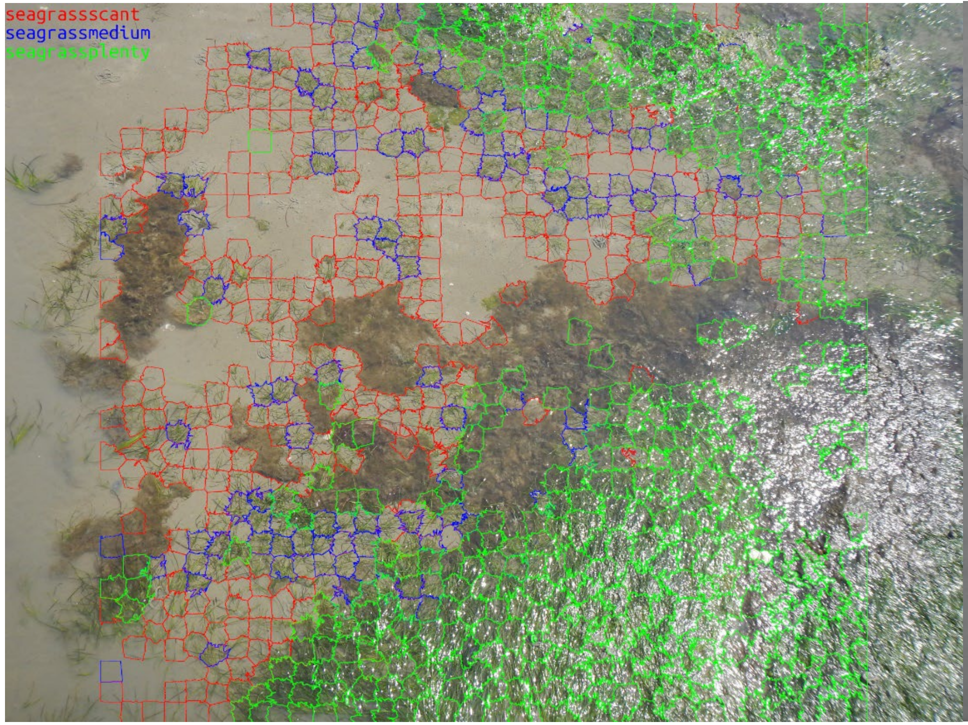
- Allocation of segment images into seagrass (scant, medium, plenty) and non-seagrass classes by hand for training
- Random split of dataset into training, validation and test (80%, 10%, 10%)
- Usage of transfer learning (InceptionV3)
- Optimization on the Area Under the Curve of the Receiver Operating Characteristic (ROC AUC) with Early Stopping
- Implementation in Tensor Flow

AI-based estimate: coverage calculation

- Wanted: calculation of seagrass ground coverage in percent
- But: segments do not always contain 100% coverage
- Different methods tried to determine the coverage:
  - „Simple“: Allocation of flat coverage (10%, 50%, 90%) to the different seagrass classes (scant, medium, plenty)
  - „GLI“: Green Leaf Index; RGB-approximation on the infrared characteristics of vegetation
  - „Otsu“: finding the valley between peaks to divide between light and dark areas

