Chapter 8

Impact on science, capacity development, policy and fisheries management

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"Before the *Nansen*, the commercial potential of fisheries resources in the Western Indian Ocean was unknown, and there was very little capacity to survey them."

Abstract

Several Western Indian Ocean countries became independent between the early 1960s and mid-1970s, and the new administrations soon showed a keen interest in fisheries development as a means of economic growth. At that time, the commercial potential of fisheries resources in marine waters was unknown, and very little capacity to survey them existed in the region. Against this background, the newly commissioned RV *Dr Fridtjof Nansen* conducted its first surveys in 1975 off Somalia, a decade after the completion of the first International Indian Ocean Expedition. Initial surveys were to explore offshore fisheries potential and map their distribution, but since then the Nansen Programme has grown through several phases (see Chapter 2). From ownership modality to mode of operation and relationships with recipient countries, the Nansen Programme differs from most other vessel-based programmes. Apart from surveys at sea, it has focussed on capacity development in marine science, policy and fisheries management. Capacity development approaches included exposure to state of the art research at sea, training courses and degree programmes, and dissemination of training materials and tools, such as species identification guides. From 2006 to 2016, a total of 232 regional scientists participated in *Nansen* surveys. Fisheries policy and management plans could be developed on the basis of survey data, which indicated realistic targets for fisheries development goals. Peer-reviewed journal articles highlighted the quality of science done and new discoveries from the region. In 2011, the EAF-Nansen Project was selected as one of ten "FAO Success Stories" – a prestigious acknowledgement based on its performance against multiple development aid criteria. The impact of the Nansen Programme on science, capacity development, policy and management in the Western Indian Ocean is here described in four sections: 1) Pre-independence context shapes the focus; 2) Capacity development 3) Broad impacts of the Nansen Programme; and 4) Key challenges and lessons learnt since 1975.

Previous page: Some participants of the 2015 EAF-Nansen Project trawling and acoustics surveys training course held at ORI, Durban, South Africa. © Deborah Catena

8.1 Introduction

Origins of marine research in the Western Indian Ocean

Scientific expeditions that covered parts of the Indian Ocean date from at least 250 years ago, when James Cook and the HMS *Endeavour* (1769–1771) passed through it on their circumnavigation of the globe. Darwin's journey on the HMS *Beagle* (1831–1835), to collect biological specimens and plankton samples is equally famous, and those by the HMS *Challenger* (1873–1876) covered a distance of 130 000 km while exploring, and catalogued over 4 000 previously unknown species. Up to the 1960s, scientific expeditions (or surveys) in the coastal waters of the Western Indian Ocean were carried out by the colonial powers, within a pre-independence context. Most of the countries in the Western Indian Ocean region became independent between the early 1960s and mid-1970s. In the process, they inherited the foundations of marine science in the region, including some of the fisheries research institutes that continue to exist to this day, albeit in different forms.

Several of the present research institutes in Kenya, Tanzania, Mozambique and Madagascar started as marine biological stations established before independence. The East African Marine Fisheries Research Organisation (EAMFRO, 1958) comprised of two substations, the Mombasa Marine Station in Kenya (1953) and the Kunduchi Marine Station in Tanzania. The substations were at first subject to the East Africa High Commission and the East Africa Common Market, but EAMFRO became part of the East Africa Community (EAC) from 1967 to 1977.

Between 1951 and 1977, EAMFRO operated three research vessels, MV *Research*, MV *Manihine* and RV *Kaskazi*. The *Research* operated for six years from 1951 to 1957 and conducted 117 surveys to study the hydrography of East African coastal waters, and the abundance and distribution of pelagic fishes (EAMFRO, 1958). It was later replaced with the *Manihine*, a 33 m long steel vessel, which operated with a 9 m work boat, *Chermin*; this was essential for estuarine and shallow water investigations (EAMFRO, 1962). In Kenya, EAMFRO owned several research boats, including RV *Menika* and RV *Kusi*. Between 1964 and 1969, *Menika* conducted several surveys with technical support from FAO/UNDP, using dip-nets for bait fish and trammel nets to explore reef ecosystems, creeks and the coastline for spiny lobsters, tuna-like and demersal fish species (IOC-UNESCO, 2016). The vessels were not purpose-built for research, and their modest size restricted their work to nearshore waters and precluded multi-disciplinary research. EAMFRO commissioned the building of RV *Kaskazi*. The RV *Mafunzo* was used for training and fishing gear development at the Mbegani Fisheries Training Institute.

When the EAC collapsed in 1977, the EAMFRO Headquarters in Zanzibar, Tanzania, became the Institute of Marine Science (IMS) of the University of Dar es Salaam, the Kunduchi substation became the Tanzania Fisheries Research Institute (TAFIRI), and the Mombasa substation became the Kenya Marine and Fisheries Research Institute (KMFRI). Today, these form the backbone of marine research in East Africa. Other stations with colonial origins and still surviving today are the Inhaca Island Marine Biological Station (Mozambique, established in 1953); Station Marine de Tulear (Madagascar, 1961) and the Nosy-Be Marine Station (Madagascar, 1962).

The International Indian Ocean Expedition

Between 1959 and 1965, the International Indian Ocean Expedition (IIOE) facilitated a major upsurge in studies of the Indian Ocean, involving scientists from 23 countries, 44 research vessels from 13 countries and numerous airborne data-collection devices (Morcos, 2002). The IIOE encompassed almost all marine science disciplines, and contributed a wealth of knowledge on basic oceanographic processes. The IIOE described the dynamics of the Somali Current, the mid-Indian Ocean ridges, effects of monsoonal winds on surface currents, productivity of upwelling areas, geochemistry and geophysics (Behrmen, 1981; Rao and Griffiths, 1998).

