TECHNICAL REPORT No. 01 – COMPENDIUM OF STOCK ASSESSMENT TRAINING AND COURSES IN THE IORA REGION

'TECHNICAL ASSISTANCE TO IORA FOR THE IMPLEMENTATION AND COORDINATION OF IORA ACTION PLAN ON FISHERIES, AQUACULTURE AND MARINE ENVIRONMENT'

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ABBREVIATIONS AND ACRONYMS

ABNJ	Areas Beyond National Jurisdiction
APFIC	Asia-Pacific Fishery Commission
BOBLME	Bay of Bengal Large Marine Ecosystem
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CIFE	Central Institute of Fisheries Education
CMFRI	Central Marine Fisheries Research Institute
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DIFS	Department of Ichthyology and Fisheries Science
DPIRD	Department of Primary Industry and Regional Development
ESSO	Earth System Science Organization
FAO	Food and Agriculture Organization of the United Nations
FIDEA	Fishing Data East Africa project
ICAR	Indian Council of Agricultural Research
ICLARM	International Center for Living Aquatic Resources Management
IFREMER	Institut français de recherche pour l'exploitation de la mer
IIP	National Institute for Fisheries Research
INCOIS	Indian National Centre for Ocean Services
IO	Indian Ocean
IORA	Indian Ocean Rim Association
IOTC	Indian Ocean Tuna Commission
MARAM	Marine Resource Assessment and Management Group
MoU	Memorandum of Understanding
MS	Member States
MSc	Masters in Science
NGO	Non-Governmental Organisation
NOAA	National Oceanic and Atmospheric Administration
NPO	Non-Profit Organisation
PhD	Doctorate of Philosophy
RFMO	Regional Fisheries Management Organization
SEAFDEC	South-East Asian Fisheries Development Centre
SWIOFC	South West Indian Ocean Fishery Commission
UBC	University of British Columbia
WAFMRL	Western Australian Fisheries and Marine Research Labs

1. Summary

Management of fisheries resources requires knowledge of the size of the resources and the extent to which they can sustain exploitation. Assessing these components is known as stock assessment, a process which generates scientific recommendations for managers and decision-makers. In response to expressed needs by Member States of the Indian Ocean Rim Association (IORA) for stock assessment capacity building, a compendium of entities capable of providing stock assessment training at a variety of levels was produced, including synopses of their capabilities and contact details. Regional (west, north and east) centres of excellence were identified, which are particularly suited to building such capacity, depending on specific needs. Recommendations are made regarding the various types of stock assessment training which could be provided to undergraduate students, scientists and managers in IORA countries.

2. Introduction and methodology

The Indian Ocean Rim Association (IORA) and France through the Agence Française de Développement (French Development Agency) (AFD) signed a Memorandum of Understanding (MoU) on the 9th March 2020 for "Strengthening the Capacities of IORA in Promoting the Blue Economy and Fisheries Management".

The partnership will support the implementation of the IORA Action Plan (2017-2021) with an allocation of EUR1 million over three years. It will offer expertise, training, networking and material resources to decision makers, officials and experts working to promote regional cooperation in blue economy and fisheries management issues. In addition, the project will strengthen the capacity of the IORA Secretariat.

The overall objective of the technical assistance (TA) is to "support IORA and its Member States in the coordination and implementation of the Action Plan on Blue Economy and Work Plan of IORA CGFM, with a strong focus on fisheries, aquaculture and protection of marine environment."

One of the specific objectives of this project is "to promote sustainable fisheries management". In the context of this objective, the activity 2.1 "Initiate a Capacity Building programme in fish stock assessment" is planned as part of the IORA Action plan.

The methodology adopted within that activity is to produce a compendium of existing institutions in the IORA region that provide stock assessment courses or related facilities largely from available internet and public sources . Also, to separately seek information from IORA Member States (MS) on their existing capacities and needs for stock assessment capacity within a concise questionnaire sent to IORA MS focal points through the IORA Secretariat so that these can be analysed in relation to available facilities to provide the basis for the development of a capacity programme. Such a programme would have to be in collaboration with the regional fisheries organisations and relevant institutions over the longer term (> 3 years).

The questionnaire was developed by the Main Resident Expert of the project with assistance of a Fisheries Management expert recruited under the Study Fund. It was sent to the IORA MS in October 2020 through the IORA Secretariat and will be the subject of a separate analysis and report when sufficient responses are received. In January 2021, the level of response from the IORA MS was 45%.

The present report starts with a background to stock assessments, what they are and their importance to sustainable fisheries management. It follows with the approach used to collect and collate

information for the report. An overview of the results is subsequently provided summarizing the entities found and their distribution across countries and institutions. This section makes reference to four appendices within which the various entities are presented with their internet links to provide easy and comprehensive access to the reader, depending on the reader's particular interest. They provide profiles of entities in Indian Ocean countries which have capacity to provide stock assessment training, examples of under/post-graduate stock assessment courses, centers of excellence for stock assessment training, and examples of recent short training in stock assessment undertaken in the IORA region. The report continues with suggestions on how countries could increase their human and institutional capacity in stock assessment and is followed by the possible role of IORA in this process. Finally, the report makes some concluding observations and comments.

3. Background

Formal stock assessments are typically a combination of mathematical and statistical models that are used to estimate stock (resource) abundance and to predict the response of the stock to harvesting pressure. Fish (fisheries) stock assessment is required to be undertaken when management agencies or states have to make decisions about suitable levels of allowable harvesting in order to ensure long-term sustainability of resources. Without stock assessment information, there is substantial risk that resources will be over-exploited, resulting in economic losses and/or declines in food availability for humans, as well as wider ecosystem effects driven by declines in species caught by fisheries. Stock assessment can also provide spatial and temporal information to assist in allocating equitable access to resources (between countries, and also between the various fisheries sectors which access the resource). Such decision-making is particularly complicated when a resource is shared between several countries or occurs in the high seas in Areas Beyond National Jurisdiction (ABNJ).

