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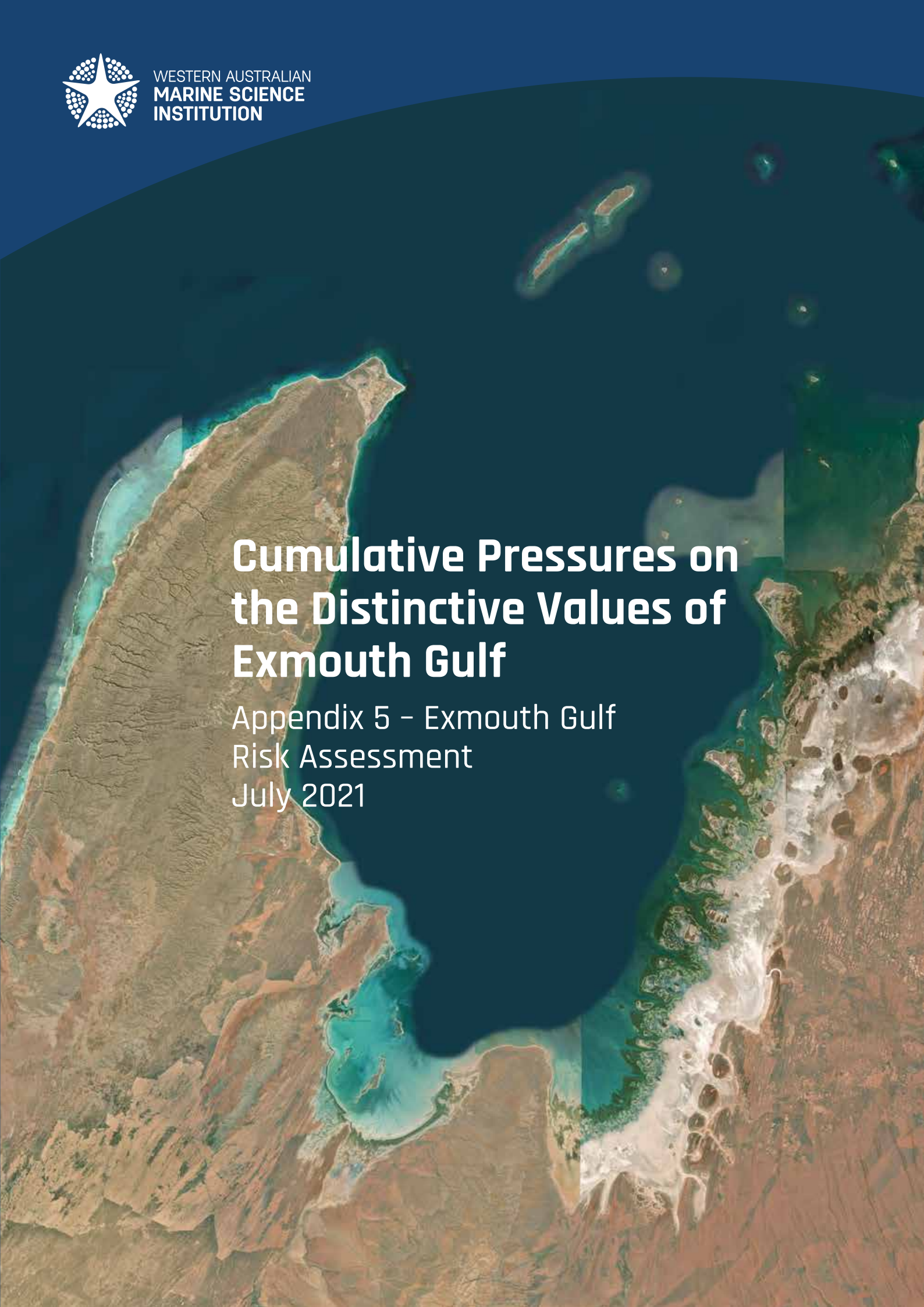

Cumulative Pressures on the Distinctive Values of Exmouth Gulf

Appendix 5 – Exmouth Gulf Risk Assessment

July 2021

Contents

EPA SEA THEME

Negligible	Low	Medium	High	Severe
1-2	3-4	6-8	9-12	16

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						

General statements to consider for all values

As a point of comparison, Shark Bay is quite shallow - water flows in and has a harder time flowing back out. Exmouth Gulf is a bit deeper, has big tides, more mixing and water comes in and out much quicker. In Exmouth Gulf, warm water mixes and dissipates quicker. The Gulf, however, still has captured water compared to coastal areas with no embayments.

During a heatwave, warm water will come in and out with the tide every day, and solar radiation is added on top (this can happen for weeks/months).

There can be strong temperature and salinity gradients along the Exmouth Gulf from north to south. So perhaps we cannot assume mixing is happening all the time, or at least throughout the whole Gulf?

During some events, like La Niña years, we are going to experience warmer periods and an increase in the frequency of heatwaves and storms.

Many of Exmouth Gulf's habitats and the biodiversity they support are existing at their physiological extremes and biogeographical limits. This means they are susceptible to stress and perturbations from anthropogenic impacts, such as industrialisation and climate change. The Gulf's prevailing environmental conditions such as aridity, sporadic intense rainfall, salinity and other factors mean that habitats, such as mangroves, are likely to respond more acutely to climate change effects.

Another component of heatwaves is wind. During La Niña periods, winds decrease and become more easterly. Winds can dilute the warm water coming into Exmouth Gulf. Currently (Feb 2021), the cold water is not present to modulate temperatures.

Kathleen McInnes meeting - 4 March 2021 - comments made generally, not specific to Exmouth Gulf

- There is already natural variability. It is hard to predict the influence of climate change drivers on the Exmouth Gulf marine environment over a short 5-10 year time frame
- A 3.5mm sea level rise per year is predicted - but this is strongly influenced by the El Niño-Southern Oscillation (ENSO)
- Marine heatwave frequency is projected using longer time scales
- Over 5-10 years you are mainly looking at ENSO cycles and how that covaries with rainfall in Exmouth Gulf. There are different predictions for each region. Climate change will be less of an issue over this time frame, but it would still be going on in the background and will amplify other impacts.
- Typically, we look at 20-100 years when looking at projections.

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
	• For projections for 2030, the values are small in comparison with natural variability. We do not start to see a separation in values/patterns until about 2040 and beyond. • The last time national projections were rolled out for Western Australia they focused on Natural Resource Management (NRM) regions - The Rangelands North sub-cluster comprises NRM regions in four States and the Northern Territory, extending from the Indian Ocean to northwestern New South Wales. Climate projections are on the national climate change website (www.climatechangeinaustralia.gov.au/en/projections-tools/regional-climate-change-explorer/sub-clusters/?current=RLNC&tooltip=true&popup=true) • Work on marine heatwave projections out to 2100 (not specific to Exmouth Gulf), show permanent hot conditions e.g., current heatwave conditions, but permanent. • Drying climate, lack of rainfall and increase in air temperature of 1.3 degrees by 2030 • 34 days over 35 degrees by 2030 (increase of 7 days since 1981), and an increase of 4 days over 40 degrees. • There has been some Shark Bay CSIRO work on climate change • Under high emission scenarios, marine heatwaves as intense as 2011 off the coast of W.A. could change from a one-in-80-year event to an annual event • 4-7 years cycle for ENSO - The Bureau of Meteorology does seasonal forecast outlooks. El Niño conditions are usually characterised by drought conditions, low sea levels and low rainfall. • La Niña has a tendency towards warmer ocean temps, higher rainfall, rapid transpiration, more rainfall, more floods, more tropical cyclones • Tidal movements could be impacted by climate change, but it would need modelling work done to determine the extent. Still expect the same tidal regime but low tides are getting higher, and high tides are getting higher, and the shoreline is incrementally becoming more submerged. Climate Change in Australia website: Rangelands North (incl. Exmouth Gulf) - **On an annual and decadal basis, natural variability in the climate system can act to either mask or enhance any long-term human-induced trend, particularly in the next 20 years and for rainfall.**					
Factor: Benthic habitats and communities						
Value: Macroalgae and turf algae						
Y	Marine heatwaves	2	4	8	M	There has been impacts on macroalgae from the 2011 marine heatwave but not sure to what degree - **more knowledge needed - low data confidence** The supply of propagules into the Exmouth Gulf system may not be as good as elsewhere We have a better understanding for corals from long-term data sets. Impacts to species would also depend on their distribution in the Gulf **Consider cumulative impacts here:** • *Marine heatwave projections are increased frequency and longer duration* • *If there are two every ten years, this may be too much for a system to handle*

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
						• *Under high emissions scenarios, there could be a marine heatwave similar in intensity to 2011 occurring almost every year* When thinking of climate change impacts and projections, are we considering ecosystem services provided by macroalgae or specific species? The amount of light reaching the bottom is usually lower in summer. As temperature increases, primary producers need more light to photosynthesise. *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *High confidence that marine heatwaves can negatively impact algae* • *Low confidence of how marine heatwaves have impacted algae in Exmouth Gulf*
Y	Tropical storms and cyclones	2	3	6	H	For Rangelands North, which includes Exmouth Gulf, increased intensity of extreme rainfall events is projected, with high confidence. With medium confidence, fewer but more intense tropical cyclones are projected - *Climate Change in Australia website* Influx of freshwater, sediments, nutrients and direct removal of holdfasts are considerations here. *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *High confidence that storms/cyclones can dislodge algae* • *High confidence that past cyclones have caused the loss of significant macroalgae beds - see Loneragan et al 2013*
Y	Sea level rise	1	3	3	M	For Rangelands North, which includes Exmouth Gulf, mean sea level will continue to rise, and the height of extreme sea-level events will also increase (very high confidence) - Climate Change in Australia website A rise in sea level could permanently inundate macroalgae adapted to intertidal areas, but algae grows quickly and could shift distribution. This may not be realised in the 5-10 year timeframe. Unlikely to have a significant impact *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
						• *High confidence in sea level rise predictions* • *Low confidence in how sea level rise will impact subtidal and intertidal macroalgae in Exmouth Gulf*
Value: Seagrass						
Y	Marine heatwaves	3	4	12	H	Prawn stocks declined after the 2011 heatwave; impacts were seen on seagrass loss. The amount of light reaching the bottom is usually lower in summer. As temperature increases, primary producers need more light to photosynthesise. There were large-scale losses observed for seagrass in Shark Bay following 2011 marine heatwave *Data confidence* • High confidence that marine heatwaves will increase as predicted • *High confidence that marine heatwaves can negatively impact seagrass (e.g. Shark Bay)* • *High confidence in how past marine heatwaves have impacted seagrass in Exmouth Gulf*
Y	Tropical storms and cyclones	3	3	9	H	For Rangelands North, which includes Exmouth Gulf, increased intensity of extreme rainfall events is projected, with high confidence - Climate Change in Australia website Flooding was noted to have contributed to the loss of seagrass in Shark Bay coupled with the marine heatwave. Freshwater influx, nutrient runoff and direct removal of seagrasses are considerations here. Note that projected marine heatwave events can be mitigated by tropical cyclone events, so the two risks are inter-related. Cumulative impacts are not always 'cumulative' *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *High confidence that storms/cyclones can dislodge seagrass* • *High confidence that past cyclones have caused the loss of seagrass beds - see Loneragan et al 2013*

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
Y	Sea level rise	1	3	3		For Rangelands North, which includes Exmouth Gulf, mean sea level will continue to rise, and the height of extreme sea-level events will also increase (very high confidence) - Climate Change in Australia website Could cause a shift in distribution but may not be realised in the 5-10 year timeframe. *Data confidence* • *High confidence in sea level rise predictions* • *Low confidence in how sea level rise will impact seagrasses in Exmouth Gulf*
Value: Coral						
Y	Marine heatwaves	4	3	12	H	Bleaching currently occuring for corals in the Gulf e.g., along the eastern margin. It is well known that increased temperatures cause bleaching and the subsequent death of corals. There are cumulative considerations here if algal growth on deteriorating corals cannot be controlled by herbivores. *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *High confidence that marine heatwaves can negatively impact corals* • *High confidence that warmer waters have caused bleaching of corals in Exmouth Gulf (as recently occurred over the summer months 2020-2021) see Moore et al. 2012 and Depczynski et al. 2013*
Y	Tropical storms and cyclones	2	4	8	H	For Rangelands North, which includes Exmouth Gulf, increased intensity of extreme rainfall events is projected, with high confidence - Climate Change in Australia website Storm/cyclone events can cause direct damage to corals. Freshwater influxes may stress corals at points of freshwater entry. *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *High confidence that storms/cyclones can cause damage to corals* • *High confidence that past cyclones have caused the loss of corals in the Gulf, e.g., lots of coral rubble is still evident at Bundegi - see Loneragan et al 2003 and Day et al 2013*

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
Y	Sea level rise	3	2	6	M	Corals may be at risk if growth cannot keep up with sea level rise, but it is unlikely that the impact of this would be realised in the 5-10 year timeframe. *Data confidence* • *High confidence in sea level rise predictions* • *Medium confidence on how sea level rise can impact seagrasses in general* • *Low confidence in how sea level rise will impact seagrasses in Exmouth Gulf*
Value: Sponges and filter feeders						
Y	Marine heatwaves	2	3	6	L-M	Not as much is known about the impacts to sponges and filter feeders, though we would expect there to be some impact depending on the physiological tolerance limits of species. *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *Low confidence around the impact of marine heatwaves on sponges and filter feeders, and how they will be impacted in Exmouth Gulf*
Y	Tropical storms and cyclones	2	3	6	H	For Rangelands North, which includes Exmouth Gulf, increased intensity of extreme rainfall events is projected, with high confidence - Climate Change in Australia website Storm events could directly dislodge sponges and filter feeders. It is uncertain how freshwater influxes may impact growth. *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *High confidence that storms/cyclones can cause damage to sponges and filter feeders* • *High confidence that past cyclones have caused the loss of sponges in the Gulf, e.g., sponges were found uprooted following Cyclone Vance - see Loneragan et al. 2003*
Y	Sea level rise	1	3	3	L-M	For Rangelands North, which includes Exmouth Gulf, mean sea level will continue to rise, and height of extreme sea-level events will also increase (very high confidence) - Climate Change in Australia website

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
						It could cause a shift in distribution, but this may not be realised in the 5-10 year timeframe. *Data confidence* • *High confidence in sea level rise predictions* • *Low confidence in how sea level rise will impact sponges and filter feeders, and how they will be impacted in Exmouth Gulf*
Value: Sand and mud						
Y	Marine heatwaves	2	3	6	L-M	Infauna communities may be impacted by increased temperatures. **More knowledge needed.** If decaying material is increased due to death of seagrasses, macroalgae etc. following a heatwave, then the increased organic load may have positive and negative consequences. Infauna is relatively fast growing, so it could recover after disturbances. *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *Low confidence around the impact of marine heatwaves on sand and mud habitat and communities, and how they will be impacted in Exmouth Gulf*
Y	Tropical storms and cyclones	1	4	4	M	For Rangelands North, which includes Exmouth Gulf, increased intensity of extreme rainfall events is projected, with high confidence - Climate Change in Australia website Some impact may be felt at the benthic level with mixing of water but could be similar to above. *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *High confidence that storms/cyclones would cause some disturbance to sand and mud habitats and communities* • *Low confidence in the knowledge of sand and mud habitats and communities, and the extent to which they would be impacted in the Gulf*
Y	Sea level rise	1	2	2	L-M	Uncertain whether there would be many/any negative effects

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
						Data confidence • *High confidence in sea level rise predictions* • *Low confidence in how sea level rise will impact sand and mud habitats and communities, and how they will be impacted in Exmouth Gulf*
Value: Mangroves						
Y	Marine heatwaves	2	4	8	M	Air temps and heatwaves - mangroves can be stressed by periods of lower-than-average sea level combined with a lack of rainfall. This has caused some dieback in the Gulf of Carpentaria. Root systems dried out. 1000km coastline impacted with dieback. Given position on landscape, mangroves will experience some inundation of roots with warm waters, but possibly not complete inundation? *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *Low confidence around the impact of marine heatwaves on mangroves* • *High confidence that past warming events in the Gulf have not resulted in significant die off*
Y	Tropical storms and cyclones	3	3	9	H	For Rangelands North, which includes Exmouth Gulf, increased intensity of extreme rainfall events is projected, with high confidence - Climate Change in Australia website Rainfall and dry root systems leads to mangrove death. Erosion will impact growth and stability and movement of sediments can release carbon buried among roots. *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *High confidence that storms/cyclones can cause damage to mangroves* • *High confidence that past cyclones have caused significant loss of mangroves in the Gulf, e.g., see Paling et al. 2008*
Y	Sea level rise	4	2	8	H	Mangroves can migrate shoreward if room is available. If the land is developed however, coastal squeeze could reduce the extent of mangroves.

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
						Tidal regimes require modelling for the localised area and the effect of La Niña needs to be considered as well. In general, the effect of climate change on tides tends to be small, and we would expect roughly the same tidal regime with rising sea levels, but low tides are getting higher, and high tides are getting higher. Incrementally mangroves are becoming more submerged. The extent of landward migration and coastal squeeze is not likely to be realised in a 5-10 timeframe. If consideration was given to 20+ years, then we would expect a higher likelihood of a high or severe consequence. *Data confidence* • *High confidence in sea level rise predictions* • *High confidence in how sea level rise will impact mangroves, and how they will be impacted in Exmouth Gulf - see Reef and Lovelock 2019*
Value: Samphire						
Y	Marine heatwaves	2	2	4	L-M	Tidal regimes may mean samphire is exposed to warmer water temperatures; however, it has already adapted to living in a hot environment. *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *Low confidence around the impact of marine heatwaves on samphire, and how they will be impacted in Exmouth Gulf*
Y	Tropical storms and cyclones	3	3	9	M	Similar concerns as for mangroves *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *High confidence that storms/cyclones can cause damage to samphire* • *Low confidence that past storms/cyclones have caused significant loss of samphire in the Gulf*
Y	Sea level rise	4	2	8	M-H	Same reasons as for mangroves *Data confidence* • *High confidence in sea level rise predictions*

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
						• *High confidence in how sea level rise will impact samphire, and how they will be impacted in Exmouth Gulf, though no specific studies in the area*
Value: Blue green algal mats						
Y	Marine heatwaves	2	2	4	L-M	May have some influence due to periodic inundation, but have already adapted to a hot, harsh environment. *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *Low confidence around the impact of marine heatwaves on blue green algal mats, and the impact specifically within the Gulf*
Y	Tropical storms and cyclones	1	4	4	M	For Rangelands North, which includes Exmouth Gulf, increased intensity of extreme rainfall events is projected, with high confidence - Climate Change in Australia website Winds could cause disturbance to mats and prolonged flooding may cause death or lack of activity if tolerances are low. Grows quickly so it can recover. *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *High confidence that storms/cyclones can cause damage to blue green algal mats* • *Low confidence that past storms/cyclones have caused significant loss of blue green algal mats in the Gulf*
Y	Sea level rise	4	2	8	M-H	Same reasons as for mangroves *Data confidence* • *High confidence in sea level rise predictions* • *High confidence in how sea level rise will impact on blue green algal mats, and how they will be impacted specifically in Exmouth Gulf, though no specific studies in the area*
Value: Reef flats and oyster beds						
Y	Marine heatwaves	1	2	2	M	Unlikely to have much of an impact as oysters are adapted for harsh, hot conditions.

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
						Reef flats (excluding biota growing on flats, which is covered above) would not be impacted. *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *High confidence around the impact of marine heatwaves on blue green algal mats* • *Low confidence on impact of warmer water on oysters*
Y	Tropical storms and cyclones	1	2	2	M-H	Minimal impact. *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *High confidence that storms/cyclones will not cause significant damage to solid reefs flats and oyster beds* • *High confidence that past storms/cyclones have not caused significant loss of reef flats and oyster beds in the Gulf, though no specific studies have examined this*
Y	Sea level rise	3	2	6	M-H	Oyster beds would need to grow in height at a speed that matches sea level rise, but likely not realised in the 5-10 year time frame. *Data confidence* • *High confidence in sea level rise predictions* • *High confidence in how sea level rise will impact on reef flats and oyster beds, and how they will be impacted specifically in Exmouth Gulf, though no specific studies in the area*
Value: Salt flats						
N	Marine heatwaves					
Y	Tropical storms and cyclones	1	4	4	M	Erosion and winds would disturb flats. *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *High confidence that storms/cyclones can cause damage to salt flats*

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
						• *Low confidence that past storms/cyclones have caused significant loss of salt slats in the Gulf*
Y	Sea level rise	1	3	3	M-H	If considering a longer timeframe, then sea level rise would have more of an impact. *Data confidence* • *High confidence in sea level rise predictions* • *High confidence in how sea level rise will impact on salt flats, and how they will be impacted specifically in Exmouth Gulf, though no specific studies in the area*
Factor: Marine fauna						
Value: Crustaceans - prawns						
Y	Marine heatwaves	2	4	8	H	The heatwave had a marked indirect effect on brown tiger prawns in Exmouth Gulf due to loss of seagrass habitat. The heatwave also resulted in a decline in western king prawn recruitment. Recovery of prawns occurred as macroalgae and seagrass recovered, several years after the cyclone. Scored based off a one-in-10 -year event. Prawns recovered from the 2011 within ~ five years, but western king prawns appear to be slowly declining, which may be related to warming temperatures. **Consequence would increase if heatwaves were more frequent** See Fisheries research report for more information on the climate change risks to invertebrates and fishes. - *Management implications of climate change effect on fisheries in Western Australia Part 1: Environmental change and risk assessment* *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *High confidence in the impact of marine heatwaves on prawns* • *High confidence in the impact of marine heatwaves on prawns in Exmouth Gulf*
Y	Tropical storms and cyclones	2	4	8	H	Cyclone Vance in 1999 caused a decline in prawn abundance two years after the cyclone event, due to loss of macroalgae and seagrass habitat. *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones*

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
						• *High confidence that storms/cyclones can negatively impact prawns in Exmouth Gulf see Loneragan et al 2013*
Y	Sea level rise	1	4	4	L-M	Uncertainty around the effects of sea level rise on prawns. *Data confidence* • *High confidence in sea level rise predictions* • *Low confidence in how sea level rise will impact on prawns, and how they will be impacted specifically in Exmouth Gulf*
Value: Crustaceans - mud crabs						
Y	Marine heatwaves	2	4	8	L-M	Similar reasons as above but less certainty around impacts to mud crabs. Ranked as medium risk in Fisheries research report. - *Management implications of climate change effect on fisheries in Western Australia Part 1: Environmental change and risk assessment* *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *Low confidence in the impact of marine heatwaves on mud crabs, and the impact specifically in Exmouth Gulf*
Y	Tropical storms and cyclones	2	4	8	L-M	Similar reasons as above but less certainty around impacts to mud crabs. *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *Low confidence that storms/cyclones can negatively impact mud crabs, and the impact specifically in Exmouth Gulf*
Y	Sea level rise	1	4	4	L-M	Similar reasons as above but less certainty around impacts to mud crabs. *Data confidence* • *High confidence in sea level rise predictions* • *Low confidence in how sea level rise will impact on mud crabs, and how they will be impacted specifically in Exmouth Gulf*
Value: Teleost - whiting						

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
Y	Marine heatwaves	1	3	3	M	Warm temperatures from the 2011 heatwave were noted as providing favourable conditions for spawning by whiting in the West Coast Bioregion. - *Fisheries fact sheet for yellowfin whiting* **More knowledge needed** on the direct and indirect impacts to different fish species. *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *Medium confidence in the impact of marine heatwaves on whiting in general* • *Low confidence of the impact specifically in Exmouth Gulf*
Y	Tropical storms and cyclones	1	3	3	L-M	**More knowledge needed** on the direct and indirect impacts to different fish species. *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *Low confidence that storms/cyclones can negatively impact whiting, and the impact specifically in Exmouth Gulf*
?	Sea level rise	1	3	3	L-M	**More knowledge needed** on the direct and indirect impacts to different fish species *Data confidence* • *High confidence in sea level rise predictions* • *Low confidence in how sea level rise will impact whiting, and how they will be impacted specifically in Exmouth Gulf*
Value: Teleost - mangrove jack						
Y	Marine heatwaves	1	3	3	M-H	Warm waters during La Niña years correlated with higher growth rates of mangrove jack. There may be growth implications during El Niño years. **More knowledge needed** - *Ong et al 2015 - Contrasting environmental drivers of adult and juvenile growth in a marine fish: implications for the effects of climate change.* *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *Medium confidence of the impact specifically in Exmouth Gulf - see Ong et al 2015*

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
Y	Tropical storms and cyclones	1	3	3	M-H	For Rangelands North, which includes Exmouth Gulf, increased intensity of extreme rainfall events is projected, with high confidence - Climate Change in Australia website Some evidence that the growth of juveniles responds positively to increased rainfall. This was not similarly observed for adults - *Ong et al 2015 - Contrasting environmental drivers of adult and juvenile growth in a marine fish: implications for the effects of climate change.* *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *Medium confidence that storms/cyclones may have some positive impacts to mangrove jack juveniles in Exmouth Gulf - see Ong et al 2015*
Y	Sea level rise	1	3	3	L-M	**More knowledge needed** on the direct and indirect impacts to different fish species. *Data confidence* • *High confidence in sea level rise predictions* • *Low confidence in how sea level rise will impact mangrove jack, and how they will be impacted specifically in Exmouth Gulf*
Value: Teleost - trevally						
Y	Marine heatwaves	1	3	3	L-M	**More knowledge needed** on the direct and indirect impacts to different fish species. Wide ranging species. *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *Low confidence in the impact of marine heatwaves on trevally in general, and in Exmouth Gulf*
Y	Tropical storms and cyclones	1	3	3	L-M	**More knowledge needed** on the direct and indirect impacts to different fish species. Wide ranging species *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *Low confidence that storms/cyclones can negatively impact trevally, and the impact specifically in Exmouth Gulf*

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
Y	Sea level rise	1	3	3	L-M	**More knowledge needed** on the direct and indirect impacts to different fish species. Wide ranging species. *Data confidence* • *High confidence in sea level rise predictions* • *Low confidence in how sea level rise will impact trevally, and how they will be impacted specifically in Exmouth Gulf*
Value: Teleost - coral trout						
Y	Marine heatwaves	4	3	12	M	Coral trout are associated with coral habitats, which are threatened by marine heatwaves. Experiments on *Plectropomus leopardus* off the east coast of Australia (Great Barrier Reef) showed that growth and survival of larvae were impacted by increased temperatures. *Pratchett et al 2010 - Effects of climate change on reproduction, larval development, and adult health of coral trout (Plectropomus* spp.*)* *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *High confidence in the impact of marine heatwaves on coral trout in general* • *Low confidence of the impact to coral trout specifically in the Gulf*
Y	Tropical storms and cyclones	2	3	6	M	**More knowledge needed** on the direct and indirect impacts to different fish species. *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *Medium confidence that storms/cyclones can negatively impact coral trout due to impacts to coral - e.g., lots of coral rubble is still evident at Bundegi - see Loneragan et al 2003 and Day et al 2013*
Y	Sea level rise	1	3	3	L-M	**More knowledge needed** on the direct and indirect impacts to different fish species. *Data confidence* • *High confidence in sea level rise predictions* • *Low confidence in how sea level rise will impact coral trout, and how they will be impacted specifically in Exmouth Gulf*

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
Value: Teleost - red emperor						
Y	Marine heatwaves	1	3	3	M	Fisheries report includes red emperors in a low risk group for climate change - Caputi et al 2015. *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *High confidence in the impact of climate change on red emperor in general* • *Low confidence of the impact of marine heatwaves to red emperor specifically in the Gulf*
Y	Tropical storms and cyclones	1	3	3	M	Fisheries report includes red emperors in a low risk group for climate change - Caputi et al 2015. *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *High confidence in the impact of climate change on red emperor in general* • *Low confidence of the impact of extreme rainfall events and cyclones to red emperor specifically in the Gulf*
Y	Sea level rise	1	3	3	M	Fisheries report includes red emperors in a low risk group for climate change - Caputi et al 2015. *Data confidence* • *High confidence in sea level rise predictions* • *High confidence in the impact of climate change on red emperor in general* • *Low confidence in how sea level rise will impact red emperor specifically in Exmouth Gulf*
Value: Teleost - tuskfish						
Y	Marine heatwaves	2	3	6	L-M	**More knowledge needed** on the direct and indirect impacts to different fish species. *Data confidence* • *High confidence that marine heatwaves will increase as predicted*

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
						• *Low confidence in the impact of marine heatwaves on tuskfish in general, and specifically in the Gulf*
Y	Tropical storms and cyclones	2	3	6	L-M	**More knowledge needed** on the direct and indirect impacts to different fish species. *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *Low confidence in the impact of extreme rainfall events and cyclones on tuskfish in general, and specifically in the Gulf*
Y	Sea level rise	1	3	3	L-M	**More knowledge needed** on the direct and indirect impacts to different fish species. *Data confidence* • *High confidence in sea level rise predictions* • *Low confidence in the impact of sea level rise on tuskfish in general, and specifically in the Gulf*
Value: Elasmobranchs - rays (shovelnose)						
Y	Marine heatwaves	2	3	6	L-M	Could impact on food sources for shovelnose rays, and increased temperatures could cause temporary shifts in distribution of both prey and rays. *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *Low confidence in the impact of marine heatwaves on shovelnose rays in general, and specifically in the Gulf*
Y	Tropical storms and cyclones	1	3	3	L-M	Uncertainty around impact - **more knowledge needed.** *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *Low confidence in the impact of extreme rainfall events and cyclones* • *on shovelnose rays in general, and specifically in the Gulf*
Y	Sea level rise	1	2	2	L-M	Uncertainty around impact - **more knowledge needed.**

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
						Data confidence • *High confidence in sea level rise predictions* • *Low confidence in the impact of sea level rise on shovelnose rays in general, and specifically in the Gulf*
Value: Elasmobranchs - rays (manta) ***EPBC Act - Migratory, Marine listed***						
Y	Marine heatwaves	2	4	8	L-M	Could impact on food sources for manta rays, and increased temperatures could cause temporary shifts in distribution of both prey and mantas. *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *Low confidence in the impact of marine heatwaves on manta rays in general, and specifically in the Gulf*
Y	Tropical storms and cyclones	1	3	3	L-M	Uncertainty around impact - **more knowledge needed.** *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *Low confidence in the impact of extreme rainfall events and cyclones on manta rays in general, and specifically in the Gulf*
Y	Sea level rise	1	2	2	L-M	Uncertainty around impact - **more knowledge needed.** *Data confidence* • *High confidence in sea level rise predictions* • *Low confidence in the impact of sea level rise on manta rays in general, and specifically in the Gulf*
Value: Elasmobranchs - sawfish						
Y	Marine heatwaves	3	3	9	M	Sawfishes (Great Barrier Reef) were found to be highly vulnerable to climate change - *A Vulnerability Assessment for the Great Barrier Reef* Uncertainty around climate change impacts to WA populations. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
						• *High confidence that marine heatwaves will increase as predicted* • *High confidence that climate change impacts sawfishes* • *Low confidence in the impact of marine heatwaves on sawfishes in the Gulf*
Y	Tropical storms and cyclones	2	3	6	M	As above *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *High confidence that climate change impacts sawfishes* • *Low confidence in the impact of extreme rainfall events and cyclones on sawfishes in the Gulf*
Y	Sea level rise	1	2	2	M	Uncertainty around impact - **more knowledge needed.** Likely will not impact within 5-10 years. *Data confidence* • *High confidence in sea level rise predictions* • *High confidence that climate change impacts sawfishes* • *Low confidence in the impact of sea level rise on sawfishes in the Gulf*
Value: Elasmobranchs - sharks						
Y	Marine heatwaves	2	3	6	M	Wide ranging. Could impact prey (plankton) of whale sharks (EPBC Act - Vulnerable, Migratory). Some work at the Great Barrier Reef show epaulette sharks are being born smaller, exhausted and undernourished. Warmer temperatures may impact on migration, food availability, brain development etc. If heatwaves become a more common occurrence, then impacts may be more obvious. Scored based on likelihood within 5-10 years. **More knowledge needed** *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *High confidence that marine heatwaves can impact sharks* • *Low confidence in the impact of marine heatwaves on sharks in the Gulf*

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
Y	Tropical storms and cyclones	1	3	3	L-M	Uncertainty around impact - **more knowledge needed.** Sharks can swim deeper to avoid surface impacts of storms. *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *Low confidence that extreme rainfall events and cyclones impact sharks, and specifically impacts them in the Gulf*
Y	Sea level rise	1	2	2	L-M	Uncertainty around impact - **more knowledge needed.** Likely will not impact sharks within 5-10 years. *Data confidence* • *High confidence in sea level rise predictions* • *Low confidence that sea level rise impacts sharks, and specifically impacts them in the Gulf*
Value: Marine reptiles - sea snakes						
Y	Marine heatwaves	2	3	6	L-M	Several species are EPBC conservation listed, including Critically Endangered. Research underway but not a lot known regarding climate change. *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *Low confidence in how marine heatwaves can impact sea snakes, and what impacts those will be specifically in the Gulf*
Y	Tropical storms and cyclones	2	3	6	L-M	Research underway but not a lot known regarding climate change. *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *Low confidence that extreme rainfall events and cyclones can impact sea snakes, and specifically impact them in the Gulf*
Y	Sea level rise	1	2	2	L-M	Likely will not impact sharks within 5-10 years. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
						• *High confidence in sea level rise predictions* • *Low confidence in whether sea level rise impacts sea snakes, and specifically impacts them in the Gulf*
Value: Marine reptiles - turtles *(EPBC Act - all species are Vulnerable or Endangered)*						
Y	Marine heatwaves	2	3	6	L-M	Likely impacted through changes in prey. *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *Low confidence in how marine heatwaves will impact marine turtles, and what impacts those will be specifically in the Gulf*
Y	Tropical storms and cyclones	3	3	9	M	Winds, floods could erode suitable nesting beaches. *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *High confidence that extreme rainfall events and cyclones can impact marine turtle nesting beaches* • *Low confidence how marine turtles and beaches will be specifically impacted in the Gulf*
Y	Sea level rise	3	2	6	M	Will cause erosion of nesting beaches. Probably not too much in the 5-10 year timeframe *Data confidence* • *High confidence in sea level rise predictions* • *High confidence that sea level rise can impact marine turtle nesting beaches* • *Low confidence in how sea level rise will impact marine turtles in the Gulf*
Y	Air temperatures	4	2	8	H	Temperature of the nests influence what sex hatchlings will be. Warming temperatures may cause an unbalanced proportion of males and females and have severe reproductive repercussions. Temperature of nests will depend on the depth eggs are buried at. May not be realised in 5-10 year timeframe. *Data confidence* • *High confidence in air temperature predictions*

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
						• *High confidence that rising air temperatures can impact marine turtles due to temperature dependant sex determination, and how turtles will be impacted in the Gulf - see Bentley et al 2020, Stubbs and Mitchell 2018, Stubbs et al 2019*
Value: Marine mammals - whales (humpback) ***(EPBC Act - Vulnerable, Migratory, Cetacean listed species)***						
Y	Marine heatwaves	2	3	6	L-M	If occurs during the time whales are in the Gulf (Aug-Oct), then may affect whether they would use Gulf as normally would. Any impacts to mothers and calves could impact population growth that year. May be too hot for mothers and calves to stay for too long. *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *Low confidence in how marine heatwaves will impact humpback whales, and what impacts those will be specifically in the Gulf*
Y	Tropical storms and cyclones	2	3	6	L-M	Any disturbance on mothers and calves could have reproductive impacts *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *Low confidence in whether extreme rainfall events and cyclones can impact humpback whales, specifically in the Gulf*
Y	Sea level rise					Linked to melting of sea ice. This will impact Antarctic krill, the food source for humpback whales in Antarctica. Not assessed here.
Value: Marine mammals - dolphins (coastal)						
Y	Marine heatwaves	2	3	6	M	Coastal dolphins are EPBC Act listed as Cetacean and/or Migratory species. Changes in prey could have impacts, and reproductive outputs could be impacted by warm temperatures. Dolphins were impacted due to the loss of seagrass in Shark Bay following the 2011 marine heatwave. *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *High confidence that marine heatwaves can impact dolphins due to impacts to prey*

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
						• *Low confidence in how marine heatwaves will impact dolphins specifically in the Gulf*
Y	Tropical storms and cyclones	2	3	6	L-M	Could disturb resident populations, particularly if prey and prey habitat are disturbed or damaged. It is Unknown whether dolphins move away or die during a cyclone. Cyclones can alter the distribution of the population. *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *Low confidence in how extreme rainfall events and cyclones can impact dolphins and to what extent, specifically in the Gulf*
Y	Sea level rise					
Value: Marine mammals - dugongs *(EPBC Act - Migratory, Marine listed species)*						
Y	Marine heatwaves	2	4	8	M-H	Seagrass loss will directly impact dugong feeding. *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *High confidence that marine heatwaves can impact the food source of dugongs* • *Medium confidence in how past losses of seagrass have resulted in dugongs moving out of the Gulf - see Gales et al 2004. Losses were associated with a tropical cyclone, but losses could also occur due to a marine heatwave*
Y	Tropical storms and cyclones	2	3	6	L-M	Could disturb resident populations. It is unknown whether dugongs move away or die during a cyclone. Cyclones can alter the abundance of populations, particularly if seagrass habitat is lost. Dugongs may move out of an area until the seagrass has recovered, which has been recorded for the Gulf. *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *Low confidence in how extreme rainfall events and cyclones can impact dugongs and to what extent, specifically in the Gulf*
Y	Sea level rise					

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
Value: Seabirds and shorebirds						
Y	Marine heatwaves	2	3	6	M	Some species are EPBC Act listed species, including Critically Endangered. Could impact reproduction and growth of birds through changes to prey density and distribution. *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *High confidence that marine heatwaves can impact the food source of seabirds and shorebirds* • *Low confidence in how past marine heatwaves have impacted seabirds and shorebirds in the Gulf*
Y	Tropical storms and cyclones	2	4	8	M	Can inundate shorelines and islands where birds are nesting. Could cause direct destruction of nests and populations themselves Scores would be different for migratory vs resident bird populations. Shearwaters nest on islands, among other species. *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *High confidence that extreme rainfall events and cyclones can erode nesting beaches* • *Low confidence in how nesting beaches have been impacted in the Gulf*
Y	Sea level rise	4	2	8	M	Can inundate shorelines and islands where birds are nesting. May not occur within 5-10 year timeframe. Shearwaters nest on islands, among other species. Birdlife Australia 2020 - 'Exmouth Gulf is one of the largest embayments on Australia's west coast, providing over 200 kilometres of coast with wide intertidal flats and supratidal salt flats, mangroves and islands; it has only recently been recognised as important for shorebirds'. *Data confidence* • *High confidence in sea level rise predictions*

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
						• *High confidence that sea level rise can impact seabird and shorebird nesting beaches* • *Low confidence in how seabirds and shorebirds may be impacted in the Gulf*
Factor: Marine environmental quality						
Value: Water quality						
Y	Marine heatwaves	2	3	6	M	Water quality has been influenced by ENSO events. An examination of 25 years of satellite imagery from the Moderate Resolution Imaging Spectroradiometer (MODIS) on board NASA's Terra satellite shows that during La Niña there has been a reduction of water quality due to increased sediment in the water column. So, if increased sediments coincides with warmer waters, then the system will get a double hit (Paula Cartwright). *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *High confidence that increased temperatures can impact water quality* • *Low confidence in how past marine heatwaves have impacted water quality in the Gulf*
Y	Tropical storms and cyclones	2	3	6	M	For Rangelands North, which includes Exmouth Gulf, increased intensity of extreme rainfall events is projected, with high confidence - Climate Change in Australia website Influxes of freshwater, sediments and nutrients will lessen water quality. *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *High confidence that extreme rainfall events and cyclones can impact water quality* • *Low confidence in the extent to which water quality is impacted in the Gulf*
Y	Sea level rise	1	3	3	M	Erosion would result in more sediments in the water. *Data confidence* • *High confidence in sea level rise predictions* • *High confidence that sea level rise can impact water quality*

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
						• *Low confidence in how water quality will be impacted in the Gulf*
Value: Sediment quality						
Y	Marine heatwaves	1	3	3	M	Could impact on organic matter in sediments. *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *High confidence that increased temperatures can impact sediment quality* • *Low confidence in how past marine heatwaves have impacted sediment quality in the Gulf*
Y	Tropical storms and cyclones	1	3	3	M	Sediments would get stirred up and resuspended - not sure if it would impact sediment quality. May impact water quality if resuspends contaminants. *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *High confidence that extreme rainfall events and cyclones can impact sediment quality* • *Low confidence in the extent to which sediment quality is impacted in the Gulf*
Y	Sea level rise	1	3	3	M	Erosion would result in more sediments in water. *Data confidence* • *High confidence in sea level rise predictions* • *High confidence that sea level rise can impact sediment quality* • *Low confidence in how sediment quality will be impacted in the Gulf*
Factor: Coastal processes						
Value: Geophysical processes						
N	Marine heatwaves					
Y	Tropical storms and cyclones	2	3	6	H	May cause significant shifts in coastal sediments and cause erosion and accretion at certain locations. Resilience of coral reef islands, such as the Exmouth Gulf islands, relies on the balance between the import and export of sediment

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
						Data confidence • *High confidence for increased intensity of extreme rainfall events and cyclones* • *High confidence that extreme rainfall events and cyclones can cause erosion* • *High confidence in the extent to which geophysical processes will be impacted in the Gulf e.g., see Eliot et al 2011, Perry et al 2011, Brill et al 2016, Callow et al 2018, May et al 2018*
Y	Sea level rise	2	3	6	H	Will impact on coastline formations e.g., erosion. Resilience of coral reef islands, such as the Exmouth Gulf islands, relies on the balance between the import and export of sediment *Data confidence* • *High confidence in sea level rise predictions* • *High confidence that sea level rise can impact coastline formations* • *High confidence in how geophysical processes will be impacted in the Gulf e.g., see Cuttler et al 2020, Bonesso et al 2020*
Value: Hydrodynamic processes						
N	Marine heatwaves					
Y	Tropical storms and cyclones	1	3	3	M	Would have short-term localised impacts. Not sustained. Tropical cyclones can impact salinity. *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *High confidence that extreme rainfall events and cyclones can impact hydrodynamic processes* • *Low confidence in the extent to which hydrodynamic processes will be impacted in the Gulf*
Y	Sea level rise	2	2	4	L-M	Would likely have changes to hydrodynamics but probably not realised in 5-10 years. *Data confidence* • *High confidence in sea level rise predictions*

Score?	Drivers / Pressures	Cons	Like	Risk	Data conf HML	Justification
Climate change						
						• *Low confidence in how much sea level rise will impact hydrodynamic processes, particularly in the Gulf*
Value: Nutrient flow						
Y	Marine heatwaves	1	3	3	L-M	May impact on organic matter in water column, but perhaps not nutrient flow from land into water as much? *Data confidence* • *High confidence that marine heatwaves will increase as predicted* • *Low confidence in how marine heatwaves will impact nutrient flow, particularly in the Gulf*
Y	Tropical storms and cyclones	1	4	4	H	Flooding and run off would increase nutrient input into waters. This could have positive or negative flow on effects. *Data confidence* • *High confidence for increased intensity of extreme rainfall events and cyclones* • *High confidence that extreme rainfall events and cyclones impact nutrient flow* • *High confidence that extreme rainfall events and cyclones will impact nutrient flow in the Gulf e.g., see Lovelock et al 2011*
Y	Sea level rise	2	3	6	H	Higher sea level would likely increase flow of nutrients into the water but possibly not realised within 5-10 years. *Data confidence* • *High confidence in sea level rise predictions* • *High confidence that sea level rise will impact nutrient flow, including in the Gulf, though not specific studies have been done*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Fishing						
Factor: Benthic habitats and communities						
Value: Macroalgae and turf algae						
Y	Commercial - physical trawling	1z	2	2	H	It is uncommon for macroalgae to be captured in the trawl nets. Communities are usually attached to some type of solid substrate e.g., limestone. Trawling avoids these areas and typically is over sand / mud bottom. Macroalgae recovers quickly (unlike sponge and coral). Marine Stewardship Council (MSC) - prawns DPIRD (2020): Between 2012 and 2016, very small overlap of fishing on mixed habitat assemblages. *Data confidence* • *High confidence that trawling predominantly occurs over sandy habitat*
N	Commercial - catch					NA
N	Recreational - catch					NA
Value: Seagrass						
Y	Commercial - physical trawling	1	1	1	H	Seagrass is sparse and tends to occur in shallow areas, not in deeper trawl grounds. Areas of more abundant seagrass are protected in closed prawn nursery area. DPIRD (2020) - MSC prawns: Between 2012 and 2016, less than 5% of fishing occurred on seagrass habitat. There is a suggestion there may be a high abundance of seagrass in depths <6m on high tide, where trawling occurs at depths >7m (confirmation subject to review of recent research). *Data confidence* • *High confidence that trawling predominantly occurs over sandy habitat*
N	Commercial - catch					NA
N	Recreational - catch					NA
Value: Coral						

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Fishing						
Y	Commercial - physical trawling	1	2	2	H	There are no obvious large coral communities abundant in the trawl grounds. Trawlers avoid these areas to avoid damage to nets. There is anecdotal evidence that 'duffing', or the removal of large objects using boats and chains, may have occurred prior to prawn trawling (Shaw 2000). DPIRD (2020) - MSC prawns: Between 2012 and 2016, only about 0.1% of fishing occurred on coral reefs. Evidence shows that the trawler fleet avoids coral to prevent damage to trawl gear. *Data confidence* • *High confidence that trawling predominantly occurs over sandy habitat*
N	Commercial - catch					NA
N	Recreational - catch					NA
Value: Sponges and filter feeders						
Y	Commercial - physical trawling	2	4	8	H	See above, likely that habitat previously modified, recovery of sponges slower and less net damage. Kangas et al. (2007) pg95: 'It is likely that the faunal assemblages, biodiversity and habitats in the trawled areas of Shark Bay, Exmouth Gulf and Onslow have changed significantly since trawling began but have now reached a new 'balance' compatible with trawling. Comparisons of biodiversity and abundance measures are difficult to make since there are no equivalent soft sediment untrawled regions similar to Shark Bay or Exmouth Gulf in Western Australia.' DPIRD (2020) - MSC prawns: Between 2012 and 2016, about 5-8% of fishing occurred on mapped filter feeder communities within the managed fishery area of Exmouth Gulf. The extent of damage to filter feeding communities depends on the frequency of trawling. Rationale for scoring likelihood could not be agreed by the participants between unlikely and possible, and the likelihood of 'possible' was recorded, subject to further review of existing data. *Data confidence* • *High confidence that trawling predominantly occurs over sandy habitat, but can overlap with filter feeding communities*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Fishing						
N	Commercial - catch					NA
N	Recreational - catch					NA
Value: Sand and mud						
Y	Commercial - physical trawling	1	4	4	H	DPIRD (2020) - MSC prawns: Between 2012 and 2016, the majority (~72%) of fishing occurred on mapped sand habitats. Recognition of World Heritage Area boundary should be included in habitat mapping. *Data confidence* • *High confidence that trawling predominantly occurs over sandy habitat*
N	Commercial - catch					NA
N	Recreational - catch					NA
Value: Mangroves						
N	Commercial - physical trawling					NA
N	Commercial - catch					NA
N	Recreational - catch					NA
Value: Samphire						
N	Commercial - physical trawling					
N	Commercial - catch					
N	Recreational - catch					
Value: Blue green algal mats						
N	Commercial - physical trawling					
N	Commercial - catch					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Fishing						
N	Recreational - catch					
Value: Reef flats and oyster beds						
Y	Commercial - physical trawling					NA Intertidal - no trawling occurs
N	Commercial - catch					NA
N	Recreational - catch					NA
Value: Salt flats						
Y	Commercial - physical trawling					NA Intertidal - no trawling occurs
N	Commercial - catch					NA
N	Recreational - catch					NA
Factor: Marine fauna						
Value: Crustaceans - prawns						
Y	Commercial - physical trawling	1	4	4	H	Of low concern. Large nursery areas are protected and closed. Trawl method uses a tickle chain (1cm diameter), designed to skim over sand and not dig into the sea floor. DPIRD (2020) - MSC prawns pg. 10 *Data confidence* • *High confidence - regular reporting by Fisheries - DPIRD*
Y	Commercial - catch	2	4	8	H	Indicator species: brown tiger, western king and blue endeavour prawns are fished within their catch range with breeding stocks above target levels. Gaughan and Santoro (2020). MSC Certification 2015., EPBC Accreditation 2015-2025. DPIRD (2020) - MSC prawns. *Data confidence* • *High confidence - regular reporting by Fisheries - DPIRD*
N	Recreational - catch					NA
Value: Crustaceans - mud crabs						

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Fishing						
N	Commercial - physical trawling					NA in shallower intertidal waters and mangrove habitat
N	Commercial - catch					NA- Worth noting DPIRD (2020) - MSC prawns: blue swimmer crabs *Portunus armatus* represent 0.5% of the total catch. Extensive refuge in the permanently closed nursery areas. Minimum legal size (127mm carapace length) is larger than size at maturity. DoF scored Minor Possible Risk = Low
Y	Recreational - catch	2	3	6	L	Recreational fishing likely to have increased in eastern part of gulf, of which mud crabs are the likely target. *Data confidence* • *Low confidence in catch of mud crabs by recreational fishers in Exmouth Gulf*
Value: Teleost - whiting						
Y	Commercial - physical trawling	1	1	1	H	Likely to move out of the way. May also escape through bycatch reduction devices (BRDs). *Data confidence* • *High confidence that physical trawling has minimal impact on whiting due to regular reporting by Fisheries DPIRD*
Y	Commercial - catch	1	2	2	H	DPIRD (2020) - MSC prawns. If caught in a trawl net, whiting is retained. Fishery independent survey shots recorded a Sillago spp. catch as 3.1% of total catch. Used to be commercial fisher beach seining along western edge of gulf. No longer operating. When considering bycatch from trawling, survival rates from being returned alive are a consideration. *Data confidence* • *High confidence in catch of whiting - regular reporting by Fisheries DPIRD see - Kangas and Thompson (2004)*
Y	Recreational - catch	2	3	6	L	Target whiting - don't know catch. Recreational fishing likely to have increased in Exmouth Gulf, and whiting are a likely target. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Fishing						
						• *Low confidence in catch of whiting by recreational fishers in Exmouth Gulf*
Value: Teleost - mangrove jack						
Y	Commercial - physical trawling	1	2	2	M	Habitat likely in nearshore waters. Potential impacts to juveniles? Unlikely to be major trawling impacts unless sponge gardens trawled. Same for trevally, coral trout and red emperor. Likely risk is about right - rarely captured in low numbers. *Data confidence* • *Medium confidence in the extent physical trawling impacts the habitat of mangrove jack given most trawling occurs over sandy habitats*
Y	Commercial - catch	1	2	2	H	The majority of bycatch species are not targeted by other fisheries in the region - DPIRD (2020) - MSC prawns *Data confidence* • *High confidence in catch of mangrove jack - regular reporting by Fisheries DPIRD see - Kangas and Thompson (2004)*
Y	Recreational - catch	2	3	6	L	Targeted species, increasing number of recreational fishers and fishing effort. *Data confidence* • *Low confidence in catch of mangrove jack by recreational fishers in Exmouth Gulf*
Value: Teleost - trevally						
Y	Commercial - physical trawling	1	2	2	M	Unlikely to be major trawling impacts unless sponge gardens trawled. *Data confidence* • *Medium confidence in the extent physical trawling impacts the habitat of trevally given most trawling occurs over sandy habitats*
Y	Commercial - catch	1	2	2	H	Trevally make up 0.9% of total trawl catch. The majority of bycatch species are not targeted by other fisheries in the region - DPIRD (2020) - MSC prawns. *Data confidence* • *High confidence in catch of trevally - regular reporting by Fisheries DPIRD see - Kangas and Thompson (2004), DPIRD (2020)*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Fishing						
Y	Recreational - catch	1/2	3	6	L	Targeted species, increasing number of recreational fishers and fishing effort *Data confidence* • *Low confidence in catch of trevally by recreational fishers in Exmouth Gulf*
Value: Teleost - coral trout						
Y	Commercial - physical trawling	1	2	2	M	Unlikely to be major trawling impacts unless sponge gardens trawled. *Data confidence* • *Medium confidence in the extent physical trawling impacts the habitat of coral trout given most trawling occurs over sandy habitats*
Y	Commercial - catch	1	2	2	H	Not caught in trawl nets, not targeted commercially. *Data confidence* • *High confidence in catch of coral trout - regular reporting by Fisheries DPIRD see - Kangas and Thompson 2004, DPIRD (2020) - MSC prawns*
Y	Recreational - catch	3	4	12	L	Targeted species, increasing number of recreational fishers and fishing effort. Small home range. Easy to spear and catch. *Data confidence* • *Low confidence in catch of coral trout by recreational fishers in Exmouth Gulf*
Value: Teleost - red emperor						
Y	Commercial - physical trawling	2	2	4	M	Unlikely to be major trawling impacts unless sponge gardens trawled. Possible impacts on juvenile red emperor which are less mobile than adults and which do recruit into the Gulf. *Data confidence* • *Medium confidence in the extent physical trawling impacts the habitat of red emperor given most trawling occurs over sandy habitats*
Y	Commercial - catch	1	2	2	H	Red emperor make up 0.4% of total trawl catch. The majority of bycatch species are not targeted by other fisheries in the region, with the exception of minor catches of demersal finfish such as emperors - DPIRD (2020) - MSC prawns. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Fishing						
						• *High confidence in catch of coral trout - regular reporting by Fisheries DPIRD see - Kangas and Thompson (2004), DPIRD (2020) - MSC prawns*
Y	Recreational - catch	3	4	12	L	Targeted species, increasing number of recreational fishers and fishing effort. *Data confidence* • *Low confidence in catch of red emperor by recreational fishers in Exmouth Gulf*
Value: Teleost - tuskfish						
Y	Commercial - physical trawling	1	2	2	M	Major impacts unlikely for most species. *Data confidence* • *Medium confidence in the extent physical trawling impacts the habitat of tuskfish given most trawling occurs over sandy habitats*
Y	Commercial - catch	1	2	2	H	DPIRD (2020) - MSC prawns - red emperor make up 0.4% of total trawl catch. The majority of bycatch species are not targeted by other fisheries in the region, with the exception of minor catches of demersal finfish such as emperors. *Data confidence* • *High confidence in catch of tuskfish - regular reporting by Fisheries DPIRD see - Kangas and Thompson (2004), DPIRD (2020) - MSC prawns*
Y	Recreational - catch	3	4	12	L	Targeted species, increasing number of recreational fishers and fishing effort. Blackspot Tuskfish (*Choerodon schoenleinii*) is one of three most commonly caught fish at Nanga, Shark Bay. Tuskfish are significant contributors to sand production in the Gulf. *Data confidence* • *Low confidence in catch of red emperor by recreational fishers in Exmouth Gulf*
Value: Elasmobranchs - rays (shovel nose rays)						
N	Commercial - physical trawling					NA
Y	Commercial - catch	2	3	6	M	A significant portion of nearshore waters are closed to trawling. There is compliance with national recovery plan. Reduction in stock (very low numbers of small animals captured

