Ecological risk assessment of Queensland's Blue Swimmer, Spanner and Mud Crab Fisheries

Queensland's Blue Swimmer Crab Fishery has been updated to include Threatened, Endangered and Protected (TEP) species and ghost fishing consequence scores (2009)

A report to the Australian Government on the ecological risk assessment requirements set out in Wildlife Trade Operation approvals for Gulf fisheries under *Environment Protection and Biodiversity Conservation Act 1999* approvals.

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Queensland Government

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Queensland Primary Industries and Fisheries, part of the Department of Employment, Economic Development and Innovation (DEEDI), seeks to maximise the economic potential of Queensland's primary industries on a sustainable basis.

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Introduction

The Queensland Spanner Crab, Blue Swimmer Crab and Mud Crab Fisheries were all assessed by the Australian Government Department of the Environment, Water, Heritage and the Arts[1] (DEWHA) against stringent sustainability guidelines. The Blue Swimmer and Mud Crab Fisheries were accredited as Wildlife Trade Operations (WTO) and the Spanner Crab Fishery was accredited with a five year exemption from export controls. Continued export approval for crab fisheries is contingent upon each fishery meeting a number of recommendations, including:

Blue Swimmer Crab Fishery

'As part of management planning process, or no later than December 2006, Queensland Primary Industries and Fisheries (QPIF) to assess the appropriateness and effectiveness of current management arrangements for the offshore component of the fishery with regard to the sustainable harvest of the target species, minimisation of bycatch and interactions with threatened species.'

'Within two years, or no later than October 2009, Queensland Primary Industries and Fisheries (QPIF) to update the Ecological Risk Assessment by including information on the impact on protected species for the commercial sector of the fishery, including the level and effects of ghost fishing by lost or discarded commercial and recreational crab apparatus on protected species. QPIF to investigate measures to ensure that issues identified at risk are minimised.'

Spanner Crab Fishery

'Undertake a formal risk assessment of the ecological impact of the fishery on predator prey relationships before the next assessment to confirm assumptions that the broad ecosystem effects of the fishery are low.'

Mud Crab Fishery

'QPIF to conduct a risk assessment to determine the likely impact of protected species interactions in the fishery (including recreational sector) within two years. In the event that a species is found to be at risk, QPIF will investigate measures to mitigate interaction with the species, to ensure that any risks to protected species can be minimised.'

'QPIF to investigate the effects of ghost fishing by lost or discarded mud crab apparatus within two years.'

Given the requirement to address DEWHA's recommendations, and the Queensland Government's commitment to manage fisheries sustainably, QPIF facilitated a two-day stakeholder meeting in May 2006 to conduct the initial assessment to identify ecological risks in the crab fisheries. A desktop study was completed in September 2009 to complete a Threatened, Endangered and Protected (TEP) Species and ghost fishing addendum to the Blue Swimmer Crab Fishery Ecological Risk Assessment (ERA).

[1] Formerly known as the Department of the Environment and Water Resources (DEW).

The 'Ecological Risk Assessment for Effects of Fishing' (ERAEF) Level One model[2], developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) that has been applied to a range of Australian Fisheries Management Authority (AFMA) managed Commonwealth fisheries, has been selected as an appropriate methodology to assess ecological risks in Queensland's crab fisheries.

The ERAEF model uses a step-wise process involving the development of three 'Scoping Documents' to build the final 'Scale, Intensity and Consequence Assessment (SICA)' table which details the risk rating for each issue. The outcomes of the ERAEF process from the QPIF stakeholder workshop were provided to the Crab Management Advisory Committee (CrabMAC) for comment and endorsement. The outcomes of the ERAEF process from the QPIF desktop study were provided to a range of internal and external stakeholders out of session for comment and endorsement.

The tables below provide a summary of the consequence scores as determined by QPIF and endorsed by CrabMAC and a series of other stakeholders. The consequence scores are inherently precautionary as the ERAEF process assesses the components of the ecological community associated with the fishery that were considered by QPIF to be 'most at risk' from fishing and related activities. Consequence scores of three or higher require a management response regarding the mitigation of this risk.

[2] Hobday, A. J., Smith, A., Webb, H., Daley, R., Wayte, S., Bulman, C., Dowdney, J., Williams, A., Sporcic, M., Dambacher, J., Fuller, M. and Walker, T. 2007, *Ecological Risk Assessment for the Effects of Fishing: Methodology*. Report R04/1072 for the Australian Fisheries Management Authority, Canberra.

Blue Swimmer Crab Fishery

Consequence score of 0 = No Hazard; 1 = Negligible risk; 2 = Minor risk; 3 = Moderate risk; 4 = Major risk; 5 = Severe risk; 6 = Intolerable risk.

