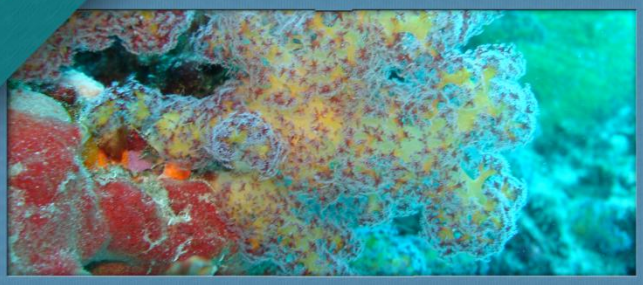
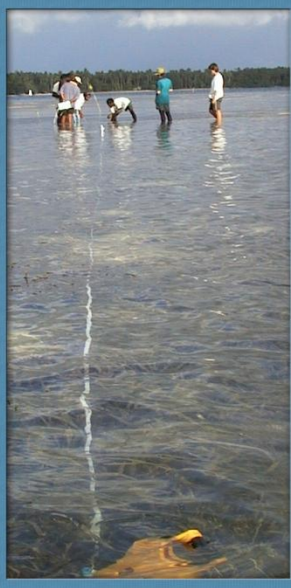
Bay of Bengal Large Marine Ecosystem Project





Post survey meeting on the 2013 marine ecosystem survey in Myanmar

Report of the

5-8 May 2014 • Yangon, Myanmar

BOBLME-2014-Ecology-29

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Acronyms used

BIMSTEC	Bay of Bengal Initiative for Multi Sectoral Technical and Economic Cooperation
BOBLME	Bay of Bengal Large Marine Ecosystem Project
BRD	By-catch Reduction Devices
DIVA	Data-Interpolating Variational Analysis
DOF	Department of Fisheries
EAF	Ecosystem Approach to Fisheries
EAFM	Ecosystem Approach to Fisheries Management
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
FAO	Food and Agriculture Organization of the United Nations
FAORAP	FAO (Regional Office for Asia Pacific)
GLM	Generalized Linear Model
HAB	Harmful Algal Blooms
ICES	International Council for the Exploration of the Sea
IMR	Institute of Marine Research of Bergen
IUU	Illegal Unreported and Unregulated
JTED	Juvenile and Trash Excluder Devices
MCS	Monitoring Control and Surveillance
MLF	Ministry of Livestock and Fishery, Myanmar
MSY	Maximum Sustainable Yield
NORAD	Norwegian Agency for Development Cooperation
RAP	Region Asia-Pacific
RV	Research vessel
SEAFDEC	Southeast Asian Fisheries Development Centre
TED	Turtle Excluder Device
VMS	Vessel Monitoring System

A Collaboration of the Bay of Bengal Large Marine Ecosystem (BOBLME) Project and the Strengthening the Knowledge Base for and Implementing an Ecosystem Approach to Marine Fisheries in Developing Countries (EAF-Nansen) Project with the Department of Fisheries, Ministry of Livestock, Fisheries and Rural Development, Myanmar.

1. Background

The Department of Fisheries of Myanmar, as part of the BOBLME Project, carried out a marine ecosystem assessment survey in 2013. The survey was implemented within the framework of a tripartite agreement between NORAD (on behalf of the Norwegian Ministry of Foreign Affairs), the Institute of Marine Research of Bergen (IMR) and FAO, The survey, by the research vessel Dr Fridtjof Nansen, was conducted between 13 November and 18 December 2013 and covered the shelf and slope from the border with Bangladesh in the north to the border with Thailand in the south.

FAO has been collaborating with NORAD and the Institute of Marine Research of Bergen, Norway to carry out fisheries resources and environment surveys in developing countries in Africa, Asia and Latin America using the vessel RV Dr Fridtjof Nansen since 1975. The 2013 survey was the second such survey by the EAF Nansen programme in Myanmar waters.

The first Nansen survey took place in September-November 1979 and March-April 1980. A major objective of this survey was to make an estimate of the marine fish biomass within the EEZ of Myanmar. The work programme also included an acoustic estimation of the biomass of demersal and pelagic fish, with fishing for identification and sampling purposes and for assessment of catch rates. Environmental work included recording of type of bottom and hydrographical profiles from the coast to 500 m depth for temperature, salinity and oxygen.

The 2013 survey involved trawl and acoustic surveys for fish, collection of physical and biological oceanography data (phytoplankton and zooplankton), bottom profiling and sediment samples. The EAF Nansen team, consisting of Norwegian and Myanmar researchers, has already produced a preliminary report in the 2013 survey containing preliminary results and analyses.

A synoptic ecosystem survey, mapping most features of the marine ecosystem on the Myanmar shelf was also completed.

The post-survey meeting was organised to undertake the following activities:

- Review of survey activities and overview of data and samples collected
- Finalize the cruise report
- Prepare advisories on the survey results and Power point presentations
- Present the survey results to government and sector representatives
- Discuss and identify follow-up activities

The final day was a high level meeting with the Deputy Minister. The brief note on the meeting is given in Appendix I.

2. Opening

The “Post survey meeting on the Marine ecosystem survey (2013) in Myanmar” was convened in the Summit Parkview Hotel, Yangon, Myanmar, from 5 to 8 May 2014.

The meeting was opened by Jens-Otto Krakstad, Senior Scientist, Institute of Marine Research, Norway, who recalled the purpose and process of the survey and this meeting.

Mya Than Tun, Chief Scientist Counterpart, welcomed participants on behalf of the Department of Fisheries, Myanmar.

Rudolf Hermes, Chief Technical Advisor, Bay of Bengal Large Marine Ecosystem Project, underlined the cross-cutting areas of knowledge management, capacity development and regional cooperation in the context of the Ecosystem Approach to Fisheries – all relevant to this EAF Nansen survey activity.

The information generated by this survey will provide a basis and contribute to informed decision making about the need for improving management for long term sustainability.

3. Purpose

The purpose of the Meeting was to,

- Convene a stakeholder review of the results of the Nansen ecosystem survey
- Draw conclusions and recommendations regarding further work, capacity development needs, with implications for fishery management and fishery policy.

4. Participants

The meeting was logistically supported by FAO-Representation Office Myanmar and attended by 14 participants from:

- Department of Fisheries, Myanmar
- University of Myeik
- University of Mawlamyine
- Bay of Bengal Large Marine Ecosystem Project
- FAO Regional Office for Asia and the Pacific
- Institute of Marine Research, Bergen

5. A brief description of the survey

The RV Dr Fridtjof Nansen survey was conducted 13 November - 17 December 2013, supported by the Government of Norway through NORAD.

The brief summary of the survey is given in **Appendix II**

There have been a series of surveys over the years which cover the marine fisheries and environment of Myanmar.

- The first Nansen survey was conducted in 1980
- Subsequent surveys have been conducted by MV SEAFDEC (2004 and 2007)
- Department of Fisheries Thailand, BIMSTEC survey (2007)
- RV Linzin 1966/1968 (Druzhinin IPFC paper)

This 2013 Nansen survey repeats in part, the methods of the 1980 Nansen survey and thus can be used to some degree, as a comparison.

6. Overview of the results of the survey

Jens-Otto Krakstad

Two shifts of scientists from Norway (IMR) and Myanmar (DOF, Mawlamyine University)

- Survey stations extended the length of the coastline and across the EEZ.
- Transects were performed at a series of depths, separated by 20 nm
- Survey results were split into three regional zones: Rakhine Coast, Delta Coast , Thanintharyi Coast
- 145 bottom trawls at various depths according to a stratified sampling pattern
- 3 pelagic trawls were performed to identify acoustic targets not identified by acoustic survey. Abundance of pelagic fish is relatively low and most covered by the bottom trawls.
- Acoustics for fish ID and sonar for bottom scanning
- 214 stations recorded CTD conductivity, temperature, density, oxygen, nutrients, chlorophyll-a
- 38 plankton stations (phytoplankton, zooplankton); 145 sediment stations (type and carbon content).
- Photographic records (>500 species) as a species collection

Meteorological data was also collected during the survey. Weather was mainly calm, except for a cyclone passing through the Andaman Islands (post monsoon cyclone).

- **Temperature**: waters are very warm (>29) in the north (except around the Naf River) becoming cooler to the centre and south (27.5 - 28.5).
- **Salinity gradients***:* are lower in areas where driven by river outflows (Ayeyarwady and the north). More typical oceanic salinities below the Ayeyarwady Delta and southwards (limited freshwater inputs)
- **Surface dissolved oxygen***:* varied between supersaturation (in cool water for northernmost area and around the Ayeyarwady Delta and coincides with high phytoplankton and primary production.

Overall the three regions have different physical conditions, largely reflecting the strong effect of the Ayeyarwady Delta in the Central Region.

There are also clear differences in species composition and environmental parameters between these three regions.

The season when this survey took place is typified by very stable conditions (little wind driven mixing; few storms or cyclones - clear weather, and steady inflow from rivers)

- Northern (Phayonika, Rakhine) transect: waters become hypoxic below 100 m; salinities in surface water remain far from shore but stabilize below 50 m; there is no evidence of upwelling.
- Central (Yangon) transect: the shelf drops off at 50 km from shore ; thermocline at 150 m whereupon temperatures decline to 18 degrees; salinity stabilizes at 34 below 80 m depth; evidence of very slight upwelling close to shore, possibly driven by internal waves; Hypoxia (<1 ppm) below 100 m.
- Southern (Kampong Lama) transect: shelf extends to 50 km from shore; the thermocline is at 100 m; surface salinity is high (more oceanic); Hypoxia (<1 ppm) below 150 m depth; some cooler more saline water rises up over the edge of the shelf.

Recommend: Names of places and transects need to be checked against the Myanmar names to ensure consistent use.

Nutrients:

Pooled data sets of concentrations of nutrients versus depth for the whole survey area.

- **Nitrate**: very low surface levels from 0-50 m then increasing to 50-200 m then stabilizing.
- **Nitrite**: At 50 m depth there is a strong increase. But not deeper (something related to halocline?)
- **Silicate and phosphate**: are low in surface waters but increase in levels below 75 m.
- **Chlorophyll a**: In shallow waters highest levels were close to the bottom (around 30 m); In waters at 100m depth, the highest chlorophyll a is at 50 metres, coinciding with the halocline); at deep water stations (500 m depth) there is increasing chlorophyll a down to 50 m after which is gets lower again.
- In all stations a clear relationship between chlorophyll a and the halocline.

Plankton sampling:

Biomass of zooplankton separated into three size categories (180-1000 microns, 1000-200, over 2000 microns)

- Species diversity - highest diversity in the North and South areas; lowest diversity in the Central area.
- Higher densities in zooplankton found in a number of areas along the coast.
- Larger zooplankton found in the deeper water areas.

Recommendation:

- Compare the data found with surveys made in other parts of the Bay of Bengal
- E.g. how typical or unique is the area surveyed with respect to India, etc.

