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Alistair McIlgorm
Southern Cross University

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HOW CAN FISHERIES GOVERNANCE MEET THE CHALLENGES OF OCEANIC CLIMATE CHANGE?: EXAMPLES FROM SOUTH WEST PACIFIC OCEAN FISHERIES.

Alistair McIlgorm, National Marine Science Centre, The University New England and Southern Cross University, amcilgorm@nmsc.edu.au

ABSTRACT

A scientific literature is developing on the possible long term implications of climate change on ocean fisheries. Some of this addresses possible changes in fishing patterns, but there is less on the management and economic implications on both fish stocks and fishing nations. The paper draws on the fishery management literature and examines steps for analysis of economic impact identification arising from climate change impacts on fisheries. It appears that climate change may add complexity to the existing fisheries management task. Areas such as management of fishing vessel overcapacity and subsidisation of fishing in the global ocean fishing industry will need to be revisited. Two short case studies illustrating potential economic impacts drawn from East Australian and Western Pacific Tuna fisheries are used to show the underlying economic issues for coastal fishers under national jurisdiction, foreign and domestic fishers and the additional risks that climate change may bring to these fisheries. The paper proposes several areas where fisheries governance can prepare for an altered future and to consider altering fisheries management.

Keywords: climate change, fisheries, governance, pacific

INTRODUCTION

A scientific literature is developing on the possible long term implications of climate change on ocean fisheries. Some of this addresses possible changes in fishing patterns, but there is less on the management and economic implications of climate change on fisheries and fishery governance.

What is ocean climate change?

Although there have been lone voices in the scientific community warning of impending climate change, it is really only in the past decade that the international scientific community have gained a substantial platform through the International Panel on Climate Change (IPCC). In their recent 4th assessment they summarise the following.

“Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level” (IPCC, 2007) .

They go on to say the *“Impacts of large-scale and persistent changesare likely to include changes in marine ecosystem productivity, fisheries, ocean CO₂ uptake, oceanic oxygen concentrations and terrestrial vegetation. Changes in terrestrial and ocean CO₂ uptake may feed back on the climate system”.* (IPCC 2007)

Currently the international oceanographic and fishery science community are examining the physical implications through a range of for a. One of these is GLOBEC (Global Ocean Ecosystem Dynamics) was initiated by SCOR and the IOC of UNESCO in 1991, to understand how global change will affect the abundance, diversity and productivity of marine populations comprising a major component of oceanic ecosystems. The aim of GLOBEC is to advance the understanding of the structure and functioning of the

global ocean ecosystem, its major subsystems, and its response to physical forcing so that a capability can be developed to forecast the responses of the marine ecosystem to global change. Climate Change in Top Ocean Predators (CLIOTOPS) is one of the research areas promoted by GLOBEC. CLIOTOPS has a small socio-economic working group (Working group 5) which has several IIFET members involved.

FISHERY IMPACTS OF CLIMATE CHANGE

Generally the scientific community are still determining the physical ocean impacts, their severity and distribution and the future prognosis. In the mean time socio-economic analysis must work with available data and postulate the likely impacts.

This situation is made more complex by the physical impacts of ocean climate change being not only the warming and cooling of water adjacent to land based fisheries, but also fundamental changes in the ocean ecosystem due to seawater acidification arising from carbon dioxide and changes in oxygen levels. Any of these features can be localized or general and thus predictions of change have many assumptions.

Climate change is expected to alter fish production and impact fish stock levels. Fish growth may either increase (decrease) with water temperature and this is species dependent. It is envisaged that fish and marine invertebrate populations may move from traditional areas. More difficult to predict are the impacts on species at critical life stages, where larval fish may face higher than previous water temperatures with altered fishery recruitment patterns. The impacts of ocean acidification, are poorly understood and may lead to invertebrates in the marine food chain having difficulty forming their shells (calcium carbonate). Sea level rise and coastal inundation will have fishery impacts also.

The net changes can be positive, zero or negative, though many impacts may be distributional changes. The resilience of marine systems to climate change are the subject of research. Adaptation strategies are becoming necessary. Cumulative impacts may arise from combining climate change with other physical stressors like pollution. In the economy, climate change and the carbon crisis fuel price will have potentially cumulative impacts.

This paper recognizes the variety of ocean impacts and suggests that we can re-examine fishery governance arrangements with potential ocean climate change impacts in mind. Two areas in the South West Pacific Ocean are reviewed. Here the warm water currents make climate change a reality for fishery managers in the coming decades.