Direct impact of fishing	Fishing Activity	CONSEQUENCE SCORES (1 – 6)		
		TARGET	BYCATCH	TEP Species[3]
Capture	Bait collection	2	2	2
	Fishing	3	2	3
	Gear loss (ghost fishing)	-	-	3
	Anchoring/mooring	-	-	1
	Incidental behaviour	1	1	1
Direct impact without capture	Bait collection	2	2	2
	Fishing	1	1	2
	Gear loss (ghost fishing)	3	3	2
	Anchoring/mooring	1	1	1
	Navigation/steaming	1	1	3
	Incidental behaviour	1	1	1
Addition/ Movement of Biological Material	Translocation of species	2	2	1
	On board processing	0	0	0
	Discarding catch	2	1	2
	Stock enhancement	0	0	0
	Provisioning	2	1	2
	Organic waste disposal	1	1	1
Addition of Non-Biological Material	Debris	1	1	2
	Chemical pollution	1	1	1
	Exhaust	1	1	1
	Gear loss (ghost fishing)	3	3	2
	Navigation/steaming	2	1	1
	Activity/presence on water	2	1	1
Disturb Physical Processes	Bait collection	2	2	1
	Fishing	1	1	1
	Boat launching	1	1	1
	Anchoring/mooring	1	1	1
	Navigation/steaming	1	1	1
External Hazards	Other capture fishery method	3	3	3
	Aquaculture/mariculture	0	0	1
	Coastal development	1	2	2
	Other extractive activities	0	0	1
	Other non-extractive activities	2	1	2
	Other anthropogenic activities	1	1	2

[3] Please note that during the 2009 Blue Swimmer Crab Ecological Risk Assessment addendum for TEP species and ghost fishing, additional 'fishing activities' were included and/or moved into neighbouring categories of 'direct impacts of fishing'. The modified approach to the ERAEF model will be carried over into the bycatch and target columns pending the review of the Blue Swimmer Crab Ecological Risk Assessment in mid 2010.

Target

Justification of Blue Swimmer Crab Fishery consequence scores of three or above:

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1 – 6)	Temporal scale of Hazard (1- 6)	Sub-component	Unit of Analysis	Operational Objective (S2.1)	Intensity Score (1 – 6)	Consequence Score (1 – 6)	Confidence score (1 – 2)
Capture	Fishing	1	4	6	Population size	Blue Swimmer Crab	T1.1	3	3	2

The offshore[4] Blue Swimmer Crab Fishery encompasses a spatial scale of 100 – 500 nautical miles (nm) in Queensland. Fishing activity using crab pots occurs all-year round on a daily basis, with major peaks in February – May and September – December.

Fishing is considered to have the greatest risk to the population size of blue swimmer crabs due to the intrinsic nature of fishing. Blue swimmer crabs are the primary target species in the fishery and their removal will affect population size before other subcomponents.

Intensity of fishing is considered to be moderate; fishing for blue swimmer crabs would have a severe local impact in high catch/effort areas but a moderate impact on a broader spatial scale.

The consequence of capture through fishing on the population size of blue swimmer crabs in Queensland is considered moderate. At current fishing levels the resource is considered not to be fully exploited and current fishing levels are not considered to adversely affect the long term recruitment dynamics of blue swimmer crabs. The precautionary management arrangements in place in the fishery, particularly the ban on take of females and the minimum size limit, provide strong protection against recruitment overfishing.

Confidence in the scores assigned to capture of target species is considered to be high based on the precautionary management arrangements in place, the resilience of the species and the legal requirement for fishers to report all catch and effort data supported by appropriate enforcement.

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1 – 6)	Temporal scale of Hazard (1- 6)	Sub-component	Unit of Analysis	Operational Objective (S2.1)	Intensity Score (1 – 6)	Consequence Score (1 – 6)	Confidence score (1 – 2)
Direct Impact without Capture	Gear loss	1	4	6	Population size	Blue Swimmer Crab	T1.1	2	3	1
Addition of Non-Biological Material	Gear loss	1	4	6	Population size	Blue Swimmer Crab	T1.1	2	3	1

The opportunity for gear loss occurs where the fishery is active, which encompasses a spatial scale of 100 – 500 nm in Queensland. The temporal scale of the fishery, and therefore the potential for gear loss, is daily.

[4] As defined in: W Sumpton, S Gaddes, M McLennan, M Campbell, M Tonks, N Good, W Hagedoorn and G Skilleter, *Fisheries Biology and assessment of the blue swimmer crab (Portunus pelagicus) in Queensland,* FRDC Project No, 98/117, Department of Primary Industries, Brisbane, Australia, 2003.

