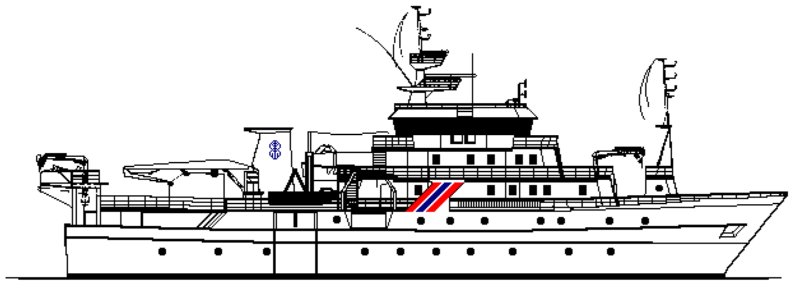
NORAD - FAO/UNDP PROJECT GLO 92/013

CRUISE REPORTS "DR. FRIDTJOF NANSEN"



BENEFIT SURVEYS

Cruise Report No 4/2001

Jellyfish acoustic target strength, vertical distribution and biology

1 - 7 September 2001

University of Western Cape
Bellville
South-Africa

Marine Coastal Management
Cape Town
South-Africa

Cape Technikon
Cape Town
South-Africa

Ministry of Fisheries & Marine Resources
Swakopmund
Namibia

University of St. Andrews
Fife
Scotland

Institute of Marine Research
Bergen
Norway

BENEFIT SURVEYS

Cruise Report No 4/2001

Jellyfish acoustic target strength, vertical distribution and biology

1 - 7 September 2001

by

Bjørn Erik Axelsen[1], Dave Boyer[2], Helen Boyer[2], Andrew Brierley[3], Mark Gibbons[4], Allie Gumbo[2], Victor Hashoongo[2], Larwrence Hutchings[5], Jennifer Purcell[6], Roar Skeide[1], Conrad Sparks[7] and Ulric Van Bloemenstein[4]

1. Institute of Marine Research, P. O. Box 1870 Nordnes, N-5817 Bergen, Norway.
2. Ministry of Fisheries and Marine Resources, P.O. Box 912, Swakopmund, Namibia
3. Gatty Marine Laboratory, University of St. Andrews, Fife, KY16 9DY, Scotland, U.K.
4. University of Western Cape, Zoology Department, Private Bag X 17, Bellville 7535 Cape Town, South-Africa
5. Marine and Coastal Management, Private Bag X2, Rogge Bay 8012 Cape Town, South-Africa
6. Shannon Point Marine Center, 1900 Shannon Point Rd., Anacortes, WA 98221, 360-650-7400, Maryland, U.S.A.
7. Cape Technikon, Faculty of Applied Sciences, P.O. Box 652, Cape Town, South-Africa

Institute of Marine Research
Bergen, 2001

TABLE OF CONTENTS

CHAPTER 1 INTRODUCTION

1.1 BACKGROUND (essentially 1999)

The jellyfish species *Chrysaora hysoscella* (class Scyphozoa, colloquially known as "reds") and *Aequorea aequorea* (class Hydrozoa, "mags") occur in great abundance in Namibian waters. There is some evidence to suggest that prior to the 1970s this was not the case (eg Hart and Currie 1960, Stander and de Decker 1969), and it is possible therefore that these jellyfish have become established as a major component of the Bengualan ecosystem over a relatively short period of time (Fearon et al. 1992). Rapid increases in jellyfish abundance (blooms) have recently been reported from numerous marine ecosystems worldwide (e.g. Mills 1995). The diets of *C. hysoscella* and *A. aequorea* are not well described, but related species are known to prey upon fish eggs and larvae (e.g. Purcell 1989). The increase of jellyfish abundance off Namibia appears to have coincided with a period of decline of commercial fish catches (pilchard and anchovy - Shannon et al. 1992), and it has been suggested that these phenomena are in fact directly linked. Introduction of the jellyfish *Mnemiopsis leidyi* in the Black Sea has been related to the crash of fish stocks there (Travis 1993). In addition to their potential predatory impact on fish, jellyfish also hamper fishing activities off Namibia by clogging and subsequently bursting trawl nets. This is a big problem during surveying of the pelagic fish stocks, particularly for sardine ("pilchard", *Sardinops ocellata*), but also for horse mackerel (*Trachurus trachurus capensis*), due to the fine meshes in the sampling trawls used on research vessels. Jellyfish also cause problems to the diamond extraction industry by blocking suction devices used to dredge marine alluvial sediments.

Despite potential ecological and economic importance of jellyfish in Namibian waters, little of their biology or population dynamics is known (Gibbons et al. 1992, Sparks et al. 2001). Some information on the distribution and abundance of reds and mags is available from Bongo net surveys (Pagès 1991, Fearon et al. 1992), but these nets are small (50 cm mouth opening) and are unlikely to provide unbiased data, partiularly for adult *C. hysoscella* that commonly attain umbrella diameters exceeding 50 cm. Acoustic survey techniques are used commonly for studies of distribution and abundance of fish and zooplankton, and may be useful for studies on jellyfish (Mutlu 1996, Monger et al. 1998) as well. Knowledge of mesoscale distribution and abundance variation, which acoustic surveys may be able to provide, would be of great value to a number of parties operating in Namibian waters.

Acoustic abundance estimation requires knowledge of the acoustical backscattering properties of the ensonified targets in order to identify observed scatters as a given species. Due to the limited information that can be obtained from the target in conventional single frequency echosounders, some *a priori* knowledge of the acoustical appearence of the target species at the given frequency is prerequisite, even though frequent trawl samples confirming the allocation of acoustical density to given species are necessary in any case.

Unless all ensonified targets can be resolved as single echo targets by the echosounder, which is hardly ever the case, knowledge of the dorsal aspect target strength (TS) is required in order to convert the acoustical densities of the targets into an absolute measure of biomass. Target strength is thus an essential parameter in acoustic abundance estimation. Very little work has been conducted on jellyfish regarding either acoustical target identification or measurements of dorsal aspect target strength.

For fish, assuming that the target strength increases proportionally to body length, the target strength at a given frequency can be expressed as a a function of mean total length. For jellyfish, a similar procedure can be followed, relating target strength to the diameter of the umbrella or to wet weight (Mutlu 1996, Monger et al. 1998). This has been carried out in experimental settings at 120 and 200 kHz for the common jellyfish *Aurelia aurita* (Mutlu 1996) and at 200, 420 and 1000 kHz for the gelatinuos zooplankters *Aequora victoria* and *Pleurobrachia bachei* (Monger et al. 1998). To the best of our knowledge, however, no measurements have been reported at 38 kHz, a frequency commonly used in fish abundance estimation surveys, nor have any *in situ* measurements, at any given frequency, been published.

The high abundances of *A. aequora* and *C. hysoscella* along the Namibian coast provide excellent opportunities for studying these animals, as well as a strong motivation for elaborating their acoustic characteristics.

1.2 OBJECTIVES OF THE SURVEY (from 1999)

The overall goal of the cruise was to determine whether acoustic survey techniques are applicable for mapping distribution and abundance of jellyfish in Namibian waters. In order to achieve this, the following objectives were identified:

To carry out repeated acoustic measurements of aggregations of jellyfish at 18, 38 and 120 kHz to elaborate potential acoustical characteristics of A. *aequora* and C. *hysoscella* for target identification purposes (cf. Brierley et al. 1998). Identification of the recorded species was to be conducted using standard pelagic sampling trawl. In order to achieve a high degree of compatability between the acoustic observations and the fish samples, frequent hauls of short duration each were to be executed.

To measure the acoustic target strength of A. *aequora* and C. *hysoscella* at 18, 38 and 120 kHz *in situ* using hull mounted split-beam transducer in combination with SIMRAD EK 500 echosounder.

To conduct an on/off shelf mesoscale survey of jelly fish distribution, using information from 1 and 2 to guide acoustic identification of common jellyfish species

1.3 PARTICIPATION

The scientific staff consisted of:

From Namibia:
Dave BOYER, Helen BOYER, Allie GUMBO, Victor HASHOONGO

From South Africa:
Mark GIBBONS, Lawrence HUTCHINGS, Conrad SPARKS, Ulric VAN BLOEMENSTEIN

From Norway:
Bjørn Erik AXELSEN (Cruise leader), Tore MØRK, Roar SKEIDE and Jan-Frode WILHELMSEN

From Scotland:
Andrew BRIERLEY

From U.S.A:
Jennifer PURCELL.

1.4 NARRATIVE

The observations made in September 1999 showed that mags and reds co-occurred in high densities at about 22° 00’ S. Reds were in 1999 found in largest concentration inshore, while mags were found further offshore (150-200 m bottom depth). After departure from Walvis Bay 1 September at 18h00 local time (UTC +1), course was therefore set for north-west and the first trawl station (Multisampler, PT 937-939) was worked in shore at 22° 25' S, 14° 10' E at 60, 50 and 20 m headrope depth. A marked scattering layers could be seen at about 50 m depth. Although the effective tow time (time elapsed between opening and closing of each codend) only was 5 min for each haul, the high densities of jelly caused the trawl extension piece to tear badly. Retrieved jellies were reds only, suggesting that they dominated the area, as they were observed to do in 1999. The repair of the trawl took a full day, and meanwhile the ship headed westwards at reduced speed (~8 knots) in search for an area with lower densities. Qualitative jellyfish samples were taken using the somewhat stronger bottom trawl (6.9 m vertical opening when towed in midwater). Quantitative zooplankton samples were obtained using the Hydrobios multinet (x5) plankton sampler (405 micrometer) and the Bongo (200 micrometer ?). CTD casts were conducted as well. The ADCP had to be turned off as it interferred with the 120 and 200 transceivers of the echosounder.

As we moved westwards, the tawl samples contained progressively more mags and fewer reds (BT 940: 1 single mag, ~320 kg reds; BT 941: ~1.000 kg mags, ~1.000 kg reds; BT 942: 300 kg mags, 90 kg reds). However, the next sample (BT 943), recovered from about 70 m depth at 00:15 UTC, contained relatively more reds (100 kg mags, 160 reds). An area dominated by mags was therefore sought further offshore.

BT 944 was towed **01:55 UTC** at 70 m (~250 m bottom depth) for 5 minutes, and contained **~500 kg of mags and ~100 kg of reds**. The multisampler was fished on the same aggregation (03:00 UTC), but there was no response from the multisampler. Next deployment (**PT 945-947**) was successful (although confirmation on net opening and closing from response switches on lower part of steel frame were not received). Samples were fished beneath (**150** m depth), inside (**90** m) and above the main pelagic scattering (38 kHz) layer (**50** m). **Big (how big)** cathes of (**mags, reds ??**) were obtained in top and bottom layers while little was caught in the main layer layer, but some contamination of the samples may have occurred if one or more of the nets were not properly closed after deployment (although this should not be expected, as the net profiles rarely get jammed). Multinet and CTD. Moved further west and fished another multisampler series (**PT 948-950**).

The "Dr. Fridtjof Nansen" docked in Walvis Bay 7 September 2001 at 17h00.

CHAPTER 2 METHODS

Upon encountering scattering layers that appeared to be suitable for net sampling, cycle experiments consisting of consecutive deployments of ***Multisampler*** trawl hauls (3* remote opening and closing of codend (22 mm) at acoustic targets, i.e. scattering layers, in discrete depth intervals) (Skeide et al. 1997, ***Multinet*** plankton hauls (Hydrobios, 5* remote opening/closing of plankton nets (405 µm) sampling the water clumn obliquely in adjoining, vertical sample intervals, ***Bongo*** plankton hauls (2-sample vertically towed plankton sampler with fixed opening (180 µm)) and ***CTD*** casts (temperature, salinity, oxygen, density). ADCP measurements (Acoustic Doppler Current Profiler), recording current speed and direction, including the vertical component, in depth intervals, were carried out continously in the beginning of the survey, but the instrument had to be turned off due to interference with the 120 and 200 kHz keel mounted echosounder transceivers. Instead, ADCP readings were carried out routinely during CTD casts.

2.1 WEATHER DATA

Air and sea surface temperature (SST), wind speed and direction, and incident solar intensity recorded with the ANDREAA weather station was logged in 20 sec intervals.

2.2 TRAWL SAMPLING

Detailed illustrations of all pelagic and demersal sampling trawls, including the *Multisampler* system, are illustrated in **Annex III**. For each trawl station, catch size and species composition was determined and punched onto NAN-SIS database following standard procedure. For the jelliyfish, umbrella diameter, gonad diameter, oral arm length and wet weight were measured and punched into EXCEL spreadsheets. Some stations were disregarded due to tearing of trawl extension.

2.2.1 Multisampler

The *Multisampler* (Skeide et al. 1997) was fitted with the mid-sized pelagic trawl (~15 m vertical opening), and generally performed well during the cruise (the first deployment had to be aborted due to oil intrusion into the release motor, causing communication problems and erronous messages to the bridge; and during a deployment on 3 September 03:00 UTC acoustic contact for unknown reasons could not be established and the haul was aborted.

One problem during utilization of *Multisampler* on dense aggregations of jellyfish is that the reduced flow through the trawl increases the "bucket effect" (= no flow) when there are big catches in the codend and hence significantly increases the risk of net tearing. Formation of looser net sections in the belly-section, where the rigid *Multisampler* steel-frame is mounted, further enhances tearing in this part of the trawl. This is rarely a problem during "normal" use on fish aggregations, but is accentuated by the extreme animal densities of jellyfish frequently encountered in the Namibian Benguela. During the jellyfish survey in September 1999, a split was cut in the bottom panel in the extension piece in front of the *Multisampler* to reduce net tearing. The split was sewn lightly together using thin twine, hence allowing for "controlled" bursts.

Notwithstanding the problems associated with dense jellyfish aggregations, tow times were kept short. The first *Multisampler* trawl series (PT 937-939), worked inshore at 22° 25' S, 14° 10' E at 60, 50 and 20 m headrope depths, were 3*5 min. Even with this short tow period (5 min was towed routinely in 1999), this was enough to t ow time was never more than 5 minutes, and less (2-3 min) whenever densities were high. Despite these precautions, the multisampler trawl was torn from time to time due to high concentrations of jellyfish.

