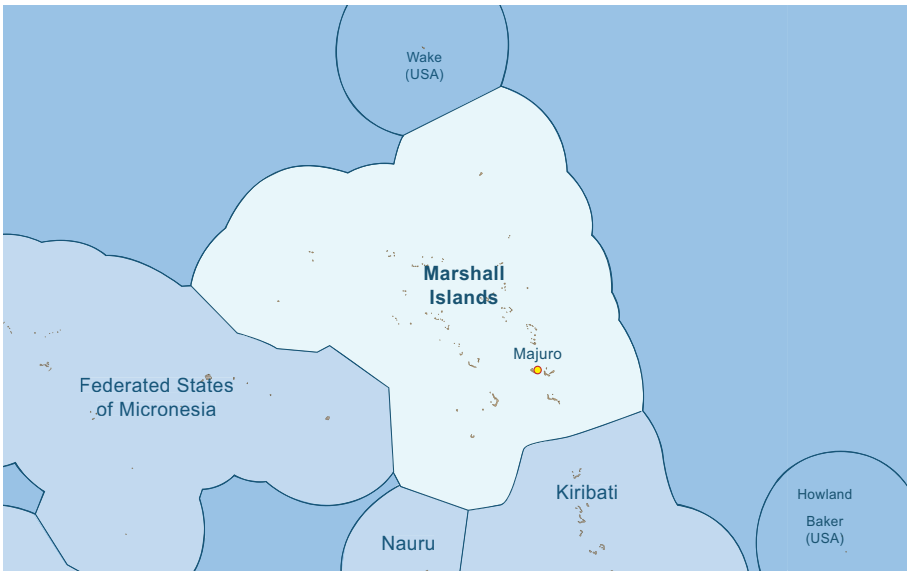
2.8 Marshall Islands



Key features

Population

Year	2010	2035	2050	2100
Population (x 1000)[a]	54	63	61	61
Population growth rate[a]	0.7	0.2	-0.2	0

a = Data from SPC Statistics for Development Programme (www.spc.int/sdp).

EEZ area (km²) 2,004,888

Land area (km²) 112

Land as % of EEZ 0.006

Fisheries and aquaculture activities: Oceanic fisheries and coastal fisheries, with some coastal aquaculture.

Membership of regional fisheries management arrangements: Forum Fisheries Agency; Western and Central Pacific Fisheries Commission; Parties to the Nauru Agreement.

Surface climate and the ocean

Existing features

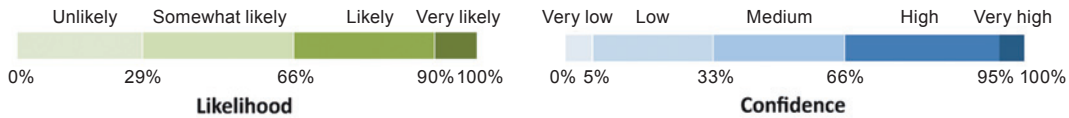
Marshall Islands has a tropical climate {Chapter 2}. Recent air temperatures in Majuro have averaged 27.5°C and average rainfall is ~ 3200 mm per year. Marshall Islands lies within the North Pacific Tropical Gyre Province (NPTG) {Chapter 4, Figure 4.6}. The NPTG Province is created by anticyclonic atmospheric circulation and rainfall in the centre of the province is low. The rotation of the gyre deepens the vertical structure of the water column, making the surface waters nutrient poor {Chapter 4}. As a result, the primary production is very low.

Projected changes to surface climate

Air temperatures and rainfall in Marshall Islands are projected to increase due to climate change under the low (B1) and high (A2) emissions scenarios in 2035 and 2100 {see Chapter 1, Section 1.3 for definition of scenarios} relative to long-term averages {Chapter 2, Section 2.5, Table 2.6}.

Climate feature[a]	1980–1999 average	Projected change			
		B1 2035	A2 2035	B1 2100*	A2 2100
Air temperature (°C)	27.5 (Majuro)	+0.5 to +1.0	+0.5 to +1.0	+1.0 to +1.5	+2.5 to +3.0
Rainfall (mm)	3238 (Majuro)	+5 to +15%	+5 to +20%	+10 to +20%	+10 to +20%
		More extreme wet and dry periods			
Cyclones (no. per year)	n/a	➢ Total number of tropical cyclones may decrease ➢ Cyclones are likely to be more intense			

* Approximates A2 in 2050; a = for more detailed projections of rainfall, air temperature and cyclones in the vicinity of Marshall Islands, see www.cawcr.gov.au/projects/PCCSP; n/a = data not available.