Gear loss is considered to pose the greatest risk to the population size of blue swimmer crabs (the primary target species in the fishery) before other subcomponents given the potential for mortality through entrapment.
The intensity of fishing is considered to be minor; the scale of gear loss and subsequent persistence in the environment is unquantified however anecdotal information from fishers suggests it is at a low level. Gear loss in the offshore fishery is considered to be less frequent than in Moreton Bay given the trotline configuration in which gear is deployed in offshore waters. Not all lost gear persists in the environment, with a considerable proportion believed to be incidentally picked up by trawl gear etc. Fishers also suggest that, on average, lost pots would be unlikely to continue fishing after approximately one month due to degradation and sanding/weeding up of pots.

The consequence of 'Direct impact without capture' and 'Addition of Non-Biological Material' through gear loss on the population size of blue swimmer crabs in Queensland is considered to be moderate. This is a precautionary rating reflecting the lack of information on the extent or scale of gear loss or on the relative impact of lost gear on the blue swimmer crab fishery.

Confidence in the scores assigned to the direct impact without capture from gear loss on blue swimmer crabs is considered to be low as assessment is based on limited anecdotal evidence.

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1 – 6)	Temporal scale of Hazard (1- 6)	Sub-component	Unit of Analysis	Operational Objective (S2.1)	Intensity Score (1 – 6)	Consequence Score (1 – 6)	Confidence score (1 – 2)
External hazards	Other capture fishery method	1	6	6	Population size	Blue Swimmer Crab	T1.1	3	3	1

A number of 'Other capture fisheries' (commercial, recreational and Indigenous) operate within the area of the Blue Swimmer Crab Fishery including trawling, inshore/reef line, net fishing and the spanner crab fishery. Several of these fisheries extend throughout Queensland/NSW and Commonwealth waters, with a spatial scale of >1000 nm.

These fisheries operate at a range of temporal scales, the highest being daily. QPIF believe that other fisheries are likely to affect population size before other subcomponents, with direct mortality and habitat degradation/modification believed to be the main impacts on blue swimmer crab populations (the primary target species in the fishery).

Consequence of 'Other capture fisheries' on the population size of blue swimmer crabs in Queensland is moderate. Trawl fisheries are believed to have the greatest impact on blue swimmer crabs. Trip limits apply to trawl-caught blue swimmer crab catches, which has reduced the retained trawl catch to less than 5% of the total annual pot catch. Notwithstanding this, the level of discarding of blue swimmer crabs in the trawl fishery has not been quantified, nor has the impact of cryptic mortality[5] or habitat degradation.

Confidence in the scores assigned to external hazards to blue swimmer crabs through capture in other fisheries is considered to be low as scores are based on the expert opinion of workshop participants; there is a lack of qualitative data on the cumulative impacts of other fisheries on blue swimmer crab stocks.

[5] Cryptic mortality refers to those crabs that die unobserved after having been caught and released.

Bycatch

Justification of Blue Swimmer Crab Fishery consequence scores of three or above:

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1 – 6)	Temporal scale of Hazard (1- 6)	Sub-component	Unit of Analysis	Operational Objective (S2.1)	Intensity Score (1 – 6)	Consequence Score (1 – 6)	Confidence score (1 – 2)
Direct Impact without Capture	Gear loss	1	4	6	Population size	Three-spot crabs (*Portunus sanguinolentus)*	B1.1	2	3	1
Addition of Non-Biological Material	Gear loss	1	4	6	Population size	Three-spot crabs (*Portunus sanguinolentus)*	B1.1	2	3	1

The opportunity for gear loss in the Blue Swimmer Crab Fishery impacting on three-spot crab populations occurs where the fishery is active, which encompasses a spatial scale of 100 – 500 nautical miles (nm) in Queensland. The temporal scale of the fishery, and therefore the potential for gear loss, is daily.

Gear loss is considered to affect population size of three-spot crabs before other subcomponents, given the general impacts of lost pots/lines and gear on bycatch species. Three-spot crabs are considered most at risk from gear loss as they are the second most abundant species and more at risk than spanner crabs from this pot fishery. The pots used when targeting blue swimmer crabs are designed to capture crabs when they are swimming rather than entangle, which is the method used in the spanner crab fishery.

The intensity of direct impact without capture through gear loss on three-spot crabs is considered to be minor; the scale of gear loss and subsequent persistence in the environment is unquantified however anecdotal information from fishers suggests it is at a low level. Gear loss in the offshore fishery is considered to be less frequent than in Moreton Bay given the trotline configuration in which gear is deployed in offshore waters. Species interactions with lost gear is also unknown but is considered to be relatively low, and decreases over time as each pot degrades: fishers have suggested that, on average, lost pots would be unlikely to continue fishing after approximately one month due to degradation and sanding/weeding up and bio-fouling of pots.

The consequence of 'Direct Impact without Capture' and 'Addition of Non-Biological Material' through gear loss on the population size of three-spot crabs is considered, based on the expert opinion of workshop participants, to be moderate. No information is available on the extent or scale of gear loss, and on the relative impact to three-spot crabs, including susceptibility to capture.

The confidence in the scores assigned is low as it is based on limited anecdotal evidence and expert opinion only.