2.2.2 Trawl sample volume

In order to calculate the overall sample volume of a trawl, certain assumptions must to be made. Jellyfish will not actively avoid the net, and will therefore primarily be caught were the meshes are large enough to stop them, e.g. no herding effect. From the extension and backwards, the meshes are 400 mm (stretched) for all sampling trawls, and in front of this they are 1620 mm and larger (**Annex III**). Assuming for now that the sampling trawl only catches jellyfish effectively from the 400 mm panels and backwards, the volume sampled by the trawl V can be considered as cylinder, where the diameter is half the opening of the trawl in this section O (m) and the height is towed distance td (m) (**figure 1**), hence (1):

$$V = \pi(O/2)^2 \, td \qquad (m^3) \qquad (1)$$

To estimate the opening of the trawl in the sampling section, a Scanmar height sensor was mounted on the top panel (figure 1) during two experimental hauls. An 8" float was attached to the bottom panel to ensure that the sensor detected the correct distance. The opening was measured to 12 m (6.7 and 6.8 m, respectively). Using the known vertical opening of the trawl (from headline to footrope, 30 m), the sample depth interval (19 to 31 m from the surface) was calculated as well. If n is number of individuals in the sample and V is the volume sampled by the trawl (m^3), the volume density, or number of individuals per unit sampled volume, ρ_V (n/m$^-$

[3]) corresponds to (2):

$$\rho_V = n/V \qquad (n \cdot m^{-3}) \tag{2}$$

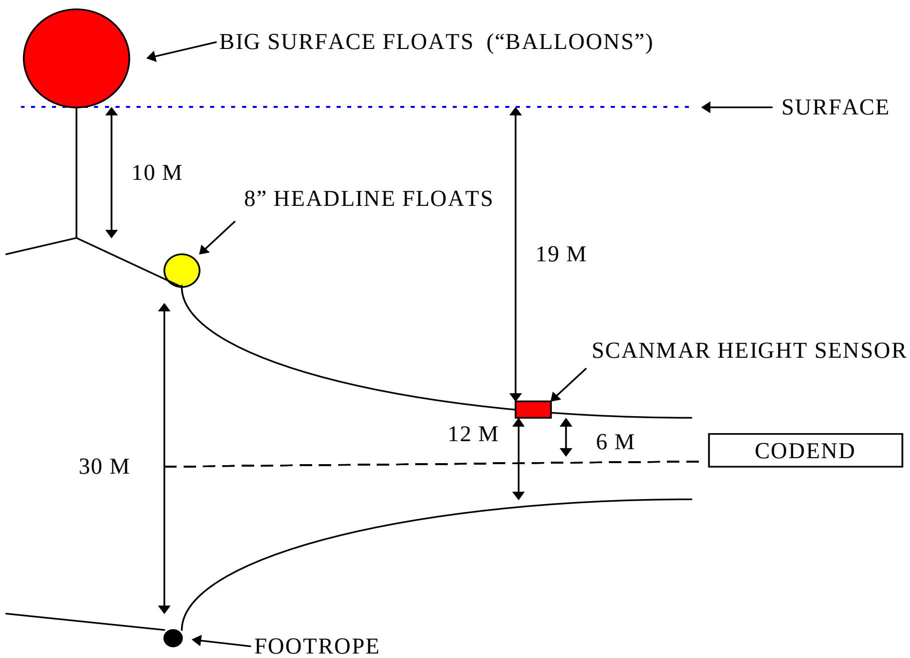


Figure 1 Illustration of the sampling trawl rigged with "balloons".

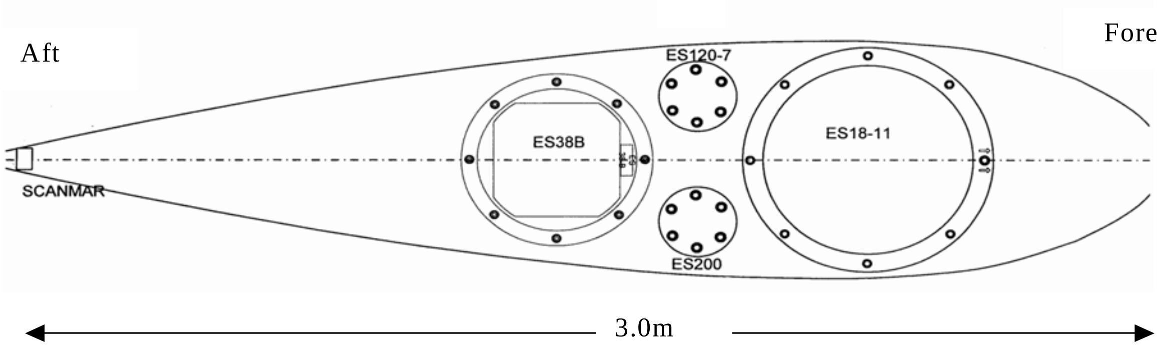
2.2 ACOUSTIC SAMPLING

2.3.1 Refit of drop keel in Cape Town, January 2001

Recently, several modifactions have been made to the transducer arrangement of the drop keel. The modifications were done during a refit in Cape Town in January 2001. The ship was dry-docked, and the keel was lifted up through a shaft that runs in the full height of the ship and opens up onto the roof of the wheelhouse. The keel was transported to a workshop where the keel-face was levelled according the off-axis deviation angle at normal ship trim, as estimated during acoustic surveys. The keel was sandblasted, primed and painted. Shells, barnacles and other shrubbery were removed form the keel and inside the shaft. A new, bigger cable gate was fitted to the shaft in order for all cables to run through the same gate. The cables for the 38 and 120 kHz transducers, and the Scanmar hydrophone (HCL) were squeezed, and replaced with new, thinner, cables (50 m).

New holes were bored for 18 kHz (aft), 120 kHz (central, stirbord side) and 200 kHz (central, port) transducers. The 38 khx was left in its original position. The hole for the 120 kHz was covered. The existing 18 kHz transducer was removed from its initial position on the keel and fitted onto the keel. A new 200 kHz single beam transducer (ES 200-7F) was fitted next to the 120 split beam in the center of the keel face. The modifications of the transducer arrangement have effectively ensured optimal configuration of the transducer, as they are now positioned on the same acoustic axis giving ~vertical transmission at normal ship trim and with minimal horizontal spacing of the transducer faces. The new transducer arrangement on the drop keel is illustrated in Figure 2a, while Figures 2b and 2 are photos of the keelface before and after the refit, respectively.

a)



b)

c)

Figure 2 Transducer arrangement of the drop keel of R/V "Dr. Fridtjof Nansen" showing schematic illustration of the new orientation of the transducers on the keel (scale 1:10) (a) and photo taken before (b) and after (c) the refit in Cape Town in January 2001.

2.3.2 Collection of acoustic data

Two EK 500 echo sounders running split-beam transducers operating at nominal frequencies of 18, 38, 120 kHz (EK 1) and a single-beam transducer at 200 kHz (EK 2) were utilized. Data were logged continuously during the diel cycle experiments utilizing both Sonardata_Echolog (PC ver. 2.00.21) and Bergen Echo Integrator (BEI) (Sun Unix) logging platforms. The settings used in the EK 500 transceiver menus are presented in ANNEX I. Note that the pulse length and band width settings were optimised with regard to obtaining similar and high sampling resolution of all frequencies (18 kHz: short/ wide; 38 kHz: medium: wide; 120 kHz: long/narrow; 200 kHz: long/narrow). Post-processing was done using Sonardata Echoview.

Calibration of all four transceivers were carried out 8 September 2001, on the following survey (BENEFIT survey no 5/2001 on multifrequency acoustics). All recorded data will consequently have to be post-processed with modified transceiver gain settings. There were, however, only small changes in all frequencies, except for the new 200 kHz transducer (ES 200-F). A complete description of the calibration procedures and results are shown in ANNEX II. The drop-keel was in lifted position for the duration of the survey, giving an effective transducer depth of 8 m.

A Hewlett Packard Deskjet printer was set to print the 120 kHz output. Colour s_V minimum was set to -70 dB. Recordings from the different 24 hour stations were scrutinised, using both Echoview and BEI in conjunction with the trawl catch data.

2.4 TARGET STRENGTH MEASUREMENTS

Unless all ensonified targets can be resolved as single echo targets by the echosounder, which is hardly ever the case, knowledge of the dorsal aspect target strength (TS) is required in order to convert the acoustical densities of the targets into numbers of individuals and hence into an absolute measure of biomass. Two approaches were attempted in order to elucidate jellyfish target strength, specifically direct measurements from the hull mounted transducers (*in situ* method) and backcalculation from integrator values to sigma considering sample volume and density (comparison method).

2.4.1 *In situ method*

Making use of the single target detection algorithm in the EK500, TS recordings of single targets were offloaded from the serial port to an IBM compatible computer. The single target detection algorithm has its clearly identified limitations (Soule et al. 1995), but tracking single targets (Ona and Hansen 1991) using the split beam technology, multiple targets interpreted as single echo targets by the EK 500 can be expelled from the recorded material. By tracking individual targets one will also reduce the likeliness off some individuals contributing more to the estimated mean than others, obtain a measure of within and between ping variation, and reveal rough information about the tilt angle of the fish between consecutive pings.

For fish, assuming that the target strength increases proportionally to body length, the target strength at a given frequency can be expressed as a a function of mean total length (L) in the logarithmic domain using equation (3):

$$TS = x \log L + y \quad (dB) \qquad (3)$$

where x and y are linear regression coefficients. If the average acoustic backsacattering crossection, σ (m), of the ensonified population is known, recorded area backscattering coefficient, S_A (m^2/nm^2) can be converted to number of fish per unit squared nautical mile, ρ_A using (4):

$$\rho_A = S_A/\sigma \qquad (4)$$

Split beam echosounders, like the Simrad EK500 38 kHz system used in this investigation, combine the signals from four quadrants of the transducer (with individual signal detection and time varied gain amplification) in pairwise fashion by simple summing, forming four half beams. Selecting the larger of the arithmetical means of target strengths computed for each pair of adjacent samples, the target strength detection algorithms then compute the target strength in the range -50 dB to -20 dB with 0.375 dB resolutiuon in several steps (described in Foote et al., 1986). In order to calculate mean average backscattering crossection, the observations must be converted from the logarithmic domain (dB) to the intensity domain. This can be achieved assuming (5) (Love 1971):

$$TS = 10 \log(\sigma/4\pi) \quad (dB) \tag{5}$$

At 38 kHz, σ has been shown to be proportional to the squared total length of the fish for many comercially important species. For faciliation of direct comparison between different regressions series, equation (1) can thus be modified to a one-coefficient form, keeping x=20 (Love 1977), giving equation (6):

$$TS = 20 \log L + b_{20} \quad (dB) \tag{6}$$

Mean TS can then be calculated from mean σ using (3), and by inserting mean total length from the fish sample, b_{20} can be calculated by rearranging (4) with respect to b_{20}. The relation between umbrella diameter and target strength for jellyfish may, however, not follow a 20 logL dependence usually observed in fish (Mutlu 1996). Ideally therefore, discrete measurements of different sized populations should be carried out in order to estabish a valid regression between umbrella diameter and target strength.

Jellyfish, being zooplankters, can be assumed to have a “behaviour” independent of the presence of the ship. Obtaining reliable TS-measurements may therefore be done using hull-mounted transducers at short range. However, encountering loosely aggregated targets in distinct mono-species layers in adequate density is needed to ensure reliable conditions for *in situ* measurements of target strength. Representative samples of the jellyfish are also prerequisite.

2.4.2 *Comparison method*

The comparison method (Misund and Beltestad 1996, Misund et al. 1997) is based on backcalulating average acoustic bacscattering crossection σ (m^2) from recorded area backscattering coefficient S_A and area density using (4) rearranged as (7):

$$\sigma = S_A/\rho_A \tag{7}$$

This type of calculations have previously been carried out on schools of herring, mackerel and horse mackerel by repeated integration of the schools, mapping of their overall geometry using multibeam sonar, and capture of the entire school using purse seiner (Misund and Beltestad

1996, Misund et al. 1997).

Similarily for mono-species layers of jellyfish, one could consider the volume sampled by the trawl, and the total number of individuals in the sample. Average umbrella diameter could then be related to target strength using (5).

To convert sample volume density ρ_V (n/m^3) (see chapter 2.2.2) to area density ρ_A (n/nm^2), the total number of individuals must be related to the surveyed area in nm^2. The trawl sample volume can be considered a cylinder, according to (1). Assuming that the recorded acoustic density in the depth range of the trawl sample is representative for the density in the volume sampled by the trawl, the area density can be considered as (8):

$$\rho_A = n/1852^2 \cdot td \cdot (\pi(O/2)^2)^{-2} \qquad (n/nm^2) \qquad (8)$$

where n is number of fish and td is towed distance (m).

CHAPTER 3 RESULTS

3.1 WEATHER CONDITIONS

Weather conditions were good and stable with moderate wind, ranging from 0 to 25 m/s (**figure 1**). It was generally cloudy, but no rain throughout the cruise. The Solar intensity levels measured on top of the wheelhouse are given in **figure 2**. The temperature at the sea surface and in the air ranged from 12.4 to 16.0°C and from 9.8 to 14.6°C, respectively.

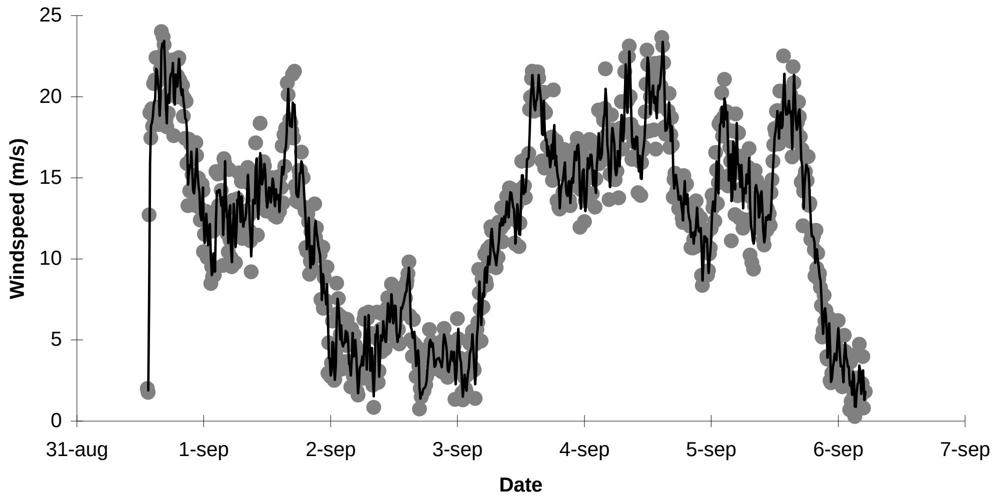


Figure 1 Wind speed recorded every 10 min (•) with the Andreaa weather station throughout the cruise (—: moving average).

