The Future of Commercial Fishing in Aotearoa New Zealand

A report from the Office of the Prime Minister's Chief Science Advisor, Kaitohutohu Mātanga Pūtaiao Matua ki te Pirimia.

References & Appendices

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Front cover: *Juvenile pāua. Image credit Dave Allen/NIWA (CC BY-NC-ND 4.0); Hoki. Image credit: Peter Marriott/NIWA (CC BY-NC-ND 4.0).*

Back cover: *Pāua fishing vessel on Rēkohu Wharekauri the Chatham Islands.*

APPENDICES

APPENDIX 1: EAFM PRINCIPLES AND RELEVANT FISHERIES ACT 1996 PROVISIONS

Table taken directly from 'EAFM and the Fisheries Act 1996' (Fathom, 2019) available at Seafood.org.nz. Usually we refer to sections of the Fisheries Act 1996 as section X. In this table, these are abbreviated to sX.

Principles	Key Fisheries Act provisions
1. Ensuring the sustainability of fish stocks	s11 sustainability measures; s13 total allowable catch (TAC); s14 and s14A alternative TACs.
2. Rebuilding depleted stocks	s11 sustainability measures; s13 TAC
3. Ecosystem integrity: safeguarding biodiversity and ecosystem structure and functioning	s8 purpose; s9 environmental principles; s11 sustainability measures.
4. Taking account of species interactions	s9 environmental principles; s13 TAC; s15 fishing-related mortality of marine mammals and other wildlife.
5. Minimising impacts on non-target species	s9 environmental principles; s11 sustainability measures; s15 fishing-related mortality of marine mammals and other wildlife; s72 dumping of fish prohibited.
6. Protecting fisheries habitats	s9 environmental principles; s11 sustainability measures.
7. Managing at appropriate spatial scale	s19 (QMS introduction); s11 sustainability measures; s11A fisheries plans; Part 9 taiāpure-local fisheries and customary fishing.
8. Considering trans-boundary effects	s5 application of international obligations; s17A highly migratory species taken outside NZ fisheries waters; Part 6A high seas fishing; Schedule 1A (fish stocks agreement).
9. Managing at appropriate temporal scale	s8 purpose; s9 environmental principles; s13 TAC; s11 sustainability measures; s11A fisheries plans.
10. Adopting a precautionary approach	s5 application of international obligations; s8 purpose; s9 environmental principles; s10 information principles; s13 TAC.
11. Using science and diverse forms of knowledge	s12 consultation; Part 10 record keeping and reporting; Part 12 observer programme.
12. Broadening stakeholder participation	s12 consultation; various specific consultation provisions; s11A fisheries plans; various provisions enabling active stakeholder involvement; s5 application of Treaty of Waitangi (Fisheries Claims) Settlement Act 1992.
13. Recognising and providing for Indigenous rights	s5 application of Treaty of Waitangi (Fisheries Claims) Settlement Act 1992; s12 consultation; s44 (settlement allocation); Part 9 taiāpure-local fisheries and customary fishing.
14. Balancing utilisation and sustainability	s8 purpose.
15. Taking account of social and economic factors	s8 purpose; s13 TAC; s14A alternative TAC; Part 9 taiāpure-local fisheries and customary fishing; s123 dispute resolution; Part 14 cost recovery.
16. Taking account of environmental influences on fisheries	s11 sustainability measures; s13 TAC; s16 emergency measures.
17. Encouraging integrated management	s6 application of RMA; s11 sustainability measures; s15 fishing-related mortality of marine mammals and other wildlife.

APPENDIX 2: CLIMATE CHANGE DATA

The table below highlights environmental areas of concern and summarises the Ministry for the Environment's marine environmental reporting in these areas (taken from *Our Marine Environment 2019*). This is not a comprehensive summary of all environmental information available – it is to show what information is analysed and presented within the current environmental reporting framework.

Indicator	Measurement	2018/2019 Summary
Climate and oceans		
Sea-level rise	National mean trends in annual sea-level rise at four long-term monitoring sites (Auckland, Wellington, Lyttelton and Dunedin).	The rate of sea-level rise has increased (the average rate in the past 60 years was more than double the rate of the previous 60 years).
Ocean sea-surface temperature	Average temperature recorded by satellite since 1981.	The seas are warming – satellite data recorded an average increase of 0.2°C per decade since 1981.
Extreme wave events	Extreme wave events from 2008.	Frequency of extreme wave events is increasing to the east and south of New Zealand and decreasing on the North Island's west coast and to the north of the Bay of Plenty. The short time period makes it too early to definitively separate this trend from longer-term climate cycles.
Ocean acidity	pH of New Zealand subantarctic surface waters along from the Munida Transect, from 1998. New dataset for coastal water pH for nine sites across NZ.	Long-term measurements of subantarctic waters off the Otago coast show an increase of 7.1% in ocean acidity in the past 20 years. More data is needed before role of climate change can be separated from other factors that may be affecting coastal water acidity.
Primary productivity	Abundance of phytoplankton (measured as chlorophyll-a) measured by satellite near the sea surface from 1997.	The abundance of phytoplankton has increased and decreased in different New Zealand waters. Changing oceanic productivity is specific to the location; an increase or decrease in one area may not have the same impacts as in another area.
Marine heatwaves	High sea-surface temperatures over significant area and for significant duration.	Marine heatwaves are increasing in frequency. A marine heatwave occurring in the Tasman Sea and south of the Chatham Rise in 2017/18 was unprecedented (based on data since 1981).

APPENDIX 3: ESTIMATES FOR NEWLY TRAWLED AREA

Tables reproduced from Baird, S.J. and Mules, R. (2021, in review). Extent of bottom contact by commercial trawling and dredging in New Zealand waters, 1990-2019. *New Zealand Aquatic Environment and Biodiversity Report*, pending.

For the **deepwater fish stocks**, the number of cells contacted in a year, that had not been contacted in previous years, and the aggregate area and footprint within those cells. A base of 25,103 cells were contacted in 1990-94, and, for example, 1,316 cells were contacted in 1995 (but not in 1990-94), with an aggregate area of 1,201 km^2 and footprint of 1,022 km^2. The table shows the equivalent data for Tier 1 and Tier 2 fish stocks.

Fishing year	No. new cells	Aggregate area (km^2)	Footprint (km^2)
No. cells contacted in 1990-94 = 25,103			
1995	1,316	1,201.5	1,022.3
1996	1,420	1,032.1	948.8
1997	1,185	916.0	868.5
1998	1,543	1,892.8	1,538.1
1999	1,388	1,360.6	1,172.7
2000	1,227	1,517.1	1,363.2
2001	737	715.7	614.1
2002	1,173	1,050.2	1,007.5
2003	633	703.5	629.7
2004	328	319.8	294.9
2005	557	587.0	519.9
2006	266	134.0	129.3
2007	251	153.4	143.7
2008	279	191.0	177.7
2009	220	99.7	96.6
2010	165	60.3	59.5
2011	167	59.1	58.7
2012	106	36.9	36.7
2013	74	35.6	35.0
2014	94	34.4	34.2
2015	178	171.8	157.7
2016	172	108.6	104.5
2017	100	60.8	59.4
2018	117	32.8	32.8
2019	73	89.9	85.7

For the **inshore fish stocks**, the number of cells contacted in a year, that had not been contacted in previous years, and the aggregate area and footprint within those cells. A base of 9,459 cells were contacted in 2008 (the fishing year that tow-level data were first collected for all inshore fisheries), and, for example, 1,497 cells were contacted in 2009 (but not in 2008), with an aggregate area of 819.3 km^2 and footprint of 775.9 km^2.

