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ixblue stands as a global leader in the design and manufacturing of innovative solutions for the navigation and positioning markets. Using its unique technologies, the company offers innovations that are key to addressing increased challenges and carry out their operations with optimum efficiency and safety.

ixblue is recognized throughout the industry for its expertise and products in underwater imaging, for its acoustic positioning systems, and its range of fiber-optic gyroscope (FOG) inertial navigation systems (INS) which has revolutionized subsea navigation in the last decade, providing unequalled performance and cost of ownership benefits.

Combining the mastery of technology and agility to solve our customers’ issues

At ixblue, we strongly believe that mastering technology is key to finding the answers to unsolved questions. We believe it is our responsibility to provide our customers with clear solutions. To that end, we are capable of pushing technology beyond its existing limits. Mastering technology also means being agile in a complex and changing environment. ixblue is convinced that our flexibility allows us to find the solutions that best fit our customers’ needs.

Making technology accessible & adapting it to individual customer needs.

It is our responsibility not only to push technology forward but also to make it accessible to our customers. In addition to adapting it to their very specific needs, we must make it easy to use, and easy to master. This is why we strive to make our solutions:

- Tailored to customers’ specific needs
- Easy to integrate and deploy
- Compatible with third-party sensors
- Easy to use
- Reliable
- Cost-efficient

Trusting ixblue experts to implement tomorrow’s solutions

ixblue has always been an avant-garde high-technology company. It is in our DNA. By working with our experts, you choose to rely on our unique expertise and be visionary. You implement today’s innovative solutions which will become tomorrow’s standards. You embrace technological breakthroughs.

The trust you place in ixblue allows us to always go further and push technology beyond its limits.
Extensive expertise in subsea imagery
Underpinned by extensive experience in the field of subsea imagery, iXblue has developed a complete range of imagery solutions to meet the operational requirements of fishermen. Based on a strategy of excellence and constant innovation, iXblue systems leverage the most advanced and proven imagery technologies for efficient and reliable operations at sea.

A dedicated team of experts
Both manufacturing and assistance in implementing iXblue technology is led by a dedicated team of experienced experts on the fishery market. Combining both theoretical knowledge and on-hands offshore experience, iXblue team of experts has formed close ties with fishermen which enables them to come up with the most relevant and innovative products and solutions for the fishery market.

Training
Based in La Ciotat (France), our team of skilled professionals provide customers with regular training courses throughout the year, including:
- Fishery acoustic theory
- Operation theory
- Fish classification operation
- Fishery research theory
- Operations at sea
- Scientific data processing
- Installation and maintenance

24/7 Support
At iXblue, we care about your peace of mind and we stand behind our products and solutions. Our trained support teams offer 24/7 assistance, made easy thanks to the remote control of the SeapiX consoles, and provide you with top-quality service, helping you meet your day-to-day objectives.
They trust iXblue
SeapiX generates one or more scan swaths along or across a vessel’s axis, providing total three-dimensional coverage of the water column (in order to provide metrological target strength and volume backscattering strength) as well as a bathymetric profile of the seabed and sediment identification analysis.

Each detection operation in the water column is referenced in 3D and is automatically represented on a map created in real time, including local bathymetry. According to IHO standards, SeapiX’s bathymetry, when combined with external high-precision motion reference units, is ‘Special Order’ level.

Its accuracy achieves an unparalleled level, thanks to its narrowest beams (1.6° x 1.6°), its advanced acoustic modulation principles (resolution ±7.5 cm only) and its embedded motion sensor (each array has stabilizing beams with a micro-electric-mechanical systems (MEMS) sensor included in the sonar head). Its transducer generates several multibeam transmissions and acoustic processes to yield quantitative and qualitative measurements of the marine environment. Its multiple advanced modulation modes, including CHIRP, combined with pulse compression, guarantee the highest possible detection performance, even in harsh environments.

SeapiX is a new proven technology, which will be updated every year with new features. It has been developed to provide fishermen and scientists with a next generation acoustic instrument for more accurate biomass assessment.