Hydro-acoustics:

Effort made to develop some biomass calculations based on the,

- Pelagic group 1: clupeids and engraulids: groups with similar properties; species which have a strong acoustic reflection (Dussmieria, Hilsa, Sardinella, Stolephorus, Thryssa). Relatively concentrated in each of the three regions.
- Pelagic group 2: have a lower signal (Carangids, Scombrids, Trichiurids, Sphyraenids); more broadly distributed across marine areas, however abundance is low.
- Demersal groups
- Mesopelagic species
- Plankton also appears as a separate group

Biomass calculations are approximate and should be considered as indexes rather than absolute values. (e.g. the figures represent the underlying biomass, but not that actual amount). They can be compared between surveys (not with historic data as the equipment used is different). Uncertainty in this type of biomass estimate is about 30% where there are many surveys/a lot of data. In the case of this 2013 acoustic survey uncertainty would probably be about 50%

- Pelagic species 1: Rakhine Coast has highest density but these are concentrated thus biomass overall is lower than the delta area which has lower concentrations but broader distribution. (calculated 103 000 tonnes)
- Pelagic species 2: This group has approximately double the biomass as the small pelagic group 1 (221 000) highest abundance in the Central Region.

- The lower biomass of small pelagics versus large pelagics seems unusual, but this may not take into account seasonal variations and migrations or areas/species which were not covered by the survey.
- The 1980 survey had relatively common echograms that indicated large schools of pelagic fish. This type of echogram was not found in the 2013 survey.

The relative proportions can be compared between regions. The survey was conducted post monsoon, the 1980 survey indicate considerable differences better monsoon season a post monsoon abundance and biomass.

Conclusion: A comparison of the pelagic fish abundance maps between 1980 and 2013 shows a strong decline in the pelagic fish abundance.

Recommendation: these estimates are indicative, but they contain uncertainty. Repeated acoustic surveys will build a better picture of the biomass and can give a more confident estimate as well as indicate changes in relative distribution

Bottom trawl:

- Catch per square nautical mile and the demersal biomass
- The three survey regions were stratified into depths to provide an area: depth profile (percentage contribution of each depth strata by area of each region)
- There are significant parts of the area of nearshore shallow water area (0-20 m) not covered by the trawl survey (29% North, 26% Central; 16% Southern area).

The catch rates for the main taxonomic groups were developed for each depth and region. Those were then converted into total biomass.

Table 1. Total biomass for the main taxonomic groups for each depth and region developed from the catch rates

Species	Comments	Total biomass (tonnes)
Croakers	Area specific, focused mainly in the delta area; and not found in the South at all and only shallow water in Rakhine	2 985
Groupers	Generally very low catch levels; highest catches in Tenasserim 50-100 m depth.	1 900
Grunts	Low catch rates, found in shallow areas in Rakhine and Delta less in the South. Highest biomass in delta area due to area covered	1 245
Snappers	Associated with reefs and rocky habitats - these are not typically trawl and therefore probably underestimated There are few coral reefs in the area. Slope associate snapper species may not be present due to anoxic conditions	821
Mullets	Catches relatively low, but very broadly distributed	6 706
Ariid catfish		
Brotula	Deepwater species, valuable. Not found except Rakhine in 2000-500 m. Found in deep water (200-500 m) in Tenasserim but very low abundance.	1 388
Soles	Mainly found in delta area and the Southern Region and low catch rates	2 852
Threadfin breams	Relatively abundant particularly in deeper water (indicating tolerance to hypoxia)	8 656
Other threadfins	Five fingered threadfin only found in the delta area in 20-50 m depth. Major target for the bamboo raft fishery	632
Sharks	Species composition varies between regions. Found in deeper water indicating tolerance to hypoxia. In very deep water shark (squalus)	6 588
Rays	Also found in delta Region and Tensasserim Coast in particular	
Crabs	Between 10-200 m on Rakhine Coast had highest catch rates of crab.	4 070
Shrimps	Highest catch rates in deep water in the delta (200-500 m) and Tenasserim Coast. The highest biomass was on the Tenasserim Coast.	17 045
Lobsters/mantis shrimp	Found only in deep waters (Delta, Tenasserim) typically 200 m or more. Biomass highest in Tenasserim	3 824
Cephalo-pods	High biomass. Highest biomass in the delta found in shallow waters and deeper waters. Different species according to the depth.	12 330
"Other species"	These are the non-commercial food fish, but which are used for local consumption, fermentation and aquaculture/animal feeds (includes what are commonly known as low value/trash fish and species not exported lizard fish, *Trichiurus*. This group needs to be expanded.	196 885

Overall demersal biomass

- The total biomass estimate based on demersal trawl catches (tonnes per square nautical mile) is 280 170 tonnes.
- Approximately 30% of the 1980 estimate (noting the provisos regarding this estimate that it may be under - or overestimated).

- The highest average catch was in Rakhine Coast (11.6 tonnes/square nautical mile, 20-50 m depth). The Southern coastline had relatively low catch rates (2.37-5.8 tonnes).
- The total overall biomass 280 170 tonnes, considerably reduced (to ~30% of the 1980 figure) (e.g. demersal biomass estimate for 1980 survey 750-800 000 tonnes Pauly *et al.,* 1984[1]).

Species by importance (by frequency, size, abundance)

The majority of the common and abundant species are relatively low value species.

- Rakhine Region: *Lepturacanthus, Leiognathus, Saurida, Nemipterus* and loliginid squid
- Central Region: *Saurida, Loligo, Nemipterus, Myctophids and Lepturacanthus*
- Southern Region: *Aristeus, Myctophids, Sauridae, Decapterus, Loligo, Plesiobatis, Satyrichthys, Dactyloptena, Priacanthus*.

Fishery biomass summary

Table 2 Fishery biomass summary

Survey date	Pelagic	Demersal	Total
1979-1980	1 000 000	800 000	1 800 000
2013	324 000	280 170	604 170
Difference	-676 000	-71 830	

Recommendation:

- The "other species" grouping could be broken down into some functional sub-groups (e.g. species for surimi, used for feeds; or local high value species e.g. *Trichiurus*, pike conger).
- Need to relate the new estimates to the historic estimates
- Need to rebuild fish stocks

Phytoplankton

Phytoplankton represent the primary productivity that drives ecosystem production. A previous phytoplankton study was performed in February-March 2008 when M/V SEAFDEC 2 carried out a plankton survey at 61 stations in Tanintharyi Coastal Region.

- Phytoplankton study are divided into 3 regions: Rakhine and Ayeyarwady and Tanintharyi
- Total of 41 families with 194 species of phytoplankton identified.
- Distributions have clear linkage to oceanographic factors (temperatures salinity, nutrients)
- Diatoms most abundant (55-61%), followed by dinoflagellates, cyanobacteria and silicoflagellates.
- A number of "harmful" phytoplankton species (HAB species); some of them had a narrow w distribution, but others were more widely distributed.
- Results of species identified are similar to the M/V SEAFDEC-2 cruise
- The studies differ in the M/V SEAFDEC-2 cruise found that dinoflagellates were the dominant group, but this was during a different season.

[1] Pauly, D., Sann Aung, L. Rijavec, and Htun Htein, (1984). The marine living resources of Burma: A short review. FAO Fish.Rep. (318): 96–108.

Table 3. Abundance of diatoms and dinoflagellates

	Diatoms	Dinoflagellates
Rakhine	34	52
Delta	72	45
Thanintaryi	93	71

Conclusions:

- This survey provides a baseline for future EIA work.
- What do these observations mean for possible management actions?
- Are any areas at risk from HAB? Most areas are not enclosed and are well flushed. The straight coastline has the result that red tides may not from due to higher water exchange.
- Are there any implications for aquaculture production zones (especially crab and shellfish)? Are there areas where there are possibilities of local harmful blooms?

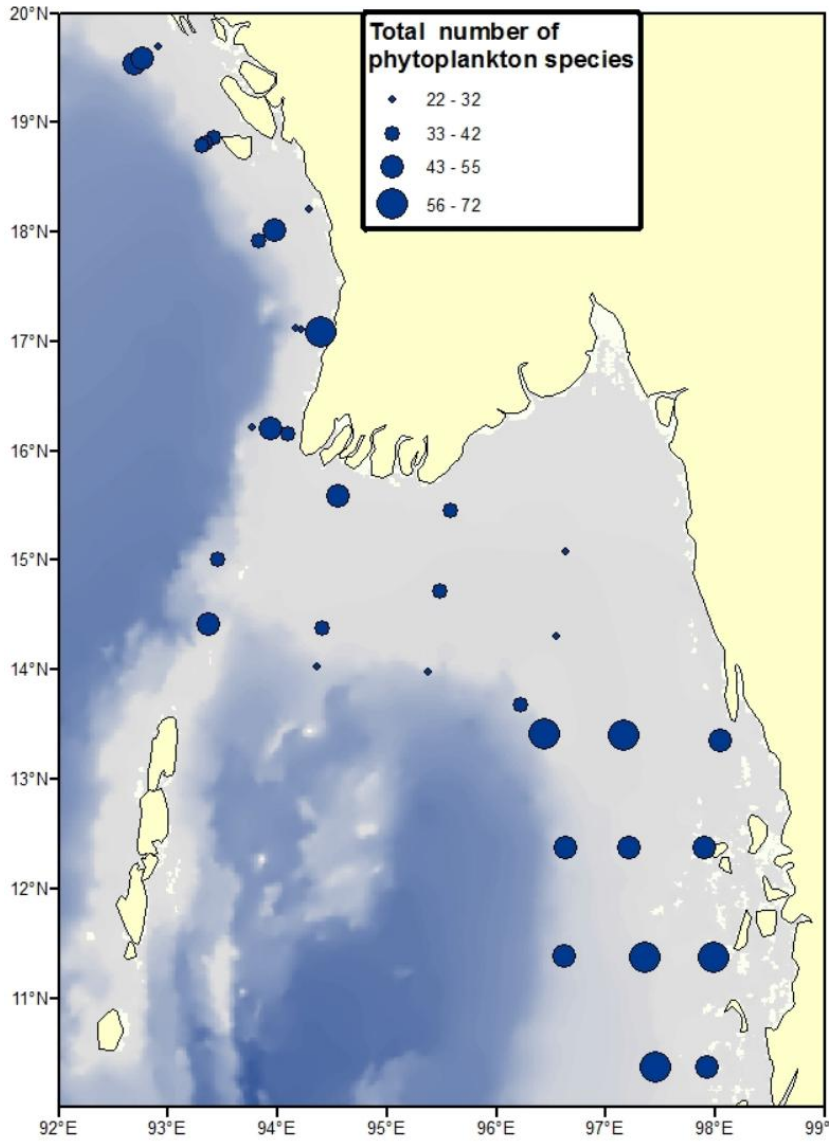
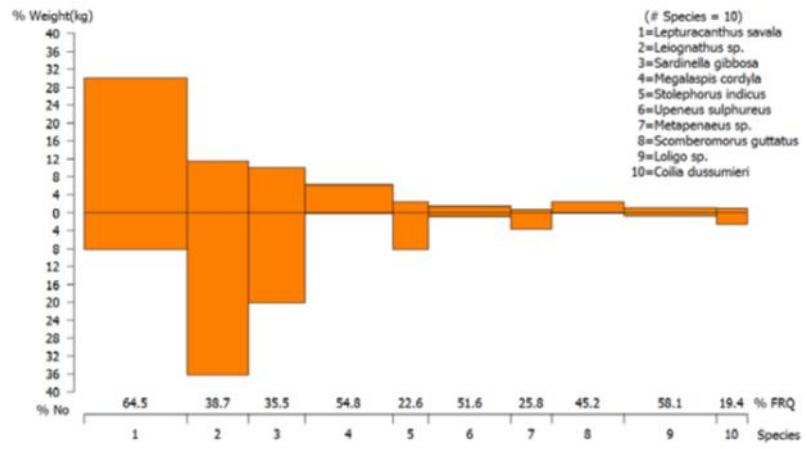
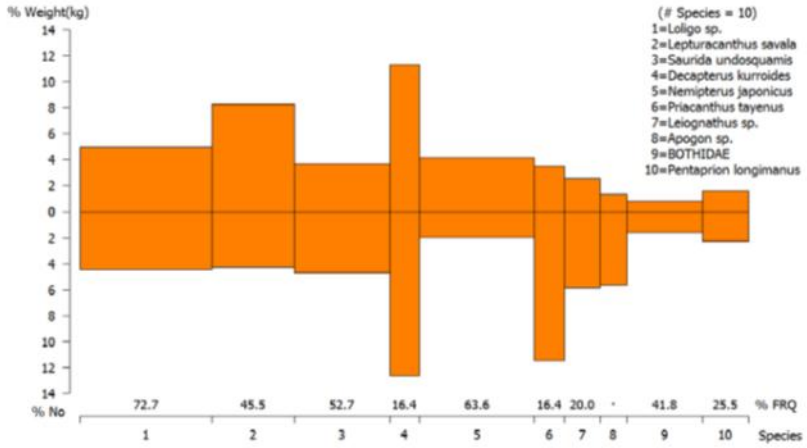


