KELPPRO

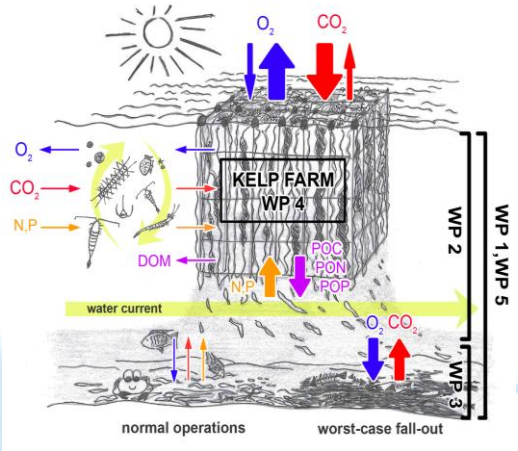
Kelp industrial production: Potential impacts on coastal ecosystems

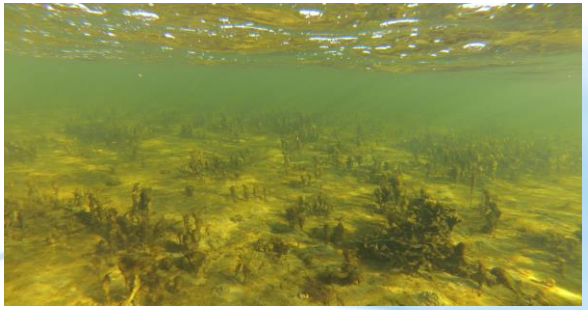
WP#2 – EFFECTS OF INDUSTRIAL KELP PRODUCTION ON SEA FLOOR ECOSYSTEMS

- **WP lead**: Kasper Hancke, NIVA
- **Partners**: SINTEF, ApN, SDU and SES
- **Time frame**: 2017-2019

Kasper Hancke, PhD, Researcher at NIVA

KELPPRO Kick-off meeting, Oslo Science Park 22. March 2017





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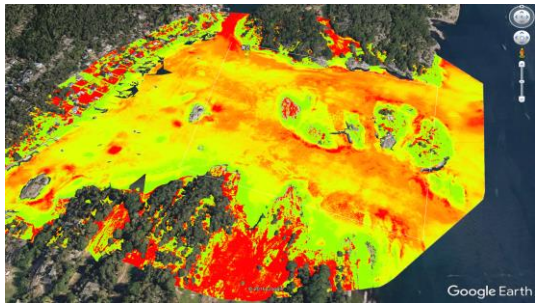
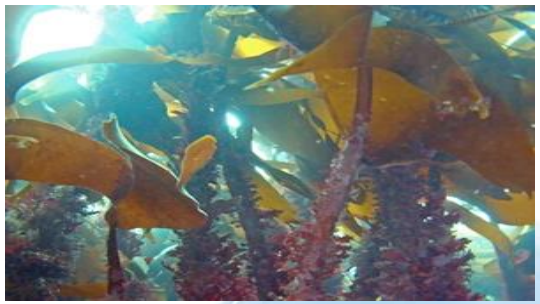
Objectives:

1) Quantify the potential export of detached kelp biomass from commercial production facilities

2) Map transport pathways and 'deposit areas' for exported kelp

3) Investigate impact and fate of exported kelp on sea floor habitats under and in vicinity to production sites





