

Department of Planning and Environment

Marine Debris Threat and Risk Assessment Literature Review Summary

An analysis of the relevant literature supporting the NSW Marine Debris Threat and Risk Assessment (MDTARA) and a summary of the key findings



2022 State of NSW and Department of Planning and Environment

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Acknowledgment of Country

The Department of Planning and Environment acknowledges the Traditional Owners and Custodians of the land and seas on which we live and work, and pays respect to Elders past, present and emerging. It also recognises and respects the strong connection and custodial relationship Indigenous peoples have with Sea Country.

NSW Marine Debris Threat and Risk Assessment (MDTARA)

The MDTARA is a study of the risks posed by marine debris to the marine estate in New South Wales. The assessment is documented in the *Marine Debris Threat and Risk Assessment Summary Report* (DPE 2022a) to which this document is a supplement, as is the *Marine Debris Threat and Risk Assessment Supplementary Material Report* (DPE 2022b).

The statewide threat and risk assessment of the NSW marine estate (MEMA 2017) identified marine debris as posing a significant threat to the environmental, social and economic values of the marine estate. When addressing these threats, the NSW Marine Estate Management Strategy (MEMS) prioritised the risks posed by marine debris to the marine estate. The MDTARA is the next step towards addressing this significant threat.

Literature review

Stage 1 of the 3 stages in the MDTARA involved a literature review. Relevant entries were included in background documents for experts within an elicitation process. The review was updated with additional references provided by these experts. This document summarises the source details and key findings for each entry, and also includes an assessment of the characteristics of the literature used.

1.1 Characteristics of sources in the literature review

An external assessment of the references included in the literature review of the MDTARA was undertaken by the University of New South Wales (UNSW) (UNSW 2022). The summary identified features of the literature to characterise the evidence base supporting the MDTARA and identify knowledge gaps.

A key focus was the location of the studies, inside or outside the marine estate. Of the 231 articles and reports in the literature reviewed, only 13% (31 documents) contained data from, or were conducted in, New South Wales. Table 1 highlights the difference in characteristics between these 31 NSW-related studies and those outside the marine estate.

Table 1 Characteristics of the studies, inside or outside the NSW marine estate, included in the MDTARA literature review

Study	Inside NSW marine estate	Outside NSW marine estate
Type	A variety of study types: experimental, review, grey literature (research not published commercially or in academic journals for example government reports or event proceedings)	Most experimental followed by reviews then grey literature
Theme	Most focused on stressors, then socio-ecological values	Majority focused on environmental threats, stressors then socio-ecological values
Habitat or value	Mostly not specific to a habitat type or value	Many not specific but ocean water habitat was studied more than twice any other
Benefits	Social values followed by seabirds, benthic invertebrates and fish/sharks	Benthic invertebrates, followed by fish/sharks, turtles and seabirds
Impact pathways	Primarily ingestion	Primarily ingestion, toxicity and entanglement
Debris items	Narrow range. All items, plastic items, microplastic, fishing-related items and polyethylene	Broad range. Main items same as NSW, plus nanoplastics and others.

1.2 Literature review catalogue and key findings summary

Table 2 summarises the reference details, source links and key findings for all the reviewed literature.

Abbreviations and acronyms used are defined in Table 3 and additional key terms are defined in the MDTARA Supplementary Material Report (DPE 2022b).

Table 2 Key findings summary from the MDTARA literature review catalogue

Source			Summary and key findings								
Name	Year	Web link	Theme	Debris	Asset	Habitat	Impact pathway	Key findings		MDTARA application	Type
Comparing plastic ingestion in juvenile and adult stranded short-tailed shearwaters (<i>Puffinus tenuirostris</i>) in eastern Australia	2014	Acampora et al. 2014	S TE	All items Hard plastic Balloons Rubber	Seabird	Ocean waters	Ingestion	Ingestion of debris by a group of shearwaters in Aus > 67%. > 48% plastic ingestion. Juveniles more likely to ingest and ingest more. No significant impact on body condition. No significant difference between sexes. Showed birds selected for hard plastic, rubber and balloons.		INFERRED from Qld	E
Entanglement of grey seals <i>Halichoerus grypus</i> at a haul out site in Cornwall, UK	2012	Allen et al. 2012	S AE TE	Plastic and fishing-related	Pinnipeds	All	Entanglement	Photo ID monitoring entanglement in seals (SW England). Rates of 3.6–5%, increased mortality rates for affected seals, majority of visible entanglements from fisheries gear (monofilament line / net or multifilament net). Australian fur seals <i>Arctocephalus pusillus</i> 1.3–1.9% entanglement rate from 1992 (Pemberton et al. 1992).		INFERRED from OS and past Aus studies	E
Examination of the ocean as a source for atmospheric microplastics	2020	Allen et al., 2020	S	Microplastics	All assets	All	Ingestion Toxicity	Evidence the ocean is a secondary source of MP and that ocean to atmosphere is transport pathway that could help identify some of the missing plastic forecast in global marine models. MP/NP leaving sea via bubble burst ejection process and enters atmosphere with other small particles. Found in onshore and offshore air samples. MP availability affected by mixing and upwelling processes.		YES source of MPs	E
Microplastic ingestion by <i>Mullus surmuletus</i> Linnaeus, 1758 fish and its potential for causing oxidative stress	2017	Alomar et al. 2017	TE	Microplastics	Fish/sharks	Ocean waters	Ingestion Toxicity	Striped, red mullet exposure to MPs led to 27.3% ingestion. In MP ingesting fish no evidence of oxidative stress or cellular damage, potential indications of detoxification processes. MP ingestion values not related to distance from land.		INFERRED to local mullet fish spp.	E
Increased plastic litter cover affects the foraging activity of the sandy intertidal gastropod <i>Nassarius pullus</i>	2011	Aloy et al. 2011	TE	Plastic	Benthic invertebrates	Beach / flats (M & E)	Changes to habitat	Foraging behaviour of the gastropod <i>Nassarius pullus</i> (a whelk) on sandy shores was negatively impacted by plastic litter cover. Decreased efficiency locating and moving to food and increased time and more breaks when searching for food. Consistent with significant decreases in the abundance of the gastropod observed during periods of high deposition of plastic and other debris on shore.		INFERRED to local spp.	E
Plastic Litter as Pollutant in the Aquatic Environment: A mini-review	2020	Anggraini et al. 2020	S TE TS	Plastic	All assets		All environmental threats	A review of all aspects of the threats posed by marine debris, including its influence on the food chain as a vector of plastic litter distribution, particularly microplastic on aquatic biota, through all trophic levels.		INFERRED	R
Responses of <i>Hyaella azteca</i> to acute and chronic microplastic exposures	2015	Au et al. 2015	TE	Microplastics PE	Benthic invertebrates	Estuarine waters	Ingestion Toxicity	MP ingestion in freshwater (FW) amphipod when exposed to PE MPs and PP MP – fibres. PP MP – fibres >> more toxic than PE MPs (could be due to residence time in gut.) PP MP – fibres slowed food and reduced growth. Chronic exposure to PE MPs significantly decreased growth and reproduction at low and intermediate doses.		INFERRED to local & marine spp.	E
Toxic tide: the threat of marine plastic pollution in Australia	2016	Australian Govt. 2016	S TE TS MM	All debris types	All assets	All	All environmental threats Human health	Report summarising Commonwealth findings from a Senate enquiry into marine debris: overview, effects, remediation, reduction and recommendations. Recommendations included research to underpin policy, MPs, human-health effects, effects on fauna, quantify costs and assessing ghost net threats. They also included increased clean-up support, new technologies for fishing, packaging etc., improved stormwater management, behaviour change campaigns, CDS, SUP bans, microbead bans and better nurdle management.		INFERRED – Aus	R
Threat abatement plan for the impacts of marine debris on the vertebrate wildlife of Australia's coasts and oceans	2018	Australian Govt. 2018	S TE MM	All	Cetaceans Pinnipeds Fish/Sharks Seabirds Turtles	All	Entanglement Ingestion Toxicity	Threat abatement plan addressing key threatening process: marine debris. Plan guides national action to prevent/mitigate impacts of harmful marine debris on vertebrate marine life. 5 main objectives: prevention, understanding, removing, contaminants & public awareness.		INFERRED – Aus	R
Pollutants bioavailability and toxicological risk from microplastics to marine mussels	2015	Avio et al. 2015	S TE	Microplastics – PS & PE	Benthic invertebrates	Shallow soft sediments (M & E)	Ingestion Bioaccumulation Toxicity	Plastic polymers PE & PS sorb environmental pollutants. Mussels (<i>Mytilus galloprovincialis</i>) were exposed to MPs with adsorbed pyrene which then transferred to organisms and concentrated in tissues. Both virgin and contaminated microplastics induced several effects at transcriptional and cellular levels, especially under long-term, chronic exposure. Immunological, lysosomal, cholinesterasic and antioxidant effects were observed.		INFERRED to local mussel spp.	E
Biodiversity: Invasions by marine life on plastic debris	2002	Barnes 2002	S TE	Macro – Floating	Benthic invertebrates	ocean Waters	Bioinvasion Novel habitat	Marine debris more than doubles the rafting opportunities for biota, particularly at high latitudes, enabling colonisation by marine organisms on drift debris deposited on the shores of 30 remote islands from the Arctic to the Antarctic (across all oceans). Poles may be protected by freezing SST but warming increases the threat. 20–80% of debris is human-made (highest in Southern Ocean.)		INFERRED	E
Lethal lesions and amputation caused by plastic debris and fishing gear on the loggerhead turtle <i>Caretta caretta</i>	2014	Barreiros and Raykov 2014	S TE	Macro Fishing-related plastics	Turtle	Ocean waters	Entanglement Ingestion	Loggerhead turtles (<i>C. caretta</i>) suffer sublethal and lethal impacts after being entangled in either plastic debris or discarded/lost nylon fishing gear. Entangled in nylon line(s) & ingestion of hooks and line.		INFERRED from OS	E

Source			Summary and key findings							
Name	Year	Web link	Theme	Debris	Asset	Habitat	Impact pathway	Key findings	MDTARA application	Type
Toxicity of leachate from weathering plastics: An exploratory screening study with <i>Nitocra spinipes</i>	2015	Beigarn et al. 2015	S TE	Plastic & leachate	Benthic invertebrates	Ocean waters	Toxicity	Hazard properties of leachates from weathering plastics to the marine copepod [Crustacea] <i>Nitocra spinipes</i> . 35% of different plastic products produced leachates that caused toxicity to <i>N. spinipes</i> . The level of toxicity varies by product and was shown it could change in either direction under simulated weathering.	INFERRED to local marine copepod	E
Effects of Microplastic on Fitness and PCB Bioaccumulation by the Lugworm <i>Arenicola marina</i> (L.)	2013	Besseling et al. 2013	S TE	Plastic Sorbed chemicals	Benthic invertebrates	Shallow soft sediments (M & E)	Ingestion Bioaccumulation Via Trophic Transfer Toxicity	In-sediment polystyrene (PS) MP concentration increased uptake of plastic particles and weight loss by lugworm <i>A. marina</i> . Led to reduction in feeding at 7.4% MP. Low-dose PS (0.074%) increased bioaccumulation of PCBs – toxic chemicals in envt. PS had statistically significant effects on the organisms' fitness, but at a low level.	INFERRED to similar species of lug/beach worms	E
Microplastic in a macro filter feeder: Humpback whale <i>Megaptera novaeangliae</i>	2015	Besseling et al. 2015	S TE	Microplastics	Cetaceans	Ocean waters	Ingestion Bioaccumulation	MP in a baleen whale. Filter feeder with a high chance of MP ingestion directly and via prey spp. (plankton to small fish). A high variation in MP types reflects water concentrations (not selective feeders). Can estimate a plastic concentration of foraging area by estimating volume of filtered water; gut passage time and plastic particles in the organism.	INFERRED	E
Nanoplastic Affects Growth of <i>S. obliquus</i> and Reproduction of <i>D. magna</i>	2014	Besseling et al. 2014	TE	Nanoplastic (NPs)	Benthic invertebrates	Estuarine waters	Toxicity	Exposure to nano-polystyrene (nano-PS) shown to have direct life history impacts in algae and zooplankton (<i>Daphnia magna</i>). Impacts on algae were decreases in population growth and chlorophyll concentration. Impacts on zooplankton noted in offspring included decreases in number and size and increases in malformations.	INFERRED to marine spp. of zooplankton	E
Derelict fishing gear in Chesapeake Bay, Virginia: Spatial patterns and implications for marine fauna	2014	Bilkovic et al. 2014	S TE & TS MM	Fishing gear Crab pots	All assets & social	All habitats & (Social) economics	Entanglement Economic losses Remediation costs	Assessment of derelict fishing gear and implication for marine fauna in USA showing crab pots; vast majority of items capturing 40 spp. as bycatch (notably commercial fishery spp.). Blue crab bycatch from derelict pots estimated as an economic loss of \$300,000 USD annually. Management options to reduce abandonment discussed e.g. economic incentives, education/outreach, removal in hotspots, design gear to decrease bycatch when discarded.	INFERRED	E
Impact of cigarette butt leachate on tidepool snails	2015	Booth DJ et al. 2015	S TE	Cigarette butts	Benthic invertebrates	Rocky shores (M & E)	Ingestion Toxicity	Common intertidal snails exposure to cig. butt leachate, leading to high but different lethal and sublethal impacts (via behavioural modifications). 100% mortality at highest concentration, varied % at lower concentrations. Species-specific impacts of closely related taxa may affect the relative abundance/community dynamics.	INFERRED to local spp.	E
Entanglement of New Zealand fur seals in man-made debris at Kaikoura, New Zealand	2006	Boren et al. 2006	TE MM	Fishing gear and macro debris	Pinnipeds	Ocean waters Rocky shores (M) Beach (M)	Entanglement	Entanglement rates of pinnipeds in NZ are some of the highest reported worldwide (average range: 0.6–2.8%). Australia equivalent 0.9% for <i>A. forsteri</i> in Australia (Page et al. 2004). In NZ green trawl net (42%), and plastic strapping tape (31%) the most abundant types, similar to Aus. 43% successfully released; post-monitoring showed high success rates. Future successful management should involve monitoring and intervention.	INFERRED from OS & Aus examples	E
Bioavailability and effects of microplastics on marine zooplankton: A review	2019	Botterell et al. 2019	TE	Microplastics	Benthic invertebrates		Ingestion Toxicity	Review of MP ingestion in zooplankton in 39 spp. Mostly lab studies, 45% negative effects on feeding, growth, development, reproduction and lifespan. Phys. and biol. factors impact bioavailability of MPs: size, shape, age and abundance.		R
The stomach contents of post-hatchling green and loggerhead sea turtles in the southwest Pacific: an insight into habitat association	2008	Boyle and Limpus 2008	S TE	Plastic	Turtle	Ocean waters	Ingestion	Predominance of pelagic feeding in small post-hatchling green and loggerhead turtles. Synthetic flotsam ingested frequently (hard, soft plastics & nylon.) Other study suggests they don't compensate for non-nutritional items leading to reduced energy & nitrogen uptake.	INFERRED	E
Marine debris ingestion by Magellanic penguins, <i>Spheniscus magellanicus</i> (Aves: Sphenisciformes), from the Brazilian coastal zone	2011	Brandao et al. 2011	S TE	Macro – All	Seabird	Ocean waters	Ingestion	Magellanic penguins (<i>Spheniscus magellanicus</i>) ingested debris at a rate of 15% in a 2-year study. Debris ingestion in 15% of dead penguins (Rio de Janeiro). Inconclusive whether fatality was due to ingestion or if this level reflects whole population. Predominance of debris is juvenile penguins potentially reflecting a broader diet than adults.	INFERRED to local spp.	E
Rafting on abiotic substrata: properties of floating items and their influence on community succession	2011	Bravo et al. 2011	S TE	Floating debris	Invertebrates (various)	Ocean waters	Bioinvasion Novel habitat	The surface floating behaviour of plastics and styrofoam impact biofouling communities (spp. colonisation, taxonomic richness, % cover and community succession.) Styrofoam is so buoyant a % is out of the water so colonisation & diversity is lower whereas more stable types of plastic move positions less and have higher taxa richness and cover. Surface rugosity and buoyancy important during initial stages of community succession. The most common colonisers in all experiments were diatoms, ulvae and clonal ascidians from the genus Diplosoma.	INFERRED from OS	E
Validation of a Forest Values Typology for Use in National Forest Planning	2000	Brown and Reed 2000	AS	NA	Social	NA	All social	13 forest values identified by survey, related to attitudes to forest management practices e.g. logging/mining. Values are a decent predictor of support for management practices and related to uses. 4 ways for value: economic/utilitarian, life support, aesthetic & moral/spiritual.	INFERRED from OS & terrestrial system	E
Spatial and Temporal Patterns of Stranded Intertidal Marine Debris: Is There a Picture of Global Change?	2015	Browne et al. 2015 (Intertidal)	S AE TE MM	All debris	NA		Stressors: distribution & drivers	Review of global studies of marine debris distribution with focus on methods to create global picture. Comparison of aims, methods, replication, habitats, common factors influencing accumulation. Concluded that given the huge variation in aspects of the research there was very limited ability to look for global patterns of intertidal stranded debris types. Summaries of common factors shown to influence debris accumulation and that explains temporal variation.	INFERRED	R