To interpret data needed for stock assessment and management, knowledge is needed of resource population processes (e.g. growth, natural mortality, and recruitment), and of the fisheries (e.g. selectivity, catches), and of appropriate data sampling processes. Unfortunately, there is a lack of understanding of these aspects for most stocks, and there is a lack of relevant and reliable data needed to assess the status of all stocks. Further, the lack of stock assessment scientists and the consequent lack of directed technical effort are obstacles to assessing all stocks and to improving fisheries management - there is a lack of critical mass due to the specialized nature of stock assessment. This is however not a situation unique to the Indian Ocean, it is a global problem. One way to start overcoming this is via collaboration among institutions, and IORA is attempting to promote this, following the indication by numerous IORA countries of their need for capacity building in stock assessments as expressed in the IORA Working Group on the Blue Economy[1]. A first step is to determine what stock assessment capacity exists in the IORA region and what institutions are able to provide capacity building. To this end, a questionnaire survey on local assessment capacity and needs was distributed to IORA MS, and a compendium of IO institutions with stock assessment training capacity was produced - the latter is the subject of this document.

1 First Meeting of the Working Group on the Blue Economy, Mauritius, 5-6 December 2019. Final Report. IORA Secretariat.

4. Approach

There were several approaches used to identify entities in the IO involved in stock assessment training, or which have related facilities/capacity. First, a focussed internet search was undertaken on Google, Google Scholar and Research Gate using the search terms “Indian Ocean”, “stock assessment” and “stock assessment course”, limited to the years 2015 to 2020. Then the search was repeated for each IORA country individually. The websites of entities identified this way either provided adequate information, or, if information was not available, email addresses were available for contact persons who are responsible for, or are involved in, stock assessment and/or training. These persons were emailed to determine the stock assessment training capacity of the entity to which they are affiliated/belong.

The responses from questionnaires distributed to IORA MS on stock assessment capacities that had been received were also followed up for possible links to entities - sometimes these responses listed universities or other institutions in their capacity section. To the extent possible these were followed up also through internet searches making use of Google translating facilities to search for key words in the national languages. Thirdly, the Fisheries Management Expert[2] and the Main Resident Expert[3] of this technical assistance project have knowledge of entities which have stock assessment capacity in the Indian Ocean; the websites of these entities were consulted to establish details of their involvement in training, and in some cases, individuals at these entities who are known to the Experts were approached directly for information. Finally, in order to broaden the search, the terms: "fish resources assessment" or “fisheries assessment”, and "Indian Ocean", were used in a Google Scholar search, and the websites of additional likely entities produced by these searches were examined for their stock assessment capacity. If any IORA MS were still missing in the list at this point, a Google search using “marine science/biology” and “country name” were used to identify possible entities there. The information gathered was captured in an Excel spreadsheet, and the findings are provided below and in appendices.

5. Overview of Results

Of the 27 entities identified from the initial focussed internet searches, 21 were emailed for information to supplement that on their websites - 7 responded, providing varying levels of information, mostly of a qualitative nature. Information from a further 18 entities known to the Experts was obtained independently, and another 12 were added via the broader subject searches or were listed by IORA MS in questionnaires or other communications i.e. 55 entities from 21 countries were identified, of which 33 from 13 IORA countries (Table 1) currently undertake or have recently provided stock assessment training in the Indian Ocean region, or have the potential capacity to present some level of training. The remainder (9 IORA countries[4]) have some involvement in stock assessments but do not appear to have capacity to provide training. Note that it is possible that there are other entities which present courses on, or related to, stock assessment and which were not identified during the searches – perhaps because of language or terminology issues, or because stock assessment training

2 Dr Sean Fennessy, Oceanographic Research Institute, Durban, South Africa.
3 Mr Aubrey Harris, Main Resident Expert, Technical Assistance Project for the Implementation and Coordination of the IORA Action Plan in fisheries, aquaculture and the marine environment.
4 Comoros, Madagascar, Maldives, Seychelles, Singapore, Somalia, United Republic of Tanzania, United Arab Emirates and Yemen.

capacity is not clearly identified in the main webpages of these entities, or because webpages were not accessible/non-functional – perhaps due to COVID.

Table 1: IORA countries and the number of their entities which have, or potentially have, or recently had, capacity to provide stock assessment training at some level (including university undergraduate courses).

IORA country	No.
Australia	12
Bangladesh	2
India	4
Indonesia	2
Iran	2
Kenya	1
Malaysia	1
Mauritius	1
Mozambique	1
Oman	1
South Africa	4
Sri Lanka	1
Thailand	1

Note that Regional entities/projects based in countries are not included here.

The nature of an overall 41 entities with training capacity is diverse, with national institutes and universities dominating (Table 2). Note that entities which have training capacity, but which are not based in the IO region (e.g. NOAA, University of British Columbia) are not listed here, nor are private/consulting companies, but their potential role is explored later. Of the 41 entities, 33 can be considered National, comprising universities or institutes/departments etc; 8 are Regional fisheries bodies/organizations/ projects. Brief descriptions of these entities and their involvement in stock assessment training are provided in Appendix 1.

Table 2: Entities based in the IO region which have, or potentially have, or recently had, capacity to provide stock assessment training.

Entity type	No.
National Institute	12
Research Institute	3
University	10
University institute	4
National Departments	4
Regional fisheries entities/projects	8

Most of the university/university institutes identified offer annual courses in stock assessment to their own undergraduate and/or postgraduate students, as part of the curriculum for a marine science degree. The courses range from basic to fairly advanced as students progress through the system (see Appendix 2 for examples), and are mostly presented by university staff, occasionally with contributions from experts from other institutions. Some universities accept foreign students, although it is not always explicitly stated. Some university staff are involved in stock assessments as research projects.

Identified national departments undertake applied fisheries research and are generally part of ministries of agriculture/fisheries, to which they provide management advice on stock status. They may have both stock assessment research capacity and training capacity, or have their own research institutes with this capacity; additional training capacity may be sourced from other entities if required. Training is not always via formal courses and is not routinely carried out, but is provided inhouse as needed. Some of these national departments/institutes are extremely capable (see Appendix 3) and sometimes accept external requests to present training courses; these courses can be customized for students, scientists or managers. Frequently, staff at national departments/ institutes participate in regional stock assessment activities as well as in training which is co-ordinated by regional fisheries entities.