Its advanced hardware technology allows permanent development of new processing operations and functions offering new indicators.

To meet the requirements of the field, iXblue offers a complete range of SeapiX versions dedicated to fishery, research and industrial applications.

As a military technology covered by a number of patents, SeapiX is the first compact civilian system comprising a dual Mills Cross multibeam sonar transducer. This technology provides unique volume coverage and the highest volume resolution.

Complete fishery ecosystem monitoring, from water column fish discrimination to seabed mapping and classification
Facing constraints in productivity and fish stock management, the fishing industry has to compromise between selectivity and profitability in their operations. Therefore, new expectations have arisen for the development of an innovative instrument capable of:

- Searching a high water volume and a large area of seabed in real-time
- Providing the highest spatial resolution possible for individual discrimination
- Analyzing a large number of individual fish

Neither standard single/split beam sounders or MBES provide this type of information, due to the reconstruction time in the fishing zone’s volume. To address this need, iXblue has developed a new type of instrument for the fishing industry and research: 3D MBES based on steerable symmetrical Mills Cross arrays, called ‘3D Sonar’.

As in standard MBES, the original architecture of the SeapiX makes it possible to analyze a cross-section of the water column and seabed and also to steer these sections in the fore or aft direction of the vessel as well as swath analysis of the water column and bottom fore-and-aft sections.

Steering capability in transmission and reception allows a volume of 120° × 120° to be covered below the ship with a 1.6° × 1.6° beam aperture on the antenna axis mapping. Three simultaneous angle-adjustable echograms from the desired swath are processed.

The SeapiX’s very high ‘3D pixel’ resolution and its large volume coverage are two main conditions for making fish species classification and realistic abundance assessment possible.
Since 1950, fisheries have operated using hydroacoustics systems to assist in fish abundance evaluation. Very simple time-distance vertical sounder systems were installed on board fishing vessels. Later, search light and omni sonar systems were developed to locate shoals. By the 1980s, scientists had also developed a new method to determine biomass using a vertical sounder with ‘echo-Integration’. The latest development for both scientists and fishermen was the introduction of fish target analysis by “split beam” processing in vertical sounders. This technology has been used for the last 35 years to determine fish stocks and quotas.

Fish stock evaluation and management is a complex field of research, and several parameters need to be taken in account, such as fish vessel avoidance, aggregation modes, single-multiple fish target confusion etc. These parameters are observed by fishermen and scientists, and fisheries occasionally face difficulties in reliably assessing stocks.

For a more realistic assessment, new advanced features in hydroacoustic instruments are required:

1. The highest volume resolution possible in order to distinguish individual fish, even when scattered.
2. The capacity to fully describe a shoal of fish in order to provide realistic fish abundance and behaviour.

To comply with these demanding requirements, iXblue has developed a genuine ‘three-way’ acoustic system, i.e. the 3D volume sonar.

Key features
(At 100 m Depth/distance)

- 3D pixel resolution of volume: 0.6 m³
- Water volume search: 4 Million m³

Volume resolution and range

Having high resolution 3D pixels in water, SeapiX provides unexpected operating range according to its high frequency. It provides the best of systems: Range similar at lower Frequency while it provides unique high resolution for realistic fish discrimination and classification.

Typical range (m)

<table>
<thead>
<tr>
<th>Water column coverage (m³)</th>
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</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>Bottom echogram</td>
</tr>
<tr>
<td>Bathymetry</td>
</tr>
<tr>
<td>Pelagic Fish</td>
</tr>
<tr>
<td>Near-bottom Fish</td>
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Water column coverage (m³)

<p>| |</p>
<table>
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<tbody>
<tr>
<td>0</td>
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3D Pixel (m³)

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<tr>
<td>25</td>
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<tr>
<td>30</td>
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</tbody>
</table>