Source			Summary and key findings							
Name	Year	Web link	Theme	Debris	Asset	Habitat	Impact pathway	Key findings	MDTARA application	Type
Linking effects of anthropogenic debris to ecological impacts	2015	Browne et al. 2015 (Impacts)	S AE TE	All	All assets		Entanglement Ingestion Bioinvasion Changes to habitats Toxicity	Debris presence does not necessarily mean impact. Use adverse outcome pathways and existing linkages as surrogates (lab and field experiments, hypotheticals and population models.) Impact of debris must be supported by evidence that impact on individuals had a tangible impact on other levels of biological organisation (e.g. populations).	INFERRED	R
Microplastic Moves Pollutants and Additives to Worms, Reducing Functions Linked to Health and Biodiversity	2013	Browne et al. 2013	S AE TE	MPs Additives Pollutants	Benthic invertebrates	Shallow soft sediments (M & E)	Ingestion Adsorption Toxicity	Exposed lugworms (<i>Arenicola marina</i>) to sand with 5% MPs presorbed with pollutants and additive chemicals. Sand led to increased absorption of pollutants. Gastric concentrations of pollutants (ingested) were > 180% greater than body wall concentration (sorbed from surroundings). Same for MP additives. Worms eating MPs accumulated pollutants/additives led to different impacts including reduced survival, feeding, immunity and antioxidant capacity.	INFERRED to similar species of lug/beach worms	E
What is known and unknown about the effects of plastic pollution: A meta-analysis and systematic review	2019	Bucci et al. 2019	S TE	All debris	All assets		All environmental assets	Literature review of effects of plastic (macro and micro) pollution. Of all effects 59% were detected (of these, 58% due to MPs, 42% due to MPs). Plastic dose, particle shape, polymer type, and particle size drive detection, severity and direction of effect. Experiment concentrations mostly did not equate to nature concentrations (83%) and 80% of particle sizes < size range of majority of environmental sampling. Better testing is required to delineate how types, sizes, shapes, doses and exposure durations affect wildlife.	INFERRED	R
Marine Debris and Human Impacts on Sea Turtles in Southern Brazil	2001	Bugoni et al. 2001	S TE	All debris Plastic bags Rope	Turtle		Ingestion	Green turtles in Southern Brazil: 60.5% ingestion of anthropogenic debris, 13.2% fatality from ingesting debris. Sublethal impacts hard to estimate but obstruction evident in some digestive tracts.	INFERRED from OS & from late 1990s	E
Lethal fishing hook penetration and line entanglement in an adult bottlenose dolphin (<i>Tursiops aduncus</i>)	2020	Byard et al. 2020	S TE	Fishing gear	Cetaceans		Entanglement Ingestion	Entanglement and ingestion in fishing gear can lead to death in bottlenose dolphins in Australia.	INFERRED - from SA	E
Accumulation and Embryotoxicity of Polystyrene Nanoparticles at Early Stage of Development of Sea Urchin Embryos <i>Paracentrotus lividus</i>	2014	Della Torre et al. 2014		NPs PS	Benthic invertebrates		Ingestion Toxicity	Exposure to 2 types of PS NPs (PS-COOH & PS-NH ₂) led to varying impacts on early developmental stage of a sea urchin. No embryotoxicity for exposure to PS-COOH but PS-NH ₂ caused severe developmental defects. PS-COOH accumulated inside embryo's digestive tract while PS-NH ₂ were more dispersed. PS-NH ₂ gene activity suggests cell death.	INFERRED to local spp.	E
Entanglement of southern elephant seals in squid fishing gear	2007	Campagna et al. 2007	S TE	Fishing-related debris Monofilament line	Pinnipeds	Not defined	Entanglement	Pinniped spp. experience entanglement rates of 0.11–7.9% off Argentina. Entanglement from active and discarded fishing gear is possible.	INFERRED from OS & from late 1990s	E
A Detailed Review Study on Potential Effects of Microplastics and Additives of Concern on Human Health	2020	Campanale et al. 2020	S TE TS	MPs and NPs	Social	Health	Human health: Ingestion	MPs possess chemicals from additives/raw materials and absorbed from surroundings. Additives leach into air, water, food, human tissue. Of concern: BPA, phthalates, heavy metals, flame-retardants. INGESTION entry point: contaminated food & trophic transfer, < 2.5 micrometre can enter the gastrointestinal tract. Effects: toxicity via inflammation, accumulative depending on dose. INHALATION entry point: airborne MPs and fibres. NPs can cross lung barrier to bloodstream. Effects: respiratory distress, cytotoxicity, inflammatory effects, secondary microorganism transmission on MP/NP. ABSORPTION entry point: skin – NP only.	INFERRED	R
Human health impacts from litter on beaches and associated perceptions: A case study of 'clean' Tasmanian beaches	2016	Campbell et al. 2016	TS	All debris types	Social	Health	All social	21.6% of beach visitors have sustained injuries from beach litter, 65% of injuries are wounds. Risk of injury is high on clean beaches and slightly decreases with daily visitation. Not seen as a concern to human health but it is to biota health.	INFERRED (Tas)	E
Evidence for immunomodulation and apoptotic processes induced by cationic polystyrene nanoparticles in the hemocytes of the marine bivalve <i>Mytilus</i>	2015	Canesi et al. 2015	TE	Plastic – PS NPs	Benthic invertebrates		Toxicity	Demonstrated that PS particles impact hemocytes (equivalent to blood cells) of a marine bivalve (mussel). Impacts included toxicity and cell death at highest concentrations and variable immune functions at different levels.	INFERRED from OS mussel spp.	E
Trophic transfer of microplastics and mixed contaminants in the marine food web and implications for human health	2018	Carbery et al. 2018	TE TS	MPs	Social Fish & sharks Cetaceans		Toxicity - Bioaccumulation Human Ingestion	Review of factors influencing MP ingestion: MP distribution, MP physical characteristic, biofilms, impact of chemicals in or absorbed by MPs, trophic transfer, bioaccumulation. Research into bioaccumulation and biomagnification in higher order predators and humans is limited. Research should be directed at bioaccumulation factors for popular seafood items in order to identify the potential impacts on human health.	INFERRED	R

Source			Summary and key findings							
Name	Year	Web link	Theme	Debris	Asset	Habitat	Impact pathway	Key findings	MDTARA application	Type
Intergenerational transfer of plastic debris by Short-tailed Shearwaters (<i>Ardenna tenuirostris</i>)	2011	Carey 2011	S TE	Plastic: user pellets other	Seabird	All	Ingestion	100 % of fledgling short-tailed shearwaters (<i>Ardenna tenuirostris</i>) on Phillip Island, Vic, contained plastic, mean of 7.6 particles/bird. User plastic was most common. No clear influence of ingested plastic on body condition, some evidence of physical damage to the gizzard. Chicks at greater risk as they ingest more (transgenerational) and expel less.	INFERRED from Aus (Vic)	E
Small plastic debris changes water movement and heat transfer through beach sediments	2011	Carson et al. 2011	S TE	Plastic fragments	Benthic invertebrates	Beach / flats (M & E)	Changes to habitats	Plastic fragments in beach sand effect physical properties, significantly increasing permeability and decreasing temp. increase (16% max. decrease in thermal diffusivity) and temp. max. (21% max. increase in heat capacity). Resulting changes in grain size, permeability and higher desiccation effects organisms and eggs such as crustacea, molluscs, polychaetes, interstitial meiofauna. Particularly temperature-dependent sex-determination (e.g. sea turtle eggs).	INFERRED	E
Sea turtle strandings reveal high anthropogenic mortality in Italian waters	2010	Casale et al. 2010	TE	Fishing-related	Turtle	Ocean waters	Entanglement	Record of stranding/floating loggerhead turtles (<i>Caretta caretta</i>) in Italy. Anthropogenic mortality is higher than natural mortality. Entanglement in ghost gear or in other anthropogenic debris affects high numbers of turtles. Highest impacts from active fisheries interactions.	INFERRED from OS	E
Impacts of Plastic Debris on Australian Marine Wildlife	2009	C & R 2009	S TE MM	Common debris types: fishing nets, line and hooks	Cetaceans Pinnipeds Fish/Sharks Rays Seabird Turtle Benthic invertebrates	All	Entanglement Ingestion Toxicity	A compilation of wildlife interactions with marine debris in Australian waters (1974–2008). Details primarily entanglement and ingestions and provides a summary of impacts. Interactions were found in 77 species of Australian marine wildlife: marine turtles (6 spp.), cetaceans (12 spp.), seabirds (at least 34 spp.), dugongs, pinnipeds(6 spp.), sharks and rays (at least 10 spp.) and at least 8 more spp. groups. The most common debris items were derelict fishing nets (entanglement) and synthetic fishing line/hooks (ingestion). Recommends a national database to improve management.	KNOWN NSW & Aus	R
Impacts of lost fishing gear on coral reef sessile invertebrates in the Florida Keys National Marine Sanctuary	2005	Chiappone et al. 2005	S TE	Fishing gear	Benthic invertebrates	Coral reef	Entanglement	Lost hook-and-line fishing gear was 87% of all debris; responsible for 84% of documented impacts to sponges and benthic cnidarians. 56% of branching gorgonians (<i>Octocorallia</i>) affected, 19% milleporid hydrocorals and 13% sponges.	INFERRED from OS	E
Using citizen science data to assess the difference in marine debris loads on reefs in Queensland, Australia	2018	Bauer-Civiello et al. 2018	S	All debris	NA	Coral reef Shallow reef (M)	Stressor: Distribution	Distribution of debris and types on reefs showed a dominance of fishing gear that increased with a reef's proximity to population centres and high-use areas. But all non-fishing debris was grouped as 'other'.	INFERRED from Qld	E
Marine microplastic debris: a targeted plan for understanding and quantifying interactions with marine life	2016	Clark et al. 2016	SE	MPs	All assets		Ingestion	MP interaction with organisms has a significant role in the movement, impact and fate of MP in the oceans. Patterns in ocean currents and biological productivity indicate encounters are most likely to occur in coastal environments, close to sources of plastic contamination.	INFERRED	R
Tools and constraints in monitoring interactions between marine litter and megafauna: Insights from case studies around the world	2019	Claro et al. 2019	S TE MM	All macro & micro	Cetaceans Pinnipeds Fish & sharks Rays Seabirds Shorebirds Turtles		Ingestion entanglement	Review of megafauna and marine litter interaction research shows studies inconsistent. Sentinel spp. used. Recommends 1) working groups 2) multidisciplinary workshops 3) coordination of future works.	INFERRED	R
The Impact of Polystyrene Microplastics on Feeding, Function and Fecundity in the Marine Copepod <i>Calanus helgolandicus</i>	2015	Cole M et al. 2015	TE	Plastic PS MPs	Benthic invertebrates	All	Ingestion Toxicity	PS MPs impede feeding in marine copepod, ingesting 11% less algal cells, more smaller cells and 40% less copepod biomass. The resulting energy differences were conceptually modelled between MP exposed and not-exposed animals.	INFERRED to local spp.	E
A Social Values Typology for Comprehensive Assessment of Coastal Zone Ecosystem Services	2015	Cole Z et al. 2015	AS MM	NA	Social		All social	Valuation of all social assets in coastal areas that equate to environmental assets, through stakeholder engagement. Expert elicitation used to highlight 16 relevant social values from ecosystem services. Crucial to robust resource management and policies.	INFERRED	E
Plastic debris straps on threatened blue shark <i>Prionace glauca</i>	2017	Colmenero et al. 2017	TE	Plastic	Fish/sharks	Ocean waters	Entanglement	Entanglement by strapping bands on the threatened blue shark <i>Prionace glauca</i> leading to injuries and probable breathing issues. Includes review of shark species injured by plastic debris worldwide (excluding fishing gear).	Local spp. INFERRED IMPACTS	E & R
Risk assessment of plastic pollution on marine diversity in the Mediterranean Sea	2019	Compa et al. 2019	S TE	Plastic	Cetaceans Fish/sharks Rays Turtle Benthic invertebrates		Ingestion	Ingestion risk from plastic pollution in 84 spp. (6 classes) using risk framework and spp. characteristics (home range, ecology & life history) alongside plastic dispersion models in the Mediterranean Sea. Mapped plastic ingestion hotspots. Species-specific attributes affected risk: larger home ranges higher risk with increased distances; local spp. higher risk closer to the centre of home range.	INFERRED	R