Apart from the vast amounts of data collected, the IIOE also resulted in over 1 000 scientific papers and unique atlases on plankton, hydrography and the geology of the Indian Ocean. It strengthened international scientific cooperation amongst scientists from many countries, and provided a platform for international oceanographic programmes, such as the Indian Ocean Experiment (INDEX) (Morcos, 2002). However, the IIOE was largely uncoordinated and without a systematic coverage in time and space. Also, with the exception of India and Pakistan, scientists from countries bordering on the Western Indian Ocean did not actively participate in the IIOE, because of limited research capacity.

Several oceanographic surveys took place in the Indian Ocean between 1965 (when the IIOE ended) and 1977; records show a total of 22 vessels, from France (3 vessels); Japan (5); United Kingdom (1); former USSR (11) and the USA (2) (IOC-UNESCO, 2016). Romanov (2003) reviews Soviet and Ukranian scientific and commercial fishing operations between 1972 and 1994 on the deep-water ridges of the southern Indian Ocean.

Status of fisheries management

Prior to independence, fisheries in Kenya and Tanzania received little government attention, as the sector was considered to be of low economic value. This changed after independence, when fishing was recognized as a potential contributor to economic development. In Tanzania, development of the fisheries sector was recognized as a priority in the first Three Years Development Plan (1961–1964) and also in the second Five Years Development Plan (1969–1974) (GOT, 1969). The first plan recommended a survey of fisheries resources and their marketing potential; the second plan noted that 20 percent of fish supply came from the sea (the rest from lakes and rivers) and that offshore fisheries had potential. It was argued that expanding fishing operations offshore would increase catches of fish, prawns and lobsters tenfold (GOT, 1969).

In Kenya, the Fisheries Department was established after independence in 1964, and the principal statutes regulating and governing fisheries were the Fish Protection Act (Cap 163) of 1902, which was later replaced by the Fisheries Act (Cap 378) of 1989 and Regulations (1991). In Tanzania, the Fisheries Division was established in 1965, and regulation and governance of the fisheries sector deferred to the Fisheries Act of 1970 and Fisheries Regulations (1982).

Fisheries development was also a high priority in post-independence Mozambique and Seychelles. Within three years of independence in 1975, the Mozambique government signed an agreement with Norad (then NORAD) for the RV *Dr Fridtjof Nansen* to conduct surveys to map the distribution of commercially important fish stocks in Mozambican waters (Sætre and Paula e Silva, 1979). Surveys with similar objectives were conducted in Seychelles in 1978, two years after independence. These surveys were carried out in collaboration with the fisheries departments of the newly emerging administrations, hence contributing to capacity development.

These examples show a keen post-independent interest in fisheries development during the 1960s and 1970s. It was, however, based on the assumption that fisheries resources in sovereign waters could be exploitable at industrial scale. Despite these ambitious plans, actual knowledge of the potential of fisheries resources was very limited.

Early development and evolution of the Nansen Programme

Three factors informed the focus of *Nansen* surveys during the exploratory phase (1975–1980). Firstly, whereas newly independent countries recognized the potential contribution of fisheries to their economic development, they had limited knowledge of the size of their fish resources. Secondly, the IIOE provided a wealth of information on many aspects of the Indian Ocean, but very little on fish resources (Rao and Griffiths, 1998). *Nansen* surveys could fill this gap. And thirdly, the FAO created the Indian Ocean Programme (IOP), aiming to support fisheries development in the Indian Ocean. This idea originated from the finding of high productivity areas during the IIOE,

suggesting that large fish stocks might be present (Marr *et al*., 1971). The IOP plan contained a series of pre-investment fishery development surveys, with priority given to a pelagic fish assessment survey in the northwest Arabian Sea.

Whereas the initial objective, to provide information on the potential of fish resources, remained the same over the past four decades, specific objectives and the focus of the programme have changed over time, to align with changing needs and the global agenda on fisheries. As a result, the Nansen Programme evolved through four main phases: exploratory surveys (1975–1980), mapping of resources (1980–1990), monitoring, management and capacity development (1990–2006), and support for implementing ecosystem approaches to fisheries (2006–2016). These four phases are described in detail in Chapter 2.

How does the Nansen Programme differ from other ship-based programmes?

Several other research vessels surveyed the Western Indian Ocean over the same period (1975–2015) than the *Nansen*. These were the RV *Marion Dufresne II* (France, 1995 to present), RV *Meteor* (Germany, 1995 to present) and RV *Discovery* (UK, 1979–2010). The approach taken by the Nansen Programme differs from the other vessel-based programmes in several ways, ranging from ownership modality to mode of operation and relationship with recipient countries. The Nansen Programme is much broader than its contemporaries, and forms one of the cornerstones of the Norwegian government's development assistance programme through the Norwegian Agency for Development Cooperation (Norad). The *Nansen* is the only vessel managed by a United Nations agency, and therefore it flies a UN flag, although operated by the Norwegian Institute of Marine Research (IMR). The UN flag enables the *Nansen* to move freely across maritime boundaries of member countries.