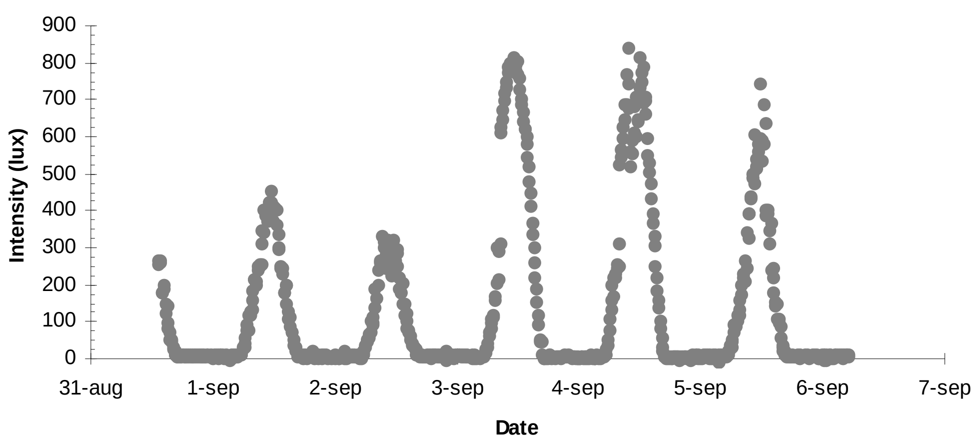
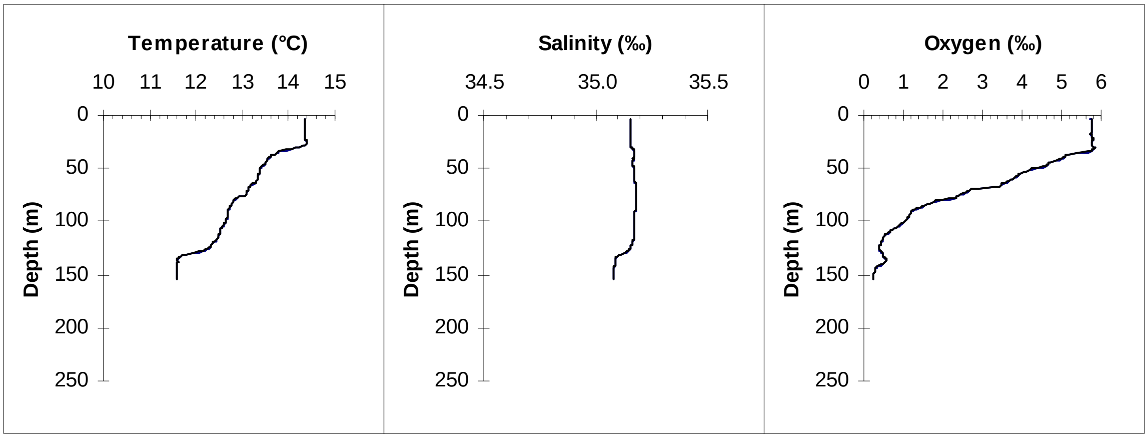


Figure 2 Surface solar intensity (lux) recorded every 10 min (•) with the Andreaa weather station throughout the cruise.

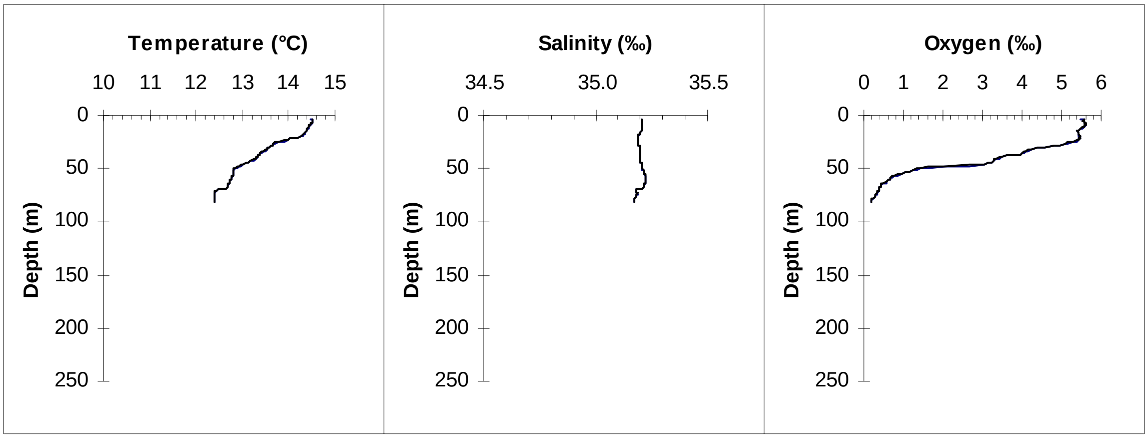
3.2 HYDROGRAPHY

Temperature-depth profiles for the three main study sites are given in **Figure 3**.

a)



b)



c)

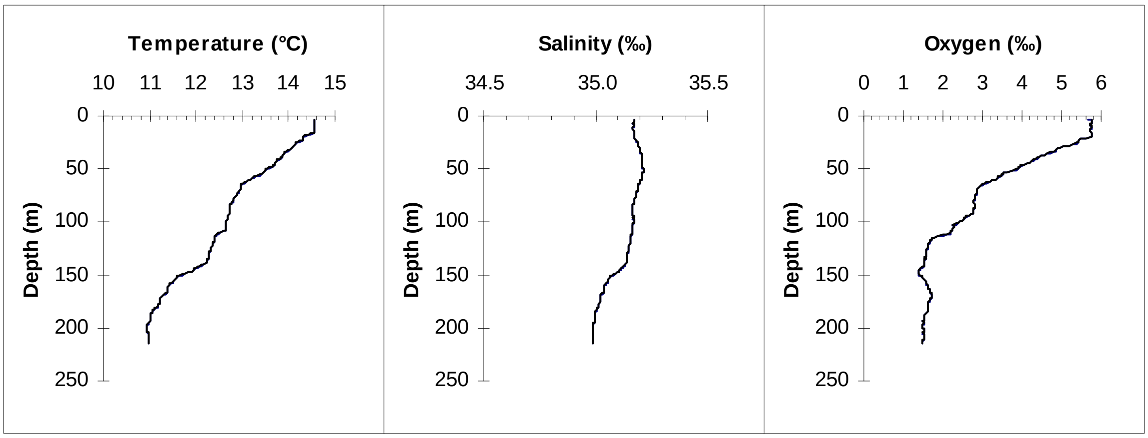


Figure 3 CTD profiles at a): study site 1, b): study site 2 and 3): study site 3.

3.3 VERTICAL DISTRIBUTION

The majority of catches were dominated by jellyfish. On most occasions the greatest concentrations of jellyfish were found at the surface (10-25 m from the surface). Visual observations suggested that at night there was a general migration (particularly by reds) to the very near surface zone. However, jellyfish were not always confined to the surface: on one occasion the multisampler revealed large numbers of mags at 150 m but failed to catch many individuals on the same deployment at 100 and 50 m depths. Later catches with the same net at the same site suggested that mags too exhibit some vertical migration.

3.4 ABUNDANCE

The trawl samples showed that jellyfish were extremely abundant and patchily distributed on the study sites (**Annex II**). If dense aggregations of jellyfish in the opening of the trawl caused reduced inflow of water through the trawl opening ("clogging"), however, the indicated patchyness could to some degree have been caused by sample-bias. Despite potential sample-bias, the trawl samples are believed to reflect jellyfish abundance. The trawl sampling also revealed that even though the distribution of both common jellyfish species was extremely patchy, reds nevertheless were dominant inshore, whereas mags were more common in the deeper waters off shore.

It was not possible to identify the jellyfish acoustically during surveying at any of the applied frequencies. Echoes omitted from jellyfish within the observed dense plankton layers may have been covered by plankton echoes, but even where the trawl samples indicated extremely high densities above the scattering plankton layer, the recorded S_A values were low. Reds and mags being extremely weak sound scatterers was also supported by measurements indicating that both species had densities indistinguishable from water (~1.0) (see also Mutlu 1996).

Post-processing of calibrated acoustic data in conjunction with systematic scrutinisation information on trawl depth and wire length enabled, however, more representative Sa values to be extracted from the recorded data for each net haul. Considering only those hauls where the catch comprised >95 % by wet mass of *C. hysoscella*, a statistically significant ($p < 0.01$) linear relationship between volume corrected catch (numbers) and s_A at 38 kHz was derrived (**figure 4**).

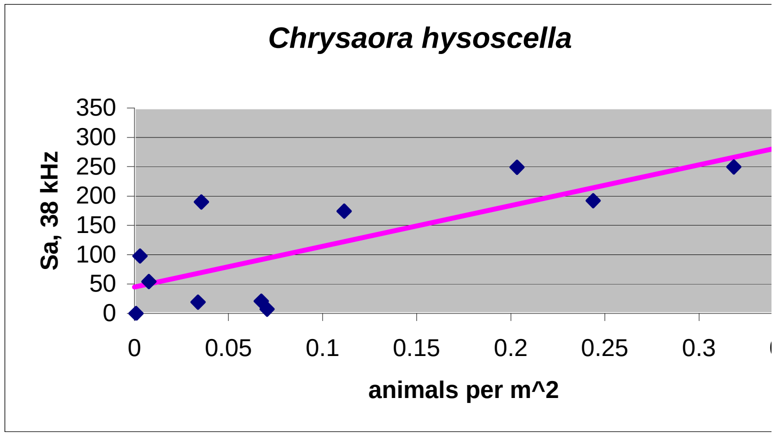


Figure 4 Example plot showing the relationship between s_A at 38 kHz and numerical abundance of *C. hysoscella*.

No significant relationship between s_A and sample density was detected at 18 or 120 kHz. It is probable that backscatter detected at 120 kHz was caused predominantly by small zooplankton that were not retained by the relatively large meshes of the pelagic trawls we used.

3.5 TARGET STRENGTH

Target strength measurements were carried out *in situ* on mono-species aggregations of reds on all frequencies. The ship was drifting freely during the course of the experiments and the ping rate was maximised in order to obtain as many repeated measurments of single targets as possible. Both day and night-time observations were made. TS considerations were also to be carried out from integration of jellyfish layers and consideration of trawl sample voulme using the comparison method.

3.5.1 *In situ measurements*

Weak single target echoes that may have been omitted from jellyfish were observed. Interestingly, the observed patterns of the targets were quite different between frequencies. At 18 kHz, very few targets were detected, whereas a more reasonable target density was observed at 38 kHz. Of the latter, parts of the recorded material appeared applicable for computation of mean recorded acoustic backscattering crossection. At 120 kHz, the target density was too high for reliable identification of single targets. A between-beam traingulation analysis, increasing the stringency of the single target detections (Demer et al. 1999), will be carried out at a later stage.

3.5.2 *Comparison method*

This approach is based on mean recorded area backscattering coefficient S_A as described in chapter 2.2.2. Combining area density calculated from volume density with recorded acoustic density for the same water volume in a preliminary analysis, mean acoustic backscattering coefficient was calculated to range between –31 and –57 dB at 38 kHz for C. *hysoscella*.

3.6 COPEPOD PRODUCTION EXPERIMENTS

3.6.1 Introduction

In order to assess the predation impact of jellyfish on zooplankton, one needs to know the biomass of zooplankton and the production rate. Biomass will be assessed using two different nets: The vertical Bongo hauls (180 µm mesh) between the bottom and the surface. These samples will be counted and sized ashore. This net is comparable with the WP-2 net samples collected during the monitoring transects conducted each month by NatMIRC in Swakopmund, Namibia. The Hydrobios Multi-Net (5 * 405 µm nets) will be used to examine the vertical distribution of larger zooplankton which contribute to the acoustic backscatter, to allow some distinction to be made between jellyfish, euphausiids, mesopelagic fish and copepods which constitute different layers.

3.6.2 Methods

Growth rates of the dominant copepod species were estimated using egg production and molting rate experiments. Live specimens were collected with a drift net in the upper 10-20 meters and individual females placed in 1-liter containers in 63 µm filtered sea water for 24 hours. Eggs were counted at the end of each experiment and females checked to ensure they were still alive. For molting rate measurements, 20-50 individuals of the same stage were placed in 2 litre plastic jars and incubated for 24 hours. Samples were preserved in 4 % formalin for counting in the laboratory. The proportion molting is determined by identifying the number which molt to the next stage, confirmed by the presence of the molted carapace of the previous stage. This proportion molting is converted to the population turnover rate using the Bongo samples counts. The turnover rate can also be estimated using the size vs P/B ratio of the copepods published by Richardson, Verheye and Field (S. Afr. J. Mar. Sci, 2001)

3.6.3 Results

17 vertical Bongo hauls (60 cm mouth opening, 180 µm mesh) were made from 10 meters off the bottom to the surface. These samples will be counted in Cape Town. ## Hydrobios Plankton Multi-net tows were made at depths related to the multi-sampler midwater trawls. Altogether 69 egg production and 13 molting experiments were conducted. No eggs were produced by female copepods inshore, but offshore at the location of the 24 hour station 0-121 eggs per female were measured per day. Table 1 summarizes the results to date (as 8 experiments were outstanding).

Table 1 Preliminary results showing the mean number of eggs produced per female copepod (8 experiments outstanding).