Source			Summary and key findings							
Name	Year	Web link	Theme	Debris	Asset	Habitat	Impact pathway	Key findings	MDTARA application	Type
Entanglement in man-made debris of Antarctic fur seals at Bird Island, South Georgia	1990	Croxall et al. 1990	TE	Plastic – types	Pinnipeds	All	Entanglement	Antarctic fur seals entangled with neck collars from human-made debris at 0.4% of population at South Georgia but could be up to 1% (figures for late 1980s). Collars consisting of packaging bands (59%), nylon string (16%), fishing net (13%) and other (12%).	INFERRED to local spp.	E
Marine Debris on Beaches of the Greater Sydney Region	2003	Cunningham and Wilson. 2003	S	All Majority plastic	NA	Beach / flats (M & E)	Stressor: distribution & type	Marine debris surveys on 6 beaches in the Greater Sydney Region. Debris composition: plastic (89.8%), hard plastic (52.3%). Sources: stormwater or beachgoers. Highest debris density not always proportionate to urbanised area – debris is mobile. High variability in abundance between sites, between areas of sites and over time. Density of debris comparable to some of the world's most-polluted beaches.	KNOWN	
Marine debris ingestion by <i>Chelonia mydas</i> (Testudines: Cheloniidae) on the Brazilian coast	2015	da Silva Mendes et al. 2015	TE	Plastic – Soft white/clear	Turtle		Ingestion	Green turtles in Brazil survey had 45% plastic ingestion rate. Mostly small white and colourless soft plastics supporting hypothesis that turtles mistake them for jellyfish.	INFERRED to local populations	E
Polyethylene microbeads induce transcriptional responses with tissue-dependent patterns in the mussel <i>Mytilus galloprovincialis</i>	2017	Detree et al. 2017	S TE	PE MPs	Benthic invertebrates	All	Ingestion Toxicity	Ingestion of PE microbeads by mussel (filter-feeder) over short period (24 hours). Exposure led to changes in gene regulation of metabolism, oxidative stress, immune response and cell death. Variation was between genes and between tissue types. Results suggest disruptive and tissue-dependent effects on major biological processes.	INFERRED to all mussel spp.	E
Microplastic ingestion ubiquitous in marine turtles	2018	Duncan et al. 2018	S TE	MPs Fibres, fragments and microbeads	Turtle		Ingestion	Microplastic ingestion ubiquitous in marine turtles. Mostly fibres, also fragments and microbeads. Multiple ingestion pathways as present across different trophic levels – e.g. polluted water/sediments and/or trophic transfer from plants and invertebrates. MP levels mean threat is currently less significant than fisheries bycatch, ingestion of macroplastics or entanglement in anthropogenic marine debris.	INFERRED	E
Leachate from microplastics impairs larval development in brown mussels	2016	E Silva et al. 2016	S TE	MPs	Benthic invertebrates		Toxicity	Indirect exposure to MP leachate (without ingestion) effected larval development in mussels. Higher toxicity from beached pellets (absorbed in environment) than from virgin pellets (toxicity from plastic additives.)	INFERRED	E
Origins and Biological Accumulation of Small Plastic Particles in Fur Seals from Macquarie Island	2003	Eriksson and Burton 2003	S TE	Plastic	Pinnipeds Fish/sharks	Ocean waters	Ingestion Bioaccumulation	Plastic particles in fur seal scat from eating pelagic prey fish <i>Electrona subaspera</i> , who select particles for size. Normal feeding led to accumulation. Particle numbers lower than in seabirds in similar ranges as birds actively select plastic when feeding.	INFERRED	E
The wider cost of litter: A summary paper	2013	Eunomia UK 2013	S AS TS	All litter	NA		Remediation cost	Analysis of the indirect cost of litter in Britain, estimated between £1.4–12 billion. Internalised costs between £207 million – 11 billion and external costs of between £1.2–8.7 billion. Discusses the threats to social wellbeing and environmental harm posed by litter and identifies knowledge gaps.	INFERRED from Britain	S
Dynamics of plastic resin pellets deposition on a microtidal sandy beach: Informative variables and potential integration into sandy beach studies	2018	Fanini and Bozzeda 2018	S TE	Plastic pellets	NA	Shallow soft sediments (M & E)	Stressor: distribution & type	Modelled density of plastic pellets from temporal samples (both new and old) on a Mediterranean beach. Found constant input of pellets ashore, about 50% 'new'. Beach width was the only variable significant to pellet density. Surmises that plastic resin pellets have a pressure impact, rather than a spill-related, time-limited one. Describes physical beach properties to measure to reflect beach status, pellet mobility and infauna.	INFERRED	E
Microplastics in fisheries and aquaculture – Status of knowledge on their occurrence and implications for aquatic organisms and food safety	2017	FAO 2017	S TE & TS	MPs	Fish/sharks Benthic invertebrates Social	Aquaculture areas	Stressor – Source Threats (envt): Ingestion Toxicity Bioaccumulation Threat (social): Health	Microplastics in fisheries and aquaculture industries and their contribution to the issue. Over 220 spp. are reported to have been found to ingest microplastic debris, 55 of which are of commercial importance. Comprehensive summaries of plastic additives and PBTs. In the wild, evidence of the impact of ingestion of microplastics is minimal. Not found to be transferring between trophic levels (at current densities). Human uptake of microplastics is estimated at 1–30 particles/day dependant on seafood intake.	INFERRED global study	R
Sea countries of New South Wales: a benefits and threats analysis of Aboriginal people's connections with the marine estate	2015	Feary and Donaldson 2015	S AS TS	All	Social	All	All social threats with particular reference to impacts on Indigenous peoples	Aboriginal people's connections with the NSW marine estate are long standing and complex, with variations among communities in different marine bioregions. Provides a summary of contemporary resource use and has complete tables of Indigenous environmental, cultural and social values; assets; and threats as well as consequence and likelihood definitions. Pollution and run-off defined as a threat to Aboriginal environmental and heritage/cultural values and assets. Associated consequences range from moderate to major, with likelihoods from unlikely to almost certain.	KNOWN	E
With the noose around the neck: Marine debris entangling otariid species	2017	Franco-Trecu et al. 2017		Fishing-related	Pinnipeds	Not defined	Entanglement	Pinniped entanglements are commonly neck collars causing injuries, death by suffocation and starvation. In the SW Atlantic, impacts on 2 spp. described. For <i>Arctocephalus australis</i> , injuries ~ 40% from industrial fishing (active/ALDFG), 48% very severe.		
Ingestion and Egestion of Microplastics by the Cladoceran <i>Daphnia magna</i> : Effects of Regular and Irregular Shaped Plastic and Sorbed Phenanthrene	2017	Frydkjaer et al. 2017	S TE	PE MPs	Benthic invertebrates		Ingestion Toxicity	PE MPs ingestion in <i>Daphnia magna</i> with a regular and irregular shape comparison on rate of digestion. Irregular slower to egest.	INFERRED	E

Source			Summary and key findings							
Name	Year	Web link	Theme	Debris	Asset	Habitat	Impact pathway	Key findings	MDTARA application	Type
Marine microplastics spell big problems for future generations	2016	Galloway and Lewis 2016	S TE	MPs	All Assets		Ingestion Toxicity	AOP of microplastics exposure of aquatic species showing potential pathways linking ingestion, uptake across membranes, and chemical release.	INFERRED	R
Effects of polystyrene microbeads in marine planktonic crustaceans	2017	Gambardella et al. 2017	S TE	PE MPs	Benthic invertebrates		Ingestion Toxicity	PS MPs exposure in marine planktonic crustacean spp. (larval barnacle and brine shrimp) varied concentration for 24 and 48 hours. With MP accumulation no lethal impact, sublethal consistent indications of oxidative stress and neurotoxic effects. At highest exposure significant changes to swimming behaviour.	INFERRED	E
Sources, fate and effects of microplastics in the marine environment: a global assessment	2015	GESAMP 2015	S TE & TS MM	MPs	NA		All envt threats	Review of global research, scientific methods and definition of MPs. Also summary of MP distribution, transport, effects, chemical transfer, trophic transfer, social perceptions and policy recommendations.	INFERRED	R
Sources, fate and effects of microplastics in the marine environment: Part 2 of a global assessment	2016	GESAMP 2016	S TE & TS MM	MPs & NPs	NA		All envt & social assets	Huge review of all aspects of marine debris, sources, fate, review of studies of all aspects. Detailed overview of ecological impacts – delineated by group – from lab and field studies – both macro and micro. Summarises impacts to fisheries, socio-economic factors and how a risk framework was used for analysis, with key recommendations for each aspect.	INFERRED	R
Proceedings of the GESAMP Workshop on Assessing the Risks associated with Plastics and Microplastics in the Marine Environment	2020	GESAMP 2020	S AE, AS TE, TS MM	Plastic (macro, micro and nano)	All assets		All envt, social & economic	Provides overviews of the linkages between stressors, threats and consequences. Probability = EXPOSURE; Threats = HAZARDS/IMPACTS; Consequences = EFFECTS.	INFERRED	R
Oceanic barnacles act as foundation species on plastic debris: implications for marine dispersal	2016	Gil and Pfaller 2016		Floating	Benthic invertebrates	Ocean waters	Bioinvasion (potential)	<i>Lepas</i> barnacles provide complex structural habitat on otherwise structurally limited plastic debris. Spp.–area relationship driven by higher colonisation/persistence of sessile taxa with greater raft area and facilitation of mobile taxa with greater <i>Lepas</i> abundance.	INFERRED	E
Marine species mortality in derelict fishing nets in Puget Sound, WA and the cost/benefits of derelict net removal	2010	Gilardi et al. 2010	TE TS MM	Fishing nets	Benthic invertebrates	All	Entanglement Economics	Derelict gillnet entanglement study with predictive modelling cost on fishery due to loss vs cost of retrieval. Cost:benefit is 1:14.5. Additional indirect costs such as damage to vessels, equipment, habitat damage, loss of non-commercial spp. & ecosystem health.	INFERRED	E
Increased oceanic microplastic debris enhances oviposition in an endemic pelagic insect	2012	Goldstein et al. 2012	TE	MP	Benthic invertebrates	Ocean waters	Bioinvasion Changes to habitat	Microplastic in the 'Great Pacific Garbage Patch' – NPSG – providing large increase in substrate for pelagic insect eggs increasing their range and abundance and providing additional transfer of energy from pelagic and substrate assemblages. Plastic particles in oceanic ecosystems, termed the 'plastisphere'.	INFERRED	E
Maximising community wellbeing: Assessing the threats to the benefits communities derive from the marine estate	2019	Gollan et al. 2019	AS TS	NA	Social		All social threats	Assessment of the NSW statewide TARA social assessment – defining risk from threats to benefits using a social wellbeing approach. Providing an integrated perspective on environmental policy and decision-making. Benefits: participation, enjoyment, cultural heritage & use, intrinsic & bequest values, business & economics. Threats to community benefits: resource-use conflict, environmental, governance, public safety, critical knowledge gaps and lack of access.	YES	R
Derelict fishing nets in Puget Sound and the Northwest Straits: Patterns and threats to marine fauna	2010	Good et al. 2010	TE MM	Fishing nets	All assets	All	Entanglement	870 derelict gillnets entangling 31,278 invertebrates (76 spp.), 1036 fishes (22 spp.), 514 birds (16 spp.), and 23 mammals (4 spp.). Majority of animals dead when recovered; invertebrates (56%), fish (93%), birds & mammals (100%). Nets effect different habitats unevenly: rocky complex substrate ensnares nets and with oceanography can create hotspots.	INFERRED	E
Size- and shape-dependent effects of microplastic particles on adult daggerblade grass shrimp (<i>Palaemonetes pugio</i>)	2017	Gray and Weinstein 2017	TE	MPs: spheres (PE & PS) fragments (PP) fibres (PP)	Benthic invertebrates		Ingestion Toxicity	Exposure to MP (sizes) spheres (7), fragments (2) & fibres (2) in grass shrimp, shows MPs of various sizes and shapes can be ingested/ventilated, resulting in acute toxicity. Mortality 5–40% much higher for large fibres. MP shape effected no. of ingested particles. Residence time higher in gut than in gills.	INFERRED	E
Effects of microplastics on European flat oysters, <i>Ostrea edulis</i> and their associated benthic communities	2016	Green 2016	TE	MPs	Benthic invertebrates		Ingestion Toxicity	Demonstrating effects of MPs at ecological community level. Low and high exposure had minimal effects on European oysters. Water column MP exposure (high) can decrease the abundances and biomasses of several key organisms in these habitats.	INFERRED from OS	E
Smoked cigarette butt leachate impacts survival and behaviour of freshwater invertebrates	2020	Green et al. 2020	S TE	Cigarette butts (plastic & biodegradable)	Benthic invertebrates	Not defined	Ingestion Toxicity	Impact of cigarette butt leachate on four FW invertebrates. Butt leachate derived from biodegradable (i.e. cellulose) filters equally as detrimental as from conventional filters. High concentration of either led to increased mortality. Lower, environmentally relevant, concentrations lethal to juvenile snails and reduced activity levels in 4 spp.	INFERRED from FW spp.	E
Impacts of Discarded Plastic Bags on Marine Assemblages and Ecosystem Functioning	2015	Green et al. 2015	TE	SUP bags (conventional & biodegradable)	Benthic invertebrates	Shallow soft sediments (M & E)	Entanglement (smothering) Toxicity	Conventional and biodegradable SUP bags on an intertidal shore created anoxic conditions in sediment. Led to lower infaunal invertebrate abundance, lower primary production, less organic matter, changes to infaunal assemblage structures, higher ammonium and biogenic silicate (impaired transport across the sediment–water interface.) For most measurements no difference between bag types.	INFERRED	E

Source			Summary and key findings							
Name	Year	Web link	Theme	Debris	Asset	Habitat	Impact pathway	Key findings	MDTARA application	Type
Polycarbonate and polystyrene nanoplastic particles act as stressors to the innate immune system of fathead minnow (<i>Pimephales promelas</i>)	2016	Greven et al. 2016	TE	PS NPs & PC NPs	Fish/sharks	Not defined	Toxicity	PS NPs and PC NPs can act as stressors to the cellular component of the innate immune response of fish, leading to altering organismal defence mechanisms which can interfere with disease resistance in fish populations.	INFERRED	E
Effects of micro-plastic particles on paraquat toxicity to common carp (<i>Cyprinus carpio</i>): biochemical changes	2017	Haghi and Banaee 2017	TE	MPs	Fish/sharks	Not defined	Toxicity	Exposure to MPs and/or microplastics paraquat (a toxic herbicide) changes blood biochemistry in fish which can affect survival. MPs in water significantly increased the toxicity and bioavailability of the pesticide.	INFERRED	E
Estimating recreational values of coastal zones	2017	Halkos and Matsiori 2017	AS	NA	Social		NA	Assesses values associated with the coastal zone, attitudes for increased protection as well as the impact that has on people's willingness to pay (WTP) for conservation. In a wetland study, WTP (and amount to pay) is influenced by demographics, coastal zone values & protection attitudes.	INFERRED	E
Migration of nonylphenol from food-grade plastic is toxic to the coral reef fish species <i>Pseudochromis fridmani</i>	2015	Hamlin et al. 2015	TE TS	Food-grade plastic	Fish/sharks Social	All	Ingestion Toxicity Human health	The leachate nonylphenol can migrate from food-safe plastic at levels shown to be toxic to fish. Leachate levels vary between manufacturers. In one case, high levels of leachate were taken up by fish, induced toxicity and decreased short- and long-term survival. Threat of leachate impacts humans even with products defined as 'food-safe'.	INFERRED	E
Entanglement of Pinnipeds in Synthetic Materials at South-east Farallon Island, California, 1976 to 1998	2000	Hanni and Pyle 2000	TE	Macroplastic	Pinnipeds	All	Entanglement	Summary of trends of pinnipeds entangled in synthetic material at SE Farallon Island 1976–98. 914 pinnipeds showed evidence of present or past entanglement; 32% entangled in observable material, 68% with constrictions.	INFERRED	E
Understanding debris sources and transport from the coastal margin to the ocean: final report to the Australian Packaging Covenant Industry Organisation Ltd	2016	Hardesty et al. for APC 2016	S MM	All	NA	All	Stressor: distribution & type Management actions	Defines debris hotspots in Australia using existing data and modelling site characteristics: key intervention areas and actions for society. Uses site attributes to assess loads and types of debris. Debris transport modelling shows effective interception points in the system.	KNOWN	R
Understanding the effects of marine debris on wildlife: Final report to Earthwatch Australia	2014	Hardesty et al. 2014	S TE MM	All debris types	Pinnipeds Seabirds Turtles	All	Ingestion Entanglement	Summary report for the 3-year CSIRO national marine debris project. Includes sources, distribution and fate of marine debris, threats to wildlife, implementation of citizen science and solutions.	Yes (NSW) INFERRED (Aus)	E
A biochemical approach for identifying plastics exposure in live wildlife	2014	Hardesty et al. 2014 (Biochem)	S TE MM	Plastic	Seabird		Ingestion	Method for assessing plastics ingestion in live seabirds via plasticiser (3) presence in preen oil. Broad applicability to all levels of biol. organisation & other taxa. Minimally invasive.	INFERRED from Aus	E
Novel methods, new results and science-based solutions to tackle marine debris impacts on wildlife	2015	Hardesty et al. 2015 (Methods)	S TE MM	All debris – top 20 items mostly plastic	Cetaceans Pinnipeds Seabirds Turtles		Entanglement Ingestion Toxicity	Assesses relative threat to seabirds, turtles and marine mammals from entanglement, ingestion and chemical toxicity. Looks at impacts to wildlife and assessing management policies. Using expert elicitation and a global database of top 20 litter items, assesses risk each poses to marine animals. Fishing nets and gear, balloons, plastic bags, plastic beverage bottle caps, and plastic utensils are most harmful. Models risk areas with co-incident taxa and debris spatial distribution. Discusses using focal marine species as biological indicators.	INFERRED	E
Multiple approaches to assessing the risk posed by anthropogenic plastic debris	2019	Hardesty et al. 2019	TE MM	All	NA	All	All	Assessment of risk-based approach to marine debris issues. 2 main components of risk from marine debris: exposure & impact. Precautionary approach to protect human and ecosystem health, given knowledge gaps. Source reduction is critical.	INFERRED	R
Toxic effects of polyethylene terephthalate microparticles and Di(2-ethylhexyl)phthalate on the calanoid copepod, <i>Parvocalanus crassirostris</i>	2017	Heindler et al. 2017	TE	PET MPs	Benthic invertebrates	All	Ingestion Toxicity	Copepod exposure to PET MPs reduces egg production and overall populations. Recovery takes more than 1 generation. Shorter MP exposure (6 days) showed signs of population recovery. Longer exposure had severe consequences on population viability. Exposure to DEHP (a plasticiser) resulted in persistent long-lasting effects with no indication of recovery. DEHP led to highly variable toxicity, depending on developmental stage.	INFERRED	E
A Pre- and Post-MARPOL Annex V Summary of Hawaiian Monk Seal Entanglements and Marine Debris Accumulation in the Northwestern Hawaiian Islands, 1982–1998	2001	Henderson 2001	TE	Fishing-related and other	Pinnipeds		Entanglement	Monk seal entanglement more likely in pups/juveniles, who are commonly entangled in nets. Older seals more likely to entangle in line. Number of entanglements is not proportionate to seal population nor to level of debris at their location. Entanglement impact on this species is higher as subpopulations are relatively discrete and isolated from one another.	INFERRED	E
Entanglement of Antarctic fur seals at Bouvetøya, Southern Ocean	2006	Hofmeyr et al. 2006	TE	Majority fishing	Pinnipeds	Ocean waters	Entanglement	Rates of entanglements of Antarctic fur seals between 0.024–0.059%. Very low for a pinniped population. > two-thirds of entangling materials are from fishery sources. No known local source of pollution so entanglement occurs in distant waters or when materials drift substantially from their origin.	INFERRED	E