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1 – 6)	Temporal scale of Hazard (1- 6)	Sub-component	Unit of Analysis	Operational Objective (S2.1)	Intensity Score (1 – 6)	Consequence Score (1 – 6)	Confidence score (1 – 2)
External hazards	Other capture fishery method	1	6	6	Population size	Three-spot crabs (*Portunus sanguinolentus)*	B1.1	3	3	1

A number of 'Other capture fisheries' (commercial, recreational and Indigenous) operate within the area of the Blue Swimmer Crab Fishery including trawling, inshore/reef line, net fishing and the spanner crab fishery. Several of these fisheries extend widely through Queensland/NSW and Commonwealth waters, with a spatial scale of >1000 nm.

These fisheries operate at a range of temporal scales, the highest being daily. QPIF believe that other fisheries are likely to affect population size of three-spot crabs before other subcomponents, with direct mortality and habitat degradation/modification believed to be the main impacts on bycatch species populations.

Three-spot crabs are considered the most at risk by-product/bycatch species due to increased fishing interest in targeting soft shell crab and incidental catch by the general trawl fleet.

The intensity of 'External hazards' through other capture fishery methods on the population size of three-spot crabs is considered to be moderate. The soft shell crab fishery is localised in a restricted fishing area, though catches are taken across a broad fishing area.

The confidence in these scores is low due to limited current data on the level of bycatch in these fisheries.

Threatened, Endangered and Protected (TEP) Species

Justification of Blue Swimmer Crab Fishery consequence scores of three or above:

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1 – 6)	Temporal scale of Hazard (1- 6)	Sub-component	Unit of Analysis	Operational Objective (S2.1)	Intensity Score (1 – 6)	Consequence Score (1 – 6)	Confidence score (1 – 2)
Capture	Fishing	1	4	6	Population size	Green turtle (*Chelonia mydas*)	P1.1	3	3	2

The Blue Swimmer Crab Fishery is concentrated in tidal waters throughout Queensland at a spatial scale of 100 – 500 nautical miles (nm). Fishing activity associated with the Blue Swimmer Crab Fishery occurs all-year round on a daily basis, with major effort peaks during the summer and autumn months (i.e. effort in this fishery is highest between October and May).

Fishing is considered to pose the greatest risk to the population size of green turtles. Turtles are considered as the TEP species most at risk due to the potential for entanglement in ropes/lines and the possibility of direct capture in pots. Entanglement is considered to be a greater risk than direct capture; though both outcomes can result in mortality. Green turtles are considered more susceptible than other turtle species due to their high abundance in the fishery area, late reproductive maturity, low reproductive output and likely productivity. The Queensland Parks and Wildlife Services (QPWS) stranding and mortality database (S&MD) identifies green turtles as the turtle species with the most interactions with fishing gear in the Blue Swimmer Crab Fishery.

The intensity of fishing is considered to be moderate. The Blue Swimmer Crab Fishery has a severe local impact[6] in areas of high effort (E.g. Moreton Bay) but a relatively low level of impact on a broader spatial scale.

The consequence of capture through fishing on the population size of green turtles in the Blue Swimmer Crab Fishery is considered moderate. Given the low number of green turtle mortalities in most areas of the fishery, the consequence on the population from these areas would be negligible. However, in areas where greater levels of entanglement/capture have been recorded, a detectable change in population size/growth rate may be evident. Overall there should be minimal impact on the population size and none on the population dynamics of green turtles.

[6] As defined in: Hobday, A. J., Smith, A., Webb, H., Daley, R., Wayte, S., Bulman, C., Dowdney, J., Williams, A., Sporcic, M., Dambacher, J., Fuller, M. and Walker, T. 2007, *Ecological Risk Assessment for the Effects of Fishing: Methodology*. Report R04/1072 for the Australian Fisheries Management Authority, Canberra.

Confidence in the scores assigned to the capture of green turtles as a result fishing in the Blue Swimmer Crab Fishery is considered to be high, due to knowledge of turtle aggregating areas, data on high fishing effort areas, species of conservation interest (SOCI) logbook data, stranding and mortality database information from QPWS, and a consensus held by experts.

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1 – 6)	Temporal scale of Hazard (1- 6)	Sub-component	Unit of Analysis	Operational Objective (S2.1)	Intensity Score (1 – 6)	Consequence Score (1 – 6)	Confidence score (1 – 2)
Capture	Gear loss (ghost fishing)	1	4	5	Population size	Green turtle (*Chelonia mydas*)	P1.1	2	3	2

The opportunity for ghost fishing is associated with the extent of gear loss; as a result the spatial and temporal scales of ghost fishing reflect those of gear loss. The opportunity for gear loss occurs where the fishery is active, which encompasses a spatial scale of 100 – 500 nm in Queensland. Gear loss associated with the Blue Swimmer Crab Fishery is considered to occur weekly.