Fishing year	No. new cells	Aggregate area (km^2)	Footprint (km^2)
No. cells contacted in 2008 = 9,459			
2009	1,497	819.3	775.9
2010	934	657.8	576.4
2011	771	304.1	296.9
2012	484	151.7	148.3
2013	384	145.4	142.4
2014	400	167.9	161.0
2015	316	133.0	130.2
2016	285	79.1	79.1
2017	275	80.6	80.5
2018	198	66.1	65.9
2019	196	63.5	62.3

APPENDIX 4: LAND-BASED EFFECTS DATA

Fisheries New Zealand, as reported in the trends and indicators section of the Aquatic Environment and Biodiversity Annual Review:

Indicator	Measurement	2018/2019 Summary
Land-based effects on the coastal environment		
A national view of the impacts of land-based influences upon seafood production does not exist.	N/A	N/A

The table below highlights environmental areas of concern and summarises the Ministry for the Environment's marine environmental reporting in these areas. This is not a comprehensive summary of all environmental information available – it is to show what information is analysed and presented within the current environmental reporting framework.

Indicator	Measurement	2018/2019 Summary
Human land use and sediment impacts		
Sediment	Focus on sediment accumulation in estuaries.	Accumulation rates have increased. Intertidal sedimentation rates have generally increased and become highly variable since European settlement.
Biogenic habitats	Review of the state of key biogenic habitats using nationally available data.	Most have decreased (e.g. mussel beds, seagrass meadows).
Litter and contaminants	Beach litter density, monitoring of contaminants limited and inconsistent.	Have increased in the habitat and food webs, particularly plastic.
Water quality	Nutrients (phosphorus and nitrogen), phytoplankton, oxygen, water clarity, and pH monitoring.	It is difficult to assess the overall state of coastal water quality.

APPENDIX 5: NEW ZEALAND FISHERIES LEGAL INSTRUMENTS

New Zealand fisheries legal instruments: Acts and regulations

Instrument	Purpose	Lead
Fisheries Act 1996 & residual parts of Fisheries Act 1983	Provides for the utilisation of fisheries resources while ensuring sustainability. Ensuring sustainability means: • Maintaining the potential of fisheries resources to meet the reasonably foreseeable needs of future generations, and • Avoiding, remedying, or mitigating any adverse effects of fishing on the aquatic environment. Utilisation means conserving, using, enhancing, and developing fisheries resources to enable people to provide for their social, economic, and cultural wellbeing.	MPI
Treaty of Waitangi (Fisheries Claims) Settlement Act 1992	Gives effect to settlement of claims relating to Māori commercial fishing rights: • Makes better provision for Māori non-commercial traditional and customary fishing rights and interests, and • Makes better provision for Māori participation in the management and conservation of New Zealand's fisheries.	MPI

Māori Fisheries Act 2004	• Implements agreements made in the Deed of Settlement dated 23 September 1992, and
	• Provides for development of the collective and individual interests of iwi in fisheries, fishing, and fisheries-related activities in a manner that is ultimately for the benefit of all Māori.
	• Provision is made to establish a framework for the allocation and management of settlement assets through:
	  ○ allocation and transfer of specified settlement assets to iwi as provided for by or under this Act, and
	  ○ central management of the remainder of those settlement assets.
		MPI

Māori Commercial Aquaculture Claims Settlement Act 2004	• Provide a full and final settlement of Māori claims to commercial aquaculture on or after 21 September 1992. • Provides for the allocation and management of aquaculture settlement assets.	MPI
Aquaculture Reform (Repeals and Transitional Provisions) Act 2004 (provides only for transitional matters for aquaculture)	• Repeals Marine Farming Act 1971 and provides for transitional matters relating to the repeal; and • Repeals certain provisions in Part 4A of the Fisheries Act 1983 and provides for transitional matters relating to the repeal. • Provides for transitional matters relating to the ending of the moratorium under the Resource Management Act 1991. • Provides for transitional matters relating to amendments made in 2011 to the Fisheries Act 1996, Resource Management Act 1991, and Māori Commercial Aquaculture Claims Settlement Act 2004 to further reform the law relating to aquaculture, including the removal of requirements relating to aquaculture management areas.	MPI
Driftnet Prohibition Act 1991	Prohibits driftnet fishing activities and implements the Convention for the Prohibition of Fishing with Long Driftnets in the South Pacific.	MPI
Antarctic Marine Living Resources Act 1981	Gives effect to the Convention on the Conservation of Antarctic Marine Living Resources: No person shall in the Convention Area take any marine organism, whether alive or dead, without first obtaining a permit to do so.	MFAT
Wildlife Act 1953	Consolidates and amends the law relating to the protection and control of wild animals and birds, the regulation of game shooting seasons, and the constitution and powers of acclimatisation societies.	DOC
Marine Mammals Protection Act 1978	Makes provision for the protection, conservation, and management of marine mammals within New Zealand and within New Zealand fisheries waters.	DOC

Instrument	Purpose	Lead
Marine Reserves Act 1971	Provides for the setting up and management of areas of the sea and foreshore as marine reserves for the purpose of preserving them in their natural state as the habitat of marine life for scientific study.	DOC
Conservation Act 1987	Promotes the conservation of New Zealand's natural and historic resources, and for that purpose to establish a Department of Conservation.	DOC
Resource Management Act 1991	Restates and reforms the law relating to the use of land, air, and water.	MfE
Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012	• Promotes sustainable management of the natural resources of the EEZ and the continental shelf. • In relation to the EEZ, the continental shelf, and the waters above the continental shelf beyond the outer limits of the EEZ, to protect the environment from pollution by regulating or prohibiting the discharge of harmful substances and the dumping or incineration of waste or other matter.	MfE
Environmental Reporting Act 2015	Requires regular reports on New Zealand's environment.	MfE
Biosecurity Act 1993	An Act to restate and reform the law relating to the exclusion, eradication, and effective management of pests and unwanted organisms.	MPI
Crown Minerals Act 1991	The purpose of this Act is to promote prospecting for, exploration for, and mining of Crown-owned minerals for the benefit of New Zealand.	MBIE
Maritime Transport Act 1994	The functions of the Minister under this Act are: • to promote safety in maritime transport; • to promote protection of the marine environment; • to administer New Zealand's participation in the conventions and any other international maritime or marine protection convention, agreement, or understanding to which the Government of New Zealand is a party; • to ensure New Zealand's preparedness for, and ability to respond to, marine oil pollution spills; and • to make maritime rules and marine protection rules under this Act.	MoT
Marine and Coastal Area (Takutai Moana) Act 2011	• Establishes a durable scheme to ensure the protection of the legitimate interests of all New Zealanders in the marine and coastal area of New Zealand; • Recognises the mana tuku iho exercised in the marine and coastal area by iwi, hapū, and whānau as tangata whenua; • Provides for the exercise of customary interests in the common marine and coastal area; and • Acknowledges the Treaty of Waitangi (te Tiriti o Waitangi).	MoJ
Fisheries (Reporting) Regulations 2017	Regulations made under the Fisheries Act 1996.	MPI
Fisheries (Commercial Fishing) Regulations 2001	• Sets out measures for governing administrative matters including the registration and marking of vessels. • Places restrictions on take of certain species. • Outlines conditions governing use of fishing equipment, reporting obligations, communication requirements etc. • Sets out fees, offenses and penalties.	MPI
Fisheries (Auckland and Kermadec Areas Commercial Fishing) Regulations 1986	Places restrictions on types of fishing, fishing gear and permitted catch in areas around Auckland, Northland and the Kermadecs.	MPI