Projected changes to the ocean

The projected changes to the key features of the tropical Pacific Ocean surrounding Marshall Islands relative to the long-term averages are expected to result in increases in sea surface temperature (SST), sea level and ocean acidification. Changes to ocean currents (increases in the North Pacific gyre) and reductions in nutrient supply are also expected to occur {Chapter 3, Sections 3.3 and 3.4, Tables 3.1 and 3.2}.

Ocean feature	1980–1999 average	Projected change			
		B1 2035	A2 2035	B1 2100*	A2 2100
Sea surface temperature (°C)	28.8[a]	+0.6 to +0.8	+0.7 to +0.8	+1.2 to +1.6	+2.2 to +2.7
Sea level (cm)	+6 since 1960				
IPCC **		+8	+8	+18 to +38	+23 to +51
Empirical models ***		+20 to +30	+20 to +30	+70 to +110	+90 to +140
Ocean pH (units)	8.08	-0.1	-0.1	-0.2	-0.3
Currents	Increase in North Pacific gyre	Continued increase in strength of North Pacific gyre			
Nutrient supply	Decreased slightly	Decrease due to increased stratification and shallower mixed layer			< -20%

* Approximates A2 in 2050; ** projections from the IPCC-AR4; *** projections from recent empirical models {Chapter 3, Section 3.3.8}; a = average for EEZ derived from the HadISST dataset.

Oceanic fisheries

Recent catch and value

Marshall Islands has an industrial purse-seine tuna fishery within its exclusive economic zone (EEZ). Recent average catches (2004–2008) by this fishery have exceeded 47,000 tonnes per year, worth > USD 56.7 million per year. Marshall Islands also licenses foreign fleets to fish for tuna in its EEZ. Recent average annual catches by foreign purse-seine fleets were ~ 22,500 tonnes between 1999 and 2008, worth USD 20 million per year {Chapter 12}. Significant quantities of tuna (> 100,000 tonnes per year) are also landed in Marshall Islands by foreign vessels for transhipping {Chapter 12}. See 'Coastal Fisheries' below for contributions of tuna to nearshore artisanal and small-scale commercial fisheries.

Local oceanic fisheries	Average annual catch (tonnes) 2004–2008	Average annual catch value (USD million)* 2004–2008
Tuna		
Purse-seine	47,493	56.2
Longline	98	0.5
Other oceanic fish[a]	33	0.03
Total	**47,624**	**56.73**

* Calculated using market value per tonne for 2004–2008; a = billfish catch only, valued at USD 1000 per tonne.

Existing oceanic fish habitat

The NPTG Province is characterised by low primary production due to the convergence of surface waters and downwelling. Local upwelling near islands can result in enriched surface productivity {Chapter 4, Section 3.2.4}. In general, however, the NTPG Province does not provide prime feeding areas for tuna.

Projected changes to oceanic fish habitat

Under climate change, the surface area of the NPTG Province is projected to increase only slightly and extend poleward. Key components of the food web (net primary production and zooplankton biomass) are expected to decrease significantly in NPTG, particularly by 2100 {Chapter 4, Table 4.3}.

NPTG feature	Projected change (%)			
	B1 2035	A2 2035	B1 2100*	A2 2100
Surface area[a]	+1	+1	+1	+1
Location	Poleward			
Net primary production	-3	-5	-11	-22
Zooplankton biomass	-3	-4	-10	-18

* Approximates A2 in 2050; a = area derived from modelling of nutrients and salinity {Chapter 4, Table 4.3}.

Projected changes in oceanic fisheries production

Preliminary modelling suggests that under the B1 and A2 emissions scenarios, catches of skipjack tuna in the EEZ of Marshall Islands are expected to increase by > 20% in 2035 and B1 in 2100, relative to the 20-year average (1980–2000). Catches under A2 in 2100 are projected to increase to a lesser degree due to the increased warming of the Western Central Pacific Ocean. Catches of bigeye tuna are projected to decrease in 2035 and 2100 under both scenarios, with quite significant changes expected under A2 in 2100 {Chapter 8, Section 8.7}. Modelling for yellowfin tuna is now in progress. The trends for yellowfin tuna are expected to be similar to those for skipjack tuna.

Projected change in skipjack tuna catch (%)			Projected change in bigeye tuna catch (%)		
B1/A2 2035	B1 2100*	A2 2100	B1/A2 2035	B1 2100*	A2 2100
+24	+24	+10	-3	-10	-27

* Approximates A2 in 2050.

