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FP7-IDREEM project Deliverable 5.1.

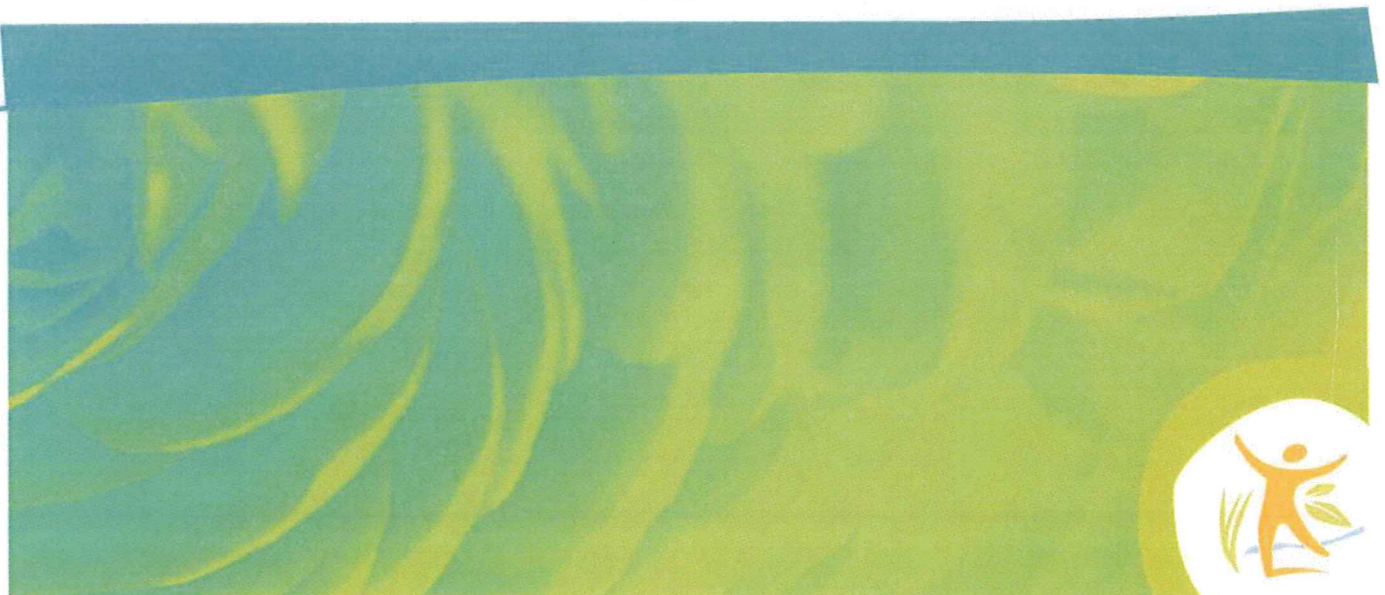
Detailed plan and description of the future IMTA system at Oldervika site (Nordland, Norway).

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Sammendrag:
7RP - EU IDREEM (Økt ressursutnyttelse i Europeisk akvakulturindustri) prosjektet vil ta for seg Muligheter og utfordringer for IMTA (integrert multi-trofisk akvakultur), og slik søke å utvikle økonomiske, miljømessige, tekniske, sosiale eller juridiske løsninger. IDREEM-prosjektet vil utvikle verktøy og kunnskapsgrunnlag for implementering av IMTA i oppdrettsnæringen. I Norge er oppdrett av Atlantisk laks i Morsdalfjorden på lokaliteten Oldervika (Gildeskål, Nordland) blitt valgt ut til å være et demonstrasjonsanlegg for dette tverrfaglige forskningsprosjektet. Denne rapporten presenterer fremtidige IMTA-systemer som planlegges gjennomført i løpet av de neste fire årene i Oldervika, samt de utfordringer (hovedsakelig forskriftsmessige og teknologiske) som må imøtekommes av Bioforsk og GIFAS for å kunne implementere IMTA-system i kommersiell størrelse.

Summary:
The FP7 - IDREEM EU (Increasing Industrial Resource Efficiency in European Mariculture) project addresses the obstacles and challenges of IMTA, and on this basis develop economic, environmental, technical, social or legal solutions. The IDREEM project will provide tools and evidence knowledge-based to support adaptation to IMTA in the aquaculture industry. In Norway, the Atlantic salmon farm located on Oldervika site in the Morsdalfjorden (Nordland, Norway) has been selected to be a demonstration site for an interdisciplinary research project. This report presents a description of future IMTA systems planned to be implemented in the next 4 years at the Oldervika salmon farm as well as the challenges (mainly regulatory and technological) met by Bioforsk and GIFAS to implement a commercial IMTA system at a commercial size.