Source			Summary and key findings							
Name	Year	Web link	Theme	Debris	Asset	Habitat	Impact pathway	Key findings	MDTARA application	Type
Entanglement of Pinnipeds at Marion Island, Southern Ocean: 1991–2001	2002	Hofmeyr et al. 2002	TE	Fishing-related and other	Pinnipeds		Entanglement	Entanglement of pinniped spp. 1991–2001 in Southern Ocean; 67% of entangling items from fishing industry, PP packaging straps the most prevalent then trawl netting. Distinct increase in embedded hooks, entanglement due to line and portions of plastic in 1996 after commencement of longline fishing in surrounding waters (50% increase in entanglement of fur seals spp.). Entanglement most likely will lead to individual death although impacts not seen at the population level.	INFERRED	E
Impacts of marine debris on wild animals in the coastal area of Korea	2013	Hong et al. 2013	TE MM	Majority fishing	All assets		Entanglement Ingestion	Marine debris impacts in Korea showed primarily birds affected (including threatened spp.). Recreational fishing gear most frequently impacted wildlife, especially birds, hence a management priority. No. of affected spp. increasing.	INFERRED	E
The Honolulu Strategy: A Global Framework for Prevention and Management of Marine Debris	2012	UNEP 2012	S TE & TS MM	All	NA		Management applications	A global framework for prevention and management of marine debris (tool for planning, collaboration, monitoring). 3 main goals (with associated strategies) to reduce amount and impact of 1) land-based sourced 2) sea-based sourced and 3) shoreline accumulated marine debris.	INFERRED	R
Marine debris stakeholder research report	2018	IPSOS, NSW EPA, 2018	ALL S, AE, AS, TE, TS, MM	All debris	Social	All	All social threats: perceptions	Perception of debris types and distribution in NSW. Describes effective mechanisms to communicate marine debris information to combat perceived issues for future awareness campaigns.	KNOWN	E
Fatal ingestion of floating net debris by two sperm whales (<i>Physeter macrocephalus</i>).	2010	Jacobsen et al. 2010	S TE	Fishing gear: net main	Cetaceans	All	Ingestion	Sperm whale fatal ingestion of debris: fishing-net scraps, rope, line, plastic bags and other plastic debris. Causes of death (COD) were debris impaction (over time) that was a) fatal and b) led to fatal gastric rupture. Debris ingested from the surface, likely accumulated over many years; most were scraps that had been discarded during net repairs.	INFERRED from OS	E
Uptake and effects of microplastic textile fibers on freshwater crustacean <i>Daphnia magna</i>	2016	Jemec et al. 2016	TE	PET microfibres	Benthic invertebrates		Ingestion	PET textile microfibres readily ingested by zooplankton <i>Daphnia magna</i> at various sizes and led to increased mortality when not fed beforehand. No recovery after return to normal conditions in either feeding regime.	INFERRED from FW spp.	E
Adverse effects of microplastics and oxidative stress-induced MAPK/Nrf2 pathway-mediated defense mechanisms in the marine copepod <i>Paracyclopsina nana</i>	2017	Jeong et al. 2017	S TE	NP & MP PS beads	Benthic invertebrates	Ocean waters	Ingestion Toxicity Bioaccumulation	Impact of exposure to PS microbeads in marine copepod: NP (0.05 µm) and MP (0.5 and 6 µm). Toxicity increased with smaller size (higher bioavailability). NPs retained for longer in body (not just digestive tract) led to developmental delays, reduced fecundity and induced oxidative stress. Zooplankton are primary consumers so uptake of MP/NPs can affect whole ecosystems.	INFERRED	E
Pathologies of the digestive system caused by marine debris in <i>Chelonia mydas</i>	2017	Jerdy et al. 2017	TE	All	Turtle	Not defined	Ingestion	Study MD impact on green sea turtles (SE Brazil) found 37% had debris in the gastrointestinal tract. Plastic most common material (61%); directly fishing-related was 11.6%. Mostly in large intestine (59.5%). All debris may be harmful, independent of the segment involved, and increases the risk of impaction.	INFERRED	E
Plastic debris in the stomach of a Longman's Beaked Whale, <i>Indopacetus pacificus</i> (Longman, 1926) stranded off Sutrapada, Veraval, Saurashtra coast, India	2014	Kaladharan et al. 2014	TE	Plastic bag	Cetaceans	Ocean waters	Ingestion	Death of adult, rare Indo-Pacific whale due to choking after ingestion of 4 thick plastic bags, blocking passage of food. Deliberate or accidental ingestion is unknown.	INFERRED	E
Fishing gear- related injury in Californian Marine Wildlife	2009	Kaplan Dau et al. 2009	TE MM	Fishing-related debris	Seabirds Pinnipeds	Ocean waters	Entanglement Ingestion	Ingestion and entanglement rates of spp. off California were 11.3% fishing-related, variable by targeted spp. and year: pelicans (~14 to 62%), gulls (~9 to 14%) & pinnipeds (~1 to 4%). Variation in rates by sex, age, region and impact (entanglement and/or ingestion). No distinction between active and ALDFG fishing gear. Lost fishing gear recovery program removing gear from nearshore water, public-access fishing areas, providing adequate disposal. Efficacy of program measured in part by reduction in rates of injury.	INFERRED	E
Microplastics in eviscerated flesh and excised organs of dried fish	2017	Karami et al. 2017 (Fish)	S TE TS	MPs	Social	Health	Human health: ingestion	Analysis of MPs presence in the flesh and excised organs of 4 fish spp. Present in flesh after MPs translocated from the digestive systems. In 2 spp. significantly more MPs in flesh than in organs. Hence gutting fish doesn't eliminate all risk of MP ingestion. Based upon consumption of 4 spp., humans' ingestion could be up to 246 particles/year.	INFERRED	E
The presence of microplastics in commercial salts from different countries	2017	Karami et al. 2017 (Salt)	S TE TS	MPs	Social	Health	Human health: ingestion	Analysis of presence of MPs in table salt products (incl. sea salt from Australia.) Low-density PE and PP polymers float therefore readily directed to salt pans and redistributed by air. Impacts of MPs include microinjuries from fragments and absorption of POPs. Currently there is not significant consumption due to sea salt, but long-term consumption of various products containing MPs could compound to become a problem in the future.	INFERRED	E
Effect of marine litter on the benthic megafauna of coastal soft bottoms: A manipulative field experiment	2007	Katsanevaki s et al. 2007	S AE TE	Plastic bottles Glass jars	Benthic invertebrates Fish/sharks	Shallow soft sediments (M & E)	Changes to habitats & assemblages	Marine litter in coves (Aegean Sea): increased abundance and number of soft-bottom epibenthic megafauna spp. Provided refuge / reproduction sites for mobile spp. (fish, sea snails, hermit crabs) and settling surfaces for hard-substratum sessile spp. (ascidian, sponge, barnacle, anemone). Community structure change was gradual with a clear succession pattern.	INFERRED from OS	E

Source			Summary and key findings							
Name	Year	Web link	Theme	Debris	Asset	Habitat	Impact pathway	Key findings	MDTARA application	Type
A biocultural basis for an ethic toward the natural environment (Chapter)	2008	Kellert 2008	AS	NA	Social		All social	Society's perception of the environment has changed, resulting in increased stewardship of some aspects. Requires biocultural response (combination of biological and cultural factors affecting human behaviour): human values re the environment, influenced both by biological requirements and by society's knowledge/experience.	INFERRED	R
Mixture Toxicity of Nickel and Microplastics with Different Functional Groups on Daphnia magna	2017	Kim et al. 2017		PS MPs some with coating	Benthic invertebrates		Ingestion/ Adsorption Toxicity	Toxic effects of microplastics and pollutants may vary depending on the type of each. Ingestion and indirect adsorption of PS MPs & PS MPs coated in carboxyl (COOH) with Ni (<i>Daphnia magna</i>) showed toxicity for Ni + MP > Ni alone and the combo of Ni + MP - COOH led to greater immobilisation than Ni + PS.	INFERRED from FW spp.	E
Classification of marine microdebris: A review and case study on fish from the Great Barrier Reef, Australia	2018	Kroon et al. 2018	S	Microdebris	Fish/sharks	Coral reef Shallow reef (M)	Ingestion	Review of studies of microdebris (0.1 µm to < 5 mm) analysis in fish shows some misclassification of semi-synthetic & naturally derived as synthetic. Over representation of 'synthetic' in many cases. Proposes standard methods for analysis, classification and reporting of results, then applied in the Great Barrier Reef to juvenile coral trout demonstrating all types present with high levels of natural particles.	INFERRED	R
Unusual Multisystemic Pathology in a Sperm Whale Bull	1987	Lambertsen and Kohn 1987	TE	Plastic bucket	Cetaceans	Ocean waters	Ingestion	Ingestion of a broken 3-gallon bucket, that lodged in a part of the duodenum, obstructed the gut, probably fatal.	INFERRED	E
Entrapment in plastic debris endangers hermit crabs	2020	Lavers et al. 2020	TE	Plastic	Benthic invertebrates	Beach / flats (M & E)	Entanglement (by entrapment)	Accumulated plastic debris in nearshore environments leading to high rates of fatality due to entrapment of 2 hermit crab species on islands (> 2.4% and > 1.1%). Although terrestrial spp., significant impacts on ecosystems and predators (e.g. shorebirds).	INFERRED to NSW islands & beaches	E
Plastic ingestion by Flesh-footed Shearwaters (<i>Puffinus carneipes</i>): Implications for fledgling body condition and the accumulation of plastic-derived chemicals	2014	Lavers et al. 2014	TE	Plastic	Seabird		Ingestion	Plastic ingestion by flesh-footed shearwater fledglings in eastern Australia (Lord Howe Island) is the highest reported for any marine vertebrate. High plastic ingestion reduced body condition and increased contaminant load. > 60% of fledglings exceed international targets, 16% failing after a single feeding. Results suggest condition of Australian marine environment is poor and helps explain the ongoing decline of this species.	YES – NSW	E
Characteristics of marine debris that entangle Australian fur seals (<i>Arctocephalus pusillus doriferus</i>) in southern Australia	2015	Lawson et al. 2015	S TE	Plastic	Pinnipeds		Entanglement Priority stressors	Australian fur seals are at risk of entanglement, most commonly: - from plastic rope/twine and monofilament - from green items - when seals are younger.	INFERRED – in Victoria	E
Ingestion of marine debris by loggerhead sea turtles, <i>Caretta caretta</i>, in the Adriatic Sea	2011	Lazar and Gračan 2011	TE	All – mostly plastic	Turtle	Ocean waters	Ingestion	35% of 54 loggerhead turtles (Adriatic Sea) found with ingested marine debris. Debris types: soft plastic (68.4%), ropes (42.1%), styrofoam (15.8%) & monofilament lines (5.3%). Undefined COD in all but 1 turtle (COD ingestion of debris).	INFERRED from Atlantic Ocean	E
Microplastics reduced posterior segment regeneration rate of the polychaete <i>Perinereis aibuhitensis</i>	2018	Leung and Chan 2018	TE	PS MPs	Benthic invertebrates	All	Ingestion Toxicity	PS MP beads reduced regeneration rate and increased mortality in a commercially important polychaete. MP size & conc. affected regeneration, smaller beads had greater negative impact. Greater impact could be due to their physical properties, sorption rates, selective feeding. Polychaetes are important bioengineers; MPs pose a significant threat.	INFERRED to other polychaete spp.	E
Laryngeal Snaring by Ingested Fishing Net in a Common Bottlenose Dolphin (<i>Tursiops truncatus</i>) Off the Israeli Shoreline	2009	Levy et al. 2009	TE	Plastic cord, line, netting	Cetaceans	Ocean waters	Ingestion	Ingestion of cord, line and netting by a bottlenose dolphin led to death through starvation.	INFERRED to local area	E
Effects of Toxic Leachate from Commercial Plastics on Larval Survival and Settlement of the Barnacle <i>Amphibalanus amphitrite</i>	2015	Li et al. 2015	TE	Recyclable plastic: PET, HDPE, PVC, LDPE, PP, PS, PC	Benthic invertebrates		Toxicity Bioinvasion	Plastic leachate from 7 recyclable plastics led to varied life-stage impacts in a barnacle. Larval toxicity and significantly increased mortality in nauplii (first stage larval). Plastic leachates significantly inhibited settlement of final larval stage (cyprids). Variable surface chemistry of plastics impacts mortality differently. Plastic leachate depends on the physicochemical properties of additives and polymer matrix of plastic.	INFERRED	E
Recyclable plastics as substrata for settlement and growth of bryozoans <i>Bugula neritina</i> and barnacles <i>Amphibalanus amphitrite</i>	2016	Li et al., 2016	TE	Recyclable plastic: PET, HDPE, PVC, LDPE, PP, PS, PC	Benthic invertebrates		Toxicity Bioinvasion	Settlement/growth of bryozoans & barnacles on 7 recyclable plastic substrata – significantly different than on glass controls. Fewer barnacles settled on plastic. More bryozoans settled on plastic except for HDPE (maybe leachate interaction from different additives.) Evidence that juvenile barnacles are impaired by plastic leachate.	INFERRED	E
The influence of plastic pollution and ocean change on detrital decomposition	2020	Litchfield et al. 2020	S TE	Plastic MPs	Benthic invertebrates		Changes to habitat Toxicity	High quantities of plastic slow the decomposition for some NSW seagrass and kelp spp. Could infer negative effects on nutrient liberation and secondary production. Ocean warming, but not acidification, significantly increases decomposition but could be offset by reduction due to plastics.	KNOWN	E
Negative effects of microplastic exposure on growth and development of <i>Crepidula onyx</i>	2017	Lo et al. 2017	TE	PS MPs	Benthic invertebrates		Toxicity	PS MP exposure in larval & juvenile sea snails at environmental levels had no significant results but at higher levels slowed growth (MP ingestion or removal costs energy) and reduced settlement time & size of settlers (potential impacts on post-settlement success). Legacy of smaller size present even after exposure had stopped.	INFERRED	E