Coastal fisheries

Recent catch and value

The coastal fisheries of Marshall Islands are made up of four categories: demersal fish (bottom-dwelling fish associated with coral reef, mangrove and seagrass habitats), nearshore pelagic fish (including tuna, rainbow runner, wahoo and mahi-mahi), invertebrates targeted for export, and invertebrates gleaned from intertidal and subtidal areas {Chapter 9, Section 9.2.1}. The total annual catch was estimated to be 3750 tonnes in 2007, worth > USD 7.2 million. The commercial catch was 950 tonnes. Demersal fish are estimated to make up > 60% of the total catch.

Feature	Coastal fisheries category				Total	Total value (USD m)*
	Demersal fish	Nearshore pelagic fish[b]	Targeted invertebrates	Inter/subtidal invertebrates		
Catch (tonnes)*	2417	1080	3	250	3750	7.2
Contribution (%)[a]	64	29	< 1	7	100	

* Estimated total catch and value in 2007 (Gillett 2009)[1]; a = method for calculating disaggregated catch data for each category is outlined in Chapter 9 {Appendix 9.2, Supplementary Table 9.1}; b = catch dominated by non-tuna species.

Existing coastal fish habitat

Marshall Islands has significant areas of coral reef habitat {Chapter 5} that support many important fisheries species. Small areas of mangroves also occur. The areas of seagrasses and intertidal sand and flats have not been mapped {Chapter 6}.

Habitat	Coral reef[a]	Mangrove[b]	Seagrass[b]	Intertidal flat
Area (km^2)	13,930	0.03	n/a	n/a

a = Includes barrier, patch and fringing reefs and reef lagoons {Chapter 5, Table 5.1}; b = values from Chapter 6, Table 6.1; n/a = data not available.

Projected changes to coastal fish habitat

Climate change is expected to add to the existing local threats to coral reefs, mangroves, seagrasses and intertidal flats in Marshall Islands, resulting in declines in the quality and area of all habitats {Chapters 5 and 6}.

Habitat feature[a]	Projected change (%)		
	B1/A2 2035	B1 2100*	A2 2100
Coral cover[b]	-25 to -65	-50 to -75	> -90
Mangrove area[c]	-10	-50	-60
Seagrass area[c]	< -5 to -10	-5 to -25	-10 to -30

* Approximates A2 in 2050; a = no estimates in reduction of intertidal flats available; b = assumes there is strong management of coral reefs; c = indicative estimates from Federated States of Micronesia {Chapter 6}.

Projected changes in coastal fisheries production

All categories of coastal fisheries in Marshall Islands are projected to show progressive declines in productivity due to both the direct effects (e.g. increased SST) and the indirect effects (changes to fish habitats) of climate change {Chapter 9, Section 9.5}.

Coastal fisheries category	Projected change (%)			Main effects
	B1/A2 2035	B1 2100*	A2 2100	
Demersal fish	-2 to -5	-20	-20 to -50	Habitat loss and reduced recruitment (due to increasing SST and reduced currents)
Nearshore pelagic fish[a]	0	-10	-15 to -20	Reduced production of zooplankton in food webs for non-tuna species and changes in distribution of tuna
Targeted invertebrates	-2 to -5	-10	-20	Habitat degradation, and declines in aragonite saturation due to ocean acidification
Inter/subtidal invertebrates	0	-5	-10	Declines in aragonite saturation due to ocean acidification

* Approximates A2 in 2050; a = tuna contribute to the nearshore pelagic fishery {Chapter 9, Tables 9.8 and 9.10}.

The overall projected change to coastal fisheries catch reflects the relatively heavy reliance on demersal fish and the projected decrease in productivity of all coastal fishery components. As a result, potential catches from coastal fisheries in Marshall Islands are projected to decrease slightly under both scenarios in 2035. By 2100, decreases in coastal fisheries production are projected to be ~ 15% under the B1 scenario and ~ 30% under A2.

Coastal fisheries category	Contrib. (%)**	Projected change in productivity (P) and catch (%)					
		B1/A2 2035		B1 2100*		A2 2100	
		P***	Catch	P***	Catch	P***	Catch
Demersal fish	64	-3.5	-2	-20	-13	-35	-22.5
Nearshore pelagic fish	29	0	0	-10	-3	-17.5	-5
Targeted invertebrates	< 1	-3.5	-0.004	-10	-0.01	-20	-0.02
Inter/subtidal invertebrates	7	0	0	-5	-0.3	-10	-0.7
Total catch[a]			**-2**		**-16**		**-28**

* Approximates A2 in 2050; ** contribution of each component to total coastal fisheries catch in Marshall Islands; *** median projected change in productivity based on range in Chapter 9; a = assumes that proportion of each category remains constant.