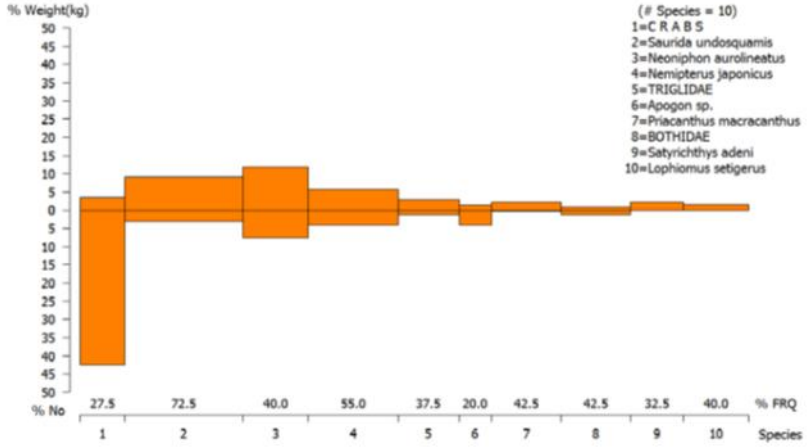
Figure 1. Phytoplankton species diversity at environmental stations along the Myanmar coast, November December 2013

(a) Rakhine Coastal Region
0-50 m


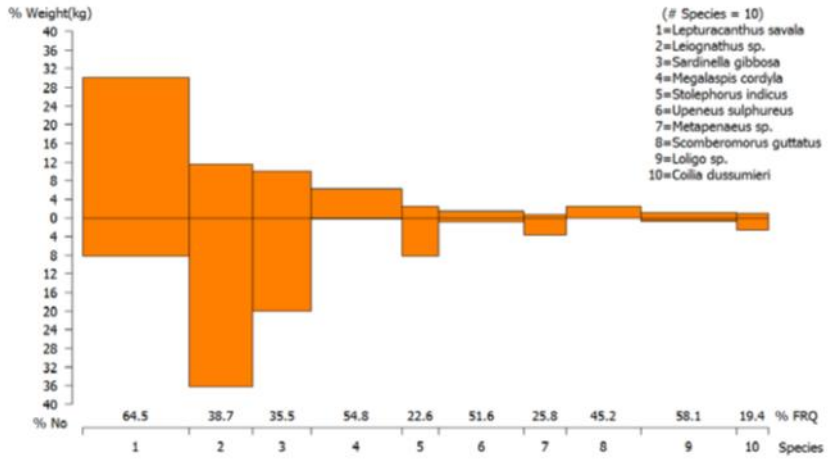
50-100 m



100-200 m

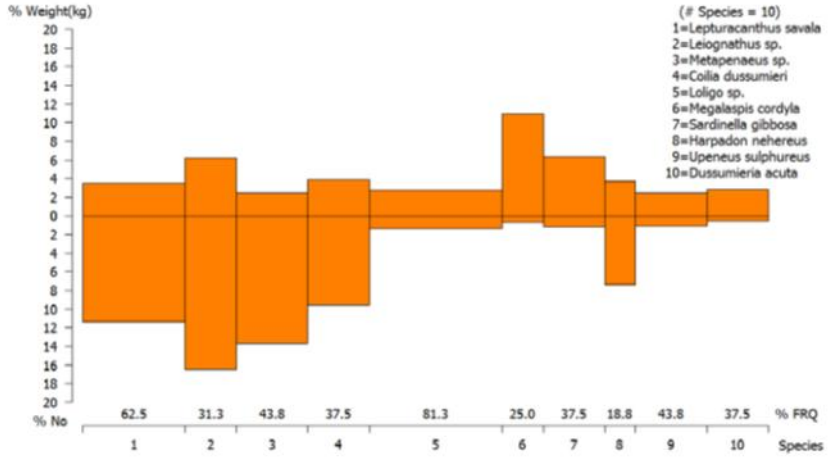


200-500 m

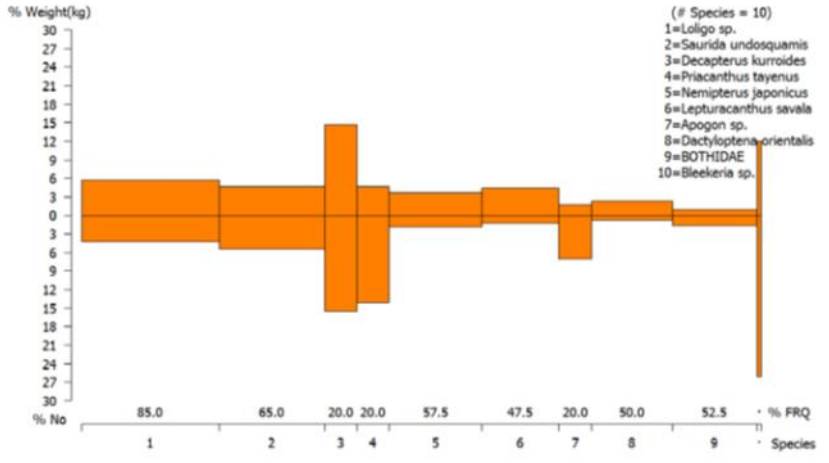


(b) The Deltaic Cost

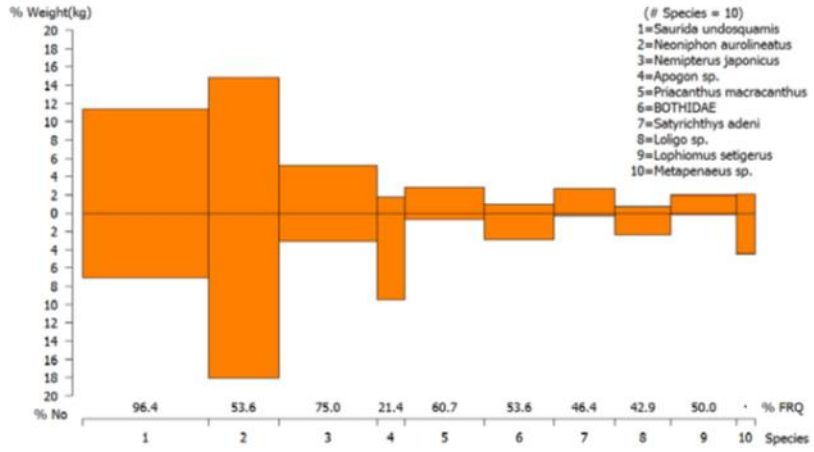
0-50 m



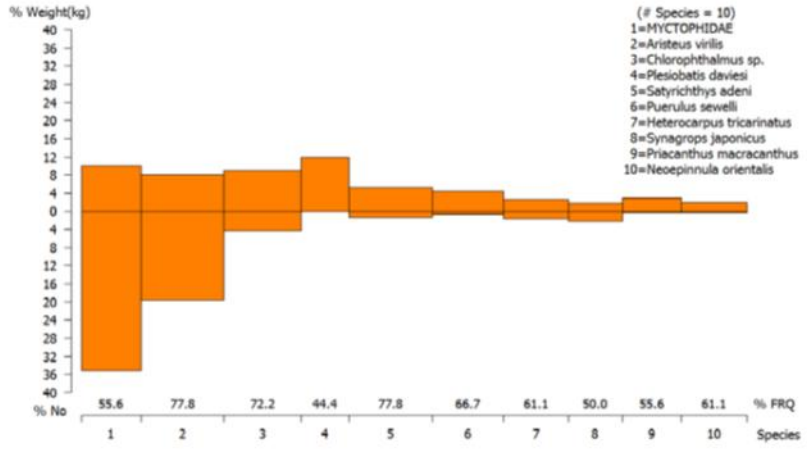
50-100 m



100-200 m

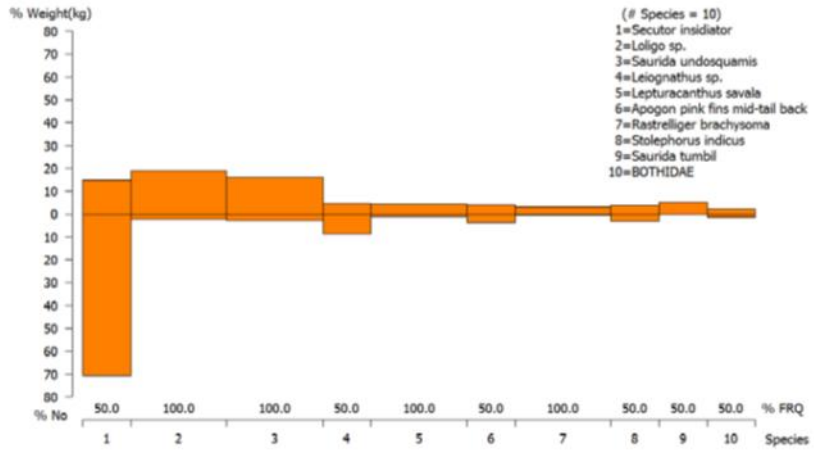