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Fishing						
						and released). Captured in very low numbers. Given the short duration of the trawl, post-release survival is likely to be moderate to high. *Data confidence* • *Medium confidence in catch of shovelnose rays - regular reporting by Fisheries DPIRD, though post release survival in more uncertain*
N	Recreational - catch					NA
Value: Elasmobranchs - rays (manta) ***EPBC Act - Migratory, Marine listed***						
Y	Commercial - physical trawling	1	1	1	H	Mainly north of the Gulf. More surface water feeders *Data confidence* • *High confidence that physical trawling does not significantly impact manta rays*
Y	Commercial - catch	1	1	1	H	Bycatch reduction devices in place, which free any catches of large fish. *Data confidence* • *High confidence that bycatch does not significantly impact manta rays - regular reporting by Fisheries DPIRD*
N	Recreational - catch					NA
Value: Elasmobranchs - sawfish						
N	Commercial - physical trawling					NA
Y	Commercial - catch	2	3	6	M	Statutory reporting of all endangered, threatened and protected species (ETP) species. A significant portion of nearshore waters are closed to trawling. Compliance with national recovery plan. Reduction in stock (very low numbers of small animals captured and released). Captured in very low numbers. Post-release survival is likely to be low - DPIRD (2020) - MSC prawns. *Data confidence* • *Medium confidence that bycatch does not significantly impact sawfish - regular reporting by Fisheries DPIRD, though post release survival in more uncertain*
N	Recreational - catch					NA

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Fishing						
Value: Elasmobranchs - sharks						
N	Commercial - physical trawling					NA
Y	Commercial - catch	1	1	1	M	DPIRD (2020) - MSC prawns. Very low numbers of small animals captured and released. Significant portion of nearshore waters are closed to trawling. Bycatch reduction devices on trawl gear. *Data confidence* • *Medium confidence that bycatch does not significantly impact sharks - regular reporting by Fisheries DPIRD, though post release survival in more uncertain*
Y	Recreational - catch	2	3	6	L-M	Shark depredation - may be more incidental as well as targeted recreational catch. *Data confidence* • *Medium confidence in rates of depredation* • *Low confidence on catch of sharks in Exmouth Gulf*
Value: Marine reptiles - sea snakes						
Y	Commercial - physical trawling	2	3	6	L	Several species are EPBC conservation listed, including Critically Endangered. Possible that physical trawling may disturb habitat or sea snakes. Small home ranges to consider *Data confidence* • *Low confidence in the impact of trawling on sea snakes and their habitat*
Y	Commercial - catch	2	4	8	H	DPIRD (2020) - MSC prawns - Regularly captured in prawn trawl gear but majority are returned alive. Listed conservation status of short-nose sea snake is a source of public concern and is under review to relax status based on abundance and distribution. Trawl fishery observes about 25% of this species being caught in trawl gear and released. Further research in progress to determine current conservation status. Increasing public interest may occur based on public perception. Review risk if capture trends change significantly or if a public campaign eventuates to generate interest in perceived risk. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Fishing						
						• *High confidence that bycatch significantly impacts sea snakes - regular reporting by Fisheries DPIRD*
Y	Recreational - catch	1	4	4	L	It is common for sea snakes to be caught incidentally by recreational fishers. *Data confidence* • *Low confidence in catch of sea snakes by recreational fishers in Exmouth Gulf*
Value: Marine reptiles - turtles *(EPBC Act - all species are Vulnerable or Endangered)*						
Y	Commercial - physical trawling	1	2	2	M	Bycatch reduction devices in all nets. Long trawl time in this fishery likely to exceed breath hold times for most turtles. *Data confidence* • *Medium confidence in the impact of trawling on marine turtles*
Y	Commercial - catch	1	2	2	M	DPIRD (2020) - MSC prawns - Low numbers mostly captured in prawn try gear, but almost all returned alive. Capture in trawl gear and returned to sea. Bycatch reduction devices in all nets. *Data confidence* • *Medium confidence in the bycatch impact on turtles - regular reporting by Fisheries DPIRD, though post release survival in more uncertain*
N	Recreational - catch					
Value: Marine mammals - whales (humpback) *(EPBC Act - Vulnerable, Migratory, Cetacean listed species)*						
Y	Commercial - physical trawling	1	1	1	H	DPIRD (2020) - MSC prawns. Potential vessel strike with cetaceans resulting in injury /fatality. Unlikely given low speed of trawl vessels and engine when underway. *Data confidence* • *High confidence in the impact of trawling on whales*
N	Commercial - catch					Fishing gear entanglement included under Tourism/Visitation
N	Recreational - catch					
Value: Marine mammals - dolphins (coastal)						

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Fishing						
Y	Commercial - physical trawling	1	1	1	H	Coastal dolphins are EPBC Act listed as Cetacean and/or Migratory species. DPIRD (2020) - MSC prawns - Vessel strikes unlikely because of low speed of trawl vessels and engine noise when underway. *Data confidence* • *High confidence in the impact of trawling on dolphins*
Y	Commercial - catch	1	1	1	H	DPIRD (2020) - MSC prawns - Potential injury or mortality from vessel strike unlikely because of low speed of trawl vessels and engine noise when underway. Prawn nets are small and low profile (quad nets) and close to the bottom compared to other nets and midwater trawls. *Data confidence* • *High confidence in the impact of trawling on dolphins - regular reporting by Fisheries DPIRD*
Y	Recreational - catch	1	1	1	L	Most dolphins could avoid recreational boat traffic. Entanglement in fishing gear considered under Tourism/Visitation. *Data confidence* • *Low confidence in the impact of recreational fishing on dolphins*
3Value: Marine mammals - dugongs *(EPBC Act - Migratory, Marine listed species)*						
Y	Commercial - physical trawling	1	1	1	H	DPIRD (2020) - MSC prawns - Potential injury or mortality from boat strike unlikely. Low speed of trawl vessels and noise when underway. Kathryn McMahon: Dugongs mainly in the eastern Gulf where there is a trawling exclusion zone. *Data confidence* • *High confidence in the impact of trawling on dugongs*
Y	Commercial - catch	1	1	1	H	DPIRD (2020) - MSC prawns - vessel strikes with dugongs and cetaceans. Potential injury or mortality. Low speed of trawl vessels and engine noise when underway. Prawn nets are small and low profile (quad nets) and close to the bottom compared to other nets and midwater trawls. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Fishing						
						• *High confidence in the impact of trawling on dugongs - regular reporting by Fisheries DPIRD*
Y	Recreational - catch	1	1	1	L	Dugongs likely to move out of the way. Disturbance likely to be an issue. Will move and graze elsewhere. *Data confidence* • *Low confidence in the impact of recreational fishing on dolphins*
Value: Seabirds and shorebirds						
N	Commercial - physical trawling					NA
	Commercial - catch	1	2	2	H	Some species are EPBC Act listed species, including Critically Endangered. State of Fisheries reports do not list seabirds as a bycatch species. Not as common for Exmouth Gulf as for other locations e.g., south coast. Low potential for diving birds to be caught up in trawl netting. Birds are attracted to fishing vessels for a source of food. Interactions with seabirds can happen when boats are trawling, and the bird comes into contact with the wires used to drag the net along. - AFMA website. *Data confidence* • *High confidence in the impact of trawling on dugongs - regular reporting by Fisheries DPIRD*
N	Recreational - catch					NA
Factor: Marine environmental quality						
Value: Water quality						
Y	Commercial - physical trawling	1	4	4	M	DPIRD (2020) - MSC prawns - Turbidity. Deployment of benthic trawl gear from six vessels. Disturbance of sediments likely from trawling. Short-lived phenomenon. Tides and currents disperse turbidity rapidly. Strong currents and tides in Exmouth Gulf dominate potential sources of turbidity. The contribution from trawling would unlikely be measurable. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Fishing						
						• *Medium confidence in the impact of trawling on water quality - gear would stir up sediments, but no specific studies done in the Gulf*
N	Commercial - catch					
N	Recreational - catch					
Value: Sediment quality						
Y	Commercial - physical trawling	1	1	1	M	Contamination associated with chains is negligible. Any oil & fuel waste likely to be surface pollution *Data confidence* • *Medium confidence in the impact of trawling on sediment quality - gear would stir up sediments, but no specific studies done in the Gulf*
N	Commercial - catch					
N	Recreational - catch					
Factor: Coastal processes						
Value: Geophysical processes						
N	Commercial - physical trawling					
N	Commercial - catch					
N	Recreational - catch					
Value: Hydrodynamic processes						
N	Commercial - physical trawling					
N	Commercial - catch					
N	Recreational - catch					
Value: Nutrient flow						

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Fishing						
N	Commercial - physical trawling					NA
N	Commercial - catch					NA
N	Recreational - catch					NA

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
Factor: Benthic habitats and communities						
Value: Macroalgae and turf algae						
N	Mining - industrial salt production facility - footprint					
Y	Mining - industrial salt production facility - bitterns discharge	1	4	4	L	Bitterns would be localised. The risk would increase if bitterns discharge went unmanaged. Exmouth Gulf is already hypersaline, bitterns could add more stress. Bitterns are very dense when released but mixing of the bittern plume would happen straight away. There will be a core of influence where all values will be impacted, but probably would not translate to a population or system-wide impact. No other contaminants are introduced to bitterns. In Nickol Bay, Dampier, mangroves and seagrasses have been lost. This has been (inconclusively) related to continuous bittern discharge. The loss could also be from the ponds' saline groundwater being pushed sideways into mangroves. Modelling of the spread of bitterns was ~4-5km^2. *Assumptions: Risk score is based on the assumption that discharge is from one point and diffuse. Assumes that the discharge location will be into the Gulf from the eastern margin. Any chemicals lining the outflow pipe would be neutralised/wiped out by the concentration of the bitterns - it would kill everything.* ***Cumulative impact considerations*** *Consequences will increase if more than one industrial salt production facility is realised. Currently three proposals ~20km length. Exmouth Gulf is already hypersaline.* Depends on how it is regulated - *scoring does not consider potential controls/management.* *Data confidence* • *Low confidence around the impact of bitterns discharge* • *Low confidence around the location of bitterns discharge*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
N	Mining - industrial salt production facility - seawater intake					
N	Mining - O&G - seismic surveys					
Value: Seagrass						
N	Mining - industrial salt production facility - footprint					
Y	Mining - industrial salt production facility - bitterns discharge	1	4	4	L	Bitterns would be localised. The risk would increase if bitterns discharge is unmanaged. *Data confidence* • *Low confidence around the impact of bitterns discharge* • *Low confidence around the location of bitterns discharge*
N	Mining - industrial salt production facility - seawater intake					
N	Mining - O&G - seismic surveys					
Value: Coral						
N	Mining - industrial salt production facility - footprint					
Y	Mining - industrial salt production facility - bitterns discharge	1	4	4	L	Bitterns would be localised. The risk would increase if bitterns discharge is unmanaged. There are many patches of corals/bommies on the east side of the Gulf and quite a bit of soft coral on east side.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						The impact of bittern discharge on corals would depend on the location of discharge, and there is enough reef on the east side to be aware of where you would place a discharge pipe. Coral will take longer to recover than algae or seagrass, so the consequences would be higher, but still considered a local impact. *Assumption: Risk score is based on the assumption that discharge is from one point and there will be diffusion. There are currently three proposals ~20km length. Assumes that the discharge location will be into the Gulf from the eastern margin.* ***Cumulative impact considerations*** *Consequences will increase if more than one industrial salt production facility is realised.* *Data confidence* • *Low confidence around the impact of bitterns discharge* • *Low confidence around the location of bitterns discharge*
N	Mining - industrial salt production facility - seawater intake					
N	Mining - O&G - seismic surveys					
Value: Sponges and filter feeders						
N	Mining - industrial salt production facility - footprint					
Y	Mining - industrial salt production facility - bitterns discharge	1	4	4	L	Bitterns would be localised. The risk would increase if bittern discharge is unmanaged. *Data confidence* • *Low confidence around the impact of bitterns discharge* • *Low confidence around the location of bitterns discharge*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
N	Mining - industrial salt production facility - seawater intake					
N	Mining - O&G - seismic surveys					
Value: Sand and mud						
N	Mining - industrial salt production facility - footprint					
Y	Mining - industrial salt production facility - bitterns discharge	1	4	4	L	Bitterns would be localised. The risk would increase if bittern discharge is unmanaged. *Data confidence* • *Low confidence around the impact of bitterns discharge* • *Low confidence around the location of bitterns discharge*
N	Mining - industrial salt production facility - seawater intake					
N	Mining - O&G - seismic surveys					
Value: Mangroves						

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
Y	Mining - industrial salt production facility - footprint	2	4	8	M-H	Footprint would have an impact on hydrology, surface runoff, and subsurface water flow. Consequences for mangroves could possibly result. Mangroves live in saline condition most of the time. The likelihood of coastal squeeze in the future should be considered. Sea level rise limits the ability for mangroves to retreat landward. Total mortality of mangroves could occur within the area if coastal squeeze is realised. A small increase in sea level can lead to a large horizontal displacement. Keep 5-10 years in mind when thinking about sea level rise and squeeze. If there are many La Niña years, this would increase the water level a lot more than the mean sea level rise. Think about connectivity as well. Potential flow-on effects to fish or prawns. - *fish and prawns assessed separately* One industrial salt production facility is unlikely to lead to local extinction. *Assumption: Risk score is based on the assumption of one industrial salt production facility- 20km length.* ***Cumulative impact considerations*** *Consequences will increase if more than one industrial salt production facility is realised. There are also proposals throughout the Pilbara area that could impact mangroves.* If there is divergence in scores, this may indicate we do not know enough - **more knowledge needed** *Data confidence* • *High confidence that coastal squeeze can impact mangroves, and salt facility is proposed adjacent to mangrove habitat* • *Medium confidence in the extent of impact on mangroves given exact footprint is not known*
Y	Mining - industrial salt production facility - bitterns discharge	2	3	6	L	In Nickol Bay, Dampier, mangroves and seagrass has been lost. This has been (inconclusively) linked to continuous bitterns discharge. It could also be from the ponds' saline groundwater being pushed sideways into mangroves. Modelling of the spread of bitterns was ~4-5km^2. In Adelaide, there has been damage to mangroves due to leakage of highly saline water.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						The impact to the composition of species depends on how much discharge there will be and where. *Assumptions: Risk score is based on the assumption that discharge is from one point and diffuse. Assumes that the discharge location will be into the Gulf from the eastern margin. Any chemicals lining the outflow pipe would be neutralised/wiped out by the concentration of the bitterns - it would kill everything.* ***Cumulative impact considerations*** *Consequences will increase if more than one industrial salt production facility is realised. Currently three proposals ~20km length. There are also proposals throughout the Pilbara area that could impact mangroves* *Data confidence* • *Medium confidence around the impact of bitterns discharge on mangroves* • *Low confidence around the location of bitterns discharge*
N	Mining - industrial salt production facility - seawater intake					
N	Mining - O&G - seismic surveys					
Value: Samphire						
Y	Mining - industrial salt production facility - footprint	2	4	8	M-H	Samphire might be more impacted than mangroves because salt ponds tend to be built on top of those habitats. Not just the immediate footprint to think about but the influence of other related industrial salt production facility infrastructure. *Assumption: Risk score is based on the assumption of one industrial salt production facility (20km length), one discharge point and that diffusion will occur.* ***Cumulative impact considerations*** *Consequences will increase if more than one industrial salt production facility is realised. There is the Wyloo Potash project also to consider.*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						Data confidence • *High confidence that footprint will directly impact samphire* • *Medium confidence in the extent of impact given exact footprint is not known*
N	Mining - industrial salt production facility - bitterns discharge					Samphire occurs high on the intertidal zone, so it is likely not impacted
N	Mining - industrial salt production facility - seawater intake					
N	Mining - O&G - seismic surveys					
Value: Blue green algal mats						
Y	Mining - industrial salt production facility - footprint	3	4	12	M-H	Algal mats could be quite severely affected by an industrial salt production facility. Algal mats migrate seaward and landward depending on the sea level e.g., during La Niña years, the mats migrate landward. When the sea level drops, they migrate seaward. The footprint of an industrial salt production facility could prevent this movement. Algal mats occupy a very narrow tidal inundation regime and are sensitive to changes e.g., sea level rise. Blue green algae are quick to grow so they can be resilient *IF* the industrial salt production facility and/or walls are removed. The Straits Salt proposal suggested a seaward wall just behind the mats assuming that the mats were static - but they are not. Eastern Gulf salt flats is one of the largest and last intact examples of salt flat ecosystems in WA (which are not well represented in conservation reserves). The area was listed in the Directory of Important Wetlands for its regionally and internationally significant mangroves (included by World Heritage Committee as grounds for recommending the inclusion of Exmouth Gulf for World Heritage listing, given ecological links with Ningaloo). *Assumption: Risk score is based on the assumption of one industrial salt production facility (20km length), one discharge point and that diffusion will occur.*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						Cumulative impact considerations *Consequences will increase if more than one industrial salt production facility is realised. Removal of intertidal areas like blue green algal mats and, in turn, productivity, are going to have a trophic impact on the system, including for fishes. The link with hydrodynamics and nutrient flows needs to be considered. There is the Wyloo Potash project also to consider* *Data confidence* • *High confidence that footprint will directly impact mats* • *Medium confidence in the extent of impact given exact footprint is not known*
N	Mining - industrial salt production facility - bitterns discharge					
N	Mining - industrial salt production facility - seawater intake					
N	Mining - O&G - seismic surveys					
Value: Reef flats and oyster beds						
N	Mining - industrial salt production facility - footprint					
Y	Mining - industrial salt production facility - bitterns discharge	1	4	4	L	Oyster beds occur in the southwest margin of the Gulf, so they may not be impacted as much by bitterns discharge. *Assumption: the bitterns discharge locations would not be in the southern end of the Gulf near oyster beds.* Significant reef flats occur around Tubridgi and near Ashburton. There is uncertainty around how bitterns would impact these reef flats, but the outfall location could avoid these reef flats.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						Assumption: Risk score is based on the assumption of one industrial salt production facility (20km length), one discharge point and that diffusion will occur. ***Cumulative impact considerations*** *Consequences will increase if more than one industrial salt production facility is realised.* *Data confidence* • *Low confidence around the impact of bitterns discharge* • *Low confidence around the location of bitterns discharge*
N	Mining - industrial salt production facility - seawater intake					
N	Mining - O&G - seismic surveys					
Value: Salt flats						
Y	Mining - industrial salt production facility - footprint	3	4	12	M-H	Salt flats are very much the footprint of an industrial salt production facility. Materials that accumulate on salt flats will not get delivered to the nearshore zone if an industrial salt production facility is in the way. Eastern Gulf salt flats is one of the largest and last intact examples of salt flat ecosystems in WA (which are not well represented in conservation reserves). This area was listed in the Directory of Important Wetlands, for its regionally and internationally significant mangroves (included by World Heritage Committee as grounds for recommending the inclusion of Exmouth Gulf for World Heritage listing, given ecological links with Ningaloo). Salt flats can look unvegetated, but they can have microbial communities growing on them. With sea level rise, mangroves and blue green algal mats can migrate over salt flats. *Assumption: Risk score is based on the assumption of one industrial salt production facility (20km length), one discharge point and that diffusion will occur.* ***Cumulative impact considerations*** *Consequences will increase if more than one industrial salt production facility is realised.*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						Data confidence • *High confidence that footprint will directly impact salt flats* • *Medium confidence in the extent of impact given exact footprint is not known*
N	Mining - industrial salt production facility - bitterns discharge					
N	Mining - industrial salt production facility - seawater intake					
N	Mining - O&G - seismic surveys					
Factor: Marine fauna						
Value: Crustaceans - prawns						
N	Mining - industrial salt production facility - footprint					Check back to coastal processes as impacts to run off impacts prawn productivity.
Y	Mining - industrial salt production facility - bitterns discharge	1	4	4	L	Magnesium chloride has an impact on invertebrates. Two main prawn species use the nursery area. The impact on them from bitterns will depend on scale - how much, how long and where. In the overall scheme of things e.g., that the extent of the nursery is large, bitterns will probably have a low and localised impact. When there is a lot of rainfall, nutrient runoff on to the flat helps to stimulate the prawn nursery. If you change the hydrology of the water coming off the land, this will have an impact on the nursery. *Assumptions: Risk score is based on the assumption that discharge is from one point and diffuse. Assumes that the discharge location will be into the Gulf from the eastern margin. Any chemicals lining the outflow pipe would be neutralised/wiped out by the concentration of the bitterns - it would kill everything.*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						Cumulative impact considerations *Consequences will increase if more than one industrial salt production facility is realised. Currently there are three proposals ~20km length* *Data confidence* • *Low confidence around the impact of bitterns discharge* • *Low confidence around the location of bitterns discharge*
Y	Mining - industrial salt production facility - seawater intake	1	4	4	L-M	Prawns spawn down east coast of Gulf, so the impact would depend on where the intake pipe is placed and the volume of seawater that goes into the facility. There could be possible active recruitment taken into intake pipes. Marine life can get drawn in as evidenced by intake pipes in other locations. For example, Cargill salt ponds have 50mm intake grids and have had mangroves propagules enter as well as mud crabs and fish growing inside ponds. Dampier Salt is exposed to a huge tidal range and has high volumes coming in through the intake pipe. Species do grow in ponds, but these species are occuring outside - so overall is it a minor consequence? The industrial salt production facility at Mardie can pull in the volume of the creek system in a day. *Assumption: the intake pipe would be in the Gulf along the eastern margin.* *Caveats: There are temporal and spatial scales to consider, and data confidence is low.* ***So, assume minor consequence. More knowledge needed.*** *Data confidence* • *High confidence around marine life being drawn into intake pipes* • *Low confidence around location of intake pipe* • *Low confidence around direct impact to prawns in the Gulf*
Y	Mining - O&G - seismic surveys	1	3	3	L-M	The prawn fishery is still productive so are seismic survey activities occuring outside of the Gulf having that much of an impact? The impact will depend on the proximity of seismic activity to prawns. Work by Rob McCauley from Curtin University looked at the impacts of seismic activity on zooplankton, which would include larval stages of species such as prawns. McCauley et al.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						(1998a and 1998b) also tested seismic activity responses of a suite of taxa, from squid to whales. *Caveat: scored on very limited knowledge.* ***More knowledge needed.*** *Data confidence* • *High confidence that seismic surveys can impact marine life - see McCauley et al. (1998a)* • *Low confidence around impacts to prawns specifically* • *Low confidence around the seismic activities that will occur in vicinity to Exmouth Gulf*
Value: Crustaceans - mud crabs						
N	Mining - industrial salt production facility - footprint					
Y	Mining - industrial salt production facility - bitterns discharge	1	4	4	L	Same as above for prawns. *Data confidence* • *Low confidence around the impact of bitterns discharge* • *Low confidence around the location of bitterns discharge*
Y	Mining - industrial salt production facility - seawater intake	1	4	4	L-M	Same as above for prawns. *Data confidence* • *High confidence around marine life being drawn into intake pipes* • *Low confidence around location of intake pipe* • *Low confidence around direct impact to mud crabs in the Gulf*
Y	Mining - O&G - seismic surveys	1	3	3	L-M	Same as above for prawns. *Data confidence* • *High confidence that seismic surveys can impact marine life - see McCauley et al. (1998a)* • *Low confidence around impacts to mud crabs specifically*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						• *Low confidence around the seismic activities that will occur in vicinity to Exmouth Gulf*
Value: Teleost - whiting						
N	Mining - industrial salt production facility - footprint					
Y	Mining - industrial salt production facility - bitterns discharge	1/2	4	4-8	L	There is a lot of whiting occuring all through Exmouth Gulf. They could move away from a bitterns discharge area. **More knowledge needed** on the migratory route of whiting down the eastern side of Gulf. The discharge location could occur within their pathway. The Gulf is already a saline environment, so will bitterns discharge be outside tolerance limits of whiting? There was no knowledge of fish kills being linked to bitterns discharge, but there could be sublethal effects. The level of risk would depend on whether the habitat impacted by bitters is critical for whiting. - **more knowledge needed** It is standard practice for salt discharge to go through a diffuser. - *mitigation measures are not considered when scoring* *Assumption: Risk score is based on the assumption that discharge is from one point and diffuse. Assumes that the discharge location will be into the Gulf from the eastern margin. Any chemicals lining the outflow pipe would be neutralised/wiped out by the concentration of the bitterns - it would kill everything.* ***Cumulative considerations:** Consequences will increase if more than one industrial salt production facility is realised. There are currently three proposals ~20km length.* *Data confidence* • *Low confidence around the impact of bitterns discharge* • *Low confidence around the location of bitterns discharge*
Y	Mining - industrial salt production facility - seawater intake	1	4	4	L-M	Same reasonings as prawns and mud crabs. Any impact, if there was an impact, would be localised. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						• *High confidence around marine life being drawn into intake pipes* • *Low confidence around location of intake pipe* • *Low confidence around direct impact to whiting in the Gulf*
Y	Mining - O&G - seismic surveys	2	3	6	L-M	The impact depends on the proximity to seismic activity. It is unlikely that such mobile species could move far enough and fast enough to prevent any impacts. Essentially, by the time they hear it, it would be too late. The Australian Institute of Marine Science is currently doing research in this space. Different seismic activities affect different species in different ways and *Carroll et al. (2017) - A critical review of the potential impacts of marine seismic surveys on fish & invertebrates* warns about generalising when there is a lack of knowledge. *Caveat: Scored on very limited knowledge, therefor higher likelihood. -* ***More knowledge needed*** *Data confidence* • *High confidence that seismic surveys can impact fishes - see McCauley et al. (1998a)* • *Low confidence around impacts to whiting specifically* • *Low confidence around the seismic activities that will occur in vicinity to Exmouth Gulf*
Value: Teleost - mangrove jack						
N	Mining - industrial salt production facility - footprint					
Y	Mining - industrial salt production facility - bitterns discharge	1	4	4	L	Mangrove Jacks are more likely to occur in coastal waters adjacent to industrial salt production facility. They live in schools around mudflats and creeks. It is unlikely that discharge will occur in creeks. It is still a localised impact. *Assumption: the discharge pipe would be in the Gulf along the eastern margin, not in creeks that mangrove jacks use. Risk score is based on the assumption that discharge is from one point and diffuse. It assumes that the discharge location will be into the Gulf from*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						the eastern margin. Any chemicals lining the outflow pipe would be neutralised/wiped out by the concentration of the bitterns - it would kill everything. ***Cumulative considerations:*** *Consequences will increase if more than one industrial salt production facility is realised. There are currently three proposals ~20km length.* *Data confidence* • *Low confidence around the impact of bitterns discharge* • *Low confidence around the location of bitterns discharge*
Y	Mining - industrial salt production facility - seawater intake	1	4	4	L-M	Same reasons as above for whiting *Data confidence* • *High confidence around marine life being drawn into intake pipes* • *Low confidence around location of intake pipe* • *Low confidence around direct impact to mangrove jacks in the Gulf*
Y	Mining - O&G - seismic surveys	2	3	6	L-M	The impact depends on proximity to seismic activity. It is unlikely that such mobile species could move far enough and fast enough to avoid any impacts. Essentially, by the time they hear it, it would be too late. The Australian Institute of Marine Science is currently doing research in this space. Different seismic activities affect different species in different ways and *Carroll et al. (2017) - A critical review of the potential impacts of marine seismic surveys on fish & invertebrates* warns about generalising when there is a lack of knowledge. *Caveat: Scored on very limited knowledge, therefore a higher likelihood -* ***More knowledge needed.*** *Data confidence* • *High confidence that seismic surveys can impact fishes - see McCauley et al. (1998a)* • *Low confidence around impacts to mangrove jack specifically* • *Low confidence around the seismic activities that will occur in vicinity to Exmouth Gulf*
Value: Teleost - trevally						

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
N	Mining - industrial salt production facility - footprint					
Y	Mining - industrial salt production facility - bitterns discharge	1	4	4	L	Move around a lot and can avoid discharge locations. *Assumption: Risk score is based on the assumption that discharge is from one point and diffuse. It assumes that the discharge location will be into the Gulf from the eastern margin. Any chemicals lining the outflow pipe would be neutralised/wiped out by the concentration of the bitterns - it would kill everything.* ***Cumulative considerations:*** *Consequences will increase if more than one industrial salt production facility is realised. Currently there are three proposals ~20km length.* *Data confidence* • *Low confidence around the impact of bitterns discharge* • *Low confidence around the location of bitterns discharge*
Y	Mining - industrial salt production facility - seawater intake	1	4	4	L-M	Same reasons as above for whiting *Data confidence* • *High confidence around marine life being drawn into intake pipes* • *Low confidence around location of intake pipe* • *Low confidence around direct impact to trevally in the Gulf*
Y	Mining - O&G - seismic surveys	2	3	6	L-M	Impact depends on proximity to seismic activity. Unlikely that such mobile species could move far enough and fast enough to prevent any impacts. Essentially by the time they hear it, it would be too late. The Australian Institute of Marine Science is currently doing research in this space. Different seismic activities affect different species in different ways and *Carroll et al. (2017) - A critical review of the potential impacts of marine seismic surveys on fish & invertebrates* warns about generalising when there is a lack of knowledge. *Data confidence* • *High confidence that seismic surveys can impact fishes - see McCauley et al. (1998a)*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						• *Low confidence around impacts to trevally specifically* • *Low confidence around the seismic activities that will occur in vicinity to Exmouth Gulf*
Value: Teleost - coral trout						
N	Mining - industrial salt production facility - footprint					
Y	Mining - industrial salt production facility - bitterns discharge	1/2	4	4-8	L	Some juveniles use areas around subtidal reef. Perhaps coral trout are more at risk due to their association with a particular habitat - e.g., corals/reefs. *Assumption: Risk score is based on the assumption that discharge is from one point and diffuse. Assumes that the discharge location will be into the Gulf from the eastern margin. Any chemicals lining the outflow pipe would be neutralised/wiped out by the concentration of the bitterns - it would kill everything.* ***Cumulative considerations:*** *Consequences will increase if more than one industrial salt production facility is realised. Currently there are three proposals ~20km length.* *Data confidence* • *Low confidence around the impact of bitterns discharge* • *Low confidence around the location of bitterns discharge*
Y	Mining - industrial salt production facility - seawater intake	1	4	4	L-M	Same reasons as above for whiting *Data confidence* • *High confidence around marine life being drawn into intake pipes* • *Low confidence around location of intake pipe* • *Low confidence around direct impact to coral trout in the Gulf*
Y	Mining - O&G - seismic surveys	2	3	6	L-M	Impact depends on proximity to seismic activity. Unlikely that such mobile species could move far enough and fast enough to prevent any impacts. Essentially by the time they hear it, it would be too late. The Australian Institute of Marine Science is currently doing research in this space.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						Different seismic activities affect different species in different ways and *Carroll et al. (2017) - A critical review of the potential impacts of marine seismic surveys on fish & invertebrates* warns about generalising when there is a lack of knowledge. *Caveat: Scored on very limited knowledge, therefore a higher likelihood. -* ***More knowledge needed.*** *Data confidence* • *High confidence that seismic surveys can impact fishes - see McCauley et al. (1998a)* • *Low confidence around impacts to coral trout specifically* • *Low confidence around the seismic activities that will occur in vicinity to Exmouth Gulf*
Value: Teleost - red emperor						
N	Mining - industrial salt production facility - footprint					
Y	Mining - industrial salt production facility - bitterns discharge	1	4	4	L	Juveniles typically use deeper areas but may make use of macroalgal habitats like other emperors do. *Assumption: Risk score is based on the assumption that discharge is from one point and diffuse. Assumes that the discharge location will be into the Gulf from the eastern margin. Any chemicals lining the outflow pipe would be neutralised/wiped out by the concentration of the bitterns - it would kill everything.* ***Cumulative considerations:*** *Consequences will increase if more than one industrial salt production facility is realised. Currently there are three proposals ~20km length.* *Data confidence* • *Low confidence around the impact of bitterns discharge* • *Low confidence around the location of bitterns discharge*
Y	Mining - industrial salt production facility - seawater intake	1	4	4	L-M	Same reasons as above for whiting *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						• *High confidence around marine life being drawn into intake pipes* • *Low confidence around location of intake pipe* • *Low confidence around direct impact to red emperor in the Gulf*
Y	Mining - O&G - seismic surveys	2	3	6	L-M	Impact depends on proximity to seismic activity. Unlikely that such mobile species could move far enough and fast enough to prevent any impacts. Essentially by the time they hear it, it would be too late. The Australian Institute of Marine Science is currently doing research in this space. Different seismic activities affect different species in different ways and *Carroll et al. (2017) - A critical review of the potential impacts of marine seismic surveys on fish & invertebrates* warns about generalising when there is a lack of knowledge. *Data confidence* • *High confidence that seismic surveys can impact fishes - see McCauley et al. (1998a)* • *Low confidence around impacts to red emperor specifically* • *Low confidence around the seismic activities that will occur in vicinity to Exmouth Gulf*
Value: Teleost - Tuskfish						
N	Mining - industrial salt production facility - footprint					
Y	Mining - industrial salt production facility - bitterns discharge	2	4	8	L	A lot of sediment has been found in the stomachs of tuskfish in the Gulf. They may play quite significant roles for sediment production and may be responsible for island sediments. So perhaps there is more than just a local impact to consider if bitterns discharge affects tuskfish. *Assumption: Risk score is based on the assumption that discharge is from one point and diffuse. Assumes that the discharge location will be into the Gulf from the eastern margin. Any chemicals lining the outflow pipe would be neutralised/wiped out by the concentration of the bitterns - it would kill everything.*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						Cumulative considerations: *Consequences will increase if more than one industrial salt production facility is realised. Currently there are three proposals ~20km length.* *Data confidence* • *Low confidence around the impact of bitterns discharge* • *Low confidence around the location of bitterns discharge*
Y	Mining - industrial salt production facility - seawater intake	1	4	4	L-M	Same reasons as above for whiting *Data confidence* • *High confidence around marine life being drawn into intake pipes* • *Low confidence around location of intake pipe* • *Low confidence around direct impact to tuskfish in the Gulf*
Y	Mining - O&G - seismic surveys	2	3	6	L-M	Impact depends on proximity to seismic activity. Unlikely that such mobile species could move far enough and fast enough to prevent any impacts. Essentially by the time they hear it, it would be too late. The Australian Institute of Marine Science is currently doing research in this space. Different seismic activities affect different species in different ways and *Carroll et al. (2017) - A critical review of the potential impacts of marine seismic surveys on fish & invertebrates* warns about generalising when there is a lack of knowledge. The role of tuskfish in sediment production would increase the consequence. *Caveat: Scored on very limited knowledge, therefore higher likelihood. -* ***More knowledge needed.*** *Data confidence* • *High confidence that seismic surveys can impact fishes - see McCauley et al. (1998a)* • *Low confidence around impacts to tuskfish specifically* • *Low confidence around the seismic activities that will occur in vicinity to Exmouth Gulf*

Value: Elasmobranchs - rays (shovel nose rays)

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
N	Mining - industrial salt production facility - footprint					
Y	Mining - industrial salt production facility - bitterns discharge	1	4	4	L	Juveniles derive nutrients from nearshore habitats that could be affected by bitterns discharge. There is a high abundance of juveniles in the creeks. *Assumption: Risk score is based on the assumption that discharge is from one point and diffuse. Assumes that the discharge location will be into the Gulf from the eastern margin. Any chemicals lining the outflow pipe would be neutralised/wiped out by the concentration of the bitterns - it would kill everything.* ***Cumulative considerations:*** *Consequences will increase if more than one industrial salt production facility is realised. Currently there are three proposals ~20km length.* *Data confidence* • *Low confidence around the impact of bitterns discharge* • *Low confidence around the location of bitterns discharge*
N	Mining - industrial salt production facility - seawater intake					
Y	Mining - O&G - seismic surveys	2	3	6	L-M	Impact depends on proximity to seismic activity. Unlikely that such mobile species could move far enough and fast enough to prevent any impacts. Essentially by the time they hear it, it would be too late. The Australian Institute of Marine Science is currently doing research in this space. Different seismic activities affect different species in different ways and *Carroll et al. (2017) - A critical review of the potential impacts of marine seismic surveys on fish & invertebrates* warns about generalising when there is a lack of knowledge. *Caveat: Scored on very limited knowledge, therefore a higher likelihood. -* ***More knowledge needed*** *Data confidence* • *High confidence that seismic surveys can impact marine life - see McCauley et al. (1998a)*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						• *Low confidence around impacts to shovel nose rays specifically* • *Low confidence around the seismic activities that will occur in vicinity to Exmouth Gulf*
Value: Elasmobranchs - rays (manta) ***EPBC Act - Migratory, Marine listed***						
N	Mining - industrial salt production facility - footprint					
N	Mining - industrial salt production facility - bitterns discharge					Mantas occur more along the west and south of the Gulf. Large aggregations are seen on western coast.
N	Mining - industrial salt production facility - seawater intake					
Y	Mining - O&G - seismic surveys	2	3	6	L-M	Impact depends on proximity to seismic activity. Unlikely that such mobile species could move far enough and fast enough to prevent any impacts. Essentially by the time they hear it, it would be too late. The Australian Institute of Marine Science is currently doing research in this space. Different seismic activities affect different species in different ways and *Carroll et al. (2017) - A critical review of the potential impacts of marine seismic surveys on fish & invertebrates* warns about generalising when there is a lack of knowledge. *Caveat: Scored on very limited knowledge, therefore a higher likelihood. -* ***More knowledge needed.*** *Data confidence* • *High confidence that seismic surveys can impact marine life - see McCauley et al. (1998a)* • *Low confidence around impacts to manta rays specifically* • *Low confidence around the seismic activities that will occur in vicinity to Exmouth Gulf*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
Value: Elasmobranchs - sawfish						
N	Mining - industrial salt production facility - footprint					
Y	Mining - industrial salt production facility - bitterns discharge	2	4	8	L	Ashburton River is a pupping site in general - not just for supplying the Gulf. The river is one of the few pupping locations identified in the state. Sawfish have a spatially restricted habitat. No dedicated sawfish surveys have been carried out in the Gulf. There is uncertainty around the impacts of bitterns discharge on sawfish, but if there is any impact, it would be a higher consequence than other rays given the spatially restricted habitat. • *Caveat: Scored with low confidence in sawfish data in the Gulf. -* ***More knowledge needed*** *Assumption: Risk score is based on the assumption that discharge is from one point and diffuse. Assumes that the discharge location will be into the Gulf from the eastern margin. Any chemicals lining the outflow pipe would be neutralised/wiped out by the concentration of the bitterns - it would kill everything.* ***Cumulative considerations:*** *Consequences will increase if more than one industrial salt production facility is realised. Currently there are three proposals ~20km length.* *Data confidence* • *Low confidence around the impact of bitterns discharge* • *Low confidence around the location of bitterns discharge* • *Low confidence around sawfish population in the Gulf*
N	Mining - industrial salt production facility - seawater intake					Too large for grids
Y	Mining - O&G - seismic surveys	2	3	6	L-M	Impact depends on proximity to seismic activity. Unlikely that such mobile species could move far enough and fast enough to prevent any impacts. Essentially by the time they hear it, it would be too late. The Australian Institute of Marine Science is currently doing research in this space.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						Different seismic activities affect different species in different ways and *Carroll et al. (2017) - A critical review of the potential impacts of marine seismic surveys on fish & invertebrates* warns about generalising when there is a lack of knowledge. *Caveat: Scored on very limited knowledge, therefore a higher likelihood. -* ***More knowledge needed*** *Data confidence* • *High confidence that seismic surveys can impact marine life - see McCauley et al. (1998a)* • *Low confidence around impacts to sawfish specifically* • *Low confidence around the seismic activities that will occur in vicinity to Exmouth Gulf*
Value: Elasmobranchs - sharks						
N	Mining - industrial salt production facility - footprint					
Y	Mining - industrial salt production facility - bitterns discharge	1	4	4	L	Sharks can move out of the way of discharge locations. *Assumption: Risk score is based on the assumption that discharge is from one point and diffuse. Assumes that the discharge location will be into the Gulf from the eastern margin. Any chemicals lining the outflow pipe would be neutralised/wiped out by the concentration of the bitterns - it would kill everything.* ***Cumulative considerations:*** *Consequences will increase if more than one industrial salt production facility is realised. Currently there are three proposals ~20km length.* *Data confidence* • *Low confidence around the impact of bitterns discharge* • *Low confidence around the location of bitterns discharge*
N	Mining - industrial salt production facility - seawater intake					Too large for grids

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
Y	Mining - O&G - seismic surveys	2	3	6	L-M	Impact depends on proximity to seismic activity. Unlikely that such mobile species could move far enough and fast enough to prevent any impacts. Essentially by the time they hear it, it would be too late. The Australian Institute of Marine Science is currently doing research in this space. Different seismic activities affect different species in different ways and *Carroll et al. (2017) - A critical review of the potential impacts of marine seismic surveys on fish & invertebrates* warns about generalising when there is a lack of knowledge. *Caveat: Scored on very limited knowledge, therefore a higher likelihood - **More knowledge needed.*** *Data confidence* • *High confidence that seismic surveys can impact marine life - see McCauley et al. (1998a)* • *Low confidence around impacts to sharks specifically* • *Low confidence around the seismic activities that will occur in vicinity to Exmouth Gulf*
Value: Marine reptiles - sea snakes						
N	Mining - industrial salt production facility - footprint					Footprint - some snakes may come up to areas that may be impacted by footprint
Y	Mining - industrial salt production facility - bitterns discharge	2	3	6	L	Several species are EPBC conservation listed, including Critically Endangered. Endemic species of sea snakes, Critically Endangered short-nosed sea snake, occurs in the Gulf. The importance of this habitat (Exmouth Gulf) to this species needs to be ascertained before making a confident risk assessment. • *They may swim away from a bitterns discharge location unless the location is in a nursery area - **More knowledge needed** on nursery locations. Low confidence in data. Some prawn trawl bycatch data.* Environment Protection and Biodiversity Conservation listed species.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						Some? species have small home ranges (e.g., ~100m) and are susceptible to localised impacts. Some individuals might be impacted if they occur around outflow. Small home ranges could probably justify a consequence of 2. *Assumption: Risk score is based on the assumption that discharge is from one point and diffuse. Assumes that the discharge location will be into the Gulf from the eastern margin. Any chemicals lining the outflow pipe would be neutralised/wiped out by the concentration of the bitterns - it would kill everything.* ***Cumulative considerations:*** *Consequences will increase if more than one industrial salt production facility is realised. Currently there are three proposals ~20km length.* *Data confidence* • *Low confidence around the impact of bitterns discharge* • *Low confidence around the location of bitterns discharge* • *Low confidence around sea snake populations in the Gulf*
Y	Mining - industrial salt production facility - seawater intake	1	4	4	L-M	Any impact, if there was an impact, would be localised. *Data confidence* • *High confidence around marine life being drawn into intake pipes* • *Low confidence around location of intake pipe* • *Low confidence around direct impact to sea snakes in the Gulf*
Y	Mining - O&G - seismic surveys	2	3	6	L-M	Impact depends on proximity to seismic activity. Unlikely that such mobile species could move far enough and fast enough to prevent any impacts. Essentially by the time they hear it, it would be too late. The Australian Institute of Marine Science is currently doing research in this space. Different seismic activities affect different species in different ways and *Carroll et al. (20170 - A critical review of the potential impacts of marine seismic surveys on fish & invertebrates* warns about generalising when there is a lack of knowledge. *Caveat: Scored on very limited knowledge, therefore higher likelihood. -* ***More knowledge needed*** *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						• *High confidence that seismic surveys can impact marine life - see McCauley et al. (1998a)* • *Low confidence around impacts to sea snakes specifically* • *Low confidence around the seismic activities that will occur in vicinity to Exmouth Gulf*
Value: Marine reptiles - turtles *(EPBC Act - all species are Vulnerable or Endangered)*						
N	Mining - industrial salt production facility - footprint					
Y	Mining - industrial salt production facility - bitterns discharge	1/2	4	4-8	L	No turtle nesting sites have been identified within the Gulf, but the Gulf is used as feeding habitat during inter-nesting periods (time between egg laying). This can occur around mangrove creeks. Juvenile green turtles feed on vegetation around mangrove areas and do not move very far. Marine turtles are already threatened species. They could move away from discharge location, but there is uncertainty about any indirect effects. *Assumption: Risk score is based on the assumption that discharge is from one point and diffuse. Assumes that the discharge location will be into the Gulf from the eastern margin. Any chemicals lining the outflow pipe would be neutralised/wiped out by the concentration of the bitterns - it would kill everything.* ***Cumulative considerations:** Consequences will increase if more than one industrial salt production facility is realised. Currently there are three proposals ~20km length.* *Data confidence* • *Low confidence around the impact of bitterns discharge* • *Low confidence around the location of bitterns discharge*
Y	Mining - industrial salt production facility - seawater intake	1	4	4	L-M	The seawater intake should be slow enough for a juvenile fish to swim away, so it should be ok for juvenile sea turtles. May not need to score at all.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						Data confidence • *High confidence around marine life being drawn into intake pipes* • *Low confidence around location of intake pipe* • *Low confidence around direct impact to turtles in the Gulf*
Y	Mining - O&G - seismic surveys	2	3	6	M	'Possible ramifications for turtles include: exclusion from critical habitats, damage to hearing and entanglement in seismic survey equipment' - Nelms et al. (2016) Impact depends on proximity to seismic activity. *Caveat: Scored on very limited knowledge, therefore a higher likelihood. -* ***More knowledge needed*** *Data confidence* • *High confidence that seismic surveys can impact marine turtles - see McCauley et al. (1998a)* • *Low confidence around the seismic activities that will occur in vicinity to Exmouth Gulf*
Value: Marine mammals - whales (humpback) ***(EPBC Act - Vulnerable, Migratory, Cetacean listed species)***						
N	Mining - industrial salt production facility - footprint					
N	Mining - industrial salt production facility - bitterns discharge					
N	Mining - industrial salt production facility - seawater intake					
Y	Mining - O&G - seismic surveys	2	3	6	M	Seismic surveys in the Gulf would be "a horrible idea" due to the shallow embayment and sound propagation from any seismic activity. There have been previous seismic programs proposed well within the scope and the Federal government stepped in to stop one in particular.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						Seismic activity currently occurs within and adjacent to the scope area (northern area of scope/outer Gulf) at certain times throughout the year. Jaquelin Hines - can speak more on this. Past study by *McCauley et al. (1998b)* looked at seismic impacts to humpback whales. The study area was 50 km northeast of North West Cape, Exmouth, Western Australia. Migratory species need to be considered when carrying out seismic activities. e.g., Humpbacks are in the Gulf for ~4 months of the year. If seismic activity happens on their migratory route while travelling, the whales will respond differently to if they are resting in the Gulf. The impacts to whales during resting periods would be greater. There is a need to consider the migratory route itself - they are more vulnerable if they are in a restricted migratory corridor (such as the narrow continental shelf on the west side of the cape) but they also exit the Gulf in the narrow corridor between the mainland and the Muiron Islands. If migratory species are seen, seismic activities must stop, so management actions could reduce the consequence. C*ontrols are not considered in scoring.* **More knowledge needed** What are the long-term impacts of seismic? What is the likely distance from seismic activity? *Data confidence* • *High confidence that seismic surveys can impact humpback whales - see McCauley et al. (1998b)* • *Low confidence around the seismic activities that will occur in vicinity to Exmouth Gulf*
Value: Marine mammals - dolphins (coastal)						
N	Mining - industrial salt production facility - footprint					
Y	Mining - industrial salt production facility - bitterns discharge	1	4	4	L	Coastal dolphins are EPBC Act listed as Cetacean and/or Migratory species.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						There are known sites where dolphins feed on mullet and it is not known if foraging activities will be affected by localised discharge. Dolphins will follow prey, so if their prey is impacted by bitterns, then dolphins will be too. *Assumption: Risk score is based on the assumption that discharge is from one point and diffuse. Assumes that the discharge location will be into the Gulf from the eastern margin. Any chemicals lining the outflow pipe would be neutralised/wiped out by the concentration of the bitterns - it would kill everything.* ***Cumulative considerations:*** *Consequences will increase if more than one industrial salt production facility is realised. Currently there are three proposals ~20km length.* *Data confidence* • *Low confidence around the impact of bitterns discharge* • *Low confidence around the location of bitterns discharge*
N	Mining - industrial salt production facility - seawater intake					
Y	Mining - O&G - seismic surveys	1/2	3	3-6	L-M	Hearing and vocals are the main form of communication between dolphins. Noise/seismic impacts could mask communications. It is unlikely that such a mobile species could move far enough and fast enough to avoid any impacts. Essentially, by the time they hear it, it would be too late. *Caveat: scored with uncertainty on how dolphins are using the different areas of the Gulf.* *Assumption: seismic activity is occurring close to the Gulf.* *Data confidence* • *High confidence that seismic surveys can impact cetaceans - see McCauley et al. (1998b)* • *Low confidence around the seismic activities that will occur in vicinity to Exmouth Gulf* • *Low confidence around the extent dolphins are using Exmouth Gulf*

Value: Marine mammals - dugongs *(EPBC Act - Migratory, Marine listed species)*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
N	Mining - industrial salt production facility - footprint					
Y	Mining - industrial salt production facility - bitterns discharge	1	4	4	L	Bitterns discharge may impact on seagrass, which is a food source for dugongs. Dugongs can move away from a discharge location. *Caveat: knowledge of local use by dugongs is low - **more knowledge needed.** They are most likely feeding but we do not know how important that is on a larger scale. There are also connectivity considerations.* *Assumption: Risk score is based on the assumption that discharge is from one point and diffuse. Assumes that the discharge location will be into the Gulf from the eastern margin. Any chemicals lining the outflow pipe would be neutralised/wiped out by the concentration of the bitterns - it would kill everything.* ***Cumulative considerations:** Consequences will increase if more than one industrial salt production facility is realised. Currently there are three proposals ~20km length.* *Data confidence* • *Low confidence around the impact of bitterns discharge* • *Low confidence around the location of bitterns discharge*
N	Mining - industrial salt production facility - seawater intake					
Y	Mining - O&G - seismic surveys	2	3	6	L-M	*Dugongs do not see well, but they can hear well. So, noise is likely to have an impact on them.* *Dugongs can relocate temporarily* *Assumption: seismic activity is occurring close to the gulf.* *Data confidence* • *High confidence that seismic surveys can impact marine life - see McCauley et al. (1998a and 1998b)* • *Low confidence around the impact to dugongs specifically*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						• *Low confidence around the seismic activities that will occur in vicinity to Exmouth Gulf*
Value: Seabirds and shorebirds						
Y	Mining - industrial salt production facility - footprint	2	3	6	M	Some species are EPBC Act listed species, including Critically Endangered. It could impact on foraging opportunities along salt flats and may impact on nearby nesting, if that is occurring? Salt flats beyond the mangroves on the eastern (and to a lesser extent southern) side of Exmouth Gulf are used extensively by shorebirds when inundated (as foraging habitat). They are vast. Salt ponds (from saltworks) have also provided alternative feeding habitats at Port Hedland and Dampier (often accessed at high tide when the natural intertidal foraging habitat is inundated). *Data confidence* • *Medium confidence that footprint will impact foraging opportunities for seabirds and shorebirds* • *Medium confidence in the extent of impact given exact footprint is not known*
Y	Mining - industrial salt production facility - bitterns discharge	2	3	6	L	More knowledge is needed. It could impact prey species and cause more energy expenditure to hunt further away. That would depend on the outflow location. If benthic invertebrates prey are impacted, then shorebirds will be affected. *Data confidence* • *Low confidence around the impact of bitterns discharge* • *Low confidence around the location of bitterns discharge*
N	Mining - industrial salt production facility - seawater intake					
N	Mining - O&G - seismic surveys					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
Factor: Marine environmental quality						
Value: Water quality						
N	Mining - industrial salt production facility - footprint					
Y	Mining - industrial salt production facility - bitterns discharge	1	4	4	M	Localised impact that will recover quickly *Assumption: Risk score is based on the assumption that discharge is from one point and diffuse. Assumes that the discharge location will be into the Gulf from the eastern margin. Any chemicals lining the outflow pipe would be neutralised/wiped out by the concentration of the bitterns - it would kill everything.* ***Cumulative considerations:*** *Consequences will increase if more than one industrial salt production facility is realised. Currently there are three proposals ~20km length.* *Data confidence* • *High confidence around the impact of bitterns discharge on water quality* • *Low confidence around the location of bitterns discharge*
Y	Mining - industrial salt production facility - seawater intake	1	4	4	L	Continual removal of water and associated nutrients and salt. Uncertainty on whether this would be an issue. *Data confidence* • *Low confidence around location of intake pipe* • *Low confidence around direct impact to water quality in the Gulf*
N	Mining - O&G - seismic surveys					
Value: Sediment quality						
Y	Mining - industrial salt production facility - footprint	1	4	4	M	Construction of an industrial salt production facility would disrupt sediments. There is likely to be some erosion of walls initially during construction. A wall would increase the mean water level. Putting a pipeline on the seabed will involve some dredging.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						Satellite evidence after high storm surges show a big resuspension of sediments that are flushed out during ebb tides. Ponds may impact the level of flush off during flooding and impact nutrient flow. There could be a reduction in the transfer of intertidal sediments to the subtidal environment due to the salt pond footprint. *Data confidence* • *Medium confidence that footprint will impact sediment quality* • *Medium confidence in the extent of impact given exact footprint is not known*
Y	Mining - industrial salt production facility - bitterns discharge	1	4	4	M	Still localised. Will redissolve over time. Any stratification of layers may have a greater impact. *Data confidence* • *High confidence around the impact of bitterns discharge on sediment quality* • *Low confidence around the location of bitterns discharge*
N	Mining - industrial salt production facility - seawater intake					
N	Mining - O&G - seismic surveys					
Factor: Coastal processes						
Value: Geophysical processes						
Y	Mining - industrial salt production facility - footprint	1	4	4	M	Localised movements may be impacted somewhat. *Data confidence* • *Medium confidence that footprint will impact geophysical processes* • *Medium confidence in the extent of impact given exact footprint is not known*
N	Mining - industrial salt production facility - bitterns discharge					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
N	Mining - industrial salt production facility - seawater intake					
N	Mining - O&G - seismic surveys					
Value: Hydrodynamic processes						
N	Mining - industrial salt production facility - footprint					Disagreement on whether this pressure should be scored for hydrodynamic processes. One viewpoint - tides flood salt flats and the footprint will impact tides. Second viewpoint - if there is a wall, this can change the habitat but not the hydrodynamics. How can an industrial salt production facility be considered localised? The DBCA Plan for our Parks proposed boundary means that Yannarie Solar Salt, or a similar project, cannot be reactivated in the same area. The northern proposed boundary of the park is yet to be confirmed is waiting for the K+S Salt proposal assessment and the boundary associated with that.
N	Mining - industrial salt production facility - bitterns discharge					
Y	Mining - industrial salt production facility - seawater intake	1	4	4	L	Localised impact. Mixing zone is in proximity of assumed intake pipe. *Data confidence* • *Low confidence around location of intake pipe* • *Low confidence around direct impact to hydrodynamic processes*
N	Mining - O&G - seismic surveys					
Value: Nutrient flow						

