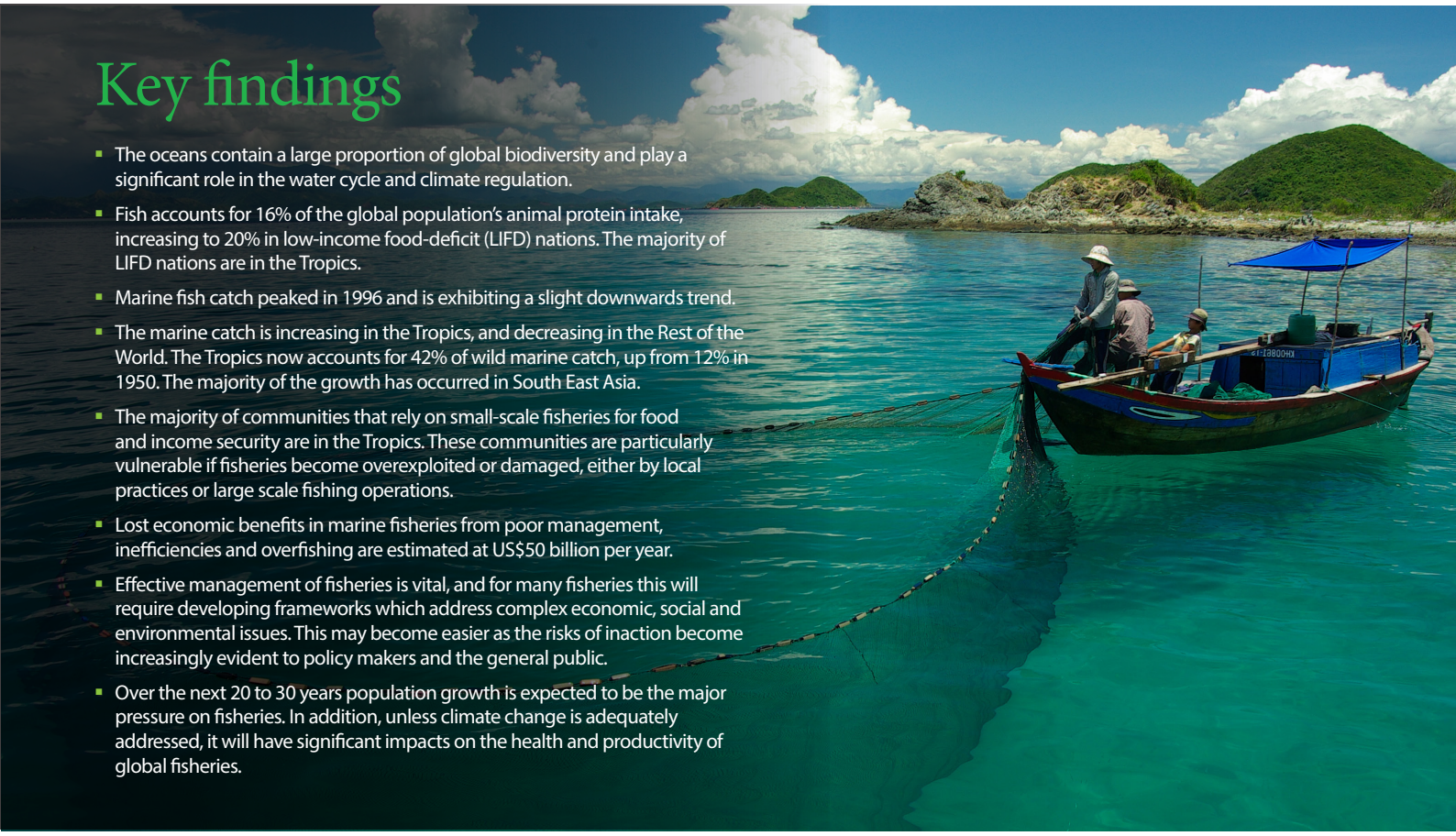
STATE OF THE TROPICS

Wild Marine Catch



Key findings

- The oceans contain a large proportion of global biodiversity and play a significant role in the water cycle and climate regulation.
- Fish accounts for 16% of the global population's animal protein intake, increasing to 20% in low-income food-deficit (LIFD) nations. The majority of LIFD nations are in the Tropics.
- Marine fish catch peaked in 1996 and is exhibiting a slight downwards trend.
- The marine catch is increasing in the Tropics, and decreasing in the Rest of the World. The Tropics now accounts for 42% of wild marine catch, up from 12% in 1950. The majority of the growth has occurred in South East Asia.
- The majority of communities that rely on small-scale fisheries for food and income security are in the Tropics. These communities are particularly vulnerable if fisheries become overexploited or damaged, either by local practices or large scale fishing operations.
- Lost economic benefits in marine fisheries from poor management, inefficiencies and overfishing are estimated at US$50 billion per year.
- Effective management of fisheries is vital, and for many fisheries this will require developing frameworks which address complex economic, social and environmental issues. This may become easier as the risks of inaction become increasingly evident to policy makers and the general public.
- Over the next 20 to 30 years population growth is expected to be the major pressure on fisheries. In addition, unless climate change is adequately addressed, it will have significant impacts on the health and productivity of global fisheries.