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## SEAPIX RANGE

<table>
<thead>
<tr>
<th>APPLICATIONS</th>
<th>SeapiX-F</th>
<th>SeapiX-R</th>
<th>SeapiX-P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fishery</td>
<td>Fishery Research</td>
<td>Marine science, fish farming</td>
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</tr>
<tr>
<td>FREQUENCY</td>
<td>150 Khz</td>
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</tr>
<tr>
<td>MODULATION</td>
<td>CW and CHIRP</td>
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<td></td>
</tr>
<tr>
<td>ACROSS TRACK MULTIBEAM SWATH</td>
<td>64 channels, stabilized</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALONG TRACK MULTIBEAM SWATH</td>
<td>64 channels, stabilized</td>
<td></td>
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<tr>
<td>BEAM STABILIZATION</td>
<td>TX + RX, built-in MRU</td>
<td></td>
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<tr>
<td>BEAM RESOLUTION</td>
<td>1.6° angular / 75 cm radial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRIPLE ECHOCGRAMS FROM ALL SWATH</td>
<td>Adjustable from 1° to 120° each</td>
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<td></td>
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<tr>
<td>TYPICAL RANGE</td>
<td>Biomass 400m, Bathymetry 600m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOLUME RESOLUTION</td>
<td>0.6 m³ @100 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOLUME COVERAGE</td>
<td>120° X 120°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIGNAL PROCESSING</td>
<td>SV, TS, NORM, calibrated</td>
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<td></td>
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<tr>
<td>SED FISH EXTRACTION</td>
<td>Up to 200,000 single fish detections</td>
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<td></td>
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<tr>
<td>TRANSMISSION POWER</td>
<td>2KW (4KW as an option)</td>
<td>4KW</td>
<td>2KW (4KW as an option)</td>
</tr>
<tr>
<td>SCIENTIFIC PACK</td>
<td>(Option)</td>
<td></td>
<td>(Option)</td>
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<tr>
<td>SONAR ANTENNA UNIT (SAU) CABLE</td>
<td>20 m</td>
<td>20 m</td>
<td>10 m</td>
</tr>
<tr>
<td>SAU WEIGHT</td>
<td>58 Kg</td>
<td>58 Kg</td>
<td>24 Kg, floating</td>
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</table>
**BIOMASS DISCRIMINATION**

**Relevant technology for fish analysis**

Fish discrimination and its classification is one of the most challenging goals for fishery acoustic devices. Due to scientific requirements, over the last 30 years manufacturers have developed several techniques to discriminate fish species. The well-known “split beam” method was developed and improved. SeapiX operates its four half antennae (4x32 beams) to provide a split beam calculation for its entire volume coverage of 120° X 120°. Thanks to its acoustic array features and processing of both phasic and amplitude signals, target positioning is extremely accurate (+/-0.15° only, while the value for standard split beam sounders is +/- 0.6°). Scientists and fishermen can take advantage of these most accurate split beam TS calculations for single fish species in an entire shoal in real time.

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**Revolutionary “Volume Split Beam” technology**

Split beam sounders usually have 4 quadrants to process fish target strength (TS) in its 7-10° conical beam. SeapiX operates its four half antennae (4x32 beams) to provide a split beam calculation for its entire volume coverage of 120° X 120°. Thanks to its acoustic array features and processing of both phasic and amplitude signals, target positioning is extremely accurate (+/-0.15° only, while the value for standard split beam sounders is +/- 0.6°). Scientists and fishermen can take advantage of these most accurate split beam TS calculations for single fish species in an entire shoal in real time.

**Proven classification**

Deployed in many fisheries worldwide, SeapiX provides unique sea-tested classification results, for both pelagic and demersal fish species. The SeapiX support team prefers to carry out survey services on behalf of fishing companies in order to train crews in species classification.