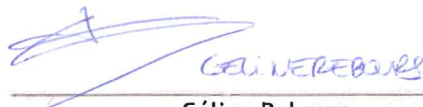
Land/Country:	Norway
Fylke/County:	Nordland
Kommune/Municipality:	Bodø and Gildeskål
Sted/Lokalitet:	Bodø and Gildeskål

Godkjent / Approved

Prosjektleder / Project leader

A handwritten signature in blue ink, appearing to read 'Rolf Rødven', written over a horizontal line.

Rolf Rødven

A handwritten signature in blue ink, appearing to read 'CÉLINE REBOURS', written over a horizontal line.

Céline Rebours

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1. Keys Aspects to design an IMTA system in North of Norway

1.1. Criteria of selection for testing IMTA systems at the Oldervika site (Nordland, Norway)

Oldervika site was selected based on the description of the production parameters as well as the environmental and ecological conditions described in Meland *et al.*, 2013. In addition the criteria of easiness to access to the site as well as working on site were also considered to select the Oldervika site (ANNEX I). Road access is available on the East side of the Morsdalsfjorden and the access from this road to the off shore fish farm is convenient by RIB or barge (Figure 1). Working premises (platform with housing including office and lab facilities) are also directly available on site (ANNEX I, figure 3). On the East side of the Morsdalsfjorden, GIFAS owns also on land facilities that can be used to perform the analyses needed to study the site (Figure 1).

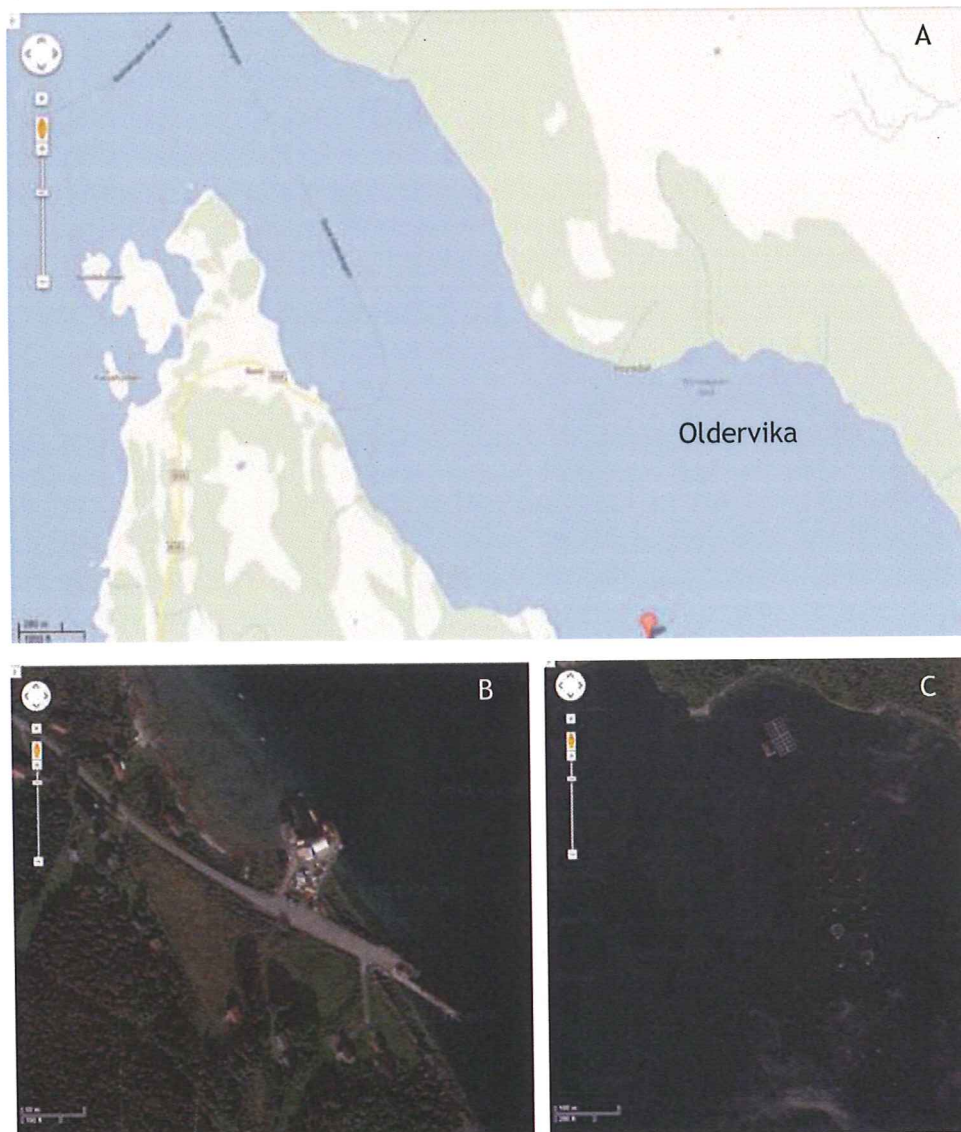


Figure 1: Morsdalsfjorden close to the Oldervika site (A) with road access and premises both on land (B) and at sea (C)(Google Maps - ©2013 Google).