Climate change impacts on an open access fishery are seen in Figure 1 using the standard open access fishery model. Management seeks to limit the total fishery effort, so as not to surpass maximum sustainable yield (MSY). As fishing effort has a cost and the total yield (catch) has an associated price per kg, giving a Total Revenue (Figure 1), economic theory recommends that the desirable sustainable fishing effort level for society is the maximum economic yield (E_{MEY}). The total net return is maximised at E_{MEY} and the stock of fish are generally at level below E_{MSY} . Without management to contain effort levels, the effort delivered by fishing boats will naturally move to the open access equilibrium (OAE in Figure 1), where Total Revenue (TR) = Total Costs (TC) across the fishery. At the OAE level of effort no economic surplus is achieved, having been dissipated by the application of more effort than E_{MEY} (Anderson, 1986).

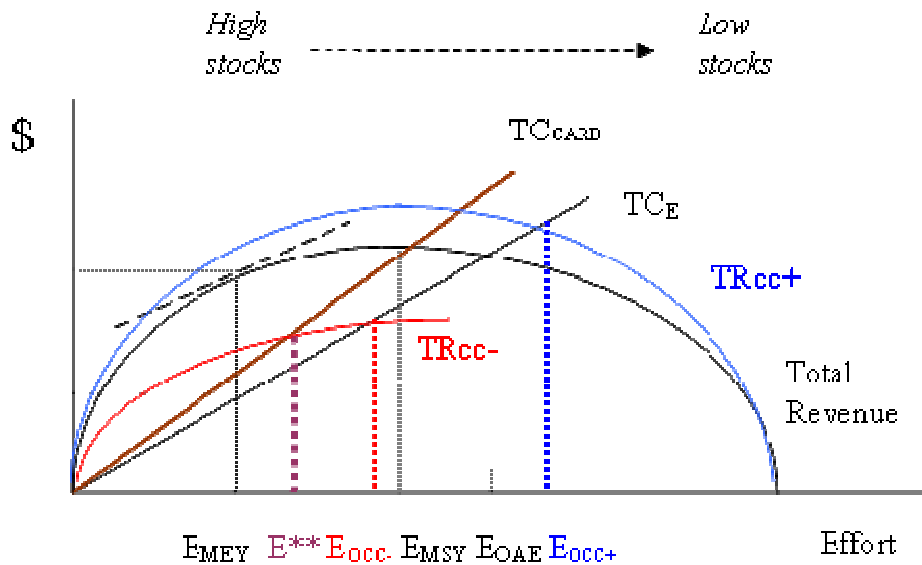


Figure 1: A diagram of sustainable Total Revenue curve and Fishing Effort for the open access fishery. The effort levels and revenues in dollars associated with E_{MEY} Maximum Economic Yield, E_{MSY} Maximum Sustainable Yield and the E_{OAE} Open Access Equilibrium. $TR_{cc+/-}$ are rises and falls in the yield of the fishery due to climate change increasing/decreasing the net growth of the fish stock. E_{occ+} and E_{occ-} are new open access equilibria after climate change. TC_{CARB} reflects rising fuel prices impact of total cost of effort due to the carbon crisis. E^{**} is the OAE effort level after a negative change in yield and higher fuel prices – a dual impact.

The impacts of climate change are seen where the yield curve increases due to improved growth conditions and when yield contracts due to reduced growth. A higher open access equilibrium E_{occ+} is possible, as is a lower one E_{occ-} , due to reduced growth. Of concern is that the lower yield scenario when combined with potential carbon crisis fuel price rises give E^{**} , a cumulative outcome with significant impacts of sustainable yields and fishing vessel viability and fleet capacity.

FISHERY GOVERNANCE

There are generally three categories of governance (left) and these have fishery equivalents (right):

- Government; Intervention by limited entry and fishing regulations;
- Markets; fishing rights and self governance;
- Civil society; social cooperation in fishing regimes.

Additionally international governance regimes have developed in fisheries (Regional Fishery Management Organisations RFMOs);

Gaps in Fishery Governance are market failures, errors in price signals, information gaps and other failures, such as government subsidies. Excessive fishing effort and stocks reflect a market failure often addressed by governance. Many poor environmental outcomes arise due to the prices of natural resources not including ecological values. Information gaps also plague governance responses such as the future price of fuel or the implications of ocean acidification?