A number of leading institutions from across the world have joined forces to assess and report on the critical questions facing one of the world's most important and fastest growing regions: the Tropics.

Over the past half-century the Tropics has emerged as an increasingly critical region. More than 40% of the world's population now lives in the Tropics and this is likely to be close to 50% by 2050. The region generates around 20% of global economic output and is home to some 80% of the world's biodiversity.

However, the resources to sustain larger populations and economic growth are imposing ever-increasing pressures. Issues of concern include relatively poor health outcomes, with more than one billion people suffering from tropical diseases, unacceptable levels of infant mortality and reduced life expectancy; extreme poverty; poor educational outcomes; environmental degradation; and, in some cases, political and economic instability.

The Project

In early 2011 a group of leading institutions decided to examine the condition of life in the Tropics. The group met in Singapore in mid-2011 to scope a project, and decided to share their expertise to prepare a report assessing a broad range of environmental, social and economic indicators.

This work will culminate with the release of the ***State of the Tropics Report*** **in mid 2014**, which will shine a light on key issues of the tropical world, and contribute to efforts to improve the lives of the peoples of the Tropics and their environment. Leading up to the report's release, a series of briefings on indicators underpinning the report will be released, including this one which looks at the extent of wild marine catch.

The institutions involved in the project are: Escuela Superior Politiécnica del Litorial (Ecuador), Instituto Nacional de Pesquisas da Amazônia (Brazil), James Cook University (Australia), Liverpool School of Tropical Medicine (England), Mahidol University (Thailand), Nanyang Technological University (Singapore), National University of Singapore, Organisation for Tropical Studies (Costa Rica), University of Hawaii – Manoa (USA), University of Nairobi (Kenya), University of Papua New Guinea and University of the South Pacific (Fiji).

Background

More than 2,000 years ago Aristotle described the world as being divided into three zones – the Frigid Zone, The Temperate Zone and the Torrid Zone. He decided that the Torrid Zone was too hot for civilised habitation, and that humans could only live and work productively in the Temperate Zone. While Aristotle's Torrid Zone was not precisely defined geographically, it is clear his uninhabitable region was what we know as the tropics.

Other ways of viewing the world have subsequently waxed and waned: north/south was a focus of attention during early European expansion; east/west as this expansion accelerated and political and economic systems developed; as we became aware of economic, social and political inequalities there was a focus on a first world/third world perspective; and, in the post-WWII environment, it has been on OECD/non-OECD or developing/developed countries dichotomies.

Each of these world perspectives generated temporally relevant insights, but also papered over Aristotle's fundamental insight – his lateral view of a world. We might expect Aristotle's three geographic and climatic zones to share common problems and challenges, and for there also to be issues unique to each zone.

The range and significance of issues facing nations and territories in the tropics suggests it is now time to examine the world using Aristotle's insight, viewing the tropics as a discrete region and defining its characteristics and issues. With the exception of Europe and Antarctica all continents are partly in the tropics, and there are 144 nations and territories either fully or partly in the tropical region[1]. More than 40% of the world's population is estimated to already live in the tropics – up from 30% in 1950.

While annual economic growth has been around a full percentage point higher than the Rest of the World over the past 30 years, the disparity between population (40% of the world's population) and economic output (20% of global economic output) means that, for the tropics as a whole, people are less wealthy compared to other latitudes.

Many tropical nations face relatively greater and more imminent exposure to some of the most critical issues of our time, most notably the impacts of climate change on human and food security, such as rising sea levels, declining crop yields and the extinction of vulnerable species.

A significant proportion of the estimated 80% of the world's biodiversity that exists in the tropics is also under threat, and climate change is likely to have a greater impact in the tropics where many species are thermal specialists, and do not tolerate changes in climate as well as those species accustomed to more significant changes in seasonal conditions.

