SONATE 2011 – a decision aid tool to mitigate the impact of sonar operations on marine life

Nina Nordlund, Frank Benders (TNO) and Petter Kvadsheim

Norwegian Defence Research Establishment (FFI)

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Approved by

Petter Kvadsheim	Project Manager
Elling Tveit	Director of Research
Jan Erik Torp	Director

English summary

The Royal Norwegian Navy has five frigates equipped with 1-8 kHz active sonars. Such sonars are potentially harmful to marine life. Mass strandings of whales have been claimed to be caused by naval sonar exercises. Furthermore, the navy has been met with allegations that fish are also affected. As a way to mitigate this potential problem, FFI has developed a decision aid tool for the Norwegian Navy, SONATE, which will help reduce the potential environmental impact of naval exercises.

SONATE is a decision aid tool for use during planning and execution of sonar exercises, with the aim to minimize influence on marine life and conflicts with activities such as fisheries, fish farming, tourism etc. SONATE combines cartographic information on species distribution, fishing activity and fish farms with a set of guidelines that defines precautions to be taken towards vulnerable species and commercial activity when using sonar.

SONATE comes in two different editions. The first edition was developed in 2006, and the latest version called SONATE 3.2 (2011) was released in 2011. This first edition is a stand alone software that can be installed on an independent computer. The second edition, which we have called SONATE-WMS, is based on internet technology. Both editions are supporting the *Regulations regarding use of active sonar in Norwegian territorial waters* efficient of October 1th 2011.

Even if the Norwegian Navy mainly is satisfied with the first edition of SONATE, they have expressed that the response time is too long. Also, the Norwegian navy wants a development towards less stand-alone software. This is motivated by the fact that fewer tools will be more efficient, both in use and maintenance. Management of the database and software have been relatively labour intensive and complicated, and there is a need to reduce this before the end of the project at FFI, when the Navy is meant to take over.

SONATE WMS will solve many of these issues. SONATE WMS is developed in cooperation with METOC project at FFI, which already supplies the Navy with a selection of cartographic information. The maintenance of SONATE will be simpler, because the major part of the cartographic information in SONATE will be accessed directly from the data supplier (e.g. Institute of Marine Research) and not processed at FFI or within the Navy.

The structure of SONATE WMS is mainly finished, but some details in the user interface remains. These things will be completed in parallel with completion of the METOC WMS. Until that we will continue to release SONATE on the old platform, to be sure we deliver a fully usable product. FFI are pleased with the direction of development of SONATE and feels that the decision to work towards a SONATE WMS was the right decision.

Sammendrag

Det norske forsvaret har fem fregatter som er utstyrt med 1-8 kHz aktive sonarer. Slike sonarer kan være potensielt skadelig for marint liv. Militære sonarøvelser har blitt beskyldt for å være årsaken til massestranding av hvaler. Det har også kommet fram påstander om at også fisk blir påvirket av militære sonarøvelser. For å prøve å begrense dette potensielle problemet, har FFI for Sjøforsvaret utviklet et beslutningsstøtteverktøy (SONATE), som vil hjelpe til å reduserere de potensielle miljømessige påvirkningene fra marineøvelser.

SONATE er et beslutningsstøtteverktøy for bruk under planlegging og utføring av sonarøvelser, med hensikt å minimere påvirkningen på marint liv og konflikter med aktiviteter som industri fiskeri, havbruk, turisme etc. SONATE kombinerer kartfestet informasjon over utbredelsekart, fiskeriaktivitet og oppdrettsanlegg med retningslinjer som definerer hvilke hensyn som bør tas i hvilke områder, med hensyn på sårbare arter og kommersiell aktivitet.

SONATE finnes i to ulike utgaver. Den første utgaven har eksistert siden 2006, og i 2011 kom den versjonen vi har kalt SONATE 3.2 (2011). Dette er en frittstående programvare som kan installeres på en PC uten tilkobling til nettverk. Den andre utgaven, som vi har kalt SONATE-WMS, har hovedsakelig blitt utviklet i 2010 og 2011, og er basert på internett-teknologi. Begge utgaver støtter *Bestemmelse for bruk av aktiv sonar i norske farvann* med ikrafttredelse fra 1.oktober 2011.

Selv om Forsvaret i hovedsak er tilfreds med den første utgaven av SONATE, har de uttrykt at responstiden er for lang. Generelt ønsker også Forsvaret en utvikling som går mot å samle flere verktøy i samme plattform. Begrunnelsen for dette er at dette vil spare tid og bli mer oversiktlig. Vedlikeholdet av SONATE har vært relativt arbeidskrevende, og det er behov for å forenkle dette arbeidet, særlig med tanke på at forvaltningen av SONATE etter avslutning av FFI-prosjektet må overtas av Forsvaret selv.

SONATE WMS vil løse mange av disse problemene, da denne utgaven er utviklet i samarbeid med METOC prosjektet ved FFI som allerede leverer mange typer kartbasert informasjon til Forsvaret. Vedlikeholdet av SONATE WMS vil bli enklere enn med den første utgaven, fordi mye av den kartbaserte informasjonen hentes direkte fra dataleverandøren og ikke må bearbeides ved FFI.

Strukturen på SONATE WMS er hovedsakelig ferdigstilt, men noen detaljer i brukergrensesnittet gjenstår. Dette vill bli fullført i parallell med at METOC WMS utvikles. FFI er fornøyd med retningen på utviklingen av SONATE og mener at beslutningen om å jobbe mot SONATE WMS var et riktig valg.

Contents

Preface

The story of SONATE started in 2003 with the FFI (Norwegian Defence Research Establishment) project “LFAS og Havmiljø”. John Kenneth Grytten designed the first versions of SONATE in collaboration with Erik Sevaldsen and Petter Kvadsheim. Nina Nordlund took over Grytten's work when he resigned from FFI in 2006. SONATE 2.0 was completed 2007, with the help of Frank Benders who was a visiting scientist at FFI from TNO in 2007. In 2008 SONATE 3.0 was completed, and the latest version, SONATE 3.2 (2011) was completed in 2011.

In parallel to the work with SONATE on the original platform, development of an internet based version started in 2009. This work was carried out in cooperation with the Institute of Marine Research and the METOC project at FFI.

1 Introduction

The Royal Norwegian Navy has purchased five new frigates equipped with 1-8 kHz active sonars. Such sonars are potentially harmful to marine life. Mass stranding of whales have been claimed to be caused by naval sonar exercises. Furthermore, the navy has been met with allegations that fish are also affected. As a way to mitigate this potential problem, the FFI (The Norwegian Defence Research Establishment) have developed SONATE for the Norwegian navy, a decision aid tool that will help reduce the environmental impact of naval exercises. The project is executed by FFI and funded by the Royal Norwegian Navy and the Norwegian Ministry of Defence.

SONATE is a decision aid tool for use during planning and execution of sonar exercises, with the aim to minimize conflicts with sea based industry (fisheries, fish farms, tourism) and influence of marine life. SONATE contains cartographic information on distribution maps, fishing activity and fish farms. SONATE also contains a set of guidelines that defines precautions to be taken towards vulnerable species and commercial activity when using sonar. Combining the cartographic information with the guidelines, SONATE defines which precautions to take in which areas.

SONATE comes in two different editions. The first edition was finished in 2006, and the version called SONATE 3.2 (2011) was released in 2011. This first edition is stand alone software that can be installed on an independent computer. The second edition, which we have called SONATE-WMS, is based on internet technology.

The content of the two editions are similar, and we have sought to make the presentation of the data as identical as possible in the two.

This report is written as a users manual to the two editions (SONATE 3.2 (2011) and SONATE-WMS). At the same time it is a description on how to manage and update the databases used by the tools and guidance for programmers who are to make changes in the SONATE user interface or software.

Chapter 2 of this report gives a description of the input data used in SONATE; file format and the actual information.

Chapter 3 describes the SONATE 3.2 (2011) edition. First, a description of the graphical user interface is given, and this part also works as a user's manual. The next part of Chapter 3 is meant for the data managers and describes how to update the databases that are used by SONATE. The third and last part of this chapter is mainly meant for the programmer who is to do changes in the software (like calculations of fishing activity, changes in the GUI etc).

Chapter 0 describes the SONATE WMS editions, and is as the last chapter divided in three parts. The first part works as a user's manual. The second is meant for the data manager and the last for the programmer. These two last parts are not detailed, as data management is mainly carried out

by IMR, and programming of the user interface of the SONATE WMS is done by the METOC project at FFI.

2 Input data

The input data to SONATE comes from different sources. In addition to land contours, the input data are distribution maps of fish and marine mammals, whaling, fishing activity, fishery zones, safari activities (e.g. whale watching) and fish farm locations. See overview in Table 2.1.

The land contours in SONATE 3.2 (and earlier versions) are imported from a shape file (ESRI format). The land contours are not very detailed, which makes SONATE unusable for navigation. The low detail level is chosen to keep the speed of SONATE up.

In SONATE WMS there is a selection of land contours and background maps of different resolutions and detail levels. These are the same background maps that are available elsewhere in the METOC WMS (For instance low detail world map and Norwegian nautical charts).

Input data	**Source**
Distribution maps (fish and marine mammals)	Institute of Marine Research
Fish farms	Directorate of Fisheries
Fishing activity	Directorate of Fisheries
Safari activities	From tourist companies
Fishing zones and locations	Directorate of Fisheries
Whaling areas	FFI, based on data from IMR

Table 2.1 Table showing input data and sources

2.1 The distribution maps

The distribution maps are obtained from Institute of Marine Research (Bergen, Norway). For SONATE 3.2 IMR delivers shape files (ArcGIS). Distribution data for the SONATE WMS are extracted from a postgis data base at IMR. For more information on this, please refer to the METOC project, by Atle Ommundsen or Espen Messel at FFI.

The delivery from IMR includes 19 fish species and 19 marine mammal species (see Table 2.2 for a complete list of species). This covers the most important species in Norwegian waters. In the North Sea, Norwegian Sea, most of the Greenland Sea and the Barents Sea, this dataset gives a complete data coverage. For some species the distribution maps cover a larger area.

In addition to geographical distribution of species, these data hold information on time period for which the maps apply. For some species the distribution varies with age-class, life stage (feeding,

moulting, spawning etc), and this is reflected in the maps in SONATE. For a more detailed description of the shape files, see Chapter 3.2.1 Input to distribution maps.

Most distribution maps are originally delivered as valid for whole months, but for a few species, the validity period is given for another period. At these few occasions, the validity period in SONATE 3.2 (2011) is extended to the beginning and end of month. For SONATE-WMS the original dates are kept.

In addition to the distribution maps, SONATE also contains maps with information on safari activities (e.g. whale watching) and areas of whaling. Figure 3.2 and Figure 3.3 shows examples of how distribution data are presented in SONATE.

Table 2.2 SONATE contains distribution maps for the species in the table below (Norwegian names in parentheses.

FISH:	**MAMMALS:**
Blue whiting (Kolmule)	Atlantic white sided dolphin (Kvitskjeving)
Capelin (Lodde)	Bearded seal (Storkobbe)
North Sea Cod (Nordsjøtorsk)	Beluga (Hvithval)
North East Arctic Cod (Nord-øst-arktisk torsk)	Bottlenose whale (Nebbhval)
Coastal Cod (Kysttorsk)	Fin whale (Finnhval)
Deepwater Redfish (Snabeluer)	Grey seal (Havert)
Greenland halibut (Blåkveite)	Harbour porpoise (Nise)
North Sea Haddock (Nordsjøhyse)	Harbour seal (Steinkobbe)
North East Arctic Haddock (Nord-øst-arktisk hyse)	Harp seal (Grønlandssel)
Norwegian Spring Spawning Herring (Norsk vårgytende sild)	Hooded seal (Klappmyss)
Fjord Herring (Fjordsild)	Humpback whale (Knølhval)
North Sea Herring (Norsdjøsild)	Killer whale (Spekkhogger)
Horse mackerel (Taggmakrell)	Minke whale (Vågehval)
Mackerel (Makrell)	Narwhale (Narhval)
North Sea Saithe (Nordsjøsei)	Pilot whale (Grindhval)
North East Arctic Saithe (nord-øst-arktisk sei)	Ringed seal (Ringsel)
Sprat (Brisling)	Sperm whale (Spermhval)
Fjord Sprat (Fjord brisling)	Walrus (Hvalross)
Polar Cod (Polartorsk)	White beaked dolphin (Kvitnos)

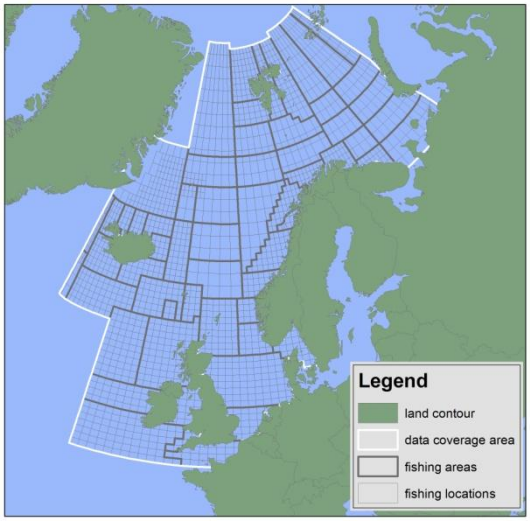


Figure 2.1 *The white lines in the map show the area of complete data coverage of distribution maps and fishery data. Some of the distribution maps cover areas outside these white lines, but the data coverage is not complete here. The fishing areas and fishing locations are information used by the Directorate of Fisheries to report fishing activity and catch.*

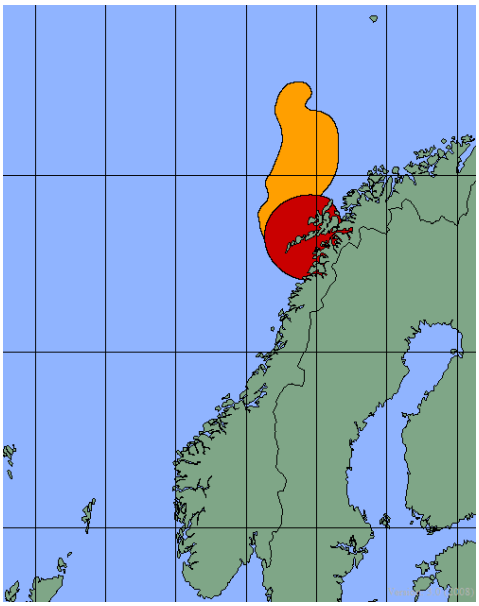


Figure 2.2 *The figure shows a typical example of a distribution map as presented in SONATE 3.2. The orange areas show distribution of herring (winter area) in January, the red area is killer whale distribution in January.*

2.2 Fishing activity

Fishing activity data are obtained from The Directorate of Fisheries (Point of contact: Randi Sofie Sletten [randi-sofie.sletten@fiskeridir.no]). The Directorate of Fisheries divides the

Norwegian Waters into fishing areas and fishing locations, in which catch of fish is reported. These areas and locations are also used in SONATE to display fishing activity (Figure 2.1 shows the areas and locations).

The fishing activity data holds information on catch period (monthly), area, location, fishing tool, species (or groups of species), catch (in kg) and number of vessels which have reported catch from the location. Be aware that this dataset only holds information on catches delivered in Norway. Figure 3.4 shows examples of how fishing activity data are presented in SONATE 3.2.

Fangst år	Fartøy nasjon	Homr	Lok	Lev_ år	Lev_ mnd	Lev_ år-md	Redskaps gruppe	Fisk_ gruppe	Rund-vekt i kg	Utbetalt verdi i kr	Ant far tøy
2007	NOR	42	14	2007	11	2007-11	Not	Sild	2299981	4835681	6
2007	NOR	42	14	2007	11	2007-11	Not	Anna pelagisk fisk	4738	2207	3
2007	UTL	43	83	2007	11	2007-11	Trål	Sild	9000	0	1
2007	UTL	43	83	2007	11	2007-11	Trål	Anna pelagisk fisk	1096489	9404331	2
2007	UTL	43	66	2007	11	2007-11	Trål	Sild	1500	0	1
2007	UTL	43	66	2007	11	2007-11	Trål	Anna pelagisk fisk	129816	1079497	1
2007	NOR	54	8	2007	11	2007-11	Line	Anna fisk	173	4410	1
2007	NOR	54	8	2007	11	2007-11	Line	Torsk og torskeartet fisk	16808	318258	1
2007	NOR	61	0	2007	11	2007-11	Trål	Anna fisk	31085	452036	1
2007	NOR	68	0	2007	11	2007-11	Trål	Anna fisk	293139	4928261	1

Table 2.3 The table below shows an example from the fishing activity input file. The file is in Norwegian. The fields of the table are: year; nation; area; location no; year of delivery; month of delivery; yr-month; fishing tool; fish group/species; weight in kg; value in NOK; # boats

2.3 Fish farms

The fish farms data are obtained from the Directorate of Fisheries ("http://www.fiskeridir.no/akvakultur/registre"), on an excel file, and keeps concession holders name and address, species, production capacity, geographic coordinates etc. Be aware that the fish farm locations presented in SONATE are existing concessions. Some companies have concessions on several locations and move the fish farms between these. This means that not all fish farm locations indicated in SONATE contains a physical farm at all times.

Figure 3.6 shows an example of how fish farm data are presented in SONATE. For an example of the input excel file, see Chapter 0 F.1 Fish farms information.

2.4 The guidelines

The sonar regulations (guidelines) are issued by the Chief of the Norwegian Navy (GIS) based on recommendations from FFI. The textbox below shows an extract of the complete guideline for sonar operations in Norwegian waters. The entire guideline is summarized in 7 points. See 0 for the complete document.

The requirements for selection of an area and a period for execution of intense sonar exercises[1] are stricter than for routine sonar exercises[1].

During planning and execution of sonar exercises the following applies:

3.1. Sonar activity in an area can result in avoidance responses in marine mammals, and they might leave the exercise area. This can result in lost feeding opportunities risk of mother calf separation and increased energetic cost. Therefore, avoid as much as possible intensive[1] and routine[1] sonar exercises in areas/periods[2] expected to have a high abundance of any species of marine mammals[2], and because they are considered to be particularly sensitive also in known beaked whale[1] areas[2].

3.2. Sonar activity in an area can result in avoidance responses in marine mammals, and they might leave the exercise area. However, threshold of avoidance is still uncertain and will vary between species. Therefore, avoid as much as possible intensive sonar exercises[1] in areas/periods where whale safari activity[2] can be directly influenced by use of sonar.

3.3. Sonar activity in an area can result in avoidance responses in marine mammals, and they might leave the exercise area. However, threshold of avoidance is still uncertain and will vary between species. Forces are therefore instructed to be aware of and consider whaling activity as much as possible, including notification of planned sonar activity, when operating in areas/periods with whaling[2].

3.4. To reduce the risk of inflicting direct injury to marine mammals, special procedures for sonar transmission should be used during routine[1] and intensive sonar exercises[1] in all areas/periods[2] where marine mammals[1] are expected to be encountered (see section 3. *Procedures for sonar transmission in areas where marine mammals are expected to be encountered*).

3.5. In the area closest to a sonar source, it is still uncertain if fish might respond to sonar transmissions. In areas/periods with fishery[2], one should be aware of the fishing activity and always maintain a safety distance of 200m from all fishing vessels actively engaged in fishing. If the fishery involves herring[2] or sprat[2] the safety distance should be extended to 500m if transmissions include signals below 5 kHz. This is connected to the sensitive hearing of herrings[1] in this frequency band compared to most other species of fish.

3.6. In the area closest to a sonar source, it is still uncertain if fish might respond to sonar transmissions. During sonar transmission a 200 m safety zone from fish farms[2] shall therefore be maintained.

3.7. At high sound levels, tonal signals (CW[1]) have a destructive impact on juvenile herring[2] (no; sildelarver/yngel)

3 SONATE 3.2 (2011)

3.1 User interface description

The SONATE application can be used by users with different points of view and requirements. The application is mainly meant for planners of sonar operation and operational users (sonar operators). It can also be used by scientists or managers to get an overview of species distribution and commercial activity.

We assume that a typical planner of sonar exercises will use SONATE to locate an area and time period suited to perform an exercise with a minimum of operational restrictions. A typical operational user will use SONATE to view details in the exercise area, and to find information on critical frequency bands and start up procedures.

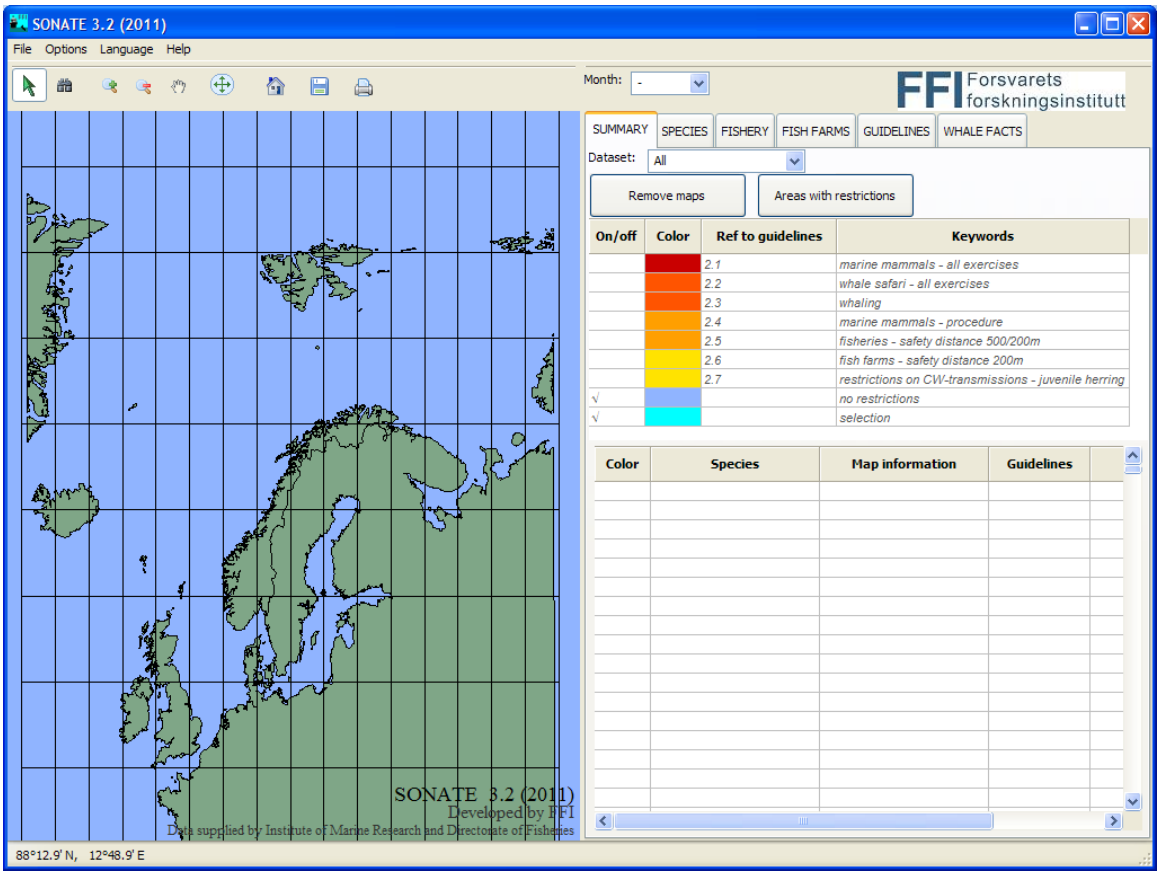


Figure 3.1 the overall structure of the SONATE window

The SONATE application has been split into several maps showing different kinds and details of information. The most complete overview of information can be found under the *SUMMARY* tab. This map shows only information about areas where restrictions are recommended. More detailed information on species can be found under the *SPECIES* tab. These maps focus on all marine

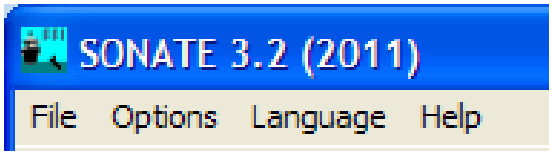
species (including species and areas without restrictions). The fishery information is found under the *FISHERY* tab. Information on the fish farms (including positions) can be found under the *FISH FARMS* tab.