SPECIES	**# Experiments**	**Mean**	**SD**	**Min.**	**Max.**
Calanoides carinatus	18	19	11	0	59
Centropages brachiatus	19	58	40	0	121
Nannocalanus minor	4	17	15	0	30
Calanus agulhensis?	4	29	28	0	65

High mesozooplankton concentrations were present inshore, with late stages (C5 and C6) *Calanoides carinatus* and *Metridia lucens* dominating the biomass and numbers of the vertical Bongo samples. Offshore, *Calanoides carinatus,* C*entropages brachiatus* and *Paracalanus parvus* were dominant but in lower concentrations than inshore. All development stages were present. The egg production results indicate quite high productivity by the offshore copepods, with daily egg production rates of 30 % to 100 % of maximal laboratory-derived values. No measure of phytoplankton abundance (e.g. fluorescence) was available during the cruise, which is a great pity, but the water colour offshore indicated lower phytoplankton concentrations than inshore. Two very large diatom species (*Coscinodiscus* and *??*) were collected in the drift net (330 µm mesh) and the vertical Bongo offshore and also in the sheltered area of Walvis Bay.

3.6.4 Conclusions

The inshore waters were recently upwelled (12 ^{o}C) with low phytoplankton concentrations. The inshore copepod population may have been recently upwelled from resting depths, as the C5 *Calanoides* is known to occur at depths of 400-700 m offshore, and may have just molted to adult stages but had not yet had time to start reproducing. The mesozooplankton offshore were moderately productive, with warmer water (14 ^{o}C) and more phytoplankton. Eggs were being produced and the population comprised all developmental stages.

3.7 JELLYFISH TROPHIC STUDIES

The goal of this part of the jellyfish project is to determine the rates of zooplankton consumption and predation effects on zooplankton of the main jellyfish species (*Aequorea aequorea, Chrysaora hysoscella*) off Namibia. To do this, we collected specimens and preserved them immediately for later gut content analysis. We also collected fresh specimens for shipboard experiments to determine gut passage times of zooplankton. Bongo net plankton samples (180 µm mesh) were taken to determine the prey types and densities available. This work is critically linked to the larger project in which trawling determines jellyfish densities and biomass.

Several specimens of *A. aequorea* were collected off shore and maintained for gut clearance. One specimen had several prey items in the gut, which we determined were 3 euphausiids and an ostrocod. We fed the medusae only a few prey items, which then could be monitored at 1 h intervals with a dissecting microscope. They were maintained at ambient surface water temperature of 13 ºC by placing them in small bowls in a water bath. The time when the prey could no longer be seen in the gut is the digestion time. The medusae required from 3.5 to 9.0 h to digest small to large copepods. The medusae digested euphausiids in 17 to 26 h.

Specimens of *C. hysoscella* were collected from Walvis Bay. Because of their large size, different methods were required than for *A. aequorea*. We collected and immediately preserved several specimens for later gut content analysis. We collected 4 specimens and maintained them in a large tank on shipboard. They were preserved at 0, 2, 4, and 6 h time intervals. This experiment was repeated 3 times. Later gut analysis will reveal at what time the prey previously caught by the medusae *in situ* will no longer be visible in the gut contents. That time represents an estimate of the digestion time.

This part of the project requires further microscopic analysis of jellyfish gut contents and zooplankton samples before any meaningful results are available. The combination of gut contents, digestion times, medusa densities and zooplankton densities will enable us to estimate the effects of these jellyfish on zooplankton populations.

CHAPTER 4 DISCUSSION

4.1 TRAWL SAMPLING

All pelagic sampling trawls on R/V "Dr. Fridtjof Nansen" are identical from the extension and backwards, with fine meshes (XY mm, Annex III). The two pelagic trawls applied were the biggest one (30 m vertical opening) and the intermediate one (15 m opening, *Multisampler*). Only the biggest trawl could be used at the surface due to problems with tearing of the smaller one. The problems of tearing may be related to the fact that the largest trawl inevitably will select out jellyfish more selectively due to the larger meshes from the extension and forewards. The tearing may however also have been caused by the fact that the rigedly mounted metal frame behind the extension reduced the flexibility of the trawl. Furthermore, the extension in the smaller trawl consists of square meshes, in order to keep the side-, top- and bottom panels straight to avoid bulbs around the metal framework of the multisampler, and these have considerably lower tearing strength than diamond meshes have. If, however, as previously assumed effective catching of jellyfish primarily takes place were the meshes are small enough to retain the jellyfish (e.g. no herding or "inflow" effect), the effective sampling volume will be the same for the two trawls. There will nevertheless be bias both from haul to haul with the same trawl and between the two pelagic trawls. A poistive bias may caused by jellyfish being lead in to the trawl by the current created by the trawl, and a negative bias is the "bucket-effect", or reduced inflow of water into the trawl, which also sometimes cause tearing of the nets.

4.2 ACOUSTIC OBSERVATIONS

Jellyfish appeared as weak acoustic scatters. In some instances, jellyfish echoes may have been disguised by the massive backscattering plankton layers, but even in cases where extreme densities were recognised from the trawl samples at the surface (above the plankton layer), only wek integrator values were recorded. It therefore seems unlikely that they can be surveyed acoustically at the frequencies and with the technical configuration applied in the current investigation, at least with the high concentrations of plankton prevailing in the Benguela.

However, careful post-processing of acoustic and net haul data however revealed a linear and statistically significant relationship between catch size and integrated echo energy for reds, and multi-beam filtering techniques may be of help to extract jellyfish echoes from plankton. Further processing may hopefully reveal a similar relationship for mags, although our impression at this stage is that mags are much less detectable acoustic targets than reds. Reds and mags being extremely weak sound scatterers was supported by measurements indicating that both species had densities indistinguishable from water (~1.0) (see also Mutlu 1996).

4.3 CONCLUDING REMARKS

- Mags and reds are weak acoustic targets, and can presently not be integrated in acoustic surveying using the technical configuration applied in this investigation. Thus, even great aggregations of jellyfish are unlikely to bias acoustic fish abundance estimates, given conditions similar to the ones in the present survey. Nevertheless, a significant linear relationship between sample density and recorded S_A strongly suggests that reds are acoustically detectable.

- Mags and reds were patchily distributed and may occur in very high densities.

- The distribution of both jellyfish species appeared to be confined to the upper 150 m of the water column, and reds were typically found shallower than mags within this range. Both species seemed to undertake some diel vertical migration: the proportion of mags in the upper 50 m multisampler net (from sample depths 150, 100 and 50 m) increased with the onset of darkness, whereas reds were caught in larger numbers in surface trawls at night than in the day. Higher densities of reds at the surface at night was supported by visual observations of the jellyfish.

- Reds and mags appeared to have different cross shelf distribution patterns. Catches containing reds only were made exclusively inshore (<100 m bottom depth), while mixed catches were made on the mid-shelf (100-250 m), and clean catches of mags were only made offshore (>250 m).

- There seems, at least to some extent, to be mechanisms separating the two species in terms of depth and cross shelf location.

REFERENCES

Brierley AS, Ward P, Watkins JL, Goss C. 1998. Acoustic discrimination of Southern Ocean zooplankton. *Deep-Sea Research II* **45**: 1155-1173

Demer DA, Soule MA, Hewitt RP. 1999. A multiple-frequency method for potentially improving the accuracy and precision of *in situ* target strength measurements. *Journal of the Acoustical Society of America* **105**: 2359-2376

Fearon JJ, Boyd AJ, Schülen FH. 1991. Views on the biomass and distribution of *Chrysaora hysoscella* (Linné, 1766) and Aequorea aequorea (Forskål, 1775) off Namibia, 1982-1989. *Scientia Marina* **56**: 75-85

Gibbons MJ, Stuart V, Verheye HM. 1992. Trophic ecology of carnivorous zooplankton in the Benguela. *South African Journal of Marine Science* **12**: 421-437

Hart TJ, Currie RI. 1960. The Benguela Current. *Discovery Reports* **31**: 123-298

Mills CE. 1995. Medusae, siphonophores and ctenophores as planktivorous predators in changing global ecosystems. *ICES Journal of Marine Science* **52**: 575-581

Monger BC, Chinniah-Chandy S, Meir E, Billings S, Greene CH, Wiebe PH. 1998. Sound scattering by the gelatinous zooplankters *Aequorea victoria* and *Pleurobrachia bachei*. *Deep-Sea Research II* **45**: 1255-1271

Mutlu E. 1996. Target strength of the common jellyfish (*Aurelia aurita*): a preliminary experimental study with a dual-beam acoustic system. *ICES Journal of Marine Science* **53**: 309-311

Misund OA, Beltestad AK. 1996. Target-strength estimates of schooling herring and mackerel using the comparison method. *ICES Journal of Marine Science* **53**: 281-284

Misund OA, Beltestad AK, Castillo J, Knudsen HP, Skagen D. 1997. Distribution and acoustic abundance estimation of horse mackerel and mackerel in the northern North Sea, October 1996. Document to ICES WG on assessment of anchovy, horse mackerel, mackerel and sardine, Copenhagen, September 1997

Ona E, Hansen, D. 1991. Software for target tracking with split beam echosounders. User manual. Institute of Marine Research, Bergen, Norway.

Pagès, F. 1991. Ecología y sistemática de los Cnidarios planctónicos de la corriente de Benguela (Atlántico Sudoriental). Ph. D. thesis, University of Barcelona: 466 pp

Purcell JE.1989. Predation on fish larvae and eggs by the hydromedusa *Aequorea victoria* at a herring spawning ground in British Colombia. *Canadian Journal of Fisheries and Aquatic Science* **46**: 1415-1427

Shannon LV, Crawford RJM, Pollock DE, Hutchings L, Boyd AJ, Taunton-Clark J, Badenhorst A, Melville-Smith R, Augustyn CJ, Cochrane KL, Hampton I, Nelson G, Japp DW, Tarr RJQ. The 1980s - a decade of change in the Benguela ecosystem. *South African Journal of Marine Science* **12**: 271-296

Skeide, R., Engås, A., and West, C. W. 1997. Multisampler - a new tool for use in sampling trawls. Proceedings of the seventh IMR-PINRO Symposium. Murmansk, 23-24 June 1997. Eds.: Shleinik, V., and Zaferman, M. PINRO Press, PINRO, 6 Knipovich str., 183763, Murmansk.

Soule MA, Barange M, and Hampton I. 1995. Evidence of bias in estimates of target strength obtained with a split-beam echo-sounder. *ICES Journal of Marine Science* **52**: 139-144

Sparks, C. A. J, Buecher, E., Brierley, A. S., Axelsen, B. E., Boyer, H., and Gibbons, M. J. 2001. Observations on the distribution and relative abundance of the scyphomedusan *Chrysaora hysocella* (Linné, 1766) and the hydrozoan *Aequora aequora* (Forskål, 1755) in the northern Benguela ecosystem. *Hydrobiologia*. In press.

Stander GH, de Decker AHB. 1969. Some physical and biological aspects of an oceanographic anomaly off South West Africa in 1963. *Investigative Report of the Division of Sea Fisheries of South Africa* **81**: 46pp

Travis J. 1993. Invader threatens Black and Azov Seas. *Science* **262**: 1366-1367

ANNEX I SIMRAD EK 500 TRANCEIVER MENU SETTINGS

Tranceiver 1 (38 kHz, keel mounted)

/TRANSCEIVER MENU/Transceiver-1 Menu/Mode=Active
/TRANSCEIVER MENU/Transceiver-1 Menu/Transducer Type=ES38B
/TRANSCEIVER MENU/Transceiver-1 Menu/Transd. Sequence=Off
/TRANSCEIVER MENU/Transceiver-1 Menu/Transducer Depth=8.00 m
/TRANSCEIVER MENU/Transceiver-1 Menu/Absorption Coef.=10 dBkm
/TRANSCEIVER MENU/Transceiver-1 Menu/Pulse Length=Medium
/TRANSCEIVER MENU/Transceiver-1 Menu/Bandwidth=Wide
/TRANSCEIVER MENU/Transceiver-1 Menu/Max. Power=2000 W
/TRANSCEIVER MENU/Transceiver-1 Menu/2-Way Beam Angle=-21.0 dB
/TRANSCEIVER MENU/Transceiver-1 Menu/Sv Transd. Gain=27.45 dB
/TRANSCEIVER MENU/Transceiver-1 Menu/TS Transd. Gain=27.65 dB
/TRANSCEIVER MENU/Transceiver-1 Menu/Angle Sens.Along=21.9
/TRANSCEIVER MENU/Transceiver-1 Menu/Angle Sens.Athw.=21.9
/TRANSCEIVER MENU/Transceiver-1 Menu/3 dB Beamw.Along=6.8 dg
/TRANSCEIVER MENU/Transceiver-1 Menu/3 dB Beamw.Athw.=6.7 dg
/TRANSCEIVER MENU/Transceiver-1 Menu/Alongship Offset=-0.03 dg
/TRANSCEIVER MENU/Transceiver-1 Menu/Athw.ship Offset=0.06 dg

Tranceiver 2 (120 kHz, keel mounted)

/TRANSCEIVER MENU/Transceiver-2 Menu/Mode=Active
/TRANSCEIVER MENU/Transceiver-2 Menu/Transducer Type=ES120-7
/TRANSCEIVER MENU/Transceiver-2 Menu/Transd. Sequence=Off
/TRANSCEIVER MENU/Transceiver-2 Menu/Transducer Depth=8.00 m
/TRANSCEIVER MENU/Transceiver-2 Menu/Absorption Coef.=38 dBkm
/TRANSCEIVER MENU/Transceiver-2 Menu/Pulse Length=Long
/TRANSCEIVER MENU/Transceiver-2 Menu/Bandwidth=Narrow
/TRANSCEIVER MENU/Transceiver-2 Menu/Max. Power=1000 W
/TRANSCEIVER MENU/Transceiver-2 Menu/2-Way Beam Angle=-20.6 dB
/TRANSCEIVER MENU/Transceiver-2 Menu/Sv Transd. Gain=25.62 dB
/TRANSCEIVER MENU/Transceiver-2 Menu/TS Transd. Gain=25.62 dB
/TRANSCEIVER MENU/Transceiver-2 Menu/Angle Sens.Along=21.0
/TRANSCEIVER MENU/Transceiver-2 Menu/Angle Sens.Athw.=21.0
/TRANSCEIVER MENU/Transceiver-2 Menu/3 dB Beamw.Along=7.6 dg
/TRANSCEIVER MENU/Transceiver-2 Menu/3 dB Beamw.Athw.=7.6 dg
/TRANSCEIVER MENU/Transceiver-2 Menu/Alongship Offset=-0.05 dg