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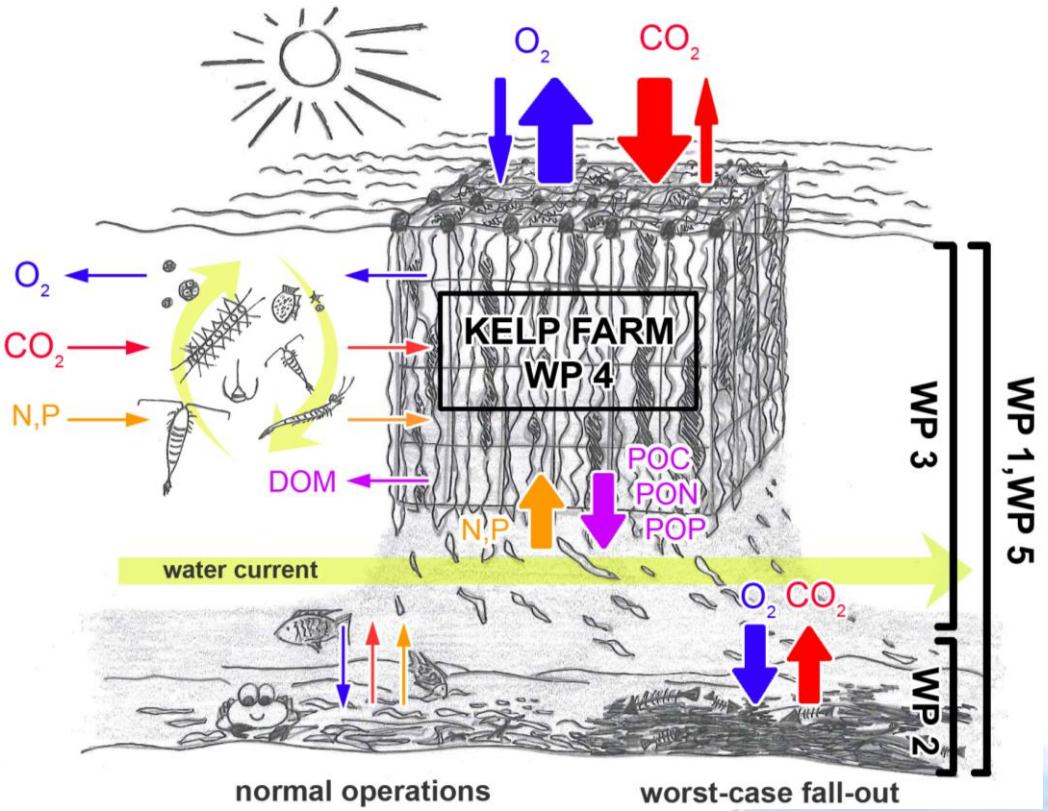
Research focus:

- **WP#1**: Industrial kelp cultivation scenarios
- **WP#2**: Effects of industrial kelp farming on sea floor ecosystems
- **WP#3**: Effects on open water ecosystems
- **WP#4**: Industrial kelp facilities as 'artificial kelp forests'
- **WP#5**: Integration and dissemination