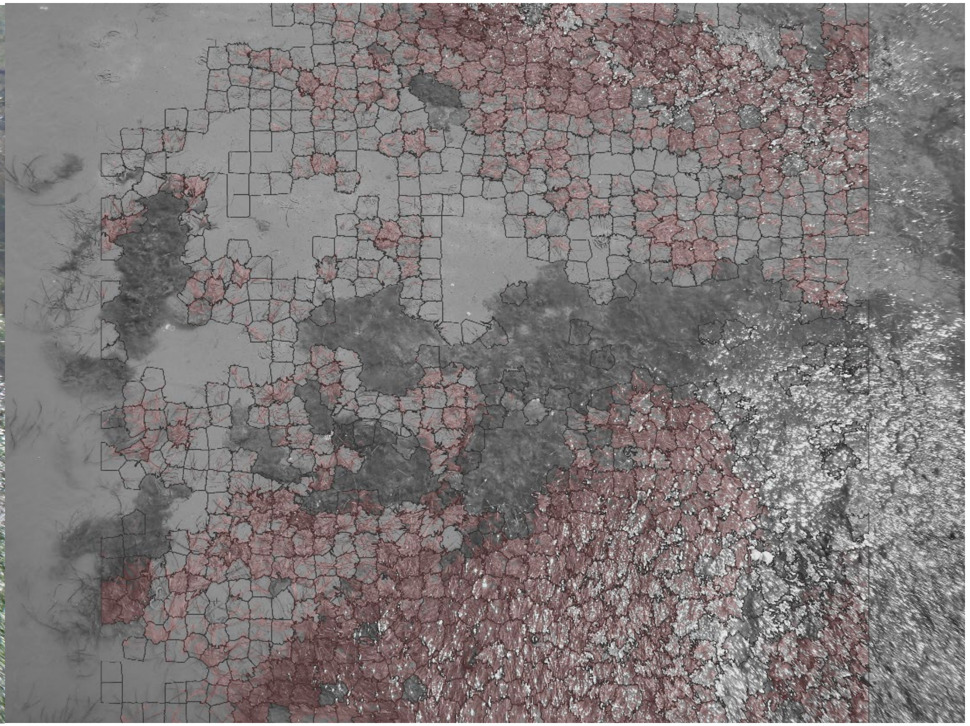
AI-based estimate: coverage calculation example

Simple



37 (err: + 3 – 3) %

GLI



30 (err: + 7 – 5) %

Brockmann Consult GmbH

Nationalpark Wattenmeer
Schleswig-Holstein

AI-based estimate: Uncertainties

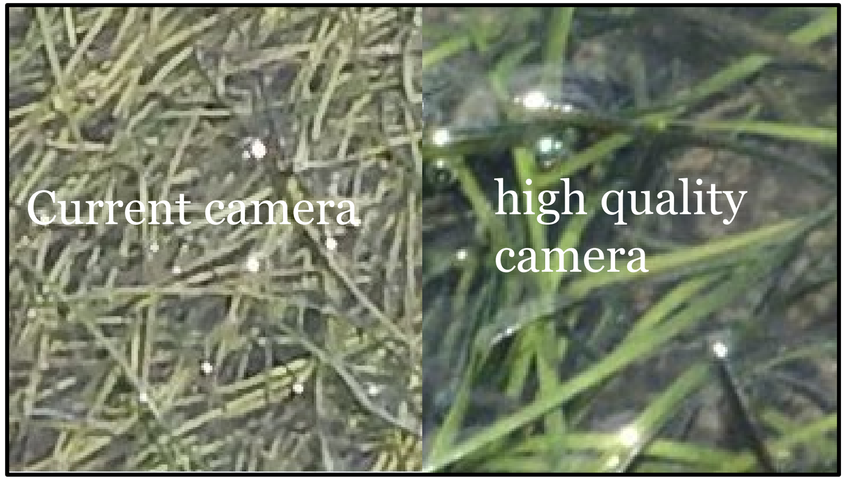
- Classification uncertainty by using Monte Carlo Dropout (100 runs)
- Uncertainty of area calculation by variation of the opening angles of the camera, the image taking height and the inclination of the plane
- Uncertainty for „Simple“ und „Otsu“ by flat 10% uncertainty per segment; for „GLI“ variation of the threshold value.
- Uncertainties on the individual segments are neither fully correlated (linear combination) nor fully uncorrelated (quadratic combination) -> mean value from both
- Uncertainty on the result of the transect point by error propagation from the individual images