Gear loss and the resultant effects of ghost fishing are considered to pose the greatest risk to the population size of green turtles before other subcomponents, given the potential for mortality. Gear loss (the precursor to ghost fishing) can result in either entanglement or capture, with entanglement considered to be of greater risk than direct entrapment. Green turtles are considered more susceptible than other turtle species due to their high abundance in the fishery area (greater population size) hence a higher likelihood of interaction and a possible attraction to the build up of algae on lost pots.

The intensity of fishing is considered to be minor. Gear loss in the Blue Swimmer Crab Fishery and subsequent persistence in environment is detailed in Campbell and Sumpton 2009[7].

The consequence of capture as a result of ghost fishing from lost gear in the Blue Swimmer Crab Fishery poses a moderate threat towards the population size of green turtles in Queensland. This is a precautionary rating; lost crab apparatus has the potential to cause consequential damage; however, no information is available on the relative impact to green turtles.

Confidence in the scores assigned to capture as a result of ghost fishing from lost gear in the Blue Swimmer Crab Fishery is considered to be high, as a result of published knowledge on crab pot loss and a consensus held by experts.

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1 – 6)	Temporal scale of Hazard (1- 6)	Sub-component	Unit of Analysis	Operational Objective (S2.1)	Intensity Score (1 – 6)	Consequence Score (1 – 6)	Confidence score (1 – 2)
Direct Impact without Capture	Navigation/ steaming	1	4	6	Population size	Green turtle (*Chelonia mydas*)	P1.1	2	3	2

Navigation/steaming is a standard part of fishing operations, as a result the activity occurs throughout the fishing area at a spatial scale of 100 – 500 nm in Queensland. Navigation/steaming occurs in line with fishing operations in the Blue Swimmer Crab Fishery and is undertaken on a daily basis.

[7] Campbell, M. J. and Sumpton, W. D. 2009, *Ghost fishing in the pot fishery for blue swimmer crabs Portunus pelagicus in Queensland, Australia*. Fisheries Research vol. 95, pg. 246 -253.

Navigation/steaming is considered to pose the greatest risk to the population size of green turtles before other subcomponents, given the potential for severe injury or mortality as a result of a boat strike. Navigation/steaming would affect green turtles through the dispersal or attraction of individuals to the boat/noise etc. Green turtles are considered more susceptible than other turtle species due to their high abundance in the fishery area and regular occurrence in surface waters.

The intensity of navigating/steaming is considered to be minor. Given the mobility of most turtles species (and therefore their ability to avoid impacts), the broad spatial scale of the fishery and the relatively low number of commercial boats accessing the Blue Swimmer Crab Fishery area, the likelihood of detecting the impacts of boat strikes in the restricted locations would be rare.

The consequence of direct impact without capture through navigating/steaming on the population size of green turtles in the Blue Swimmer Crab Fishery is considered moderate; this is a precautionary score reflecting the deficiency of detailed and up to date data regarding boat strikes on turtle species in Queensland fisheries. The ability of green turtles to avoid a boat (once the turtle is firmly within the vicinity of the boat) is low. Boat strikes commonly result in severe injury and/or death. This score realises that boat strikes can have maximum results (i.e. Death), however the overall consequence of boat strikes on the green turtle population size and population dynamics will be minimal.

Confidence in the scores assigned to direct impact without capture of green turtles as a result navigation/steaming in the Blue Swimmer Crab Fishery is considered to be high, due to anecdotal information about the sighting of green turtles in the fishery area, records provided through the stranding and mortality database from QPWS, information detailed in the Biological Review of Australian Marine Turtles[8] and a consensus held by experts.

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1 – 6)	Temporal scale of Hazard (1- 6)	Sub-component	Unit of Analysis	Operational Objective (S2.1)	Intensity Score (1 – 6)	Consequence Score (1 – 6)	Confidence score (1 – 2)
External Hazards	Other capture fishery method	1	6	6	Population size	Green turtle (*Chelonia mydas*)	P1.1	3	3	2

A number of 'other capture fisheries' (commercial, recreational and Indigenous) operate within the area of the Blue Swimmer Crab Fishery, these include trawl, inshore, reef line, net fishing and the Spanner Crab Fishery. Several of these fisheries extend throughout Queensland, New South Wales and Commonwealth waters, at a spatial scale of >1000 nm. These fisheries operate at a range of temporal scales, the highest being daily.

'Other capture fisheries' are considered to pose the greatest risk to the population size of green turtles before other subcomponents, given the potential for mortality and habitat degradation as a direct result of fishing operations. Green turtles are considered more susceptible than other turtle species due to their high abundance in the fishery area, frequenting of surface waters, late reproductive maturity, low reproductive output and likely productivity.