1.2. Issues pertaining to the logistics of running a research project alongside with existing commercial fish farms at Oldervika site

At GIFAS, the activities related to the commercial production of the Atlantic salmon, are coordinated by the manager for small-scale production (Ronald Jørgensen) and the manager for large-scale production (Roy Arne Eilertsen). The research activities are coordinated by the GIFAS research manager (Dr Johan Johansen). In the IDREEM project, the project manager at Bioforsk (Dr Céline Rebours) develops documents and suggestions with her team (Marte Meland, Lill Iren Dreyer and Per Magnus Hansen). Bioforsk team submits schedules, proposals and reports for the research activities related to the IDREEM project needed to be done on the production site to the research manager at GIFAS. The schedules, proposals and reports are then adjusted to the recommendations from the research manager at GIFAS, whom later coordinate with the different managers at GIFAS the practicalities of the research activities related to the IDREEM project on GIFAS facilities. The research activities regarding the IDREEM project around a commercial production of fish are very much related to availability of personnel and boats at the fish farm. The spring is the busiest period of the year for marine fish farming, and priority must be given to the production of the salmon as it is for now the main source of income for GIFAS.

However GIFAS has strong interest to develop IMTA system and therefore wishes to investigate several IMTA system including kelp, red algae and mussels as added-on species at the same site that a pre-existing 6 years old Salmon farm. GIFAS wish to implement the existing fish farm with blue mussels in order to observe the effects on sea-lice infestation. The blue mussels' farm was not initially planned in the IDREEM project and therefore could be considered in the latest year of the IDREEM project and if funding is allocated thought additional projects. Several years of data are already available on the salmon farming at Oldervika and a description of the production parameters and environmental and ecological conditions are made by Meland *et al.*, 2013. GIFAS wishes also to have the possibility to use these local added-on products directly in their fish farm, either under the form of food ingredients or as local source of energy supply. GIFAS has interest in having environmentally friendly production and therefore wish to also develop a system that will reduce the emission of nutrients (Nitrogen, Phosphorus) from their fish farms to the environment.

The restrictions on implementing add-on species on the existing the fish farm site are related to the daily running of the activity on the salmon farm, meaning that at the distance between any added-on infrastructures and the existing salmon farm should not prevent the maneuver of the Well boat (fish harvesting). Moreover no rope or structure in the water that could prevent the workers at the salmon farm to reach shelter in case of bad weather. At the time being the required distance between any added-on infrastructures and the existing salmon farm by the site manager (Roy Arne Eilertsen) is 100 m.

There are other fish farms and hatcheries in the fjord (ANNEX II) that affect strongly the load of nutrients. The closest is the GIFAS site in Stigvika, but as the current across the fjord is considered minimal, the farms are considered to be separated and not to impact each other. Other sites are Leirvik Nord and Sundsfjord Smolt (land based smolt production). Rivers and runoff from the mountain especially in the spring also delivered consequent amount of freshwater and nutrients to the Morsdalsfjorden. Some rivers such as Sundsfjordelva are also regulated by a dam. All these activities in the fjord may affect the direct observation that will be achieved during the IDREEM project.

1.3. Regulatory restriction pertaining to the logistics of running a research project on IMTA alongside with the commercial fish farm

The main restriction for the design a commercial scale IMTA production system is due to the regulation that do not allowed the aquaculture of 2 species on the same location and required a distance of at least of 5 km between 2 different species. At any given site only monoculture is allowed and regulations do not allowed combinations of fish or shellfish species (with the exception of cleaner fish). Seaweed represents an unclear area as their aquaculture was not taken into consideration in establishing the regulation. In the case of pilot or research studies scales, exceptional authorizations have been obtained to cultivate 2 different species on the same production site. Until now in Norway, these exceptional authorizations have been only delivered for IMTA systems including salmon-algae or mussels-algae. As far as we know, there have been no authorizations for farming of mussel-salmon, or algae-mussels-salmon on a same production site.

2. Proposals for implementation of an IMTA system in a salmon farm at Oldervika site (Nordland, Norway).

2.1. Locations of the add-on species

Different solutions are for now considered to be implemented at the Oldervika site:

- 1) Longlines placed in cages (Canadian method),
- 2) Longlines placed in open rooms between the frames of the fish farm,
- 3) Longlines structures (2x 400m, 10-15 wide). The structures should be placed 100m from the fish cages in a North West direction, in the main current direction,
- 4) As 3, but install two rafts, one in a North West and South-West.

At the present stage of the IDREEM project, the IMTA system has been designed to place the seaweed lines downstream of the strongest tide current (green rectangle, Figure 2). These longlines will be placed at 100m from the fish cages. The location of the control site where add-on species will be grown without effect from the fish farm is still in discussion.