Here is an example of an Alaskan fishing trip on board the fishing vessel “Alaska Victory”, showing the performance of SeapiX in species discrimination. Based on 1200 metric tons caught through 45 tows, the SeapiX GBA classification tool achieved a 1% accuracy rate for Alaska mackerel, 6% for redfish and 5% for Pacific cod. For every tow, the results were compared to National Oceanic and Atmospheric Administration (NOAA) scientific findings and Geographical Biomass Analyzer (GBA) samples.
FINDING FISH

Entire biomass in column

High volume resolution and coverage enable accurate assessments to be made. SeapiX shows 4 multibeam swaths, searching the entire water column and seabed. These multibeam swaths show ‘sonar multibeam’ images in 4 sections of a water column according to the operator’s wishes. This provides volume shoal evaluation and enables fish behavior to be understood.

One or several swaths can be selected to provide classic echogram presentation. From a 1° to 120° beam angle, the SeapiX echogram can obtain the same resolution as a 1.6° beam regardless of the echogram opening chosen; thereby ensuring an unparalleled high resolution echogram compared to normal fish sounders.

SeapiX simultaneously processes both whole shoal and individual detection operations. At any moment a skipper can choose the most relevant signal processing method and thereby have a real-time comparison between ‘SV’ (shoal gain) and ‘TS’ (fish gain). In addition, iXblue has developed special ‘normalized’ processing for special applications such as thermocline plankton, shrimp and thermocline layer detection (detectable up to 250m).

Acoustic signals from all running swaths are processed thanks to a ‘single echo detector’ (SED) capable of extracting individuals. This feature provides a skipper with a 2D and 3D volumetric summary representation of all the available biomass around the vessel.

Volume extraction of biomass, produced by all directional running swaths, provides a skipper with a 2D and 3D understanding of the acoustic signal of biomass. In addition summary biomass extraction shows time-scaled fish points in 3D for a full understanding on how shoals aggregate and move. SeapiX’s unique high resolution graphically shows ‘shoal polarization’ related to each species.

Having the widest coverage with the highest resolution, SeapiX is capable of creating fish-finder echograms from each swath according to the operator’s needs. The echograms created in SeapiX provide the best resolution using the 1.6° beams to create the desired sectors, and the best coverage obtaining up to a 120° pattern in real time. Regardless of how SeapiX is installed, it offers up to 6 echogram arrangements.

Traditionally, by using an across track swath, SeapiX provides three echograms from port to starboard covering 2° to 120°, each with a suitable angle. A unique feature of SeapiX is its ability to provide trawlers with forward-looking and backward-looking echograms in order to anticipate and understand shoal behavior while the trawler is approaching the shoal to catch it.

Installed as side/forward-looking modes, SeapiX provides up to a 0° ‘tilt near-surface looking echograms to below-keel triple echograms. For purse seiners and tuna seiners it performs 100% control of the shoal from the surface to the deeper layers.

Single fish

Shoal behavior

Fish finder echograms
FISH CLASSIFICATION

Calibrated acoustic fish responses

A ‘single echo detector’ for SeapiX is capable of recovering a single detection thanks to its high acoustic dynamics of 139 dB. Every SeapiX system is factory-calibrated to provide an absolute acoustic value on targets during fishing operations. Combined with unique volume coverage, it detects thousands and thousands of individuals. Each fish detected gives its own acoustic response (TS and SV fish response) entered into a large database with time/position/ acoustic response tags. SeapiX then carries out unique “Geographical Biomass Analysis” (GBA) capable of sorting biomass detection by area/ layers/species.

GBA biomass processing

The GBA (Geographic Biomass Analyzer) algorithm manages and filters all the biomass points shown in 2D and 3D mapping views. The ‘Fish Class’ editor allows a skipper to characterize species according to acoustic responses related to the individuals providing similar responses. A statistical calculation is performed on large detection values (up to 200,000) in order to show the percentage of each fish class in the selected area or layer. A skipper can finely adjust his fish classes by correlating his catch samples and the GBA fish class adjustments. The use of the GBA function is highly popular in order to discriminate species by keeping only the desired species or layers on the screen. It also allows targeted shoals to be selected and located by using the echogram or the navigational 2D to map. Gear manoeuvring can also be improved.
**Bathymetry**

Each multibeam swath can provide accurate bathymetric measurements in real time. Just as standard hydrographic multibeam sounders do, SeapiX builds its starboard-port bathymetric values by operating across track vessel swaths. SeapiX also offers the unique capability to run long track swaths to generate fore and aft bathymetric values of the vessel, providing a skipper with an unparalleled bathymetric view of the environment.