The intensity of 'other capture fishery methods' are considered to be moderate. From the 'other capture fishery methods' which overlap with the Blue Swimmer Crab Fishery area, green turtles are most likely to interact with inshore net gear. Green turtles may interact with nets, floats and lines as part of their natural foraging and surface behaviour. It is suspected that higher numbers of interactions will occur at high effort locations, which incidentally coincide with nesting and foraging corridors. 'Other capture fishery methods' will have a have a severe local impact[9] in high effort areas but a moderate impact on a broader spatial scale; much like the Blue Swimmer Crab Fishery.

The consequence of external hazards through 'other capture fishery methods' on the population size of green turtles in Queensland is considered moderate. This score has been assigned on the basis of SOCI logbook data, directly

[8] Limpus, C. 2007, *A biological review of Australian marine turtles. Chapter 2.Green turtle Chelonia mydas.* Environmental Protection Agency, Brisbane, Australia.

[9] As defined in: Hobday, A. J., Smith, A., Webb, H., Daley, R., Wayte, S., Bulman, C., Dowdney, J., Williams, A., Sporcic, M., Dambacher, J., Fuller, M. and Walker, T. 2007, *Ecological Risk Assessment for the Effects of Fishing: Methodology*. Report R04/1072 for the Australian Fisheries Management Authority, Canberra.

attributable to specific fisheries, a risk assessment and the distribution and relative abundance of sea turtles in Queensland waters. This is a precautionary score reflecting the deficiency of up to date (with the exception of SOCI logbook data) and detailed data noting the consequences of ‘other capture fishery methods’ on turtle species in Queensland fisheries.

Confidence in the scores assigned to external hazards of green turtles as a result ’other capture fishery methods’ are considered to be high, based on the evidence in the SOCI logbook, anecdotal information about the sighting of green turtles in the fishery area and a consensus held by experts.

Spanner Crab Fishery

Consequence score of 0 = No Hazard; 1 = Negligible risk; 2 = Minor risk; 3 = Moderate risk; 4 = Major risk; 5 = Severe risk; 6 = Intolerable risk.

Direct impact of fishing	Fishing Activity	CONSEQUENCE SCORES (1 – 6)		
		TARGET	BYCATCH	COMMUNITY
Capture	Bait Collection	1	1	1
	Fishing	3	1	2
	Incidental behaviour	1	1	1
Direct impact without capture	Bait collection	1	1	1
	Fishing	1	1	1
	Incidental behaviour	1	1	1
	Gear loss	2	1	2
	Anchoring/mooring	1	1	1
	Navigation/steaming	1	1	1
Addition/ Movement of Biological Material	Translocation of species	2	2	2
	On board processing	0	1	0
	Discarding catch	2	1	2
	Stock enhancement	0	0	0
	Provisioning	2	1	2
	Organic waste disposal	1	1	2
Addition of Non-Biological Material	Debris	1	1	2
	Chemical pollution	1	1	1
	Exhaust	1	1	1
	Gear loss	2	1	2
	Navigation/Steaming	1	1	2
	Activity/presence on water	1	1	1
Disturb Physical Processes	Bait collection	1	1	1
	Fishing	2	1	1
	Boat launching	1	1	1
	Anchoring/mooring	1	1	1
	Navigation/steaming	1	1	1
External Hazards	Other capture fishery method	1	2	1
	Aquaculture/Mariculture	1	1	1
	Coastal development	1	2	1
	Other extractive activities	1	1	1
	Other non-extractive activities	2	1	2
	Other anthropogenic activities	1	1	2

Target

Justification of Spanner Crab Fishery consequence scores of three or above:

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1 – 6)	Temporal scale of Hazard (1- 6)	Sub-component	Unit of Analysis	Operational Objective (S2.1)	Intensity Score (1 – 6)	Consequence Score (1 – 6)	Confidence score (1 – 2)
Capture	Fishing	1	4	6	Population size	Spanner crab	T1.1	3	3	2

Fishing activity in the Spanner Crab Fishery occurs at spatial scale of 100 – 500 nautical miles (nm) in Queensland. The temporal scale of the fishery is daily for approximately 334 days of the year (weather dependent).

Fishing is considered to have the greatest risk to the population size of spanner crabs due to the intrinsic nature of fishing. The east coast population of spanner crabs is considered to be a single genetic stock with a geographic range that extends the Queensland/New South Wales (NSW) border. QPIF did not take the catch of spanner crabs taken in NSW into account explicitly in the Ecological Risk Assessment; catch levels in NSW are lower than in Queensland waters.

Intensity of fishing is considered to rate a moderate score; fishing for spanner crabs would have a severe local impact in high catch/effort areas but a moderate impact on a broader spatial scale. The fishing behaviour of the fishers operating in the spanner crab fishery is patchy, with several grounds recording consistently high catches while other grounds are highly variable.

Consequence of fishing on the population size of spanner crab in Queensland is moderate. At current fishing levels the resource is considered not to be fully exploited and current fishing levels are not considered to adversely affect the long term recruitment dynamics of spanner crabs.