/TRANSCEIVER MENU/Transceiver-2 Menu/Athw.ship Offset=0.08 dg

Tranceiver 3 (18 kHz, hull mounted)
/TRANSCEIVER MENU/Transceiver-3 Menu/Mode=Active
/TRANSCEIVER MENU/Transceiver-3 Menu/Transducer Type=ES18-11
/TRANSCEIVER MENU/Transceiver-3 Menu/Transd. Sequence=Off
/TRANSCEIVER MENU/Transceiver-3 Menu/Transducer Depth=5.50 m
/TRANSCEIVER MENU/Transceiver-3 Menu/Absorption Coef.=3 dBkm
/TRANSCEIVER MENU/Transceiver-3 Menu/Pulse Length=Short
/TRANSCEIVER MENU/Transceiver-3 Menu/Bandwidth=Wide
/TRANSCEIVER MENU/Transceiver-3 Menu/Max. Power=2000 W
/TRANSCEIVER MENU/Transceiver-3 Menu/2-Way Beam Angle=-17.2 dB
/TRANSCEIVER MENU/Transceiver-3 Menu/Sv Transd. Gain=21.70 dB
/TRANSCEIVER MENU/Transceiver-3 Menu/TS Transd. Gain=21.50 dB
/TRANSCEIVER MENU/Transceiver-3 Menu/Angle Sens.Along=13.9
/TRANSCEIVER MENU/Transceiver-3 Menu/Angle Sens.Athw.=13.9
/TRANSCEIVER MENU/Transceiver-3 Menu/3 dB Beamw.Along=10.9 dg
/TRANSCEIVER MENU/Transceiver-3 Menu/3 dB Beamw.Athw.=10.9 dg
/TRANSCEIVER MENU/Transceiver-3 Menu/Alongship Offset=-0.04 dg
/TRANSCEIVER MENU/Transceiver-3 Menu/Athw.ship Offset=0.03 dg

ANNEX II RECORDS OF FISHING STATIONS

```
R/V Dr. Fridtjof Nansen      SURVEY:2001408       STATION:  937
DATE  :1/2/2000           GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°24.00
         start    stop    duration                      Lon   E 14°9.00
TIME  :12:43:00 AM12:48:00 AM5.0  (min)          Purpose   : 1
LOG   : 6872.40  6872.70   0.3                 Region    : 5020
FDEPTH:      60       80                       Gear cond.: 0
BDEPTH:      82       82                       Validity  : 0
Towing dir:   0°     Wire out   : 240  m       Speed     : 3.0 kn
Sorted    :   0      Total catch: 0.00         Catch/hour: 0.00

   SPECIES                                  CATCH/HOUR    % OF TOT. C   SAMP
                                         weight   numbers
   N O  C A T C H                           0.00        0       0.00
                                      __________         ________
```

```
R/V Dr. Fridtjof Nansen      SURVEY:2001408       STATION:  938
DATE  :9/2/2001           GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°25.98
         start    stop    duration                      Lon   E 14°10.02
TIME  :12:55:00 AM1:00:00 AM5.0  (min)          Purpose   : 1
LOG   : 6873.22  6873.52   0.0                 Region    : 5020
FDEPTH:      40       60                       Gear cond.: 0
BDEPTH:      82       82                       Validity  : 0
Towing dir:   0°     Wire out   : 140  m       Speed     : 3.0 kn
Sorted    :   0      Total catch: 1200.00      Catch/hour: 14400.00

   SPECIES                                  CATCH/HOUR    % OF TOT. C   SAMP
                                         weight   numbers
   Chrysaora sp.                            0.00        0       0.00
   Aequorea sp.                             0.00        0       0.00
   Sufflogobius bibarbatus                  0.00        0       0.00
                                      __________         ________
   Total                                    0.00                0.00
```

```
R/V Dr. Fridtjof Nansen      SURVEY:2001408       STATION:  939
DATE  :9/2/2001           GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°25.98
         start    stop    duration                      Lon   E 14°10.02
TIME  :1:09:00 AM1:14:00 AM6.0  (min)          Purpose   : 1
LOG   : 6873.76  6874.10   0.3                 Region    : 5020
FDEPTH:      20       40                       Gear cond.: 0
BDEPTH:      82       83                       Validity  : 0
Towing dir:   0°     Wire out   : 90   m       Speed     : 3.0 kn
Sorted    :   0      Total catch: 0.00         Catch/hour: 0.00

   SPECIES                                  CATCH/HOUR    % OF TOT. C   SAMP
                                         weight   numbers
   N O  C A T C H                           0.00        0       0.00
                                      __________         ________
```

```
R/V Dr. Fridtjof Nansen      SURVEY:2001408       STATION:  940
DATE  :9/2/2001           GEAR TYPE: PT NO:  7  POSITION:Lat   S 22°21.00
         start    stop    duration                      Lon   E 14°3.00
TIME  :1:02:00 PM1:06:00 PM4.0  (min)          Purpose   : 1
LOG   : 6891.85  6892.14   0.3                 Region    : 5020
FDEPTH:      30       30                       Gear cond.: 0
BDEPTH:      97       96                       Validity  : 0
Towing dir:   0°     Wire out   : 120  m       Speed     : 3.0 kn
Sorted    :  90      Total catch: 420.20       Catch/hour: 6303.00

   SPECIES                                  CATCH/HOUR    % OF TOT. C   SAMP
                                         weight   numbers
   Chrysaora sp.                         6300.00     4200      99.95        1
   Aequorea sp.                             3.00       15       0.05
                                      __________         ________
   Total                                 6303.00              100.00
```

```
R/V Dr. Fridtjof Nansen      SURVEY:2001408       STATION:  941
DATE  :9/2/2001           GEAR TYPE: PT NO:  7  POSITION:Lat   S 22°19.02
         start    stop    duration                      Lon   E 13°52.98
TIME  :5:28:00 PM5:42:00 PM14.0 (min)          Purpose   : 1
LOG   : 6905.17  6905.97   0.8                 Region    : 5020
FDEPTH:      70       70                       Gear cond.: 0
BDEPTH:     113      111                       Validity  : 0
Towing dir:   0°     Wire out   : 210  m       Speed     : 30.0 kn
Sorted    : 120      Total catch: 4000.00      Catch/hour: 17142.86

   SPECIES                                  CATCH/HOUR    % OF TOT. C   SAMP
                                         weight   numbers
   Chrysaora sp.                         8571.43     5571      50.00        2
   Aequorea sp.                          8571.43    35859      50.00        3
                                      __________         ________
   Total                                17142.86              100.00
```

```
R/V Dr. Fridtjof Nansen      SURVEY:2001408       STATION:  942
DATE  :9/2/2001           GEAR TYPE: PT NO:  7  POSITION:Lat   S 22°19.02
         start    stop    duration                      Lon   E 13°28.98
TIME  :9:20:00 PM9:25:00 PM5.0  (min)          Purpose   : 1
LOG   : 6931.57  6931.83   0.3                 Region    : 5020
FDEPTH:      70       70                       Gear cond.: 0
BDEPTH:     165      165                       Validity  : 0
Towing dir:   0°     Wire out   : 170  m       Speed     : 3.0 kn
Sorted    : 108      Total catch: 393.90       Catch/hour: 4726.80

   SPECIES                                  CATCH/HOUR    % OF TOT. C   SAMP
                                         weight   numbers
   Aequorea sp.                          3624.00    47796      76.67        4
   Chrysaora sp.                         1056.00      276      22.34        5
   Thyrsites atun                          46.80       12       0.99
                                      __________         ________
   Total                                 4726.80              100.00
```

```
R/V Dr. Fridtjof Nansen      SURVEY:2001408       STATION:  943
DATE  :9/2/2001           GEAR TYPE: PT NO:  7  POSITION:Lat   S 22°18.00
         start    stop    duration                      Lon   E 13°16.98
TIME  :11:49:00 PM11:54:00 PM5.0  (min)          Purpose   : 1
LOG   : 6945.13  6945.38   0.3                 Region    : 5020
FDEPTH:      70       70                       Gear cond.: 0
BDEPTH:     224      226                       Validity  : 0
Towing dir:   0°     Wire out   : 260  m       Speed     : 3.0 kn
Sorted    : 265      Total catch: 265.00       Catch/hour: 3180.00

   SPECIES                                  CATCH/HOUR    % OF TOT. C   SAMP
                                         weight   numbers
   Chrysaora sp.                         1968.00     1212      61.89        6
   Aequorea sp.                          1212.00     3204      38.11        7
   MYCTOPHIDAE                              0.00      240       0.00
   C E P H A L O P O D A                    0.00       36       0.00
                                      __________         ________
   Total                                 3180.00              100.00
```

```
R/V Dr. Fridtjof Nansen      SURVEY:2001408       STATION:  944
DATE  :9/3/2001           GEAR TYPE: PT NO:  7  POSITION:Lat   S 22°16.98
         start    stop    duration                      Lon   E 13°7.02
TIME  :2:08:00 AM2:15:00 AM7.0  (min)          Purpose   : 1
LOG   : 6957.86  6958.21   0.3                 Region    : 5020
FDEPTH:      70       70                       Gear cond.: 0
BDEPTH:     252      252                       Validity  : 0
Towing dir:   0°     Wire out   : 250  m       Speed     : 3.0 kn
Sorted    : 540      Total catch: 540.00       Catch/hour: 4628.57

   SPECIES                                  CATCH/HOUR    % OF TOT. C   SAMP
                                         weight   numbers
   Chrysaora sp.                          771.43        0      16.67
   Aequorea sp.                          3857.14        0      83.33
                                      __________         ________
   Total                                 4628.57              100.00
```

```
R/V Dr. Fridtjof Nansen      SURVEY:2001408       STATION:  945
DATE  :9/3/2001           GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°16.98
         start    stop    duration                      Lon   E 13°7.02
TIME  :4:34:00 AM4:44:00 AM10.0 (min)          Purpose   : 1
LOG   : 6963.76  6964.36   0.6                 Region    : 5020
FDEPTH:     120      120                       Gear cond.: 0
BDEPTH:     249      250                       Validity  : 0
Towing dir:   0°     Wire out   : 430  m       Speed     : 3.0 kn
Sorted    :  34      Total catch: 236.00       Catch/hour: 1416.00

   SPECIES                                  CATCH/HOUR    % OF TOT. C   SAMP
                                         weight   numbers
   Aequorea sp.                          1416.00     4758     100.00        8
                                      __________         ________
   Total                                 1416.00              100.00
```

```
R/V Dr. Fridtjof Nansen      SURVEY:2001408       STATION:  946
DATE  :9/3/2001           GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°16.02
         start    stop    duration                      Lon   E 13°7.02
TIME  :4:48:00 AM4:53:00 AM6.0  (min)          Purpose   : 1
LOG   : 6964.53  6964.78   0.3                 Region    : 5020
FDEPTH:      60       60                       Gear cond.: 0
BDEPTH:     250      250                       Validity  : 0
Towing dir:   0°     Wire out   : 180  m       Speed     : 3.0 kn
Sorted    :  15      Total catch: 15.19        Catch/hour: 151.88

   SPECIES                                  CATCH/HOUR    % OF TOT. C   SAMP
                                         weight   numbers
   Aequorea sp.                           149.50     1120      98.43        9
   Symbolophorus boops                      1.19      630       0.78       10
   Unidentified fish                        1.19     1450       0.78
                                      __________         ________
   Total                                  151.88              100.00
```

```
R/V Dr. Fridtjof Nansen      SURVEY:2001408       STATION:  947
DATE  :9/3/2001           GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°16.02
         start    stop    duration                      Lon   E 13°6.00
TIME  :4:58:00 AM5:03:00 AM5.0  (min)          Purpose   : 1
LOG   : 6965.03  6965.34   0.3                 Region    : 5020
FDEPTH:      30       30                       Gear cond.: 0
BDEPTH:     250      248                       Validity  : 0
Towing dir:   0°     Wire out   : 85   m       Speed     : 3.0 kn
Sorted    :  38      Total catch: 380.00       Catch/hour: 4560.00

   SPECIES                                  CATCH/HOUR    % OF TOT. C   SAMP
                                         weight   numbers
   Aequorea sp.                          4560.00    13320     100.00       11
                                      __________         ________
   Total                                 4560.00              100.00
```

```
R/V Dr. Fridtjof Nansen      SURVEY:2001408       STATION:  948
DATE  :9/3/2001           GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°13.98
         start    stop    duration                      Lon   E 13°6.00
TIME  :8:52:00 AM8:58:00 AM5.0  (min)          Purpose   : 1
LOG   : 6970.97  6971.25   0.3                 Region    : 5020
FDEPTH:      70       70                       Gear cond.: 0
BDEPTH:     252      252                       Validity  : 0
Towing dir:   0°     Wire out   : 200  m       Speed     : 3.0 kn
Sorted    :  28      Total catch: 56.00        Catch/hour: 672.00

   SPECIES                                  CATCH/HOUR    % OF TOT. C   SAMP
                                         weight   numbers
   Aequorea sp.                           606.00    12360      90.18       12
   Chrysaora sp.                           66.00       24       9.82       13
                                      __________         ________
   Total                                  672.00              100.00
```

```
R/V Dr. Fridtjof Nansen      SURVEY:2001408       STATION:  949
DATE  :9/3/2001           GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°13.02
         start    stop    duration                      Lon   E 13°4.98
TIME  :9:05:00 AM9:10:00 AM5.0  (min)          Purpose   : 1
LOG   : 6971.58  6971.84   0.3                 Region    : 5020
FDEPTH:      50       50                       Gear cond.: 0
BDEPTH:     252      256                       Validity  : 0
Towing dir:   0°     Wire out   : 120  m       Speed     : 3.0 kn
Sorted    :  28      Total catch: 56.30        Catch/hour: 675.60

   SPECIES                                  CATCH/HOUR    % OF TOT. C   SAMP
                                         weight   numbers
   Aequorea sp.                           636.00    12240      94.14       14
   Chrysaora sp.                           39.60       24       5.86
                                      __________         ________
   Total                                  675.60              100.00
```

```
R/V Dr. Fridtjof Nansen      SURVEY:2001408       STATION:  950
DATE  :9/3/2001           GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°13.02
         start    stop    duration                      Lon   E 13°4.98
TIME  :9:13:00 AM9:19:00 AM5.0  (min)          Purpose   : 1
LOG   : 6972.04  6972.35   0.3                 Region    : 5020
FDEPTH:      30       30                       Gear cond.: 0
BDEPTH:     255      255                       Validity  : 0
Towing dir:   0°     Wire out   : 75   m       Speed     : 3.0 kn
Sorted    :  32      Total catch: 127.37       Catch/hour: 1528.44

   SPECIES                                  CATCH/HOUR    % OF TOT. C   SAMP
                                         weight   numbers
   Aequorea sp.                          1290.00    23712      84.40       15
   Chrysaora sp.                          238.44       96      15.60       16
                                      __________         ________
   Total                                 1528.44              100.00
```

```
R/V Dr. Fridtjof Nansen      SURVEY:2001408       STATION:  951
DATE  :9/3/2001           GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°13.98
         start    stop    duration                      Lon   E 13°6.00
TIME  :11:39:00 AM11:44:00 AM6.0  (min)          Purpose   : 1
LOG   : 6976.71  6976.99   0.3                 Region    : 5020
FDEPTH:     235      235                       Gear cond.: 0
BDEPTH:     250      249                       Validity  : 0
Towing dir:   0°     Wire out   : 640  m       Speed     : 3.0 kn
Sorted    :  11      Total catch: 10.99        Catch/hour: 109.87

   SPECIES                                  CATCH/HOUR    % OF TOT. C   SAMP
                                         weight   numbers
   Aequorea sp.                             5.50      130       5.01       17
   Chrysaora sp.                           95.50       40      86.92       18
   MYCTOPHIDAE                              6.21     3260       5.65       19
   S H R I M P S                            2.67        0       2.43
                                      __________         ________
   Total                                  109.87              100.00
```

```
R/V Dr. Fridtjof Nansen      SURVEY:2001408       STATION:  952
DATE  :9/3/2001           GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°15.00
         start    stop    duration                      Lon   E 13°6.00
TIME  :11:48:00 AM11:54:00 AM5.0  (min)          Purpose   : 1
LOG   : 6977.15  6977.43   0.3                 Region    : 5020
FDEPTH:     190      190                       Gear cond.: 0
BDEPTH:     250      250                       Validity  : 0
Towing dir:   0°     Wire out   : 500  m       Speed     : 3.0 kn
Sorted    : 102      Total catch: 128.76       Catch/hour: 1545.12

   SPECIES                                  CATCH/HOUR    % OF TOT. C   SAMP
                                         weight   numbers
   Chrysaora sp.                         1098.60      348      71.10       20
   C E P H A L O P O D A                   14.40      168       0.93       21
   Aequorea sp.                           429.60     6876      27.80       22
   MYCTOPHIDAE                              2.52     1656       0.16       23
                                      __________         ________
   Total                                 1545.12              100.00
```