**Seabed hardness**

As for a water column, seabed acoustic detection is calibrated, offering accurate hardness values while bathymetry is in progress. Skippers can evaluate changes between hard and soft bottom areas in real time to enhance their fishing operations.

**Seabed discrimination and classification**

An innovative and robust method used to classify seabeds uses the longitudinal swath providing a full back scatter strength (BS) profile measurement (+/- 60° fore and aft aperture) on each insonified pixel at the nadir point (below the keel). The measured BS profile is compared to classified BS profile values in order to discriminate seabed type in real time.

**Side scan imaging**

To create comprehensive seabed roughness images, SeapiX operates its across track swath on both sides with various grazing angles. In order to build shadowing effects of the seabed material, rocks and objects appear as light areas and shadows in a monochrome image.
**FISHING OPERATION MANAGEMENT**

**Full image of fishing operations**

For faster and clearer decision-making, SeapiX provides skippers with a real-time tactical fishing situation displaying all relevant parameters in an immersive 3D view. Showing all seafloor dangers and the fish species to target together with vessel and gear behaviour, SeapiX provides a unique “comprehensive 3D fishing view.”

**2D Fishing navigation and database**

From the early stages of acoustic processing, biomass assessment is linked to SeapiX’s Geographical Information System (GIS). This allows skippers to conduct fishing operations on a genuine advanced electronic chart system (ECS) fishing plotter while all fish data is correlated with the navigational pattern and gear monitoring systems, if available.

A powerful fishing time database (tracks, routes, marks, areas, etc.) can be managed in order to safely perform standard fishing navigational operations.

**Selective fishing strategy**

SeapiX’s volume description of the whole ecosystem makes it possible to select the desired species according to quotas and regulatory requirements as well as the targeting of the most profitable resources.

Skippers can develop and apply genuine “fishing strategies” including surveys of fish spots to locate shoals and to analyze and classify species in order to turn back and catch targeted fish.

SeapiX users in pelagic and demersal fisheries like to follow the classification and fish mapping displayed in order to enhance fishing efficiency or to dramatically reduce discards.

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APPLICATIONS
PELAGIC TRAWLING
Thanks to its wide coverage, SeapiX provides pelagic trawler skippers with a realistic assessment of shoals. Pelagic species such as mackerel or herring are heavily impacted by the presence of vessels and noise and some valuable shoals swim past without being detected. SeapiX provides side, aft and fore shoal estimations around the vessel while omni sonars and sounders have neither the relevant coverage or resolution for approaching pelagic shoals.

Known for its unique capability to assess fish near the surface, SeapiX also offers deep-range pelagic layer detection, especially with its 4KW version. Until now, skippers have operated using low frequency sounders to reach a suitable depth. The disadvantage of this technology lies in its poor resolution and thereby its inability to provide realistic information on abundance and species discrimination.

According to their allocated quota and area, pelagic trawlers must target the most valuable species and avoid discards. By deploying a GBA biomass classification tool, a skipper can estimate the percentage of a defined class of species and can, for example, evaluate if he is dealing with herring or mackerel. Then, only the targeted fish are shown in 3D to improve maneuvering in order to place the targeted shoal in the net.
PELAGIC TRAWLING

In practice
Evaluating real abundance is crucial. Assessing the upper layer of waters is impossible with traditional sounders which only have a 7° visibility under the keel and whose very short range capacity is poor. SeapiX shows a much more realistic abundance of pelagic fish, even when located close to the surface, thanks to its 120° aperture and its detection capability from a distance of 2m.