Government failure is also seen in subsidies being given by government for vessel construction, low cost loans, lower operational costs and fuel. These are proposed for trade disciplines by the WTO as they reduce fishing costs and adversely impact sustainability (McIlgorm 2006). Fishing subsidies may be increased in response domestic industry pressures due to Climate Change and the Carbon Crisis and have detrimental impacts on fishery sustainability. The addition of ocean acidification introduces potential ecosystems alteration, or collapse. Fishery governance is not generally prepared for these scenarios.

HOW CAN GOVERNANCE ADDRESS CLIMATE CHANGE IN FISHERIES?

The potential categories of issues that governance has to meet are listed below:

1. Spatial displacement of fisheries and fishers;
2. Adjustment of vessels capacity and infrastructure;
3. Flexible management systems;
4. Promoting alternative fisheries or employment for fishers;
5. Account for variation in sustainable fishery regimes (TAC setting); and
6. Altering legal and policy frameworks.

These are applied in the two case studies below to see their relevance.

There are also a range of practical information needs that governance systems need. Predictions from oceanographers on what physical ocean changes may occur, or have occurred through time, are essential. With the oceanographic data fishery biological expertise is required to interpret potential species impacts and changes. Familiarity with existing fishery management systems and their economic/social/governance drivers is essential. Information is required on the fishers, processors and their communities in order to predict impacts.

The following fishery examples in (1) the Western Pacific (2) the East Australia tuna longline fishery will be used to identify climate change governance issues.

CASE 1 - THE WESTERN PACIFIC

The Western Pacific is a complex ocean fishery with island nations and foreign fishers taking substantial tuna catches. This case study concentrates on the area to the north of Papua New Guinea which predominantly takes tunas by purse seining for canning (Figure 2 – dashed line horizontal box to north of PNG).

Governance arrangements

Politically independent states in the Pacific with jointly managed tuna fisheries come together in several regional organisations. The South Pacific Forum Fisheries Agency (FFA), is located in the Solomon Islands, and is involved in assisting the management of the tuna and billfish fishing, advising national governments in the region¹ on fishery access agreements for Distant Water Fishing Nations (DWFNs) and domestic fishery development. In the last decade the Western Pacific Fishery Commission (WPFC), located in Pohnpei, has become the Regional Fisheries Management Organisation (RFMO).