The SONATE window is divided in two panels: at the left side a map and at the right side text, tables and legend (see Figure 3.1). The information shown in the map depends on the selected tab. In addition to the tabs with maps (*SUMMARY*, *SPECIES*, *FISHERY* and *FISH FARMS*) there are also two other tabs containing *GUIDELINES* and *WHALE FACTS*.

The buttons above the map can be used to select areas on the map and to navigate through the map by zoom in/out and changing the centre. The functions of the buttons are described in the table below.

	The *selection* functionality will provide information of the top layer of the map
	The *binocular* will provide information on all layers under the SUMMARY and SPECIES tabs (the other tabs have only single layer maps).
	*Zoom in function*. When the *zoom-in* function is used, only the areas inside the borders of the map will be listed in the table on the right side under the species tab.
	*Zoom out function* When the user *zooms out*, the table to the right will again be updated with the information inside the map shown on the left.
	*Pan function*
	The *zoom to fit* button can be used to reset the size of the screen.
	The *home* button resets the entire application to the initial settings can be done with.
	Save map to HTML format
	*print* button

In the menu bar of the application, the user can find:



- under *File*: the functionality to print and store the map and tables, and to export m5layer files that can be imported to Maria.
- under *Options*: turn on/off area coverage display (data coverage is assumed to be 100% inside the area), turn on/off grid display (5° latitude and longitude intervals)
- under *Language*: choose between English, Norwegian or Dutch language
- under *Help*: a help text

Above the table at the right side of the window, the user can specify the month. A "-" in the month dropdown box means that there is no month selected.

At the left bottom of the SONATE window, the position of the cursor on the map is shown. Version number is always displayed at the bottom of the map.

The SONATE database contains a vast amount of data, which is to be displayed graphically. If all these data are read to the memory at the same time, SONATE will respond slowly to new requests. Selecting a specific month and restricting the geographical selection to the relevant area (by zooming in the map), will reduce the amount of data in memory and thereby the response time.

3.1.1 Summary maps

The summary maps are made to provide a quick overview of all areas where the guidelines recommend restrictions on use of active sonar. For the fishing activity, only locations with catch of herring is shown in the summary maps (related to guideline no 2.5). Fishing activity in general and fish farms are not shown in the summary map. Initially, no guidelines are selected. Figure 3.2 shows an example of the summary maps. The colours indicate the importance of the guideline (red is more stringent than orange). The most important information will mainly be visualised on top of the map (overlapping the other information).

At the top of the *SUMMARY* tab, the user can select the dataset (species and/or fishery) of interest by means of the dropdown menu. Below the dropdown menu, two buttons are visible. The button *Areas with restrictions* button enables the user to select all visible areas where the guidelines recommend restrictions on use of sonars, at once and show them on the map. The *Remove maps* button will remove all areas from the map.

Below the buttons, a legend explains the colours and the corresponding guidelines. The left column shows whether the guideline(s) are visualised, followed by the colour corresponding to the guideline. At the right side a small guideline description by means of keywords is given. By clicking in the *On/off* column, a guideline can be visualised or removed. By clicking in the *colour* column, all guidelines with the same colour are selected. The *guideline* column can be used to jump directly to the guideline description (under the *GUIDELINE* tab). When a guideline applies in the selected area, the text in the *Ref to guideline* column is written in blue, otherwise it will be *grey italic.*

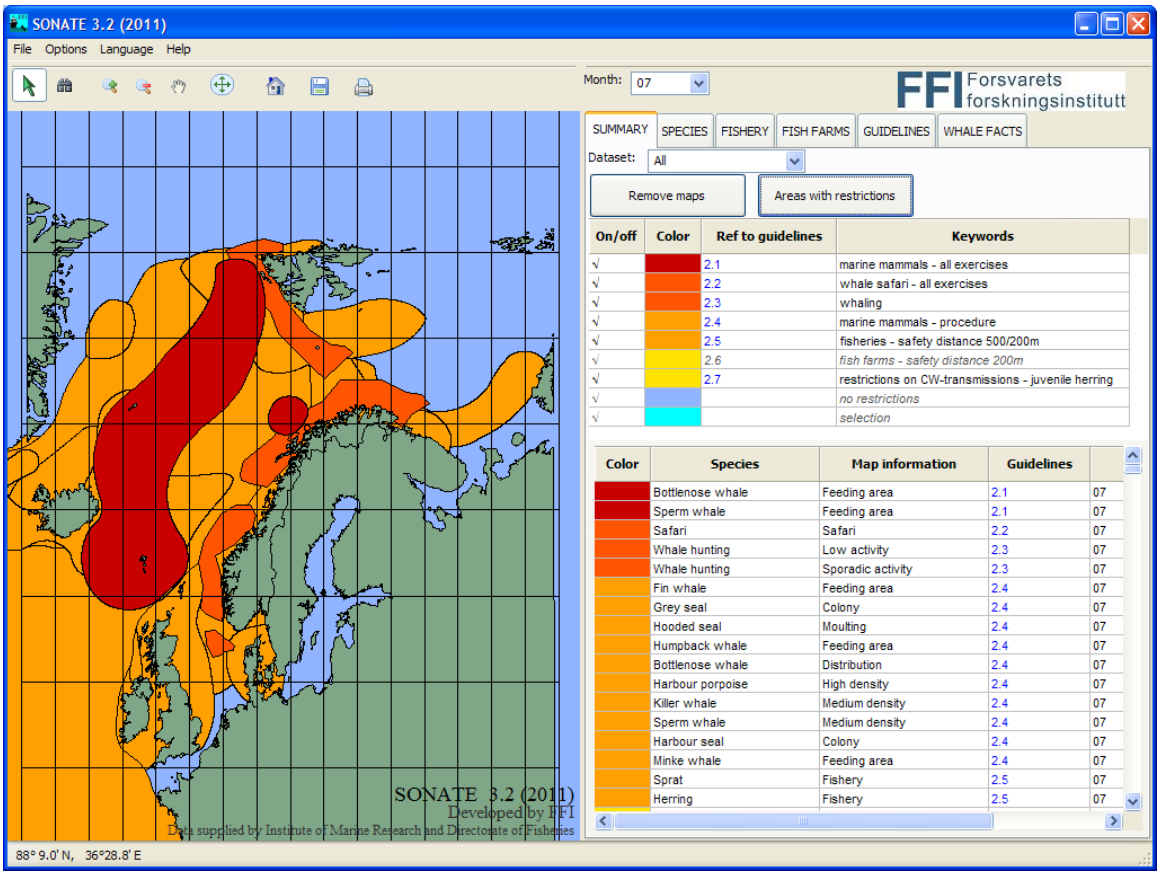


Figure 3.2 An example showing the summary map of July. Map to the left. To the right a menu to select month, dataset (species, fishing activity or both), buttons to show or hide groups of maps, legends and a table which lists all areas inside the map extent.

The table at the bottom shows a list of all areas where restrictions are recommended, either caused by the presence of vulnerable species or high fishing activity. When the *colour* column is coloured, the area corresponding to this information is shown in the map. For each area in the table, the *species* name, *map* information, *guidelines* and *month* is shown in the table. In some cases more detailed information is given in the *guidelines* column (e.g. frequency band restrictions). When all months are selected (at the top of the tab), the last column shows a list of month numbers in which the guidelines recommend restrictions on use of active sonar. To turn

on or off the distribution maps one clicks in the *colour* column of the table. The last distribution map turned on, will have a cyan outline.

Only restricted areas that are inside the margins of the map to the left will be shown in the table. After zooming in, only the guidelines concerning the visualised area will be displayed in the table.

3.1.2 Species maps

The *SPECIES* tab provides the user with distribution maps of all species in the database Figure 3.3 shows an example of distribution maps for some marine mammals in July. The colour coding is similar to the one used under the *SUMMARY* tab, but also species with no restrictions linked to them are shown (in green).

At the species drop down menu, the user can select species or group of species (fish or mammals). The table below can be sorted by guideline, species name, or map information by means of the sorting dropdown menu.

By pressing the *All species maps* button all distribution maps inside the visible part of the map will be shown. The *Areas with guidelines* button will only show areas where restrictions are recommended. Removing all distribution maps can be done by clicking the *Remove distribution maps* button.

The table at the right shows a list of all distribution maps in the visible area of the map. When the *colour* column is coloured, the habitat of the species is shown on the map. For each row in the table, the species name, map information, guidelines, and month is depicted. In some cases more details concerning the guidelines is given in the *guidelines* column (e.g. frequency band restrictions). When all months are selected (at the top of the tab), the *month* column shows a list of month numbers in which the distribution map applies.

Clicking in the *colour* column of the table to the right will turn the distribution map on or off in the map to the left. Clicking on the *species* column will result in (un)highlighting of the corresponding distribution map. An example is shown in Figure 3.3 where grey seal migration area is highlighted.

Clicking on areas on the map will hightlight them. By using the *binocular* button, information on all distribution maps below will be shown in a small information window.

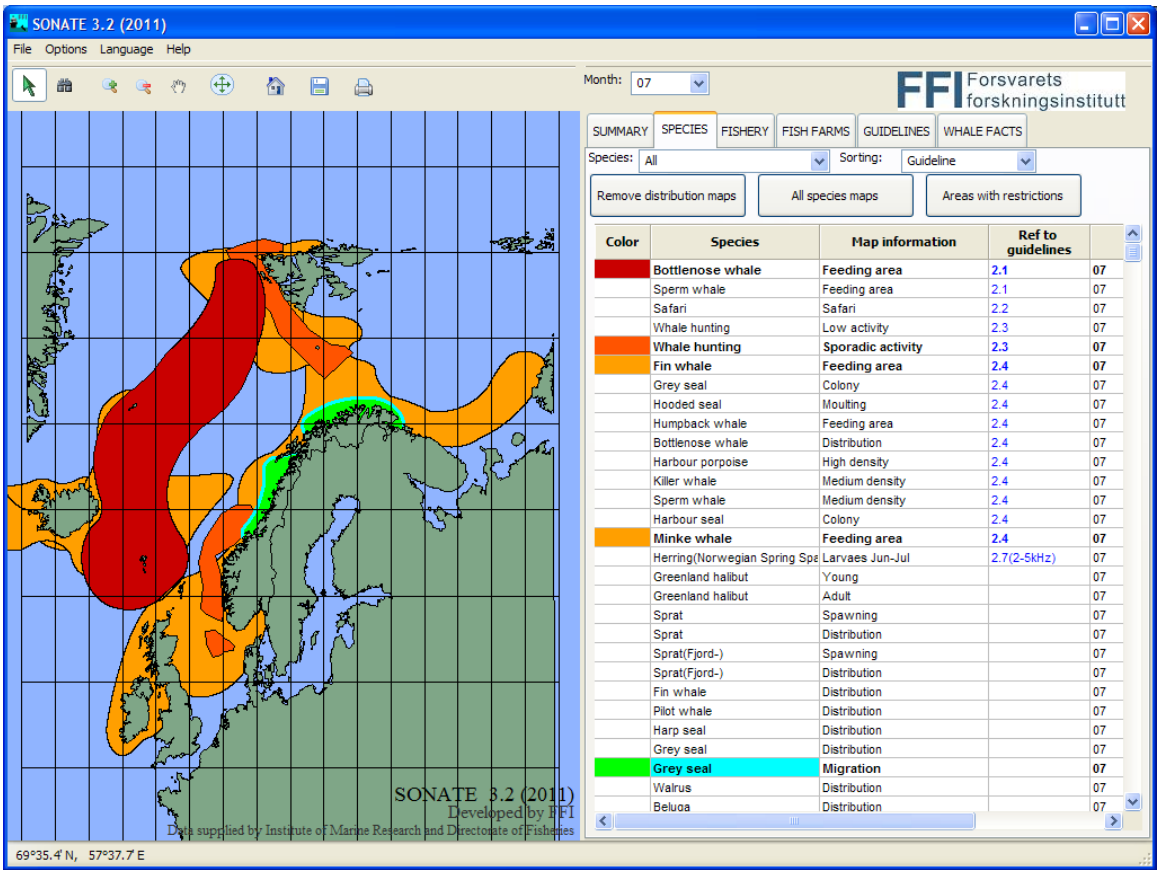


Figure 3.3 The species tab distribution maps. July month is selected, and some marine mammal distribution maps are visualised. The grey seal migration area map is selected and is shown with a cyan outline.

3.1.3 Fishery maps

The *FISHERY* tab gives information on fishing activity in the different fishing locations. The fishing locations are areas used by the Directorate of Fisheries for reporting catches. Fishing activity in SONATE is calculated from reported catch and number of vessels in each location. The activity is calculated month by month, and can be extracted from the database as values based on data from one year or an average of the last three years. Current regulations on use of sonars (0 0) recommend a safety zone of 200m to fishing vessels in general, and a safety zone of 500m to vessels fishing for herring or sprat. Locations where herring or sprat catch is reported are shown with orange outline. The dataset shown in the map can be either catch OR number of vessels, which is selected by the dataset drop down menu above the table. As default, average number of vessels is selected. The fishing activity can vary a lot from year to year, this is the reason for including both yearly and three-years-average datasets. Initially, average catch and all fish groups are selected.

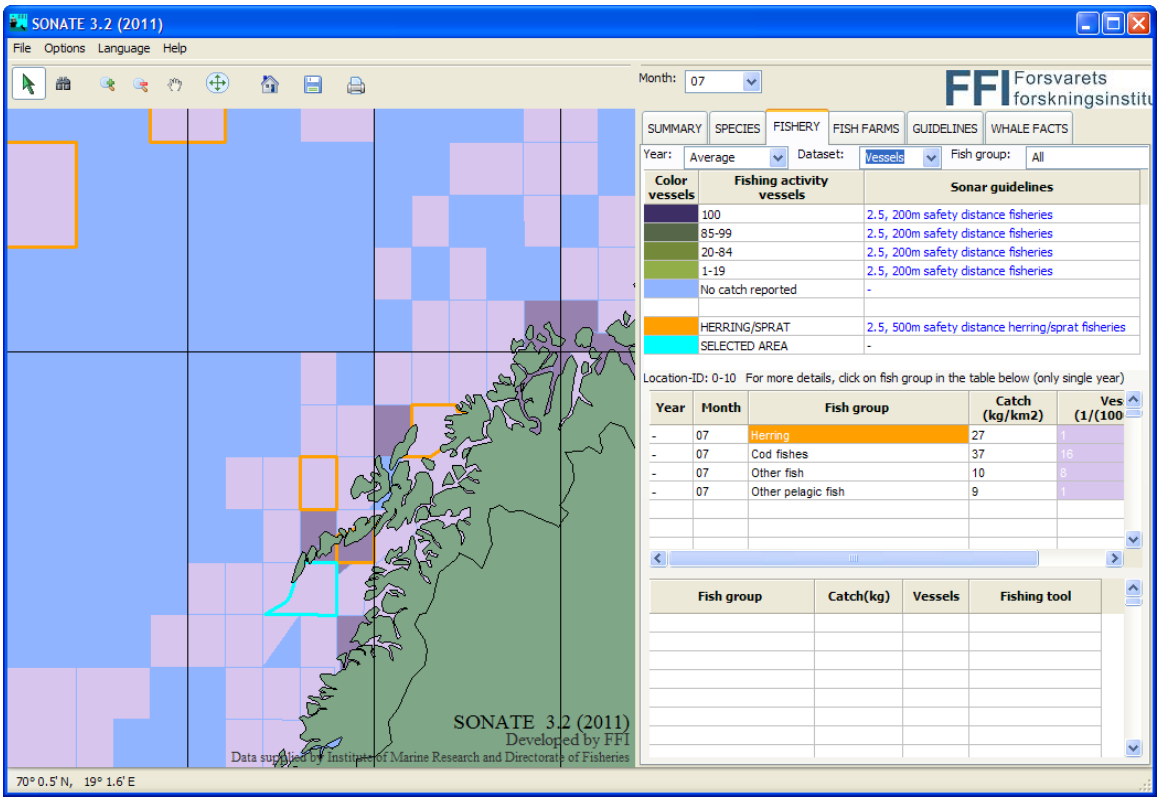


Figure 3.4 *The fishery tab reveals fishing catch activity. As an example numbers of vessels per area are shown for July. Details are shown for the area with location-ID: 0-10. This area appears with a cyan outline in the map. The areas with orange outline are locations where herring catch is reported.*

Clicking on a location will reveal detailed information of the location in the table below the legend.

With one year selected (not average), the user can select one fish group in the middle table (by clicking on it). For this fish group detailed information about the catch, number of vessels and fishing tools are shown in the bottom table. An example can be seen in Figure 3.5.

As mentioned above, any recommended restrictions on use of sonar caused by fishing activity is based on average values for the last three years. Also taken into consideration is the vulnerability of different fish species.

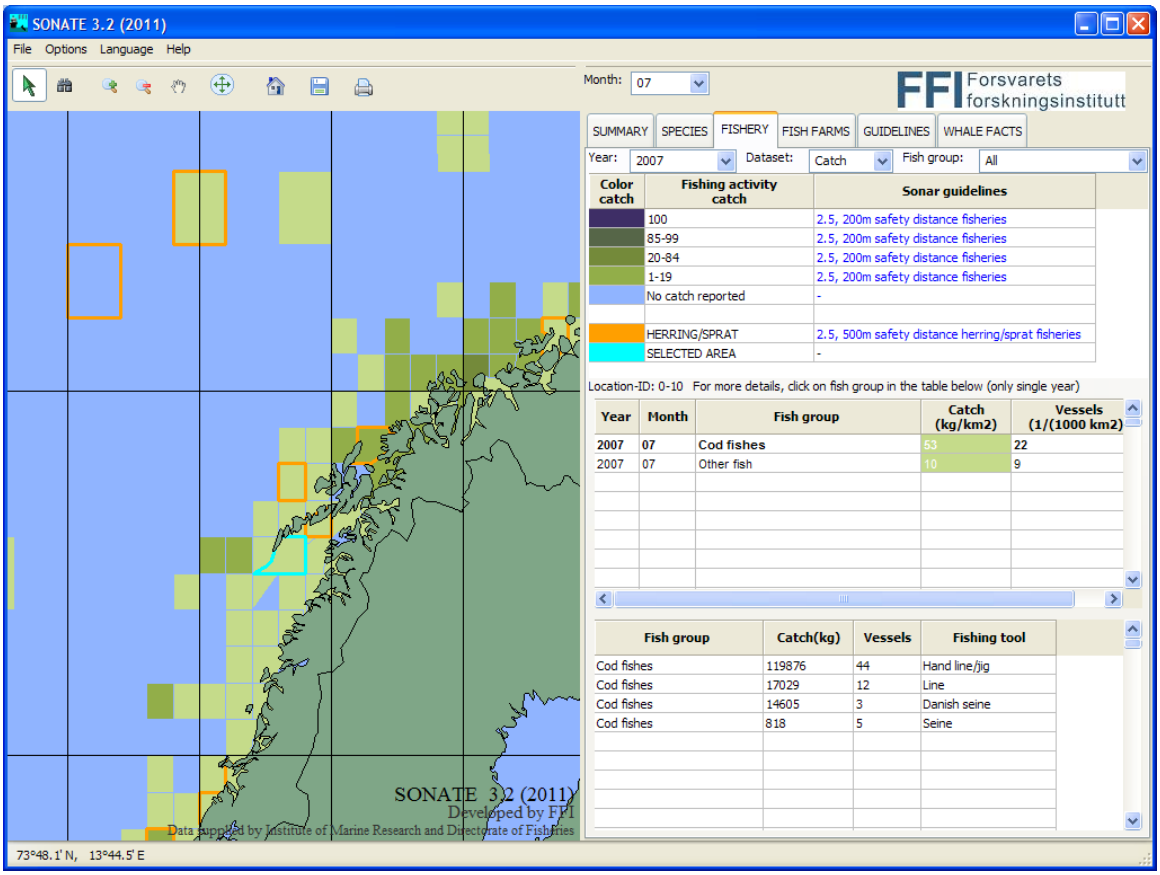


Figure 3.5 The fishery tab reveals catch per area. As an example, catch for July 2007 is shown, with details for location-ID:0-10.

3.1.4 Fishfarm maps

The *FISH FARMS* tab gives an overview of all concessions for fish farms in Norway. The first time this map is selected, all fishfarm information will be read from the fish farms database (this will take some time).

Detailed information on a each fishfarm is obtained by clicking on the markers on the map. Information of the selected fish farms will appear in the table at the right side, with the most recent selection highlighted on top. Selected fish farms in the map will change color to the selection color. All fish farms can be unselected and removed from the table by clicking on the "Remove selection" button.

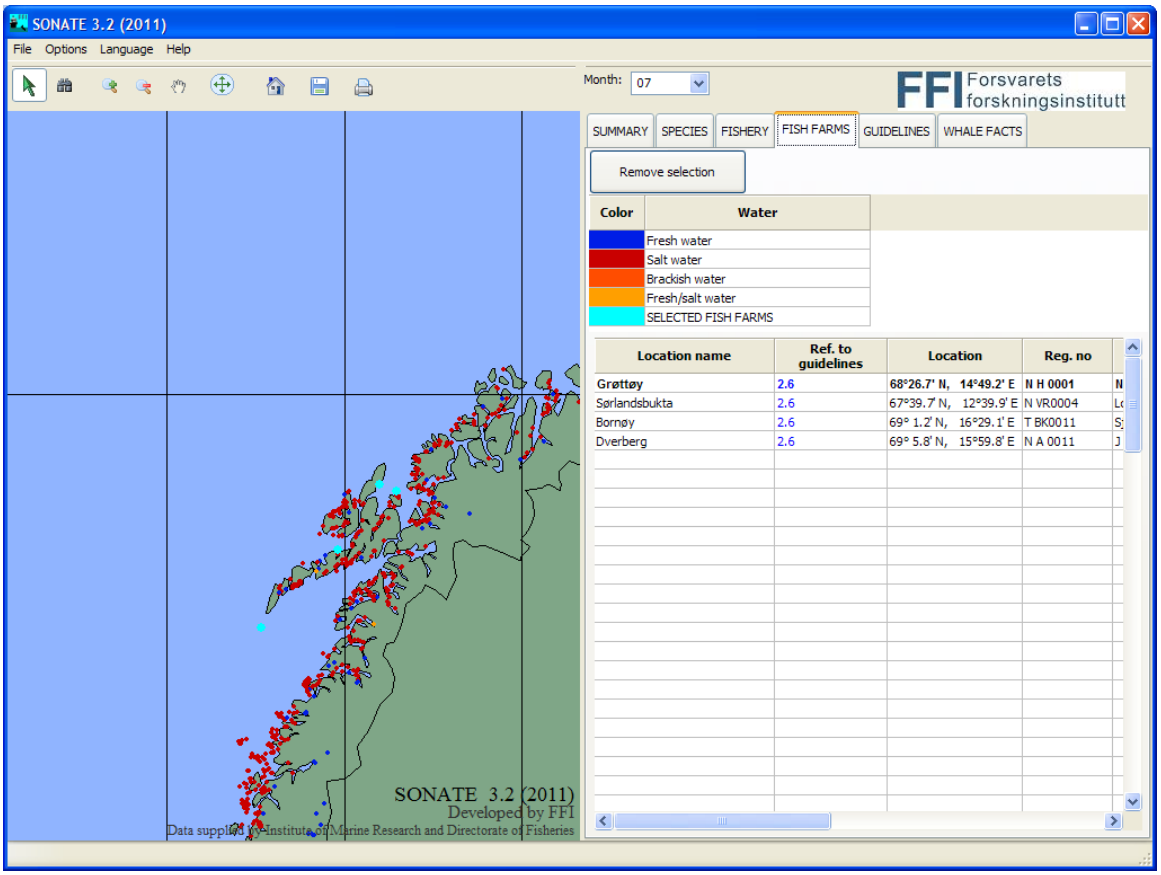


Figure 3.6 Example of the fish farms information in SONATE

The capacity of fish farms can be given in numbers (stk) (number is to be multiplied by 1000), tonnes (tn), DA (decare- 1000m^2), kg, l, m^2 or m^3.

3.1.5 Guidelines

The *GUIDELINE* tab will show the complete official guidelines (see Figure 3.7) as implemented by the Chief of the Norwegian Navy (GIS) based on scientific recommendations from FFI. The language of the guidelines can be changed by selecting another language in the menu bar. Links to the *GUIDELINE* tab appears numerous places elsewhere in SONATE 3.2, for instance in the legend of the *SUMMARY* tab and in the *Ref to guidelines* columns under the *SUMMARY* tab and the *SPECIES* tab.