Most of the regional entities with training capacity are advisory/management bodies, promoting sustainable utilization, management and development of living marine resources. Some focus on coastal fisheries, others on high seas fisheries which are more complex in terms of stock assessments owing to their shared nature. They are mostly permanent bodies, although there is one regional project which has been running for several years, and one project which concludes soon. Several of the regional entities have branches/units located in different countries, with some level of separation of specialization. Stock assessment training capacity is not always located within the entity itself, but may draw on scientists/experts from member states or from extra-regional bodies or institutions. Courses are held irregularly, and vary in level of complexity (examples in Appendix 4). Some have funds assigned for capacity building in order to ensure compliance with conservation and management measures, and data requirements. Several of the regional entities operate under the aegis of FAO, which can be seen as an extra-regional (global) player, having stock assessment training capacity in its own right, and has run training courses in the IO (Appendix 4).

Not listed in the compendium are other extra-regional entities which are capable of presenting, or have already presented, stock assessment training courses in the IO on an ad hoc basis. These include several fisheries research facilities located in the Americas and Europe, such as NOAA, University of British Columbia, and CEFAS[5]. Also not listed are several private companies which have capacity for and interest in presenting stock assessment training on a consultancy basis. The impression from the compendium could be gained that there is considerable capacity in the region; however, considering only those entities which can be explicitly identified as having presented training courses using their own staff, excluding university courses, then only 10 entities have this capability; several of these are described in Appendix 3.

5 https://oceans.ubc.ca/research/research-themes/ ; https://www.fisheries.noaa.gov/topic/population-assessments ; https://www.cefas.co.uk/

6. Suggestions how countries could increase their human and institutional capacity in stock assessment

Most fisheries scientists and managers come through a university system which exposes them to basic fisheries and stock assessment concepts at undergraduate level while studying for a marine science degree. These courses have a role in encouraging the interest of young undergraduates to pursue a stock assessment career. Those graduates who have aspirations to focus on stock assessment continue to study this subject further at postgraduate level, assuming they have the means and access to a university which offers this advanced training. If they do not have access to such facility, and they commence work at a national fisheries institute, they will be poorly equipped to undertake stock assessments. Prospective managers who continue to study further (to obtain financial and administrative skills) likely will also not be exposed to stock assessment again until they start work, and will be poorly prepared for this. This explains the frequently-expressed requests from member states for stock assessment training.

It is important to recognize that there are two different types of stock assessment training – one to enable people (scientists) to undertake stock assessments so as to make recommendations for management, and one to enable people (managers, fishers etc.) to understand the outputs of stock assessments so as to make input on management decisions. To undertake a stock assessment requires a considerable level of numeracy (mathematical ability), particularly for advanced assessments. And, formal stock assessments require considerable amounts of high quality data which are often lacking for the non-industrial fisheries which predominate in the IORA region. This latter issue has been recognized, with FAO organizing workshops for participants to undertake assessments for data-poor fisheries, for example using Productivity Susceptibility Analysis and weight of evidence approaches. IORA member states which express the need for stock assessment training need to consider the type of training they require and provide the appropriate level of detail about this.

There is little to indicate that courses for training of decision-makers and managers on how to interpret stock assessment findings and results have been held in the region, apart from one presented by MARAM in 2017. Interestingly, the premise for the course was that most fisheries scientists do not necessarily carry out detailed stock assessments themselves (recommended that these are done by applied mathematicians – see below), but they do need to be able to contribute - particularly with regard to data considerations, development of assessments, and interpretation of their results, particularly in the context of management. The purpose of the 2017 course was to assist scientists, managers and industry to interpret results of stock assessment analysis, and in particular to understand what aspects to focus on and what questions they should be asking those who did the assessment. The course was attended by around 40 fishery scientists, managers and other stakeholders (e.g. fishing industry executives), mainly from South Africa but also Angola, Namibia and Mauritius. They focussed on stock assessment overview and results interpretation, rather than on technical details of stock assessment itself, and generated much discussion and positive reactions from participants. The course presenters believe it is better to hold courses on how to ask questions about stock assessment results (rather than running short training courses on how to do stock assessments), so that scientists/managers/decision-makers are better equipped to interact in scientific fishery meetings which develop management recommendations.

There is a perspective which maintains that short training courses for life science students in the fundamentals of stock assessment are a waste of time, as these courses usually do not have enough time to include adequate mathematical content to enable participants to understand stock assessment

concepts (Maunder and Piner 2015)[6]. And life science students frequently do not have the interest, numerical aptitude and skills to pursue stock assessment as a speciality. Applied mathematics graduates are needed for stock assessment, but there are very few universities in which such graduates are provided with fisheries stock assessment research opportunities. A 1-year post-PhD diploma programme has been suggested as the quickest way to train the stock assessment scientists needed and may require collaboration between several facilities to provide mentoring and practical experience (Maunder and Piner 2015). Note that this was suggested in the context of northern hemisphere, first-world nations where there is considerably more stock assessment training expertise available, but it may be a useful model for IORA to promote – at least for increasing capacity of scientists from IO MS to undertake formal stock assessments. An alternative is to promote thesis-based MSc degrees with a strong stock assessment focus, and with suitable supervision from appropriate specialists in this field.

Based on the information gathered for the compendium, it is apparent that there are three geographic centres of regionally-available expertise for stock assessment training in the Indian Ocean: western (South Africa), northern (India) and eastern (Australia). Of these, the only centre that currently regularly hosts training for non-students is India. The western and eastern centres do not regularly present courses, possibly because they do not consider effort spent in preparing and presenting such courses to be worthwhile - participants return home and there is limited critical mass at their home institutes to implement learnt techniques, or their local data sets are inadequate to undertake assessments. Additionally, some of the scientists at these centres who are capable of presenting stock assessment training are busy enough undertaking assessments without giving up time to conduct training. This suggests that there may be scope for a dedicated training facility which runs regular training courses (other than for students), and which is accessible to candidates from the IO region. The entities which already have excellent training facilities, and which have positioned themselves to offer stock assessment training to foreign participants, are presented in Appendix 3 - these would be a logical starting point for IORA member states to consider if they have candidates requiring training.