Confidence in the scores assigned to capture of target species is considered to be high due to the formal assessment process and management regime in place including:

- comprehensive daily catch and effort data provided by fishers available from the Commercial Fisheries Information System (CFISH);
- fishery independent Catch Per Unit Effort (CPUE) Long Term Monitoring Program (LTMP) data collected annually;
- seasonal closures;
- commercial Total Allowable Catch (TAC) set using decision rules; and
- a high level of enforcement and compliance activities associated with the fishery.

The response time to changes in fishing pressure is rapid due to the biennial review of the commercial TAC which mitigates risk.

Mud Crab Fishery

Consequence score of 0 = No Hazard; 1 = Negligible risk; 2 = Minor risk; 3 = Moderate risk; 4 = Major risk; 5 = Severe risk; 6 = Intolerable risk.

Direct impact of fishing	Fishing Activity	CONSEQUENCE SCORES (1 – 6)
		Threatened, Endangered and Protected (TEP) species
Capture	Bait Collection	1
	Fishing	3
	Incidental behaviour	1
Direct impact without capture	Bait collection	2
	Fishing	2
	Incidental behaviour	1
	Gear loss	3
	Anchoring/mooring	1
	Navigation/steaming	2
Addition/ Movement of Biological Material	Translocation of species	2
	On board processing	
	Discarding catch	2
	Stock enhancement	
	Provisioning	2
	Organic waste disposal	1
Addition of Non-Biological Material	Debris	1
	Chemical pollution	1
	Exhaust	1
	Gear loss	3
	Navigation/Steaming	2
	Activity/presence on water	1
Disturb Physical Processes	Bait collection	1
	Fishing	1
	Boat launching	1
	Anchoring/mooring	1
	Navigation/steaming	1
External Hazards	Other capture fishery method	3
	Aquaculture/Mariculture	1
	Coastal development	3
	Other extractive activities	1
	Other non-extractive activities	2
	Other anthropogenic activities	2

Assessment of ghost fishing impacts of lost gear in the Queensland Mud Crab (*Scylla serrata)* fishery

The risk assessment of ghost fishing by mud crab pots has been explicitly addressed in regard to the DEW recommendation for the QPIF to investigate ghost fishing in the mud crab fishery.

Direct impact of fishing	Target	Bycatch	Habitat	Community
Ghost Fishing (impacts of lost gear)	2	2	2	1

Threatened, Endangered and Protected (TEP) Species

Justification of Mud Crab Fishery consequence scores of three or above:

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1 – 6)	Temporal scale of Hazard (1- 6)	Sub-component	Unit of Analysis	Operational Objective (S2.1)	Intensity Score (1 – 6)	Consequence Score (1 – 6)	Confidence score (1 – 2)
Capture	Fishing	1	6	6	Population size	Green Turtles (*Chelonia mydas)*	P1.1	3	3	2

Fishing activity in the Queensland Mud Crab Fishery is widespread in tidal waters throughout Queensland at a spatial scale of › 1000 nm. The temporal scale of the fishery is daily.

Capture or entanglement is likely to affect population size before other subcomponents as capture or entanglement is likely to lead to mortality. In general, turtles are considered as the TEP group most at risk from the mud crab fishery due to potential for entanglement in ropes/lines and possibility of direct capture in pots. Entanglement is considered to be a greater risk than direct capture and Green turtles are considered more at risk of entanglement than other turtle species due to:

- their greater abundance in the fishery area (and hence higher likelihood of interactions);
- their late reproductive maturity (26 – 40 years[10]) compared to the other species:
    - Loggerhead turtle (*Caretta caretta)* 10 – 30 years[11]
    - Hawksbill turtle (*Eretmochelys imbricata)* ›31 years[12]
    - Flatback turtle (*Natator depressus)* reproductive half life of 10 years[13]
    - Leatherback (*Dermochelys coriacea)* 10 – 13 years[14]
    - Olive ridley turtle (*Lepidochelys olivacea)* unknown[15]
- past evidence of interactions with crab pots.

Green turtles are listed as vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999*.

The intensity of fishing is considered to be at a moderate intensity. Although interactions occur at a relatively low level throughout the fishery the total number of interactions can be greater in areas of high fishing effort, for example Moreton Bay.

The consequence of capture through fishing on the population size of green turtles is considered to be moderate. Given the low number of green turtle mortalities in most areas of the fishery the consequence on the population from these areas would be negligible. However, in areas where greater levels of mortality / interaction have been recorded, such as Moreton Bay, a detectable change in population size / growth rate may be evident.

Confidence in the scores assigned to the impact of fishing on the population size of green turtles is high due to good knowledge of turtle distribution, including aggregating areas and areas of high fishing effort.