Source			Summary and key findings							
Name	Year	Web link	Theme	Debris	Asset	Habitat	Impact pathway	Key findings	MDTARA application	Type
Overview of global status of plastic presence in marine vertebrates	2020	Lopez-Martinez et al. 2020	TE	Plastic	Cetaceans Pinnipeds Fish & sharks Rays Seabirds Shorebirds Turtles			Review of approaches assessing plastic ingestion in marine vertebrates. Summary of global findings, ingestion highest in Mediterranean and NE Indian Ocean with significant variation between animal groups. Variation in type, colour, polymer and for sea turtles majority white plastics, fibres and LDPE; in cetaceans, white, fibres and PA and in fishes, transparent, fibres and PET.	INFERRED from global overview	R
Does the presence of microplastics influence the acute toxicity of chromium (VI) to early juveniles of the common goby (<i>Pomatoschistus microps</i>)? A study with juveniles from two wild estuarine populations	2015	Luis et al. 2015	TE	MPs	Fish/sharks	Estuarine waters	Toxicity	Chromium (VI) induces toxicity in juvenile common goby fish, increasing mortality and decreasing predatory performance. When also exposed to MPs, predatory performance was reduced and caused new inhibition of Acetylcholinesterase (AChE) activity – indicative of neurotoxicity. The environmental conditions of natural habitats impact sensitivity and response.	INFERRED	E
Prioritising Recreational Amenity in Coastal Management	1997	Lustig and Hibbert 1997	AS	NA	Social		NA	Prioritising the management of beaches by experience, not available activities. Hunter (NSW) beaches can be categorised by physical and environmental attributes and influenced by levels of development, accessibility and crowdedness. Enables prioritisation of recreational amenity projects, management actions and environmentally sustainable development.	YES	R
A nutritional perspective on plastic ingestion in wildlife	2019	Machovsky-Capuska et al. 2019	SE	MPs	All assets	All	Ingestion	Nutritional framework to assess impacts of plastic ingestion across food webs. Influencing factors include foods, diets, generalists v specialist feeding, habitats. Evidence suggesting MPs into food web via ingestion by producers (e.g. plankton) and low-level consumers (e.g. crustaceans, bivalves). Then predation by predators (e.g. fish and cephalopods) then apex predators.	INFERRED	R
Debris ingestion and nutritional niches in estuarine and reef green turtles	2020	Machovsky-Capuska et al. 2020	SE	All majority plastic	Turtle	Estuarine waters Ocean waters	Ingestion	Green turtles adjusted nutritional needs in response to foraging in environments differently impacted by marine debris. Ingested debris, mostly plastics, significantly higher in estuarine turtles than in reef turtles. Subject to the debris density in the environment, lack of benthic food resources available and surface foraging behaviour.	INFERRED	E
Altered Behaviour, Physiology, and Metabolism in Fish Exposed to Polystyrene Nanoparticles	2015	Mattson et al. 2015	TE	NPs	Fish/sharks	All	Ingestion Toxicity	Severe effects of PS NPs through food chain (algae – zooplankton – fish) on fish. Behavioural: fish showed lower activity, increased feeding time, stayed closer together, and were less explorative. Metabolic: showed general disturbance of cellular function (many cellular changes).	INFERRED	E
Brain damage and behavioural disorders in fish induced by plastic nanoparticles delivered through the food chain	2017	Mattson et al. 2017	TE	PS NPs	Fish/sharks	All	Ingestion Toxicity	PS NPs are transferred through 3 trophic levels, toxic to <i>Daphnia</i> zooplankton and detectable in the brain tissue of fish predators. Changes to fish behaviour at varied concentrations in activity, feeding time & distance swum to food. Effects shown to be from accumulation over time.	INFERRED	E
Evaluation of the impact of polyethylene microbeads ingestion in European sea bass (<i>Dicentrarchus labrax</i>) larvae	2015	Mazurais et al. 2015	TE	PE NPs	Fish/sharks	All	Ingestion Toxicity	At environmentally relevant levels, larval fish shown to ingest PE MP beads show no adverse effects. High egestion rates probable cause although still potential for bioaccumulation of MPs through predation.	INFERRED	E
Drivers and annual estimates of marine wildlife entanglement rates: A long-term case study with Australian fur seals	2015	McIntosh et al. 2015	TE	All – macro	Pinnipeds	All	Entanglement	Long-term entanglement study in Australian fur seals in Vic. Most material is from commercial fisheries. Pups & juveniles more frequently affected & pups entangled more as they approach weaning. A model normalised for survey effort and estimates yearly entanglement rate of ~1% of population.	INFERRED from Vic	E
Threat and Risk Assessment Framework for the NSW Marine Estate	2015	MEMA 2015	S TE, TS, AE, AS, MM	All	NA		Statewide TARA for management	Framework for undertaking the NSW TARA. 5-step decision-making process to ensure that threats to those benefits are efficiently and effectively managed and that management efforts are well targeted at the most significant threats.	KNOWN	E
New South Wales Marine Estate Threat and Risk Assessment Report: Final Report	2017	MEMA 2017	MM	All	NA		Statewide TARA for management	A draft report summarising the threat and risk assessment (TARA) process and outcomes undertaken for the State of NSW by MEMA agencies and independent experts.	KNOWN	E
Are we eating plastic-ingesting fish?	2016	Miranda and Carvalho-Souza 2016	TE TS	MPs	Social Fish & sharks		Toxicity - Bioaccumulation Human ingestion	Ingestion of microplastic by 2 fish spp. commonly consumed by humans (Brazil). 2–6 plastic pellets in the stomachs of king mackerel (62.5% of fish) & Brazilian sharpnose shark (33% of sharks). Bioaccumulation up food chain, including to humans. Further research needed on presence, accumulation levels and rates of transfer across trophic levels.	INFERRED	E R
How leachates from wasted cigarette butts influence aquatic life? A case study on freshwater mussel <i>Anodonta trapesialis</i>	2019	Montalvão et al. 2019	S TE	Cigarette butts	Benthic invertebrates		Biotoxicity	Exposure to environmentally relevant levels of cigarette butt leachate produced mutagenic effects on cells in the haemolymph (blood equivalent) in a freshwater bivalve.	INFERRED from FW spp.	E

Source			Summary and key findings							
Name	Year	Web link	Theme	Debris	Asset	Habitat	Impact pathway	Key findings	MDTARA application	Type
Entanglements of marine mammals and seabirds in central California and the north-west coast of the United States 2001–2005	2009	Moore et al. 2009	S TE	Fishing Balloons General	Cetaceans Pinnipeds Seabirds	Ocean Waters	Entanglement	Entanglement records for marine mammals and seabirds (west coast USA 2001–5). Most frequently common murre, western gulls and Californian sea lions. Entanglement materials primarily fishing-related (could be active or discarded). 40 species (31 bird and 9 marine mammal). Not always able to determine if entanglement was fatal.	INFERRED from OS	E
Litter Costs to the NSW Economy – a preliminary report	2016	MRA Consulting Group 2016	TS	All Litter	Social	Economics	Remediation cost	Over \$167 million estimation of the cost (direct and indirect) of litter in NSW in 2014–15. Over \$70 million is directly attributable to coastal councils. Direct costs are added to extrapolated costs from values that are adjusted for factors such as population or visitation. Uses the time spent by volunteers to approximate a cost per annum and apply a value to litter disamenity.	KNOWN	R & E
Sinking of microbial-associated microplastics in natural waters	2020	Nguyen et al. 2020	S TE	MPs	NA		Debris transport Bioinvasion	Biological accumulation on MPs can affect their size, shape and settling velocity. In some cases additional accumulation decreases sinking (given the nature of the bio content) or slows its rate.	KNOWN	E
Ingestion of marine litter by loggerhead sea turtles, <i>Caretta caretta</i> , in Portuguese continental waters	2016	Nicolau et al. 2016	TE	All majority plastic	Turtle	Ocean waters	Ingestion	Presence of marine litter in loggerhead sea turtle digestive tract (Portugal) was 59%. Plastic main category (56.8%), sheet the main subcategory (45.3%). Most had < 10 items (76.8%) and < 5 g (96.8%).	INFERRED	E
Assessment of microplastic toxicity to embryonic development of the sea urchin <i>Lytechinus variegatus</i> (Echinodermata: Echinoidea)	2015	Nobre 2015	TE	MP plastic pellets	Benthic invertebrates		Toxicity	Virgin MP pellets exposure on sea urchin embryo development show toxicity under all conditions. Beach-stranded pellets had lower toxic effect and only with repeated contaminant from re-suspended sediments. Shows plastic pellets act as a vector of pollutants, especially for additives on virgin particles.	INFERRED	E
Review of information on marine debris in New South Wales	2018	NSW DPIE unpublished	S AE TE & TS	All debris MP	NA	All	Entanglement Ingestion Toxicity Human ingestion	Top 5 littered items from the available NSW-specific data in all coastal habitats. Plastics predominate (91%). The most commonly found litter items in the marine environment are cigarette butts, food and drink packaging (plastics, paper, foam) including straws and hard plastics, plastic bags and fishing-related debris.	KNOWN	R
Cleaning Up Our Act: Redirecting the Future of Plastic in NSW	2020	NSW DPIE 2020	S TE & TS MM	Plastic	NA	All	All envt & social assets Proposed management for plastics	Draft NSW Plastics Plan for discussion – aiming to protect the environment and human health from the impact of plastics, while minimising impacts on consumers and maximising the economic opportunities available. Describes threats posed in NSW and outlines a whole-of-life-cycle plan for management.	KNOWN	R
Plastic debris collars: An underreported stressor in tropical reef fishes	2018	Nunes et al. 2018	TE	Plastic	Fish/sharks	Ocean waters	Entanglement	Plastic debris collar wrapping (PDCW) in tropical reef fishes is an important source of stress and impaired performance, in one case creating deep laceration. Suggests that PDCW, although not instantly fatal, may cause debilitating stress and reductions in swimming, feeding and antipredator behaviour, reducing overall fitness.	INFERRED	E
The Effects of Natural and Anthropogenic Microparticles on Individual Fitness in <i>daphnia magna</i>	2016	Ogonowski et al. 2016	TE	MPs Primary & secondary	Benthic invertebrates	Not defined	Ingestion Toxicity	Lowered feeding and reproduction in zooplankton spp. were observed at high MP levels. Secondary MPs more harmful (more effect) than primary. Secondary MPs increase gut passage time and form aggregates in the gut. At lower concentrations no more impact than the ingestion of natural clay particles.	INFERRED	E
Single and combined effects of microplastics and pyrene on juveniles (0+ group) of the common goby <i>Pomatoschistus microps</i> (Teleostei, Gobiidae)	2013	Oliveira et al. 2013	S TE	MPs	Fish/sharks	Coral Reef Shallow reefs Beach / flats (M & E) Shallow soft sediments (M & E)	Toxicity Bioaccumulation	Effects of MP and pyrene exposure in common goby juveniles. Biomarkers used to determine effects of exposure. Concluded that (1) MPs reduce impacts of pyrene, (2) MPs & pyrene together decrease available energy (could limit fish ability to feed/escape from predators/increase population mortality), and (3) MPs impact neurological function crucial to physiological (e.g. growth, reproduction) and behavioural (e.g. swimming) processes.	INFERRED	E
Coastal margins and backshores represent a major sink for marine debris: insights from a continental-scale analysis	2020	Olivelli et al. 2020	S	All debris	NA	Beach / flats (M & E)	Stressors: coastal area distribution, drivers & size	Assessment of coastal areas as debris sinks in Australia. Analysed spatial distribution of debris from waterline to backshore. Debris distribution is correlated with onshore drift and wind and factors associated with recreational usage. Debris density and size increased with distance inshore and backshore an evident sink and for larger items.	INFERRED (AUS)	E
Impact of accumulated beach litter on <i>Chelonia mydas</i> L. 1758 (green turtle) hatchlings of the Samandag Coast, Hatay, Turkey	2006	Ozdilek et al. 2006	S TE	All	Turtle	Beach / flats (M & E)	Changes to habitats	Beach litter was negatively correlated to the success of green turtle hatchlings trying to reach the sea in Turkey. Not the most influential factor but increase in litter decreases success. Litter is an obstacle for the hatchlings and increases habitat for predatory ghost crabs.	INFERRED from OS	E