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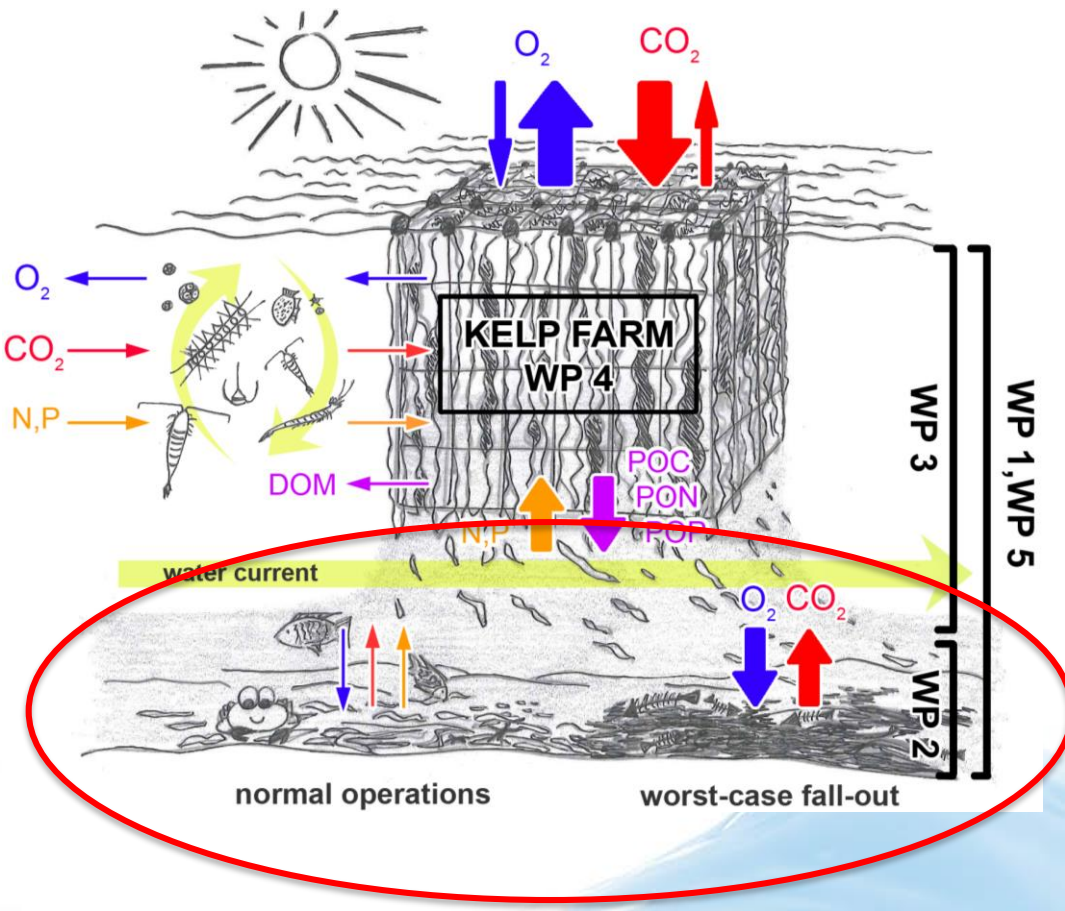
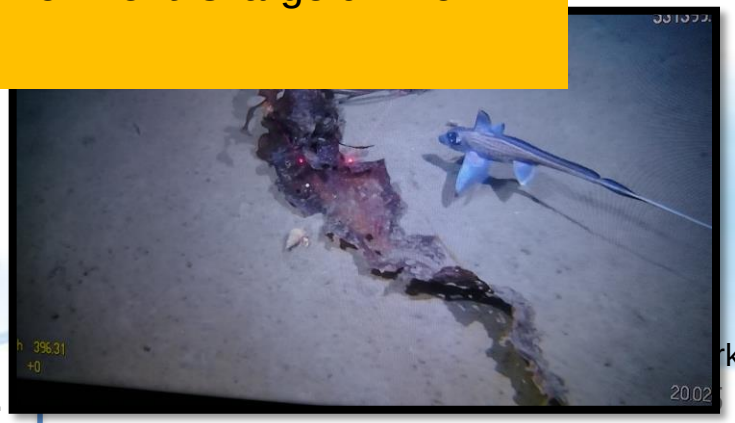


Kelp detritus as blade erosion, partial fragmentation, or entire dislodgement



- Export from natural kelp forests is estimated to ~80% of the standing biomass per year (20% is internal turnover (Norderhaug & Christie 2011).
- Expected export of cultivated kelp is less, however preliminary data suggest substantial export (Fieler & Hangstad 2012).
- Kelp detritus export estimates are ~700 g C m^{-2} yr^{-1}, but the fate and turnover time in the environment is large unknown (Krumhansl and Scheibling 2012)

Photographs: K. Filbee-Dexter and T Bakken

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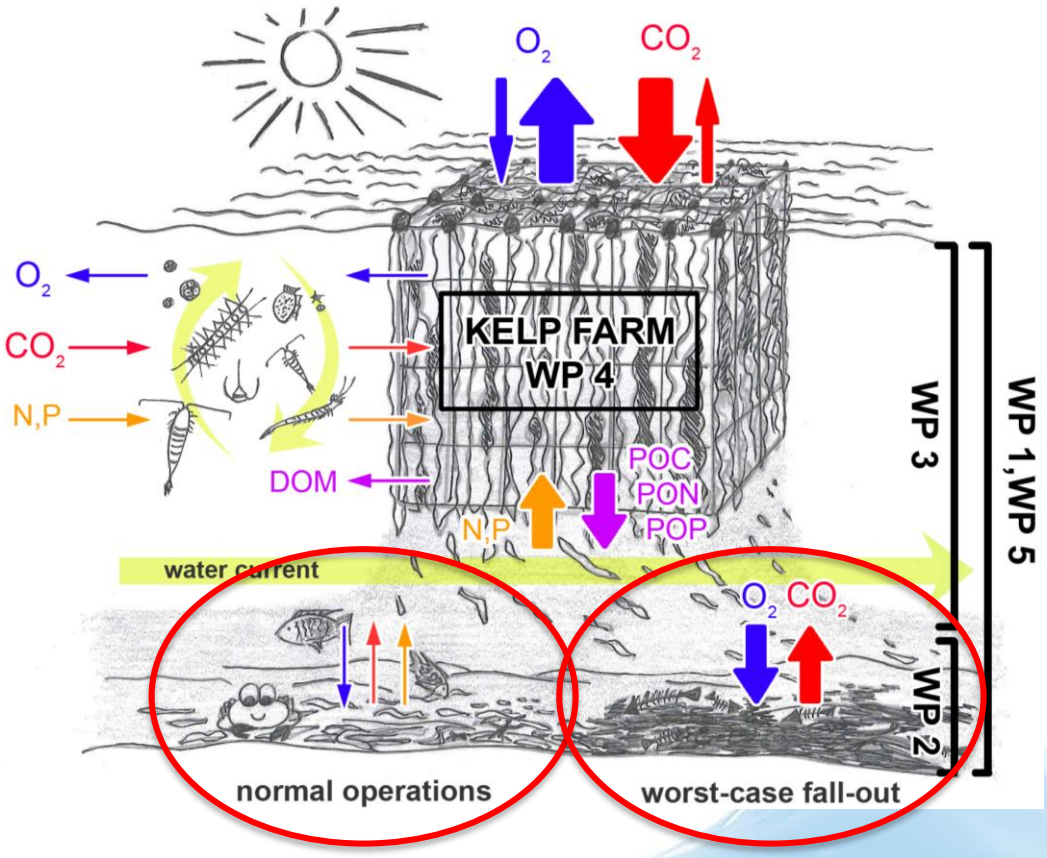
Task 2.1 (ApN)