200-500 m

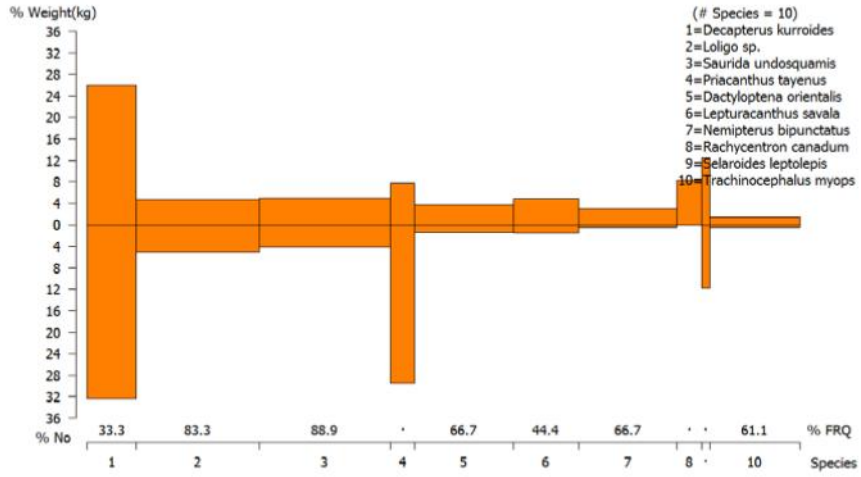


(c) The Tanintharyi Coast

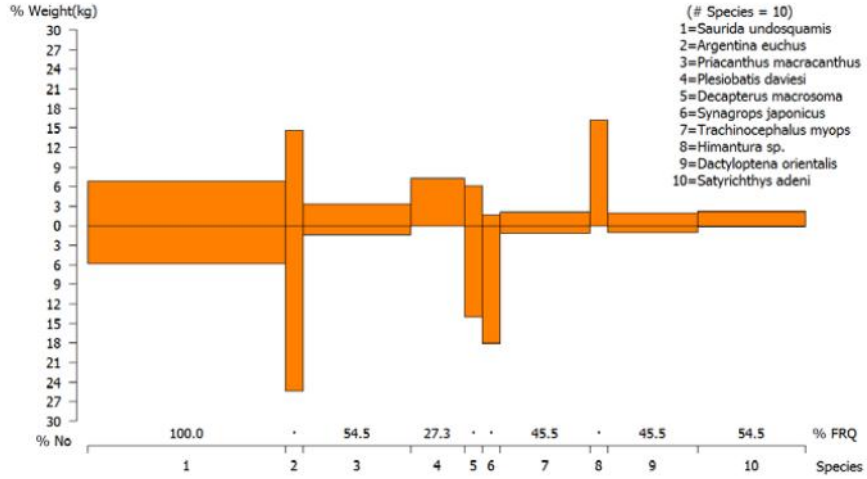
0-50 m



50-100 m



100-200 m



200-500 m

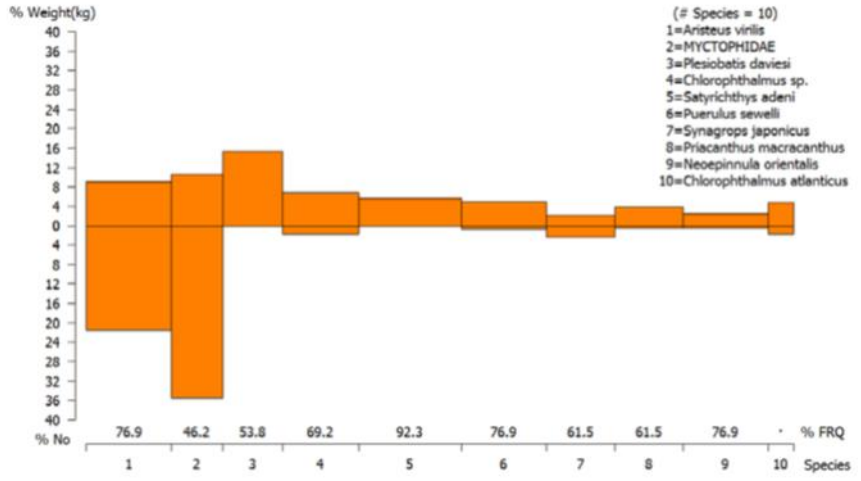
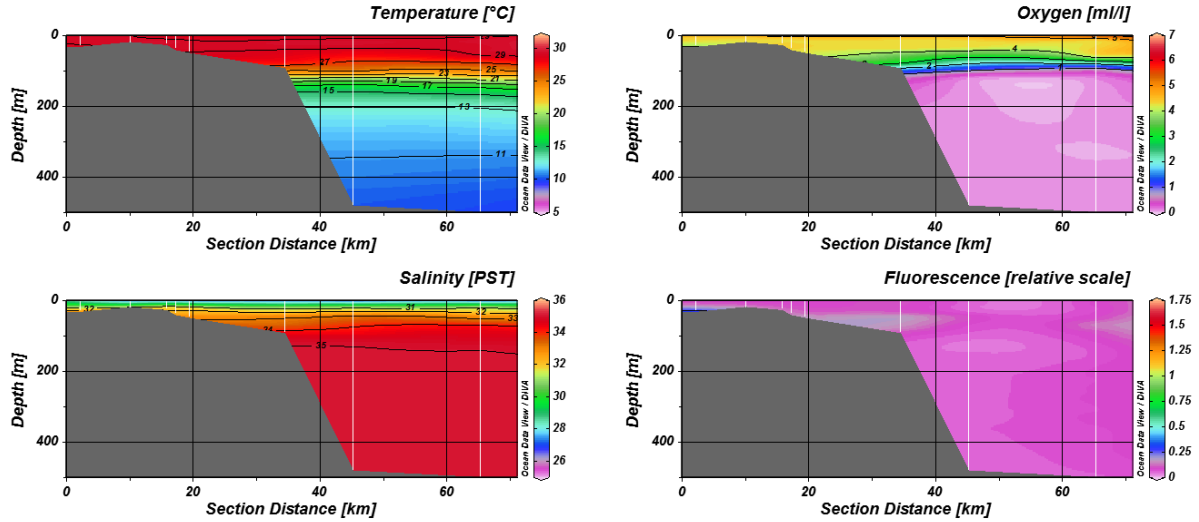


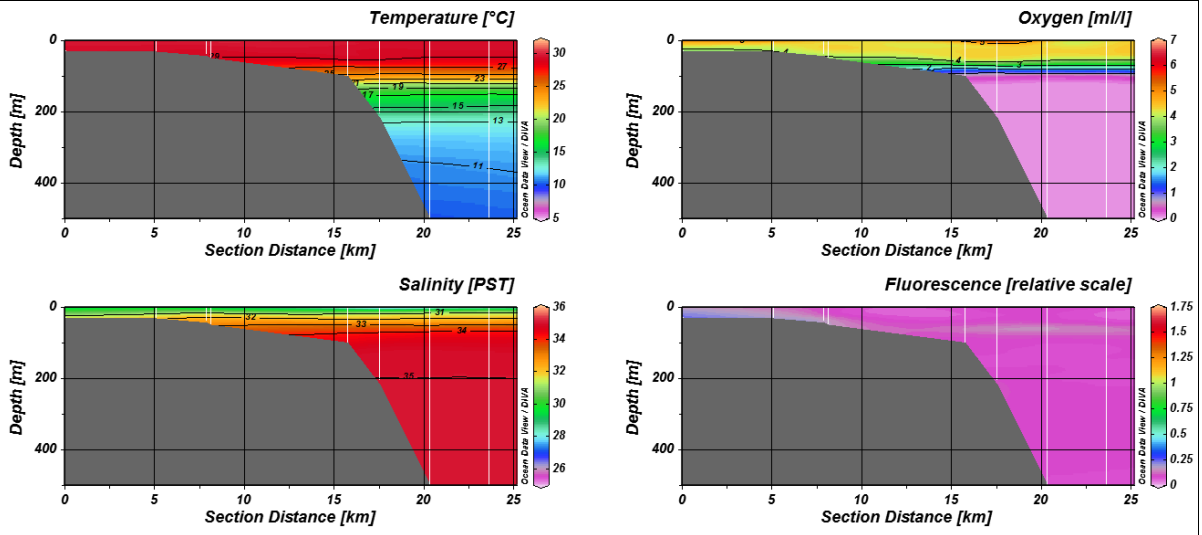
Figure 2. Index of relative importance for the 10 most important species or species groups for the depth strata 20–50 m, 50-100 m, 100-200 m and 200-500 m in the Rakhine Coastal Region (a), the Deltaic Cost (b) and the Tanintharyi Coast (c)