Source			Summary and key findings							
Name	Year	Web link	Theme	Debris	Asset	Habitat	Impact pathway	Key findings	MDTARA application	Type
Entanglement of Australian sea lions and New Zealand fur seals in lost fishing gear and other marine debris before and after Government and industry attempts to reduce the problem	2004	Page et al. 2004	TE MM	Plastic mostly fisheries-related	Pinnipeds		Entanglement	Entanglement data of pinnipeds in SA to assess government / fishing industry attempts to reduce impact of fishing on non-target spp. Rates did not decrease & most items came from local fisheries. Australian sea lion entanglement rate (1.3% in 2002) mostly from monofilament gillnet associated with shark fishery. NZ fur seal entanglement rate (0.9% in 2002) mostly items associated with rock lobster & trawl fisheries. In 2004, these were the 3rd & 4th highest entanglement rates for any pinniped spp. No mention of active vs ALDFG. Proposed future interventions – phase-outs, degradable packaging, mandatory uptake of recommended methods/materials, incentives, greater research & monitoring.	INFERRED from SA	E
Investigating the presence of microplastics in demersal sharks of the North-East Atlantic	2020	Parton et al. 2020	SE	MPs	Fish/sharks		Ingestion	67% of sharks contained at least 1 MP particle. Estimated particle burden increased with body size but not systematically with sex or species. Estimated 2 to 7.5 ingested contaminants per animal (4 spp.) MPs majority fibrous (95%) and blue (88%) or black (9%) in colour. Subsample synthetic cellulose (33.3%), PP (25%), PAM (10%) and PES (8.3%). Risk from exposure unknown.	INFERRED	E
Exposure of marine mussels <i>Mytilus</i> spp. to polystyrene microplastics: Toxicity and influence on fluoranthene bioaccumulation	2016	Paul-Pont et al. 2016	TE	PS MPs	Benthic invertebrates	Not defined	Ingestion Toxicity	PS MPs exposure had direct toxic effects at tissue, cellular and molecular levels in a marine mussel. Combined exposure to flouranthene (FLU) & MPs led to higher FLU levels than exposure to FLU alone.	INFERRED to local spp.	E
Analysis and Prevention of Microplastics Pollution in Water: Current Perspectives and Future Directions	2019	Pico and Barcelo 2019	S MM	MPs	NA		Management options for MPs	MP management options including direct prevention (ban use of plastic bags, plastic bottles, etc.), improved recyclability of plastic, increased remediation and removal technologies.	INFERRED	R
Plastic ingestion by sea turtles in Paraíba State, Northeast Brazil	2015	Poli et al. 2015	TE	Plastic: variable types	Turtle		Ingestion	Plastic ingestion of 20.4% in sea turtles off Brazil. Of these 65% green, 25% hawksbill, 10% olive ridley turtles. 85% of plastic in intestines, and fatal complete tract blockage in 65%. Differences between hard and soft ingestion and between white/transparent >> coloured.	INFERRED from OS	E
Uncovering the sub-lethal impacts of plastic ingestion by shearwaters using fatty acid analysis	2019	Puskic et al. 2019	S TE	Plastic	Seabird	Ocean waters	Ingestion	Seabirds have very high plastic ingestion rate which can lead to sublethal impacts such as morbidity and starvation. Describes an analytical tool to measure the impacts using levels of fatty acids (important for metabolic function such as energy storage) in 2 spp. of shearwaters. No effect from sample but significant methodology for future.	INFERRED	E
Entanglement of Steller sea lions (<i>Eumetopias jubatus</i>) in marine debris: Identifying causes and finding solutions	2009	Raum-Suryan et al. 2009	TE MM	Plastic & rubber mostly fisheries-related	Pinnipeds		Entanglement Ingestion	Sea lion entanglement in Alaska/Canada from packing bands (54%), rubber bands (30%), net (7%), rope (7%), & monofilament line (2%). Juveniles and males more frequently entangled. Ingestion commonly from active fishing gear. Suggested prevention measures 'Lose the Loop' education, beach clean-up, monofilament recycling, derelict gear collection, cutting entangling loops of synthetic material and eliminating packing band use.	INFERRED from OS	E
Cigarette Butts as Litter – Toxic as Well as Ugly	2000	Register 2000	S	Cigarette butts	NA		Toxicity	Chemicals leached from discarded cigarette butts present a biohazard to the water flea (<i>Daphnia magna</i>). Concentrations of 0.125 cigarette butts/L are lethal (uncertain of how this relates to environmental levels). Assessed used filters, remnant tobacco, new filters. Used and remnant tobacco acutely toxic. Unsmoked butts only toxic at much higher concentrations.	INFERRED	E
Short-term exposure with high concentrations of pristine microplastic particles leads to immobilisation of <i>Daphnia magna</i>	2016	Rehse et al. 2016	TE	MPs - HDPE	Benthic invertebrates		Ingestion Toxicity	Short-term and high-level exposure of zooplankton to virgin HDPE MPs. Particles are ingested and this results in immobilisation of daphnids at high concentrations.	INFERRED from FW spp.	E
Millimeter-Sized Marine Plastics: A New Pelagic Habitat for Microorganisms and Invertebrates	2014	Reisser et al. 2014	S TE	MPs	Benthic invertebrates Planktonic assemblages	Ocean waters	Bioinvasion Changes to habitat	MPs act as novel pelagic habitat for microorganisms and invertebrates, particularly diatoms and bacteria. They can influence the strength and type of ecological impacts of plastic pollution and observed changes in plastic morphology suggest they impact plastic degradation.	INFERRED	E
As main meal for sperm whales: Plastics debris	2013	de Stephanis et al. 2013		Macro debris	Cetaceans	Ocean waters	Ingestion	Mortality of a sperm whale related to the ingestion of large amounts of marine debris in the Mediterranean, from gastric rupture following impaction with debris, adding to existing starvation problem. Debris types related to local industry in the local whale feeding area.	INFERRED to local populations	E
Impact of derelict fish traps in Caribbean waters: an experimental approach	2014	Renchen et al. 2014	TE	Fish traps	Fish/sharks	Shallow reefs (M) Deep reefs (M)	Entanglement	Impacts of ALD fish traps in the Caribbean are 2% mortality in trapped fishes & high instance of injury from traps. Time in trap has a significant effect on assemblage composition, hence impact of traps will vary over time. Potential management includes trap modification with escape panels & land-based trap disposal programs.	INFERRED from OS	E
Marine Plastic Pollution in Waters around Australia: Characteristics, Concentrations, and Pathways	2013	Reisser et al. 2013	S	Plastic	NA		Stressor: distribution & type	Estimated the mean sea-surface plastic concentration in Australian waters at 4256.4 pieces/km ² using tows. Also inferred pathways using further analysis and estimated concentration considering vertical wind-mixing as more than double 8966.3 pieces/km ² . Higher amounts found close to cities on the east coast. Majority of plastics were MPs, mostly by-products of degradation of larger pieces of PE & PP. Debris composition: hard plastic (75.4%), soft plastic (16.5%) and lines (mostly fishing, 6.4%).	YES (NSW) & INFERRED (Aus)	E

Source			Summary and key findings							
Name	Year	Web link	Theme	Debris	Asset	Habitat	Impact pathway	Key findings	MDTARA application	Type
Quantitative Analysis of Selected Plastics in High-Commercial-Value Australian Seafood by Pyrolysis Gas Chromatography Mass Spectrometry	2020	Ribeiro et al. 2020	TS	PS, PE, PVC, PP, PMMA	Social Fish & sharks Benthic invertebrates		Human ingestion Ingestion	High-value Australian seafood plastic analysis using simple seafood sample analysis method. PS, PE, PVC, PP, PMMA in edible section of oysters, prawns, squid, crabs and sardines. Sardines highest total plastic mass concentration (0.3 mg/g tissue) and squid lowest (0.04 mg/g tissue). Concentrations highly variable within and between spp. Estimates potential plastic ingestion by humans based upon consumption rates.	INFERRED	R
Microplastics effects in <i>Scrobicularia plana</i>	2017	Ribeiro et al. 2017	TE	MPs: PS	Benthic invertebrates		Ingestion Toxicity	PS MPs are up taken by clam gills and digestive gland, where they accumulated and stayed after depuration. Gill tissues more effective response to oxidative stress than digestive gland. Over time, exposure to PS MPs increases genotoxicity and neurotoxicity.	INFERRED to local spp.	E
A quantification of the standing stock of macro-debris in Majuro lagoon and its effect on hard coral communities	2011	Richards and Beger 2011	TE	Macro debris	Benthic invertebrates	Coral reef	Entanglement/ smothering	Macrodebris density in Majuro Lagoon > 234.24 items/km ² . Majority from household sources (78.7%). Abundance changes with affluence. Coral cover decreased as macrodebris cover increased. Debris is persistent and will have long-term effects even if not replenished. Management initiatives are needed to stop waste dumping in the lagoon. Impacts of macrodebris on coral: suffocation, shading, tissue abrasion and mortality.	INFERRED from OS	E
Suspended micro-sized PVC particles impair the performance and decrease survival in the Asian green mussel <i>Perna viridis</i>	2016	Rist et al. 2016	TE	MPs – PVC	Benthic invertebrates		Ingestion Toxicity	Exposure of mussels to PVC MP: 1) impair physiological performance (decreased filtration, respiration and production of filaments for attachment (byssus) 2) longer term exposure (~90 days) decreased survival. Effects are PVC dose dependant.	INFERRED to local spp.	E
Ingested plastic transfers hazardous chemicals to fish and induces hepatic stress	2013	Rochman et al. 2013	S TE	MPs additives pollutants	Fish/sharks	Ocean waters	Ingestion Toxicity	Plastic debris ingestion is a vector for the bioaccumulation of PBT substances in fish; resulting toxicity is from the plastic material and additional sorbed contaminants. Exposed fish suffer liver toxicity and pathology such as hepatic stress (reduced brain function due to liver toxicity).	INFERRED from OS	E
The ecological impacts of marine debris: Unravelling the demonstrated evidence from what is perceived	2015	Rochman et al. 2015	S TE MM	All debris mostly plastic	All assets		All environmental assets	Analysis of perceived and demonstrated impacts of marine debris. Of 366 perceived, 296 were tested (83% demonstrated). 82% of actual due to plastic, majority reporting on suborganismal levels of organisation (89%). Impacts at higher levels were largely due to plastic marine debris.	INFERRED	R
Early warning signs of endocrine disruption in adult fish from the ingestion of polyethylene with and without sorbed chemical pollutants from the marine environment	2014	Rochman et al. 2014	TE	MPs – PA	Fish/sharks		Ingestion Toxicity	Environmentally relevant levels of exposure of adult fish to PE MPs (both virgin and marine treated) resulted in varying alterations of numerous gene expressions. Early warning signs of endocrine disruption.	INFERRED to local spp.	E
Incidence of entanglements with marine debris by northern gannets (<i>Morus bassanus</i>) in the non-breeding grounds	2013	Rodriguez et al. 2013	TE	All	Seabird		Entanglement	Rate of entanglement by a gannet species in non-breeding grounds was 0.93% of all counted. Geographically variable but predominantly immature birds, entanglement in the lower bill mandible and red-coloured plastic objects. 'Plunge diving' fishing behaviour likely the cause of high entanglement.	INFERRED to local spp.	E
Anthropogenic Debris Ingestion by Avifauna in Eastern Australia	2016	Roman et al. 2016	S TE MM	All mostly plastic	Seabird		Ingestion	Seabirds in eastern Australia ingestion in 19 spp., 30% effected. Birds exhibit selectivity and favour certain debris types and colours. Ingestion influenced by taxonomic grouping, habitat, and foraging method. E.g. surface feeding birds ingesting more buoyant litter items and a disproportionate amount of balloons.	KNOWN: north NSW and Lord Howe Island	E
The size of marine debris items ingested and retained by petrels	2019	Roman et al. 2019 (Size and petrel)	S TE	Hard debris sized	Seabird		Ingestion	Seabirds mistake plastic for food; half of petrel spp. ingest debris. In petrels, size of debris scales positively with bird size. 90% of all debris items ingested in study 'danger zone' 2–10mm (fragments < 10 mm most abundant). Therefore petrel spp. particularly vulnerable to ingestion and retention of marine debris.	INFERRED to NSW	E
Is plastic ingestion in birds as toxic as we think? Insights from a plastic feeding experiment	2019	Roman et al. 2019 (Feeding)	TE	Plastic	Seabirds Shorebirds		Ingestion Toxicity	Plastic ingestion causing varied toxicological effects through development. Exposure caused delayed growth and female maturity onset in chicks, development of cysts in males. Lower than expected impacts (particularly in adults) with none on mortality, morbidity or reproductive success.	INFERRED to sea & shore spp.	E
Ecological drivers of marine debris ingestion in Procellariiform Seabirds	2019	Roman et al. 2019 (Ingestion)	TE	Plastic	Seabird	Ocean waters	Ingestion	<i>Procellariiform</i> seabirds group have highest incidence of marine debris ingestion of bird groups. Ecological factors affecting ingestion: taxonomy, foraging method and diet. Combined with debris exposure leads to greatest risk. Family at greatest risk are the storm-petrels (Hydrobatidae and Oceanitidae).	YES & INFERRED other states & NZ	E
A quantitative analysis linking seabird mortality and marine debris ingestion	2019	Roman et al. 2019 (Quantitative)	S TE	All debris	Seabird	All	Ingestion Priority stressors	Seabirds are the group with the highest frequency of marine debris ingestion. Significant relationship between ingested debris and cause of death. Ingestion of a single debris item leads to 20.4% chance of lifetime mortality up to 100% for > 93 items. Obstruction of the gastrointestinal tract is the leading cause of death. Highest risk debris item is balloons (32 x the death risk of ingesting hard plastic).	INFERRED	E
Spatially explicit economic assessment of cultural ecosystem services: Non-extractive recreational uses of the coastal environment related to marine biodiversity	2013	Ruiz-Frau et al. 2013	AS	NA	Social		Reduced economics and business	Monetary valuation of non-extractive uses of marine assets in Wales, UK, is equivalent to extractive value. User survey to estimate usage, expenditure and spatial distribution.	INFERRED from other temperate area	E

Source			Summary and key findings							
Name	Year	Web link	Theme	Debris	Asset	Habitat	Impact pathway	Key findings	MDTARA application	Type
Entanglement of birds in plastics and other synthetic materials	2018	Ryan 2018	S TE	Plastic	Seabird Shorebird		Entanglement management suggestions	Entanglement of birds is underestimated using only published records. Debris types: 83% fishing gear, entangled spp. listed. Mitigation through alternatives to high-risk items, signage and better litter infrastructure.	INFERRED	R
Impacts of plastic ingestion on post-hatchling loggerhead turtles off South Africa	2016	Ryan et al. 2016	TE	Plastic	Turtle	Ocean waters	Ingestion	Plastic ingestion rate of 60% in post-hatchling loggerhead turtles stranded in South Africa. 77% hard plastic fragments, 10% flexible packaging, 8% fibres, 3% pellets. Greater rate of ingestion and diversity of plastic than in 1970s. Favoured blue & white plastic items; clear items under-represented when you consider proportions of macrodebris. Ingested plastic retained for up to 2 months in captivity. Ingestion contributed to the deaths of at least 40% of turtles. Post-hatchlings at higher risk as feeding is still pelagic.	INFERRED from OS	E
Debris ingestion by juvenile marine turtles: An underestimated problem	2015	Santos et al. 2015	TE	All mostly plastic	Turtle	Ocean waters Estuarine waters	Ingestion	70% debris ingestion rate in juvenile green turtles near Brazil. Mean items 47.5/turtle. Mean fatality from debris is 10.7%, higher in estuarine habitats, highly urbanised reef & reef habitats. A small amount of debris (0.5 g) sufficient to block digestive tract and be fatal. Plastic was most of ingested debris, suggesting much might come from plastic bags and food-related items. 87.8% of items from land-based sources; the rest all related to fisheries.	INFERRED from OS	E
Plastic debris collars on juvenile carcharhinid sharks (<i>Rhizoprionodon lalandii</i>) in southwest Atlantic	2002	Sazima et al. 2002	TE	Plastic collar shapes	Fish/sharks	Ocean waters	Entanglement	Juvenile shallow-water sharks entangled in plastic debris: rings caused serious abrasion with subsequent likely decrease in feeding and/or ventilation. Rings likely fishing- or boating-related, common in shallower waters.	INFERRED from OS	E
To Eat or Not to Eat: Debris Selectivity by Marine Turtles	2012	Schuyler et al. 2012	TE	All Plastic Balloons	Turtle	Estuarine waters	Ingestion	Debris ingestion in turtles varies by size class. Rates of 54% for small, oceanic feeders (low selectivity for rubber (balloons) and 25% in large, benthic feeders (selecting for soft, clear plastic – i.e. jellyfish). Almost 90% of ingested items were plastic. Modelled debris availability from beach surveys.	INFERRED from Qld	E
Mistaken identity? Visual similarities of marine debris to natural prey items of sea turtles	2014	Schuyler et al. 2014	TE	Plastic	Turtle	Ocean waters	Ingestion	Shows that sea turtles ingest plastic because of its resemblance to jellyfish, a common prey item. Feeding is driven by visual recognition and turtles are selective in what they eat.	INFERRED	E
Risk analysis reveals global hotspots for marine debris ingestion by sea turtles	2015	Schuyler et al. 2015	TE	Plastic	Turtle	Ocean waters	Ingestion	Debris mapping & turtle distribution define EXPOSURE. Necropsy data for CONSEQUENCE. Risk assessment includes these & life stage, spp. & stranding date. Life stage best predictor of ingestion, others are spp., debris close to home & debris loads when ingested. World turtle risk maps combines all spp. Australia is one of the highest risk areas.	INFERRED from Aus & worldwide	E R
Economic incentives reduce plastic inputs to the ocean	2018	Schuyler et al. 2018	S MM	Beverage containers	NA		Management effectiveness	Coastal debris surveys in states with and without CDL in Australia and US. States with CDL had approx. 40% lower CDL proportion in coastal surveys than states without. Socioeconomic status proportionate to both reduction in CDS & to littering behaviour. Strong evidence that state CDL reduces leakage to environment.	INFERRED – Aus	R
Detection of Various Microplastics in Human Stool	2019	Schwabl et al. 2019	TS	MP	Social	Health	Human health (ingestion)	Evidence of MPs in human stool of all participants. Although a limited study it implies accidental human ingestion of MPs. 9 plastic types suggesting a variety of sources; PP & PET most common. Mean density 20 particles/10 g stool. Potential effects still being investigated but could include (similar to other animals) translocation to tissues / adsorption from the gastro. tract.	YES	E
Sea Country – an Indigenous perspective, The South-east Regional Marine Plan Assessment Report	2002	National Oceans Office 2002	AS & TS MM	All	Social	Intrinsic value	Loss of intrinsic value Cultural heritage	Description of the Indigenous cultural heritage, rights, uses and opportunities in the coastal areas of south-east Australia. Summary also for the south coast of NSW.	KNOWN	E
Anthropogenic effects on the smalltooth sawfish (<i>Pristis pectinata</i>) in the United States	2006	Seitz and Poulakis 2006	TE	All	Fish/sharks	Ocean waters Estuarine waters	Entanglement	Endangered sawfish entangled in marine debris in USA: monofilament and other lines, rope, PVC pipe, elastic band, coffee can. Most acting as a collar or encircling the saw area and causing injury. Entanglement and injuries likely to impact feeding.	INFERRED to local spp.	E
Global Review of Beach Debris Monitoring and Future Recommendations	2019	Serra Goncalves et al. 2019	S MM	All debris	NA	Beach / flats (M & E)	Stressor: distribution & type	Global review of beach debris surveys and suggestions for the future standardisation of methods, reporting and metrics. Of all studies, issues prevented comparison due to debris density metrics (27%), lack of date data (9.8%) and lack of size data (19.5%). The proportion of plastic in all studies was 70.1%.	INFERRED	R
Toxicity of cigarette butts, and their chemical components, to marine and freshwater fish	2011	Slaughter et al. 2011	S TE	Cigarette butts	Fish/sharks		Toxicity	Cigarette-butt-derived leachate acutely toxic in 2 fish spp.: marine topsmelt (<i>Atherinops affinis</i>) and & freshwater minnow (<i>Pimephales promelas</i>). Leachate toxicity highest from smoked cigarette butts (smoked filter + tobacco), then smoked cigarette filters (no tobacco) and lowest in unsmoked cigarette filters (no tobacco) – although still toxic at higher concentrations.	INFERRED to local spp.	
Documenting the Density of Subtidal Marine Debris Across Multiple Marine and Coastal Habitats	2014	Smith and Edgar 2014	S AE MM	All debris	Benthic invertebrates	All subtidal	Stressor: distribution & type	Subtidal habitat debris surveys in NSW. Debris composition was 33% plastic & 27% fishing line (monofilament). Debris types: 38% fishing (plus more indirect from fishing e.g. food/drink from fishers) & 27% food & bev. Debris distribution: significantly higher loads in estuaries and bays; ease of access and in situ deposition strong contributors. Debris threats: demonstrated association between monofilament entanglement and the morbidity and mortality of coral and other sessile invertebrates.	KNOWN	E