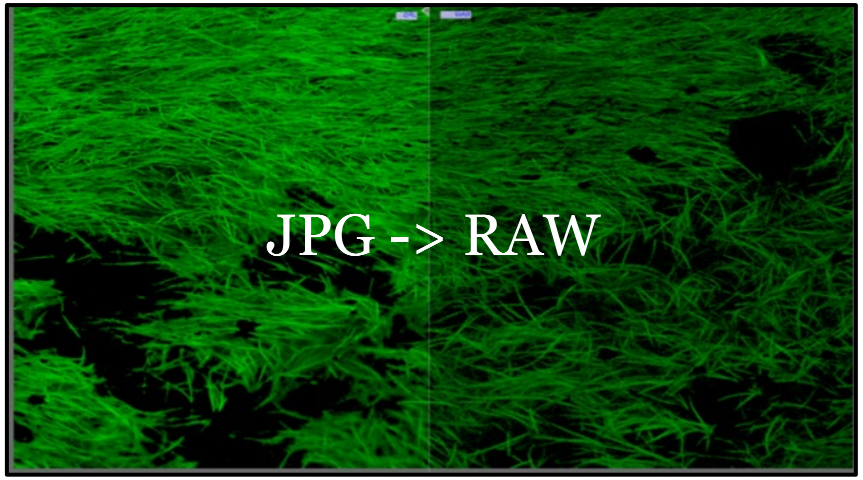
AI-based estimate: BOLKI2Fly

Planned for 2022

Improvements by usage of higher quality images

- Collection of data with a higher resolution and evaluation of new performance
  - Usage of polarization filter to reduce reflections
  - Possible usage of RAW instead of JPG format





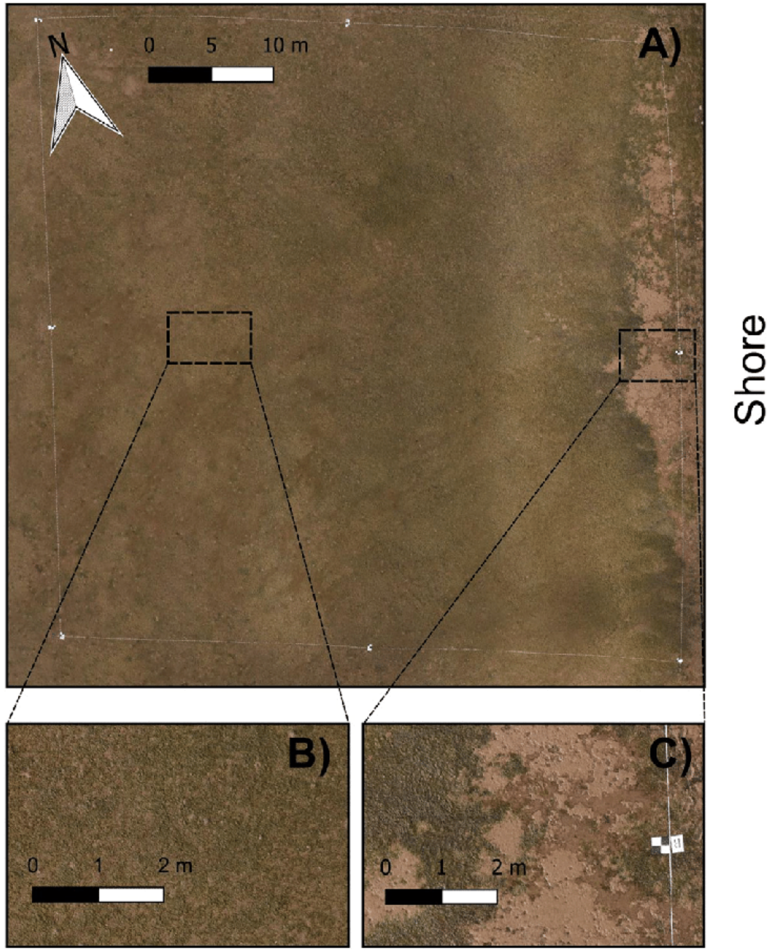
- Evaluation of feasability and benefit in the field
- Provision of an interfaces for running and managing of training by the LKN
- Testing of the procedure on drone images

AI-based estimate: data taking via drones

Planned for 2022

- Few images per transect point needed
- Challenges in the wadden sea:
  - Frequent high wind speeds -> sufficiently large drone needed
  - Several hours of data taking -> large drones have small range
  - Starting an landing in the wadden sea problematic

- Incorporate this objective ground truth data into EO production process will improve the whole process.