Instrument	Purpose	Lead
Fisheries (Challenger Area Commercial Fishing) Regulations 1986	Places restrictions on types of fishing, fishing gear and permitted catch in the Challenger FMA.	MPI
Fisheries (Southland and Sub-Antarctic Areas Commercial Fishing) Regulations 1986	Places restrictions on types of fishing, fishing gear and permitted catch in Southland and the subantarctic.	MPI
Fisheries (South-East Area Commercial Fishing) Regulations 1986	Places restrictions on types of fishing, fishing gear and permitted catch in the South-East FMA.	MPI
Fisheries (Central Area Commercial Fishing) Regulations 1986	Places restrictions on types of fishing, fishing gear and permitted catch in the Central FMA.	MPI
Fisheries (Infringement Offences) Regulations 2001	Sets out infringement offences, fees and notices.	MPI
Fisheries (Foreign Fishing Vessel) Regulations 2001	Outlines licensing, control and enforcement of foreign vessels operating in New Zealand's EEZ.	MPI
Fisheries (Recordkeeping) Regulations 1990	Sets out who must keep records within the fishing industry, what records must be kept, and how they must be kept.	MPI
Fisheries (South Island Customary Fishing) Regulations 1999 and Fisheries (Kaimoana Customary Fishing) Regulations 1998	Tangata kaitiaki/tiaki (guardians) can be appointed for a specific rohe moana. Tangata kaitiaki/tiaki are proposed by tangata whenua and confirmed by the Minister. They authorise and manage customary activities within the rohe moana. The South Island Customary Fishing Regulations apply to the South Island and Stewart Island. The Kaimoana Customary Fishing Regulations apply to the North Island and Chatham Islands.	MPI
Ngā Rohe Moana o Ngā Hapū o Ngāti Porou Act 2019	• Contributes to the legal expression, protection, and recognition of the continued exercise of mana by ngā hapū o Ngāti Porou in relation to ngā rohe moana o ngā hapū o Ngāti Porou. • Gives effect to the deed of agreement between ngā hapū o Ngāti Porou and the Crown.	
Submarine Cables and Pipelines Protection Act 1996	• Protection of New Zealand's undersea cables.	MOT
Fisheries (Amateur Fishing) Regulations 2013	• Applies to people taking fish or other aquatic life who are not licensed fishers and not taking for customary purposes. • Sets out restrictions on minimum sizes, mesh sizes, gear types, daily quotas and take of certain species. • Outlines offences and penalties.	MPI

APPENDIX 6: KEY REGULATORS IN AOTEAROA NEW ZEALAND'S MARINE FISHERIES SPACE

Fisheries New Zealand (Ministry for Primary Industries)

Fisheries New Zealand is the key regulator tasked with guiding the sustainable use of fisheries resources to the greatest overall benefit to New Zealanders.

This focus includes the sustainability of New Zealand's wild fish stocks, aquaculture, and the wider aquatic environment.

Key legislation Fisheries New Zealand administers includes:

- Fisheries Act 1996 and regulations
- Fisheries Act 1983 (residual parts)
- Treaty of Waitangi (Fisheries Claims) Settlement Act 1992
- Fisheries (Quota Operations Validation) Act 1997
- Māori Fisheries Act 2004
- Māori Commercial Aquaculture Claims Settlement Act 2004
- Aquaculture Reform (Repeals and Transitional Provisions) Act 2004
- Driftnet Prohibition Act 1991
- Antarctic Marine Living Resources Act 1981

Department of Conservation

The Department of Conservation is the key regulator for species protection and biodiversity in the marine space.

This includes marine reserves and parks, protection of protected or threatened species, and protection of biodiversity.

Key legislation the Department of Conservation administers includes:

- Wildlife Act 1953
- Conservation Act 1987
- Hauraki Gulf Marine Park Act 2000
- Marine Mammals Protection Act 1978
- Marine Reserves Act 1971
- National Parks Act 1980

Ministry for the Environment

The Ministry for the Environment is responsible for national environmental reporting, including the marine environment, and promoting the sustainable management of natural resources in our EEZ and continental shelf.

Key legislation the Ministry for the Environment administers includes:

- Resource Management Act 1991
- Environmental Reporting Act 2015
- EEZ and Continental Shelf (Environmental Effects) Act 2012
- Fiordland (Te Moana o Atawhenua) Marine Management Act 2005 (case study 4.4.1: Fiordland created a novel model for managing the marine area)

Regional councils

Our 11 regional councils are responsible for managing the territorial sea (out to 12 nautical miles).

This includes land use and its impacts on the marine environment.

Regional councils are empowered in the marine space through the:

- Resource Management Act 1991
- Marine Transport Act 1994

Other regulators

Ministry of Foreign Affairs and Trade represents Aotearoa New Zealand in global discussions to ensure successful implementation of international agreements on ocean governance and fisheries management.

Ministry of Business, Innovation and Employment is responsible for health and safety in the marine environment. This includes managing permits and licences for oil, gas and minerals (via New Zealand Petroleum and Minerals).

Environmental Protection Authority is responsible for consenting, monitoring and enforcement under the EEZ Act.

Ministry of Transport is responsible for the Maritime Transport Act 1994.