Source			Summary and key findings							
Name	Year	Web link	Theme	Debris	Asset	Habitat	Impact pathway	Key findings	MDTARA application	Type
Monitoring the sea change: Preliminary assessment of the conservation value of nearshore reefs, and existing impacts, in a high-growth, coastal region of subtropical eastern Australia	2008	Smith et al. 2008	S TE	All debris Fishing a majority	Fish/sharks Benthic invertebrates	Coral reef Shallow reefs (M) Deep reefs (M)	Entanglement	Offshore reef surveys in north NSW, with debris surveys undertaken. Significant difference between one of the sites and the others; fishing-related debris the most prevalent at all locations (35–61%) and over 50% was entangled around coral. Non-fishing-related plastics were at all locations (15–18% of debris load).	KNOWN	E
Biodegradable and Petroleum-Based Microplastics Do Not Differ in Their Ingestion and Excretion but in Their Biological Effects in a Freshwater Invertebrate <i>Gammarus fossarum</i>	2017	Straub et al. 2017	TE	MPs PHB & PMMA (biodegradable)	Benthic invertebrates	Estuarine waters	Ingestion Toxicity	Freshwater amphipod exposed to biodegradable (PMMA) MPs and petroleum-based (PHB) MPs showed ready ingestion and excretion of both types although less than exposure to natural particles. PHB led to less assimilation of food energy than PMMA, but weight gain was lower in both MP treatments. Management implications of the unknown comparison of biodegradable products to plastics.	INFERRED from FW to marine spp.	E
Microplastics and the Impact of Plastic on Wildlife: A Literature Review	2020	Susanti 2020	SE	MPs	Seabirds		Ingestion	MPs can be primary or secondary and of the following types: fragments, pellets, fibre, plastic film, foamed plastic and styrofoam. The impact of the plastics and microplastics in seabirds are reproductive problems, malnutrition and death.	INFERRED	R
Oyster reproduction is affected by exposure to polystyrene microplastics	2016	Sussarellu et al. 2016	TE	MPs	Benthic invertebrates		Ingestion Toxicity	Exposure to PS MPs particles in oysters was shown to affect energy uptake and allocation, reproduction and offspring performance. Higher food intake and digestion to compensate for MP in gut. Lower energy levels meant energy spent on reproduction was redirected for maintenance and growth. Resulting in lower reproductive output and success of offspring.	INFERRED to local spp.	E
Marine Estate Community Survey – Final Report	2014	Sweeney Research 2014	AS TS	NA	Social	All	All envt, social & economic	Summary of the benefits, threats and opportunities for the environmental, social and economic values of and benefits derived from the NSW Marine Estate, from a community survey with NSW residents.	KNOWN	E
Spatial and temporal variations in debris accumulation and composition on an estuarine shoreline, Cliffwood Beach, New Jersey, USA	1998	Thornton and Jackson 1998	S	All	NA	Beach / flats (M & E)	Stressor: distribution & type in estuaries	Field study of cross-shore debris accumulation of a sandy estuarine shoreline. Debris composition was 42.5% plastic and 29.3% glass, mostly consumer/household items and increased with beach usage. Cross-shore spatial distribution reflects wind/wave processes. Upper, wind-dominated areas led to more small, lightweight debris, with higher plastic content in dune and backbeach areas particularly after onshore winds. Lower, wave-dominated areas tended to heavier debris, more glass as lower transport.	INFERRED	E
Microplastics on beaches: ingestion and behavioural consequences for beach hoppers	2016	Tosetto et al. 2016	TE	MPs	Fish/sharks	Not defined	Ingestion Toxicity	Beachhoppers exposed to MPs readily ingested and accumulated them. MPs shown to affect survival via reduced jump height and an increase in weight. MPs adsorbed contaminants in sea water from Sydney Harbour which slightly transferred to beachhoppers but faded after time (48 h). Longer exposure (120 h) led to high mortality.	YES – NSW Sydney Harbour	E
Is marine debris ingestion still a problem for the coastal marine biota of southern Brazil?	2010	Tourinho et al. 2010	TE	All: mostly plastic	Turtle Seabirds Shorebirds		Ingestion	Marine debris ingestion by 100% of green sea turtles (southern Brazil coast) was mainly plastic and located in intestine. Overall seabirds showed 40% ingestion rate but variable by order (66% albatrosses/petrels (Procellariiformes), 22% penguins (Sphenisciformes), 0% shorebirds (Charadriiformes). Mainly plastic.	INFERRED	E
Beach Condition and Marine Debris: New Hurdles for Sea Turtle Hatchling Survival	2012	Triessnig et al. 2012		Plastic bottles styrofoam Cups plastic cannister fishing nets	Turtle	Beach / flats (M & E)	Entanglement	Sea turtle hatchlings dash significantly impaired by marine debris entanglement (fishing line/net) and entrapment (cups & cannisters.) 2 out of 3 unsuccessful due to debris (in experiment). Hatchlings do not actively avoid debris, maintained their direction of movement, and escape was limited. Management of nesting areas should focus on removal of debris before hatching.	INFERRED	E
Quantifying local coastal stewardship reveals motivations, models and engagement strategies	2020	Turnbull et al. 2020	TS AS	NA	Social		Social	UNSW (2018–20) investigating the values and perceptions of coastal users in NSW, Vic, Tas, SA, WA. Semi-structured interviews of representative mix of coastal users. Covered social and ecological values: perceptions of place, marine life, protection and stewardship.	YES	E
A new Paradigm for Social License as a Path to Marine Sustainability	2020	Uffman-Kirsch et al. 2020	AS MM	NA	All social			Stakeholders and public due a 'social licence to operate' given oceans are public assets which governments are responsible for managing now and in future. Stakeholders driven for mutual agreement even when values diverge. Informed and empowered public engagement management by government leading to socially legitimate and environmentally acceptable decisions.	INFERRED	R
Marine debris impacts to a tidal fringing-marsh in North Carolina	2011	Uhrin and Schellinger 2011	S TE	Macro debris	NA	Saltmarsh	Changes to habitats	Assessed damage to saltmarsh vegetation (<i>Spartina alterniflora</i>) by different debris types, & duration, and monitored recovery post-removal. Debris leads to shading, crushing, blocked substrate, and affects vegetation zonation. Tyres caused an immediate and long-term impact. Crab-pot impacts were not as abrupt and recovery was short term (< 10 months). Management would benefit from the inclusion of habitat information to focus removal.	INFERRED from OS	E
Marine Litter Vital Graphics	2016	UNEP 2016	S, TE & TS, MM	All debris	All assets		All envt, some social threats	Multiple conceptual models and global summary of the marine debris issue. Full suite of conceptual models pertaining to all aspects of marine debris, microplastics, etc.	INFERRED from global	R

Source			Summary and key findings							
Name	Year	Web link	Theme	Debris	Asset	Habitat	Impact pathway	Key findings	MDTARA application	Type
The impact of plastic debris on the biota of tidal flats in Ambon Bay (Eastern Indonesia)	1997	Uneputtu and Evans 1997	S TE	Macro debris > 10 mm diameter or length	Benthic invertebrates	Beach / flats (M & E)	Smothering Changes to habitats & assemblages	Compared assemblages of meiofauna, macrofauna and diatoms beneath litter and in litter-free areas of Ambon Bay (Indonesia). Meiofauna abundance increased beneath litter (large numbers of polychaetes, nematodes, protozoa, copepods and turbellarians). Macrofauna abundance was not sig. different but assemblages differed. (Littered: decapod crustaceans and oligochaetes dominant, and for non-littered nereid and spionid polychaetes.) Diatom densities increased but no change to assemblages. Debris assessments made for floating, sublittoral and littoral zones.	INFERRED from OS	E
Cultural Ecosystem Services, in Leal Filho W, Azul AM, Brandli L, Özuyar PG and Wall T (eds)	2019	Vasiljevic Gavrilovic 2019	AS	NA	Social		All social	Defining 'cultural ecosystem services' as 'non-material benefits that people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experience'. Tangible and intangible. Crucial for spatial and value analysis of ecosystems and their management.	INFERRED	R
Marine turtle threats in Uruguayan waters: insights from 12 years of stranding data	2013	Velez-Rubio et al. 2013	TE	All	Turtle	Ocean waters	Ingestion	Stranding data provides indirect evidence of threats to marine turtles in the south-west Atlantic Ocean. Marine debris identified as a principal threat. Documented fatality in green turtles from marine debris ingestion, plus smaller sizes of animals found infers debris is a more important threat for juvenile green turtles. Debris could be from long-term accumulation. Green turtles COD marine debris obstruction in digestive tract was ~ 38%. Of all greens this was < 8%. Seems to effect smaller turtles than other CODs.	INFERRED from OS	E
Global research priorities to mitigate plastic pollution impacts on marine wildlife	2014	Vegter et al. 2014	MM	All	All assets	All	All	Expert elicitation of priority research questions into marine debris (16) addressing: impacts at various levels (environmental & socioeconomic), quantification, stressors, sources, movement, standardisation, costs, alternatives. Suggested research be at scales relevant to management, interdisciplinary, partnered with management.	YES	R
Pathway analysis of systemic transcriptome responses to injected polystyrene particles in zebrafish larvae	2017	Veneman et al. 2017	TE	PS MPs	Fish/sharks larval		Ingestion Toxicity	Impact of PS MPs varied on zebrafish embryos at different development stages. MP movement is different for different larval stages: some redistribution, some not. Systemic response. Activated biological pathways related to an immune response.	INFERRED	E
Sources and sinks of plastic debris in estuaries: A conceptual model integrating biological, physical and chemical distribution mechanisms	2016	Vermeiren et al. 2016	S TE MM	All debris	NA	Estuarine waters	Stressors: distribution & drivers in estuaries	Conceptual models of local and estuary-wide sources, sinks and the transport of plastics. Source-sink patterns vary among estuary types and with local-scale processes. Key factors include: (large scale) relative fresh vs saltwater flow, MP and macro input; (local scale) wind, waves, erosion, biological interactions. The different properties of plastics, such as shape, polymer type and density greatly impact distribution.	INFERRED	R
Uptake and effects of microplastics on cells and tissue of the blue mussel <i>Mytilus edulis</i> L. after an experimental exposure	2012	von Moos et al. 2012	S TE	MP – HDPE	Benthic invertebrates		Ingestion Toxicity	MP HDPE (no additives) is ingested and taken up by the blue mussel <i>Mytilus edulis</i> L. (sibling spp. to the one present in Australia). The filter feeders caught larger particles and ingested them to the digestive system; smaller particles got directly into gills. Effects of ingestion and exposure observed at the cellular and subcellular level with notable tissue changes and a strong inflammatory response.	INFERRED from sibling spp.	E
The use of plastic debris as nesting material by a colonial seabird and associated entanglement mortality	2011	Votier et al. 2011	TE	All: mostly plastic rope	Seabird		Entanglement	Plastics used as nesting material by northern gannets in a colony, with ~470 g of plastic in the average nest, became entangled on bird. Material used mostly plastic rope; seems to be chosen preferentially. Mean > 62 birds entangled/year, majority (mean ~90%/year). Although mortality high (max 0.4% of fledglings), unlikely to have population-level effects as not effecting many adults.	INFERRED to local spp.	E
Social and Economic Evaluation of NSW Coastal Professional Wild-Catch Fisheries – Valuing Coastal Fisheries	2016	Voyer et al. 2016	AE AS	NA	Social	Economics	Loss of economic worth	NSW professional fishing has a gross value of production (GVP) of \$81.7 m. It provides significant benefits to tourism, recreational fisheries, local food security, community and cultural heritage. 67% of coastal NSW public believe the industry can be trusted to act in a sustainable manner and 72% support its continuation.	KNOWN	R
Entanglement of Antarctic fur seals at Bird Island, South Georgia	2013	Waluda and Staniland 2013	TE MM	All: mostly fishing-related	Pinnipeds		Entanglement	Antarctic fur seals (South Georgia) entangled in plastic packaging bands (43%), synthetic line (25%) or fishing net (17%). Juvenile males most commonly entangled (44%). A significant decrease in entanglements since 1994, coincides with a ban on fishing without a licence within 200 miles of site in 1993, showing that legislation imposed by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) has, to a certain extent, been effective.	INFERRED to local spp.	E
Effect of Microplastic on the Gills of the Shore Crab <i>Carcinus maenas</i>	2016	Watts et al. 2016	TE	MPs PS	Benthic invertebrates	Rocky shores (M & E) Beach / flats (M & E)	Ingestion/ Inhalation	MP (sphere) uptake to crab gills reduced oxygen consumption and altered ion regulation after 1 hour (dose dependant) although recovery was complete after 16 hours. Exposure had no impact on crab function in low salinity. Shore crabs resilient to acute exposure of MPs.	INFERRED to local spp. but pest spp. in NSW	E
Effects of prolonged entanglement in discarded fishing gear with substantive biofouling on the health and behaviour of an adult shortfin mako shark, <i>Isurus oxyrinchus</i>	2012	Wegner and Cartamil 2012	S TE	Rope	Fish/sharks	Ocean waters	Entanglement	Effects of prolonged entanglement in discarded fishing gear on adult shortfin mako shark, <i>Isurus oxyrinchus</i> , are deep abrasions, scoliosis/deformation, constriction of gills/mouth & increased drag, likely to cause decreased swimming & feeding efficiency and undernourishment.	INFERRED but local spp.	E