Estimate **export** of kelp detritus.

'**Normal operation**' kelp detritus export will be estimated in situ using a novel **labelling technique** enabling estimates of specific growth, loss of biomass, and fraction size (*ApN*)

Site: SES.

The kelp module of **SINMOD** will be updated and used to extrapolate detritus export to future and '**worst-case**' scenarios *(SINTEF)*



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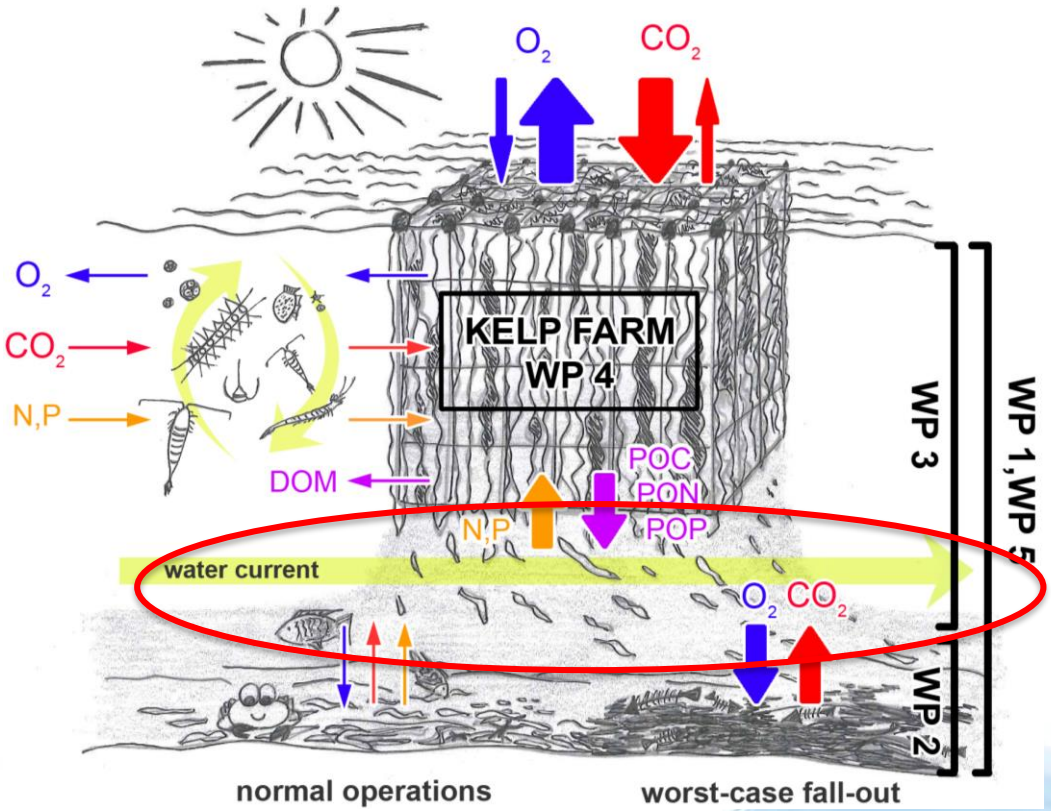
Task 2.2 (SINTEF)

Transport pathways and '**deposit areas**' for exported kelp will be simulated using **particle tracking** modules coupled with the kelp growth model (WP#1).