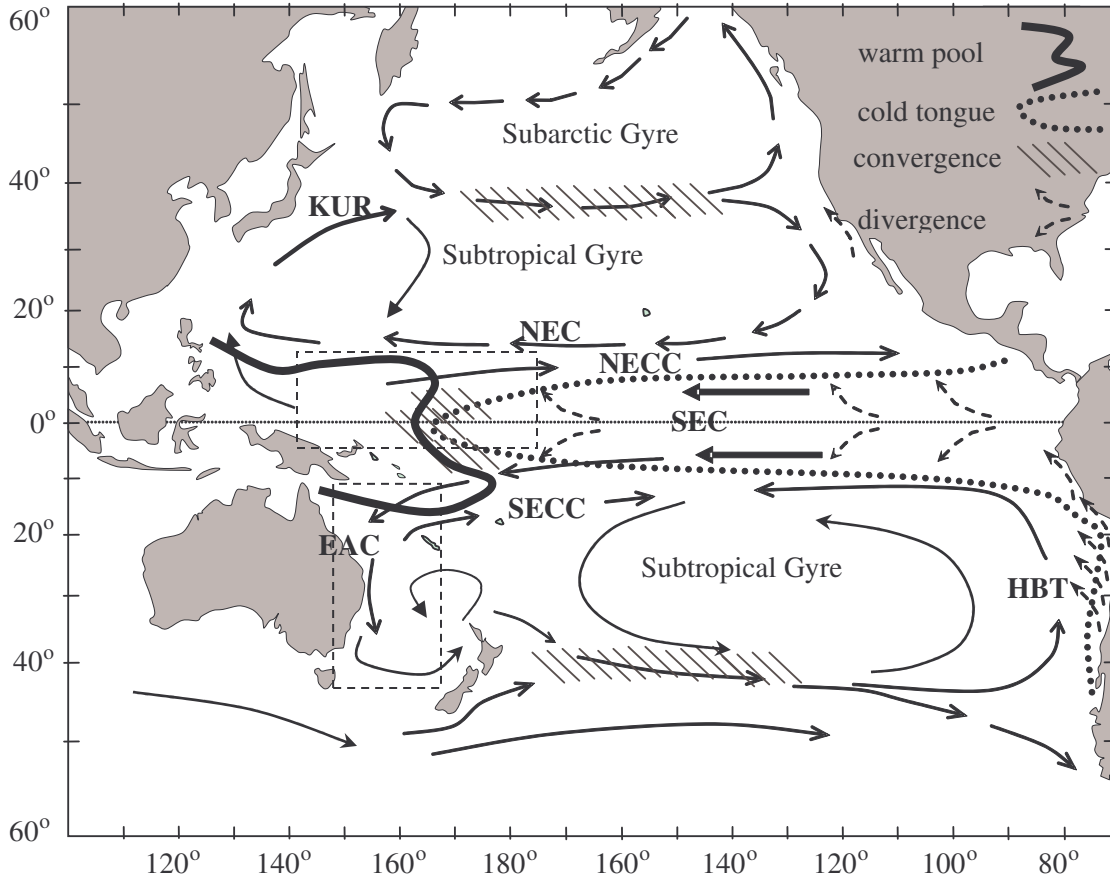


Figure 2: The main oceanographic features of the Pacific Ocean (adapted from SPC, 2005).

Key: SEC: South Equatorial Current; NEC: North Equatorial Current; SECC: South Equatorial Counter-Current; NECC: North Equatorial Counter-Current; KUR: Kuroshio Current; EAC: East-Australian Current; HBT: Humboldt Current. (Kindly from P. Lehodey, Secretariat of the Pacific Community; SPC 2005). The case study areas are shown by the dotted horizontal rectangle to the north east of PNG (warm pool-cold tongue interface) and in the east Australian “EAC” dotted vertical rectangle.

RFMOs are a product of the United Nations Fish Stock Convention and add foreign fishing nations who have traditionally fished the Western Pacific to the group of island resource owning states represented in the FFA. The current coastal state and high seas fishing arrangements have been developed within the Law of the Sea delimitations based on 200 nmiles and with knowledge of the past and current patterns of fish stock distribution. Political negotiations have been based around the past and current knowledge of each state’s fishery activity. The patterns of fishery abundance of these highly migratory species (Skipjack, yellowfin tuna and other tunas) may be impacted by climate change.

The majority of fishery production in the WPC area is by DFWNs under access agreements to FFA member states. In the past two decades, gaining economic benefits from domestic tuna fishery processing by island states has been set as a priority due to the potential economic flow on benefits. The access licence is generally sold for a period of time either in months or years. There is no quantitative limit of most licences, though much discussion at the WPC has focused around the need for regional catch limits, especially to protect vulnerable species. Several studies have examined tradable catch limits as a prospective means of fishery management.

Potential ocean circulation changes

Past fishery research reported in Figure 3 shows the spatial pattern of skipjack tuna purse seine catch per unit effort for the years 1999 to 2005 (SPC, 2005). When the warm water front to the north east of Papua New Guinea (PNG) moves East under La Niña conditions (see Figure 2 and 3), there is a corresponding shift in the surface skipjack tuna fishery distribution. The West to East movement is related to La Niña years and an increase in the frequency and intensity of El Niño conditions (Lehodey et al., 1997).

The observation that movement of the surface purse seine tuna fishery coincides with movement of the warm water front, strongly suggests that there will be changes to the fishery as ocean temperatures rise. If ocean temperatures rise, these ocean effects might be exacerbated, the warm water front moving further. A general rise in water temperatures might disperse the fishery over a wider area.

Climate change impacts on fishery governance

The impact of changes to the fishery as a result of climate change could impact a range of fishers and processing plants. Significant movement of fish stocks due to climate change will alter the location of fishing grounds. For example a tuna fishery could now spend several months of the year inside a national EEZ, but this could increase (or decrease) as fish move to another EEZ, or out of (in to) the High Seas. This movement has implications for licensing of fishing vessels. Tuna canneries based on local vessels supplying fish from their adjacent EEZ may have to use fish trade to maintain the supply of raw material.

Fishery governance systems need to be aware of the fishery areas which are likely to show climate change impacts. These may show as variations in annual catches, or location of fish schools. They are all observations that indicate increasing variability in an already complex and variable fishing process.