The Tropics

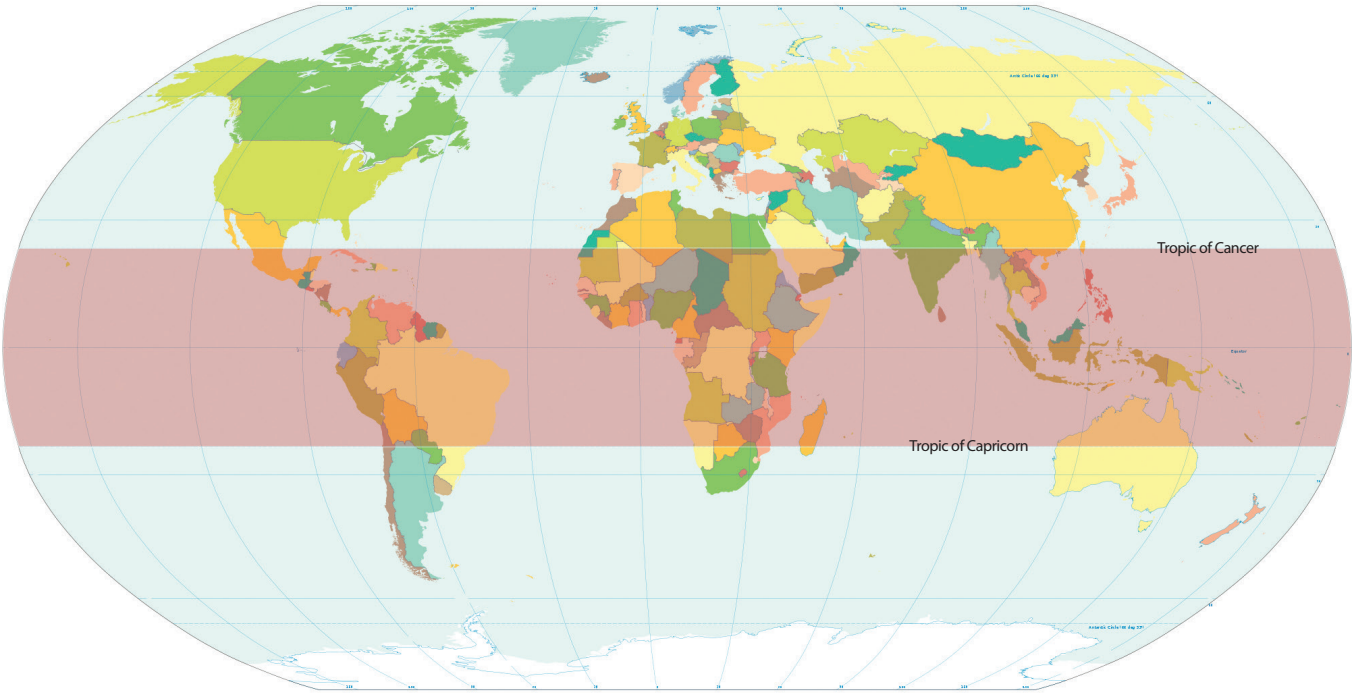
The Tropics is commonly defined as the region of the Earth surrounding the Equator within the latitudes of the Tropics of Cancer and Capricorn at +/– 23.5 degrees (see Figure 1). With its origins in astronomy, these latitudes are the limit of where the Sun reaches a point directly overhead at least once during the solar year, and are used to define the Tropics in this paper.

Although topography and other factors contribute to climatic variation, tropical regions are typically warm and experience little seasonal change in day-to-day temperature. An important feature of the Tropics is the prevalence of rain in the moist inner regions near the equator, and that the seasonality of rainfall increases with distance from the equator[2].

In the Köppen-Geiger[3] climate classification the Tropics is dominated by 'equatorial' and 'arid' climates, with the balance of the world being primarily 'warm temperate', 'snow' and 'polar' climates.

Equatorial climates have a mean temperature for all months above 18°C (64°F), and arid zones are defined with reference to both temperature and rainfall, but are characterised by a lack of water which inhibits plant and animal life.

Figure 1: The Tropics



Wild Marine Catch

The oceans cover 71% of the Earth's surface and contain around 97% of its water[4]. It is also estimated that 25% of all species diversity exists in the oceans (of which, 91% is still undescribed)[5].

Oceans and marine life support many elements that are critical for human life. Marine organisms are significant contributors to the oxygen cycle and oceans play a major role in determining the Earth's climate and the water cycle. Many human activities are, however, affecting the health of oceans – both directly and indirectly. The impact of increased anthropogenic CO_2 emissions is the most pervasive. These emissions are changing ocean acidity and contributing to climate change which is affecting sea levels, precipitation patterns, the incidence of extreme weather events and possibly ocean circulatory patterns[6].

Urbanisation is also having significant impacts in many coastal ecosystems. Coastal development includes dredging, reclamation and the construction of physical barriers (such as sea walls). Each of these factors can disrupt currents, sediment flow and discharge, with impacts on sensitive coastal ecosystems.

The ocean's marine life represents a vast resource which provides food, medicine, and raw materials that support human life and economic activities. In 2007 fish accounted for 16% of the global population's intake of animal protein, and 20% in low-income food-deficit (LIFD) nations[7], most of which are in the Tropics. As around half the global wild marine catch is in small-scale fisheries[8], sustainable fish stocks are critical to the lives of millions of people in developing nations.

For many developing nations rising incomes are contributing to increased demand for seafood, although in others, ongoing poverty means there is a high reliance on subsistence fishing as the primary protein source[9]. As the global population increases there will be greater demand for seafood, and a need for more sustainable production methods. The impact of persistent over-fishing has had long term impacts on the productivity of marine ecosystems, notably in areas where poverty overshadows environmental concerns, and where unregulated and illegal fishing is prevalent. As such, the sustainable management of wild marine stocks is a critical issue for the wellbeing of many small-scale fishing communities. Collapse of these fisherieswould have significant food and human security implications.

To some extent aquaculture is reducing pressure on wild fish stocks, but the benefits are offset by the extensive use of fish meal. Globally, aquaculture's proportion of total fisheries production is increasing rapidly. However, in many developing nations, the output is increasingly high-value fish destined for export markets rather than for local consumption, meaning that food security is an ongoing issue, even in many fish producing nations.

Marine Catch[10]

Global fisheries production (excluding aquatic plants) increased from 18 million tonnes in 1950 to 154 million tonnes in 2011. Over this period the wild marine catch increased from 16 to 79 million tonnes, but its proportion of the global catch fell from 89% to 51%. At the same time aquaculture's contribution to global production increased from 3% in 1950 to 41% in 2011.