The aforementioned are possible options for regular training and highlighting them is not meant to diminish the role of the other entities which also contribute to stock assessment capacity building in the region. FAO (and its commissions etc), SEAFDEC, BOBLME and Worldfish all run and/or facilitate training, but their courses are held on an ad hoc basis. It is anticipated that they will continue to do so, ideally by way of contributing training expertise or other support (funding, course materials) to more regular training. It is apparent that, more often than not, there are multiple entities and stakeholders which collaborate in order to ensure that training courses take place. Also not excluded is the contribution of expertise from extra-regional facilities which specialize in stock assessment training, such as NOAA and UBC.

6 Maunder, M.N. and Piner, K.R. 2015. Contemporary fisheries stock assessment: many issues still remain. ICES Journal of Marine Science 72(1): 7-18.

7. Role of IORA

There is little IORA can do regarding university undergraduate level stock assessment training on a regional basis – individual universities will have their own priorities and capacities. However, there is scope for IORA to provide support for regular postgraduate courses in stock assessment for worthy candidates from the region, and for training of fisheries managers in this field – to be hosted at the capable entities described in Appendix 3. This support could be at a variety of levels: Regularly determining demand for such courses by issuing calls for expressions of interest from candidates; contributing to the list of topics to be covered in courses; and soliciting and/or providing funding for running of courses and supporting candidates' attendance. IORA could thus be a facilitator and promoter of improving capacity – by regularly updating information on availability and types of training capacity, as well as guiding Member States to suitable providers of training.

The exercise of providing information, overview and raising the awareness of MS to relevant courses and centres of excellence could be extended, too. Through the direction of the Cluster Group for Fisheries Management, IORA could partner with a key regional provider in organising stock assessment training aimed at those countries with particular requirements that are reflected in their feedback from the stock assessment capacity questionnaires. It may include the possibility of a long-term regional programme with IORA member and partner support. To develop such a programme would require further collation, analysis, liaison with a member or partner, and programme formulation and funding.

Since Universities are the main repository of this knowledge and training over the long-term, there should perhaps be a role for the Academic group. The initiatives for the Chair of Indian Ocean Studies, and University Mobility in the Indian Ocean Rim (UMIOR) are relevant in this respect. There may be merit in IORA identifying suitable applied mathematics students from the region, and initiating a regional centralized post-graduate specialist stock assessment course, with training by experts from South Africa and Australia, and IORA Dialogue Partners US, UK, China, France (IFREMER, NOAA, UBC, MARAM, CSIRO), and FAO. That would address formal stock assessment training.

8. Concluding observations and comments

Introductory courses on stock assessment are quite widely available at universities in the IORA region, as part of general undergraduate marine biological courses. These provide a taste of the skills that are required to undertake assessments. However, undertaking formal assessments requires a high level of numeracy, and is best done as part of postgraduate research projects by applied mathematics graduates under the guidance of experienced supervisors – as opposed to short training courses which have little impact in the long term. Having said this, though, there is scope for the establishment of a regional post-graduate extended course in stock assessment, which could be hosted by one or more of the regional centres of excellence. There is also scope for shorter courses aimed at fisheries scientists, managers and decision-makers, which would provide the background and principles of stock assessment, enabling participants to understand outputs and recommendations generated by stock assessment analyses – as opposed to actually undertaking actual assessments - thus enabling these stakeholders to be better informed as to how use the information provided by experts, in the interest of national and regional agendas. IORA Member States should be guided as to how to more explicitly describe the level of stock assessment capacity-building required, and who it is aimed at.

9. Appendices

Appendix 1: Brief profiles of entities in Indian Ocean countries which have, or potentially have, or recently had, capacity to provide stock assessment training.

Official email contacts are provided. Entities are listed alphabetically by country and alphabetically by entity within country.

NATIONAL ENTITIES

Australia

Centre for Marine Science and Technology, Curtin University

Undergraduate course includes modules delivered by staff actively researching a variety of fields including sustainable fisheries. Staff have undertaken individual species' stock assessment projects, so are capable of presenting assessment training. https://scieng.curtin.edu.au/schools/school-of-molecular-and-life-sciences/ecology/coastal-marine-science/ Contact: MLS-Admin@curtin.edu.au

Centre for Sustainable Tropical Fisheries and Aquaculture, James Cook University

Undergraduate and postgraduate (MSc) courses in stock dynamics, use of population models and fisheries management tools. Research includes maximising social, environmental and economic benefits of wild fisheries and ensuring the long-term sustainability of aquatic resources in Australia and the tropics worldwide. https://www.jcu.edu.au/tropical-fisheries-and-aquaculture/our-research/sustainable-wild-fisheries Contact: cstfa@jcu.edu.au

Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Aims to develop a consistent, national approach to harvest strategies within Australia's fisheries. CSIRO Is involved in developing standard approaches for fisheries assessment for several national and regional harvested resources https://www.csiro.au/en/Research/OandA/Areas/Marine-resources-and-industries/Fisheries. Customized training courses available on request. EnquiriesTeam@csiro.au

Department of Agriculture and Fisheries, Queensland

Manages the sustainability and allocation of fisheries resources for Queensland state. Staff are skilled in undertaking research in population dynamics, assessment and modelling, and fishery statistics analysis. No evidence training in such is offered, but they are highly capable. https://www.daf.qld.gov.au/business-priorities/fisheries/sustainable/sustainable-fisheries-expert-panel/sustainable-fisheries-expert-panel-member-biographies Contact: info@daf.qld.gov.au