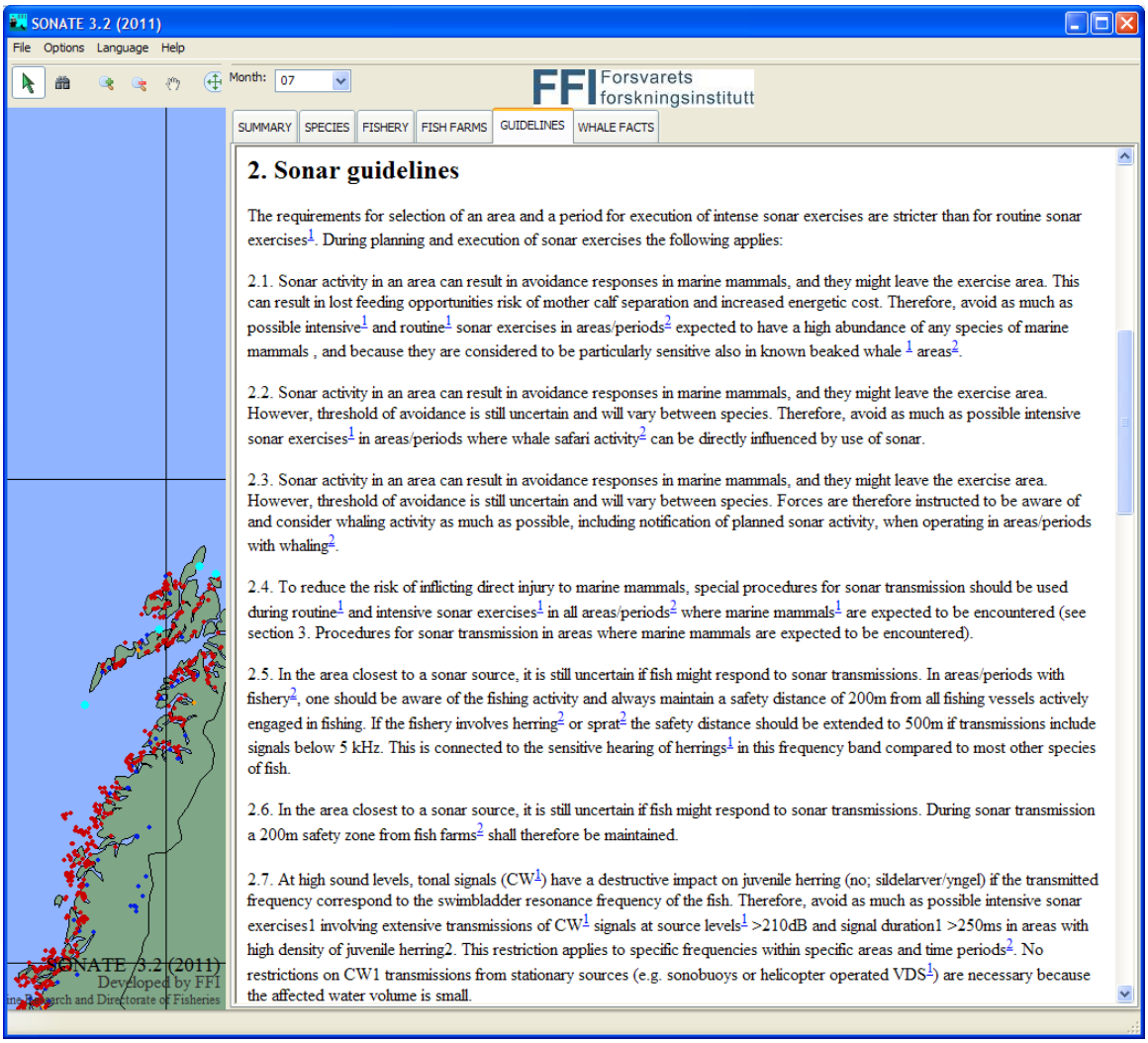


Figure 3.7 Example of the guidelines in SONATE

3.1.6 Whale facts

The *WHALE FACTS* tab is meant to support visual observers during exercises. The tab shows detailed visual and behavioural information about the whales. An example is shown in Figure 3.8.

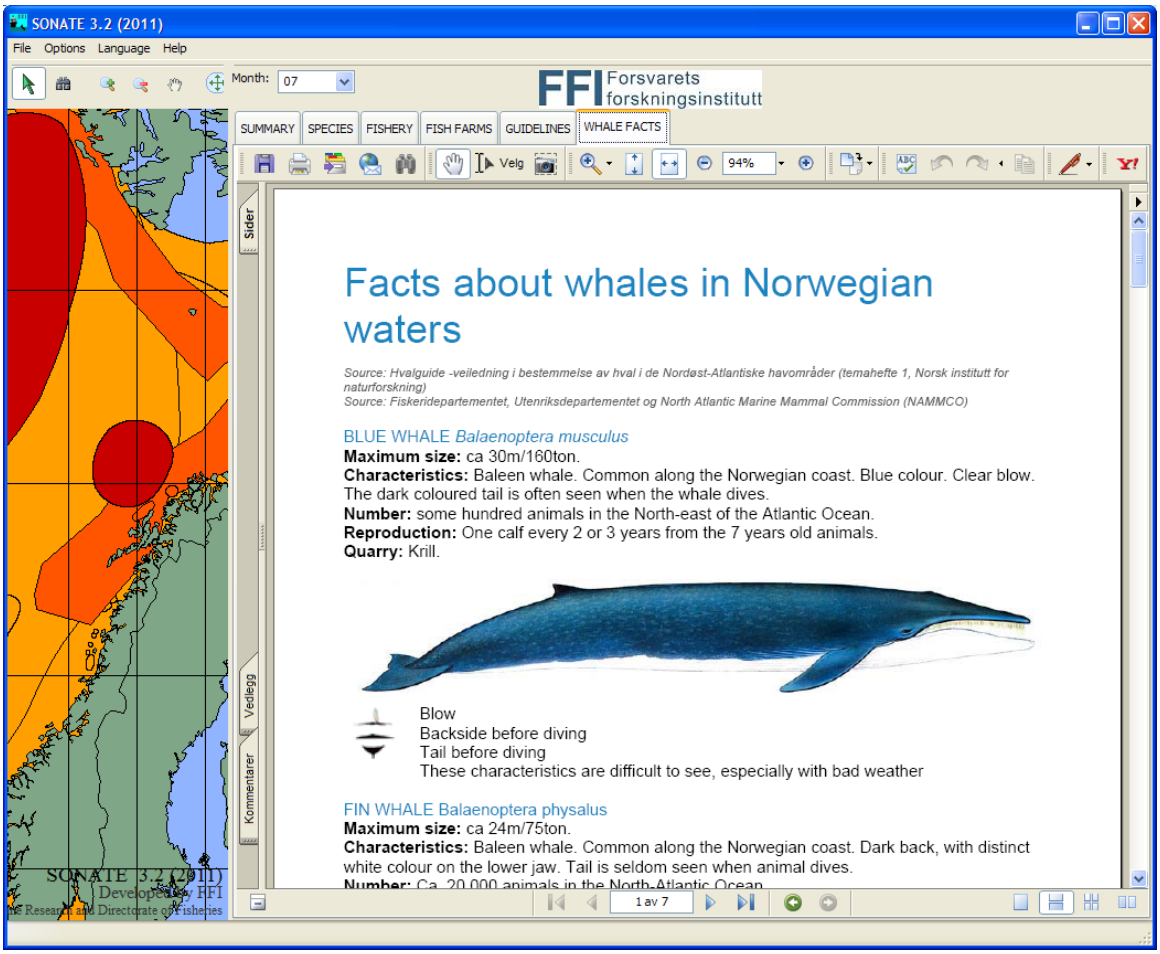


Figure 3.8 Example of the whale facts in SONATE. The map shows the distribution of the fin whale around the year

3.2 For the data manager: From input data files to a SONATE installation file

SONATE is programmed in python, with wxPython to take care of the graphical user interface. Geographical data are handled with POSTGRESQL (with postgis extension) database and hdf5 data format, and other database information is handled with sqlite. See Chapter 3.3 and 0 for a closer description. (More information on http://www.postgresql.org/ , http://postgis.refractions.net/ , http://www.python.org/ , http://www.sqlite.org/)

A program is made to take care of the processing of the data from input data format to make them ready for use in SONATE. This program is called ***sonate_dbms.py***.

This program requires that you have POSTGRESQL with the postgis extension installed, and you will also need sqlite. See 0 for a complete list of extensions and installations needed.

The ***sonate_dbms.py*** has different modules to take care of the input data. The *Species* tab is used to read distribution data from shape files and export them to the SONATE databases. The *Fishery* tab is used to read data from an MS excel file containing fishing activity data and to

export the data to the SONATE databases. The *Fishfarms* tab is used to read information on fish farms from an MS excel file and import the data to the SONATE databases. Finally, the *Map* and *Area* tab are used to read background maps from shape files to the SONATE databases.

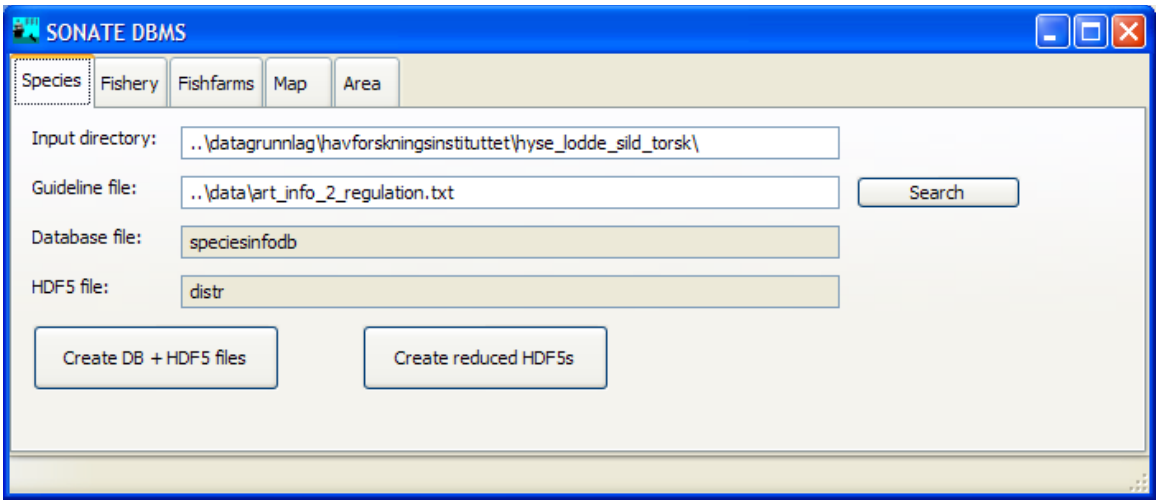


Figure 3.9 sonate_dbms.py consists of different modules

After exporting the data into the databases, SONATE can be tested by running sonate.py. To make an executable installation file, se chapter 3.2.4.

3.2.1 Input to distribution maps

The distribution maps are obtained from IMR as shape files (ESRI-format). The coordinate-system used in the shape-files has been WGS84 or North Pole stereographic with WGS84 datum. The input to SONATE must be North Polar Stereographic with WGS84 datum, so some of the shape-files have to be transformed prior to importing them to SONATE.

Normally the shape files are delivered with the fields shown in Table 3.1, but due to minor differences in the deliveries, especially the early deliveries, all shape-files have been reduced to contain only FID, Id, INFO, shape. This is because the software sets the field of the SONATE databases equal to the fields of the first shape file imported, so that all shape files must have the same fields, or the program will abort.

Field	description
Id	unique ID
ATRSDATA	
DYREGRUPPE	group
ART	species
STADIUM	
STARTDATO	The distribution map is valid from this date
SLUTTDATO	to this date (MMDD)
INFO	
OPPDATERIN	date for updating of shape-file
MENGDE	amount
REFERANSE	reference
TETTHET	density
ARTSNAVN	species name
ARTSBESKRI	description
LATINSK_NA	latin name

Table 3.1 Fields in standard shape file delivery

Prior to importing the data to SONATE, the files have to be organized in a well-defined structure, where the file path defines the species names and period, and the filename defines the mapinfo (if the file shows spawning areas, winter areas, juveniles, adults etc). See example in Figure 3.10. When the shape files are well organized, data are imported to the database by pressing the button *Create db + hdf5 files.* The drawback of this organization is that the same polygon is imported to the database several times (once for each month they are valid). The button *Create reduced HDF5s* organize the maps in the internal databases so that polygons are stored only once.

If a new type of mapinfo is introduced to the dataset, changes have to be made to the code in sonate_dbms.py. The connection between the *mapinfo* given in the *filename* and the *mapinfo* that appears in the SONATE application is hardcoded. See example in Textbox 1 below. The text marked in green is part of the filename; the text marked in yellow is the *mapinfo* that will appear in SONATE.

When a new species is added to the database, or to the set of shapefiles, this has to be added to the hardcoded list in sonate.py, where the dropdown menus for selecting species are defined. In addition to the shape files, a file is required that defines the connection between the species, mapinfo *and* guideline number *(default file: art_info_2_regulation.txt. See example in textbox 2.*

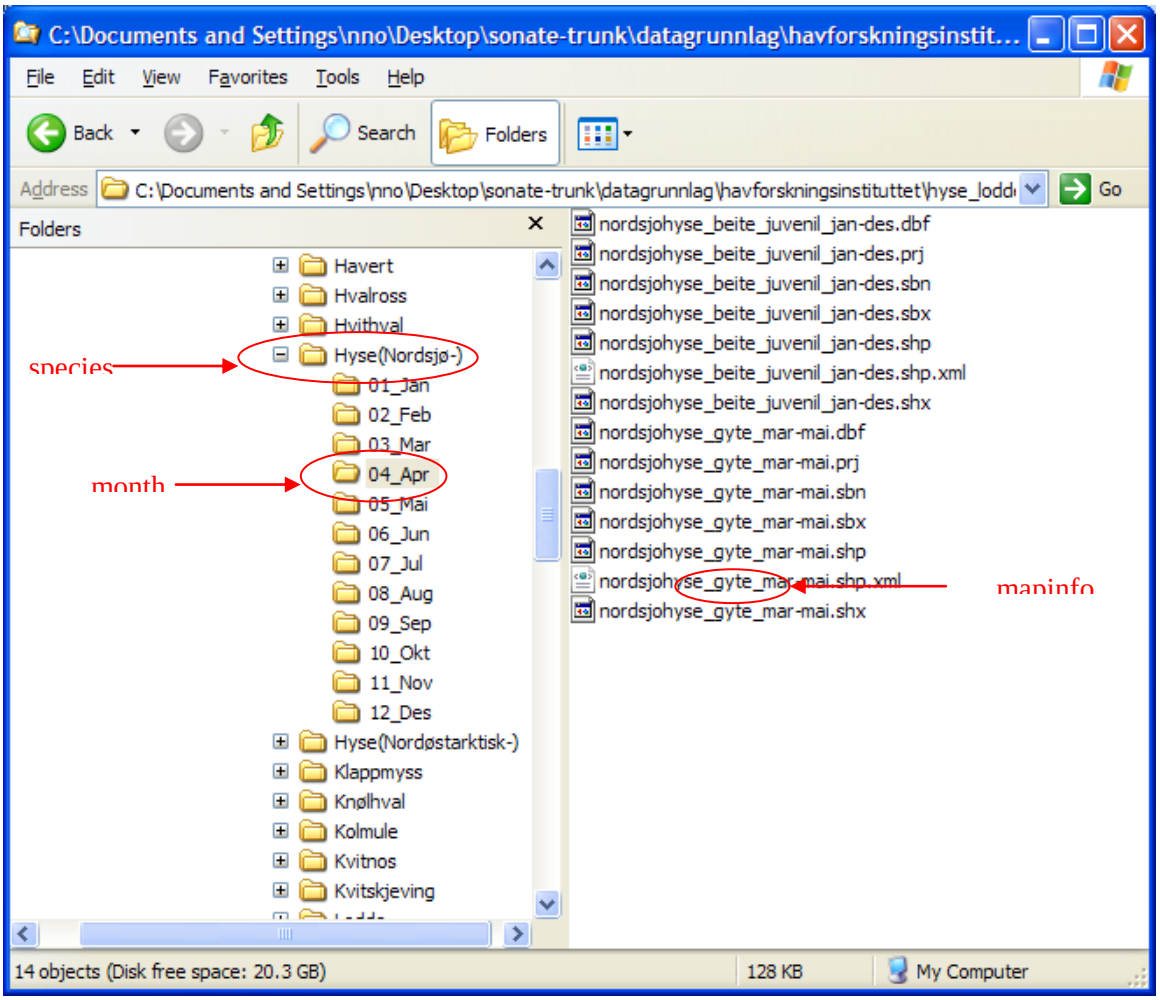


Figure 3.10 The input files for distribution maps are organized after species, month and mapinfo. "Beite" means feeding ground, "gyte" means "spawning area".

```
mappings = [('gyt','Gyting'),
            ('NiseHoyTetthet',u'Høy tetthet'),
            ('hoy_tetthet',u'Høy tetthet'),
            ('MiddelsTetthet',u'Middels tetthet'),
            ('beite','Beiteomr'),
            ('egg','Egg'),
            ('larve','Larver'),
            ('yngle','Yngling'),
            ('sild_larve_apr','Larver apr'),
            (u'(4_år|4aar)',u'4 år og eldre'),
            ('voksen','Voksen')]
```

Textbox 1 *The connection between the mapinfo given in the filename and the mapinfo that appears in the SONATE application is hardcoded. In Norwegian. Example: in filename: hoy_tetthet (high density) gives mapinfo 'Høy tetthet'. Translation to other languages is done elsewhere in the code.*

```
Finnhval Beiteomr 2.4
Grønlandssel Hårfelling 2.4
Grønlandssel Kasting 2.1
Havert Kasting 2.1
Havert Hårfelling 2.4
Havert Koloni 2.4
Knølhval Beiteomr 2.4
Klappmyss Hårfelling 2.4
Klappmyss Kasting 2.1
Nebbhval Beiteomr 2.1
Nebbhval Utbredelse 2.4
Nise Høy tetthet 2.4
Sild(NorskVårGytende-) Larver mai 2.7(3-6kHz) 5
Sild(NorskVårGytende-) Larver apr 2.7(3-6kHz) 4
Sild(NorskVårGytende-) Larver jun-jul 2.7(2-5kHz) 6,7
Sild(NorskVårGytende-) Larver aug-sep 2.7(1.5-3kHz) 8,9
Safari Safari 2.2
Spermhval Beiteomr 2.1
Spermhval Middels tetthet 2.4
Spekkhogger Høy tetthet 2.1
Spekkhogger Middels tetthet 2.4
Steinkobbe Koloni 2.4
Steinkobbe Hårfelling 2.4
Steinkobbe Kasting 2.1
Hvalfangst Sporadisk aktivitet 2.3
Hvalfangst Lav aktivitet 2.3
Hvalfangst Sporadisk aktivitet 2.3
Hvalfangst Moderat aktivitet 2.3
Vågehval Beiteomr 2.3
```

Textbox 2 *Example of art_info_2_regulation.txt file. Species, mapinfo and guideline number*

3.2.2 Calculation of fishing activity

The fishing activity input data is an MS excel file. The fishing activity data holds information on catch period, area, location, fishing tool, species (or groups of species), catch in kg and number of boats which have reported catch from the area.

If the content changes, or column number changes, the code of sonate_dbms.py has to be changed. See Chapter 3.3 For the programmer for closer description.

The guidelines recommend restrictions on use of sonar in areas with high fishing activity for vulnerable species or periods of vulnerability. High fishing activity areas are defined as locations where the catch per km^2 per month OR the number of boats per km^2 per month is above a threshold value.

The catch and number of boats per area is calculated in sonate_dbms.py, under the *Fishing* tab. See Figure 3.11. In addition to the fishing activity data (as shown in Figure 3.12) a file containing the areas of the different locations is needed (AREA.XLS), and a file (default: fish_info_2_regulation2.txt) which sets the threshold values for recommending restrictions on use of sonar.

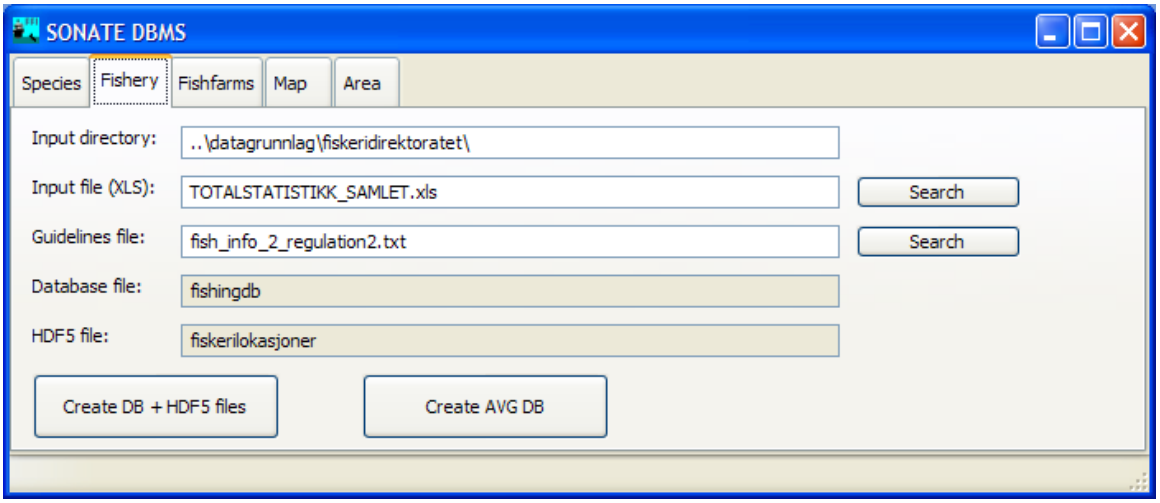


Figure 3.11 SONATE DBMS, the fishery tab.

To perform the calculations of the fishing activity, first press the *Create DB + HDF5 files* button, this will import the data from the input files. Then press the *Create AVG DB* button, to calculate the average values for the last three years. This process updates the input files to SONATE and the file missing_areas.txt. The missing_areas.txt lists all locations from the input file that are missing in the map (default: fiskerilokasjonerf_33N.shp). A missing location can be caused by the facts that some catches are reported to be delivered from a location that not exists, or that the location number is not reported. The fishing activity data from non-existing locations are not used in the calculations.

When updating the fishery data with new data, the code has to be changed to read and calculate data from the correct years. In sonate_dbms.py this is to be done in _create_fishing_average_database where end_year shold be the most recent year in the database, and in _create_fishing_summary_database where "Year to be read from input file" is given by the statement "for j in range(6,10):" (This example will read data from the years 2006-2009).

	A	B	C	D	E	F	G	H	I	J	K	L
1												
2												
3	Fangs tår	Fartøy-nasjon	Homr	Lok	Lev-år	Lev_ mnd	Lev_år-md	Redskaps-gruppe	Fiske-gruppe	Rundvekt i kg	Utbetalt verdi i kr	Antal fartøy
4	2007	NOR	12	10	2008	2	2008-02	Line	Anna fisk	7110	20994	1
5	2007	NOR	12	10	2008	2	2008-02	Line	Torsk og torskeartet fisk	238393	1736714	1
6	2007	NOR	0	44	2008	1	2008-01	Garn	Anna fisk	50	1166	1
7	2007	NOR	0	44	2008	1	2008-01	Garn	Torsk og torskeartet fisk	438	5889	1
8	2007	NOR	0	0	2008	1	2008-01	Juksa/pilk	Torsk og torskeartet fisk	919	15645	1
9	2007	UTL	1	11	2008	1	2008-01	Trål	Skalldyr og bløtdyr	74011	5073005	1
10	2007	NOR	3	25	2008	1	2008-01	Line	Torsk og torskeartet fisk	725	9887	1
11	2007	NOR	3	23	2008	1	2008-01	Line	Anna fisk	990	5093	1
12	2007	NOR	3	23	2008	1	2008-01	Line	Torsk og torskeartet fisk	30020	380888	1
13	2007	NOR	3	12	2008	1	2008-01	Trål	Anna fisk	4555	25225	2
14	2007	NOR	3	12	2008	1	2008-01	Trål	Torsk og torskeartet fisk	377985	6023160	2
15	2007	NOR	3	7	2008	1	2008-01	Trål	Anna fisk	18424	170262	1

Figure 3.12 Input to the fishing activity calculations (TOTALSTATISTIKK.XLS)

```
#This file is used by sonate_dbms.py to set guidelines to the fishing activity data
#fish; month; catch/km2 ; vessels/km2; areas; guideline
Sild;   All  ;  0.01;    0.0000001; All            ; 2.5
Brisling; All  ; 0.01;     0.0000001; All            ; 2.5
```

Textbox 3 The file fish_info_2_regulation.txt, which is input to sonate_dbms (the numbers in the catch/km^2 and the vessels/km^2 columns are the threshold values, which is in the latest versions set very low, because the guidelines is valid for all vessels catching herring and do not depend on amount of catch).