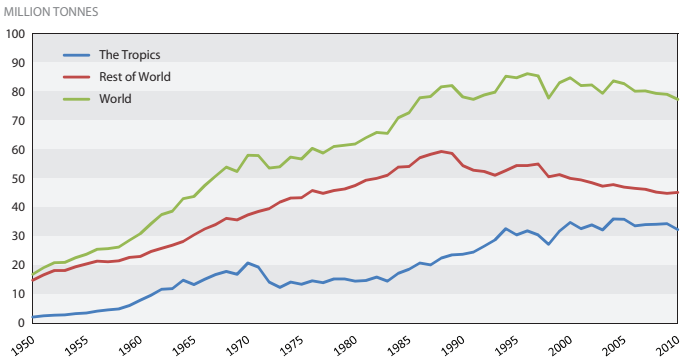
The wild marine catch increased rapidly from the 1950s to the late-1980s. This was driven by strong population growth (and increased demand for food) and technological advances which increased the precision and efficiency of fishing effort, and made commercial fishing in deeper offshore waters feasible. The Tropics accounted for around two million tonnes of the marine wild catch in 1950 (12%), increasing to 32 million tonnes in 2010 (42%) (see Figure 2). The proportion of the wild marine catch from the Tropics has increased rapidly since the late 1980s, reflecting both the steady decline in the catch in the Rest of the World, (notably in northern Europe and North America), and increased production in the Tropics. In the Tropics, South East Asia and South America are the major producers (see Figure 3).

In South East Asia the wild marine catch increased from less than one million tonnes in 1950 to more than 18 million tonnes in 2010. The majority of the increase was in Indonesia (up by 4.7 million tonnes), China (3.0 million tonnes), Philippines (2.2 million tonnes) and Vietnam (2.0 million tonnes). The combination of strong population growth and rising living standards in these nations contributed to strong demand for fisheries output.

The rapid increase in production in the Tropics to 1970 was driven by Peru's anchoveta catch. Between 1950 and 1970 Peru's marine catch increased at an average rate of almost 30% per annum, from 75,000 tonnes in 1950 to 12.5 million tonnes in 1970. Between 1960 and 1970 anchoveta accounted for 98% of Peru's wild marine catch. Overfishing and the disruptive El Niño and La Niña weather patterns contributed to the fishery's collapse in the early 1970s, and almost two decades of poor catches. Production has since started to recover, supported by improved fisheries management (see Box 1).

In the Rest of the World the wild marine catch peaked in 1988 at 59 million tonnes, and has since

Figure 2: Global Wild Marine Catch



Source: FAO

fallen by 640,000 tonnes per annum on average, to around 45 million tonnes in 2010. Over the same period the wild marine catch in the Tropics increased by 450,000 tonnes per annum. Nonetheless, since the peak in the global catch in 1996, the rate of increase in the Tropics has fallen considerably, from an average rate of 5.1% per annum in the 14 years to 1996, to 0.1% per annum in the 14 years to 2010.

Up to the mid-1990s increases in catch were supported by the exploitation of new fisheries. For example, there was a rapid expansion of commercial fishing into the open oceans in the 1980s and 1990s[11].

Slower growth in the rate of expansion (and, the marine catch) since then reflects that most commercially viable wild fisheries have now been exploited.

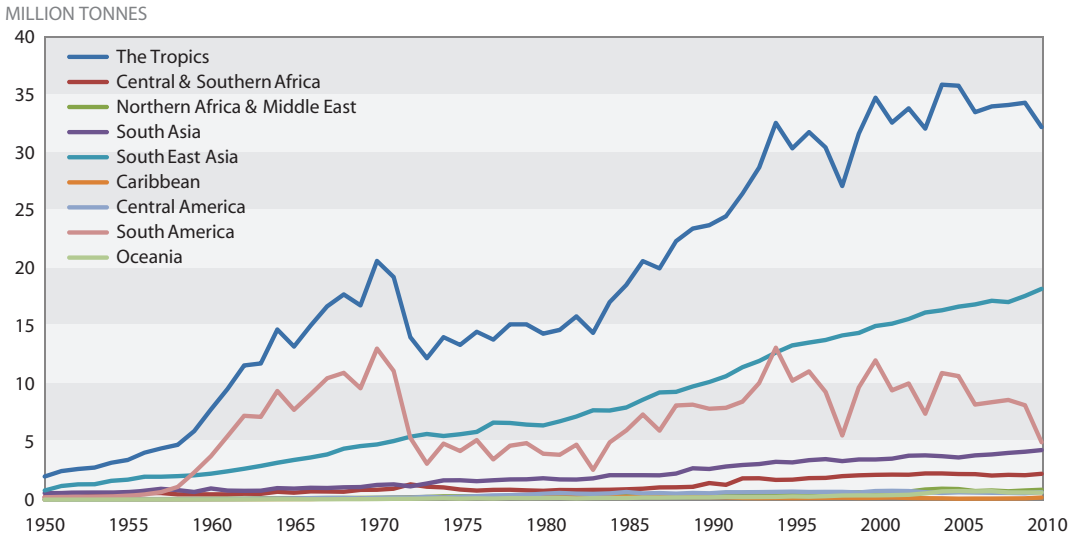
The moderation in growth of fisheries since the mid-1990s also reflects international efforts to improve fisheries management, as the serious ecological and socioeconomic consequences of overexploitation in broad scale fisheries is increasingly recognised. Efforts in this area aim to prevent over-exploitation of species, maintain biodiversity and ensure a sustainable food supply[12].