Freshwater and estuarine fisheries

Marshall Islands has no freshwater or estuarine fisheries.

Aquaculture

Recent and potential production

The main aquaculture commodities in Marshall Islands are produced in coastal waters for livelihoods. The commodities include black pearls, marine ornamentals (cultured hard and soft corals and giant clam) and trochus. The farming of marine fish is also under development.

Existing and projected environmental features

Increasing SST, rainfall, ocean acidification and possibly stronger storm surge from more severe cyclones are expected to reduce the survival and growth of pearl oyster spat, ornamental products and trochus {Chapter 11}.

Environmental feature	1980–1999 average	Projected change			
		B1 2035	A2 2035	B1 2100*	A2 2100
Annual rainfall (mm)	3238[a]	+5 to +15%	+5 to +20%	+10 to +20%	+10 to +20%
Cyclones (no. per year)	n/a	➢ Total number of tropical cyclones may decrease ➢ Cyclones are likely to be more intense			
Sea surface temperature (°C)	28.8	+0.6 to +0.8	+0.7 to +0.8	+1.2 to +1.6	+2.2 to +2.7
Ocean pH (units)	8.08	-0.1	-0.1	-0.2	-0.3

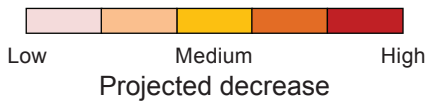
* Approximates A2 in 2050; a = data for Majuro.

Projected changes in aquaculture production

The effects of climate change are eventually expected to have an adverse effect on the existing and potential coastal aquaculture commodities in Marshall Islands {Chapter 11, Table 11.5}.

Aquaculture commodity	Use	Projected change		
		B1/A2 2035	B1 2100*	A2 2100
Existing				
Pearls	Livelihoods			
Marine ornamentals	Livelihoods			
Trochus	Livelihoods			
Potential				
Marine fish	Livelihoods			

* Approximates A2 in 2050.



Economic and social implications

Economic development and government revenue

Current contributions

The surface fishery for tuna contributed ~ 20%, and the longline fishery contributed 2%, to the gross domestic product (GDP) of Marshall Islands in 2007 {Chapter 12}. Licence fees from foreign purse-seine and longline vessels contributed 2% and 1.2% to government revenue (GR), respectively.

Industrial fishery	Contribution to GDP*		Contribution to GR**	
	USD m	GDP (%)	USD m	GR (%)
Surface[a]	32.7	21	2	2
Longline	3.2	2	1.4	1.2

* Information for 2007, when national GDP was USD 156 million (Gillett 2009)[1]; ** information for longline contribution to GR for 2003; a = locally-based purse-seine fleet.

Projected effects of climate change

Preliminary modelling indicates that the contribution of the industrial tuna fishery to GDP in Marshall Islands is projected to increase from ~ 20% to ~ 25% by 2035 and under the B1 scenario in 2100. Smaller increases are projected under A2 in 2100 {Chapter 12}. Minor increases are also expected to government revenue. The projected increases are due to the expected shift to the east in the abundance and distribution of tuna {Chapter 8}.

Projected changes to GDP (%)			Projected changes to GR (%)		
B1/A2 2035	B1 2100*	A2 2100	B1/A2 2035	B1 2100*	A2 2100
+2 to +6	+2 to +6	+1 to +2	0 to +1	0 to +1	0

* Approximates A2 in 2050.

Food security

Marshall Islands is among the group of PICTs (Group 1) where the estimated sustainable production of fish and invertebrates from coastal habitats will be more than enough to supply the national population with the 35 kg of fish per person per year recommended for good nutrition[i] {Chapter 12, Section 12.7.1}.

Current contributions of fish to food security

Average national fish consumption in Marshall Islands is estimated to be 39 kg per person per year[1], just above the recommended level for good nutrition. At present, coral reefs in Marshall Islands are estimated to be able to supply a surplus of > 700 kg of fish per person per year above the recommended level.

Effects of population growth

The demand for fish for food security increases in Marshall Islands due to the predicted growth in population. However, there will still be more than enough fish available from coastal habitats to provide significant surpluses of fish for the remainder of the century.