Often the surface layer contains quite a good abundance of scattered fish, and tows can be profitable. SeapiX shows when to shoot the gear. In many cases, pelagic fish avoid vessels and are not visible in vertical sounders. SeapiX offers the unique ability to evaluate this effect and whether or not it is worthwhile towing.

Installation
SeapiX can be installed as a normal ‘downward-looking’ echo sounder to cover 120° port-starboard and 120° fore and aft.

For pelagic vessels also deploying the purse seine technique ‘side-looking’ installation is recommended, which allows perfect control of an oncoming side shoal and classification of fish before shooting. During purse seining, a skipper can follow the shoal’s behavior and gear to optimize operations.

Key features
- 120° X 120° volume coverage all around the vessel
- 5m near-surface detection
- Species classification
- Species range detection
  - Mackerel: 5 to 250m
  - Herring: 5 to 300m
  - Blue whiting: 5 to 450m
BOTTOM TRAWLING
As all skippers know, bottom trawling layer fish estimation is usually inaccurate. Sometimes sounders show very dense “red” marks that give poor catch results, and sometimes the opposite occurs. Indeed, usual sounder technologies are limited by their resolutions (low frequencies) or their range (high frequencies) in order to assess the real abundance of biomass in deep and bottom trawling layers. To make this evaluation more reliable, SeapiX combines high volume resolution and very concentrated high acoustic power in its 164 beams and can thereby offer a deep operating range. Bottom trawlers operating at around 150m to 330m take advantage of this valuable abundance/species distribution (such as cod, pollock, red fish, hake, deep mackerel species, etc.) in order to decide when to tow, saving costs and discards. The GBA fish class analyzer can be set to “bottom” mode to provide relevant fish classification of the trawling layer only.

Bottom trawling operations require accurate knowledge of the seabed to avoid gear incidents and to increase fish catchability. In addition to water column biomass evaluation, SeapiX provides real-time bathymetry mapping to correlate biomass, gear and vessel navigation within a unique and synchronized representation.

Thanks to its original array geometry, it not only maps bottom profiles in the same way as a conventional hydrographic multibeam sounder, from starboard to portside, but also maps fore and aft bottom trawling in the vessel’s longitudinal axis by using its along track swath. This unique forward-looking feature provides a skipper with advanced warning of an oncoming obstacle, giving more time to react on gear behaviour. A dedicated “hook alarm” process also warns the skipper of oncoming obstacles.

Under the heading “Option” the skipper can take advantage of the unique advanced real-time seabed classification tool. This computes and shows the type of straight seabed material contouring layer over a 2D and 3D bathymetry representation.
**In practice**

Bottom operation requires a perfect understanding of seabed morphology to reduce risk of gear damage, and the positioning/depth and classification of fish concentrations to ensure profitable and sustainable operations. SeapiX carries out real-time bathymetry and can be interfaced with trawl monitoring systems to correlate seabed and gear behavior. Near-bottom fish, located in the vertical trawl’s 6m opening above the bed is detected and mapped by SeapiX at 60° port-starboard and fore-aft. At a depth of 200m it provides 100m coverage of the trawling layer in both directions. With its very narrow beams and high volume resolution SeapiX allows close extraction of bottom fish. The acoustic response provided is much more realistic compared to traditional low frequency sounders, thereby making it possible to identify fish species.

**Installation**

SeapiX is installed as a normal, ‘downward looking’ echo sounder and covers 120° port-starboard and 120° fore and aft for demersal fish control.

**Key features**

- 30° X 30° all directions near-bottom biomass coverage (100m wide at a depth of 200m)
- Bathymetry, bottom hardness, seabed classification
- 1 m above-bottom detection
- Species classification
- Species range detection
  - Horse mackerel: 250m
  - Hake: 250m
  - Atka mackerel: 280m
  - Northern rockfish: 300m
  - Atlantic cod: 300m
  - Pollock: 350m
  - Pacific cod: 380m

Near bottom mapping of Red fish at 130 Ftm. Alaskan and Greenlandic bottom trawlers classifying and selecting bottom species.
TUNA & PURSE SEINING
TUNA & PURSE SEINING

Approaching shoal

Thanks to the SeapiX ‘side-looking’ installation, tuna and seining vessels can control the entire shoal in the earliest stages of fishing operations. The world’s first 3D volume sonar, SeapiX provides skippers with 1000 times more water volume coverage than omni- sonar or vertical/side sounders.