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
Y	Mining - industrial salt production facility - footprint	3	4	12	M	If there is a change in habitat, then there will be a change in nutrient flow. Salt flats have a lot of organic debris, which could no longer be reached by high tides at the location of the footprint. This organic debris is a food sources for inshore animals. The EPA's recommendation against the proposed Yannarie solar salt project included potential impacts on nutrient inputs and high levels of uncertainty about this, as well as commentary that there is limited capacity for management remediation of these impacts. Large events, like cyclones, in the Gulf are followed by a spike in productivity of mangrove and seagrass communities. The K+S Salt proposal encompasses ~ 15-20% of the salt marsh area and could affect the nutrient runoff that contributes to the spike in productivity. We do not have a complete understanding on sources of productivity/nutrients in the Gulf. Nutrients could come from a number of sources. Blue green algal mats are considered a major contributor. Another suggestion was the soldier crabs bioturbating the large intertidal flats every tidal cycle. Low data confidence of nutrient sources - **more knowledge needed** *Data confidence* • *High confidence that footprint will impact nutrient flow* • *Medium confidence in the extent of impact given exact footprint is not known* • *Low to medium data confidence around all sources of nutrients into the Gulf*
Y	Mining - industrial salt production facility - bitterns discharge	1	4	4	L	The composition of bitterns discharge is not changed, therefore may not impact nutrient flow highly. *Assumption: Risk score is based on the assumption that discharge is from one point and diffuse. Assumes that the discharge location will be into the Gulf from the eastern margin. Any chemicals lining the outflow pipe would be neutralised/wiped out by the concentration of the bitterns - it would kill everything.* ***Cumulative considerations:*** *Removal of intertidal areas like blue green algal mats and, in turn, productivity, are going to have a trophic impact on the system, including for fishes. The link with hydrodynamics and nutrient flows needs to be considered. Consequences will increase if more than one industrial salt production facility is realised. Currently there are three proposals ~20km length.*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
Mining						
						Data confidence • *Low confidence around the impact of bitterns discharge* • *Low confidence around the location of bitterns discharge*
Y	Mining - industrial salt production facility - seawater intake	1	4	4		*Caveat: Not a lot of confidence on how intake of water will impact nutrient flow -* ***more knowledge needed*** *Data confidence* • *High confidence around marine life being drawn into intake pipes* • *Low confidence around location of intake pipe* • *Low confidence around direct impact to prawns in the Gulf*
N	Mining - O&G - seismic surveys					

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
Factor: Benthic habitats and communities						
Value: Macroalgae and turf algae						
Y	Shipping - port infrastructure footprint (incl channel)	2	4	8	M	Could estimate a footprint of ~10 hectares. Plus associated marine offloading facilities and hardstands, and channel ~1km out to 12.5m deep. Turn around area potentially 2km out from shore (or Gulf?) to get required depth. Is 12.5m enough depth for large vessels? Moderately large dredging operation possible. Will probably utilise natural channel. Exmouth marina was built on a pre-existing channel. It gets flooded often. Houses are raised up to avoid flooding impacts. A proposed port would probably require some raising up. Consequences are not likely to be minimal. There will be direct removal of macroalgae. The southerly flow and alongshore drift of sediments will be changed, which may impact on sediment build up and cover over nearshore algal limestone pavements. *Some overlap of knowledge/score with coastal processes.* What is the distribution of platform reefs along the western margin? Are they broken or continuous? - **More knowledge needed.** Would need to be consideration of spatial extent of habitats (~40km of limestone pavement). Forecasting done for Westport about the future of ship designs shows that ships are only going to get bigger - but this consideration may be beyond the 5-10 year timeframe. Coal terminal channels are going to be 19m deep. Allows for tidal regime and 1m below *Caveats: We do not know the final port footprint.* *Data confidence* • *Medium confidence in the extent of macroalgae along western margin of Gulf - e.g., Lyne et al. (2006), Cassata and Collins (2004); Cassata and Collins (2008); van Keulen and Langdon (2011)* • *Medium confidence around final footprint extent*
N	Shipping - vessel strike					

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
N	Shipping - noise pollution (vessel)					
N	Shipping - noise pollution (pile driving & dredging)					
Y	Shipping - pollution (oil, fuel, antifoul)	1	4	4	L	Tributyltin biocide (TBT) is no longer used for small and large vessels, which is considered an improvement. However, copper-based coatings are being used and impact of copper and contemporary contaminants is unknown. *Caveat: Scored with no knowledge on impacts of copper-based contaminants.* *Data confidence* • *Low confidence around the impact of copper-based contaminants*
Y	Shipping - pests	2	3	6	M	Pests likely would not come from ballast water discharge, which is prohibited, but they could come from hull fouling. Shipping and ship movement in and out of Gulf already exists. No biosecurity monitoring by DPIRD is taking place. Potential for pests (including bacteria, viruses, pathogens, and fungi) to smother or consume algae. However, algae is expansive and quick to reproduce. Currently, the majority of Exmouth Gulf users (industrial and recreational) are from domestic waters. A port targeting international ships would change the risk - based on this consequence changed to a 2. *Assumptions: Tourist, industrial vessels and international vessels need to be considered, given the type of port and exact uses of the port are unknown. Would prefer to see only small cargo ships use a port if it were to go into Exmouth Gulf. Submarines could potentially enter the Exmouth Gulf, as well as other local, national and foreign naval vessels.* *Data confidence* • *High confidence that vessels entering Exmouth Gulf increase the risk of introduced marine pests - see Biofouling Solutions (2018). Subsea 7 Learmonth Bundle Site - Invasive Marine Species and Pathogen Desktop Risk Assessment. Report for Subsea 7 Australia Contracting Pty Ltd. Report Reference BFS1551; Version 4.0.*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						• *Medium confidence around the types of vessels entering the Gulf if a port was developed* • *Low confidence in how macroalgae would be impacted specifically*
N	Shipping - light pollution					
Y	Shipping - suspended sediments (dredging and prop wash)	2	4	8	H	The types of dredging that can produce suspended sediments include capital and maintenance dredging. Stirring up of sediments from ships should also be considered. The Gulf is a shallow body of water and thus more susceptible to resuspension of sediments. Platforms along the western Gulf that macroalgae grow on are 3-4m deep. These would be locally impacted if resuspension is continuous. Considerations: Dredging for port will be short term and near platforms. Dredging plume from ships would likely be offshore, and not around platforms? Easterly winds may blow plume inshore. Trawling for prawns results in high levels of resuspended sediments and decreases water quality along the western margin of the Gulf. Divers often will not dive at certain locations during trawling season (Apr-Dec). Suspended sediments are more significant for coral. There can be controls put in place to manage suspended sediments and how to handle dredge spoil. Less controls are needed with shipping plumes than with dredging plumes. *Scoring does not consider potential controls/management.* ***Cumulative impact considerations*** *The Gulf is already a very turbid environment - strong tides influence greater movement of sediments (2.5m tidal range). Trawling adds to turbidity. Future shipping and volume of ships could then add to this. However, ships move on high tide.* *Caveats* ***More knowledge needed*** *on the type of sediments in the Gulf. Need to know grain size, muddy or sandy.* *Subsea 7 should have some info here - reports mentions 'pretty fine' sediments.* *The dredging process generates fine sediments.*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						Some discussion around whether a 3 or 4 was needed for Likelihood. Settled on 4 after considering the above caveat. *Data confidence* • *High confidence that algae occur in the area that would be exposed to suspended sediments* • *High confidence that suspended sediments can impact benthic habitats such as macroalgae beds - see WAMSI Dredging Node reports* • *Medium confidence around the exact port footprint and extent of dredging*
Value: Seagrass						
Y	Shipping - port infrastructure footprint (incl channel)	2	4	8	L-M	There are significant patches of seagrass north and south of proposed Gascoyne Gateway port footprint on the western Gulf. If this is a smaller spatial extent compared to seagrass meadows on the east side, does that make it more important to protect? Dugongs have been observed feeding on the western margin of Gulf, around proposed Gascoyne Gateway area, and feeding scars are visible along the stretch of the western margin. *Caveats* ***More knowledge needed.*** *There is uncertainty around the species present on the western margin. Some of the seagrass species in the Gulf form permanent meadows and some ephemeral.* *Data confidence* • *Low - medium confidence in the extent of seagrass along western margin of Gulf e.g., Lyne et al. (2006)* • *Medium confidence around final footprint extent*
N	Shipping - vessel strike					
N	Shipping - noise pollution (vessel)					
N	Shipping - noise pollution (pile driving & dredging)					

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
Y	Shipping - pollution (oil, fuel, antifoul)	1	4	4	L	TBT biocide is no longer used for small and large vessels, which is considered an improvement. However, copper-based coatings are being used and the impact of copper and contemporary contaminants is unknown. *Caveat: scored with no knowledge on impacts of copper-based contaminants.* *Data confidence* • *Low confidence around the impact of copper-based contaminants*
Y	Shipping - pests	2	3	6	M	Pests likely would not come from ballast water discharge, which is prohibited, but they could come from hull fouling. Shipping and ship movement in and out of Gulf already exists. No biosecurity monitoring by DPIRD is taking place. There is a potential for pests to smother or consume seagrass. Seagrass slower to recover than algae. Currently, the majority of Exmouth Gulf users (industrial and recreational) are from domestic waters. A port targeting international ships would change the risk - based on this consequence changed to a 2. *Assumptions: Tourist, industrial vessels and international vessels need to be considered, given the type of port and exact uses of the port are unknown. Would prefer to see only small cargo ships use a port if it were to go into Exmouth Gulf. Submarines could potentially enter the Exmouth Gulf, as well as other local, national and foreign naval vessels.* *Data confidence* • *High confidence that vessels entering Exmouth Gulf increase the risk of introduced marine pests - see Biofouling Solutions (2018)* • *Medium confidence around the types of vessels entering the Gulf if a port was developed* • *Low confidence in how seagrass would be impacted specifically*
N	Shipping - light pollution					

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
Y	Shipping - suspended sediments (dredging and prop wash)	2	4	8	H	The types of dredging that can produce suspended sediments include capital and maintenance dredging. Stirring up of sediments from ships should also be considered. The Gulf is a shallow body of water and thus more susceptible to resuspension of sediments. Seagrass occurring along western margin. These would be locally impacted if resuspension is continuous. Considerations: Dredging for port will be short term and near platforms. Dredging plume from ships would likely be offshore, and not around platforms? Easterly winds may blow plume inshore. Trawling for prawns results in a high level of resuspended sediments and decreases water quality along the western margin of the Gulf. Divers often will not dive at certain locations during trawling season (Apr-Dec). Suspended sediments are more significant for coral. There can be controls put in place to manage suspended sediments and how to handle dredge spoil. Less controls are needed with shipping plumes than with dredging plumes. *Scoring does not consider potential controls/management.* ***Cumulative impact considerations*** *The Gulf is already a very turbid environment - strong tides influence greater movement of sediments (2.5m tidal range). Trawling adds to turbidity. Future shipping and volume of ships could then add to this. However, ships move on high tide.* *Caveats* ***More knowledge needed*** *on the type of sediments in the Gulf i.e., grain size, muddy or sandy.* *Subsea 7 should have some info here - reports mentions 'pretty fine' sediments.* *The dredging process generates fine sediments.* There was some discussion around whether a 3 or 4 was needed for Likelihood. Settled on 4 after considering the above caveat. *Data confidence* • *High confidence that seagrass occurs in the area that would be exposed to suspended sediments*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						• *High confidence that suspended sediments can impact benthic habitats such as seagrasses - see WAMSI Dredging Node reports* • *Medium confidence around the exact port footprint and extent of dredging*
Value: Coral						
Y	Shipping - port infrastructure footprint (incl channel)	2	4	8	M	Some bommies may be impacted. These are known to occur in the area of the proposed footprint (dependent on the port concept). *Data confidence* • *Medium confidence in the extent of corals along western margin of Gulf e.g., Lyne et al. (2006), Twiggs and Collins (2010)* • *Medium confidence around final footprint extent*
N	Shipping - vessel strike					
N	Shipping - noise pollution (vessel)					
N	Shipping - noise pollution (pile driving & dredging)					
Y	Shipping - pollution (oil, fuel, antifoul)	1	4	4	L	TBT is no longer used for small and large vessels, which is considered an improvement. However, copper-based coatings are being used and impact of copper and contemporary contaminants is unknown. *Caveat: scored with no knowledge on impacts of copper-based contaminants.* *Data confidence* • *Low confidence around the impact of copper-based contaminants*
Y	Shipping - pests	2	3	6	M	Pests/diseases likely would not come from ballast water discharge, which is prohibited, but they could come from hull fouling. Shipping and ship movement in and out of Gulf already exists. No biosecurity monitoring by DPIRD is taking place.

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						There is uncertainty around what pests would impact corals, though coral disease has occurred on Ningaloo Reef. Need to check whether these are introduced diseases or naturally occurring in the region. Currently, the majority of Exmouth Gulf users (industrial and recreational) are from domestic waters. A port targeting international ships would change the risk - based on this, consequence changed to a 2. *Assumptions: Tourist, industrial vessels and international vessels need to be considered, given the type of port and exact uses of the port are unknown. Would prefer to see only small cargo ships use a port if it were to go into Exmouth Gulf. Submarines could potentially enter the Exmouth Gulf, as well as other local, national and foreign naval vessels.* *Data confidence* • *High confidence that vessels entering Exmouth Gulf increase the risk of introduced marine pests - see Biofouling Solutions (2018)* • *Medium confidence around the types of vessels entering the Gulf if a port was developed* • *Low confidence in how corals would be impacted specifically*
N	Shipping - light pollution					
Y	Shipping - suspended sediments (dredging and prop wash)	2	4	8	H	The types of dredging that can produce suspended sediments include capital and maintenance dredging. Stirring up of sediments from ships should also be considered. The Gulf is a shallow body of water and thus more susceptible to resuspension of sediments. Coral bommies occur along the western margin. These would be locally impacted if resuspension is continuous. Considerations: Dredging for port will be short term and near platforms. Dredging plume from ships would likely be offshore, and not around platforms? Easterly winds may blow plume inshore. Trawling for prawns results in high levels of resuspended sediments and decreases water quality along the western margin of the Gulf. Divers often will not dive at certain locations during trawling season (Apr-Dec).

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						Suspended sediments are more significant for coral than seagrass or algae. There can be controls put in place to manage suspended sediments and how to handle dredge spoil. Less controls are needed with shipping plumes than with dredging plumes. *Scoring does not consider potential controls/management.* ***Cumulative impact considerations*** *The Gulf is already a very turbid environment - strong tides influence greater movement of sediments (2.5m tidal range). Trawling adds to turbidity. Future shipping and volume of ships could then add to this. However, ships move on high tide.* *Caveats* ***More knowledge needed*** *on the type of sediments in the Gulf i.e., grain size, muddy or sandy.* *Subsea 7 should have some info here - reports mentions 'pretty fine' sediments.* *The dredging process generates fine sediments.* Some discussion around whether a 3 or 4 was needed for Likelihood. Settled on 4 after considering the above caveat. *Data confidence* • *High confidence that coral occurs in the area that would be exposed to suspended sediments* • *High confidence that suspended sediments can impact benthic habitats such as corals - see WAMSI Dredging Node reports* • *Medium confidence around the exact port footprint and extent of dredging*
Value: Sponges and filter feeders						
Y	Shipping - port infrastructure footprint (incl channel)	2	4	8	L-M	Likely some occurrences of sponges and filter feeders along the western margin. **More knowledge needed** about the density of occurrence *Data confidence* • *Low confidence in the extent of sponges and filter feeders along the western margin of Gulf. Most extensive area known is between North West Cape and the Muiron Islands e.g., RPS Bowman Bishaw Gorham (2004)*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						• *Medium confidence around final footprint extent*
N	Shipping - vessel strike					
N	Shipping - noise pollution (vessel)					
N	Shipping - noise pollution (pile driving & dredging)					
Y	Shipping - pollution (oil, fuel, antifoul)	1	4	4	L	TBT is no longer used for small and large vessels, which is considered an improvement. However, copper-based coatings are being used and impact of copper and contemporary contaminants is unknown. *Caveat: scored with no knowledge on impacts of copper-based contaminants.* *Data confidence* • *Low confidence around the impact of copper-based contaminants*
Y	Shipping - pests	2	3	6	M	Pests/diseases likely would not come from ballast water discharge, which is prohibited, but they could come from hull fouling. Shipping and ship movement in and out of Gulf already exists. No biosecurity monitoring by DPIRD is taking place. Uncertainty around what pests would impact sponges/ascidians. Currently, the majority of Exmouth Gulf users (industrial and recreational) are from domestic waters. A port targeting international ships would change the risk - based on this consequence changed to a 2. *Assumptions: Tourist, industrial vessels and international vessels need to be considered, given the type of port and exact uses of the port are unknown. Would prefer to see only small cargo ships use a port if it were to go into Exmouth Gulf. Submarines could potentially enter the Exmouth Gulf, as well as other local, national and foreign naval vessels.* *Data confidence* • *High confidence that vessels entering Exmouth Gulf increase the risk of introduced marine pests - see Biofouling Solutions (2018)*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						• *Medium confidence around the types of vessels entering the Gulf if a port was developed* • *Low confidence in how sponges and filter feeders would be impacted specifically - the only known pest record in the Gulf in a colonial ascidian which appears to be confined to artificial structures. Could increase competition for resources, though this report considered sea bottom sponges and filter feeders rather than communities occuring on artificial structures.*
N	Shipping - light pollution					
Y	Shipping - suspended sediments (dredging and prop wash)	2	4	8	M	Impacted more than macroalgae and seagrass. Impacted similar to coral. As above. *Data confidence* • *Medium confidence that sponges and filter feeders occur in the area that would be exposed to suspended sediments* • *High confidence that suspended sediments can impact benthic habitats such as sponges and filter feeders - see WAMSI Dredging Node reports* • *Medium confidence around the exact port footprint and extent of dredging*
Value: Sand and mud						
Y	Shipping - port infrastructure footprint (incl channel)	1	4	4	M-H	Sediments and infauna communities will definitely be impacted by the footprint. Growth of infauna species is quicker than other marine life. Typically, widespread - prevalent. Not likely to be wiping out a small, localised patch of endemics as they will occur nearby. Sub-sediment communities would be occurring at 10-15m, where a channel could be and ships anchor. These soft sediment communities need more investigation. Unsure about their ecological importance - **More knowledge needed.** Not sure what footprint will look like. *Data confidence*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						• *High confidence that sand and mud communities will be disturbed as they are the most extensive habitat throughout the Gulf - e.g., BMT (2020); Lyne et al. (2006); MBS Environmental (2018)* • *Medium confidence around final footprint extent*
N	Shipping - vessel strike					
N	Shipping - noise pollution (vessel)					
N	Shipping - noise pollution (pile driving & dredging)					
Y	Shipping - pollution (oil, fuel, antifoul)	1	4	4	L	TBT is no longer used for small and large vessels, which is considered an improvement. However, copper-based coatings are being used and impact of copper and contemporary contaminants is unknown. *Caveat: scored with no knowledge on impacts of copper-based contaminants.* *Data confidence* • *Low confidence around the impact of copper-based contaminants*
Y	Shipping - pests	2	3	6	M	Pests/diseases likely would not come from ballast water discharge, which is prohibited, but they could come from hull fouling. Shipping and ship movement in and out of Gulf already exists. No biosecurity monitoring by DPIRD is taking place. There is uncertainty around what pests would impact infauna. Currently, the majority of Exmouth Gulf users (industrial and recreational) are from domestic waters. A port targeting international ships would change the risk - based on this consequence changed to a 2. *Assumptions: Tourist, industrial vessels and international vessels need to be considered, given the type of port and exact uses of the port are unknown. Would prefer to see only small cargo ships use a port if it were to go into Exmouth Gulf. Submarines could potentially enter the Exmouth Gulf, as well as other local, national and foreign naval vessels.*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						Data confidence • *High confidence that vessels entering Exmouth Gulf increase the risk of introduced marine pests - see Biofouling Solutions (2018)* • *Medium confidence around the types of vessels entering the Gulf if a port was developed* • *Low confidence in how sand and mud communities would be impacted specifically*
N	Shipping - light pollution					
Y	Shipping - suspended sediments (dredging and prop wash)	1/2	3	3-6	M	Infauna live in sediments, so continual resuspension will disturb communities. Same reasonings as above. *Data confidence* • *High confidence that sand and mud (and associated communities) occur in the area that would be exposed to suspended sediments* • *High confidence that suspended sediments can impact benthic habitats - see WAMSI Dredging Node reports - but low confidence in how sand and mud communities would specifically be impacted* • *Medium confidence around the exact port footprint and extent of dredging*
Value: Mangroves						
Y	Shipping - port infrastructure footprint (incl channel)	1	3	3	M	Shipping needs to be considered for any industrial salt facility established on the eastern margin of the Gulf. *Assumption: Low barges would be needed to make transfers to a deeper water port around Serrurier Island.* If K+S Salt's Ashburton Salt proposal goes ahead, it will most likely be shipping off the northern most end of the scope area. The footprint for this would likely be less than the Gascoyne Gateway proposal and there would be less accompanying dredging activities. It is likely a cut would need to be made through the mangroves to reach the barge. Localised impact. Unsure if there will be a cut, so a 'possible'. Mangroves occurring along the western and southern margins of the Gulf are not in close proximity to the proposed Gascoyne Gateway footprint

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						Data confidence • *High confidence that mangrove occurs along eastern margin and would be impacted by shipping infrastructure in relation to salt facility* • *Low confidence around footprint extent related to salt facilities*
N	Shipping - vessel strike					
N	Shipping - noise pollution (vessel)					
N	Shipping - noise pollution (pile driving & dredging)					
Y	Shipping - pollution (oil, fuel, antifoul)	2	4	8	M	Oil and fuel spills will impact mangroves as the spill would inundate intertidal areas. Roots and stems can get smothered. Bay of Rest and Giralia Bay to Yanrey Flats are identified as Regionally Significant areas for mangroves. *Caveat: Scored with no knowledge on impacts of copper-based contaminants.* *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *High confidence that oil and fuel spills can impact mangroves* • *Medium confidence that wetlands along eastern margin in Exmouth Gulf are at 'low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*
Y	Shipping - pests	1	3	3	M	Similar reasons as above for sand and mud. *Data confidence* • *High confidence that vessels entering Exmouth Gulf increase the risk of introduced marine pests - see Biofouling Solutions (2018)* • *Medium confidence around the types of vessels entering the Gulf if a port was developed* • *Low confidence in how mangroves would be impacted specifically*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
N	Shipping - light pollution					
N	Shipping - suspended sediments (dredging and prop wash)					
Value: Samphire						
Y	Shipping - port infrastructure footprint (including channel)	1	3	3	L-M	Shipping needs to be considered if an industrial salt facility is established on the eastern margin of the Gulf. *Assumption: Low barges would be needed to make transfers to a deeper water port around Serrurier Island.* If K+S Salt's Ashburton Salt proposal goes ahead, it will most likely be shipping off the northern most end of the scope area. The footprint for this would likely be less than the Gascoyne Gateway proposal (less accompanying dredging activities). It is likely that a cut would need to be made through the samphire to reach the barge. Localised impact. Unsure if there will be a cut so a 'possible'. Some samphire may occur along the western margin. The Gascoyne Gateway footprint will not be over samphire. *Data confidence* • *High confidence that samphire occurs along eastern margin and would be impacted by shipping infrastructure in relation to salt facility* • *Low confidence around footprint extent related to salt facilities* • *Low confidence around the occurrence of samphire in area of proposed Gascoyne Gateway footprint, but is known to occur elsewhere along western margin*
N	Shipping - vessel strike					
N	Shipping - noise pollution (vessel)					
N	Shipping - noise pollution (pile driving & dredging)					

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
Y	Shipping - pollution (oil, fuel, antifoul)	1/2	4	4-8	M	Oil and fuel spills will impact samphire as the spill will inundate intertidal areas. Roots and stems can get smothered. *Caveat: Scored with no knowledge on impacts of copper-based contaminants.* *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *High confidence that oil and fuel spills can impact samphire* • *Medium confidence that wetlands along eastern margin in Exmouth Gulf at 'low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*
Y	Shipping - pests	1	3	3	M	Similar reasons as above for sand and mud. *Data confidence* • *High confidence that vessels entering Exmouth Gulf increase the risk of introduced marine pests - see Biofouling Solutions (2018)* • *Medium confidence around the types of vessels entering the Gulf if a port was developed* • *Low confidence in how samphire would be impacted specifically*
N	Shipping - light pollution					
N	Shipping - suspended sediments (dredging and prop wash)					
Value: Blue green algal mats						
N	Shipping - port infrastructure footprint (incl channel)					Shipping infrastructure should not impact algal mats. Industrial salt facility footprint already considered and scored. N/A
N	Shipping - vessel strike					
N	Shipping - noise pollution (vessel)					

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
N	Shipping - noise pollution (pile driving & dredging)					
Y	Shipping - pollution (oil, fuel, antifoul)	1	3	3	L-M	Most spills would likely accumulate around stems of mangroves and saltmarshes and may not reach the algal mats. However, the algal mats may still get submerged depending on the tides and whether the waters were carrying an oil and fuel spill. It is unlikely that a huge spill will occur and reach the upper intertidal areas of the eastern gulf - but not impossible. *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Medium confidence that oil and fuel spills can impact blue green algae mats* • *Medium confidence that wetlands along eastern margin in Exmouth Gulf at 'low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*
Y	Shipping - pests	1	2	2	L-M	There is uncertainty as to whether there would be marine and or terrestrial pests that could grow over algal mats. Algal mats are at the interface between both environments, so require marine and terrestrial pest considerations. Marine pests would need to survive the extreme environment of the intertidal zone and exposure to sun - hypersaline environment. *Data confidence* • *High confidence that vessels entering Exmouth Gulf increase the risk of introduced marine pests - see Biofouling Solutions (2018)* • *Medium confidence around the types of vessels entering the Gulf if a port was developed* • *Low confidence in the types of terrestrial pests that could impact mats* • *Low confidence in the types of marine pests that could impact mats*
N	Shipping - light pollution					

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
N	Shipping - suspended sediments (dredging and prop wash)					
Value: Reef flats and oyster beds						
Y	Shipping - port infrastructure footprint (incl channel)	1	4	4	M	Limestone flats are present in the area of the proposed Gascoyne Gateway footprint. Oyster beds are towards south. Infrastructure would remove the physical hard structures of reefs. *Data confidence* • *High confidence that reef flats occur along western margin and in vicinity of proposed port area* • *Medium confidence around footprint extent of port facility on western margin*
N	Shipping - vessel strike					
N	Shipping - noise pollution (vessel)					
N	Shipping - noise pollution (pile driving & dredging)					
Y	Shipping - pollution (oil, fuel, antifoul)	1	4	4	M	Oil and fuel can smother surfaces of reef flats and oyster beds *Caveat: Scored with no knowledge on impacts of copper-based contaminants.* *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *High confidence that oil and fuel spills can impact reef flats and oyster beds* • *Medium confidence around much of Exmouth Gulf being rated as 'very low to low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*
Y	Shipping - pests	2	3	6	M	Similar reasons as above for sand and mud. *Data confidence*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						• *High confidence that vessels entering Exmouth Gulf increase the risk of introduced marine pests - see Biofouling Solutions (2018)* • *Medium confidence around the types of vessels entering the Gulf if a port was developed* • *Low confidence in how reef flats and oyster beds would be impacted specifically. 'The only known pathogen documented to date in the Exmouth Gulf is an unknown species of infectious intracellular ciliate which was found in the digestive glands of cultured oysters (Pinctada maxima) in the Exmouth Gulf in 2006, and appears to have caused oyster oedema disease and severe mortality' - see Biofouling Solutions (2018)*
N	Shipping - light pollution					
Y	Shipping - suspended sediments (dredging and prop wash)	2	4	8	M	Not really an issue for reef flats but could be a serious issue for oysters as they are filter feeders. *Data confidence* • *High confidence that reef flats occur in the in the area that would be exposed to suspended sediments* • *High confidence that suspended sediments can impact filter feeders* • *Low confidence whether dredge plumes would reach oyster stacks in the southern end* • *Medium confidence around the exact port footprint and extent of dredging*
Value: Salt flats						
N	Shipping - port infrastructure footprint (incl channel)					N/A - as above
N	Shipping - vessel strike					
N	Shipping - noise pollution (vessel)					

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
N	Shipping - noise pollution (pile driving & dredging)					
Y	Shipping - pollution (oil, fuel, antifoul)	1	3	3	L-M	Most spills would likely accumulate around stems of mangroves and saltmarshes and may not reach the salt flats. However, salt flats still may get submerged depending on the tides and whether the waters were carrying oil and fuel spill. It is unlikely that a huge spill will occur and reach the upper intertidal areas of the eastern gulf - but not impossible. *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Medium confidence that oil and fuel spills can impact blue green algae mats* • *Medium confidence that wetlands along eastern margin in Exmouth Gulf at 'low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*
Y	Shipping - pests	1	2	2	L-M	There is uncertainty around whether there would be marine and or terrestrial pests that could row over salt flats. Salt flats are at the interface between both environments, so have marine and terrestrial pest considerations. Marine pests would need to survive the extreme environment of the intertidal zone and exposure to sun - hypersaline environment. *Data confidence* • *High confidence that vessels entering Exmouth Gulf increase the risk of introduced marine pests - see Biofouling Solutions (2018)* • *Medium confidence around the types of vessels entering the Gulf if a port was developed* • *Low confidence in the types of terrestrial pests that could impact mats* • *Low confidence in the types of marine pests that could impact mats*
N	Shipping - light pollution					

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
N	Shipping - suspended sediments (dredging and prop wash)					NA
Factor: Marine fauna						
Value: Crustaceans - prawns						
Y	Shipping - port infrastructure footprint (incl channel)	1	3/4	3-4	M	A shipping channel may have some impacts, though this would just be deepening the sandy habitat that prawns inhabit. *Data confidence* • *High confidence that prawns would occur in area of port footprint* • *Medium confidence around footprint extent of port* • *Low confidence around direct impacts to prawns in the Gulf*
N	Shipping - vessel strike					
Y	Shipping - noise pollution (vessel)	1	3	3	L-M	Limited knowledge on noise impacts on prawns. Some shipping traffic already exists and there is still a productive prawn fishery. Cumulative impacts to consider: How much noise is too much? There is already noise to consider, let alone future noises. *Data confidence* • *Low confidence around the impact of anthropogenic noises on prawns* • *Medium confidence around the types of vessels that will be using the gulf in relation to port development, and the noise they will emit*
Y	Shipping - noise pollution (pile driving & dredging)	1	3	3	L	Limited knowledge on noise impacts on prawns. Some shipping traffic already exists and there is still a productive prawn fishery. Cumulative impacts to consider: How much noise is too much? There is already noise to consider, let alone future noises. *Data confidence* • *Low confidence around the impact of anthropogenic noises on prawns*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						• *Low confidence around the frequency of pile driving and dredging activity*
Y	Shipping - pollution (oil, fuel, antifoul)	1	4	4	L-M	Unless oil and fuel sinks to bottom, prawns may be relatively unaffected. *Caveat: Scored with no knowledge on impacts of copper-based contaminants.* *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spills impact prawns* • *Medium confidence around much of Exmouth Gulf being rated as 'very low to low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*
Y	Shipping - pests	2	2/3	4-6	M-H	There is a biosecurity risk for prawns - white spot disease. There is no evidence to suggest this has come from shipping, and it is more likely the use of raw products as bait by recreational fishers could be the cause. Addressed by the Australian Quarantine and Inspection Service and bait imports. Currently, the majority of Exmouth Gulf users (industrial and recreational), are from domestic waters. A port targeting international ships would change the risk - based on this consequence changed to a 2. *Data confidence* • *High confidence that vessels entering Exmouth Gulf increase the risk of introduced marine pests - see Biofouling Solutions (2018)* • *Medium confidence around the types of vessels entering the Gulf if a port was developed* • *Medium confidence in the types of marine pests and pathogens that could impact prawns*
Y	Shipping - light pollution	1	3	3	M	Prawns come out at night. There is uncertainty as to how they are impacted by light above the surface. It is expected the Gascoyne Gateway proposal would produce a lot of light. Light interacting with turbidity is a factor - light reaching the bottom and disturbing prawns is unlikely due to turbidity?

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						Data confidence • *High confidence that light pollution will increase with port development* • *Low confidence around how light pollution impacts prawns*
Y	Shipping - suspended sediments (dredging and prop wash)	1	4	4	M	Prawns live and feed on soft-bottom environments, and suspended sediments may impact on foraging and other behaviours. Cumulative impacts to consider: The Gulf is already a turbid environment. *Data confidence* • *High confidence that prawns occur in the in the area that would be exposed to suspended sediments* • *Low confidence that suspended sediments can impact prawns* • *Medium confidence around the exact port footprint and extent of dredging*
Value: Crustaceans - mud crabs						
Y	Shipping - port infrastructure footprint (incl channel)	1	3/4	3-4	M	As above for prawns. *Data confidence* • *High confidence that mud crabs would not occur in area of port footprint on western margin* • *Medium confidence around footprint extent of port on western margin* • *Low confidence around possibility of some infrastructure on eastern margin in relation to salt facility, which would impact on mud crabs*
N	Shipping - vessel strike					
Y	Shipping - noise pollution (vessel)	1	3	3	L-M	As above for prawns. *Data confidence* • *Low confidence around the impact of anthropogenic noises on mud crabs* • *Medium confidence around the types of vessels that will be using the gulf in relation to port development, and the noise they will emit*
Y	Shipping - noise pollution (pile driving & dredging)	1	3	3	L	As above for prawns.

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						Data confidence • *Low confidence around the impact of anthropogenic noises on mud crabs* • *Low confidence around the frequency of pile driving and dredging activity*
Y	Shipping - pollution (oil, fuel, antifoul)	1	4	4	L-M	As above for prawns. *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spills impact mud crabs* • *Medium confidence around much of Exmouth Gulf being rated as 'very low to low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*
Y	Shipping - pests	2	2/3	4-6	M	Uncertainty around diseases, parasites. Currently, the majority of Exmouth Gulf users (industrial and recreational) are from domestic waters. A port targeting international ships would change the risk - based on this consequence changed to a 2. *Caveat: scored with limited data -* ***more knowledge needed.*** *Data confidence* • *High confidence that vessels entering Exmouth Gulf increase the risk of introduced marine pests - see Biofouling Solutions (2018)* • *Medium confidence around the types of vessels entering the Gulf if a port was developed* • *Low confidence in the types of marine pests that could impact mud crabs*
Y	Shipping - light pollution	1	3	3	M	It is expected the Gascoyne Gateway proposal would produce a lot of light. Light interacting with turbidity is a factor i.e., less light reaching through the water column. *Data confidence* • *High confidence that light pollution will increase with port development* • *Low confidence around how light pollution impacts mud crabs*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
Y	Shipping - suspended sediments (dredging and prop wash)	1	4	4	M	As above for prawns. *Data confidence* • *High confidence that mud crabs probably do not occur in the area that would be exposed to suspended sediments* • *Low confidence that suspended sediments can impact mud crabs* • *Medium confidence around the exact port footprint and extent of dredging*
Value: Teleost - whiting						
N	Shipping - port infrastructure footprint (incl channel)					Not likely to influence whiting as they can move to more favourable waters. Wide ranging. N/A
N	Shipping - vessel strike					
Y	Shipping - noise pollution (vessel)	1	3	3	L-M	Possible effects but unknown. Whiting can move away from a noise source. *Caveat: Scored on very limited knowledge, therefore higher likelihood.* ***More knowledge needed.*** *Data confidence* • *Low confidence around the impact of anthropogenic noises on whiting* • *Medium confidence around the types of vessels that will be using the gulf in relation to port development, and the noise they will emit*
Y	Shipping - noise pollution (pile driving & dredging)	1	3	3	L	Possible effects but unknown. Whiting can move away from a noise source. *Caveat: Scored on very limited knowledge, therefore higher likelihood.* ***More knowledge needed.*** *Data confidence* • *Low confidence around the impact of anthropogenic noises on whiting* • *Low confidence around the frequency of pile driving and dredging activity*
Y	Shipping - pollution (oil, fuel, antifoul)	2	3	6	L-M	Whiting can swim away from oil spills, though they could come into contact with pollutants which could impact their gills. There is uncertainty around copper-based contaminates. Contaminates can bioaccumulate in higher order consumers.

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						Caveat: scored with no knowledge on impacts of copper-based contaminants. *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spills impacts to whiting* • *Medium confidence around much of Exmouth Gulf being rated as 'very low to low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*
Y	Shipping - pests	2	3	6	M	Uncertainty around diseases, parasites. Currently, the majority of Exmouth Gulf users (industrial and recreational) are from domestic waters. A port targeting international ships would change the risk - based on this consequence changed to a 2. *Caveat: scored with limited data - **more knowledge needed.*** *Data confidence* • *High confidence that vessels entering Exmouth Gulf increase the risk of introduced marine pests - see Biofouling Solutions (2018)* • *Medium confidence around the types of vessels entering the Gulf if a port was developed* • *Low confidence in the types of marine pests that could impact fishes*
Y	Shipping - light pollution	1	3	3	M	It is expected the Gascoyne Gateway proposal would produce a lot of light. Light interacting with turbidity is a factor i.e., less light reaching through the water column. *Data confidence* • *High confidence that light pollution will increase with port development* • *Low confidence around how light pollution impacts fishes*
Y	Shipping - suspended sediments (dredging and prop wash)	2	4	8	M-H	Fine sediments can irritate gills and affect the respiratory system. *Data confidence* • *High confidence that whiting occur in the area that would be exposed to suspended sediments*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						• *Medium confidence that suspended sediments can impact fishes e.g., Partridge, G.J., and Michael, R.J. (2010) Direct and indirect effects of simulated calcareous dredge material on eggs and larvae of pink snapper Pagrus auratus. J Fish Biol 77(1), 227-40.* • *Medium confidence around the exact port footprint and extent of dredging*
Value: Teleost - mangrove jack						
Y	Shipping - port infrastructure footprint (incl channel)	1	3	3	L-M	Shipping needs to be considered for any industrial salt facility established on the eastern margin of the Gulf. Uncertain whether mangrove jacks would use the western margin much, but typically mangrove, river dwelling. *Data confidence* • *Low confidence around mangrove jacks occurring in area of port footprint on western margin* • *Medium confidence around footprint extent of port on western margin* • *Low confidence around possibility of some infrastructure on eastern margin in relation to salt facility*
N	Shipping - vessel strike					
Y	Shipping - noise pollution (vessel)	1	3	3	L-M	Perhaps more territorial and may not move away from noise? Mangrove jacks are found in mangroves. *Caveat: Scored on very limited knowledge, therefore higher likelihood. -* ***More knowledge needed*** *Data confidence* • *Low confidence around the impact of anthropogenic noises on mangrove jack* • *Medium confidence around the types of vessels that will be using the gulf in relation to port development, and the noise they will emit*
Y	Shipping - noise pollution (pile driving & dredging)	1	3	3	L	Perhaps more territorial and may not move away from noise? Mangrove jacks are found in mangroves.

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						Caveat: Scored on very limited knowledge, therefore higher likelihood. - ***More knowledge needed*** *Data confidence* • *Low confidence around the impact of anthropogenic noises on mangrove jack* • *Low confidence around the frequency of pile driving and dredging activity*
Y	Shipping - pollution (oil, fuel, antifoul)	2	3	6	L-M	Mangrove jacks can swim away from spills, though they could come into contact and impact gills. Uncertainty around copper-based contaminates. Contaminates can bioaccumulate in higher order consumers. *Caveat: scored with no knowledge on impacts of copper-based contaminants.* *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spills impacts to mangrove jack* • *Medium confidence around much of Exmouth Gulf being rated as 'very low to low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*
Y	Shipping - pests	2	3	6	M	There is uncertainty around diseases, parasites. Currently, the majority of Exmouth Gulf users (industrial and recreational) are from domestic waters. A port targeting international ships would change the risk - based on this, consequence changed to a 2. *Caveat: scored with limited data -* ***more knowledge needed*** *Data confidence* • *High confidence that vessels entering Exmouth Gulf increase the risk of introduced marine pests - see Biofouling Solutions (2018)* • *Medium confidence around the types of vessels entering the Gulf if a port was developed* • *Low confidence in the types of marine pests that could impact fishes*
Y	Shipping - light pollution	1	3	3	M	It is expected the Gascoyne Gateway proposal would produce a lot of light.

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						Light interacting with turbidity is a factor i.e., less light reaching through the water column. *Data confidence* • *High confidence that light pollution will increase with port development* • *Low confidence around how light pollution impacts fishes*
Y	Shipping - suspended sediments (dredging and prop wash)	2	4	8	M-H	Fine sediments can irritate gills and affect the respiratory system. *Data confidence* • *High confidence that mangrove jack probably do not occur in the area that would be exposed to suspended sediments - but suspended sediments could spread to mangrove areas* • *Medium confidence that suspended sediments can impact fishes e.g., Partridge, G.J., and Michael, R.J. (2010) Direct and indirect effects of simulated calcareous dredge material on eggs and larvae of pink snapper Pagrus auratus. J Fish Biol 77(1), 227-40.* • *Medium confidence around the exact port footprint and extent of dredging*
Value: Teleost - trevally						
N	Shipping - port infrastructure footprint (incl channel)					Not likely to influence trevally as they can move to more favourable waters. Wide ranging. N/A
N	Shipping - vessel strike					
Y	Shipping - noise pollution (vessel)	1	3	3	L-M	Possible effects but unknown. Trevally can move away from noise source. *Caveat: Scored on very limited knowledge, therefore higher likelihood. -* ***More knowledge needed*** *Data confidence* • *Low confidence around the impact of anthropogenic noises on trevally* • *Medium confidence around the types of vessels that will be using the gulf in relation to port development, and the noise they will emit*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
Y	Shipping - noise pollution (pile driving & dredging)	1	3	3	L	Possible effects but unknown. Trevally can move away from noise source. *Caveat: Scored on very limited knowledge, therefore higher likelihood. -* ***More knowledge needed*** *Data confidence* • *Low confidence around the impact of anthropogenic noises on trevally* • *Low confidence around the frequency of pile driving and dredging activity*
Y	Shipping - pollution (oil, fuel, antifoul)	2	3	6	L-M	Trevally can swim away from spills, though could come into contact and impact their gills. There is uncertainty around copper-based contaminates. Contaminates can bioaccumulate in higher order consumers. *Caveat: Scored with no knowledge on impacts of copper-based contaminants.* *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spills impacts to trevally* • *Medium confidence around much of Exmouth Gulf being rated as 'very low to low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*
Y	Shipping - pests	2	3	6	M	Uncertainty around diseases, parasites. Currently, the majority of Exmouth Gulf users (industrial and recreational) are from domestic waters. A port targeting international ships would change the risk - based on this, consequence changed to a 2. *Caveat: Scored with limited data -* ***more knowledge needed*** *Data confidence* • *High confidence that vessels entering Exmouth Gulf increase the risk of introduced marine pests - see Biofouling Solutions (2018)* • *Medium confidence around the types of vessels entering the Gulf if a port was developed* • *Low confidence in the types of marine pests that could impact fishes*
Y	Shipping - light pollution	1	3	3	M	It is expected the Gascoyne Gateway proposal would produce a lot of light.

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						Light interacting with turbidity is a factor i.e., less light reaching through the water column. *Data confidence* • *High confidence that light pollution will increase with port development* • *Low confidence around how light pollution impacts fishes*
Y	Shipping - suspended sediments (dredging and prop wash)	2	4	8	M-H	Fine sediments can irritate gills and affect the respiratory system. *Data confidence* • *High confidence that trevally occur in the area that would be exposed to suspended sediments* • *Medium confidence that suspended sediments can impact fishes e.g., Partridge, G.J., and Michael, R.J. (2010) Direct and indirect effects of simulated calcareous dredge material on eggs and larvae of pink snapper Pagrus auratus. J Fish Biol 77(1), 227-40.* • *Medium confidence around the exact port footprint and extent of dredging*
Value: Teleost - coral trout						
Y	Shipping - port infrastructure footprint (incl channel)	1	3	3	M	Coral trout would likely be occurring along the western margin in the vicinity of a port footprint. Benthic dwelling and infrastructure could remove some suitable habitat *Data confidence* • *Medium confidence coral trout are occurring in area of port footprint on western margin* • *Medium confidence around footprint extent of port on western margin* • *Low confidence around possibility of some infrastructure on eastern margin in relation to salt facility*
N	Shipping - vessel strike					
Y	Shipping - noise pollution (vessel)	1	3	3	L-M	Perhaps more territorial and may not move away? Found around corals/reef. Would depend on proximity to seismic activity. *Caveat: Scored on very limited knowledge, therefore higher likelihood. -* ***More knowledge needed***

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						Data confidence • *Low confidence around the impact of anthropogenic noises on coral trout* • *Medium confidence around the types of vessels that will be using the gulf in relation to port development, and the noise they will emit*
Y	Shipping - noise pollution (pile driving & dredging)	1	3	3	L	Perhaps more territorial and may not move away? Found around corals/reef. *Caveat: scored on very limited knowledge, therefore higher likelihood. -* ***More knowledge needed*** *Data confidence* • *Low confidence around the impact of anthropogenic noises on coral trout* • *Low confidence around the frequency of pile driving and dredging activity*
Y	Shipping - pollution (oil, fuel, antifoul)	2	3	6	L-M	Can swim away from spills, though could come into contact and impact gills. Uncertainty around copper-based contaminates. Contaminates can bioaccumulate in higher order consumers. *Caveat: Scored with no knowledge on impacts of copper-based contaminants.* *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spills impacts to coral trout* • *Medium confidence around much of Exmouth Gulf being rated as 'very low to low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*
Y	Shipping - pests	2	3	6	M	Uncertainty around diseases, parasites. Currently, the majority of Exmouth Gulf users (industrial and recreational) are from domestic waters. A port targeting international ships would change the risk - based on this, consequence changed to a 2. *Caveat: scored with limited data. -* ***more knowledge needed*** *Data confidence* • *High confidence that vessels entering Exmouth Gulf increase the risk of introduced marine pests - see Biofouling Solutions (2018)*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						• *Medium confidence around the types of vessels entering the Gulf if a port was developed* • *Low confidence in the types of marine pests that could impact fishes*
Y	Shipping - light pollution	1	3	3	M	It is expected the Gascoyne Gateway proposal would produce a lot of light. Light interacting with turbidity is a factor i.e., less light reaching through the water column. *Data confidence* • *High confidence that light pollution will increase with port development* • *Low confidence around how light pollution impacts fishes*
Y	Shipping - suspended sediments (dredging and prop wash)	2	4	8	M-H	Fine sediments can irritate gills and affect the respiratory system. *Data confidence* • *High confidence that coral trout occur in the area that would be exposed to suspended sediments* • *Medium confidence that suspended sediments can impact fishes e.g., Partridge, G.J., and Michael, R.J. (2010) Direct and indirect effects of simulated calcareous dredge material on eggs and larvae of pink snapper Pagrus auratus. J Fish Biol 77(1), 227-40.* • *Medium confidence around the exact port footprint and extent of dredging*
Value: Teleost - red emperor						
Y	Shipping - port infrastructure footprint (incl channel)	1	3	3	M	Red emperor is a demersal and reef-associated species that inhabit hard bottom areas and areas of vertical relief and/or large epibenthos. Shipping infrastructure on eastern and western margins could remove suitable habitat *Data confidence* • *Medium confidence red emperor is occurring in area of port footprint on western margin* • *Medium confidence around footprint extent of port on western margin* • *Low confidence around possibility of some infrastructure on eastern margin in relation to salt facility*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
N	Shipping - vessel strike					
Y	Shipping - noise pollution (vessel)	1	3	3	L-M	Possible effects but unknown. Can move away from noise source *Caveat: scored on very limited knowledge, therefore higher likelihood.* ***More knowledge needed*** *Data confidence* • *Low confidence around the impact of anthropogenic noises on red emperor* • *Medium confidence around the types of vessels that will be using the gulf in relation to port development, and the noise they will emit*
Y	Shipping - noise pollution (pile driving & dredging)	1	3	3	L	Possible effects but unknown. Can move away from noise source *Caveat: scored on very limited knowledge, therefore higher likelihood.* ***More knowledge needed*** *Data confidence* • *Low confidence around the impact of anthropogenic noises on red emperor* • *Low confidence around the frequency of pile driving and dredging activity*
Y	Shipping - pollution (oil, fuel, antifoul)	2	3	6	L-M	Can swim away from spills, though could come into contact and impact gills. Uncertainty around copper-based contaminates. Contaminates can bioaccumulate in higher order consumers. *Caveat: Scored with no knowledge on impacts of copper-based contaminants.* *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spills impacts to red emperor* • *Medium confidence around much of Exmouth Gulf being rated as 'very low to low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*
Y	Shipping - pests	2	3	6	M	Uncertainty around diseases, parasites.

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						Currently, the majority of Exmouth Gulf users (industrial and recreational) are from domestic waters. A port targeting international ships would change the risk - based on this, consequence changed to a 2. *Caveat: scored with limited data - **more knowledge needed*** *Data confidence* • *High confidence that vessels entering Exmouth Gulf increase the risk of introduced marine pests - see Biofouling Solutions (2018)* • *Medium confidence around the types of vessels entering the Gulf if a port was developed* • *Low confidence in the types of marine pests that could impact fishes*
Y	Shipping - light pollution	1	3	3	M	It is expected the Gascoyne Gateway proposal would produce a lot of light. Light interacting with turbidity is a factor i.e., less light reaching through the water column. *Data confidence* • *High confidence that light pollution will increase with port development* • *Low confidence around how light pollution impacts fishes*
Y	Shipping - suspended sediments (dredging and prop wash)	2	4	8	M-H	Fine sediments can irritate gills and affect the respiratory system. *Data confidence* • *High confidence that red emperor occurs in the area that would be exposed to suspended sediments* • *Medium confidence that suspended sediments can impact fishes e.g., Partridge, G.J., and Michael, R.J. (2010) Direct and indirect effects of simulated calcareous dredge material on eggs and larvae of pink snapper Pagrus auratus. J Fish Biol 77(1), 227-40.* • *Medium confidence around the exact port footprint and extent of dredging*

Value: Teleost - Tuskfish

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
Y	Shipping - port infrastructure footprint (incl channel)	1	3	3	M	Tuskfish can be associated with a range of habitats including sand, rubble, seagrass, algae, rock and coral substrates. Shipping infrastructure on eastern and western margins could remove suitable habitat *Data confidence* • *Medium confidence tuskfish are occurring in area of port footprint on western margin* • *Medium confidence around footprint extent of port on western margin* • *Low confidence around possibility of some infrastructure on eastern margin in relation to salt facility*
N	Shipping - vessel strike					
Y	Shipping - noise pollution (vessel)	2	3	6	L-M	A lot of sediment has been found in the stomachs of tuskfish in the gulf. They may play quite significant roles for sediment production and may be responsible for island sediments. So perhaps more than just a local impact to consider if noise impacts tuskfish. Mobile animals can move away from the sound. Role in sediment production would increase consequence. *Caveat: scored on very limited knowledge, therefore higher likelihood.* ***More knowledge needed*** *Data confidence* • *Low confidence around the impact of anthropogenic noises on tuskfish* • *Medium confidence around the types of vessels that will be using the gulf in relation to port development, and the noise they will emit*
Y	Shipping - noise pollution (pile driving & dredging)	2	3	6	L	As above *Data confidence* • *Low confidence around the impact of anthropogenic noises on tuskfish* • *Low confidence around the frequency of pile driving and dredging activity*
Y	Shipping - pollution (oil, fuel, antifoul)	2	3	6	L-M	Can swim away from spills, though could come into contact and impact gills. Uncertainty around copper-based contaminates. Contaminates can bioaccumulate in higher order consumers.