3.2.3 Importing the fish farm locations

The fish farm locations are imported from an excel file, which in turn are downloaded from http://www.fdir.no/fiskeridir/kystsone_og_havbruk/registre.

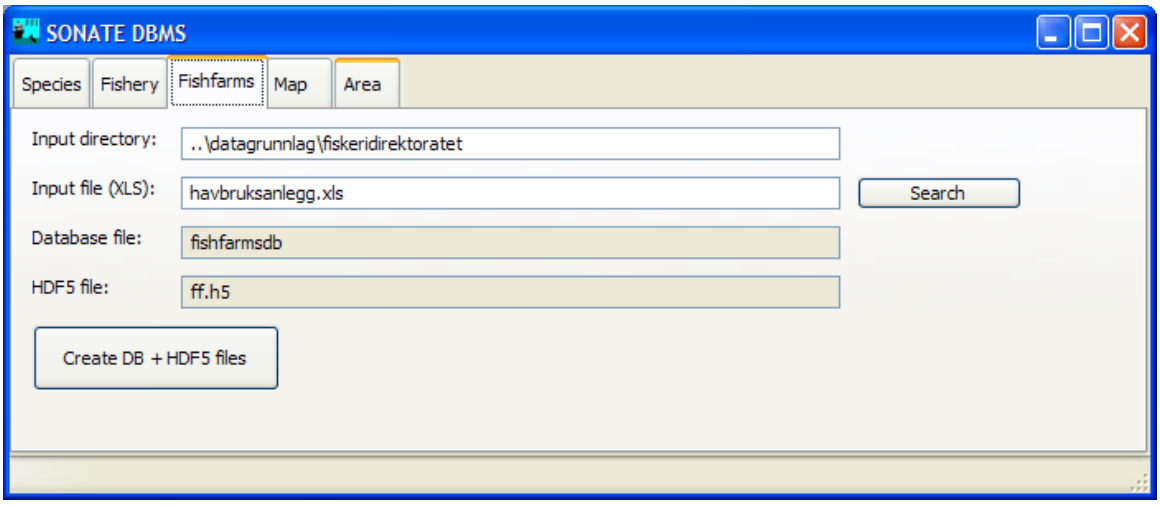


Figure 3.13 The Fishfarms tab in SONATE DBMS

SONATE DBMS reads data from the MS excel file and writes them to two database files that are used in SONATE. The positions are read from the two last columns of the excel file. See example in Figure 3.14.

	A	M	V	Z	AA
1	AKVAKUL				
2	TILL_NR	ART	LOK_MILJØ	N_GEOWGS84	Ø_GEOWGS84
3	A A 0001	LAKSEFISK	FERSKVANN	59.670232	10.759353
4	A AH0701	ØRRET	FERSKVANN	59.871073	11.595335
5	A AH0701	ØRRET	FERSKVANN	59.871073	11.595335
6	A AH0701	ØRRET	FERSKVANN	59.871073	11.595335
7	A AS0701	ØRRET	FERSKVANN	59.857369	10.437123
8	A AS0701	ØRRET	FERSKVANN	59.857369	10.437123
9	A AS0701	ØRRET	FERSKVANN	59.857369	10.437123
10	A F 0001	LAKSEFISK	SALTVANN	59.620653	10.649025
11	A N 0301	BLÅSKJELL	SALTVANN	59.808648	10.611528
12	A NI0701	ØRRET	FERSKVANN	60.105207	10.870654
13	A NI0701	ØRRET	FERSKVANN	60.105207	10.870654
14	A U 0003	KREPS	FERSKVANN	60.109390	11.290145

Figure 3.14 Example of fish farms input to SONATE DBMS. Only some of the columns in the input file are shown

In SONATE the guideline number which applies in the vicinity of fish farms are read from the file named fishfarms.txt. See Textbox 4.

3.6

Textbox 4 The content of the file that defines guideline number that applies in the vicinity of the fish farms.

3.2.4 Creating a new installation file, and the different modes of SONATE

A new executable installation file is made by means of the setup.exe.
(usage: python setup.py py2exe). Depending on the mode defined in sonate.ini, the installations file will be in either of the modes described in Table 3.2. The sonate.ini also gives the possibility to change some of the colours in the SONATE window and change the screen dimension. The grid step is the intervals in degrees shown on the map display. The sonate.ini file is shown in Textbox 1. The USER_MODE controls which tabs to be visible in SONATE. Table 3.2 gives an overview.

```
BACKGROUND_COLOR = (144, 180, 255)
LAND_COLOR = (127, 166, 135)
GRID_COLOR = (0, 0, 0)
GRID_STEP = 5
SELECTION_COLOR = (0, 255, 255)
SCREEN_DIMENSIONS = (1024, 768)
USER_MODE = -1    #-1: normal; -11: all; 0: operational (not all details about species) ; 1: planning (not "facts about whales" and fishfarms); 2 : track mode
```

Textbox 1 The sonate.ini file

The track mode also gives the possibility to load a detailed map of an area, or another map adjusted to the track data. The map file must be on hdf5 format. To load a new map, select from the menu: File – Load map.

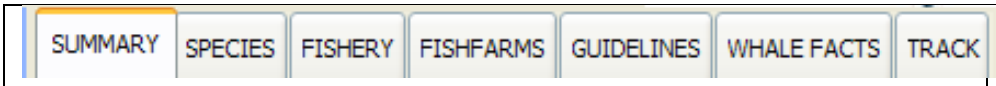
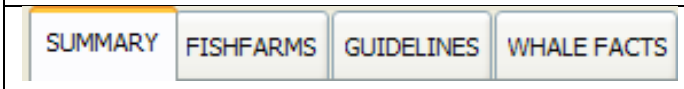
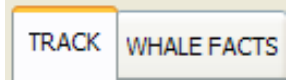
	USER_MODE = -11 All
	USER_MODE = -1 Normal
	USER_MODE = 0 Operational mode
	USER_MODE = 1 Planning
	USER_MODE = 1 Track

Table 3.2 Overview of the different USER_MODEs

3.3 For the programmer

The SONATE software is developed using the object oriented software engineering. Therefore the software description will be shown by means of Unified Modelling Language (UML) diagrams. The application is developed by FFI (Norwegian Defence Research Establishment) for the Norwegian Defence. The data on fish, marine mammals, fishing activities, and fish farms is received from other institutions.

The software can be split in a number of software packages (see Figure 3.15). The main application the users will use is the SONATE application. This application uses the SONATE Database. The databases are created by means of the SONATE Database package. This package uses the environmental information delivered by the other institutions, together with the guidelines, to create new versions of the SONATE databases.

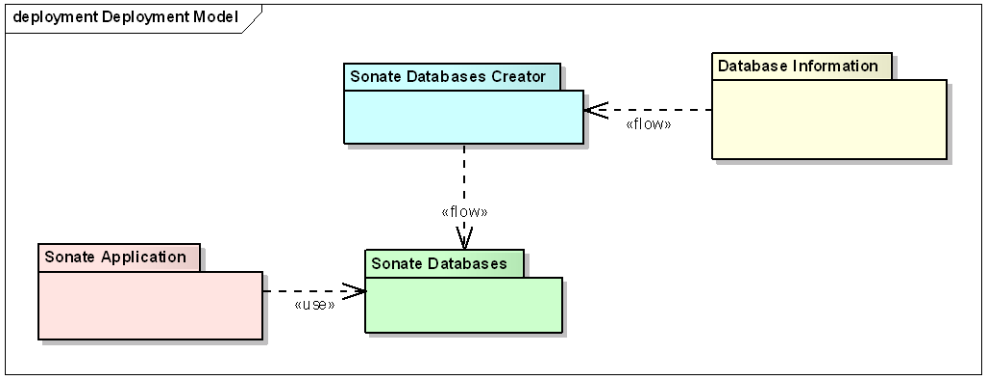


Figure 3.15 The deployment model of the SONATE application

The main idea is to develop the SONATE application such that no commercial tools are needed to run this application. This leads to the fact that the databases are stored in open source databases and file formats. Furthermore, the applications are developed in Python which is an open source development environment.

The database and information that are used to create these databases can be in other formats (e.g. MS Excel, ArcGIS shape files).

3.3.1 SONATE application

SONATE is a windows based application that focuses on presenting data on a geographical display. Any detailed information is always shown in tables. Figure 3.16 shows the schematic structure of the application. The main SONATE window has a menu bar at the top and a status bar at the bottom. The window is split into two parts: 1) the SONATE frame showing the map information, and 2) the SONATE notebook showing the detailed (textual) information.

The SONATE frame also contains a toolbar to interact with the visualised map.

The main SONATE can create a help dialog to show the supporting help of the application. The application support multi languages, to support users from other countries to be able to use the application.

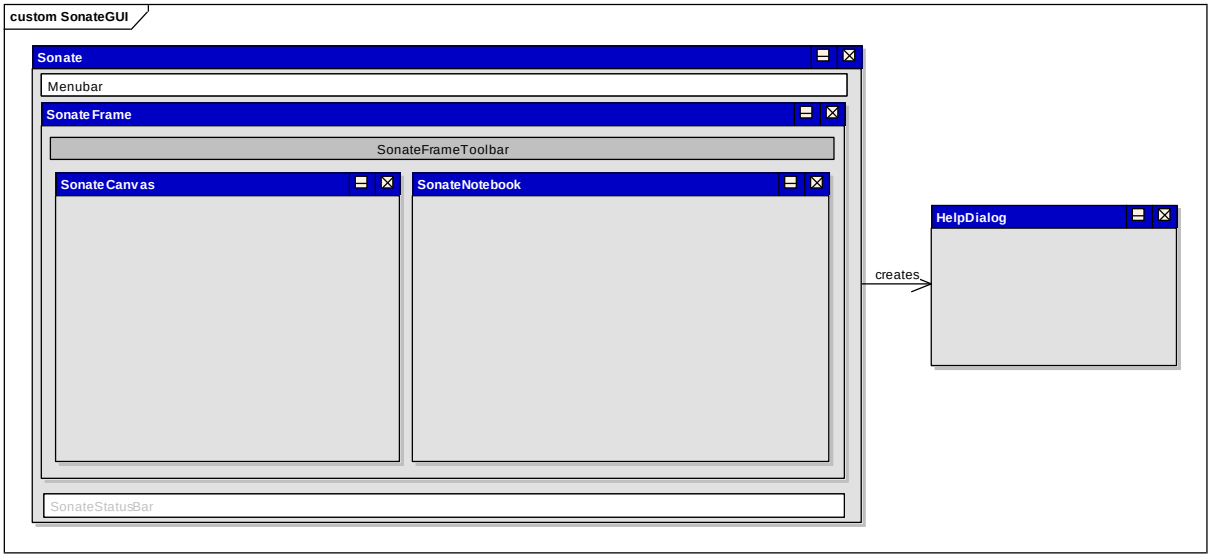


Figure 3.16 Graphical user interface structure

3.3.2 Software architecture

The SONATE application uses external databases to retrieve data from, so the application is a client of the databases (see Figure 3.17). The application will interact with these databases all the time, so only the required information is retrieved from the database and stored in the memory. The application also supports several user modes for the different users: 1) sonar planner, 2) sonar operator, and 3) scientific user. Depending on this mode, functionality will be enabled in the user interface. For instance the visual whale facts will only be displayed for the sonar operators and scientific users and not to the planner.

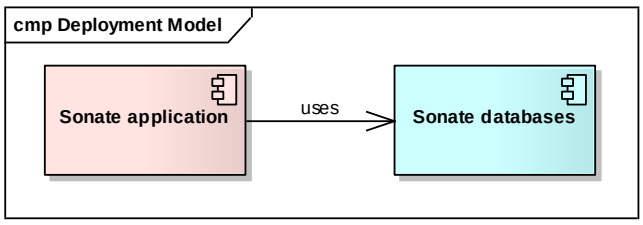


Figure 3.17 Architecture of the SONATE application

3.3.3 Software design of SONATE

The design of the SONATE application has been made after the code was written. Figure 3.18 and Figure 3.19 shows the object diagram (in UML) of the SONATE application. The *SonateApp* is the main application object to start.

This application creates the *SonateFrame*. This object creates the *SonateCanvas* and *SonateGridPanel* and gives them to the *SonateSplitter* to enable a split window view. The *SonateFrame* can also create *SonateTransientPopup* and *SonateHelpDialog* dialogs to show more information to the user. The *SonateFrame* sets up the connection to the databases and retrieve the most important information.

The *SonateGridPanel* contains a *SonateNotebook* containing tabs of information; summary map, species map, fishery map, fish farms map, guidelines, and whale facts. Depending on the user mode, these information tabs are created. Each of the tabs can also contain a number of tables (grids). These are created during the initialisation of the notebook.

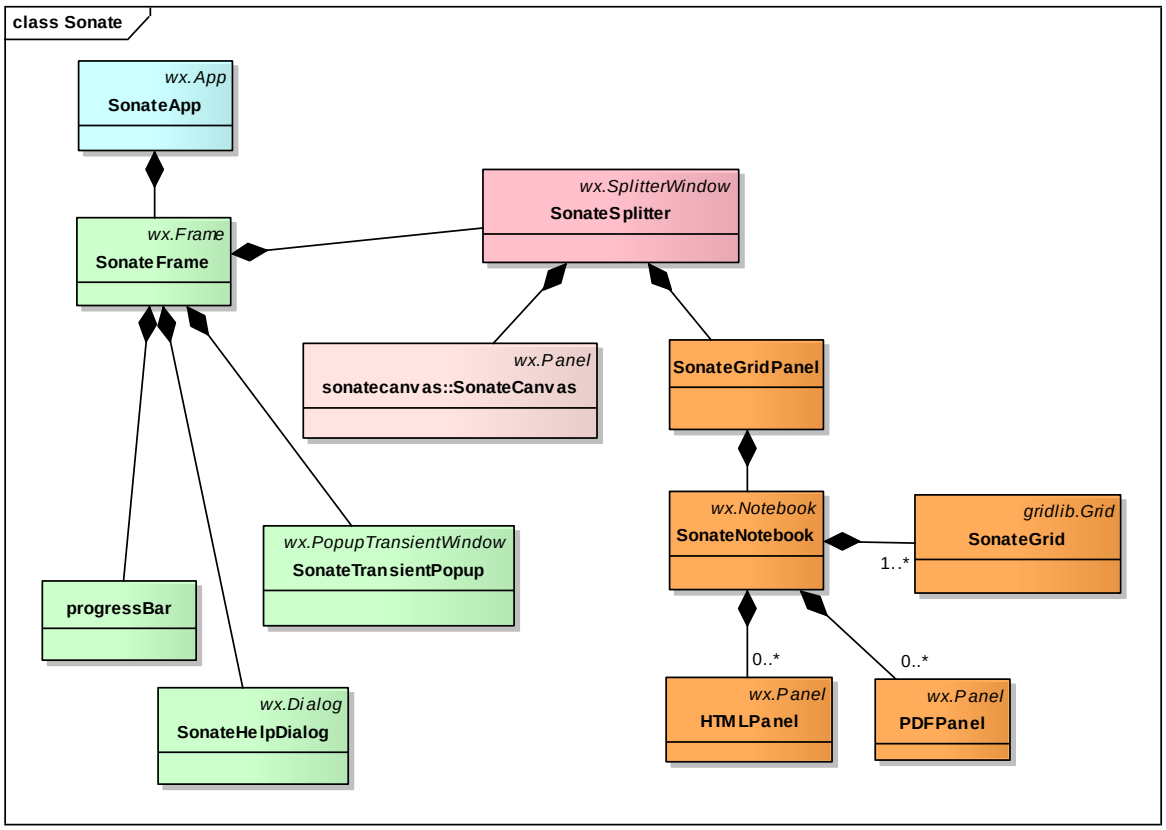


Figure 3.18 Object model of the SONATE application

There are different grids that can be visualised on the notebook. The following diagram shows all grids that are available.

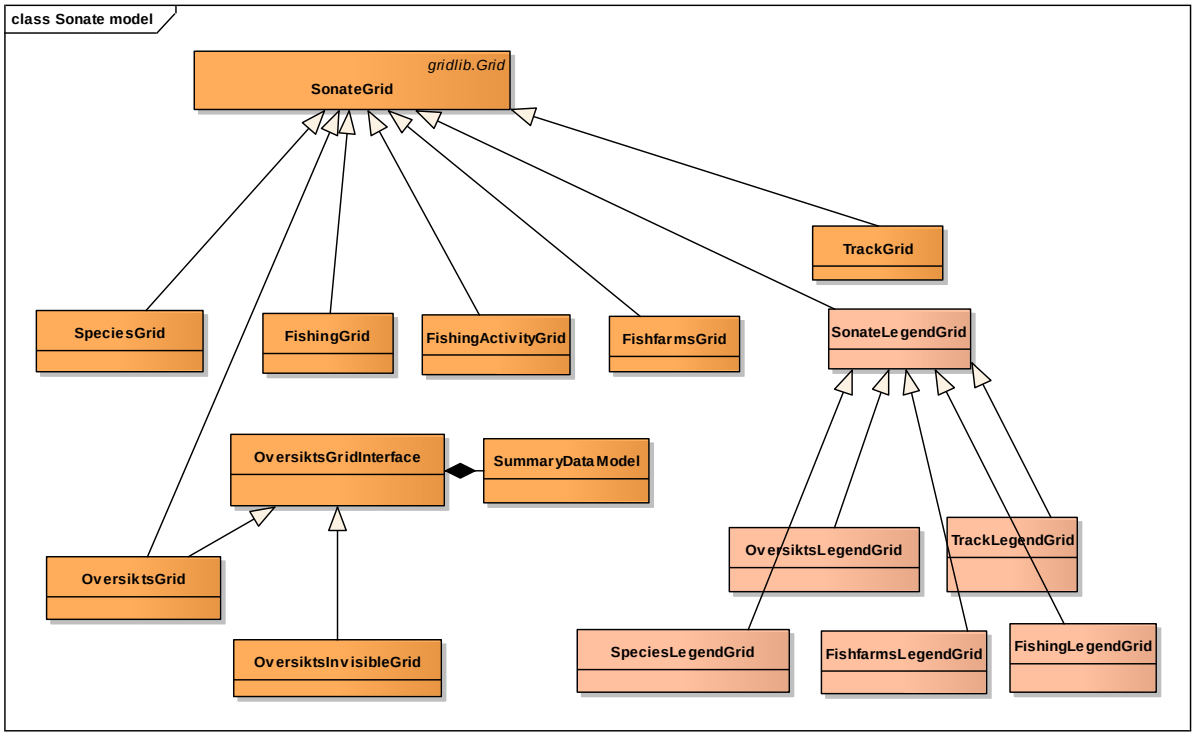


Figure 3.19 Object model of the different grids which can be attached to the notebook

In the SONATE application a large set of databases are used. Figure 3.20 shows all databases and other files that are used by the SONATE application. The HDF5 files (*.h5) contain the location and shape/contour information. The databases (coloured green) contain more information about species, fishing activities, and fish farms. These databases refer to the HDF5 files to indicate the locations.

The text files are used in the display of the application to define the colours and corresponding description. The regulations text file describes the regulations, the colour coding, and guideline importance. This file is used in the *SUMMARY* and *SPECIES* Tab. The fishery.txt file describes the legend of the fishing activity and the colour coding and link to the regulations. This file is only used in the Fishery tab. When the guidelines change, these files need also to be updated.

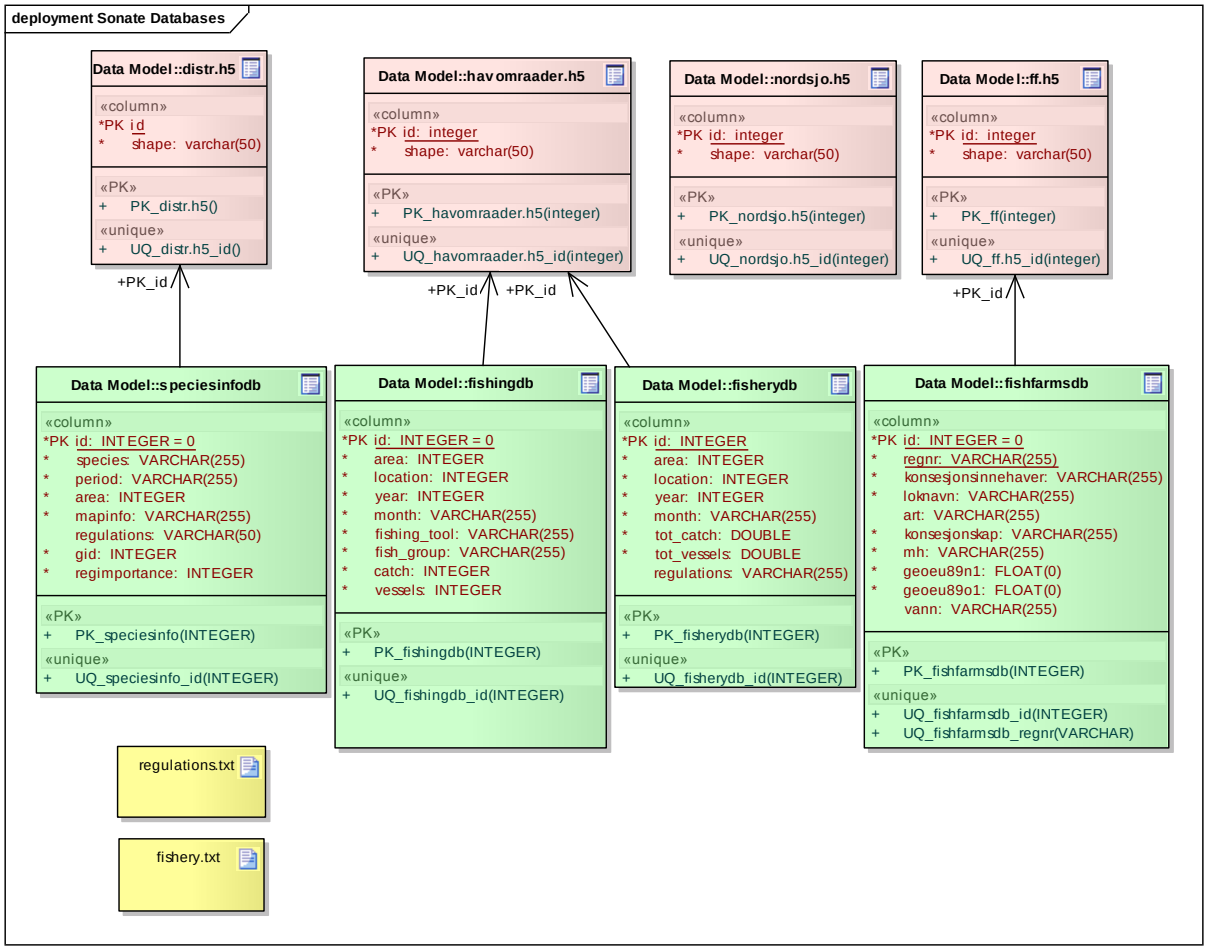


Figure 3.20 Database model of the SONATE application

3.3.4 Implementation

The SONATE application is written in Python (version 2.4) and uses *wx.Python* do create the graphical user-interface. In the implementation the standard python coding styles is used (http://www.python.org/doc/peps/pep-0008). The application uses SQLite database (http://www.sqlite.org/index.html) to retrieve the information from. The geographical information is stored in HDF5 format (a general purpose library and file format for storing scientific data (http://www.hdfgroup.org/).

The default setting and user mode are selected in the *sonate.ini* file. This file is loaded during the start of the application and overrules the initial settings in the code. The file format is written in the python language format.

The setup/installation executable is created by means of the *InnoSetup* compiler and the py2exe script. The script creates the SONATE executable and the compiler collects all relevant input files and executable and composes the installation file.