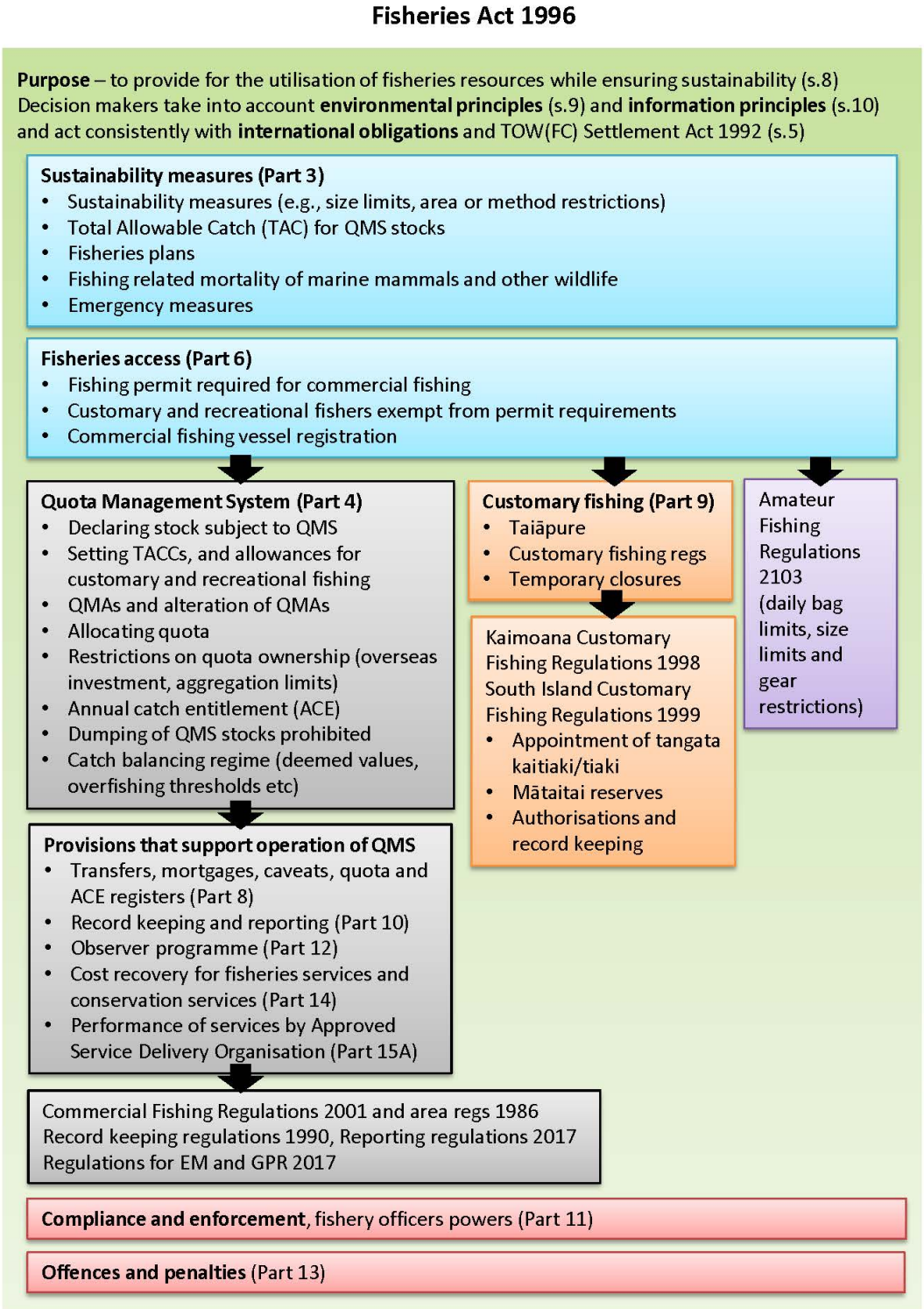
Maritime New Zealand is responsible for managing maritime transport and its effects.

National Maritime Coordination Centre is responsible for managing Aotearoa New Zealand's maritime surveillance. It is part of the New Zealand Customs Service.

Many other ministries have adjacent or supporting roles: Te Arawhiti, Department of Prime Minister and Cabinet, Te Puni Kōkiri, Ministry for Culture and Heritage, New Zealand Defence Force, Ministry of Health, Ministry of Justice, Stats NZ, and Land Information New Zealand.

APPENDIX 7: FISHERIES ACT 1996 SCHEMATIC

As provided by industry:



APPENDIX 8: SPECIFIC MARINE MANAGEMENT ACTS

Act	Purpose	Admin
Hauraki Gulf Marine Park Act 2000	• Integrates management of the natural, historic, and physical resources of the Hauraki Gulf, its islands, and catchments. • Establishes the Hauraki Gulf Marine Park. • Establishes objectives for the management of the Hauraki Gulf, its islands, and catchments. • Recognises the historic, traditional, cultural, and spiritual relationship of the tangata whenua with the Hauraki Gulf and its islands. • Establishes the Hauraki Gulf Forum.	DOC
Fiordland (Te Moana o Atawhenua) Marine Management Act 2005	• Establishes the Fiordland (Te Moana o Atawhenua) Marine Area and eight marine reserves in that area. • Implements measures to assist in the preservation, protection, and sustainable management of the marine environment and biological diversity of the Fiordland (Te Moana o Atawhenua) Marine Area. • Establishes the Fiordland Marine Guardians to provide advice on fisheries management, biosecurity, sustainable management, and marine preservation and protection. • Facilitates and promotes co-operation between the Guardians and management agencies, to assist in achieving the integrated management of the Fiordland (Te Moana o Atawhenua) Marine Area. • Acknowledges the importance of kaitiakitanga.	MfE

Kaikōura (Te Tai o Marokura) Marine Management Act 2014	• Recognises the local, national, and international importance of the coast and sea around Kaikōura (Te Tai o Marokura) as a consequence of its unique coastal and marine environment and distinctive biological diversity and cultural heritage.
	• Provides measures to assist the preservation, protection, and sustainable and integrated management of the coastal and marine environment and biological diversity of Te Tai o Marokura.
	• Acknowledges the importance of kaitiakitanga and local leadership.
	• Establishes an advisory committee to provide advice regarding biosecurity, conservation, and fisheries matters within a marine management area.
	• Establishes, within Te Tai o Marokura:
	  ○ a marine reserve,
	  ○ a whale sanctuary,
	  ○ a New Zealand fur seal sanctuary, and
	  ○ various mātaitai reserves and taiāpure-local fisheries.
	• Amends the Fisheries (Amateur Fishing) Regulations 2013 to provide specific regulation of amateur fishing in the marine management area.	

Sugar Loaf Islands Marine Protected Area Act 1991	• Ensures that the scenery, natural features, and ecosystems of the Protected Area that should be protected and conserved by reason of their distinctive quality, beauty, typicality, or uniqueness are conserved.	DOC
Subantarctic Islands Marine Reserves Act 2014	• Provides for the setting up and management of the Subantarctic Islands Marine Reserves, so as to conserve and protect its scenery, natural features and ecosystem.	DOC

APPENDIX 9: NEW ZEALAND INTERNATIONAL OBLIGATIONS

Instrument	Purpose	Admin
United Nations Convention on the Law of the Sea (UNCLOS)	UNCLOS is a comprehensive regime of law and order in the world's oceans and seas establishing rules governing all uses of the oceans and their resources.	MFAT
United Nations Fish Stocks Agreements	Sets out principles for the conservation and management of straddling fish stocks and highly migratory fish stocks and establishes that such management must be based on the precautionary approach and the best available scientific information.	
United Nations Sustainable Development Goals (SDGs)	A collection of 17 global goals set by the 2015 UN General Assembly and adopted by all member states. Of particular relevance is SDG 14: Life below water – Conserve and sustainably use the oceans, seas and marine resources for sustainable development.	
Convention on the Conservation of Migratory Species of Wild Animals (CMS)	As an environmental treaty of the United Nations, CMS provides a global platform for the conservation and sustainable use of migratory animals and their habitats. Migratory species threatened with extinction are listed on Appendix I of the Convention. CMS Parties strive towards strictly protecting these animals, conserving or restoring the places where they live, mitigating obstacles to migration and controlling other factors that might endanger them.	
Convention on Biological Diversity (CBD)	This intentional legal instrument is for the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources. Overall objective is to encourage actions, which will lead to a sustainable future. **See also:** Aichi Biodiversity Targets Aotearoa New Zealand reports every four years (see New Zealand's Sixth National Report to the United Nations Convention on Biological Diversity (2014-2018)).	
Aichi Biodiversity Targets	At the CBD meeting in November 2010, a Strategic Plan for Biodiversity 2011-2020 was agreed and published. This included the Aichi Biodiversity Targets, 20 targets that would move towards a world where "pressures on biodiversity are reduced, ecosystems are restored" and "biological resources are sustainably used". The international community failed to achieve any of the targets by 2020, with progress made on only six of the 20 goals.	
South Pacific Regional Fisheries Management Organisation (SPRFMO)	An inter-governmental organisation that is committed to the long-term conservation and sustainable use of the fishery resources of the South Pacific Ocean and in so doing safeguarding the marine ecosystems in which the resources occur. The SPRFMO Convention applies to the high seas of the South Pacific.	
Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES)	The aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.	DOC/ MPI
International Whaling Commission (IWC)	In addition to regulation of whaling, today's IWC works to address a wide range of conservation issues including bycatch and entanglement, ocean noise, pollution and debris, collision between whales and ships, and sustainable whale watching.	MPI
Wellington Convention	Multilateral treaty to prohibit the use of fishing driftnets longer than 2.5 km in the South Pacific. See appendix 5: Driftnet Prohibition Act 1991.	
Noumea Convention	Aims to address the accelerating degradation of the world's oceans and coastal areas through the sustainable management and use of marine and coastal environments.	