Department of Primary Industries - Fisheries NSW

Undertakes and facilitates research on aquatic animals and plants, and their habitats and ecosystems, to ensure management receives the best scientific advice to make informed decisions; fisheries-based information is used to evaluate health of fish stocks. No evidence that stock assessment training courses are available, but staff are capable of presenting courses. https://www.dpi.nsw.gov.au/content/research/fishing-aquaculture/sustainable-fish-harvest-program Contact: information-advisory@dpi.nsw.gov.au

Fisheries Management and Science Branch, Victorian Fisheries Authority

Fisheries science focus areas include assessing fish stocks. The department is nationally recognised in quantitative fisheries assessment and is also regionally recognised for stock assessment including

monitoring and modelling key target fisheries. No indication that they offer training courses, but are certainly capable thereof. https://vfa.vic.gov.au/science-in-fisheries/fisheries-management-and-science-branch Contact: Dallas.d'silva@vfa.vic.gov.au (Director)

Fisheries Research and Development Corporation, Ministry for Agriculture, Fisheries and Forestry

Plans, invests in and manages fisheries research and development throughout Australia. Includes coordination of monitoring and evaluating, facilitating dissemination and extension. They funded a course and consultancy in fish stock assessment techniques on behalf of the Department of Agriculture, Water & Environment several years ago, and more recently (2018) arranged custom training and technical support for fishery stock assessment software. https://www.frdc.com.au/project/2018-148 Contact: frdc@frdc.com.au

Indian Ocean Marine Research Centre (IOMRC)

A multidisciplinary collaborative institute based at the University of Western Australia, supported by the Australian Institute of Marine Science, CSIRO and the Western Australian Department of Primary Industries and Regional Development. Can draw on staff based at the institute to run fisheries stock assessment courses. https://www.uwa.edu.au/facilities/indian-ocean-marine-research-centre Contact: oceans@uwa.edu.au

Institute for Marine and Antarctic Studies (IMAS); University of Tasmania

Supports the long-term sustainable harvest of wild marine resources. Stock assessments are undertaken by IMAS as service provider to the Tasmanian Government (Department of Primary Industries, Parks, Water and Environment); includes building capacity of people in temperate marine research, including postgraduate students. https://www.imas.utas.edu.au/research/fisheries-and-aquaculture/fisheries. Contact: fishing.enquiries@dpipwe.tas.gov.au

South Australian Research and Development Institute (SARDI); The Department of Primary Industries and Regions (PIRSA)

Provides scientific advice to State and Commonwealth Governments about the sustainable management of Australia's fisheries resources; scientists specialise in stock assessment of commercial and recreational marine and inland waters fisheries, and developing sophisticated stock assessment models. Have the capabilities to present training courses. https://pir.sa.gov.au/research/research_specialties/aquatic_sciences/fisheries. Contact: pirsa.sardi@sa.gov.au

University of Technology Sydney

Undergraduate courses include analysing/interpreting data for fish stock assessment, and using established modelling techniques and interpreting results for fish stock assessment and management and applying these to issues and conflicts in fishery management. https://handbook.uts.edu.au/subjects/details/91118.html. Contact: science.lifesciences@uts.edu.au

Western Australian Fisheries and Marine Research Labs (WAFMRL) - Department of Primary Industry and Regional Development (DPIRD)

Has a dedicated fish ageing unit and specialist group of stock assessment/modellers (Stock Assessment and Data Analysis Branch). https://www.fish.wa.gov.au/Sustainability-and-Environment/Fisheries-Science/Stock-assessment-and-data-analysis/Pages/index.aspx. Did initially include facilities to provide short stock assessment courses as part of an Indian Ocean initiative and ran a couple of short training programs. This initiative has not developed further and is not part of the new DPIRD strategy

but could possibly be resurrected if there was outside interest. Auto email contact https://www.fish.wa.gov.au/About-Us/Contact-Us/Pages/Feedback.aspx.

Bangladesh

Department of Fisheries Management, Bangladesh Agricultural University

Aims to advance knowledge, modern approaches and analytical techniques of fisheries and environmental management for sustainable development, exploitation and equitable use of aquatic resources of fresh, brackish and marine waters. Undergraduate course includes stock assessment, but no other evidence of training. https://www.bau.edu.bd/pages/faculty_list/FM Contact: nfo@bau.edu.bd

Fisheries Department, Dhaka University

Its vision is to advance the fisheries and aquaculture sectors by supplying high-quality human resources and research-based knowledge and technologies. Hosts a one-year MSc fisheries course with a stock assessment component, no other evidence of training.
https://www.du.ac.bd/academic/department_item/AQF Contact: fisheries@du.ac.bd

India

Central Marine Fisheries Research Institute (CMFRI)

Regularly conducts stock assessment courses for students, faculty staff, departmental fishery scientists. Customized stock assessment training organized for international researchers upon request. Also undertakes collaborative training in advanced stock assessment with international institutions. https://core.ac.uk/download/pdf/95776188.pdf Contact: director.cmfri@icar.gov.in

Central Institute of Fisheries Education (CIFE) - Indian Council of Agricultural Research (ICAR)

A university centre of excellence in fisheries and allied disciplines. Regularly conducts stock assessment courses for students, faculty staff and fisheries department scientists. Customized stock assessment training is organized for international researchers upon request. Also undertakes collaborative training in advanced stock assessment with international institutions www.cife.edu.in. Contact: director@cife.edu.in

Fisheries College and Research Institute, Tamil Nadu Fisheries University

Courses are presented to undergraduate and post-graduate (MSc, PhD) students at the university every year, by university staff. Courses for scientists and trainees can be provided on request. https://www.tnjfu.ac.in/fcritut/programmes.php#pg-programme. Contact: info@tnjfu.ac.in

Kerala University of Fisheries and Ocean Studies

Aims to serve as a flagship of higher learning through demonstrated and growing excellence in teaching, research, extension, scholarship and creative work in fisheries (and other disciplines). Offers BSc and MSc courses with a stock assessment component. http://kufos.ac.in/courses-offered/ Contact: contact@kufos.ac.in

Indonesia[7]

Fisheries Research Centre (Pusat Riset Perikanan)