3.3.5 Testing

Before a release of the software is distributed, a large number of tests are performed. The testing of the application is done on four levels:

1. programmers test,
2. data test,
3. internal software test,
4. external user test.

The programmers develop the python software and test the implementation by looking at the functionality and the specified requirements. These tests are mainly done by debugging the code. The data tests are very important, since they focus on the correctness of the databases and the interaction between the application and the databases. It also focuses on the correctness of the translation of the external input data into the internal databases.

The internal software tests are performed by the people within FFI (not the programmers, but some times the users), to check the functionality and user interaction. They focus in whether the application is user friendly and intuitive. They also check whether the application will give the expected results.

After the application is tested within the FFI organisation, the first version is sent to a selected group of users to check the databases and whether the tool reflects their idea of how the application should function. This user group will do the beta testing of the application. When they accept the version, a new release can be created.

3.3.6 Updating guidelines

When the guidelines are changed, the developer also needs to update the following file:
regulations.txt
fishery.txt
regulations#.pdf
The text files are used in the user-interface to colour-code different guidelines. In these files, every guideline should be described.

Note that the SONATE application assumes that the guideline numbers are defined as "#.#" where each # is one digit/letter. When longer numbers are used, the program will not distinguish between the last digits/letters.

3.3.7 SONATE database creation application

This application focuses on the creation of the databases and supporting files that are used by the SONATE application. It uses external input data to create the internal data, and mainly transfers data in commercial formats to open-source databases and formats.

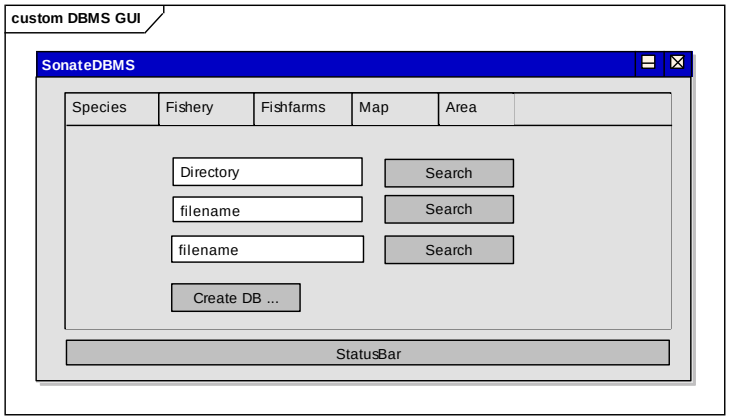


Figure 3.21 Example user interface of the SONATE DBMS application

The user-interface consists of five tabs: *Species*, *Fishery*, *Fish farms*, *Map* and *Area*. Each tab contains some text fields in which files can be specified. The search buttons can be used to select a file with a file selector. Below the text fields, the buttons are placed to create the output files.

At the bottom of the windows a status bar is placed to indicate the progress of the creation process.

3.3.8 Software design of SONATE DBMS

The design consists of an application that has a main frame containing a notebook and progress bar (see Figure 3.22).

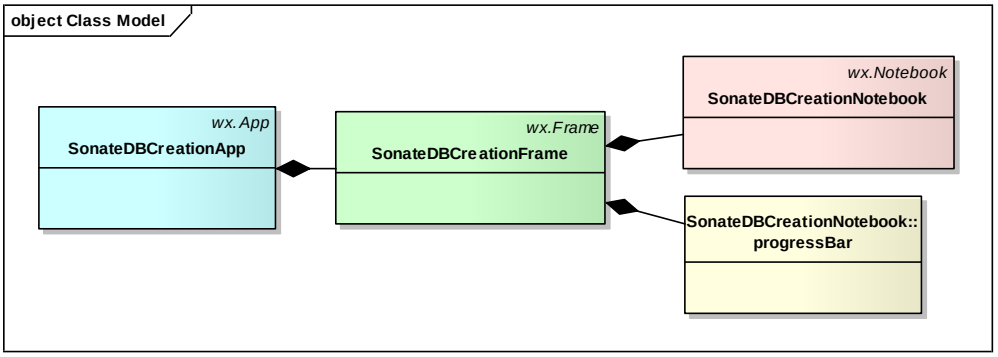


Figure 3.22 Object model of the SONATE DBMS application

The following diagrams show the dataflow within the SONATE DBMS. Figure 3.23 shows the creation of the *speciesinfodb* (SQLite) database and the corresponding *distr.h5* (HDF5) file. The creation process uses the Postgres Database (*distrinfo.pql*), a large number of shape files (*species_###.shp*), and a file describing the guidelines in combination with the related species (*art_2_regulations.txt*). In the diagram also the tables in the database are shown.

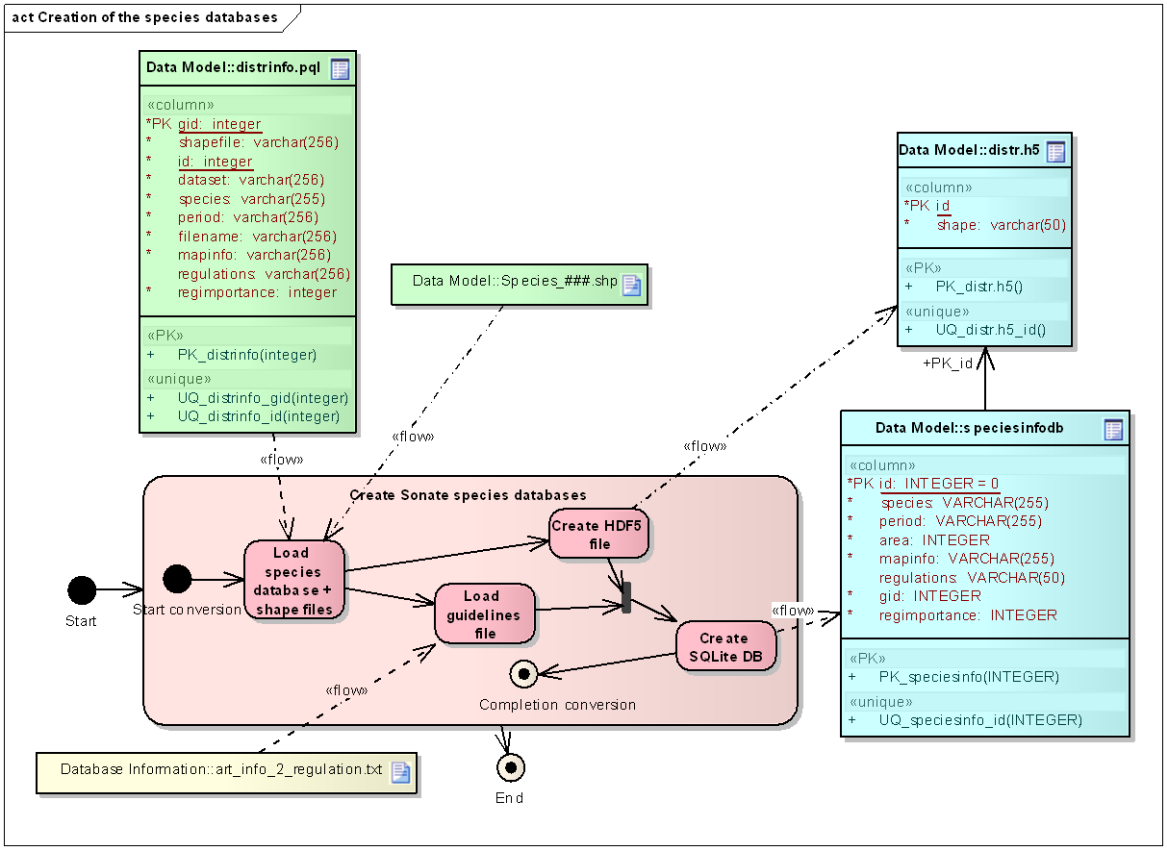


Figure 3.23 Activity diagram of the creation process of the species databases

1. The fishery databases (fishingdb and fisherydb) and shape file (havomraader.h5) are created by means of a similar process. Figure 3.24 shows the activity diagrams of this creation process. Within the Create Summary fishery database the total catch of each fish group is summed and divided by the fishing area size (km²). In the Link guidelines activity, the average catch of the last three years is determined and the appropriate guidelines are specified in the database. The data is stored with year=9999 in the database.

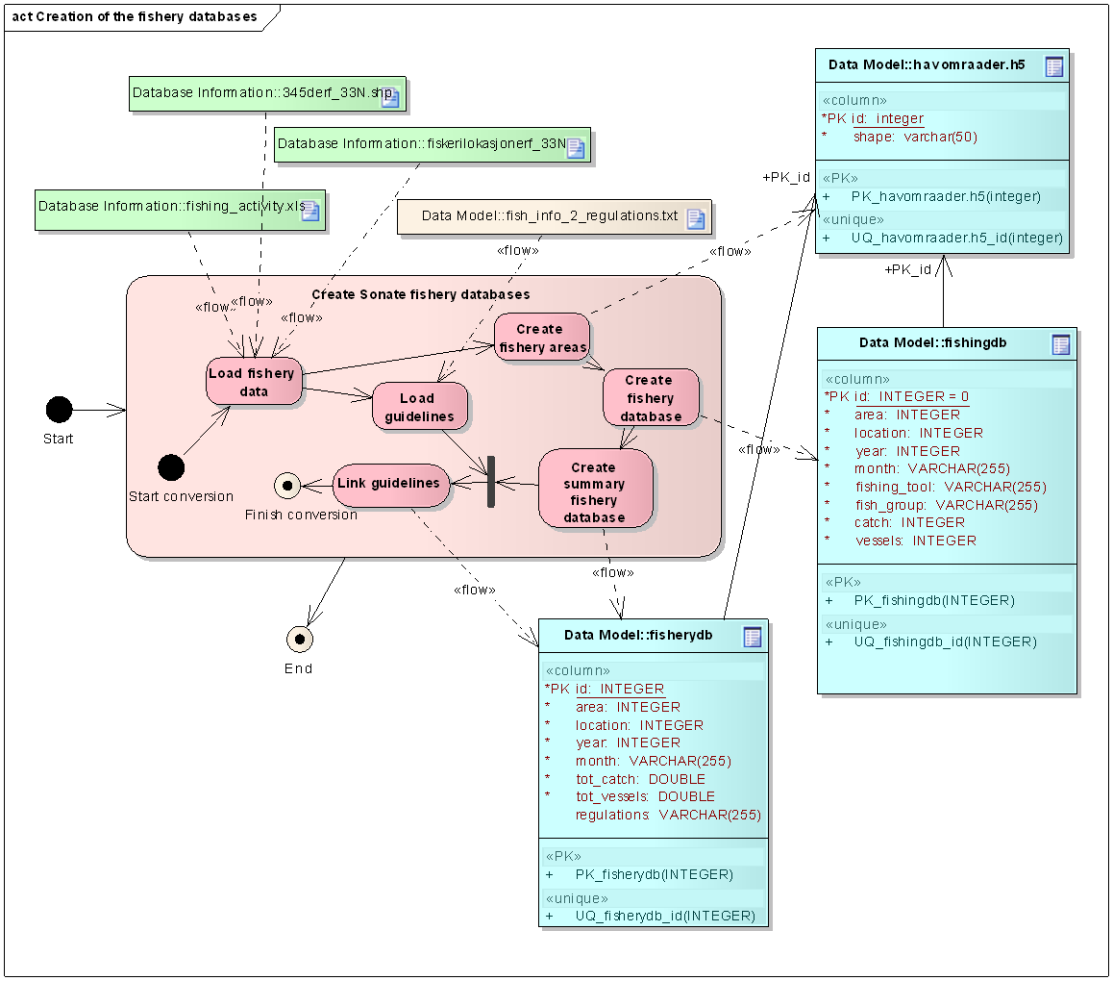


Figure 3.24 Activity diagram of the creation of the fishery databases

The creation of the fish farms database (*fishfarmsdb*) and position file (*ff.h5*) is very simple and similar. Figure 3.25 shows the activity diagram. All information of the fish farms is read from the *fishfarms.xls* file. In the fish farms database no guideline numbers are stored since there is only one regulation that holds for all fish farms.

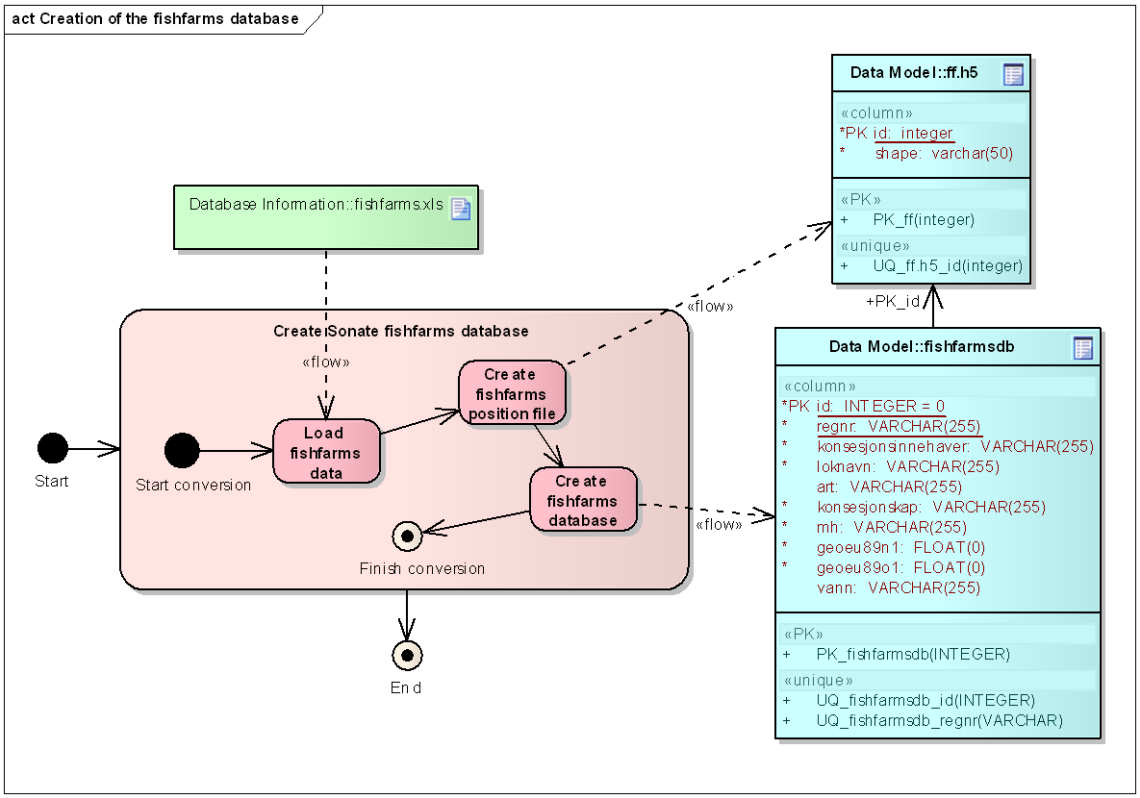


Figure 3.25 Activity diagram of the creation process of the fish farms database and position file

4 SONATE WMS

SONATE WMS is a version of SONATE that is based on internet technology (WMS – Web Map Services). It is developed in cooperation with the **FFI project, METOC II**, who delivers meteorological and oceanographic data to the Norwegian Defence, through the METOC WMS service. METOC WMS is an interactive service, where you are able to select data and area of interest and show them in an internet browser of your choice. The SONATE WMS and the METOC WMS is still under development, and the user interface will go probably through changes soon after this report is issued. The main components of the user interface will still be present and recognisable, though.

At the time of writing, the SONATE WMS is not completely finished. This chapter gives a description of SONATE WMS as it is today (October 2011).

SONATE WMS reads species distribution data from a postgis database developed and maintained by IMR (Institute of Marine Research). Fishery data and fish farms information are stored on an FFI server. For further information on this system, please contact Espen Messel or Atle Ommundsen (METOC project at FFI) or email metoc@ffi.no.

There are several reasons for developing SONATE on a new platform. One reason is to minimize the need for updates of database and platform after the end of project, another is to improve the

user friendliness and to ease the access to the huge amount of data available from SONATE. Until the SONATE WMS is complete, we will continue to release SONATE on the old platform, to be sure we deliver a fully usable product.

4.1 User interface description

As the SONATE 3.2 version, the SONATE WMS version can be used by users with different points of view and requirements, but it is mainly designed for planners of sonar operations and operational users (sonar operators). We have tried to mirror the functionality of the stand alone version of SONATE as much as possible, since this is well tested by the users. Hopefully little functionality got lost, but some information may be available in another format than earlier, and some of the most detailed information will not be available at least in the first versions.

SONATE WMS, can, as SONATE 3.2, be used to locate an area and time period suited to perform an exercise with a minimum of operational restrictions. An operational user will probably use SONATE mainly to view details in the exercise area, and to find information on critical frequency bands and start up procedures. We have been assuming that the natural starting point for the typical user will probably be the Guidelines category. Here, the user can find an overview of areas with any restrictions recommended in the guidelines. One or several guidelines can be selected, and the different guidelines will be shown in different colours.

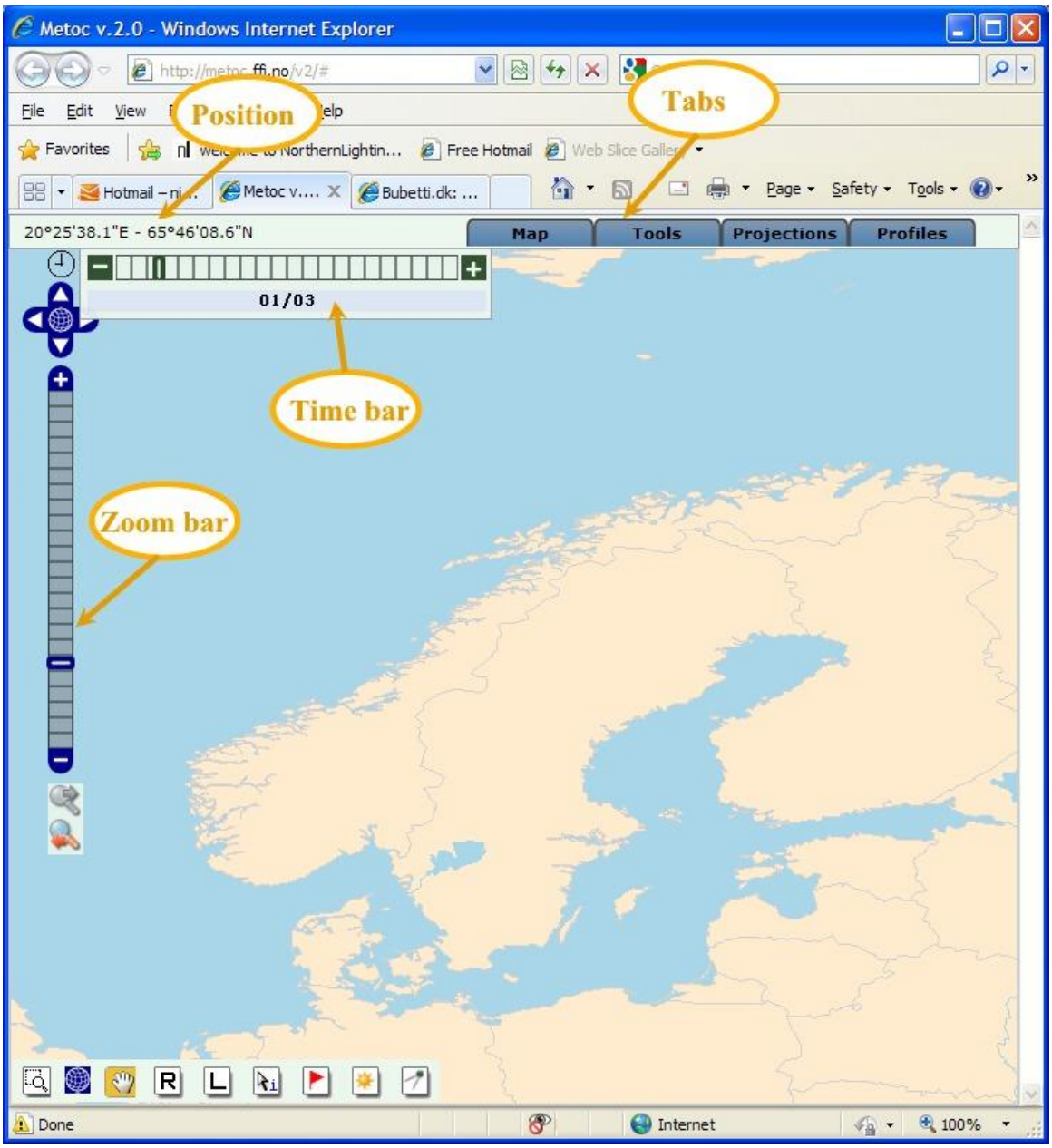


Figure 4.1 *The SONATE WMS window with main tools of the window marked. The tabs – to select profiles, windows, projections and tools. Time Bar – makes the user able to slide through a year of data. Zoom Bar – to set zoom level of map. The position of the cursor is shown in the upper right corner of the window. With the buttons at the lower left corner of the window, the user can zoom in, zoom to full extent and pan. The button with an "i" gives information of a detail. The remaining buttons are not meant for SONATE users, but a short description of the function is displayed when holding the cursor on top of the button.*

The SONATE WMS is found at the METOC WMS service, at URL: http://metoc.ffi.no/v2/, and is password restricted. Username and password can be obtained from metoc@ffi.no.

The METOC WMS service has several profiles, designed for different user groups. These profiles are found *under the "Profiles" tab, and the SONATE data are found under the profile SONATE (See* Figure 4.1).

SONATE WMS/METOC WMS have a number of standard tools for navigating in time and space that are visible for any profile. See Figure 4.1 for description. The time bar let the user jump through the year using the "+" and "-" signs. The time bar will stop at each date where any of the selected maps are changing. E.g. if the map of a species change at July 8, the time bar will stop at that date, and show the corresponding map.

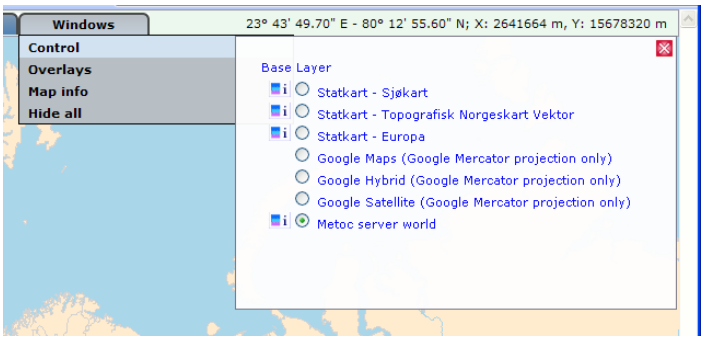


Figure 4.2 In SONATE WMS the user can choose between several background maps. The figure shows an example.

The SONATE data are organized in 3 categories: **Guidelines**, **Species**, **Commercial activity** (fishery, fish farms and safari activity e.g. whale watching). Each category is divided in sub categories. Under the Guideline category one finds one sub category for each guideline, under Species one finds one sub category for each species in the database. The user can choose to show data from one or several categories, and from one or several sub categories.

When the SONATE profile is selected, the user will find all the available data categories listed under the Map Editor. When the categories of interest are selected, the user should turn on the Map Control. In the Map Control, the user can turn on and off the selected categories, change drawing order, change transparency or remove layers from the selection. By clicking the button marked with an "i", a legend will be displayed in the map.

For a complete overview of all species in the database, including those not connected to any guideline, look under the category **Species**. There might be several maps for each species, depending on time of year, behaviour, life-stage and density.

Detailed information on fishery activity is found under **Commercial activity – Fishery**. The user can choose to show either number of fishing vessels per area or catch per area in the different locations. Further one can choose between single years or an average value from the last three years. All fishing activity data are calculated month by month.

More detailed information on the location will pop up by using the "I"-button at the bottom left of the screen.

