NET POSITIVE FISHING

Disruptive Seafood Harvesting Workshop

To create and build support for innovative selective harvest design concepts

JULY 2016

DELIVERED BY:

FUNDED BY:

FACILITATED BY:

EXECUTIVE SUMMARY:

To ensure a sustainable future for our fisheries, our oceans and the livelihoods of fishing communities, we have to disrupt the way we catch fish. And we have to start with **bottom trawling**, a deep sea fishing method where a large, heavy fishing net is pulled behind a boat along the seabed. Trawling has come under intense scrutiny from both environmental groups and regulators due to its often-negative impact on the seabed and the number of by-catch, or 'unwanted' sea creatures it mistakenly catches.

Recent developments in underwater image recognition, seaborne drones, light and laser technology are expanding our capabilities to better navigate the seas. Combine these technologies with greater understanding of fish behaviour, good fisheries management and improved ability to collect, analyse and curate vast amounts of data, and many of the tools needed to spur this disruption already exists.

To help fuel this innovation, three leading seafood-processing brands – Espersen, Icelandic Seachill and Nomad Foods – hosted a workshop and launched a **design challenge** aimed at reimagining fishing as we know it. Co-funded by the UK seafood authority Seafish and facilitated and hosted by FAI Farms, the workshop brought together industry actors and fishermen, scientists and technology developers to prototype transformational design concepts for new gear to effectively address the problems will bottom trawling.

Disruptive Technology Workshop: Selective Harvesting

ORGANISERS:

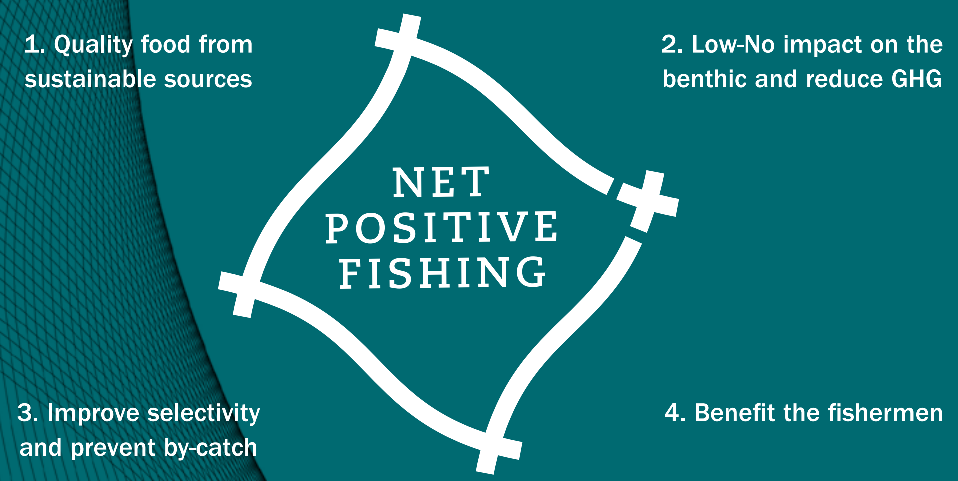
- Espersen, Icelandic Seachill and Nomad Foods
- Funded by Seafish
- Hosted and facilitated by FAI Farms

THE WORKSHOP PARTICIPANTS:

The workshop was hosted at FAI Farms in Oxford, UK, May 24–25th 2016 and brought together seafood industry actors, scientists and technology developers from across a variety of disciplines including, laser, light and ultrasound, seaborne drones and underwater recognition technology. The goal was to create and build support for innovative selective harvest design concepts, with the potential to transform the wild caught seafood sector.

NAME	ORGANISATION
Jan Geert Hiddink	Bangor University
Mark Smithers	Boston Engineering Corp
Bjarne Stage	DTU Aqua (University)
Alex Olsen	Espersen
Klaus Nielsen	Espersen
Øistein Thorsen	FAI
Rachel Aninakwah	FAI
Jan Roger Lerbukt	Hermes
William Davies	Icelandic Seachill
Torfi Þórhallsson	Light Hunting
Christian Degel	The Fraunhofer Institute for Biomedical Engineering
Daniel Stepputtis	Thünen-Institute
Dan Watson	Safetynet Technologies Ltd
Phil Macmullen	Seafish
Sigmar Gudbjornsson	Star-Oddi
Beatrice Crone	Stockholm Resilience Center

THE DESIGN CHALLENGE



We believe disruptive technology can affect and drive industry transformation.