Located within the Marine Fisheries Research and Human Resource Agency, the Fisheries Research Centre conducts routine and relevant research to support stock assessment. The Fisheries Research Centre hosts the Indonesian Fisheries Research Journal http://ejournal-balitbang.kkp.go.id/index.php/ifrj/about/editorialPolicies#focusAndScope an international peer-reviewed and open access journal that publishes scientific articles in the field of fisheries and conservation. The journal occasionally includes contributions on stock assessment from its staff as well as the National Commission for Fish Stock Assessment and from the Research Institute for Tuna Fisheries http://ejournal-balitbang.kkp.go.id/index.php/ifrj/article/view/8209/6680

National Commission for Fish Stock Assessment (Komnas Kajistan)

This National Commission collects and assesses all relevant information to determine stock status in form of estimation of stock potential, level of utilisation and total allowable catch. It presents its work to the Minister of Marine Affairs and Fisheries. Established in 2005 (FAO Country Profile), it produces marine resources status reports over periods of 3 – 5 years. https://kkp.go.id/brsdm/pusriskan/artikel/6918-pertemuan-komisi-nasional-pengkajian-sumber-daya-ikan-komnas-kajiskan-2018

Iran

Persian Gulf and Oman Sea Ecological Research Centre - Iranian Fisheries Science Research Institute; Ministry of science, research and technology

Research activities of the Institute are organized in different research departments including for marine stocks evaluation; has a Biology and Stock Assessment Department for stock assessment of commercial fish, shrimp and molluscs. They hold training courses for staff, scholars, researchers and students, but it is not specified if this includes stock assessment. http://ifro.ir Contact: http://english.ifsri.ir/default.aspx

Gorgan University of Agricultural Sciences and Natural Resources

Difficult to determine the facilities available, primarily in Persian on the website and is not Google friendly. https://gau.academia.edu/. Appear to offer fisheries courses to students. Possible contact : ravabet.gorgan@gmail.com

Kenya

Technical University of Mombasa, Environment and Health Sciences

Stock assessment as a course unit is offered to students studying BSc in Fisheries and Oceanography, BSc in Marine Resource Management and MSc in Fisheries and Aquaculture. Collaborates with the Kenya Marine and Fisheries Research Institute (KMFRI) which has limited capacity to undertake assessments. https://www.tum.ac.ke/academics/courses. Contact: info@tum.ac.ke

7 It was difficult to access the entities with capacity to provide stock assessment courses and training in Indonesia because these seem to mostly exist on internet sites in the national language. Two are provided based on the response received from the stock assessment questionnaire. Possibly significantly more capacity exists than what is reflected in the two entities presented.

Malaysia

Fisheries Research Institute, Department of Fisheries

The institute is responsible for undertaking research on varied aspects of fisheries, including ship-based fisheries assessment surveys. Does not appear to offer training in stock assessment, but could have capacity to do so. https://www.dof.gov.my/fri.php. Contact: fri_helpdesk@dof.gov.my

Mauritius

Albion Fisheries Research Centre

Undertakes collaborative research/studies with regional, international organisations such as IOTC for the management of tuna stocks in the Indian Ocean, and the Indian Ocean Commission (COI) in fisheries, including assessment of new resources, and fish stock assessment (artisanal, banks and tuna). Availability of training courses not explicitly mentioned but likely some capacity for this. https://blueconomy.govmu.org/Pages/Departments/Albion%20Fisheries%20Research%20Centre%20(AFRC)/AFRC.aspx. Contact: fisheries@govmu.org

Mozambique

National Institute for Fisheries Research (IIP)

The institute has been re-organized, and intends to offer basic and advanced courses by IIP staff and partners to multiple targets in future. Based on personal experience, stock assessments on crustacean trawl fisheries are undertaken regularly; reasonable inhouse capacity has increased with inputs from external consultants, but has limited capacity in terms of providing training courses. http://www.iip.gov.mz/. Contact: iip@iip.gov.mz

Oman

Department of Marine Science and Fisheries, Sultan Qaboos University

Teaching of stock assessment was included in the undergraduate syllabus, and was presented by a foreign scientist on contract; he left the university in 2020 and has not been replaced. FAO organized a training course on methodologies for fish stock assessment in 2013 in Oman. https://www.squ.edu.om/agriculture/Academic-Department/Marine-Science-and-Fisheries. Contact: michelc@squ.edu.om (Head of Department)

South Africa

Department of Agriculture, Forestry and Fisheries

Manages the development and sustainable use of marine and coastal resources. Scientists undertake stock assessments to provide management advice on local harvest/effort levels and also participate in RFMOs and regional bodies. Training courses are not presented, but scientists are capable of contributing to courses. www.daff.gov.za. Contact: enquiries@daff.gov.za

Department of Ichthyology and Fisheries Science (DIFS), Rhodes University

Run an annual basic stock assessment course for undergraduate students. https://www.ru.ac.za/ichthyology/studentresources/ichthyology3/populationecology/. Scientists also undertake stock assessments in collaboration with other institutions. DIFS (and the South African

Institute for Aquatic Biodiversity as its main partner) has recently become an African Union Centre of Excellence for training in Aquaculture and Marine Fisheries. Contact: difs@ru.ac.za

Marine Resource Assessment and Management Group (MARAM), University of Cape Town

Undertakes advanced stock assessments for the South African Department of Fisheries, and other countries on contract. Has run and has the capacity to run assessment training courses for young scientists and managers but does not do so regularly; elements of stock assessment also presented to a local university as part of coursework undergraduate degrees. http://www.maram.uct.ac.za/maram/research. Contact: di.lapidoloureiro@uct.ac.za (Secretary)

Oceanographic Research Institute (ORI)

An NPO NGO which undertakes applied marine research in the SWIO region. Basic stock assessments are done on an ad hoc basis. https://www.saambr.org.za/research-2/#demersal. Presents a course on basic stock assessment principles and techniques to BSc hons. (4th year) students at the local university. Contact: info@saambr.org.za