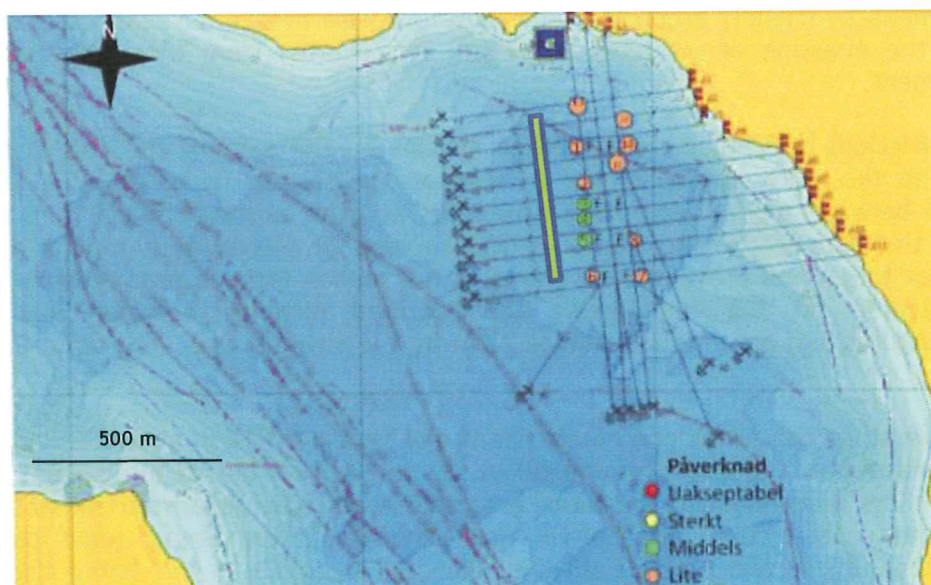


Figure 2: Fish farm infrastructure at the Oldervika site with position of the longline raft (green rectangle). “Påverknad” indicated the gradient of the effect of the farm on the sediment from no acceptable (uakseptabel), strong (sterk), medium (middels), small (lite). F: cages with fish.

2.2. Selection of the add-on species

Due to the status of IMTA and seaweed culture in Norway, GIFAS future development strategies and the actual regulatory restriction on polyculture in Norway (Rebours *et al.* 2013): two species have been proposed for cultivation by Bioforsk: *Saccharina latissima* as a first choice and eventually *Alaria esculenta*.

However, different set ups are still under discussion and different add-on systems could be tested and monitored during the period of the IDREEM project:

- Year 1: Atlantic salmon monoculture
- Year 2: Atlantic salmon + kelp
- Year 3: Atlantic salmon + kelp + mussels
- Year 4: Atlantic salmon + kelp + mussels + red algae

In addition the add-on species will be cultivated on a control site located away from any fish farm.

2.3. Design for the longline infrastructure

The infrastructure of the existing fish farm is very complex and required to take precaution while installing the new infrastructure in order to implement the add-on species on the same site. The site Manager (Roy Arne Eilertsen) is very closely involved in the decision making when designing the infrastructure. In addition, Bioforsk and GIFAS are in the process of establishing a closed collaboration with companies that have expertise in seaweed longlines cultivation (Hortimare BV) and maritime infrastructures (Løvold AS).

Hortimare is a leading company in seaweed breeding and culture in Norway and the Netherlands (Figure 3, www.hortimare.com). Their concept of seaweed culture in an IMTA system is already implemented in the South of Norway (Figure 3). Subcontractor in the IDREEM project, Hortimare will act as a consultant for:

- Organising with Bioforsk the infrastructure of the future seaweed farm in an IMTA system at Oldervika site (and eventually at the control site) with close collaboration with GIFAS. Further meetings with GIFAS will be organised at the end of August 2013 to decide of the practical way to achieve the future deployment at sea of the seaweed farm.
- Organising with Bioforsk the production of the seedlings strings prior to the deployment at sea
- Organising with Bioforsk the deployment of the seedling at sea
- Organising with Bioforsk the parameters that need to be followed on the seaweed farms for assessing the productivity of the farm

Løvold AS (<http://lovoldas.no>) is a local company that was involved in the construction of Oldervika salmon farm. This company has longtime expertise in industry, construction, offshore, marine, aquaculture and can delivered most of the products and services tailored to any industry especially maritime. Løvold AS is interested in collaborating in the design of the infrastructure for the seaweed farm at sea and in delivering the ropes for settlement of seedling.