In comparison, the RV *Meteor* is owned by the German Government, but is operated by private companies, F. Laeisz GmbH. (1995–2012) and Briese Schiffahrt (2013 to date). Like the *Nansen*, the current *Meteor* is the third vessel bearing the same name. Similarly, the RV *Marion Dufresne II*, named after the French explorer Marc-Joseph Marion du Fresne, and operating from Reunion Island, is owned by a private company, Compagnie Maritime d'Affrètement – Compagnie Général Maritime (CMA-CGM) and chartered every year by the French government's Territoire des Terres Australes et Antarctiques Françaises (TAAF) to carry out surveys in the Western Indian Ocean. While the *Nansen* surveys focus on support for fisheries development and its management by governments and regionally, the *Marion Dufresne* and *Meteor* focus on basic research in oceanography.

The support given by the Norwegian government to the Nansen Programme forms part of a framework of cooperation between Norway and beneficiary governments. Scientists from the region are involved in all stages of the Nansen operations, from planning to participation in the surveys, and in the use of data for management and policy purposes. Conversely, the research priorities of scientists participating in the *Marion Dufresne* and *Meteor* surveys form the basis of sampling strategies followed by the vessels; these may not always be aligned with national and regional priorities.

8.2 Capacity development

Capacity development was not a major objective during the initial two phases of the Nansen Programme, when training was mainly geared towards ship-based sampling. It became more important in Phase 3 (but not in the Western Indian Ocean because the programme focussed on the Atlantic coast of Africa; see Chapter 2) and Phase 4 (2006–2016), when a major objective of the programme was to improve the capacity to manage fisheries, through introduction of the EAF concept, and support for its implementation (FAO, 2009, 2013).

Capacity development in the Nansen Programme encompasses a range of techniques, including ship-based training, short-term courses, long-term degree programmes and development and

dissemination of training materials and tools. In Phase 4 of the programme (2006–2016), capacity development activities also targeted institutions/organizations, assisting particularly with the development and implementation of fisheries management plans. In the Western Indian Ocean, many of the capacity development activities were carried out in partnership with other regional projects, such as the World Bank funded Southwest Indian Ocean Fisheries Project (SWIOFP; van der Elst *et al*., 2009), and the UNDP-funded Agulhas and Somali Currents Large Marine Ecosystems project (ASCLME).

Ship-based training

Scientists and trainees from surveyed countries were invited to participate in *Nansen* surveys, to gain first-hand experience of ship-based ocean research. They were trained in survey techniques, fish species identification, deck sampling of the catches, as well as in data logging, processing and preliminary analysis (Sætersdal *et al*., 1999). More experienced participants also contributed to the writing of the survey reports.

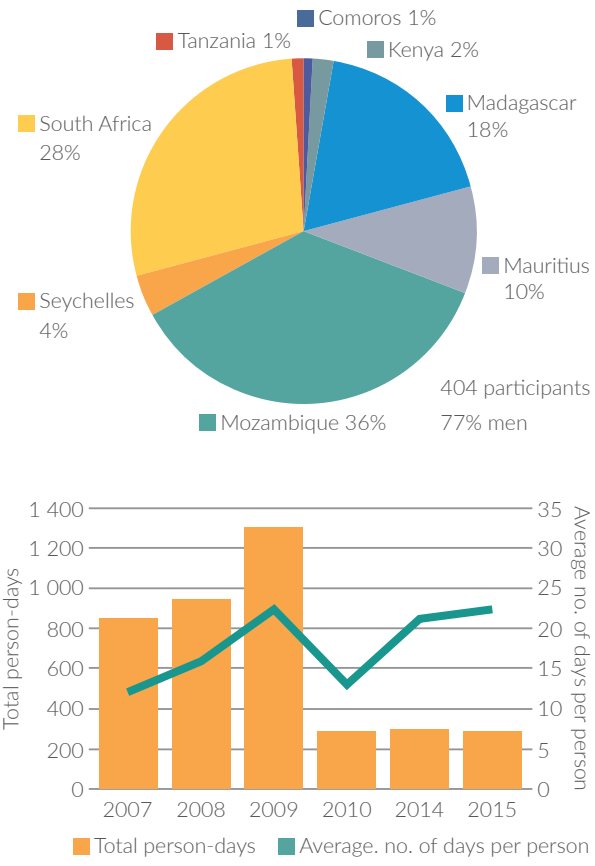

Figure 8.1 Percentage of regional participants on *Nansen* surveys per country in Phase 4 (top), and total person-days spent on the vessel per year (bottom).

In Phase 1 surveys, ship-based training was extended to personnel of the Serviço de Investigações Pesqueiras (later the IIP) in Mozambique, and the Seychelles Fishing Authority. In Phase 2, participants in the ship-based activities included scientists from Kenya (KMFRI and Department of Fisheries), Tanzania (TAFIRI and University of Dar es Salaam), Mozambique (IIP) and Madagascar (Centre National de Recherches Oceanographiques, Nosy-Be). In surveys between 1977 and 1983, a total of 27 Mozambicans (23 men and 4 women) participated, with lower numbers from Kenya (10 men and 2 women), Somalia (2) and Tanzania (9).

In Phase 4 (2006–2016), the partnerships with the SWIOFP and ASCLME projects, as well as the larger number of *Nansen* surveys in the Western Indian Ocean, resulted in an upsurge in ship-based participation. Scientists from the region were encouraged to submit their own research proposals for the period that they would be on the vessel. The bulk of participants (scientists and trainees) came from Mozambique, South Africa, Madagascar and Mauritius (Figure 8.1), reflecting the countries that were surveyed most. Participants from South Africa were associated with the SWIOFP and ASCLME partner projects. No surveys were carried out in Tanzania and Kenya – explaining the low uptake in these countries. The total number of ship-based person-days was 3 970 in Phase 4, ranging from 280 in 2010 to 1 306 in 2009 (Figure 8.1). On average, a participant from the region spent about 18 days on the vessel.