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						Caveat: Scored with no knowledge on impacts of copper-based contaminants. *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spills impacts to tuskfish* • *Medium confidence around much of Exmouth Gulf being rated as 'very low to low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*
Y	Shipping - pests	2	3	6	M	Uncertainty around diseases, parasites. Currently, the majority of Exmouth Gulf users (industrial and recreational) are from domestic waters. A port targeting international ships would change the risk - based on this, consequence changed to a 2. *Caveat: scored with limited data - **more knowledge needed*** *Data confidence* • *High confidence that vessels entering Exmouth Gulf increase the risk of introduced marine pests - see Biofouling Solutions (2018)* • *Medium confidence around the types of vessels entering the Gulf if a port was developed* • *Low confidence in the types of marine pests that could impact fishes*
Y	Shipping - light pollution	1	3	3	M	It is expected the Gascoyne Gateway proposal would produce a lot of light. Light interacting with turbidity is a factor i.e., less light reaching through the water column. *Data confidence* • *High confidence that light pollution will increase with port development* • *Low confidence around how light pollution impacts fishes*
Y	Shipping - suspended sediments (dredging and prop wash)	2	4	8	M-H	Fine sediments can irritate gills and affect the respiratory system. *Data confidence* • *High confidence that tuskfish occur in the area that would be exposed to suspended sediments*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						• *Medium confidence that suspended sediments can impact fishes e.g., Partridge, G.J., and Michael, R.J. (2010) Direct and indirect effects of simulated calcareous dredge material on eggs and larvae of pink snapper Pagrus auratus. J Fish Biol 77(1), 227-40.* • *Medium confidence around the exact port footprint and extent of dredging*
Value: Elasmobranchs - rays (shovelnose)						
Y	Shipping - port infrastructure footprint (incl channel)	2	3	6	L-M	Potentially impacts rays more than fish, as rays use the benthic environment for resting and feeding. A port footprint can remove available space. *Data confidence* • *Low confidence around the use of the western margin by rays* • *Medium confidence around footprint extent of port on western margin* • *Low confidence around possibility of some infrastructure on eastern margin in relation to salt facility, which could also impact on rays*
N	Shipping - vessel strike					Not likely as bottom dwelling. N/A
Y	Shipping - noise pollution (vessel)	1	3	3	L-M	Shovelnose rays can move away from noise. *Caveat: Scored on very limited knowledge, therefore higher likelihood - **More knowledge needed*** *Data confidence* • *Low confidence around the impact of anthropogenic noises on rays* • *Medium confidence around the types of vessels that will be using the gulf in relation to port development, and the noise they will emit*
Y	Shipping - noise pollution (pile driving & dredging)	1	3	3	L	Shovelnose rays can move away from noise. The role the rays play in sediment production would increase consequence. *Caveat: Scored on very limited knowledge, therefore higher likelihood - **More knowledge needed*** *Data confidence* • *Low confidence around the impact of anthropogenic noises on rays*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						• *Low confidence around the frequency of pile driving and dredging activity*
Y	Shipping - pollution (oil, fuel, antifoul)	2	2	4	L-M	Shovelnose rays can swim away from spills. As they are bottom dwelling, it is less likely for their gills to come into contact with oil/fuel. There is uncertainty around copper-based contaminates. Contaminates can bioaccumulate in higher order consumers. *Caveat: Scored with no knowledge on impacts of copper-based contaminants.* *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spills impacts to rays* • *Medium confidence around much of Exmouth Gulf being rated as 'very low to low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*
Y	Shipping - pests	2	3	6	M	Uncertainty around diseases and parasites. Currently, the majority of Exmouth Gulf users (industrial and recreational) are from domestic waters. A port targeting international ships would change the risk- based on this consequence changed to a 2. *Caveat: Scored with limited data - **more knowledge needed*** *Data confidence* • *High confidence that vessels entering Exmouth Gulf increase the risk of introduced marine pests - see Biofouling Solutions (2018)* • *Medium confidence around the types of vessels entering the Gulf if a port was developed* • *Low confidence in the types of marine pests that could impact rays*
Y	Shipping - light pollution	1	3	3	M	It is expected the Gascoyne Gateway proposal would produce a lot of light. Light interacting with turbidity is a factor i.e., less light reaching through the water column. *Data confidence* • *High confidence that light pollution will increase with port development* • *Low confidence around how light pollution impacts rays*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
Y	Shipping - suspended sediments (dredging and prop wash)	2	4	8	M	Fine sediments can irritate gills and affect the respiratory system. *Data confidence* • *Low confidence that shovel nose rays occur in the area that would be exposed to suspended sediments, though suspended sediments could spread* • *Medium confidence that suspended sediments can impact fishes e.g., Partridge, G.J., and Michael, R.J. (2010) Direct and indirect effects of simulated calcareous dredge material on eggs and larvae of pink snapper Pagrus auratus. J Fish Biol 77(1), 227-40.* • *Medium confidence around the exact port footprint and extent of dredging*
Value: Elasmobranchs - rays (manta) ***EPBC Act - Migratory, Marine listed***						
Y	Shipping - port infrastructure footprint (incl channel)	1	4	4	M-H	Manta rays exist in the water column, they are not bottom dwelling. The proposed port may remove a small area that would otherwise we available for feeding. *Data confidence* • *High confidence around the use of the western margin by rays - see Irvine & Salgado-Kent (2019), Jenner and Jenner (2005), Hodgson (2007)* • *Medium confidence around footprint extent of port on western margin*
Y	Shipping - vessel strike	1	2	2	L	Vessel strike is possible as mantas occur in the water column and on the surface. However, ships would be moving slowly. Vessel strike would be more of an issue for recreational boats - SEE TOURISM *Data confidence* • *Low confidence around the incidence of ship strike on manta rays in the Gulf*
Y	Shipping - noise pollution (vessel)	1	3	3	L-M	Mantas can move away from noise. *Caveat: Scored on very limited knowledge, therefore higher likelihood. -* ***More knowledge needed*** *Data confidence* • *Low confidence around the impact of anthropogenic noises on rays* • *Medium confidence around the types of vessels that will be using the gulf in relation to port development, and the noise they will emit*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
Y	Shipping - noise pollution (pile driving & dredging)	1	3	3	L	Mantas can move away from noise. *Caveat: Scored on very limited knowledge, therefore higher likelihood. -* ***More knowledge needed*** *Data confidence* • *Low confidence around the impact of anthropogenic noises on rays* • *Low confidence around the frequency of pile driving and dredging activity*
Y	Shipping - pollution (oil, fuel, antifoul)	2	3	6	L-M	Mantas can swim away from spills, though contact is possible which could impact their gills. There is uncertainty around copper-based contaminates. Contaminates can bioaccumulate in higher order consumers. *Caveat: Scored with no knowledge on impacts of copper-based contaminants.* *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spills impacts to rays* • *Medium confidence around much of Exmouth Gulf being rated as 'very low to low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*
Y	Shipping - pests	2	3	6	M	Uncertainty around diseases, parasites. Currently, the majority of Exmouth Gulf users (industrial and recreational) are from domestic waters. A port targeting international ships would change the risk - based on this, consequence changed to a 2. *Caveat: Scored with limited data. -* ***more knowledge needed*** *Data confidence* • *High confidence that vessels entering Exmouth Gulf increase the risk of introduced marine pests - see Biofouling Solutions (2018)* • *Medium confidence around the types of vessels entering the Gulf if a port was developed* • *Low confidence in the types of marine pests that could impact rays*
Y	Shipping - light pollution	1	3	3	M	It is expected the Gascoyne Gateway proposal would produce a lot of light.

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						Light interacting with turbidity is a factor i.e., less light reaching through the water column. *Data confidence* • *High confidence that light pollution will increase with port development* • *Low confidence around how light pollution impacts rays*
Y	Shipping - suspended sediments (dredging and prop wash)	2	4	8	M-H	Fine sediments can irritate gills and affect the respiratory system. *Data confidence* • *High confidence that manta rays occur in the area that would be exposed to suspended sediments - see Irvine & Salgado-Kent (2019), Jenner and Jenner (2005), Hodgson (2007)* • *Medium confidence that suspended sediments can impact fishes e.g., Partridge, G.J., and Michael, R.J. (2010) Direct and indirect effects of simulated calcareous dredge material on eggs and larvae of pink snapper Pagrus auratus. J Fish Biol 77(1), 227-40.* • *Medium confidence around the exact port footprint and extent of dredging*
Value: Elasmobranchs - sawfish						
Y	Shipping - port infrastructure footprint (incl channel)	2	3	6	L-M	Potentially impacts rays more than fish, as rays use the benthic environment for resting and feeding. A port footprint could remove available space. *Data confidence* • *Low confidence around the use of the western margin by sawfish* • *Medium confidence around footprint extent of port on western margin* • *Low confidence around possibility of some infrastructure on eastern margin in relation to salt facility, which could also impact on sawfish*
Y	Shipping - vessel strike	1	2	2	L	Sawfish are mainly bottom dwelling, but there is some possibility of vessel strike. It is more of an issue for recreational boats - SEE TOURISM *Data confidence* • *Low confidence around the incidence of ship strike on sawfish in the Gulf*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
Y	Shipping - noise pollution (vessel)	1	3	3	L-M	Sawfish can move away from noise. *Caveat: Scored on very limited knowledge, therefore higher likelihood - **More knowledge needed*** *Data confidence* • *Low confidence around the impact of anthropogenic noises on sawfish* • *Medium confidence around the types of vessels that will be using the gulf in relation to port development, and the noise they will emit*
Y	Shipping - noise pollution (pile driving & dredging)	1	3	3	L	Sawfish can move away from noise. *Caveat: Scored on very limited knowledge, therefore higher likelihood - **More knowledge needed*** *Data confidence* • *Low confidence around the impact of anthropogenic noises on sawfish* • *Low confidence around the frequency of pile driving and dredging activity*
Y	Shipping - pollution (oil, fuel, antifoul)	2	2	4	L-M	Sawfish can swim away from spills. They are bottom dwelling and less likely to come into contact with oil/fuel. There is uncertainty around copper-based contaminates. Contaminates can bioaccumulate in higher order consumers. *Caveat: Scored with no knowledge on impacts of copper-based contaminants.* *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spills impacts to sawfish* • *Medium confidence around much of Exmouth Gulf being rated as 'very low to low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*
Y	Shipping - pests	2	3	6	M	Uncertainty around diseases, parasites. Currently, the majority of Exmouth Gulf users (industrial and recreational) are from domestic waters. A port targeting international ships would change the risk - based on this, consequence changed to a 2. *Caveat: Scored with limited data - **more knowledge needed.***

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						Data confidence • *High confidence that vessels entering Exmouth Gulf increase the risk of introduced marine pests - see Biofouling Solutions (2018)* • *Medium confidence around the types of vessels entering the Gulf if a port was developed* • *Low confidence in the types of marine pests that could impact sawfish*
Y	Shipping - light pollution	1	3	3	M	It is expected the Gascoyne Gateway proposal would produce a lot of light. Light interacting with turbidity is a factor i.e., less light reaching through the water column. *Data confidence* • *High confidence that light pollution will increase with port development* • *Low confidence around how light pollution impacts sawfish*
Y	Shipping - suspended sediments (dredging and prop wash)	2	4	8	M	Fine sediments can irritate gills and affect the respiratory system. *Data confidence* • *Low confidence that sawfish occur in the area that would be exposed to suspended sediments, though suspended sediments could spread* • *Medium confidence that suspended sediments can impact fishes e.g., Partridge, G.J., and Michael, R.J. (2010) Direct and indirect effects of simulated calcareous dredge material on eggs and larvae of pink snapper Pagrus auratus. J Fish Biol 77(1), 227-40.* • *Medium confidence around the exact port footprint and extent of dredging*
Value: Elasmobranchs - sharks						
Y	Shipping - port infrastructure footprint (incl channel)	1	4	4	M	Sharks use the water column. The proposed port area might remove a small area that would otherwise be available for feeding. *Data confidence* • *Medium confidence around the use of the western margin by sharks (whale sharks do not usually occur, but other sharks likely would)* • *Medium confidence around footprint extent of port on western margin*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
Y	Shipping - vessel strike	1/2	3	3-6	L	Sharks inhabit the water column and can come to the surface. However, ships are moving slowly. However, whale sharks (EPBC Act - Vulnerable, Migratory) move slowly, are less agile than other sharks and are more likely to be at the surface. Vessel strike could be more of an issue for recreational boats? - SEE TOURISM *Data confidence* • *Low confidence around the incidence of ship strike on sharks in the Gulf*
Y	Shipping - noise pollution (vessel)	1	3	3	L-M	Sharks can move away from noise. *Caveat: Scored on very limited knowledge, therefore higher likelihood -* ***More knowledge needed*** *Data confidence* • *Low confidence around the impact of anthropogenic noises on sharks* • *Medium confidence around the types of vessels that will be using the gulf in relation to port development, and the noise they will emit*
Y	Shipping - noise pollution (pile driving & dredging)	1	3	3	L	Sharks can move away from noise. *Caveat: Scored on very limited knowledge, therefore higher likelihood -* ***More knowledge needed*** *Data confidence* • *Low confidence around the impact of anthropogenic noises on sharks* • *Low confidence around the frequency of pile driving and dredging activity*
Y	Shipping - pollution (oil, fuel, antifoul)	2	3	6	L-M	Sharks can swim away from spills, though contact is possible which could impact their gills. There is uncertainty around copper-based contaminates. Contaminates can bioaccumulate in higher order consumers. *Caveat: Scored with no knowledge on impacts of copper-based contaminants.* *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spills impacts to sharks*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						• *Medium confidence around much of Exmouth Gulf being rated as 'very low to low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*
Y	Shipping - pests	2	3	6	M	Uncertainty around diseases, parasites. Currently, the majority of Exmouth Gulf users (industrial and recreational) are from domestic waters. A port targeting international ships would change the risk - based on this, consequence changed to a 2. *Caveat: Scored with limited data -* ***more knowledge needed*** *Data confidence* • *High confidence that vessels entering Exmouth Gulf increase the risk of introduced marine pests - see Biofouling Solutions (2018)* • *Medium confidence around the types of vessels entering the Gulf if a port was developed* • *Low confidence in the types of marine pests that could impact sharks*
Y	Shipping - light pollution	1	3	3	M	It is expected the Gascoyne Gateway proposal would produce a lot of light. Light interacting with turbidity is a factor i.e., less light reaching through the water column. *Data confidence* • *High confidence that light pollution will increase with port development* • *Low confidence around how light pollution impacts sharks*
Y	Shipping - suspended sediments (dredging and prop wash)	2	4	8	M	Fine sediments can irritate gills and affect the respiratory system. *Data confidence* • *Medium confidence that sharks occur in the area that would be exposed to suspended sediments, though suspended sediments could spread* • *Medium confidence that suspended sediments can impact fishes e.g., Partridge, G.J., and Michael, R.J. (2010) Direct and indirect effects of simulated calcareous dredge material on eggs and larvae of pink snapper Pagrus auratus. J Fish Biol 77(1), 227-40.*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						• *Medium confidence around the exact port footprint and extent of dredging*
Value: Marine reptiles - sea snakes						
Y	Shipping - port infrastructure footprint (incl channel)	2	3	6	M	Several species are EPBC conservation listed, including Critically Endangered. Some species have a small home range, and the port may impact on this home range. It might also remove some foraging area. A small home range suggests a higher consequence. *Data confidence* • *Medium confidence around the use of the western margin by sea snakes (based on catch in trawl nets)* • *Medium confidence around footprint extent of port on western margin*
Y	Shipping - vessel strike	1/2	2	2-4	L	Strikes could relate more to entanglement in propellors? There is uncertainty around the occurrence of snakes and vessel strikes. This is more of an issue for recreational boats - SEE TOURISM *Caveat: Scored with very limited data - **more knowledge needed*** *Data confidence* • *Low confidence around the incidence of ship strike on sea snakes in the Gulf*
Y	Shipping - noise pollution (vessel)	1	3	3	L-M	Sea snakes can move away from noise. *Caveat: Scored on very limited knowledge, therefore higher likelihood - **More knowledge needed*** *Data confidence* • *Low confidence around the impact of anthropogenic noises on sea snakes* • *Medium confidence around the types of vessels that will be using the gulf in relation to port development, and the noise they will emit*
Y	Shipping - noise pollution (pile driving & dredging)	1	3	3	L	Sea snakes can move away from noise. *Caveat: Scored on very limited knowledge, therefore higher likelihood - **More knowledge needed*** *Data confidence*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						• *Low confidence around the impact of anthropogenic noises on sea snakes* • *Low confidence around the frequency of pile driving and dredging activity*
Y	Shipping - pollution (oil, fuel, antifoul)	2	3	6	L-M	Sea snakes can swim away from spills, though contact is possible which, as air breathers, could impact their respiratory system. There is uncertainty around copper-based contaminates. Contaminates can bioaccumulate in higher order consumers. *Caveat: Scored with no knowledge on impacts of copper-based contaminants.* *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spills impacts to sea snakes* • *Medium confidence around much of Exmouth Gulf being rated as 'very low to low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*
Y	Shipping - pests	2	3	6	M	Uncertainty around diseases, parasites. Currently, the majority of Exmouth Gulf users (industrial and recreational) are from domestic waters. A port targeting international ships would change the risk - based on this, consequence changed to a 2. *Caveat: Scored with limited data - **more knowledge needed*** *Data confidence* • *High confidence that vessels entering Exmouth Gulf increase the risk of introduced marine pests - see Biofouling Solutions (2018)* • *Medium confidence around the types of vessels entering the Gulf if a port was developed* • *Low confidence in the types of marine pests that could impact sea snakes*
Y	Shipping - light pollution	1	3	3	M	It is expected the Gascoyne Gateway proposal would produce a lot of light. Light interacting with turbidity is a factor i.e., less light reaching through the water column. *Data confidence* • *High confidence that light pollution will increase with port development*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						• *Low confidence around how light pollution impacts sea snakes*
Y	Shipping - suspended sediments (dredging and prop wash)	1	4	4	M	Fine sediments could irritate snakes in some way, but not gills as in fish. *Data confidence* • *Medium confidence that sea snakes occur in the area (based on capture in trawl nets) that would be exposed to suspended sediments, though suspended sediments could spread* • *Low confidence that suspended sediments can impact sea snakes* • *Medium confidence around the exact port footprint and extent of dredging*
Value: Marine reptiles - turtles *(EPBC Act - all species are Vulnerable or Endangered)*						
Y	Shipping - port infrastructure footprint (incl channel)	2	3	6	M-H	Turtles do not nest within the proposed Gascoyne Gateway footprint. However, there is evidence of use of the Qualing Pool area for foraging/mating etc. *Data confidence* • *High confidence around the use of the western margin by turtles - see Irvine & Salgado-Kent (2019), Jenner and Jenner (2005), Hodgson (2007)* • *Medium confidence around footprint extent of port on western margin*
Y	Shipping - vessel strike	1	3	3	L	Vessel strike can occur as turtles come to the surface to breath. However, large vessels move slowly. Vessel strike is more of an issue for recreational boats. - SEE TOURISM *Data confidence* • *Low confidence around the incidence of ship strike on turtles in the Gulf*
Y	Shipping - noise pollution (vessel)	1	3	3	L-M	Turtles can move away from noise. Nelms et al. 2016 mentions that it is possible there can be damage to hearing from seismic activity, so perhaps there is some disturbance also caused from vessel noise. *Caveat: Scored on very limited knowledge, therefore higher likelihood - **More knowledge needed*** *Data confidence* • *Low confidence around the impact of anthropogenic noises on turtles*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						• *Medium confidence around the types of vessels that will be using the gulf in relation to port development, and the noise they will emit*
Y	Shipping - noise pollution (pile driving & dredging)	1	3	3	L	Turtles can move away from noise. Nelms et al. (2016) mentions that it is possible there can be damage to hearing from seismic, so perhaps there is also some disturbance caused from vessel noise. *Caveat: Scored on very limited knowledge, therefore higher likelihood. -* ***More knowledge needed*** *Data confidence* • *Low confidence around the impact of anthropogenic noises on turtles* • *Low confidence around the frequency of pile driving and dredging activity*
Y	Shipping - pollution (oil, fuel, antifoul)	2	3	6	M	Turtles can swim away from spills, though contact is possible which, as air breathers, could impact their respiratory system. Turtles can get coated in oil causing skin irritation and suffocation. There is uncertainty around copper-based contaminates. Contaminates can bioaccumulate in higher order consumers. *Caveat: Scored with no knowledge on impacts of copper-based contaminants.* *Data confidence* • *Low confidence around the impact of copper-based contaminants* *Med confidence around oil and fuel spills impacts to turtles* • *Medium confidence around much of Exmouth Gulf being rated as 'very low to low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*
Y	Shipping - pests	2	3	6	M	There is uncertainty around diseases and parasites for turtles. Tumour disease occurs in Shark Bay. There are also some naturally occurring diseases. Currently, the majority of Exmouth Gulf users (industrial and recreational) are from domestic waters. A port targeting international ships would change the risk - based on this, consequence changed to a 2. *Data confidence* • *High confidence that vessels entering Exmouth Gulf increase the risk of introduced marine pests - see Biofouling Solutions (2018)*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						• *Medium confidence around the types of vessels entering the Gulf if a port was developed* • *Low confidence in the types of marine pests that could impact turtles*
Y	Shipping - light pollution	3	4	12	H	Light pollution poses a major impact on turtle hatchlings. The proposed Gascoyne Gateway infrastructure would have lighting and markers in the water, but greater impacts are likely from the lights on land as hatchlings will be attracted landward, whereas lights out in water on port infrastructure would at least lead hatchlings out to the water. Light pollution could also lead to increased predation of turtle hatchlings. Light pollution may also disorient females returning to their nesting beach. *Data confidence* • *High confidence that light pollution will increase with port development* • *High confidence around how light pollution impacts marine turtles*
Y	Shipping - suspended sediments (dredging and prop wash)	1	4	4	M	Fine sediments could irritate turtles in some way, but not gills as in fish *Data confidence* • *High confidence that turtles occur in the area that would be exposed to suspended sediments* • *Low confidence that suspended sediments can impact turtles* • *Medium confidence around the exact port footprint and extent of dredging*

Value: Marine mammals - whales (humpback) ***(EPBC Act - Vulnerable, Migratory, Cetacean listed species)***

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
Y	Shipping - port infrastructure footprint (incl channel)	1/2	3/4	3-8	H	Port infrastructure would have a lower impact on humpbacks compared to shipping and underwater noise. However, the footprint of the proposed Gascoyne Gateway port is in humpback whale waters. Humpback whales occur throughout most of the Gulf, and many will use shallow waters, particularly the 10m depth contour (mainly the central-western side of the Gulf), for migrating out of the Gulf. There is the potential for whale contact if vessels are moored and moving around this contour. The highest density area of whales overlaps with the preferred industry anchoring sites. More vessels/infrastructure will impact on the space available for nursing females and their calves. Killer whales will cause humpbacks to hug the coastline to avoid predation. Other considerations: Is it a small spatial area when you are thinking about the entire stock of Humpback whales? Not all stock enters Exmouth on their southern migration, but large numbers do. It is an important resting area. Marine mammals are protected through other legislation. Exmouth region has now been designated as an Important Marine Mammal Area (IMMA) - although it remains to be seen if this does/changes anything. The IMMA acknowledges that this is an important area for cetaceans. The Gulf is a resting and nursing habitat, and neonate humpback whales can use the Gulf as well. Note: the calving ground located on the west side of Ningaloo Reef increases the chances of very young whales in the vicinity. *Data confidence* • *High confidence around the use of the western margin by humpback whales - see Irvine & Salgado-Kent (2019), Jenner and Jenner (2005), Hodgson (2007)* • *Medium confidence around footprint extent of port on western margin, however given the area humpbacks use, it would overlap with port placement anywhere along the western margin*
Y	Shipping - vessel strike	2	3/4	6-8	M	Vessel strike is a bigger issue than the port/dredge channel footprint. Increased shipping is likely to increase the risk/number of strikes. A new port would increase the shipping

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						movement into the Gulf, and potentially deeper into the Gulf. Shipping movement at night would increase the risk of strike due to lower chance of visuals on whales. Humpback whale mothers can rest just below the surface, or on the surface, and are hard to see, which increases their chances of vessel strike. Calves can surface randomly in front of boats. During the peak whale season, the risk increases. South of the proposed GG footprint is an important resting area, so a lot of attention is required by vessels in that area. Anecdotally, there are ship strikes on humpback whales. There is uncertainty around the responsibility of vessel skippers to report strikes, although there are small boat/humpback whale strike signs at the boat ramps around Exmouth. You do not generally see a dead whale and they do not all die from boat strikes. Around 20% of whale sharks (EPBC Act - Vulnerable, Migratory) have boat scars. There is a higher chance of ship strike in the southern end of Gulf as it is a high density area for whales to rest on the surface and just below the surface e.g., 3-5m depth. *Data confidence* • *High confidence around cetaceans and ships strikes* • *Low confidence around the incidence of ship strike on whales in the Gulf*
Y	Shipping - noise pollution (vessel)	3	4	12	M-H	Louder vessels will disturb whales and they will swim away. The Gulf is a shallow water environment, which makes it noisier. More vessels mean more noise, and more disturbance, such as short-term behavioural responses. Communication is very quiet/silent between mothers and calves, so increased shipping/noise can mask these communications. The use of dynamic positioning in lieu of anchoring also needs to be considered. There is a study in the Gulf showing humpbacks avoid ships on dynamic positioning. Whales use hearing as their primary sense. If noise disturbs important behaviours, like nursing and resting, then there may be an impact on reproductive output, which in turn will have population level impacts (as mothers cannot replenish their energy stores lost due to disturbance from humans). Noise travels five-times faster in water than in air, so underwater noise is important to consider. *Cumulative impact of noises is a consideration*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						Ambient noise is relatively high already as it is a shallow embayment - snapping shrimp and wave action contribute to this. *Increased noise may jeopardise the Gulf as a resting area.* *Ships currently operate in the Gulf but an increasing in shipping activity, would increase the risk to humpback whales.* *Data confidence to consider - **more knowledge needed** on noise impacts to whales.* *Data confidence* • *High confidence that vessel noise can impact humpbacks in general - e.g., Dunlop RA. 2019 The effects of vessel noise on the communication network of humpback whales. R. Soc. open sci. 6: 190967. http://dx.doi.org/10.1098/rsos.190967* • *Medium confidence around the impact of anthropogenic noises on humpback whales in the Gulf - see Sprogis et al. (2020)* • *Medium confidence around the types of vessels that will be using the gulf in relation to port development, and the noise they will emit*
Y	Shipping - noise pollution (pile driving & dredging)	2	2/3	4-6	L-M	Noise from pile driving and dredging is spatially and temporarily constrained. However, the noise is loud and acute. Noise travels five-times faster in water than in air. If these activities and noise occurred during whale season, the noise would impact the behaviour of whales. However, this would not be an ongoing disturbance. It is suggested that if one breeding season was missed due to construction disturbance in the Gulf, this would not have an impact on population. However, if dredging of potential shipping lanes and mooring stations was to occur (e.g., to allow for large ships), then the noise would disturb whales in the vicinity - **more knowledge needed here.** There would be a recommendation that these activities do not happen during whale season at all. Whales arrive in the Gulf in late August and leave between the end of October and early November, depending on the timing of the migration that year. The peak whale season is around mid-end September. Juvenile whales arrive first, then competitive breeding adults, and lastly mother-calf pairs. There are controls that exist to mitigate the risk to whales. If these were in place, the consequence would be lower. *Control measures not considered in scoring.* *Data confidence*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						• *Medium confidence around the impact of anthropogenic noises on humpback whales in the Gulf - see Sprogis et al. (2020)* • *Low confidence around the frequency of pile driving and dredging activity*
Y	Shipping - pollution (oil, fuel, antifoul)	2	2	4	M-H	Probably small and localised if no major oil spills occur. If a large oil spill/pollution occurs during the breeding season, then this will have a larger impact on the whales. *Data confidence* • *High confidence around oil and fuel spills impacts to whales if they are resting in the Gulf* • *Medium confidence around much of Exmouth Gulf being rated as 'very low to low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*
N	Shipping - pests					NA
N	Shipping - light pollution					NA
N	Shipping - suspended sediments (dredging and prop wash)					NA
Value: Marine mammals - dolphins (coastal)						
Y	Shipping - port infrastructure footprint (incl channel)	3	3	9	M	Coastal dolphins are EPBC Act listed as Cetacean and/or Migratory species. Construction will remove benthic habitat used by Indo-Pacific bottlenose dolphins, and Australian humpback dolphins. These two species frequent Exmouth Gulf, using shallow, coastal waters. The different habitat types, of reef, seagrass and sand/mud are likely to be important feeding habitats for the dolphins. Australian humpback dolphins are listed as Vulnerable, and Indo-Pacific bottlenose dolphins are listed as Near Threatened on the International Union Conservation Nature Red List. Australian snubfin dolphins are also sighted in the Gulf, but mostly in the southern and eastern portion. Australian snubfin dolphins are listed as Vulnerable. No dedicated boat-based surveys have been conducted on dolphins south of Exmouth Marina, thus there is no data on habitat use and abundance of the different species of dolphins in Exmouth Gulf.

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						Data confidence • *Medium confidence around the use of the western margin by different dolphin species* • *Medium confidence around footprint extent of port on western margin*
Y	Shipping - vessel strike	2	2	4	M	Ship strike on dolphins does occur, but more so from fast moving vessels like jet skis and small recreational vessels. Dolphins have more time to move away from larger slower moving vessels. If a dolphin is hit by a boat or jet ski, then death can occur, or large wounds can occur that heal. This risk is higher for larger, slower moving whales like humpback whales (especially as they rest on and near the surface), and slower moving dugongs. SEE TOURISM for scoring of recreational boats *Data confidence* • *High confidence around cetaceans and ships strikes* • *Low confidence around the incidence of ship strike on dolphins in the Gulf*
Y	Shipping - noise pollution (vessel)	3	3	9	M-H	Underwater noise from vessels disturbs cetaceans in general, as this is their primary sensory modality. They use sound for communication, finding prey and sensing predators. Thus, the more noise pollution the more chance there is for masking of communication whistles and foraging echolocation. Shipping is generally a low frequency noise but does have high level transients which dolphins can hear. The noise from shipping is more in the auditory range of baleen whales; however, it can still affect dolphins. For example, masking of whistles between mother and calves can, for example, mean that the calf is separated from its mother which leaves it vulnerable to predation from sharks and/or humans (boat strike) etc. Thus, managing underwater noise levels in a shallow water embayment is important as resident dolphins will decline in abundance if there is too much pressure on the system. This has been shown in Shark Bay, when there were two whale-watch vessels, the number of bottlenose dolphins declined from that area. It has also occurred in Fjords in New Zealand, when the dolphins leave the area because there is too much boat noise in the Fjords. It needs to be managed correctly, for these resident, shallow water dolphins. *Data confidence*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						• *High confidence around the impact of anthropogenic noises on dolphins, though no specific studies in Exmouth Gulf* • *Medium confidence around the types of vessels that will be using the gulf in relation to port development, and the noise they will emit*
Y	Shipping - noise pollution (pile driving & dredging)	2	3	6	M	Coastal dolphins are resident to an area and have restricted home ranges. If construction occurs in an area, then particular individuals will be impacted where the noise and construction occur. Dolphins cannot necessarily just leave an area. They reside in a range, and some dolphins have small ranges (i.e., 20km^2). These individuals are sensitive to disturbance. Dolphins are also sensitive to construction and underwater noise, depending on the time of the year e.g., the breeding or calving season. Construction is recommended to only take place outside of calving season. This is a seasonal trend across around three months. The peak dolphin birthing time in Exmouth Gulf is unknown, however it is suspected to occur over Spring-Summer. Generally, when construction occurs, a Marine Mammal Observer is required to ensure construction is not taking place when dolphins come within a certain distance. - *control measures are not considered in the score* *Data confidence* • *High confidence around the impact of anthropogenic noises on dolphins, though no specific studies in Exmouth Gulf* • *Low confidence around the frequency of pile driving and dredging activity*
Y	Shipping - pollution (oil, fuel, antifoul)	3	2	6	M	If there is a big oil spill (e.g., the 2010 Deep Water Horizon oil spill event in the Gulf of Mexico), then a range of problems will occur, including respiratory illnesses from inhaling oil on the surface of the water. *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *High confidence around oil and fuel spill impacts to dolphins* • *Medium confidence around much of Exmouth Gulf being rated as 'very low to low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
N	Shipping - pests					NA
N	Shipping - light pollution					NA
Y	Shipping - suspended sediments (dredging and prop wash)	1	1	1	M	Exmouth Gulf is already a highly turbid environment. However, some dolphins may specialise on certain prey, e.g., fish that live in the seagrass. Thus, if the seagrass is affected by sediment and that has an impact on the fish, then dolphins with a specialised diet will be affected. However, the diet of the dolphins in Exmouth Gulf is unknown and it can only be inferred from other similar locations where diet isotope studies have been done. *Data confidence* • *Medium confidence that dolphins occur in the area that would be exposed to suspended sediments* • *Low confidence that suspended sediments can impact dolphins* • *Medium confidence around the exact port footprint and extent of dredging*
Value: Marine mammals - dugongs *(EPBC Act - Migratory, Marine listed species)*						
Y	Shipping - port infrastructure footprint (incl channel)	2	4	8	M-H	Dugongs use the Gulf year-round and can occur throughout the Gulf. They also migrate, so the population can fluctuate. There are seagrass beds along the western margin - which does not look to be shown in benthic habitat maps for Gascoyne Gateway proposal. Dugongs consume seagrass, so there may be some impacts on dugongs, but it may not impact whole population. There is evidence of dugong feeding trails along the western margin, including in the area of the port proposal footprint. This is considered a 'prime' area for dugongs. Mother and calves are also seen close to shore along the western margin. A few population surveys have been done using aerial surveys, which shows a high concentration of dugongs in the eastern Gulf. Their general distribution in the Gulf is known based off coarse surveys. A fine-scale monitoring program is needed to understand dugong uses of the Gulf. *Data confidence*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						• *High confidence around the use of the western margin by dugongs, see Irvine & Salgado-Kent (2019), Jenner and Jenner (2005), Hodgson (2007)* • *Medium confidence around footprint extent of port on western margin*
Y	Shipping - vessel strike	1	4	4	M	Dugongs are sometimes hit by large vessels, but it is rare, because the large ships are slow moving and the dugongs have more time to respond and swim away. As soon as a mother is hit, they are separated from their calf. In Moreton Bay, there is a higher strike risk due to more vessels. There has been a significant decline in the dugong population, which is attributed to boat strikes. The impact of vessel strikes does vary between locations. New Caledonia has high vessel activity, but dugongs remain there. This is not the case in Moreton Bay and there is evidence of learned behaviour from boats and hunting. Dugongs may move away, at least temporarily, and there is evidence of this. They will come back when the noise is gone. Anecdotally, necropsies show that dugongs appear to be hit by small vessels, like jet skis. Is it just boat strike - or also boating activity frightening them? Cumulative impacts to consider: more vessels increases the risk. *Data confidence* • *High confidence around dugongs and ships strikes* • *Low confidence around the incidence of ship strike on dugongs in the Gulf*
Y	Shipping - noise pollution (vessel)	2	4	8	L-M	Dugongs do not see well, but they can hear well. So, noise is likely to have an impact on them. Dugongs can relocate temporarily. Dugong behaviour and distribution patterns can change in response to vessel noise and movements (i.e., their natural behaviours are altered). *Data confidence* • *Low confidence around the impact of anthropogenic noises on dugongs* • *Medium confidence around the types of vessels that will be using the gulf in relation to port development, and the noise they will emit*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
Y	Shipping - noise pollution (pile driving & dredging)	1	4	4	L	In New Caledonia, dugongs showed shifts in local populations during dredging, but they came back after the work. Given the scale, it is probably a minor consequence. *Data confidence* • *Low confidence around the impact of anthropogenic noises on dugongs* • *Low confidence around the frequency of pile driving and dredging activity*
Y	Shipping - pollution (oil, fuel, antifoul)	3	2	6	M	Indirect pollution - If there is pollution that affects seagrass then it can be ingested by dugongs. Dugong respiration should be a consideration, as it is for dolphins. If there are oil slicks, and if the dugongs are residents, then they may breathe in air that is contaminated causing respiratory problems. *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *High confidence around oil and fuel spill impacts to dugongs* • *Medium confidence around much of Exmouth Gulf being rated as 'very low to low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*
N	Shipping - pests					N/A
N	Shipping - light pollution					N/A
N	Shipping - suspended sediments (dredging and prop wash)					Suspended sediments will affect dugongs if the seagrass is impacted. Dugongs only feed on seagrass thus rely on it. Effects to seagrass have been considered above.
Value: Seabirds and shorebirds						
Y	Shipping - port infrastructure footprint (incl channel)	2	3	6	M	Some species are EPBC Act listed species, including Critically Endangered. Existing or future habitat for nesting could be removed. Nesting locations can be unpredictable, and in the face of rising sea levels, there needs to be as much suitable nesting habitat available as possible. Exmouth Gulf mangroves are listed as an Important Bird Area for migratory shorebirds - Dutson et al. (2009)

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						Data confidence • *Low - Medium confidence around the use of the western margin by seabirds and shorebirds* • *Medium confidence around footprint extent of port on western margin* • *High confidence that shipping infrastructure on the eastern margin relating to salt facility would impact on the recognised Important Bird Area* • *Low confidence around possibility of shipping infrastructure on eastern margin*
N	Shipping - vessel strike					
Y	Shipping - noise pollution (vessel)	1	4	4	L-M	Noise may mask communications between birds on land. Underwater, they may largely rely on vision to find prey. *Data confidence* • *Low confidence around the impact of anthropogenic noises on seabirds and shorebirds* • *Medium confidence around the types of vessels that will be using the gulf in relation to port development, and the noise they will emit*
Y	Shipping - noise pollution (pile driving & dredging)	1	3	4	L	Noise may mask communications between birds on land. Underwater, they may largely rely on vision to find prey. *Data confidence* • *Low confidence around the impact of anthropogenic noises on seabirds and shorebirds* • *Low confidence around the frequency of pile driving and dredging activity*
Y	Shipping - pollution (oil, fuel, antifoul)	3	3	9	M	Shorebirds and seabirds are vulnerable to oil spills and fuel slicks because they use surface waters and nest on shorelines. The risks would likely be the same for migratory and resident bird populations, though the impacts would be different (i.e., could affect nesting habitat for residents, whereas non-nesting birds will have roost and foraging habitat impacted). *Data confidence* • *Low confidence around the impact of copper-based contaminants*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						• *High confidence around oil and fuel spill impacts to seabirds and shorebirds* • *Medium confidence around much of Exmouth Gulf being rated as 'very low to low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*
N	Shipping - pests					
N	Shipping - light pollution	3	3	9	H	Light pollution could interrupt the birds' natural light cycles and have flow-on effects for population biology. The impact of light disorientation is well known for seabirds - *see National Light Pollution Guidelines for Wildlife* - "lights can disorient flying birds, particularly during migration, and cause them to divert from efficient migratory routes or collide with infrastructure". Birds may starve when artificial lighting disrupts foraging, and fledgling seabirds may not be able to take their first flight if their nesting habitat never becomes dark. Migratory shorebirds may use less preferable roosting sites to avoid lights and may be exposed to increased predation where lighting makes them visible at night." Lighting, alongside oil pollution, is the most significant known threat to shorebirds/seabirds from shipping. *Data confidence* • *High confidence that light pollution will increase with port development* • *High confidence around how light pollution impacts seabirds and shorebirds*
N	Shipping - suspended sediments (dredging and prop wash)	2	3	6	M	Effectiveness at catching prey may be affected if birds are fishing in turbid waters. *Data confidence* • *High confidence that seabirds would use the area that would be exposed to suspended sediments* • *Low confidence that suspended sediments can impact seabirds* • *Medium confidence around the exact port footprint and extent of dredging*
Factor: Marine environmental quality						
Value: Water quality						

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
Y	Shipping - port infrastructure footprint (incl channel)	1	4	4	M	Assuming that the port is an open port, the water quality is probably not a big issue, though Gascoyne Gateway Limited mentioned plans to rezone the entire Exmouth Gulf as a 'port'. How will this impact on the water quality currently assigned to Exmouth Gulf? Are there any water quality issues in the existing marina, given marinas generally have water quality issues? Anchoring and dynamic positioning occurs all through the Gulf, e.g., with service vessels. Offshore platform supply vessels (120m) are a common fixture in the Gulf at certain times of the year, anchored around the 10-15m isobar. *Data confidence* • *Medium confidence around footprint extent of port on western margin* • *Low confidence around possibility of shipping infrastructure on eastern margin* • *High confidence that ports can reduce water quality in general* • *Low confidence in how water quality will be impacted in the Gulf*
N	Shipping - vessel strike					
N	Shipping - noise pollution (vessel)					
N	Shipping - noise pollution (pile driving & dredging)					
Y	Shipping - pollution (oil, fuel, antifoul)	2/3	3	6-9	M	Nearby oil spill response equipment does not guarantee containment. Antifoulants and contaminants from the washing of ship decks would enter the water column. Exmouth marina is closed and therefore easier to contain an oil spill. Whereas the proposed Gascoyne Gateway port would be open, so pollutants could spread across Gulf. Marine offshore facilities in deeper water are also a consideration. Big storm events flush out the marina. If porous materials are under the marina/port, then water circulation is less inhibited. The marina has been built on an old waste tip.

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						Four trawlers were turned over during a flood in Exmouth marina. Contaminants could get pushed out into Gulf this way. *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *High confidence around oil and fuel spill impacts to water quality* • *Medium confidence around much of Exmouth Gulf being rated as 'very low to low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*
N	Shipping - pests					
N	Shipping - light pollution					
Y	Shipping - suspended sediments (dredging and prop wash)	2	4	8	M-H	Dredging and ship movements could continually resuspend contaminants into the water column, which will cause increased turbidity. Cumulative impacts to consider: It is already a turbid environment. *Data confidence* • *High confidence that water quality is impacted by suspended sediments* • *Medium confidence around the exact port footprint and extent of dredging*
Value: Sediment quality						
Y	Shipping - port infrastructure footprint (incl channel)	1	4	4	M	Construction may leach chemicals into sediments. This would have an initial disturbance to sediments. Infrastructure could restrict some water flow which could prevent turnover and flushing of sediments. *Data confidence* • *Medium confidence around footprint extent of port on western margin* • *Low confidence around possibility of shipping infrastructure on eastern margin* • *High confidence that ports can reduce sediment quality in general* • *Low confidence in how sediment quality will be impacted in the Gulf*
N	Shipping - vessel strike					

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
N	Shipping - noise pollution (vessel)					
N	Shipping - noise pollution (pile driving & dredging)					
Y	Shipping - pollution (oil, fuel, antifoul)	2/3	3	6-9	M	The concentration of vessels in a small area could cause a build-up of chemicals and contaminants in sediments. Sediments can then be distributed across the Gulf from winds and storms etc. *Comment: "it is not helpful to include risks from shipping due to antifoul and minor refuelling spillages into the same category as potentially major accidents resulting from shipwrecks (e.g., large amounts of bunker oil). The possibility of even larger spills from production accidents, pipeline issues etc. is not even mentioned. The consequences of these two types of pressures/drivers are not in the same end of the spectrum. Consequently, it is difficult to provide meaningful assessments for the various taxonomic groups."* We understand this is a valid point, but separate assessments were not done due to time constraints. *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *High confidence around oil and fuel spill impacts to sediment quality* • *Medium confidence around much of Exmouth Gulf being rated as 'very low to low risk' to oil spills - see Navigatus Consulting (2018). Medium because oil spill exposure and risk was modelled for the Pilbara region, not specifically the Gulf*
N	Shipping - pests					
N	Shipping - light pollution					
Y	Shipping - suspended sediments (dredging and prop wash)	1	4	4	M-H	Dredging and ship movements could continually resuspend contaminants into the water column. These activities could continually change and/or interrupt sediment composition. Probably not a significant impact. *Data confidence* • *High confidence that sediment quality is impacted by suspended sediments*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						• *Medium confidence around the exact port footprint and extent of dredging*
Factor: Coastal processes						
Value: Geophysical processes						
Y	Shipping - port infrastructure footprint (incl channel)	1	4	4	L-M	If a marine offshore facility happens, then there will be localised coastal change to the adjacent shoreline. *Data confidence* • *Medium confidence around footprint extent of port on western margin* • *Low confidence around possibility of shipping infrastructure on eastern margin* • *Low confidence in how geophysical processes will be impacted in the Gulf*
N	Shipping - vessel strike					
N	Shipping - noise pollution (vessel)					
N	Shipping - noise pollution (pile driving & dredging)					
N	Shipping - pollution (oil, fuel, antifoul)					
N	Shipping - pests					
N	Shipping - light pollution					
N	Shipping - suspended sediments (dredging and prop wash)					
Value: Hydrodynamic processes						
Y	Shipping - port infrastructure footprint (incl channel)	1	4	4	L-M	If the Gascoyne Gateway port is a floating platform, then the impact to hydrodynamic processes is likely to be minimal. If it is not a floating platform, and there was a 1km long structure, then the flow would go around it. Some sediment build up could be expected, as the port footprint will be on sandy beaches.

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						Generally southward travelling sediments in the Gulf - the tide out is strong. *Data confidence* • *Medium confidence around footprint extent of port on western margin* • *Low confidence around possibility of shipping infrastructure on eastern margin* • *Low confidence in how geophysical processes will be impacted in the Gulf*
N	Shipping - vessel strike					
N	Shipping - noise pollution (vessel)					
N	Shipping - noise pollution (pile driving & dredging)					
N	Shipping - pollution (oil, fuel, antifoul)					
N	Shipping - pests					
N	Shipping - light pollution					
N	Shipping - suspended sediments (dredging and prop wash)					
Value: Nutrient flow						
Y	Shipping - port infrastructure footprint (incl channel)	1	4	4	L-M	May be localised impacts to nutrient flows. If a marine offshore facility is built, how much guano build-up will occur, and how much would this influence nutrients? A low barge transfer to a ship loader is a possibility for an industrial salt facility. A jetty jutting out could potentially impact on some of the nutrient flow. *Data confidence* • *Medium confidence around footprint extent of port on western margin* • *Low confidence around possibility of shipping infrastructure on eastern margin*

Score?	Drivers / Pressures	Cons.	Like.	Risk	Data conf HML	Justification
Shipping						
						• *Low confidence in how nutrient flow will be impacted in the Gulf*
N	Shipping - vessel strike					
N	Shipping - noise pollution (vessel)					
N	Shipping - noise pollution (pile driving & dredging)					
N	Shipping - pollution (oil, fuel, antifoul)					
N	Shipping - pests					
N	Shipping - light pollution					
N	Shipping - suspended sediments (dredging and prop wash)					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
Factor: Benthic habitats and communities						
Value: Macroalgae and turf algae						
N	Disturbance - noise					
Y	Disturbance - damage (anchoring/diving)	1	4	4	M	Some damage is possible from trampling and anchor damage. Algae grows relatively quickly so it could be likely to recover easily. *Data confidence* • *High confidence that anchors can damage algae beds* • *Low confidence around the extent of damage to algae in Exmouth Gulf* • *Medium confidence around the full extent of algal beds in Exmouth Gulf*
Y	Pollution - oil/fuel	1	4	4	L	The impacts and likelihood of an oil and fuel spill from recreational vessels is probably low. Potentially there are some considerations around the use of copper-based antifoul - similar to shipping relating vessels. *Data confidence* • *Low confidence around impacts of copper-based contaminants* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
Y	Pollution - rubbish	1	2	2	L	Rubbish can smother and prevent the growth of algae if lodged. Entanglements of fishing gear are sometimes hard to remove from algae clumps and may impact on fauna of not removed. Community underwater clean-ups occur semi-regularly. *Data confidence* • *Low confidence around the extent of rubbish in the Gulf* • *Low confidence around the extent to which rubbish is impacting algae in the Gulf*
Value: Seagrass						

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
N	Disturbance - noise					
Y	Disturbance - damage (anchoring/diving)	1	4	4	M	Some damage is possible from trampling and anchor damage. Continual disturbance may prevent regrowth. Seagrass grows slower than algae. *Data confidence* • *High confidence that anchors can damage seagrass beds* • *Low confidence around the extent of damage to seagrass in Exmouth Gulf* • *Medium confidence around the full extent of seagrass beds in Exmouth Gulf*
Y	Pollution - oil/fuel	1	4	4	L	Impacts and likelihood of oil and fuel spill from recreational vessels is probably low. Potentially there are some considerations around the use of copper-based antifoul - similar to shipping relating vessels. *Data confidence* • *Low confidence around impacts of copper-based contaminants* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
Y	Pollution - rubbish	1	2	2	L	Rubbish can smother and block light for photosynthesis if lodged. Entanglements of fishing gear are sometimes hard to remove from clumps and may impact on fauna of not removed. Community underwater clean-ups occur semi-regularly. *Data confidence* • *Low confidence around the extent of rubbish in the Gulf* • *Low confidence around the extent to which rubbish is impacting seagrass in the Gulf*
Value: Coral						
N	Disturbance - noise					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
Y	Disturbance - damage (anchoring/diving)	2	3	6	M	Some damage is possible from trampling/fin kicks and anchor damage. Bundegi is advertised as a snorkelling spot so would expect people to be swimming near/over coral. Some corals grow faster than others. Increased tourism and water use would increase the risk of damage. *Data confidence* • *High confidence that anchors and diving can damage corals* • *Low confidence around the extent of damage to corals in Exmouth Gulf* • *Medium confidence around the full extent of corals in Exmouth Gulf*
Y	Pollution - oil/fuel	1	4	4	L	Impacts and likelihood of oil and fuel spill from recreational vessels is probably low. Potentially there are some considerations around the use of copper-based antifoul - similar to shipping relating vessels. *Data confidence* • *Low confidence around impacts of copper-based contaminants* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
Y	Pollution - rubbish	1	2	2	L-M	Rubbish can smother and block light for photosynthesis if lodged. Entanglements of fishing gear are sometimes hard to remove and may impact on fauna of not removed. Community underwater clean-ups occur semi-regularly. *Data confidence* • *High confidence that microplastics occur in the water column of Exmouth Gulf - see King (2019)* • *Low confidence around the extent of hard rubbish in the Gulf* • *Low confidence around the extent to which rubbish is impacting coral in the Gulf*
Value: Sponges and filter feeders						
N	Disturbance - noise					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
Y	Disturbance - damage (anchoring/diving)	1	4	4	M	Some damage possible from trampling and anchor damage. *Data confidence* • *High confidence that anchors and diving can damage sponges and filter feeders* • *Low confidence around the extent of damage to sponges and filter feeders in Exmouth Gulf* • *Medium confidence around the full extent of sponges and filter feeders in Exmouth Gulf*
Y	Pollution - oil/fuel	1	4	4	L	Impacts and likelihood of oil and fuel spill from recreational vessels is probably low. Potentially some consideration around the use of copper-based antifoul - similar to shipping relating vessels. *Data confidence* • *Low confidence around impacts of copper-based contaminants* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
Y	Pollution - rubbish	1	2	2	L-M	Rubbish can smother and block water flow if lodged. Entanglements of fishing gear are sometimes hard to remove from clumps and may impact on fauna of not removed. Community underwater clean-ups occur semi-regularly. *Data confidence* • *High confidence that microplastics occur in the water column of Exmouth Gulf - see King (2019)* • *Low confidence around the extent of hard rubbish in the Gulf* • *Low confidence around the extent to which rubbish is impacting sponges and filter feeders in the Gulf*
Value: Sand and mud						
N	Disturbance - noise					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
N	Disturbance - damage (anchoring/diving)					NA
Y	Pollution - oil/fuel	1	4	4	L	Impacts and likelihood of oil and fuel spill from recreational vessels is probably low. Potentially some consideration around the use of copper-based antifoul - similar to shipping relating vessels. *Data confidence* • *Low confidence around impacts of copper-based contaminants* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
N	Pollution - rubbish					NA
Value: Mangroves						
N	Disturbance - noise					
Y	Disturbance - damage (anchoring/diving)	1	4	4	M	Damage may occur to mangrove roots from trampling. 4WD tracks? Increased tourism could increase the risk if tourists and use of areas are not properly regulated. *Data confidence* • *High confidence that mangroves can be directly damaged from human activity such as trampling and 4WD* • *Low confidence around the extent of damage to mangroves in Exmouth Gulf, and if it is even occurring* • *High confidence around the full extent of mangroves in Exmouth Gulf*
Y	Pollution - oil/fuel	1	4	4	L	Impacts and likelihood of oil and fuel spill from recreational vessels is probably low. Potentially some consideration around the use of copper-based antifoul - similar to shipping relating vessels.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
						Data confidence • *Low confidence around impacts of copper-based contaminants* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
Y	Pollution - rubbish	1	2	2	L	Rubbish could smother pneumatophores. Community clean-ups occur semi-regularly *Data confidence* • *Low confidence around the extent of rubbish in the Gulf* • *Low confidence around the extent to which rubbish is impacting mangroves in the Gulf*
Value: Samphire						
N	Disturbance - noise					
Y	Disturbance - damage (anchoring/diving)	1	4	4	M	Damage may occur to shrubs from trampling. 4WD tracks? Increased tourism could increase risk if tourists and use of areas are not properly regulated. *Data confidence* • *High confidence that samphire can be directly damaged from human activity such as trampling and 4WD* • *Low confidence around the extent of damage to samphire in Exmouth Gulf, and if it is even occurring* • *Medium confidence around the full extent of samphire in Exmouth Gulf*
Y	Pollution - oil/fuel	1	4	4	L	Impacts and likelihood of oil and fuel spill from recreational vessels is probably low. Potentially some consideration around the use of copper-based antifoul - similar to shipping relating vessels. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
						• *Low confidence around impacts of copper-based contaminants* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
Y	Pollution - rubbish	1	2	2	L	Rubbish could smother plants are prevent photosynthesis. Community clean-ups occur semi-regularly *Data confidence* • *Low confidence around the extent of rubbish in the Gulf* • *Low confidence around the extent to which rubbish is impacting samphire in the Gulf*
Value: Blue green algal mats						
N	Disturbance - noise					
Y	Disturbance - damage (anchoring/diving)	1	4	4	M	Damage may occur to algal mats from trampling. 4WD tracks? Increased tourism could increase risk if tourists and use of areas are not properly regulated. *Data confidence* • *High confidence that mats can be directly damaged from human activity such as trampling and 4WD* • *Low confidence around the extent of damage to mats in Exmouth Gulf, and if it is even occurring* • *High confidence around the full extent of mats in Exmouth Gulf*
Y	Pollution - oil/fuel	1	4	4	L	Impacts and likelihood of oil and fuel spill from recreational vessels is probably low. Potentially some consideration around the use of copper-based antifoul - similar to shipping relating vessels. *Data confidence* • *Low confidence around impacts of copper-based contaminants*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
						• *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
N	Pollution - rubbish					N/A
Value: Reef flats and oyster beds						
N	Disturbance - noise					
Y	Disturbance - damage (anchoring/diving)	1	4	4	M	Damage may occur to oyster beds from trampling. Increased tourism could increase risk if tourists and use of areas are not properly regulated. *Data confidence* • *High confidence that anchors and trampling can damage reef flats and oyster beds* • *Low confidence around the extent of damage in Exmouth Gulf* • *Medium confidence around the full extent of reef flats in Exmouth Gulf*
Y	Pollution - oil/fuel	1	4	4	L	Impacts and likelihood of oil and fuel spill from recreational vessels is probably low. Potentially some consideration around the use of copper-based antifoul - similar to shipping relating vessels. *Data confidence* • *Low confidence around impacts of copper-based contaminants* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
Y	Pollution - rubbish	1	2	2	L	Rubbish can smother and block filter feeding of oysters if lodged. Entanglements of fishing gear are sometimes hard to remove from clumps and may impact on fauna of not removed. Community underwater clean-ups occur semi-regularly. *Data confidence* • *Low confidence around the extent of rubbish in the Gulf*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
						• *Low confidence around the extent to which rubbish is impacting reef flats and oyster beds in the Gulf*
Value: Salt flats						
N	Disturbance - noise					
Y	Disturbance - damage (anchoring/diving)	1	4	4	M	Damage may occur to flats from trampling. 4WD tracks? Increased tourism could increase risk if tourists and use of areas are not properly regulated. *Data confidence* • *High confidence that salt flats can be directly damaged from human activity such as trampling and 4WD* • *Low confidence around the extent of damage to salt flats in Exmouth Gulf, and if it is even occurring* • *High confidence around the full extent of salt flats in Exmouth Gulf*
Y	Pollution - oil/fuel	1	4	4	L	Impacts and likelihood of oil and fuel spill from recreational vessels is probably low. Potentially some consideration around the use of copper-based antifoul - similar to shipping relating vessels. *Data confidence* • *Low confidence around impacts of copper-based contaminants* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
N	Pollution - rubbish					N/A
Factor: Marine fauna						
Value: Crustaceans - prawns						
Y	Disturbance - noise	1	3	3	L-M	Limited knowledge on noise impacts