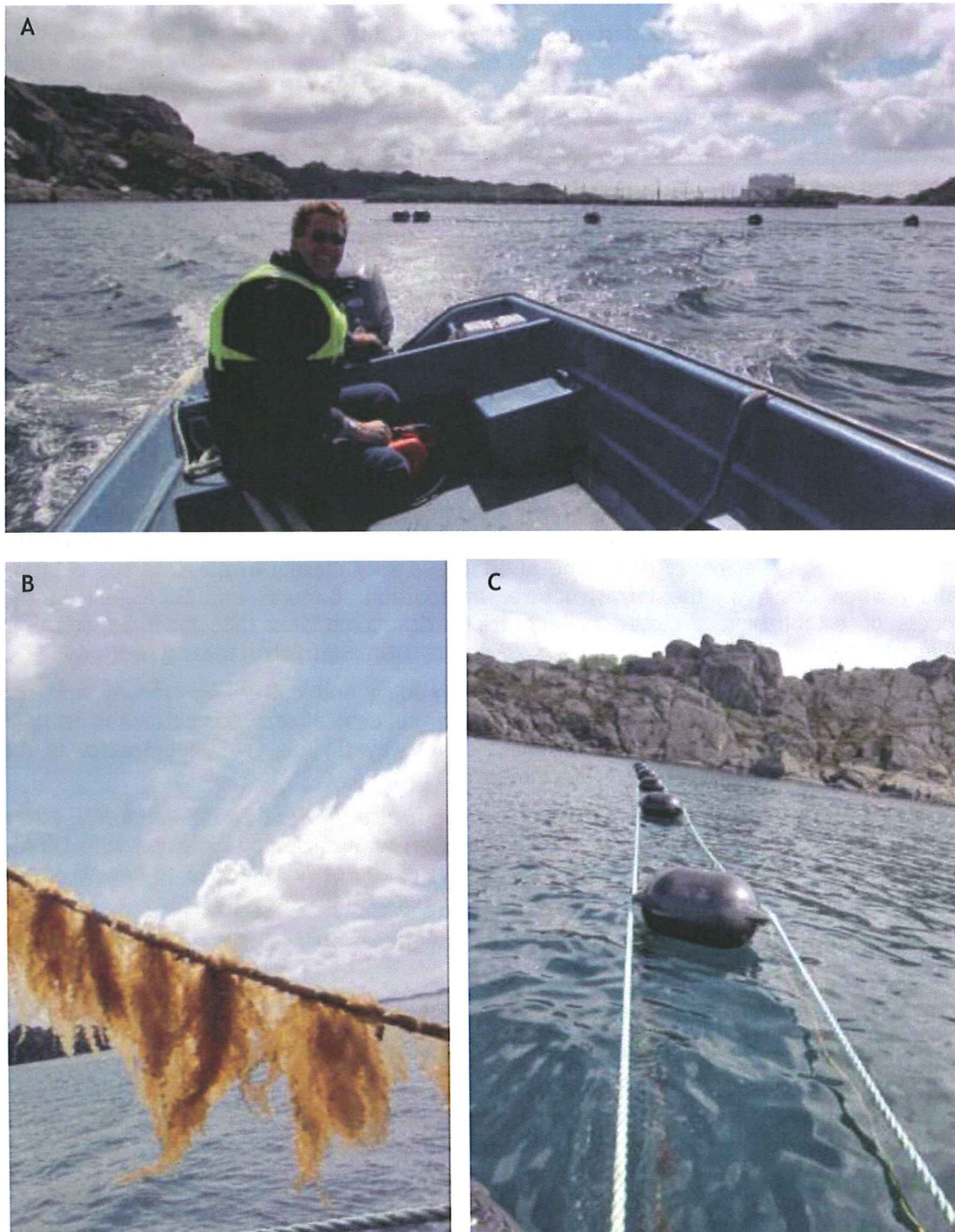


Figure 3: Example of Hortimare BV's IMTA Design for combination of Salmon and Seaweed at Fureholmen site (Sølund Kommunen, Norway). **A:** founder and CEO of HORTIMARE AS, Job Schipper at the IMTA site at Fureholmen site (Sølund Kommunen, Norway); **B:** *Saccharina latissima* juveniles in Hortimare AS's Seaweed design for an IMTA system that include seaweed within the salmon farm of Sulefisk AS; **C:** Close-up of the seaweed raft.

3. Conclusions

Detailed plan and description of the future IMTA system at the Oldervika salmon farm is still under discussion as several components still need to be addressed:

1/Regulatory challenges: In the following months Bioforsk and GIFAS will meet with the Gildeskål Township and Nordland County council to address the regulatory issues that limited the development of an IMTA system to a commercial scale. In the meantime, GIFAS will apply for a temporary dispensation to be able to have a pilot study infrastructure on the Oldervika site in 2014.

2/Technological challenges: Bioforsk and GIFAS have invited two leading companies (Hortimare BV and Løvold AS) in the field of aquaculture with interested in IMTA and seaweed to collaborate in the design of seaweed longlines cultivation.