Sri Lanka

The National Aquatic Resources Research and Development Agency (NARA)

The Marine Biological Resources Division (MBRD) indicates that it undertakes monitoring and scientific assessments and predictions of the status of finfish and shellfish stocks in Sri Lankan waters, but independent indications are that there is limited stock assessment capacity, including for presenting training. http://www.nara.ac.lk/?page_id=475. Contact: postmaster@nara.ac.lk

Thailand

Fisheries Resource Assessment Group, Marine Fisheries Research and Development Division, Department of Fisheries

Scientists estimate potential harvest levels of fisheries resources, including undertaking analysis and evaluation of effective means of fisheries management. Assessments are undertaken with other local institutions, but training in assessments is not described. https://www.fisheries.go.th/. Contact:

For other IORA MS (Comoros, Madagascar, Maldives, Seychelles, Singapore, Somalia, United Republic of Tanzania, United Arab Emirates and Yemen)

There was no evidence of their having capacity to present stock assessment training, albeit that scientists and managers at fisheries entities in some of these countries may have undergone training.

REGIONAL ENTITIES

Asia-Pacific Fishery Commission (APFIC)

Advisory body on coastal fisheries under the aegis of FAO. Its objective is to promote the full and proper use of living aquatic resources in the region from the Indian Ocean to the Pacific Ocean; does not appear to have run stock assessment courses recently, but could facilitate and support such. http://www.fao.org/asiapacific/apfic/en/. Contact: simon.fungesmith@fao.org (Secretary)

Bay of Bengal Large Marine Ecosystem (BOBLME)

A regional project; FAO and IUCN have partnered to support the development of the full project document for BOBLME to improve regional management of the Bay of Bengal environment and its fisheries. Relevant to stock assessment capacity is that working groups have been established for fisheries statistics and two transboundary fish stocks. Phase 2 is underway. https://www.boblme.org. Auto email contact via https://www.boblme.org/contact.html

Commission for the Conservation of Southern Bluefin Tuna (CCSBT)

Responsible for the management of southern bluefin tuna throughout its distribution; its objective is to ensure, through appropriate management, the conservation and optimum utilisation of southern bluefin tuna. The Scientific Committee undertakes and co-ordinates stock assessments, and there have been some capacity-building initiatives, including training.
https://www.ccsbt.org/en/content/scientific-process. Contact: rkennedy@ccsbt.org (Executive Secretary)

Fishing Data East Africa (FIDEA) – MeerWissen

A German-funded regional project whose objectives are the development of a training curriculum and conducting training workshops to equip fisheries researchers and managers with the skills in data collection, analysis and interpretation for informed decision-making; and to contribute to the development of harmonised regional fisheries assessments and reporting guidelines relating to the SDG 14.4 target on the proportion of fish stocks that are sustainably fished. A training workshop has been held, but the project ends in June 2021. https://meerwissen.org/partnership-projects/fidea. Contact: info@meerwissen.org

Indian Ocean Tuna Commission (IOTC)

Intergovernmental organisation responsible for management of tuna and tuna-like species in the Indian Ocean. Provides capacity building and support programs for Members, including on these core topics relevant to stock assessment: How to interpret science advice as a manager; and country level implications arising from stock assessment results. https://iotc.org/science/capacity-building-science. Formal stock assessment training courses have not been held for some years, but there was IOTC support and participation in the BOBLME tuna assessment course (see above). Contact: IOTC-Secretariat@fao.org

South West Indian Ocean Fishery Commission (SWIOFC) - FAO

Advisory body on coastal fisheries. Promotes sustainable utilization, management and development of living marine resources. Has working groups (Fisheries Data and Statistics, Demersal, Pelagic) which include stock assessments in their activities. Training courses for stock assessment are run irregularly with experts from FAO. http://www.fao.org/fishery/rfb/swiofc/en. Contact: Vasco.Schmidt@fao.org (Secretary a.i.)

South-East Asian Fisheries Development Centre (SEAFDEC)

A regional treaty organization which promotes sustainable fisheries development in Southeast Asia. Their training division only focuses on technology/ equipment/ gear. The Fisheries Research Dept focuses on promoting, undertaking, and coordinating research in fisheries post-harvest technology and developing of the fish processing industry in the region. The Marine Fishery Resources Development and Management Department has run stock assessment training courses. Expertise appears stronger in small pelagic acoustic surveys rather than modelling. http://www.seafdec.org/strategies/. Contact: secretariat@seafdec.org

Worldfish - formerly International Center for Living Aquatic Resources Management (ICLARM)

An international research institute, considered here as a regional entity. Conducts long-term coordinated research on principal fisheries problems, particularly small-scale fisheries. In early years, ICLARM undertook many trainings and produced many materials for stock assessment capacity building. There is less evidence of this in recent years, but they have the facilities and staff to do this. https://www.worldfishcenter.org/content/resilient-small-scale-fisheries. The ECOFISH-Bangladesh Project, a Worldfish initiative, included a once-off basic stock assessment course which was run by the project scientist and three experts from a U.S. university, for field level researchers, officers and managers from the Department of Fisheries and the Bangladesh Fisheries Research Institute. Contact: worldfishcenter@cgiar.org

Appendix 2: Examples of under/postgraduate stock assessment courses presented at universities as part of marine science degrees.

The nature of these courses varies considerably from university to university, depending on the university's focus and staff capabilities; consequently the nature of the courses can change over relatively a short time scale. Stock assessment is a component (coursework module) of a broader degree in marine biology or fisheries science i.e. no coursework degrees specializing in stock assessment were encountered. Degrees in stock assessment are feasible, but are done as research-based theses, on topics proposed by supervisors. The contribution of the stock assessment module to the overall degree also varies considerably between universities – fisheries degrees tend to emphasize stock assessment more, while biological degrees do less; compulsory and/or elective stock assessment modules may be offered. Some universities insist on prerequisite modules being completed before students can embark on coursework degrees which include stock assessment modules. Generally there are biological elements (age, growth, maturation etc) which are also taught as part of the degree, which are important inputs to stock assessment; similarly, aspects of data collection may be covered as well.