The Rakhine Coastal Region

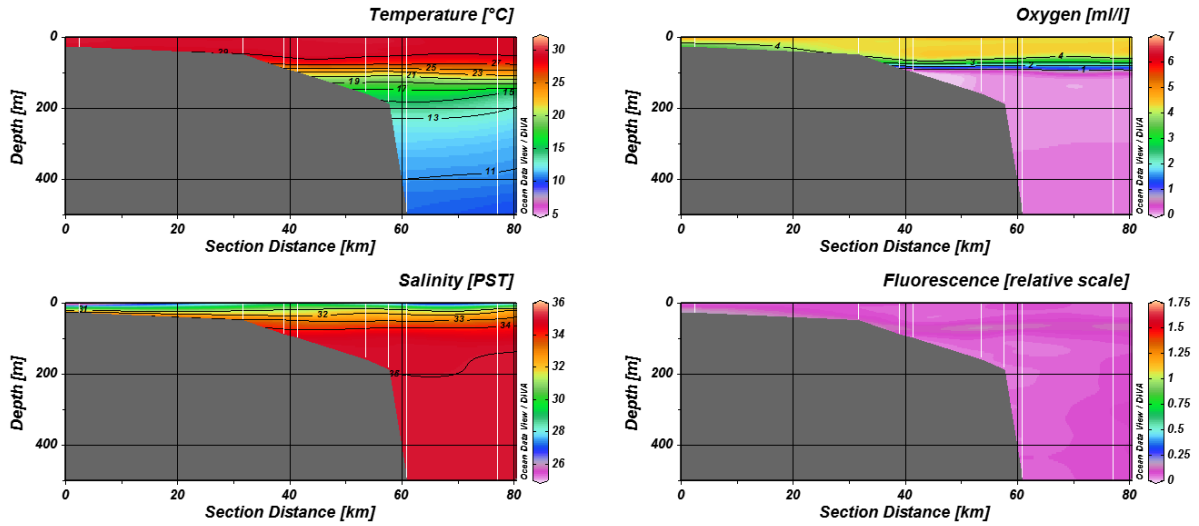
Transect Phayonika



Transect Munaung



Transect Andrew Bay



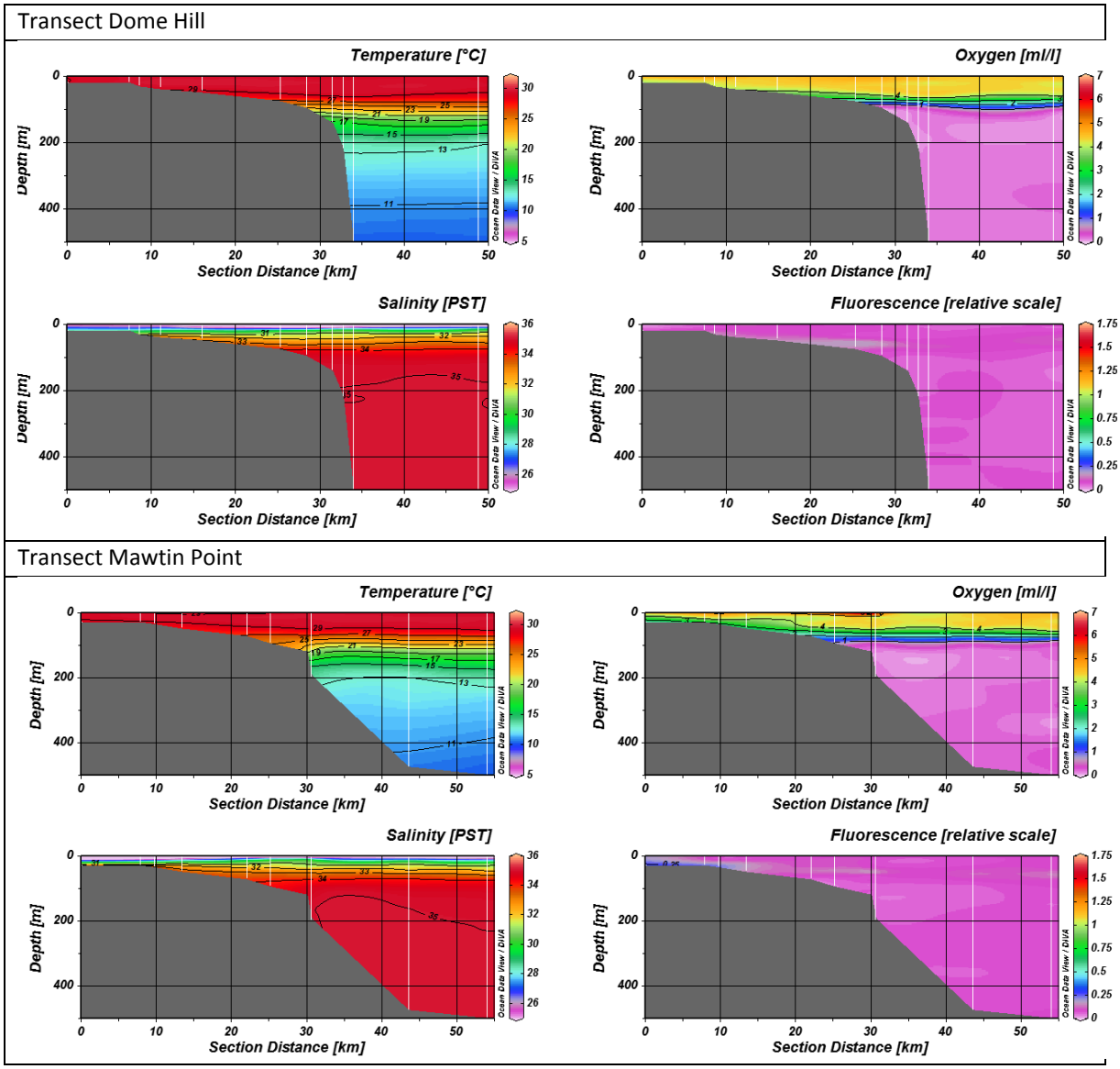
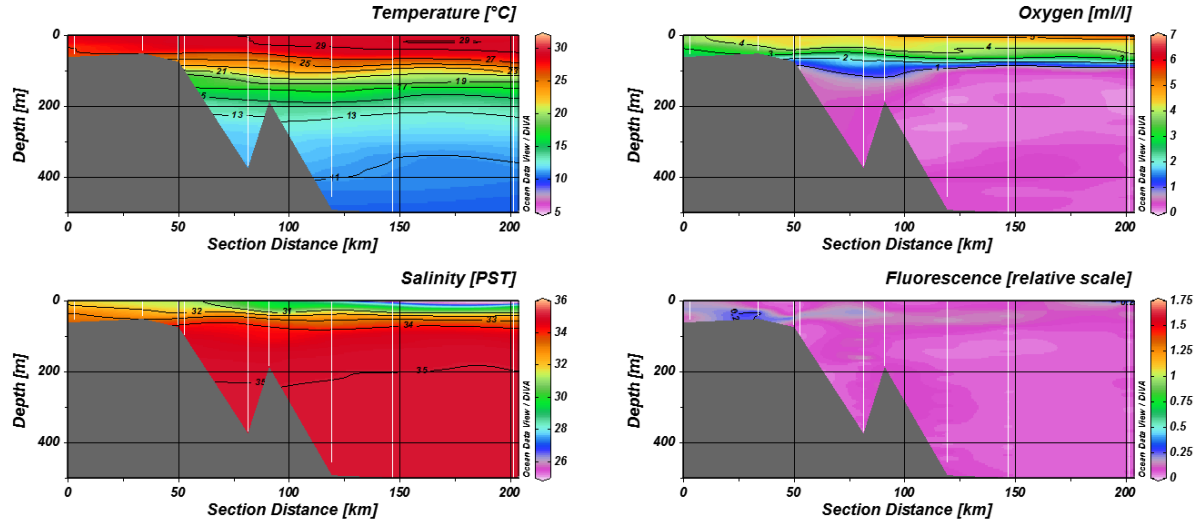


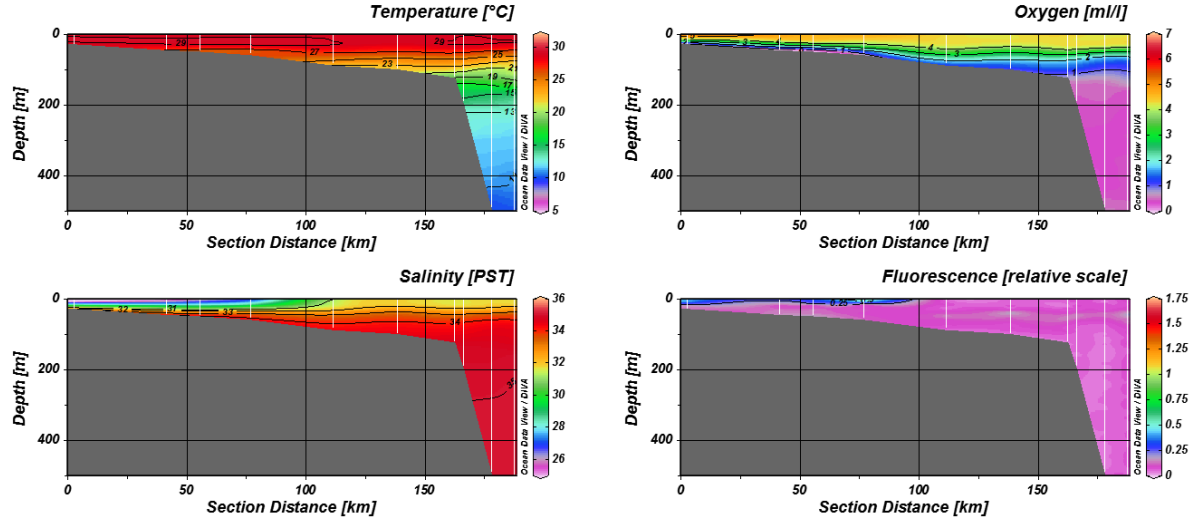
Figure 3. Cross shelf distributions of temperature, salinity, oxygen and fluorescence in the Rakhine Coastal Region. Sections at Phayonika, Munaung, Andrew Bay, Dome Hill and Mawtin Point. CTD stations indicated by white vertical lines. Produced with the software Ocean Data View, interpolating by DIVA gridding (Ocean Data View, Schlitzer, R., http://odv.awi.de, 2013)

The Ayeyarwady Delta Region

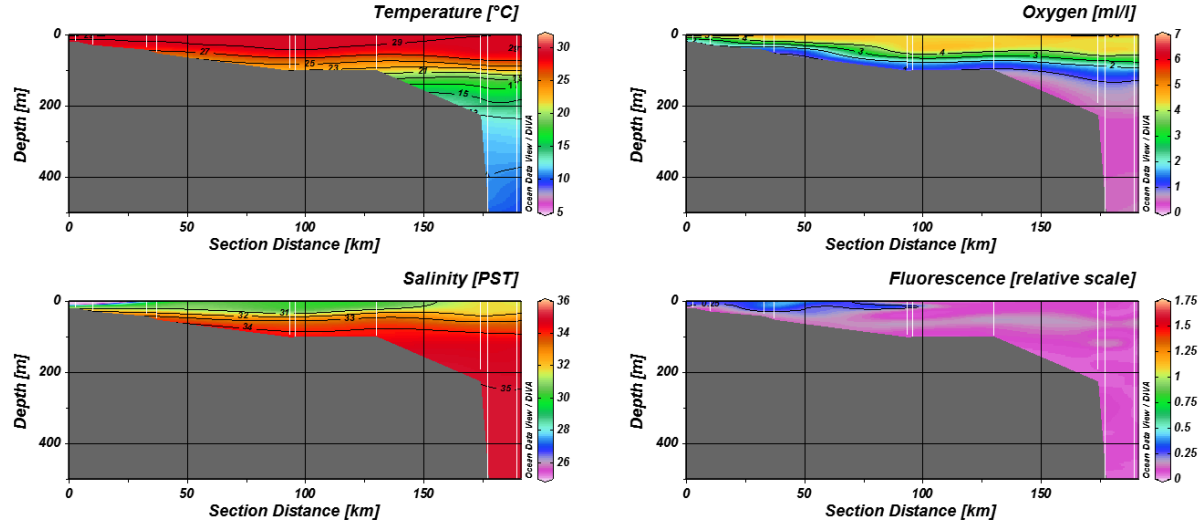
Transect Nicobar



Transect Patheine – west



Transect Pathein – east



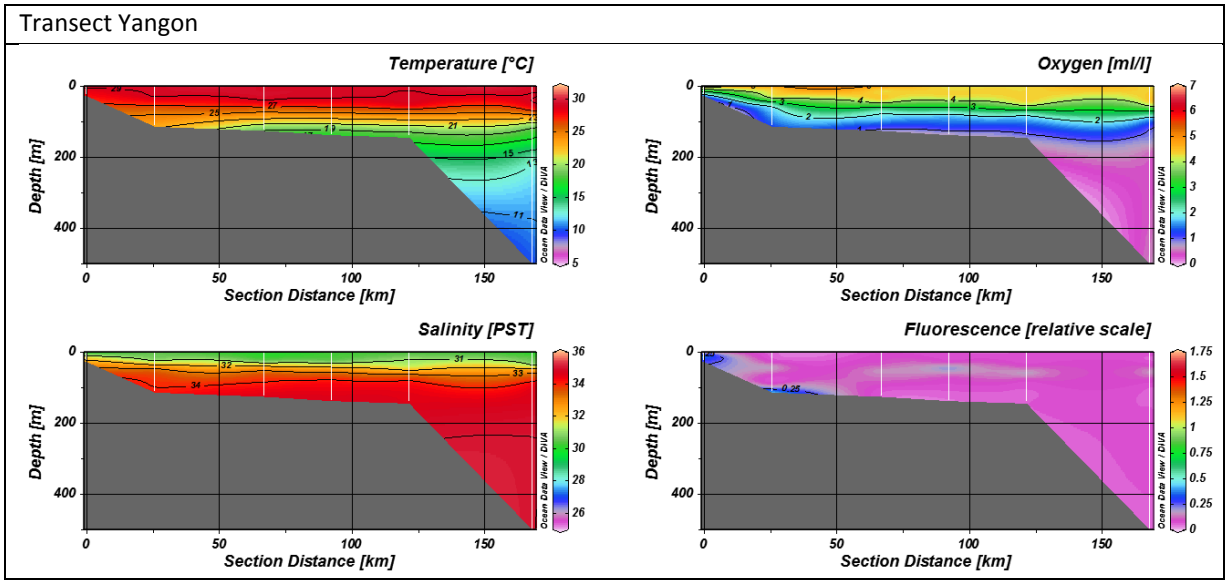
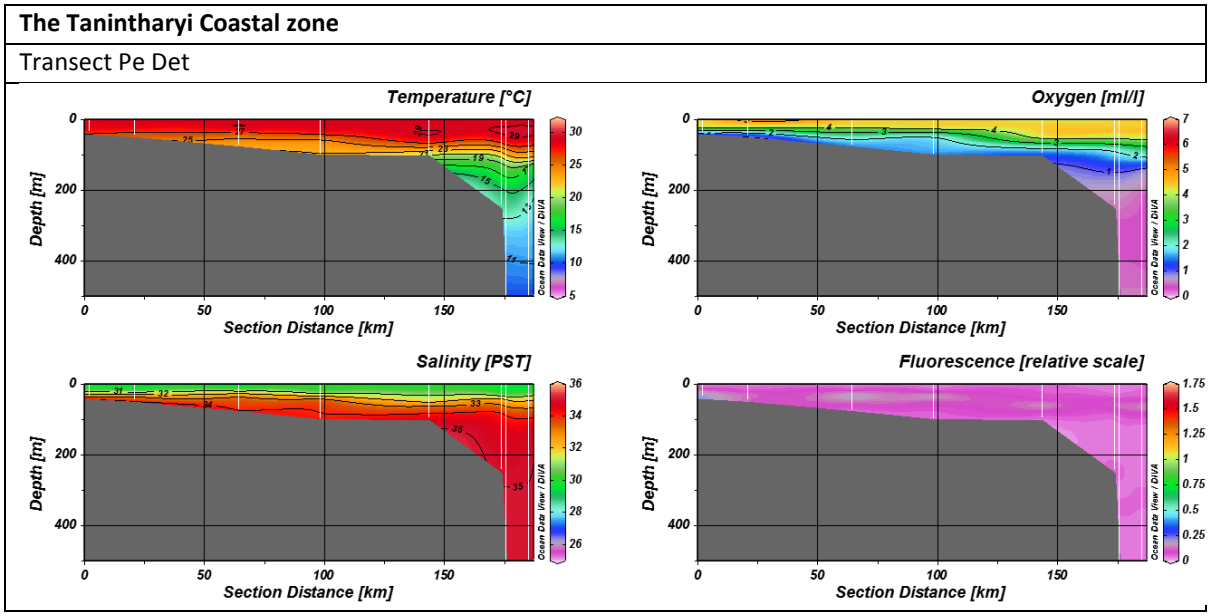