'Disruptive technology' was defined as techniques, skills, methods and processes that achieve an objective better than what went before it, yielding significant *benefits* to its key stakeholders, and has the potential to be implemented and scaled up in a *big* way. To live up to this ambition we purposefully brought together a diverse group of people to create an environment conducive to ideas both outlandish and impactful.

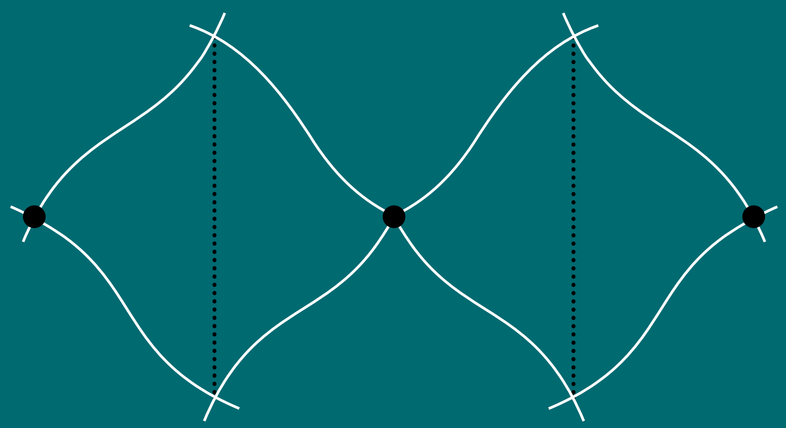
The challenge is clear; to ensure a sustainable future for our fisheries, oceans and the fishermen's livelihoods we must think beyond today's bottom trawling technology. Trawling is a widely used and extremely important and efficient fishing method. However, due to its environmental impact it has attracted controversy and criticism from a variety of stakeholders, including the EU Commission which released a proposal to ban this catching method. Scientific reports show that bottom trawling can result in elevated by-catch rates, higher fuel use and be detrimental to the benthic; these impacts vary in severity dependent on the characteristics of the gear. With increased consumer consciousness of health and sustainability the seafood sector is simultaneously the target of constant scrutiny and fast growing demand world-wide. Demand-growth is primarily driven by 'population growth, increasing affluence, and urbanization' in developing and emerging economies, especially in Asia.

→ FISH TO 2030 – Prospects for Fisheries and Aquaculture

With this backdrop, the workshop brought together participants with knowledge of a variety of advanced technologies and areas of expertise – including underwater image recognition, seaborne drones, light and laser technology, commercial fishing, fish behaviour science, seabed research, fisheries management and big data. The workshop participants were challenged with developing ideas for new gear that would effectively address the following four objectives:

1) **Harvest high quality and affordable seafood from sustainable fish stocks, today and in the future**
2) **Reduce or eliminate the negative environmental impact of trawler fishing, including GHG emissions and on damage to the seafloor and to our oceans**
3) **Only catch the fish we want by improving our ability to target and select particular species and avoid by-catch**
4) **Generate real and tangible benefits to the fishermen**

THE DESIGN PROCESS



This workshop deployed the 'double diamond' design process model. This is a process that will be repeated as the project moves forward but applied to the ideas delivered by this workshop.

DISCOVER:

The workshop program began with a process to discover the problem and challenge at hand. This was done first through general framing by the facilitators and second through technical presentations from seven of the participants. Presentations included:

- **Øistein Thorsen:** *The problem with trawling and the design challenge*
- **Jan Hiddink:** Seabed impact & pulse trawl
- **Torfi Porhallson:** *Laser Nets*
- **Mark Smithers:** *Seaborne Drones and Autonomous underwater vehicles*
- **Dan Watson:** *Light and its impact on fish behaviour*
- **Christian Degel:** *Ultrasound & Sonar*
- **Bjarne Stage:** *Sensor and Sound Herding*
- **Sigmar Gudbjornsson:** *Underwater fish selector*

DEFINE:

Following the presentations the workshop was split into 4 groups of 4-5 participants with the task to define the problem, brain-storm solutions focused on the four objectives listed in the design challenge illustration above, and exploration of various technologies' potential to address them. In this phase the problem was more specifically defined to tackle challenges experienced in the cod fishery in the Barents and North Sea. These areas were chosen because they present different challenges in terms of water depth, concentration of target species and commonly used vessel size.