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
						Still productive prawn fishery - is it having that much of an impact? Cumulative impacts to consider in terms of how much noise is too much. *Data confidence* • *Low confidence around the impact of anthropogenic noises on prawns* • *Medium confidence around the volume of recreational vessels using the gulf and the noise they emit*
N	Disturbance - damage (anchoring/diving)					
Y	Pollution - oil/fuel	1	4	4	L	Impacts and likelihood of oil and fuel spill from recreational vessels is probably low. Potentially some consideration around the use of copper-based antifoul - similar to shipping relating vessels. *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spills impact prawns* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
Y	Pollution - rubbish	2	3	6	L-M	Breakdown products of rubbish (e.g., microplastics) could make their way into sediments and accumulate in prawns. Evidence elsewhere of microplastics being ingested by smaller invertebrates such as coral polyps and zooplankton. Researchers are still understanding the impact of microplastics on marine life at all scales. Microplastic fibres occur in beach samples 4-5 pieces per 25g samples. Microplastics <5mm are present in surface waters of Exmouth Gulf. Would expect microplastic pollution to increase over time - local sources and oceanographic influences need to be considered. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
						• *High confidence that microplastics occur in the water column of Exmouth Gulf - see King (2019)* • *Low confidence around the extent of hard rubbish in the Gulf* • *Low confidence around the extent to which rubbish is impacting prawns in the Gulf*
Value: Crustaceans - mud crabs						
Y	Disturbance - noise	1	3	3	L-M	Limited knowledge on noise impacts. Cumulative impacts to consider in terms of how much noise is too much. *Data confidence* • *Low confidence around the impact of anthropogenic noises on mud crabs* • *Medium confidence around the volume of recreational vessels using the gulf and the noise they emit*
N	Disturbance - damage (anchoring/diving)					
Y	Pollution - oil/fuel	1	4	4	L	Impacts and likelihood of oil and fuel spill from recreational vessels is probably low. Potentially some consideration around the use of copper-based antifoul - similar to shipping relating vessels. *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spills impact mud crabs* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
Y	Pollution - rubbish	2	3	6	L-M	Similar as for prawns. *Data confidence* • *High confidence that microplastics occur in the water column of Exmouth Gulf - see King (2019)*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
						• *Low confidence around the extent of hard rubbish in the Gulf* • *Low confidence around the extent to which rubbish is impacting mud crabs in the Gulf*
Value: Teleost - whiting						
Y	Disturbance - noise	1	3	3	L-M	Possible effects but unknown. Can move away from noise source. *Data confidence* • *Low confidence around the impact of anthropogenic noises on whiting* • *Medium confidence around the volume of recreational vessels using the gulf and the noise they emit*
N	Disturbance - damage (anchoring/diving)					
Y	Pollution - oil/fuel	2	2	4	L	Can swim away from spills, though could come into contact and impact gills. Impacts and likelihood of oil and fuel spill from recreational vessels is probably low. Uncertainty around copper-based contaminates. Contaminates can bioaccumulate in higher order consumers. *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spill impacts to fishes* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
Y	Pollution - rubbish	2	3	6	L-M	Similar as for prawns. *Data confidence* • *High confidence that microplastics occur in the water column of Exmouth Gulf - see King (2019)* • *Low confidence around the extent of hard rubbish in the Gulf* • *Low confidence around the extent to which rubbish is impacting fishes in the Gulf*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
Value: Teleost - mangrove jack						
Y	Disturbance - noise	1	3	3	L-M	Possible effects but unknown. Can move away from noise source. *Data confidence* • *Low confidence around the impact of anthropogenic noises on mangrove jack* • *Medium confidence around the volume of recreational vessels using the gulf and the noise they emit*
N	Disturbance - damage (anchoring/diving)					
Y	Pollution - oil/fuel	2	2	4	L	Can swim away from spills, though could come into contact and impact gills. Impacts and likelihood of oil and fuel spill from recreational vessels is probably low. Uncertainty around copper-based contaminates. Contaminates can bioaccumulate in higher order consumers. *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spill impacts to fishes* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
Y	Pollution - rubbish	2	3	6	L-M	Similar as for prawns. *Data confidence* • *High confidence that microplastics occur in the water column of Exmouth Gulf - see King (2019)* • *Low confidence around the extent of hard rubbish in the Gulf* • *Low confidence around the extent to which rubbish is impacting fishes in the Gulf*
Value: Teleost - trevally						
Y	Disturbance - noise	1	3	3	L-M	Possible effects but unknown. Can move away from noise source.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
						Data confidence • *Low confidence around the impact of anthropogenic noises on trevally* • *Medium confidence around the volume of recreational vessels using the gulf and the noise they emit*
N	Disturbance - damage (anchoring/diving)					
Y	Pollution - oil/fuel	2	2	4	L	Can swim away from spills, though could come into contact and impact gills. Impacts and likelihood of oil and fuel spill from recreational vessels is probably low. Uncertainty around copper-based contaminates. Contaminates can bioaccumulate in higher order consumers. *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spill impacts to fishes* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
Y	Pollution - rubbish	2	3	6	L-M	Similar as for prawns. *Data confidence* • *High confidence that microplastics occur in the water column of Exmouth Gulf - see King (2019)* • *Low confidence around the extent of hard rubbish in the Gulf* • *Low confidence around the extent to which rubbish is impacting fishes in the Gulf*
Value: Teleost - coral trout						
Y	Disturbance - noise	1	3	3	L-M	Possible effects but unknown. Can move away from noise source. *Data confidence* • *Low confidence around the impact of anthropogenic noises on coral trout*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
						• *Medium confidence around the volume of recreational vessels using the gulf and the noise they emit*
N	Disturbance - damage (anchoring/diving)					
Y	Pollution - oil/fuel	2	2	4	L	Can swim away from spills, though could come into contact and impact gills. Impacts and likelihood of oil and fuel spill from recreational vessels is probably low. Uncertainty around copper-based contaminates. Contaminates can bioaccumulate in higher order consumers. *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spill impacts to fishes* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
Y	Pollution - rubbish	2	3	6	L-M	Similar as for prawns. *Data confidence* • *High confidence that microplastics occur in the water column of Exmouth Gulf - see King (2019)* • *Low confidence around the extent of hard rubbish in the Gulf* • *Low confidence around the extent to which rubbish is impacting fishes in the Gulf*
Value: Teleost - red emperor						
Y	Disturbance - noise	1	3	3	L-M	Possible effects but unknown. Can move away from noise source. *Data confidence* • *Low confidence around the impact of anthropogenic noises on red emperor* • *Medium confidence around the volume of recreational vessels using the gulf and the noise they emit*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
N	Disturbance - damage (anchoring/diving)					
Y	Pollution - oil/fuel	2	2	4	L	Can swim away from spills, though could come into contact and impact gills. Impacts and likelihood of oil and fuel spill from recreational vessels is probably low. Uncertainty around copper-based contaminants. Contaminates can bioaccumulate in higher order consumers. *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spill impacts to fishes* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
Y	Pollution - rubbish	2	3	6	L-M	Similar as for prawns. *Data confidence* • *High confidence that microplastics occur in the water column of Exmouth Gulf - see King (2019)* • *Low confidence around the extent of hard rubbish in the Gulf* • *Low confidence around the extent to which rubbish is impacting fishes in the Gulf*
Value: Teleost - tuskfish						
Y	Disturbance - noise	1	3	3	L-M	Possible effects but unknown. Can move away from noise source. *Data confidence* • *Low confidence around the impact of anthropogenic noises on tuskfish* • *Medium confidence around the volume of recreational vessels using the gulf and the noise they emit*
N	Disturbance - damage (anchoring/diving)					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
Y	Pollution - oil/fuel	2	2	4	L	Can swim away from spills, though could come into contact and impact gills. Impacts and likelihood of oil and fuel spill from recreational vessels is probably low. Uncertainty around copper-based contaminates. Contaminates can bioaccumulate in higher order consumers. *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spill impacts to fishes* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
Y	Pollution - rubbish	2	3	6	L-M	Similar as for prawns. *Data confidence* • *High confidence that microplastics occur in the water column of Exmouth Gulf - see King (2019)* • *Low confidence around the extent of hard rubbish in the Gulf* • *Low confidence around the extent to which rubbish is impacting fishes in the Gulf*
Value: Elasmobranchs - rays (shovelnose)						
Y	Disturbance - noise	1	3	3	L-M	Mobile animals - can move. Do not know what the impacts would be - **more knowledge needed**, therefore higher likelihood. *Data confidence* • *Low confidence around the impact of anthropogenic noises on rays* • *Medium confidence around the volume of recreational vessels using the gulf and the noise they emit*
N	Disturbance - damage (anchoring/diving) - incl. vessel strikes					Bottom dwelling may not be an issue?

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
Y	Pollution - oil/fuel	2	2	4	L	Can swim away from spills, though could come into contact and impact gills. Impacts and likelihood of oil and fuel spill from recreational vessels is probably low. Uncertainty around copper-based contaminates. Contaminates can bioaccumulate in higher order consumers. *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spill impacts to rays* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
Y	Pollution - rubbish	2	3	6	L-M	Similar as for prawns. Fishing gear entanglement a consideration as well. *Data confidence* • *High confidence that microplastics occur in the water column of Exmouth Gulf - see King (2019)* • *Low confidence around the extent of hard rubbish in the Gulf* • *Low confidence around the extent to which rubbish is impacting rays in the Gulf*
Value: Elasmobranchs - rays (manta) ***EPBC Act - Migratory, Marine listed***						
Y	Disturbance - noise	2	3	6	L-M	Manta rays are disturbed by tourism - this is the case for mantas off Coral Bay (Venables et al. 2016). Whether the driver of disturbance is noise is unknown. Manta rays occur in the Gulf almost year-round, with occurrences higher between August - November. There is potential for disturbance to the manta rays from tourism, ship strike, jet ski harassment etc. Recreational and tourism vessels are more of a concern than shipping vessels as manta rays are actively targeted and there are no proximity or duration rules/limits as there are for whales/whale sharks etc. Would expect an increase in recreational vessels and tourism over time. Do not know what the impacts would be - **more knowledge needed**, therefore higher likelihood. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
						• *Low confidence around the impact of anthropogenic noises on rays* • *Medium confidence around the volume of recreational vessels using the gulf and the noise they emit*
Y	Disturbance - damage (anchoring/diving) - incl. vessel strikes	2	3	6	M-H	Fast moving vessels can strike mantas using the surface waters. Increased recreational vessels in the Gulf increases the risk of strike. *Data confidence* • *High confidence that vessels strike manta rays* • *Medium confidence around the frequency of vessel strikes in the gulf- see McGregor et al. (2020)* • *Medium confidence around the volume of recreational vessels using the gulf*
Y	Pollution - oil/fuel	2	2	4	L	Minimal, however if there are oil or fuel slicks when the mantas are feeding then they will also ingest this fuel. Potential to impact/irritate gills. Impacts and likelihood of oil and fuel spill from recreational vessels is probably low. Uncertainty around copper-based contaminants. Contaminants can bioaccumulate in higher order consumers. *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spill impacts to rays* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
Y	Pollution - rubbish	3	3	9	L-M	Manta rays are filter feeders and feed in the tide lines. There are huge tide lines that occur along the 5-10m depth contour off the Exmouth Marina and north along the coast to Bundegi. The manta rays feed in these tide lines, especially from August. The manta rays arrive in the Gulf at this time in large numbers. As they are feeding, they will take in plastics and rubbish that is floating on and near the surface as they barrel roll and skim feed. Any rubbish in the ocean is no good for filter feeders like manta rays and whale sharks (EPBC Act - Vulnerable, Migratory).

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
						Researchers are still understanding the impact of microplastics on marine life at all scales. Microplastic fibres occur in beach samples 4-5 pieces per 25g samples. Microplastics <5mm are present in surface waters of Exmouth Gulf and occur where manta rays feed. Would expect microplastic pollution to increase over time - local sources and oceanographic influences need to be considered. Fishing gear entanglement a consideration as well. *Data confidence* • *High confidence that microplastics occur in the water column of Exmouth Gulf - see King (2019)* • *Low confidence around the extent of hard rubbish in the Gulf* • *Low to Medium confidence around the extent to which rubbish is impacting manta rays in the Gulf - see King (2019)*
Value: Elasmobranchs - sawfish						
Y	Disturbance - noise	1	3	3	L-M	Mobile animals - can move. Do not know what the impacts would be - **more knowledge needed**, therefor higher likelihood. *Data confidence* • *Low confidence around the impact of anthropogenic noises on sawfish* • *Medium confidence around the volume of recreational vessels using the gulf and the noise they emit*
N	Disturbance - damage (anchoring/diving) - incl. vessel strikes					Bottom dwelling may not be an issue?
Y	Pollution - oil/fuel	2	2	4	L	Can swim away from spills, though could come into contact and impact gills. Impacts and likelihood of oil and fuel spill from recreational vessels is probably low. Uncertainty around copper-based contaminates. Contaminates can bioaccumulate in higher order consumers.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
						Data confidence • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spill impacts to sawfish* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
Y	Pollution - rubbish	2	3	6	L-M	Breakdown products of rubbish (e.g., microplastics) occur in the water column and accumulate in animals. Evidence elsewhere of microplastics being ingested by smaller invertebrates such as coral polyps and zooplankton through to mobile vertebrates. Researchers are still understanding the impact of microplastics on marine life at all scales. Microplastic fibres occur in beach samples 4-5 pieces per 25g samples. Microplastics <5mm are present in surface waters of Exmouth Gulf. Would expect microplastic pollution to increase over time - local sources and oceanographic influences need to be considered. Fishing gear entanglement a consideration as well. *Data confidence* • *High confidence that microplastics occur in the water column of Exmouth Gulf - see King (2019)* • *Low confidence around the extent of hard rubbish/fishing gear in the Gulf* • *Low confidence around the extent to which rubbish is impacting sawfish in the Gulf*
Value: Elasmobranchs - sharks						
Y	Disturbance - noise	2	2	4	L-M	Sharks can be disturbed by vessels approaching them and when swimmers are placed in the water- this is the case for whale sharks (EPBC Act - Vulnerable, Migratory) (Raudino et al. 2016). Whether the driver of the disturbance is noise is yet to be determined.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
						Sharks are not that heavily targeted in Exmouth Gulf due to the high turbidity and fewer whale sharks compared to the Ningaloo Reef. This is the same for tiger sharks, that are targeted off Coral Bay and not in Exmouth Gulf due to the turbidity. Recreational and tourism vessels are more of a concern than shipping vessels for sharks other than whale sharks as can be actively targeted and there are no proximity or duration rules/limits as there are for whales/whale sharks etc. *Data confidence* • *Low confidence around the impact of anthropogenic noises on whiting* • *Medium confidence around the volume of recreational vessels using the gulf and the noise they emit*
Y	Disturbance - damage (anchoring/diving) - incl. vessel strikes	2	3	6	M	Fast moving vessels can strike whale sharks. Increased recreational vessels in the Gulf increases the risk of strike. *Data confidence* • *High confidence that vessels have hit whale sharks in the Ningaloo area - see recent incident May 2021* • *Low confidence around the frequency of vessel strikes* • *Medium confidence around the volume of recreational vessels using the gulf*
Y	Pollution - oil/fuel	2	1	2	L	Minimal- unless a filter feeder like whale sharks. However, there are minimal whale sharks in the Gulf compared to Ningaloo Reef side. Can swim away from spills, though could come into contact and impact gills. Impacts and likelihood of oil and fuel spill from recreational vessels is probably low. Uncertainty around copper-based contaminates. Contaminates can bioaccumulate in higher order consumers. *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spill impacts to sharks*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
						• *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
Y	Pollution - rubbish	3	2	6	L-M	Higher risk to filter feeding whale sharks than non-filter feeders. However, there are minimal whale sharks in the Gulf compared to Ningaloo Reef side. Breakdown products of rubbish (e.g., microplastics) occur in the water column and accumulate in animals. Evidence elsewhere of microplastics being ingested by smaller invertebrates such as coral polyps and zooplankton through to mobile vertebrates. Researchers are still understanding the impact of microplastics on marine life at all scales. Microplastic fibres occur in beach samples 4-5 pieces per 25g samples. Microplastics <5mm are present in surface waters of Exmouth Gulf. Would expect microplastic pollution to increase over time - local sources and oceanographic influences need to be considered. Fishing gear entanglement a consideration as well. *Data confidence* • *High confidence that microplastics occur in the water column of Exmouth Gulf - see King (2019)* • *Low confidence around the extent of hard rubbish/fishing gear in the Gulf* • *Low confidence around the extent to which rubbish is impacting sharks in the Gulf*
Value: Marine reptiles - sea snakes						
Y	Disturbance - noise	1	3	3	L-M	Several species are EPBC conservation listed, including Critically Endangered. Mobile animals - can move. Do not know what the impacts would be - **more knowledge needed**, therefor higher likelihood. *Data confidence* • *Low confidence around the impact of anthropogenic noises on sea snakes*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
						• *Medium confidence around the volume of recreational vessels using the gulf and the noise they emit*
Y	Disturbance - damage (anchoring/diving) - incl. vessel strikes	1	4	4	L-M	Fast moving vessels can strike snakes, or snakes may get tangled in propellors. Increased recreational vessels in the Gulf increases the risk of strike. *Data confidence* • *Low confidence around the frequency of vessel strikes in the gulf* • *Medium confidence around the volume of recreational vessels using the gulf*
Y	Pollution - oil/fuel	2	2	4	L	Can swim away from spills, though could come into contact and impact respiratory as air breathers. Spills from recreational vessels unlikely. Uncertainty around copper-based contaminates. Contaminants can bioaccumulate in higher order consumers. *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Low confidence around oil and fuel spill impacts to sea snakes* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
Y	Pollution - rubbish	2	3	6	L-M	Breakdown products of rubbish (e.g., microplastics) occur in the water column and accumulate in animals. Evidence elsewhere of microplastics being ingested by smaller invertebrates such as coral polyps and zooplankton through to mobile vertebrates. Researchers are still understanding the impact of microplastics on marine life at all scales. Microplastic fibres occur in beach samples 4-5 pieces per 25g samples. Microplastics <5mm are present in surface waters of Exmouth Gulf. Would expect microplastic pollution to increase over time - local sources and oceanographic influences need to be considered. Fishing gear entanglement a consideration as well. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
						• *High confidence that microplastics occur in the water column of Exmouth Gulf - see King (2019)* • *Low confidence around the extent of hard rubbish/fishing gear in the Gulf* • *Low confidence around the extent to which rubbish is impacting sea snakes in the Gulf*
Value: Marine reptiles - turtles *(EPBC Act - all species are Vulnerable or Endangered)*						
Y	Disturbance - noise	2	3	6	L-M	Turtles come to breed and nest around the North West Cape. There are turtles in Exmouth Gulf and when nesting on the beaches people can disturb the breeding mothers coming up the beach to lay their eggs. Mating turtles in the shallows can be disturbed by vessels, jet skis, and people. Whether the driver of disturbance is noise needs to be determined. Turtles are present in the Gulf year-round, but different species may be occurring at different times of the year. Observations of greens and hawksbill turtles arriving in the Gulf around August have been made, when the water increases in temperature. Recreational and tourism vessels are more of a concern than shipping vessels for turtles as they can be actively targeted and there are no proximity or duration rules/limits as there are for whales/whale sharks etc. Can expect tourism and vessel use to increase. *Data confidence* • *Low confidence around the impact of anthropogenic noises on turtles* • *Medium confidence around the volume of recreational vessels using the gulf and the noise they emit*
Y	Disturbance - damage (anchoring/diving) - incl. vessel strikes	2	3	6	L-M	Fast moving vessels can strike turtles. Increased recreational vessels, including greater incidence of jet ski use, in the Gulf increases the risk of strike. *Data confidence* • *Low confidence around the frequency of vessel strikes in the gulf* • *Medium confidence around the volume of recreational vessels using the gulf*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
Y	Pollution - oil/fuel	2	2	4	L-M	Can swim away from spills, though could come into contact and impact respiratory as air breathers. Spills from rec vessels unlikely. Uncertainty around copper-based contaminates. Contaminates can bioaccumulate in higher order consumers. *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *Medium confidence around oil and fuel spill impacts to turtles* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
Y	Pollution - rubbish	3	2/3	6-9	L-M	Plastic bags and look like floating jellyfish etc. and thus turtles ingest the plastics and rubbish. Turtles can't digest the rubbish and they become 'floaters', preventing them from diving to feed and causing death from starvation. Floaters are more easily predated upon by tiger sharks or are more easily hit by vessels and jet skis, which can also cause death or their shells to crack. Fishing gear entanglement a consideration as well. *Data confidence* • *High confidence that microplastics occur in the water column of Exmouth Gulf - see King (2019)* • *Low confidence around the extent of hard rubbish/fishing gear in the Gulf* • *Low confidence around the extent to which rubbish is impacting turtles in the Gulf*
Value: Marine mammals - whales (humpback) ***(EPBC Act - Vulnerable, Migratory, Cetacean listed species)***						
Y	Disturbance - noise	2	4	8	M	Humpback whales are targeted for the whale-watching industry- which is focused on the north western side of the Gulf. Tours are done for several hours for sunset tours. Whales in this area range from juvenile, adults and mother-calves. They are all targeted to 100 m distance which is the Australian National Guidelines. At 100 m if the vessel is a quiet vessel underwater, then the whales may not be disturbed. However, if the vessel is loud (e.g., over 160dB re 1 µpa source level) then the whales will be disturbed and will swim away. Operators are to adhere to the Australian National Whale-Watching Guidelines in regard to approach angles, distance and speed. There are however currently no guidelines on the

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
						limits of vessel noise, and this research has been conducted in Exmouth Gulf on humpback whales (Sprogis et al. 2020b). There is also the swim-with-humpback whale industry which began in the Ningaloo Marine Park in 2016 and occurs in the northwestern portion of the Gulf when the water is clearer. The vessels target whales up to 75m and place swimmers in the water (noise source closer to whales). Some vessels will do an in-path approach by moving in front of the whales and place swimmers in the water in the hope that the whales swim under the swimmers, however this is an invasive approach and causes behavioural disturbance to the whales. This approach is known globally and not recommended. Also, mother and calves are swum-with, which is also not best practice. These older calves may only be 3-4 months old. This is not best-practice, and behavioural responses have been published off the Ningaloo Marine Park (Sprogis et al. 2020a). At this stage, the swim-with industry is likely more invasive than whale-watching due to the in-path approaches allowed (which places the noise source in front of the whales), the closer distances allowed to approach whales (noise is more abrupt at closer distances), and that calves are still allowed to be swum with (mother-calves are the most sensitive to disturbance). *Data confidence* • *Medium confidence around the impact of anthropogenic noises on humpback whales in the Gulf - see Sprogis et al. (2020)* • *Medium confidence around the volume of recreational vessels using the gulf and the noise they emit*
Y	Disturbance - damage (e.g., anchoring/diving) - incl. vessel strikes and harassment	2/3	3	6-9	M	Gulls have been shown to change the behaviour of resting humpback whales in the Gulf. Off Argentina, gulls have had a significant negative impact on humpback whales as the rubbish tip is close to the coastline. Gulls tear off skin and blubber from the backs of the whales and disturb both mothers and calves. This harassment has happened over decades and behaviours and physiology of the whales has been altered permanently due to the gull. There is concern this could start to happen in the Gulf if not managed well. Anecdotal evidence that there has been an explosion of silver gull numbers in Exmouth over the past 10 years.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
						Fast moving vessels can strike resting whales in the Gulf. However, this is likely not reported. *Data confidence* • *High confidence that vessel strikes do occur in the gulf* • *Low confidence around the frequency of vessel strikes in the gulf* • *Medium confidence around the volume of recreational vessels using the gulf* • *Medium confidence around the disturbance to whales from gulls*
N	Pollution - oil/fuel					N/A
Y	Pollution - rubbish	1	2	2	L	Entanglement in fishing gear can be an issue for humpback whales. Unsure about the extent of gear in the Gulf that would lead to this. *Data confidence* • *Low confidence around the extent of hard rubbish/fishing gear in the Gulf* • *Low confidence around the extent to which rubbish is impacting whales in the Gulf*
Value: Marine mammals - dolphins (coastal)						
Y	Disturbance - noise	2	3	6	M-H	Coastal dolphins are EPBC Act listed as Cetacean and/or Migratory species. There is limited tourism with dolphins in Exmouth Gulf. The tours generally target humpback whales and see dolphins as a bonus. There is an eco-tour which incorporates dolphins, but it does not focus on them. Generally, the Australian humpback dolphins are shyer than the Indo-Pacific bottlenose dolphins, and the humpback dolphins will swim away from any approaching vessels. The bottlenose dolphins may bow ride but can move away from the area unless being harassed. Recreational users such as jet skis and water skiing have fast and unpredictable movements of which this noise disturbance can change the natural behaviour of the dolphins i.e., moving away. *Data confidence* • *High confidence around the impact of anthropogenic noises on dolphins, though no specific studies in Exmouth Gulf*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
						• *Medium confidence around the volume of recreational vessels using the gulf and the noise they emit*
Y	Disturbance - damage (anchoring/diving) - incl. vessel strikes	2	3	6	L-M	Fast moving vessels can strike dolphins. Increased recreational vessels in the Gulf increases the risk of strike. *Data confidence* • *Low confidence that vessel strikes do occur in the gulf* • *Low confidence around the frequency of vessel strikes in the gulf* • *Medium confidence around the volume of recreational vessels using the gulf*
N	Pollution - oil/fuel					N/A
Y	Pollution - rubbish	2	2	4	L-M	Bioaccumulation of microplastics may occur through ingestion of prey, but likely less of a risk that direct feeding by filter feeders and turtles. Entanglement in marine debris (e.g., discarded fishing line) is also an issue. *Data confidence* • *High confidence that microplastics occur in the water column of Exmouth Gulf - see King (2019)* • *Low confidence around the extent of hard rubbish/fishing gear in the Gulf* • *Low confidence around the extent to which rubbish is impacting dolphins in the Gulf*
Value: Marine mammals - dugongs *(EPBC Act - Migratory, Marine listed species)*						
Y	Disturbance - noise	2	3	6	L-M	There is an eco-tour company in the Gulf, however it does not target dugongs. There are dugongs around Bundegi and the Navy Pier where the Eco-tour transits, however the vessel is generally slow moving and the dugongs would not be highly disturbed. This is not the case for jet skis. There would be high disturbance from the harassment and noise from jet skis. Also, water skiing activities occur in the region e.g., along Town Beach. Possibly an operator with a license to use underwater scooters. Uncertainty on the license restrictions around this but this should not be allowed to occur around animals. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
						• *Low confidence around the impact of anthropogenic noises on dugongs* • *Medium confidence around the volume of recreational vessels using the gulf and the noise they emit*
Y	Disturbance - damage (e.g., anchoring/diving - includes vessel strikes	2	3	6	L-M	Usually happens with small high-speed boats and jet skis - As dugongs need time to pinpoint the noise source and react, and if it is shallow water, then there is a high chance of being hit by fast moving vessels. *Data confidence* • *Low confidence around the frequency of vessel strikes in the gulf* • *Medium confidence around the volume of recreational vessels using the gulf*
N	Pollution - oil/fuel					N/A
Y	Pollution - rubbish	2	1	2	L-M	Less likely that bioaccumulation would occur as microplastics do not attach to seagrass leave, but some ingestion of contaminated sediments may occur? *Data confidence* • *High confidence that microplastics occur in the water column of Exmouth Gulf - see King (2019)* • *Low confidence around the extent of hard rubbish/fishing gear in the Gulf* • *Low confidence around the extent to which rubbish is impacting dugongs in the Gulf*
Value: Seabirds and shorebirds						
Y	Disturbance - noise	2	3	6	L-M	Some species are EPBC Act listed species, including Critically Endangered. Could disturb foraging birds and nesting activities on land *Data confidence* • *Low confidence around the impact of anthropogenic noises on seabirds and shorebirds* • *Medium confidence around the volume of recreational vessels using the gulf and the noise they emit*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
Y	Disturbance - damage (anchoring/diving) - incl. vessel strikes and 4WD	3	4	12	L	More likely to get hit by fast moving recreational vessels than slow moving ships, though the risk and consequence at a population level would be very low. Disturbance here also includes potential impacts by 4WD to nesting and roosting seabirds and shorebirds, both through nest destruction and disturbance causing energy expenditure and potentially abandoning sites. If this can capture seabirds and shorebirds, suggest the consequence is increased to 3, making the overall risk 12. Trampling on islands (seabird nests and burrows and physical disturbance) and pets (i.e., dogs) are also greatest disturbance risks. *Data confidence* • *Low confidence around the frequency of vessel strikes in the gulf* • *Medium confidence around the volume of recreational vessels using the gulf* • *Low confidence around the disturbance to seabirds and shorebirds from 4WDs* • *Low confidence around the disturbance to seabirds and shorebirds from people and dogs*
Y	Pollution - oil/fuel	2	3	6	M	Are vulnerable to oil spills and fuel slicks due to use of surface waters and shorelines *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *High confidence around oil and fuel spill impacts to seabirds and shorebirds* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
Y	Pollution - rubbish	3	3	9	L-M	Can get tangled in rubbish and fishing line. May ingest plastics and feed to young. *Data confidence* • *High confidence that microplastics occur in the water column of Exmouth Gulf - see King (2019)* • *Low confidence around the extent of hard rubbish/fishing gear in the Gulf* • *Low confidence around the extent to which rubbish is impacting seabirds and shorebirds in the Gulf*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
Factor: Marine environmental quality						
Value: Water quality						
N	Disturbance - noise					
N	Disturbance - damage (anchoring/diving)					
Y	Pollution - oil/fuel	2	2	4	L-M	Spills from recreational/tourism vessels less likely. Antifoulants entering into water column *Data confidence* • *Low confidence around the impact of copper-based contaminants* • *High confidence around oil and fuel spill impacts to water quality* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
Y	Pollution - rubbish	2	2	4	M	Breakdown of rubbish could increase particles in the water column and microplastics can carry accumulated contaminants. *Data confidence* • *High confidence that microplastics occur in the water column of Exmouth Gulf - see King (2019)* • *Low confidence around the extent of hard rubbish/fishing gear in the Gulf*
Value: Sediment quality						
N	Disturbance - noise					
N	Disturbance - damage (anchoring/diving)					
Y	Pollution - oil/fuel	2	2	4	L-M	Spills from recreational/tourism vessels less likely. Antifoulants entering into water column and sediments *Data confidence* • *Low confidence around the impact of copper-based contaminants*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
						• *High confidence around oil and fuel spill impacts to sediment quality* • *Low confidence around the frequency of occurrence of oil and fuel spills in the Gulf or in general*
Y	Pollution - rubbish	2	2	4	L-M	Breakdown of rubbish could increase particles in the sediments and microplastics can carry accumulated contaminants. *Data confidence* • *High confidence that microplastics occur in the water column of Exmouth Gulf - see King (2019)* • *Low confidence around the extent of hard rubbish/fishing gear in the Gulf, and in sediments*
Factor: Coastal processes						
Value: Geophysical processes						
N	Disturbance - noise					
N	Disturbance - damage (anchoring/diving)					
N	Pollution - oil/fuel					
N	Pollution - rubbish					
Value: Hydrodynamic processes						
N	Disturbance - noise					
N	Disturbance - damage (anchoring/diving)					
N	Pollution - oil/fuel					
N	Pollution - rubbish					
Value: Nutrient flow						

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
N	Disturbance - noise					
N	Disturbance - damage (anchoring/diving)					
N	Pollution - oil/fuel					
N	Pollution - rubbish					

EPA LAND THEME

Negligible	Low	Medium	High	Severe
1-2	3-4	6-8	9-12	16

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
CLIMATE CHANGE						
Factor: Flora & vegetation						
Value: Coastal plains						
N	Sea level rise					
Y	Tropical storms/cyclones	2	3	6	M	Within 10 years, likely to increase frequency and extent in some way which may impact flora and vegetation communities. *Data confidence* • *High confidence about cyclone predictions* • *High confidence that changes in cyclones will impact the area as multiple reports and papers over many years detail the impact of cyclones on the Exmouth area* • *Lower confidence about how exactly this will impact which types of flora and the extent & timeframe of those effects*
Y	Fire	2	3	6	M	As above *Data confidence* • *High confidence about fire predictions as robust data on the increased risk of fire and altered fire regimes in a changing climate* • *Lower confidence about how exactly this will impact which types of flora and the extent & timeframe of those effects*
N	Atmospheric temperatures					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
CLIMATE CHANGE						
Value: Limestone cliffs & gullies						
N	Sea level rise					
Y	Tropical storms/cyclones	2	3	6	M	As above *Data confidence* • *High confidence about cyclone predictions* • *High confidence that changes in cyclones will impact the area as multiple reports and papers over many years detail the impact of cyclones on the Exmouth area* • *Lower confidence about how exactly this will impact which types of flora and the extent & timeframe of those effects*
Y	Fire	2	3	6	M	As above *Data confidence* • *High confidence about fire predictions as robust data on the increased risk of fire and altered fire regimes in a changing climate* • *Lower confidence about how exactly this will impact which types of flora and the extent & timeframe of those effects*
N	Atmospheric temperatures					
Value: Coastal dunes						
Y	Sea level rise	1	3	3	M-H	We will see some localised sea level rise in 10 years. *Data confidence* • *High confidence in sea level rise predictions*
Y	Tropical storms/cyclones	2	3	6	M	As above *Data confidence* • *High confidence about cyclone predictions* • *High confidence that changes in cyclones will impact the area as multiple reports and papers over many years detail the impact of cyclones on the Exmouth area*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
CLIMATE CHANGE						
						• *Lower confidence about how exactly this will impact which types of flora and the extent & timeframe of those effects*
Y	Fire	2	3	6	M	As above *Data confidence* • *High confidence about fire predictions as robust data on the increased risk of fire and altered fire regimes in a changing climate* • *Lower confidence about how exactly this will impact which types of flora and the extent & timeframe of those effects*
N	Atmospheric temperatures					
Value: Threatened/priority flora						
N	Sea level rise					Endemic threatened/priority flora on dunes & coastal plains may be at risk with sea level rise.
Y	Tropical storms/cyclones	3	3	9	M	• *Frequency and extent could increase and cause population level impacts. Low confidence in baseline data.* *Data confidence* • *High confidence about cyclone predictions* • *High confidence that changes in cyclones will impact the area as multiple reports and papers over many years detail the impact of cyclones on the Exmouth area* • *Low confidence around the extent of threatened/priority flora*
Y	Fire	3	3	9	M	As above *Data confidence* • *High confidence about fire predictions as robust data on the increased risk of fire and altered fire regimes in a changing climate* • *Lower confidence about how exactly this will impact which types of flora and the extent & timeframe of those effects*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
CLIMATE CHANGE						
N	Atmospheric temperatures					
Factor: Terrestrial fauna						
Value: Reptiles						
Y	Sea level rise	1	2	2	L-M	Low lying islands and coastal fringes will eventually experience some level of inundation and erosion, which would impact on fauna, but probably not to a large extent within 5-10 years Uncertainty exists as to which species would be affected due to an overall lack of survey in the area and lack of detail around community structure for reptiles. *Data confidence* • *High confidence in sea level rise predictions and likely impact on reptiles in the longer term* • *Low confidence around risk of seal level rise on reptiles in the area* • *Low confidence around the distribution of species in the area*
Y	Tropical storms/cyclones	2	3	6	L-M	Storm surges have potential to inundate islands, which have reptile communities, although reptiles in general have higher resilience to short term perturbations than do mammals. There is a lack of survey on islands. *Data confidence* • *High confidence in cyclone predictions and likely impact on reptiles in general* • *Low confidence around risk of cyclones on reptiles in the area* • *Low confidence around the distribution of species in the area*
Y	Fire	2	3	6	M	In the case of large extent and hot fire there could be medium term effects on species and assemblages. The effects can be exacerbated by dry conditions post fire, increased grazing and/or weed invasion/predation. A combination of these may have longer term impacts on species persistence and species community structure. Frequent fire could have cumulative impacts through lack of population recovery in intervening periods. Conversely, in some cases lack of managed fire can also have negative impacts through senescence of vegetation resulting in structural change of habitat.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
CLIMATE CHANGE						
						Data confidence • *High confidence in fire predictions and impact on reptiles in general* • *Low confidence around risk of fire on reptiles in the area.*
Y	Atmospheric temperatures	1	2	2	M	As reptiles are ectothermic, they rely on behavioural patterns to regulate body temperature and in the short term it is doubtful shifts in temperature would have a significant negative effect. Temperatures changes could potentially impact on development of eggs. *Data confidence* • *High confidence in atmospheric temperature predictions and impact on reptiles in general* • *Low confidence around risk of atmospheric temperatures on reptiles in the area.*
Value: mammals						
Y	Sea level rise	2	2	4	M	Low lying islands will eventually experience some level of inundation and erosion, which would impact fauna, but possibly not to a large extent within 5-10 years. *Data confidence* • *High confidence in sea level rise predictions and likely impact on mammals in general* • *Low confidence around risk of seal level rise on mammals in the area*
Y	Tropical storms/cyclones	2	4	8	M	Doole Islands- potential for inundation to storm surges - most of the islands go under water. Bandicoots have been translocated onto Doole Island - all nesting sites are below storm surge level as based off Olwen surge level. *Data confidence* • *High confidence in cyclone predictions and likely impact on mammals in general* • *Low confidence around risk of cyclones on mammals in the area.*
Y	Fire	2	3	6	M	As above for reptiles *Data confidence* • *High confidence in cyclone predictions and impact on mammals in general*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
CLIMATE CHANGE						
						• *Low confidence around risk of fire on mammals in the area.*
Y	Atmospheric temperatures	1	3	3	M	Some species may not be able to tolerate warming temperature, although effects of this on species may not be seen within 5-10 years. *Data confidence* • *High confidence in atmospheric temperature predictions and impact on mammals in general* • *Low confidence around risk of atmospheric temperatures on mammals in the area.*
Value: birds						
Y	Sea level rise	1	3	3	M	Nesting habitat may be impacted. *Data confidence* • *High confidence in sea level rise predictions and impact on terrestrial birds in general* • *Low confidence around risk of sea level rise on terrestrial birds in the area.*
Y	Tropical storms/cyclones	1	3	3	M	As above for mammals *Data confidence* • *High confidence in cyclone predictions and likely impact on terrestrial birds in general* • *Low confidence around risk of cyclones on terrestrial birds in the area.*
Y	Fire	1	3	3	M	As above for reptiles *Data confidence* • *High confidence in fire predictions and impact on terrestrial birds in general* • *Low confidence around risk of fire on terrestrial birds in the area.*
Y	Atmospheric temperatures	3	3	9	M-H	Some species may not be able to tolerate warming temperature & mass avian mortalities & range shifts have occurred in WA. However more information is required to assess the risk of atmospheric temperatures on birds in the area. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
CLIMATE CHANGE						
						• *High confidence in atmospheric temperature predictions* • *High confidence that heatwaves can cause mass mortalities - see McKechnie et al. (2012), McKechnie and Wolf (2010)* • *Low confidence around whether birds in the Exmouth region have been impacted*
Value: short range endemic invertebrates						
N	Sea level rise					
Y	Tropical storms/cyclones	2	3	6	L-M	Storm surges have the potential to inundate islands, which may have short-range endemic communities. *Data confidence* • *High confidence in cyclone predictions* • *Low confidence around the diversity and distribution of SREs in the Exmouth area* • *Low confidence around risk to terrestrial invertebrates from storms in the Exmouth area*
Y	Fire	2	3	6	L-M	In the case of a catastrophic fire. *Data confidence* • *High confidence in fire predictions* • *Low confidence around the diversity and distribution of SREs in the Exmouth area* • *Low confidence around risk to terrestrial invertebrates from fire in the Exmouth area*
Y	Atmospheric temperatures	1	3	3	L-M	Some species may not be able to tolerate warming temperature, although effects of this on species may not be seen within 5-10 years. *Data confidence* • *High confidence in atmospheric temperature predictions* • *Low confidence around the diversity and distribution of SREs in the Exmouth area* • *Low confidence around risk to terrestrial invertebrates from rising temperatures in the Exmouth area*
Value: amphibians						

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
CLIMATE CHANGE						
N	Sea level rise					
Y	Tropical storms/cyclones	1	3	3	L-M	For islands there are likely few if any amphibians. Storm surges have the potential to inundate ephemeral freshwater systems adjacent to the gulf, in which case breeding success in these areas could be compromised. *Data confidence* • *High confidence in cyclone predictions and likely impact on amphibians in general* • *Low confidence around the distribution of amphibians in the Exmouth area* • *Low confidence around risk to amphibians from cyclones in the Exmouth area*
Y	Fire	1	3	3	L-M	Most amphibians that would occur around the periphery of the gulf cocoon below ground or bury themselves in dry conditions so are unlikely to feel direct effects from fire. It is the following indirect effects that have greater potential for negative impacts such as changes to hydrology and/or landscape changes as a result of grazing pressure and/or weeds. *Data confidence* • *High confidence in fire predictions and likely impact on amphibians in general* • *Low confidence around the distribution of amphibians in the Exmouth area* • *Low confidence around risk to amphibians from fires in the Exmouth area*
Y	Atmospheric temperature	2	2	4	L-M	Amphibians typically need moist environments, or access to water during life cycles, however species found around the gulf are arid adapted and can deal with fairly long durations (generally multiple years) of low rainfall. *Data confidence* • *High confidence in atmospheric temperature predictions and the impact on amphibians in general* • *Low confidence around the distribution of amphibians in the Exmouth area* • *Low confidence around risk to amphibians from rising temperatures in the Exmouth area*
Factor: Landforms						
Value: islands						

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
CLIMATE CHANGE						
Y	Sea level rise	4	2	8	M-H	Low-lying islands will eventually experience some level of inundation and erosion, but possibly not to a large extent within 5-10 years. *Data confidence* • *High confidence in sea level rise predictions and impact on islands in general* • *Medium confidence around risk of sea level rise to islands around Exmouth Gulf - see Cuttler et al. (2020) and Bonesso et al. (2020)*
Y	Tropical storms/cyclones	2	4	8	M-H	Doole Islands- potential for inundation to storm surges - most of the islands go under water. Bandicoots have been translocated onto Doole Island - all nesting sites are below storm surge level as based off Olwen surge level. Sandy covered rock islands are more sensitive to changes. If sand is eroded by winds cyclones or rainfall, then that habitat is removed for fauna, including birds. Island would still exist though. *Data confidence* • *High confidence in storm and cyclone predictions and impact on islands in general* • *Medium confidence around risk to islands around Exmouth Gulf*
N	Fire					
N	Atmospheric temperatures					
Value: karst systems						
Y	Sea level rise	3	2	6	M	Sea level rise will impact on chemistry and hydrology of karst systems *Data confidence* • *High confidence in sea level rise predictions* • *High confidence around impact of changes in seawater intrusion on karst systems* • *Low confidence around assessing the likelihood or timeframe for the impact of sea level rise on Karst systems*
Y	Tropical storms/cyclones	1	3	3	M	Potentially impacted by the frequency of the volume of water falling on and draining off the landscape. Could impact sedimentation of cave systems. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
CLIMATE CHANGE						
						• *High confidence in cyclone predictions* • *High confidence around impact of flooding/inundation on karst systems* • *Low confidence around assessing the likelihood or timeframe for the impact of cyclones on Karst systems*
N	Fire					
Y	Atmospheric temperatures	2	3	6	M	Hot, drying climate could change humidity of karst systems. *Data confidence* • *High confidence in temperature predictions* • *High confidence around impact of drying/changing humidity on karst systems* • *Low confidence around assessing the likelihood or timeframe for the impact of atmospheric changes on Karst systems.*
Factor: Subterranean fauna						
Value: troglofauna						
Y	Sea level rise	4	1	4	M	Sea level rise will impact on chemistry and hydrology of karst systems, and the space available for troglofauna, but this may not be realised within 5-10yr timeframe. *Data confidence* • *High confidence in sea level rise predictions* • *High confidence around potential impact of changes in seawater intrusion on troglofauna* • *Low confidence around assessing the likelihood or timeframe for the impact of sea level rise on troglofauna.*
Y	Tropical storms/cyclones	1	3	3	M	As above for karst systems *Data confidence* • *High confidence in cyclone predictions* • *High confidence around potential impact of the potential impact of flooding/ inundation on troglofauna*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
CLIMATE CHANGE						
						• *Low confidence around assessing the likelihood or timeframe for the impact of cyclones on troglofauna.*
N	Fire					
Y	Atmospheric temperatures	2	3	6	M	Troglofauna are sensitive in changes to humidity in underground cave systems. *Data confidence* • *High confidence in both atmospheric temperature and precipitation predictions* • *High confidence that troglofauna are sensitive to changes to humidity* • *Low confidence around assessing the likelihood or timeframe for the impact of atmospheric changes on troglofauna*
Value: stygofauna						
Y	Sea level rise	4	2	8	M	Sea level rise will impact on chemistry and hydrology of karst systems, and thus stygofauna, but this may not be realised within 5-10yr timeframe. *Data confidence* • *High confidence in sea level rise predictions* • *High confidence that any changes in salinity will significantly impact stygofauna* • *Low confidence around the information available to assess the likelihood or timeframe for the impact*
Y	Tropical storms/cyclones	1	3	3	M	As above. • *High confidence in cyclone predictions* • *High confidence around potential impact of the potential impact of flooding/ inundation on stygofauna* • *Low confidence around assessing the likelihood or timeframe for the impact of cyclones on troglofauna*
N	Fire					
Y	Atmospheric temperatures	1/2	3	3-6	M	Uncertainty whether stygofauna are as affected as troglofauna by changes to air temperature/humidity.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
CLIMATE CHANGE						
						Data confidence • *High confidence in both atmospheric temperature and precipitation predictions* • *High confidence that stygofauna will be impacted by a drying climate* • *Low confidence around assessing the likelihood or timeframe for the impact of atmospheric changes on stygofauna*
Factor: Terrestrial environmental quality						
Value: topsoil						
N	Sea level rise					
Y	Tropical storms/cyclones	1	4	4	M	Cyclone winds can erode soil, and flood waters could transport and accumulate soils in certain locations. *Data confidence* • *High confidence in cyclone predictions and likely impact on topsoil in general.* • *Low confidence around impact of cyclones on topsoil in the Exmouth area*
Y	Fire	1	4	4	M	Fires can significantly affect soil properties as organic matter is combusted, which then has flow on effects to chemical, physical, and microbiological properties. *Data confidence* • *High confidence in fire predictions* • *Low confidence around extent of impact to topsoil in Exmouth area*
N	Atmospheric temperatures					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEFENCE						
Factor: Flora & vegetation						
Value: Coastal plains						
Y	Contamination	1	3	3	M	Assuming there is low level legacy contamination, however it is difficult to score with certainty, as military exercises are ongoing. *Data confidence* • *High confidence in data indicating contamination has occurred/is occurring - see DoD (2019)* • *Low confidence around the effects on flora & vegetation in the Exmouth area*
Value: Limestone cliffs & gullies						
Y	Contamination	1	3	3	M	As above. *Data confidence* • *High confidence in data indicating contamination has occurred/is occurring - see DoD (2019)* • *Low confidence around the effects on flora & vegetation in the Exmouth area*
Value: Coastal dunes						
Y	Contamination	1	3	3	M	As above. *Data confidence* • *High confidence in data indicating contamination has occurred/is occurring - see DoD (2019)* • *Low confidence around the effects on flora & vegetation in the Exmouth area*
Value: Threatened/priority flora						
Y	Contamination	2	3	6	L-M	Slightly higher consequence, just by virtue of flora being threatened/priority. Not a high confidence in baseline data. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEFENCE						
						• *High confidence in data indicating contamination has occurred/is occurring - see DoD (2019)* • *High confidence that PFAS can accumulate and have toxic implications for flora and fauna in general* • *Low confidence around the effects on flora & vegetation in the Exmouth area* • *Low confidence around the distribution of threatened and priority flora in the Exmouth area*
Factor: Terrestrial fauna						
Value: Reptiles						
Y	Contamination	1	3	3	M	Likely to be localised as there is legacy contamination. Providing contamination is localised and not widespread then impacts should not be large. *Data confidence* • *High confidence in data indicating contamination has occurred/is occurring - see DoD (2019)* • *High confidence that PFAS can accumulate and have toxic implications for flora and fauna in general* • *Low confidence around the effects on fauna in the Exmouth area*
Value: mammals						
Y	Contamination	1	3	3	M	As above. *Data confidence* • *High confidence in data indicating contamination has occurred/is occurring - see DoD (2019)* • *High confidence that PFAS can accumulate and have toxic implications for flora and fauna in general* • *Low confidence around the effects on fauna in the Exmouth area*
Value: birds						
Y	Contamination	2	3	6	M	Birds rely on specific freshwater sources, and migratory birds may be impacted.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEFENCE						
						Data confidence • *High confidence in data indicating contamination has occurred/is occurring - see DoD (2019)* • *High confidence that PFAS can accumulate and have toxic implications for flora and fauna in general* • *Low confidence around the effects on fauna in the Exmouth area*
Value: short range endemic invertebrates						
Y	Contamination	1	3	3	M	As above. *Data confidence* • *High confidence in data indicating contamination has occurred/is occurring - see DoD (2019)* • *High confidence that PFAS can accumulate and have toxic implications for flora and fauna in general* • *Low confidence around the effects on fauna in the Exmouth area*
Value: amphibians						
Y	Contamination	2	3	6	M	Providing contamination is localised and not widespread then impacts should not be large. *Data confidence* • *High confidence in data indicating contamination has occurred/is occurring - see DoD (2019)* • *High confidence that PFAS can accumulate and have toxic implications for flora and fauna in general* • *Low confidence around the effects on fauna in the Exmouth area*
Factor: Landforms						
Value: islands						
N	Contamination					
Value: karst systems						

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEFENCE						
Y	Contamination	1/2	3	3-6	M	Localised contamination could seep into karst systems. *Data confidence* • *High confidence in data indicating contamination has occurred/is occurring - see DoD (2019)* • *Low confidence around the extent that run-off containing PFAS is entering karst systems*
Factor: Subterranean fauna						
Value: troglofauna						
Y	Contamination	1/2	3	3-6	M	Same as Karst above. *Data confidence* • *High confidence in data indicating contamination has occurred/is occurring - see DoD (2019)* • *High confidence that PFAS can accumulate and have toxic implications for flora and fauna in general* • *Low confidence around the extent that run-off containing PFAS is entering karst systems*
Value: stygofauna						
Y	Contamination	1/2	3	3-6	M	As above. *Data confidence* • *High confidence in data indicating contamination has occurred/is occurring - see DoD (2019)* • *High confidence that PFAS can accumulate and have toxic implications for flora and fauna in general* • *Low confidence around the extent that run-off containing PFAS is entering karst systems*
Factor: Terrestrial environmental quality						
Value: topsoil						

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEFENCE						
Y	Contamination	1/2	3	3-6	H	Same as flora and vegetation. *Data confidence* • *High confidence in data indicating contamination has occurred/is occurring - see DoD (2019)*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
Factor: Flora & vegetation						

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
	• What has been the total loss of quality and function of the peninsula? • A map would be useful to see where vegetation types are. Then we can have a more adequate assessment of the risk. • There are unknowns around light industrial opportunities - do not know what might pop up. • Impact not just confined to the development e.g., introduced weeds and plant pathogens could impact other areas. • Relatively few waterways in the area. On western side of Exmouth Gulf - half a dozen waterways that drain into Gulf - probably two or three have been radically altered e.g., one that leads into marina, Wappet Creek, Mowbowra, Qualing Pool. Associated vegetation complexes have likely been impacted for three or four of the waterways. The waterway near the VLF transmitter masts is no longer there, and at Harold E. Holt Base, the waterway has radically altered. • Fragmentation of vegetation complexes near town. • Goats were a major problem in the past and were wide roaming. Goats not such a large issue anymore, at least not in the last five years. Annual camera surveys have been conducted and goats have been under control (Department of Biodiversity, Conservation and Attractions (DBCA) - aerial shoots). Camera surveys have been done on Defence, DBCA and Watercorp land. Goats have been picked up on camera on Exmouth Gulf pastoral lease behind Learmonth area. • Permanent waterholes occur around Badjirrajirra Creek and there are 'rainforest' pockets around this creek. In the past they were overrun by goats. • Surface water changes will be assessed under WATER factor. • Some stations derive most of income from grazing animals - no fences - goats used to roam through hinterland around town. • In the past, goats were impacting more than pastoral areas. 'Mobs' of goats were found behind the town.					
Value: Coastal plains						
Y	Residential - footprint	1	3	3	M	Shire has informed that future residential development will be to infill areas (mostly in the main town), rather than develop whole new areas. There is **currently** no identified major residential development in Exmouth within the next 5-10 years, as far as the Shire is aware. The main footprint of town is ~3-4km long by ~2km wide. There is a housing shortage so there would be pressures from increased residential builds, which may/may not happen within 5-10 years. What is the vegetation within infill areas? **Knowledge needed.** Vegetation has faced impacts of destructive activities around town - motorbike use etc. Need to understand what the baseline is for coastal vegetation, then can assess the incremental risks better. Some info exists, **but a better understanding is needed, particularly for unique flora.** Subspecies of flora exist in Cape Range.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						DBCA did a lot of vegetation work through area which included defining the spatial area of some vegetation complexes - course level data. Coastal plain vegetation includes samphire, which are extensive throughout region. Big Defence towers sit on saltmarshes. Coastal saltmarshes are an Environment Protection and Biodiversity Conservation listed community. Dunes adjacent to town have all been impacted by people. *Data confidence* • *High confidence that increased infill will lead to further damage & fragmentation of coastal vegetation* • *Low confidence around the plant species and community composition that may be affected and how severe those effects will be*
Y	Residential - groundwater drawdown	2/3	2	6	M	Groundwater drawdown has the potential to impact flora and vegetation through lack of water *Data confidence* • *High confidence that groundwater drawdown can impact flora and vegetation* • *Low confidence around how much flora and vegetation has been/or will be impacted in the Exmouth area*
N	Residential - solid waste					
N	Residential - light					
N	Residential - noise					
Y	Industrial - footprint	2/3	4	8-12	L-M	Shire planning maps do not show major industrial development in next 5-10 years. Gascoyne Gateway (GG) - tourism (cruise ships) will be less than 10 visitations a year (Department of Jobs, Tourism, Science and Innovation), industrial port activities will occur on a regular basis. What is land based footprint? Substantial ~100 hectares??? Solar arrays to consider - west of development. **Score based on assumption of 100 hectares for Gascoyne Gateway (GG) if proposing a multi-user jetty facility goes ahead.**