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 953
DATE :9/3/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 22°15.00
start stop duration Lon E 13°6.00
TIME :12:00:00 PM12:05:00 PM5.0 (min) Purpose : 1
LOG : 6977.65 6977.91 0.3 Region : 5020
FDEPTH: 140 140 Gear cond.: 0
BDEPTH: 250 250 Validity : 0
Towing dir: 0° Wire out : 300 m Speed : 3.0 kn
Sorted : 9 Total catch: 50.52 Catch/hour: 606.22

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea sp.	606.00	10080	99.96	24
MYCTOPHIDAE	0.21	120	0.04	25
Total	606.21		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 954
DATE :9/3/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 22°15.00
start stop duration Lon E 13°6.00
TIME :1:12:00 PM1:16:00 PM4.0 (min) Purpose : 1
LOG : 6980.58 6980.84 0.3 Region : 5020
FDEPTH: 75 75 Gear cond.: 0
BDEPTH: 253 251 Validity : 0
Towing dir: 0° Wire out : 225 m Speed : 3.0 kn
Sorted : 76 Total catch: 76.07 Catch/hour: 1141.11

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea sp.	853.50	16245	74.80	26
Chrysaora sp.	285.75	75	25.04	27
C E P H A L O P O D A	1.86	90	0.16	28
Total	1141.11		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 955
DATE :9/3/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 22°13.98
start stop duration Lon E 13°6.00
TIME :1:22:00 PM1:28:00 PM6.0 (min) Purpose : 1
LOG : 6981.10 6981.44 0.3 Region : 5020
FDEPTH: 50 50 Gear cond.: 0
BDEPTH: 252 254 Validity : 0
Towing dir: 0° Wire out : 130 m Speed : 3.0 kn
Sorted : 62 Total catch: 211.00 Catch/hour: 2110.00

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea sp.	1857.50	32880	88.03	29
Chrysaora sp.	252.50	60	11.97	30
Total	2110.00		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 956
DATE :9/3/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 22°13.02
start stop duration Lon E 13°4.98
TIME :1:36:00 PM1:41:00 PM6.0 (min) Purpose : 1
LOG : 6981.89 6982.24 0.4 Region : 5020
FDEPTH: 20 20 Gear cond.: 0
BDEPTH: 253 252 Validity : 0
Towing dir: 0° Wire out : 80 m Speed : 3.0 kn
Sorted : 73 Total catch: 112.83 Catch/hour: 1128.28

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea sp.	806.00	14860	71.44	31
Chrysaora sp.	322.00	50	28.54	32
C E P H A L O P O D A	0.28	20	0.03	33
Total	1128.28		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 957
DATE :9/3/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 22°13.98
start stop duration Lon E 13°6.00
TIME :4:09:00 PM4:14:00 PM5.0 (min) Purpose : 1
LOG : 6986.90 6987.17 0.3 Region : 5020
FDEPTH: 230 230 Gear cond.: 0
BDEPTH: 249 249 Validity : 0
Towing dir: 0° Wire out : 600 m Speed : 3.0 kn
Sorted : 50 Total catch: 49.78 Catch/hour: 597.41

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Chrysaora sp.	580.80	168	97.22	34
Aequorea sp.	16.20	324	2.71	35
MYCTOPHIDAE	0.39	192	0.06	36
Leptocephalus	0.03	12	0.00	
Total	597.41		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 958
DATE :9/3/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 22°15.00
start stop duration Lon E 13°6.00
TIME :4:24:00 PM4:30:00 PM6.0 (min) Purpose : 1
LOG : 6987.62 6987.93 0.3 Region : 5020
FDEPTH: 160 160 Gear cond.: 0
BDEPTH: 251 251 Validity : 0
Towing dir: 0° Wire out : 430 m Speed : 3.0 kn
Sorted : 148 Total catch: 147.58 Catch/hour: 1475.78

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea sp.	1394.00	21400	94.46	37
Chrysaora sp.	81.50	30	5.52	38
MYCTOPHIDAE	0.28	210	0.02	39
Total	1475.78		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 959
DATE :9/3/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 22°16.02
start stop duration Lon E 13°6.00
TIME :4:38:00 PM4:43:00 PM5.0 (min) Purpose : 1
LOG : 6988.20 6988.50 0.3 Region : 5020
FDEPTH: 120 120 Gear cond.: 0
BDEPTH: 251 254 Validity : 0
Towing dir: 0° Wire out : 310 m Speed : 3.0 kn
Sorted : 52 Total catch: 51.90 Catch/hour: 622.80

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea sp.	622.80	10404	100.00	40
Chrysaora sp.	0.00	12	0.00	
Total	622.80		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 960
DATE :9/3/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 22°15.00
start stop duration Lon E 13°4.98
TIME :6:26:00 PM6:31:00 PM5.0 (min) Purpose : 1
LOG : 6991.73 6992.02 0.3 Region : 5020
FDEPTH: 225 225 Gear cond.: 0
BDEPTH: 251 250 Validity : 0
Towing dir: 0° Wire out : 600 m Speed : 3.0 kn
Sorted : 17 Total catch: 16.85 Catch/hour: 202.24

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea sp.	200.40	3540	99.09	41
Sufflogobius bibarbatus	0.20	72	0.10	42
Merluccius capensis	0.90	168	0.45	43
Pterothrissus belloci	0.03	24	0.01	44
Lophius vomerinus	0.54	24	0.27	45
MYCTOPHIDAE	0.17	108	0.08	46
Chrysaora sp.	0.00	120	0.00	47
Total	202.23		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 961
DATE :9/3/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 22°13.98
start stop duration Lon E 13°6.00
TIME :6:37:00 PM6:42:00 PM5.0 (min) Purpose : 1
LOG : 6992.26 6992.53 0.3 Region : 5020
FDEPTH: 190 190 Gear cond.: 0
BDEPTH: 249 248 Validity : 0
Towing dir: 0° Wire out : 400 m Speed : 3.0 kn
Sorted : 355 Total catch: 355.37 Catch/hour: 4264.44

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea sp.	4263.60	74052	99.98	48
Merluccius capensis	0.40	24	0.01	49
Lophius vomerinus	0.22	12	0.01	50
MYCTOPHIDAE	0.22	204	0.01	51
Total	4264.44		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 962
DATE :9/3/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 22°13.98
start stop duration Lon E 13°6.00
TIME :6:49:00 PM6:54:00 PM5.0 (min) Purpose : 1
LOG : 6992.83 6993.09 0.3 Region : 5020
FDEPTH: 140 140 Gear cond.: 0
BDEPTH: 248 247 Validity : 0
Towing dir: 0° Wire out : 330 m Speed : 3.0 kn
Sorted : 37 Total catch: 37.41 Catch/hour: 448.94

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea sp.	392.40	6576	87.41	52
MYCTOPHIDAE	0.10	96	0.02	53
Synagrops microlepis	0.03	12	0.01	54
Chrysaora sp.	56.40	12	12.56	55
Total	448.94		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 963
DATE :9/3/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 22°13.02
start stop duration Lon E 13°7.98
TIME :9:58:00 PM10:03:00 PM6.0 (min) Purpose : 1
LOG : 6997.57 6997.87 0.3 Region : 5020
FDEPTH: 110 110 Gear cond.: 0
BDEPTH: 242 243 Validity : 0
Towing dir: 0° Wire out : 300 m Speed : 3.0 kn
Sorted : 117 Total catch: 117.30 Catch/hour: 1172.96

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea sp.	400.50	7120	34.14	56
MYCTOPHIDAE	1.23	860	0.10	57
C E P H A L O P O D A	0.44	40	0.04	58
Chrysaora sp.	770.80	250	65.71	59
Total	1172.96		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 964
DATE :9/3/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 22°13.98
start stop duration Lon E 13°7.98
TIME :10:11:00 PM10:17:00 PM6.0 (min) Purpose : 1
LOG : 6998.20 6998.49 0.3 Region : 5020
FDEPTH: 50 50 Gear cond.: 0
BDEPTH: 244 245 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.0 kn
Sorted : 314 Total catch: 314.07 Catch/hour: 3140.66

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
MYCTOPHIDAE	2.01	1360	0.06	60
Aequorea sp.	2384.20	42880	75.91	61
Chrysaora sp.	749.00	230	23.85	62
C E P H A L O P O D A	5.45	30	0.17	63
Total	3140.66		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 965
DATE :9/3/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 22°15.00
start stop duration Lon E 13°7.02
TIME :10:24:00 PM10:29:00 PM5.0 (min) Purpose : 1
LOG : 6998.88 6999.13 0.2 Region : 5020
FDEPTH: 27 27 Gear cond.: 0
BDEPTH: 246 246 Validity : 0
Towing dir: 0° Wire out : 70 m Speed : 3.0 kn
Sorted : 0 Total catch: 736.15 Catch/hour: 8833.85

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
MYCTOPHIDAE	1.63	816	0.02	64
C E P H A L O P O D A	0.15	12	0.00	65
S H R I M P S	0.06	108	0.00	66
Aequorea sp.	8832.00	168012	99.98	67
Total	8833.85		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 966
DATE :9/4/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 22°15.00
start stop duration Lon E 13°7.02
TIME :1:16:00 AM1:22:00 AM6.0 (min) Purpose : 1
LOG : 7006.02 7006.35 0.3 Region : 5020
FDEPTH: 210 210 Gear cond.: 0
BDEPTH: 247 250 Validity : 0
Towing dir: 0° Wire out : 600 m Speed : 3.0 kn
Sorted : 0 Total catch: 104.56 Catch/hour: 1045.56

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea sp.	414.00	7760	39.60	68
Merluccius capensis	9.93	160	0.95	69
Lophius vomerinus	0.13	10	0.01	70
Chrysaora sp.	621.50	150	59.44	71
Total	1045.56		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 967
DATE :9/4/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 22°13.98
start stop duration Lon E 13°6.00
TIME :1:28:00 AM1:33:00 AM6.0 (min) Purpose : 1
LOG : 7006.57 7006.84 0.3 Region : 5020
FDEPTH: 170 170 Gear cond.: 0
BDEPTH: 248 249 Validity : 0
Towing dir: 0° Wire out : 460 m Speed : 3.0 kn
Sorted : 0 Total catch: 255.63 Catch/hour: 2556.25

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea sp.	2556.00	38600	99.99	72
Merluccius capensis	0.25	20	0.01	73
Total	2556.25		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 968
DATE :9/4/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 22°13.98
start stop duration Lon E 13°6.00
TIME :1:38:00 AM1:44:00 AM5.0 (min) Purpose : 1
LOG : 7007.04 7007.28 0.2 Region : 5020
FDEPTH: 125 125 Gear cond.: 0
BDEPTH: 248 248 Validity : 0
Towing dir: 0° Wire out : 260 m Speed : 3.0 kn
Sorted : 0 Total catch: 53.05 Catch/hour: 636.60

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea sp.	636.60	12120	100.00	74
Total	636.60		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 969
DATE :9/4/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 22°13.98
start stop duration Lon E 13°6.00
TIME :3:41:00 AM3:43:00 AM2.0 (min) Purpose : 1
LOG : 7012.11 7012.22 0.1 Region : 5020
FDEPTH: 60 60 Gear cond.: 0
BDEPTH: 249 251 Validity : 0
Towing dir: 0° Wire out : 180 m Speed : 3.0 kn
Sorted : 0 Total catch: 117.69 Catch/hour: 3530.73