DEVELOP:

During day two the workshop was again split up into new groups – this time only 3 groups with 5-6 members in each. The groups were tasked with developing one disruptive concept to present to the larger group.

DELIVER:

At the end of day 2 each group delivered the following outcome in presentation format to the workshop:

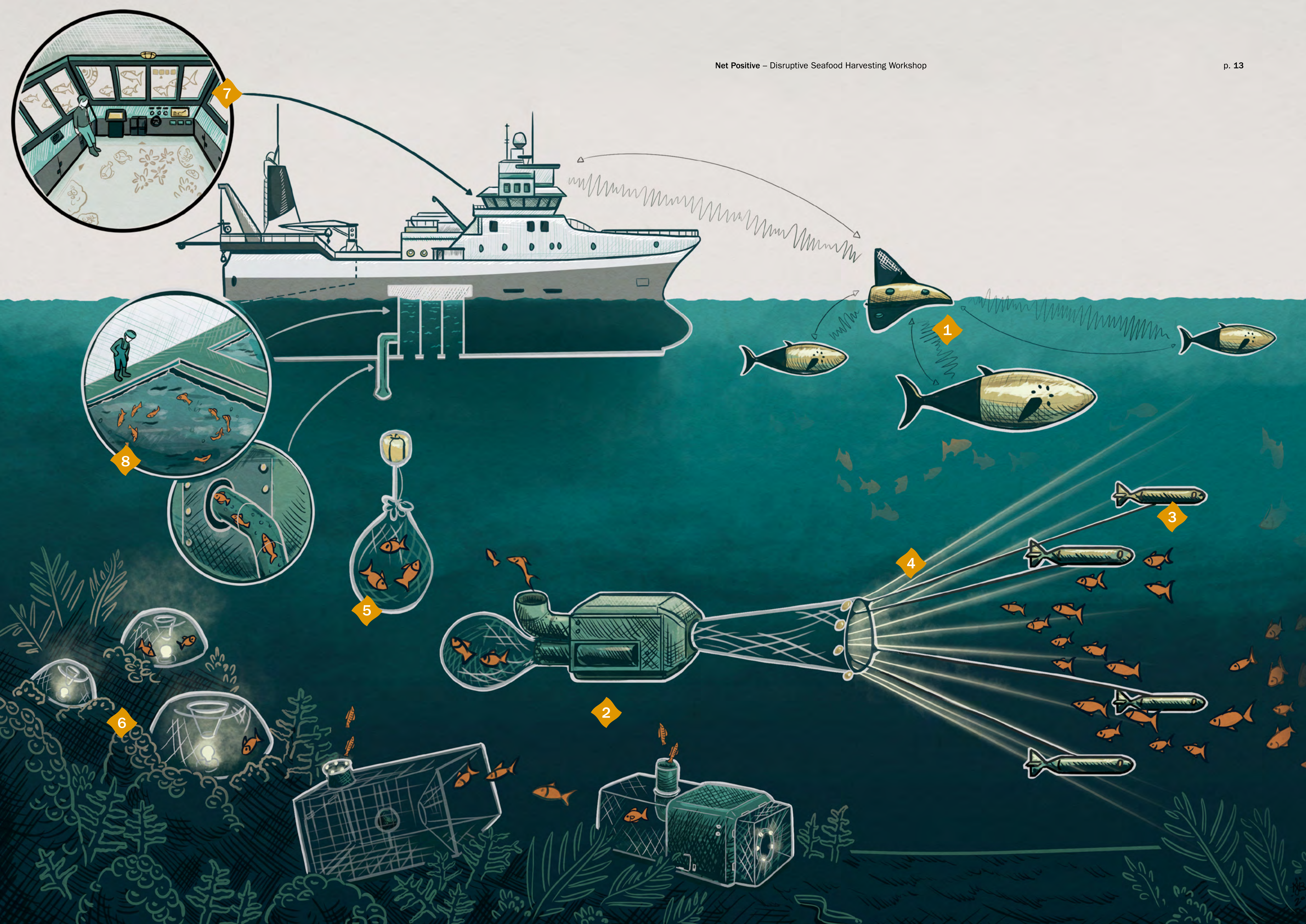
a) Visual representations of the design concepts
b) Description of key technological components
c) Identification of 'What we don't know yet'
d) Opportunities and barriers to adoption through key stakeholder analysis