The adaption of governance to climate change could:

- involve greater clarity in the links between ocean science, fishery scientists and the policy makers charged with governance responses;
- develop possible climate change scenarios from best available information and have this information available for governments and industry. This would enable government, the fishing and processing industries to plan and adapt;
- where fish look to be moving from the relative protection of national sovereignty into the High Seas area regional fishing arrangements should respond to make sure over fishing does not occur on the High Seas area;
- managers should interpret this additional variability in a precautionary fashion, so as not to have the amount of fishing capacity increasing, even if fish stocks in one area appear to increase (McIlgorm, in press).

Climate change related fish stock movements are likely to have different impacts on foreign and domestic vessels. Foreign vessels pay fess for EEZ access and bear the risks of fish availability due to movement. This evaluation may have implications for capital investment, past and future and labour requirements.

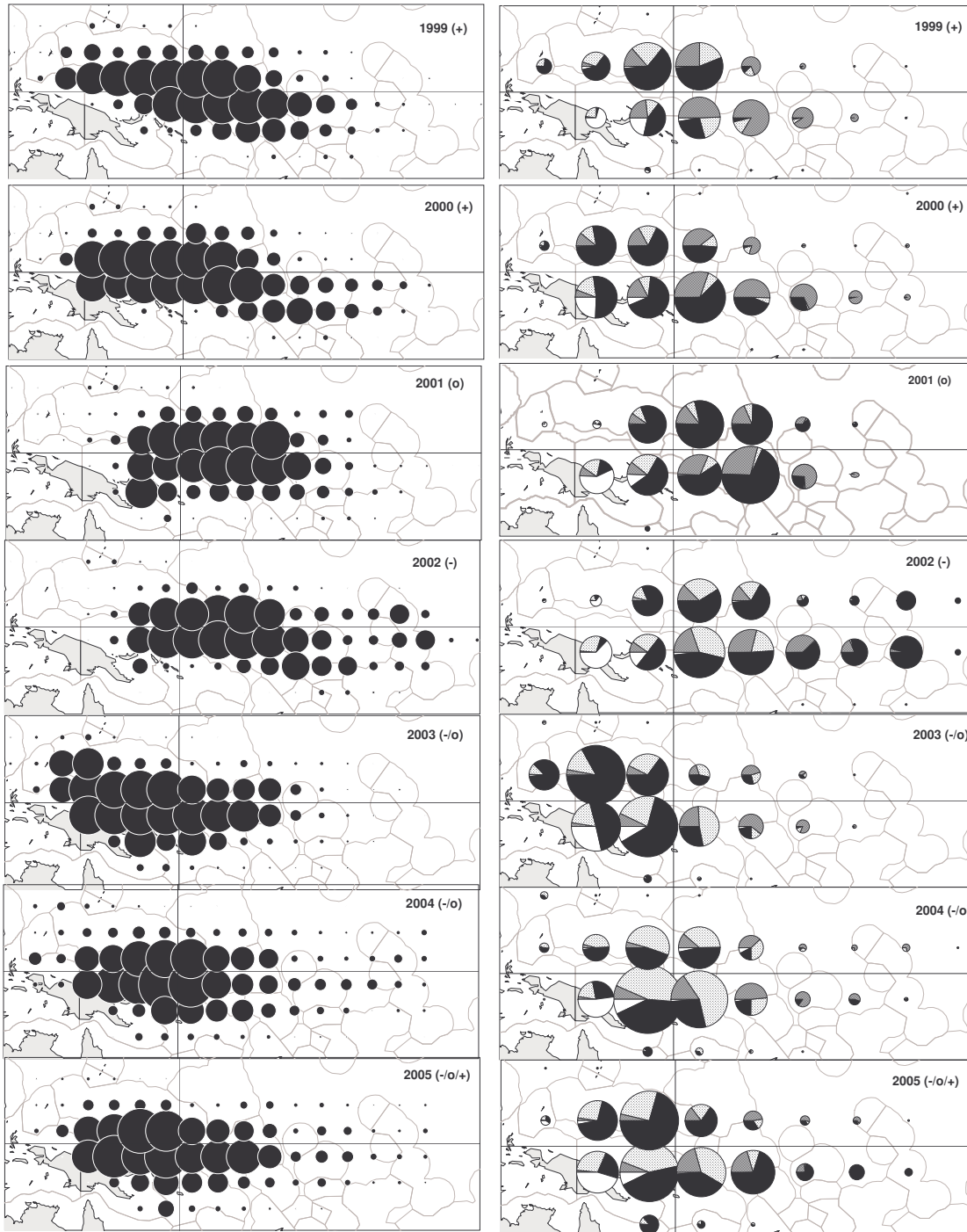


Figure 3: Annual purse seine catch per unit effort in the SPC region in the 1999-2005 period (Source: SPC, 2005).