Variable	2010	2035	2050	2100
Population (x 1000)	54	63	61	61
Fish available per person (kg/year)[a]	768	667	683	685
Surplus (kg/person/year)[b]	733	632	648	650

a = Based on 3 tonnes of fish per km^2 of coral reef habitat {Chapter 9}; b = relative to recommended consumption of 35 kg per person per year.

Additional effects of climate change

The effects of climate change on coastal fisheries in Marshall Islands are not expected to have a significant effect on the fish available for food security per person. The large area of coral reef relative to population size should continue to supply a surplus of coastal fish for food security, even if coastal fish production declines by up to 50% under the A2 scenario in 2100 {Chapter 9}. The improved access to nearshore tuna resources expected to occur as a result of climate change should also provide more fish.

i Based on fish contributing 50% of dietary protein as recommended by the SPC Public Health Programme (SPC 2008)[25].

Livelihoods

Current contributions

Large numbers of full-time and part-time jobs have been created through tuna processing in Marshall Islands, and there is also a small number of jobs on tuna vessels. Coastal fisheries also provide > 50% of households in rural communities with either their first or second source of income.

Jobs on tuna vessels			Jobs in shore-based tuna processing			Coastal households earning income from fishing (%)			Jobs in aquaculture*
2002	2006	2008	2002	2006	2008	1st	2nd	Both	2007
5	0	25	457	100	116	36	18	54	5

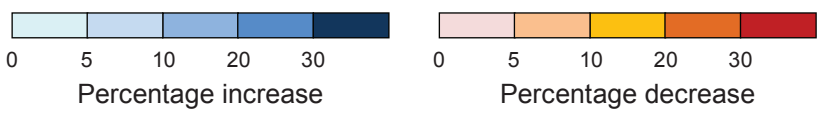
* Ponia (2010)[4]; information derived from Chapter 12, Table 12.6 and the SPC PROCFish Project.

Projected effects of climate change

The effects of climate change on the potential to create more livelihoods based on fisheries and aquaculture are difficult to estimate because there is still scope to derive new jobs from oceanic fisheries, the nearshore component of coastal fisheries and coastal aquaculture. However, the A2 emissions scenario is expected to eventually enhance or retard these opportunities as indicated below.

Year	Projected change under A2 scenario			
	Oceanic fisheries**	Coastal fisheries		Aquaculture (coastal)
		Nearshore pelagic fish	Other resources	
Present*	⇧	⇧	⇩	⇧
2035	↑	No effect	↓	↓
2050	↑	↓	↓	↓
2100	↓	↓	↓	↓

* Indicates general direction of new opportunities for livelihoods based on the activity; ** based on projected changes in skipjack tuna catches.



Adaptations and suggested policies

The plans Marshall Islands has to derive greater socio-economic benefits from fisheries and aquaculture will depend heavily on interventions to:

1. secure access to the tuna required for industrial fishing and processing operations;

2. manage coastal fish habitats and fish stocks to ensure the continued supply of fish for food security; and
3. increase the number of livelihoods that can be based on fishing, tourism and coastal aquaculture.

The adaptations and suggested policies to achieve these plans under a changing climate are summarised below (see Section 3 for details).

Economic development and government revenue

Adaptation no. (Section 3.2)	Summary of adaptation	Supporting policy no. (Section 3.3)
E1	Full implementation of sustainable fishing effort schemes	E1, E2, E4–E6
E2	Diversify sources of fish for processing	E1–E5
E3	Immediate conservation management measures for bigeye tuna	E8
E4	Energy efficiency programmes for industrial tuna fleets	E9
E5	Environmentally-friendly fishing operations	
E6	Gender-sensitive fish processing operations	
E7	Safety at sea	E10
E8	Climate-proof infrastructure	E11
E9	Pan-Pacific tuna management	E2

Food security

Adaptation no. (Section 3.4)	Summary of adaptation	Supporting policy no. (Section 3.5)
F2	Foster the care of coastal fish habitats	F1–F3, F18
F5	Sustain production of coastal demersal fish and invertebrates	F6, F7, F13, F18
F6	Diversify catches of coastal demersal fish	F6, F13, F18
F8	Increase access to tuna for urban and rural populations	F8–F13, F18

Sustainable livelihoods

Adaptation no. (Section 3.6)	Summary of adaptation	Supporting policy no. (Section 3.7)
L1	Improve technical and business skills of communities	L1, L2
L2	Rebuild populations of sea cucumbers and trochus	L2
L3	Develop coral reef ecotourism ventures	L3
L4	Diversify production of coastal aquaculture commodities	L4, L5
L5	Modify locations and infrastructure for coastal aquaculture	L6