Post-survey meetings and training courses

Preliminary survey results were presented to national fisheries managers and scientists at post-survey meetings. In Phase 4, these meetings started with a workshop, during which the Norwegian survey leader and the local scientists

BOX 8.1

New species found during *Nansen* surveys in the Western Indian Ocean

Although taxonomic research has never been part of the *Nansen* survey objectives, its focus on the relatively unknown waters of the Western Indian Ocean has resulted in the description of several species new to science. Surveys in the Arabian Sea in 1984 resulted in the identification of four new species. Three of these new species were groupers, two from Oman (*Epinephelus gabriellae*, Randall and Heemstra, 1991; *Epinephelus polylepis*, Randall and Heemstra, 1991) and one from Somalia (*Epinephelus indistinctus*, Randall and Heemstra, 1991). A seabream (*Diplodus cervinus omanensis*, Bauchot and Bianchi, 1984) found off Oman was later raised to species level as *D. omanensis*. It is interesting to note that the genus *Diplodus* had never been recorded in the Western Indian Ocean before that, except off eastern South Africa.

The *Nansen* surveys in Mozambique in 2007 and 2008 saw the participation of several taxonomists, and resulted in the identification of eight new species. These discoveries suggest that marine diversity in the Western Indian Ocean may be far from fully documented, and that more dedicated research is required.

The new species identified are:

- sawshark *Pristiophorus nancyae*, Ebert and Cailliet 2011;
- threadfin bream *Nemipterus flavomandibularis*, Russell and Tweddle 2013;
- two species of goatfish, *Parupeneus nansen*, Heemstra and Randall 2009 and *Upeneus seychellensis* Uiblein and Heemstra, 2011;
- two seabreams, *Polysteganus cerasinus*, Iwatsuki and Heemstra 2015, and *P. flavodorsalis*, Iwatsuki and Heemstra, 2015;
- frogmouth *Chaunax atimovatae*, Ho and Ma 2016; and
- wrasse *Novaculops alvheimi*, Randall 2013.

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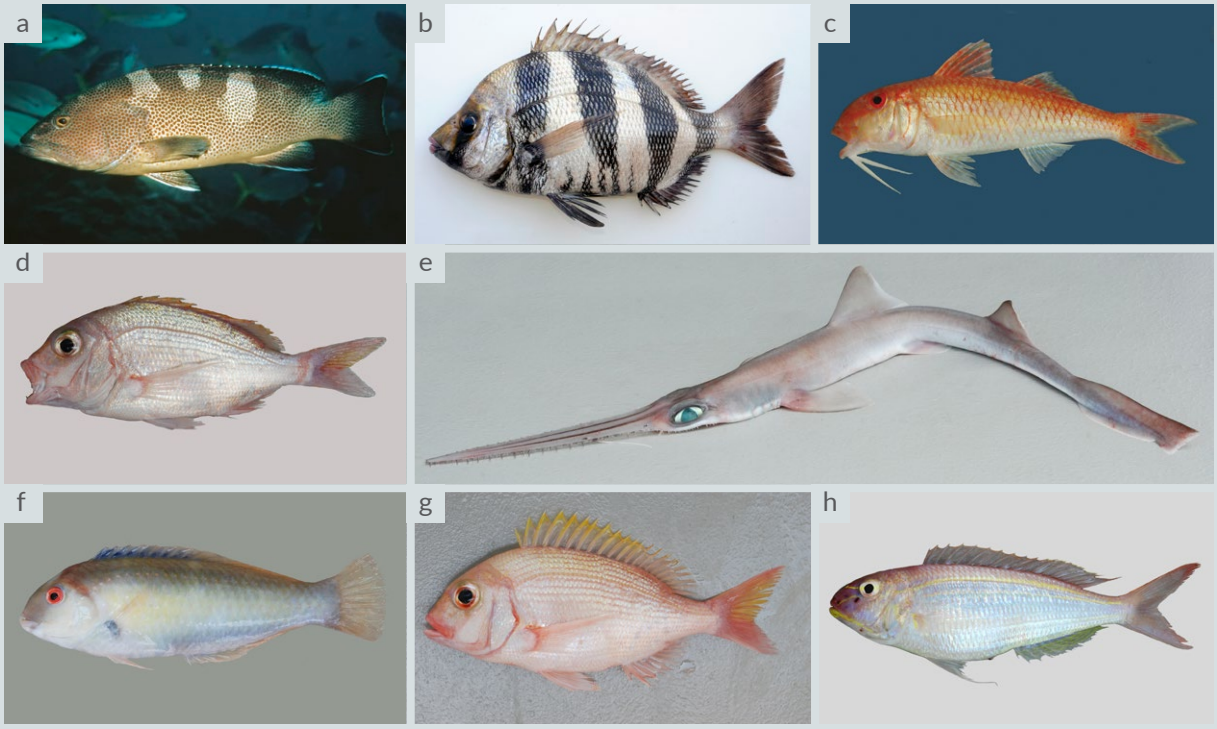

New species discovered on Nansen *surveys in the Western Indian Ocean: a. Epinephelus gabriellae; b. Diplodus omanensis; c. Parupeneus nansen; d. Polysteganus cerasinus; e. Pristiophorus nancyae; d. Polysteganus cerasinus; f. Novaculops alvheimi; g. Polysteganus flavodorsalis; h. Nemipterus flavomandibularis.*

that accompanied the vessel finalized the survey report. Local scientists prepared presentations, which they then delivered at the post-survey meeting, attended by fisheries researchers and managers, and other stakeholders.