The "**numerical particles**" will be equipped with biomass, composition (C:N) and density. Transport ways, deposited biomass and areas with size ranges will be computed.

Data will make available detailed spatial **distribution maps** of **accumulated kelp**, and be guiding the in situ sampling and measurements (T2.3, 2.4).



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Task 2.3 (NIVA)

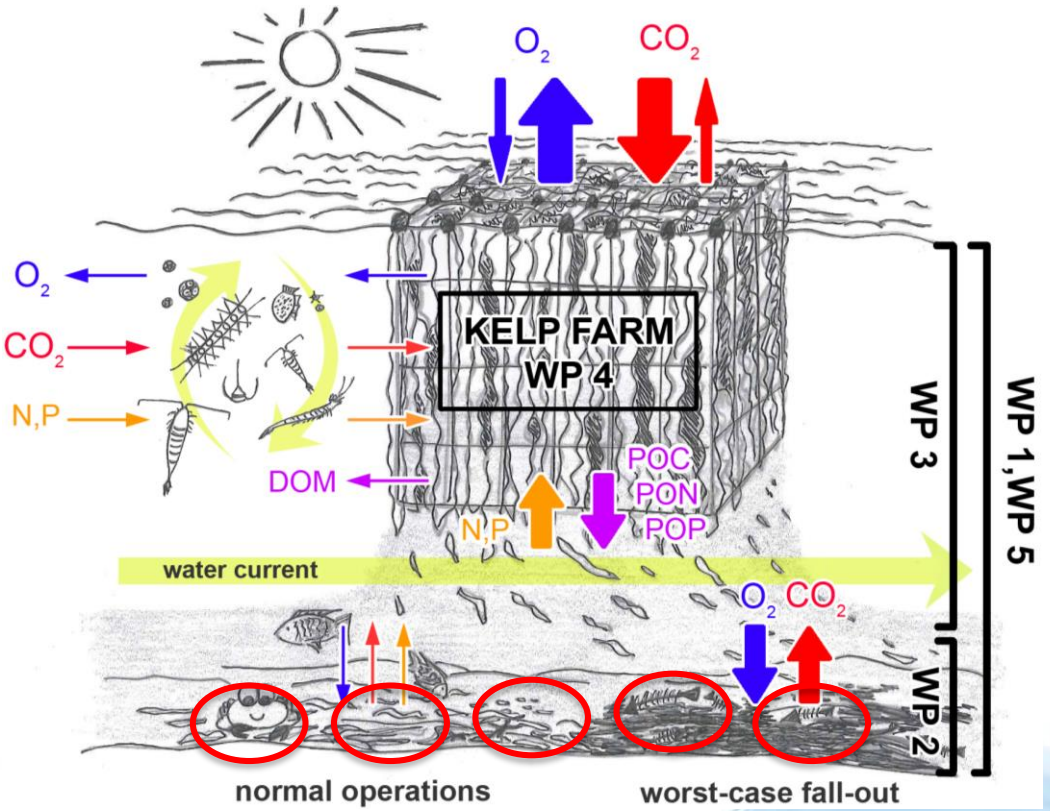
Impact studies on sea floor biodiversity and function.

Benthic macrofauna (>1 mm) abundance and diversity will be estimated using grab samples across a density gradient of kelp detritus (including TOC, total N, grain size).

Species composition indexes will be calculated to assess the 'ecological quality'.

Functional trait analysis will be related to morphology, physiology, phenology and behavior.

Form guidelines for monitoring methods (WP#5).



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Task 2.4 (SDU & NIVA)

Impact of kelp detritus; tipping point between food source or ecosystem threat.