Figure 4. Cross-shelf distributions of temperature, salinity, oxygen and fluorescence in the Ayeyarwady Delta Region. Sections at Nicoba, Pathine, Rear-Pathine, Yangon. CTD stations indicated by white vertical lines



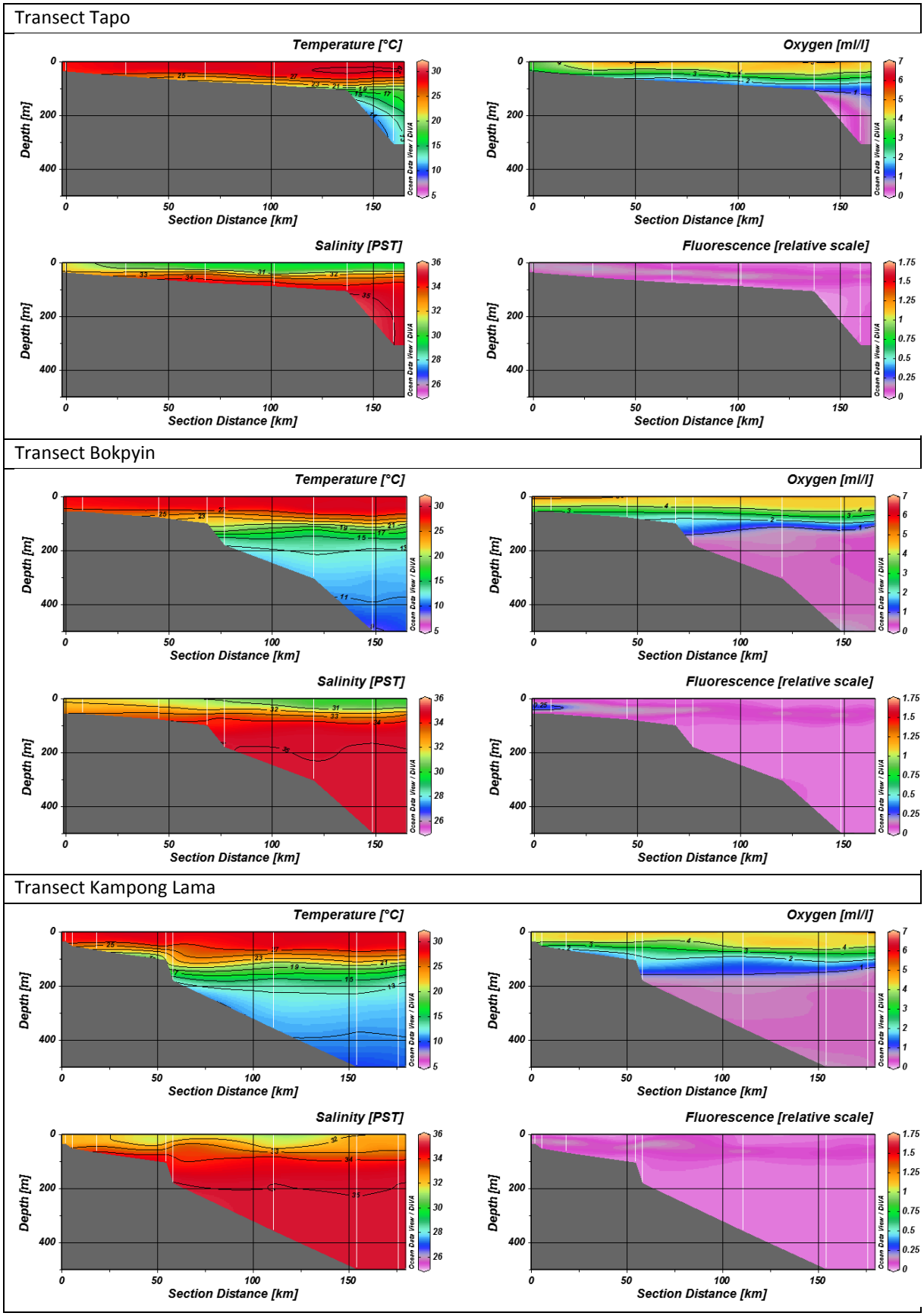


Figure 5. Cross-shelf distributions of temperature, salinity, oxygen and fluorescence in the Tanintharyi Region. Sections at Pe Det, Tapo, Bokpyin, Kampong Lama. CTD stations indicated by white vertical lines.

Zooplankton survey

Zooplankton is the second level of productivity that will support fish production. A previous zooplankton survey was conducted with M/V SEAFDEC-2 February-March 2007. The current RV Dr Fridtjof Nansen zooplankton survey conducted in 2013:

- Had 38 survey stations within the EEZ and along the entire coastline of Myanmar.
- Sampled vertically between three depth ranges (200-100 m 100-30 m 30 surface), using three types of sampling nets.
- Jellyfish larvae, were removed from samples
- Zooplankton identified to genus and species.
- Fish eggs and fish larvae were not included in the study and will be analysed and studied separately
- The biomass of the samples was estimated (but there are not historic data to compare with)

The results of the preliminary analysis were as follows:

- A total of 212 species from 39 taxa were identified.

Table 4. Number of species per area

	No. of species
Rakhine	87 - 108
Delta	60 - 107
Thanintaryi	90 - 183

- Highest concentrations found in the southern Region (Tanintharyi Coast)
- Composition of zooplankton were unique to the three sampling regions, and
- Copepods Calanoids were the most commonly found group; Chaetognaths second most abundant; Urochordates third most abundant
- Compositions of zooplankton in Rakhine were very consistent, with more variation seen in the central (strongly influenced by Ayeyarwady delta outflow) and southern (High salinity, oceanic waters and currents?) regions.
- Relatively consistent amongst sampling stations within the region).
    - Low diversity in Rakhine
    - Central Region
    - True marine species dominate in southern Region
- Fish larvae:
    - In Rakhine waters, Hairtail fish larvae were most abundant
    - In Thanintaryi station 1331 Carangidae, Lutjanidae, Gobidae and station 1319 Scorpion fish, sea horse, Puffer fish, Hairtail
- Acetes (sergestid shrimps) were found in high concentrations.

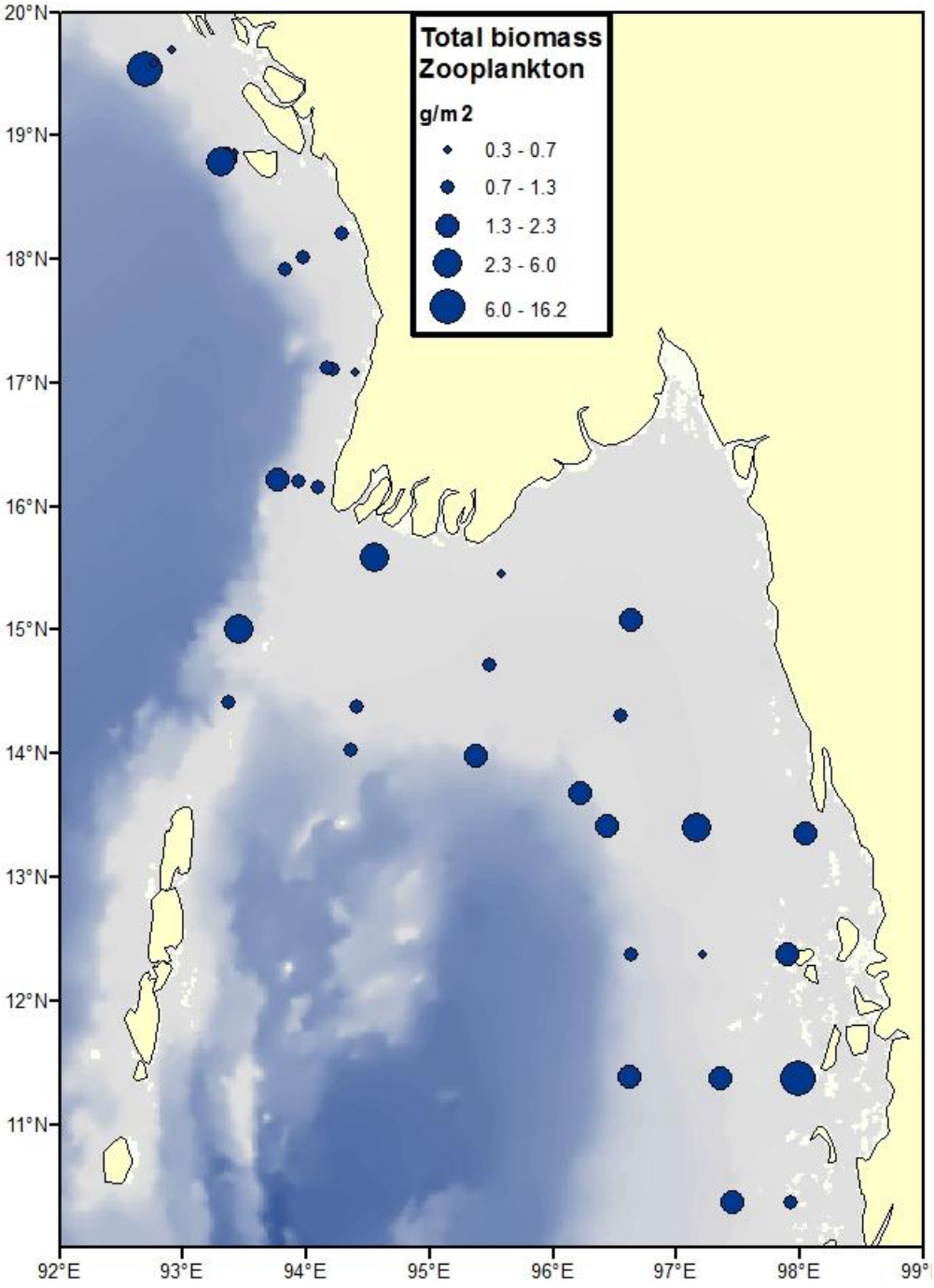


Figure 6. Biomass zooplankton (dry-weight g/m^2) collected with WP2-net along the cruise lines (left)