Nonetheless, overfishing, defined as when production exceeds the capacity for replacement by reproduction and growth, is common. Fisheries typically progress through sequential stages of development, going from being undeveloped to developing, fully exploited to overfished to collapsed, and then to rebuilding[13].

FAO estimates that the proportion of underexploited or moderately exploited stocks declined from 40% of species/ stocks in the mid-1970s to 15% in 2008, and that the proportion of overexploited, collapsed or recovering stocks increased from 10% to 32%[7,14]. The proportion of fully exploited stocks has been relatively stable at about 50% since the 1970s. FAO estimates that in 2008:

- 3% of stocks were underexploited and 12% moderately exploited, and therefore, able to produce more than their current catches;
- 53% were fully exploited, with current catches at or near their maximum sustainable production; and
- 28% were overexploited, 3% collapsed and 1% recovering from depletion, and therefore yielding less than their maximum potential production.

Figure 3: Wild Marine Catch – the Tropics



Source: FAO

Other research suggests the situation may be considerably worse, with 33% of stocks overexploited and 24% collapsed in 2008[15].

The Sea Around Us Project estimates that in 2006 the proportion of stocks in the Tropics and the Rest of the World that were overexploited or collapsed was roughly similar, at around 45%[16]. Nonetheless, it is likely that poorer data availability in the Tropics combined with higher levels of illegal, unreported and unregulated fishing mean that, relative to the Rest of the World, there is considerable under-reporting in official catch statistics for the Tropics.

The increased proportion of overexploited, collapsed or recovering stocks combined with limited scope to expand into new fisheries means that many wild marine fisheries will not be able to increase production until effective management plans are put in place to rebuild overfished stocks[7].

Box 1: Anchoveta Fishing in Peru

Off the coast of Peru is one of the world's most productive fishing areas. The coastal upwelling created as the cold Humboldt current collides with sharp coastal shelves forces nutrient rich cool water to the surface feeding a rich phytoplankton and zooplankton 'soup', a major source of food for a variety of animals, including anchoveta.

The extreme abundance of anchoveta and their proximity to the coast has made their capture, processing and export a major economic activity in Peru. Nonetheless, the fishery is susceptible to El Niño events which cause ocean currents to change direction, surface temperatures to rise, and the upwelling to stop. In the absence of this food source the anchoveta and other animals either migrate, or feed at greater depth where they are not accessible to fishers.

The Peruvian anchoveta fishery began in the early 1950s and is one of the most important fisheries in the world in terms of landings and fishmeal production. Once it was identified as a valuable economic resource, landings of Peruvian anchoveta increased rapidly, from 1,200 tonnes in 1951 to more than 6.6 million tonnes in 1963. The majority of catch was used for fishmeal production for export. By 1963 Peru was the world's largest producer of fishmeal.

Between 1951 and 1964 the fleet increased from 25 vessels to 1,744. Rapid fleet development reflected an 'open access' environment (where access rights did not exist or were poorly defined) and poorly defined fisheries management principles. This resulted in significant over capacity as fishers to invested in larger and more modern vessels and equipment to ensure larger individual shares.

By 1965 scientists recognised the risks of overexploitation and recommended the introduction of a total allowable catch of seven million tonnes. Nonetheless, in 1971 landings reached 12.3 million tonnes – the highest level ever experienced for a single-species fishery in the world. In 1972 the industry was hit by a particularly strong El Niño event, and during 1972-73 anchoveta landings collapsed to less than two million tonnes.

The government nationalised the industry in 1973, aiming to rationalise activity and preserve the resource. Subsidising the fishing fleet during consecutive years of poor catch was impossible and led to it being denationalised in 1976. Anchoveta stocks began to recover in the early 1980s but a strong El Niño in 1982-83 affected production and stocks did not recover through the 1980s. By the late 1980s, twenty years of poor catch was reflected in the age and condition of the fleet of less than 400 vessels.

In the 1990s the privatisation of state-owned fishing assets saw strong investment to upgrade the fleet and its capacity, despite the introduction of laws in 1992 designed to prevent capacity building. The ensuing over-capacity led to the development of a range of policies aimed to ensure the industry's sustainability. Vessel restrictions were introduced in 1998, and in 2008 individual vessel quotas (IVQ) were introduced.

The IVQ model allocates temporary access rights to a vessel and a fishing license. Should a boat be withdrawn, its rights can be accumulated to other boats belonging to the same boat owner, but there is no increase in vessel numbers. A key aim of the IVQ model is to reduce over capacity and move towards a smaller, more efficient fleet. Other policy changes include an enforced sustainable quota (aimed at ensuring five million tonnes of anchoveta are left each year as spawning stock) and mandatory installation of satellite-tracking devices on vessels.