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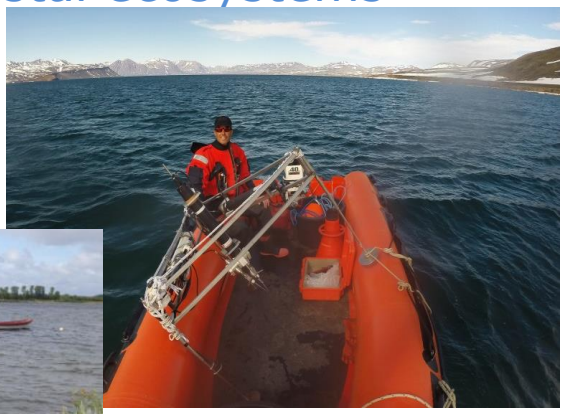
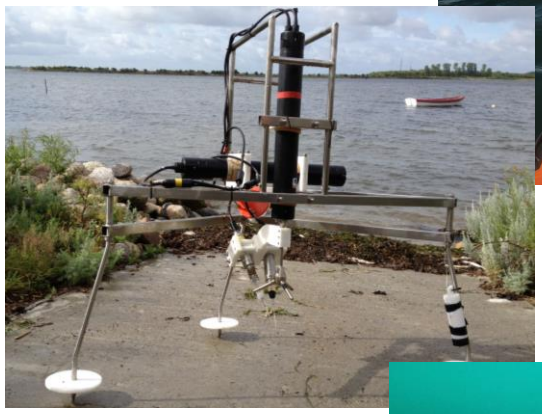
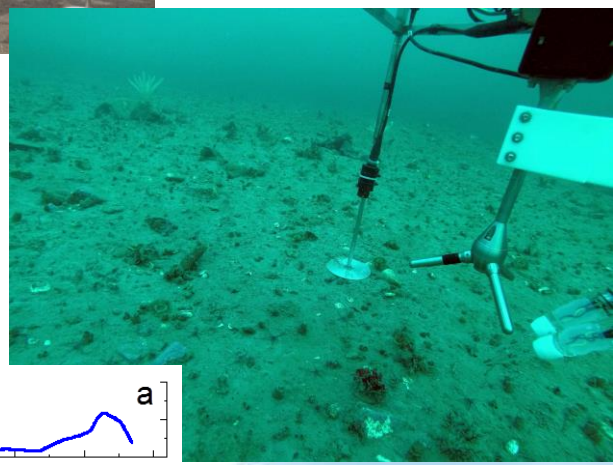
State-of-the-art "Eddy Covariance" (EC) measurements will be applied in situ to resolve sea floor O2 consumption and current velocity continuously (4Hz) over periods for days to weeks.

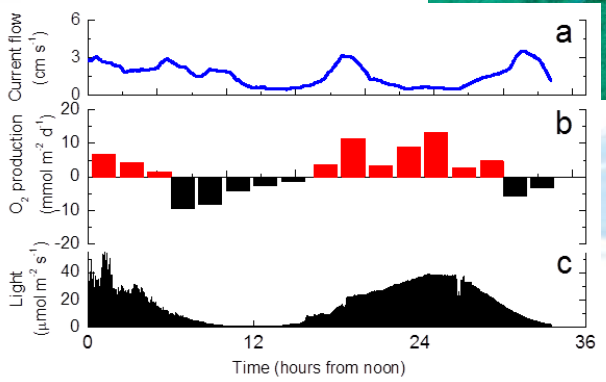
SCUBA deployments across detritus gradients will provide in situ data to determine tipping point of kelp detritus being a food source or threat to sea floor habitats.

Findings will be compared with KELPEX (RCN, 2016-2018) which address the biogeochemical fate of export of biomass from natural kelp forests.









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Task 2.5 (NIVA, Solbergstrand)

Fate and bio-availability of exported kelp will be quantified from mesocosms experiments (Solbergstrand research facility, NIVA).

Degradation time of kelp will be quantified (*Saccharina and Alaria*) as a function of biomass, detritus particle size, O2 availability, and flow velocity.

Experiments will provide data on degradation time, oxygen demand for degradation, CO2 production, and nutrient release rates.