Conclusions

- Establish a zooplankton monitoring programme (coupled to fish larvae sampling) that collects data regularly throughout the year
- Analysis of fish egg and fish larvae distribution would also be very useful to report to support fishery management
- It is suggested to use a GLM or cluster analysis to link environmental factors to the zooplankton (and phytoplankton) abundance and distribution.
- Consider developing a zooplankton community index as a tool for ecosystem monitoring (e.g. Tett *et. al.,* 2008[2])

General conclusions and recommendations

The evidence: What the survey tells us about the current status of fisheries

- The evidence provided by the pelagic acoustic survey and the demersal trawl surveys indicate that the maximum biomass is probably much lower than expected.
- Comparison of abundance between 1980 and 2013 indicates significant reduction in abundance and distribution of many key commercial species.
- Demersal trawl catch rates (kg/hour) are <20-25% of the 1980 figure.
- An average size of major species has declined.

The evidence: What the survey tells us about the oceanographic and environmental status

- Oceanographic, species distribution and plankton analysis indicates three clear regions with distinct characteristics (Rakhine, Delta area and Southern Region).
- Zooplankton and phytoplankton surveys indicate little change between historic surveys. This indicates that the productivity base remains (e.g. there is no major environmental change or impacts).
- Productivity of these three regions and the environmental health appears to be good.

Implications: What does the evidence mean?

- The current fishing effort (and catch) seems to be well beyond bMSY
- The environmental quality appears to be good and the productivity of the waters of Myanmar indicate a good basis for supporting fish stocks
- The fishery shows strong indications of prolonged over-fishing, but would respond to management measures to rebuild fish stocks
- A stock rebuilding plan, would probably yield benefits within a year due to the resilience and rapid recruitment and growth rates of many of the species
- It is likely that the national marine fishery statistics are over-estimated, beyond what is realistically possible from the national fisheries.

Conclusions: Some actions which could be taken

- Establish some clear management objectives which will address the problem of overfishing, e.g.:
    - Rebuild fish stocks in three regions to 50% of 1980 levels
    - Reduce fishing effort to a level that is commensurate to the bMSY estimated from the 2013 Nansen survey

[2] Tett, P., Carreira, C., Mills, D. K., Van Leeuwen, S., Foden, J., Bresnan, E., and Gowen, R. J. (2008). Use of a Phytoplankton Community Index to assess the health of coastal waters. – ICES Journal of Marine Science, 65: 1475–1482.

- Introduce specific management measures and policies which will address these objectives, e.g.
    - Manage (freeze) national fishing capacity
        - Cap/limit trawl/purse seine fishing vessel numbers
        - Limit specific gears
        - Limit access by foreign fishing vessels
        - Limit numbers of foreign vessels which might be transferred to Myanmar flag
    - Substantially reduce fishing effort
        - Introduce closed seasons
        - Trawl area zoning
        - Power restrictions
        - Gear mesh size measures
    - Enforce more strongly against use of highly impacting gears and methods
        - Especially light fishing
        - Cyanide, dynamite fishing
        - Small mesh size nets; baby trawl
    - Promote improved fishing gears (e.g. JTED, BRD, TED)
    - Improve MCS, licensing and registration of vessels; introduce VMS for larger vessels
- Improve information on the fishery to assist management advice
    - Follow up survey during the monsoon season could improve confidence/accuracy of biomass estimates.
    - Regular fishery monitoring (e.g. trawl surveys with commercial vessels; landing monitoring)
- The detailed catch compositions of the trawl surveys could be used to improve the reporting to FAO.
- The phytoplankton and zooplankton surveys can provide a good basis for a longer term programme for monitoring of environmental quality. This should be linked to more regular fishery surveys.

Capacity building: How can we strengthen the ability of our staff to follow up this survey?

- DOF needs to consider a more comprehensive marine fisheries management service - this could include:
    - Include resources monitoring, statistics collection
    - Fishery management advice
    - Vessel licensing (and registration?) (capacity management)
    - Compliance : monitoring ,control and surveillance
    - Communications/outreach

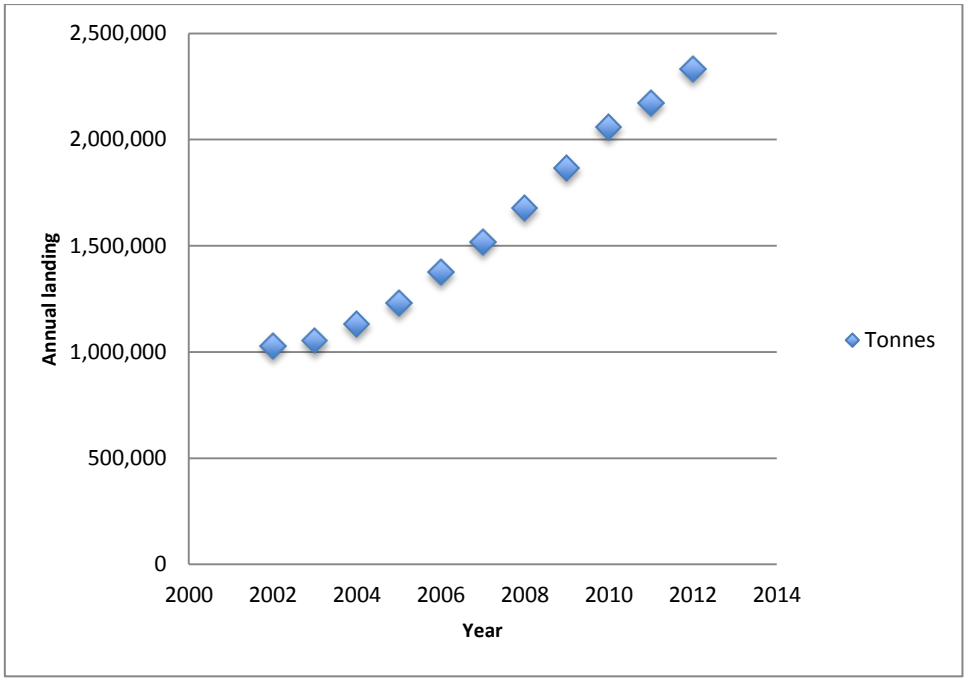


Figure 7. Marine Fisheries catch over the years (Official published fisheries statistics)

Appendix I Short report on high level meeting

The high level meeting was convened on 8 May 2014 at the Summit Parkview and presided over by the Deputy Minister and was joined by the Norwegian Ambassador and the FAO Representative. The meeting participants included the Nansen Chief Scientist, EAF-Nansen Research Coordinator, Senior Fishery Officer FAORAP, Regional Coordinator and Chief Technical Officer (CTA) BOBLME, advisors to the Minster and representatives of the Department of Fisheries and scientists from two universities who had contributed to the survey.

Presentation of survey results

The results of the survey were presented to the high level meeting. Evidence points to greatly reduced biomass in the waters of Myanmar. This is found for both pelagic and demersal species. Echo-sounder information did not reveal large pelagic shoals, relative to the previous surveys. The catch rates in demersal trawls are quite low and the composition of catches indicates strong impacts on longer lived, demersal species that have higher values. There are increases in the shorter lived fast recruiting species which is a typical response when the larger predator species are reduced. The reliability of the data and the estimates (versus previous surveys e.g. MV SEAFDEC-2 and MV Chulabhorn etc.) is good, and the survey leader expressed confidence that these have been derived from good science. It was noted that comparisons from earlier surveys may not be directly possible due to the different method used. The science developed by the survey as greatly contributed to an improved understanding of the marine oceanography and fishery resources of Myanmar and will form an important baseline for future ecosystem work and fishery management.

Discussion

Deputy Minister sincerely thanked the Government of Norway and the Norwegian scientists for the support to the survey of the RV Fridtjof Nansen. He also thanked FAO for its assistance in coordinating the arrangements.

He expressed regret to learn that stocks have been severely depleted over the past 30 years. He noted the need to restore fish stocks, this is clear and need to establish conservation measures. Myanmar has taken some measures to reduce IUU, reduce foreign access and introduce a closed season. There are foreign investors and foreign fleets, looking for access to fish and to develop on-board processing of fish in Myanmar waters. This situation is cause to think about this. Aquaculture is also a strong potential and looking for technical support in that regard.

The Deputy Minister commented on some key national policies:

- Increasing food production and improving food security
- Improving the penetration of Myanmar products into international markets

There are a range of reforms and modernizing policies that are being rolled out by the government. Within this he particularly noted the following which are relevant to the coastal area and fisheries:

- Sustainable management of natural resources
- Human resources development
- Rural development
- Reduction of risks
- Adaptation and mitigation of climate change

The Ambassador of Norway commented that she was looking for a follow up meeting to discuss longer term support by Norway to Myanmar.

The FAO representative, need to enhance the fishery monitoring system to try to keep track on resources, and the impact of management measures.

FAO emphasized the need for a clear goal to improve fisheries (e.g. rebuild stocks and strengthen fishery management). Requests for support should be clearly and logically linked to these goals and expressed in terms of the outcomes that are being sought.

Request from the Ministry of Livestock and Fisheries

The Deputy Minister made a formal request for assistance from NORAD for follow up to the 2013 survey which would contribute to strengthening fishery management and rebuilding of marine fish stocks in Myanmar.

Long term goal: To set up a sustainable national fishery research and management system, that has strong links to international and regional bodies.

In the immediate term: assistance is requested to set up a fish a monitoring system (ecosystem monitoring) for fisheries research to support management actions to stop the decline of fisheries resources and contribute to stock rebuilding measures.

Specific requests*:*

- Assistance to re-establish a marine fisheries resources survey and research unit
- Support to strengthen fisheries management
- Assistance in developing modern mariculture (interest largely focussed on marine carnivorous species and has implications for fisheries and targeting of by-catch/low value trash fish)
- Support to long-term training programme for fisheries scientists and managers

Other assistance that was mentioned covered:

- The development of a fishery management plan for sustainable marine fisheries.
- Support to the strengthening of fishery statistics.
- Improving food safety and quality aspects of seafood to enter international markets (preparation of fishery standards and regulations for export products).

Follow up and next steps

Ministry of Livestock and Fishery

MLF will convene a follow up meeting with Norwegian Embassy and FAO regarding the nest steps which can be made.

A request would be made from the Ministry to FAO, copied to the Norwegian Embassy concerning a possible follow up survey from the RV Fridtjof Nansen.

A second request for bilateral support to strengthen fisheries management would be made to the Norwegian Embassy. These requests should be submitted a soon as possible.