Recognition that over-exploitation of anchoveta could lead to the collapse of a nationally significant industry was a key factor in introducing more sustainable fishing practices in Peru. After accounting for the El Niño impact in 1998, the benefits of this approach are reflected in the relatively stable catch over the past 20 years.

Source: Aranda M (2009). Evolution and state of the art of fishing capacity management in Peru: The case of the anchoveta fishery. Pan-American Journal of Aquatic Sciences, 4(2): 146-153.
The Economist (2011). Fishing in Peru – the next anchovy. Print edition, 5 May 2011.

Fishing Communities

Marine capture fisheries is probably the single most important way in which wild species are directly used by humans[17], providing food security and income for millions of people. However, many of the world's fisheries are severely overfished. The source of this over-exploitation can be from both small-scale, subsistence fishers and large-scale, commercial fishers.

Small-scale fisheries account for more than half of the global fish catch and employ more than 90% of the world's 35 million capture fishers[7]. Almost all of the catch from small-scale fisheries is used for human consumption, and many of the communities that rely on these fisheries are in the Tropics – in Asia, Africa, Latin America, the Caribbean and Oceania.

Despite the significant contribution of small-scale fisheries to food security, its catch and economic status are poorly understood. For example, research undertaken in a number of tropical nations suggests that poor data for small-scale fisheries contributes to the actual marine catch being 1.7 to 6.2 higher than official estimates[18,19,20]. This general lack of data impacts the effectiveness of fisheries management and increases the likelihood of fishing access being over-licensed, to the detriment of marine ecosystems and national food security.

Unlike large-scale commercial fisheries, small-scale fisheries also have a low visibility and receive little attention from policy-makers. The communities supported by small-scale fisheries are typically poor, have insecure access rights to fishery resources and are not adequately represented in decision making processes. In the short term these communities are likely to be the most affected by the implementation of sustainable fisheries management, but they have the most to gain in the long run if more equitable fisheries management can be achieved. The FAO is currently taking leadership to address these issues (see Box 2).

The development of large, capital intensive, commercial offshore fleets using modern technologies to target fish is affecting small-scale fisheries, often reducing the volume of stock accessible to coastal subsistence fishers using small and often non-motorised craft. Reflecting the small-scale and localised nature of fishing in Africa and Asia, production in these regions is less than 2.5 tonnes per fisher per annum, compared with 24 tonnes per fisher in Europe's more industrialised fisheries[7].

The spread of distant-water fishing contracts which allow foreign nations to fish another country's waters is also affecting fishing communities in many developing nations. Licence fees for these contracts are typically paid to central governments, and the fishing communities that bear the major costs of these contracts – through reduced fish stocks and habitat destruction – typically see limited benefits from the allocation of contract revenues.

Box 2: Small-scale Fisheries

In 1995 FAO developed the Code of Conduct for Responsible Fisheries in response to the growing concerns regarding the sustainability of global fishery resources. The Code explicitly recognises the importance of small-scale fisheries in poverty alleviation and food security, and acknowledges the right of small scale fishers to a secure a just livelihood and preferential access to traditional fishing grounds. Threats to communities in these fisheries go beyond low fish catch from increased competition with external fishers, and include the impacts on fisheries from pollution, coastal development and other land-based practices.

The 29th session of the Committee of Fisheries of the FAO agreed that, in view of the important role played by small-scale fisheries, FAO should continue to give priority to small-scale fisheries and ensure adequate visibility for them, particularly in relevant international forums that deal directly or indirectly with these fisheries. The Committee also approved development of a new international instrument on small-scale fisheries to complement the existing Code of Conduct for Responsible Fisheries, with input from all relevant stakeholders.

Source: FAO, World Fish Centre, The World Bank (2009). Small-scale capture fisheries: a global overview with emphasis on developing countries. A preliminary report of the Big Numbers Project.
FAO (2011). Report of the twenty-ninth session of the Committee on Fisheries. Rome, 31 January–4 February 2011. FAO Fisheries and Aquaculture Report. No. 973. United Nations. Rome.

Marine Catch and Biodiversity

Fishing effort is undertaken in a range of marine environments ranging from coastal habitats (such as mangroves and seagrass beds), coral reefs and deep water habitats. The wellbeing of each of these environments is being impacted by climate change, as well as a range of other risks such as pollution from land-based sources, destructive fishing practices and overfishing.

Many climate change impacts will not be felt immediately, but will accumulate over time if not addressed. For example, the International Panel on Climate Change's high carbon dioxide emission scenarios suggest that drastic changes in tropical oceans and coastal habitats will occur by the end of the century. Resulting habitat degradation and environmental change could reduce fisheries productivity in the Tropics by up to 50%, especially in near shore, shallow water environments such as coral reefs[21].

One reason for the declining marine catch is the 'tragedy of the commons' where, in the absence of clearly defined property rights, anyone with access to a shared resource has an interest in overexploiting it, and it is in no individuals interest alone to maintain it. This can lead to significant over capacity as fishers have incentives to invest in larger and more modern vessels to ensure larger individual shares. Without intervention, collapse of the resource is inevitable, with significant socioeconomic and ecological consequences.