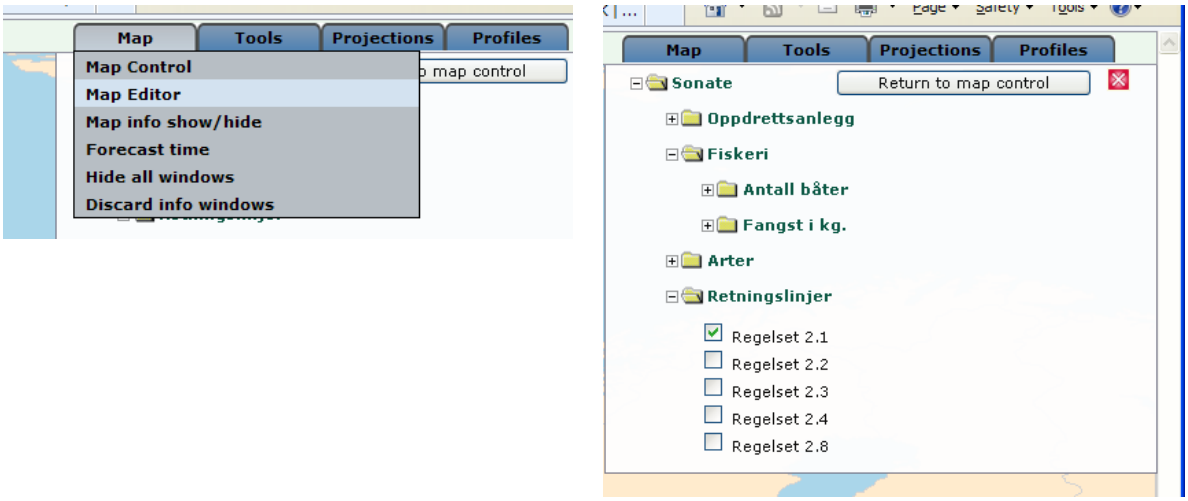


Figure 4.3 Under Map Editor the user finds all available data listed, and can select the categories of interest.

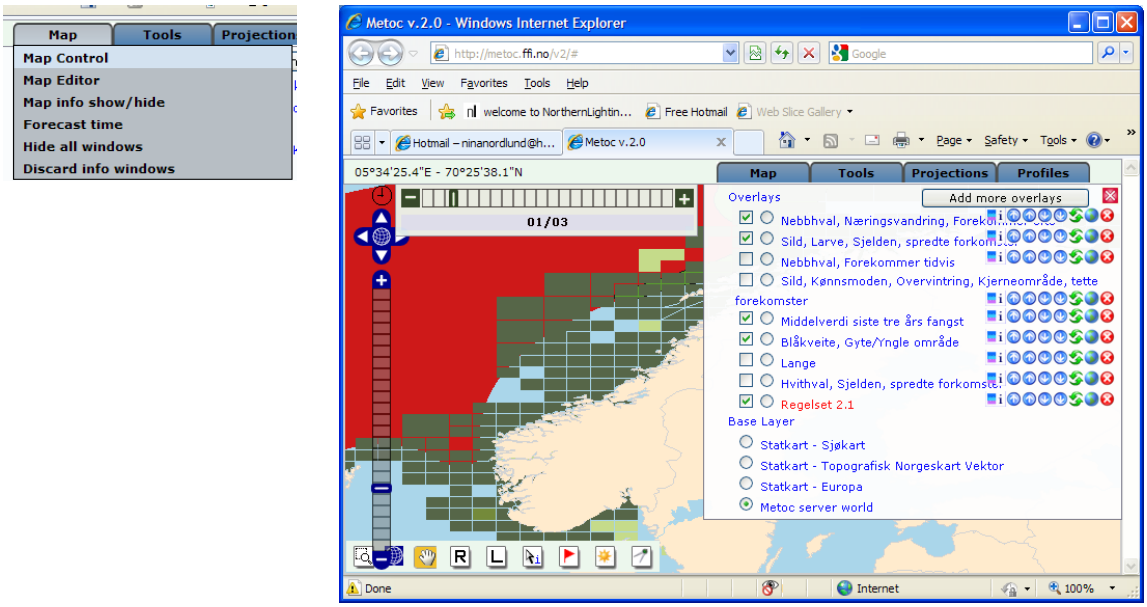


Figure 4.4 In the Map Control, the user can turn on or off the selected layers, move them backwards and forwards in the set of layers, modify transparency of the layers or remove them from the selection.

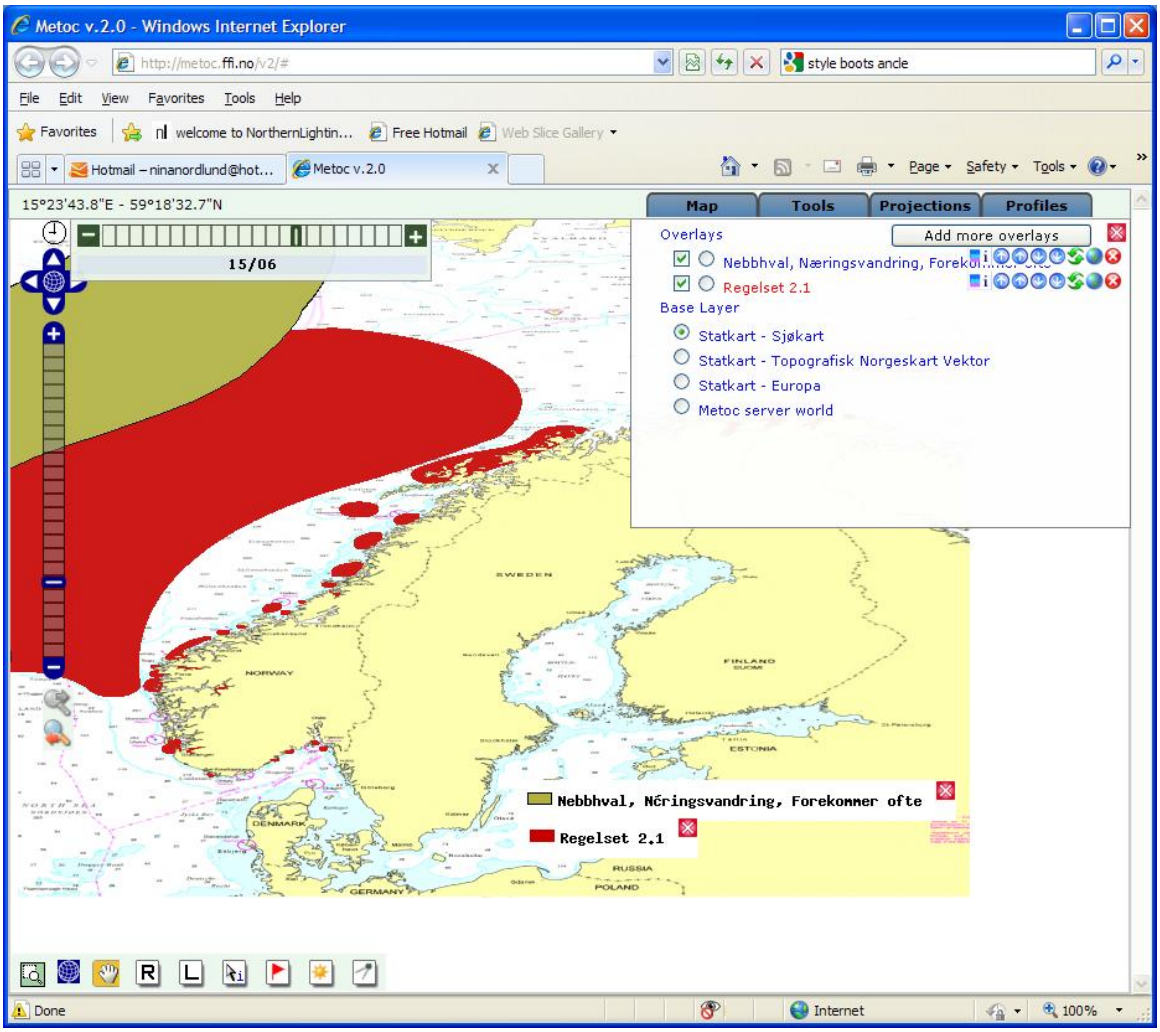


Figure 4.5 Example map showing areas related to guideline 2.1 and feeding area for bottlenose whale. Example of how one can show information from two different categories in one map. The legend is displayed by clicking the button marked with an "i" in the ***Map Control***

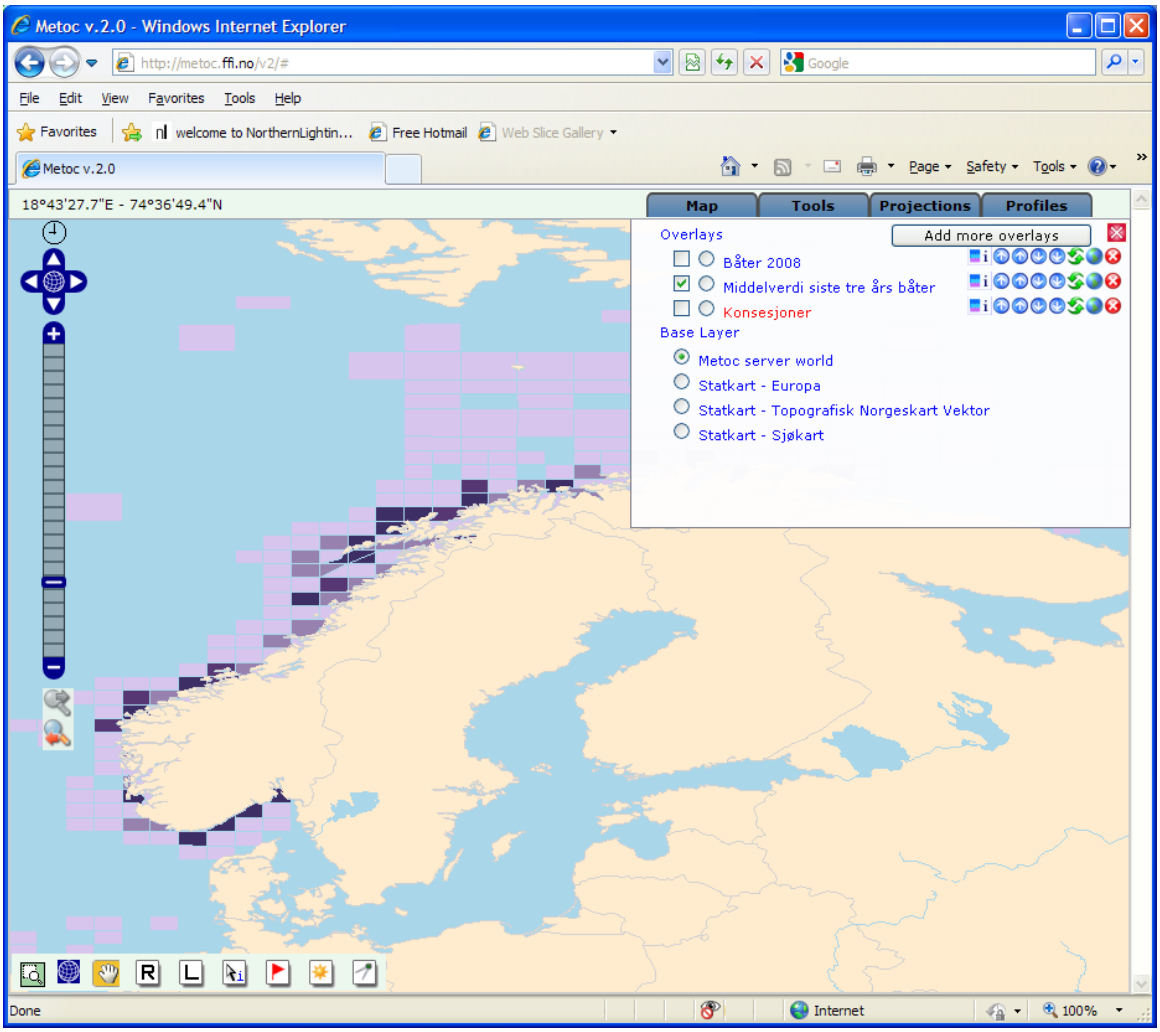


Figure 4.6 Example map showing fishing activity data in SONATE WMS. The logic and colors from earlier versions are maintained.

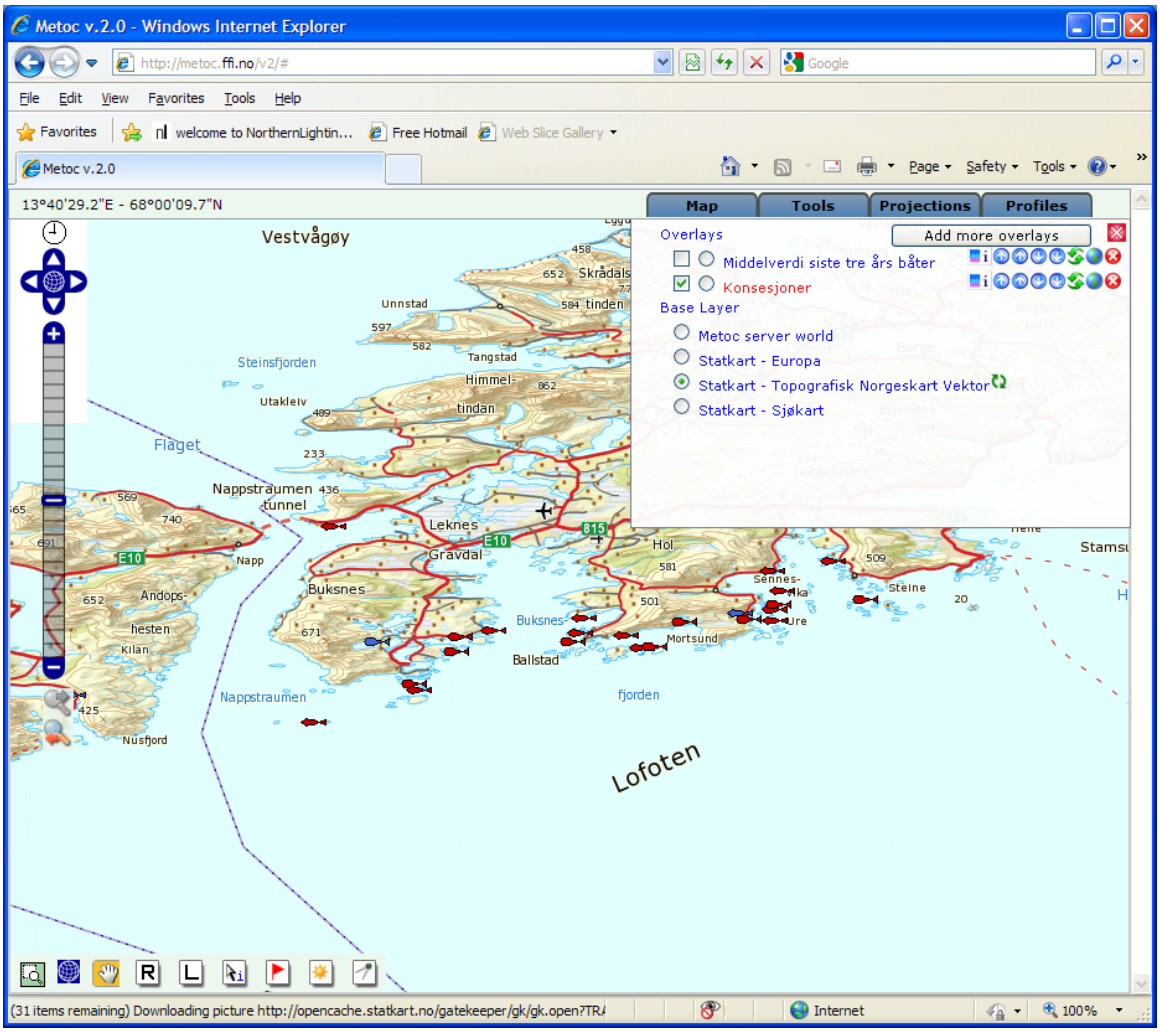


Figure 4.7 Example map showing SONATE WMS with fish farm concessions on a detailed map. In contrast to earlier versions of SONATE, the positions of the fish farms can now be read reasonably accurate from the map.

Fish group	Catch kg	Worth NOK	Vessel (s)	Fishing tool
Anna fisk	31,964	424,919	2	Garn
Anna fisk	5,213	69,883	5	Snurrevad
Anna fisk	6	149	1	Line
Anna fisk	3	33	1	Juksapilk
Skalldyr og bloetdyr	88,072	961,720	1	Traal
Torsk og torskeartet fisk	20,828	203,719	2	Line
Torsk og torskeartet fisk	15,049	92,293	1	Garn
Torsk og torskeartet fisk	12,372	190,814	5	Snurrevad
Torsk og torskeartet fisk	1,727	20,005	2	Juksapilk

Figure 4.8 Detailed information on one specific location and year will appear when clicking on one location using the "I"-button at the lower left of the SONATE WMS window. (For the time being this information is available in Norwegian only)

4.2 For the data manager

The distribution map database used in SONATE WMS is held by Institute of Marine Research. At FFI the distribution maps are fitted into the SONATE WMS, but no changes are done to the data. When IMR is updating their database, a quality control might be necessary at FFI, to assure that the data displayed in the WMS client are correct. Problems can occur if new species are added to the database or if the attributes of the distribution map are changed (e.g. behaviour, abundance etc). This must be fixed in cooperation with the responsible for maintenance of the METOC WMS (Espen Messel or Atle Ommundsen, metoc@ffi.no).

The fishery activity data are until further stored on an FFI server, and has to be updated by requesting a yearly update from the Directorate of Fisheries. (See Chapter 0 Input data).

The fish farms information is, as the fishery activity, stored on an FFI server, and has to be updated by downloading an excel files from Directorate of Fisheries. (See Chapter 0 Input data).

4.3 For the programmer

For changes to be made in the graphical user interface, or other changes in the WMS client, please contact (Espen Messel or Atle Ommundsen, metoc@ffi.no).

5 Status and future developments

SONATE have been in use by the Defence since 2006. FFI has experienced that SONATE are used regularly in connection to sonar exercises, both prior to and during exercises. SONATE with the sonar guidelines is a tool which the sonar operators are aware of and take into account in their daily tasks. However, our impression is that at the level of operational authorities and exercise planning (NorTG, FOH) there is still a need to increase their awareness of the sonar regulations and SONATE, and that they need to consider this when planning activities.

Users of SONATE 3.2 (2011) will, as earlier, experience a relatively long response time of the software. With the technology used, it is difficult to improve this further. SONATE 3.2 (2011) and earlier versions have the disadvantage that different information are shown in different views (or tabs). The update procedures of distribution maps have been a labour-intensive task, mainly caused by the fact that FFI are holding a copy of the complete IMR database, and have to maintain and adapt the database to the SONATE 3.2 (2011). These are all drawbacks that we stated in our last report on SONATE (Nordlund and Benders 2008).

The Norwegian Defence have stated that they prefer tools that can be integrated in software they are already using, so that they can avoid a large number of stand alone software. During the last years we have worked on the SONATE WMS which is our attempt to solve these problems.

Even if we at the time being have not finished the SONATE WMS completely, we are quite satisfied with the direction of the development, and we believe that we with this solution can meet most of the earlier stated requirements to SONATE.

As mentioned above, the speed of SONATE has been a problem since the first version, but with the SONATE WMS we see that this is greatly improved. This means that not only can the user display the typical SONATE data at a higher rate than earlier, but also the background maps can have a much higher detail level without reducing the speed of the tool significantly.

Updating of the distribution data in SONATE WMS will not longer be a time consuming and complicated process, as this is mainly done by the data owner, Institute of Marine Research. Some maintenance will also have to be done by FFI or any other responsible for the METOC WMS, mainly if new species are added to the IMR database, or if other major changes are made to the database or sonar guidelines.

SONATE WMS has a much more flexible user interface than SONATE 3.2 (2011), where the user freely can select different kinds of data and show them on the same map (e.g. distribution maps, fishing activity and fish farms together).

The structure of SONATE WMS is mainly finished, but some details in the user interface remains (legends, explanatory texts, guidelines etc). These things will be completed in parallel with completion of the METOC WMS. SONATE WMS will also be translated into English. Some

important distribution maps are also still missing in SONATE WMS. This is due to a software conversion problem at IMR, and this work will hopefully be completed at IMR in the beginning of 2012.

The conclusion to this is that we hope to have a fully functional version of SONATE WMS ready in 2012.

References

Nina Nordlund, Frank Benders, 2008	FFI-rapport 2008/01414 SONATE 3.0 A decision aid tool to mitigate the impact of sonar operations in Norwegian waters on marine life

Appendix A Files in src folder and data folder

A.1 source folder

build	
dist	folder
floatcanvas	folder - The FloatCanvas is a high level window for drawing maps and anything else in an arbitrary coordinate system.
sonatecanvas	folder
missing_areas.txt	Missing areas in the AREA.xls – locations that occur in AREA.xls but not exist as a location in the file havomraader.shp. Output from sonate_dbms.py
postgis.py	makes connection to the postgis database
readtracks.py	used when sonate is in track mode. Reads track from track file.
setup.py	run to make installation file
sonate.py	the main program
sonatedbcreation.py	used in SONATE DBMS
sonate_dbms.ini	setting default paths for files in SONATE DBMS
sonate_dbms.py	tool for creating databases to SONATE
sonate_image.png	icon

A.2 data folder

art_info_2_regulation.txt	defines the connection between the species, mapinfo and guideline number
distr.h5	the geometry table – distribution maps
distr_boundingbox.h5	bounding box for distr
distr_small.h5	reduced version of distr, only one version of each polygon
ff.h5	fish farms table
FFI-logo.bmp	icon used in SONATE
find.bmp	icon used in SONATE
fishery.txt	defines the legend and intervals of fishing activity
fisherydb	the fishing actvity database table, output from SONATE DBMS, input to SONATE (SQLITE)
fishfarms.txt	defines the guidelines number that applies in vicinity of fish farms, see Textbox 4, page 32
fishfarmsdb	the fish farms database, used in SONATE DBMS to create input table to SONATE (SQLITE)
fishingdb	the fishing activity database table, output from SONATE DBMS, input to SONATE (SQLITE)
fish_info_2_regulation2.txt	defines the threshold values for recommending restrictions
fiskerilokasjoner.h5	table of fishing locations
hand.bmp	icon used in SONATE
havomraader.h5	table of fishing zones
help0.pdf	help file in Norwegian, found under the HELP menu in SONATE
help1.pdf	help file in English, found under the HELP menu in SONATE
help2.pdf	help file in English, found under the HELP menu in SONATE, used in Dutch mode
home.bmp	icon used in SONATE
id_mapping.h5	only for internal use, used in ”Reduce species database”, used in combination with distr_small.h5
mfc71.dll	dll file needed for SONATE to run properly
msvcp71.dll	dll file needed for SONATE to run properly
msvcr71.dll	dll file needed for SONATE to run properly
nordsjo.h5	background map
pointer.bmp	icon used in SONATE
printer.bmp	icon used in SONATE
regulations.txt	defines the legend of the overview map, colours, guideline number and key words, and the drawing order
regulations0.html	the regulations in Norwegian, found under the regulations tab in SONATE
regulations1.html	the regulations in English, found under the regulations tab in SONATE
regulations2.html	the regulations in English, found under the regulations tab in SONATE, used in Dutch mode
save.bmp	icon used in SONATE
sonate.ico	icon
sonate.ini	defines map colours, user mode

sonate_dbms.ini	defines initial settings of the SONATE DBMS
sonate_image.png	icon used in SONATE
speciesinfodb	species information table
vestfjordendetalj.h5	detailed map of Vestfjorden. Can be imported when in track mode.
whaleinfo0.pdf	whale facts in Norwegian, found under the Whale Facts tab in SONATE
whaleinfo1.pdf	whale facts in English, found under the Whale Facts tab in SONATE
whaleinfo2.pdf	whale facts in Dutch, found under the Whale Facts tab in SONATE
zoomfit.bmp	icon used in SONATE
zoomin.bmp	icon used in SONATE
zoomout.bmp	icon used in SONATE

Appendix B File examples

B.1 fishery.txt

fishery.txt defines the colours used in the fishing activity maps, the intervals and text describing the guideline:

```
=          ;  FF9F00; =          ; FF9F00; 2.5, 2000m sikkerhetsavstand; 2.5, 2000m safety dist; 2.5, 2000m veiligheidsafstand;
0          ;  90B4FF; 0          ; 90B4FF; -; -; -;
 1 - 99  ;  C5DB8A; 1-19        ; D7C5ED; 2.6, 200m; 2.6, 200m safety distance fisheries; 2.6, 200m veiligheidsafstand;
 100 - 749 ;  92AE49; 20-84       ; 9781AE; 2.6, 200m sikkerhetsavstand; 2.6, 200m safety dist; 2.6, 200m;
 750 - 999 ;  748A3A; 85-99       ; 573773; 2.6, 200m sikkerhetsavstand; 2.6, 200m safety distance; 2.6, 200m;

 1000       ;  566648; 100        ; 3E2E66; 2.6, 200m sikkerhetsavstand; 2.6, 200m safety distance; 2.6, 200m;
```

(The text description is made short in this example.)