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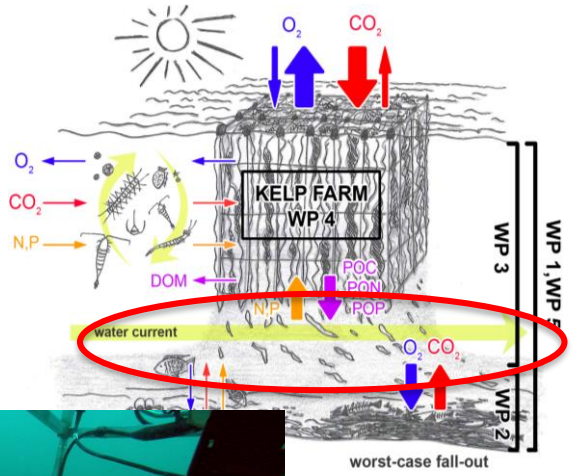
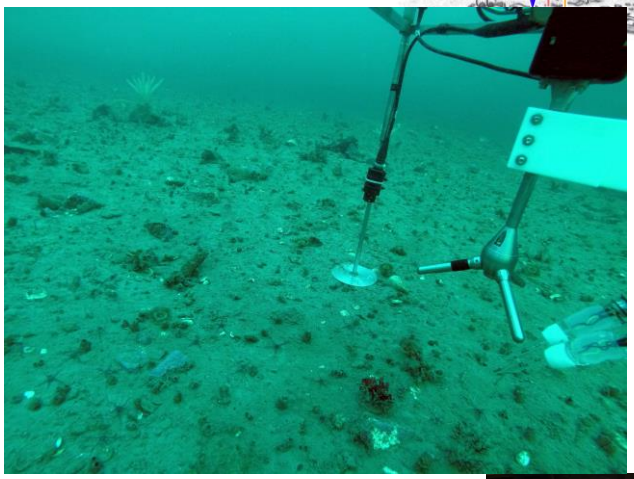
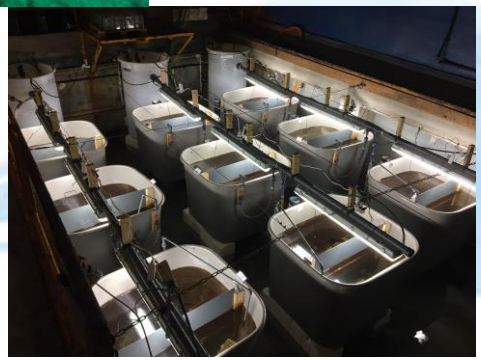
WP#2 deliverables:

- **Paper on kelp detritus export** (C, N, P), fate, and impact on sea floor biodiversity and ecosystem functioning
- **Paper on kelp detritus being a food source or ecosystem threat**: an in situ Eddy Covariance study
- **Paper on degradation and bioavailability of kelp detritus** as function of detritus size and O2 availability: a mesocosms study
- **Input to WP#5**







Time line

KELPPRO gantt diagram	2017				2018				2019				2020			
NFR HAVBRUK2, 2017-2020	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
T1.1 Areas for kelp production	x	x														
T1.2 Specification of cultivation scenarios	x	x	x													
T2.1 Estimate export of kelp detritus				x	x											
T2.2. Transport pathways and 'deposit areas' for exported kelp					x	x										
T2.3 Impact studies on sea floor biodiversity and function						x	x									
T2.4 Impact of kelp detritus; tipping point between food source or ecosystem threat						x	x									
T2.5 Fate and bio-availability of exported kelp									x	x	x					
T3.1. Quantification of nutrient (N, P) and C (CO_2) uptake and retention in kelp	x	x	x													
T3.2. The effect of kelp farming on the carrying capacity	x	x	x													
T3.3 The potential of bioremediation by kelp farming								x	x	x						
T4.1. Abundance, species composition and function										x	x					
T4.2. Distribution of unwanted and red-listed species										x	x					
T4.3. Genetic diversity in natural kelp											x	x	x			
T5.1. Synthesis an integrated assessment												x	x	x		
T5.2. Provide guidance													x	x	x	
T5.3 *Ensure efficient communication*		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Kick-off workshop		x														
Concluding workshop															x	
Annual meetings		(x)			x				x						(x)	
post doc (SDU)									x	x	x	x			x	
post doc (NTNU)	x	x	x	x											x	
Scientic publication				x	x	x	x	x	x	x	x	x	x	x	x	x
End-user guidance and reporting				x				x				x	x	x	x	x
Conferance contributions							x								x	
Website and public outreach	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x