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Chrysaora sp.	105.00	30	2.97	75
Aequorea sp.	3421.50	66330	96.91	76
MYCTOPHIDAE	1.93	990	0.05	77
C E P H A L O P O D A	2.30	270	0.07	78
Total	3530.73		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2001408        STATION:  970
DATE  :9/4/2001             GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°15.00
         start    stop    duration                          Lon   E 13°6.00
TIME  :3:52:00 AM3:54:00 AM2.0  (min)          Purpose   : 1
LOG   : 7012.60  7012.70   0.1                Region    : 5020
FDEPTH:      40       40                      Gear cond.: 0
BDEPTH:     251      252                      Validity  : 0
Towing dir:   0°     Wire out   : 100  m      Speed     : 3.0 kn
Sorted    :   0      Total catch: 60.55       Catch/hour: 1816.48
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Aequorea sp.	1813.50	27420	99.84	79
MYCTOPHIDAE	2.23	1710	0.12	80
C E P H A L O P O D A	0.35	90	0.02	81
Synagrops microlepis	0.41	30	0.02	82
Total	1816.48		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2001408        STATION:  971
DATE  :9/4/2001             GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°15.00
         start    stop    duration                          Lon   E 13°6.00
TIME  :4:00:00 AM4:02:00 AM2.0  (min)          Purpose   : 1
LOG   : 7013.03  7013.16   0.1                Region    : 5020
FDEPTH:      27       27                      Gear cond.: 0
BDEPTH:     253      251                      Validity  : 0
Towing dir:   0°     Wire out   : 70   m      Speed     : 3.0 kn
Sorted    :   0      Total catch: 59.21       Catch/hour: 1776.34
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Chrysaora sp.	552.00	90	31.08	83
Aequorea sp.	1222.50	20970	68.82	84
MYCTOPHIDAE	1.26	960	0.07	85
C E P H A L O P O D A	0.32	120	0.02	86
Trachurus capensis	0.26	30	0.01	87
Euphausia larseni	0.00	1500	0.00	88
Total	1776.34		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2001408        STATION:  972
DATE  :9/4/2001             GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°13.02
         start    stop    duration                          Lon   E 13°7.02
TIME  :8:59:00 AM9:04:00 AM5.0  (min)          Purpose   : 1
LOG   : 7018.84  7019.11   0.3                Region    : 5020
FDEPTH:      75       75                      Gear cond.: 0
BDEPTH:     245      244                      Validity  : 0
Towing dir:   0°     Wire out   : 230  m      Speed     : 3.0 kn
Sorted    :   0      Total catch: 59.36       Catch/hour: 712.31
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Aequorea sp.	631.20	11136	88.61	89
Chrysaora sp.	79.80	12	11.20	90
C E P H A L O P O D A	1.31	60	0.18	91
Total	712.31		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2001408        STATION:  973
DATE  :9/4/2001             GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°12.00
         start    stop    duration                          Lon   E 13°7.98
TIME  :9:10:00 AM9:15:00 AM5.0  (min)          Purpose   : 1
LOG   : 7019.39  7019.67   0.3                Region    : 5020
FDEPTH:      50       50                      Gear cond.: 0
BDEPTH:     243      242                      Validity  : 0
Towing dir:   0°     Wire out   : 130  m      Speed     : 3.0 kn
Sorted    :   0      Total catch: 58.56       Catch/hour: 702.77
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Aequorea sp.	543.60	9696	77.35	92
Chrysaora sp.	159.00	48	22.62	93
C E P H A L O P O D A	0.17	24	0.02	94
Total	702.77		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2001408        STATION:  974
DATE  :9/4/2001             GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°12.00
         start    stop    duration                          Lon   E 13°7.98
TIME  :9:23:00 AM9:25:00 AM3.0  (min)          Purpose   : 1
LOG   : 7020.07  7020.22   0.2                Region    : 5020
FDEPTH:      25       25                      Gear cond.: 0
BDEPTH:     240      241                      Validity  : 0
Towing dir:   0°     Wire out   : 70   m      Speed     : 3.0 kn
Sorted    :   0      Total catch: 172.90      Catch/hour: 3458.00
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Aequorea sp.	3000.00	50840	86.76	95
Chrysaora sp.	458.00	140	13.24	96
Total	3458.00		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2001408        STATION:  975
DATE  :9/4/2001             GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°13.98
         start    stop    duration                          Lon   E 13°7.02
TIME  :11:11:00 AM11:16:00 AM5.0  (min)          Purpose   : 1
LOG   : 7023.83  7024.09   0.2                Region    : 5020
FDEPTH:     225      225                      Gear cond.: 0
BDEPTH:     244      245                      Validity  : 0
Towing dir:   0°     Wire out   : 600  m      Speed     : 3.0 kn
Sorted    :   0      Total catch: 11.77       Catch/hour: 141.19
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Aequorea sp.	30.00	624	21.25	97
Chrysaora sp.	96.60	36	68.42	98
MYCTOPHIDAE	7.80	8208	5.52	99
Merluccius capensis	0.79	24	0.56	100
S H R I M P S	6.00	0	4.25	
Total	141.19		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2001408        STATION:  976
DATE  :9/4/2001             GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°13.98
         start    stop    duration                          Lon   E 13°7.02
TIME  :11:21:00 AM11:26:00 AM5.0  (min)          Purpose   : 1
LOG   : 7024.24  7024.48   0.2                Region    : 5020
FDEPTH:     176      180                      Gear cond.: 0
BDEPTH:     245      248                      Validity  : 0
Towing dir:   0°     Wire out   : 400  m      Speed     : 3.0 kn
Sorted    :   0      Total catch: 428.07      Catch/hour: 5136.82
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Aequorea sp.	2832.60	43884	55.14	101
Chrysaora sp.	2304.00	588	44.85	102
MYCTOPHIDAE	0.21	132	0.00	103
Total	5136.81		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2001408        STATION:  977
DATE  :9/4/2001             GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°13.98
         start    stop    duration                          Lon   E 13°7.02
TIME  :11:32:00 AM11:37:00 AM5.0  (min)          Purpose   : 1
LOG   : 7024.67  7024.87   0.2                Region    : 5020
FDEPTH:     125      117                      Gear cond.: 0
BDEPTH:     246      247                      Validity  : 0
Towing dir:   0°     Wire out   : 200  m      Speed     : 3.0 kn
Sorted    :  62      Total catch: 62.26       Catch/hour: 747.14
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Aequorea sp.	727.80	12384	97.41	104
Chrysaora sp.	17.40	12	2.33	105
C E P H A L O P O D A	1.94	12	0.26	106
Total	747.14		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2001408        STATION:  978
DATE  :9/4/2001             GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°15.00
         start    stop    duration                          Lon   E 13°4.98
TIME  :2:21:00 PM2:26:00 PM5.0  (min)          Purpose   : 1
LOG   : 7031.61  7031.87   0.3                Region    : 5020
FDEPTH:      80       77                      Gear cond.: 0
BDEPTH:     257      257                      Validity  : 0
Towing dir:   0°     Wire out   : 200  m      Speed     : 3.0 kn
Sorted    :  19      Total catch: 19.05       Catch/hour: 228.60
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Aequorea sp.	228.60	4320	100.00	107
Total	228.60		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2001408        STATION:  979
DATE  :9/4/2001             GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°15.00
         start    stop    duration                          Lon   E 13°4.98
TIME  :2:34:00 PM2:39:00 PM5.0  (min)          Purpose   : 1
LOG   : 7032.24  7032.51   0.3                Region    : 5020
FDEPTH:      47       43                      Gear cond.: 0
BDEPTH:     254      254                      Validity  : 0
Towing dir:   0°     Wire out   : 120  m      Speed     : 3.0 kn
Sorted    :   0      Total catch: 82.55       Catch/hour: 990.60
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Aequorea sp.	957.60	15840	96.67	108
Chrysaora sp.	33.00	12	3.33	109
Total	990.60		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2001408        STATION:  980
DATE  :9/4/2001             GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°16.02
         start    stop    duration                          Lon   E 13°6.00
TIME  :2:48:00 PM2:50:00 PM2.0  (min)          Purpose   : 1
LOG   : 7032.95  7033.07   0.1                Region    : 5020
FDEPTH:      28       26                      Gear cond.: 0
BDEPTH:     254      252                      Validity  : 0
Towing dir:   0°     Wire out   : 70   m      Speed     : 3.0 kn
Sorted    :  39      Total catch: 38.65       Catch/hour: 1159.50
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Aequorea sp.	1098.00	18690	94.70	110
Chrysaora sp.	61.50	30	5.30	
Total	1159.50		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2001408        STATION:  981
DATE  :9/4/2001             GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°15.00
         start    stop    duration                          Lon   E 13°6.00
TIME  :3:50:00 PM3:55:00 PM5.0  (min)          Purpose   : 1
LOG   : 7035.95  7036.25   0.3                Region    : 5020
FDEPTH:     224      222                      Gear cond.: 0
BDEPTH:     252      252                      Validity  : 0
Towing dir:   0°     Wire out   : 600  m      Speed     : 3.0 kn
Sorted    :   0      Total catch: 131.79      Catch/hour: 1581.47
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Aequorea sp.	1346.40	21792	85.14	111
Chrysaora sp.	234.00	72	14.80	112
MYCTOPHIDAE	1.07	492	0.07	113
Total	1581.47		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2001408        STATION:  982
DATE  :9/4/2001             GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°13.98
         start    stop    duration                          Lon   E 13°6.00
TIME  :4:05:00 PM4:09:00 PM4.0  (min)          Purpose   : 1
LOG   : 7036.73  7036.92   0.2                Region    : 5020
FDEPTH:     180      180                      Gear cond.: 0
BDEPTH:     252      252                      Validity  : 0
Towing dir:   0°     Wire out   : 480  m      Speed     : 3.0 kn
Sorted    :   0      Total catch: 259.30      Catch/hour: 3889.50
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Aequorea sp.	1705.50	28005	43.85	114
Chrysaora sp.	2184.00	525	56.15	115
Total	3889.50		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2001408        STATION:  983
DATE  :9/4/2001             GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°13.02
         start    stop    duration                          Lon   E 13°4.98
TIME  :4:17:00 PM4:22:00 PM5.0  (min)          Purpose   : 1
LOG   : 7037.25  7037.53   0.3                Region    : 5020
FDEPTH:     135      135                      Gear cond.: 0
BDEPTH:     253      251                      Validity  : 0
Towing dir:   0°     Wire out   : 300  m      Speed     : 3.0 kn
Sorted    :  20      Total catch: 19.96       Catch/hour: 239.51
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Aequorea sp.	127.80	2016	53.36	116
Chrysaora sp.	111.60	36	46.60	117
MYCTOPHIDAE	0.11	120	0.04	118
Total	239.51		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2001408        STATION:  984
DATE  :9/4/2001             GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°13.98
         start    stop    duration                          Lon   E 13°7.02
TIME  :7:39:00 PM7:43:00 PM3.0  (min)          Purpose   : 1
LOG   : 7042.30  7042.47   0.2                Region    : 5020
FDEPTH:     125      125                      Gear cond.: 0
BDEPTH:     244      246                      Validity  : 0
Towing dir:   0°     Wire out   : 300  m      Speed     : 3.0 kn
Sorted    :  28      Total catch: 27.66       Catch/hour: 553.18
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Aequorea sp.	384.00	7140	69.42	119
Chrysaora sp.	166.00	40	30.01	120
Miscellaneous fishes	3.18	660	0.57	121
Total	553.18		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2001408        STATION:  985
DATE  :9/4/2001             GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°15.00
         start    stop    duration                          Lon   E 13°7.02
TIME  :7:57:00 PM7:58:00 PM1.0  (min)          Purpose   : 1
LOG   : 7043.18  7043.24   0.1                Region    : 5020
FDEPTH:      55       55                      Gear cond.: 0
BDEPTH:     247      247                      Validity  : 0
Towing dir:   0°     Wire out   : 130  m      Speed     : 30.0 kn
Sorted    :  15      Total catch: 14.99       Catch/hour: 899.34
```

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Aequorea sp.	621.00	12600	69.05	122
Chrysaora sp.	237.00	60	26.35	125
C E P H A L O P O D A	9.97	1200	1.11	124
Miscellaneous fishes	31.36	8760	3.49	123
Total	899.32		100.00	