Instrument	Purpose	Admin
Food and Agriculture Organisation – Code of Conduct for Responsible Fisheries	Sets out principles and international standards of behavior for responsible practices with a view to ensuring the effective conservation, management and development of living aquatic resources, with due respect for the ecosystem and biodiversity.	
Food and Agriculture Organisation – International Plan of Action for Seabirds (IPOA-Seabirds)	The objective of the IPOA-Seabirds is to reduce the incidental catch of seabirds in longline fisheries where this occurs. See also New Zealand's National Plan of Action – Seabirds 2020: Reducing the incidental catch of seabirds in fisheries.	MPI/ DOC
Agreement on the Conservation of Albatrosses and Petrels (ACAP)	The objective of this agreement is to achieve and maintain a favourable conservation status for albatrosses and petrels.	
Food and Agriculture Organisation – International Plan of Action for Sharks (IPOA-Sharks)	The objective of the IPOA-Sharks is to ensure the conservation and management of sharks and their long-term sustainable use. See also New Zealand's National Plan of Action for the conservation and management of Sharks 2013 (was to be reviewed in 2018).	MPI
Convention for the Conservation of Southern Bluefin Tuna (CCSBT)	Objective to ensure, through appropriate management, the conservation and optimum utilisation of southern bluefin tuna.	
Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean (WCPFC)	The objective of the Convention is to ensure, through effective management, the long-term conservation and sustainable use of highly migratory fish stocks in the western and central Pacific Ocean in accordance with the 1982 United Nations Convention on the Law of the Sea and the 1995 UN Fish Stocks Agreement.	
South Tasman Rise Orange Roughy Arrangement	Arrangement between Government of Australia and Government of New Zealand for the conservation and management of orange roughy on the South Tasman Rise. In New Zealand see the Fisheries (South Tasman Rise Orange Roughy Fishery) Regulations 2000.	
Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR)	Applies to all Antarctic populations of finfish, molluscs, crustacean and seabirds found south of the Antarctic Convergence.	MFAT/ MPI
Convention on the Conservation and Management of High Seas Fishery Resources in the South Pacific Ocean	The objective is to ensure, through effective management, the long-term conservation and sustainable use of highly migratory fish stocks in the south Pacific Ocean in accordance with the 1982 Convention and the Agreement.	
World Heritage Convention	The Convention sets out the duties of States Parties in identifying potential sites and their role in protecting and preserving them. By signing the Convention, each country pledges to conserve not only the World Heritage sites situated on its territory, but also to protect its national heritage. The States Parties are encouraged to integrate the protection of the cultural and natural heritage into regional planning programmes, set up staff and services at their sites, undertake scientific and technical conservation research and adopt measures which give this heritage a function in the day-to-day life of the community.	

APPENDIX 10: NATIONAL FISHERIES PLANS MANAGEMENT OBJECTIVES

Management objectives of the *National Fisheries Plan for Deepwater and Middle-depth Fisheries* (Fisheries New Zealand, 2019).

	Management objectives
Use	**1** Ensure the deepwater and middle-depth fisheries resources are managed so as to provide for the needs of future generations.
	2 Ensure excellence in the management of New Zealand's deepwater and middle-depth fisheries, so they are consistent with, or exceed, international best practice.
	3 Ensure effective management of deepwater and middle-depth fisheries is achieved through the availability of appropriate, accurate and robust information.
	4 Ensure deepwater and middle-depth fish stocks and key bycatch fish stocks are managed to an agreed harvest strategy or reference points.
Environmental outcome	**5** Ensure that maintenance of biological diversity of the aquatic environment and protection of habitats of particular significance for fisheries management are explicitly considered in management.
	6 Manage deepwater and middle-depth fisheries to avoid, remedy or mitigate the adverse effects of these fisheries on associated or dependent and incidentally caught fish species.
	7 Manage deepwater and middle-depth fisheries to avoid, remedy or mitigate the adverse effects of these fisheries on the benthic habitat.
	8 Manage deepwater and middle-depth fisheries to avoid, remedy or mitigate the adverse effects of these fisheries on the long-term viability of endangered, threatened and protected species populations.
Governance conditions	**9** Ensure the management of New Zealand's deepwater and middle-depth fisheries meets the Crown's obligations to Māori.
	10 Ensure there is consistency and certainty of management measures and processes in the deepwater and middle-depth fisheries.
	11 Ensure New Zealand's deepwater and middle-depth fisheries are transparently managed.

Management objectives of the *National Fisheries Plan for Highly Migratory Species (HMS)* (Fisheries New Zealand, 2017).

	Management objectives
Use	**1 Support viable and profitable commercial tuna fisheries in New Zealand**
	1.1 Support initiatives to add value to HMS fisheries.
	1.2 Negotiate favourable country allocations for New Zealand fishers.
	1.3 Reduce administrative barriers to profitability in HMS fisheries.
	1.4 Recognise importance of access to fisheries resources in New Zealand and the South Pacific region, and identify potential threats and opportunities.
	2 Maintain and enhance world class game fisheries in New Zealand fisheries waters.
	2.1 Maintain and enhance recreational catch rates for HMS game fisheries.
	3 Māori interests (including customary, commercial, recreational, and environmental) are enhanced.
	3.1 Take into account the views of relevant iwi and hapū in management of HMS.
	3.2 Ensure abundant HMS for customary use.
Environmental	**4 Maintain sustainable HMS fisheries within environmental standards.**
	4.1 Encourage management of HMS at specified target reference points.
	4.2 Support the objectives of the National Plan of Action for Sharks.
	4.3 Promote sustainable management of HMS fisheries through RFMOs.
	5 Implement an ecosystem approach to fisheries management, taking into account associated and dependent species.
	5.1 Recognise value of HMS and their ecosystems, including predators, prey, and protected species.
	5.2 Improve the quality of information available on the capture of protected species.
	5.3 Avoid, remedy, or mitigate the adverse effects of fishing on associated and dependent species (including protected species), using a risk assessment approach.
	5.4 Support the objectives of the National Plan of Action for Seabirds.
	6 Protect, maintain, and enhance fisheries habitat.
	6.1 Identify and, where appropriate, protect habitats of particular significance to HMS, especially within New Zealand fisheries waters.