A VISION FOR DISRUPTION

The workshop generated several overlapping design concepts with multiple technology components that could be combined in numerous ways to help transform how wild seafood is harvested. Some groups adopted a modular approach, focusing on disruptive technology components that could be added on to existing gear or integrated into existing practices to help facilitate fishermen uptake of the new technology. Others were more wholesale in their disruptive approach, reimagining the entire process of seafood harvesting.

This report presents a vision for seafood disruption – in text and illustrations – incorporating the major technology components developed collectively by the workshop participants. It is worth noting that this vision relies on, and in turn supports, the effective management of the target fishery.

Workshop Sketches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The following ideas are opportunities for further prototyping, feasibility studies, piloting and financing:

Internet of the Sea

One strong theme that emerged is the need to have eyes on, and in, the sea to help us better identify locations, species and movements of fish before fishermen even put their gear in the water. Knowing where to fish has the potential to save on cost and fuel use by reducing the amount of time a boat needs to have its gear in the water searching for fish. The workshop explored viability of deploying large numbers of solar and wind powered AUV's equipped with echo sounders and sensors with the ability to send real-time ocean and fisheries data back to a central depository accessible to an entire fishing fleet. Another option, or one to be pursued in parallel, is to equip existing vessels with autonomy packages (e.g. sea-machines.com or even commercial vessels.) Advantages of using existing vessels include utilizing existing assets as well as using larger vessels that can go a little faster and handle rough seas better. There are technology addition variants, such as using towed depressors to get clearer images below the thermocline and using the same equipment that a trawler uses on the 'scout boat'. If we really want 'eyes in the water', then we can add ROV-like systems, such a BIOSwimmer, tethered to the scout boat(s) and get real-time images up and posted to a base camp for review. (In other words, data bandwidth is not as much an issue if we have a larger scout boat (still relatively little fuel in comparison to a trawler) with power to send data 'home'). Also, these Scouts with BIOS-like ROV platforms can combine to herd fish into a trawler path.

Improved Selection

Improving selectivity of target fish species was explored at a number of different stages of the fish harvesting process. Different wavelengths and intensities of light can be used, statically or dynamically animated, as a way of selecting between different species of ocean organisms. Simple to apply to both fishing gears and other ocean-based equipment, such as drones and AUVs, light could be used as a first pass for filtering large quantities of fish before they reach more sophisticated selection mechanisms deploying underwater image recognition, or even ultra sound, such as the Fish Selector – a device in development by one of the workshop participants. Through image recognition technology this devise is able to identify target species based on size and shape specifications. When deployed in the back of a net or other capture device it allows the fishermen to release non-target fish underwater, increasing survival rate and reducing by-catch. Further testing is needed of different scanning technologies (high/low tech) as well as the tool's ability to select target fish from a large catch of mixed species.

Autonomous Catching Devices

Smaller catching device powered by multiple torpedo shaped AUVs in front of the fishing vessel. The AUV's can be programmed to always hover above the seabed. Such AUVs are in existence – mostly for under water data collection and monitoring – so further work is needed to assess their engine power and ability to drag a catching device. The AUV's would be equipped with visual capacity and enhanced manoeuvrability enabling the crew on the boat to steer the device towards the target fish from the boat. This could further be combined with a fish selector (see below) to weed out any unwanted species while leading target species into a collection device, before being pumped/water jetted (still alive) onboard the boat or recovered through a 'moon pool' inside the vessel, for immediate live processing. The latter option would require more selective lower bulk volume catches at a rate similar to line catch.

Virtual Nets

The replacement of the solid trawl doors that account for much of the heavy drag that results in the high fuel use and seabed damage caused by conventional trawlers is a key area for disruption. One of the participants from Iceland is working on a technology that aims to deploy laser beams to create 'virtual nets' at the front of smaller fish catching devices. This has the potential to reduce weight and drag while still ensuring fish are herded in from a large volume of water. The need for further research into the impact of different light-waves and colours on different fish species' behaviour was also identified as an opportunity to increase the selectivity of fish targeting and catching.