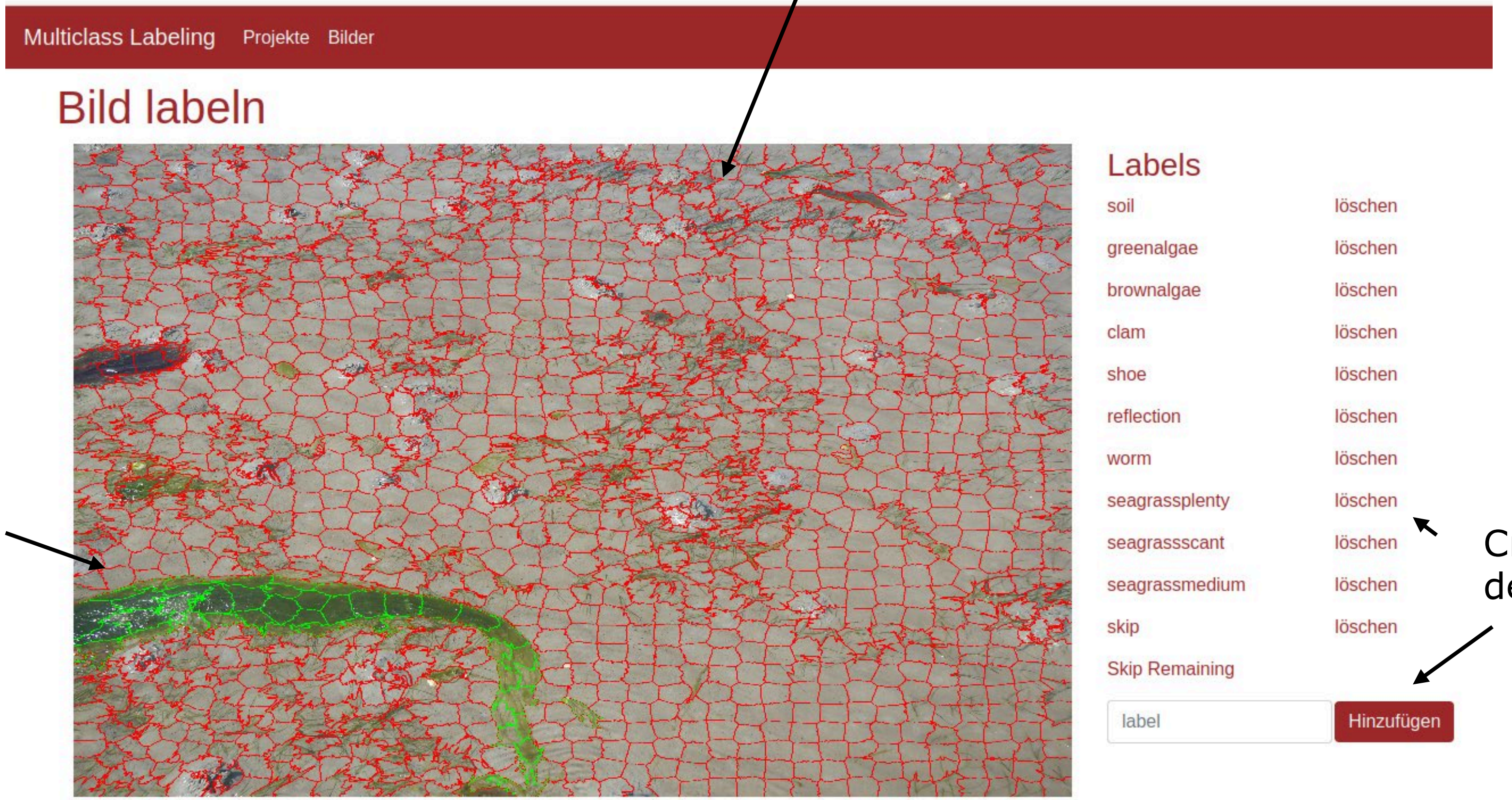
Source: „Spatial assessment of intertidal seagrass meadows using optical imaging systems and a lightweight drone“, Duffy et al.


Thank you
for your attention

AI-based estimate: labeling tool

Zoom by mouse wheel

Labeled images will be saved in a format imediately usable by Tensor Flow



Choose segments and label them in bulk

Create and delete classes

AI-based estimate: training data

- Efficiency calculation on test data
- Quality probably slightly overestimated since calculated on segements easily assessed by eye

Class	Number of images	Efficiency [%]
Soil	8319	95
Brown algae	215	29
Green algea	524	42
Shell	95	56
Reflection	103	30
Seagrass (scant)	4213	82
Seagrass (medium)	2500	68
Seagrass (plenty)	6194	94
Lob hill	1129	79

AI-based estimate: misidentification examples

- Misidentification by neural net
- Smearing by non optimal threshold setting (GLI)
- Overselection by Otsu