A briefing meeting to be jointly convened by Ministry and FAO inviting development partners to share information on the fishery sector and the potential for support and development (within the context of rural development). A concept note would be The RC of BOBLME and Senior Fishery Officer RAP would provide technical support.

IMR

- Finalize the survey report and submit (by mid-May)
- Further analysis of the data (IMR and Myanmar counterparts)
  - e.g. community analysis

FAO/EAF-Nansen

- Emphasized the need to communicate the findings of the survey effectively
- Will look into possibility to mobilize a second survey by the RV Fridtjof Nansen to:
    - Conduct a pre-monsoon survey
    - To validate findings of the current survey
    - Contribute to a more complete seasonal baseline
    - This would require a specific request from the Ministry to FAO EAF-Nansen, but also requires co-funding

BOBLME

- Noted the importance of communicating the benefits and positive impacts of the survey
- Commended the establishment of a baseline
- BOBLME will review the FAO statistics in Myanmar, to build capacity and strengthen reporting of statistics in fisheries to FAO
- Training of scientists in the ecosystem monitoring techniques has started and will be ongoing
- Further socio-economic information will be collected.
- Support could be given to the formulation of a fishery management plan. This would be supported through a technical mission and in-country consultations.

Consider following up with SEAFDEC to roll-out the EAFM training as part of strengthening of extension/outreach at more local levels. The importance here is that this links the science programme of EAF-Nansen survey to communication of the results to local levels and the linkage to fishery management measures.

Agenda of the high level meeting

Thursday - 8 May 2014	
Morning **09:00 - 12:30**	**Opening session** • Welcome by Myanmar Government (MLF and RD, DoF) • Welcome by FAO Representative • Welcome by Norwegian Embassy/NORAD • Welcome by BOBLME **Main session** • Brief introduction by EAF Nansen/IMR • Presentation on the fishery sector in Myanmar (social and economic significance, trends etc.) by DoF Myanmar • Presentation of survey results • Questions and answers • Discussion of conclusions and recommendations from the survey • Identification of key challenges for translating the results of the survey into policy and management actions <u>Participants:</u> Government representatives, invited others, FAO Representation Office/BOBLME, IMR, Norwegian Embassy
Afternoon **13:30 – 14:30** **14:30 – 16:00**	**Main session (continued)** • Discussion and identification of possible next steps (continued) **Meeting closure** Roundtable meeting on the follow up to the survey results meeting of the RV Dr Fridtjof Nansen (Government of Myanmar, FAO/BOBLME, IMR/EAF Nansen)

Appendix II Summary of the cruise report – RV Dr Fridtjof Nansen

Myanmar

Marine Ecosystem Survey

13 November - 17 December 2013

Back ground

This survey with the Research Vessel "Dr Fridtjof Nansen" in Myanmar came about after a request from Myanmar Department of Fisheries (DoF) to FAO following consultations between the Norwegian Agency for Development Cooperation (NORAD), the Bay of Bengal Marge Marine Ecosystem (BOBLME) Project and the Department of Fisheries (DoF) of Myanmar.

The survey was implemented within the framework of a tripartite agreement between NORAD (on behalf of the Norwegian Ministry of Foreign Affairs), the Institute of Marine Research of Bergen (IMR) and FAO. The survey by the RV Dr Fridtjof Nansen, was conducted between 13 November and 18 December 2013 and covered the shelf and slope from the border with Bangladesh in the north to the border with Thailand in the south.

Objectives

The main objectives of the survey were set as follows:

- To obtain information on demersal fish abundance and biodiversity by demersal trawling where conditions for bottom-trawling are adequate
- To determine the distribution and abundance of small pelagic fish resources using acoustic methods and a systematic grid survey strategy
- Additional biological sampling from trawl catches to collect data on size distribution, further biological information and genetic material from selected species
- To establish as far as possible the distribution, abundance and composition of other taxa at different trophic levels along the shelf (phyto and zooplankton, fish eggs and larvae)
- Map the environmental conditions in the survey area (temperature, salinity, oxygen, chlorophyll, nutrients and sediments)
- Capacity building of BOBLME trainees and young scientists

Participation

A total of 24 scientists and technicians from Myanmar and Norway participated in the survey.

Present results

The cruise results demonstrate marked spatial patterns in near-surface temperature, salinity, oxygen-levels and relative fluorescence within the Myanmar Coastal region. All four variables display clear spatial dynamics, and in some areas also strong horizontal gradients. Most notable are the comparatively warmer upper water-masses along the Rhakine Coast, the more saline upper water masses in the southern part of Myanmar Coastal Area, as well as the high-fluorescence area in the Ayeyarwady Delta Coastal region. Our results also show low-oxygen waters with concentrations as low as about 1 ml/l dissolved oxygen in many cases reaching shelf-depths as shallow as ca. 100 m.

Nutrient concentrations generally varied strongly with depth, and particularly nitrate, silicate and phosphate concentrations spanned great ranges. Nitrate and phosphate levels were generally very low in the surface, increased with depth, and could reach very high levels at the depths of 500 m. Silicate concentrations also tended to be low near the surface, though not depleted, and increased to very high values at depths of 500 m. In contrast, nitrite displayed a different vertical distribution from the three other nutrients here described. Nitrite concentrations were typically highest at depth of ~ 50 m, never surpassing values above 0.7 µmol l-1 at any station or depth. Nutrient

concentrations in the surface-near layers were generally higher at near-shore stations than at stations located further away from land.

Chlorophyll a levels were generally low to moderate, depending on location and depth. Considering all stations and depths within the entire survey area, the range of values spanned between 0 and 3.4 mg Chlorophyll a m-3. Chlorophyll concentrations in surface-near layers were generally highest at the innermost stations near the coast. A few "extreme" values between 2.1 and 3.4 mg Chlorophyll .a m-3 were observed near the coast, comprising 2 stations in the Ayeyarwady Delta region as well as one coastal station further south in the Thanintharyi region. For the stations with bottom-depths of 100 and 500 m, the chlorophyll values were generally low near the surface, and showing the highest median values at sampling-depth of 50 m (ca. 0.3 mg Chlorophyll a m-3). The concentrations would thereafter decrease with depth down to 200 m.

Fish abundance

Abundance of pelagic and demersal fish is reported from the region covered by the survey- generally the depth region between 20- 500 m depth covering the shelf of Myanmar from approximately. 19°30' N in the north to the border with Thailand at 10°00' N in the south, see Figure 1.1. Regions with heavy fishing activity, like parts of the delta area, or inshore of 20 m depth was not covered, and the reported abundance estimates does not include those areas even though we are aware that there are important fishing grounds also inshore. However, experience give reason to believe that the catch rates reported for the survey is also reflected in more shallow regions.

The acoustic biomass estimates of pelagic fish was estimated based on an average fish length of 10 cm, and separated in two species groups, Pelagic 1 and pelagic 2. Based on this a total estimate of 109 000 was estimated. Of this approximately 1/3 (35 000 tonnes) was clupeids and anchovies (Pelagic 1), while the rest consisted of carangids and associated species. The highest abundance of fish was found in the delta area, however, pelagic fish was in general scattered and showed low abundance.

The total swept area biomass estimate (Table 1) based on valid bottom trawl hauls was estimated to be 280 000 tonnes. Of this the Rakhine Coastal zone had an estimate of 60 000 tonnes. The Deltaic cost gave a total biomass estimate of 101 000 tonnes while the Tanintharyi coast showed the highest overall biomass estimate of 112 000 tonnes.

Table 1. Summary of biomass estimates from the different regions and depth strata estimated during the survey

Depth/Region	Rakhine Coast	The Deltaic Cost	The Tanintharyi Coast
20-50 m	31 000	31 000	12 000
50-100 m	19 000	40 000	47 000
100-200 m	4 900	19 000	10 000
200-500 m	5 200	11 000	43 000
Total	60 000	101 000	112 000
Grand Total	280 000		

A more detailed classification of the ecosystem is outside the scope of this cruise report but can be done based on the results and data collected through this survey. However there is evidence from the survey of strong separation between three main ecological regions separating the coastal shelf of Myanmar both in relation to oceanographic characteristics and fish distribution, and also a strong depth separation in relation to the same. The ecosystem in general has strong signs of overfishing/other changes indicated by a general lack of long lived species and considerable lower biomass estimates compared with the findings from the four surveys in 1979 and 1980. These results should be corroborated by any additional information that may be available as regards trends in catch and effort statistics.

Recommended follow up work

The present survey has provided valuable insights and information on the state of Myanmar marine ecosystems and resources. In particular, there seems to be evidence that fish stocks may be overfished, although it is noted that it would be important to carry out another survey during a contrasting season considering that productivity and fish abundance may be subject to seasonal cycles and or migrations.

Key recommendations in relation to the scientific work include:

- Carry out a new survey in Myanmar waters in a contrasting season to validate results obtained during December 2013.
- Complement the information obtained through the surveys with other knowledge (including fishers' knowledge). It is important that the information obtained through the surveys is put into context in relation to fisheries management objectives and related knowledge needs.
- All data collected during the survey belong to Myanmar (these were handed over by the end of the survey). Efforts should be made to further explore the data collected. These could be used to further characterize marine ecosystems and resources of Myanmar, become the basis for several scientific papers, Master and PhD studies. It is strongly recommended that FAO (including BOBLME) and IMR initiate a dialogue with relevant institutions in Myanmar to further explore possible scientific activities based on the data collected by the Dr F. Nansen.
- The data collected during this survey should be used for additional analyses to contribute to building an ecosystem characterization, including identification of sensitive/critical habitats or to develop indicators for future resources and ecosystem monitoring.
- Fish egg and larvae samples were not analysed at the time this report was produced. It is recommended and agreed during the post survey meeting that the Mawlamyine University would follow up this. It is important to get a better understanding of fish spawning areas and larval drift in Myanmar waters.
- These investigations showed that several species of poisonous phytoplankton were present. It will be important in the future to establish regular (weekly or monthly) routine monitoring of both zoo and phytoplankton to understand variability in species composition and abundance, and to be able to warn future aquaculture facilities against red tide conditions. Several locations along the coast should be selected for this monitoring.
- Several years ago FAO took the initiative to prepare a fish identification guide for Myanmar. However the guide book is still pending. It is strongly recommended that this work is resumed to improve species identification for both official and recreational use in this country. The work should be carried out in close cooperation with national institutions.
- Baseline studies in relation to oil exploration activities are recommended as a reference/baseline to monitor possible changes caused by this industrial activity.
- Sediment samples are in the custody of the BOBLME and will be analysed in Thailand. Results will be presented to the Department of Fisheries separately from this report. These can also be part of the above mentioned base line studies.
- Likewise fish genetic samples collected are yet to be analysed and results will be presented to Department of Fisheries separately from this report.

Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka and Thailand are working together through the Bay of Bengal Large Marine Ecosystem (BOBLME) Project to lay the foundations for a coordinated programme of action designed to better the lives of the coastal populations through improved regional management of the Bay of Bengal environment and its fisheries.

The Food and Agriculture Organization (FAO) is the implementing agency for the BOBLME Project.

The Project is funded principally by the Global Environment Facility (GEF), Norway, the Swedish International Development Cooperation Agency, the FAO, and the National Oceanic and Atmospheric Administration of the USA.

For more information, please visit www.boblme.org

Food and Agriculture Organization of the United Nations

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