Governance	**7**	**Maintain an effective fisheries management regime.**
	7.1	Ensure transparency by providing stakeholders with relevant information and performance indicators for HMS fisheries.
	8	**Recognise and provide for Deed of Settlement obligations.**
	8.1	Implement Deed of Settlement obligations as they relate to HMS.
	9	**Ensure New Zealand interests are taken into account internationally.**
	9.1	Influence international fora and ensure New Zealand interests are taken into account.
	9.2	Build and maintain strong relationships with other fishing nations, in order to influence international fora governance.
	10	**Contribute to Pacific capacity development.**
	10.1	Contribute to the implementation of MPI's Memorandum of Understanding with NZAID on Pacific capacity development.

APPENDIX 11: SOME HISTORY SURROUNDING AN OCEANS STRATEGY IN AOTEAROA NEW ZEALAND

The idea of an Oceans Strategy has been around for a long time. In 1998, Australia explored its own Ocean Policy to set 'in place the framework for integrated and ecosystem-based planning and management for all of Australia's marine jurisdictions'.

Shortly after, in 2000, the New Zealand Government announced plans for development of their own Oceans Policy. Then Fisheries Minister, Pete Hodgson, stated in the announcement:

> "We begin simply with a recognition of the value of our oceans, a recognition of the growing pressures on the marine environment, and a determination to address problems before they become crises…. Vast or not, ecological strains have begun to show in our oceans. Conflicts in their use are erupting more and more frequently… If there is one simple reason why an Oceans Policy is a good idea, it is that those strains and conflicts will increase. That's a certainty…
>
> But do we have overarching goals well defined? What are the points of reference for this complex mixture of law and practice? Have we ever collectively identified and expressed the range of cultural, economic, environmental or social values that apply? Or the range of interests?
>
> Have we ever looked forward 20 years, and identified the opportunities and threats we might encounter?"

The vision created to support the Oceans Policy was:

> Healthy Oceans: wisely managed for the greatest benefit of all New Zealanders, now and in the future.[1]

The Oceans Policy was never completed. Some of the delays were reportedly so that it could take account of government decisions on public access and customary rights to the foreshore and seabed.

Another strategy of mention is the Strategy for Managing the Environmental Effects of Fishing (known as SMEEF) developed by the then Ministry of Fisheries in 2005, which proposed the development of a set of standards for defining acceptable limits of effects of fishing on the aquatic environment (Ministry of Fisheries, 2005). Challenges to setting limits identified included (Clubb and Helson, 2006):

- "The scale of impact that fishing is having on aspects of the aquatic environment
- The biological consequences of that impact
- The utilisation value associated with that impact, or the cost of avoiding it
- The value placed on that impact by society
- The value likely to be placed on that impact by future generations"

In practice, much of the work on developing standards has been superseded by the development of National Plans of Action.

Over the subsequent years there have been various calls for greater development of maritime strategy (Peart, *et al.*, 2011; Cozens, 2014). In 2014, NIWA's Marine Futures project funded by MBIE sought to enable stakeholders to develop an agreed decision making framework to facilitate 'economic growth, improve marine

[1] A longer vision is also given of: Healthy Oceans: New Zealanders understand marine life and marine processes and, accordingly take responsibility for wisely managing the health of the ocean and its contribution to the present and future social, cultural, environmental and economic wellbeing of New Zealand.

stewardship and ensure that cumulative stresses placed on the environment do not degrade the ecosystem beyond its ecological adaptive capacity'. It was hoped the research would help decision making where there were conflicting resource uses and different trade-offs, allowing improved integrative management activities (like marine spatial planning and ecosystem-based management).

In 2014, the McGuiness Institute Te Hononga Waka (a 'non-partisan think tank') held a structured discussion on ocean management as part of their OneOceanNZ project. The project looks at how public policy solution around ocean governance can support best practice ocean management. In the discussion they found that the ineffective aspect of the existing framework most commonly cited was a fragmented political and policy process, followed by fragmented legislation, lack of scientific information, lack of a clear national goal, and imbalance of economic/social/environmental objectives (Tremlett, 2015). Nationally holistic strategic considerations are not able to be made in a consistent and considered way (McGuinness and Hett, 2015).

APPENDIX 12: METHODS AND APPLICATIONS OF GENETIC TECHNOLOGY IN FISHERIES

There are a range of methods for generating genetic data and numerous ways to apply these methods to glean information that can inform fisheries management decisions. Looking to the future in fisheries management, we are better to focus on the application of genomic approaches rather than traditional genetic methods, though there will still be applications where older methods are appropriate. The table below highlights key methods that are available for genomic studies.

Method/application	Strengths	Limitations	Best suited applications/uses
Whole genome sequencing (WGS) ***Sequencing all of the DNA found in the nucleus of the cell.***	Captures majority of genetic variation in a population and is typically summarised as SNP differences. Can delineate differences based on fine-scale similarities and differences. High throughput, so can sequence many samples at once. Can detect both genome-wide (neutral) and allele-specific (adaptive) patterns of diversity.	Price. Production of large volumes of genome sequence data can be challenging for the transfer, storage and analysis of datasets. Data capture improved by the presence of a reference genome.	Delineating stock structure. Developing reference SNP marker sets that can be used for a SNP chip to delineate stocks/species/provenance/sexes. Understanding of population structure and the evolutionary process. Identifying species for conservation efforts, detecting pathogens, compliance surveillance etc. Identifying individuals for conservation efforts (e.g. through genetic tagging). Stock size (note: best for species with small population sizes). Understanding age demographics of population (with epigenomics) or for biopsied samples through telomere length (though this is not validated for most species). Can be combined with eDNA and ancient DNA applications. Traceability.
Gene-tagging ***Sequencing the genes from a biopsied sample and using their unique genetic fingerprint as a tag to track that individual in the future.***	Allows estimating real-time migration rates and dispersal. Could replace physical tagging as it is permanent and cannot get lost. Data can be used for other applications. Can identify the species or the population of origin of exploited fish, as well as their associated pathogens.	Invasive technique. May not be better than conventional approaches if samples are from dead specimens or sampling is lethal.	See case study 6.4.9: Genetic tagging to understand bluefin tuna population dynamics. Can provide information about stock biomass and growth and how these change through time. Best used for species where the biopsy is low-risk. Use WGS to have the power to identify unique individuals.