B.2 fish_info_2_regulation2.txt

```
#This file is used by sonate_dbms.py to set guidelines to the fishing activity data
#fish; month; catch/km2 ; vessels/km2; areas; guideline
Sild;   All  ;  0.01;    0.0000001; All             ; 2.5
Brisling; All  ; 0.01;     0.0000001; All             ; 2.5
```

B.3 regulations.txt

guideline number; colour; Norwegian keywords; English keywords; Dutch keywords:

```
2.1; 8; C90000;alle øvelser - sjøpattedyr; all exercises - marine mammals;vermijd alle oefeningen - zeezoogdieren;
2.2; 7; FF5400; alle øvelser - hvalsafari; all exercises - whale safari; ermijd alle oefeningen - safari;
2.3; 5; FF5400; hvalfangst - sikkerhetsavstand ; whaling - safety distance ;Walvisjacht - veiligheidsafstand ;
2.4; 6; FF9F00;prosedyre - sjøpattedyr; procedure - marine mammals; procedure - zeezoogdieren;
2.5; 4; FF9F00; sikkerhetsavstand fiskeri (500/200m); herring/sprat fisheries - safety distance 500m ;500m
                veiligheidsafstand haring/sprotvisserij;
2.6; 2; FFE300; oppdrettsanlegg - sikkerhetsavsand 200m; fish farms - safety distance 200m;viskwekerij -
                veiligheidsafstand 200m;
2.7; 1; FFE300; sildeyngel , restriksjoner på CW signaler; restrictions on CW-transmissions - juvenile herring;
                restricties op CW-uitzendingen - volwassen vis;
```

B.4 art_info_2_regulation.txt

Species name in Norwegian; mapinfo; guideline number and critical frequency band

```
Finnhval Beiteomr 2.3
Grønlandssel Hårfelling 2.3
Grønlandssel Kasting 2.1
Havert Kasting 2.1
Havert Hårfelling 2.3
Havert Koloni 2.3
Knølhval Beiteomr 2.3
Klappmyss Hårfelling 2.3
Klappmyss Kasting 2.1
Nebbhval Beiteomr 2.1
Nebbhval Utbredelse 2.3
Nise Høy tetthet 2.3
```

Sild(NorskVårGytende-) Larver mai 2.8(3-6kHz) 5
Sild(NorskVårGytende-) Larver apr 2.8(3-6kHz) 4
Sild(NorskVårGytende-) Larver jun-jul 2.8(2-5kHz) 6,7
Sild(NorskVårGytende-) Larver aug-sep 2.8(1.5-3kHz) 8,9
Safari Safari 2.2
Spermhval Beiteomr 2.1
Spermhval Middels tetthet 2.3
Spekkhogger Høy tetthet 2.1
Spekkhogger Middels tetthet 2.3
Steinkobbe Koloni 2.3
Steinkobbe Hårfelling 2.3
Steinkobbe Kasting 2.1
Hvalfangst Sporadisk aktivitet 2.4
Hvalfangst Lav aktivitet 2.4
Hvalfangst Sporadisk aktivitet 2.4
Hvalfangst Moderat aktivitet 2.4
Vågehval Beiteomr 2.3

Appendix C Installations needed

The following batch file gives an overview of the installations needed, and web-addresses for downloading:

```
# Cygwin: http://www.cygwin.com
# You need cygwin with wget and unzip installed in order to run this script
# To run type: sh get_dependencies.sh in cygwin

mkdir dependencies
cd dependencies
# Subversion: http://subversion.tigris.org
#wget http://subversion.tigris.org/files/documents/15/25364/svn-1.2.3-setup.exe
# Python 2.4: http://www.python.org
wget http://www.python.org/ftp/python/2.5.1/python-2.5.1.msi
# matplotlib: http://matplotlib.sourceforge.net
# wget http://kent.dl.sourceforge.net/sourceforge/matplotlib/matplotlib-0.90.1.win32-py2.5.exe
wget http://kent.dl.sourceforge.net/sourceforge/matplotlib/basemap-0.9.5.win32-py2.5.exe
# Numarray: http://www.stsci.edu/resources/software_hardware/numarray
wget http://kent.dl.sourceforge.net/sourceforge/numpy/numarray-1.5.2.win32-py2.5.exe
# Numeric: http://sourceforge.net/projects/numpy
wget http://kent.dl.sourceforge.net/sourceforge/numpy/numpy-1.0rc2.win32-py2.5.exe
wget http://kent.dl.sourceforge.net/sourceforge/numpy/numpy-1.0.3.win32-py2.5.exe
# HDF5: http://hdf.ncsa.uiuc.edu/HDF5
wget ftp://ftp.ncsa.uiuc.edu/HDF/HDF5/prev-releases/hdf5-1.6.4/bin/windows/5-164-win-net.ZIP
#wget ftp://ftp.ncsa.uiuc.edu/HDF/HDF5/current/bin/windows/5-165-win-net.zip
wget ftp://ftp.ncsa.uiuc.edu/HDF/lib-external/szip/2.0/bin/windows/xp-net/szip20-win-xpnet-enc.tar.gz
#wget ftp://ftp.ncsa.uiuc.edu/HDF/lib-external/szip/2.0/bin/windows/xp-net/szip20-win-xpnet-
noenc.tar.gz
# PyTables: http://pytables.sourceforge.net
wget http://kent.dl.sourceforge.net/sourceforge/pytables/tables-2.0.win32-py2.5.exe
# pysqlite (2.x) and psycopg (2.x): http://initd.org
# see also http://stickpeople.com/projects/python/win-psycopg/
wget http://stickpeople.com/projects/python/win-psycopg/psycopg2-2.0.6.win32-py2.5-pg8.2.4-
release.exe
wget http://initd.org/pub/software/pysqlite/releases/2.3/2.3.5/pysqlite-2.3.5.win32-py2.5.exe
# SQLite: http://www.sqlite.org
wget http://www.sqlite.org/sqlitedll-3_4_2.zip
# wxPython 2.6: http://www.wxpython.org (see vendorsrc/ for required patch)
wget http://kent.dl.sourceforge.net/sourceforge/wxpython/wxPython2.8-win32-unicode-2.8.4.2-py25.exe
wget http://kent.dl.sourceforge.net/sourceforge/wxpython/wxPython2.8-win32-docs-demos-2.8.4.2.exe
# py2exe: http://www.py2exe.org
wget http://kent.dl.sourceforge.net/sourceforge/py2exe/py2exe-0.6.6.win32-py2.5.exe
# Inno Setup: http://www.jrsoftware.org/isinfo.php
# current version: 5.1.6 \ 5.1.14
wget http://www.jrsoftware.org/download.php/is.exe?site=3
# PostgreSQL: http://www.postgresql.org
# PostGIS: http://www.postgis.com
wget
http://wwwmaster.postgresql.org/redir?ftp%3A%2F%2Fftp.no.postgresql.org%2Fpub%2Fdatabases%2F
postgresql%2Fbinary%2Fv8.1.2%2Fwin32%2Fpostgresql-8.1.2-1.zip
wget http://wwwmaster.postgresql.org/download/mirrors-
ftp?file=%2Fbinary%2Fv8.2.4%2Fwin32%2Fpostgresql-8.2.4-1.zip
# Python Imaging Library (PIL): http://www.pythonware.com/products/pil/
wget http://effbot.org/downloads/PIL-1.1.6.win32-py2.5.exe
# Python "xlrd" package for extracting data from Excel files:
# http://www.lexicon.net/sjmachin/xlrd.htm
wget http://www.lexicon.net/sjmachin/xlrd-0.6.1.win32.exe
wget ftp://ftp.ncsa.uiuc.edu/HDF/lib-external/zlib/1.2/bin/zlib122-windows.tar.gz
pywin32-210.win32-py2.5.exe
#http://sourceforge.net/projects/pywin32/
```

Appendix D Track files support within SONATE

**.GPX*

This is a standardised format used by many GPS systems. The format is described in http://www.topografix.com/GPX/1/0/gpx.xsd.

**.CSV*

The file format contains the following elements separated by commas. The other data will not be used. This file format is used by ARGOS to store the information of satellite tags.

Latitude	**Longitude**	**Altitude**	**TimeDate(yyyy/mm/dd hh:mm:ss:S)**
59.436182	10.467248	40	2007/9/27 09:45:31:104

**.XLS*

This MS Excel file format contains the following elements. Only the first nine columns are used in Sonate tracker module. This file format is used by ARGOS to store the information of satellite tags.

Year	**Month**	**Day**	**Hour**	**Min**	**Sec**	**Lat**	**Lon**	**Alt**	**.....**
2007	9	27	11	17	41	59,43538	10,46633	43	....

**.LOG*

This log file format contains the time and positions of the track. All elements are separated by commas.

Year	**Month**	**Day**	**Hour**	**Min**	**Sec**	**Lat (deg)**	**Lat (min)**	**Lon (deg)**	**Lon (min)**
2007	9	27	11	17	41	59	43.538	10	46.633

**.TXT*

This file format is used by MARIA to store tracks.

SRF/ARTSTAG/HO/
592608.5N-0102802.8E 271117ZSep2007
592610.0N-0102803.5E 271117ZSep2007

**.NMEA*

This standardised NMEA file format. It uses the line starting with $GPRMC.

$GPRMC,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>,<10>,<11><CR><LF>

1) UTC time of position fix, hhmmss.sss format.
2) Status, A = data valid, V = data not valid.
3) Latitude, ddmm.mmmm format.

4) Latitude hemisphere, N or S.
5) Longitude, dddmmm.mmmm format.
6) Longitude hemisphere, E or W.
7) Speed over ground, 0.0 to 1851.8 knots.
8) Course over ground, 000.0 to 359.9 degrees, true.
9) Date, ddmmyy format.
10) Magnetic variation, 000.0 to 180.O.
11) Degrees
12) Checksum.

Appendix E The sonar guidelines

Chief of the Norwegian Navy (GIS) sets *Regulations regarding use of active sonar in Norwegian territorial waters* to apply to all maritime units in the Royal Norwegian Armed Forces and foreign units granted diplomatic clearance. The current version of the regulations is dated August 31. 2011 and is efficient as of October 1. 2011. The regulations are based on scientific knowledge on how marine mammals and fish are affected by intense sound pulses such as sonar pings. This knowledge is partly generated by the international research community but partly also through the Sonar & Marine Life projects (FFI project 867, 1082 and 1199), run by FFI and funded by the Royal Norwegian and Navy and Norwegian Ministry of Defence. FFI gives scientific recommendations to the Naval Staff, and so far the Navy has accepted these recommendations and implemented them into their regulations. A national group of experts, which includes national expertise in the areas of marine biology and underwater acoustics, representing academic - and governmental research institutions as well as industry, has given input to and have quality checked FFI's recommendations. GIS recently upgraded the sonar guidelines to regulations. Section 0 to 6.5.4 shows copies of relevant letters and documents, including the complete regulations in Norwegian and in English.

E.1 The letter accompanying the recommendations from FFI to Naval staff (SST) (in Norwegian).

The document was exempted from public disclosure with reference to the Open Files Act (Offentlighetsloven) §14. Since the Naval staff has executed the case, this is no longer valid.

Forsvarets forskningsinstitutt

Unntatt offentlighet
iht. Ofl §14

Dato
09.desember 2010
Vår referanse
09/01740-4/FFI/914
Deres referanse

Forsvarsstaben/Sjøforsvarsstaben
Postmottak
2617 Lillehammer

Kopi:
KK Terje Nylund (FST/SST)
OK Jørn Hammarbeck (FOH/OPS-STAB/J3/SJØ)

Retningslinjer for bruk av aktiv sonar i norske farvann

Med referanse til prosjektavtalen for FFI-prosjektet 1082 Sonar og Havmiljø oversendes herved forslag til retningslinjer for bruk av aktiv sonar i norske farvann. Retningslinjene er basert på det vi nå vet om hvilke effekter sonarsignaler i frekvensområdet 1-10 kHz har på marint liv. Denne kunnskapen er dels generert gjennom studier utført som en del av prosjektet og dels gjennom studier som andre har utført. FFI har lagt vekt på å utnytte den nasjonale kompetanse som finnes på dette området og den såkalte "Ekspertgruppen på sonareffekter på marint liv" har hatt årlige møter og kommet med innspill til FFIs anbefalte retningslinjer. Denne gruppen er nedsatt av FFI og har bestått av medlemmer fra de mest sentrale havforskningsmiljøene i landet.

Retningslinjene er en oppdatering av tidligere versjoner, og oppdateringen er basert på ny kunnskap. Prosjektet har i samarbeid med Havforskningsinstituttet gjennomført flere studier på effekter av militære sonarer på fisk og fiskeri. Vi kan nå dokumentere at effektene av den aktuelle type sonarer er vesentlig mindre enn først antatt, og vi foreslår derfor en liberalisering av de retningslinjene vi anbefalte for et år siden. Dette innebærer at anbefalte sikkerhetsavstander til fiskefartøy reduseres betydelig (pkt 2.5 i vedlagte dokument). Når det gjelder kunnskap om effekter på sjøpattedyr (sel og hval) har prosjektet sammen med internasjonale samarbeidspartnere gjennomført flere studier de senere år. Vi har nå relativt god kunnskap om direkte skadeeffekter som hørselskader o.l og har derfor fokusert på atferdseffekter. Det er samlet inn et stort datasett i norske farvann, som nå analyseres. Det ser foreløpig ut til at det er store variasjoner i hvordan ulike arter av hval reagerer på sonar, og at vår kunnskap derfor fortsatt vil være noe mangelfull. Spesielt mangelfull er kunnskapen om hvordan de

Vedlegg: 2 (norsk og engelsk versjon av anbefalte retningslinjer for bruk av aktiv sonar i norske farvann)

Postadresse:	Postboks 25, 2027 Kjeller	Mil retn nr:	525	Organisasjonsnr:	NO 970 963 340 MVA
Kontoradresse:	Karljohansvern, 3190 Horten	Sentralbord:	63 80 70 00	WWW-adresse:	www.ffi.no
Saksbehandler:	Petter Kvadsheim	Innvalg:	0525 3886	Offisiell e-post:	ffi@ffi.no
Personlig e-post:	phk@ffi.no	Telefaks:	33 04 78 34		

store badehvalene reagerer, og dette er spesielt viktig da de også utnyttes kommersielt (hvalfangst). Våre anbefalinger vil derimot til enhver tid være basert på den beste tilgjengelige kunnskap, og skal balansere miljøeffektene ved bruk av sonar mot de operative konsekvensene av eventuelle restriksjoner. Resultater fra våre studier viser at sonaraktivitet kan føre til at enkelte hvalarter søker bort fra øvingsområdet. Basert på nye analyser har FFI oppdatert terskelen for en slik unnvikelse fra 160 dB til 134 dB. Denne type unnvikelse har ikke nødvendigvis noen biologisk signifikant effekt, men vil kunne ha negative konsekvenser for kommersielle interesser knyttet til sjøpattedyr, som hvalfangst og hvalsafari. Den gamle responsterskelen på 160 dB innebar at effektsonen rundt et fartøy med aktiv sonar ble i størrelsesorden 1000-2000m. Den nye responsterskelen på 134 dB innebærer at effektsonen kan være så stor som 20-40 km, avhengig av oseanografiske forhold og sonarfrekvens (lavere frekvens lengre avstand). Dersom man i retningslinjene implementerer en sikkerhetsavstand på 20-40 km mellom militære kampfartøy som bruker aktiv sonar og hvalfangst- eller hvalsafarifartøy, vil dette for det første bli vanskelig å etterleve rent praktisk, og det vil også kunne få operative konsekvenser i form av tapte øvingsmuligheter. Selv om FFIs nye estimat på terskel for unnvikelse er basert på et bedre vitenskapelig grunnlag enn det gamle estimatet, så er det fortsatt usikkerhet knyttet til en slik responsterskel, og den vil variere mellom artene. Vi har derfor valgt å foreløpig ikke definert noen entydig sikkerhetssone, men har bare anbefalt et generelt pålegg om å ta hensyn til sivile kommersielle interesser ifm sonaraktivitet (pkt 2.2 og 2.3 i vedlagte dokument).

Som en del av prosjekt Sonar og Havmiljø leverer også FFI et beslutningsstøtteverktøy (SONATE) som angir hvilke retningslinjer som gjelder hvor og når, ut fra tilstedeværelse av sårbare arter, og kommersiell aktivitet som kan påvirkes negativt. SONATE er i dag i bruk i Forsvarets avdelinger, men FFI foretar en årlig oppdatering. Det er derfor viktig at FFI får tilbakemelding fra Forsvaret om når de nye retningslinjene eventuelt implementeres i operativ bruk, slik at vi får lagt inn disse i neste versjon av SONATE. Denne versjonen er planlagt levert ved utgangen av 2010, og vi ber derfor om en slik tilbakemelding så raskt som mulig.

Etter hvert som kunnskapen vår om virkningene av aktive sonarer på livet i havet øker, vil det kunne komme yterligere oppdateringer til retningslinjene.

Forslag til retningslinjer undras offentlighet ifm den interne saksbehandlingen, men retningslinjene er formulert slik at de ikke skal inneholde taktisk eller teknisk informasjon som tilsier et behov for dette etter at saksbehandlingen er sluttført. Vi anbefaler derfor at endelig versjon gjøres offentlig tilgjengelig.

Vedlagte retningslinjer er formulert på både norsk og engelsk.

Petter H. Kvadsheim

Petter Kvadsheim
Prosjektleder, p1082 Sonar og havmiljø

E.2 Letter from Chief of the Norwegian Navy (GIS) to military operational authority (FOH) (in Norwegian)

The letter instructs FOH to implement the sonar regulations in operational use and to inform any foreign units operating in Norwegian waters.

FORSVARET
Sjøforsvaret

Vår saksbehandler
KK Terje Hansen Nylund, tenylund@mil.no
+47 55 50 42 34, 0540 4234
SST/Plan avd

Vår dato 2011-08-31
Vår referanse 2008/019219-015/FORSVARET/ 913
Tidligere dato 2010-12-09
Tidligere referanse 09/01740-4/914

Til
Forsvarets operative hovedkvarter
FST/SEKR/LSS/Regverksenh

Kopi til
Forsvarets forskningsinstitutt
133 Luftving/333 SKV
FOH/Opr stab/J3 FOPS(JOC)/J3 Sjø
Kysteskadren
Kysteskadren/Fregattvåpen
Kysteskadren/NorTG/N5 plan
SSK/KNM Tordensk
SSK/KNM Tordensk/Taktikksent.
SST/Virksavd/Operasjonsk

Retningslinjer for bruk av aktiv sonar i norske farvann

1 Bakgrunn

SST har fra FFI mottatt forslag til oppdaterte *Retningslinjer for bruk av aktiv sonar i norske farvann* til erstatning for dokument med samme tittel av 19. juni 2008. Innholdet er ment å beskytte marint liv mot potensiell skade fra anvendelse av aktiv sonar på militære maritime enheter. Retningslinjene er beskrevet på norsk og på engelsk. Forslaget baserer seg på FFIs senere studier i prosjektet *Sonarer og Havmiljø*. Resultatet av de siste studiene har medført lettelser i restriksjonene på bruk av aktiv sonar i forhold til marint liv. GIS har fagmyndighet i Forsvaret i forhold til innholdet. KNM Tordenskjold har fagansvar for anvendelse av aktiv sonar.

2 Drøfting

Dokumentet er tilpasset *Regelverksdirektivet*. Hovedkonsekvensen av dette er at tittelen endres til *Bestemmelse for bruk av aktiv sonar i norske farvann* og at GIS som fagmyndighet overtar ansvaret for dokumentet fra FOH. Faglig innhold mht sonar og dyreliv er ikke endret, men noen endringer er gjort mht beskrivelse av forholdet til utenlandske statsfartøy.

GIS anmoder FOH om å gjøre bestemmelsene kjent for relevante utenlandske enheter ifm innvilgelse av diplomatisk klarering. Sjef FOH anmodes i tillegg om å sende et skriv i doculive til FST/SEKR/LSS/Regelverksenheten som setter "retningslinjer for bruk av aktiv sonar i norske farvann" ut av kraft fra 2011-10-01.

GIS ber FST/SEKR/LSS/Regelverksenheten om å publisere dokumentene på FOBID.

Bestemmelse for bruk av aktiv sonar i norske farvann fastsettes til bruk i Forsvaret fra 1. oktober 2011.

3 Konklusjon

Bestemmelse for bruk av aktiv sonar i norske farvann fastsettes til bruk i Forsvaret fra 1. oktober 2011.

Postadresse **Besøksadresse**
Sivil telefon/telefaks /
Militær telefon/telefaks 05404208
Epost/ Internett postmottak@mil.no www.forsvaret.no
Organisasjonsnummer NO 986 105 174 MVA

Vedlegg 2

GIS anmoder FOH om å gjøre bestemmelsene kjent for relevante utenlandske enheter ifm innvilgelse av diplomatisk klarering.

for Bernt Grimstvedt
Kontreadmiral
Generalinspektør for Sjøforsvaret

E.3 The sonar guidelines – in Norwegian

The next pages show a copy of the Norwegian version of the guidelines, as issued by the Chief of the Royal Norwegian Navy (GIS).

2011-08-312008/019219-015/FORSVARET/ 9132011-08-302008/019219-015/FORSVARET/ 9132011-08-302008/019219-015/FORSVARET/ 913

Kopi til

Retningslinjer for bruk av aktiv sonar i norske farvann

GIS fastsetter *Retningslinjer for bruk av aktiv sonar i norske farvann* til bruk for Forsvarets enheter og enheter innvilget diplomatisk klarering til norsk territorialfarvann.

Haakonsvern, 31. august 2011

Bernt Grimstvedt
Kontreadmiral
Generalinspektør for Sjøforsvaret

Retningslinjer for bruk av aktiv sonar i norske farvann

Metadata

KORTTITTEL:	Sonarbestemmelsen
SIKKERHETSGRADERING:	UGRADERT
HJEMMEL:	Organisasjons- og instruksjonsmyndigheten
GJELDER FOR:	Forsvarets enheter og utenlandske enheter innvilget diplomatisk klarering som anvender aktiv sonar i norsk farvann
FAGMYNDIGHET:	GIS (Maritime operasjoner)
FAGANSVAR:	KNM Tordenskiold (Anvendelse av aktiv sonar)
IKRAFTTREDELSE:	01.10.2011
FORRIGE VERSJON:	19.06.2008

Innhold

1 Innledning

1.1 Formål

Formålet med bestemmelsen er å sikre at Forsvarets bruk av aktive sonarer ikke fører til unødig negativ påvirkning på bestander av fisk, enkeltindivider av sjøpattedyr og næringsvirksomhet knyttet til disse.

1.2 Virkeområde

Bestemmelsen gjelder for alle norske militære enheter som anvender aktive sonarer som sender i frekvensområdet 1-10 kHz.

Norske enheter som øver i fremmed nasjons farvann skal anvende angjeldende nasjons bestemmelser. Under øvelser underlagt for eksempel NATO eller FN, vil disse organisasjonenes bestemmelser være gjeldende. Dersom slike bestemmelser ikke eksisterer, skal denne bestemmelsen anvendes.

Utenlandske enheter som øver i norsk territorialfarvann skal følge denne bestemmelsen og vil bli gjort kjent med den i forbindelse med diplomatisk klarering og øvelsesordrer. Utenlandske enheter som øver i norsk farvann utenfor territorialfarvannet, men i en norsk kontrollert øvelse, skal anmodes om å følge bestemmelsen.

Bestemmelsen dekker ikke effekter som skyldes andre typer påvirkninger av militær aktivitet. Hensynet til dykkere er heller ikke ivaretatt gjennom denne bestemmelsen.

