

So long and thanks for all the fish: a hitchhiker's guide to saving the sea

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Marine systems deliver ecosystem services upon which human well-being depends. These services include provisioning (e.g. food production), climate regulating (e.g. CO₂ and heat absorption), supporting (e.g. oxygen production), and cultural (e.g. recreational benefits). Despite a clear understanding of this dependency, humans continue to impact marine systems in potentially irreversible ways. An estimated 70% of fish populations are either fully or over exploited and altered food webs together with ocean warming are reducing food security and increasing the frequency of toxic algal blooms. Habitat destruction, pollution, ocean acidification, alien species introductions, the increase in number of threatened marine species and the removal of genetically fit individuals further reduce ocean health. In addition, complex and ineffective governance, policy and economic regimes reduce our ability to manage ocean ecosystems sustainably and provide no adaptive capacity or resilience to global change. Sustainability scientists warn that since the advent of the Anthropocene (the current epoch where humans have significantly impacted earth's ecosystems and climate), several planetary boundaries (which demarcate a "safe operating space for humanity") have already been breached, most notably a loss of genetic diversity, a disruption of biochemical flows, and ecosystem changes including climate change. The urgent need to move towards integrated ocean management has been globally recognised in policies and strategies such as United Nations Sustainable Development Goal 14 (to "conserve and sustainably use the oceans, seas and marine resources for sustainable development"). However, these goals need to be met at local and regional scales, and thus rely on matching management strategies at country (national) level, as well as in the high seas (areas beyond national jurisdiction).

Unfortunately, national policies tend to be fragmented and sector-specific and include decision-support tools that address only components of marine systems. For example, fisheries management tools focus on living resource extraction; integrated coastal management tools are implemented mainly along coasts; and marine protected areas and marine spatial planning are both area-based management tools. These tools are all represented in South Africa's legislative toolbox, the most recent addition being the draft Marine Spatial Planning Bill, and a proposal to declare 21 offshore marine protected areas. The enabling policy environment for these recent developments is Operation Phakisa, a government initiative launched in 2014 to unlock the country's ocean economy. But is Phakisa's agenda, based on economic growth, in line with sustainable development goals? Will it really address poverty, or is it just the "business-as-usual" model of short-term gains for the few (catch all the fish now), rather than long-term gains for all South Africans ("infinity" fish)?

"So long, and thanks for all the fish" represents one possible outcome of a business-as-usual approach to ocean management (i.e. catch all the fish now). So what is required to move South Africa's ocean policies into a safe operating space? Do we need more research, and if so, what questions should we be asking, and what relationships should we be building, and with whom? In this presentation, I outline a trans-disciplinary research agenda, built on key research gaps identified over 15 years of marine spatial

planning initiatives in South Africa's continental and Southern Ocean Exclusive Economic Zone. Research projects span a continuum from purely ecological, to social-ecological, and include researchers from the physical, social and economic sciences, and law. We work with academics, government scientists, managers and civil society (particularly key NGOs). We work across habitats (from deep water corals, through marine canyons, to shallower reefs and estuaries), oceans (Indian, Atlantic, Southern) and countries (from Angola to Western Indian Ocean Islands). Using a Systems Thinking approach, we build spatial and temporal models, and are working out how best to couple them in scenario-planning exercises. We aim to mainstream our research products into decision-making, by focusing on applied research that can be implemented for effective sustainable-use outcomes.