[10] Seminoff, J. A. *Chelonia mydas*, 2004 In: IUCN 2006. *2006 IUCN Red List of Threatened Species.* Available [online] at: www.iucnredlist.org [Accessed 22 May 2007]

[11] Bjorndal, K. A., Bolten, A. B., and Martins, H. R. 2000, *'Somatic growth model of juvenile loggerhead sea turtles Caretta caretta: duration of pelagic stage'*, Mar Ecol Prog Ser, Vol. 202, pp. 265–272.

[12] Limpus, C. J. 1992, *'The Hawksbill Turtle, Eretmochelys imbricata, in Queensland: Population Structure within a Southern Great Barrier Reef Feeding Ground'*, Wildl. Res., Vol. 19, pp. 489–506, 1992.

[13] Department of the Environment and Water Resources, 2007, *Natator depressus in Species Profile and Threats Database,* Department of the Environment and Water Resources, Canberra. Available [online] at: www.environment.gov.au [Accessed 22 May 2007].

[14] Sartir Martinez, A. L. *Dermochelys coriacea*, 2000. In: IUCN 2006. *2006 IUCN Red List of Threatened Species.* Available [online] at: www.iucnredlist.org [Accessed 21 May 2007]

[15] Department of the Environment and Water Resources. 2007, *Lepidochelys olivacea in Species Profile and Threats Database,* Department of the Environment and Water Resources, Canberra. Available [online] at: www.environment.gov.au [Accessed 22 May 2007].

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1 – 6)	Temporal scale of Hazard (1- 6)	Sub-component	Unit of Analysis	Operational Objective (S2.1)	Intensity Score (1 – 6)	Consequence Score (1 – 6)	Confidence score (1 – 2)
Direct Impact without Capture	Gear loss	1	6	6	Population size	Green Turtles (*Chelonia mydas)*	P1.1	2	3	1
Addition of Non-Biological Material	Gear loss	1	6	6	Population size	Green Turtles (*Chelonia mydas)*	P1.1	2	3	1

The opportunity for gear loss occurs where the fishery is active, which encompasses a spatial scale of › 1000 nm. The temporal scale of the fishery, and therefore potential for gear loss, is daily.

Gear loss is likely to affect population size of green turtles before other subcomponents, given the general impacts of lost pots and lines to bycatch species. In general, turtles are considered as the TEP group most at risk from the loss of gear due to potential for entanglement in ropes/lines and possibility of direct capture in lost pots. Entanglement is considered a greater risk than direct capture and green turtles are considered more susceptible to entanglement than other species due greater population size and hence higher likelihood of interaction occurring. There may also be a possible attraction to build up of algae on lost gear (algae is a part of the diet of green turtles).

The intensity of gear loss is considered to be minor; the scale of gear loss and subsequent persistence in the environment is unquantified however anecdotal information from fishers suggests it is at a low level. Gear is likely to be lost in estuarine/mangrove areas where green turtle abundance is thought to be low.

The consequence of gear loss on the population size of green turtles is considered to be moderate. There is no information available on the extent or scale of gear loss or on the relative impact to green turtles, including susceptibility to capture.

There is low confidence in the scores assigned as they were based on limited anecdotal information.

Direct impact of fishing	Fishing activity	Presence (1) Absence (0)	Spatial scale of Hazard (1 – 6)	Temporal scale of Hazard (1- 6)	Sub-component	Unit of Analysis	Operational Objective (S2.1)	Intensity Score (1 – 6)	Consequence Score (1 – 6)	Confidence score (1 – 2)
External Hazards	Other capture fishery method	1	6	6	Population size	Green Turtles (*Chelonia mydas)*	P1.1	3	3	1

A number of other capture fisheries (commercial, recreational and Indigenous) operate within the area of the mud crab fishery, including inshore line and net fishing, blue swimmer and spanner crab fishing and to a lesser extent trawling. Some of these fisheries extend through Queensland, NSW and Commonwealth waters, with a spatial scale of ›1000 nm. These fisheries operate at a range of temporal scales, the highest being daily.

Other capture fisheries are likely to affect population size before other subcomponents, with direct mortality and habitat degradation likely to be the main impacts to protected species populations. Green turtles are considered the most at risk protected species given their general abundance in the fishery area.

The intensity of other capture fishery methods is moderate. Of all other capture fishery methods turtles are likely to interact most with inshore net gear. Turtles may interact with nets/floats/lines as part of their natural foraging behaviour with such interactions to be at a moderate rather than severe scale.

The consequence of other capture fisheries on the population size of green turtles is considered to be moderate. The score is precautionary given the lack of information directly related to turtle interactions, and the resulting reliance on anecdotal comments from researchers and fishers. This can be reviewed at a later date when more specific information is available for a range of fisheries.

There is low confidence in the scores assigned as they were based on limited anecdotal information.

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Image
Mud Crab - *Scylla serrata* (Photograph by B Miller)