Key: Distribution of purse-seine effort (days fishing – left; sets by set type – right), 1999– 2005 (unassociated sets – black; log sets – light grey; drifting FAD sets – dark grey; anchored FAD sets – white). ENSO periods are denoted by: ‘+’ = La Niña; ‘-’ = El Niño; ‘--’ = strong El Niño; ‘o’ = transition period. The vertical line is the 160°E longitude (Source SPC, 2005).

CASE 2- THE EAST AUSTRALIAN TUNA LONGLINE FISHERY

The East Australian tuna longline fishery operates amongst the East Australia Current (EAC, Figure 2 and 4rhs) catching yellowfin, albacore, swordfish and striped marlin.

Fishery governance

The fishery is managed by the Australian Fisheries Management Authority, Canberra. Until the 1990s, the East Australian area was seasonally fished by the Japanese longline fleet under annual access agreements of 8-9million hooks per annum. In the late 1980s the Australians developed a small inshore longline fishery while the Japanese were still admitted under access agreements.

In the mid 1990s the Australia government did not renew Japanese fishing access and the domestic Australian longline fishery developed rapidly with many new larger special offshore vessels being purchased. The fishing access was under limited entry with several categories of licence being issues, with some area specifications, due to historical considerations.

By 2005-06 it was realised fishing effort and vessel capacity were too large and many vessels exited under a Federally funded buy back program. Rising fuel prices have caused some vessel owners to tie up their vessels.

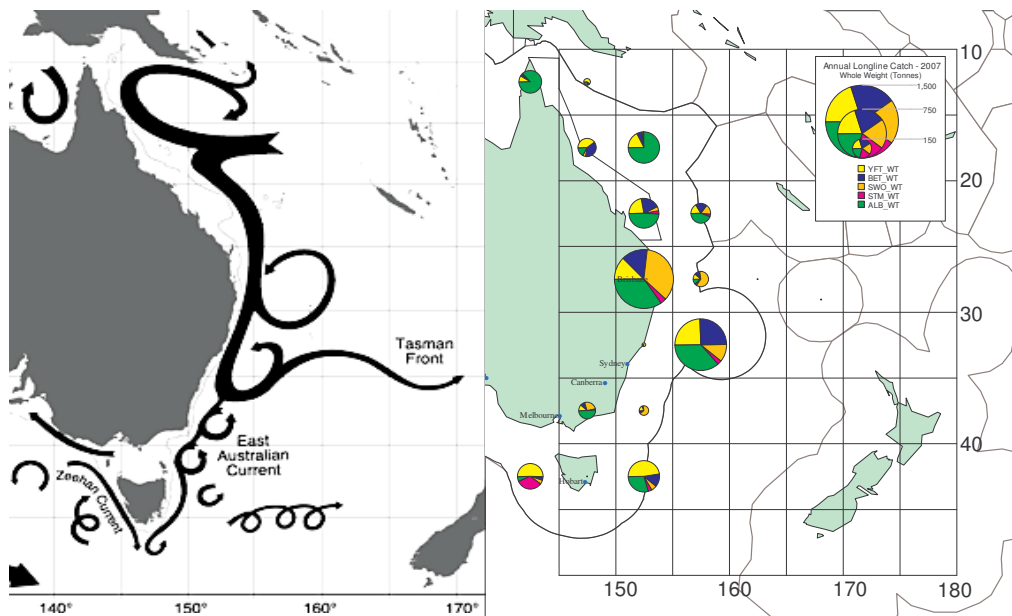


Figure 4: Left - The East Australian Current showing development of warm cores eddies as the current progress south (Source: G.Cresswell, CSIRO) and **Right-** Longline fishing catch data in the East Australian Longline fishery 2006 (Source: CSIRO in Campbell, 2007).

In 2007, the fishery has had a new management plan, with a Total Allowable Effort cap of 7 million hooks per annum. However the East Coast tuna fishery may move to Individual Transferable Quota's by 2010, under Commonwealth Government policy.