Short-term training courses during and after surveys have focussed on trawling and acoustic surveys, fish stock assessment and survey data analysis. Courses also covered the use of the Nansis database to extract and analyse data, basic taxonomy and fish species identification, and principles and practice of EAF – the latter with a focus on preparing and implementing fisheries management plans.

Long-term degree programmes have also been supported since the late 1970s, when the University of Bergen, in close cooperation with the IMR, started a "diploma course" in fisheries biology and acoustics. The course was upgraded to an MPhil course in fisheries biology in the late 1980s, with a curriculum that included use of scientific survey techniques, elementary statistics, fish stock assessment, fishing gear technology and fisheries management.

Scholarships were granted to scientists from developing countries to undertake their Masters and PhD degree programmes at the University of Bergen and IMR. Students from Mozambique, Tanzania and Kenya, identified through their participation in *Nansen* surveys, participated in the programme. In addition, the mentoring programme of the EAF-Nansen Project supported scientists doing PhD research, by funding visits abroad to acquire specialised analytical skills.

Technical support for other research vessels

Technical support and training on acoustic instruments on national vessels were provided, including coordinated surveys in which inter-calibration with the *Nansen* was required. Vessels that benefitted included the South African RV *Algoa* and French vessels operating in the Western Indian Ocean. During Phase 1, an acoustic inter-calibration of the *Nansen* and TAFIRI's research vessel *Mafunzo* was done as part of training in survey methodology.

Use of *Nansen* data

The data and information gathered by the Nansen Programme have, *inter alia*, been used for policy documents, development of management strategies, scientific papers, field guides and species identification, and as basic data for further research. The information has also been used for educational purposes, such as in training courses, preparation of theses, and exhibitions to make people aware of the marine environment.

At first, species identification constituted a major challenge during surveys, because few field guides for the Western Indian Ocean fishes existed, and those that did (for example Smith, 1972), covered only parts of the region. The Nansen Programme collaborated with the FAO Species Identification Programme to publish field guides for the whole Western Indian Ocean (Fischer and Bianchi, 1984), for Tanzania (Bianchi, 1985) and for Mozambique (Fischer *et al*., 1990). These have been important reference materials for data collection, and for research and academic purposes.

The *Nansen* data have been used to set policy, based on realistic expectations of fisheries development. For example, during the 1980s, plans for fisheries expansion in Kenya and Tanzania were ambitious, but they were not based on knowledge of fish stock potential. *Nansen* surveys showed that fish stocks would not be able to support commercial exploitation at industrial level (Hallenstvedt *et al*., 1983), and hence projections of fisheries development were adjusted downwards.

Nansen surveys between 2008 and 2012 provided much of the information used to prepare the joint Transboundary Diagnostic Analysis (TDA) undertaken by the ASCLME and SWIOFP projects. The TDA is a scientific and technical synthesis report, describing the ecological status of the Agulhas and Somali Current Large Marine Ecosystems, and threats to long-term sustainability of coastal and marine processes. It provides a technical basis for a Strategic Action Plan.

The Nansen Programme played an important role in establishing the Fisheries Assessment Working

BOX 8.2

"Research vessel promotes ecosystem approach" – the EAF-Nansen Project is an FAO success story

Cruise participants prepare specimens for biological sampling.

Practical session at a species identification course.

In 2011 the EAF-Nansen Project was selected as one of ten "FAO Success Stories", based on its unwavering support of the FAO Code of Conduct for Responsible Fisheries and the ecosystem approach to fisheries (EAF); mainstreaming EAF in GEF-funded Large Marine Ecosystem- and other African regional programmes; providing fisheries assessment information to support management; and promoting communication for development.

The "FAO Success Stories series" is a Knowledge Management publication intended to showcase to the public and external stakeholders what FAO does, and what it does well, towards achieving its mandate. The EAF-Nansen story featured the critical data collected at sea by the RV *Dr Fridtjof Nansen* and how the data were used by working groups to generate information for fisheries management. It also featured the hands-on on-board and on-land capacity development activities, and support to Working Groups and Scientific Committees of Regional Fisheries Bodies. The story showed sponsorships for scientists from developing countries to join *Nansen* surveys, not as observers, but as participants in the design and execution of surveys.

On land, the EAF-Nansen Project hosted workshops to interpret *Nansen* data together with data from other sources, such as commercial fisheries, for use in fishery management systems. It offered overview of management plans prepared by national experts, to encourage consistency with international standards and EAF concepts. Where several countries fish for the same resource, transboundary conflict may occur – to mitigate these, the FAO uses regional mechanisms (such as fisheries working groups or commissions) to advance compatible management strategies. The role of the EAF-Nansen Project in facilitating this process was underscored, and it was commended for placing partnerships – national, regional and international – central to its delivery. Collaboration with African universities to offer EAF courses was highlighted – these courses produced a new calibre of fisheries scientist and manager, with a deeper understanding of the value and functioning of marine ecosystems.

The EAF-Nansen Project reached out to future scientists and managers, through engagement of school children in partner countries. Children were sensitized to understand the importance of healthy seas for people and sustainable fisheries. The project's marine data gathering, combined with the land-based sharing of information, have increased national and regional understanding of the need to maintain healthy ecosystems – and their role in sustainable fisheries. In conclusion, the collaboration of the EAF-Nansen Project with other UN agencies, to create a common platform to monitor climate-related changes in the oceans, mainly in the developing world, was applauded.

Group of the Southwest Indian Ocean Fisheries Commission (SWIOFC). The inaugural meeting on demersal fishery resources in Mombasa in 2011 used Nansen data for assessments, and also commented on the lack of reliable fishery-dependent data in the SWIOFC region.