SeapiX images show entire shoals in 3D as well as changes in fish aggregating behavior in real time. A seiner can travel full speed ahead while approaching and estimating shoal displacement. SeapiX allows skippers to be reactive and to make a decision on the way in which to start circling a shoal. SeapiX provides control of an entire shoal from 5m below the surface without any vessel wake turbulence. Skippers can circle fish several times without losing the shoal, while sonars are jammed by the ‘red stripes’ representing vessel wake.

Species classification and mapping

Skippers can start processing shoals at an early stage, when a shoal enters inside the SeapiX’s 120° side volume sector. Information about a shoal’s abundance estimation, depth and species composition is provided to the skipper. CBA fish species classification provides a percentage ratio of fish species and discard fish and its location. A skipper can activate the ‘Class of fish’ filter to sort mixes and locate desired shoal.

Shooting decision

A pelagic seiner can easily identify desired species and can optimize vessel track to shoot at the right place, even close to shores, thanks to bottom profiling on the side. Tuna seiners have to optimize their operation on free shoals or on FADs. A skipper has all the information he requires regarding a shoal, its behavior and its species composition in order to make the relevant shooting decision.

Seining control

Fish behavior and distribution are still measured accurately during seining by SeapiX. Fish leakage below the keel is also monitored as well as seine profile and depth in order to make the right decision as to whether or not to keep sinking the mesh or to speedup hauling in order to close the gear.
TUNA & PURSE SEINING

In practice

Depending on tuna fisheries, vessels have to distinguish the largest authorized fish or tuna species. SeapiX’s very accurate and fully stabilized beams, along with its built-in motion sensor, enables the fish very close to surface to be controlled without any wave interference, at a perfect range, in order to assist the skipper in the trawler’s final approach and shooting manoeuvre. The practical range reported by skippers is more than 400m for isolated tuna fish.

Even when a shoal’s behavior changes fast, rapidly changing its depth or coming very close to the vessel, SeapiX ensures full control in all situations 2D and 3D views presenting catch situations without vessel propeller wake secure catches!

The major difference in fish detection is in its representation (1 dot = 1 fish) and is a huge improvement for operators compared to traditional sonars or sounders.

The clear abundance value for each class allows a skipper to make the right decision and can save much operational time in terms of bait fish or non-profitable shoals.

Key features

- 120° X 120° volume side-looking coverage from the surface
- 5m near-surface detection without vessel wake turbulence
- Shoal behavior, direction and depth
- Species classification
  - Mackarel: 200m
  - Anchovy: 230m
  - Herring: 250m
  - Sardine: 300m
  - Yellowfin Tuna: 450m
  - BigEye Tuna: 450m
  - Bluefin Tuna: 450m

Even when a shoal’s behavior changes fast, rapidly changing its depth or coming very close to the vessel, SeapiX ensures full control in all situations 2D and 3D views presenting catch situations without vessel propeller wake secure catches!
Acoustic systems have been identified as among the most promising tools available to scientists for the Ecosystem Approach for Fishery (EAF), as well as the characterization and identification of targets in the water column or benthic habitat mapping.

In fishery acoustics, acoustic techniques are well known and used daily for biomass assessment by fishery scientists through echo-integration and isolated fish target strength measurement with split-beam techniques, such as single beam echo sounders (SBES) calibrated by standardized methods.

Multibeam echo sounders (MBES) have considerable advantages over conventional fishery SBES. First, they offer a much larger volume coverage (320° athwartship aperture for the MBES versus 7° to 12° for the standard SBES). This then allows precise positioning of athwartship fish detection thanks to a small angular beam aperture of between 0.5° to 2°. Finally, small beam aperture and secondary lobe reduction enable near-bottom fish to be detected.