Potential ocean circulation changes

The East Australian Current progresses south and starts to break up and form warm core eddies that continue south towards Tasmania (Figure 4 lhs).

Ridgeway (2007) notes the southward penetration of the East Australian Current (EAC) has increased over the last 60 years with changes in temperature and salinity being highly correlated at timescales greater than seasonal, with long-term trends which differ markedly from global ocean values. *“The data show that the region has become both warmer and saltier with mean trends of 2.28C/century and 0.34 psu/century over the 1944–2002 period which corresponds to a poleward advance of the EAC of 350-km”* (Ridgeway, 2007). On the basis of this past trend data, we would expect a further poleward movement south by the EAC of approximately 180 km in the next thirty years at historic rates.

Climate change impacts on fishery governance

The additional southward movement of the EAC will have fishery impacts which are currently being appraised. It is known that the tuna and marlin can travel as far south as Northern Tasmania in warm water eddies from the EAC. If the southward trend of the EAC increases it may require changes in the delimitations of the Federal fishery and consultation with the Tasmanian State Government regarding jurisdictional limits.

The east Australian area may also benefit, (or lose) from ocean current changes in the Western Pacific, bringing (not bringing) fish into the East Australian region. Both changes in fish movements and in biological processes could cause economic impacts through changing the cost to catch fish and impacting the reproduction cycles.

ANALYSIS OF GOVERNANCE CASE STUDIES

Two case studies have been used to appraise how governance can meet climate change challenges in the Western Pacific (WP) and East Australian (EA) tuna fishery under the previously identified criteria. Table 1 presents the results.

Table 1: A comparison of the potential fishery issues for altered governance in the W. Pacific and E. Australian fisheries.

Governance criteria for climate change impacts	Western Pacific	East Australian Longline
Spatial displacement	Tuna moving, out of the reach of domestic fishers?	Tuna moving south to new areas, out of reach of domestic fishers?
Adjustment mechanisms	Mechanisms needed to retire redundant capital due to climate and carbon crisis impacts	Move to ITQs promotes autonomous adjustment - carbon crisis impacts evident
Flexible management systems	Less cumbersome management regime needed and effort cap or TACs	ECT is moving to ITQs in 2010 which may assist adaptation
Promoting alternatives	Are there alternative fisheries or employment for fishers?	Are there alternative fisheries or employment for fishers?
Account for variation in catches	Poor catch controls, some TACs at aggregate level (PNA)	Setting fishery catch limits (TAC setting) in ITQs
Altering legal and policy frameworks	Prepare to diffuse national disputes between beneficiaries	State/Federal legal issues

It is seen that spatial displacement of stocks is an issue for both the WP and EA fishery areas bringing impacts on fishers. Governance must take these movements into account. Governance must start to have more planned and more effective fishery capacity adjustment mechanisms, the EA fishery having an ITQ arrangement which enables autonomous self adjustment.

Flexibility in regimes is also required and in both fisheries less rigid management scheme and more autonomous adjustment is required. This flexibility also needs to consider putting controls on the quantity of fish catch “capping” the take. It appears the area which has had least attention is the opportunities available for fishers impacted by climate change adjustment regimes. Alternative fishing and livelihoods is a major need in the two fishery areas.

Finally the legal and policy frameworks in both fisheries will face national disputes in the WP and the movement of the fishery in EA may require alteration of fishery management areas.

CONCLUSIONS

The assessment framework developed here translates into the following steps for those in fishery governance regimes. It is important to:

- Get sound scientific estimation of the climate change risks & account for the variations;
- Have risk management adjustment scenarios for CC as part of fishery management plans;
- Build more management flexibility and ability to adjust to different climate change conditions;
- Prepare alternatives for displaced capacity adjustment and impacts of fishers; and
- Promote multidisciplinary human capacity building to equip staff to meet the climate change challenges in fisheries governance and management.

The two examples here show that given the long term nature of climate change both fisheries have experienced changes in climate in the last fifty years and have dealt with it as normal variation. It is apparent that if the rate of climate change increases, then fishery governance will have to move to address these changes. This means revisiting some areas such as fishing vessel capacity where many fishery governance regimes have not excelled. Climate change will cause fishery governance to take a second look at old problems for new reasons.

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ⁱ Forum Fisheries Agency 17 member states are Australia, Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, New Zealand, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu and Vanuatu.