Nansen data have been used as a key input in the development of fisheries management plans, including for the industrial shrimp- and line fisheries in Mozambique, the demersal fishery in Madagascar and Comoros, the fisheries of Saya de Malha and Nazareth Banks in Mauritius, and the small and medium pelagic fisheries in Tanzania. Data from earlier Nansen surveys in Kenya were used for a co-management plan for Malindi-Ungwana Bay (GOK, 2016).

8.3 Impacts of the Nansen Programme

Several internal and external evaluations of the Nansen Programme (for example, Hallenstvedt *et al*., 1983; Barnes and Gordon, 2009; FAO, 2013) have found that it has achieved measurable positive impacts at regional and national levels. In 2011, the EAF-Nansen Project was selected as

Table 8.1 Conceptual "Impact Framework" (Buxton and Hanney, 1996) modified to describe the impact of the Nansen Programme in the Western Indian Ocean.

Category	Description	Aspects being described
1. Knowledge generation	– Data on fish stocks and ecosystems – Journal articles – Conference presentations – Books and book chapters – Research reports	– Number of papers published – Main research results
2. Research targeting and capacity development	– Better targeting of future research – Development of research skills, personnel and overall research infrastructure – A critical capacity to absorb and utilise existing knowledge from research for educational purposes	– Research agenda and evolution of the Nansen Programme – Capacity developed – Collaborations attracted by *Nansen* research – Techniques developed – Research and educational products
3. Informing policy and product development	– Improved information base for policy and management decisions – Informing development of models, equipment and methods	– Use of research results to inform policies/ plans – Citations of *Nansen* reports in plans/policies/strategies – Models, equipment and methods developed by the programme for wider use – Examples of *Nansen* researchers advising governments
4. Fishery sector benefits	– Improved fish stocks – Improved/recovered fisheries management	– Changes in fishery sector (national and regional) attributable to the Nansen Programme – New fisheries developed
5. Broader social and economic benefits	– Wider economic benefits – Social benefits	– Increased contribution of fisheries to national economy – Increased income of fisherfolk – Contribution to behaviour change in communities

one of ten "FAO Success Stories" – a prestigious acknowledgement based on a number of set criteria, including: measurable, sustainable and replicable results that have positive impact at both regional and local reach; putting in place a wide participatory and consultative process involving various partners; establishing best practices/guidelines; developing capacity; and fostering interagency collaboration. The endorsement by the FAO is captured in Box 8.2.

A conceptual framework developed by Buxton and Hanney (1996) was adapted to describe the key impacts of the Nansen Programme in the Western Indian Ocean (Table 8.1).

Knowledge generation

The Nansen Programme has produced a wide array of primary research outputs on the resources and ecosystems surveyed – such as survey and technical reports for fisheries managers and decision-makers, scientific articles in the peer-reviewed literature, and books and conference presentations to a wider scientific community. Large quantities of data have been stored, and remain to be analysed before it becomes useful – this recurring theme in knowledge generation has been highlighted in Chapters 4 to 7.

To determine the extent to which information generated from *Nansen* surveys in the Western Indian Ocean have been used in publications, Google Scholar was searched using relevant search terms. An initial list of about 250 articles was obtained, but after screening the list was reduced to 92 articles based directly on Nansen surveys. Many of the other articles made primary or secondary reference to Nansen surveys, or cited works based on them. The meta-analysis excluded all *Nansen* survey reports, and focussed on published articles.

Figure 8.2 summarizes outputs by type and geographical area. Some 66 percent of outputs were journal articles, 23 percent were reports, and books (and chapters) and theses made up 6 percent and 5 percent respectively. Most outputs covered more than one country in the Western Indian Ocean, resulting in 47 percent of outputs being categorized under Region. By country, most outputs originated from Mozambique (29 percent), where most surveys took place, whereas no other country exceeded 6 percent of the output.

The number of publications over the lifetime of the Nansen Programme increased notably during Phase 4 (Figure 8.3), coinciding with the partnership of the EAF-Nansen Project with the regional ASCLME and SWIOFP projects. The implementation of the latter two projects, between 2008 and 2013, supported ship-based research in several disciplines. The ship-based research was often collaborative in nature, incorporating acknowledged international experts, scientists from the region and students working towards masters or PhD projects. Hence, the projects generated many reports, theses and journal articles during

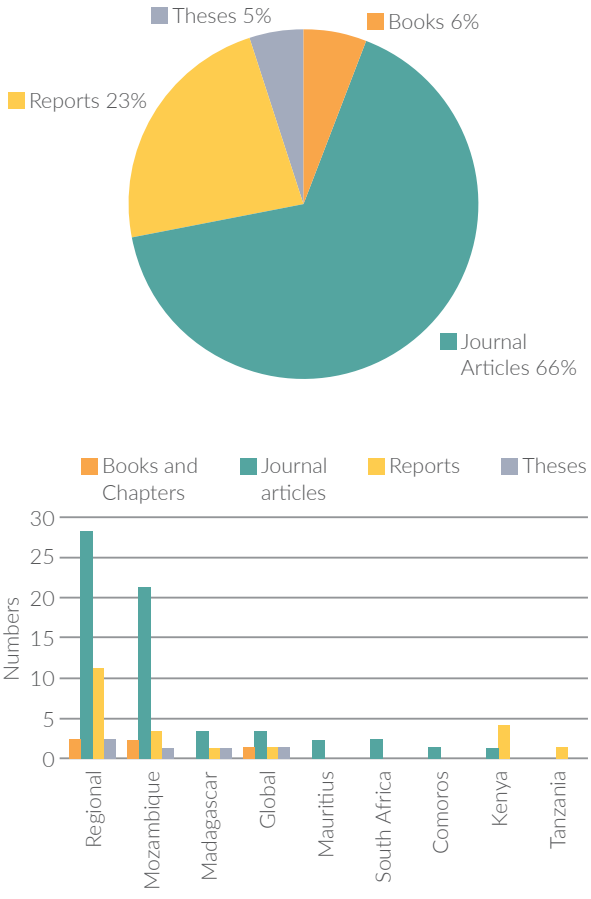

Figure 8.2 Percentage of outputs by publication type (top), and number by country (bottom).