Live Fish Capture and Storing

To address the issue of boats having to drag heavy nets filled with fish, causing both high GHG emissions and negative impact on the flesh quality (through bruising and stress) participants developed devices that would enable fishermen to capture the fish alive in order to make the onboard loading and processing and more controlled and gradual process. These could be larger stationary devices, or smaller detachable compartments on the back of the smaller capturing devices, programmed to slowly float to the surface when full.

Fish Attraction Device and Traps

Instead of looking for fish across the sea, participants explored the opportunity to deploy fish behaviour and environmental science to concentrate large numbers of fish in smaller geographic areas to ease the process of catch – either by deploying passive traps, or through smaller catching devices (see above). LED lights, selected for use with particular species, can be applied to attract or repel organisms from a particular area. Additionally it is believed that there is potential in exploring the use of smells, sound, creation of artificial reefs, ecosystem and enriched environments as attraction devices, as well as using baits and deploying AUVs to identify and herd schools of fish toward the traps. Successful acoustic herding of some fish species has been demonstrated by one of the participants, and recent research from NYU shows the potential of AUVs to not only integrate into schools of fish, but also lead them.

→ Schools of fish follow the robot leader.

Effective use of attraction devices require further research into particular target species behaviour and preferences to ensure the fish attraction devices do not attract unwanted species.

Interactive Control Room in the Wheel House:

Redesign of the skippers' wheel-house on-board the fishing vessel into a high-tech data driven control room (inspired by Minority Report). The participants imagined overlaying the floor and windows of the bridge with smart screens or Google glass-like data projection making relevant information about the seabed, the activity in the ocean below behind, in front and to the sides of the boat accessible and actionable in real-time (integrating with existing charting systems, i.e. Kingfisher Charts which already provides fishermen with digitised habitat and protected areas information). This includes identifying where the target fish is, when to release catch equipment, as well as identifying sensitive seabed habitat to avoid. One participant is in contact with a possible technology provider with a new system ready to be tested in August 2016.

Improved processing at sea/live fish

To improve the quality of seafood participants explored different options for both enhancing processing at sea, as well as landing live fish to shore. This includes the storage devices described above, as well as pumps essentially 'hoovering' fish from the sea into the boat for processing or for further live storage in large pools onboard boats (like 'Havfarm' developed for off shore salmon farming.

Capturing the fish alive improves quality and enhances opportunities for efficient processing on board. Separating catching and storing/processing means that the catching unit can be of a radically different design and with fewer crew.

NEXT STEPS: RAISE CAPITAL TO SPUR DISRUPTION

Disruption is Possible

This exercise has shown that it is possible to eliminate the detrimental environmental impacts of bottom trawling by designing new technologies – better than what have to today. By bringing together experts including fishermen and fishery scientists, light/laser technologists and roboticists, we have demonstrated that there is not only widespread interest and will, but also the necessary skills and ability to completely reimagine seafood harvesting as we know it.

The proposals in this report combine proven technologies from other fields with in-development concepts from the fisheries sector to create a roadmap for change. The knowhow and technology exists, now we need the support necessary to refine, adapt and trial the best ideas and concepts.

A Powerful Coalition

The organizers and participants of this event represent a powerful coalition with the footprint and influence necessary to transform the seafood-harvesting sector. Their ongoing involvement is crucial in developing these concepts further and to mobilise support for our disruptive vision. Now we need capital to spur the change.

Seeking Partners

We are actively looking for partners and investors – government, private and philanthropic – that can provide the capital needed to take these concepts from the drawing board to common practice in the industry. We need funds and support to develop the most viable concepts further by creating technical drawings, conducting feasibility studies and at-sea trials, as well as create financing models that will allow the commercial fishing fleet to adopt these new technologies when they are available.

It is time we work together – environmentalists, scientists, technologist and fishermen, to solve the problems of trawler fishing once and for all and build a net positive future for our fisheries and fishing communities, our oceans and our seafood.

For more information please contact:

Øistein Thorsen – Fai Farms
oistein.thorsen@faifarms.com
Tel: +1 347 330 9926

Alex Olsen – Espersen
alex.olsen@espersen.com
Tel: +452 015 4259

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