The tragedy of the commons effect has been exacerbated by government subsidies, particularly in Europe and East Asia, which can act to support otherwise marginal fisheries. Globally, capacity enhancing fishing subsidies – such as for fuel and boat construction or renovation – were estimated at US$16.2 billion in 2003[22], which is contributing to a fleet capacity that is significantly greater than is needed to fish sustainably[23].

An indicator of the direct impact of overfishing is the Marine Trophic Index (MTI) which, until the early 1980s, showed the global fisheries catch increasingly consisted of smaller fish, lower in the food web[17]. This process, known as 'fishing down marine food webs', is a major issue as it shows larger predators are being caught preferentially in such numbers that their stocks do not recover. The loss of top predators and the reduction of the trophic structure have consequences for ecosystem stability and function, and threaten biodiversity more broadly. Although there are large regional variations in the MTI, overall it has been stabilising or improving since the mid-1980s. While this is promising, the Fishing-in-Balance Index suggests that the improvement largely reflects the spatial expansion of fishing effort[24]. That is, the expansion of fishing effort into areas where higher level predators have not previously been targeted is contributing to increases in the MTI.

The condition of recently exploited deep water habitats is also starting to cause concern as there is a greater awareness of the impact of modern fishing techniques on these previously inaccessible ecosystems. Deep ocean species

are increasingly targeted as more accessible fish stocks are depleted, and more strictly regulated. Deep water habitats are particularly vulnerable to overfishing as, at greater depths, species tend to be slow growing and long lived compared with shallow water habitats. Although improving, a lack of data for these environments mean that fishing's impacts are poorly understood at present.

Reduced or static fish landings are not only the result of overfishing over the past twenty years, but also poor fishing methods that have degraded marine habitats. The use of destructive fishing gear and practices – such as bottom trawlers, dynamite and poison – are still widely employed, even though their impacts are widely understood.

Another major issue is by-catch (the unintentional taking of non-targeted species including marine mammals, turtles and birds). It is estimated that 27 million tonnes of fish are discarded each year in commercial fisheries[25]. These practices can compromise the productivity of global fisheries and the viability of marine ecosystems.

Looking Forward

As human populations continue to grow, the future benefits that fishery resources can provide will depend largely on how well they are rebuilt and managed[26]. A key challenge will be maintaining marine biodiversity and ecosystem services while also developing sustainable marine fishing practices.

New approaches to fisheries management being developed include the ecosystem approach to fisheries management (EAF) and co-management[27]. EAF has a greater focus on ecosystem health and sustainability, and gives greater prominence to the 'precautionary approach' in fisheries management. The EAF also aims to deliver food and income security in an equitable manner. Practical issues associated with implementation of EAF are being resolved[28], though there are particular challenges in developing cross-border institutional and governance frameworks that address complex economic, social and environmental policy issues[29].

Widespread acceptance of ecosystem and co-management approaches to fisheries management represent a shift away from traditional single species management tools such as maximum sustainable yield[30].

However, marine environments are complex, and fishing occurs at different scales, targets multiple species and uses multiple fishing gears. As such, a range of methods and management tools are needed for appropriate, sustainable fisheries management.