Source			Summary and key findings							
Name	Year	Web link	Theme	Debris	Asset	Habitat	Impact pathway	Key findings	MDTARA application	Type
Long-term microplastic retention causes reduced body condition in the langoustine, <i>Nephrops norvegicus</i>	2016	Welden and Cowie 2016	TE	MP: PP fibres	Benthic invertebrates		Ingestion Toxicity	Extended (over 8 months) exposure of benthic crustacean (commercially significant lobster) to PP fibres leads to MP aggregations. These reduce nutritional health. MPs lower growth rates lead to loss of body mass (similar to starved lobsters) and reduce nutrient uptake causing metabolic depression.	INFERRED to local spp.	E
Turn Back the Toxic Tide: Threat Abatement Plan: Marine Plastic Pollution – Draft	2016	West 2016	S TE & TS MM	ALL	NA	All	All envt social & economic	Threat abatement plan from the Boomerang Alliance – a comprehensive summary of the marine plastic pollution (MPP) issue in Australia to promote effective and coordinated action to mitigate MPP impacts. Covers all facets such as types, distribution, composition, impacts, threats, community expectations, priority actions, research summary and recommended actions.	INFERRED – Aus	R
Ghostnet impacts on globally threatened turtles, a spatial risk analysis for northern Australia	2013	Wilcox et al. 2013 (Ghost net)	S TE MM	Ghost nets	Turtle	Ocean waters	Entanglement	Threat to turtles from ghost nets modelled using spp. distribution, ocean drift & onshore ghost-net density. Predicts high risk areas and areas for interception of nets.	INFERRED from Aus	E
Using expert elicitation to estimate the impacts of plastic pollution on marine wildlife	2016	Wilcox et al. 2016 (Expert elic.)	S TE	All	Cetaceans Pinnipeds Seabirds Turtles	Ocean waters	Entanglement Ingestion Toxicity	Expert elicitation to assess ecological threat (severity & likelihood of impact) of debris on seabirds, sea turtles and marine mammals. Items posing largest risk by stressor: entanglement (fishing-related gear, balloons, plastic bags); ingestion (plastic bags, utensils). Both impact similar spp. numbers but entanglement more lethal. Contamination lower risk as impacts fewer spp. and non-lethally.	INFERRED	E R
A quantitative analysis linking sea turtle mortality and plastic debris ingestion	2018	Wilcox et al. 2018	TE	Plastic	Turtle		Ingestion	Less plastic in gut of turtles who died of known causes than of those who died of not-known causes or from plastic ingestion. 50% probability of mortality once 14 plastic pieces in gut. Higher plastic concentration in gastroint. tract led to a higher probability of mortality.	INFERRED from Qld	E
Threat of plastic pollution to seabirds is global, pervasive and increasing	2015	Wilcox et al. 2015	TE	Plastic	Seabird	Ocean waters	Ingestion	Created a model to predict ingestion risk in seabird spp. using 1) published data on plastic ingestion in seabirds, 2) predicted debris distribution, 3) seabird spp. High impact in bird hotspots not debris hotspots. Prediction that plastic ingestion will increase and be at 99% of spp. by 2050.	INFERRED worldwide	R
Differentiating littering, urban runoff and marine transport as sources of marine debris in coastal and estuarine environments	2017	Willis et al. 2017	S MM	All	NA	Beach / flats (M & E)	Stressors: distribution in estuaries	Analysis of sources of debris in surveys in Tas open coast and in estuaries: 1) direct deposition, 2) stormwater drains and coastal runoff, 3) onshore transport. Onshore transport was shown to be most important mechanism. Suggests most debris is deposited locally, and local interventions could be effective for reducing debris inputs.	INFERRED	E
Gladstone Region Shoreline Debris Survey: Final Report	2014	Gladstone Regional Council Website	S TE MM	All debris most fishing	NA	Beach / flats (M & E)	Debris management	Monitoring success of fishing line bins in Qld. Bins were in part successful at removing a proportion of fishing debris. High variability over time in overall litter amounts.	INFERRED	E
Microplastic ingestion decreases energy reserves in marine worms	2013	Wright et al. 2013	S TE	MP – UPVC	Benthic invertebrates	Shallow soft sediments (M & E)	Ingestion	At environmental levels, UPVC exposure in lugworms (<i>Arenicola marina</i>) significantly reduced feeding activity. Onflow effects could include less bioturbation and less oxygenation of the sediment, crucial for maintaining infaunal diversity. Exposure led to an inflammatory response and reduction in total available of energy reserves, which compromises repair, growth, maturation and reproduction. Exposure led to increased gut residence times implying MPs are being retained and extensively digested, draining energy.	INFERRED to similar species of lug/beach worms	E
Bioaccumulation and biological effects of cigarette litter in marine worms	2015	Wright et al. 2015	S TE	Cigarette litter	Benthic invertebrates		Biotoxicity	Impacts of smoked cigarette filter toxicants and microfibres on the polychaete worm <i>Hediste diversicolor</i> (ragworm). Toxicants in sea water (levels environmentally relevant) led to longer burrowing times, weight loss & DNA damage. Toxicants in marine sediment showed no significant effects. Hence high vulnerability of organisms in the water column to smoking debris.	INFERRED	E
No plastic in nature: Assessing plastic ingestion from nature to people	2019	WWF 2019	TS	MPs	Social	Health	Health Human ingestion	Summary of the under-researched field of impacts of human MP ingestion. Significant potential for health risks from sources such as sea salt and shellfish, consumption of common food and beverages. An estimated weekly ingestion of approx. 5 grams of plastic.		R
Kelp Gulls (<i>Larus dominicanus</i>) killed and injured by discarded monofilament lines at a marine recreational fishery in northern Patagonia	2014	Yorio et al. 2014	TE	All: mostly rec-fishing-related	Seabird	Beach / flats (M & E)	Entanglement	Kelp gull entanglement within a major shore-based recreational fishery (SW Atlantic). 55% of debris is recreational-fishing based, mostly monofilament line (density of 40.5 items/km). Other debris often indirect from fishers (but not gear). Entanglements occurring within colony boundaries (high impact). Management options include monitoring, recycling & public awareness.	INFERRED to local spp.	E
Additional references provided by experts in the elicitation process										
Plastic ingestion by fish: A global assessment	2019	Azevedo-Santos et al. 2019	S TE	Plastic	Fish/sharks	All	Ingestion	Review of literature of plastic ingestion in fish. 108 studies, 427 spp. Global evidence, underreported. Assessment by habitat, trophic guild, ecosystem, all plastic sizes.	YES & INFERRED	R

Source			Summary and key findings							
Name	Year	Web link	Theme	Debris	Asset	Habitat	Impact pathway	Key findings	MDTARA application	Type
Breeding seabirds as vectors of microplastics from sea to land: Evidence from colonies in Arctic Canada	2021	Bourdages et al. 2021	S	MPs	Seabird	Ocean waters Estuarine waters Saltmarsh Mangrove Rocky shores (M & E)	Sources of plastic pollution	2 spp. of colonial seabirds found to be vectors of plastic pollution in the Arctic. Hotspots in colonies of birds. Used guano and population surveys to estimate total particles deposited.	INFERRED	E
Tsunami-driven rafting: Transoceanic species dispersal and implications for marine biogeography	2017	Carlton et al. 2017	S TE	Plastic buoyant	All assets	Ocean waters	Bioinvasion	Japanese tsunami marine debris travelled to USA and others (up to > 7,000 km). Living species continued to arrive after nearly 6 years at sea. Minimum of 289 spp. never arrived before: macroinvertebrates (235), fish (2), microinvertebrates (33), protists (19). Mean per-capita richness/object consistent over time – hence risk of invasion maintained over time.	INFERRED	E
Turning microplastics into nanoplastic through digestive fragmentation by Antarctic krill	2018	Dawson et al. 2018	TE	MPs & NPs	Benthic invertebrates	Ocean waters	Ingestion Source of nanoplastics	Antarctic krill can fragment PE microbeads (down to nanoplastics) by ingestion, reducing particle size by an average of 78%. Fragments small enough to cross physical barriers or be egested to the environment as nanoparticles. Shows a role in biogeochemical cycling and the fate of plastic.	INFERRED	E
A meta-analysis of the effects of exposure to microplastics on fish and aquatic invertebrates	2018	Foley et al. 2018	TE	MPs	Fish/sharks Benthic invertebrates	All	Ingestion	Meta-analysis of literature on MP exposure impacts on consumption, growth, reproduction and survival of fish/aquatic invertebrates. Highly variable across taxa, few trends. Most consistent was reduced prey consumption when MPs present. Strongest effects lower in food web. Zooplankton are among the most susceptible. MP effects might be more subtle.	INFERRED	R
Impacts of Micro- and Nano-Sized Plastic Particles on Benthic Invertebrates: A Literature Review and Gap Analysis	2019	Haegerbaeumer et al. 2019	S TE	MPs NPs	Benthic invertebrates	Deep soft sediments (M) Beach / flats (M & E) Shallow soft sediments (M & E)	Ingestion Toxicity Bioinvasion	Benthic fauna at high risk of impact as biofouling settles MPs in sediments. Comprehensive lit. review of ecotoxicological impact of micro- and nano-sized plastics on benthic invertebrates. Impacts vary by spp., plastic type and chemical exposure but include huge array of ecotoxicological effects. Suggests future standardisation of concentrations, conditions, use of 'natural' particles and nanoparticles.	INFERRED	R
Plastic ingestion by marine fish in the wild	2020	Markic et al. 2020	TE	Plastic	Fish/sharks	All	Ingestion	Plastic ingestion in 65% fish spp. examined and 67% of commercial spp. Review assesses methods used and recommends methods to use to decrease current underreporting of ingestion e.g. chemical digestion method.	INFERRED	R
Evidence for a Novel Marine Harmful Algal Bloom: Cyanotoxin (Microcystin) Transfer from Land to Sea Otters	2010	Miller et al. 2010	TE	NA	Marine mammal	Ocean waters Estuarine waters	Ingestion Bioaccumulation	Evidence of trophic transfer of toxins through marine invertebrates to apex predator (marine mammal). Bioaccumulation of toxins in inverts. (107 x environmental levels). Land-sea interface delivering toxins to marine environment.	INFERRED	E
Bioaccumulation and biomagnification of microplastics in marine organisms: A review and meta-analysis of current data	2020	Miller et al. 2020	S TE	MPs	All assets	All	Bioaccumulation Biomagnification	Systematic lit. review; evidence of bioaccumulation and biomagnification of MPs and chemical additives. MP bioaccumulation occurs within trophic levels with bioaccumulation of chemical additives also detailed. No clear sign of MP biomagnification in situ observed at higher trophic levels.	INFERRED	R
Migrating humpback whales show no detectable response to whale alarms off Sydney, Australia	2016	Pirodda et al. 2016	TE	Fishing gear	Cetaceans	Ocean waters	Entanglement	Entanglement of cetaceans in fishing gear causes injury and death. Threatens the recovery of endangered species. Acoustic alarms to deter animals was not effective. Impact of fishing gear active vs debris was not differentiated.	INFERRED	E
Garbage in guano? Microplastic debris found in faecal precursors of seabirds known to ingest plastics	2018	Provencher et al. 2018	TE	MPs	Seabird	Rocky shores (M & E)	Ingestion Bioaccumulation	Seabirds are acting as vectors of microplastics and debris in the marine environment where their guano accumulates around their colonies. MPs in 47% of faecal precursor (surrogate for guano) samples from northern fulmars. 93% microfibers. Different to stomach samples.	INFERRED	E
Ingestion and transfer of microplastics in the planktonic food web	2014	Setälä et al. 2014	S TE	MPs microspheres	Benthic invertebrates	Ocean waters Estuarine waters	Ingestion Bioaccumulation Food-web transfer	Potential of zooplankton taxa to ingest PS MSs. Ingestion in all taxa; mysid shrimps, copepods, cladocerans, rotifers, polychaete larvae and ciliates. Highest % in pelagic polychaete larvae. Demonstrated food-web transfer of MPs from one trophic level (mesozooplankton) to a higher level (macrozooplankton) between zooplankton with ingested PS MS and mysid shrimps.	INFERRED	E
Seasonal ingestion of anthropogenic debris in an urban population of gulls	2020	Stewart et al. 2020	S TE	All	Seabird	Estuarine waters	Ingestion Debris distribution/ sources	Pacific gull ingestion of debris/litter assessed from boluses (regurgitated pellets) in Tasmania. Debris in 92.51%, major types: plastic (86.63%) and glass (64.71%). Many intact; household items suggest gulls feed at landfill sites. Gulls are a vector of debris from landfill (urban) to wetland (roosting area).	INFERRED	E

1.3 Abbreviations and definitions

Table 3 Abbreviations, acronyms, initialisms and definitions of terms used in the key findings summary from the MDTARA literature review catalogue (Table 2)

Term	Definition
Themes	
S	Stressor
TE	Threat – environmental
TS	Threat – social
AE	Asset – environmental
AS	Asset – social
MM	Management
Study types	
E	Empirical
R	Review
S	Summary
Habitats	
M	Marine
E	Estuarine
Other acronyms, abbreviations, initialisms and definitions	
Active fishing gear	Fishing gear actively being used – as distinct from ghost gear or marine debris that has been deliberately or accidentally discarded, disposed of or abandoned.
ALD	Abandoned, lost or otherwise discarded
ALDFG	Abandoned, lost or otherwise discarded fishing gear
AO	Adverse outcome
AOP	Adverse outcome pathway
BPA	Bisphenol A
CDL	Container deposit laws/legislation
CDS	Container deposit scheme
COD	Cause/causes of death
DEHP	Diethylhexyl phthalate
Envt	Environmental
FLU	Flouranthene
FW	Freshwater
HDPE	High-density polyethylene
LDPE	Low-density polyethylene

Term	Definition
Marine debris	Any persistent, manufactured or processed solid material made or used by humans and either deliberately or accidentally discarded, disposed of or abandoned in the marine and coastal environment (UNEP 2009).
MP	Microplastic
MPP	Marine plastic pollution
MS	Microspheres
NP	Nanoplastic
NPGS	North Pacific Subtropical Gyre
PA	Polyamide
PAM	Polyacrylamides
PBT	Persistent, bioaccumulative and toxic
PC	Polycarbonate
PCBs	Polychlorinated biphenyls
PDCW	Plastic debris collar wrapping
PE	Polyethylene
PES	Polyester
PET	Polyethylene terephthalate
PHB	Polyhydroxybutyrate – petroleum-based plastic
Plastisphere	Ecosystems that have evolved to live in human-made plastic environments
PMMA	Polymethyl methacrylate
POPs	Persistent organic pollutants
PP	Polypropylene
PS	Polystyrene
PS-COOH	Polystyrene (monocarboxy terminated)
PS-NH ₂	Polystyrene (amine terminated)
PVC	Polyvinyl chloride
SST	Sea surface temperature
SUP	Single-use plastic
UPVC	Unplasticised polyvinyl chloride

References

References below are those identified outside the MDTARA literature review catalogue table (Table 2).

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