Method/application	Strengths	Limitations	Best suited applications/uses
	Doesn't rely on self-reporting from fishers.		
Mitochondrial DNA (mtDNA) sequencing ***Sequencing the short, circular DNA found in the mitochondria of the cell.***	Cheaper than WGS techniques. Methods well established. More species have had their mtDNA sequenced so there are more reference genomes.	Limited statistical power to identify unique individuals. Often fails to detect population differences. Limited value as a gene-tagging marker.	eDNA applications because it can be used to identify species and many have reference barcodes for it. Ancient DNA applications because it is abundant in the cell so remains after degradation. Identifying species. Detect mixed species stocks. Useful for preliminary stock structure analyses.
Sequencing genetic markers ***Sequencing a select number of genetic markers, typically SNPs.***	Cheaper than WGS techniques. Method well established.	Have to know what genetic markers can provide the information you are after (e.g. delineate stocks) to design the test. Cannot be used to identify unique individuals if a limited number of markers are used.	Detect mixed species stocks. See case study 6.4.7: Real time genetic management of a marine fishery.
Microsatellite DNA ***Detecting variation in length of specific repetitive stretches of DNA.***	Cheaper than WGS techniques.	Limited statistical power to identify unique individuals. Often fails to detect population differences.	Species identification. Understanding genetic variation and stock structure.
RNA sequencing ***Measuring gene expression.***	Tells us about responsiveness to environmental conditions if baseline data is available.	Requires specific sample collection and storage to ensure results are valid because the RNA degrades. Cost – as it is usually more expensive than DNA-based methods per individual.	Support conservation management of species by understanding responses to environmental change (Connon *et al.*, 2018).
DNA methylation ***Detecting variation in epigenetic patterns which can impact gene expression.***	Tells us about responsiveness to environmental conditions. Can provide information about sample age.	Need to understand the association between DNA methylation signatures and the outcome for this to be applicable – limited data on age-	Understanding age demographics of population or for biopsied samples. Support conservation management of species by understanding responses to environmental change.

Method/application	Strengths	Limitations	Best suited applications/uses
	More stable to measure than RNA.	related epigenetic signatures for fish so requires study first but proof-of-principle exists (Anastasiadi and Piferrer, 2019). Requires baseline data.	
Environmental DNA (eDNA) ***Collecting DNA from the environment (e.g. collection of seawater) and sequencing it to identify the different species that have been in that area recently.***	Non-invasive sampling. Can provide a high-level overview of genetic biodiversity, including presence/absence data. Can detect ecosystem changes over time. Can identify elusive species or detect low-density or pelagic species. Can be used to estimate species abundance (not yet precise numbers of fish but this may improve in the future with analytical advances) (Thomsen *et al.*, 2016; Jerde, 2019; Hansen *et al.*, 2018). Overcomes limitations in more complex biological survey methods e.g. time-consuming microscopy, difficulties identifying different life stages and sexes, and cryptic species.	Methods are relatively new and still require sampling and analytical consistency to make sure results are robust (e.g. weather conditions or recent trawling could impact findings) (Zaiko *et al.*, 2018). Relies on species having reference DNA in databases to match the sample. These databases will continue to grow making this application more powerful. Quick degradation of DNA in marine environment (Thomsen *et al.*, 2016). Potential for contamination from fishing gear or lab contamination (Hansen *et al.*, 2018). No direct information on numbers, age, weight, life-stage or fecundity (Hansen *et al.*, 2018).	Use in conservation and biosecurity by detecting specific species. See case study 6.4.17: Managing great white shark conservation through environmental DNA. Monitoring ecosystems through species detection, determining species diversity and further details about ecosystem function e.g. diet, pathogens, invasive species (Ficetola *et al.*, 2008; Zaiko *et al.*, 2018). Potential to provide abundance data and input into management decisions. Potential to collect samples now for future use with technological advances. Need to ensure these are collected correctly so that DNA does not degrade (Hansen *et al.*, 2018).
Ancient DNA ***Extracting and sequencing DNA from ancient samples (e.g. over 100 years old).***	Provides genetic information from a snapshot in history which can be compared to modern samples.	Degradation of DNA over time means DNA may not be able to be retrieved from all samples, but technological advances are reducing this issue (Oosting *et al.*, 2019).	Answering evolutionary ecology questions which can inform management and conservation decisions. See case study 6.4.8: What does ancient DNA tell us about the snapper population?

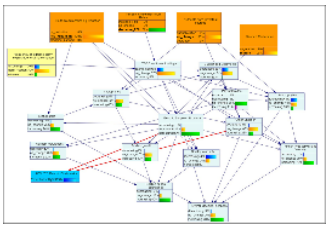
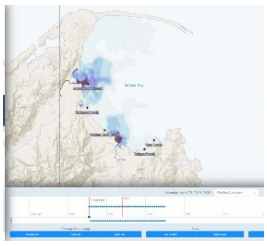
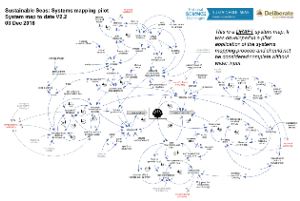
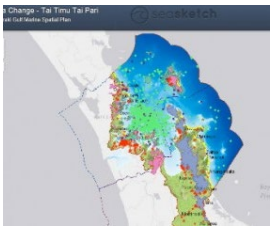
APPENDIX 13: GENETICS IN FISHERIES IN AOTEAROA NEW ZEALAND

The local genetics work in the fisheries sector includes:

- A recently funded SIL project led by the Deepwater Group and Plant & Food Research investigates the stock structure of hoki in Aotearoa New Zealand waters. The study employs WGS of individuals from 10 locations and will assemble the genome of hoki (contact person Dr Maren Wellenreuther).
- Dr Maren Wellenreuther and Dr Peter Ritchie together oversee projects on ancient DNA in snapper to study fisheries-induced evolution (Marsden-funded) and tarakihi stock structure (MBIE-supported). Both projects apply WGS methods, and use genome assemblies.
- Dr Maren Wellenreuther leads a project investigating the role of epigenomic versus genomic variation in enabling rapid adaptation to a changing climate (Marsden-funded). The data will be produced using whole genome and epigenome sequencing and use the snapper genome.
- Together with researchers in Australia (led by Professor Beheregaray), Dr Maren Wellenreuther investigates the stock structure of snapper in Australia and Aotearoa New Zealand using genome-wide markers (ARC Linkage Program-funded) using reduced representation libraries and some WGS and the snapper genome.
- The Ira Moana – Genes of the Sea project is enabling a collaborative network of scientists to deliver a searchable meta-database for genetic and genomic data (from both old and next-generation sequencing techniques) for terrestrial and marine species, as well as environmental samples.
- A study at the Cawthron Institute taking seabed samples from beneath fish farms to detect bacterial DNA to check whether these farms are meeting best practice management practice. This could be an alternative or complementary method and is considered to be cost-effective (contact person is Xavier Ponchon).
- A group led by Dr Peter Ritchie at the Victoria University of Wellington researches the population genetics of the New Zealand scampi.
- Genomics Aotearoa have provided funding in this area to allow the development of new shallow sequencing methods in marine fisheries species (contact Dr Maren Wellenreuther) and to trial improved sequencing and assembly methods for key species, and this is being trialled on the blue cod genome.
- A special issue focused on eDNA is coming out in 2021 New Zealand Journal of Zoology.
- A review on the use of genetics on Aotearoa New Zealand fisheries was published in late 2020 (Papa *et al.*, 2020).