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						Probably a combination of hard stand and cleared area, not all concrete - but either way NOT vegetation. Could be limestone in parts. Cumulative impacts to consider along west edge of Gulf - starting to look like a considerable impact if development continues. Existing development further up the cape already adds to cumulative development and impacts. At least a moderate consequence if considering cumulative impacts. Exmouth Gulf Marina - filled in base of catchment - infill has influenced the impacts felt from cyclones and floods. **Data confidence is not high for scoring impacts of industrial development.** *Data confidence* • *High confidence that increased development will lead to further damage & fragmentation of coastal vegetation* • *Low confidence around the plant species and community composition that may be affected and how severe those effects will be* • *Low confidence around details and extent of proposed developments*
Y	Industrial - groundwater drawdown	2/3	2	6	M	Groundwater drawdown has the potential to impact flora and vegetation through lack of water *Data confidence* • *High confidence that groundwater drawdown can impact flora and vegetation* • *Low confidence around how much flora and vegetation has been/or will be impacted in the Exmouth area*
Y	Industrial - solid waste	1/2	4	4-8	M	Based on numerous anecdotal reports and satellite imagery, illegal dumping occurs (~500 mounds of dumped materials, including fill and demolition rubbish) at a location between the town and the industrial area (between the main road and coastline). Unsure if this is contaminated. *Data confidence* • *High confidence that rubbish and illegal dumping occurs* • *Low confidence around the extent of impacts on coastal plain vegetation*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
N	Industrial - light					
N	Industrial - noise					
Y	Tourism - footprint (inc. road)	2/3	4	8-12	L-M	Two areas are earmarked for future caravan parks in the town Not sure of the quality of the land of the proposed areas. Is it already degraded?) Lighthouse redevelopment project is a major consideration. Not a lot of information about the project - so will need to speculate. Road at lighthouse is proposed to be moved behind the existing development so that there is access to the beach - this would go through pristine vegetation. Scoring of this pressure/activity includes ROADS. Lighthouse could be an improvement- but the road is a major impact. Increased tourism will have a significant impact on groundwater draw down - how will this impact vegetation? All three tourism developments will result in cumulative issues - and this needs to be considered. Caravan park, if properly managed, could be a good thing, otherwise the area at the moment is degraded (if the locations believed to be earmarked are correct). Camping occurs on pastoral lands and future proposals are likely. Data confidence is not high for scoring impacts of tourism development. *Data confidence* • *High confidence that increased development will lead to further damage & fragmentation of coastal vegetation* • *Low confidence around the plant species and community composition that may be affected and how severe those effects will be* • *Low confidence around details and extent of proposed developments*
Y	Tourism - groundwater drawdown	2/3	2	6	M	Groundwater drawdown has the potential to impact flora and vegetation through lack of water *Data confidence* • *High confidence that groundwater drawdown can impact flora and vegetation*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						• *Low confidence around how much flora and vegetation has been/or will be impacted in the Exmouth area*
N	Tourism - solid waste					
N	Tourism - light					
N	Tourism - noise					
Value: Limestone cliffs & gullies						
Y	Residential - footprint	1	3	3	L-M	Similar justification to above. Along the dry creek beds are Eucalyptus and Acacia species. Qualing Pool - has limestone cliff and gullies, old fossil coral ridges plus four vegetation types in vicinity of GG and Qualing Pool area How do the vegetation complexes in the residential areas compare with other vegetation complexes? **Botanical surveys needed to capture detail.** *Data confidence* • *Medium confidence that increased infill will lead to further damage & fragmentation of vegetation on limestone cliffs & gullies* • *Low confidence around the plant species and community composition that may be affected and how severe those effects will be*
Y	Residential - groundwater drawdown	2/3	2	6	M	Groundwater drawdown has the potential to impact flora and vegetation through lack of water *Data confidence* • *High confidence that groundwater drawdown can impact flora and vegetation* • *Low confidence around how much flora and vegetation has been/or will be impacted in the Exmouth area*
Y	Residential - solid waste	1	4	4	L-M	Quite a lot of illegal dumping occurs around Mowbowra area (old fridges and car bodies). Vegetation has already been impacted. Anecdotal reports of illegal dumping but no empirical data on extent, type or impact on limestone cliff & gully vegetation.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						Data confidence • *High confidence that illegal dumping is occurring* • *Low confidence around the full extent and types of rubbish that is dumped* • *Low confidence around the impact of illegal dumping and rubbish tip on flora and vegetation*
N	Residential - light					
N	Residential - noise					
Y	Industrial - footprint	3	4	12	M	GG port - concerns from public submissions around Qualing Pool and freshwater expression. Given the values of Qualing Pool, the consequence is likely to be high. There is a light industrial area just north of Qualing Pool already - so an impact already. Cumulative impacts to consider. *Data confidence* • *High confidence that increased development will lead to further damage & fragmentation of vegetation* • *Low confidence around the plant species and community composition that may be affected and how severe those effects will be* • *Low confidence around details and extent of proposed developments*
Y	Industrial - groundwater drawdown	2/3	2	6	M	Groundwater drawdown has the potential to impact flora and vegetation through lack of water *Data confidence* • *High confidence that groundwater drawdown can impact flora and vegetation* • *Low confidence around how much flora and vegetation has been/or will be impacted in the Exmouth area*
N	Industrial - solid waste					
N	Industrial - light					
N	Industrial - noise					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
Y	Tourism - footprint	3	4	12	L-M	Proposed lighthouse and caravan parks. Vlamingh Head - limestone. Future developments will increase consequence - cumulative impacts. *Data confidence* • *High confidence that increased development will lead to further damage & fragmentation of vegetation of cliffs and gullies* • *Low confidence around the plant species and community composition that may be affected and how severe those effects will be* • *Low confidence around details and extent of proposed developments*
N	Tourism - groundwater drawdown					
N	Tourism - solid waste					
N	Tourism - light					
N	Tourism - noise					
Value: Coastal dunes						
Y	Residential - footprint	1	3	3	M	Coastal dunes: soft spinifex covers the front and back of dunes. Plains: *Triodia*- spikey spinifex and other shrubs. Most residential development is away from dunes. *Data confidence* • *High confidence that increased infill will lead to further damage & fragmentation of vegetation on dunes.* • *Low confidence around the plant species and community composition that may be affected and how severe those effects will be*
Y	Residential - groundwater drawdown	2/3	2	6	M	Groundwater drawdown has the potential to impact flora and vegetation through lack of water *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						• *High confidence that groundwater drawdown can impact flora and vegetation* • *Low confidence around how much flora and vegetation has been/or will be impacted in the Exmouth area*
N	Residential - solid waste					
N	Residential - light					
N	Residential - noise					
Y	Industrial - footprint	1	4	4	M	Main industrial areas in town are not an issue but GG will be. It will probably cut through dunes for access. Due to different versions of the GG footprint, we do not know the GG footprint so can only speculate. GG might cut through and not overlay dunes. If the footprint does back on to the dunes, rather than cut through the dunes, then the consequence score would be different. Different conceptual designs will impact the consequence score. Trying to do a conceptual assessment - not actually assessing GG or lighthouse specifically - these developments are concepts only. For the existing industrial footprint, the consequence would be minor, but proposals/concept plans increase the consequence. *Data confidence* • *High confidence that increased development will lead to further damage & fragmentation of dune vegetation* • *Low confidence around the plant species and community composition that may be affected and how severe those effects will be* • *Low confidence around details and extent of proposed developments*
Y	Industrial - groundwater drawdown	2/3	2	6	M	Groundwater drawdown has the potential to impact flora and vegetation through lack of water *Data confidence* • *High confidence that groundwater drawdown can impact flora and vegetation* • *Low confidence around how much flora and vegetation has been/or will be impacted in the Exmouth area*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
N	Industrial - solid waste					
N	Industrial - light					
N	Industrial - noise					
Y	Tourism - footprint	3	3	9	L-M	Coastal plains and dunes are probably most impacted by the road. Would still have access to surfing and dive spots. Track out to Mildura wreck would probably stay. Two carparks in between coast and lighthouse would probably stay. Some locals concerned about limited access. Turtles in coastal dunes - degraded vegetation on dunes would cause secondary impacts to turtle nesting. Minor consequence with current developments, but future proposed developments would increase this consequence, largely because of the road, to a moderate/high consequence. Do not know where the road will go. One possible road option - Base of Vlamingh head and in behind existing lighthouse?? Can only speculate. All we can say is that there will be impacts from a road on flora and fauna. Score for the worst case scenario - if the road went through the dune system. Access from old caravan park to lighthouse bay, along the old creek bed, has some implications on pedestrian access. Lighthouse Bay regularly monitored for turtle nesting - lighting an issue here, as is access to people looking at nesting turtles. Also, a significant Aboriginal site - shell middens are found through the dunes. Osprey also nest in the area. SCORE LIGHT POLLUTION AND TURTLES UNDER FAUNA *Data confidence* • *High confidence that increased development will lead to further damage & fragmentation of vegetation of dunes* • *Low confidence around the plant species and community composition that may be affected and how severe those effects will be* • *Low confidence around details and extent of proposed developments*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
Y	Tourism - groundwater drawdown	2/3	2	6	M	Groundwater drawdown has the potential to impact flora and vegetation through lack of water *Data confidence* • *High confidence that groundwater drawdown can impact flora and vegetation* • *Low confidence around how much flora and vegetation has been/or will be impacted in the Exmouth area*
N	Tourism - solid waste					
N	Tourism - light					
N	Tourism - noise					
Value: Threatened/priority flora						
Y	Residential - footprint	1	3	3	L	Do not have expertise in the room. Limited baseline information Priority 3 species: *Tecticornia (samphire - considered under SEA)* *Tephrosia* DBCA mapping shows no 'threatened' flora species within scope - but it does not mean they are not there. Surveys for flora are required in a separate Environmental Impact Assessment. Much of peninsula was an island for a long time - so speciesism and endemism are likely. Harold E. Holt base possibly impacted by road realignment. What was there or lost before the roads went in? Subsea 7 did some targeted vegetation surveys - but not sure if representative of entire area. Impacts on vegetation behind salt flats is considered under MINING *Data confidence* • *Low confidence around whether threatened/priority flora are located at infill sites and if so, the extent to which they would be affected by developments*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
Y	Residential - groundwater drawdown	2/3	2	6	M	Groundwater drawdown has the potential to impact flora and vegetation through lack of water *Data confidence* • *High confidence that groundwater drawdown can impact flora and vegetation* • *Low confidence around how much flora and vegetation has been/or will be impacted in the Exmouth area*
N	Residential - solid waste					
N	Residential - light					
N	Residential - noise					
Y	Industrial - footprint	3	3	9	L	If there is an impact, consequence would be high because threatened species unlikely to be covering vast distances. **More knowledge needed** on the presence and distribution of species. *Data confidence* • *Low confidence around whether threatened/priority flora are located at sites proposed for industrial development and, if so, the extent to which they would be impacted*
Y	Industrial - groundwater drawdown	2/3	2	6	M	Groundwater drawdown has the potential to impact flora and vegetation through lack of water *Data confidence* • *High confidence that groundwater drawdown can impact flora and vegetation* • *Low confidence around how much flora and vegetation has been/or will be impacted in the Exmouth area*
N	Industrial - solid waste					
N	Industrial - light					
N	Industrial - noise					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
Y	Tourism - footprint	3	3	9	L	Minor consequence with current developments, but future proposed developments would increase this consequence, largely because of the lighthouse road, to a moderate/high consequence. Do not know where the road will go. All we can say is that there will be impacts from a road on flora and fauna. *Data confidence* • *Low confidence around whether threatened/priority flora are located at development sites and if so, the extent to which they would be affected by developments*
Y	Tourism - groundwater drawdown	2/3	2	6	M	Groundwater drawdown has the potential to impact flora and vegetation through lack of water *Data confidence* • *High confidence that groundwater drawdown can impact flora and vegetation* • *Low confidence around how much flora and vegetation has been/or will be impacted in the Exmouth area*
N	Tourism - solid waste					
N	Tourism - light					
N	Tourism - noise					
Factor: Terrestrial fauna						
Value: Reptiles						
Y	Residential - footprint	1	4	4	L-M	Due to localised extent and footprint being infill in existing urban landscapes, the overall consequence is minor as species occurring within the Exmouth precinct are likely to have substantial distributions outside of the townsite. Shire has informed that future residential development will be to infill areas - mostly in the main town - rather than develop whole new areas. Some clearing of habitat would occur with infilling. Development/urban sprawl in general can push fauna out. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						• *High confidence that increased infill will remove habitat for reptiles occuring in residential footprints* • *Low confidence around species diversity, community assemblages* • *Low confidence around the extent to which reptiles would be impacted*
Y	Residential - groundwater drawdown	3	2	6	M	Groundwater drawdown has the potential to indirectly impact terrestrial fauna habitat e.g., vegetation and wetlands *Data confidence* • *High confidence that groundwater drawdown can impact flora and vegetation and, in turn, fauna* • *Low confidence around how fauna have or will be impacted in the Exmouth area*
Y	Residential - solid waste	1	3	3	M	Rubbish and contamination leached from rubbish may accumulate in food webs/fauna over time but perhaps will not be realised within the timeframe of 5-10 years. *Data confidence* • *High confidence that illegal dumping is occurring* • *Low confidence around the full extent and types of rubbish that is dumped* • *High confidence that native reptiles will be present at sites affected by solid waste* • *Low confidence around the impact of waste on fauna in the area*
Y	Residential - light	2	3	6	M	Increased light pollution impacts on natural light cycles which reptiles have evolved with. Impacts of light on many terrestrial fauna species not well studied. There may be impacts to behaviour and/or physiology, reducing survivorship or reproductive output. - *Perry et al. 2008 - Effects of night lights on urban reptiles and amphibians* and *DEE 2020 - National Light Pollution Guidelines for Wildlife.* It is unlikely that light will affect species outside a residential footprint and as disturbance will have already occurred from development, species that are tolerant of such change will likely persist. If only assessing the risk to terrestrial reptiles, then the consequence and likelihood would be 1 and 3, respectively. However, marine turtle hatchlings are significantly impacted by light from land development, which can disorient hatchlings inland rather than out to sea. Note that marine turtles are part of the EPA's marine fauna factor, however, because light pollution

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						from Development was not assessed under the Sea theme (only light pollution from Shipping is), it is assessed here. The score reflects both terrestrial reptiles and marine turtles. An assessment of light pollution across Australia identified the North West Shelf of Australia (including Cape Range) as one of two sites facing the highest potential risk from light pollution. Altered light horizons are associated with oil and gas facilities on islands outside of Exmouth Gulf (Limpus 2007). *Data confidence* • *Medium confidence in the effect of light pollution on terrestrial reptiles in general* • *High confidence in the effect of light pollution on marine turtles - see Kamrowski et al. (2012)* • *Low confidence in the impact of light pollution on terrestrial and marine reptiles specifically in Exmouth*
Y	Residential - noise	1	3	3	L-M	It is unlikely that noise will affect species outside a residential footprint and as disturbance will have already occurred from development, species that are tolerant of such change will likely persist. Overall, the consequence would likely be only minor to moderate for terrestrial reptiles. Some species of reptiles are also vocal and vocalisations (and mating behaviours) may be impacted by anthropogenic noise - knowledge about the effects of anthropogenic noise on reptile social behaviours are severely lacking. - *Simmons and Narins 2018 - Effects of Anthropogenic Noise on Amphibians and Reptiles* *Data confidence* • *High confidence that noise is generated from residential developments* • *Low confidence in the diversity of reptiles in residential areas* • *Low confidence in the impact of noise on reptiles*
Y	Industrial - footprint	2	4	8	L-M	Due to the likelihood of industrial footprints being larger than residential and affecting areas outside of the townsite through land clearing and habitat loss, the consequence could be considered moderate. Particularly in that there is a lack of detail around species distributions and assemblage structures associated with different environments. There are

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						also several priority species recorded in the general area for which we have little knowledge on habitat requirements. More development results in less natural areas available for habitation. Development in general can push fauna out. *Data confidence* • *High confidence that increased industrial development will remove habitat for reptiles* • *Low confidence around species diversity, community assemblages* • *Low confidence around the extent to which reptiles would be impacted*
Y	Industrial - groundwater drawdown	3	2	6	M	Groundwater drawdown has the potential to indirectly impact terrestrial fauna habitat e.g., vegetation and wetlands *Data confidence* • *High confidence that groundwater drawdown can impact flora and vegetation and, in turn, fauna* • *Low confidence around how fauna have or will be impacted in the Exmouth area*
Y	Industrial - solid waste	1	3	3	M	Rubbish and contamination leached from rubbish may accumulate in food webs/fauna over time but perhaps will not be realised within the timeframe of 5-10 years. *Data confidence* • *High confidence that industrial solid waste is present in the area* • *Low confidence around the full extent and types of waste* • *High confidence that native reptiles will be present at sites affected by solid waste* • *Low confidence around the impact of waste on fauna in the area*
Y	Industrial - light	2	3	6	M	As for residential. *Data confidence* • *Medium confidence in the effect of light pollution on terrestrial reptiles in general* • *High confidence in the effect of light pollution on marine turtles - see Kamrowski et al. (2012)*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						• *Low confidence in the impact of light pollution on terrestrial and marine reptiles specifically in Exmouth*
Y	Industrial - noise	1	3	3	L-M	As for residential. *Data confidence* • *High confidence that noise is generated from industrial developments* • *Low confidence in the diversity of reptiles in industrial areas* • *Low confidence in the impact of noise on reptiles*
Y	Tourism - footprint	2	4	8	L-M	More development results in less natural areas available for habitation. Similar to industrial, depending on where developments and land usage occurs. A lack of detail on species distributions and assemblage structures elevates risks over that of urban development. *Data confidence* • *High confidence that increased tourism development will remove habitat for reptiles* • *Low confidence around species diversity, community assemblages* • *Low confidence around the extent to which reptiles would be impacted*
Y	Tourism - groundwater drawdown	3	2	6	M	Groundwater drawdown has the potential to indirectly impact terrestrial fauna habitat e.g., vegetation and wetlands *Data confidence* • *High confidence that groundwater drawdown can impact flora and vegetation and, in turn, fauna* • *Low confidence around how fauna have or will be impacted in the Exmouth area*
N	Tourism - solid waste					Considered under TOURISM/VISITATION.
Y	Tourism - light	3	3	9	M	As above for residential, however, given lighthouse redevelopment project is close to the coast and turtles nesting beaches, the impacts would be greater. *Data confidence* • *Medium confidence in the effect of light pollution on terrestrial reptiles in general*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						• *High confidence in the effect of light pollution on marine turtles - see Kamrowski et al. (2012)* • *Low confidence in the impact of light pollution on terrestrial and marine reptiles specifically in Exmouth*
Y	Tourism - noise	1	3	3	L-M	As above for residential. *Data confidence* • *High confidence that noise is generated from tourism developments* • *Low confidence in the diversity of reptiles in residential areas* • *Low confidence in the impact of noise on reptiles*
Value: mammals						
Y	Residential - footprint	2	4	8	L-M	Similar reasons to above. *Data confidence* • *High confidence that increased infill will remove habitat for mammals occuring in residential footprints* • *Low confidence around species diversity, community assemblages* • *Low confidence around the extent to which mammals would be impacted*
Y	Residential - groundwater drawdown	3	2	6		Groundwater drawdown has the potential to indirectly impact terrestrial fauna habitat e.g., vegetation and wetlands
Y	Residential - solid waste	1	3	3	M	Similar reasons to above. *Data confidence* • *High confidence that residential solid waste is present in the area and illegal dumping occurs* • *Low confidence around the full extent and types of waste* • *High confidence that native mammals will be present at sites affected by solid waste* • *Low confidence around the impact of waste on fauna in the area*
Y	Residential - light	2	3	6	L-M	Similar reasons to above.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						Data confidence • *Medium confidence in the effect of light pollution on mammals in general* • *Low confidence in the impact of light pollution on mammals specifically in Exmouth*
Y	Residential - noise	2	3	6	M	Similar reasons to above. *Data confidence* • *High confidence that noise is generated from residential developments* • *High confidence in the impact of noise on mammals e.g., Slabbekoorn et al. (2018) Effects of Man-Made Sound on Terrestrial Mammals. In Effects of Anthropogenic Noise on Animals (eds. Slabbekoorn, H., Dooling, R. J., Popper, A. N. & Fay, R. R.) 243-276 (Springer, 2018). doi:10.1007/978-1-4939-8574-6_9.* • *Low confidence in the diversity of mammals in residential areas* • *Low confidence in the impact of noise on mammals in Exmouth specifically*
Y	Industrial - footprint	2	4	8	L-M	Similar reasons to above. *Data confidence* • *High confidence that increased industrial development will remove habitat for mammals* • *Low confidence around species diversity, community assemblages* • *Low confidence around the extent to which mammals would be impacted*
Y	Industrial - groundwater drawdown	3	2	6	M	Groundwater drawdown has the potential to indirectly impact terrestrial fauna habitat e.g., vegetation and wetlands *Data confidence* • *High confidence that groundwater drawdown can impact flora and vegetation and, in turn, fauna* • *Low confidence around how fauna have or will be impacted in the Exmouth area*
Y	Industrial - solid waste	1	3	3	M	Similar reasons to above. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						• *High confidence that industrial solid waste is present in the area* • *Low confidence around the full extent and types of waste* • *High confidence that native mammals will be present at sites affected by solid waste* • *Low confidence around the impact of waste on fauna in the area*
Y	Industrial - light	2	3	6	L-M	Similar reasons to above. *Data confidence* • *Medium confidence in the effect of light pollution on mammals in general* • *Low confidence in the impact of light pollution on mammals specifically in Exmouth*
Y	Industrial - noise	2	3	6	M	Similar reasons to above. *Data confidence* • *High confidence that noise is generated from industrial developments* • *High confidence in the impact of noise on mammals e.g., Slabbekoorn et al. (2018) Effects of Man-Made Sound on Terrestrial Mammals. In Effects of Anthropogenic Noise on Animals (eds. Slabbekoorn, H., Dooling, R. J., Popper, A. N. & Fay, R. R.) 243-276 (Springer, 2018). doi:10.1007/978-1-4939-8574-6_9.* • *Low confidence in the diversity of mammals in industrial areas* • *Low confidence in the impact of noise on mammals in Exmouth specifically*
Y	Tourism - footprint	2	4	8	L-M	Similar reasons to above. *Data confidence* • *High confidence that increased tourism development will remove habitat for mammals* • *Low confidence around species diversity, community assemblages* • *Low confidence around the extent to which mammals would be impacted*
Y	Tourism - groundwater drawdown	3	2	6	M	Groundwater drawdown has the potential to indirectly impact terrestrial fauna habitat e.g., vegetation and wetlands

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						Data confidence • *High confidence that groundwater drawdown can impact flora and vegetation and, in turn, fauna* • *Low confidence around how fauna have or will be impacted in the Exmouth area*
N	Tourism - solid waste					Considered under TOURIMS/VISITATION.
Y	Tourism - light	2	3	6	L-M	Similar reasons to above. *Data confidence* • *Medium confidence in the effect of light pollution on mammals in general* • *Low confidence in the impact of light pollution on mammals specifically in Exmouth*
Y	Tourism - noise	2	3	6	M	Similar reasons to above. *Data confidence* • *High confidence that noise is generated from tourism developments* • *High confidence in the impact of noise on mammals e.g., Slabbekoorn et al. (2018) Effects of Man-Made Sound on Terrestrial Mammals. In Effects of Anthropogenic Noise on Animals (eds. Slabbekoorn, H., Dooling, R. J., Popper, A. N. & Fay, R. R.) 243-276 (Springer, 2018). doi:10.1007/978-1-4939-8574-6_9.* • *Low confidence in the diversity of mammals in tourism areas* • *Low confidence in the impact of noise on mammals in Exmouth specifically*
Value: birds						
Y	Residential - footprint	2	4	8	L-M	Similar reasons to above. *Data confidence* • *High confidence that increased infill will remove habitat for birds occuring in residential footprints* • *Low confidence around species diversity, community assemblages* • *Low confidence around the extent to which birds would be impacted*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
Y	Residential - groundwater drawdown	3	2	6	M	Groundwater drawdown has the potential to indirectly impact terrestrial fauna habitat e.g., vegetation and wetlands *Data confidence* • *High confidence that groundwater drawdown can impact flora and vegetation and, in turn, fauna* • *Low confidence around how fauna have or will be impacted in the Exmouth area*
Y	Residential - solid waste	1	3	3	M	Similar reasons to above. *Data confidence* • *High confidence that residential solid waste is present in the area and illegal dumping occurs* • *Low confidence around the full extent and types of waste* • *High confidence that native birds will be present at sites affected by solid waste* • *Low confidence around the impact of waste on fauna in the area*
Y	Residential - light	2	3	6	L-M	Similar reasons to above. *Data confidence* • *Medium confidence in the effect of light pollution on birds in general* • *Low confidence in the impact of light pollution on birds specifically in Exmouth*
Y	Residential - noise	2	3	6	L-M	Similar reasons to above. *Data confidence* • *High confidence that noise is generated from residential developments* • *Low confidence in the diversity of birds in residential areas* • *Low confidence in the impact of noise on birds*
Y	Industrial - footprint	2	4	8	L-M	Similar reasons to above. *Data confidence* • *High confidence that increased industrial development will remove habitat for birds* • *Low confidence around species diversity, community assemblages*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						• *Low confidence around the extent to which birds would be impacted*
Y	Industrial - groundwater drawdown	3	2	6	M	Groundwater drawdown has the potential to indirectly impact terrestrial fauna habitat e.g., vegetation and wetlands *Data confidence* • *High confidence that groundwater drawdown can impact flora and vegetation and, in turn, fauna* • *Low confidence around how fauna have or will be impacted in the Exmouth area*
Y	Industrial - solid waste	1	3	3	M	Similar reasons to above. *Data confidence* • *High confidence that industrial solid waste is present in the area* • *Low confidence around the full extent and types of waste* • *High confidence that native birds will be present at sites affected by solid waste* • *Low confidence around the impact of waste on fauna in the area*
Y	Industrial - light	2	3	6	L-M	Similar reasons to above. *Data confidence* • *Medium confidence in the effect of light pollution on birds in general* • *Low confidence in the impact of light pollution on birds specifically in Exmouth*
Y	Industrial - noise	2	3	6	L-M	Similar reasons to above. *Data confidence* • *High confidence that noise is generated from industrial developments* • *Low confidence in the diversity of birds in industrial areas* • *Low confidence in the impact of noise on birds*
Y	Tourism - footprint	2	4	8	L-M	Similar reasons to above. *Data confidence* • *High confidence that increased tourism development will remove habitat for birds* • *Low confidence around species diversity, community assemblages*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						• *Low confidence around the extent to which birds would be impacted*
Y	Tourism - groundwater drawdown	3	2	6	M	Groundwater drawdown has the potential to indirectly impact terrestrial fauna habitat e.g., vegetation and wetlands *Data confidence* • *High confidence that groundwater drawdown can impact flora and vegetation and, in turn, fauna* • *Low confidence around how fauna have or will be impacted in the Exmouth area*
N	Tourism - solid waste					Considered under TOURIMS/VISITATION.
Y	Tourism - light	2	3	6	L-M	Similar reasons to above. *Data confidence* • *Medium confidence in the effect of light pollution on birds in general* • *Low confidence in the impact of light pollution on birds specifically in Exmouth*
Y	Tourism - noise	2	3	6	L-M	Similar reasons to above. *Data confidence* • *High confidence that noise is generated from tourism developments* • *Low confidence in the diversity of birds in tourism areas* • *Low confidence in the impact of noise on birds*
Value: short range endemic invertebrates						
Y	Residential - footprint	2	4	8	L	Similar reasons to above. *Data confidence* • *Low confidence around the occurrence of short range endemics in residential footprints* • *Low confidence around the extent to which short range endemics would be impacted*
Y	Residential - groundwater drawdown	3	2	6	M	Groundwater drawdown has the potential to indirectly impact terrestrial fauna habitat e.g., vegetation and wetlands

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						Data confidence • *High confidence that groundwater drawdown can impact flora and vegetation and, in turn, fauna* • *Low confidence around how fauna have or will be impacted in the Exmouth area*
Y	Residential - solid waste	1	3	3	L	Similar reasons to above. *Data confidence* • *High confidence that residential solid waste is present in the area and illegal dumping occurs* • *Low confidence around the full extent and types of waste* • *Low confidence that short range endemics will be present at sites affected by solid waste* • *Low confidence around the impact of waste on fauna in the area*
Y	Residential - light	2	3	6	L	Similar reasons to above. *Data confidence* • *Low confidence around the occurrence of short range endemics in residential areas* • *Low confidence in the effect of light pollution on short range endemics in general or in Exmouth*
Y	Residential - noise	2	3	6	L	Similar reasons to above. *Data confidence* • *High confidence that noise is generated from residential developments* • *Low confidence around the occurrence of short range endemics in residential areas* • *Low confidence in the impact of noise on short range endemics in general or in Exmouth*
Y	Industrial - footprint	2	4	8	L	Similar reasons to above. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						• *Low confidence around the occurrence of short range endemics in industrial footprints* • *Low confidence around the extent to which short range endemics would be impacted*
Y	Industrial - groundwater drawdown	3	2	6	M	Groundwater drawdown has the potential to indirectly impact terrestrial fauna habitat e.g., vegetation and wetlands *Data confidence* • *High confidence that groundwater drawdown can impact flora and vegetation and, in turn, fauna* • *Low confidence around how fauna have or will be impacted in the Exmouth area*
Y	Industrial - solid waste	1	3	3	L	Similar reasons to above. *Data confidence* • *High confidence that industrial solid waste is present in the area* • *Low confidence around the full extent and types of waste* • *Low confidence that short range endemics will be present at sites affected by solid waste* • *Low confidence around the impact of waste on fauna in the area*
Y	Industrial - light	2	3	6	L	Similar reasons to above. *Data confidence* • *Low confidence around the occurrence of short range endemics in industrial areas* • *Low confidence in the effect of light pollution on short range endemics in general or in Exmouth*
Y	Industrial - noise	2	3	6	L	Similar reasons to above. *Data confidence* • *High confidence that noise is generated from industrial developments* • *Low confidence around the occurrence of short range endemics in industrial areas*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						• *Low confidence in the impact of noise on short range endemics in general or in Exmouth*
Y	Tourism - footprint	2	4	8	L	Similar reasons to above. *Data confidence* • *Low confidence around the occurrence of short range endemics in tourism footprints* • *Low confidence around the extent to which short range endemics would be impacted*
Y	Tourism - groundwater drawdown	3	2	6	M	Groundwater drawdown has the potential to indirectly impact terrestrial fauna habitat e.g., vegetation and wetlands *Data confidence* • *High confidence that groundwater drawdown can impact flora and vegetation and, in turn, fauna* • *Low confidence around how fauna have or will be impacted in the Exmouth area*
N	Tourism - solid waste					Considered under TOURIMS/VISITATION.
Y	Tourism - light	2	3	6	L	Similar reasons to above. *Data confidence* • *Low confidence around the occurrence of short range endemics in tourism development areas* • *Low confidence in the effect of light pollution on short range endemics in general or in Exmouth*
Y	Tourism - noise	2	3	6	L	Similar reasons to above. *Data confidence* • *High confidence that noise is generated from tourism developments* • *Low confidence around the occurrence of short range endemics in tourism areas* • *Low confidence in the impact of noise on short range endemics in general or in Exmouth*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
Value: amphibians						
Y	Residential - footprint	1	4	4	L-M	Town site unlikely to broadly represent significant habitat for most species. If urban landscape support wetlands or areas that are episodically inundated and form breeding habitat there may be medium consequence but likely to be at the local scale only. *Data confidence* • *Medium confidence that increased infill will remove habitat for amphibians occuring in residential footprints* • *Low confidence around species diversity, community assemblages* • *Low confidence around the extent to which amphibians would be impacted*
Y	Residential - groundwater drawdown	3	2	6	M	Groundwater drawdown has the potential to indirectly impact terrestrial fauna habitat e.g., vegetation and wetlands *Data confidence* • *High confidence that groundwater drawdown can impact flora and vegetation and, in turn, fauna* • *Low confidence around how fauna have or will be impacted in the Exmouth area*
Y	Residential - solid waste	1	3	3	M	Similar reasons to reptiles above. *Data confidence* • *High confidence that residential solid waste is present in the area and illegal dumping occurs* • *Low confidence around the full extent and types of waste* • *Medium confidence that amphibians will be present at sites affected by solid waste* • *Low confidence around the impact of waste on fauna in the area*
Y	Residential - light	1	3	3	L-M	Similar reasons to reptiles above. *Data confidence* • *Medium confidence in the effect of light pollution on amphibians in general*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						• *Low confidence in the impact of light pollution on amphibians specifically in Exmouth*
Y	Residential - noise	1	3	3	L-M	Similar reasons to reptiles above. *Data confidence* • *High confidence that noise is generated from residential developments* • *Low confidence in the diversity of amphibians in residential areas* • *Low confidence in the impact of noise on amphibians*
Y	Industrial - footprint	2	4	8	L-M	Similar reasons to above. Similar as for reptiles albeit that there is significantly less diversity in the frog community. Greatest risks are associated with habitat clearing and changes to drainage or areas of episodic flooding. *Data confidence* • *Medium confidence that increased industrial developments will remove habitat for amphibians* • *Low confidence around species diversity, community assemblages* • *Low confidence around the extent to which amphibians would be impacted*
Y	Industrial - groundwater drawdown	3	2	6	M	Groundwater drawdown has the potential to indirectly impact terrestrial fauna habitat e.g., vegetation and wetlands *Data confidence* • *High confidence that groundwater drawdown can impact flora and vegetation and, in turn, fauna* • *Low confidence around how fauna have or will be impacted in the Exmouth area*
Y	Industrial - solid waste	1	3	3	M	Similar reasons to reptiles above *Data confidence* • *High confidence that industrial solid waste is present in the area* • *Low confidence around the full extent and types of waste* • *Medium confidence that amphibians will be present at sites affected by solid waste* • *Low confidence around the impact of waste on fauna in the area*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
Y	Industrial - light	1	3	3	L-M	Similar reasons to reptiles above. *Data confidence* • *Medium confidence in the effect of light pollution on amphibians in general* • *Low confidence in the impact of light pollution on amphibians specifically in Exmouth*
Y	Industrial - noise	1	3	3	L-M	Similar reasons to reptiles above *Data confidence* • *High confidence that noise is generated from industrial developments* • *Low confidence in the diversity of amphibians in industrial areas* • *Low confidence in the impact of noise on amphibians*
Y	Tourism - footprint	2	4	8	L-M	Similar reasons to reptiles above *Data confidence* • *Medium confidence that increased tourism developments will remove habitat for amphibians* • *Low confidence around species diversity, community assemblages* • *Low confidence around the extent to which amphibians would be impacted*
y	Tourism - groundwater drawdown	3	2	6	M	Groundwater drawdown has the potential to indirectly impact terrestrial fauna habitat e.g., vegetation and wetlands *Data confidence* • *High confidence that groundwater drawdown can impact flora and vegetation and, in turn, fauna* • *Low confidence around how fauna have or will be impacted in the Exmouth area*
N	Tourism - solid waste					Considered under TOURIMS/VISITATION.
Y	Tourism - light	1	3	3	L-M	Similar reasons to reptiles above *Data confidence* • *Medium confidence in the effect of light pollution on amphibians in general*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						• *Low confidence in the impact of light pollution on amphibians specifically in Exmouth*
Y	Tourism - noise	1	3	3	L-M	Similar reasons to reptiles above *Data confidence* • *High confidence that noise is generated from tourism developments* • *Low confidence in the diversity of amphibians in tourism areas* • *Low confidence in the impact of noise on amphibians*
Factor: Landforms						
Value: islands						
N	Residential - footprint					
N	Residential - groundwater drawdown					
N	Residential - solid waste					
N	Residential - light					
N	Residential - noise					
N	Industrial - footprint					
N	Industrial - groundwater drawdown					
N	Industrial - solid waste					
N	Industrial - light					
N	Industrial - noise					
Y	Tourism - footprint	1	4	4	H	A couple of islands have accommodation. Uncertain whether island accommodation and activities will increase, but unlikely. *Data confidence* • *High confidence about locations and extent of the tourism footprint on the islands*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
N	Tourism - groundwater drawdown					
N	Tourism - solid waste					Assessed under TOURISM/VISITATION.
N	Tourism - light					
N	Tourism - noise					
Value: karst systems						
Y	Residential - footprint	1	3	3	M	There is not a good understanding of the linkages between karsts systems and how connected they are. Impacts of gardening, fertiliser, runoff, household waste should be considered. There have been changes in the way stormwater is managed - it runs off quickly rather than soaking into the landscape. Hardening of surfaces changes storm water runoff e.g., concrete, bitumen, roofs. *Data confidence* • *High confidence about current and future residential footprint* • *Medium confidence about extent of karst systems close to the residential area*
Y	Residential - groundwater drawdown	3/4	3	9-12	H	There has been a measurable drawdown of water table in Watercorp bore field. This has the potential to impact upon larger areas of the karst system than it currently does - particularly with new subdivisions, increased tourism and the need to populate out the light industrial area. Groundwater resources on the Exmouth peninsula are limited due to the relatively small size of the peninsula and low rainfall. The Exmouth Town Water Supply (TWS) bore field is located immediately west of town in the Town and Central sub-areas. The bore field extends about 7km southwards along the eastern flank of Cape Range, and consists of 34 Production bores, 10 of which were drilled in 2007/08, solar panels to power these bores were installed in June 2017. The bore field also contains 22 monitoring bores consisting of saltwater interface monitoring bores (SWIM) and stygofauna habitat monitoring bores (SHM). The production bores abstract

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						fresh to brackish groundwater from the unconfined Cape Range aquifer between 30m and 200m below ground level. Groundwater resources are subdivided into five regions in the Exmouth area, each with varying levels of groundwater available. As well as the main Exmouth town water supply, there are other backyard bores and the navy also contributes to the drawdown of groundwater. The navy has a desalination plant and can create fresh water on site. Water stress: impact on subterranean waterways is likely. Stress can occur through drying up of freshwater lens that supports stygofauna and can also change the humidity in the caves which is important for troglofauna. Troglofauna need humidity to exist. Spatial extent of the impact of the drawdown of fresh water is uncertain in terms of how it will impact on overall karst system and values. Some gaps in knowledge on distribution of species along Exmouth side of Cape Range. Organisms are genetically distinct from western side of Cape Range. Water drawdown will have an impact on eastern fauna - so knowledge of the spatial extent of impact from drawdown is important. Karst management Considerations for the Cape Range Karst Province, Western Australia" (Hamilton-Smith et al. 1998). This report is a key reference that outlines a number of threats (EPA). *Data confidence* • *High confidence about current and future residential footprint* • *High confidence that expanded residential footprint will result in higher groundwater drawdown* • *High confidence that higher groundwater drawdown will affect karst systems*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
Y	Residential - solid waste (litter, pollution) - includes anything 'foreign' to karsts systems including hard rubbish, rocks, contaminants	2	4	8	M	Potential for pollutants for get down into karst systems, e.g., has happened diesel spills from flooding events, Per- and polyfluoroalkyl substances (PFAS) contamination from firefighting foams, sewage treatment, pre-existing and historical rubbish tips. Each waste source has potential to leach contaminants. People throw litter down holes e.g., cans/beer bottles. People throw rocks (big boulders) down holes. Some rubbish types would have a local impact, and some would have a larger impact. Darren Brooks (does expedition into holes and has mapped most of karst features in Cape Range). Pollution, and dumping of rubbish or toxic waste was listed as a potential threat to Camerons Cave in *the Camerons Cave troglobitic community, Camerons Cave millipede and Camerons Cave pseudoscorpion Interim Recovery Plan 2012-2017* as well as for Bundera Sinkhole - *Cape Range remipede community (Bundera Sinkhole) and Cape Range remipede Interim Recovery Plan 2000-2003* (EPA). *Data confidence* • *High confidence that expanded residential footprint will result in more residential solid waste* • *High confidence that karst systems would be very sensitive to any increase in solid waste entering the systems* • *Low confidence around the full extent of waste impacting karsts systems*
N	Residential - light					
N	Residential - noise					
Y	Industrial - footprint	1	3	3	M	Can cause changes to run-off which can impact runoff into karst systems - hardening of surfaces, concrete, bitumen, roofs *Data confidence* • *Medium confidence about future industrial footprint* • *Medium confidence about extent of karst systems close to the industrial area*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
Y	Industrial - groundwater drawdown	3/4	3	9-12	M-H	See 'residential groundwater' - hard to separate out residential, industrial and tourism drawdown of groundwater as coming from same sources. Do not know the proportion each takes. *Data confidence* • *Medium confidence about future industrial footprint* • *High confidence that expanded industrial footprint will result in higher groundwater drawdown* • *High confidence that higher groundwater drawdown will affect karst systems*
Y	Industrial - solid waste - includes anything 'foreign' to karsts systems including hard rubbish, rocks, contaminants	2	4	8	M	Similar waste issues to above. *Data confidence* • *High confidence that expanded industrial footprint will result in more industrial solid waste* • *High confidence that karst systems would be very sensitive to any increase in solid waste entering the systems* • *Low confidence around the full extent of waste impacting karsts systems*
N	Industrial - light					
N	Industrial - noise					
Y	Tourism - footprint	1	3	3	M	Similar considerations to residential and industrial *Data confidence* • *Medium confidence about future tourism footprint* • *Medium confidence about extent of karst systems close to the tourism area*
Y	Tourism - groundwater drawdown	3/4	3	9-12	M-H	See 'residential groundwater' - Hard to separate out residential, industrial and tourism drawdown of groundwater as coming from same sources. Do not know the proportions each takes. *Data confidence* • *Medium confidence about future tourism footprint*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						• *High confidence that expanded tourism footprint will result in higher groundwater drawdown* • *High confidence that higher groundwater drawdown will affect karst systems*
N	Tourism - solid waste - includes anything 'foreign' to karsts systems including hard rubbish, rocks, contaminants					Scored under TOURISM/VISITATION
N	Tourism - light					
N	Tourism - noise					
Y	Sedimentation	2	4	8	M	Sedimentation - some systems/holes been filled in by sediments due to changes in hydrology. Changes in storm water runoff regimes has led to exposure of holes to water flow, which has then led to dumping of sediments into the holes. *Data confidence* • *High confidence that any changes or increases in sedimentation would negatively impact karst systems* • *Low confidence in the quantifiable impacts of sedimentation to karst systems so far*
Factor: Subterranean fauna						
Value: troglofauna						
Y	Residential - footprint	1	3	3	M-H	For reasons given above regarding impacts to karst systems, could expect scores to fauna, which depend on the systems, to be similar. *Data confidence* • *High confidence about current and future residential footprint* • *Medium confidence about the occurrence of troglofauna near residential area*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
Y	Residential - groundwater drawdown	3	3	9	H	Water stress: impact on subterranean waterways is likely. Stress can occur through drying up of freshwater lens that supports stygofauna and can also change the humidity in the caves which is important for the troglofauna. Depends on humid conditions and changes to this, and on the amount of water that comes into karst systems. Groundwater drawdown can reduce humidity. EPA - From the Cameron's Cave Interim Recovery Plan "Water levels in the Exmouth borefield bores fell between 1981 and 1991, apparently due to low rainfall (Lee 2008) and, concurrently, salinity has increased across many bores in the borefield. The freshwater lens has thinned and there has been more mixing with seawater in the northern half of the borefield presumably because of a longer history of excessive abstraction relative to recharge, and due to higher conductivities in the Upper Tulki Karst Aquifer (Lee 2008). Increasing groundwater salinity was also noted in periods of lower rainfall (Lee 2008). The lens has thinned considerably with seawater intrusion mainly due to historical groundwater abstraction, long term below average rainfall and tidal influences (Lee 2008). The sustainability of the aquifer will be dependent on ensuring that drawdown does not cause seawater to encroach into the aquifer, as this kind of damage to aquifers is not reversible (Lee 2008). A lot of subterranean fauna have limited distributions of 500 m radius. There is a lack of resolution and knowledge on genetic structure for a lot of populations. *Data confidence* • *High confidence about current and future residential footprint* • *High confidence that expanded residential footprint will result in higher groundwater drawdown* • *High confidence that higher groundwater drawdown will affect karst systems and, in turn, troglofauna*
Y	Residential - solid waste includes anything 'foreign' to karsts systems including hard rubbish, rocks, contaminants	2	4	8	M	As above for karst systems *Data confidence* • *High confidence that expanded residential footprint will result in more residential solid waste*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						• *High confidence that karst systems and, in turn, troglofauna, would be very sensitive to any increase in solid waste entering the systems* • *Low confidence around the full extent of waste impacting troglofauna*
N	Residential - light					
N	Residential - noise					
Y	Industrial - footprint	1	3	3	M	As above for karst systems *Data confidence* • *Medium confidence about future industrial footprints* • *Medium confidence about the occurrence of troglofauna near industrial areas*
Y	Industrial - groundwater drawdown	3	3	9	M-H	As above for karst systems *Data confidence* • *Medium confidence about future industrial footprint* • *High confidence that expanded industrial footprint will result in higher groundwater drawdown* • *High confidence that higher groundwater drawdown will affect karst systems and, in turn, troglofauna*
Y	Industrial - solid waste includes anything 'foreign' to karsts systems including hard rubbish, rocks, contaminants	2	4	8	M	As above for karst systems *Data confidence* • *High confidence that expanded industrial footprint will result in more industrial solid waste* • *High confidence that karst systems and, in turn, troglofauna, would be very sensitive to any increase in solid waste entering the systems* • *Low confidence around the full extent of waste impacting troglofauna*
N	Industrial - light					
N	Industrial - noise					
Y	Tourism - footprint	1	3	3	M	As above for karst systems

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						Data confidence • *Medium confidence about future tourism footprints* • *Medium confidence about the occurrence of troglofauna near tourism areas*
Y	Tourism - groundwater drawdown	3	3	9	M-H	As above for karst systems *Data confidence* • *Medium confidence about future tourism footprint* • *High confidence that expanded tourism footprint will result in higher groundwater drawdown* • *High confidence that higher groundwater drawdown will affect karst systems and, in turn, troglofauna*
N	Tourism - solid waste					Scored under TOURISM/VISITATION.
N	Tourism - light					
N	Tourism - noise					
Y	Sedimentation	2	4	8	M	As above for karst systems. *Data confidence* • *High confidence that any changes or increases in sedimentation would negatively impact karst systems and, in turn, troglofauna* • *Low confidence in the quantifiable impacts of sedimentation to troglofauna so far*
Value: stygofauna						
Y	Residential - footprint	1	3	3	M-H	As above for karst systems *Data confidence* • *High confidence about current and future residential footprint* • *Medium confidence about the occurrence of stygofauna near residential area*
Y	Residential - groundwater drawdown	3	3	9	H	Highly stratified groundwater feature, freshwater lens and different physiochemical properties for different strata result if different species exist within each stratum. Some may only exist in certain strata and others can span across multiple.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						Increased groundwater drawdown could cause increased salinity from seawater intrusion, which can also impact the karst and stygofauna. There are distinct gradients of salinity in the anchialine systems in Cape Range and different fauna species inhabit different layers, and some are sensitive to the mixing of the water layers and cannot tolerate changed water chemistry (EPA). Also, water drawdown leads to loss of stygofauna habitat. A lot of subterranean fauna have limited distributions of 500 m radius. There is a lack of resolution and knowledge on genetic structure for a lot of populations. Cape Range remipedes: one species has now been divided up into three. One occurs in the south of Cape Range and two in north. Distinct barrier between populations. Need to investigate further. *Kumonga exleyi* (Cape Range remipede) is currently considered critically endangered. 10 other species are also Listed species - either endangered, threatened or Priority 4. *Data confidence* • *High confidence about current and future residential footprint* • *High confidence that expanded residential footprint will result in higher groundwater drawdown* • *High confidence that higher groundwater drawdown will affect karst systems and, in turn, stygofauna*
Y	Residential - solid waste includes anything 'foreign' to karsts systems including hard rubbish, rocks, contaminants	2	4	8	M	As above for karst systems *Data confidence* • *High confidence that expanded residential footprint will result in more residential solid waste* • *High confidence that karst systems and, in turn, stygofauna, would be very sensitive to any increase in solid waste entering the systems* • *Low confidence around the full extent of waste impacting stygofauna*
N	Residential - light					
N	Residential - noise					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
Y	Industrial - footprint	1	3	3	M	As above for karst systems *Data confidence* • *Medium confidence about future industrial footprints* • *Medium confidence about the occurrence of stygofauna near industrial areas*
Y	Industrial - groundwater drawdown	3	3	9	M-H	As above for karst systems *Data confidence* • *Medium confidence about future industrial footprint* • *High confidence that expanded industrial footprint will result in higher groundwater drawdown* • *High confidence that higher groundwater drawdown will affect karst systems and, in turn, stygofauna*
Y	Industrial - solid waste includes anything 'foreign' to karsts systems including hard rubbish, rocks, contaminants	2	4	8	M	As above for karst systems *Data confidence* • *High confidence that expanded industrial footprint will result in more industrial solid waste* • *High confidence that karst systems and, in turn, stygofauna, would be very sensitive to any increase in solid waste entering the systems* • *Low confidence around the full extent of waste impacting stygofauna*
N	Industrial - light					
N	Industrial - noise					
Y	Tourism - footprint	1	3	3	M	As above for karst systems *Data confidence* • *Medium confidence about future tourism footprints* • *Medium confidence about the occurrence of stygofauna near tourism areas*
Y	Tourism - groundwater drawdown	3	3	9	M-H	As above for karst systems *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						• *Medium confidence about future tourism footprint* • *High confidence that expanded tourism footprint will result in higher groundwater drawdown* • *High confidence that higher groundwater drawdown will affect karst systems and, in turn, stygofauna*
N	Tourism - solid waste					Scored under TOURISM/VISITATION.
N	Tourism - light					
N	Tourism - noise					
Y	Sedimentation	2	4	8	M	As above for karst systems *Data confidence* • *High confidence that any changes or increases in sedimentation would negatively impact karst systems and, in turn, stygofauna* • *Low confidence in the quantifiable impacts of sedimentation to stygofauna so far*
Factor: Terrestrial environmental quality						
Value: topsoil						
Y	Residential - footprint	1	4	4	H	Topsoil would be removed, and the ground covered in concrete with additional development. *Data confidence* • *High confidence about plans for future expansion of residential footprint* • *High confidence that damage, disturbance, removal of topsoil will occur with any terrestrial development*
N	Residential - groundwater drawdown					
N	Residential - solid waste					
N	Residential - light					
N	Residential - noise					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
Y	Industrial - footprint	1	4	4	M-H	Topsoil would be removed, and the ground covered in concrete with additional development. *Data confidence* • *Medium confidence about future expansion of industrial footprint* • *High confidence that damage, disturbance, removal of topsoil will occur with any terrestrial development*
N	Industrial - groundwater drawdown					
N	Industrial - solid waste					
N	Industrial - light					
N	Industrial - noise					
Y	Tourism - footprint	1	4	4	H	Topsoil would be removed, and the ground covered in concrete with additional development. *Data confidence* • *Medium confidence about future expansion of tourism footprint* • *High confidence that damage, disturbance, removal of topsoil will occur with any terrestrial development*
N	Tourism - groundwater drawdown					
N	Tourism - solid waste					
N	Tourism - light					
N	Tourism - noise					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
Factor: Flora & vegetation						
Value: Coastal plains						
Y	Limestone - footprint	1	4	4	M	Limestone mining already existing and the footprint has caused/is causing damage to flora and vegetation of the coastal plains. Expansions of footprint may remove surrounding vegetation. Uncertainty as to whether land for expansion is already cleared? *Data confidence* • *High confidence that expanded operations will remove flora and vegetation* • *Low confidence in the species and complexes that would be impacted*
N	Limestone - operation					
N	Limestone - groundwater drawdown					Groundwater considered under WATER theme
Y	Industrial salt facility - footprint	1	4	4	M	Vegetation inland of saltmarshes and mangroves needs to be considered here. Footprint could directly remove vegetation or disrupt localised connectivity patterns. Probably not as much as mangroves and saltmarshes? Flow on impacts on hydrology, surface runoff, and subsurface water flow needs to be considered. *Data confidence* • *High confidence that some vegetation will be impacted by an industrial salt farm footprint* • *Medium confidence around the details and extent of industrial salt farm footprint* • *Low confidence in the species and complexes that would be impacted specifically along the eastern margin*
Y	Potash - footprint	1	3	4	M	Uncertainty on how large the potash footprint would be. Vegetation inland of saltmarshes and mangroves needs to be considered here.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
						Footprint could directly remove vegetation or disrupt localised connectivity patterns. e.g., impact on hydrology, surface runoff, and subsurface water flow. *Data confidence* • *High confidence that some vegetation will be impacted by potash footprint* • *Medium confidence around the details and extent of potash footprint* • *Low confidence in the species and complexes that would be impacted specifically*
N	Potash - abstraction of brine					
Value: Limestone cliffs & gullies						
Y	Limestone - footprint	1	4	4	M	Expansion could result in removal of vegetation at a localised scale. *Data confidence* • *Medium confidence that expanded operations will remove flora and vegetation* • *Low confidence in the species and complexes that would be impacted*
N	Limestone - operation					
N	Limestone - groundwater drawdown					
N	Industrial salt facility - footprint					
N	Potash - footprint					
N	Potash - abstraction of brine					
Value: Coastal dunes						
N	Limestone - footprint					
N	Limestone - operation					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
N	Limestone - groundwater drawdown					
N	Industrial salt facility - footprint					
N	Potash - footprint					
N	Potash - abstraction of brine					
Value: Threatened/priority flora						
Y	Limestone - footprint	1	3	3	L-M	Uncertainty around the distribution and abundance of priority flora. Some impact possible. *Data confidence* • *Low confidence that expanded operations will remove threatened and priority flora due to unknown extent of flora* • *Medium confidence in the species occuring on the Cape Range Peninsula - 22 priority species (DBCA 2019b; Meissner 2011)*
N	Limestone - operation					
N	Limestone - groundwater drawdown					Groundwater considered under WATER theme.
Y	Industrial salt facility - footprint	1	4	4	L-M	Vegetation inland of saltmarshes and mangroves needs to be considered here. Footprint could directly remove vegetation or disrupt localised connectivity patterns. Probably not as much as mangroves and saltmarshes? e.g., impact on hydrology, surface runoff, and subsurface water flow. *Data confidence* • *Low confidence that threatened and priority flora occur in the footprint and will be impacted by industrial salt farm footprint - EPA (2008) reported nine priority flora species were possibly present at the proposed Yannarie Salt Mine site but were not found in surveys.*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
						• *Medium confidence around the details and extent of industrial salt farm operations*
Y	Potash - footprint	1	3	4	L-M	Vegetation inland of saltmarshes and mangroves need to be considered here. Footprint could directly remove vegetation or disrupt localised connectivity patterns. e.g., impact on hydrology, surface runoff, and subsurface water flow. Uncertainty on how large potash footprint would be. *Data confidence* • *Low confidence that threatened and priority flora occur in the footprint and will be impacted by potash footprint* • *Medium confidence around the details and extent of footprint operations*
N	Potash - abstraction of brine					
Factor: Terrestrial fauna						
Value: Reptiles						
Y	Limestone - footprint	2	4	8	M	Similar to industrial development, depending on size of footprint and where mining occurs. Lack of detail around species distributions and faunal assemblages associated with habitat. Priority listed species exist in the area more broadly and taxonomic work continues to reveal new species across Cape Range. *Data confidence* • *High confidence that expanded footprint will impact reptiles, and likely endemic species - see DEC (2010)* • *Medium confidence in the details and extent of proposed footprint* • *Low confidence in reptile abundance and distribution in the limestone area & extent, severity, timeframe of impact of limestone mining on those reptiles*
Y	Limestone - operation	1	4	4	M	Vibrations from machinery and blasting would be a consideration. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
						• *High confidence that expanded operations will impact reptiles, and likely endemic species - see DEC (2010)* • *Medium confidence in the details and extent of proposed operations* • *Low confidence in reptile abundance and distribution in the limestone area & extent, severity, timeframe of impact of limestone mining on those reptiles*
N	Limestone - groundwater drawdown					Groundwater considered under WATER theme.
Y	Industrial salt facility - footprint	2	3	6	M-H	Lack of detail around species distributions and faunal assemblages associated with habitat. Priority listed species exist in the area more broadly and taxonomic work continues to reveal new species across Cape Range. Potentially a large displacement of animals due to destruction of habitat. Uncertainty on the diversity and distribution across salt flats, as well as the use of salt flats for foraging etc. Reptiles can often be found in harsh conditions. *Data confidence* • *High confidence that footprint will impact reptiles* • *Medium confidence in the details and extent of proposed footprint* • *Medium confidence that native reptile species are present at proposed salt mining sites e.g., 58 native reptile species were recorded during surveys of the proposed Yannarie Salt Mine site (EPA 2008).*
Y	Potash - footprint	2	3	6	M-H	Lack of detail around species distributions and faunal assemblages associated with habitat. Priority listed species exist in the area more broadly and taxonomic work continues to reveal new species across Cape Range. *Data confidence* • *High confidence that footprint will impact reptiles* • *Medium confidence in the details and extent of proposed footprint* • *Medium confidence that native reptile species are present at proposed pot ash mining sites e.g., 58 native reptile species were recorded during surveys of the proposed Yannarie Salt Mine site (EPA 2008).*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
N	Potash - abstraction of brine					
Value: mammals						
Y	Limestone - footprint	1	4	4	M	Expanded footprints are likely to remove habitat, as well as displace (push out) fauna. Already a cleared and impacted area. *Data confidence* • *High confidence that expanded footprint will impact mammals - see DEC (2010)* • *Medium confidence in the details and extent of proposed footprint* • *Low confidence in mammal abundance and distribution in the limestone area & extent, severity, timeframe of impact of limestone mining on those mammals*
Y	Limestone - operation	1	4	4	M	Vibrations from machinery and blasting would be a consideration. *Data confidence* • *High confidence that expanded operations will impact mammals - see DEC (2010)* • *Medium confidence in the details and extent of proposed operations* • *Low confidence in mammal abundance and distribution in the limestone area & extent, severity, timeframe of impact of limestone mining on those mammals*
N	Limestone - groundwater drawdown					Groundwater considered under WATER theme.
Y	Industrial salt facility - footprint	1	2	2	L-M	**More knowledge needed** about likelihood, extent, severity, timeframe of how industrial salt facility would affect mammals. Macropods occasionally take advantage of low tides to visit the inshore islands (DBCA 2020) and the red fox has been able to cross flats at low tide to Burnside, Tent, Sandalwood and Hope Point islands (Abbott and Wills 2011) *Data confidence* • *Medium confidence that footprint will impact mammals which transiently use the area* • *Medium confidence in the details and extent of proposed footprint*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
						• *Low confidence in the diversity of mammals and the extent of impact*
Y	Potash - footprint	1	2	2	L-M	As above. *Data confidence* • *Medium confidence that footprint will impact mammals which transiently use the area* • *Medium confidence in the details and extent of proposed footprint* • *Low confidence in the diversity of mammals and the extent of impact*
N	Potash - abstraction of brine					
Value: birds						
Y	Limestone - footprint	1	4	4	M-H	Expanded footprints are likely to remove habitat, as well as displace (push out) fauna. Already a cleared and impacted area. *Data confidence* • *High confidence that expanded footprint will impact birds* • *Medium confidence in the details and extent of proposed footprint* • *Medium confidence round the diversity of birds in the area, but not abundance and distribution e.g., Peregrine falcon (Falco peregrinus), listed as Schedule 4 (Specially Protected), and new subspecies of rufous grasswren (Amytornis whitei) discovered in 2020 on the limestone plateau - see Black et al. (2020)*
Y	Limestone - operation	1	4	4	M-H	Vibrations from machinery and blasting would be a consideration. *Data confidence* • *High confidence that expanded operations will impact birds* • *Medium confidence in the details and extent of proposed operations* • *Medium confidence round the diversity of birds in the area, but not abundance and distribution e.g., Peregrine falcon (Falco peregrinus), listed as Schedule 4 (Specially Protected), and new subspecies of rufous grasswren (Amytornis whitei) discovered in 2020 on the limestone plateau - see Black et al. (2020)*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
N	Limestone - groundwater drawdown					Groundwater considered under WATER theme.
Y	Industrial salt facility - footprint	1	3	3	M-H	Could reduce prey options for birds on salt flats. Uncertain whether birds use the salt flats extensively. *Data confidence* • *High confidence that footprint will impact birds which use the area* • *Medium confidence in the details and extent of proposed footprint* • *High confidence that many bird species are present within proposed salt facility sites e.g., 57 bird species were recorded during surveys of the Yannarie Solar Salt site - EPA (2008)*
Y	Potash - footprint	1	3	3	M-H	Could reduce prey options for birds on salt flats. Uncertain whether birds use the salt flats extensively. *Data confidence* • *High confidence that footprint will impact birds which use the area* • *Medium confidence in the details and extent of proposed footprint* • *High confidence that many bird species are present within proposed salt facility sites e.g., 57 bird species were recorded during surveys of the Yannarie Solar Salt site - EPA (2008)*
N	Potash - abstraction of brine					
Value: short range endemic invertebrates						
Y	Limestone - footprint	1	4	4	L	Several species of endemic Camnaeid land snails are specialised to rock-face habitat and are only known from single gorges. Expanded footprints are likely to remove habitat, as well as displace (push out) fauna. Already a cleared and impacted area. *Data confidence* • *Low confidence that expanded footprint will impact short range endemics*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
						• *Medium confidence in the details and extent of proposed footprint* • *Low confidence in short range endemics abundance and distribution in the limestone area & extent, severity, timeframe of impact of limestone mining on those short range endemics*
Y	Limestone - operation	1	4	4	L	Vibrations from machinery and blasting would be a consideration. *Data confidence* • *Low confidence that expanded operations will impact short range endemics* • *Medium confidence in the details and extent of proposed operation* • *Low confidence in short range endemics abundance and distribution in the limestone area & extent, severity, timeframe of impact of limestone mining on those short range endemics*
N	Limestone - groundwater drawdown					Groundwater considered under WATER theme.
Y	Industrial salt facility - footprint	2	3	6	L	**More knowledge needed** on whether short range endemics are occurring along the salt flats. *Data confidence* • *Low confidence in short range endemics abundance and distribution along the eastern margin and in the footprint area* • *Medium confidence in the details and extent of proposed footprint*
Y	Potash - footprint	2	3	6	L	As above. *Data confidence* • *Low confidence in short range endemics abundance and distribution along the eastern margin and in the footprint area* • *Medium confidence in the details and extent of proposed footprint*
N	Potash - abstraction of brine					