By developing a more advanced concept of 3D volume DS-MBES (Dual Steerable Multibeam Echo sounder) with SeapiX offering both athwartship and aperture, the use of these systems opens up new opportunities for research in addition to the usual echo-integration and isolated fish target strength measurements using split beam.

For example, three-dimensional analysis of the geometric parameters of fish schools that further develops the geometry-based school identification methods already in place for single beam echo sounders (Scalabrin). These morphological indicators may be height, width or elongation of the school, the volume backscattering coefficient [Scalabrin], or, more recently, the internal density structure of the school as the rate of vacuoles [Carotto, Guillard]. Improvement in volume coverage as well as angular and range resolution significantly increase the number of individual echoes in comparison with standard SBES. This higher detection value allows statistical analysis of fish echoes to be considered. This may provide a new insight into fish shoals in terms of density or multi-species composition [Stanton, Scalabrin]. Finally, volume analysis of the school and its evolution over time allows school dynamics to be studied and to evidence some collective behavior such as avoidance strategies. All these features for water column and bottom analysis and the building of 3D space and time-referenced databases, provide scientists with new relevant information for fish classification and entire ecosystem management.
An all-purpose scientific tool

Whatever the purpose of survey, echointegration or target strength split beam measurements, SeapiX provides the highest level of sensitivity, directivity and accuracy. Split beam is processed in all individual beams with both real-time phasic and amplitude measurements. Thanks to its array geometry, it provides a unique target positioning accuracy of +/- 0.15°, making its split beam calculation the most accurate in fishery acoustics.

SeapiX-R provides the scientific community with the first 3D DS-MBES sounder for an entire ecosystem, integrated into a compact housing containing its dual array, its transceiver and its built-in MDU motion sensor. SeapiX-R can be deployed for usual downward-looking water column studies, as well as side-looking analysis of the upper near-surface biomass layers.

It can be hull mounted with its high seas tried and tested stainless steel housing (SeapiX-P) or used in a mobile configuration with its lightweight composite materials and fanless compact PC (SeapiX-P). This configuration has been specially designed for opportunity vessel surveying and in situ monitoring stations (Bouyic, ASV, etc.).

Factory calibrated, SeapiX-R also offers an in situ calibration utility to perform calibration on a reference sphere target. Raw data recordings and replay capabilities as well as HAC and EVD Echoview format export are available.

Key features

- Water column echo-integration and target strength measurements with split beam, fully stabilized in TX and RX
- 120° x 120°, volume coverage, downward looking or side-looking for near-surface survey
- 3D shoal behavior and fish avoidance study
- Real-time species classification
- Factory calibrated, in situ calibration
- Raw data recording, HAC and EVD exports for Echoview post processing
- Acoustic dynamics of 139 dB
- Hull mounting (SeapiX-P) or mobile transducer configurations (SeapiX-P)
## Lexicon

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>SED</td>
<td>Single Echo Detection</td>
</tr>
<tr>
<td>SAU</td>
<td>Sonar Antenna Unit</td>
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<tr>
<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration</td>
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<tr>
<td>SV</td>
<td>Volume Backscattering Strength</td>
</tr>
<tr>
<td>BS</td>
<td>Backscatter Strength</td>
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<tr>
<td>MBES</td>
<td>Multibeam Echosounder</td>
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<tr>
<td>DS-MBES</td>
<td>Dual System Multibeam Echosounder</td>
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<tr>
<td>GBA</td>
<td>Geographical Biomass Analyzer</td>
</tr>
<tr>
<td>NOAA</td>
<td>National Oceanic and Atmospheric Administration</td>
</tr>
<tr>
<td>IHO</td>
<td>International Hydrographic Organization</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographical Information System</td>
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<tr>
<td>EAF</td>
<td>Ecosystem Approach for Fishery</td>
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