```
R/V Dr. Fridtjof Nansen       SURVEY:2001408        STATION:  986
DATE  :9/4/2001             GEAR TYPE: PT NO:  1  POSITION:Lat   S 22°16.02
         start    stop    duration                          Lon   E 13°7.02
TIME  :8:09:00 PM8:12:00 PM4.0  (min)          Purpose   : 1
LOG   : 7043.85  7044.07   0.2                Region    : 5020
FDEPTH:      25       25                      Gear cond.: 0
BDEPTH:     249      249                      Validity  : 0
```

Towing dir: 0° Wire out : 70 m Speed : 3.0 kn
Sorted : 0 Total catch: 258.60 Catch/hour: 3879.00

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea sp.	3109.50	47970	80.16	173
Chrysaora sp.	769.50	195	19.84	174
Total	3879.00		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 987
DATE :9/4/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 21°55.98
start stop duration Lon E 12°45.00
TIME :11:39:00 PM11:45:00 PM5.0 (min) Purpose : 1
LOG : 7073.38 7073.69 0.3 Region : 5020
FDEPTH: 152 148 Gear cond.: 0
BDEPTH: 359 359 Validity : 0
Towing dir: 0° Wire out : 400 m Speed : 3.0 kn
Sorted : 2 Total catch: 1.59 Catch/hour: 19.02

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
MYCTOPHIDAE	5.80	2184	30.50	126
APOGONIDAE	3.54	1644	18.62	127
C E P H A L O P O D A	0.79	60	4.17	128
Stomias boa boa	0.19	72	0.98	129
Maurolicus muelleri	0.05	108	0.27	130
Brama brama	8.65	12	45.46	
Total	19.02		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 988
DATE :9/4/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 21°55.98
start stop duration Lon E 12°45.00
TIME :11:52:00 PM11:58:00 PM6.0 (min) Purpose : 1
LOG : 7074.00 7074.35 0.3 Region : 5020
FDEPTH: 89 88 Gear cond.: 0
BDEPTH: 359 359 Validity : 0
Towing dir: 0° Wire out : 220 m Speed : 3.0 kn
Sorted : 8 Total catch: 7.90 Catch/hour: 78.99

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
MYCTOPHIDAE	38.50	25870	48.74	131
C E P H A L O P O D A	2.43	340	3.08	132
MYCTOPHIDAE	0.78	450	0.99	133
Brama brama	23.00	10	29.12	
Chrysaora sp.	10.50	10	13.29	134
Aequorea sp.	3.77	100	4.77	
Total	78.99		99.99	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 989
DATE :9/5/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 21°55.02
start stop duration Lon E 12°43.98
TIME :12:07:00 AM12:11:00 AM4.0 (min) Purpose : 1
LOG : 7074.82 7075.06 0.2 Region : 5020
FDEPTH: 43 39 Gear cond.: 0
BDEPTH: 361 365 Validity : 0
Towing dir: 0° Wire out : 90 m Speed : 3.0 kn
Sorted : 1 Total catch: 1.37 Catch/hour: 20.57

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
MYCTOPHIDAE	20.25	6675	98.47	135
C E P H A L O P O D A	0.31	45	1.50	136
Total	20.56		99.97	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 990
DATE :9/5/2001 GEAR TYPE: PT NO: 4 POSITION:Lat S 21°52.02
start stop duration Lon E 12°43.98
TIME :2:18:00 AM2:23:00 AM5.0 (min) Purpose : 1
LOG : 7078.98 7079.31 0.3 Region : 5020
FDEPTH: 5 5 Gear cond.: 0
BDEPTH: 358 359 Validity : 0
Towing dir: 0° Wire out : 150 m Speed : 3.0 kn
Sorted : 4 Total catch: 4.20 Catch/hour: 50.40

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
MYCTOPHIDAE	50.40	0	100.00	
Total	50.40		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 991
DATE :9/5/2001 GEAR TYPE: PT NO: 4 POSITION:Lat S 21°52.02
start stop duration Lon E 12°43.98
TIME :2:24:00 AM2:30:00 AM6.0 (min) Purpose : 1
LOG : 7079.32 7079.69 0.4 Region : 5020
FDEPTH: 5 5 Gear cond.: 0
BDEPTH: 358 359 Validity : 0
Towing dir: 0° Wire out : 150 m Speed : 3.0 kn
Sorted : 5 Total catch: 4.97 Catch/hour: 49.73

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
MYCTOPHIDAE	49.00	17730	98.53	137
C E P H A L O P O D A	0.73	100	1.47	138
Total	49.73		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 992
DATE :9/5/2001 GEAR TYPE: PT NO: 4 POSITION:Lat S 21°52.02
start stop duration Lon E 12°43.98
TIME :2:30:00 AM2:36:00 AM6.0 (min) Purpose : 1
LOG : 7079.71 7080.07 0.4 Region : 5020
FDEPTH: 5 5 Gear cond.: 0
BDEPTH: 359 360 Validity : 0
Towing dir: 0° Wire out : 150 m Speed : 3.0 kn
Sorted : 3 Total catch: 2.60 Catch/hour: 26.00

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
MYCTOPHIDAE	26.00	0	100.00	
Total	26.00		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 993
DATE :9/5/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 21°25.98
start stop duration Lon E 13°7.02
TIME :7:58:00 AM8:02:00 AM4.0 (min) Purpose : 1
LOG : 7129.40 7129.62 0.2 Region : 5020
FDEPTH: 110 110 Gear cond.: 0
BDEPTH: 165 167 Validity : 0
Towing dir: 0° Wire out : 300 m Speed : 3.0 kn
Sorted : 0 Total catch: 919.40 Catch/hour: 13791.03

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea sp.	13486.50	238125	97.79	139
Chrysaora sp.	300.90	45	2.18	140
Trachurus capensis	0.22	30	0.00	141
MYCTOPHIDAE	3.41	405	0.02	142
Total	13791.03		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 994
DATE :9/5/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 21°25.98
start stop duration Lon E 13°7.02
TIME :8:09:00 AM8:14:00 AM5.0 (min) Purpose : 1
LOG : 7129.95 7130.23 0.3 Region : 5020
FDEPTH: 50 50 Gear cond.: 0
BDEPTH: 164 161 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.0 kn
Sorted : 0 Total catch: 852.18 Catch/hour: 10226.10

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea sp.	9926.40	183756	97.07	143
Chrysaora sp.	288.60	96	2.82	144
MYCTOPHIDAE	6.42	2640	0.06	145
Sardinops ocellatus	0.60	12	0.01	146
Trachurus capensis	0.09	12	0.00	147
Argonauta sp.	3.99	12	0.04	
Total	10226.10		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 995
DATE :9/5/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 21°45.00
start stop duration Lon E 13°25.02
TIME :12:39:00 PM12:44:00 PM5.0 (min) Purpose : 1
LOG : 7157.19 7157.42 0.2 Region : 5020
FDEPTH: 110 110 Gear cond.: 0
BDEPTH: 139 138 Validity : 0
Towing dir: 0° Wire out : 300 m Speed : 3.0 kn
Sorted : 0 Total catch: 1208.00 Catch/hour: 14496.00

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea sp.	724.80	10380	5.00	148
Chrysaora sp.	13771.20	2724	95.00	149
Total	14496.00		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 996
DATE :9/5/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 21°45.00
start stop duration Lon E 13°25.02
TIME :12:52:00 PM12:54:00 PM2.0 (min) Purpose : 1
LOG : 7157.71 7157.80 0.1 Region : 5020
FDEPTH: 60 60 Gear cond.: 8
BDEPTH: 137 136 Validity : 2
Towing dir: 0° Wire out : 150 m Speed : 3.0 kn
Sorted : 41 Total catch: 41.36 Catch/hour: 1240.71

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea sp.	58.50	1170	4.72	150
Chrysaora sp.	1182.00	270	95.27	151
Trachurus capensis	0.21	30	0.02	
Total	1240.71		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 997
DATE :9/5/2001 GEAR TYPE: PT NO: 1 POSITION:Lat S 21°46.02
start stop duration Lon E 13°25.02
TIME :1:03:00 PM1:05:00 PM2.0 (min) Purpose : 1
LOG : 7158.21 7158.30 0.1 Region : 5020
FDEPTH: 25 25 Gear cond.: 8
BDEPTH: 137 136 Validity : 2
Towing dir: 0° Wire out : 70 m Speed : 3.0 kn
Sorted : 82 Total catch: 81.60 Catch/hour: 2448.00

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea sp.	73.50	1230	3.00	152
Chrysaora sp.	2374.50	720	97.00	153
Total	2448.00		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 998
DATE :9/5/2001 GEAR TYPE: PT NO: 7 POSITION:Lat S 21°45.00
start stop duration Lon E 13°27.00
TIME :2:38:00 PM2:40:00 PM2.0 (min) Purpose : 1
LOG : 7161.06 7161.10 0.1 Region : 5020
FDEPTH: 50 50 Gear cond.: 0
BDEPTH: 132 131 Validity : 0
Towing dir: 0° Wire out : 150 m Speed : 3.0 kn
Sorted : 29 Total catch: 29.45 Catch/hour: 883.50

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Chrysaora sp.	546.00	150	61.80	154
Aequorea sp.	337.50	5340	38.20	155
Total	883.50		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 999
DATE :9/5/2001 GEAR TYPE: PT NO: 7 POSITION:Lat S 22°4.02
start stop duration Lon E 13°40.02
TIME :5:13:00 PM5:19:00 PM6.0 (min) Purpose : 1
LOG : 7183.17 7183.43 0.3 Region : 5020
FDEPTH: 40 40 Gear cond.: 0
BDEPTH: 121 121 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.0 kn
Sorted : 99 Total catch: 99.28 Catch/hour: 992.80

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea sp.	284.80	3780	28.69	156
Chrysaora sp.	708.00	330	71.31	157
Total	992.80		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 1000
DATE :9/5/2001 GEAR TYPE: PT NO: 7 POSITION:Lat S 22°4.98
start stop duration Lon E 13°40.98
TIME :5:50:00 PM6:00:00 PM10.0 (min) Purpose : 1
LOG : 7184.73 7185.24 0.5 Region : 5020
FDEPTH: 70 70 Gear cond.: 0
BDEPTH: 121 120 Validity : 0
Towing dir: 0° Wire out : 220 m Speed : 3.0 kn
Sorted : 0 Total catch: 1254.97 Catch/hour: 7529.82

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Chrysaora sp.	713.70	336	9.48	158
Aequorea sp.	6816.00	89460	90.52	159
C E P H A L O P O D A	0.12	0	0.00	
Total	7529.82		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 1001
DATE :9/5/2001 GEAR TYPE: PT NO: 7 POSITION:Lat S 22°22.98
start stop duration Lon E 13°58.98
TIME :10:24:00 PM10:28:00 PM3.0 (min) Purpose : 1
LOG : 7210.31 7210.46 0.2 Region : 5020
FDEPTH: 70 70 Gear cond.: 0
BDEPTH: 109 108 Validity : 0
Towing dir: 0° Wire out : 220 m Speed : 3.0 kn
Sorted : 310 Total catch: 310.30 Catch/hour: 6206.00

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Chrysaora sp.	4695.00	1240	75.65	160
Aequorea sp.	1511.00	15440	24.35	161
Total	6206.00		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 1002
DATE :9/5/2001 GEAR TYPE: PT NO: 7 POSITION:Lat S 22°24.00
start stop duration Lon E 13°58.98
TIME :11:00:00 PM11:02:00 PM2.0 (min) Purpose : 1
LOG : 7211.45 7211.54 0.1 Region : 5020
FDEPTH: 25 25 Gear cond.: 0
BDEPTH: 107 108 Validity : 0
Towing dir: 0° Wire out : 80 m Speed : 3.0 kn
Sorted : 67 Total catch: 66.96 Catch/hour: 2008.70

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Aequorea sp.	1244.40	14340	61.95	162
Chrysaora sp.	763.50	180	38.01	163
Sufflogobius bibarbatus	0.80	360	0.04	164
Total	2008.70		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 1003
DATE :9/6/2001 GEAR TYPE: PT NO: 7 POSITION:Lat S 22°40.02
start stop duration Lon E 14°15.00
TIME :6:55:00 PM7:04:00 PM10.0 (min) Purpose : 1
LOG : 7286.13 7286.68 0.6 Region : 5020
FDEPTH: 30 30 Gear cond.: 0
BDEPTH: 86 85 Validity : 0
Towing dir: 0° Wire out : 90 m Speed : 3.0 kn

Sorted : 0 Total catch: 116.33 Catch/hour: 697.96

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Aequorea sp.	566.10	8148	81.11	165
Chrysaora sp.	122.70	18	17.58	166
Sufflogobius bibarbatus	9.00	6222	1.29	167
C E P H A L O P O D A	0.16	12	0.02	168
Total	697.96		100.00	

R/V Dr. Fridtjof Nansen SURVEY:2001408 STATION: 1004
DATE :9/6/2001 GEAR TYPE: PT NO: 7 POSITION:Lat S 22°39.00
start stop duration Lon E 14°15.00

TIME :8:12:00 PM8:22:00 PM10.0 (min) Purpose : 1
LOG : 7288.82 7289.34 0.5 Region : 5020
FDEPTH: 60 60 Gear cond.: 0
BDEPTH: 84 85 Validity : 0
Towing dir: 0° Wire out : 200 m Speed : 3.0 kn
Sorted : 0 Total catch: 353.96 Catch/hour: 2123.75

SPECIES	CATCH/HOUR weight	CATCH/HOUR numbers	% OF TOT. C	SAMP
Aequorea sp.	1050.00	14034	49.44	169
Chrysaora sp.	1072.50	162	50.50	170
Sufflogobius bibarbatus	1.14	642	0.05	171
C E P H A L O P O D A	0.11	6	0.00	172
Total	2123.75		100.00	

ANNEX III   MultiSampler

SPECIFICATIONS

The main sampling devise used during this cruise has been the MultiSampler attached to a very small pelagic trawl, named “small Åkratrål”. As illustrated in Fig.1, the MultiSampler was equipped with a new 16 meter long extension net that gave a very smooth funnel from the trawlbelly to the 1m″ opening of the MultiSampler. This extension piece is manufactured from 40mm diamond meshes that ensured no escapement of even small fish. To prevent a possible expansion of the net in situations while trawling in very dense aggregations of fish, the end of the extension piece was covered by a 80mm square mesh net.

The three new codends showed in Fig.2, were 18 meters long with 24 mm meshsize. They were equipped with a cover in 140 mm meshes, and an inner-net of 10 mm mesh size at the end section. This design enabled us to handle the catch very safely and efficiently. At the same time, the species composition and size frequencies of the samples were much more representative than would have been the case had only one ordinary codend been used.

FIG. 1
EXTENSION PIECE FOR MultiSampler

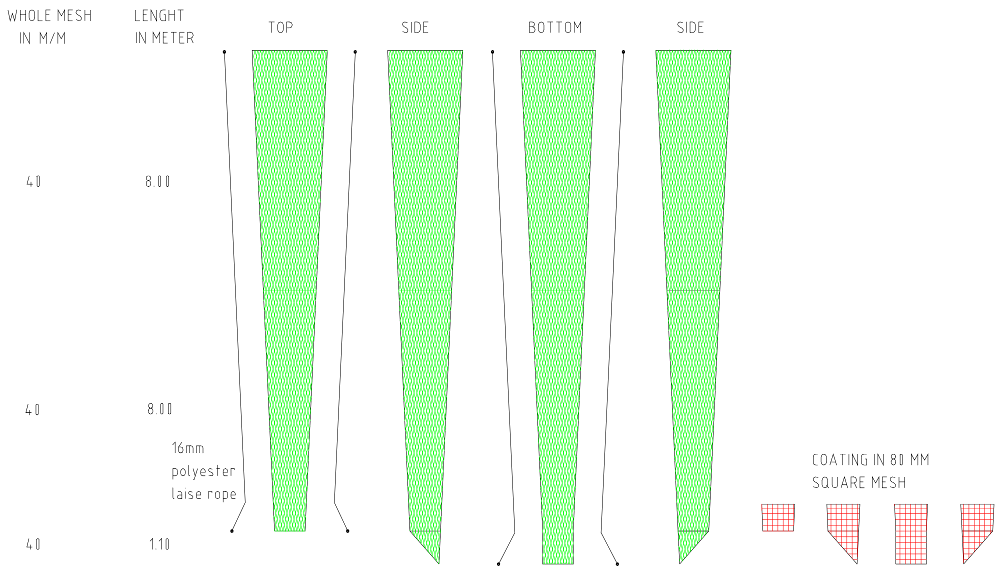


FIG. 2
CODENDS FOR MultiSampler (3Pcs.)