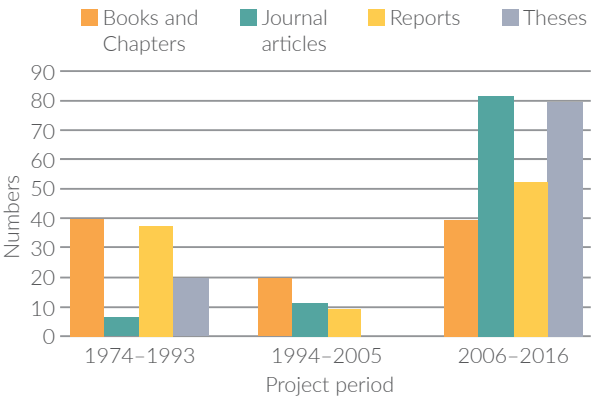

Figure 8.3 Percentage distribution by type of publications between 1974 and 1993 (Phases 1 and 2), 1994–2005 (Phase 3) and 2006–2016 (Phase 4).

this period. There were relatively few publications between 1994 and 2005, when the *Nansen* undertook no surveys in the Western Indian Ocean.

Research targeting and capacity developed

The questions asked under this heading were how future research could be better targeted at specific aims as measured by relevance of outputs, follow-up projects (starting a trend), and streamlining of surveys to improve cost-efficiency. Relevance of outputs has been one of the main drivers of the evolution of the Nansen Programme. These show successive cycles of research targeting, giving rise to follow-up strategies: such as exploring for new fish resources, then mapping them in the EEZs of beneficiary countries, then supporting capacity development towards fisheries (environmental) policy and management and finally implementing an ecosystem approach to fisheries management. Though the focus has shifted to keep up with changing circumstances, the overarching aim of the Nansen Programme, set in 1975, has remained substantially unchanged – providing aid to developing countries, to facilitate sustainable fisheries development.

Relevance of outputs are highlighted in some recent research results, such as the assessment of fish stocks to determine their status and potential (Sætersdal *et al*., 1999; FAO, 2013); understanding the nature of the Mozambique Channel eddies (FAO, 2013; Ternon *et al*., 2014); investigating the Mascarene Plateau ecosystem (Strømme *et al*., 2008; FAO, 2013); and mapping the biodiversity of Southern Indian Ocean Seamounts (Rogers *et al*., 2009; FAO, 2013). These outputs have given rise to several follow-up projects, such as surveys by the FV *Caroline* and FV *Roberto* to assess deep-water fisheries resources by SWIOFP (Everett *et al*., 2015a, b; Kaunda-Arara *et al*., 2016), the MESOBIO programme to investigate mesoscale dynamics in the Mozambique Channel (Marsac *et al*., 2014) and the ACEP ("Suitcase") project to study larval transport by eddies (S. Fennessy, personal communication, 2016). For the latter project, additional surveys were undertaken in the Mozambique Channel by the South African RV *Algoa* in 2013. Earlier, studies under the Indian Ocean Programme (1990–1995) built on the surveys carried out by the *Nansen* during the 1970s and 1980s, for instance, the RV *Tyro* surveys of monsoons and coastal ecosystems in Kenya (Stel, 1997).

Informing policy and product development

A broader definition of policy used here includes national policies and fisheries management plans, as well as regional strategies adopted by recognized government entities. The Nansen Programme piloted a method developed by FAO to incorporate key EAF principles in the preparation of fishery management plans (FAO, 2013). At country level, fisheries management plans consistent with EAF principles were developed through broad-based stakeholder participation, to ensure their relevance and acceptance. Comoros, Madagascar, Mauritius, Mozambique, Kenya and Tanzania have all started to implement the EAF management plans. At regional level, the joint Strategic Action Plan of the ASCLME and SWIOFP projects, developed in collaboration with the Nansen Programme, was approved by governments.

The Nansis database and information system, a product of the Nansen Programme, is now widely available to scientists and technicians worldwide. It can be used to store and manage data from different types of stock assessment surveys. The

Nansen Programme has also contributed to the EAF Toolbox (FAO, 2012), which guides users through the EAF planning steps. With the support of the FAO Legal Office a "How-to Guide on Legislating for EAF" has been developed (FAO, 2017). The guide has been prepared in response to a need identified by developers and drafters of legislation as well as fisheries managers. It provides examples to demonstrate approaches to drafting national legislation that incorporate EAF-relevant components.

The guide contributes to improving the legal framework for fisheries management in partner countries, and in other FAO member countries.

Fishery sector benefits

The adoption of the EAF strategy by Western Indian Ocean countries was a major achievement of the Nansen Programme. A baseline score for EAF implementation across the region was computed as 46.2 percent in 2011 (Table 8.2), based on the criteria (operational objectives) adapted from Paterson and Petersen (2010). The criteria were again scored in 2015 (FAO, 2015), showing an overall increase of 3.2 percent in implementation success, to 49.4 percent. Notably, the level of implementation was higher than the overall average (43 percent) computed by the EAF-Nansen Project for 29 countries in Africa.