In conclusion, Bioforsk and GIFAS will follow the above process to be able to implement a commercial IMTA system at Oldervika site:

- Design an IMTA system that will integrate salmon and algae farms,
- Consult Hortimare AS on the deployment of algae lines at sea in IMTA systems. Hortimare AS has already developed a pilot IMTA with Salmon Group in the south of Norway,
- Consult with Løvold AS for the rope technology and infrastructure at sea. Løvold was involved in the deployment of the salmon cages at Oldervika site,
- Produce documentation about the implementation of an experimental or pilot-scale IMTA system in Nordland County,
- Meeting and consultation with Representative of Gildeskål Township in the planning to get access to area to develop the IMTA farm,
- Meeting and consultation with the representatives of the Nordland County in the planning in order to apply for co-cultivation of seaweed at the experimental site,
- Deployment at sea of a pilot scale experimental IMTA farm (added-on seaweed farm to an existing salmon farm) in mid-2014,
- Produce documentation about the implementation of an IMTA system in Norway at commercial size,
- Meeting and consultation with various police markers to inform about the IMTA,
- Apply to the Ministry of Fisheries and Coastal Affairs for a concession to cultivate algae at a commercial size,
- Inform stakeholders at the regional and national levels about the results of the project.

4. References

Meland M., Johansen J., Jørgensen J. & Rebours C., 2013. FP7-IDREEM project Milestone 18. Part I: Review of the production parameters at the Oldervika salmon farm (Nordland, Norway). Bioforsk RAPPORT: 8 (74) 2013. ISBN: 978-82-17-01095-1

Rebours C., Meland M., Johansen J., Jørgensen J. & Eilertsen R.A., 2013. FP7-IDREEM project Milestone 18. Part II: gaps identification and samplings methods for establishment of a future IMTA design at the Oldervika salmon farm (Nordland, Norway). Bioforsk RAPPORT (*in progress*).

ANNEX I: Oldervika in Pictures 1/4



Figure 1: Face to face meeting between RTD & SME pairings to develop IMTA system at GIFAS facilities in Gildeskål (NORWAY), Mars 14.2013. Left to right: Ronald Jørgensen (GIFAS), Johan Johansen (GIFAS), Marte Meland (Bioforsk), Céline Rebours (Bioforsk), Lill-Iren Dreyer (Bioforsk), Per Magnus Hansen (Bioforsk). Photographer: Roy Arne Eilertsen (GIFAS).