Value: amphibians

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
Y	Limestone - footprint	1	4	4	L	Expanded footprints are likely to remove habitat, as well as displace (push out) fauna. Already a cleared and impacted area. Probably lower consequence than for reptiles unless alteration of breeding habitat occurs. *Data confidence* • *Low confidence that expanded footprint will impact amphibians* • *Low confidence in amphibian abundance and distribution in the limestone area & extent, severity, timeframe of impact of limestone mining*
Y	Limestone - operation	1	4	4	L	Vibrations from machinery and blasting would be a consideration. As above. *Data confidence* • *Low confidence that expanded operations will impact amphibians* • *Low confidence in amphibian abundance and distribution in the limestone area & extent, severity, timeframe of impact of limestone mining*
N	Limestone - groundwater drawdown					
Y	Industrial salt facility - footprint	1	2	2	M-H	Some amphibians would be occurring along salt flats. Five native amphibians have been recorded during surveys of the Yannarie Solar Salt site (EPA 2008). *Data confidence* • *High confidence that footprint will impact amphibian which use the area* • *Medium confidence in the details and extent of proposed footprint* • *High confidence that amphibian species are present within proposed salt facility sites - EPA (2008)*
Y	Potash - footprint	1	2	2	M-H	Some amphibians would be occurring along salt flats. Five native amphibians have been recorded during surveys of the Yannarie Solar Salt site (EPA 2008). *Data confidence* • *High confidence that footprint will impact amphibian which use the area* • *Medium confidence in the details and extent of proposed footprint*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
						• *High confidence that amphibian species are present within proposed salt facility sites - EPA (2008)*
N	Potash - abstraction of brine					
MINING						
Factor: Landforms						
Value: islands						
N	Limestone - footprint					
N	Limestone - operation					
N	Limestone - groundwater drawdown					
N	Salt farm - footprint					
N	Potash - footprint					
N	Potash - abstraction of brine					
Value: karst systems						
Y	Limestone - footprint	2	3/4	6-8	M	Production of limestone is proposed to increase significantly. Uncertainty around how much water is used for limestone mining. Anecdotally some sub-feature opened up due to mining and organisms have been found. Highly desirable product for metallurgy. Hard to score as definition does not really apply to geological features. We do not know how connected the systems are. There will not be a recovery of the landform removed, but can it be sacrificed because there are more of them nearby? **More knowledge needed.** *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
						• *High confidence that karst features have been found in the vicinity of limestone quarry areas* • *Medium confidence in details and extent of proposed limestone footprint* • *Low confidence about extent, severity, timeframe of effects of future expanded limestone quarrying on karst systems*
Y	Limestone - operation	1	4	4	M	Vibrations from machinery and blasting would be a consideration. Not a lot of understanding here. • *High confidence that karst features have been found in the vicinity of limestone quarry areas* • *Medium confidence in details and extent of proposed limestone operations* • *Low confidence about extent, severity, timeframe of effects of future expanded limestone quarrying on karst systems*
Y	Limestone - groundwater drawdown	2	4	8	M	Production of limestone is proposed to increase significantly. Not enough knowledge. Is dewatering needed? Are they draining nearby water from karsts systems? *Data confidence* • *High confidence that limestone quarrying affects groundwater chemistry & physical properties generally (e.g. Marzouk, S.H. (2018). Influences of limestone stone quarries on groundwater quality. Int. J. Hum. Capital Urban Manage., 3(4): 315-324, Autumn 2018* • *Medium confidence in details and extent of proposed limestone operations* • *High confidence that higher groundwater drawdown will affect karst systems* • *Low confidence about extent, severity, timeframe of effects of future expanded limestone quarrying on karst systems*
N	Industrial salt facility - footprint					
N	Potash - footprint					
N	Potash - abstraction of brine					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
Factor: Subterranean fauna						
Value: troglofauna						
Y	Limestone - footprint	2	3/4	6-8	M	For reasons given above regarding the karst system, which supports subterranean fauna, scoring would likely be the same. *Data confidence* • *High confidence that karst features have been found in the vicinity of limestone quarry areas* • *Medium confidence in details and extent of proposed limestone footprint* • *Low confidence about extent, severity, timeframe of effects of future expanded limestone quarrying on karst systems and troglofauna*
Y	Limestone - operation	1	4	4	M	Vibrations from machinery and blasting would be a consideration. *Data confidence* • *High confidence that karst features have been found in the vicinity of limestone quarry areas* • *Medium confidence in details and extent of proposed limestone operations* • *Low confidence about extent, severity, timeframe of effects of future expanded limestone quarrying on karst systems and troglofauna*
Y	Limestone - groundwater drawdown	2	4	8	M	Production of limestone is proposed to increase significantly. Not enough knowledge. Is dewatering needed? Are they draining nearby water from karsts systems? Troglofauna will be impacted if humidity conditions change *Data confidence* • *High confidence that higher groundwater drawdown will affect karst systems and the humid conditions for troglofaunal* • *Medium confidence in details and extent of proposed limestone operations* • *Low confidence about extent, severity, timeframe of effects of future expanded limestone quarrying on karst systems and troglofauna*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
N	Industrial salt facility - footprint					
N	Potash - footprint					
N	Potash - abstraction of brine					
Value: stygofauna						
Y	Limestone - footprint	2	3/4	6-8	M	For reasons given above regarding the karst system, which supports subterranean fauna, scoring would likely be the same. *Data confidence* • *High confidence that karst features have been found in the vicinity of limestone quarry areas* • *Medium confidence in details and extent of proposed limestone footprint* • *Low confidence about extent, severity, timeframe of effects of future expanded limestone quarrying on karst systems and stygofauna*
Y	Limestone - operation	1	4	4	M	Vibrations from machinery and blasting would be a consideration. *Data confidence* • *High confidence that karst features have been found in the vicinity of limestone quarry areas* • *Medium confidence in details and extent of proposed limestone operations* • *Low confidence about extent, severity, timeframe of effects of future expanded limestone quarrying on karst systems and stygofauna*
Y	Limestone - groundwater drawdown	2	4	8	M-H	Possible effects: loss of habitat for unique, endemic subterranean fauna (including listed species) and changes to water chemistry and salinity from drawdown. *Data confidence* • *High confidence that limestone quarrying affects groundwater chemistry & physical properties generally (e.g. Marzouk, S.H. (2018). Influences of limestone*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
						stone quarries on groundwater quality. Int. J. Hum. Capital Urban Manage., 3(4): 315-324, Autumn 2018 • *High confidence that higher groundwater drawdown will affect karst systems and the water chemistry conditions for stygofauna* • *Medium confidence in details and extent of proposed limestone operations* • *Low confidence about extent, severity, timeframe of effects of future expanded limestone quarrying on karst systems and stygofauna*
N	Industrial salt facility - footprint					
N	Potash - footprint					
N	Potash - abstraction of brine					
Factor: Terrestrial environmental quality						
Value: topsoil						
Y	Limestone - footprint	1	3	3	M-H	Removal of topsoil would likely occur for expansion of the quarry. *Data confidence* • *Medium confidence in details and extent of proposed limestone footprint* • *High confidence expanded footprint would remove topsoil*
N	Limestone - operation					
N	Limestone - groundwater drawdown					
N	Industrial salt facility - footprint					
N	Potash - footprint					
N	Potash - abstraction of brine					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
PASTORALISM						
Factor: Flora & vegetation						
Value: Coastal plains						
Y	Overgrazing	2	3	6	M	Note that runoff/contamination is a by-product of overgrazing. This rating really depends on the continued cooperation of responsible pastoral land managers to ensure stocking rates are appropriate. It is possible that future land activities on pastoral land presents a risk to the coastal plain, particularly as the majority of pastoral tenure is within the coastal plains area. *Data confidence* • *High confidence that overgrazing has occurred/is occurring in the area* • *Low confidence around up to date data on the current extent and impacts of overgrazing on coastal plain vegetation*
Y	Pests/feral animals	2	4	8	M-H	Land managers are responsible for managing the spread of weeds and controlling feral species on pastoral lands. Pest species are an ongoing threat that requires constant management over large areas of land. The majority of pastoral tenure is within the coastal plains area. *Data confidence* • *High confidence that feral animals are present in the area* • *High confidence that feral herbivores have significant impact on coastal plain flora* • *Low confidence around up to date data about the abundance & distribution of feral herbivores & the effects they are having on native flora in Exmouth*
Value: Limestone cliffs & gullies						
Y	Overgrazing	2/3	3	6-9	M	Gullies are more relevant in the pastoral land space than cliffs. Cattle and other pastoral animals are attracted to and gather at water source areas such as gullies. The congregation of species at these locations leads to degradation of landscapes and habitats for native species. Overgrazing may lead to changes in water quality in ephemeral gully systems and movement of soil into the ocean.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
PASTORALISM						
						Data confidence • *High confidence that overgrazing has occurred/is occurring in the area* • *Low confidence around up to date data on the current extent and impacts of overgrazing on limestone and gully vegetation*
Y	Pests/feral animals	2	4	8	M-H	Large feral herbivores such as goats, donkeys and camels are attracted to areas with water such as gullies. Weeds can also infest areas with permanent water sources. Feral animals and weeds can change gully landscapes. *Data confidence* • *High confidence that feral animals are present in the area* • *High confidence that feral herbivores have significant impact on flora and vegetation* • *Low confidence around up to date data about the abundance & distribution of feral herbivores & the effects they are having on native flora in Exmouth*
Value: Coastal dunes						
Y	Overgrazing	2	3	6	M	Note that runoff/contamination is a by-product of over-grazing. Runoff and trampling of vegetation from overgrazing may impact on some coastal dune systems, depending on the how close pastoral land is to the Exmouth Gulf and whether appropriate containment/fencing is available to ensure stock do not venture into coastal systems. *Data confidence* • *High confidence that overgrazing has occurred/is occurring in the area* • *Low confidence around up to date data on the current extent and impacts of overgrazing on coastal dune vegetation*
Y	Pests/feral animals	2	4	8	M-H	As above *Data confidence* • *High confidence that feral animals are present in the area* • *High confidence that feral herbivores have significant impact on vegetation and flora*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
PASTORALISM						
						• *Low confidence around up to date data about the abundance & distribution of feral herbivores & the effects they are having on native flora in Exmouth*
Value: Threatened/priority flora						
Y	Overgrazing	3	3	9	L-M	It is assumed that there are some threatened or priority species on pastoral lands, even though the baseline data is weak. *Data confidence* • *High confidence that overgrazing has occurred/is occurring in the area* • *Low confidence around up to date data on the current extent and impacts of overgrazing on coastal dune vegetation* • *Low confidence in the distribution of threatened and priority flora*
Y	Pests/ feral animals	3	3	9	L-M	As above *Data confidence* • *High confidence that feral animals are present in the area* • *Low confidence around up to date data about the abundance & distribution of feral herbivores & the effects they are having on threatened and priority flora in Exmouth* • *Low confidence in the distribution of threatened and priority flora*
Factor: Terrestrial fauna						
Value: Reptiles						
Y	Overgrazing	3	4	12	M-H	Habitat degradation/loss through intensive trampling of foraging and denning areas. Because of the scale of pastoral activity and the continuing alteration of habitat this activity probably poses the greatest risk to individual species and the maintenance of species community structure. Issues are confounded through lack of detailed knowledge around patterns of distribution for reptile fauna around the periphery of the gulf. Interactions between grazing, weed invasion, soil compaction and or loss, fire and predator activity can have compounding and long-term detrimental impacts *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
PASTORALISM						
						• *High confidence that overgrazing has occurred/is occurring in the area* • *High confidence that overgrazing impacts reptiles generally* • *Low confidence around reptile assemblage(s) in the area and the extent, severity, timeframe of any effects*
Y	Pests/ feral animals	3	4	12	M-H	Feral animals can compete with native animals for habitat and food. Feral animals also predate native animals. Weeds can degrade habitat and cause changes in landscapes. Weed invasion is capable of permanently altering landscapes at large scales, generally with a resulting loss in species diversity. Predation may be detrimental to a number of species but particularly to larger less abundant species. Grazing by feral animals may have similar impacts to those of pastoralism more generally. Complexities between interactions of all these elements at landscape scales elevate the risks. Lack of knowledge around species distributional patterns inject uncertainty into what has occurred and what may continue to occur (same for all of the broader land usage and altering Note: Cane toads may be present in the Gulf within 10 years. If this does occur, then the risk would be much higher, particularly regarding reptiles. However, this is not necessarily a pastoral-only related pressure. *Data confidence* • *High confidence that feral animals are present* • *High confidence that feral animals affect reptiles generally* • *Low confidence about reptile assemblages in the Exmouth area and the extent and severity of any effects*
Value: mammals						
Y	Overgrazing	1/2	3	3-6	M-H	Small mammals are more likely to be affected with cattle likely to trample foraging and denning habitats. *Data confidence* • *High confidence that overgrazing has occurred/is occurring in the area* • *High confidence that overgrazing impacts mammals generally* • *Low confidence around mammal assemblage(s) in the area and the extent, severity, timeframe of any effects*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
PASTORALISM						
Y	Pests/ feral animals	1	3	3	M-H	Feral herbivores (goats, donkeys, camels etc.) and other feral animals compete for food, water and habitat. Feral animals also predate native animals. *Data confidence* • *High confidence that feral animals are present* • *High confidence that feral animals affect mammals generally* • *Low confidence about mammals assemblages in the Exmouth area and the extent and severity of any effects*
Value: birds						
Y	Overgrazing	1	3	3	M-H	Degradation/loss of bird habitats is likely from intensive trampling of foraging and nesting areas. *Data confidence* • *High confidence that overgrazing has occurred/is occurring in the area* • *High confidence that overgrazing impacts birds generally* • *Medium confidence around bird assemblage(s) in the Exmouth area and the extent, severity, timeframe of any effects*
Y	Pests/ feral animals	1	3	3	M-H	Feral animals can compete with native animals for habitat and food. Feral animals also predate native animals. *Data confidence* • *High confidence that feral animals are present* • *High confidence that feral animals affect birds generally* • *Medium confidence about bird assemblages in the Exmouth area and the extent and severity of any effects*
Value: short range endemic invertebrates						
Y	Overgrazing	1	3	3	M	Habitat degradation/loss through intensive trampling of mosaic vegetation. *Data confidence* • *High confidence that overgrazing has occurred/is occurring in the area*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
PASTORALISM						
						• *Low confidence around short range endemic assemblage(s) in the Exmouth area and the extent and severity of any effects*
Y	Pests/ feral animals	1	3	3	M	Pests/feral animals could completely change the mosaic habitats needed for short-range endemic fauna. *Data confidence* • *High confidence that feral animals are present* • *Low confidence around short range endemic assemblage(s) in the Exmouth area and the extent and severity of any effects*
Value: amphibians						
Y	Overgrazing	2	4	8	M-H	Habitat degradation/loss through intensive trampling of foraging and breeding areas. Amphibians rely on water bodies to reproduce and live, which could be impacted through loss of water quality from runoff and contamination. Same reasoning as for reptiles but due to lower diversity perhaps marginally lower consequence *Data confidence* • *High confidence that overgrazing has occurred/is occurring in the area* • *High confidence that overgrazing impacts amphibians generally* • *Low confidence around amphibian assemblages in the Exmouth area and the extent, severity, timeframe of any effects*
Y	Pests/ feral animals	2	4	8	M-H	Feral animals can compete with native amphibians for habitat and food or become a food source for invasive predators. Weeds can degrade habitat and cause changes in landscapes. Same reasoning as for reptiles but due to lower diversity perhaps marginally lower consequence. *Data confidence* • *High confidence that feral animals are present* • *High confidence that feral animals affect amphibians generally*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
PASTORALISM						
						• *Low confidence about amphibians assemblages in the Exmouth area and the extent and severity of any effects*
Factor: Landforms						
Value: islands						
N	Overgrazing					
N	Pests/ feral animals					
Value: karst systems						
N	Overgrazing					
N	Pests/ feral animals					
Factor: Subterranean fauna						
Value: troglofaunal						
N	Overgrazing					
N	Pests/ feral animals					
Value: stygofauna						
N	Overgrazing					
N	Pests/ feral animals					
Factor: Terrestrial environmental quality						
Value: topsoil						
Y	Overgrazing	2	3	6	M-H	Terrestrial environmental quality could be impacted through overgrazing by changes to the chemical, physical and aesthetic characteristics of soils. Overgrazing can lead to erosion of topsoil and runoff. Severe erosion leads to poor soil structure in the remaining soil, reduced water infiltration and general loss of soil health. *Data confidence* • *High confidence that overgrazing has occurred/is occurring in the area*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
PASTORALISM						
						• *High confidence that overgrazing impacts topsoil* • *Low confidence around up to date data on extent of impact to topsoil in Exmouth*
N	Pests/ feral animals					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION- Visitation includes local impacts as well						
Factor: Flora & vegetation						
Value: Coastal plains						
N	Potable water use					Groundwater drawdown addresses this
Y	Rubbish	1	3	4	L-M	Dumped rubbish is often contaminated with seeds (weeds/pests). Weeds are probably more likely to come from tourism/visitation/transport from other areas. Site specific. *Data confidence* • *High confidence that rubbish and illegal dumping occurs* • *Low confidence around the nature and severity of impacts to vegetation* • *Low confidence about the vegetation assemblages occuring in the Exmouth area*
Y	Human waste	1	4	4	M	The Shire has said they have no major problem with sewage, and they can accommodate peak periods but what will a peak period look like in 10 years? The carrying capacity is for the Gulf is unknown. Free camping waste is more of an issue. People are not using sewage facilities. Risk could change with increased tourism **More knowledge needed** on sewage systems - becomes an issue when there are floods Assessments of water quality have not been done for Exmouth marina. *Data confidence* • *High confidence that human waste will increase in the area* • *Medium confidence around capacity for future peak periods* • *Low confidence round impacts on coastal plains vegetation*
Y	Camping	2	4	8	M	Ample anecdotal data but little empirical evidence. People camp all the way along the west side of the Exmouth Gulf, on plains and dunes, but mainly dunes. Camping is poorly regulated on some pastoral stations.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION- Visitation includes local impacts as well						
						In April 2023 there is a solar eclipse event, and a big tourism influx is expected of between 50-70,000 people. The whole of the Gulf up to Onslow is the ideal location for viewing the event due to lack of light pollution. There have been more visitors in last 12 months due to COVID-19 - so we are not working off the normal baseline figures. *Data confidence* • *High confidence that camping occurs in areas where coastal plain vegetation occurs* • *Low confidence around the extent of impacts to vegetation*
Y	Off-road driving	3	4	12	H	Ample anecdotal and some empirical evidence Four-wheel-drive (4WD) tracks cover the plains and dunes at the back of town. There is no real limitation on where people can go. The Dunes and beaches have uncontrolled 4WD access. Where there is not access, they come up into dunes then back down to beach. Weeds are probably brought from other areas by tourism, visitation and transport. There is not much 4WD access along the east coast of Gulf. Some 'Islands' of vegetation are scattered throughout salt flats and should be considered. Kobryn et al. 2017 paper showed 1200km of vehicle tracks from aerial remote sensing along the Ningaloo marine park coastline. Likely to be the same around Exmouth Gulf? One fisherman's comment was that tracks are causing a danger to their vehicles. Dunes get blown out. Tracks can be quite deep. Tracks through dunes open them up to erosion. *Data confidence* • *High confidence that 4wd tracks occur across coastal plains, which is evident in the Cape Range and adjacent to Ningaloo Reef - see Kobryn et al. (2017)* • *High confidence that 4wd tracks have had an impact to coastal plain vegetation*
Value: Limestone cliffs & gullies						
N	Potable water use					Groundwater drawdown addresses this.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION- Visitation includes local impacts as well						
Y	Rubbish	1	3	3	L-M	Probably not a big issue compared to coastal plains. *Data confidence* • *High confidence that rubbish and illegal dumping occurs* • *Low confidence around the nature and severity of impacts to vegetation* • *Low confidence about the vegetation assemblages occuring in the Exmouth area*
Y	Human waste	1	4	4	M	As above for Coastal plains. *Data confidence* • *High confidence that human waste will increase in the area* • *Medium confidence around capacity for future peak periods* • *Low confidence round impacts on limestone and gully vegetation*
Y	Camping	2	4	8	L-M	Less information available about camping on limestone cliffs & gullies compared to dunes & coastal plains *Data confidence* • *Medium confidence that camping occurs in areas where limestone cliffs & gully vegetation occurs* • *Low confidence around the extent of impacts to vegetation*
Y	Off-road driving	1	3	3	M	Not as much driving would occur here given there are cliffs and gullies. *Data confidence* • *High confidence that 4wd tracks occur extensively in the Exmouth area* • *Low confidence around the extent of impact to vegetation of cliffs and gullies*
Value: Coastal dunes						
N	Potable water use					Groundwater drawdown addresses this.
Y	Rubbish	1	4	4	L-M	Probably not a big issue compared to coastal plains. *Data confidence* • *High confidence that rubbish and illegal dumping occurs* • *Low confidence around the nature and severity of impacts to vegetation*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION- Visitation includes local impacts as well						
						• *Low confidence about the vegetation assemblages occuring in the Exmouth area*
Y	Human waste	1	4	4	M-H	People use the dunes as toilets. Toilet paper is evident in the dunes from overnight campers. Coastal dunes are probably the most at risk and this is where you would get the most threatened species. *Data confidence* • *High confidence that human waste will increase in the area* • *Medium confidence around capacity for future peak periods* • *Medium confidence round impacts on coastal plains vegetation*
Y	Camping	2	4	8	M-H	Ample anecdotal and some empirical evidence As above for Coastal plains. Coastal dunes are probably the most at risk and where you would get the most threatened species. *Data confidence* • *High confidence that camping occurs in areas where coastal dune vegetation occurs* • *Medium confidence around the extent of impacts to vegetation*
Y	Off-road driving	3	4	12	H	Ample anecdotal and empirical evidence As above or Coastal plains. Coastal dunes are probably the most at risk and where you would get the most threatened species. Residents and tourists use off-road driving tracks. *Data confidence* • *High confidence that 4wd tracks occur across coastal dunes* • *High confidence that 4wd tracks have had an impact to coastal dune vegetation*
Value: Threatened/priority flora						
	Potable water use					
	Rubbish					
	Human waste					
	Camping	2	3	6	L	As above for Coastal plains. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION- Visitation includes local impacts as well						
						• *Low confidence that camping occurs in areas where threatened and priority flora occurs* • *Low confidence around the extent of impacts to threatened and priority flora occurs*
	Off-road driving	3	3	9	M	As above or Coastal plains, but the occurrence and extent of threatened and priority flora is not well known. Off-road driving is less contained that camping thus the consequence is higher. Coastal dunes are probably the most at risk and where you would get the most threatened species. *Data confidence* • *High confidence that 4wd tracks occur extensively around the Exmouth area* • *Low confidence around the extent of impact on threatened and priority flora*
Factor: Terrestrial fauna						
Value: Reptiles						
	Potable water use					
	Rubbish	1	3	3	L-M	Rubbish could be ingested or could impact suitability of habitat. Unlikely to be much of an issue although individuals of some species do get their heads stuck in bottle or cans *Data confidence* • *High confidence that rubbish and illegal dumping occurs* • *Low confidence around the nature and severity of impacts to fauna* • *Low confidence about the reptile assemblages occuring in the Exmouth area*
	Human waste					
	Camping	1	3	3	L-M	Camping could cause some displacement of reptiles and/or dependence on campers for food. Noise considerations. *Data confidence* • *High confidence that camping occurs in areas where reptiles inhabit* • *Low confidence around the extent of impacts to reptiles* • *Low confidence about the reptile assemblages occuring in the Exmouth area*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION- Visitation includes local impacts as well						
	Off-road driving	2	4	8	M	Some empirical data on extent of off-road tracks Off-road driving could directly cause harm, loss of life and/or impact on habitat. Tracks cover large distances and could impact large stretches of habitat used by reptiles. Road kill is a significant impact during high tourism periods but this is mostly for road vehicles. *Data confidence* • *High confidence that off road driving occurs extensively in the Exmouth area* • *Low confidence around the impacts of 4WD on reptiles*
Value: mammals						
	Potable water use					
	Rubbish	1	3	3	L-M	As above for reptiles. Pearson (2013) lists pollution as likely to affect endangered rock wallabies but more information required about extent, severity etc. *Data confidence* • *High confidence that rubbish and illegal dumping occurs* • *Low confidence around the nature and severity of impacts to fauna* • *Low confidence about the mammal assemblages occuring in the Exmouth area*
	Human waste					
	Camping	1	3	3	L-M	In the Cape Range NP Management Plan 2010, DEC acknowledged camping as a threat to endangered black-flanked rock wallabies, but more information required about extent, severity etc. *Data confidence* • *High confidence that camping occurs in areas where mammals inhabit* • *Low confidence around the extent of impacts to mammals* Low confidence about the mammals assemblages occuring in the Exmouth area
	Off-road driving	2	4	8	M	As above for reptiles. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION- Visitation includes local impacts as well						
						• *High confidence that off road driving occurs extensively in the Exmouth area* • *Low confidence around the impacts of 4WD on mammals*
Value: birds						
	Potable water use					
	Rubbish	1	3	3	M	As above for reptiles. *Data confidence* • *High confidence that rubbish and illegal dumping occurs* • *Low confidence around the nature and severity of impacts to fauna* • *Medium confidence about the bird assemblages occuring in the Exmouth area*
	Human waste					
	Camping	1	3	3	M	As above for reptiles. *Data confidence* • *High confidence that camping occurs in areas where birds inhabit* • *Low confidence around the extent of impacts to birds* • *Medium confidence about the bird assemblages occuring in the Exmouth area*
	Off-road driving	2	4	8	M	Burrowing birds can be impacted by off-road vehicle use. Consideration of seabirds and shorebirds is given under sea theme. *Data confidence* • *High confidence that off road driving occurs extensively in the Exmouth area* • *Low confidence around the impacts of 4WD on birds*
Value: short range endemic invertebrates						
	Potable water use					
	Rubbish	1	3	3	L-M	As above for reptiles. *Data confidence* • *High confidence that rubbish and illegal dumping occurs*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION- Visitation includes local impacts as well						
						• *Low confidence around the nature and severity of impacts to fauna* • *Low confidence about the short range endemic assemblages occuring in the Exmouth area*
	Human waste					
	Camping	2	3	6	L	Given their short range, impacts to habitat would be more significant compared to species that can travel further away from a disturbance. Uncertainty on the number and extent of short range endemics. *Data confidence* • *Low confidence that camping occurs in areas where short range endemics inhabit* • *Low confidence around the extent of impacts to short range endemics* • *Low confidence about the short range endemics assemblages occuring in the Exmouth area*
	Off-road driving	2	3	6	L-M	Given their short range, impacts to habitat would be more significant compared to species that can travel further away from a disturbance. Uncertainty on the number and extent of short range endemics. *Data confidence* • *High confidence that off road driving occurs extensively in the Exmouth area* • *Low confidence around the impacts of 4WD on short range endemics* • *Low confidence about the short range endemics assemblages occuring in the Exmouth area*
Value: amphibians						
	Potable water use					
	Rubbish	1	3	3	L-M	Potential contamination of breeding sites. *Data confidence* • *High confidence that rubbish and illegal dumping occurs* • *Low confidence around the nature and severity of impacts to fauna* • *Low confidence about the amphibian assemblages occuring in the Exmouth area*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION- Visitation includes local impacts as well						
	Human waste					
	Camping	1	3	3	L-M	Camping near water sources may impact on frogs that breed in temporary water bodies after major rains - probably only through contamination? *Data confidence* • *High confidence that camping occurs in areas where amphibians inhabit* • *Low confidence around the extent of impacts to amphibians* • *Low confidence about the amphibian assemblages occuring in the Exmouth area*
	Off-road driving	1	3	3	M	Impacts to vegetation and soil close to a water source may impact frogs. Tracks may not be as likely to occur very close to water bodies. Tracks can alter surface flow and redirect water away from pooling or change overall structure of pools, possibly making some unsuitable for breeding. *Data confidence* • *High confidence that off road driving occurs extensively in the Exmouth area* • *Low confidence around the impacts of 4WD on amphibians*
Factor: Landforms						
Value: islands						
N	Potable water use					
Y	Rubbish	1	4	4	M	Rubbish left on islands has been documented in reports and management plans *Data confidence* • *High confidence that rubbish and illegal dumping occurs* • *Low confidence around the nature and severity of impacts to islands*
Y	Human waste	1	2	2	L	Probably not a big issue as day trekking on many islands is not allowed. *Data confidence* • *Low data confidence around impacts of human waste to islands*
Y	Camping					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION- Visitation includes local impacts as well						
Y	Off-road driving					
Value: karst systems						
	Potable water use					Already considered under development in terms of tourism groundwater drawdown
	Rubbish - includes anything 'foreign' to karsts systems including hard rubbish, rocks, contaminants	2	4	8	M	Ample anecdotal evidence for increased rubbish generation into landfill. Contaminants from landfill could leach into karst systems. Hard rubbish and rock throwing into karst system holes occurs. *Data confidence* • *High confidence that rubbish and illegal dumping occurs in karst systems* • *Low confidence around the nature and severity of impacts to karst systems*
	Human waste	2	3	6	M	Increased tourism contributes to increased sewage waste. The Shire said they had the capacity to deal with sewage/water during peak times. Broader implications may occur if there are instances with a high volume of sewage waste combined with a flooding event. *Data confidence* • *High confidence that human waste will increase in the area* • *Medium confidence around capacity for future peak periods* • *Low data confidence around impacts of human waste to karst systems*
	Camping	1	4	4	M	Ample anecdotal evidence about risks of increased human activities near karst systems but little empirical data Camping and off-road driving go hand-in-hand for some karst locations. *Data confidence* • *High confidence that camping occurs in vicinity to karst systems* • *Low confidence around the extent of impacts to karst systems*
	Off-road driving	1	4	4	M	People are exploring more obscure tracks. There is increasing visitation to less visited areas that can include karst systems. For example, Bulldozer Cave is a hole that was created when a bulldozer fell through. People can drive in there now and get to the water, and with that comes the introduction of sediments and rubbish (rubbish scored elsewhere and not considered here).

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION- Visitation includes local impacts as well						
						More knowledge needed on the impacts of tourist related activities. *Data confidence* • *High confidence that off road driving occurs in vicinity to karst systems* • *Low confidence around the impacts of 4WD on karst systems*
Factor: Subterranean fauna						
Value: troglofauna						
	Potable water use					
	Rubbish	2	4	8	M	See reasonings above. Impacts to karsts systems would impact subterranean fauna. Ample anecdotal evidence for increased rubbish *Data confidence* • *High confidence that rubbish and illegal dumping occurs in karst systems* • *Low confidence around the nature and severity of impacts to troglofauna*
	Human waste	2	3	6	M	As above. *Data confidence* • *High confidence that human waste will increase in the area* • *Medium confidence around capacity for future peak periods* • *Low data confidence around impacts of human waste to karst systems and troglofauna*
	Camping	1	4	4	M	As above. *Data confidence* • *High confidence that camping occurs in vicinity to karst systems* • *Low confidence around the extent of impacts to karst systems and troglofauna*
	Off-road driving	1	4	4	M	As above. Anecdotal evidence about risks of increased human activities near karst systems containing troglofauna but little empirical data *Data confidence* • *High confidence that off road driving occurs in vicinity to karst systems*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION- Visitation includes local impacts as well						
						• *Low confidence around the impacts of 4WD on karst systems and troglofauna*
Value: stygofauna						
	Potable water use					
	Rubbish	2	4	8	M	As above. *Data confidence* • *High confidence that rubbish and illegal dumping occurs in karst systems* • *Low confidence around the nature and severity of impacts to stygofauna*
	Human waste	2	3	6	M	As above *Data confidence* • *High confidence that human waste will increase in the area* • *Medium confidence around capacity for future peak periods* • *Low data confidence around impacts of human waste to karst systems and stygofauna*
	Camping	1	4	4	M	As above *Data confidence* • *High confidence that camping occurs in vicinity to karst systems* • *Low confidence around the extent of impacts to karst systems and stygofauna*
	Off-road driving	1	4	4	M	As above *Data confidence* • *High confidence that off road driving occurs in vicinity to karst systems* • *Low confidence around the impacts of 4WD on karst systems and stygofauna*
Factor: Terrestrial environmental quality						
Value: topsoil						
	Potable water use					
	Rubbish					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION- Visitation includes local impacts as well						
	Human waste					
	Camping					
	Off-road driving	1	4	4	M-H	Soils from tracks are expected to deteriorate and constantly be disturbed. Soil can be transported elsewhere in tyres. *Data confidence* • *High confidence that 4WD will disturb and impact soils* • *Medium confidence in the extent of impact*

EPA WATER THEME

Negligible	Low	Medium	High	Severe
1-2	3-4	6-8	9-12	16

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
CLIMATE CHANGE						
Factor: Inland waters						
Value: Groundwater systems						
Y	Sea level rise	1	3	3	H	The WA Planning Commission is allowing for 0.38 m sea level rise per year over the next 100 years. It is likely that some sea level change will occur, however the extent within a 10-year period would be localised. Within the scope of 10 years, it is more the frequency and extent of fire/storms/atmospheric temperatures that will be impacted. *Data confidence* • *High confidence in sea level rise predictions* • *High confidence that there is interaction between seawater and groundwater and that sea level rise, to a certain extent, will impact on the groundwater aquifer*
Y	Tropical storms/cyclones	1	3	3	H	It is likely that some change to tropical storms and cyclones will occur, however the extent within a 10-year period would be localised. Within the scope of 10 years, it is more the frequency and extent of fire/storms/atmospheric temperatures that will be impacted. *Data confidence* • *High confidence in cyclone predictions* • *High confidence that cyclones will bring heavy rainfall* • *High confidence that heavy rainfall will contribute to high inflow into groundwater aquifer*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
CLIMATE CHANGE						
N	Fire					
N	Atmospheric temperatures					
Value: Surface water systems						
Y	Sea level rise	1	3	3	M-H	As above for groundwater systems. *Data confidence* • *High confidence in sea level rise predictions* • *High confidence that sea level rise, to a certain extent, will impact on surface water systems* • *Low confidence about how sea level rise will impact on groundwater systems of Exmouth within the timeframe*
Y	Tropical storms/cyclones	1	3	3	H	As above for groundwater systems *Data confidence* • *High confidence in cyclone predictions* • *High confidence that cyclones will bring heavy rainfall* • *High confidence that heavy rainfall will contribute to high inflow into surface water systems*
Y	Fire	1	3	3	M	Within the scope of 10 years, it is more the frequency and extent of fire/storms/atmospheric temperatures that will be impacted. *Data confidence* • *High confidence in fire predictions* • *Low confidence around impacts to surface water systems*
Y	Atmospheric temperatures	1	3	3	H	Within the scope of 10 years, it is more the frequency and extent of fire/storms/atmospheric temperatures that will be impacted. *Data confidence* • *High confidence in atmospheric temperature predictions*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
CLIMATE CHANGE						
						• *High confidence that increased temperatures and altered precipitation patterns will affect surface water systems*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEFENCE						
Factor: Inland waters						
Value: Groundwater systems						
Y	Contamination	3	3	9	H	Per- and polyfluoroalkyl substances (PFAS) from firefighting foam can contaminate groundwater. Uncertain as to the extent of PFAS contamination. Contaminated groundwater can leach into the marine environment and karst systems. *Data confidence* • *High confidence that PFAS contamination is present at Harold Holt base - see DoD 2019*
Value: Surface water systems						
Y	Contamination	3	3	9	H	PFAS from firefighting foam can contaminate surface water. Uncertain as to the extent of PFAS contamination. *Data confidence* • *High confidence that PFAS in concentrations exceeding the ecological screening criterion is present in the backwater lagoon on the base. It most likely occurred through surface water runoff - see DoD 2019*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
Factor: Inland waters						
Value: Groundwater systems						
N	Residential - footprint					
Y	Residential - groundwater use	2	3	6	M-H	The town draws water from the aquifer, this continual drawdown may impact on karst system. WaterCorp is aware of concerns and is looking at options. The Shire has no concerns about current usage of potable water - it can handle peak periods (thinking about supply). In 1995, a warning was expressed of expansion of the bore field in Exmouth Gulf, and how impacts of the bore field are too great for a bore field extensions. There would be impacts to stygofauna. This was when visitation was lower than current days. Impacts to waterways and extraction of water can compound quite rapidly. Intense rainfall events recharge fresh water lens and the dynamic is changing due to climate change. The extraction of the freshwater lens is leading to infiltration of more saline waters into areas where extraction is occurring. The impacts on stygofauna are unknown. What would happen if tourism increased and more potable water was extracted - what are the impacts on stygofauna? What are the current proportions of groundwater water from domestic, industrial and tourism uses? Work was done in 2004 documenting the variation in freshwater and saltwater and composition of bores - from around and including Cape Range. Currently at a critical point in terms of water supply. But do not have expertise to comment and score. Expertise is not in the room. Low certainty of reliable data. Outdated reports WaterCorp need to be involved in discussions (and Department of Water and Environmental Regulation (DWER)). Kathy McInnes (CSIRO / UTAS) - climate change projections and groundwater is a complex one to entangle.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						Consequence is likely to be high if groundwater drawdown impacts on stygofauna. There have been historical falls of civilisation due to lack of water. Stygofauna are short range endemics. Blind cave fish has a 50 km limit in cave systems in the southern end of the study site. Blind cave fish can be in sea water through to fresh. For other stygofauna species, we do not know enough about their physiology to understand impacts - if we are impacting on biogeochemical processes and water sources. Humid caves are needed for stygofauna species. Dry caves may impact on some species. Taken from publications via DWER (still awaiting data from Water Licensing Team at DWER): Exmouth drinking water comes from 34 bores located on eastern side of Cape Range Peninsula. Bore field is located west and south of the town and extends over distance of 7km. Water is extracted from unconfined limestone aquifers within karst formations. Risks to towns drinking water supply is contamination via pathogens and nutrients and hydrocarbons from vehicles via spills and leaks of fuel. Department supports all existing, approved land uses and activities, and encourages land owners and managers to adopt best practices. Via the Exmouth Water Reserve Water Source Protection Plan (2000), reviewed in 2011: Water reserve is managed as a Priority 1 source protection, therefore development in water reserve is limited. Heavy, light, general industry and urban development activities are incompatible with a P1 water reserve. Extractive industries and mining are conditionally compatible. Tourism development is incompatible in the water reserve area. According to the *Carnarvon Artesian Basin water management plan*: Allocation limit for the entire region is 30,000,000 kL/year. Licensed allocations are 7,429,560 kL/year. Available supply is 22,570,440 kL/year. However, this is at a regional scale. Contacted: Erin Maher (DWER) provided info on 26/03/21: Groundwater resources on the Exmouth peninsula are limited due to the relatively small size of the peninsula and low rainfall. The town water supply uses production bores to abstract fresh to brackish groundwater between 30m to 200m below ground level. Abstraction for town water supply has been close to the licenced entitlement for a number of years (peaking in 2019/2020 at 1,010,394 kL of the 1,032,000 kL licensed

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						allocation). DWER will not allow town water supply to draw more than the allocation. Water Corp is investigating future sources (new bore field or desalination option). Residents used 482,658 kL of allocation in 2019/2020. Water Corp can maintain current water use, however not likely to be able to significantly expand water use for Town Supply. Tried to contact Water Corp without response. *Data confidence* • *High confidence around the volume of water used by residents* • *Medium confidence around the future use of water by residents and expanded residential developments*
N	Residential - solid waste					
N	Residential - light					
N	Residential - noise					
N	Industrial - footprint					
Y	Industrial - groundwater use	2	2	4	M-H	Commercial water licences used 330,000 kL of allocation in 2019/2020. DWER is unable to licence naval, communication and air bases as this is Commonwealth land. Approximately 200ML is used by Department of Defence and this is considered in DWER allocation planning. MG Kailis Group and Main Roads also have licences for water extraction, however this source is different to town supply and water availability from this source is ok. *Data confidence* • *High confidence around the volume of water used by industry* • *Medium confidence around the future use of water by industry and expanded industrial developments*
N	Industrial - solid waste					
N	Industrial - light					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
N	Industrial - noise					
N	Tourism - footprint					
Y	Tourism - groundwater use	2	3	6	M-H	Lighthouse Caravan park and Ningaloo Marine Research Facility both requested water licences, which recently underwent assessment by DWER (72 ML/year and 400 ML/year respectively). Assessments found low risk of impacting other users and the environment. The golf club, Department of Education, Caravan parks and Shire hold water licences in the area. Water Corp can maintain current water use, however not likely to be able to significantly expand water use for additional tourism use. *Data confidence* • *High confidence around the volume of water used by tourists/tourism* • *Medium confidence around the future use of water by tourists and the tourism industry*
N	Tourism - solid waste					
N	Tourism - light					
N	Tourism - noise					
Value: Surface water systems						
Y	Residential - footprint	1	1	1	M-H	Only infill is planned for residential development within Exmouth town in next 10 years due to restriction of available land, expansion of the town is unlikely, unless the Shire can secure land to the south of the existing town (Defence to the north, Water Reserve area, and crown land). *Data confidence* • *High confidence about planned residential infill and that this will not directly infill surface water bodies* • *High confidence that changes to run-off pathways will impact surface water systems*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						• *Low confidence around the extent to which residential development will impact run-off pathways*
N	Residential - groundwater drawdown					
N	Residential - solid waste					
N	Residential - light					
N	Residential - noise					
Y	Industrial - footprint	1	1	1	L-M	According to the Local Planning Scheme, there are several sites zoned for light industry, service commercial and general industry use that already exist. The Shire has indicated that there are currently no plans to extend these areas. *Data confidence* • *Low confidence about planned industrial development* • *High confidence that changes to run-off pathways will impact surface water systems* • *Low confidence around the extent to which industrial development will impact run-off pathways*
N	Industrial - groundwater drawdown					
N	Industrial - solid waste					
N	Industrial - light					
N	Industrial - noise					
Y	Tourism - footprint	1	2	2	L-M	The unknown here is the plans for lighthouse redevelopment. Not enough information is yet known about the proposal to say with certainty whether diversions to creek beds/channels or surface water flows will be required as part of this proposal or not. If needed, these changes are likely to be localised. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						• *Low confidence about planned tourism development* • *High confidence that changes to run-off pathways will impact surface water systems* • *Low confidence around the extent to which tourism development will impact run-off pathways*
N	Tourism - groundwater drawdown					
N	Tourism - solid waste					
N	Tourism - light					
N	Tourism - noise					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
Factor: Inland waters						
Value: Groundwater systems						
N	Limestone - footprint					
N	Limestone - operation					
Y	Limestone - groundwater drawdown	1/2	3	3-6	L	Groundwater supply is required for water use. However, it is unlikely to require a significant additional allocation. Groundwater contamination is unlikely. However, it requires appropriate management. Limestone quarries are already operational. However, there is a possibility that expansion of operations may increase water supply requirements in the foreseeable future. *Data confidence* • *Low confidence around the volumes of groundwater needed for current and future limestone operations*
Y	Industrial salt facility - footprint	1	4	4	L-M	Seepage and mounding from concentration and crystalliser ponds are expected and would need appropriate management. Changes in the groundwater regime are likely. However, they are expected to be localised around pond walls. *Data confidence* • *Medium confidence around the details and extent of footprint* • *Low confidence around the impact to groundwater systems*
Y	Industrial salt facility - groundwater drawdown	1	2	2	L	Some groundwater drawdown is expected to facilitate potable water use at the industrial salt facility. *Data confidence* • *Low confidence around the volumes of groundwater needed for future salt operations*
Y	Potash - footprint	1/2	4	4-8	L-M	Changes in groundwater regimes due to abstraction of brine are likely. The extent is unknown due to a lack of information regarding the Whalebone/Wyloo resources proposal.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
						Data confidence • *Medium confidence around the details and extent of footprint* • *Low confidence around the impact to groundwater systems*
N	Potash - brine extraction					
Value: Surface water systems						
Y	Limestone - footprint	1/2	3	3-6	L	Limestone quarries are already active. However, expansion of operations is possible. Any additional diversion or disturbance of creek beds/channels or drainage lines may impact water surface flows. *Data confidence* • *Low confidence around the details and extent of future footprint* • *Low confidence around the impact to surface water systems*
N	Limestone - operation					
N	Limestone - groundwater drawdown					
Y	Industrial salt facility - footprint	1	3	3	L-M	Any diversion or disturbance of creek beds/channels or drainage lines may impact water surface flows. Brine leaks and spills are a consideration. Erosion and sediment loss are also a consideration. *Data confidence* • *Medium confidence around the details and extent of footprint* • *Low confidence around the impact to surface water systems*
N	Industrial salt facility - groundwater drawdown					
Y	Potash - footprint	1	3	3	L-M	As above for industrial salt facility. *Data confidence* • *Medium confidence around the details and extent of footprint*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
						• *Low confidence around the impact to surface water systems*
N	Potash - brine extraction					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
PASTORALISM						
Factor: Inland waters						
Value: Groundwater systems						
N	Overgrazing					
N	Pests/feral animals					
Value: Surface water systems						
Y	Overgrazing	1	3	3	M	Includes contamination and runoff. Overgrazing can result in increases in stream turbidity, salinity and water quality degradation. Overgrazing removes vegetation cover and compacts exposed soil, removing topsoil. The obligations of pastoral leaseholders include methods of best pastoral and environmental management practices for the management of stock, conservation and regeneration of pasture for grazing. *Data confidence* • *High confidence that overgrazing impacts on surface waters in general* • *Low confidence around how surface water systems have been impacted locally*
Y	Pests/feral animals	1	3	3	M	Feral herbivores include such animals as goats, camels, donkeys. Pest plants include such species as mesquite (*Prosopis* spp.), kapok bush (*Aerva javanica*), lantana (*Lantana camara*), ruby dock (*Rumex vesicarius*), Tamarix (*Tamarix aphylla*). Control of declared pest animals and invasive plants on pastoral land is an obligation on leaseholders under the *Biosecurity and Agriculture Management Act 2007 (BAM Act).* Pest plants can become prolific in surface water channels due to the presence of ephemeral water. If not appropriately managed, this is likely to be localised. Feral animals are also attracted to surface water locations and can impact waterways through destruction of habitat and degradation of water quality. *Data confidence* • *High confidence that pests/ferals impact on surface waters in general*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
PASTORALISM						
						• *Low confidence around how surface water systems have been impacted locally*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
Factor: Inland waters						
Value: Groundwater systems						
Y	Potable water use	2/3	3	6-9	H	The town draws on aquifer for potable water use. Via the Exmouth Water Reserve Water Source Protection Plan (2000), reviewed in 2011: Water reserve is managed as Priority 1 source protection, therefore development in water reserve is limited. Heavy, light, general industry and urban development activities are incompatible with a P1 water reserve. Extractive industries and mining are conditionally compatible. Tourism development is incompatible in the water reserve area. According to the *Carnarvon Artesian Basin water management plan*: Allocation limit for the entire region is 30,000,000 kL/year. Licensed allocations are 7,429,560 kL/year. Available supply is 22,570,440 kL/year. However, this is at a regional scale. Contacted: Erin Maher (Department of Water and Environmental Regulation (DWER)) provided information on 26/03/21: Groundwater resources on the Exmouth peninsula are limited due to the relatively small size of the peninsula and low rainfall. The town water supply uses production bores to abstract fresh to brackish groundwater between 30m to 200m below ground level. Abstraction for town water supply has been close to the licenced entitlement for a number of years (peaking in 2019/2020 at 1,010,394 kL of the 1,032,000 kL licensed allocation). DWER will not allow town water supply to draw more than the allocation. Water Corp is investigating future sources (new borefield or desalination option). Residents used 482,658 kL of allocation in 2019/2020. Water Corp can maintain current water use, however it is not likely to be able to significantly expand water use for Town Supply. Unable to contact Water Corp for comment. *Data confidence* • *High confidence around potable water uses and capacity*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
N	Rubbish					
N	Human waste					
N	Camping					
N	Off-road driving					
Value: Surface water systems						
N	Potable water use					
Y	Rubbish	1	2	2	M	Rubbish is unlikely to change surface water flows or quality in Exmouth Gulf, although it should be managed appropriately. Anecdotal reports of rubbish but little empirical data *Data confidence* • *High confidence that rubbish occurs in the area* • *Low confidence around how rubbish is impacting surface water systems specifically in Exmouth*
Y	Human waste	1	2	2	M	Human waste is unlikely to significantly alter surface water flows or quality in Exmouth Gulf, although it should be managed appropriately. *Data confidence* • *High confidence that human waste occurs in the area* • *Low confidence around how human waste is impacting surface water systems specifically in Exmouth*
N	Camping					
Y	Off-road driving	1	3	3	M	Some erosion and changes to creek beds are expected, particularly near beach areas. However, significant alteration is unlikely. *Data confidence* • *High confidence that off-road driving extensive in the area and occurs near surface water systems* • *Low confidence around how much surface water systems have been impacted by off-road driving*