2 Definisjoner og forkortelser

ATAS	Active towed array sonar (aktiv tauet sonar)
CW-signaler	Enkelttonesignal. CW=continuous wave.
FM-signaler	Frekvensmodulert signal. FM=frequency modulation.
FN	De Forente Nasjoner
Fiskeriaktivitet	Fiskeriaktivitet oppgis i SONATE både som antall båter som har levert fangst fra et området (antall/km2 per måned), og som fangst (kg/ km2 per måned) fra et området.
HMS	Hull mounted sonar (skrogmontert sonar)
Intensiv sonarøvelse	Øvelse som innebærer at flere fartøyer bruker aktiv sonar i samme område eller at et fartøy driver aktiv sonarutsending i et område i mer enn 12 timer i løpet av et døgn. Sonartransmisjon under transitt regnes ikke som sonarintensivt.
Kildenivå	Lydintensitetsnivå som genereres av lydkilden der lydtrykket er målt i fjernfeltet og referert til 1 m fra kildens senter. Det gjennomsnittelige (rms) lydtrykket ved 1 m omregnes til lydtrykknivå i desibel, dB, i forhold til styrken av en plan lydbølge med referanselydtrykk 1µPa middelverdi (rms). Kildenivået i desibel er lik 20 log(p/p0) hvor p er kildens lydtrykk ved 1 m og p0 er referanselydtrykket. I teksten brukes bare antall dB uten referanseangivelse.
NATO	North Atlantic Treaty Organization.
Nebbhval	Hvalart (Hyporoodon ampullatus) i norske farvann. Bottlenose whale på Engelsk. Nebbhvaler er også betegnelsen på en gruppe hvaler hvor Hyporoodon ampullatus inngår som en av 19 arter, men hvor bare Hyporoodon ampullatus opptrer regelmessig i norske farvann.
Norske farvann	Med norske farvann menes her norsk territorialfarvann inkludert Jan Mayen, norsk økonomisk sone, vernesonen rundt Svalbard og tilstøtende internasjonale farvann.

Ping	Utsending av en signalpuls fra en sonar.
Rutinemessig sonarøvelse	Øvelse hvor bare ett fartøy driver sonarutsending i et område i inntil 12 timer pr døgn.
Signalintervall	Tiden fra starten av utsendt signal til starten av neste signal
Signalvarighet	Varigheten av utsendt signal (s)
Sildefisk	Sild og brisling (i norske farvann).
Sjøpattedyr	Sel og hval.
Sonarøvelser	Bruk av aktiv sonar i fredstid (Rutinemessige eller Intensive sonarøvelser).
SONATE	SONATE er et UGRADERT planleggings- og beslutningstøtteverktøy for sonarøvelser i norske farvann (se 2.1)
VDS	Variabel Dybde Sonar

2.1 Beslutningsstøtteverktøyet SONATE

SONATE er et planleggings- og beslutningstøtteverktøy for sonarøvelser i norske farvann. Samtlige enheter som berøres av disse bestemmelsene (se pkt 1.2) og alle som har ansvar for planlegging av øvelser som involverer bruk av sonarer, skal ha tilgang til dette verktøyet. Bruk av de operative anbefalingene som SONATE gir for bestemte områder i bestemte perioder, sikrer operasjon i tråd med gjeldende bestemmelser. SONATE inneholder historiske data om utbredelse av arter og fiskeriaktivitet gjennom året. Disse kan endre seg fra år til år. Dersom den faktiske situasjonen avviker fra det historiske bildet, skal de restriksjonene som gjelder i dette området og denne perioden endres tilsvarende i henhold til regelverket (se pkt 2). Kystvaktsentralen har ofte oppdatert nåtidsinformasjon om fiskeriaktivitet i et område.

SONATE forvaltes av SSK/KNMT/METOC avdeling. Epost: nornavtrainestmetoc@mil.no.

3 Bruk av sonar

Det settes strengere krav til valg av område og periode for gjennomføring av intensive sonarøvelser enn for rutinemessige sonarøvelser.

Under planlegging og gjennomføring av sonarøvelser gjelder:

3.1. Sonaraktivitet kan føre til at enkelte arter av sjøpattedyr søker bort fra øvingsområdet, og dette kan medføre tapte ernæringsmuligheter, risiko for separasjon mellom unger og mordyr, samt økte energikostnader. Unngå derfor i størst mulig grad rutinemessige og intensive sonarøvelser i områder og perioder hvor man forventer høy tetthet av sjøpattedyr, og i beiteområder for nebbhval, som betraktes som spesielt sårbar.

3.2. Sonaraktivitet kan føre til at enkelte hval- og selarter søker bort fra øvingsområdet, men terskel for unnvikelse er fortsatt usikker og vil variere mellom artene. Unngå derfor i størst mulig grad rutinemessige og intensive sonarøvelser i områder og perioder med kommersiell safariaktivitet.

3.3. Sonaraktivitet kan føre til at enkelte hvalarter søker bort fra øvingsområdet, men terskel for unnvikelse er fortsatt usikker og vil variere mellom artene. Det pålegges derfor styrker å, i størst mulig grad, ta hensyn til hvalfangst, herunder varsle om planlagt sonaraktivitet, i områder og perioder hvor det foregår slik fangst.

3.4. For å redusere risikoen for direkte skade på pattedyr skal bestemte prosedyrer for aktiv sonarbruk følges under rutinemessige og intensive sonarøvelser i alle områder/perioder hvor man forventer tilstedeværelse av sjøpattedyr (se pkt 4 Prosedyrer for sonarbruk i områder hvor man forventer tilstedeværelse av sjøpattedyr).

3.5. I området nærmest sonarkilden er det fortsatt usikkerhet knyttet til mulige reaksjon hos fisk. I områder og perioder med fiskeriaktivitet bør man derfor ikke operere sonar nærmere noe fiskefartøy under aktivt fiske enn 200 m. Dersom det fiskes etter sild og brisling bør sikkerhetsavstanden utvides til 500m dersom det brukes frekvenser under 5kHz. Dette henger sammen med at sildefisk er mer sensitiv enn andre fiskearter i dette frekvensområdet.

3.6. I nærområdet rundt sonarkilden er det fortsatt usikkerhet knyttet til mulige reaksjon hos fisk. I områder hvor det ligger havbruksanlegg bør man derfor ikke operere sonar nærmere disse enn 200 m.

3.7. Ved høye lydnivå har enkelttonesignaler (CW) vist seg å ha destruktiv virkning på sildelarver og yngel dersom frekvensen tilsvarer svømmeblærens resonansfrekvens. Unngå derfor i størst mulig grad intensive øvelser som innebærer utstrakt bruk av CW-signaler med signalvarighet1 >250 ms og kildenivå >210 dB i områder med høy tetthet av sildelarver og yngel. Begrensningen gjelder spesifikke frekvenser i spesifikke områder og perioder. Begrensninger på bruk av CW-transmisjon med stasjonære kilder (f.eks. sonarbøyer og helikopteroperert sonar) er ikke nødvendig, fordi det berørte vannvolumet er lite.

4 Prosedyrer for sonarbruk i områder hvor man forventer at det er sjøpattedyr

4.1 Prosedyre for oppstart av aktiv sonarutsending

Direkte skade på sjøpattedyr som følge av aktiv sonarutsending kan forekomme ved nivåer opp mot 200 dB avhengig av signalvarighet. I områder og perioder hvor man forventer tilstedeværelse av sjøpattedyr og ønsket kildenivå overstiger 200 dB, innledes derfor sonarutsending med en av følgende to prosedyrer, avhengig av hvilken som er mest praktisk ut fra operasjonelle hensyn:

1. Reduser farten til 5 knop, og undersøk en 100 m sikkerhetssone rundt sonarkilden visuelt og ved hjelp av tilgjengelige passive akustiske sensorer for tilstedeværelse av sjøpattedyr før sending med ønsket kildenivå og signalintervall starter. Sjekk spesielt for tilstedeværelse av delfiner nær baugen før sending med skrogmontert sonar.

2. Start sending med maks 200 dB kildenivå, maks 1 s signalvarighet og min 10 s signalintervall, og øk gradvis til ønsket kildenivå i løpet av 5 signalsykluser. Endre deretter signalvarighet og signalintervall til ønsket modus. Maksimalt sendenivå under oppstart kan økes med 3 dB for hver halvering av signalvarigheten. For eksempel så kan man starte med 206 dB dersom signalvarigheten er 250 ms. Ved bruk av svært lange signaler (>10 s) økes også signalvarigheten gradvis fra 1 s.

Ved sendeavbrudd på mer enn 5 min, skal oppstartsprosedyre gjentas. Dersom sikten ikke tillater visuell kontroll i sikkerhetssonen, skal ikke prosedyre 1 anvendes. Dersom sjøpattedyr dukker opp innenfor sikkerhetssonen rundt sonarkilden, skal sonarutsending stanses midlertidig eller kildenivå og signalvarigheten reduseres til oppstartnivå, inntil dyret er utenfor sikkerhetssonen. Dyr som beveger seg inn i sikkerhetssonen aktenfra eller inn i sikkerhetssonen til sonarkilder som ligger tilnærmet stille, kan ignoreres.

4.2 Sonarbruk i høy fart

Dersom fartøyets hastighet og sendeintervall tilsier at fartøyet tilbakelegger mer enn 200 m mellom to ping, eller fartøyets hastighet overstiger 15 knop, skal man være spesielt oppmerksom på sjøpattedyr i fartøyets fartsretning. Dette for å unngå å jage sjøpattedyr med sonaren. Sending i høy fart skal i størst mulig grad unngås dersom visuell kontroll i fartsretningen er vanskelig.

4.3 Sonarbruk i trange farvann

Ved sonarbruk i trange farvann skal man være spesielt oppmerksom på sjøpattedyr i fartøyets fartsretning for å unngå å jage dem med sonaren. Sonarutsending i trange farvann skal i størst

mulig grad unngås dersom visuell kontroll i fartsretningen er vanskelig. Kombinasjonen trange farvann og høy fart skal unngås dersom visuell kontroll i fartsretningen er vanskelig.

4.4 Bruk av helikopteroperert sonar og sonarbøyer

Dersom sjøpattedyr ikke er observert i området, er det ved bruk av helikopteroperert sonar (VDS) og sonarbøyer med kildenivå over 200 dB, tilstrekkelig at en 100 m sikkerhetssone rundt dropp-punktet er visuelt undersøkt før sending starter. Dersom sjøpattedyr er observert i området eller sikten ikke tillater visuelle observasjoner, skal sending starte med redusert nivå (200 dB) og økes til ønsket nivå i løpet av 5 signalsykluser.

5 Dokumentasjon

All bruk av aktive sonarer skal logges med starttid, stopptid, posisjon og anvendt sonarsystem (HMS, ATAS, VDS) slik at man i ettertid kan dokumentere at prosedyrene er fulgt. Dersom det er praktisk mulig skal også type utsending logges (CW/FM, frekvensbånd, pulsintervall, effekt og pulslengde). Observasjoner av sjøpattedyr og fiskeriaktivitet under sonarbruk, skal også dokumenteres. Avvik fra gjeldende bestemmelser for bruk av sonarer skal begrunnes. Dokumentasjon kan bli etterspurt av Forsvarets operative hovedkvarter (FOH) eller fagmyndighet og skal lagres i minst 1 år.

6 Ikrafttredelse

Retningslinjer for bruk av aktiv sonar i norske farvann trer i kraft 2011-10-01.

E.4 The sonar guidelines – in English

The next pages show a copy of the English version of the guidelines, as issued by the Chief of the Royal Norwegian Navy (GIS).

2011-08-302008/019219-015/FORSVARET/ 913

Retningslinjer for bruk av aktiv sonar i norske farvann

Chief of the Royal Norwegian navy sets *Regulations regarding use of active sonars in Norwegian territorial waters* to apply to all maritime units in the Royal Norwegian Armed Forces and foreign units granted diplomatic clearance.

Haakonsvern, 31. august 2011

Bernt Grimstvedt

Rear Admiral

Chief of the Royal Norwegian Navy

Retningslinjer for bruk av aktiv sonar i norske farvann

Metadata

SHORT TILE:	Sonarbestemmelsen (Norwegian title)
CLASSIFICATION:	UNCLASSIFIED
LEGAL AUTHORITY:	Organisasjons- og instruksjonsmyndigheten (Text in Norwegian)
VALID TO:	Royal Norwegian Armed Forces units and foreign units granted diplomatic clearance.
AUTHORITY:	Chief of the Royal Norwegian Navy
SPECIALIST RESPONSIBILITY:	NORNAVTRAINEST
EFFICIENT DATE:	01.10.2011
LAST VERSION:	19.06.2008

Content

1 Introduction

1.1 Objectives

The main objective of these regulations is to minimize the risk of negative effects on populations of fish, individual marine mammals and on commercial activity related to fish and marine mammals while using military active sonars.

1.2 Application

These regulations apply to all foreign military units employing active sonar transmitting in the 1-10 kHz band in Norwegian territorial waters. Units using active sonar in the frequency area below 1 kHz are requested to forward own policy to NJHQ.
Regulations for Norwegian units are basically the same but not restricted to Norwegian territorial waters.

Foreign units operating in Norwegian territorial waters must comply with these regulations and will be formally informed during diplomatic clearance process and exercise orders. During Norwegian controlled exercises foreign participating units operating in Norwegian waters outside the Norwegian territorial waters are encouraged to comply with these regulations.

Norwegian units operating outside Norwegian waters will comply with the prevailing regulations of the host nation. International operations under the leadership of NATO or UN will be run according to these organizations' regulations. If such regulations do not exist, the Norwegian regulations will apply.

These regulations do not cover effects of other types of military activity other than use of active sonar. Protection of divers is NOT covered by these regulations.

2 Definitions and abbreviations

ATAS	Active towed array sonar
Beaked whales	Family of toothed whales (Lat: Ziphiidae). Only the Bottlenose whale (Lat; Hyperoodon ampullatus) appears in Norwegian waters.
CW-signals	Single tone. CW=continuous wave.
FM-signals	Frequency sweep. FM=frequency modulation.
Fishing activity	Fishing activity is in SONATE given in number of boats which have delivered catch from an area and as catch (in kg/km2/month) from an area.
Herrings	Herring (no; sild) and sprat (no; brisling).
HMS	Hull mounted sonar
Intensive sonar exercises	Exercises involving sonar transmission from more than one vessel in the same area or that one vessel is actively transmitting sonar signals for more than 12 hours within 24 hrs within a restricted area. Thus, sonar transmission during transit is not defined as a sonar intense activity.
Marine mammals	Pinnipeds and cetaceans (seals, whales, dolphins and porpoises).
NATO	North Atlantic Treaty Organization.
Norwegian waters	Norwegian territorial water including Jan Mayen, Norwegian economic zone, plus the protection zone of Svalbard and adjoining international waters.
Ping	Transmitted signal pulse from active sonar.
Routine sonar exercises	Exercises involving sonar transmission from only one vessel for less than 12 hours within 24 hrs.
Signal duration	Duration of transmitted signal (ping).
Signal interval	Time period from the start of transmission of one ping to the start of the next ping.

Sonar exercises	Peace time active sonar transmission (Routine sonar exercises and Intense sonar exercises).
SONATE	An UNCLASSIFIED decision aid tool for planning and execution of sonar exercises in Norwegian waters (see section 2.1.)
Source level	Pressure in dB generated by an acoustic source, measured in the far field but referred to 1 m distance from the centre of the source. The mean sound pressure (rms) at 1 m distance is converted to dB-values relative to a plane wave with sound pressure of 1µPa rms. The source level in dB is calculated as 20 log(P/P0) where P is the source pressure and P0 the reference pressure.
UN	United Nations
VDS	Variable Depth Sonar

2.1 SONATE decision aid tool

SONATE is a decision aid tool for planning of sonar exercises in Norwegian waters. All units affected by these regulations (see section 1.2.) and all staff involved in planning of exercises which involves use of sonars, shall have access to SONATE. Operations within the recommendations given by SONATE for different areas and time periods ensure that the operations will be executed in compliance with these regulations. SONATE contains historical data on the distribution of marine species and fishing activity at different times of the year. This might change from one year to the next. If the actual condition in an area differs from the historical picture, the prevailing regulations must be altered correspondingly according to section 3. The Norwegian Coast Guard often possesses up-dated information of fishing activity in an area.

SONATE is distributed by Norwegian Naval Training Establishment /METOC. For guidance to procedures for downloading SONATE use email: nornavtrainestmetoc@mil.no.

3 Use of sonar

The requirements for selection of an area and a period for execution of intense sonar exercises are stricter than for routine sonar exercises.

During planning and execution of sonar exercises the following applies:

3.1. Sonar activity in an area can result in avoidance responses in marine mammals, and they might leave the exercise area. This can result in lost feeding opportunities risk of mother calf separation and increased energetic cost. Therefore, avoid as much as possible intensive and routine sonar exercises in areas/periods expected to have a high abundance of any species of marine mammals, and because they are considered to be particularly sensitive also in known beaked whale areas.

3.2. Sonar activity in an area can result in avoidance responses in marine mammals, and they might leave the exercise area. However, threshold of avoidance is still uncertain and will vary between species. Therefore, avoid as much as possible intensive sonar exercises in areas/periods where whale safari activity can be directly influenced by use of sonar.

3.3. Sonar activity in an area can result in avoidance responses in marine mammals, and they might leave the exercise area. However, threshold of avoidance is still uncertain and will vary between species. Forces are therefore instructed to be aware of and consider whaling activity as much as possible, including notification of planned sonar activity, when operating in areas/periods with whaling.

3.4. To reduce the risk of inflicting direct injury to marine mammals, special procedures for sonar transmission should be used during routine and intensive sonar exercises in all areas/periods where marine mammals are expected to be encountered (see section 4).

3.5. In the area closest to a sonar source, it is still uncertain if fish might respond to sonar transmissions. In areas/periods with fishery, one should be aware of the fishing activity and always maintain a safety distance of 200 m from all fishing vessels actively engaged in fishing. If the fishery involves herring or sprat the safety distance should be extended to 500m if transmissions include signals below 5 kHz. This is connected to the sensitive hearing of herrings in this frequency band compared to most other species of fish.

3.6. In the area closest to a sonar source, it is still uncertain if fish might respond to sonar transmissions. During sonar transmission a 200 m safety zone from fish farms shall therefore be maintained.

3.7. At high sound levels, tonal signals (CW) have a destructive impact on juvenile herring (no; sildelarver/yngel) if the transmitted frequency correspond to the swimbladder resonance frequency of the fish. Therefore, avoid as much as possible intensive sonar exercises involving extensive transmissions of CW signals at source levels >210 dB and signal duration >250ms in areas with high density of juvenile herring. This restriction applies to specific frequencies within specific areas and time periods. No restrictions on CW transmissions from stationary sources (e.g. sonobuoys or helicopter operated VDS) are necessary because the affected water volume is small.

4 Procedures for sonar transmission in areas where marine mammals are expected to be encountered

4.1 Procedure for start-up of sonar transmissions

Direct injury of marine mammals is possible at sound levels approaching 200 dB depending on signal duration. In areas/periods where marine mammals are expected to be encountered and transmitted source level will exceed 200 dB, sonar transmissions shall therefore be initialized according to one of the following two procedures depending on which is the most appropriate for the ongoing operation:

1. Reduce speed to 5 knots, examine a 100 m safety zone from the sonar source visually and using available passive acoustic sensors for presence of marine mammals before initializing transmission. Check in particular for presence of bow riding dolphins.
2. Start transmissions at a maximum source level of 200 dB, a maximum of 1 s signal duration, and a minimum 10 s signal interval. Increase gradually to desired source level during the next 5 transmissions. Adjust signal duration and interval to desired levels. The maximum initial source level might be increased by 3 dB for every halving of the signal duration, or decreased for every doubling. For example; a 206 dB initial source level is acceptable if signal duration is 250 ms, but should be reduced to 194 dB if signal duration is 4 s. Transmissions of long duration (>10 s) signals shall be initialized with transmissions of short duration signals (e.g. 1 s) and gradually increased.

If transmissions are interrupted for more than 5 min, the start-up procedure shall be repeated. If visual conditions do not allow for visual control of the safety zone, procedure 1 shall not be used. If marine mammals appear within the safety zone, transmissions shall be ceased or source level/signal duration reduced to start-up level until the animal is outside the safety zone. Animals entering the safety zone from astern or the safety zone of stationary sonar sources can be ignored.

4.2 Transmissions at high speed

If the vessel speed and the transmission interval imply that the vessel covers more than 200 m between two succeeding transmissions (pings), or the speed exceeds 15 knots, one must at all times during transmissions have a strong focus on presence of marine mammals in the travelling

direction of the vessel. This is to avoid chasing marine mammals with the sonar. Transmission at high speed should be avoided as much as possible if visual control is difficult.

4.3 Transmissions in narrow or constricted waters

During transmissions in narrow or constricted waters one must have a strong focus on the presence of marine mammals in the travelling direction of the vessel to avoid chasing them with the sonar. Transmissions in such waters should be avoided as much as possible if visual control is difficult. The combination of high speed and narrow or constricted waters must be avoided if visual control is difficult.

4.4 Use of helicopter operated sonar and sonar buoys

If marine mammals are not observed in the area of operation, it is sufficient that a 100 m safety zone surrounding the drop point of helicopter operated VDS or sonar buoys is visually examined for presence of marine mammals before transmitting at levels exceeding 200 dB. If marine mammals are observed in the area or visibility conditions do not allow for visual examination of the safety zone, transmission should start at a source level of 200 dB or less. The transmitted level may be increased to desired level within the next 5 transmissions.

5 Documentation

All use of active sonars in Norwegian territorial waters shall be logged with start-up time, position and applied sonar system (HMS, ATAS, VDS) to document compliance with these regulations. If practical, type of transmission (CW/FM, frequency band, pulse interval, transmitted power and pulse length) should also be logged. Observations of marine mammals and fishing activity in areas of active transmission shall be documented. Any infringement against these regulations must also be documented with the cause of the infringement. Documentation should be archived for at least 1 year. In case of any formal or informal investigation following any event of suspected negative impact to marine life caused by use of active sonars in Norwegian territorial waters NJHQ may request documentation.

6 Effective date

Regulations regarding use of active sonars in Norwegian territorial waters is effective 2011-10-01.

Appendix F input file examples

F.1 Fish farms information

TILL_NR	FIRMA_ID NR	INNEHAVER	ADRESSE	POST NR	POSTSTED
A A 0001	969159570	UNIVERSITETET FOR MILJØ- OG BIOVIT		1432	ÅS
A AH0701		BJØRKELANGEN JFF	BOKS 131	1940	BJØRKELANGEN
A AH0701		BJØRKELANGEN JFF	BOKS 131	1940	BJØRKELANGEN

TILL_NR	ETABL_DATO	MIDL_TILL	TILL_KOMNR	TILL_KOM
A A 0001	03-10-1991		0214	ÅS
A AH0701	21-09-1995		0221	AURSKOG HØLAND
A AH0701	21-09-1995		0221	AURSKOG HØLAND

TILL_NR	FORMÅL	PRODUKSJON	ART	TILL_KAP	TILL_MH	LOK_NR
A A 0001	KOMMERSIELL	MATFISK	LAKSEFISK	6.50	TN	10362
A AH0701	KULTIVERING	YNGEL	ØRRET	130.00	STK	12826
A AH0701	KULTIVERING	SETTEFISK	ØRRET	140.00	STK	12826

TILL_NR	LOK_NAVN	LOK_TYPE	LOK_KOMNR	LOK_KOM
A A 0001	NERFJØSET	PERMANENT	0214	ÅS
A AH0701	BJØRKELANGEN	PERMANENT	0221	AURSKOG HØLAND
A AH0701	BJØRKELANGEN	PERMANENT	0221	AURSKOG HØLAND

TILL_NR	LOK_PLASS	LOK_MILJØ	LOK_KAP	LOK_MH	LOK_MIDL	N_GEOWGS84	Ø_GEOWGS84
A A 0001	LAND	FERSKVANN	100.00	M3		59.670232	10.759353
A AH0701	LAND	FERSKVANN	270.00	STK		59.871073	11.595335
A AH0701	LAND	FERSKVANN	270.00	STK		59.871073	11.595335

Table F.1 Example from fish farms input file. The input file is in Norwegian. Standard fields of the input file are: permission no; company ID; owner; address; postal code; post office; established date; temporary permission; permission municipality ID; permission municipality; object (commercial/cultivation); production (edible fish, hatchery ...); capacity; capacity unit (tonnes, number etc); location ID; location name; location type (permanent, temporary etc);location municipality ID, location municipality name; location placement (land, sea etc); environment (salt water, fresh water etc); location capacity; location capacity unit (m^3, tonnes, number etc); location temporary; coordinate latitude WGS 84; coordinate longitude WGS 84