ANNEX I: Oldervika in Pictures 2/4

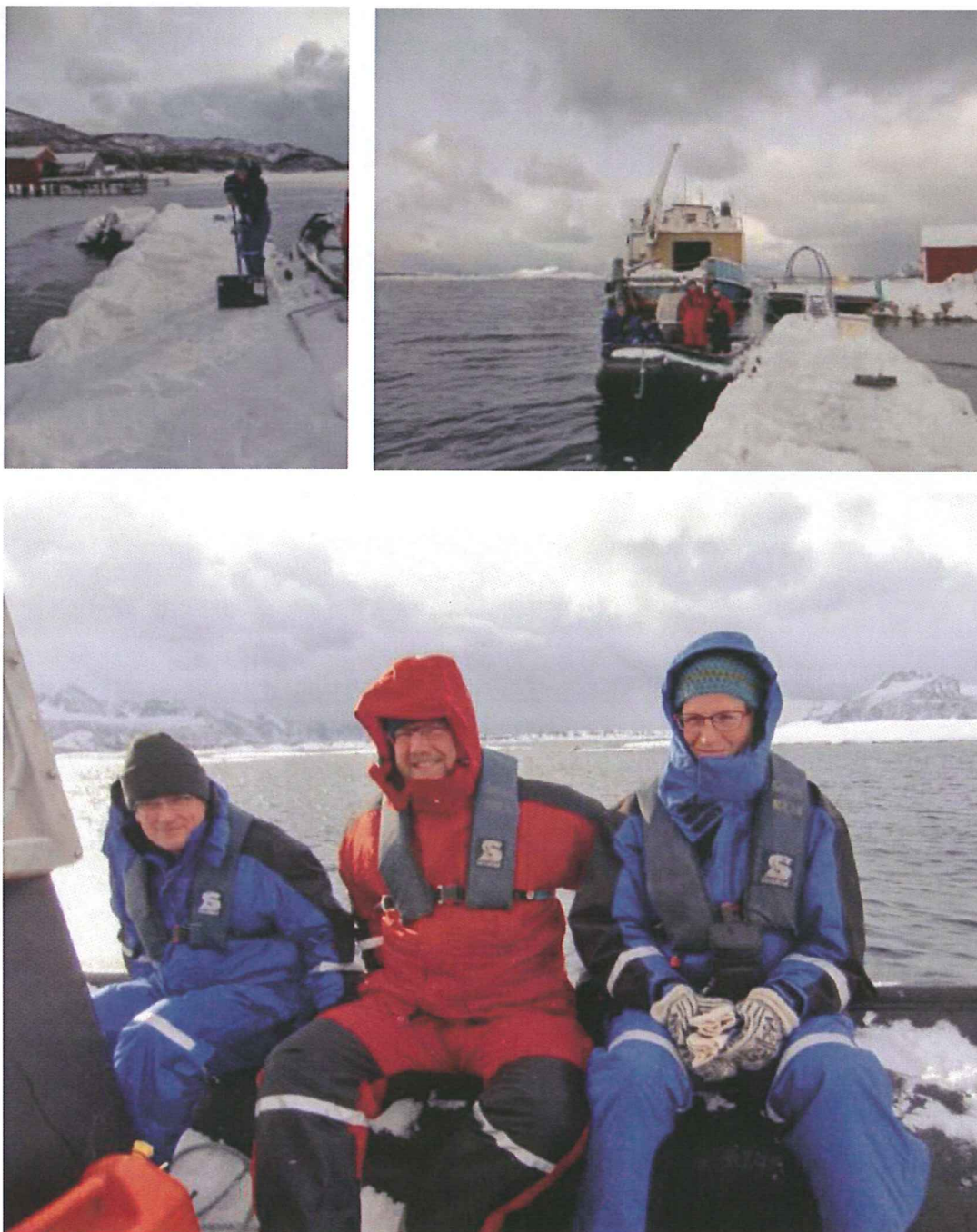


Figure 2: Departure in extreme weather conditions. Left to Right: Per Magnus technician at Bioforsk, Johan Johansen research leader at GIFAS and Marte Meland Junior researcher at Bioforsk. Photographer: Céline Rebours (Bioforsk).