Notes

1. A two stage process was undertaken to assess which nations are classified as being in the tropics for reporting purposes – a population-based stage and a data availability stage. For large nations that straddle the tropics analysis and reporting is for subnational provinces primarily in the tropics. These nations are Australia, Bangladesh, Brazil, China, India, Mexico, Saudi Arabia and the United States. The reporting covers 109 of the 144 nations fully or partially in the tropics. More information on the nations and regions included in the report is available at: www.stateofthetropics.org
2. Isaac J, Turton S. (2009). Expansion of the tropics: Evidence and implications. Retrieved on 5 March 2012 from: www-public.jcu.edu.au/public/groups/everyone/documents/media_release/jcuprd_048832.pdf
3. The system is based on the concept that native vegetation is the best expression of climate. Climate zone boundaries reflect vegetation distribution, and are defined with reference to a combination of average annual and monthly temperatures and precipitation, and the seasonality of precipitation. The five main climate groups are Equatorial, Arid, Warm Temperate, Snow and Polar.
4. National Oceanic and Atmospheric Administration, United States Department of Commerce (2011). Ocean. Accessed on 27 January 2012 from: http://www.noaa.gov/ocean.html.
5. Mora C, Tittensor DP, Adl S, Simpson AGB, Worm B (2011) How Many Species Are There on Earth and in the Ocean? *PLoS Biol* 9(8): e1001127. doi:10.1371/journal.pbio.1001127
6. UNEP (2007). *Global Environment Outlook 4*. United Nations Environment Programme. Malta.
7. FAO (2010). *The State of World Fisheries and Aquaculture 2010*. Food and Agriculture Organization of the United Nations. Rome.
8. There is no clear definition of what a small-scale fishery is, but they are characterised as requiring only a small capital investment to operate in, use low technology gear and vessels (often non-motorised) and catch fish primarily for subsistence or local markets.
9. Delgado CL, Wada N, Rosegrant MW, Meijer S, Ahmed M. (2003). *Fish to 2020: Supply and demand in changing global markets*. International Food Policy Research Institute. Washington DC. WorldFish Center, Penang, Malaysia.
10. Data are sourced from the United Nations Food and Agriculture Organisation (FAO). The data are considered to be the best available, though are subject collection and reporting limitations. For example, it is widely acknowledged that the small-scale fisheries catch is significantly under-reported in official statistics.
11. Swartz W, Sala E, Tracey S, Watson R, Pauly D (2010). The Spatial Expansion and Ecological Footprint of Fisheries (1950 to Present). *PLoS ONE* 5(12): e15143. doi:10.1371/journal.pone.0015143.
12. Mora C, Myers RA, Coll M, Libralato S, Pitcher TJ, et al. (2009) Management Effectiveness of the World's Marine Fisheries. *PLoS Biol* 7(6): e1000131. doi:10.1371/journal.pbio.1000131.
13. Sea Around Us Project (2011). *Stock Status Plots*. Accessed on 30 January 2012 from: http://www.seaaroundus.org/doc/methods/SSP_methods-April-2011-final.pdf.
14. FAO notes that probably only around 10% of the exploited fish stocks are assessed. Although the assessed stocks account for almost 80% of declared landings, for the large majority of exploited fish stocks there is little or no information on their status.
15. Froese R, Zeller D, Kleisner K Pauly D (2012) What catch data can tell us about the status of global fisheries. *Mar Biol* DOI 10.1007/s00227-012-1909-6.
16. Sea Around Us Project. *Unpublished data.*
17. Biodiversity Indicators Partnership (2012). *Marine Trophic Index*. Accessed on 31 January 2012 from: http://www.bipindicators.net/indicators/hl_marinetrophicindex.
18. Jacquet J, Fox H, Motta H, Ngusaru A, Zeller D (2010). Few data but many fish: marine small-scale fisheries catches for Mozambique and Tanzania, in African *Journal of Marine Science 2010*, 32(2): 197–206.
19. Zeller D, Booth S, Davis G, Pauly D (2006). Re-estimation of small-scale fishery catches for U.S. flag associated island areas in the western Pacific: the last 50 years, in *Fish. Bull*. 105:266–277 (2007).
20. Ramdeen R, Smith N, Frotté L, Lingard S, Harper S, Zeller D, Pauly D (2013). Reconstructed total catches by the marine fisheries of countries of the wider Caribbean (1950-2010). *Proceedings of the 65nd Meeting of the Gulf and Caribbean Fisheries Institute, Santa Marta, Colombia*, 5-9 November 2012. Vol. 65.
21. Pratchett MS, Munday PL, Graham NAJ, Kronen M, Pinca S, Friedman K, Brewer, TD, Bell JD, Wilson, SK, Cinner JE, Kinch JP, Lawton RJ, Williams AJ, Chapman L, Magron F, Webb A. (2011). Vulnerability of coastal fisheries in the tropical Pacific to climate change. In: Bell JD, Johnson JE, Hobday AJ. (eds), *Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change*, pp. 493-576. Secretariat of the Pacific Community, Noumea, New Caledonia.
22. Sumaila R, Khan A, Dyck AJ, Watson R, Munro G, Tydemers P, Pauly D (2010). J *Bioecon* 12:201–225, DOI 10.1007/s10818-010-9091-8.
23. The extent of commercial fishing fleet's overcapacity is not known with precision, though some estimates suggest it may be as high as 250%. (Schorr D. (2004). *Healthy fisheries, sustainable trade: crafting new rules on fishing subsidies in the World Trade Organization*. World Wide Fund for Nature.)
24. Kleisner K, Pauly D. (2011). The Marine Trophic Index (MTI), the Fishing in Balance (FiB) Index and the spatial expansion of fisheries. In: Christensen V, Lai S, Palomares MLD, Zeller D, Pauly D. (eds.), *The State of Biodiversity and Fisheries in Regional Seas*, pp. 41-44. Fisheries Centre Research Reports 19(3). Fisheries Centre, University of British Colombia [ISSN 1198-6727].
25. Alverson DL, Freeberg MH, Pope JG, Murawski SA. (1994). *A global assessment of fisheries bycatch and discards*. FAO Fisheries Technical Paper. No. 339. Rome.
26. Sumaila UR, Cheung W, Dyck A, Gueye K, Huang L, et al (2012). Benefits of Rebuilding Global Marine Fisheries Outweigh Costs. *PLoS ONE* 7(7): e40542. doi:10.1371/journal.pone.0040542
27. The ecosystem approach to fisheries management (EAF) presents a more holistic approach than traditional fisheries management methods, and strives to take into account the structure and functioning of ecosystems and their components, as well as the needs and desires of societies in the context of sustainable use of marine resources. In addition to sustainability, the concept of equity is given prominence.
28. Paterson B, Petersen S (2010). EAF implementation in Southern Africa: Lessons learnt. *Marine Policy*, Vol. 34(2), pp 276-292.
29. FAO (2010). *Report of the Annual Forum of the EAF-NANSEN Project*. Rome, 16 December 2008. FAO, Rome.
30. Botsford LW, Castilla JC, Peterson CH (1997). The Management of Fisheries and Marine Ecosystems. *Science* Vol. 277, pp 509- 515.

Photo credit: Purse seine fishermen fish for squid and cuttlefish on the central coast of Vietnam, Dave Mills, WorldFish Center