EPA AIR THEME

Negligible	Low	Medium	High	Severe
1-2	3-4	6-8	9-12	16

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
CLIMATE CHANGE						
Factor: Air quality						
N	Sea level rise					
N	Tropical storms/cyclones					
Y	Fire	1	3	3	H	Frequency and extent likely to be influenced by climate change within 10 years, however difficult to say with any certainty the degree of influence. As we saw on east coast of Australia last year - impacts to air quality could be from particulate matter, smoke and volatile organic compounds. *Data confidence* • *High confidence in fire predictions* • *High confidence that fire affects air quality in WA - see Borchers Arriagada et al. (2020) Exceedances of national air quality standards for particulate matter in Western Australia: sources and health-related impacts. Med J Aust 2020; 213 (6): 280-281. || doi: 10.5694/mja2.5054*
N	Atmospheric temperatures					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEFENCE						
Factor: Air quality						
N	Contamination					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
Factor: Air quality						
N	Residential - footprint					
N	Residential - groundwater drawdown					
N	Residential - solid waste					
N	Residential - light					
N	Residential - noise					
Y	Residential - emissions	1	2	2	M	Air emissions from residential development may increase slightly due to population growth (heating, lighting, cooling of buildings, construction emissions, transport emissions including greenhouse gas emissions and particulates). However, due to population growth predictions and the current state of the Exmouth Gulf, airshed is unlikely to dramatically change within 5-10 years. Should note: fluctuations in air quality and pollution changes in Exmouth Gulf can impact Defence activities and infrastructure in the Gulf. *Data confidence* • *High confidence that increased residential infill will result in increased emissions* • *Low confidence around the rate of increase and when this would start to impact air quality in Exmouth*
N	Industrial - footprint					
N	Industrial - groundwater drawdown					
N	Industrial - solid waste					
N	Industrial - light					
Y	Industrial - emissions	1	2	2	M	Light industry and service industry are the main industrial profile within Exmouth Gulf in its current state. No heavy industry is currently planned for development in Exmouth Gulf,

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						however, some additional shipping in the Gulf, as well as natural growth of the light industrial businesses can be expected, leading to minor additional emissions in the Gulf. *Data confidence* • *High confidence that increased industrial development will result in increased emissions* • *Low confidence around the rate of increase and when this would start to impact air quality in Exmouth*
N	Industrial - noise					
N	Tourism - footprint					
N	Tourism - groundwater drawdown					
N	Tourism - solid waste					
N	Tourism - light					
N	Tourism - noise					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
Factor: Air quality						
N	Limestone - footprint					
N	Limestone - operation					
N	Limestone - groundwater drawdown					
Y	Limestone - emissions	1	3	3	M	Rock quarrying can produce fine and coarse particulate matter, which can be carried by winds. Current limestone operations are expected to continue and potentially expand within the next 5/10 years, however any potential increases in particulate matter from operations are expected to be small and localised. Typically, this is managed appropriately through buffer zones, dust suppression and adjusting operations during unfavourable meteorological conditions. *Data confidence* • *High confidence that increased limestone operations will result in increased particulate matter* • *Low confidence around the rate of increase and when this would start to impact air quality in Exmouth*
N	Salt farm - footprint					
Y	Salt farm - emissions	1	3	3	M	Really depends on the type of operation proposed. Yannarie industrial salt facility as proposed was set to produce approx. 43,500 tpa CO2-e, which is not likely to be significant. *Data confidence* • *High confidence that industrial salt operations will result in increased emissions* • *Low confidence around the rate of increase and when this would start to impact air quality in Exmouth*
N	Potash - footprint					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
N	Potash - abstraction of brine					
Y	Potash - emissions	1	3	3	M	Really depends on the type of operation proposed. Based on recent Lake Way project assessed by EPA, potash production is not likely to produce significant greenhouse gas emissions. *Data confidence* • *High confidence that industrial salt operations will result in increased emissions* • *Low confidence around the rate of increase and when this would start to impact air quality in Exmouth*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
PASTORALISM						
Factor: Air quality						
N	Overgrazing					
N	Runoff/contamination					
N	Pests/ferals					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
Factor: Air quality						
N	Potable water use					
N	Rubbish					
N	Human waste					
N	Camping					
N	Off-road driving					

EPA PEOPLE THEME

Negligible	Low	Medium	High	Severe
1-2	3-4	6-8	9-12	16

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
CLIMATE CHANGE						
Factor: Social surroundings						
Value: Aboriginal heritage & culture - not scoring						
N	Sea level rise					
N	Tropical storms/cyclones					
N	Fire					
N	Atmospheric temperatures					
Value: National heritage - Ningaloo Coast World Heritage Area						
N	Sea level rise					
N	Tropical storms/cyclones					
N	Fire					
N	Atmospheric temperatures					
Value: Amenity - land based recreation						
N	Sea level rise					
Y	Tropical storms/cyclones	2	3	6	H	Recreation activities around the Gulf may not have the same access if the frequency and extent of storms increases over a 10-year period.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
CLIMATE CHANGE						
						Data confidence • *High confidence in cyclone/storm predictions* • *High confidence from past events in the Exmouth area that winds, rainfall & flooding associated with cyclones/storms results in impacted amenity*
Y	Fire	2	3	6	H	As above. *Data confidence* • *High confidence in fire predictions* • *High confidence that fire will impact amenity based on past events in the Exmouth area - see https://www.midwesttimes.com.au/news/midwest-times/firefighters-battling-to-contain-exmouth-blaze-ng-b88766600z*
Y	Atmospheric temperatures	2	2	4	H	Rising temperatures will impact on people's ability or desire to recreate outside, though this may not be too much of an issue within the next 5-10yrs. *Data confidence* • *High confidence around air temperature predictions* • *High confidence that increasing temperature will impact land based recreation in the Exmouth region*
Value: Amenity - marine based recreation						
N	Sea level rise	1	4	4	H	Would have localised impacts at swimming beaches. *Data confidence* • *High confidence in sea level predictions* • *High confidence that sea level rise will affect amenity of beaches & islands & other coastal areas*
Y	Tropical storms/cyclones	2	3	6	H	Recreation activities around the Gulf may not have the same access if the frequency and extent of storms increases over a 10-year period. *Data confidence* • *High confidence in cyclone/storm predictions*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
CLIMATE CHANGE						
						• *High confidence from past events in the Exmouth area that winds, rainfall & flooding associated with cyclones/storms results in impacted amenity*
N	Fire					
N	Atmospheric temperatures					
Value: Amenity - intrinsic/wilderness aesthetic						
Y	Sea level rise	1	3	3	H	Localised. *Data confidence* • *High confidence in sea level predictions* • *High confidence that sea level rise will affect amenity of beaches & islands & other coastal areas*
Y	Tropical storms/cyclones	1	3	3	H	Localised damage likely. *Data confidence* • *High confidence in cyclone/storm predictions* • *High confidence from past events in the Exmouth area that winds, rainfall & flooding associated with cyclones/storms results in impacted amenity*
Y	Fire	2	3	6	H	Fire intensity and frequency may wipe out wilderness areas. *Data confidence* • *High confidence in fire predictions* • *High confidence that fire will impact amenity based on past events in the Exmouth area - see https://www.midwesttimes.com.au/news/midwest-times/firefighters-battling-to-contain-exmouth-blaze-ng-b88766600z*
Y	Atmospheric temperatures	1	3	3	H	May impact the natural biota people come to see. *Data confidence* • *High confidence around air temperature predictions* • *High confidence that increasing temperature will impact the natural wilderness*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
CLIMATE CHANGE						
Value: Amenity - noise, dust, odour, light						
N	Sea level rise					
N	Tropical storms/cyclones					
Y	Fire	2	3	6	H	Particulate matter and smoke would change - dust, odour and potentially light if catastrophic event occurs. *Data confidence* • *High confidence in fire predictions* • *High confidence that fire will impact amenity based on past events in the Exmouth area - see https://www.midwesttimes.com.au/news/midwest-times/firefighters-battling-to-contain-exmouth-blaze-ng-b88766600z*
N	Atmospheric temperatures					
Value: Economic - tourism						
Y	Sea level rise	1	3	3	M	Localised, and tourism operators can avoid eroded/inaccessible areas. *Data confidence* • *High confidence in sea level predictions* • *Low confidence about the economic effect of sea level rise on tourism in the area*
Y	Tropical storms/cyclones	2	3	6	H	Potential visitors may stay away from Exmouth Gulf if frequency and extent of storms increases within 10 years. *Data confidence* • *High confidence in cyclone/storm predictions* • *High confidence that cyclones/storms result in significant economic losses to the tourism industry based on past events in the area*
Y	Fire	2	3	6	H	Particulate matter and smoke would change - dust, odour and potentially light if catastrophic event occurs. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
CLIMATE CHANGE						
						• *High confidence in fire predictions* • *High confidence that fire result in significant economic losses to the tourism industry*
Y	Atmospheric temperatures	1	3	3	H	Potential visitors may stay away from Exmouth Gulf if it becomes too hot, but unlikely in 5-10 years. *Data confidence* • *High confidence around air temperature predictions* • *High confidence that temperature impacts amenity values that draw in tourists*
Value: Economic - commercial fishing						
Y	Sea level rise	1	3	3	M	Localised, and operators can avoid eroded/inaccessible areas. *Data confidence* • *High confidence in sea level predictions* • *Low confidence about the effect of sea level rise on commercial fishing in the area and this flow on to impact economics*
Y	Tropical storms/cyclones	1	3	3	H	Some data to suggest increased nutrient flow after storms fuels the invertebrates (prawns) in Gulf. *Data confidence* • *High confidence in cyclone/storm predictions* • *High confidence that cyclone/storms result in significant economic losses to the commercial fishing industry based on past events in the area - see Loneragan et al. (2013)*
N	Fire					
N	Atmospheric temperatures					Marine heatwaves already scored under marine factors
Value: Economic - pastoralism						
N	Sea level rise					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
CLIMATE CHANGE						
Y	Tropical storms/cyclones	2	3	6	M-H	Changes in frequency and extent of storms could lead to degradation of road infrastructure and access to pastoral lands. *Data confidence* • *High confidence in cyclone/storm predictions* • *High confidence that cyclones/storms can result in flooding of pastoral lands* • *Low confidence around the impact cyclones/storms have had on pastoral lands in Exmouth to date*
Y	Fire	2	3	6	H	Particulate matter and smoke would change - dust, odour and potentially light if catastrophic event occurs. *Data confidence* • *High confidence in fire predictions* • *High confidence that fire result in significant economic losses to the pastoralism industry*
Y	Atmospheric temperatures	1	3	3	M-H	An official ABARES report in 2019 estimated that changes in climate since 2000 reduced cropping revenue by $1.1billion/year Could impact farming choices - e.g., crops and livestock, but likely not within 5-10 years. *Data confidence* • *High confidence around air temperature predictions* • *High confidence in data indicating significant economic costs of atmospheric temperature and precipitation changes on pastoralism in general* • *Low confidence around the impacts to pastoral lands specifically in Exmouth*
Value: Economic - science and research						
Y	Sea level rise	1	3	3	M	Some impacts could occur to study sites. *Data confidence* • *High confidence in sea level predictions* • *Low confidence about the extent of impact to scientific and research activities*
Y	Tropical storms/cyclones	1	3	3	H	Some impacts could occur to study sites.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
CLIMATE CHANGE						
						Data confidence • *High confidence in cyclone/storm predictions* • *High confidence that cyclones/storms can impact scientific and research activities*
Y	Fire	1	3	3	H	Some impacts could occur to study sites. Can assume fire would interfere with many scientific and research activities *Data confidence* • *High confidence in fire predictions* • *High confidence that fire would have some impact on scientific and research activities*
Y	Atmospheric temperatures	1	3	3	H	Some impacts could occur to study sites. *Data confidence* • *High confidence around air temperature predictions* • *High confidence that increasing atmospheric temperatures would impact on scientific and research activities*
Factor: Human health						
Value: potable water						
N	Sea level rise					
Y	Tropical storms/cyclones	1	3	3	M	Increased frequency and intensity of storms could cause changes in water supply depending on seepage rate, rain catchment, inundation etc. *Data confidence* • *High confidence in cyclone/storm predictions* • *Low confidence around the extent of impact to potable water*
N						
Y	Atmospheric temperatures	1	3	3	H	Hot, drying climate may result in higher water evaporation and changes to seepage and rain catchment areas. However, extent unknown within 10-year timeframe. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
CLIMATE CHANGE						
						• *High confidence around air temperature and precipitation predictions* • *High confidence that changes in temperature and precipitation will affect Exmouth's limited potable water supply as the WA government has recognised that "In the north of Western Australia, climate change has caused increased variability in weather patterns and rainfall is less predictable which impacts upon water security" (https://www.mediastatements.wa.gov.au/Pages/McGowan/2020/09/Exmouth-residents-to-receive-water-saving-support.aspx)*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEFENCE						
Factor: Social surroundings						
Value: Aboriginal heritage & culture						
N	Contamination					
Value: National heritage - Ningaloo Coast World Heritage Area						
N	Contamination					
Value: Amenity - land based recreation						
Y	Contamination	1	2	2	H	Assume localised contamination could be appropriately managed. The Department of Defence (Defence) has undertaken detailed environmental investigations regarding contamination of its sites in the Exmouth region, including investigations of Per- and polyfluoroalkyl substances (PFAS). As long as it continues to be monitored and managed appropriately, it is unlikely to present a serious risk to the community, including recreation activities. *Data confidence* • *High confidence that contamination has taken/is taking place - see DoD (2019)* • *High confidence that contamination can cause risk to people if left unmanaged*
Value: Amenity - marine based recreation						
Y	Contamination	1	2	2	H	Assume localised contamination could be appropriately managed. PFAS was detected in seepage water at the coast but poses a low risk to ecological health of the marine environment. As long as it continues to be monitored and managed appropriately, it is unlikely to present a serious risk to the community, including recreation activities. *Data confidence* • *High confidence that contamination has taken/is taking place - see DoD (2019)* • *High confidence that contamination can cause risk to people if left unmanaged*
Value: Amenity - intrinsic/wilderness aesthetic						

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEFENCE						
Y	Contamination	1	2	2	H	Assume localised contamination could be appropriately managed. *Data confidence* • *High confidence that contamination has taken/is taking place - see DoD (2019)* • *High confidence that contamination can cause risk to flora and fauna if left unmanaged, which would impact amenity*
Value: Amenity - noise, dust, odour, light						
N	Contamination					
Value: Economic - tourism						
Y	Contamination	1	2	2	H	Assume localised contamination could be appropriately managed. *Data confidence* • *High confidence that contamination has taken/is taking place - see DoD (2019)* • *High confidence that contamination can cause risk to people and likely tourist activities if left unmanaged*
Value: Economic - commercial fishing						
Y	Contamination	1	2	2	H	Assume localised contamination could be appropriately managed. As part of the investigations undertaken by Defence, marine life including fish and crustaceans were sampled at Wapet Creek and the in Exmouth Gulf and found that seafood did not present a contamination pathway, at this time. A detailed management plan is now in place to monitor and manage any future detection of PFAS. *Data confidence* • *High confidence that contamination has taken/is taking place - see DoD (2019)* • *High confidence that contamination has not caused loss of commercial fishing revenue due to contamination of prawns or other targeted species*
Value: Economic - pastoralism						

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEFENCE						
Y	Contamination	1	2	2	H	Assume localised contamination could be appropriately managed. Soil samples collected in pastoral or pastoral-adjacent land found PFAS levels were below human health and ecological criteria. *Data confidence* • *High confidence that contamination has taken/is taking place - see DoD (2019)* • *High confidence that contamination has not impacted pastoralism*
Value: Economic - science and research						
N	Contamination					
Factor: Human health						
Value: potable water						
Y	Contamination	1/2	3	3-6	H	Assume localised contamination could be appropriately managed and would not impact deep aquifer potable water source. Investigations undertaken by Defence found that drinking water supplies are safe to drink. Water Corporation testing confirmed no PFAS was detected in the town water supply bores. *Data confidence* • *High confidence that contamination has taken/is taking place - see DoD (2019)* • *High confidence that contamination has not contaminated drinking water*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
Factor: Social surroundings						
Value: Aboriginal heritage & culture - not scoring						
N	Residential - footprint					
N	Residential - groundwater drawdown					
N	Residential - solid waste					
N	Residential - light					
N	Residential - noise					
N	Industrial - footprint					Significant Aboriginal heritage sites all through waterways Kate Morse, W.A., Museum - has done surveys in area, and Peter Veth, UWA
N	Industrial - groundwater drawdown					
N	Industrial - solid waste					
N	Industrial - light					
N	Industrial - noise					
N	Tourism - footprint					
N	Tourism - groundwater drawdown					
N	Tourism - solid waste					
N	Tourism - light					
N	Tourism - noise					
Value: National heritage - Ningaloo Coast World Heritage Area						

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
N	Residential - footprint					NA - based on consideration of the Ningaloo World Heritage boundaries
N	Residential - groundwater drawdown					
N	Residential - solid waste					
N	Residential - light					NA - based on consideration of the Ningaloo World Heritage boundaries
N	Residential - noise					NA - based on consideration of the Ningaloo World Heritage boundaries
Y	Industrial - footprint	1	3	3	L-M	Not much capacity for industrial development occurring in the gulf to impact Ningaloo World Heritage Area. *Data confidence* • *Low confidence around the details of future industrial developments* • *High confidence that industrial developments will not occur within the Ningaloo Coast World Heritage Area (NCWHA)* • *Low confidence about industrial developments outside the NCWHA impacting the Outstanding Value of the NCWHA*
N	Industrial - groundwater drawdown					
N	Industrial - solid waste					
Y	Industrial - light	2	3	6	L-M	Light from shipping/shipping lanes, which could impact turtles and nesting beaches, which are a feature of the Ningaloo World Heritage Area. Moderate consequence. Dark sky impact. Likely to be shipping in the Gulf. Probably have low impact because of regulation around the turtle beaches. Downward focus lighting would be useful. Hopefully not generic street lighting to minimise any impacts. However, mitigation is not considered in the score. *Data confidence* • *Low confidence around the details of future industrial developments* • *High confidence that light from industrial developments can impact terrestrial and marine values*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						• *Low confidence about light from industrial developments impacting values within the NCWHA*
Y	Industrial - noise	2	3	6	L-M	Shipping noise from Gascoyne Gateway (GG). Shipping is likely to cross World Heritage boundaries and potentially impact species that are sensitive to noise. *Data confidence* • *Low confidence around the details of future industrial developments* • *High confidence that noise from industrial developments can impact terrestrial and marine values* • *Low confidence about noise from industrial developments impacting values within the NCWHA*
Y	Tourism - footprint	1	3	3	L-M	Lighthouse development is within current land remit. More boat based concerns than physical footprint. *Data confidence* • *Low confidence around the details of future tourism developments* • *High confidence that proposed tourism developments will impact the Ningaloo Coast World Heritage Area (NCWHA)* • *Low confidence about tourism developments outside the NCWHA impacting the Outstanding Value of the NCWHA*
N	Tourism - groundwater drawdown					
N	Tourism - solid waste					
Y	Tourism - light	2	3	6	M	Potentially more light pollution from lighthouse development and accommodation. Also, tourist vessel light emissions, e.g., cruise ships, are a consideration. Lights from vehicles driving around potential realigned road. Could impact turtles and nesting beaches, which are a feature of the Ningaloo World Heritage Area. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						• *Low confidence around the details of future tourism developments* • *High confidence that light from tourism developments can impact terrestrial and marine values* • *Medium confidence about light from tourism developments impacting values within the NCWHA*
Y	Tourism - noise	2	3	6	L-M	Noise from increased recreational boats and cruise chips. As well as tour boats targeting marine megafauna. *Data confidence* • *Low confidence around the details of future tourism developments* • *High confidence that noise from tourism developments can impact terrestrial and marine values* • *Low confidence about noise from tourism developments impacting values within the NCWHA*
Value: Amenity - land based recreation						
N	Residential - footprint					
N	Residential - groundwater drawdown					
N	Residential - solid waste					
N	Residential - light					See Amenity - intrinsic/wilderness aesthetic for scoring of dark skies value
N	Residential - noise					
Y	Industrial - footprint	2	3	6	L-M	Proposed GG, K+S Salt footprints. Salt is probably not going to impact land-based recreational activities. GG footprint could impact people's access to camping and other land-based activities. *Data confidence* • *Low confidence around the details of future industrial developments* • *Medium confidence that industrial developments will impact land based recreation*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
N	Industrial - groundwater drawdown					
N	Industrial - solid waste					
N	Industrial - light					See Amenity - intrinsic/wilderness aesthetic for scoring of dark skies value.
Y	Industrial - noise	2	3	6	L	Salt is probably not going to impact land-based recreation. GG noise may impact wildlife in immediate area and bird watching activities (and other wildlife activities). *Data confidence* • *Low confidence around the details of future industrial developments* • *Low confidence that industrial noise will impact land based recreation*
Y	Tourism - footprint	2	3	6	L-M	As above. Lighthouse and road realignment could impact access and use of the land. *Data confidence* • *Low confidence around the details of future tourism developments* • *Medium confidence that tourism developments will impact land based recreation*
N	Tourism - groundwater drawdown					
N	Tourism - solid waste					
N	Tourism - light					See Amenity - intrinsic/wilderness aesthetic for scoring of dark skies value.
Y	Tourism - noise	2	3	6	L	Increased noise from people and vehicles, generators, off-roading vehicles, with increased tourism, which could impact enjoyment of land-based activities, wildlife and noise free environments. *Data confidence* • *Low confidence around the details of future tourism developments* • *Low confidence that tourism noise will impact land based recreation*

Value: Amenity - marine based recreation

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
N	Residential - footprint					
N	Residential - groundwater drawdown					
N	Residential - solid waste					
N	Residential - light					
N	Residential - noise					
Y	Industrial - footprint	2	3	6	L-M	GG, K+S salt footprint. Salt is probably not going to impact marine-based recreational activity. GG footprint could impact people's access to the coast, fishing spots, swimming spots. *Data confidence* • *Low confidence around the details of future industrial developments* • *Medium confidence that industrial developments will impact marine based recreation*
N	Industrial - groundwater drawdown					
N	Industrial - solid waste					
N	Industrial - light					
Y	Industrial - noise	2	3	6	L-M	Salt is probably not going to impact marine-based recreational. GG noise may impact wildlife in immediate area and people's marine wildlife viewing opportunities. But could still carry out the actual recreational activity itself. The experience may not be the same, which overlaps with wilderness aesthetic value. *Data confidence* • *Low confidence around the details of future industrial developments* • *Low confidence that industrial noise will impact marine based recreation*
N	Tourism - footprint					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
N	Tourism - groundwater drawdown					
N	Tourism - solid waste					
N	Tourism - light					
Y	Tourism - noise	2	3	6	L	Increased noise from people and vessels with increased tourism, could impact enjoyment of marine based activities, wildlife and noise free environments. *Data confidence* • *Low confidence around the details of future tourism developments* • *Low confidence that tourism noise will impact marine based recreation*
Value: Amenity - intrinsic/wilderness aesthetic						
Y	Residential - footprint	1	4	4	M-H	More infilled areas could 'appear' to look like urban sprawl. *Data confidence* • *High confidence around the details of future residential developments* • *Medium confidence that residential developments will impact intrinsic/wilderness aesthetic*
N	Residential - groundwater drawdown					
Y	Residential - solid waste	1	4	4	H	Visually seeing waste will take away from the natural look and feel. *Data confidence* • *High confidence that solid waste exists and illegal dumping occurs* • *High confidence that solid waste impacts on intrinsic/wilderness aesthetic*
Y	Residential - light	3	4	12	M-H	Can impact dark sky/star gazing. Controlling and managing light pollution is an emerging priority for national heritage and attractions, especially for the eclipse in 2023. Department of Defence highlighted the need for dark skies to continue their deep space astro-activities, particularly the tracking of space junk. Western Australian Planning Commission (WAPC) Draft Position Statement: Dark Skies and Astrotourism document acknowledges that controlling and managing light pollution is an emerging

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						priority for regional economic development and tourism businesses in more remote parts of Western Australia. *Data confidence* • *High confidence that an increase in residential developments will increase light emissions* • *Medium confidence that increased light emission from residential developments will impact on a sense of intrinsic/wilderness aesthetic*
Y	Residential - noise	1	4	4	M-H	Artificial noise can detract from wilderness aesthetic. *Data confidence* • *High confidence that an increase in residential developments will increase noise* • *Medium confidence that increased noise from residential developments will impact on a sense of intrinsic/wilderness aesthetic*
Y	Industrial - footprint	2	3	6	M	Could start to give the impression of an industrial town. *Data confidence* • *Low confidence around the details of future industrial developments* • *High confidence that industrial developments will impact intrinsic/wilderness aesthetic*
N	Industrial - groundwater drawdown					
N	Industrial - solid waste					
Y	Industrial - light	3	4	12	M-H	Can impact dark sky/star gazing. Controlling and managing light pollution is an emerging priority for national heritage and attractions, especially for the eclipse in 2023. Department of Defence highlighted the need for dark skies to continue their deep space astro-activities, particularly the tracking of space junk. Western Australian Planning Commission (WAPC) Draft Position Statement: Dark Skies and Astrotourism document acknowledges that controlling and managing light pollution is an emerging

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						priority for regional economic development and tourism businesses in more remote parts of Western Australia. *Data confidence* • *High confidence that an increase in industrial developments will increase light emissions* • *Medium confidence that increased light emission from industrial developments will impact on a sense of intrinsic/wilderness aesthetic*
Y	Industrial - noise	1	4	4	M-H	Artificial noise can detract from wilderness aesthetic. *Data confidence* • *High confidence that an increase in industrial developments will increase noise* • *Medium confidence that increased noise from industrial developments will impact on a sense of intrinsic/wilderness aesthetic*
Y	Tourism - footprint	1	4	4	M	Development of lighthouse will be very visual to people and could detract from wilderness aesthetic. *Data confidence* • *Low confidence around the details of future tourism developments* • *High confidence that tourism developments will impact intrinsic/wilderness aesthetic*
N	Tourism - groundwater drawdown					
N	Tourism - solid waste					
Y	Tourism - light	3	4	12	M-H	Can impact dark sky/star gazing. Controlling and managing light pollution is an emerging priority for national heritage and attractions, especially for the eclipse in 2023. Department of Defence highlighted the need for dark skies to continue their deep space astro-activities, particularly the tracking of space junk. Western Australian Planning Commission (WAPC) Draft Position Statement: Dark Skies and Astrotourism document acknowledges that controlling and managing light pollution is an emerging priority for regional economic development and tourism businesses in more remote

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						parts of Western Australia. WAPC have stated that areas around identified astrotourism sites, including observatories, should be protected and adequate infrastructure for tourists provided, that do not contribute to light or noise pollution. Lighthouse redevelopment and road realignment behind the lighthouse has consequences for light. *Data confidence* • *High confidence that an increase in tourism developments will increase light emissions* • *Medium confidence that increased light emission from tourism developments will impact on a sense of intrinsic/wilderness aesthetic*
Y	Tourism - noise	1	4	4	M-H	Artificial noise can detract was wilderness aesthetic. *Data confidence* • *High confidence that an increase in tourism developments will increase noise* • *Medium confidence that increased noise from tourism developments will impact on a sense of intrinsic/wilderness aesthetic*
Value: Amenity - noise, dust, odour, light						
N	Residential - footprint					
N	Residential - groundwater drawdown					
Y	Residential - solid waste	1	4	4	M	Increased population leads to increased waste, which could increase odour in some locations. *Data confidence* • *High confidence that solid waste exists and illegal dumping occurs* • *Low confidence that solid waste is having an impact on noise, dust, odour or light*
Y	Residential - light	1	4	4	H	Will likely increase. See Amenity - intrinsic/wilderness aesthetic for scoring of dark skies value.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						Data confidence • *High confidence that an increase in residential developments will increase light emissions*
Y	Residential - noise	3	2	6	H	Will likely increase. The Department of Defence submission emphasised the importance of radio silence for much of the area surrounding Exmouth townsite and most especially around their infrastructure at the top of the Cape. *Data confidence* • *High confidence that an increase in residential developments will increase noise*
N	Industrial - footprint					
N	Industrial - groundwater drawdown					
Y	Industrial - solid waste	1	4	4	M-H	Increased development leads to increased waste, which could increase odour in some locations. *Data confidence* • *High confidence that solid waste exists* • *Medium confidence that solid waste would impact on dust and odour*
Y	Industrial - light	1	4	4	H	Will likely increase. See Amenity - intrinsic/wilderness aesthetic for scoring of dark skies value. *Data confidence* • *High confidence that an increase in industrial developments will increase light emissions*
Y	Industrial - noise	1	4	4	H	Will likely increase. *Data confidence* • *High confidence that an increase in industrial developments will increase noise*
N	Tourism - footprint					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
N	Tourism - groundwater drawdown					
N	Tourism - solid waste					Assessed under TOURISM/VISITATION.
Y	Tourism - light	1	4	4	H	Will likely increase. See Amenity - intrinsic/wilderness aesthetic for scoring of dark skies value. *Data confidence* • *High confidence that an increase in tourism developments will increase light emissions*
Y	Tourism - noise	3	2	6	H	Will increase. The Department of Defence submission emphasised the importance of radio silence for much of the area surrounding Exmouth townsite and most especially around their infrastructure at the top of the Cape. *Data confidence* • *High confidence that an increase in tourism developments will increase noise*
Value: Economic - tourism						
N	Residential - footprint					
N	Residential - groundwater drawdown					
N	Residential - solid waste					
N	Residential - light					
N	Residential - noise					
Y	Industrial - footprint	1/2	4	4-8	L	GG port could be a positive for tourism due to access for cruise ships. But need to look at negative impacts as well. GG port noise would impact fauna, which in turn would impact tourism. Some of the operations/activities which industrial development could impact include: Whale watching, charter fishing, manta ray tours, scenic flights, recreational boating

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						fly fishing - half a dozen operations, net fishers on western/southern end of the Gulf (father/daughter team), aquarium fish collectors Bird watchers also come to the proposed GG port site to see migratory species. Permit fisherman - some concern that there would be impacts to these businesses from GG port. Permit fishing is a high-end tourism product - can cost $10k to come from states to catch a permit fish (a type of dart fish) in a wilderness setting. Depending on where structures are built, may restrict some access on some days to certain locations (weather dependant?). Economic paper (Deloitte 2020) just released on tourism value of Ningaloo region. Exmouth Gulf is part of study. ~$110m contribution to economy from tourism for Ningaloo region/system. People cross over from Ningaloo to Gulf. Navy pier diving is a consideration. Some tourist operators worry about the impact of mass tourism and how it will be managed e.g., cruise ships in the Gulf and what it means for the whole image/brand of the Gulf. GG port footprint may not destroy tourism operations but may cause displacement form key locations. Some activities would be minor, some would be moderate. If people stop booking tours because animals are not coming into Gulf, then this has a big impact on economics. *Data confidence* • *Low confidence around the details of future industrial developments* • *Low confidence around how tourism will be impacted by future industrial developments*
N	Industrial - groundwater drawdown					
N	Industrial - solid waste					
Y	Industrial - light	1	4	4	M	Could result in less tourism income if natural and wilderness aesthetic is degraded. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						• *High confidence that an increase in industrial developments will increase light emissions* • *Low confidence around how tourism will be impacted by increased light from industrial developments*
Y	Industrial - noise	1	4	4	M	Could result in less tourism income if natural and wilderness aesthetic is degraded. *Data confidence* • *High confidence that an increase in industrial developments will increase noise* • *Low confidence around how tourism will be impacted by increased noise from industrial developments*
N	Tourism - footprint					
N	Tourism - groundwater drawdown					
N	Tourism - solid waste					
N	Tourism - light					
N	Tourism - noise					
Value: Economic - commercial fishing						
N	Residential - footprint					
N	Residential - groundwater drawdown					
N	Residential - solid waste					
N	Residential - light					
N	Residential - noise					
N	Industrial - footprint					
N	Industrial - groundwater drawdown					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
N	Industrial - solid waste					
N	Industrial - light					
N	Industrial - noise					
N	Tourism - footprint					
N	Tourism - groundwater drawdown					
N	Tourism - solid waste					
N	Tourism - light					
N	Tourism - noise					
Value: Economic - pastoralism						
N	Residential - footprint					
N	Residential - groundwater drawdown					
N	Residential - solid waste					
N	Residential - light					
N	Residential - noise					
N	Industrial - footprint					
N	Industrial - groundwater drawdown					
N	Industrial - solid waste					
N	Industrial - light					
N	Industrial - noise					
N	Tourism - footprint					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
N	Tourism - groundwater drawdown					
N	Tourism - solid waste					
N	Tourism - light					
N	Tourism - noise					
Value: Economic - science and research						
N	Residential - footprint					
N	Residential - groundwater drawdown					
N	Residential - solid waste					
Y	Residential - light	1	3	3	M	Increased residential light may impact on research that relies on dark skies but local data is required to measure light outputs and impacts on science and research Could impact on studies and/or experiments on biota. Science and research is adaptable. *Data confidence* • *High confidence that an increase in residential developments will increase light emissions* • *Low confidence that increased light will impact on science and research*
Y	Residential - noise	1	3	3	M	Little data available to measure how residential noise may impact on science and research. Science and research is adaptable. Could impact on studies and/or experiments on biota. *Data confidence* • *High confidence that an increase in residential developments will increase noise* • *Low confidence that increased noise will impact on science and research*
N	Industrial - footprint					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
N	Industrial - groundwater drawdown					
N	Industrial - solid waste					
Y	Industrial - light	1	3	3	M	Increased industrial light may impact on research that relies on dark skies but local data is required to measure light outputs and impact on science and research Could impact on studies and/or experiments on biota. Science and research is adaptable. *Data confidence* • *High confidence that an increase in industrial developments will increase light emissions* • *Low confidence that increased light will impact on science and research*
Y	Industrial - noise	1	3	3	M	Little data available to measure how industrial noise may impact on science & research. Science and research is adaptable. Could impact on studies and/or experiments on biota. *Data confidence* • *High confidence that an increase in industrial developments will increase noise* • *Low confidence that increased noise will impact on science and research*
N	Tourism - footprint					
N	Tourism - groundwater drawdown					
N	Tourism - solid waste					
Y	Tourism - light	1	3	3	M	Increased light from tourist developments may impact on research that relies on dark skies but local data is required to measure light outputs and impacts on science and research Could impact on studies and/or experiments on biota. Science and research is adaptable. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						• *High confidence that an increase in tourism developments will increase light emissions* • *Low confidence that increased light will impact on science and research*
Y	Tourism - noise	1	3	3	M	Little data available to measure how tourism development noise may impact on science & research. Science and research is adaptable. Could impact on studies and/or experiments on biota. *Data confidence* • *High confidence that an increase in tourism developments will increase noise* • *Low confidence that increased noise will impact on science and research*
Factor: Human health						
Value: potable water						
N	Residential - footprint					
Y	Residential - groundwater drawdown	3	2	6	H	Shire is confident that enough potable water will be available for human use. Future projected uses would need to be carefully considered. *Data confidence* • *High confidence around available potable water and capacity* • *High confidence around future residential developments and thus groundwater drawdown*
N	Residential - solid waste					
N	Residential - light					
N	Residential - noise					
N	Industrial - footprint					
Y	Industrial - groundwater drawdown	3	2	6	M-H	Shire is confident that enough potable water will be available for human use. Future projected uses would need to be carefully considered. *Data confidence* • *High confidence around available potable water and capacity*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
DEVELOPMENT						
						• *Medium confidence around the future use of water by industry and expanded industrial developments*
N	Industrial - solid waste					
N	Industrial - light					
N	Industrial - noise					
N	Tourism - footprint					
Y	Tourism - groundwater drawdown	3	2	6	M-H	Shire is confident that enough potable water will be available for human use. Future projected uses would need to be carefully considered. *Data confidence* • *High confidence around available potable water and capacity* • *Medium confidence around the future use of water by tourism development*
N	Tourism - solid waste					
N	Tourism - light					
N	Tourism - noise					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
Factor: Social surroundings						
Value: Aboriginal heritage & culture - Not scoring						
N	Limestone - footprint					
N	Limestone - operation					
N	Limestone - groundwater drawdown					
N	Industrial salt facility - footprint					
N	Potash - footprint					
N	Potash - abstraction of brine					
Value: National heritage - Ningaloo Coast World Heritage Area						
N	Limestone - footprint					
N	Limestone - operation					
N	Limestone - groundwater drawdown					
N	Industrial salt facility - footprint					
N	Potash - footprint					
N	Potash - abstraction of brine					
Value: Amenity - land based recreation						
N	Limestone - footprint					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
N	Limestone - operation					
N	Limestone - groundwater drawdown					
Y	Industrial salt facility - footprint	2	4	8	M	Possibly restricted access to intertidal areas. Locals may think they can do what other visitors cannot, so to them, new restrictions would have a bigger consequence than to visitors who had not experienced areas before restrictions were in place. Some anecdotal suppositions but little available data. *Data confidence* • *Medium confidence around the details and extent of industrial salt farm footprint* • *Medium confidence around land based recreation on the eastern margin of the Gulf*
Y	Potash - footprint	2	3	6	M	As above but uncertainty around the scale of the potash development and how it would affect land-based recreation *Data confidence* • *Medium confidence around the details and extent of pot ash footprint* • *Medium confidence around land based recreation on the eastern margin of the Gulf*
N	Potash - abstraction of brine					
Value: Amenity - marine based recreation						
N	Limestone - footprint					
N	Limestone - operation					
N	Limestone - groundwater drawdown					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
N	Industrial salt facility - footprint					
N	Potash - footprint					
N	Potash - abstraction of brine					
Value: Amenity - intrinsic/wilderness aesthetic						
Y	Limestone - footprint	2	3	6	M-H	Potential future development is likely. What would impact amenity more than current development? Will have a visual impact if it occurs close to town and near Wapet Creek, where people visit. Aerial tourism, light aircraft, would get another view of development. The consequence and risk would be different depending on where you are and who you are. *Data confidence* • *Medium confidence in the details and extent of proposed footprint* • *High confidence around the intrinsic/wilderness aesthetic being impacted by limestone setup and operations*
Y	Limestone - operation	1	4	4	M-H	More trucks operating and noise could impact people's enjoyment of nearby places e.g., Wapet Creek, and in general if slow moving bulky loads are commonly seen on main roads. Could give the feeling of an industrial town more so than a natural/wild/pristine location. Though operations should not be as visible or seen around large parts of the cape where tourists visit. *Data confidence* • *Medium confidence in the details and extent of proposed footprint and operations* • *High confidence around the intrinsic/wilderness aesthetic being impacted by limestone setup and operations*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
N	Limestone - groundwater drawdown					
Y	Industrial salt facility - footprint	2	4	8	M	Potential future development is likely. What would impact amenity more than current development? Will have a visual impact. Aerial tourism, light aircraft, would get another view of development - some operators fly over the Gulf due to visual amenity. The consequence and risk would be different depending on where you are and who you are. Not likely to impact the aesthetics of the whole Gulf, just the eastern margin, but it could give the feeling of an industrial town more so than a natural/wild/ pristine location. *Data confidence* • *Medium confidence around the details and extent of industrial salt farm footprint* • *Medium confidence around intrinsic/wilderness aesthetic being impacted*
Y	Potash - footprint	2	3	6	M	As above but uncertainty around the scale of the potash development. *Data confidence* • *Medium confidence around the details and extent of pot ash footprint* • *Medium confidence around intrinsic/wilderness aesthetic being impacted*
N	Potash - abstraction of brine					
Value: Amenity - noise, dust, odour, light						
N	Limestone - footprint					
Y	Limestone - operation	2	4	8	M	Dust and noise would increase from increased limestone operations. Do operations occur at night time? If so, light emissions would also be a consideration. *Data confidence* • *Medium confidence in the details and extent of proposed footprint and operations*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
						• *Medium confidence around dust and noise increasing with increasing operations*
N	Limestone - groundwater drawdown					
N	Industrial salt facility - footprint					
N	Potash - footprint					
N	Potash - abstraction of brine					
Value: Economic - tourism						
Y	Limestone - footprint	2	3	6	L-M	Aerial tourism may be impacted by the less pristine visuals. Could give the feeling of an industrial town more so than a natural/wild/pristine location. *Data confidence* • *Medium confidence in the details and extent of proposed footprint* • *Low confidence around the impact to tourism*
Y	Limestone - operation	2	3	6	L-M	Could give the feeling of an industrial town more so than a natural/wild/pristine location. *Data confidence* • *Medium confidence in the details and extent of proposed footprint and operations* • *Low confidence around the impact to tourism*
N	Limestone - groundwater drawdown					
Y	Industrial salt facility - footprint	2	3	6	L-M	Aerial tourism may be impacted by the less pristine visuals. Could give the feeling of an industrial town more so than a natural/wild/pristine location. *Data confidence* • *Medium confidence around the details and extent of industrial salt farm footprint* • *Low confidence around tourism being impacted*
Y	Potash - footprint	2	3	6	L-M	As above.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
						Data confidence • *Medium confidence around the details and extent of potash footprint* • *Low confidence around tourism being impacted*
N	Potash - abstraction of brine					
Value: Economic - commercial fishing						
N	Limestone - footprint					
N	Limestone - operation					
N	Limestone - groundwater drawdown					
Y	Industrial salt facility - footprint	2	4	8	L-M	Some concerns for potential changes in hydrodynamics e.g., will taking water from a hypersaline environment have an impact on long-term productivity? Will it impact inshore habitats and juveniles/nursery areas? Will discharge of toxins impact prawns and the areas they use and their productivity? When the proposal for an industrial salt facility was to be more extensive than currently proposed, there was potentially a major impact. The revised footprint and scale have lessened this impact. *Data confidence* • *Medium confidence around the details and extent of industrial salt farm footprint* • *Low confidence around commercial fisheries being impacted by footprint*
Y	Potash - footprint	2	3	6	L-M	As above but uncertainty around scope of potash footprint. *Data confidence* • *Medium confidence around the details and extent of potash footprint* • *Low confidence around commercial fisheries being impacted by footprint*
Y	Potash - abstraction of brine	2	3	6	L-M	As above but uncertainty around scope of potash footprint. *Data confidence* • *Medium confidence around the details and extent of potash footprint*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
						• *Low confidence around commercial fisheries being impacted by brine abstraction*
Value: Economic - pastoralism						
N	Limestone - footprint					
N	Limestone - operation					
N	Limestone - groundwater drawdown					
N	Industrial salt facility - footprint					
N	Potash - footprint					
N	Potash - abstraction of brine					
Value: Economic - science and research						
N	Limestone - footprint					
N	Limestone - operation					
N	Limestone - groundwater drawdown					
N	Industrial salt facility - footprint					
N	Potash - footprint					
N	Potash - abstraction of brine					
Factor: Human health						
Value: potable water						
N	Limestone - footprint					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
MINING						
N	Limestone - operation					
Y	Limestone - groundwater drawdown	1/2	3	3-6	M	Cumulative impacts to consider with increasing tourism and reaching capacity. Groundwater supply is used but it is unlikely to require significant additional allocation. Groundwater contamination is unlikely but requires appropriate management. Limestone quarries are already operational, however, there is a possibility that an expansion of operations may increase water supply requirements in foreseeable future. *Data confidence* • *Low confidence around the volumes of groundwater needed for current and future limestone operations* • *High confidence around available potable water and capacity*
N	Industrial salt facility - footprint					
Y	Industrial salt facility - groundwater drawdown	1	2	2	M	Some groundwater drawdown expected to facilitate potable water use at the industrial salt facility. *Data confidence* • *Low confidence around the volumes of groundwater needed for future salt operations* • *High confidence around available potable water and capacity*
N	Potash - footprint					
N	Potash - abstraction of brine					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
PASTORALISM						
Factor: Social surroundings						
Value: Aboriginal heritage & culture						
N	Overgrazing					
N	Pests/feral animals					
Value: National heritage - Ningaloo Coast World Heritage Area						
N	Overgrazing					
N	Pests/feral animals					
Value: Amenity - land based recreation						
N	Overgrazing					
N	Pests/feral animals					
Value: Amenity - marine based recreation						
N	Overgrazing					
N	Pests/feral animals					
Value: Amenity - intrinsic/wilderness aesthetic						
Y	Overgrazing	1	3	3	M	It is possible that overgrazing could impact on amenity values and aesthetics because of a degrading landscape. The consequence is likely to be localised. *Data confidence* • *High confidence that overgrazing can damage landscapes* • *Low confidence about the extent to which overgrazing has impacted landscapes of Exmouth*
Y	Pests/ feral animals	2	3	6	M	Higher consequence as a particularly unmanaged pest/feral problem could impact on aesthetics and change the look and shape of landscapes, for example, unmanaged infestations of weeds can compete with native vegetation, which can lead to changes in

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
PASTORALISM						
						the landscape. Effects of weeds and feral animals on landscape aesthetics are well documented elsewhere. *Data confidence* • *High confidence that pest/ferals can impact landscapes* • *Low confidence about the extent to which pest/ferals have impacted landscapes of Exmouth*
Value: Amenity - noise, dust, odour, light						
Y	Overgrazing	1	3	3	M	Possible localised impacts of overgrazing could generate dust, noise and odour that would cause degradation of the amenity of the area. *Data confidence* • *High confidence that overgrazing can generate dust, noise and odour* • *Low confidence about the extent to which overgrazing has impacted dust, noise and odour in Exmouth*
Y	Pests/ feral animals	1	3	3	M	For feral animals specifically - not plants/weeds etc. Uncontrolled/unmanaged feral animals, such as goats, could cause localised odour and noise impacts that leads to degraded amenity. *Data confidence* • *High confidence that pest/feral animals can cause odour and noise* • *Low confidence about the extent to which pest/ferals have impacted odour and noise specifically in Exmouth*
Value: Economic - tourism						
Y	Overgrazing	1	3	3	M	Possible negative effect on tourism - for the reasons above. *Data confidence* • *High confidence that overgrazing can generate dust, noise and odour* • *Low confidence about the extent to which overgrazing has impacted tourism in Exmouth*
Y	Pests/ feral animals	1	3	3	M	Possible negative effect on tourism - for the reasons above.

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
PASTORALISM						
						Data confidence • *High confidence that pest/feral animals can cause odour and noise* • *Low confidence about the extent to which pest/ferals have impacted tourism in Exmouth*
Value: Economic - commercial fishing						
N	Overgrazing					
N	Pests/ feral animals					
Value: Economic - pastoralism						
N	Overgrazing					
N	Pests/ feral animals					
Value: Economic - science and research						
N	Overgrazing					
N	Pests/ feral animals					
Factor: Human health						
Value: potable water						
N	Overgrazing					
N	Pests/ feral animals					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
Factor: Social surroundings						
Value: Aboriginal heritage & culture - Not scoring						
N	Potable water use					
N	Rubbish					
N	Human waste					
N	Camping					
N	Off-road driving					
Value: National heritage - Ningaloo Coast World Heritage Area						
N	Potable water use					
Y	Rubbish	1	2	2	M	People create rubbish. Rubbish is still left on land and in the water. Only scant anecdotal information. Needs more robust assessment of how rubbish may affect National heritage values. *Data confidence* • *High confidence that rubbish is left by tourists/visitors in Exmouth area* • *Low confidence around the impact on Ningaloo Coast World Heritage Area (NCWHA)*
N	Human waste					
N	Camping					
Y	Off-road driving	1	3	3	M	Some clear tracks within the World Heritage boundaries but not as much as on the eastern side of Cape Range and Exmouth town - see (Kobryn et al. 2017). More details required to specifically assess damage to national heritage values. *Data confidence* • *High confidence that off road driving occurs within the NCWHA* • *Low confidence around the flow on impacts to NCWHA values*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
Value: Amenity - land-based recreation						
N	Potable water use					
Y	Rubbish	1	3	3	M	May impact where recreation occurs. New areas could be used if rubbish is prevalent in commonly used areas. Only scant anecdotal information. Needs more robust assessment of how rubbish may affect land-based recreation. *Data confidence* • *High confidence that rubbish is left by tourists/visitors in Exmouth area* • *Low confidence around the impact on land based recreation*
N	Human waste					
N	Camping					
Y	Off-road driving	1	4	4	M	May disturb camping, recreating due to sight and noise of constant 4WDs. Will impact some people more than others. The activity itself is also a land-based recreational activity. *Data confidence* • *High confidence that off road driving occurs within the area* • *Low confidence around the impacts to land based recreation*
Value: Amenity - marine-based recreation						
N	Potable water use					
Y	Rubbish	1	3	3	M	May impact where recreation occurs. New areas could be used if rubbish is prevalent in commonly used areas. Published literature on marine plastic pollution (King 2019) but more information required about how this may impact marine-based recreation. *Data confidence* • *High confidence microplastics and larger rubbish occur in the water* • *Low confidence around the impact on marine based recreation*
N	Human waste					
N	Camping					

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
N	Off-road driving					
Value: Amenity - intrinsic/wilderness aesthetic						
N	Potable water use					
Y	Rubbish	2	4	8	M	Some coastal rubbish issues. Illegal dumping occurs near Mowbowra Creek. Foredune rubbish accumulation is evident. People will dump rubbish outside the tip area if the tip is closed. Rubbish degrades natural vistas. Fish frames are scattered around the place. Particular places would have a higher consequence and be more unpleasant e.g., Mowbowra Caves. Bay of Rest also has rubbish. Corroborating anecdotal reports and satellite imagery. Increased number of people will increase the impact of waste. Cumulative considerations. *Data confidence* • *High confidence that rubbish is left by tourists/visitors in Exmouth area* • *Low confidence around the impact on intrinsic/wilderness aesthetic*
N	Human waste					
N	Camping					
Y	Off-road driving	3	4	12	M	Poorly managed in the gulf. Big impact on surrounding. Brooke (workshop attendee; Exmouth Gulf local for 15yrs) - would score 2020 as having moderate to severe impact due to COVID-19. Increased visitation to the area meant that it was hard to get away from vehicle traffic, and the damage was evident in the dunes. A different demographic of people are also visiting e.g., people who would normally go to Bali, went to Exmouth Gulf because of COVID-19 restrictions. There was high visitation March - November 2020, then a demographic change again in December /January as people from inland visited the coast. Cumulative impact of more people and a perceived shift in the demographic type to consider. *NOTE: 'Pristine' in this context means public opinion/perception, not scientifically 'pristine'.*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
						Data confidence • *High confidence that off road driving occurs within the area* • *Low confidence around the impacts to intrinsic/wilderness aesthetic*
Value: Amenity - noise, dust, odour, light						
N	Potable water use					
N	Rubbish					
Y	Human waste	1	2	2	M	Volume of human waste not there to be an issue for odour. Unregulated camping causes some issues and is a growing problem. Town Beach has more dog poo issues. Toilet paper is evident from overnight campers, but odour has not been raised as an issue. *Data confidence* • *High confidence that managed and unmanaged human waste occurs* • *Low confidence around unmanaged waste impacting on Amenity - noise, dust, odour, light*
N	Camping					
Y	Off-road driving	1	3	3	M	Noise would impact people's ability to enjoy peaceful surroundings. Dust may also be a factor if stirred up constantly from 4WDs. *Data confidence* • *High confidence that off road driving occurs within the area* • *Low confidence around the impacts to Amenity - noise, dust, odour, light*
Value: Economic - tourism						
N	Potable water use					
Y	Rubbish	1	3	3	M	People create rubbish. Rubbish is still left on land and in the water. Tourist operators would likely avoid areas with rubbish. Toilet paper evident from overnight campers. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
						• *High confidence that rubbish is left by tourists/visitors in Exmouth area* • *Low confidence around the impact on tourism*
N	Human waste					
N	Camping					
Y	Off-road driving	2	3	6	M	Tracks everywhere. May not appear pristine for tourists. Also a tourist activity itself. *Data confidence* • *High confidence that off road driving occurs within the area* • *Low confidence around the impacts to tourism*
Value: Economic - commercial fishing						
N	Potable water use					
N	Rubbish					
N	Human waste					
N	Camping					
N	Off-road driving					
Value: Economic - pastoralism						
N	Potable water use					
N	Rubbish					
N	Human waste					
N	Camping					
Y	Off-road driving	1	3	3	M	Some stations may experience people driving through properties but it's unclear to what extent. *Data confidence*

Score?	Drivers / Pressures	Cons	Like	Risk	Data Conf HML	Justification
TOURISM/VISITATION						
						• *High data confidence that pastoral stations have the longest cumulative length of off-road tracks compared to other land-use types along the western margin of the cape (Kobryn et al. 2017)* • *Low confidence around the impacts to economics of pastoralism*
Value: Economic - science and research						
N	Potable water use					
N	Rubbish					
N	Human waste					
N	Camping					
Y	Off-road driving	1	3	3	M	Probably not a major impact but could also be used for the research. *Data confidence* • *High data confidence that off road driving occurs in the area* • *Low confidence around the impacts to science and research*
Factor: Human health						
Value: potable water						
Y	Potable water use	4	3	12	H	Exmouth and Exmouth Gulf was at capacity in 2020 supporting up to 20,000 people during the holiday season (DWER). The visitation rate has been unprecedented. It is difficult to know if this trend is going to continue. *Data confidence* • *High confidence around potable was use and capacity*
N	Rubbish					
N	Human waste					
N	Camping					
N	Off-road driving					

WESTERN AUSTRALIAN
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