ANNEX I: Oldervika in Pictures 3/4

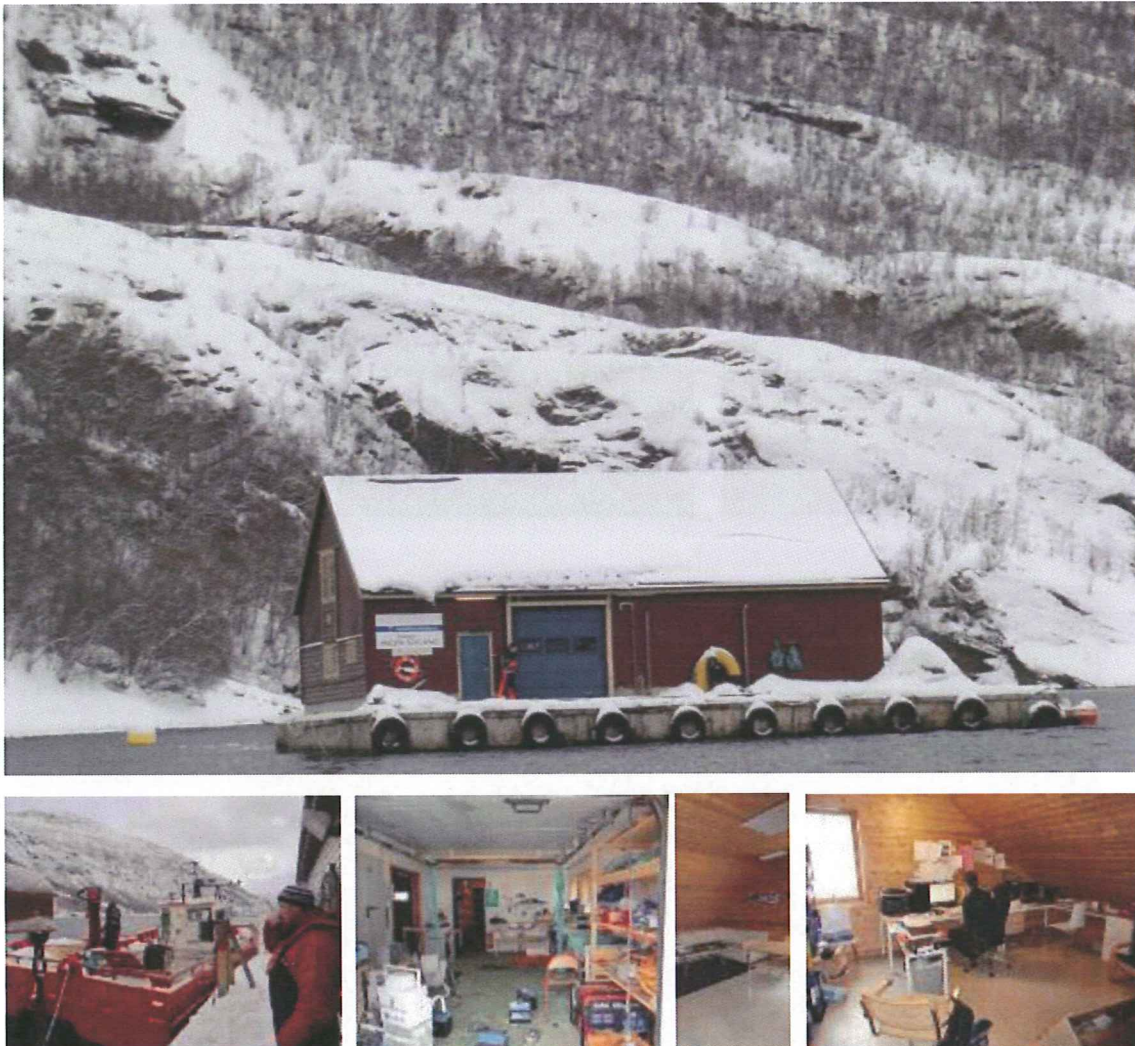


Figure 3: platform on the site of Oldervika: working boat, storage, workshop, office and lunch facilities. Photographer: Céline Rebours (Bioforsk).

ANNEX I: Oldervika in Pictures 4/4

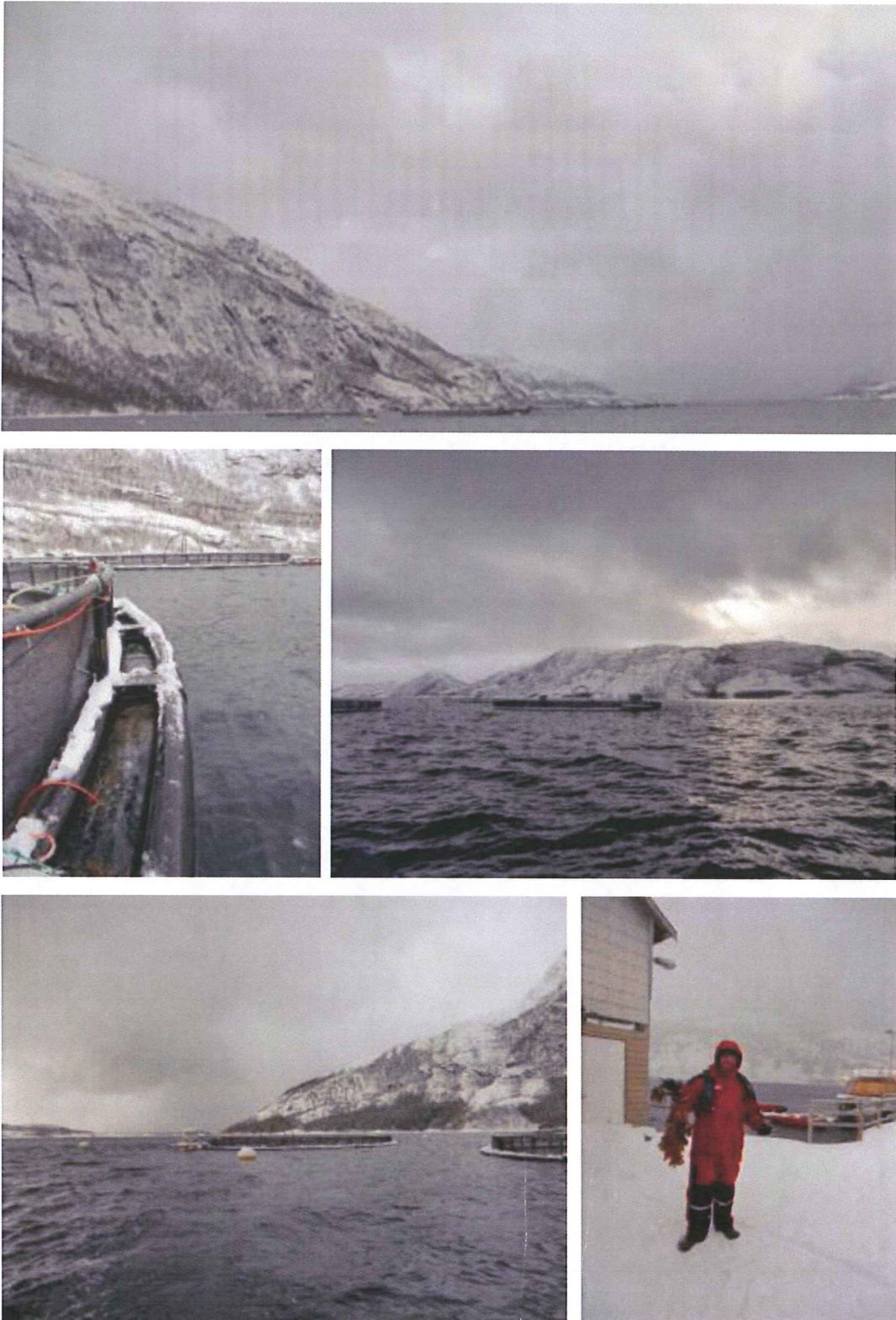


Figure 4: Oldervika's site with monoculture of salmon. Johan Johansen holding kelp harvested on the site. Photographer: Céline Rebours (Bioforsk).