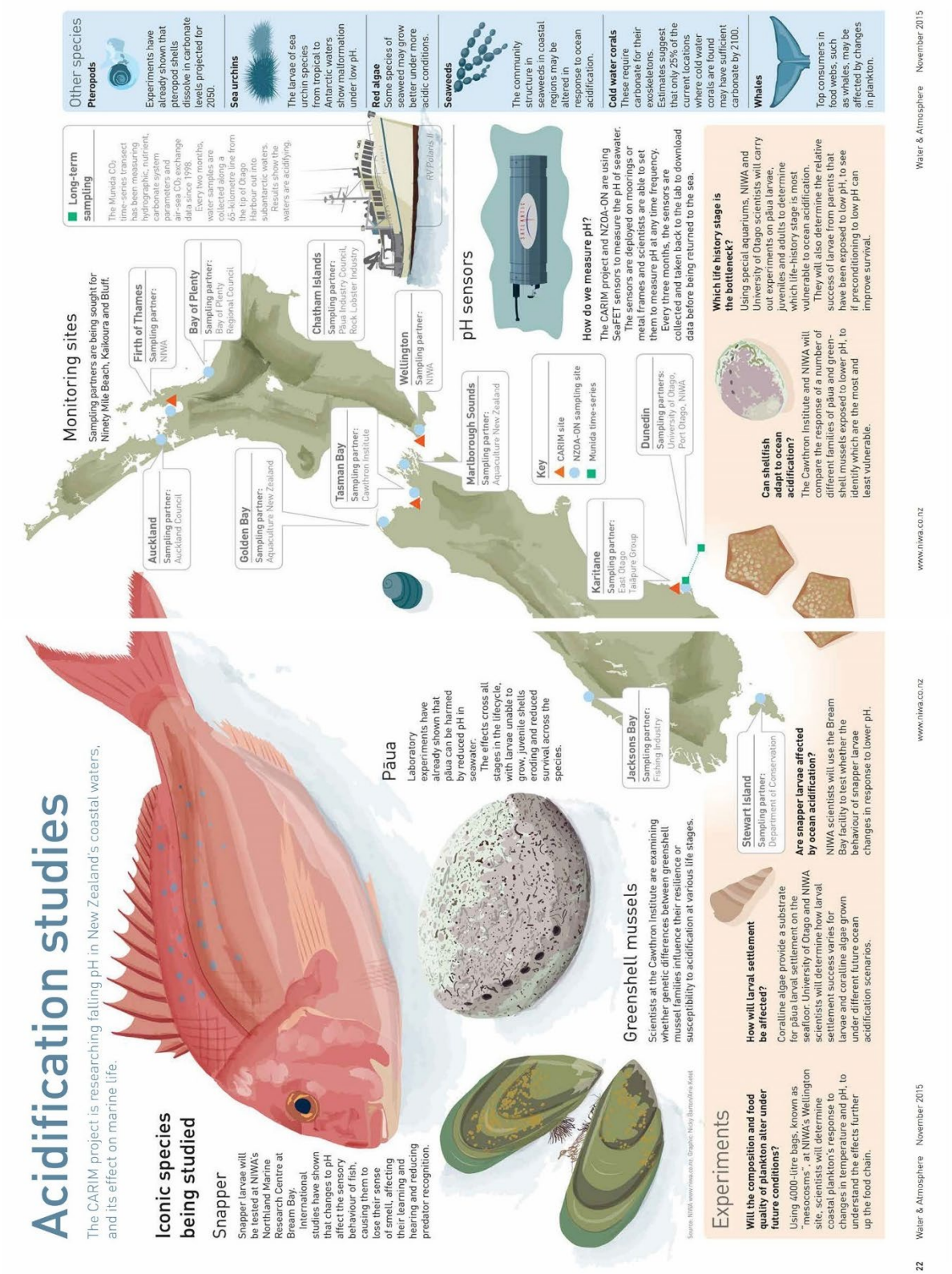
APPENDIX 14: FURTHER EXAMPLES OF MODELS

A non-exhaustive list of additional models for application in the marine domain.

Tool	How was it developed?	How can we use it?	Further development required?
BayesNet model 	Expert workshop and elicitation process.	It can be used to demonstrate how different management decisions lead to varying outcomes, the importance of which will vary among stakeholders. It can be used to gain consensus around management decisions.	The existing model and user interface requires revisiting through a proper stakeholder- and iwi-run process, whereby they are participants in the model's construction and use.
Plastic Tracker 	Coding for efficient post-processing of data generated by hydrodynamic models.	To visualize connectivity of our coastal waters. The tool is easily accessed and used with any device capable of logging onto the internet through browser (other than Internet Explorer).	No further development required, however, the tool can be expanded to the whole of the EEZ.
Contamination nowcasting tool 	Integration of catchment, river flow, coastal hydrodynamic, and bacterial survivorship models, with using real data for validation and tuning.	To obtain 'nowcasts' of the spatial extent of river plumes and levels of faecal indicator bacteria. Aquaculture farmers and council staff can use the tool to assist in managing shellfish harvest and beach closures. It can also serve as a wider communication tool for highlighting land-sea connectivity.	Full validation process and trials are required prior to roll out.
System mapping 	Series of workshops and interviews with experts, stakeholders and iwi.	Facilitating decision making; for example in helping communities to prioritise, rationalize and implement management interventions that will assist in restoring seabed health and fisheries.	Two systems maps have been completed (one pilot and one Māori-led). A full systems mapping exercise would be warranted to use to inform decisions.
SeaSketch 	Developed at UC Santa Barbara, and parameterised/ populated by Sustainable Seas and DOC scientists.	The mapping tool can be used to share spatial information and data layers widely with non-GIS experts, and has embedded participatory functions around surveying, sharing data and knowledge (safely) and collaborative spatial planning (drawing on maps).	Tool is functional for the region. Requires time/workshop(s) to train users and someone to manage and load additional data layers.

APPENDIX 15: OCEAN ACIDIFICATION STUDIES UNDERWAY

Infographic highlighting the range of acidification studies underway. Infographic and further information available from NIWA.



APPENDIX 16: PLAN FOR A NEW ZEALAND OCEAN OBSERVING SYSTEM

New Zealand Ocean Observing System (NZ-OOS) from (O'Callaghan et al., 2019)

YEAR ONE PLAN

1. A pan-New Zealand steering committee and governance board.
2. Four working groups focused on estuaries to shelf, bluewater, data systems, and communications. The scope of each group will be expansive to overcome organization and science discipline silos.
3. A catalogue of observational assets and existing marine data for New Zealand.
4. A strategy for implementing mātauranga Māori in an NZ-OOS.
5. Draft strategic plan built on a well-designed framework and collaborative governance structure.
6. Business case for funding an NZ-OOS.
7. Many of the elements, both observational and modelling, already exist in New Zealand.

FIVE YEAR VISION

1. A widely subscribed data system built around the NZ-Ocean Data Network providing data to a wide range of users.
2. A network of coastal monitoring assets in key regions across a range of organisations that follow standardised data exchange protocols.
3. Access to model hindcast and reanalysis products for simulating and visualising New Zealand's EEZ.
4. The ability for rapid response for forecasting coastal hazards, oil spill trajectories, and biosecurity risk.
5. Implementation of a network of sentinel sites for observing ecological outcome verifications along latitudinal and anthropogenic gradients.
6. Develop and implement sentinel fish and marine megafauna data collection programs that indicate ecosystem change.

TEN YEAR VISION

1. Widely accessible OOS visualisation system that enables society to engage with ocean data in new and exciting ways.
2. Data assimilating operational models providing near real time forecasting of our entire EEZ.
3. Commitment from the seafood industry, with the entire fishing fleet and aquaculture farms established as observing platforms.
4. Integration of ecological layers and the inclusion of biogeochemical and molecular ocean data through aligned sampling programs.
5. Successful integration of mātauranga Māori into a national OOS framework.

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