Central Institute of Fisheries Education (CIFE)
https://www.cife.edu.in/pdf/FRM-PhD-2014.pdf

Centre for Sustainable Tropical Fisheries and Aquaculture, James Cook University
https://secure.jcu.edu.au/app/studyfinder/?year=2018&subject=mb3150

University of Technology Sydney
https://handbook.uts.edu.au/subjects/details/91118.html

Department of Ichthyology and Fisheries Science (DIFS)
https://www.ru.ac.za/ichthyology/studentresources/ichthyology3/populationecology/

Appendix 3: Centres of excellence for stock assessment training

The Central Marine Fisheries Research Institute (CMFRI www.cmfri.org.in) in Kochi, India, undertakes periodic stock assessment of important marine fish stocks of India. The institute has several branches, and regularly conducts stock assessment courses for students, university staff and fisheries department scientists. They also present customized stock assessment training for international researchers upon request, and undertake collaborative training in advanced stock assessment with international institutions. Topics include the importance of fish stock assessment to fisheries management, and stock assessment models and methods. An example is available in Appendix 4. In Mumbai, the Central Institute of Fisheries Education (CIFE www.cife.edu.in) of the Indian Council of Agricultural Research (ICAR) conducts customised programmes in all areas of fisheries. This includes postgraduate fisheries courses, and they also provide training for workers in the fisheries and aquaculture sectors from Afro-Asian countries. Topics include choice and application of stock assessment models, and data collection and software applications for fish stock assessment.

In Perth, the Western Australian Fisheries and Marine Research Labs (WAFMRL https://www.fish.wa.gov.au/Sustainability-and-Environment/Fisheries-Science/Stock-assessment-and-data-analysis/Pages/index.aspx) has facilities to provide stock assessment courses – these were developed as part of an Indian Ocean collaboration initiative, and some short training programmes were presented several years ago, but have not been held for some time. These could be restarted if there was sufficient interest. The Commonwealth Scientific and Industrial Research Organisation (CSIRO https://www.csiro.au/en/Research/OandA/Areas/Marine-resources-and-industries/Fisheries) has several branches throughout Australia, and have a large staff complement, several of whom are highly capable in stock assessments. They have presented ad hoc courses on request from various local and international clients on a variety of assessment topics (see Appendix 4 for examples).

In South Africa, the Marine Resource Assessment and Management Group (MARAM http://www.maram.uct.ac.za/maram/research) in Cape Town has run stock assessment training courses but seldom does so. To train people to undertake stock assessments, they prefer to identify suitable applied mathematics students, and to build their capacity for the long term. The institute does also occasionally present training in stock assessment concepts to fisheries managers and decision-makers to assist them in interpreting outputs from stock assessments. The recent recognition of the Department of Ichthyology and Fisheries Science (DIFS) in Grahamstown as an African Union Centre of Excellence for fisheries training also potentially offers scope for candidates seeking increased stock assessment capacity – in addition to their basic university undergraduate stock assessment courses. Being very recent, the content for AU training has not yet been decided, but stock assessment is likely to be included.

Appendix 4: Examples of recent short training courses in stock assessment in the IO region

The Earth System Science Organization (ESSO), part of the Indian National Centre for Ocean Services (INCOIS) in Hyderabad, conducts oceanographic courses as a contribution to the Indian Ocean Commission's training and capacity development activities in mainly Indian Ocean rim countries. As part of this initiative, a stock assessment training course was organized by ESSO in September 2015 as part of ongoing cooperation between the Indian Ministry of Earth Sciences and the National Oceanic and Atmospheric Administration (NOAA). https://incois.gov.in/ITCOocean/ITCOocean_fsaem.jsp

The Central Institute of Fisheries Education (CIFE) and the Central Marine Fisheries Research Institute (CMFRI) ran an extended training course in 2017 for fisheries scientists, which included stock assessment – course details are available at https://core.ac.uk/download/pdf/95776188.pdf

The Fisheries Research Institute of the Malaysian Department of Fisheries is intimately connected to the South-East Asian Fisheries Development Centre (SEAFDEC), and under an existing MoU between the Government of Malaysia, the Government of Bangladesh and the Islamic Development Bank, Malaysia is providing consultancy services and a training programme for fish stock assessment. Under this arrangement, the Marine Fishery Resources Development and Management Department of SEAFDEC, with other local experts, recently ran a training course on population dynamics and stock assessment for Bangladesh.

http://repository.seafdec.org.my/bitstream/handle/20.500.12561/593/Opening%20Address%20by%20Yg%20Bhg.%20Dato%20Hj%20Munir%20b%20Hj%20Mohd%20Nawi%20-%20International%20Training%20on%20Population%20Dynamics%20and%20Stock%20Assessment%20for%20OIC%20Country%20%5B3%20DEC%202018%5D.pdf?sequence=1&isAllowed=y

The Bay of Bengal Large Marine Ecosystem project (BOBLME) has arranged courses which covered numerous training elements for participants from BOBLME countries for regional stock assessments of two transboundary fish stocks (tunas and hilsa); these were taught by scientists from IOTC, NOAA and CSIRO, with funding from BOBLME. https://www.boblme.org/documentRepository/BOBLME-2013-Ecology-03.pdf

In March 2020 in Zanzibar, a two-week training course on the assessment of stock status was arranged by FIDEA (Fisheries Data East Africa) project implemented under the MeerWissen initiative and funded by the German Federal Ministry for Economic Cooperation and Development. The objectives of the workshop were to provide both the purpose and theoretical basis of stock assessments, and hands-on application of how to choose and apply appropriate tools for assessment for the estimation and reporting of SDG Indicator 14.4.1.

https://meerwissen.org/resources/news/detail/fidea-regional-workshop-on-stock-assessment-and-estimation-of-sdg-indicator-1441

The Australian Fisheries Research and Development Corporation recently arranged a customized course and technical support for fishery stock assessment software, with training provided by CSIRO and UBC scientists. www.frdc.com.au/project/2018-168+