Broader social and economic benefits

An activity has social and economic impact when it affects the welfare, profits and revenues of people in question (Warry, 2006). Sætersdal *et al*. (1999) and Hersoug *et al*. (2004) concluded that one of the economic benefits bestowed by the Nansen Programme was advice on setting fisheries development goals. For instance, *Nansen* information on the low potential of fisheries resources in newly independent Kenya and Tanzania, in the early 1980s, convinced their governments to avoid large-scale investment in deep sea industrial fisheries. The data clearly showed that the size of the fish stocks was not large enough to support intensive commercial exploitation.

Table 8.2 Criteria and implementation score (percentage) from a 2011 baseline to the status four years later, in 2015 (lower values shown in orange).

Criterium	2011	2015
Good understanding of ecosystem impacts of fisheries	39	44
Ecosystem impacts of fisheries are considered in management advice	46	47
Social well-being of people who depend on fishing is accounted for in management advice	52	61
Maintaining economic well-being of fishing industry	49	45
Transparent and participatory management structures in place	69	71
Management plans incorporate EAF considerations	31	44
Compliance with regulations reduces ecosystem impacts	47	50
Availability of sufficient capacity, skills, equipment and funding to support EAF implementation	46	46
Existence of good procedures	50	48
External impacts of fisheries addressed	31	37

Fisheries management plans supported by the EAF-Nansen Project and the SWIOFC include, as objectives: optimization of social and economic benefits to local community, national and regional economies; ensuring long-term biological sustainability and ecological integrity of the pelagic fishery; and improved governance of fisheries. Although fairly generic, these objectives should lead to improved food security and livelihoods, if management plans are effectively implemented.

8.4 Future challenges

The *Nansen* cannot be everywhere at the same time, and projects that are initiated when it is present, cannot always be sustained after it has left. For example, protocols for collection of fisheries data for stock status assessments have been established by the Nansen Programme, but the surveys need to be repeated regularly, so that stock trends can be measured. Once the *Nansen* leaves the region, there are often no other research vessels available to continue with monitoring, hence follow-up data are not collected and assessments become dated and of little use in practice.

The *Nansen* adheres to a minimum depth limit of 20 m, and can therefore not survey shallower waters over the shelf, where many pelagic and demersal fish resources are concentrated. This can bias estimates of abundance based on acoustic recordings and trawling, especially of small pelagic species that use shallower water on a seasonal basis, for reproductive or other biological functions.

One of the strengths of the Nansen Programme is on-board training of regional scientists by scientific and technical staff of IMR. Whereas a core of IMR staff regularly participate in surveys, there are, however, few "counterparts" from the region, with long-term experience of the *Nansen*, at the level of the Norwegian scientists or cruise leaders. The root cause for this lack of "counterparts" is two-fold; that the *Nansen* ship-based training is geared towards giving opportunities to as many trainees as possible, and also that the *Nansen* moves between ocean basins, and is not always active in the Western Indian Ocean.

Collections during *Nansen* surveys have resulted in numerous samples and specimens, which are sent for identification to laboratories in Norway or in the countries being surveyed. This includes validation of fish species identification, identification of zooplankton, phytoplankton and benthic fauna and chemical analysis of sediment samples. In-depth analyses often take too long, resulting in delays in completing reports.

The inadequate use of survey data is a long-standing challenge. The *Nansen* collects large quantities of data during each survey, spanning from bottom mapping, to continuous collections of oceanographic information and acoustic recordings of fish densities while steaming, as well as ocean productivity information and trawl samples of biological specimens. Apart from their use in survey reports, most of these data are stored, and not used to its full potential. Limited capacity for data analysis and interpretation, especially in fields not directly related to fisheries resource use, appears to be an important factor in most Western Indian Ocean countries.

Another challenge in the Nansen Programme is the inadequate data management resources to secure the *Nansen* survey data in national research and management institutions. In several of the programme evaluations, remarks had been made on the non-availability of *Nansen* data to local scientists. Training of local scientists (by SWIOFP in partnership with the EAF-Nansen Project) to access and use Nansis data, and support for local central data repositories have had limited success.

Survey reports are not intended to directly provide advice to policy makers or managers, particularly in Phase 4 of the Nansen Programme, in which multidisciplinary research was done to support the adoption and implementation of EAF-based management. The linkage between the scientific information, and its application in policy or management remains a challenge.

A continuous monitoring programme of marine ecosystems, showing their status and trends, and based on systematic and long-term data, is absent in the Western Indian Ocean. The quality of information available for EAF-based management is therefore compromised, despite the efforts of the Nansen Programme. Potential solutions to these challenges are discussed in Chapter 10.

8.5 Conclusions

The Nansen Programme is uniquely placed to support broad-based fisheries development assistance in the Western Indian Ocean and in other developing world regions. The approach developed over the past four decades – to assist with collecting offshore fisheries data (using the RV *Dr Fridtjof Nansen*), and with capacity development to support science, policy and fisheries management – is now well-established showing clear and enduring gains. This conclusion is based on an assessment of key impacts, in categories for knowledge generation; research targeting and capacity developed; informing policy and product development; fishery sector benefits; and broader social and economic benefits. The partnership between Norad and FAO, and the availability of the *Nansen* and IMR expertise were crucial elements in the success of the Nansen Programme to date. As a counterbalance to the achievements of the programme, some challenges remain unresolved. ■

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